LAKE ROOSEVELT FISHERIES AND LIMNOLOGICAL RESEARCH

1995 ANNUAL REPORT

Prepared by:

Keith D. Underwood

and

John P. Shields

Department of Natural Resources
Spokane Tribe of Indians
Wellpinit, WA 99040

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
P. 0. Box 3621
Portland, OR 97208-3621

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EXECUTIVE SUMMARY

This document contains three 1995 annual reports, organized by sections. The first section contains the Lake Roosevelt Data Collection Project (BPA Contract No. 94BI32148; Project No. 94-043) report The second section contains the Lake Roosevelt Monitoring Program (BPA Contract No. DES 179-88DP918 19; Project No. 88-63) report, and the third section contains the Kokanee Salmon Imprinting (BPA Contract No. DE8179-88DP91819; Project No. 88-63) report.

These three projects were interdependent upon one another for data collection and interpretation. As a result, we combined the three annual reports in to one document in order to provide the reader with all aspects of the related analysis. Each section includes an abstract, introduction, methods, results, discussion, recommendations, references and appendices. In each discussion section, we have attempted to relate the results of the studies to existing knowledge, and speculate on management recommendations.

Section 1 discusses the Data Collection Project which was concerned with the effect of lake operations on the biota. This project was started in 1991 and was funded through the Systems Operation Review process that sought to develop an operational scenario of the Federal Columbia River Hydropower System which minimized the impacts of licensed river operations to all stakeholders of the Columbia River. The objective of the Data Collection Project was to build a biological model of the lake to predict how lake operations impact the biota of the lake. The goals of this project were to:

1. Quantify the impact of reservoir drawdowns and low water retention times on phytoplankton, zooplankton and fish;

2. Quantify the number, distribution, and use of fish food organisms in the reservoir by season;

3. Determine the seasonal growth of fish species as related to reservoir operations, prey abundance, and utilization; and

4. Quantification of entrainment levels of zooplankton and fish as related to reservoir operations and water retention times.

Limnological, reservoir operation, zooplankton, net-pen rainbow trout and kokanee tagging data were collected at up to eleven index stations in Lake Roosevelt, The 1995 results indicated that the reservoir reached a yearly low of 1,259 feet above sea level in March and a yearly high of 1,287 feet in December, with a mean yearly reservoir elevation of 1,277 feet. Water retention times ranged from 32 days in December to 69 days in September.

Duphnia spp. densities peaked during summer ranging from 6,38 1 to 403 #/m^3 depending on sample site location. Minimum zooplankton densities occurred during fall ranging from 0 to 1 Daphnia spp/m^3. In general, the zooplankton density was highest in the lower section of the lake.

A total of 12,984 net-pen rainbow trout were tagged at Kettle Falls and Seven Bays. Tag returns from anglers in Lake Roosevelt or below returned 200 of these tags yielding a recapture rate of 2%. Entrainment of rainbow trout through Grand Coulee Dam was considered low in 1995 (3%) due to relatively high average water retention times in the Spring (40+ days) and because rainbow trout were held in net pens until after June 1.

Results of the Data Collection Project found that reservoir elevations and storage capacity were similar in 1994 and 1995, but water retention times were reduced by an average of 12.9 days. This was due in part to a ten foot August drawdown implemented to benefit ESA listed stocks in the Snake River. Average zooplankton densities for 1995 were higher than 1994, but zooplankton biomass values for 1995 decreased due to significantly smaller Daphia spp. sizes. The temperature of Lake Roosevelt was positively correlated with zooplankton density.

Management recommendations for the Data Collection Project are as follows:

1. Continue to tag 10,000 rainbow trout at Kettle Falls and Seven Bays in order to increase the numbers of tag returns;

2. Continue to hold net pen rainbow trout until at least June 1 before release in order to reduce entrainment losses:

3. Increase the zooplankton sampling frequency to at least three times per month in the spring, summer and fall and twice per month in winter. In addition, begin to sample zooplankton in near shore areas along with mid channel tows. Also, due to the extreme variability of zooplankton data it is recommended that a minimum of three zooplankton tows be taken at each site and the densities averaged to attain a mean location density;

4. Continue to sample for zooplankton in Rufus Woods Reservoir in order to estimate entrainment losses of zooplankton from Lake Roosevelt;

5. Continue to collect zooplankton and water quality data at current sites;

6. Collect nutrient and C^{14} data to obtain nutrient abundance and assimilation rates for model development; and,

7. Detennine the depth of the euphotic zone via photometer to estimate the availability of phytoplankton habitat.

The Lake Roosevelt Monitoring Program is contained in section 2. This study was primarily concerned with the effect of stocking kokanee salmon and rainbow trout on the ecosystem. The Sherman Creek Hatchery (Washington Department of Fish and Wildlife) and the Spokane Tribal Hatchery (Spokane Tribe of Indians) were operational in 1991. To evaluate the effectiveness of stocking on the lake biota and fishery, baseline data was collected beginning in 1988. These data were compared to baseline fisheries data post-hatchery stocking. The data generated from sampling was analyzed to determine food availability, utilization and preferences, growth rates, and angler use information (e.g. harvest). The objective of the Monitoring Program was to maximize angler harvest and maximize adult returns to egg collection sites.

The goals of the Monitoring Program were:

1. Determine angler pressure, number of fish harvested, average size of fish harvested and the economic value of the fishery;

2. Estimate the relative abundance of fish in the lake;

3. Determine the diet of kokanee salmon, rainbow trout and walleye; and

4 Estimate age and growth of kokanee salmon, rainbow trout and walleye.

Kokanee harvest increased from 11,906 fish in 1989 to 32,353 fish in 1995. Rainbow trout harvest increased from 65,515 fish in 1989 to 122,939 fish in 1995. Walleye harvest decreased from 80,626 fish in 1992 to 40,185 fish in 1995.

Relative abundance of kokanee salmon in fisheries surveys increased from 3% in past years to 20% in 1995. The relative abundance of rainbow trout remained at approximately 5%. The relative abundance of yellow perch steadily decreased from 40% in 1989 to 7% in 1995.

The economic value of the lake increased from $2 million in 1988 (before hatchery supplementation) to almost $9 million in 1995 (after hatchery supplementation).

In 1995, mean lengths of kokanee were 219 mm, 385 mm and 472 mm for 1+, 2+, and 3+ fish. The mean condition factor for all age groups was 1.03. Rainbow trout mean lengths were 206,340 mm, 416 mm, 504 mm, and 537 mm for age 1+, 2+, 3+, 4+ and 5+ fish. The mean condition factor for all age groups was 1.08. Walleye lengths ranged from 149 mm for age 0+ fish to 766 mm for age 1 1+ fish.

Diet overlap predicted that kokanee and rainbow trout overlap was 0.80 (high overlap). Kokanee and walleye diet overlap was low (0.15) and rainbow and walleye overlap was moderate (0.45).

Results of the Monitoring Program suggests that the release of hatchery origin fish continued to improve harvest rates and the relative abundance of kokanee salmon and rainbow trout. Growth of kokanee and rainbow trout continued to exceed the mean growth per age class of fish in area lakes, but walleye growth and harvest rates have declined over the past 5 years. This may have been the result of food shortages since there has been a decrease in the relative abundance of yellow perch. Feeding habits of kokanee and walleye remain similar to past years with kokanee feeding mainly on Duphnia spp. and chironomids, and walleye feeding mainly on fish. However, food habits of rainbow trout were different than in past years. Rainbow fed mainly on Duphnia spp., and chironomids, but also fed on yellow perch. This apparent change in feeding habits may have been due to a change in sampling months from August to July in 1995.

Management recommendations for the Monitoring Program include:

1. Quantify the impact of walleye on newly stocked kokanee salmon;

2. Record the origin (fin clips) of every kokanee sampled to determine hatchery versus wild origin;

3. Evaluate the scientific design of the creel survey and methods used to compute indices;

4. Conduct hydroacoustic surveys monthly to identify spatial and temporal accumulations of fish along the length and width of the lake; and

5. Pursue new capture methods for fish assemblages to determine fish species, age structure, etc.

The third section of this report discusses the kokanee salmon imprinting and coded wire tagging program (Imprinting Program). This is a sub-contract to the Monitoring Program which began investigations to determine the critical period for thyroxine-induced olfactory imprinting in 1991. The objectives of this present study were to:

1. Determine the critical period(s) for olfactory imprinting; and

2. assess the best times and locations to release kokanee in order to prevent entrainment, and improve returns to creel and egg collection sites.

Field tests were conducted by exposing juvenile kokanee to the synthetic chemicals morpholine and phenethyl alcohol at different life stages. These artificially imprinted fish were coded wire tagged and stocked into Lake Roosevelt from 1992 through 1995. Adult kokanee salmon were collected during the spawning period and checked for tags to determine which life stage homed better to its release site.

Results continued to show that kokanee can be successfully imprinted to artificial odors - morpholine and phenethyl alcohol - as juveniles from hatch to swimup and again at the smolt stage. Fish double imprinted at these stages exhibited the highest percentage homing (86.5%). Also, fish exposed to chemicals showed greater homing ability than unexposed fish. Smolt releases continue to provide better adult recoveries than fry releases (99% of recoveries in 1995 came from fish released as smolts).

Based on the results of the Imprinting Program, the following recommendations were made:

1. Release more kokanee salmon into the reservoir,

2. Monitor entrainment of kokanee from Lake Roosevelt;

3. Modify hatchery ladder system at Sherman Creek Hatchery to attract more adult kokanee;

4. Set up an egg site at Hawk Creek since 286 fish were recovered at that site; and

5. Locate alternative stocks of kokanee with better genetic adaptations than Lake Whatcom stock for the Lake Roosevelt Program.

TABLE OF CONTENTS

SECTION 1

MEASUREMENT OF LAKE ROOSEVELT BIOTA IN RELATION TO RESERVOIR OPERATIONS

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Portland, OR 97208-3621

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ABSTRACT

The purpose of the Lake Roosevelt Data Collection Project (Data Collection Project) was to collect data to develop a computer model that will predict biological responses to reservoir operations as part of the System Operation Review Program. The data collected by this project was gathered to quantify and qualify the impacts of reservoir operations on the ecology and limnology of the Lake. This project began 1991 and has since worked closely with the Lake Roosevelt Monitoring Project. In 1995, limnological, reservoir operation, zooplankton and net-pen rainbow trout tagging data were collected at up to eleven index stations throughout the reservoir. The monthly mean lake elevations ranged from 1,250 feet in March to 1,287 feet in December with a mean yearly reservoir elevation of 1,277 which was similar to 1994. However, for the first time, Lake Roosevelt was drawndown ten feet in August to benefit ESA listed stocks in the Snake River. This resulted in significantly lower water retention times of 47 days for August, 1995 compared to 59 days for August, 1994. Yearly mean water retention times was 47 days and ranged from 32 days in December to 69 days in September. Daphnia spp. densities peaked during July and August, reaching a maximum density of 6,380 organisms per m^3 in August at the Confluence site. Minimum overall zooplankton densities of zero or near zero organisms per m^3 were observed in March and April at most sites. Higher zooplankton densities were found at lower end of the reservoir. Daphnia and total zooplankton densities were much higher in 1995 when compared with 1994. However, 1995 biomass values were only a fraction of those reported in 1994 due to a dramatic reduction in zooplankton size. In 1995, 12,984 net-pen rainbow trout were tagged at Kettle Falls (4,995) and Seven Bays (7,989). Anglers captured and returned 200 of these tags, yielding a recapture rate of 2%. Sixty-seven tags were returned from Kettle Falls releases and 133 were returned from Seven Bays releases. Two tags from each release location were recaptured in Rufus Woods reservoir and one additional Seven Bays fish was recaptured at Rocky Reach Dam yielding an entrainment rate of 3%.

ACKNOWLEDGMENTS

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We acknowledge Kelly Cash (National Park Service), and Gary Kuiper (NPS), for graciously providing camping at no cost to the project. We also thank Winn Self, Marty Blum, Roy Graffis, and students from Hunters High School for their assistance in the feeding and tagging of net-pen rainbow trout. Additional thanks goes to Charlie Craig (BPA, Division of Fish and Wildlife), who served as BPA project manager, Rob Pierson (Bonneville Power Administration), Larry Goodrow (Executive Director, Spokane Tribe of Indians and UCUT Administrator) Mary Vemer (Natural Resource Director, Spokane Tribe of Indians), Amy Voeller (previous project manager) and Carol Evans (Accountant, Spokane Tribe of Indians) for administration of contracts.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Project History

The Data Collection Project began in July, 1991 as part of the Bonneville Power Administration (BPA), Bureau of Reclamation (BOR), and U.S. Army Corps of Engineer's (ACE) System Operation Review process. This process sought to develop an operational scenario for the Federal Columbia River Hydropower System which minimized impacts to all stakeholders of the Columbia River. The objective of the Data Collection Project was to collect data for the development of a biological model for Lake Roosevelt enabling researchers to identify which lake operation scenario best suites the biota of the lake. Major components of the Lake Roosevelt model will be: 1) quantification of impacts to phytoplankton, zooplankton and fish caused by reservoir drawdowns and low water retention times; 2) quantification of the number, distribution, and use of fish food organisms in the reservoir by season; 3) determination of seasonal growth of fish species as related to reservoir operations, prey abundance, and utilization; and 4) quantification of entrainment levels of zooplankton and fish as related to reservoir operations and water retention times. Upon completion in the year 1998, the model will predict biological responses to different reservoir operation strategies.

This chapter contains the results of the Data Collection Project for Lake Roosevelt from January through December 1995. Previous annual reports for the Data Collection Project were written by Griffith et *al.* (1991), Griffith and McDowell (1996), Voeller (1996) and Shields and Underwood (1996).

1.2 1995 Study Objectives

Objectives of the Lake Roosevelt Data Collection Project for 1995 were, as follows:

1. Collect zooplankton biomass and density data at eleven locations throughout Lake Roosevelt.

2. Tag rainbow trout in Lake Roosevelt and use tag return data to estimate entrainment, growth rates and habitat preferences.

3. Collect limnological data on the lake including: pH, temperature, dissolved oxygen, conductivity, oxidative reductive potential and secchii disk at ten sites throughout Lake Roosevelt.

4. Compare and contrast data collected during 1995 with previous years, to identify changes in the lake.

5. Participate in operational decisions on lake Roosevelt by providing technical input to the SOR through the resident fish work group.

2.0 MATERIALS AND METHODS

2.1 Description of Study Area

Lake Roosevelt is a mainstem Columbia River impoundment formed by the construction of Grand Coulee Dam in 1939 (Figure 2.1). Filled in 1941, the reservoir inundates 33,490 hectares at a full pool elevation of 393 m above mean sea level. It has a maximum width of 3.4 km and a maximum depth of 122 m (Stober er al. 1981). Grand Coulee Dam is a Bureau of Reclamation storage project operated primarily for power, flood control, and irrigation with secondary operations for recreation, fish, and wildlife.

2.2 Reservoir Hydrology

Water quality measurements of temperature, pH, dissolved oxygen, conductivity, and oxygen reduction potential were collected using a Hydrolab Surveyor II at ten sites in the reservoir. Samples were collected mid-channel to a depth of 33 M at Kettle Falls (Location l), Gifford (Location 2), Hunters (Location 3), Porcupine Bay (Location 4), the Confluence of the Spokane River with the mainstem Columbia (Location confluence), Seven Bays (Location 6), Keller Ferry (Location 7), San Poil River (Location 8), Spring Canyon (Location 9), and at Rufus Woods Reservoir (Location 10), monthly in 1995 (Figure 2.1). Secchii disk readings were taken in conjunction with Hydrolab measurements at each of the above sites. This data collection continues investigations which began in 1991 (Appendix C).

Reservoir elevations and water retention times were calculated from daily midnight reservoir elevations (ft) and total outflows in thousand cubic feet per second per day (kcfs). Reservoir elevation and total outflow values were derived from summary reports for Grand Coulee Dam prepared monthly in 1995 by the U.S. Army Corps of Engineers, Reservoir Control Center in Portland, OR. Reservoir elevation was converted to volume of water stored (kcfsd) using a U.S. Army Corps of Engineers (198 1) reservoir water storage table. Water retention time was calculated using the formula:

$$\text{Water retention time (days)} = \frac{\text{Reservoir volume (kcfsd)}}{\text{Outflow (kcfs)}}$$

Daily values for each category were totaled and divided by the number of days in each month to attain mean reservoir elevations and water retention times (Appendix A).

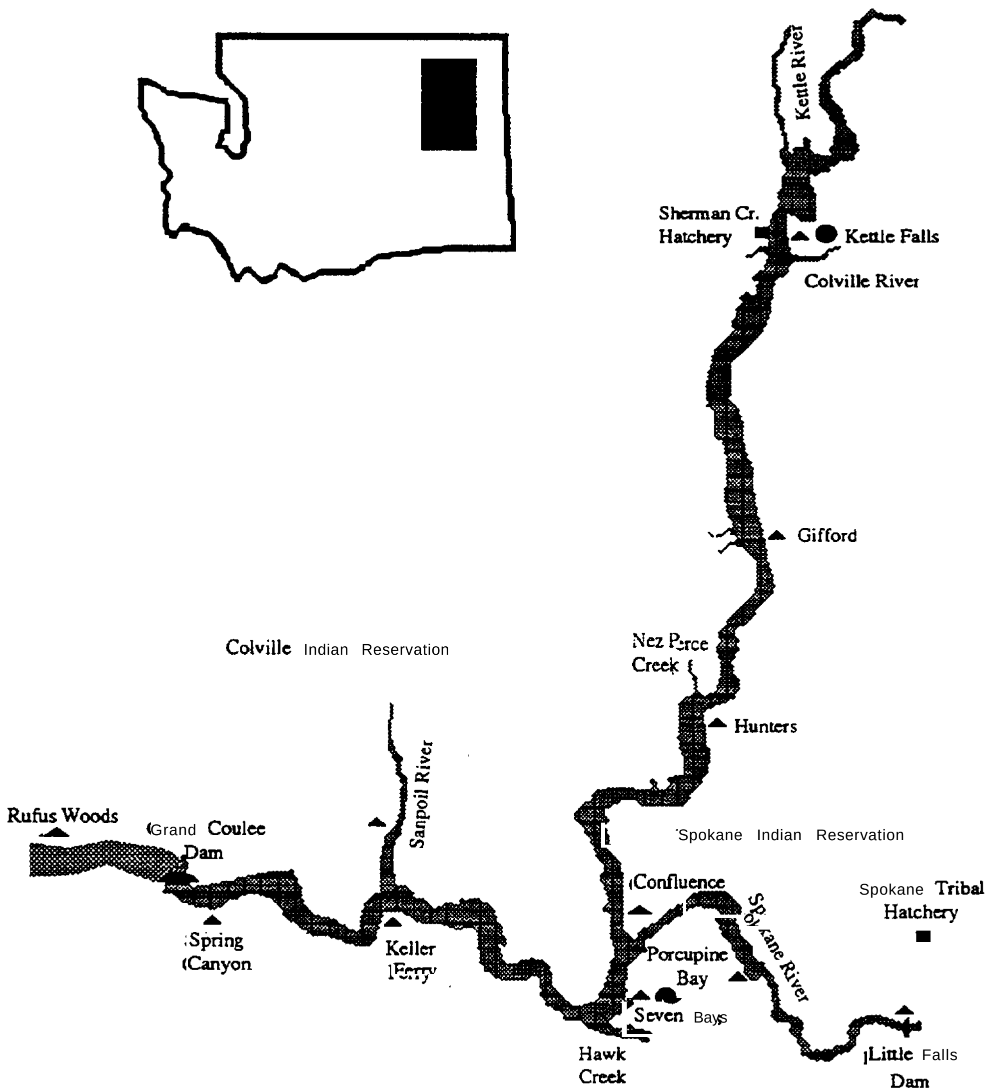


Figure 2.1 Map of Lake Roosevelt, WA. "▲" denotes sampling locations and "●" denotes tagging stations.

2.3 Zooplankton

Zooplankton samples were collected mid-channel at Seven Bays, Keller Ferry and Spring Canyon once every two weeks from January through October, 1995. Gifford, Porcupine Bay, Confluence, and Rufus Woods sites were sampled monthly from January through October, 1995. Additional samples were taken at Kettle Falls, Hunters, and the San Poil river three times per year in March, August and October as part of the Lake Roosevelt Monitoring Project's annual sampling sessions. Samples were taken using a Wisconsin vertical tow plankton net with an 80 µm silk mesh and bucket and a radius of 14.5 cm. Triplicate and some duplicate tows were made from 33 m depth to the surface at each location within Lake Roosevelt. At Rufus Woods, where main channel river depths average 20 m, two sets of three 15 m subsample tows were taken and combined into two samples. After all tows, collected organisms were washed into individual 253 ml bottles containing 10 ml of 37% formaldehyde and 0.5 g sugar Rigler (1978). Bottles were labeled with the date, location, time, tow number and tow depth. Organisms were then stained with 1.0 ml of five percent Lugol's solution and 1.0 ml of saturated eosin-y ethanol stain and brought to a volume of 200 mls.

In the laboratory, organisms were identified to species using taxonomic keys of Brandlova et *al.* (1972), Brooks (1957), Edmondson (1959), Pennak (1978;1989), Ruttner-Kolisko (1974), and Stemberger (1979). A Nikon SMZ-10 dissecting microscope with a ring illuminator system and Nikon Optiphot phase contrast microscope were used for identification. In cases where sample densities were high, three sub-samples were counted using a modified counting chamber Ward (1955), until 60 organisms or 25 ml of sample was counted (Edmondson and Winberg 1971, Downing and Rigler 1984). Volumes of sub-samples selected depended upon organism densities in the samples.

Zooplankton densities were calculated for each individual tow and the results of the three tows were averaged to arrive at a single location density. Zooplankton density (# organisms/m^3) was calculated using the following sets of equations. First, the volume (L) of sample collected by the Wisconsin plankton sampler was calculated by the formula:

$$V = \Pi r^2 h$$

where:

v	=	volume of the sample (liters);
Π	=	pi (3.14);
r	=	radius of sampler (cm); and
h	=	depth of sample (m).

Next, microcrustacean zooplankton density (# organisms/ m3) was calculated by the equation:

$$D = \frac{\left(\frac{T_c}{S_n} * \frac{SV}{SSV}\right)}{V} DF * 1000$$

where:

D	=	density (# organisms/ m3);
Sn	=	number of sub-samples;
s v	=	sample volume;
s s v	=	sub-sample volume;
V	=	volume of entire sample;
DF	=	dilution factor; and
Tc	=	total number counted of each species of organisms.

Predominant cladocera biomass was determined using the length-weight regression equations summarized by Downing and Rigler (1984). Mean cladoceran length used in these equations was determined by measuring randomly chosen groups of up to twenty individual cladocera per species. Leptodora lengths were taken by direct measurement, while all other measurements were made by first calibrating a Nikon Optiphot scope so that 10 micrometer units equaled 10 mm. Next, individual cladocera were lined up to the micrometer and measured from the top of the head to the base of the carapace, excluding the spine. Observed length data was converted to actual lengths through the use of a conversion factor of 0.02. Actual length data was then averaged for each species and recorded. Next, dry weight estimates were made by the use of the equation:

$$\ln w = \ln a + (b)(\ln L)$$

Where:

lnw	=	the natural log of the dry weight estimate (μg) for the Cladocera species;
$\ln a$	=	the natural log of the intercept for the Cladocera species;
b	=	the slope value for the Cladocera; and
$\ln L$	=	the natural log of the mean length value for the Cladocera species.

Slope (b) and intercept (ln a) values used for the dry weight estimate calculation (Downing and Rigler 1984) are found in table 3.1:

Table 2.1 Slope (b) and intercept (In a) values used for the dry weight estimate calculations.

Cladocera Species	In *a*	b
Daphnia *galeata mendota*	1.51	2.56
Daphnia retrocurva	1.4322	3.129
Daphnia *schødleri*	2.30	3.10
Daphnia thorata	2.64	2.54
Leptodora kindtii	-0.822	2.67

Average cladocera biomass was calculated using the formula:

$$B = (\ln w)(D)$$

Where:

B	=	biomass (μg/m^3);
lnw	=	log of the dry weight estimate for the Cladocera species (μg); and
D	=	density (# organisms/m^3).

2.4 Tagging Studies

Tagging studies were conducted on Lake Roosevelt using age one net-pen reared rainbow trout. Fish chosen for this study were randomly netted out of holding pens, measured to the nearest millimeter and tagged by placing individually numbered floy tags into the posterior base of the dorsal fin. Prior to tagging and length measurement, groups of up to 200 fish were anesthetized with carbon dioxide. This process involved placing 50 gallons of lake water into a large plastic holding tank and bubbling CO_2 into it from a 750 psi main tank through two 32 inch oxygen stones at a rate of 30 psi for three minutes. pH levels in the holding tank were monitored with a Hydrolab II surveyor and buffered to a level of 6.5 to 7.0 with calcium bicarbonate (Post, 1979). Once acceptable pH ranges were attained, fish were netted from holding pens and placed in the CO_2 water where they were rendered unconscious within one minute allowing for easy handling. Once measured and tagged, all fish were allowed to recuperate for up to 30 minutes in 20 gallon garbage cans prior to being returned to the net pens. Tagged fish were then held in net pens for three weeks, at which time mortality rates were calculated and fish released. Overall mortality rates for this process were less than 0.5%. In 1995, 4,995 fish were tagged at Kettle Falls and 7,989 fish were tagged at Seven Bays. Tag colors were changed by year so that each age class of tagged fish could be easily differentiated. Orange colored tags were used in 1995.

In order to maximize angler tag returns, informational posters describing the Monitoring Program's tagging studies were distributed throughout Lake Roosevelt and Rufus Woods reservoir at locations frequented by anglers. These posters gave a visual description of floy tags and also requested that anglers return tags with recapture information which included: recapture date, location, fish length and fish weight. Any angler that returned tag information was sent a letter informing him or her of the fish release date, location, and length of fish at time of release. The angler was also provided with a brief summary of the tagging program.

Tag return data was compiled and analyzed to determine fish growth rates and movement within Lake Roosevelt and was also used to estimate entrainment rates through Grand Coulee Dam. Movement was analyzed by noting recapture location and plotting it against release location and date.

3.0 RESULTS

3.1 Hydrology

Table 3.1 summarizes' mean monthly reservoir operations for Lake Roosevelt in 1995. Appendix A summarizes daily reservoir operations from January through December, 1995. Average reservoir elevations began at 1,278 feet above sea level in January and dropped to an elevation of 1,259 feet in April (Table 3.1 and Figure 3.1). The reservoir then began to refill to near full pool by June and remained stable within ten feet through the end of the year. Mean reservoir elevations ranged from a low of 1,259 feet in April to a maximum of 1,287 feet in July and December (Table and Figure 3.1). Mean yearly reservoir elevation was 1,277 feet. Mean outflows ranged from a low of 66 kcsf in September to 118 kcfs in June with a yearly mean of 96 kcfs. Mean inflows ranged from a low of 73 kcsf in January to 148 kcfs in June with a yearly mean of 100 kcfs (Table 3.1). Mean monthly water retention times ranged from a low of 32 days in December to a maximum of 69 days in September. Water retention times did not go below thirty days for any month (Table 3.1 and Figure 3.2).

Appendix C summarizes the water quality measurements taken by Hydrolab Surveyor II from January through October, 1995. Analysis of these data show that monthly temperatures ranged from a yearly low of 2.3ºC in January at Gifford to a high of 24.1ºC in July at Porcupine Bay. pH values ranged from a low of 6.9 in August at Porcupine Bay to a maximum of 8.7 at Spring Canyon in May. Higher pH readings of up to 11.2 were observed in January through March but these were due to a malfunctioning pH meter and as such are deemed unreliable. Dissolved oxygen readings ranged from a yearly minimum of 2.5 mg/L at Porcupine Bay in August to a maximum of 19.4 mg/L at Keller Ferry in March. Conductivity readings ranged from a low of 0.082 mmho/cm in March at Porcupine Bay to a high of 0.223 mmho/cm at Porcupine Bay in October. Oxidative reductive potential (ORP) in volts, ranged from a yearly low of 0.038 volts in June at Porcupine Bay to a yearly maximum of 0.302 volts in March at Spring Canyon. Appendix D also reports monthly secchii disk depths in meters for nine sampling stations within Lake Roosevelt. These measurements ranged from a yearly low of 0.3 meters in February at Porcupine Bay to a yearly high of 9.0 meters in July at Spring Canyon. Keller Ferry and Spring Canyon had the highest overall average secchii disk readings of 5.5 meters, while Porcupine Bay reported the lowest at 3.0 meters (Table D.64).

Table 3.1 Monthly and annual means for reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in 1995.

Month	Inflow (kcfs)	outflow **(kcfs)**	Reservoir Elevation **(Ft)**	Storage Capacity (kcfsd)	Water Retention Time (Days)
Jan 1995	73.0	88.3	1,278.3	4,127.8	49.3
Feb 1995	81.7	94.0	1,266.2	3,688.9	42.6
Mar 1995	101.6	90.1	1,259.0	3,434.3	42.4
Apr 1995	81.2	84.5	1,265.8	3,669.5	47.5
May 1995	112.3	93.5	1,260-l	3,460.4	39.4
Jun 1995	148.1	117.8	1,283.6	4,335.3	40.1
Jul 1995	111.6	110.5	1,287.0	4,467.4	41.4
Aug 1995	**96.3**	91.9	1,280.9	4,227.8	47.2
Sep 1995	79.9	65.9	1,285.1	4,392.8	69.0
Oct 1995	80.3	80.6	1,285.8	4,420.3	56.7
Nov 1995	97.2	91.9	1,286.5	4,448.3	50.4
Dec 1995	135.7	141.6	1,287.0	4,466.7	32.4
Mean 1995	**99.9**	**95.9**	**1,277.1**	**4,095.0**	**46.5**

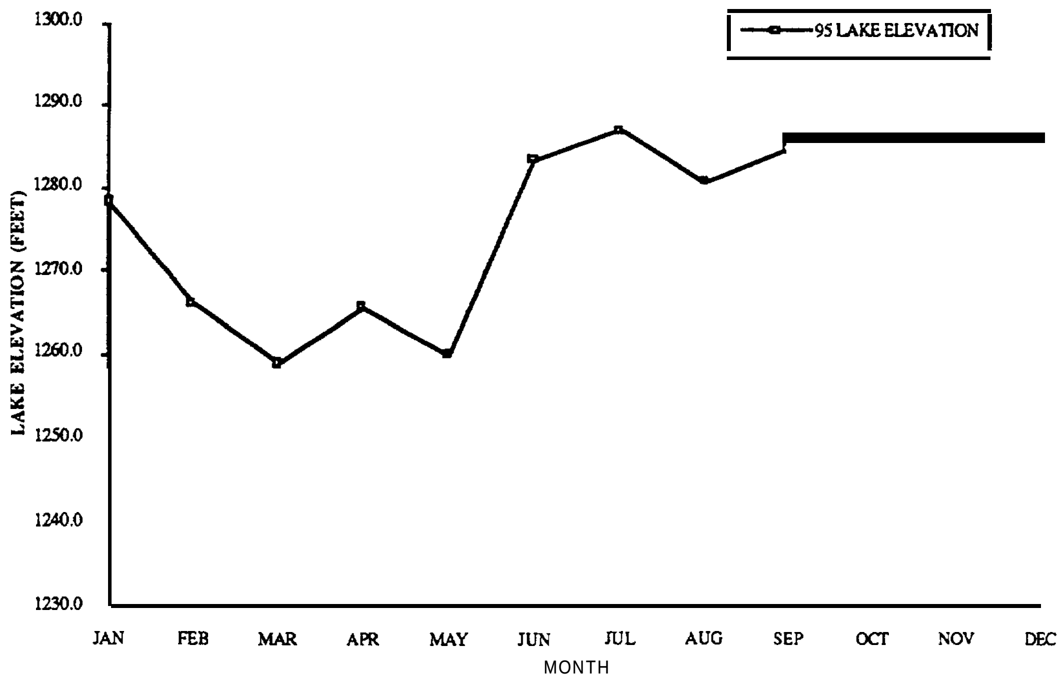


Figure 3.1 Mean monthly reservoir elevations in 1995.

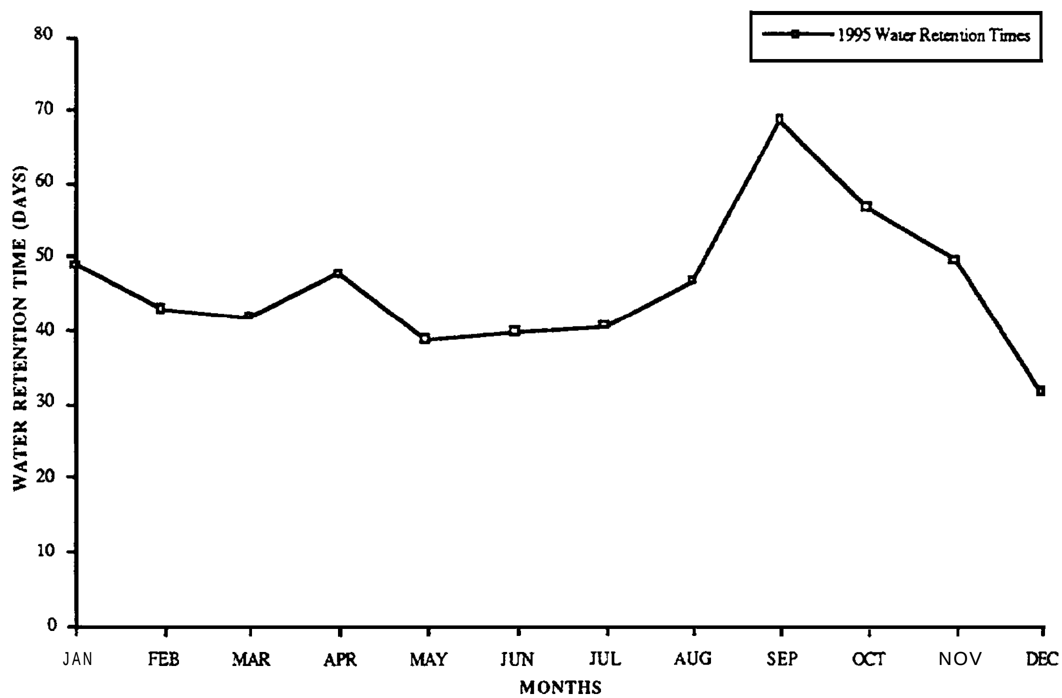


Figure 3.2 Mean monthly water retention times in 1995.

3.2 Zooplankton

3.2.1 Zooplankton Densities

A total of 11 species of zooplankton were identified in Lake Roosevelt during 1995 (Table 3.2). Seven species were identified from Order Cladocera, the most diverse group, followed by 5 species from Order Eucopepoda.

Monthly mean densities (# of organisms/m^3), of microcrustacean zooplankton collected at Kettle Falls, Gifford, Hunters, Porcupine Bay, Confluence, Seven Bays, Keller Ferry, San Poil, Spring Canyon and Rufus Woods are shown in Tables 3.3 through 3.12. Mean zooplankton densities by species for each location are found in Appendix B.

Mean total zooplankton densities at Kettle Falls ranged from a low of 24.3 organisms/m3 in May to a yearly high of 2,105.3 organisms/m3 in October yielding a mean of 742.7 organisms/m^3. Mean total zooplankton densities at Gifford ranged from 30.0 organisms/m3 in February to 8,382.3 organisms/m3 in August with an annual mean of 1,637.2 organisms/m^3. Mean total zooplankton densities at Hunters ranged from 351.0 organisms/m3 in May to 2,844.5 organisms/m3 in July with a mean of 1,642.3 organisms/m^3. Porcupine Bay values ranged from 128.7 organisms/m3 in March to 7,597.3/m^3 in June with an annual mean of 3,335.2/m^3. At the confluence of the Spokane River with the mainstream Columbia, densities ranged from a yearly low of 710.3 organisms/m3 in February to a high of 11,291.3 organisms/m3 in June yielding a yearly average of 3,977.9 organisms/m^3. Seven Bays densities ranged from a low of 105.4 organisms/m3 in February to a maximum of 5,67 1.1 organisms/m3 in September with an annual mean of 3,012.8 organisms/m ^{3}. Mean total densities at Keller Ferry ranged from 148.8 organisms/m3 in February to 9,492.9 organisms/m^3 in June yielding an average of 3,590.8 organisms/m^3. Mean total densities at San Poil ranged from 4,336.4 organisms/m3 in October to 11,106.1 organisms/m3 in July for a mean of 7.721.3 organisms/m^3. Mean total densities at Spring Canyon ranged from a yearly low of 788.2 organisms/m ^{3} in February to a maximum of 10,364.0 organisms/m^3 in June for a yearly mean of 4,427.8 organisms/m^3. Finally, Rufus Woods mean total zooplankton densities ranged from 967,3 organisms/m3 in March to 2,557.0 organisms/m^3 in July with an annual mean of 1,485.8 organisms/m^3.

Table 3.2 Synoptic list of zooplankton **taxa historically** identified in Lake Roosevelt including those identified **during** the 1995 study period.

Phylum Anthropoda
- **Class Crustacea**
  - **Subclass Brachiopoda**
    - **Order Cladocera**
      - **Family Daphnidae**
        1. *Ceriodaphnia quadranqula*
        2. **Daphnia galeata mendotae*
        3. **Daphnia retrocurva*
        4. **Daphnia schdlen'*
        5. **Daphnia thorata*
        6. *Simocephalus serrulatus*
      - **Family Chydoridae**
        7. *Alona guttata*
        8. *Alona quadrangularis*
        9. *Chydorus sphaericus*
      - **Family Sididae**
        10. **Diaphanosoma brachywwn*
        11. *Diaphanosoma birgei*
        12. *Sida crystallina*
      - **Family Bosminidae**
        13. **Bosmina longirostris*
      - **Family Leptodoriidae**
        14. **Leptodora kindtii*
  - **Subclass Copepoda**
    - **Order Eucopepoda**
      - **Suborder Calanoida**
        - **FamilyDiaptomidae**
          15. **Leptodiaptomus ashlandi*
          16. *Skistodiaptomus oregonensis*
        - **Family Temoridae**
          17. **Epischura nevadensis*
        - **Suborder Cyclopoida**
        - **Family Cyclopoidae**
          18. **Diacyclops bicuspidatus thomasi*
          19. **Mesocyclop edax*
        - **Suborder Harpacticoida**
        - **Family Harpacticoidae**
          20. *Bryocamptus* spp.

Phylum Rotifera
- **Class Monogononta**
  - **Order Floscularíacea**
    - **Family Conochilidae**
      21. *Conochilus unicornis*
    - **Family Testudinellidae**
      22. *Testudinella* spp.
    - **Family Filiniidae**
      23. *Fiiinia terminalis*
  - **Order Plioma**
    - **Family Synchaetidae**
      24. *Pleosoma truncatum*
      25. *Polyarthra* spp.
      26. *Synchaeta pectinata*
    - **Family Asplanchnidae**
      27. *Asplanchna herricki*
      28. *Asplanchna priodonta*
    - **Family Brachionidae**
      29. *Brachionus quadridentata*
      30. *Kellicottia Longispina*
      31. *Keratella* spp.
      32. *Nothoica* spp.
    - **Family Epiphanidae**
      33. *Epiphanes* spp.
    - **Family Euchlanidae**
      34. *Euchlanis dilatata*
      35. *Euchlanis triquetra*
      - **Family Trichotriidae**
        36. *Trichotria tetractis*
      - **Family Trichocercidae**
        37. *Trichocerca* spp.
  - **Family Lecanidae**
    38. *Monostyla lunaris*

*** Indicates that this species was observed in 1995.**

Table 3.3 **Mean monthly densities (#/m^3) for representative zooplankton at Kettle Falls (Index Station 1), in 1995.**

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
May	0.0 ± —	0.0 ± —	1.2 ± 0.5	23.1 ± 2.5	0.0 ± —	24.3 ± 2.1
Jul	8.4 ± 1.6	0.6 ± 0.3	43.0 ± 8.1	46.6 ± 5.0	7.0 ± 1.4	98.6 ± 11.7
Oct	1,933.7 ± 505.1	0.0 ± —	1,954.1 ± 518.2	137.6 ± 30.6	13.6 ± 2.9	2,105.3 ± 491.2
Mean	647.4 ± 253.4	0.2 ± 0.3	666.1 ± 175.6	69.1 ± 12.7	6.9 ± 2.2	742.7 ± 168.3

'- -' Indicates no data collected or no value.

Table 3.4 Mean monthly densities (#/m^3) for representative zooplankton at Gifford (Index Station 2), in 1995.

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jan	0.0 ± —	0.0 ± —	0.6 ± 0.8	49.2 ± 73.2	0.4 ± 0.5	50.2 ± 74.5
Feb	0.5 ± 0.0	0.0 ± —	1.7 ± 1.0	27.4 ± 8.8	0.9 ± 0.5	30.0 ± 10.3
Apr	0.8 ± 0.7	0.0 ± —	19.9 ± 4.2	84.7 ± 9.8	38.5 ± 6.9	143.1 ± 20.9
May	0.8 ± 0.7	0.3 ± 0.3	3.2 ± 2.4	120.8 ± 13.2	25.2 ± 11.5	149.5 ± 27.4
Jun	4.1 ± 0.5	0.5 ± 0.0	23.3 ± 1.5	277.6 ± 31.2	64.2 ± 17.2	365.6 ± 49.9
Jul	1,826.3 ± 347.9	12.6 ± 4.1	1,899.5 ± 365.2	1,275.3 ± 143.8	42.3 ± 41.0	3,229.7 ± 554.1
Aug	6,380.6 ± 1,356.5	74.8 ± 16.4	6,540.3 ± 1,353.3	1,580.3 ± 347.8	186.9 ± 23.0	8,382.3 ± 1,740.5
Sep	593.0 ± 73.9	0.0 ± —	599.8 ± 68.8	414.6 ± 130.4	326.3 ± 119.2	1,340.7 ± 318.4
Oct	574.3 ± 19.3	1.7 ± 2.9	630.4 ± 10.6	277.0 ± 5.9	134.2 ± 21.2	1,043.3 ± 40.6
Mean	**1,042.3 ± 224.9**	**11.2 ± 4.7**	**1,079.9 ± 200.9**	**456.3 ± 84.9**	**91.0 ± 26.8**	**1,637.2 ± 315.2**

'- -' Indicates no data collected or no value.

Table 3.5 **Mean monthly densities (#/m^3) for representative zooplankton at Hunters (Index Station 3), in 1995.**

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
May	5.2 ± 4.7	0.0 ± —	8.3 ± 6.8	287.2 ± 22.7	55.5 ± 42.8	351.0 ± 58.5
Jul	523.4 ± 38.9	34.0 ± 7.8	570.9 ± 38.5	2,203.9 ± 414.0	69.7 ± 7.8	2,844.5 ± 408.9
Oct	1,089.2 ± 165.8	0.0 ± —	1,111.3 ± 155.5	548.9 ± 62.3	71.4 ± 40.5	1,731.5 ± 82.4
Mean	**539.3 ± 102.4**	**11.3 ± 7.8**	**563.5 ± 66.9**	**1,013.3 ± 166.3**	**65.5 ± 24.2**	**1,642.3 ± 183.3**

'- -' Indicates no data collected or no value.

Table 3.6 **Mean monthly densities (#/m^3) for representative zooplankton at Porcupine Bay (Index Station 4), in 1995.**

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jan	21.6 ± 4.1	0.0 ± —	27.6 ± 7.8	101.1 ± 27.2	0.0 ± —	128.7 ± 35.0
Feb	30.4 ± 10.0	0.0 ± —	107.4 ± 15.9	80.3 ± 29.4	3.2 ± 1.0	190.9 ± 46.3
Mar	0.0 ± —	0.0 ± —	161.4 ± 97.3	1,497.0 ± 214.2	54.4 ± 7.8	1,712.8 ± 319.3
Apr	1.7 ± 2.9	0.0 ± —	261.7 ± 2.9	885.3 ± 67.9	76.5 ± 13.5	1,223.5 ± 84.3
May	22.4 ± 20.2	0.0 ± —	385.0 ± 73.2	3,852.3 ± 465.8	31.8 ± 21.2	4,269.1 ± 560.2
Jun	1,362.8 ± 610.2	69.7 ± 20.6	1,826.7 ± 503.6	5,634.6 ± 1,078.1	66.3 ± 20.4	7,597.3 ± 1,622.7
Jul	2,426.5 ± 175.3	22.1 ± 7.8	2,516.5 ± 170.8	1,447.7 ± 247.3	13.6 ± 2.9	3,999.9 ± 428.8
Aug	819.0 ± 43.4	0.0 ± —	956.7 ± 41.5	3,060.3 ± 263.1	96.9 ± 23.4	4,113.9 ± 328.0
Sep	2,277.0 ± 230.8	0.0 ± —	2,508.1 ± 237.0	3,118.1 ± 334.0	47.6 ± 15.6	5,673.8 ± 586.6
Oct	1,673.7 ± 154.1	1.7 ± 2.9	1,731.5 ± 156.7	2,672.9 ± 219.7	35.7 ± 23.4	4,441.8 ± 402.7
Mean	**863.5** ± 139.0	**31.2** ± 10.4	**1,048.3** ± **130.7**	**2,235.0** ± 294.7	**42.6** ± 14.4	**3,335.2** ± 441.4

'- -' Indicates no data collected or no value.

Table 3.7 Mean monthly densities (#/m^3) for representative zooplankton at the confluence of the Spokane River with the main stem Columbia (Index Station Confluence), in 1995.

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jan	338.8 ± 56.8	0.0 ± —	1,101.6 ± 405.4	1,007.0 ± 279.8	0.0 ± —	2,108.6 ± 656.9
Feb	78.3 ± 30.2	0.0 ± —	127.3 ± 37.8	508.2 ± 3.5	74.8 ± 26.3	710.3 ± 19.3
Mar	0.0 ± —	0.0 ± —	108.8 ± 22.2	2,178.4 ± 16.4	56.1 ± 20.4	2,343.2 ± 12.8
Apr	0.0 ± —	1.7 ± 2.9	90.1 ± 17.9	1,019.5 ± 163.1	137.6 ± 27.0	1,247.2 ± 176.2
Jun	822.4 ± 132.6	71.4 ± 15.3	1,075.6 ± 145.7	10,132.5 ± 318.2	83.3 ± 15.6	11,291.3 ± 420.9
Aug	4,049.2 ± 700.0	76.5 ± 17.7	4,144.4 ± 705.5	1,633.0 ± 535.8	1.7 ± 2.9	5,779.1 ± 1,238.7
Sep	1,174.2 ± 44.0	3.4 ± 2.9	1,323.7 ± 16.4	2,745.9 ± 118.2	294.0 ± 29.4	4,363.6 ± 102.3
Mean	923.3 ± 192.7	21.9 ± 9.7	1,138.8 ± 193.0	2,746.4 ± 205.0	92.5 ± 20.3	3,977.6 ± 375.3

'- -' Indicates no data collected or no value.

Table 3.8 **Mean monthly densities (#/m^3) for representative zooplankton at Seven Bays (Index Station 6), in 1995.**

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jan	66.1 ± 6.1	**0.0** ± - -	107.3 ± 9.2	390.8 ± 40.8	50.9 ± 16.8	548.9 ± 51.4
Feb	12.7 ± 3.7	0.0 ± --	23.0 ± 4.0	70.8 ± 10.8	11.6 ± 4.0	105.4 ± 14.1
Mar	0.9 ± 1.5	0.0 ± --	121.5 ± 33.7	767.2 ± 62.4	147.8 ± 5.1	1,036.5 ± 59.7
Apr	3.4 ± 1.5	0.0 ± --	752.8 ± 97.1	704.3 ± 134.5	338.1 ± 74.7	1,795.2 ± 80.9
May	138.9 ± 25.5	6.4 ± 7.7	296.9 ± 42.3	4,716.6 ± 349.2	114.7 ± 83.7	5,128.2 ± 434.6
Jun	920.1 4 46.5	79.9 ± 2.9	1,082.4 ± 49.2	3,222.6 ± 233.4	36.5 ± 8.2	4,341.5 ± 288.7
Jul	1,758.7 ± 27.0	61.2 ± 7.8	1,852.2 ± 15.6	3,060.3 ± 260.3	13.6 ± 5.9	4,926.0 ± 265.1
Aug	1,855.6 ± 238.8	5.1 ± 5.4	1,900.6 ± 249.6	1,559.9 ± 158.9	178.4 ± 19.4	3,638.9 ± 373.7
Sep	1,662.7 ± 167.7	5.1 ± 5.4	1,712.8 ± 167.9	3,683.1 ± 183.9	275.3 ± 55.2	5,671.1 ± 342.1
Oct	1,192.4 ± 97.4	0.0 ± --	1,254.5 ± 97.1	1,644.9 ± 124.6	36.5 ± 6.4	2,935.8 ± 89.7
Mean	**761.2** ± 61.6	**15.8** ± 5.8	**910.4 ± 76.6**	**1,982.1 ± 155.9**	**120.3 ± 27.9**	**3,012.8 ± 200.0**

'- -' Indicates no data collected or no value.

Table 3.9 Mean monthly densities (#/m^3) for representative zooplankton at Keller Ferry (Index Station 7), in 1995.

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jan	266.9 ± 14.3	0.0 ± —	289.1 ± 27.8	1,054.9 ± 115.9	11.1 ± 8.8	1,355.1 ± 113.1
Feb	35.0 ± 7.4	0.0 ± —	39.8 ± 6.8	101.8 ± 16.2	7.2 ± 1.7	148.8 ± 23.8
Mar	0.2 ± 0.2	0.0 ± —	121.7 ± 13.8	496.1 ± 67.2	213.2 ± 9.1	831.0 ± 75.4
Apr	4.3 ± 3.0	0.0 ± —	876.0 ± 59.0	1,028.0 ± 62.0	232.8 ± 41.0	2,136.8 ± 90.8
May	83.3 ± 10.6	0.0 ± —	100.3 ± 15.3	2,421.4 ± 367.4	62.9 ± 54.5	2,584.5 ± 336.2
Jun	3,724.9 ± 3,671	42.5 ± 11.5	3,810.7 ± 3,680	5,680.5 ± 379.4	1.7 ± 1.5	9,492.9 ± 3,686
Jul	2,729.0 ± 419.6	30.6 ± 19.2	2,895.5 ± 475.0	4,579.4 ± 413.5	99.4 ± 27.6	7,574.3 ± 716.7
Aug	2,463.9 ± 185.2	18.7 ± 10.3	2,486.8 ± 183.4	2,969.4 ± 255.4	149.5 ± 33.2	5,605.7 ± 292.8
Sep	841.1 ± 87.8	2.6 ± 4.4	858.1 ± 83.1	3,994.9 ± 235.2	190.3 ± 51.0	5,043.3 ± 222.3
Oct	33.1 ± 18.5	0.0 ± —	57.8 ± 18.8	1,017.8 ± 207.3	60.3 ± 15.6	1,135.9 ± 195.5
Mean	**1,018.2 ± 441.7**	**9.4 ± 11.4**	**1,153.6 ± 456.3**	**2,334.4 ± 212.0**	**102.8 ± 24.4**	**3,590.8 ± 575.3**

'-' Indicates no data collected or no value.

Table 3.10 **Mean monthly densities (#/m^3) for representative zooplankton at San Poil (Index Station 8), in 1995.**

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jul	4,463.9 ± 341.3	25.5 ± 22.2	4,519.9 ± 379.6	6,542.0 ± 76.5	44.2 ± 23.6	11,106.1 ± 299.3
Oct	503.0 ± 99.7	0.0 ± —	520.0 ± 91.9	3,768.9 ± 277.8	47.6 ± 12.8	4,336.4 ± 262.4
Mean	**2,483.5 ± 220.5**	**12.8 ± 22.2**	**2,520.0 ± 235.8**	**5,155.5 ± 177.2**	**45.9 ± 18.2**	**7,721.3 ± 280.9**

'--' Indicates no data collected or no value.

Table 3.11 **Mean monthly densities (#/m^3) for representative zooplankton at Spring Canyon (Index Station 9), in 1995.**

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jan	192.2 ± 44.8	0.0 ± —	224.9 ± 34.8	1,180.5 ± 226.4	51.4 ± 57.0	1,456.8 ± 185.9
Feb	138.2 ± 33.0	0.0 ± —	164.0 ± 45.5	573.6 ± 253.3	50.6 ± 26.2	788.2 ± 318.3
Mar	16.1 ± 7.9	0.0 ± —	123.2 ± 43.8	943.1 ± 108.2	124.0 ± 24.7	1,190.3 ± 161.0
Apr	63.7 ± 20.3	0.0 ± —	293.1 ± 64.8	1,900.6 ± 129.6	108.8 ± 15.6	2,302.4 ± 106.0
May	69.3 ± 0.0	7.1 ± 2.8	161.1 ± 19.1	2,787.4 ± 599.1	76.5 ± 19.1	3,025.0 ± 610.7
Jun	3,127.8 ± 118.8	64.6 ± 8.9	3,258.7 ± 160.3	7,087.4 ± 570.6	17.8 ± 7.2	10,364.0 ± 719.6
Jul	3,806.3 ± 462.3	16.1 ± 10.3	3,942.9 ± 456.1	5,608.3 ± 860.0	113.0 ± 41.1	9,665.2 ± 1,330.0
Aug	1,562.4 ± 281.7	0.9 ± 1.5	1,579.4 ± 283.2	3,963.4 ± 434.7	248.9 ± 47.2	5,791.8 ± 601.7
Sep	1,870.0 ± 255.4	1.7 ± 2.9	1,884.4 ± 253.6	5,214.9 ± 708.4	270.2 ± 93.9	7,369.5 ± 729.2
Oct	186.9 ± 49.5	0.0 ± —	247.2 ± 60.6	2,065.4 ± 272.8	11.9 ± 1.5	2,324.5 ± 331.1
Mean	**1,103.3 ± 127.4**	**9.0 ± 5.3**	**1,187.9 ± 142.2**	**3,132.5 ± 416.3**	**107.3 ± 33.4**	**4,427.8 ± 509.4**

'- -' Indicates no data collected or no value.

Table 3.12 **Mean monthly densities (#/m^3) for representative zooplankton at Rufus Woods (Index Station 10), in 1995.**

	Daphnia	Leptodora	Cladocera	Copepoda	Nauplii	Total Zooplankton
Jan	213.1 ± 68.7	0.0 ± —	258.0 ± 82.0	1,523.4 ± 105.7	35.5 ± 5.3	1,819.5 ± 179.8
Feb	172.9 ± 23.1	0.0 ± —	239.5 ± 61.1	878.5 ± 132.2	67.8 ± 13.2	1,185.7 ± 170.2
Mar	25.2 ± 1.3	0.0 ± —	67.3 ± 10.6	865.4 ± 55.5	34.6 ± 17.2	967.3 ± 27.8
Apr	9.8 ± 9.9	0.0 ± —	84.1 ± 11.9	1,202.8 ± 210.2	67.3 ± 7.9	1,354.2 ± 226.0
May	20.6 ± 2.6	0.0 ± —	44.9 ± 10.6	826.2 ± 259.1	24.3 ± 23.8	895.3 ± 224.7
Jun	856.1 ± 195.6	56.1 ± 7.9	946.7 ± 212.8	1,454.2 ± 420.3	0.0 ± —	2,400.9 ± 633.1
Jul	820.6 ± 304.0	0.0 ± —	859.8 ± 317.2	1,697.2 ± 523.4	0.0 ± —	2,557.0 ± 840.6
Aug	403.7 ± 66.1	0.9 ± 1.3	417.8 ± 59.5	716.8 ± 75.3	22.4 ± 5.3	1,159.7 ± 23.8
Sep	329.0 ± 31.7	0.0 ± —	336.4 ± 31.7	864.5 ± 91.2	0.0 ± —	1,200.9 ± 85.9
Oct	52.3 ± 31.7	0.0 ± —	76.6 ± 34.4	1,211.2 ± 401.8	29.9 ± 26.4	1,317.7 ± 409.7
Mean	290.3 ± 73.5	5.7 ± 4.6	333.1 ± 83.2	**1,124.0 ± 227.5**	**28.2 ± 9.9**	**1,485.8 ± 282.2**

'- -' Indicates no data collected or no value.

In 1995, the reservoir experienced one large peak in Daphnia spp. densities. This peak occurred between May and September and seemed to start at the lower end of the reservoir first and progress upstream with time (Tables 3.3-3.12). 1995 zooplankton population dynamics appear to be similar to those seen in 1994. There was a considerable difference in the densities of zooplankton between sample areas ranging from a yearly average low of 1,637.2 organisms/m3 at Gifford to a yearly average high of 4,427.8 organisms/m3 at Spring Canyon (Tables 3.3-3.12). The highest recorded Daphnia spp. density was 6380.6 organisms/m3 at Gifford in August followed by a value of 4,049.2/m^3 at the Confluence site in August. Total zooplankton values were highest at the Confluence site (11,29 1.3/m^3) in June, followed by densities of 11,106.1/m^3 in July at the San Poil River. Yearly low Daphnia spp. densities of 0.0/m^3 were recorded at Gifford in January, Porcupine Bay in March and at the Confluence site in March and April. Total zooplankton densities were lowest at Gifford with a value of 30.0 organisms/m3 recorded in March.

3.2.2 Zooplankton Biomass

Monthly mean biomass ($\mu g/m^3$) values for cladocera collected at Kettle Falls, Gifford, Hunters, Porcupine Bay, Confluence, Seven Bays, Keller Ferry, San Poil, Spring Canyon and Rufus Woods are shown in Tables 3.13 through 3.22. Mean biomass by species for each location can be found in Appendix B. Total cladocera biomass at Kettle Falls averaged 50.1 $\mu g/m^3$ and ranged from 0.0 $\mu g/m^3$ in May to 148.9 $\mu g/m^3$ (Table 3.13). Gifford biomass averaged 550.5 $\mu g/m^3$ for the year and ranged from 0.0 $\mu g/m^3$ in January to 4,005.8 $\mu g/m^3$ in August (Table 3.14). Total cladocera biomass at Hunters averaged 671.9 $\mu g/m^3$ and ranged from 0.1 $\mu g/m^3$ in May to 1,827.6 $\mu g/m^3$ in October (Table 3.15). Porcupine Bay averaged 494.2 $\mu g/m^3$ for the year and ranged from 0.0 $\mu g/m^3$ in March to 2,085 $\mu g/m^3$ in June (Table 3.16). The Confluence site averaged 1,719 $\mu g/m^3$ and ranged from 0.0 $\mu g/m^3$ in March and April to 8,690.6 $\mu g/m^3$ in August (Table 3.17). Total cladocera biomass at Seven Bays averaged 1,7 19.5 $\mu g/m^3$ for the year and ranged from 0.1 $\mu g/m^3$ in March to 3,422.0 $\mu g/m^3$ in July (Table 3.18). Keller Ferry total cladocera values ranged from 0.1 $\mu g/m^3$ in March to 1,78 1 in August with an average of 513.3 $\mu g/m^3$ (Table 3.19). San Poil total cladocera values ranged from 61.4 $\mu g/m^3$ in October to 2,414.0 $\mu g/m^3$ in July with a mean of 1,237.7 $\mu g/m^3$ (Table 3.20). Spring Canyon total cladocera biomass values ranged from 3.4 $\mu g/m^3$ in April to 6,085.8 $\mu g/m^3$ in June yielding an average of 839.8 $\mu g/m^3$ (Table 3.21). Finally, Rufus Woods total cladocera biomass values averaged 473.3 $\mu g/m^3$ and ranged from 1 .O $\mu g/m^3$ in April to 4,051.3 $\mu g/m^3$ in June (Table 3.22)

Table 3.13 Monthly mean zooplankton biomass **values** in $\mu g/m^3$ at Kettle **Falls** (Index Station **1),** in 1995.

	May	Jul	Oct	Mean
Daphnia Spp.	0.0	0.2	148.9	49.7
Leptodora kindtii	0.0	1.1	0.0	0.4
Total Cladocera	0.0	1.3	148.9	50.1

Table 3.14 Monthly mean zooplankton biomass values in $\mu g/m^3$ at Gifford (Index Station **2),** in 1995.

	Jan	Feb	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
Daphnia Spp.	0.0	0.1	0.0	0.1	0.1	111.9	903.2	47.3	86.1	127.6
L. kindtii	0.0	0.0	0.0	2.3	13.0	338.0	3,102.5	0.0	349.5	422.3
Total Cladocera	0.0	0.1	0.0	2.4	13.1	449.9	4,005.8	47.3	435.6	550.5

Table 3.15 Monthiy mean zooplankton biomass values in $\mu g/m^3$ at Hunters (Index Station **3),** in 1995.

	May	Jul	Oct	Mean
Daphnia Spp.	0.1	77.5	187.9	88.5
Leptodora kindtii	0.0	1,750.2	0.0	583.4
Total Cladocera	0.1	1,827.6	187.9	671.9

Table 3.16 Monthly mean zooplankton biomass values in $\mu g/m^3$ at Porcupine Bay (Index Station **4),** in 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
Daphnia Spp.	2.4	13.2	0.0	0.1	4.6	161.9	93.6	262.1	770.1	323.9	163.2
L. kindtii	0.0	0.0	0.0	0.0	0.0	1,923	1,373	0.0	0.0	14.0	331.1
Tot Cladocera	2.4	13.2	0.0	0.1	4.6	2,085	1,467	262.1	770.1	337.9	494.2

Table 3.17 Monthly mean zooplankton biomass values in μg/m^3 at the confluence of the Spokane River with the **mainstem** Columbia (Index Station Confluence), in 1995.

	Jan	Feb	Mar	Apr	Jun	Aug	**Sep**	Mean
Daphnia Spp.	43.5	7.1	0.0	0.0	98.8	1,279.8	327.0	250.9
L. kindtii	0.0	0.0	0.0	0.0	2,690.8	7,410.8	178.7	**1,468.6**
Total Cladocera	43.5	7.1	0.0	0.0	2,789.5	8,690.6	505.7	**1,719.5**

Table 3.18 Monthly mean zooplankton biomass values in μg/m^3 at Seven Bays (Index Station **6),** in 1995.

	Jan	Feb	Mar	Apr	May	Jun	**Jul**	Aug	Sep	**Oct**	Mean
Daphnia Spp.	18.4	1.0	0.1	0.4	3.9	129.1	128.7	254.2	713.2	292.8	154.2
L. kindtii	0.0	0.0	0.0	0.0	69.7	2,799	3,293	459.7	156.1	0.0	677.7
Tot Cladocera	18.4	1.0	0.1	0.4	73.6	2,928	3,422	713.9	869.3	292.8	831.9

Table 3.19 Monthly mean zooplankton biomass values in μg/m^3 at Keller (Index Station **7),** in 1995.

	Jan	Feb	Mar	Apr	May	Jun	**Jul**	Aug	Sep	**Oct**	Mean
Daphnia Spp.	41.5	10.0	0.1	0.3	3.4	555.6	126.4	960.5	209.8	1.9	191.0
L. kindtii	0.0	0.0	0.0	0.0	0.0	718.0	1,405	820.6	280.3	0.0	322.4
Tot Cladocera	41.5	10.0	0.1	0.3	3.4	1,274	1,531	1,781	490.1	1.9	513.3

Table 3.20 Monthly mean zooplankton biomass values in μg/m^3 at San Poil (Index Station **8),** in 1995.

	Jul	**Oct**	Mean
Daphnia S pp.	525.2	61.4	293.3
Leptodora kindtii	1,888.8	0.0	944.4
Total Cladocera	2,414.0	61.4	**1,237.7**

Table 3.21 Monthly mean zooplankton biomass values in $\mu g/m^3$ at Spring Canyon (Index Station **9**), in 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
Daphnia Spp.	35.1	39.3	7.0	3.4	2.8	1,013.4	541.5	597.4	605.1	17.5	286.3
L. kindtii	0.0	0.0	0.0	0.0	28.5	5,072.4	397.7	7.0	30.3	0.0	553.6
Tot Cladocera	35.1	39.3	7.0	3.4	31.3	6,085.8	939.2	604.4	635.3	17.5	839.8

Table 3.22 Monthly mean zooplankton biomass values in $\mu g/m^3$ at Rufus Woods (Index Station **10**), in 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean
Daphnia Spp.	88.1	32.9	1.9	1.0	1.7	194.0	124.3	159.8	77.3	2.7	68.4
L. kindtii	0.0	0.0	0.0	0.0	0.0	3,857.3	0.0	192.2	0.0	0.0	405.0
Tot Cladocera	88.1	32.9	1.9	1.0	1.7	4,051.3	124.3	352.1	77.3	2.7	473.3

3.2.3 Zooplankton Lengths

Lengths in millimeters were taken from randomly selected cladocera collected at Kettle Falls, Gifford, Hunters, Porcupine Bay, Confluence, Seven Bays, Keller Ferry, San Poil and Spring Canyon in 1995. The results of these measurements are shown in Tables 3.23 through 3.32. Length ranges and mean lengths by species at four sampling stations are located in Appendix B. Mean lengths of select cladocera at Kettle Falls were: Daphnia galeata mendotae - 0.20 mm; Daphnia retrocurva - 0.20 mm; Daphnia *schødleri* - 0.25 mm; and Leptodora kindtii - 6.10 mm. Mean lengths at Gifford were: Daphnia galeata mendotae - 0.30 mm; Daphnia retrocurva - 0.15 mm; Daphnia *schødleri* - 0.23 mm; and *Leptodora kindtii* - 4.10 mm. Mean lengths at Hunters were: Daphnia galeata *mendotae* - 0.25 mm; Daphnia retrocurva - 0.20 mm; Daphnia *schødleri* - 0.27 mm; and *Leptodora* kindtii - 6.00 mm. Mean lengths at Porcupine Bay were: Daphnia galeata mendotae - 0.40 mm; Daphnia retrocurva - 0.20 mm; Daphnia *schødleri* - 0.28 mm; and Leptodora kindtii - 4.70 mm. Mean lengths at the Confluence site were: Daphnia galeata mendotae - 0.20 mm; Daphnia retrocurva - 0.20 mm; Daphnia *schødleri* - 0.28 mm; and Leptodora kindtii - 6.30 mm. Mean lengths at Seven Bays were: Daphnia galeata mendotae - 0.20 mm; Daphnia retrocurva - 0.18 mm; Daphnia *schødleri* - 0.25 mm; and *Leptodora* kindtii - 5.55 mm. Mean lengths at Keller Ferry were: Daphnia galeata mendotae - 0.30 mm; Daphnia *retrocurva* - 0.23 mm; Daphnia *schødleri* - 0.27 mm; and *Leptodora* kindtii - 5.50 mm. Mean lengths at San Poil were: Daphnia retrocurva - 0.10 mm; Daphnia *schødleri* - 0.20 mm; and Leptodora kindtii - 6.80 mm. Mean lengths at Spring Canyon were: Daphnia galeata mendotae - 0.23 mm; Daphnia retrocurva - 0.23 mm; Daphnia *schødleri* - 0.28 mm; and Leptodora kindtii - 4.14 mm. Mean lengths at Rufus Woods were: Daphnia galeata mendotae - 0.50 mm; Daphnia retrocurva - 0.23 mm; Daphnia *schødleri* - 0.26 mm; and *Leptodora* kindtii - 6.90 mm. Overall, 1995 mean lengths were smaller than those reported in the 1994 report (Shields and Underwood, 1996).

Table 3.23 **Monthly mean zooplankton lengths in mm for select cladocera at Kettle Falls (Index Station I), in 1995.**

	May			Jul			Oct		
D.g.mendota	—	±	—	0.2	±	0.1	0.2	±	0.1
D.pulicaria	—	±	—	—	±	—	—	±	—
D.retrocurva	—	±	—	0.2	±	0.1	0.2	±	0.1
D.sch#dleri	—	±	—	0.2	±	0.1	0.3	±	0.1
D.thorata	—	±	—	—	±	—	—	±	—
L.kindtii	—	±	—	6.1	±	2.4	—	±	—
Total Cladocera	—	±	—	0.2	±	0.1	0.3	±	0.1

'—' Indicates no data or no organisms found.

Table 3.24 Monthly mean zooplankton lengths in mm for select cladocera at Gifford (Index Station 2), in 1995.

	Jan	Feb	Apr	May	Jun	Jul	Aug	Sep	Oct
D.g.mendota	— ± —	— ± —	— ± —	— ± —	— ± —	0.3 ± 0.1	0.3 ± 0.1	— ± —	0.3 ± 0.1
D.pulicaria	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
D.retrocurva	— ± —	— ± —	— ± —	— ± —	— ± —	0.1 ± 0.0	0.2 ± 0.1	0.2 f0.1	0.1 ± 0.0
D.schødleri	— ± —	0.3 ± 0.1	0.1 ± 0.1	0.2 ± 0.0	0.1 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1
D.thorata	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
L.kindtii	— ± —	— ± —	— ± —	1.5 ± 0.7	4.8 ± 4.1	4.5 ± 2.5	5.5 ± 1.6	— ± —	— ± —
Total Cladocera	— ± —	**0.3** ± 0.1	0.1 ± 0.1	0.2 ± 0.0	0.1 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1

'—' **Indicates no data or no organisms found.**

Table 3.25 **Monthly mean zooplankton lengths in mm for select cladocera at Hunters (Index Station 3), in 1995.**

	May			Jul			Oct		
D.g.mendota	—	±	—	0.2	±	0.1	0.3	±	0.1
D.pulicaria	—	±	—	—	±	—	—	±	—
D.retrocurva	—	±	—	0.2	±	0.0	0.2	±	0.0
D.schødleri	0.2	±	0.1	0.3	±	0.1	0.3	±	0.1
D. thorata	—	±	—	—	±	—	—	±	—
L.kindtii	—	±	—	6.0	±	1.9	—	±	—
Total Cladocera	0.2	±	0.1	0.3	±	0.1	0.3	±	0.1

'—' Indicates no data or no organisms found.

Table 3.26 **Monthly mean zooplankton lengths in mm for select cladocera at Porcupine Bay (Index Station 4), in 1995.**

	Jan	Feb	Apr	May	Jun	Jul	Aug	Sep	Oct
D.g.mendota	— ± —	— ± —	— ± —	— ± —	0.4 ± 0.1	0.4 ± 0.1	— ± —	— ± —	— ± —
D.pulicaria	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
D.retrocurva	— ± —	— ± —	— ± —	— ± —	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	— ± —	— ± —
D.schødleri	0.2 ± 0.1	0.4 ± 0.1	0.2 ± —	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
D.thorata	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
L. kindtii	— ± —	— ± —	— ± —	— ± —	4.7 ± 1.9	6.4 ± 3.1	— ± —	— ± —	3.0 ± —
Total Cladocera	0.2 ± 0.1	0.4 ± 0.1	0.2 ± —	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1

'—' Indicates no data or no organisms found.

Table 3.27 **Monthly mean zooplankton lengths in mm for select cladocera at the confluence of the Spokane River with the mainstem Columbia (Index Station Confluence), in 1995.**

	Jan	Feb	Mar	Apr	Jun	Aug	Sep
D.g.mendota	— ± —	— ± —	— ± —	— ± —	0.2 ± 0.1	— ± —	— ± —
D.pulicaria	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
D.retrocurva	— ± —	— ± —	— ± —	— ± —	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1
D.schødleri	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	— ± —	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
D. thorata	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
L. kindtii	— ± —	— ± —	— ± —	— ± —	5.3 ± 3.3	7.6 ± 2.9	6.0 ± 1.4
Total Cladocera	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	— ± —	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1

'—' Indicates no data or no organisms found.

Table 3.28 **Monthly mean zooplankton lengths in mm for select cladocera at Seven Rays (Index Station 6), in 1995.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
D.g.mendota	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	0.2 ± 0.0	0.2 ± 0.1	0.2 ± 0.1	-- ± --	-- ± --
D.pulicaria	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --
D.retrocurva	-- ± --	-- ± --	-- ± --	-- ± --	0.1 ± 0.0	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	-- ± --	-- ± --
D.schødleri	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.0	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
D. thorata	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --
L.kindtii	-- ± --	-- ± --	-- ± --	-- ± --	-- ± --	5.2 ± 2.8	6.1 ± 2.4	6.4 ± 3.1	4.5 ± 0.8	-- ± --
Total Cladocera	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.0	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1

'—' Indicates no data or no organisms found,

Table 3.29 Monthly. mean zooplankton lengths in mm for select cladocera at Keller Ferry (Index Station 7), in 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
D.g.mendota	— * —	— ± —	— ± —	— ± —	— ± —	— ± —	0.3 ± 0.1	0.3 ± 0.1	— ± —	— ± —
D.pulicaria	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
D.retrocurva	— ± —	— ± —	— ± —	— ± —	— ± —	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.0	— ± —
D.schødleri	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.4 ± 0.1	0.3 ± 0.1	0.2 ± 0.1
D. thorata	— ± —	— f —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
L. kindtii	— ± —	— ± —	— j —	— ± —	— ± —	3.8 ± 2.1	4.8 ± 1.8	5.4 ± 1.1	8.0 ± 0.0	— ± —
Total Cladocera	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.4 ± 0.1	0.3 ± 0.1	0.2 ± 0.1

'—' **Indicates no data** or no organisms found.

Table 3.30 Monthly mean zooplankton lengths in mm for select cladocera at San Poil (Index Station 8), in 1995.

	Jul			Oct		
D.g.mendota	—	±	—	—	±	—
D.pulicaria	—	±	—	—	±	—
D.retrocurva	0.1	±	0.1	—	±	—
D.schødleri	0.2	±	0.1	0.2	±	0.1
D.thorata	—	±	—	—	±	—
L.kindtii	**6.8**	±	**3.0**	—	±	—
Total Cladocera	**0.2**	±	**0.1**	0.2	±	0.1

'—' Indicates no data or no organisms found.

Table 3.31 **Monthly mean zooplankton lengths in mm for select cladocera at Spring Canyon (Index Station 9), in 1995.**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
D.g.mendota	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	0.2 ± 0.0	0.3 ± 0.1	0.2 ± 0.0	— ± —
D.pulicaria	— ± —	— * —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —
D.retrocurva	— ± —	— + —	— ± —	— ± —	— ± —	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.0	— ± —
D.schødleri	0.3 ± 0.1	0.3 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ±0.1	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1
D.thorata	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	— ± —	0.4 ± 0.1	— ± —	— ± —
L. kindtii	— ± —	— ± —	— ± —	— ± —	2.3 ± 0.5	7.0 ± 3.1	4.4 ± 1.9	3.0 ± —	4.0 ± 0.0	— ± —
Total Cladocera	0.3 ± 0.1	0.3 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1

'—' Indicates no data or no organisms found.

Table 3.32 Monthly mean zooplankton lengths in mm for select cladocera at Rufus Woods (Index Station 10), in 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
D.g.mendota	-- ± --	-- ± --	— ± —	-- ± --	-- ± --	— ± —	-- ± --	0.5 ± —	— ± —	— ± —
D.pulicaria	-- ± --	-- ± --	— ± —	-- ± --	— ± —	— ± —	-- ± —	— ± —	— ± —	— ± —
D.retrocurva	-- ± —	— ± —	— ± —	— ± —	— ± —	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	— ± —	— ± —
D.schødleri	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1
D. thorata	-- f --	-- ± --	— ± —	-- ± --	-- ± --	— ± —	— ± —	0.4 ± 0.0	-- ± --	-- ± —
L. kindtii	-- ± --	-- ± --	— ± —	-- ± —	— ± —	7.4 ± 2.6	6.4 ± 3.1	10.0 ± —	— ± —	— ± —
Total Cladocera	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1

'—' Indicates no data or no organisms found.

3.3 Rainbow Trout Tagging

In 1995, a total of 12,984 fish were tagged at the Kettle Falls and Seven Bays net-pens in May. Of these fish, 4,995 were released from Kettle Falls and 7,989 were released from Seven Bays. A total of 200 tags were returned from anglers fishing in Lake Roosevelt or below in 1995, yielding an overall recapture rate of 2.0% (Table 3.33). An analysis of the returns by location shows that 67 tags were returned from fish tagged at Kettle Falls, while 133 tags were returned from fish tagged at Seven Bays. Table 3.35 shows the capture locations and percentage breakdowns for all tags returned from 1995 Kettle Falls releases. Overall, the highest number of returns for Kettle Falls fish came from the Spring Canyon area (42%, n=25). Table 3.36 shows the capture locations and percentage breakdowns for all tags returned from the 1995 Seven Bays releases. The highest number of returns for Seven Bays area came from Seven Bays (33%, n=36). Table 3.33 summarizes fish tag recoveries from net-pen tagging efforts on Lake Roosevelt in 1995. Table 3.34 lists rainbow trout release times versus water retention times and their subsequent recapture rates. Based on this information, it can be seen that entrainment rates for rainbow trout appeared to be low in 1995. Total May releases show that only five fish out of a total of 200 returns came from below Lake Roosevelt, yielding a 3% recapture rate below Grand Coulee Dam.

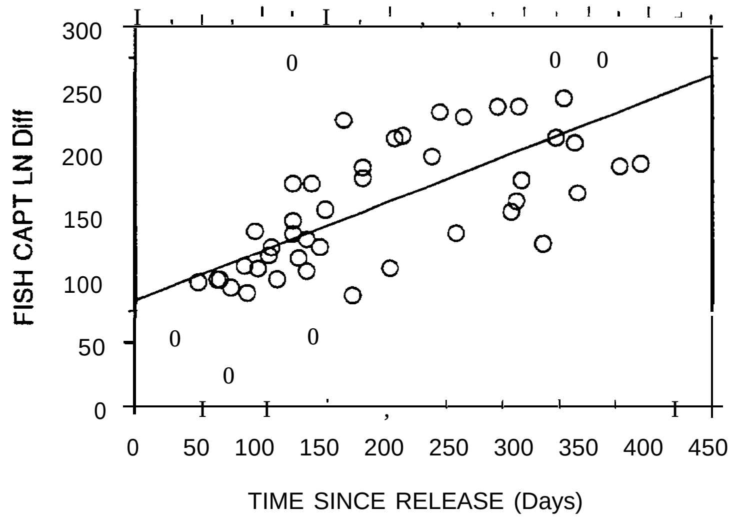
To determine growth rates of rainbow trout from the time of release to the time of recapture, we plotted days since release versus capture length and weight for the Kettle Falls and Seven Bays tag returns (Figures 3.3, 3.4 and 3.5).

Table 3.33 **Summary of release dates, numbers, and subsequent capture locations of net-pen rainbow trout tagged and released from various net pen locations in 1995.**

							Recoveries Below Grand Coulee		
Tag Location	Release Date	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	# Recovered in Rufus Woods	# Recovered at Rock Is. or McNary	% Recovered Below FDR
1	May-95	4,995	67	1%	65	97%	2	0	3%
6	May-95	7,989	133	2%	131	98%	2	1	2%

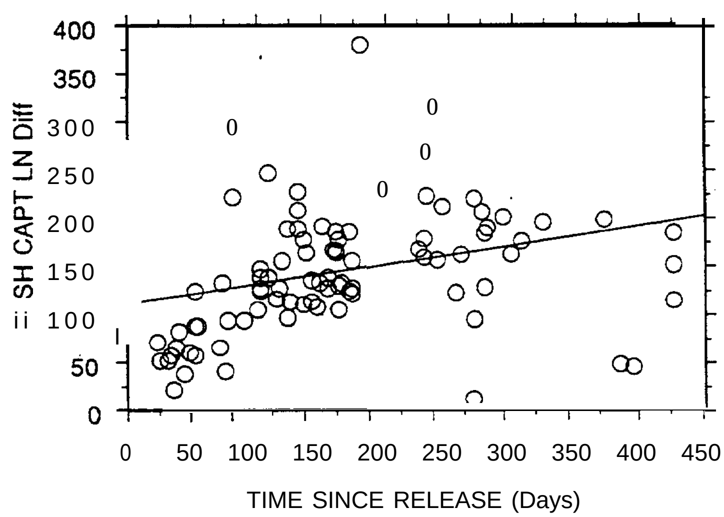
Table 3.34 **Summary of rainbow trout release times, water retention times and subsequent recapture numbers and percentages by year.**

Release Date	Water Retention Time	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coule: # Recovered in Rufus Woods	# Recovered at Rock Is. or McNary	% Recovered Below FDR
	36						0	5	
Mar. 89	32	768	8	1%	3	38%	0	3	63%
Mar. 90		1,441	7	0%	4	57%			43%
	48							0	2%
Mar. 92/93	67	[illegible]	[illegible]	<1%	[illegible]	98%	[illegible]	0	0%
Mar. 94	55	9,994	115	1%	113	98%	2	0	2%
Apr. 89	33	985	20	2%	38	55%	3	4	45%
Apr. 90	31	1,470	52	[illegible]	52	73%	10	13	27%
Apr. 91	18	2,300	78	3%		67%	13		33%
							4	0	2%
Apr. 92/93	[illegible]	[illegible]	[illegible]	1%	[illegible]	[illegible]	0	0	0%
Apr. 94	55	7,998	123	2%	121	98%	2	0	2%
May 88	40	1,171	99	9%	44	100%	0	2	0%
May 90	29	1,450	54	4%	283	81%	8	0	19%
	34								1%
May 92/93	39	[illegible]	[illegible]	[illegible]	64	[illegible]	[illegible]		0%
	44							0	1%
May 94/95	47	[illegible]	[illegible]	2%	[illegible]	98%	[illegible]	[illegible]	3%
Jun. 91		296	32	11%	27	99%	5		1%
	29			5%			0	0	0%
Jun. 92/93	[illegible]	[illegible]	[illegible]	4%	[illegible]	100%	0	0	0%
Jul. 91	62	1.749	155	9%	148	97%	7	0	3%



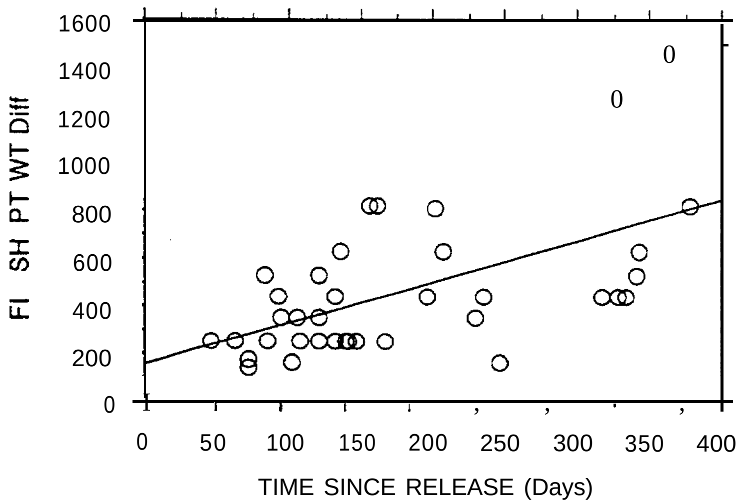
Y = 83.64 +0.389(X)

Figure 3.3 Plot of length increases (mm) versus time since release (Days) for tagged rainbow trout at Kettle Falls in 1995.



Y = 153.91 + 1.737(X)

Figure 3.4 Plot of length increases (mm) versus time since release (Days) for tagged rainbow trout at Seven Bays in 1995.



Y = 153.91 + 1.737(X)

Figure 3.5 Plot of tagged rainbow trout weight increases (g) versus time since release (Days) at Kettle Falls in 1995.

Table 3.35 Number and percent of fish captured by location from the Kettle Falls tag releases in 1995.

CAPTURE LOCATION	# CAPTURED	% CAPTURED
Kettle Falls	3	5.0
Gifford	2	3.0
Hunters	3	5.0
Seven Bays	8	13.0
Keller Ferry	15	25.0
San Poil	2	3.0
Spring Canyon	25	42.0
Rufus Woods	2	3.0
TOTAL	60	100.0

Table 3.36 Number and percent of fish captured by location from the Seven Bays tag releases in 1995.

CAPTURE LOCATION	# CAPTURED	% CAPTURED
Porcupine Bay	4	4.0
Seven Bays	31	28.0
Keller Ferry	36	32.0
San Poil	4	4.0
Spring Canyon	32	29.0
Rufus Woods	2	2.b
Rocky Reach Dam	1	1.0
TOTAL	111	100.0

4.0 DISCUSSION

4.1 Reservoir operations

Grand Coulee Dam was commissioned by congress to operate for power, flood control, irrigation, recreation, fisheries and navigation. In 1995, Lake Roosevelt also provided additional water for anadromous fish as a result of the National Marine Fisheries Service's (NMFS) Biological Opinion. During the fall and winter, Grand Coulee was operated with the objective of providing water for anadromous fish by storing water above requirements needed by the power system. System wide flood control was not shifted from Dworshak to Grand Coulee as prescribed by the Biological Opinion due to the small April 1 runoff forecast of 8.6 maf at the Dalles. On October 1, 1994, Lake Roosevelt was at 1,287 feet and was operated above 1,275 feet through early February, 1995. The lake reached a low elevation of 1,253.3 feet on March 8. The reservoir refilled to 1,269.3 feet by April 16 before being drafted for flood control down to 1,253.4 feet on May 5. Lake Roosevelt was then refilled back up to 1,289.0 feet by early July. Lake operations continued flow augmentation, normal water budget, and Endangered Species Act (ESA), draft requirements until the end of August at which time lake elevations were at 1,28 1.7 feet. The lowest elevation reached for ESA operations was 1,280.2 feet on August 23 representing a draft of 9.8 feet below full pool. The reservoir was then filled to 1,287.3 feet on September 30. The maximum daily inflow was 166.4 kcfs on June 9, and the highest daily outflow was 155.3 kcfs on June 26 (CRMG, 1995)

4.2 Hydrology

A comparison of monthly and annual means for reservoir inflow, outflow, elevation, storage capacity, and water retention time can be seen in Table *4.1*. Overall, lake elevations and storage capacity were similar for 1994 and 1995 while reservoir inflows and outflows were greater in 1995 than 1994 due to a slightly above average water year. For 1995, higher water volumes flushing through the system resulted in a shorter yearly mean water retention time of 46.5 days when compared with a yearly average of 54.8 days for 1994. Flood control rule curves were not implemented in 1995 as the result of a near average predicted spring runoff and thus, Lake Roosevelt avoided an extreme spring draw down like that seen in 1991. The 1995 lake elevations from January through May averaged nearly 13 feet below those observed in 1994. This, was due to higher predicted spring runoffs for 1995 when compared with 1994 (Table 4.1). Figures 4.1 and 4.2 show that 1991

Table 4.1 Monthly and annual means for reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in 1994 and 1995.

Month	Inflow (kcfs)	outflow (kcfs)	Reservoir Elevation **(Ft)**	Storage Capacity (kcfsd)	Water Retention Time (Days)
Jan. 1995	73.0	88.3	**1,278.3**	**4,127.8**	49.3
Jan. 1994	81.0	77.2	1,285.4	4,403.6	61.8
Feb. 1995	81.7	94.0	**1,266.2**	**3,688.9**	42.6
Feb. 1994	97.5	103.6	1,281.8	4,261.2	42.5
Mar. 1995	101.6	-90.1	1,259.0	**3,434.3**	42.4
Mar. 1994	67.9	77.7	1,276.5	4,061-l	54.9
Apr. 1995	81.2	84.5	**1,265.8**	**3,669.5**	47.5
Apr. 1994	89.5	73.0	1,268.1	3,754.4	55.0
May 1995	112.3	93.5	**1,260.1**	**3,460.4**	39.4
May 1994	112.4	99.6	1,280.6	4,215.0	44.0
Jun. 1995	148.1	117.8	**1,283.6**	**4,335.3**	40.1
Jun. 1994	133.1	135.9	1,276.0	4,041.3	30.1
Jul. 1995	111.6	110.5	1,287.0	**4,467.4**	41.4
Jul. 1994	101.7	95.8	1,274.9	3,996.1	43.5
Aug. 1995	96.3	91.9	**1,280.9**	**4,227.8**	47.2
Aug. 1994	82.5	73.3	1,277.1	4,080.0	58.7
Sept. 1995	79.9	65.9	**1,285.1**	**4,392.8**	69.0
Sept. 1994	67.6	55.9	1,281.3	4,244.6	78.4
Oct. 1995	80.3	80.6	**1,285.8**	**4,420.3**	56.7
Oct. 1994	61.6	64.0	1,287.2	4,474.9	72.6
Nov. 1995	97.2	91.9	**1,286.5**	**4,448.3**	50.4
Nov. 1994	75.5	75.7	1,284.7	4,374.9	60.1
Dec. 1995	**135.7**	**141.6**	**1,287.0**	**4,466.7**	**32.4**
Dec. 1994	85.0	83.5	1,284.2	4,356.8	56.3
Annual 1995	99.9	95.9	**1,277.1**	**4,095.0**	46.5
Annual 1994	87.9	84.6	1,279.8	4,188.7	54.8

reservoir operations produced the lowest mean elevations and water retention times when compared to the years of 1991 through 1995, while 1995 elevations were similar to the elevations in 1992 through 1994.

In addition to lake elevation data, water temperature was measured monthly to correlate temperature with zooplankton densities (Appendix C). Overall trends for temperature data show that temperatures are at yearly minimums in January at all sites with up reservoir sites being the coldest. Yearly maximum temperatures were reached at all sites in July and August.

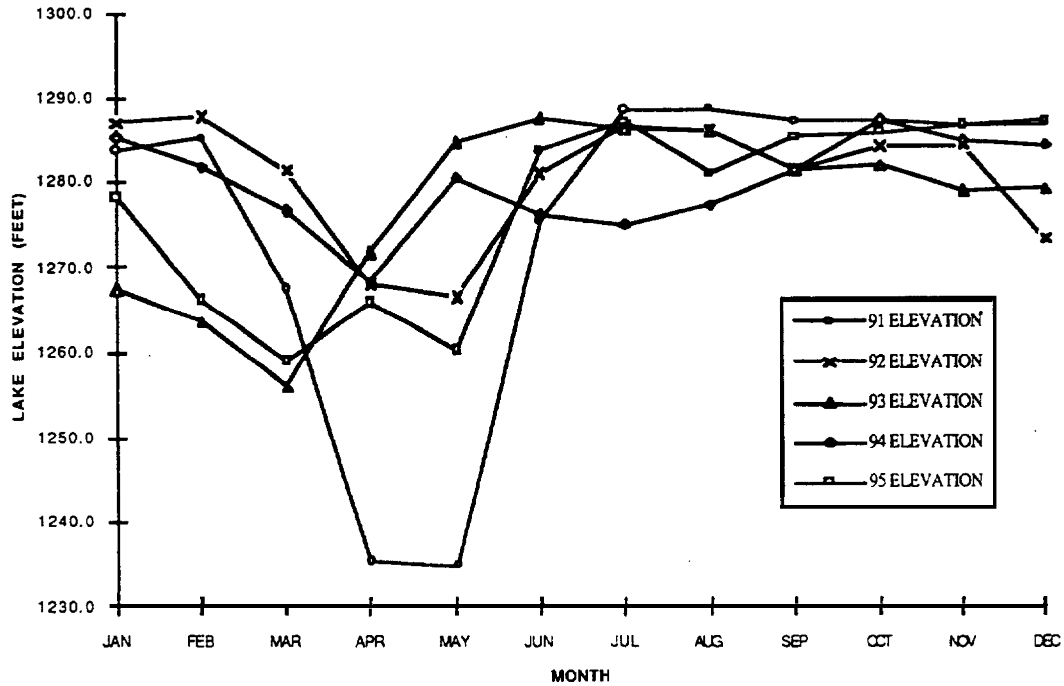


Figure 4.1 Mean monthly reservoir elevations from 1991 through 1995.

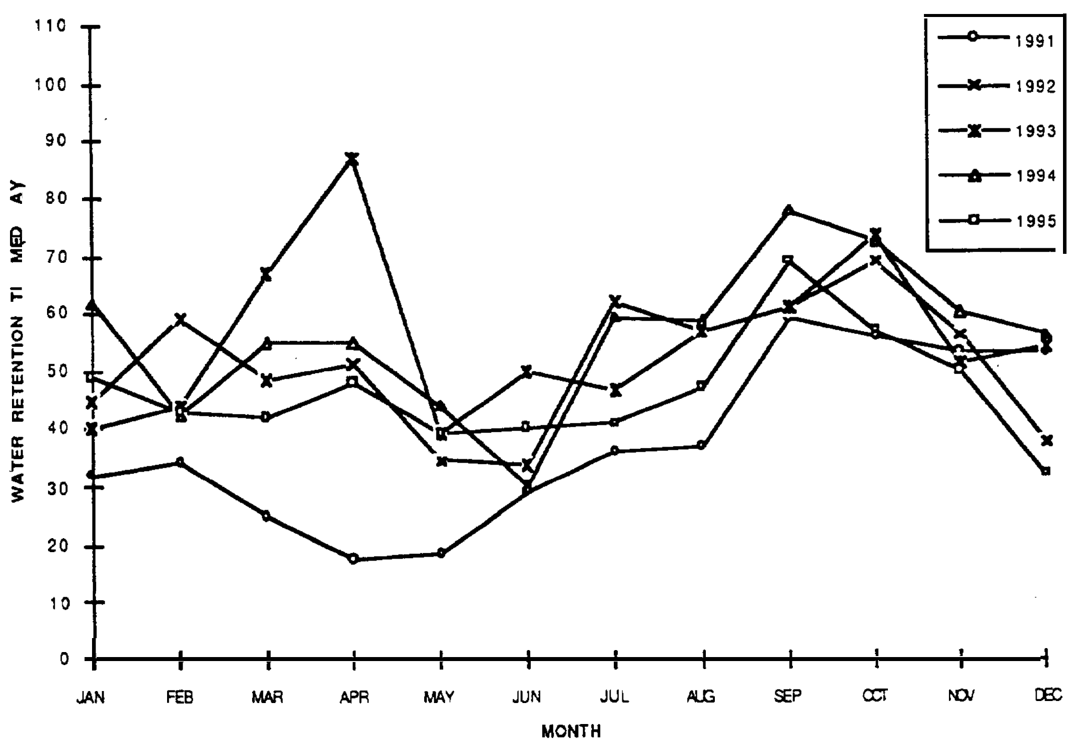


Figure 4.2 Mean monthly water retention times from 1991 through 1995.

4.3 Affect of Reservoir Operations on Zooplankton Dynamics

Figures 4.3 and 4.4 show the mean monthly Daphnia and total zooplankton density values at five locations in 1995. These figures indicated that Daphnia and total zooplankton densities remained low throughout the spring months but started to build in April and May in the lower river sections, reaching a peak density in June and July at Porcupine Bay, Seven Bays, Keller Ferry and Spring Canyon. After reaching yearly maximums, densities at the lower sites droped off through August and then incresased to a second smaller peak in September. Daphnia and total zooplankton densities at Gifford followed a much different pattern than the lower reservoir sites (Figures 4.5 and 4.6). At Gifford, densities started to build much later in the year, reaching a peak in August followed by a sharp decline by September. An analysis of zooplankton densities indicated that factors such as water temperature played a major role in zooplankton population dynamics. When water temperatures at 12 meters depth (chosen to avoid surface variations) were plotted against Daphnia spp. and total zooplankton densities, a positive correlation was evident (Figures 4.5 through 4.16). Results from a statistical analysis of Daphnia densities versus water temperatures yield a p value of <0.0001 and an r^2 value of 0.441 (Figure 4.15). Statistical analysis of total zooplankton densities versus water temperatures were significant ($p<0.0001$; $r^2 = 0.498$), meaning that, as temperature increased, zooplankton density also increased (Figure 4.16). The summer peak in zooplankton biomass and density values was probably the result of optimum temperatures coupled with a large quantity of nutrients and sunlight available for phytoplankton growth, which in turn increased the forage base for zooplankton. Warmer water temperatures increase the assimilation of nutrients by phytoplankton because they are poikilothermic organisms (Beckman *et* al. 1985). The drop in densities which occurs in August at the lower river sites may be due to the ten foot drafting of Lake Roosevelt resulting from ESA water demands, but at this time, were are unable to correlate zooplankton densities with drawdowns. August drawdowns have the greatest potential to impact zooplankton populations because they occur during a period

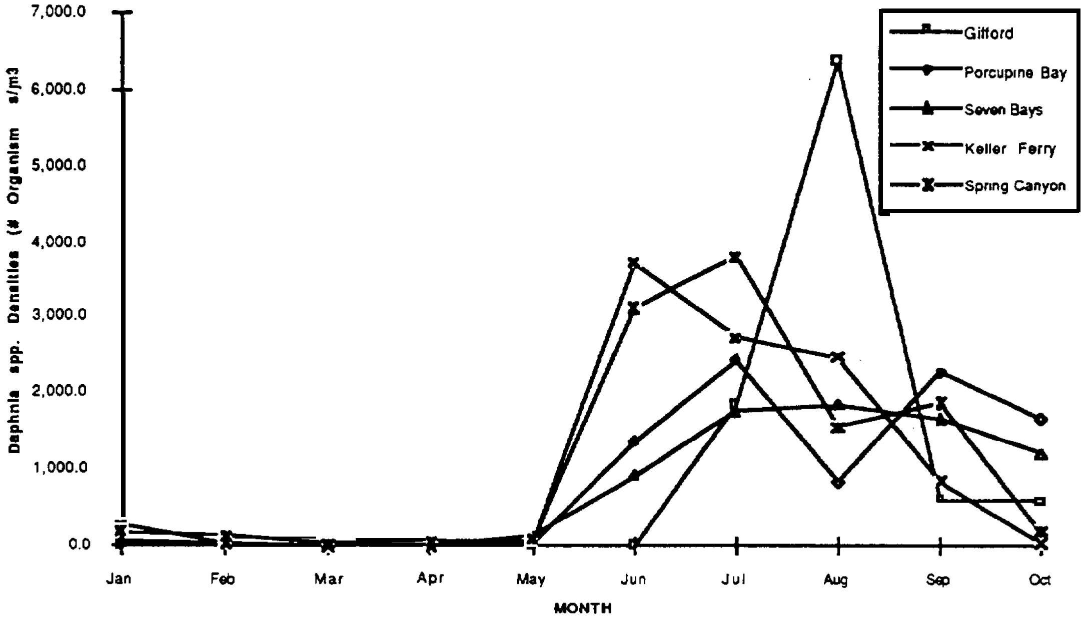


Figure 4.3 Mean monthly ***Daphnia*** spp. densities **(#/m³)** at Gifford, Porcupine Bay, Seven Bays, Keller Ferry and Spring Canyon in 1995.

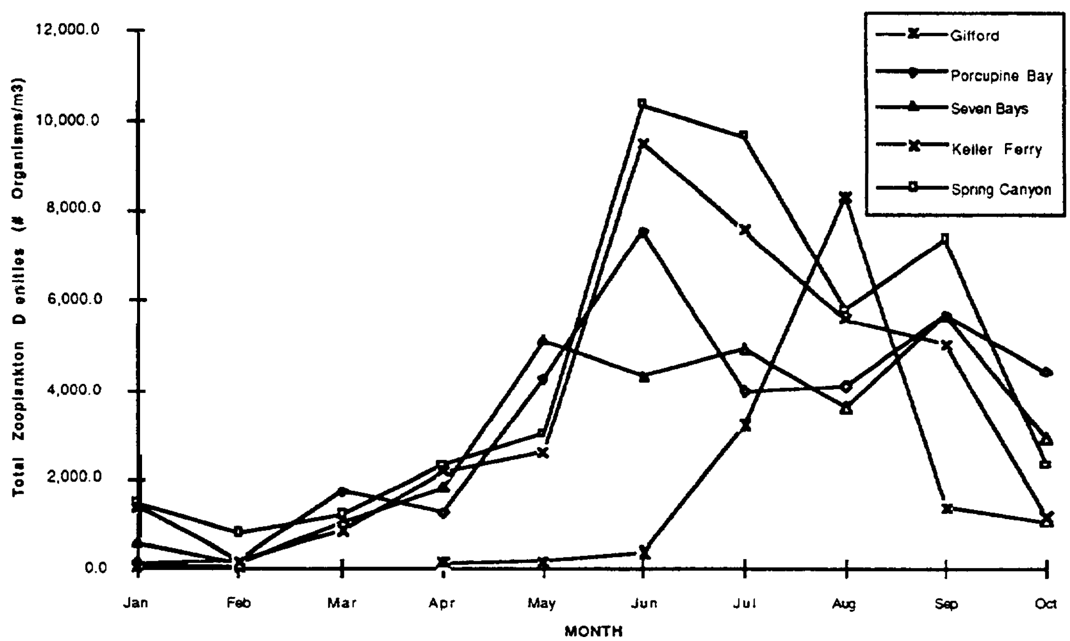


Figure 4.4 Mean monthly total zooplankton densities **(#/m³)** at Gifford, Porcupine Bay, Seven Bays, Keller Ferry and Spring Canyon in 1995.

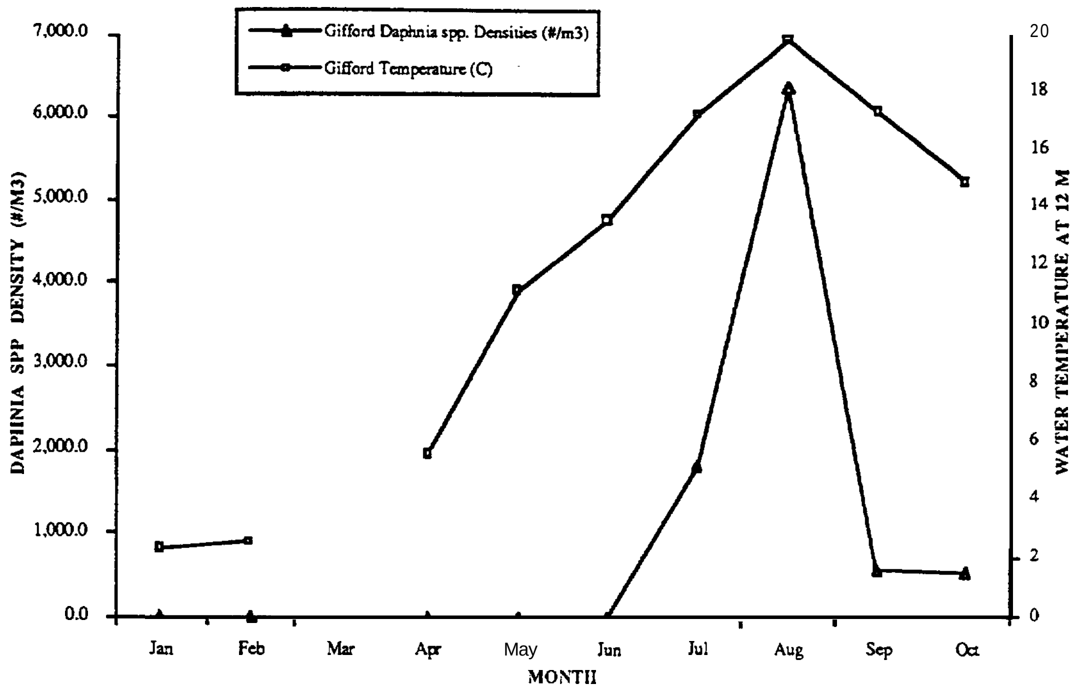


Figure 4.5 Mean Daphnia spp. densities (#/m^3) plotted against water temperature at 12 m depth at Gifford in 1995.

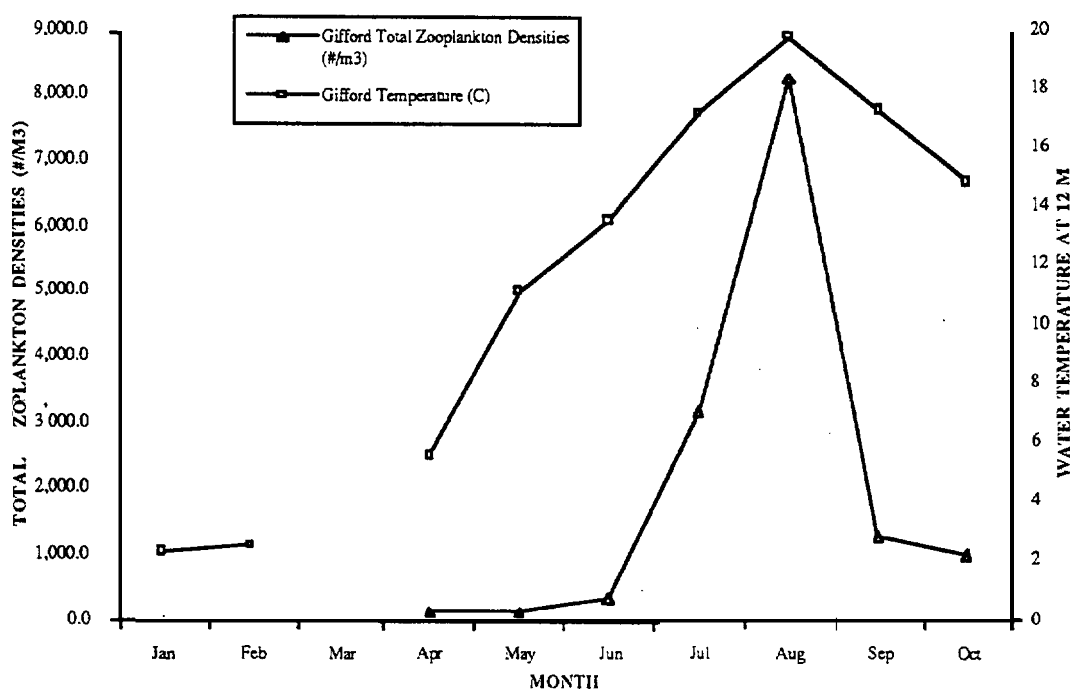


Figure 4.6 Mean total zooplankton densities (#/m^3) plotted against water temperature at 12 m depth at Gifford in 1995.

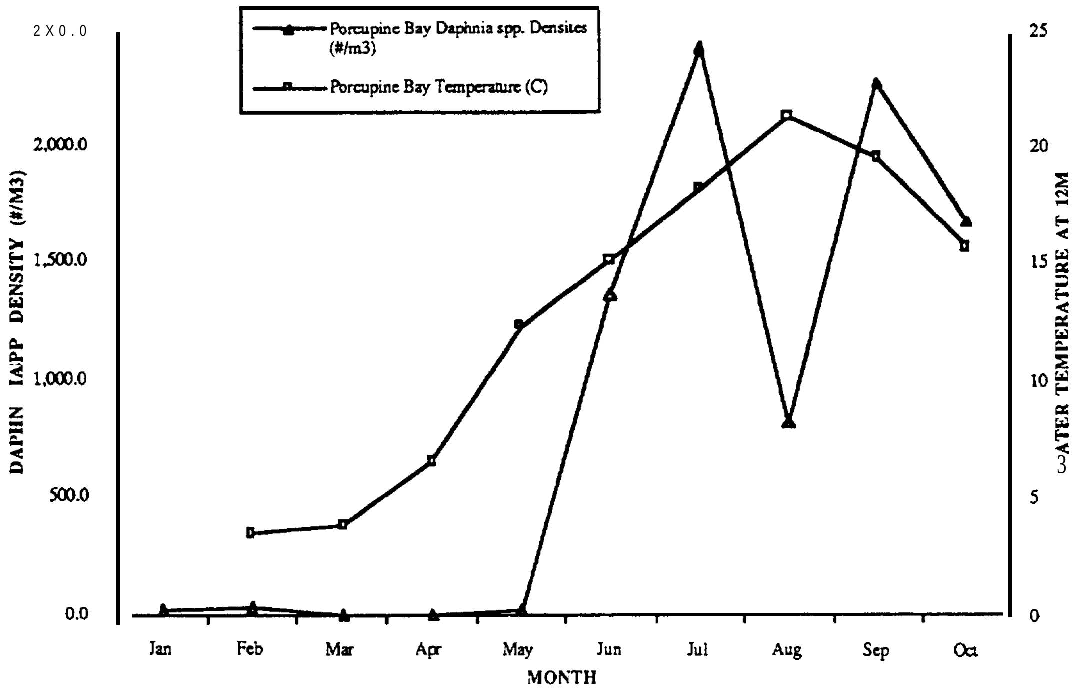


Figure 4.7 Mean *Daphnia* spp. densities **(#/m^3)** plotted against water temperature at 12 m depth at Porcupine Bay in 1995.

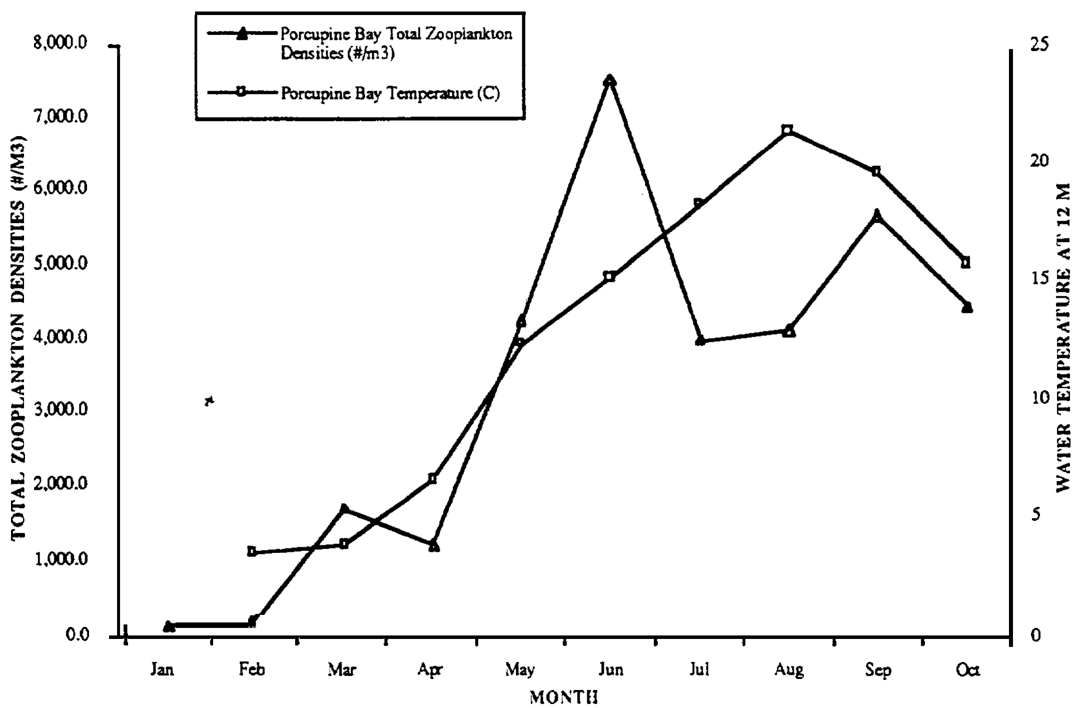


Figure 4.8 Mean total zooplankton densities **(#/m^3)** plotted against water temperature at 12 m depth at Porcupine Bay in 1995.

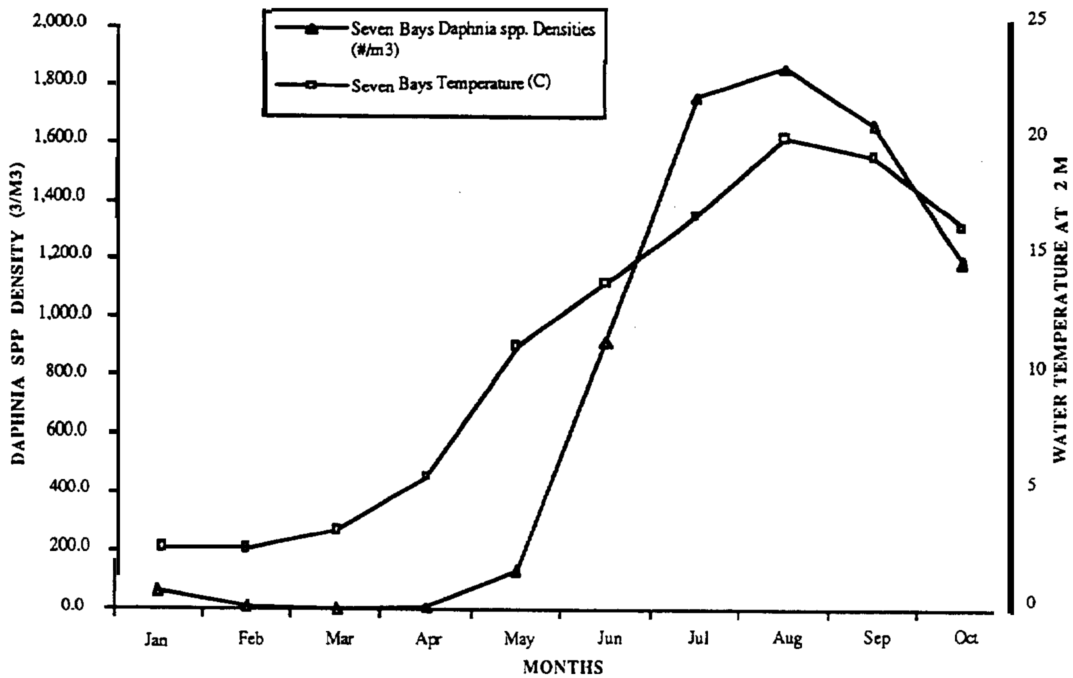


Figure 4.9 Mean *Daphnia* spp. densities (#/m^3) plotted against water temperature at 12 m depth at Seven Bays in 1995.

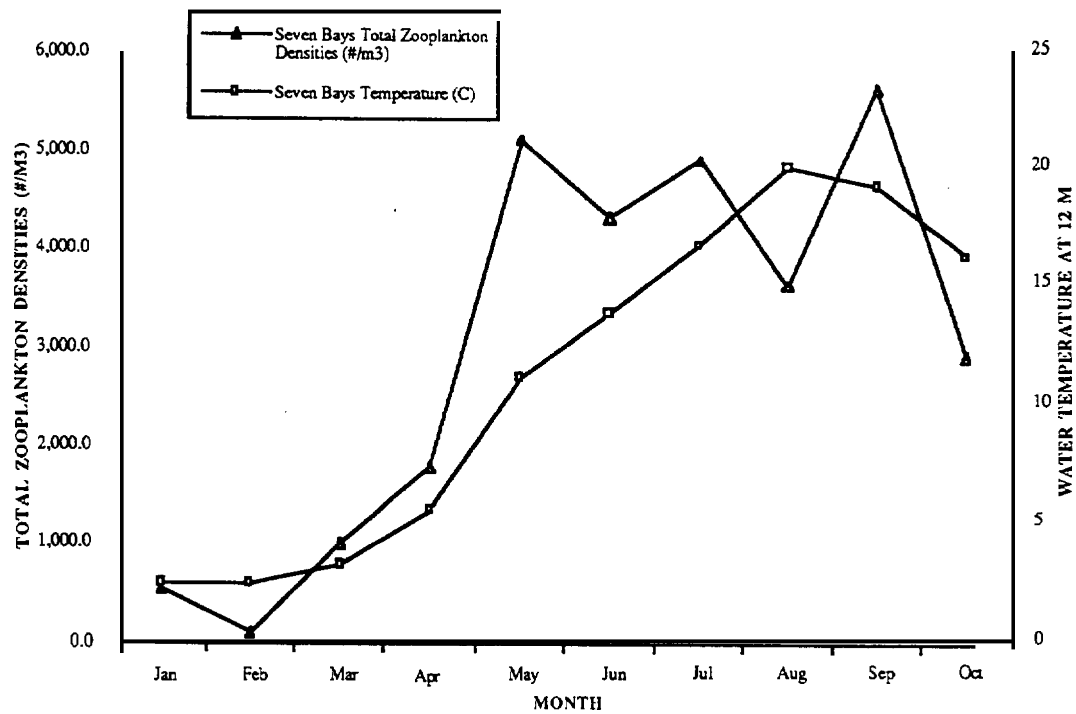


Figure 4.10 Mean total zooplankton densities (#/m^3) plotted against water temperature at 12 m depth at Seven Bays in 1995.

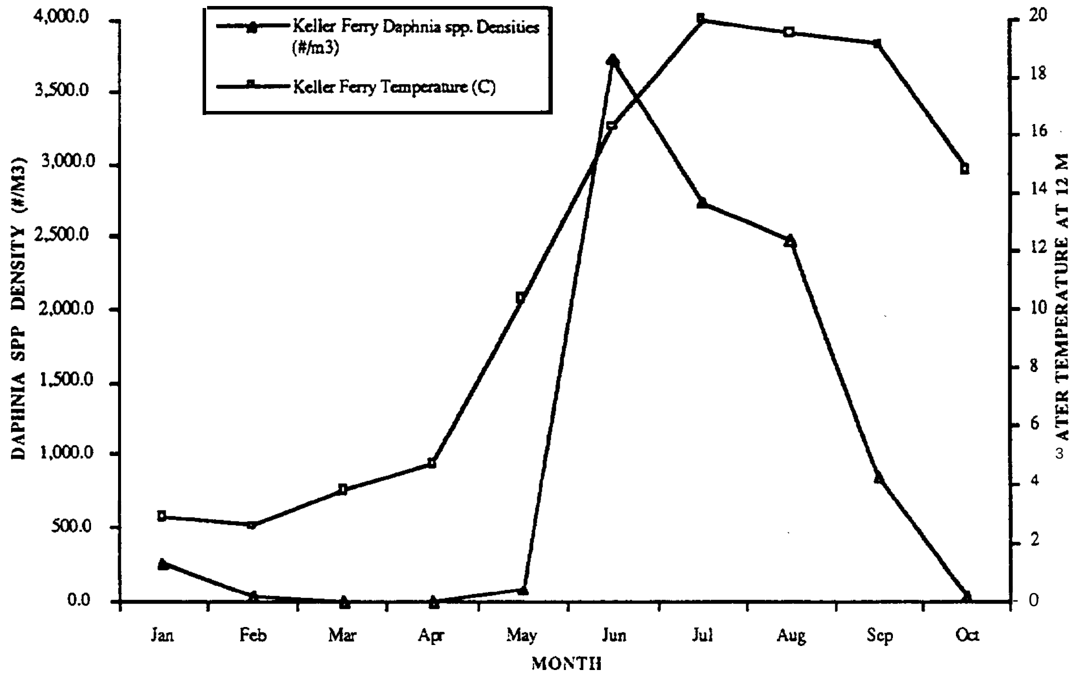


Figure 4.11 Mean ***Daphnia*** spp. densities (#/m^3) plotted against water temperature at 12 m depth at Keller Ferry in 1995.

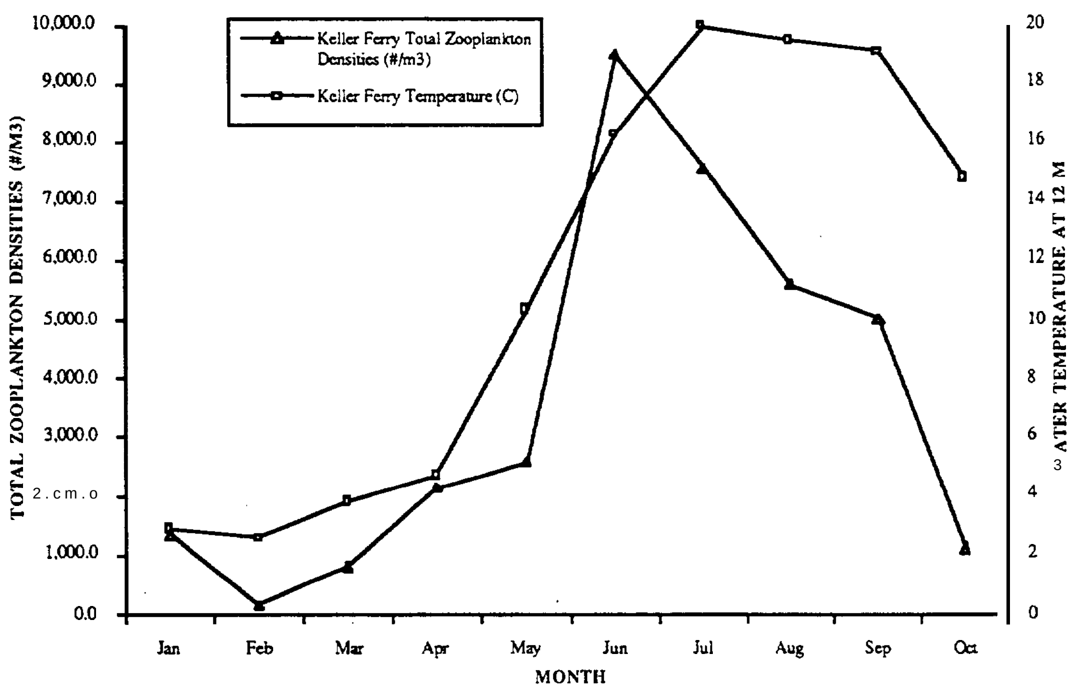


Figure 4.12 Mean total zooplankton densities (#/m^3) plotted against water temperature at 12 m depth at Keller Ferry in 1995.

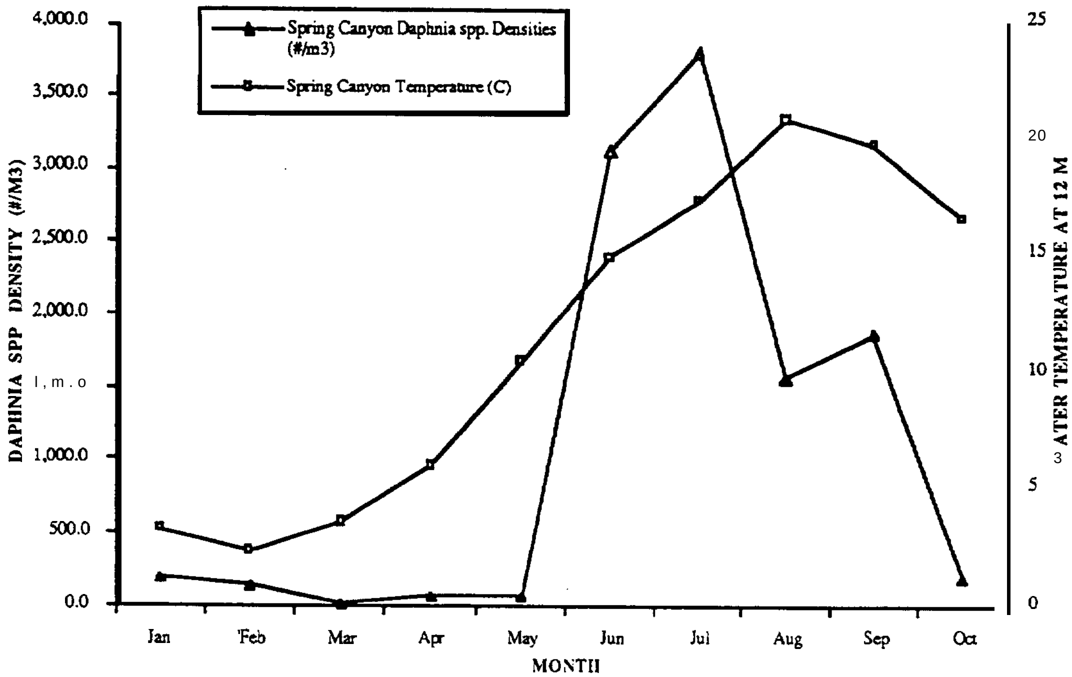


Figure 4.13 Mean ***Daphnia*** spp. densities **(#/m³)** plotted against water temperature at 12 m depth at Spring Canyon in 1995.

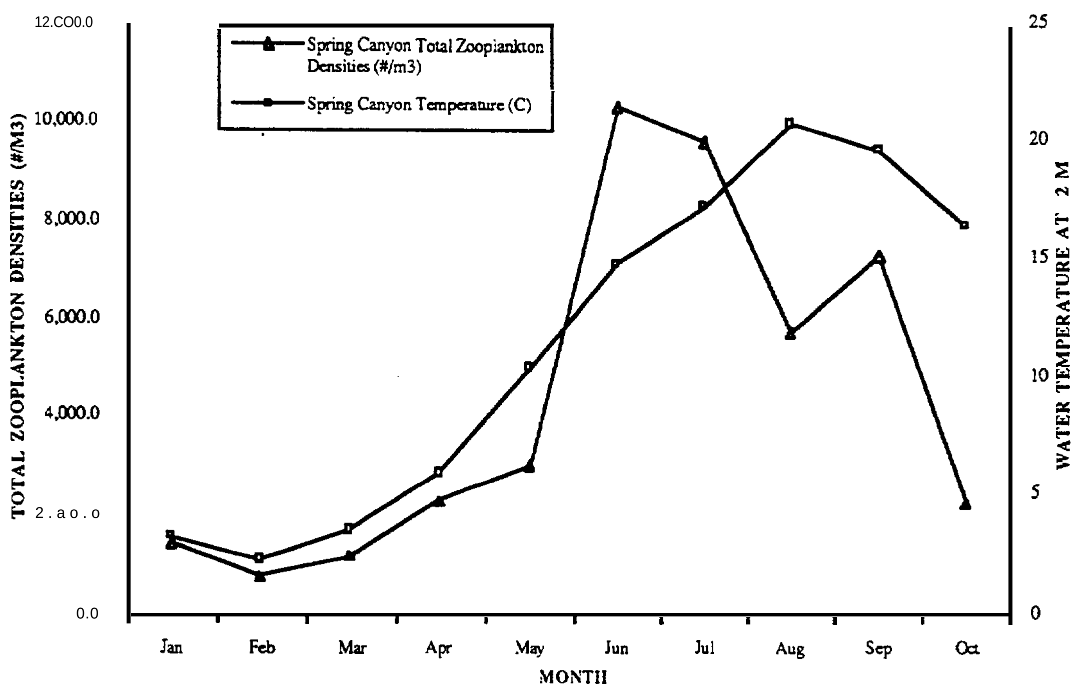


Figure 4.14 Mean total zooplankton densities **(#/m³)** plotted against water temperature at 12 m depth at Spring Canyon in 1995

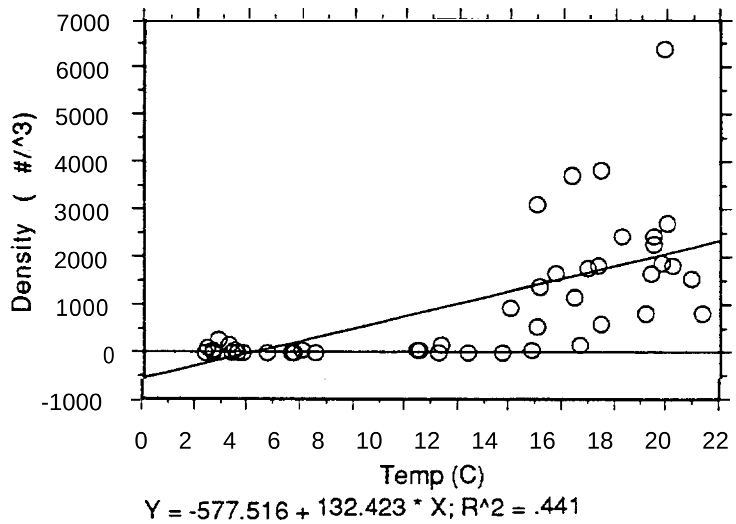


Figure 4.15 Regression plot of *Duphniu* spp. densities versus water temperatures at 12 m for five locations in Lake Roosevelt in 1995.

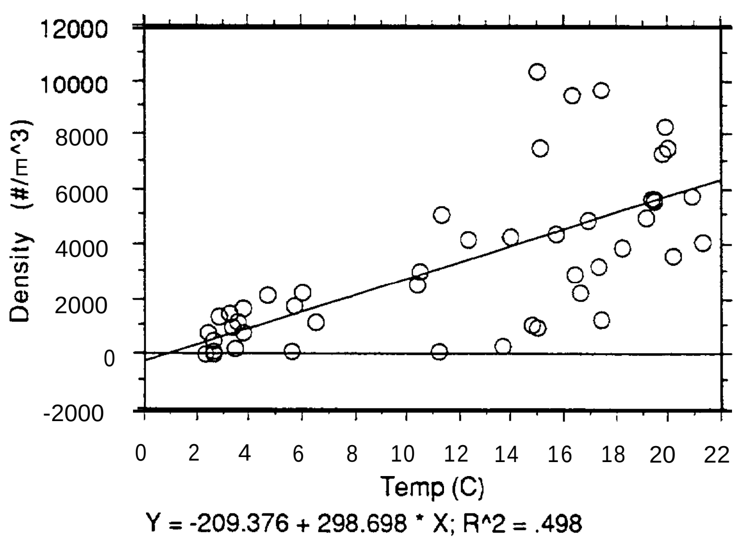


Figure 4.16 Regression plot of total zooplankton densities versus water temperatures at 12 m for five locations in Lake Roosevelt in 1995.

when zooplankton populations are greatest. In order to investigate this possibility, it is recommended that zooplankton sampling frequency be increased to weekly samplings. August population reductions may also be due to over grazing of phytoplankton by zooplankton resulting in a population crash. As August zooplankton densities decline, the phytoplankton population has a chance to rebuild, thus allowing for an additional increase in zooplankton densitiy as seen in September (Figures 4.3, 4.4 and Appendix B). The lag in *Daphnia* and total zooplankton densities at Gifford is likely the result of lower water temperatures which inhibit phytoplankton and zooplankton growth until later in the year. Based on the above analysis, it is evident that water temperature will be a significant variable in the future modeling of zooplankton population dynamics. A comparison of yearly average total zooplankton densities for 1994 and 1995 shows a marked increase in zooplankton densities in 1995 (Shields and Underwood, 1996). This increase is not evident when yearly average biomass values are cornpaired. This lack of biomass increase, despite the increase in zooplankton densities, was the result of much smaller average lengths for individual zooplanktors in 1995. The reasons for this trend are not known, but may be due to increased predation by kokanee or a reduction of nutrient inputs into the system.

Water retention times may also indirectly affect zooplankton growth. For example, short water retention times may limit growth by not allowing enough time for assimilation of nutrients into phytoplankton and may also reduce overall water temperatures by not allowing the water in the lake as much time to warm up. Increased peaks in biomass and density values are thought to be related to increased reservoir elevations and water retention times but also appear to be affected by nutrient concentrations and water temperatures (Goldman and Home 1983).

Figures 4.17 through 4.21 give the monthly mean total zooplankton densities and water retention times for a five year period beginning in 1991. Figure 4.17 shows a clear relationship between water retention time and zooplankton densities at the Gifford area. During the growing season, as water retention time increases, zooplankton densities increase shortly afterward. Peaks in water retention time during the winter months are not followed by increased zooplankton densities. This may be due to the fact that since zooplankton are poikilotherms, their metabolism and reproduction rates are reduced in winter and their populations remain low regardless of water retention times. Figure 4.17 shows that the time period of the growing season increase was slightly different each year, corresponding to water retention time and not season. For example, graphs for

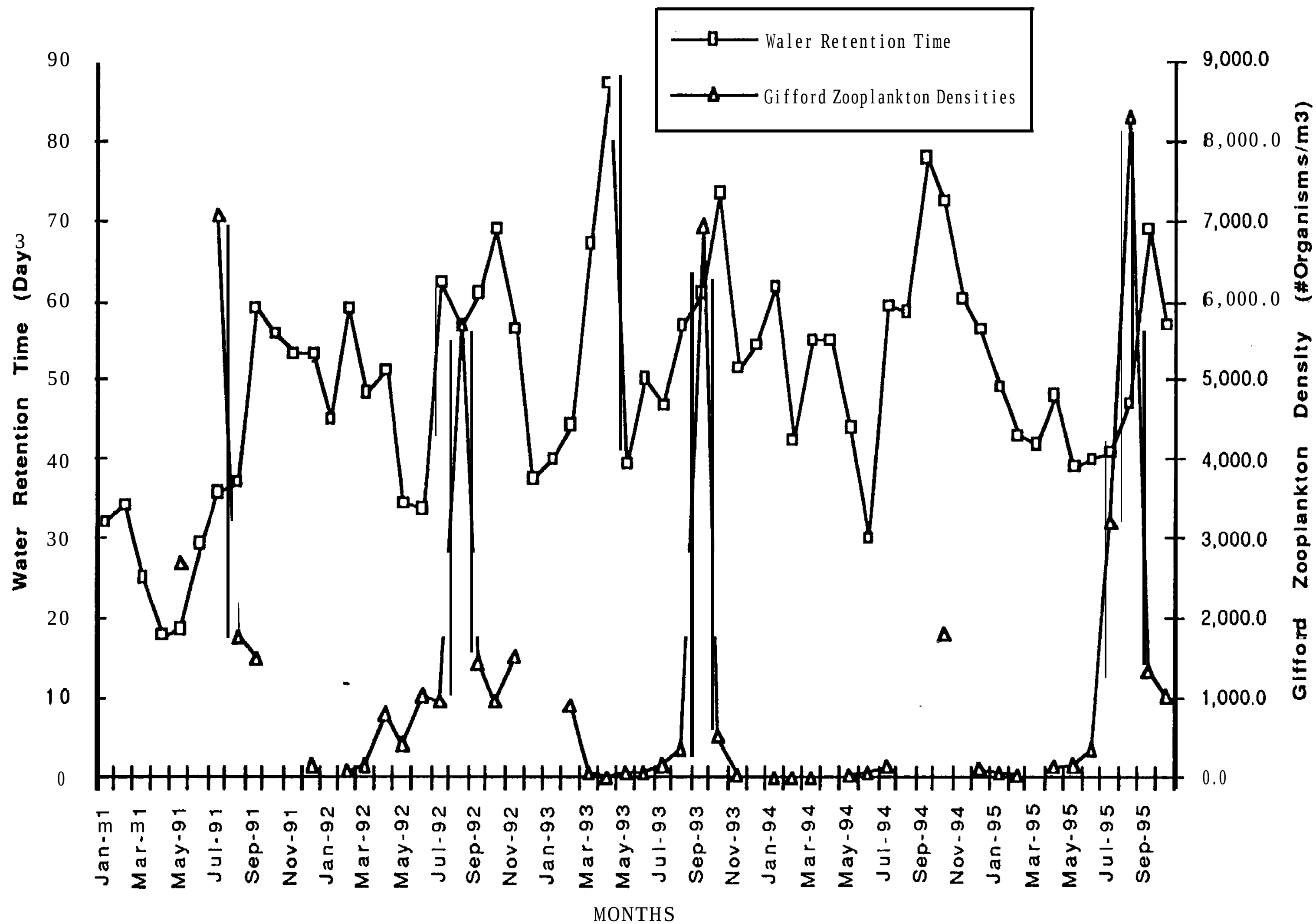


Figure 4.17 Monthly mean total zooplankton densities and monthly average water retention times at Gifford (Index Station **2),** from 1991 through 1995.

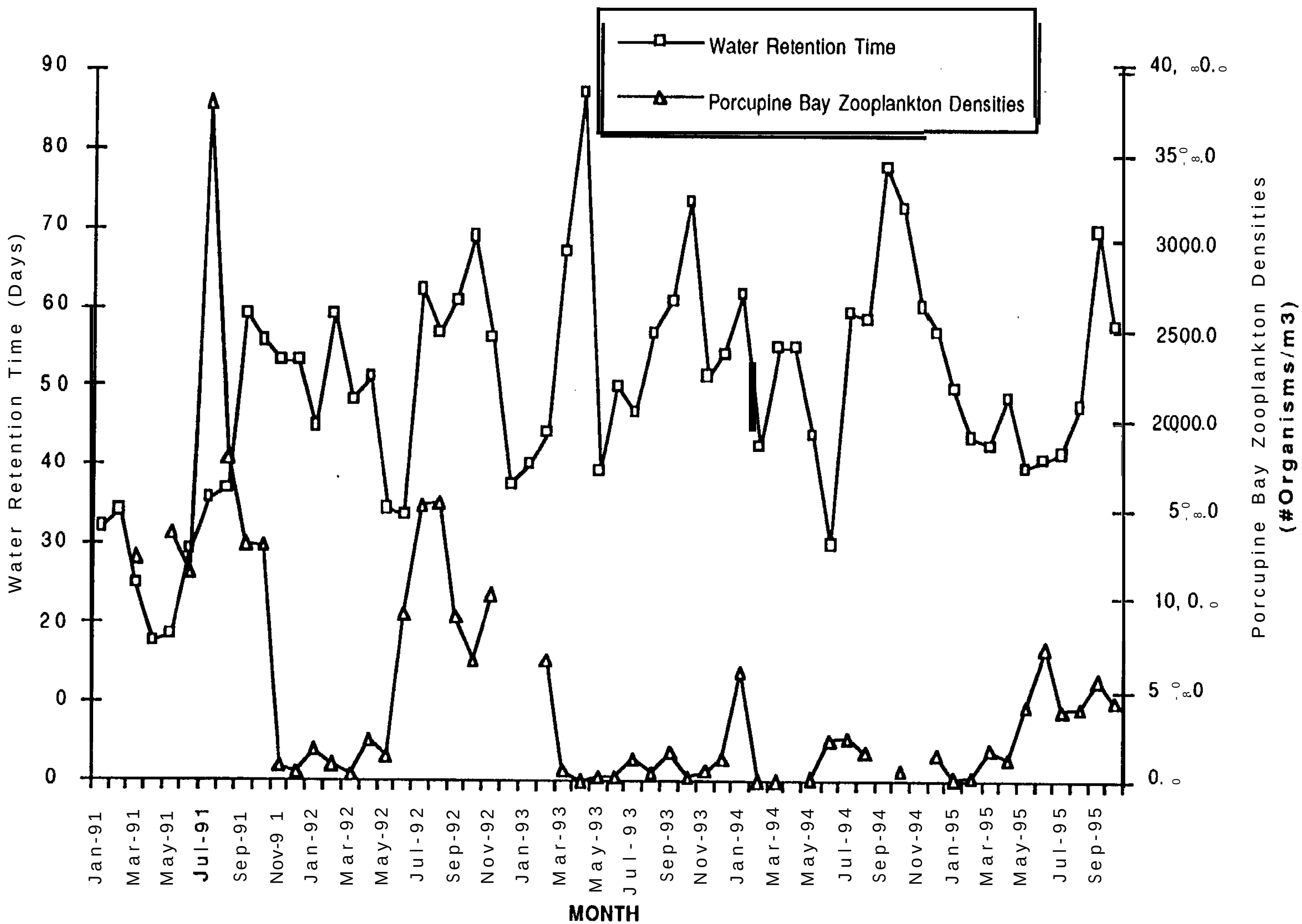


Figure 4.18 Monthly mean total zooplankton densities and monthly average water retention times a Porcupine Bay (Index Station 4), from 1991 through 1995.

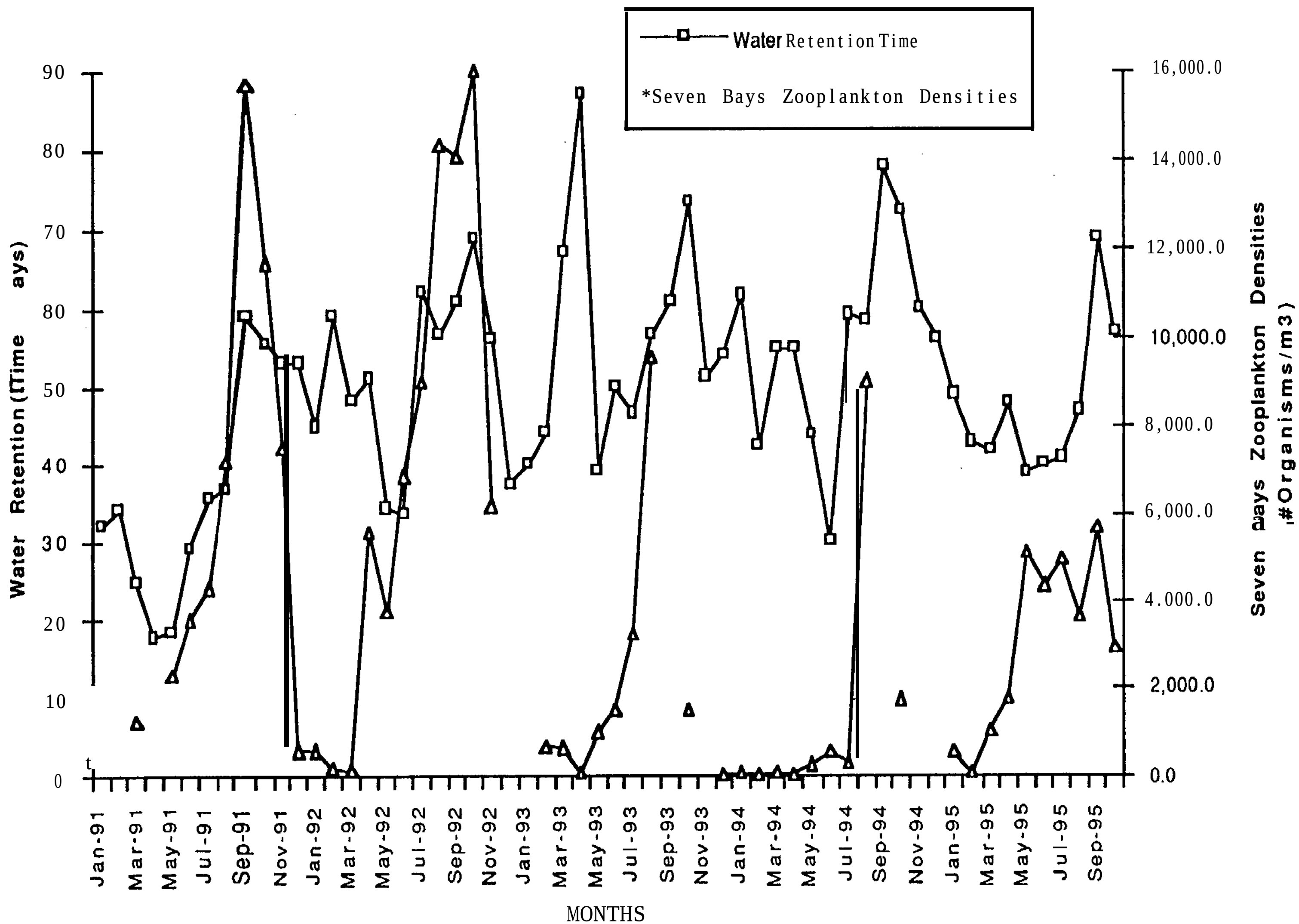


Figure 4.19 Monthly mean total zooplankton densities and monthly average water retention times at. Seven Bays (Index Station 6), from 1991 through 1995.

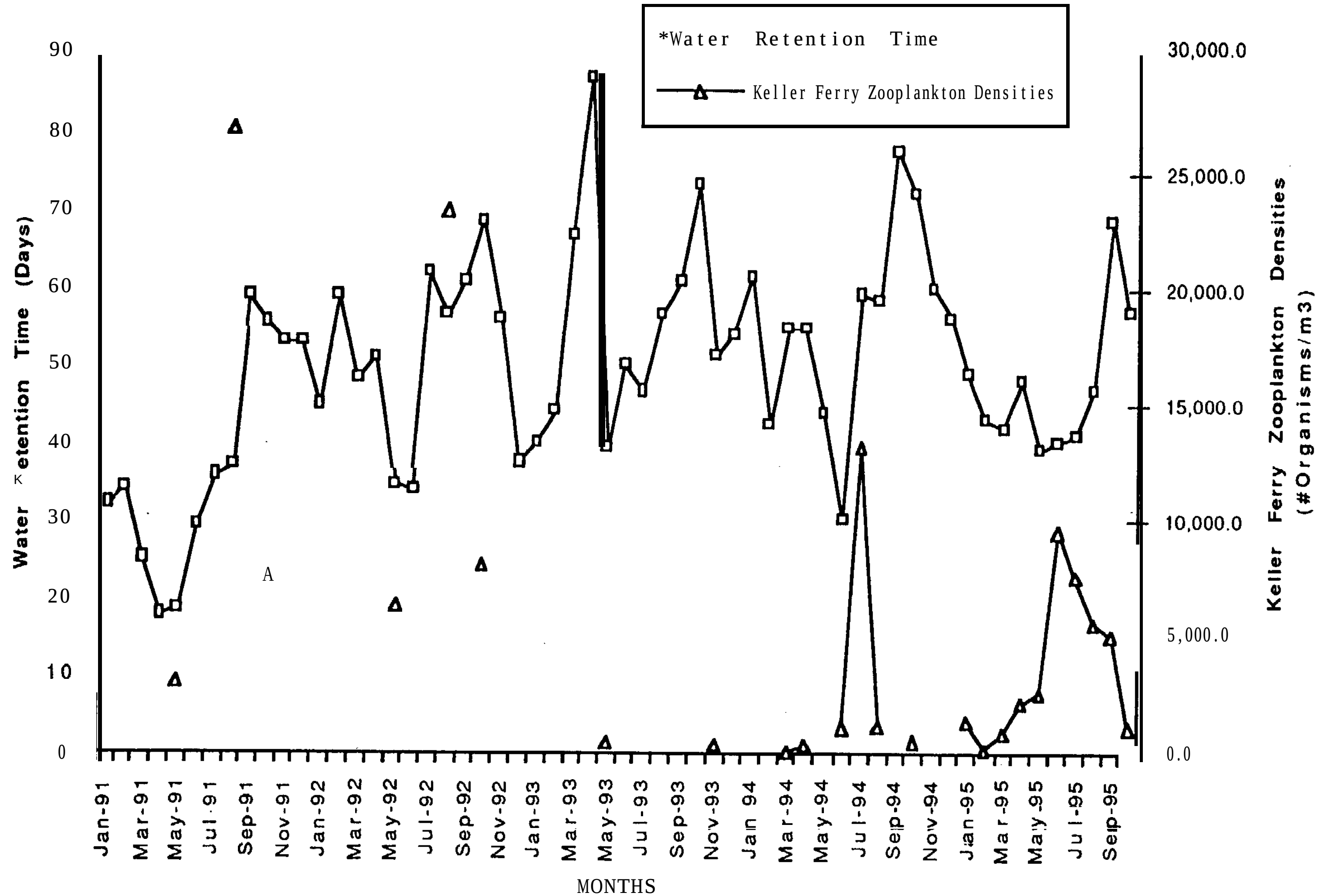


Figure 4.20 **Monthly mean total zooplankton densities and monthly average water retention times at Keller Ferry (Index Station 7), from 1991 through 1995.**

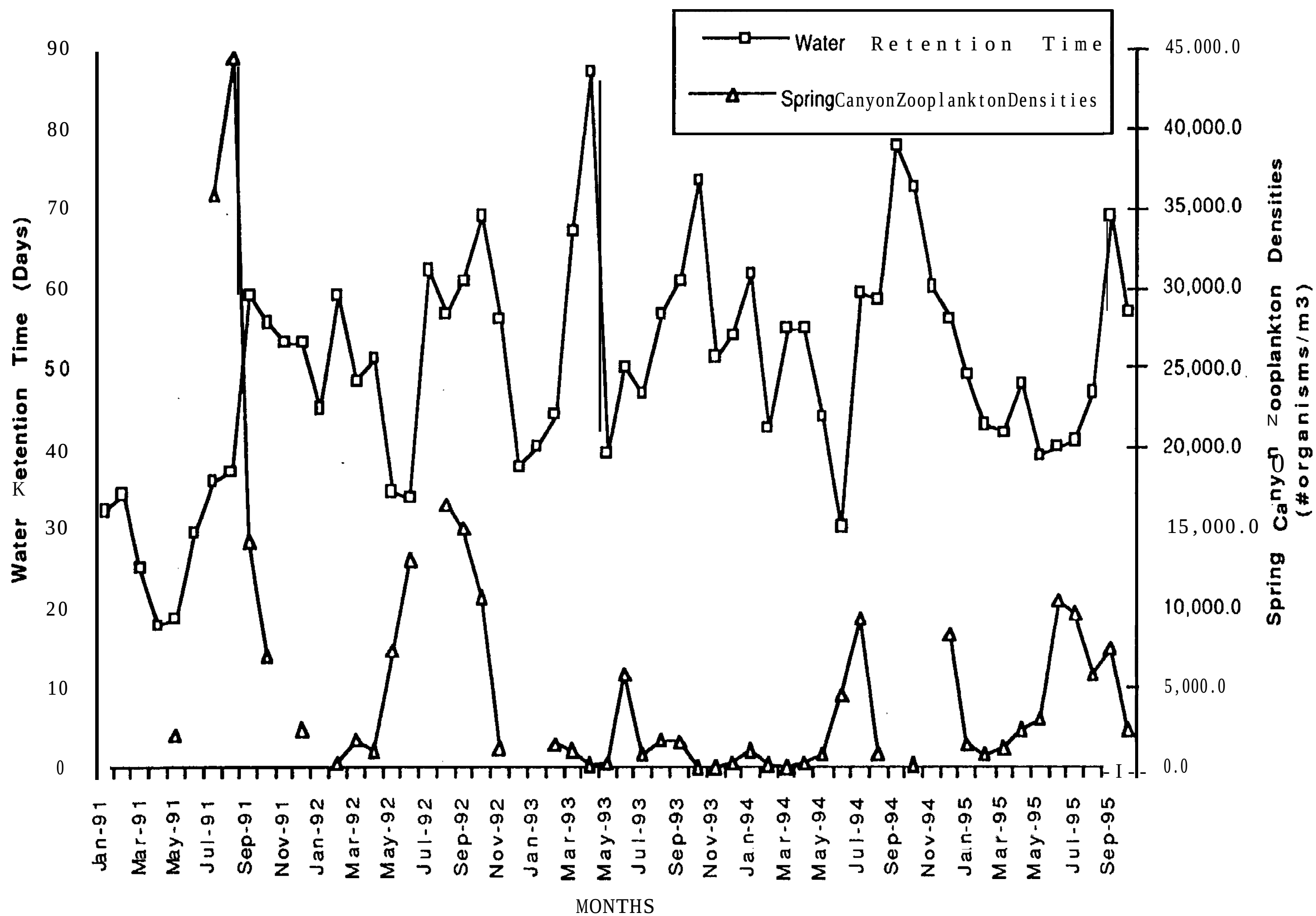


Figure 4.21 Monthly mean total zooplankton densities and monthly average water retention times at Spring Canyon (Index Station 9), from 1991 through 1995.

downstream areas of the reservoir do not show such a clear relationship between zooplankton densities and water retention time (Figures 4.18-4.21). The reasons for this are currently not known due to the fact that zooplankton dynamics are very complex and require a more in depth assessment before any conclusions can be drawn.

Overall, mean zooplankton densities and biomass were highest at the Confluence and Spring Canyon in 1995. The higher density values at the lower end of the reservoir may be a result of the flushing of water through the reservoir resulting in a "pileup" of organisms at lower reservoir sites. Declining pool elevation and large releases from the dam may further affect zooplankton by causing a downstream loss of zooplankton. Based on samples collected from Rufus Woods, it is estimated that a yearly average of 1,485.8 zooplankton organisms are lost for every cubic meter of water run through the Coulee Dam turbines. This corresponds to a biomass loss of 4.7×10^8 µg per cubic meter of water.

4.4 Rainbow Trout Tagging

The percentage of tagged fish recovered below Grand Coulee Dam is a strong indicator of entrainment and has ranged from 0 to 63% of tag recoveries by month over the past eight years (Table 3.34). In 1995, entrainment was low, with only 5 fish recovered below Grand Coulee dam yielding a 3% recapture rate below Grand Coulee dam. This may be due to the fact that 1995 fish were held in net pens until June prior to release. Also, since water retention times averaged 46.5 days for 1995, low entrainment rates should be expected. Table 3.34 shows that when water retention times average 40 or more days for a month, fish appear less likely to entrain from the reservoir. While entrainment through Grand Coulee dam appeared to be low for 1995, an analysis of tag release location versus fish capture location indicates a large down lake migration of net pen rainbow trout for both release sites. Of the tag returns sent in from the Kettle Falls releases, 95% (n=57) were captured at down lake locations. The remaining 5% of fish (n=3) were captured in the Kettle Falls area. No Kettle Falls fish were captured up lake from the release site. Down lake migrants traveled an average of 136.6 Km with a minimum migration of 41.9 Km and a maximum of 164.2 Km. An analysis of the Seven Bays releases finds that 68% (n=75) were captured down lake from the release location, 28% (n=3 1) were recaptured in the Seven Bays area and 4% (n=4) were recaptured up lake from Seven Bays. The down lake migrants from the Seven Bays area traveled an average of 50.0 Km ranging from a minimum of 24.2 Km to a maximum of 264.8 Km. Up lake migrants traveled an average of 146.0 Km. This down lake migration may have been due to the fact that more food items were available in the lower ends of the reservoir and therefore were more attractive to fish, or it may have been due to a smoltification process. The stock of rainbow trout used for the supplimentation program has been found to exhibit a smoltification process similar to that of steelhead trout and anadromous salmon (Muzi, 1984; Scholz *et al.*, 1985; White et *al.*, 1991). These rainbow trout have evidenced an increase in thyroxine, increased silvering, increased osmoregulatory capability and an increase in downstream migratory behavior during the spring (A. Scholz, personal communication). Therefore, if fish are released in early spring, they may exhibit partial smoltification and travel downstream.

When growth rates of fish released from Kettle Falls are compared to fish released from Seven Bays it can be seen that the Seven Bays fish grow at a much faster rate (Figures 3.3 and 3.4). This further indicates that the habitat in the lower reservoir is better for rainbow trout growth. When paired releases from Kettle Falls and Seven Bays areas are compared, the majority (81.7%), of the Seven Bays fish are caught in the first year when compared to Kettle Falls releases where only 68.8% are caught in the first year. This indicates that Kettle Falls may be an important release site for carry over fish, while Seven Bays fish are more likely to contribute directly to the fishery.

5.0 Recommendations

1. Continue to tag 10,000 rainbow trout at Kettle Falls and Seven Bays in order to increase the numbers of tag returns.

2. Continue to hold net pen rainbow trout until at least June 1 before release in order to reduce entrainment losses.

3. Increase the zooplankton sampling frequency to at least three times per month in the spring, summer and fall and twice per month in winter. In addition, begin to sample zooplankton in near shore areas along with mid channel tows. Also, due to the extreme variability of zooplankton data it is recommended that a minimum of three zooplankton tows be taken at each site and the densities averaged to attain a mean location density.

4. Continue to sample for zooplankton in Rufus Woods Reservoir in order to estimate entrainment losses of zooplankton from Lake Roosevelt.

5. Continue to collect zooplankton and water quality data at current sites.

6. Collect nutrient and C^{14} data to obtain nutrient abundance and assimilation rates for model development.

7. Determine the depth of the euphotic zone via photometer to estimate the availability of phytoplankton habitat.

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APPENDIX A
HYDROLOGY

Table A.1 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in January, 1995. Data from CORPs daily summary reports.

JANUARY					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1					
2	73.00 60.40	100.20 89.00	1284.30 1285.30	4400.20	49.44
3				4360.40	43.52
4	73.80 66.00	119.20 116.80	1283.20 1281.90	4317.00	36.22
				4266.20	36.53
5	73.90	112.70	1280.90	4227.40	37.5 1
6	70.70	111.10	1279.80	4185.40	37.67
8	59.60	93.90	1278.90	4150.80	44.2 1
9	71.60 73.30	88.73 82.80	1278.20 1278.45	4131.80	46.57
				4124.30	49.8 1
10	69.30	84.40	1277.80	4109.10	48.69
11	78.80	97.70	1277.30	4090.20	41.86
12	71.10	84.40	1277.00	4078.90	48.32
13	77.40	62.30	1277.40	4094.00	65.71
14	76.00	53.30	1278.00	4116.70	77.24
15	75.30	39.30	1278.90	4150.80	105.62
17	80.40	70.90	1279.20	4162.30	58.71
18	76.10 80.30	84.10 83.70	1278.90 1279.10	4158.50 4150.80	49.44
					49.59
20	78.40	89.90	1278.55	4135.60	46.00
21	74.10 74.80	77.90 80.50	1278.45 1278.30	4131.80 4128.00	53.04
					51.28
23	76.50	76.50	1278.30	4128.00	53.96
24	76.70 80.30	106.90 103.10	1277.70 1276.90	4105.30	39.82
				4075.10	38.12
25	76.00	94.80	1276.40	4056.30	42.79
26	75.20	92.10	1276.00	4041.30	43.88
27	72.40	102.30	1275.20	4011.40	39.21
28	62.70	92.50	1274.40	3981.60	43.04
29	66.20	60.60	1274.50	3985.30	65.76
30	72.20	94.50	1273.90	3963.00	41.94
31	71.20	91.60	1273.40	3944.50	43.06
Average	73.02	88.3 1	1278.28	4127.81	49.31

Table A.2 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in February, 1995. Data from CORPs daily summary reports.

FEBRUARY					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	78.60	69.30	1273.60	3951.90	57.03
2	83.60	63.30	1274.20	3974.10	62.78
3	82.10	66.70	1274.50	3985.30	59.75
4	74.20	57.40	1274.90	4002.20	69.73
5	76.30	59.50	1275.20	4011.40	67.42
6	79.30	111.90	1274.20	3974.10	35.52
7	75.00	85.60	1273.60	395 1.90	46.17
8	70.20	98.70	1272.50	3911.30	39.63
9	72.00	100.70	1271.35	3867.30	38.40
10	71.40	95.60	1270.30	3830.90	40.07
11	78.60	65.30	1270.30	3830.90	58.67
12	76.60	99.50	1269.20	3791.00	38.10
13	77.40	119.80	1268.00	3747.70	31.28
14	78.60	134.00	1266.40	3690.50	27.54
15	83.90	128.30	1265.15	3644.40	28.41
16	79.50	119.10	1263.80	3598.50	30.2 1
17	76.60	104.20	1262.50	3553.00	34.10
18	81.60	79.50	1262.00	3535.60	44.47
19	71.90	57.70	1261.90	3532.10	61.22
20	86.70	89.90	1261.30	3511.30	39.06
21	85.50	108.50	1260.15	3469.80	31.98
22	89.60	121.60	1258.90	3428.60	28.20
23	89.60	100.90	1258.50	3414.90	33.84
24	88.60	98.90	1258.20	3404.70	34.43
25	88.60	66.10	1258.40	3411.50	51.61
26	96.90	69.29	1258.80	3425.20	49.43
27	98.50	137.60	1257.60	3384.30	24.60
28	95.10	123.80	1259.70	3456.00	27.92
Average	81.66	94.02	1266.15	3688.94	42.56

Table A.3 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in March, 1995. Data from **CORPs** daily summary reports.

MARCH					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1	91.20	114.70	1256.00	3330.40	29.04
2	91.20	106.30	1255.60	33 17.00	31.20
3	86.00	103.10	1255.00	3296.90	31.98
4	91.30	97.50	1254.40	3277.00	33.61
5	94.50	84.10	1254.30	3273.60	38.93
6	92.10	101.80	1253.90	3260.40	32.00
7	89.70	104.60	1253.45	3243.90	36.00
8	89.20	94.20	1253.30	3240.60	34.03
9	97.60	87.70	1253.60	3250.50	37.06
10	85.10	93.10	1253.40	3243.90	34.84
11	99.60	67.00	1254.20	3270.30	48.81
12	102.00	55.80	1255.20	3303.60	59.20
13	96.50	87.20	1255.40	33 10.30	37.96
14	99.30	72.50	1256.20	3337.10	46.03
15	106.30	79.50	1257.00	3364.00	42.31
16	108.80	69.80	1258.20	3404.70	48.78
17	101.90	54.00	1259.60	3452.60	63.94
18	103.90	45.30	1261.30	3511.30	77.51
19	114.40	32.70	1263.60	3591.50	109.83
20	118.50	88.60	1264.50	3623.20	40.89
21	112.60	114.40	1264.40	3619.70	31.64
22	119.50	133.60	1264.00	3605.60	26.99
23	113.70	133.00	1263.45	3584.50	26.95
24	113.90	126.00	1263.10	3574.00	28.37
25	110.20	100.00	1263.30	358 1.00	35.81
26	108.20	105.00	1263.40	3584.50	34.14
27	108.20	124.20	1262.90	3567.00	28.72
28	100.00	95.84	1263.63	3591.50	37.47
29	102.90	85.60	1263.50	3588.00	41.92
30	101.70	72.00	1264.30	3616.10	50.22
31	96.90	63.10	1265.20	3647.90	57.81
Average	101.55	90.07	1258.99	3434.28	42.39

Table A.4 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in April, 1995. Data from **CORPs** daiiy summary reports.

APRIL					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
2	92.70	66.70	1265.80	3669.2	55.01
3	93.70 94.00	92.00 67.60	1266.30 1266.30	3687.0 3687.0	40.08 54.50
5	83.30	115.60	1265.20	3647.9	31.56
6	86.60 86.40	110.10 97.00	1264.50 1264.20	3623.2 3612.6	32.9 37.24 1
7	78.60	66.20	1264.50	3623.2	54.73
8					
9	77.80 81.60	40.90 67.20	1264.80 1266.00	3633.8 3676.3	54.07 89.89
10	86.70	81.40	1266.10	3679.8	45.21
11	80.00	53.20	1266.41	3690.5	69.37
12	83.90	60.60	1267.50	3729.8	61.55
13	79.10	64.80	1267.90	3744.2	57.78
14	88.20	60.50	1268.70	3772.9	62.36
15	83.40	62.30	1269.00	3783.4	60.73
16					
17	75.70 86.60	101.40 52.70	1269.30 1268.80	3794.6 3776.5	72.00 37.24
18	76.90	97.10	1268.10	3751.3	38.63
19	80.50	79.10	1268.10	3751.3	47.43
20	68.90	69.30	1268.00	3747.7	54.08
21	68.60	68.60	1268.00	3747.7	54.63
22	68.10	66.70	1267.90	3744.2	56.14
23	80.10	89.10	1267.50	3729.8	41.86
24	85.80	125.80	1266.20	3683.4	29.28
25	67.00	126.10	1264.35	3616.1	28.68
26					
27	83.00 75.80	120.50 114.80	1261.80 1263.10	3574.0 3528.6	29.66 30.74
28	81.10	105.60	1260.90	3497.4	33.12
29	80.10	107.20	1259.80	3459.5	32.27
30	80.20	105.50	1258.70	3421.8	32.43
Average	81.15	**84.52**	1265.79	3669.49	47.51

Table A.5 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in May, 1995. Data from CORPs daily summary reports.

MAY					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
2	83.70	124.30	1257.20	3370.8	27.12
3	87.50 87.50	113.20 117.90	1255.20 1256.10	3333.7	28.28
4				3303.6	29.18
5	87.50 87.20	115.85 105.60	1253.40 1255.20	3303.6	28.52
				3277.0	31.03
6	91.10	62.10	1254.00	3263.7	52.56
8	91.70	65.80	1254.50	3280.3	49.85
9	96.20 99.80	97.00 83.90	1254.70 1254.65	3286.9	39.18
				3285.3	33.87
10	102.90	86.40	1255.10	3300.3	38.20
11	108.80	80.30	1255.90	3327.0	41.43
12	104.80	90.30	1256.30	3340.4	36.99
13	108.40	60.88	1257.45	3379.3	55.51
14	109.60	67.33	1258.30	3408.1	50.62
15	112.70	118.70	1257.90	3394.5	28.60
16	125.10	115.80	1258.00	3397.9	29.34
17	127.00	116.00	1258.20	3404.7	29.35
19	128.40	99.66	1258.80	3425.2	34.37
20	132.30 126.60	93.80 61.90	1259.80 1261.50	3459.5	36.88
				3518.2	56.84
21	124.20	64.20	1263.00	3570.5	55.62
23	125.80	102.30	1263.50	3588.0	35.07
24	124.20 120.60	118.20 97.20	1264.00	3605.6	37.10
			1264.00	3605.6	30.50
25	121.80	115.80	1264.00	3605.6	31.14
27	124.90	102.50	1264.50	3623.2	35.35
28	119.10 119.40	67.20 51.20	1265.60	3623.1	53.92
			1267.10	3715.5	72.57
30	128.50	101.90	1267.60	3733.4	36.64
31	140.40 134.90	117.30 84.80	1267.90 1269.40	3744.2	31.92
				3798.2	44.79
Average	112.34	93.53	1260.06	3460.40	39.43

Table A.b Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in June, 1995. Data from CORPs daily summary reports.

JUNE					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	132.70	100.80	1270.10	3823.6	37.93
2	134.40	79.80	127 1.50	3874.6	48.55
4	129.50	49.70	1273.30	3940.8	72.29
5	130.80 141.50	42.80 87.20	1275.30 1276.50	4015.1 4060.1	46.56 93.81
6	158.10	88.80	1278.20	4124.3	46.45
7	158.00	76.20	1280.30	4204.3	55.18
8					
9	154.00 166.40	127.10 93.00	1281.70 1282.50	4258.4 4289.5	45.79 33.75
10	165.00	133.90	1282.90	4305.2	32.15
11	165.10	121.30	1283.70	4336.7	35.75
12	163.70	139.00	1284.20	4356.4	31.34
13	161.00	134.40	1284.70	4376.3	32.56
15	150.50	130.10	1285.00	4388.2	33.73
16	133.50 135.80	118.90 103.80	1285.20 1285.80	4396.2 4420.2	42.58 36.97
17	139.10	85.90	1286.80	4460.5	51.93
18	141.50	88.70	1287.90	4505.2	50.79
19					
20	140.90 150.30	129.70 137.60	1288.00 1288.10	4509.3 4513.4	34.77 32.80
21	146.60	141.30	1288.10	4513.4	31.94
22					
23	148.70 141.90	153.40 150.00	1287.90 1287.60	4505.2 4493.0	29.37 29.95
24					
25	137.00 159.90	145.00 148.50	1287.10 1287.30	4472.7 4480.8	30.12 30.90
26					
27	160.10 161.30	142.30 155.30	1287.30 1287.60	4480.8 4493.0	28.85 31.57
28	153.70	145.20	1287.60	4493.0	30.94
29	144.80	144.60	1287.50	4488.9	31.04
30	135.80	138.20	1287.30	4480.8	32.42
Average	148.05	117.75	1283.57	4335.3	40.09

Table A.7 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in July, 1995. Data from CORPs daily summary reports.

JULY					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1 2	129.10 131.30	92.30 73.90	1287.90 1289.00	4505.2	48.8 1
				4550.3	61.57
3	137.30	104.30	1289.50	4570.9	43.82
5	124.80	108.30	1289.60	4575.0	42.24
6	119.30 114.10	129.80 123.90	1289.10 1288.70	4554.4	35.09
				4537.9	36.63
8	105.80	122.80	1288.10	4513.4	36.75
9	115.50 126.50	107.30 69.80	1288.00 1289.10	4509.3	42.03
				4554.4	65.25
10	128.60	121.90	1289.10	4554.4	37.36
11	116.10	110.70	1289.10	4554.4	41.14
12	119.50	105.90	1289.30	4562.6	43.08
13	111.00	108.40	1289.20	4558.5	42.05
14	104.80	114.10	1288.80	4542.0	39.81
15	96.90	112.90	1288.20	45 17.5	40.01
16	99.60	95.10	1288.10	4513.4	47.46
17	99.10	131.30	1287.20	4476.7	34.10
19	112.30	122.70	1286.90	4464.6	36.39
20	107.80 108.90	116.70 111.30	1286.60 1286.30	4452.4	38.15
				4440.3	39.90
22	110.70	104.10	1286.30	4440.3	42.65
23	105.50 96.30	105.30 90.00	1286.00 1285.90	4428.3 4424.2	42.05
					49.16
25	107.00	111.10	1285.60	4412.2	39.71
26	109.00 108.80	123.70 116.00	1284.80 1285.30	4400.2	37.93
				4380.3	35.41
28	103.60	134.10	1283.90	4344.6	32.40
29	100.70 94.60	122.50 100.40.	1283.20 1282.70	4317.0 4297.4	35.24
30					42.80
31	109.80 106.10	119.10 115.50	1282.20 128 1.70	4277.8	37.04
				4258.4	35.76
Average	111.63	110.49	1286.95	4467.4	41.35

Table **A.8** Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in August, 1995. Data from CORPs daily summary reports.

AUGUST					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1					
2	103.20 86.60	105.90 94.80	1281.15 128 1.50	4250.6 4237.0	40.14 44.69
3	86.90	94.90	1280.80	4223.6	44.5 1
4	83.70	84.80	1280.60	4215.9	49.72
5					
6	104.20 92.90	73.30 69.20	1281.30 1280.80	4223.6 4242.9	57.62 61.31
7	109.90	96.70	128 1.50	4250.6	43.96
8					
9	101.50 95.60	102.30 99.70	128 128 1.30 1.20	4239.0 4242.9	42.56 41.44
10	105.80	100.80	128 1.20	4239.0	42.05
11	103.20	119.30	1280.60	4215.9	35.34
12	100.30	87.90	1280.70	4219.7	48.01
13	96.40	72.40	128 1.00	4231.3	58.44
14	106.10	108.30	1280.80	4223.6	39.00
15	108.40	97.60	1281.00	4231.3	43.35
16	96.70	104.60	1280.60	4215.9	40.30
17	93.50	92.00	1280.50	4212.0	45.78
18					
19	101.90 92.10	78.80 75.40	1281.10 1280.70	4219.7 4235.2	53.55 56.17
20	91.50	71.80	1281.30	4242.9	59.09
22	96.00	109.00	1280.90	4227.4	38.78
23	101.60 95.40	111.70 103.20	1280.50 1280.20	4212.0 4200.5	40.70 37.71
24	103.70	87.30	1280.60	4215.9	48.29
25					
26	101.70 87.80	73.00 75.30	1281.20 1281.20	4239.0 4239.0	58.07 56.29
27	88.70	68.50	1281.40	4246.8	62.00
28	83.90	109.20	1281.40	4246.8	38.89
29	87.40	87.40	1280.60	4215.9	48.24
30					
31	92.80 87.10	96.70 95.70	1280.30 1280.20	4204.3 4200.5	43.48 43.89
Average	**96.34**	**91.86**	**1280.91**	**4227.77**	**47.21**

Table A.9 **Daily** midnight reservoir inflow, outflow, elevation, storage **capacity,** and water retention **time** for Lake Roosevelt in September, 1995. Data from **CORPs** daily summary reports.

SEPTEMBER					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	90.20	75.40	1280.45	4210.1	55.84
2	82.40	55.80	1280.90	4227.4	75.76
3	67.40	43.10	1281.20	4239.0	98.35
4	71.40	52.80	1281.40	4246.8	80.43
5	84.30	67.70	1281.70	4258.4	62.90
6	83.90	77.30	1281.80	4262.3	55.14
7	86.90	63.00	1282.40	4285.6	68.03
8	90.30	60.00	1283.10	4313.1	71.89
9	89.70	46.90	1283.90	4344.6	92.64
10	100.90	44.50	1285.10	4392.2	98.70
11	101.40	69.70	1285.90	4424.2	63.48
12	93.60	67.60	1286.50	4448.4	65.81
13	85.80	77.90	1286.60	4452.4	57.16
14	87.40	73.40	1286.90	4464.6	60.83
15	73.30	79.30	1286.70	4456.5	56.20
16	64.50	51.80	1286.80	4460.5	86.11
17	55.90	62.10	1286.40	4444.4	71.57
18	60.90	88.00	1285.70	4416.2	50.18
19	61.50	67.50	1285.50	4408.2	65.3 1
20	69.00	68.70	1285.60	4412.2	64.22
21	81.40	70.10	1285.70	4416.2	63.00
22	82.90	69.10	1286.00	4428.3	64.09
23	88.20	57.40	1286.50	4448.4	77.50
24	80.00	51.20	1286.95	4466.6	87.24
25	81.70	72.20	1287.10	4472.7	61.95
26	81.50	69.20	1287.40	4484.8	64.81
27	79.10	87.20	1287.20	4476.7	51.34
28	69.60	73.60	1287.10	4472.7	60.77
29	79.10	80.40	1287.05	4470.7	55.61
30	71.20	54.20	1287.25	4478.8	82.64
Average	79.85	65.90	1285.09	4392.8	68.98

Table A.10 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in October, 1995. Data from **CORPs** daily summary reports.

OCTOBER					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1	75.30	51.70	1287.60	4493.0	86.91
2	75.00	95.70	1287.00	4468.6	46.69
3	73.30	82.10	1286.80	4460.5	54.33
4	76.70	67.70	1287.00	4468.6	66.01
5	81.20	69.00	1287.30	4480.8	64.94
6	76.10	75.50	1287.30	4480.6	59.35
7	80.40	73.10	1287.25	4478.8	61.27
8	73.50	66.50	1287.30	4480.8	67.38
9	85.60	84.69	1287.10	4472.7	52.8 1
10	75.90	82.30	1286.90	4464.6	54.25
11	82.80	108.90	1286.30	4440.3	40.77
12	76.50	112.60	1285.40	4404.2	39.11
13	74.40	83.50	1285.10	4392.2	52.60
14	72.20	57.20	1285.30	4400.2	76.93
15	72.00	57.00	1285.50	4408.2	77.34
16	76.80	91.10	1285.10	4392.2	48.21
17	77 .oo	88.90	1284.80	4380.3	49.27
18	72.60	64.70	1285.00	4388.2	67.82
19	86.80	78.80	1285.20	4396.2	55.79
20	75.20	84.80	1285.00	4388.2	51.75
21	86.00	72.30	1285.20	4396.2	60.81
22	94.00	86.30	1285.20	4396.2	50.94
23	84.80	90.70	1285.00	4388.2	48.38
24	80.00	84.00	1284.90	4384.2	52.19
25	82.30	96.20	1284.60	4372.3	45.45
26	82.90	78.90	1284.70	4376.3	55.47
27	79.40	73.20	1284.80	4380.3	59.84
28	90.00	66.20	1285.30	4400.2	66.47
29	100.30	88.60	1285.50	4408.2	49.75
30	86.00	98.00	1285.20	4396.2	44.86
31	82.90	86.90	1285.10	4392.2	50.54
Average	**80.25**	**80.55**	**1285.80**	**4420.31**	**56.72**

Table A.11 Daily midnight reservoir inflow, outflow elevation, storage capacity, and water retention time for Lake Roosevelt in November, 1995. Data from **CORPs** daily summary reports.

NOVEMBER					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1					
2	75.60 62.40	87.50 88.30	1284.20 1284.80	4380.30	50.06
3				4356.40	49.34
4	63.80 64.00	73.90 83.60	1283.70	4336.70	51.87
5			1283.40	4324.80	58.52
6	81.20 81.20	65.40 97.00	1283.80 1283.40	4340.60	66.37
				4324.80	44.59
8	81.90	81.90	1283.40	4324.80	52.81
9	75.20 90.70	79.20 80.90	1283.60 1283.30	4320.90	54.56
				4332.70	53.56
10	79.00	81.00	1283.50	4328.80	53.44
11	87.50	59.80	1284.20	4356.40	72.85
12	90.20	58.40	1285.00	4388.2	75.14
13	105.40	83.40	1285.60	4412.20	52.90
14	99.80	73.70	1286.20	4436.30	60.19
15	102.20	90.10	1286.50	4448.40	49.37
17	98.60	90.50	1286.70	4456.50	49.24
18	108.10 109.90	93.70 75.60	1287.90 1287.10	4472.70	47.73
19				4505.20	59.59
20	119.60 115.90	120.00 90.90	1288.60 1288.50	4533.80	49.88
21				4529.70	37.75
22	110.10 107.50	113.70 99.80	1288.40	4525.60	39.80
			1288.60	4533.80	45.43
23	97.20	76.60	1289.10	4554.40	59.46
25	117.40	100.90	1289.50	4570.90	45.30
26	105.60 112.30	117.90 108.10	1289.20 1289.30	4558.50	38.66
				4562.60	42.2 1
28	118.80	122.90	1289.20	4558.5	37.09
29	123.50 128.50	114.80 135.50	1289.40 1289.20	4566.80	39.78
				4558.50	33.64
30	101.70	110.80	1289.00	4550.30	41.07
Average	97.16	**91.86**	1286.48	4448.34	50.41

Table A.12 Daily midnight reservoir inflow, **outflow** elevation, storage capacity, and water retention time for Lake Roosevelt in December, 1995. Data from **CORPs** daily summary reports.

DECEMBER					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1	117.10	93.10	1289.50	4570.90	49.10
2	119.30	117.50	1289.50	4570.90	38.90
3	134.30	130.50	1289.50	4570.90	35.03
4	123.60	120.60	1289.50	4570.90	37.90
5	133.20	137.30	1289.40	4566.80	33.26
6	143.10	147.30	1289.30	4562.60	30.97
7	158.80	152.50	1289.50	4570.90	29.97
8	154.60	169.00	1289.10	4554.40	26.95
9	141.90	160.10	1288.70	4537.90	28.34
10	145.80	145.80	1288.60	4533.80	31.10
11	147.80	146.90	1288.55	4531.00	30.84
12	136.10	138.10	1288.50	4529.70	32.80
13	155.90	169.40	1288.20	4517.50	26.67
14	144.60	140.50	1288.25	4519.00	32.16
15	148.70	156.40	1288.05	4511.00	28.84
16	142.10	136.50	1288.00	4509.30	33.04
17	152.80	145.20	1288.00	4509.30	31.06
18	152.10	142.70	1288.20	4517.50	31.66
19	146.10	158.40	1287.90	4505.20	28.44
20	131.70	158.10	1287.30	4480.80	28.34
21	138.70	158.90	1286.80	4460.50	28.07
22	130.00	160.20	1286.00	4428.30	27.64
23	126.80	164.80	1285.10	4392.20	26.65
24	125.60	161.40	1284.20	4356.40	26.99
25	132.00	151.70	1283.70	4336.70	28.59
26	125.20	156.60	1282.90	4305.20	27.49
27	117.60	139.10	1282.30	4281.70	30.78
28	115.20	122.90	1282.10	4273.90	34.78
29	113.60	119.50	1282.30	4281.70	35.83
30	126.30	100.90	1282.90	4305.20	42.67
31	126.20	86.80	1283.90	4305.20	49.60
Average	135.70	141.57	1286.96	4466.69	32.40

APPENDIX B
ZOOPLANKTON

Table B.l Mean density (#/m^3) values for zooplankton samples collected in January, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata *mendotae*				
Daphnia retrocurva				
Daphnia *schødleri*		21.55	66.05	192.18
Daphnia *thorata*				
Daphnia pulex				
Megafenestra aurita				
Simocephalus *serrulatus*				
Alona guttata				
Alona *quadrangularis*				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum	0.21			
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	0.42	5.99	41.20	32.7 1
Leptodora kindtii				
Eucopepoda				
Leptodiaptomus ashlandi	16.72	7.68	155.02	433.99
Skistodiaptomus oregonensis				
Epischura nevadensis			0.59	
Diacyclops *bicuspidatus thomasi*	32.49	93.47	235.21	745.91
Mesocyclop *edax*				
Bryocamptus spp.				
Nauplii	0.42		50.87	51.41
Total *Daphnia* spp.	0.00	21.55	66.10	192.20
Total Cladocera	0.63	27.55	107.30	224.90
Total Copepoda	49.21	101.14	390.80	**1,180.50**
Total Nauplii	0.42	0.00	50.90	51.41
Grand Total	50.26	128.69	548.90	**1,456.80**

Table B.2 Mean density ($\#/m^3$) values for zooplankton samples collected in February, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density ($\#/m^3$)	Porcupine **Bay** Mean Density ($\#/m^3$)	Seven Bays Mean Density ($\#/m^3$)	Spring Canyon Mean Density ($\#/m^3$)
Cladocera				
Ceriodaphnia *quadranqula*				
Daphnia *galeata mendotae*				
Daphnia retrocwva				
Daphnia *schødleri*	0.46	30.39	12.73	138.21
Daphnia *thorata*				
Daphnia pulex				
Megafenestra aurita				
Simocephalus *serrulatus*				
Alona *guttata*				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum			0.38	
Diaphanosoma birgei				
Sida *crystallina*				
Macrothrix laticornis				
Streblocerus *serricaudatus*				
Bosmina *longirostris*	1.22	76.96	9.85	25.83
Leptodora kindtii				
Eucopepoda				
Leptodiaptomus *ashlandi*	6.88	16.72	25.81	269.06
Skistodiaptomus oregonensis				
Epischura *nevadensis*			0.11	
Diacyclops *bicuspidatus thomasi*	20.49	63.61	44.90	304.5 1
Mesocyclop *edax*				
Bryocamptus spp.				
Nauplii	0.92	3.15	11.59	50.59
Total Daphnia spp.	0.46	30.39	12.70	138.20
Total Cladocera	1.68	107.35	23.00	164.00
Total Copepoda	27.37	so.33	70.80	573.60
Total Nauplii	0.92	3.15	11.60	50.59
Grand Total	29.97	190.83	105.40	788.20

Table B.3 Mean density (#/m^3) values for zooplankton samples collected in March, 1995 at three sampling locations on Lake Roosevelt, WA

	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera			
Ceriodaphnia quadranqula			
Daphnia *galeata mendotae*			
Daphnia retrocwva			
Daphnia *schødleri*		0.85	16.15
Daphnia *thorata*			
Megafenestra aurita			
Simocephalus *serrulatus*			
Alona *guttata*			
Alona quadrangular-is			
Chydorus *sphaericus*			
Eurycerus lamellatus			
Pleuroxus denticulatus			
Diaphanosoma brachyurum			
Diapharwsoma birgei			
Sida *crystallina*			
Macrothrix laticornis			
Streblocerus serricaudatus			
Bosmina longirostris	161.43	120.64	107.05
Leptodora kindtii			
Eucopepoda			
Leptodiaptomus *ashlandi*	22.09	56.93	158.03
Skistodiaptomus oregonensis			
Epischura nevadensis			
Diacyclops *bicuspidatus thomasi*	1,474.92	7 10.28	785.04
Mesocyclop *edax*			
Bryocamptus spp.			
Nauplii	54.38	147.83	124.04
Total Daphnia spp.	0.00	0.85	16.10
Total Cladocera	161.43	121.49	123.20
Total Copepoda	**1,497.01**	767.20	943.10
Total Nauplii	54.38	147.83	124.04
Grand Total	**1,712.81**	**1,036.52**	**1,190.30**

Table B.4 Mean density (#/m^3) values for zooplankton samples collected in April, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia *quadranqula*				
Daphnia galeata *mendotae*				
Daphnia retrocwva				
Daphnia *schødleri*	0.76	1.70	3.40	63.72
Daphnia thorata				
Megafenestra aurita				
Simocephalus *serrulatus*				
Alona *guttata*				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus *denticulatus*				
Diaphanosoma brachyurum				0.85
Diaphanosoma birgei				
Sida *crystallina*				
Macrothrix laticornis				
Streblocerus *serricaudatus*				
Bosmina longirostris	19.12	259.98	749.36	228.55
Leptodora kindtii				
Eucopepoda				
Leptodiaptomus ashlandi	24.62	5.10	101.96	382.33
Skistodiaptomus oregonensis				
Epischura nevadensis				
Diacyclops *bicuspidatus thomasi*	60.10	880.20	602.37	1,518.25
Mesocyclop edax				
Bryocamptus spp.				
Nauplii	38.54	76.46	338.15	108.76
Total *Daphnia* spp.	0.76	1.70	3.40	63.70
Total Cladocera	19.88	261.68	752.83	293.10
Total Copepoda	34.72	885.29	704.32	**1,900.60**
Total Nauplii	38.54	76.46	338.11	108.76
Grand Total	143.14	**1,223.44**	**1,795.24**	**2,302.40**

Table B.5 Mean density (#/m^3) values for zooplankton samples collected in May, 1995 at four sampling locations on Lake **Roosevelt,** WA

	Gifford Mean Density (#/m^3)	Porcupine **Bay** Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae				
Daphnia *retrocurva*			29.3 1	
Daphnia *schødleri*	0.76	22.43	109.60	69.33
Daphnia *thorata*				
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Aiona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus *denticulatus*				
Diaphanosoma brachyurum	0.61		14.02	17.33
Diaphanosoma birgei				
Sida *crystallina*				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	1.53	362.61	137.64	67.29
Leptodora kindtii	0.31		6.37	7.14
Eucopepoda				
Leptodiaptomus *ashlandi*	6.27	7.48	188.61	360.9 1
Skistodiaptomus oregonensis				
Epischura *nevadensis*	1.53		21.67	35.68
Diacyclops bicuspidatus thomasi	113.02	3,835.48	4,494.86	2,390.80
Mesocyclop *edax*		9.35	11.47	
Bryocamptus spp.				
Nauplii	25.23	31.78	114.70	76.46
Total Daphnia spp.	0.76	22.43	138.91	69.33
Total Cladocera	3.21	385.04	**296.94**	161.09
Total Copepoda	120.81	3,852.30	**4,716.61**	**2,787.40**
Total Nauplii	25.23	**31.78**	114.70	76.46
Grand Total	149.26	**4,269.12**	**5,128.24**	**3,024.95**

Table B.6 Mean density (#/m^3) values for zooplankton samples collected in June, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia *galeata* mendotae		11.89	50.13	
Daphnia *retrocurva*		586.23	79.02	92.19
Daphnia *schødleri*	4.13	764.65	790.99	3,035.66
Daphnia thorata				
Daphnia thorata				
Megafenestra aurita				
Simocephalus *serrulatus*				
Alona guttata				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus *denticulatus*				
Diaphanosoma brachyurum	1.07	67.97	36.54	59.05
Diaphanosoma birgei				
Sida *crystallina*				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	17.59	326.25	45.88	7.23
Leptodora *kindtii*	0.46	69.67	79.87	64.57
Eucopepoda				
Leptodiaptomus *ashlandi*	10.55	256.58	341.54	1,075.19
Skistodiaptomus oregonensis				
Epischura nevadensis	2.14	365.33	15.30	20.82
Diacyclops *bicuspidatus thomasi*	264.87	4,978.71	2,865.74	5,991.45
Mesocyclop *edax*		33.98		
Bryocamptus spp.				
Nau plii	64.23	66.27	36.54	17.84
Total *Daphnia* spp.	4.13	**1,362.77**	920.10	**3,127.80**
Total Cladocera	23.25	**1,826.66**	**1,082.40**	**3,258.70**
Total Copepoda	277.57	**5,634.61**	**3,222.60**	**7,087.40**
Total Nauplii	64.23	66.27	36.50	17.84
Grand Total	365.04	**7,527.54**	**4,341.50**	**10,364.00**

Table B.7 Mean density (#/m^3) values for zooplankton samples collected in July, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia *quadranqula*				
Daphnia *galeata mendotae*	11.05	5.10	169.92	4.25
Daphnia retrocwva	216.81	40.78	52.68	118.95
Daphnia *schødleri*	1,598.41	2,380.61	1,536.09	3,683.06
Daphnia thorata				
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Aiona quadrangularis				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum	26.57	59.47	5.10	49.28
Diaphanosoma birgei				
Sida crystallina				
Macrothrix *laticornis*				
Streblocerus serricaudatus				
Bosmina longirostris	34.06	8.50	27.19	72.22
Leptodora kindtii	12.59	22.09	61.17	16.15
Eucopepoda				
Leptodiaptomus *ashlandi*	266.05	312.66	987.25	1,959.20
Skistodiaptomus oregonensis				
Epischura *nevadensis*	40.78	42.48	37.38	54.38
Diacyclops *bicuspidatus thomasi*	968.47	1,092.60	2,035.66	3,594.70
Mesocyclop *edax*				
Bryocamptus spp.				
Nauplii	43.01	13.59	13.59	113.00
Total Daphnia spp.	**1,826.30**	**2,426.49**	**1,758.69**	**3,806.30**
Total Cladocera	**1,899.50**	**2,516.54**	**1,852.15**	**3,942.90**
Total Copepoda	**1,275.30**	**1,447.73**	3.060.29	**5,608.30**
Total Nauplii	42.30	**13.59**	13.59	113.00
Grand Total	3,217-l	**3,977.87**	**4,926.04**	**9,665.20**

Table B.8 Mean density ($\#/m^3$) values for zooplankton samples collected in August, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density ($\#/m^3$)	Porcupine **Bay** Mean Density ($\#/m^3$)	Seven Bays Mean Density ($\#/m^3$)	Spring Canyon Mean Density ($\#/m^3$)
Cladocera				
Ceriodaphnia *quadranqula*				
Daphnia galeata *mendotae*	700.08		56.93	45.03
Daphnia retrocurva	1,102.79	30.59	132.54	25.49
Daphnia *schødleri*	4,577.70	788.44	1,666.09	1,487.67
Daphnia *thorata*				4.25
Megafenestra aurita				
Simocephalus *serrulatus*				
Alona guttata				
Alona quadrangularis				
Chydorus sphaericus				
Eurycerus *lamellatus*				
Pleuroxus *denticulatus*				
Diaphanosoma brachyurum	35.68	137.64	14.45	8.50
Diaphanosoma birgei				
Sida *crystallina*				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	49.28		25.49	7.65
Leptodora kindtii	74.77		5.10	0.85
Eucopepoda				
Leptodiaptomus ashlandi	688.18	1,469.82	784.19	2,561.58
Skistodiaptomus oregonensis				
Epischura nevadensis	336.45	158.03	79.01	108.75
Diacyclops *bicuspidatus thomasi*	555.64	1,432.44	696.68	1,293.11
Mesocyclop *edax*				
Bryocamptus spp.				
Nauplii	186.91	96.86	179.42	248.92
Total Daphnia spp.	**6,380.57**	819.02	**1,855.60**	**1,562.40**
Total Cladocera	**6,540.30**	956.66	**1,900.60**	**1,579.40**
Total Copepoda	**1,580.27**	**3,060.29**	**1,559.90**	**3,963.40**
Total Nauplii	186.91	96.86	178.4	248.92
Grand Total	**8,307.48**	**4,113.81**	**3,638.90**	**5,791.80**

Table B.9 Mean density (#/m³) values for zooplankton samples collected in September, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m³)	Porcupine Bay Mean Density (#/m³)	Seven Bays Mean Density (#/m³)	Spring Canyon Mean Density (#/m³)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata *mendotae*				2.55
Daphnia retrocw-va	156.33			3.40
Daphnia *schødleri*	436.70	2,276.95	1,662.69	1,864.05
Daphnia thorata				
Megafenestra aurita				
Simocephalus *serrulatus*				
Alona *guttata*				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma *brachyurum*	5.10	231.09	25.49	5.10
D iaphanosoma birgei				
Sida *crystallina*				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	1.70		19.54	7.65
Leptodora kindtii			5.10	1.70
Eucopepoda				
Leptodiaptomus *ashlandi*	317.75	1,870.84	2,678.82	4,167.34
Skistodiaptomus *oregonensis*				
Epischura nevadensis	1.70	69.67	26.34	100.25
Diacyclops *bicuspidatus thomasi*	95.16	1,172.46	977.90	947.32
Mesocyclop *edax*		5.10		
Bryocamptus spp.				
Nauplii	326.25	47.58	275.28	270.18
Total *Daphnia* spp.	593.03	**2,276.95**	**1,662.70**	**1,870.00**
Total Cladocera	599.82	**2,508.05**	**1,712.80**	**1,884.40**
Total Copepoda	414.61	**3,118.07**	**3,683.10**	**5,214.90**
Total Nauplii	326.25	47.58	275.30	270.18
Grand Total	**1,340.68**	**5,673.69**	**5,671.10**	**7,369.50**

Table B.10 Mean density (#/m^3) values for zooplankton samples collected in October, 1995 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia *quadranqula*				
Daphnia *galeata mendotae*	56.07			
Daphnia retrocwva	61.17			
Daphnia schødleri	457.09	1,673.73	1,192.43	186.92
Daphnia thorata				
Megafenestra aurita				
Simocephalus serrulatus				
Alona *guttata*				
Alona *quadrangularis*				
Chydorus sphaericus				
Eurycerus *lamellatus*				
Pleuroxus *denticulatus*				
Diaphanosoma brachyurum		33.98	5.95	22.94
Diaphanosoma birgei				
Sida *crystallina*				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	54.38	22.09	56.08	37.39
Leptodora kindtii	1.70	1.70		
Eucopepoda				
Leptodiaptomus ashlandi	86.66	971.95	1,040.77	1,334.74
Skistodiaptomus oregonensis				
Epischura nevadensis	1.70		11.47	14.45
Diacyclops bicuspidatus *thomasi*	188.61	1,700.92	592.61	716.22
Mesocyclop *edax*				
Bryocamptus spp.				
Nauplii	134.24	35.68	36.54	11.90
Total *Daphnia* spp.	574.34	**1,673.73**	**1,192.43**	**186.90**
Total Cladocera	630.41	**1,731.50**	**1,254.50**	247.20
Total Copepoda	276.97	**2,672.87**	**1,644.90**	**2,065.40**
Total Nauplii	134.24	35.68	36.50	11.90
Grand Total	**1,041.62**	**4,440.06**	**2,935.80**	**2,324.50**

Table B.11 Representative zooplankton size ranges (mm), mean lengths (mm) and biomass values ($\mu g/m^3$) for samples collected at four locations in January, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2 Gifford			
Daphnia galeata menabtae	--	--	0.00
Daphnia retrocurva	--	--	0.00
Daphnia *schødleri*	--	--	0.00
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 2 Biomass			0.00
Location 4 Porcupine Bay			
Daphnia galeata mendotae	--	--	0.00
Daphnia retrocw-va			0.00
Daphnia *schødleri*	0.06-0.44	0.23	2.36
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 4 Biomass			2.36
Location 6 Seven Bays			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia *retrocurva*	--		0.00
Daphnia *schødleri*	0.12-0.52	0.32	18.38
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 6 Biomass			18.38
Location 9 Spring Canyon			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocurva			0.00
Daphnia *schødleri*	0.10-0.64	0.28	35.10
Daphnia pulex	--	--	0.00
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 9 Biomass			35.10

Table B.12 Representative zooplankton size ranges (mm), mean lengths (mm) and biomass values ($\mu g/m^3$) for samples collected at four locations in February, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2 Gifford			
Daphnia *galeata mendotae*	--	--	0.00
Daphnia retrocwva			0.00
Daphnia *schødleri*	0.20-0.34	0.26	0.07
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 2 Biomass			0.07
Location 4 Porcupine Bay			
Daphnia *galeata mendotae*	--	--	0.00
Daphnia retrocwva	--		0.00
Daphnia *schødleri*	0.10-0.54	0.36	13.21
Daphnia thorata	--	--	0.00
Leptoa'ora kindtii	--	--	0.00
Total **Loc** 4 Biomass			13.21
Location 6 Seven Bays			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocwva	--	--	0.00
Daphnia *schødleri*	0.06-0.60	0.22	1.03
Daphnia thorata	--	--	0.00
Leptohra kindtii	--	--	0.00
Total **Loc** 6 Biomass			1.03
Location 9 Spring Canyon			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocwva			0.00
Daphnia *schødleri*	0.08-0.52	0.31	39.27
Daphnia pulex	--	--	0.00
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 9 Biomass			39.27

Table B.13 Representative zooplankton size ranges (mm), mean lengths (mm) and biomass values ($\mu g/m^3$) for samples collected at three locations in March, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 4 Porcupine Bay			
Daphnia galeata mendotae	--	--	0.00
Daphnia retrocwva			0.00
Daphnia *schødleri*	0.22-0.38	0.29	0.00
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 4 Biomass			0.00
Location 6 Seven Bays			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocwva			0.00
Daphnia *schødleri*	0.16-0.38	0.27	0.05
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 6 Biomass			0.05
Location 9 Spring Canyon			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocwva	--		0.00
Daphnia *schødleri*	0.22-0.60	0.36	6.98
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 9 Biomass			6.98

Table B.14 Representative zooplankton ‘size ranges (mm), mean lengths (mm) and biomass values (μg/m³) for samples collected at four locations in April, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m³)
Location 2 Gifford			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocwva	--	--	0.00
Daphnia *schødleri*	0.06-0.18	0.13	0.01
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 2 Biomass			0.01
Location 4 Porcupine Bay			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocurva	--	--	0.00
Daphnia *schødleri*	--	0.16	0.06
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 4 Biomass			0.06,
Location 6 Seven Bays			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocuwa			0.00
Daphnia *schødleri*	0.20-0.30	0.24	0.41
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 6 Biomass			0.41
Location 9 Spring Canyon			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia *retrocurva*		--	0.00
Daphnia *schødleri*	0.08-0.34	0.18	3.38
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 9 Biomass			3.38

Table B.15 Representative zooplankton size ranges (mm), mean lengths (mm) and biomass values ($\mu g/m^3$) for samples collected at four locations in May, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2 Gifford			
Daphnia galeata mendotae	--	--	0.00
Daphnia retrocurva			0.00
Daphnia *schødleri*	0.14-0.26	0.21	0.06
Daphnia thorata	--	--	0.00
Leptodora kindtii	1 .oo-2.00	1.50	2.32
Total **Loc** 2 Biomass			2.38
Location 4 Porcupine Bay			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia *retrocurva*		--	0.00
Daphnia *schødleri*	0.14-0.44	0.29	4.62
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 4 Biomass			4.62
Location 6 Seven Bays			
Daphnia galeata *mendotae*		--	0.00
Daphnia retrocurva	0.08-0.24	0.12	0.17
Daphnia *schødleri*	O-06-0.38	0.16	3.69
Davhnia thorata	--	--	0.00
Leptodora kindtii	2.00-5.00	3.33	69.70
Total **Loc** 6 **Biomass**			73.56
Location 9 Spring Canyon			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocurva		--	0.00
Daphnia *schødleri*	0.06-0.36	0.17	2.80
Daphnia thorata			0.00
Leptodora kindtii	2.00-3.00	2.29	28.53
Total **Loc** 9 Biomass			31.33

Table B.16 Representative zoopiankton size ranges (mm), mean lengths (mm) and biomass values (μg/m3) for samples collected at four locations in June, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m3)
Location 2 Gifford			
Daphnia galeata mendotae	--	--	0.00
Daphnia retrocwva	--	--	0.00
Daphnia *schødleri*	0.06-0.40	0.13	0.08
Daphnia thorata	--	--	0.00
Leptodora kindtii	1.00-10.00	4.75	12.96
Total **Loc** 2 Biomass			13.04
Location 4 Porcupine Bay			
Daphnia *galeata mendotae*	0.20-0.58	0.37	4.29
Daphnia retrocwva	0.06-0.54	0.19	12.65
Daphnia *schødleri*	0.10-0.52	0.28	144.98
Daphnia thorata	--	--	0.00
Leptodora kindtii	2.00-7.00	4.71	1,923.43
Total **Loc** 4 Biomass			2.085.34
Location 6 Seven Bays			
Daphnia galeata mendotae	0.04-0.40	0.15	3.04
Daphnia retrocwva	0.08-0.42	0.26	4.19
Daphnia *schødleri*	0.06-0.48	0.26	123.61
Daphnia thorata	--	--	0.00
Leptodora kindtii	1.00-13.00	4.45	2,798.50
Total **Loc** 6 **Biomass**			2.927.50
Location 9 Spring Canyon			
Daphnia *galeata mendotae*	--		0.00
Daphnia retrocwva	0.10-0.48	0.25	4.03
Daphnia *schødleri*	O-12-0.66	0.32	1,009.38
Daphnia thorata	--	--	0.00
Leptodora kindtii	3.00-15.00	6.98	$072.41
Total **Loc** 9 Biomass			**6.085.82**

Table B.17 Representative zooplankton size ranges (mm), mean lengths (mm) and biomass values ($\mu g/m^3$) for samples collected at four locations in July, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2 Gifford			
Daphnia galeata *mendotae*	O-10-0.38	0.25	1.49
Daphnia retrocurva	0.08-0.30	0.14	2.27
Daphnia schødleri	0.06-0.50	0.18	108.12
Daphnia thorata	--		0.00
Leptodora kindtii	2.00-1 3.00	451	338.00
Total **Loc** 2 Biomass			449.9
Location 4 Porcupine Bay			
Daphnia galeata *mendotae*	0.26-0.48	0.37	3.02
Daphnia *retrocurva*	0.06-0.40	0.15	0.71
Daphnia schødleri	0.06-0.58	0.17	91.33
Daphnia thorata	--	--	0.00
Leptodora kindtii	2.00- 12.00.	6.39	1,901.41
Total **Loc** 4 Biomass			
Location 6 Seven Bays			
Daphnia galeata *mendotae*	0.06-0.34	0.20	12.71
Daphnia retrocwva	0.1 O-O.28	0.18	1.06
Daphnia *schødleri*	0.1 o-0.40	0.21	114.94
Daphnia thorata	--	--	0.00
Leptodora kindtii	2.00- 12.00	6.05	3,293.15
Total **Loc** 6 Biomass			R-421.85
Location 9 Spring Canyon			
Daphnia *galeata mendotae*	0.18-0.20	0.19	0.11
Daphnia *retrocurva*	0.06-0.40	0.21	3.20
Daphnia *schødleri*	0.1 o-0.50	0.26	538.15
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	2.00-8.00	4.42	467.57
Total **Loc** 9 Biomass			**1,009.03**

Table **B.18** Representative zooplankton size ranges (mm), mean lengths (mm) and biomass values ($\mu g/m^3$) for samples collected at four locations in August, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2 Gifford			
Daphnia galeata *mendotae*	0.10-0.44	0.25	91.13
Daphnia retrocurva	0.10-0.40	0.22	38.19
Daphnia *schødleri*	0.16-0.50	0.27	773.90
Daphnia thorata			0.00
Leptodora kindtii	3.00-9.00	5.49	3,102.54
Total **Loc** 2 Biomass			**4,005.77**
Location 4 Porcupine Bay			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocurva	0.10-0.48	0.22	1.11
Daphnia *schødleri*	0.10-0.56	0.33	260.96
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 4 Biomass			262.07
Location 6 Seven Bays			
Daphnia galeata *mendotae*	0.10-0.42	0.24	6.77
Daphnia retrocwva	0.10-0.46	0.21	5.61
Daphnia *schødleri*	0.10-0.60	0.24	241.86
Daphnia thorata	--	--	0.00
Leptodora kindtii	3.00-14.00	6.38	459.69
Total **Loc** 6 Biomass			713.91
Location 9 Spring Canyon			
Daphnia galeata *mendotae*	0.20-0.54	0.31	10.08
Daphnia retrocwva	0.12-0.28	0.21	0.81
Daphnia *schødleri*	0.08-0.52	0.31	586.35
Daphnia thorata	0.18-0.48	0.40	0.18
Leptodora kindtii	--	3.00	7.02
Total **Loc** 9 Biomass			604.40

Table **B.19** Representative zooplankton size ranges (mm), mean Iengths (mm) and biomass values (μg/m^3) for samples collected at four locations in September, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m^3)
Location 2 Gifford			
Daphnia galeata mendotae		--	0.00
Daphnia retrocwva	0.08-0.40	0.17	2.79
Daphnia *schødleri*	0.10-0.52	0.23	44.53
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 2 Biomass			47.32
Location 4 Porcupine Bay			
Daphnia *galeata mendotae*	--	--	0.00
Daphnia *retrocurva*			0.00
Daphnia *schødleri*	0.14-0.54	0.34	770.10
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 4 Biomass			770.10
Location 6 Seven Bays			
Daphnia galeata mendotae	--	--	0.00
Daphnia *retrocurva*	--		0.00
Daphnia *schødleri*	0.12-0.58	0.31	713.17
Daphnia thorata	--	--	0.00
Leptodora kindtii	3.00-7.00	4.45	156.08
Total **Loc** 6 Biomass			869.25
Location 9 Spring Canyon			
Daphnia gaieata *mendotae*	0.18-0.26	0.22	0.23
Daphnia retrocurva	0.16-0.24	0.19	0.09
Daphnia schødleri	0.10-0.56	0.32	604.75
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	--	4.00	30.27
Total **Loc** 9 Biomass			635.30

Table B.20 Representative zooplankton size ranges (mm), mean lengths (mm) and biomass **values** ($\mu g/m^3$) for samples collected at four locations in October, 1995 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2 Gifford			
Daphnia galeata *mendotae*	0.10-0.46	0.27	9.00
Daphnia retrocwva	0.06-0.32	0.22	0.41
Daphnia schødleri	0.12-0.52	0.27	76.63
Daphnia thorata	--	--	--
Leptodora kindtii	--	10.00	349.5 1
Total **Loc** 2 Biomass			435.56
Location 4 Porcupine Bay			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia *retrocurva*		--	0.00
Daphnia *schødleri*	0.10-0.50	0.28	323.86
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	--	3.00	14.04
Total **Loc** 4 Biomass			337.90
Location 6 Seven Bays			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocwva			0.00
Daphnia *schødleri*	0.10-0.52	0.29	292.84
Daphnia thorata	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 6 Biomass			292.84
Location 9 Spring Canyon			
Daphnia galeata *mendotae*	--	--	0.00
Daphnia retrocwva			0.00
Daphnia *schødleri*	0.10-0.50	0.24	17.45
Daphnia *thorata*	--	--	0.00
Leptodora kindtii	--	--	0.00
Total **Loc** 9 Biomass			17.45

APPENDIX C
WATER QUALITY

Tables **C.1-C.4** Water quality measurements taken with a Hydrolab Surveyor II at Gifford, Seven Bays, Keller Ferry and Spring Canyon in January, 1995.

Table C.l;

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
3	2.30	9.37*	13.33	0.171	0.247
6	2.33 2.32	9.38*	13.71 11.79	0.150 0.166	0.249
					0.250
9	2.32	9.37*	11.53	0.162	0.251
12	2.32	9.38”	11.66	0.146	0.252
15	2.33	9.37*	11.57	0.182	0.253
18	2.30	9.37*	11.46	0.153	0.254
21					
24	2.32 2.30	9.34*	11.49 11.50	0.186 0.177	0.254 0.255
27	2.32	9.33*	11.50	0.186	0.256
30					
33	2.33 2.33	9.31*	11.49 11.43	0.156 0.134	0.257 0.258

* Indicates suspect pH readings due to sensor malfunction.

Table C.2;

SEVEN BAYS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	2.52	9.66”	11.70	0.164	0.214
3					
6	2.52 2.52	9.74*	13.05 12.00	0.152 0.163	0.214 0.210
9	2.57	9.78”	11.82	0.167	0.208
12	2.60	9.75”	11.79	0.160	0.210
15					
18	2.64 2.60	9.7[illegible]*	11.71 11.67	0.184 0.129	0.212 0.214
21	2.64	9.67”	11.67	0.148	0.215
24	2.64	9.64*	11.76	0.178	0.217
27	2.67	9.61”	11.64	0.160	0.218
30					
33	2.72 2.76	9.56*	11.55 11.58	0.148 0.137	0.218 0.221

* Indicates suspect pH readings due to sensor malfunction.

Table C.3;

KELLER FERRY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	2.82	9.79*	13.02	0.160	0.221
3	2.84	9.76*	12.00	0.165	0.219
6					
9	2.82 2.84	9.80*	12.04 12.38	0.171 0.158	0.217 0.212
12	2.86	9.90*	12.45	0.152	0.214
15					
18	2.89 2.96	9.85*	12.51 12.63	0.173 0.124	0.215 0.216
21	3.02	9.82”	12.79	0.146	0.217
24	3.01	9.80*	12.81	0.155	0.218
27	2.99	9.78*	12.70	0.151	0.219
30	3.01	9.77*	12.57	0.171	0.22 1
33	3.03	9.86*	12.49	0.194	0.22 1

* Indicates suspect pH readings due to sensor malfunction.

Table C.4;

SPRING CANYON					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.27	9.46*	13.28	0.165	0.217
3					
6	3.27 3.24	9.63*	11.26 11.59	0.166 0.171	0.200 0.207
9	3.22	9.67*	11.72	0.155	0.209
12	3.26	9.66*	11.74	0.159	0.210
15	3.24	9.67”	12.04	0.166	0.211
18	3.27	9.62*	12.13	0.174	0.213
21					
24	3.26 3.24	9.60*	12.11 12.18	0.200 0.157	0.214 0.215
27	3.33	9.56”	12.21	0.155	0.217
30	3.34	9.55*	12.21	0.166	0.218
33	3.44	9.54*	12.25	0.104	0.218

* Indicates suspect pH readings due to sensor malfunction.

Tables C.5-C.10 **Water quality measurements taken with a Hydrolab Surveyor II at Gifford, Porcupine Bay, Confluence, Seven Bays, Keller Ferry and Spring Canyon in February, 1995.**

Table C.5

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	2.55	8.56*	16.10	0.173	0.297
3	2.54	8.69*	12.60	0.172	0.288
6	2.54	8.84*	12.31	0.175	0.285
9	2.54	9.18*	12.28	0.175	0.273
12	2.57	9.30*	12.76	0.170	0.272
15	2.55	9.34*	12.21	0.182	0.271
18	2.55	9.37*	12.10	0.193	0.272
21	2.55	9.41*	12.06	0.158	0.271

* Indicates suspect pH readings due to sensor malfunction.

Table C.6

PORCUPINE BAY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.26	9.05*	18.20	0.131	0.263
3	3.33	9.11*	12.86	0.129	0.259
6	3.41	9.08*	12.00	0.128	0.256
9	3.43	9.59*	11.88	0.129	0.234
12	3.48	9.57*	11.62	0.125	0.234
15	3.54	9.56*	11.54	0.127	0.235
18	3.59	9.56*	11.32	0.127	0.235
21	3.61	9.54*	11.43	0.124	0.236
24	3.63	9.53*	11.55	0.125	0.237
27	3.63	9.52*	11.44	0.122	0.237
30	3.63	9.52*	11.50	0.121	0.237
33	3.61	9.51*	11.51	0.122	0.238

* Indicates suspect pH readings due to sensor malfunction.

Table C.7

CONFLUENCE

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	2.67	8.82*	14.08	0.159	0.251
3	2.62	9.04*	11.85	0.155	0.241
6	2.70	9.34*	11.41	0.147	0.227
9	2.77	9.45*	11.34	0.156	0.226
12	3.06	9.46*	11.32	0.148	0.226
15	3.09	9.50*	11.21	0.149	0.229
18	3.09	9.50*	11.26	0.147	0.227
21	3.07	9.51*	11.26	0.146	0.227
24	3.09	9.52*	11.31	0.148	0.228
27	3.06	9.52*	11.31	0.147	0.229
30	3.07	9.52*	11.31	0.143	0.230
33	3.07	9.52*	11.41	0.144	0.230

* Indicates suspect pH readings due to sensor malfunction.

Table C.8

SEVEN BAYS

Depth (m)	Temp. (°C)	pH	*0* (&ii)	Conduct. mmho/cm	ORP (V)
0	2.67	--	12.49	0.164	0.181
3	2.64	--	12.09	0.166	0.182
6	2.59	--	11.99	0.178	0.179
9	2.57	--	11.96	0.156	0.180
12	2.60	--	11.94	0.148	0.182
15	2.59	--	11.94	0.185	0.183
18	2.59	--	11.92	0.173	0.184
21	2.62	--	11.93	0.153	0.185
24	2.64	--	11.92	0.161	0.185
27	2.64	--	11.92	0.162	0.186
30	2.64	--	11.95	0.166	0.187
33	2.64	--	11.49	0.140	0.187

Table C.9

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
KELLER FERRY					
0	2.55	--	17.12	0.164	0.289
3	2.55	--	11.64	0.161	0.288
6	2.55	--	11.40	0.155	0.286
9	2.55	--	11.30	0.152	0.268
12	2.55	--	11.29	0.153	0.271
15	2.57	--	11.29	0.166	0.273
18	2.59	--	11.36	0.146	0.274
21	2.59	--	11.22	0.164	0.276
24	2.59	--	11.24	0.181	0.277
27	2.59	--	11.23	0.146	0.279
30	2.60	--	11.24	0.155	0.279
33	2.60	--	11.15	0.170	0.281

Table C.10

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
SPRING CANYON					
0	2.47	--	12.75	0.162	0.183
3	2.45	--	12.06	0.167	0.183
6	2.45	--	11.96	0.170	0.182
9	2.45	--	11.93	0.168	0.184
12	2.44	--	11.86	0.198	0.186
15	2.44	--	12.05	0.166	0.188
18	2.42	--	12.59	0.170	0.189
21	2.40	--	11.80	0.159	0.191
24	2.39	--	11.76	0.184	0.192
27	2.39	--	11.75	0.172	0.193
30	2.39	--	11.75	0.191	0.193
33	2.39	--	11.76	0.196	0.194

Tables C.11-C.15 Water quality measurements taken with a Hydrolab Surveyor II at Porcupine Bay, Confluence, Seven Bays, Keller Ferry and Spring Canyon in March, 1995.

Table C.11;

PORCUPINE BAY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.87	10.79*	15.41	0.084	0.179
3	3.83	10.71*	17.94	0.084	0.181
6	3.84	10.67*	17.40	0.084	0.182
9	3.81	10.69*	16.23	0.082	0.180
12	3.83	10.71*	13.67	0.085	0.182
15	3.84	10.60*	13.27	0.082	0.188
18	3.83	10.55*	19.63	0.085	0.190
21	3.84	10.55*	21.10	0.085	0.192
24	3.89	10.50*	13.73	0.086	0.193
27	3.89	10.46*	13.05	0.081	0.196

* Indicates suspect pH readings due to sensor malfunction.

Table C.12;

CONFLUENCE

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	4.24	10.63*	14.65	0.094	0.198
3	4.11	10.60*	12.87	0.095	0.199
6	4.06	10.54*	12.75	0.095	0.199
9	4.03	10.65*	12.65	0.099	0.197
12	3.98	10.59*	12.58	0.106	0.200
15	3.99	10.58*	12.58	0.105	0.202
18	3.98	10.58*	12.54	0.107	0.204
21	3.98	10.55*	12.55	0.109	0.205
24	3.90	10.54*	12.55	0.109	0.206
27	3.98	10.53*	12.60	0.106	0.207
30	3.98	10.52*	12.59	0.103	0.208
33	3.94	10.51*	12.57	0.110	0.209

* Indicates suspect pH readings due to sensor malfunction.

Table C.13;

SEVEN BAYS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.49	11.00*	16.31	0.154	0.216
3	3.44	11.02*	13.00	0.157	0.225
6	3.48	10.86*	14.56	0.160	0.226
9	3.38	10.85*	18.44	0.159	0.222
12	3.38	10.94*	12.50	0.172	0.224
15	3.58	10.93*	12.22	0.173	0.226
18	3.26	10.89*	12.15	0.179	0.228
21	3.24	10.89*	11.96	0.185	0.229
24	3.24	10.91*	13.73	0.169	0.229
27	3.26	10.91*	15.64	0.166	0.232
30	3.22	10.90*	12.66	0.186	0.233
33	3.22	10.91*	13.18	0.170	0.237

* Indicates suspect pH readings due to sensor malfunction.

Table C.14;

KELLER FERRY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.93	11.18*	19.40	0.160	0.166
3	3.94	11.12*	12.13	0.161	0.170
6	3.81	11.08*	11.63	0.146	0.170
9	3.81	11.14*	11.49	0.174	0.167
12	3.81	11.12*	11.45	0.154	0.168
15	3.79	11.11*	11.45	0.154	0.169
18	3.79	11.08*	11.50	0.157	0.169
21	3.79	11.07*	11.50	0.145	0.170
24	3.79	11.06*	11.50	0.167	0.170
27	3.79	11.05*	11.43	0.147	0.171
30	3.81	11.05*	11.44	0.167	0.171
33	3.81	11.05*	11.44	0.164	0.171

* Indicates suspect pH readings due to sensor malfunction.

Table C.15;

SPRING CANYON					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.58	10.84*	15.98	0.158	0.253
3	3.56	10.80*	12.23	0.154	0.263
6	3.54	10.92*	11.85	0.158	0.265
9	3.56	10.87*	11.78	0.140	0.273
12	3.56	10.85*	11.71	0.158	0.279
15	3.54	10.83*	11.69	0.155	0.285
18	3.54	10.81*	11.66	0.172	0.288
21	3.54	10.81*	11.63	0.157	0.292
24	3.54	10.80*	11.65	0.152	0.294
27	3.54	10.80*	11.63	0.155	0.297
30	3.56	10.79*	11.62	0.153	0.300
33	3.54	10.79*	11.65	0.154	0.302

* Indicates suspect pH readings due to sensor malfunction.

Tables C.16-C.21 **Water quality measurements taken with a Hydrolab Surveyor II at Gifford, Porcupine Bay, Confluence, Seven Bays, Keller Ferry and Spring Canyon in April, 1995.**

Table C.16;

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	6.14	--	11.78	0.178	0.200
3	5.93	--	11.81	0.174	0.199
6	5.81	--	11.80	0.172	0.200
9	5.60	--	11.71	0.165	0.202
12	5.57	--	11.59	0.168	0.203
15	5.57	--	11.53	0.166	0.204
18	5.53	--	11.42	0.154	0.205
21	5.52	--	11.43	0.172	0.205
24	5.50	--	11.53	0.183	0.205
27	5.45	--	11.49	0.190	0.206

Table C.17;

PORCUPINE BAY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	7.69	11.19*	11.70	0.092	0.205
3	6.78	11.19*	12.00	0.091	0.207
6	6.69	11.16*	11.82	0.091	0.208
9	6.58	11.07*	11.35	0.092	0.214
12	6.52	11.05*	11.50	0.092	0.216
15	6.51	11.01*	11.73	0.089	0.219
18	6.42	10.98*	11.21	0.089	0.223
21	6.36	10.97*	12.17	0.090	0.225
24	6.32	10.94*	11.60	0.091	0.227
27	6.13	10.91*	11.85	0.090	0.229
30	5.88	10.90*	11.71	0.091	0.232
33	5.88	10.94*	11.70	0.091	0.232

* Indicates suspect pH readings due to sensor malfunction.

Table C.18;

CONFLUENCE					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	6.78	--	11.75	0.156	0.230
3	6.26	--	11.86	0.161	0.230
6	6.18	--	12.76	0.183	0.231
9	6.04	--	12.83	0.145	0.233
12	5.96	--	12.30	0.145	0.236
15	5.95	--	11.93	0.121	0.237
18	5.96	--	11.81	0.140	0.239
21	5.95	--	11.81	0.195	0.240
24	5.91	--	11.85	0.165	0.241
27	5.80	--	11.78	0.169	0.242
30	5.14	--	11.75	0.161	0.243
33	4.79	--	11.56	0.172	0.243

Table C.19;

SEVEN BAYS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	7.06	10.95*	16.09	0.139	0.195
3	6.04	11.63*	16.04	0.138	0.195
6	6.03	11.09*	11.40	0.142	0.195
9	5.86	11.11*	11.45	0.142	0.195
12	5.73	11.08*	11.53	0.149	0.197
15	5.68	11.08*	11.50	0.149	0.198
18	5.63	11.07*	11.37	0.146	0.198
21	5.58	11.09*	11.35	0.145	0.199
24	5.42	11.08*	11.40	0.150	0.199
27	5.30	11.09*	11.41	0.152	0.200
30	5.10	11.10*	11.26	0.146	0.200
33	4.92	11.11*	11.27	0.153	0.201

* Indicates suspect pH readings due to sensor malfunction.

Table C.20;

KELLER FERRY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	4.76	10.98*	18.08	0.164	0.250
3	4.76	11.01*	12.55	0.162	0.248
6	4.74	11.05*	11.58	0.157	0.248
9	4.74	11.07*	11.53	0.167	0.248
12	4.72	11.06*	11.49	0.158	0.249
15	4.72	11.03*	11.49	0.171	0.251
18	4.72	11.03*	11.49	0.155	0.252
21	4.72	11.03*	11.46	0.166	0.253
24	4.72	11.03*	11.41	0.166	0.253
27	4.67	11.03*	11.45	0.179	0.254
30	4.66	11.04*	11.47	0.166	0.254
33	4.64	11.04*	11.46	0.130	0.255

* Indicates suspect pH readings due to sensor malfunction.

Table C.21;

SPRING CANYON

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	6.08	--	11.56	0.163	0.235
3	6.01	--	11.57	0.172	0.234
6	6.01	--	11.51	0.149	0.230
9	6.00	--	11.51	0.151	0.232
12	6.00	--	11.45	0.151	0.232
15	5.95	--	11.45	0.168	0.233
18	5.95	--	11.46	0.165	0.233
21	5.90	--	11.42	0.147	0.235
24	5.91	--	11.40	0.143	0.236
27	5.86	--	11.43	0.151	0.236
30	5.73	--	11.39	0.164	0.237
33	5.73	--	11.32	0.153	0.237

Tables C.22-C.29 Water quality measurements taken with a Hydrolab Surveyor II at Kettle Falls, Gifford, Hunters, Porcupine Bay, Seven Bays, Keller Ferry, San Poil and Spring Canyon in May, 1995.

Table C.22;

KETTLE FALLS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	9.82	7.83	11.69	0.134	0.144
3	9.72	7.82	11.76	0.134	0.148
6	9.71	7.81	11.77	0.133	0.150
9	9.67	7.82	11.86	0.135	0.152
12	9.66	7.82	11.86	0.134	0.154
15	9.66	7.82	11.87	0.132	0.155
18	9.61	7.83	11.89	0.134	0.156
21	9.60	7.84	11.90	0.134	0.158
24	9.60	7.84	11.85	0.133	0.159
27	9.60	7.84	11.89	0.133	0.161
30	9.62	7.85	11.89	0.133	0.162

Table C.23;

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	11.57	8.05	11.34	0.142	0.180
3	11.41	8.03	11.38	0.143	0.181
6	11.21	7.98	11.36	0.142	0.183
9	11.20	7.95	11.32	0.142	0.184
12	11.18	7.94	11.32	0.140	0.185
15	11.05	7.92	11.31	0.140	0.186
18	10.70	7.89	11.28	0.142	0.187
21	10.56	7.87	11.29	0.140	0.187
24	10.48	7.85	11.29	0.139	0.189
27	10.42	7.84	11.28	0.140	0.190
30	10.37	7.83	11.26	0.142	0.190
33	10.37	7.83	11.26	0.141	0.191

Table C.24;

HUNTERS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	11.75	8.00	11.36	0.146	0.130
3	11.13	7.99	11.36	0.146	0.136
6	10.82	7.94	11.34	0.146	0.140
9	10.76	7.93	11.35	0.145	0.142
12	10.86	7.94	11.33	0.145	0.144
15	10.70	7.92	11.29	0.145	0.145
18	10.57	7.90	11.28	0.143	0.147
21	10.53	7.89	11.24	0.144	0.148
24	10.59	7.90	11.27	0.144	0.150
27	10.56	7.90	11.28	0.144	0.151
30	10.56	7.90	11.30	0.146	0.154
33	10.48	7.90	11.27	0.146	0.155

Table C.25;

PORCUPINE BAY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	13.54	7.37	12.19	0.104	0.158
3	12.35	7.57	11.69	0.103	0.158
6	12.29	7.57	11.56	0.103	0.159
9	12.27	7.57	11.51	0.102	0.160
12	12.25	7.57	11.53	0.102	0.162
15	12.17	7.57	11.46	0.105	0.163
18	11.90	7.56	11.49	0.104	0.164
21	10.91	7.51	11.42	0.107	0.167
24	10.70	7.47	11.21	0.109	0.169
27	10.01	7.38	10.71	0.111	0.173
30	9.84	7.30	10.33	0.111	0.175

Table C.26;

SEVEN BAYS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	11.47	8.50	12.05	0.127	0.158
3	13.00	8.32	12.04	0.136	0.166
6	12.62	8.23	11.93	0.136	0.169
9	11.75	8.02	11.79	0.146	0.176
12	11.26	7.90	11.62	0.144	0.180
15	10.83	7.83	11.51	0.145	0.182
18	10.60	7.81	11.41	0.147	0.184
21	10.50	7.81	11.37	0.149	0.185
24	10.31	7.80	11.30	0.153	0.186
27	10.23	7.79	11.29	0.150	0.187
30	10.16	7.78	11.29	0.151	0.187
33	10.05	7.79	11.30	0.151	0.187

Table **C.27;**

KELLER FERRY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	14.06	8.64	11.92	0.150	0.165
3	13.24	8.57	12.10	0.151	0.167
6	12.83	8.47	12.08	0.151	0.171
9	11.14	8.19	12.02	0.154	0.179
12	10.41	8.02	11.06	0.156	0.185
15	10.30	7.98	11.78	0.156	0.187
18	10.16	7.95	11.76	0.156	0.187
21	10.14	7.93	11.71	0.155	0.190
24	10.16	7.92	11.66	0.155	0.191
27	9.46	7.90	11.72	0.158	0.192
30	9.43	7.89	11.70	0.157	0.192
33	9.38	7.89	11.67	0.157	0.193

Table **C.28;**

SAN POIL RIVER					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	16.14	7.98	10.31	0.136	0.138
3	12.67	7.97	10.74	0.144	0.141
6	11.33	8.08	11.48	0.153	0.141
9	10.90	8.08	11.68	0.153	0.143
12	10.66	8.03	11.69	0.151	0.145
15	10.44	7.97	11.68	0.151	0.147
18	10.18	7.90	11.60	0.148	0.150
21	9.93	7.86	11.56	0.151	0.151
24	9.75	7.83	11.52	0.149	0.153
27	9.55	7.79	11.43	0.149	0.155
30	9.22	7.65	10.93	0.150	0.158

Table **C.29;**

SPRING CANYON					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	14.12	8.60	13.21	0.154	0.168
3	12.94	8.70	12.80	0.153	0.165
6	11.56	8.46	12.50	0.153	0.172
9	10.71	8.28	12.37	0.155	0.177
12	10.50	8.22	12.16	0.155	0.180
15	10.17	8.16	12.10	0.156	0.182
18	10.10	8.13	11.97	0.156	0.184
21	9.46	8.07	12.16	0.157	0.186
24	9.24	8.02	11.94	0.157	0.187
27	9.21	8.01	11.90	0.156	0.188
30	9.12	8.01	11.92	0.155	0.189
33	8.87	7.99	11.92	0.157	0.189

Tables C.30-C.35 Water quality measurements taken with a Hydrolab Surveyor II at Gifford, Porcupine Bay, Seven Bays, Keller Ferry and Spring Canyon in June, 1995.

Table C.30;

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	13.79	7.89	12.02	0.137	0.118
3	13.78	7.88	11.99	0.137	0.120
6	13.71	7.86	11.93	0.136	0.123
9	13.63	7.84	11.91	0.135	0.125
12	13.62	7.84	11.88	0.136	0.127
15	13.62	7.84	11.84	0.136	0.129
18	13.60	7.85	11.80	0.134	0.130
21	13.56	7.84	11.79	0.137	0.132
24	13.50	7.82	11.82	0.135	0.134
27	13.41	7.82	11.78	0.134	0.136
30	13.45	7.81	11.75	0.134	0.138
33	13.43	7.80	11.80	0.135	0.139

Table C.31;

PORCUPINE BAY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	17.28	8.66	10.94	0.101	0.038
3	17.03	8.68	11.08	0.101	0.043
6	16.84	8.66	11.06	0.101	0.048
9	16.14	8.17	10.63	0.105	0.064
12	15.05	7.79	10.35	0.105	0.075
15	14.27	7.60	10.21	0.101	0.082
18	13.20	7.50	10.35	0.101	0.087
21	11.79	7.40	10.36	0.106	0.094
24	11.38	7.34	10.15	0.108	0.098
27	11.00	7.28	9.65	0.110	0.102

Table C.32;

CONFLUENCE

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	16.15	8.49	11.92	0.110	0.099
3	15.90	8.39	11.43	0.115	0.104
6	15.72	8.28	11.22	0.123	0.108
9	15.57	8.15	11.09	0.127	0.116
12	14.71	7.96	11.16	0.128	0.124
15	13.87	7.88	11.29	0.132	0.127
18	13.10	7.83	11.45	0.135	0.130
21	12.78	7.81	11.47	0.138	0.132
24	12.48	7.79	11.49	0.139	0.133
27	12.08	7.77	11.49	0.139	0.135
30	11.80	7.74	11.46	0.136	0.137
33	11.70	7.72	11.38	0.140	0.140

Table C.33;

SEVEN BAYS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	15.64	8.28	11.52	0.134	0.077
3	15.53	8.27	11.50	0.135	0.079
6	15.01	8.19	11.54	0.140	0.082
9	14.42	8.08	11.53	0.143	0.086
12	14.04	7.99	11.56	0.143	0.090
15	13.44	7.92	11.54	0.143	0.093
18	13.21	7.88	11.50	0.143	0.096
21	13.05	7.85	11.56	0.143	0.097
24	12.90	7.84	11.53	0.140	0.099
27	12.67	7.82	11.54	0.143	0.101
30	12.55	7.80	11.48	0.140	0.102
33	12.34	7.79	11.52	0.141	0.103

Table C.34;

KELLER FERRY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	16.56	8.32	11.19	0.133	0.135
3	16.52	8.31	11.03	0.134	0.136
6	16.37	8.29	10.96	0.133	0.137
9	16.35	8.29	10.91	0.134	0.138
12	16.30	8.26	10.90	0.133	0.139
15	13.54	7.94	11.34	0.134	0.149
18	12.97	7.84	11.46	0.138	0.153
21	12.71	7.80	11.51	0.136	0.155
24	12.32	7.77	11.45	0.136	0.157
27	12.16	7.75	11.42	0.137	0.158
30	12.06	7.74	11.43	0.136	0.159
33	11.98	7.73	11.38	0.136	0.160

Table C.35;

SPRING CANYON					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	17.06	8.28	10.74	0.121	0.112
3	17.00	8.29	10.60	0.143	0.112
6	16.52	8.26	10.62	0.141	0.114
9	16.06	8.23	10.71	0.142	0.115
12	14.95	8.23	10.90	0.142	0.120
15	13.96	7.98	10.97	0.141	0.125
18	13.60	7.91	11.00	0.140	0.127
21	12.77	7.83	11.06	0.139	0.131
24	12.53	7.79	11.03	0.140	0.132
27	12.41	7.77	11.01	0.139	0.134
30	12.23	7.76	11.09	0.138	0.135
33	12.08	7.74	11.13	0.137	0.136

Tables C.36-C.43 Water quality measurements taken with a Hydrolab Surveyor II at Kettle Falls, Gifford, Hunters, Porcupine Bay, Seven Bays, Keller Ferry, San Poil and Spring Canyon in July, 1995.

Table C.36;

KETTLE FALLS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	17.79	8.03	11.70	0.153	0.138
3	18.16	8.08	11.61	0.153	0.137
6	18.08	8.10	11.31	0.152	0.138
9	18.07	8.11	11.22	0.152	0.139
12	18.06	8.11	11.16	0.152	0.141
15	18.06	8.12	11.13	0.152	0.141
18	18.04	8.12	11.13	0.152	0.142
21	18.03	8.13	11.11	0.152	0.143
24	18.01	8.13	11.12	0.152	0.143
27	17.99	8.13	11.14	0.151	0.145
30	18.00	8.14	11.12	0.152	0.145
33	17.98	8.15	11.13	0.151	0.145

Table C.37;

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	19.41	8.31	12.47	0.152	0.113
3	18.37	8.37	11.74	0.151	0.114
6	18.16	8.35	11.24	0.152	0.117
9	17.71	8.24	10.96	0.151	0.122
12	17.29	8.14	10.86	0.151	0.124
15	17.05	8.08	11.01	0.151	0.127
18	16.84	8.03	11.14	0.151	0.129
21	16.75	8.00	11.05	0.151	0.131
24	16.68	7.98	11.00	0.150	0.132
27	16.68	7.97	10.93	0.150	0.133
30	16.61	7.96	10.89	0.150	0.135
33	16.44	7.94	10.86	0.150	0.136

Table C.38

HUNTERS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	19.41	8.13	11.54	0.150	0.099
3	18.86	8.31	11.36	0.151	0.101
6	18.87	8.37	11.29	0.151	0.102
9	17.62	8.22	11.14	0.150	0.107
12	17.25	8.13	10.95	0.152	0.111
15	17.03	8.05	10.83	0.150	0.114
18	17.02	8.03	10.79	0.150	0.115
21	17.01	8.02	10.79	0.151	0.117
24	16.63	7.98	10.71	0.149	0.119
27	16.55	7.94	10.75	0.150	0.121
30	16.41	7.92	10.76	0.149	0.122
33	16.14	7.89	10.73	0.149	0.125

Table C.39;

PORCUPINE BAY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	24.12	8.20	9.64	0.140	0.123
3	23.63	8.21	9.31	0.142	0.125
6	19.95	7.93	9.10	0.146	0.137
9	18.70	7.68	8.45	0.145	0.145
12	18.20	7.55	7.82	0.141	0.149
15	17.21	7.45	7.60	0.131	0.152
18	16.17	7.38	7.55	0.123	0.156
21	15.49	7.31	7.62	0.118	0.159
24	14.71	7.27	7.68	0.113	0.161
27	14.05	7.23	7.69	0.111	0.163
30	13.37	7.17	7.08	0.111	0.166

Table C.40;

SEVEN BAYS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	20.64	8.12	10.18	0.151	0.105
3	20.39	8.30	10.23	0.150	0.102
6	18.33	8.19	10.64	0.151	0.108
9	17.40	8.06	10.67	0.151	0.113
12	16.94	7.99	10.71	0.151	0.115
15	16.47	7.94	10.80	0.151	0.118
18	16.23	7.91	10.84	0.151	0.119
21	15.93	7.89	10.89	0.151	0.121
24	15.82	7.88	10.93	0.151	0.122
27	15.62	7.86	10.91	0.150	0.123
30	15.43	7.85	11.00	0.151	0.125
33	15.34	7.84	11.02	0.150	0.125

Table C.41;

KELLER FERRY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	21.42	8.19	10.08	0.154	0.104
3	21.00	8.17	9.16	0.153	0.106
6	20.78	8.13	9.08	0.153	0.109
9	20.55	8.10	9.04	0.152	0.111
12	20.00	8.02	9.14	0.153	0.115
15	19.50	7.96	9.25	0,152	0.118
18	19.23	7.91	9.33	0.152	0.121
21	18.70	7.87	9.42	0.153	0.125
24	18.45	7.84	9.46	0.152	0.126
27	18.36	7.82	9.51	0.154	0,127
30	18.20	7.81	9.53	0.153	0.129
33	17.85	7.78	9.60	0.151	0.131

Table C.42;

SAN POIL RIVER					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	22.57	7.90	9.74	0.157	0.107
3	19.67	8.07	10.15	0.151	0.107
6	17.78	7.99	10.50	0.149	0.112
9	17.28	7.93	10.65	0.150	0.114
12	17.06	7.90	10.60	0.150	0.116
15	16.83	7.88	10.73	0.150	0.118
18	16.52	7.87	10.80	0.150	0.119
21	16.46	7.87	10.66	0.149	0.120
24	16.28	7.79	10.32	0.147	0.123
27	16.08	7.73	9.97	0.147	0.125
30	15.89	7.69	9.66	0.147	0.126
33	15.64	7.66	9.53	0.144	0.128

Table C.43;

SPRING CANYON					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	22.78	7.77	10.25	0.060	0.162
3	21.57	8.33	9.67	0.145	0.145
6	21.12	8.33	9.73	0.146	0.146
9	19.66	8.15	9.79	0.147	0.153
12	17.36	7.97	10.22	0.149	0.160
15	17.00	7.91	10.34	0.150	0.163
18	16.72	7.89	10.40	0.150	0.164
21	16.50	7.87	10.48	0.151	0.165
24	16.00	7.85	10.56	0.150	0.167
27	15.80	7.83	10.63	0.150	0.168
30	15.74	7.82	10.62	0.150	0.168
33	15.64	7.81	10.64	0.150	0.169

Tables C.44-C.49 Water quality measurements taken with a Hydrolab Surveyor II at Gifford, Porcupine Bay, Confluence, Seven Bays, and Spring Canyon in August, 1995.

Table C.44;

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	19.91	8.07	9.12	0.144	0.092
3	19.92	8.06	9.12	0.145	0.094
6	19.91	8.04	9.13	0.145	0.095
9	19.90	8.03	9.16	0.145	0.096
12	19.90	8.02	9.16	0.145	0.096
15	19.90	8.02	9.16	0.145	0.097
18	19.90	8.02	9.16	0.144	0.098
21	19.89	8.02	9.20	0.144	0.099
24	19.86	7.99	9.18	0.145	0.100
27	19.83	7.95	9.16	0.143	0.102
30	19.72	7.88	9.10	0.144	0.105
33	19.72	7.85	9.07	0.145	0.106

Table C.45;

PORCUPINE BAY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	21.97	7.97	9.91	0.153	0.104
3	21.60	7.99	8.57	0.152	0.105
6	21.44	7.97	8.43	0.153	0.106
9	21.41	7.96	8.35	0.152	0.107
12	21.31	7.89	8.20	0.157	0.110
15	20.87	7.69	7.60	0.165	0.117
18	20.07	7.48	6.75	0.169	0.123
21	19.17	7.34	6.03	0.159	0.128
24	18.36	7.25	5.67	0.151	0.132
27	16.04	7.13	4.53	0.131	0.138
30	14.65	6.97	3.55	0.125	0.143
33	13.43	6.88	2.45	0.123	0.147

Table C.46;

CONFLUENCE					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	20.46	8.01	8.80	0.149	0.128
3	20.39	8.00	8.81	0.149	0.128
6	20.30	7.98	8.82	0.149	0.129
9	20.27	7.97	8.83	0.149	0.130
12	20.22	7.96	8.86	0.149	0.130
15	20.20	7.95	8.86	0.148	0.130
18	20.15	7.94	8.84	0.148	0.131
21	19.84	7.86	8.85	0.148	0.134
24	19.53	7.79	8.84	0.147	0.136
27	19.49	7.75	8.82	0.147	0.137
30	19.31	7.72	8.81	0.147	0.138
33	19.15	7.67	8.74	0.147	0.140

Table C.47;

SEVEN BAYS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	19.37	7.57	9.40	0.152	0.105
3	20.45	7.86	9.00	0.148	0.102
6	20.34	7.91	8.96	0.148	0.102
9	20.28	7.91	8.92	0.148	0.103
12	20.24	7.91	8.91	0.148	0.103
15	20.19	7.91	8.90	0.147	0.104
18	20.08	7.89	8.89	0.148	0.105
21	19.81	7.83	8.90	0.147	0.108
24	19.54	7.77	8.85	0.148	0.117
27	19.42	7.74	8.83	0.148	0.114
30	19.25	7.71	8.82	0.147	0.116
33	19.05	7.67	8.84	0.149	0.118

Table C.48;

KELLER FERRY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	19.57	7.67	8.95	0.148	0.163
3	19.57	7.70	8.95	0.149	0.164
6	19.54	7.70	8.93	0.150	0.165
9	19.54	7.70	8.90	0.148	0.166
12	19.54	7.71	8.90	0.148	0.166
15	19.53	7.72	8.91	0.149	0.167
18	19.51	7.72	8.91	0.148	0.168
21	19.44	7.71	8.89	0.149	0.169
24	19.40	7.68	8.84	0.147	0.170
27	19.32	7.63	8.73	0.148	0.173
30	19.18	7.57	8.62	0.146	0.175
33	19.12	7.54	8.62	0.145	0.177

Table C.49;

SPRING CANYON					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	21.05	8.05	10.26	0.152	0.097
3	21.10	8.07	9.24	0.153	0.097
6	21.06	8.07	9.01	0.153	0.098
9	20.95	8.06	8.91	0.154	0.100
12	20.86	8.05	8.83	0.153	0.101
15	20.68	8.01	8.82	0.153	0.104
18	20.51	7.96	8.84	0.152	0.106
21	20.28	7.92	8.83	0.154	0.103
24	19.99	7.83	8.86	0.152	0.114
27	19.66	7.78	8.91	0.151	0.117
30	19.43	7.76	8.96	0.151	0.119
33	19.25	7.73	9.00	0.151	0.123

Tables C.50-C.55 Water quality measurements taken with a Hydrolab Surveyor II at Gifford, Porcupine Bay, Confluence, Seven Bays, Keller Ferry, and Spring Canyon in September, 1995.

Table C.50;

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	18.21	7.80	9.86	0.144	0.170
3	17.81	7.85	10.02	0.142	0.170
6	17.58	7.84	10.07	0.142	0.172
9	17.43	7.82	10.08	0.142	0.173
12	17.36	7.80	10.11	0.142	0.175
15	17.33	7.78	10.10	0.142	0.175
18	17.28	7.75	10.05	0.142	0.177
21	17.24	7.73	10.04	0.141	0.179
24	17.23	7.72	10.04	0.141	0.180
27	17.21	7.71	10.05	0.140	0.180
30	17.17	7.69	10.00	0.142	0.182
33	17.12	7.67	9.99	0.140	0.183

Table C.51;

PORCUPINE BAY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	20.49	7.76	8.63	0.169	0.144
3	20.27	7.78	8.68	0.168	0.145
6	20.80	7.78	8.75	0.167	0.146
9	19.91	7.76	8.67	0.168	0.148
12	19.46	7.57	7.81	0.189	0.157
15	19.04	7.43	7.15	0.201	0.161
18	18.09	7.37	6.84	0.206	0.163
21	18.06	7.36	6.79	0.213	0.164
24	18.70	7.34	6.62	0.217	0.166
27	18.57	7.32	6.34	0.215	0.167
30	18.27	7.27	5.84	0.216	0.170

Table C.52;

CONFLUENCE					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	20.41	7.77	8.92	0.149	0.162
3	20.11	7.81	8.95	0.148	0.161
6	19.79	7.81	8.97	0.148	0.162
9	19.55	7.79	8.96	0.147	0.163
12	19.38	7.77	8.91	0.147	0.165
15	19.21	7.70	8.75	0.147	0.169
18	19.07	7.63	8.61	0.147	0.171
21	18.87	7.62	8.72	0.146	0.172
24	18.59	7.61	8.78	0.146	0.173
27	18.44	7.59	8.82	0.145	0.175
30	18.67	7.59	8.93	0.145	0.176
33	17.63	7.59	9.14	0.144	0.178

Table C.53;

SEVEN BAYS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	21.83	7.58	8.82	0.149	0.135
3	19.85	7.90	9.15	0.148	0.136
6	19.51	7.92	9.17	0.147	0.136
9	19.42	7.90	9.11	0.147	0.138
12	19.39	7.87	9.06	0.147	0.140
15	19.23	7.80	8.93	0.148	0.144
18	18.65	7.71	8.85	0.145	0.147
21	18.29	7.68	8.91	0.146	0.148
24	18.14	7.66	8.99	0.146	0.150
27	17.91	7.65	9.06	0.146	0.151
30	17.84	7.63	9.10	0.143	0.152
33	17.78	7.62	9.12	0.146	0.153

Table C.54;

KELLER FERRY

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	18.47	7.33	9.07	0.149	0.159
3	19.05	7.72	8.91	0.149	0.159
6	19.07	7.72	8.94	0.148	0.160
9	19.06	7.72	8.91	0.147	0.161
12	19.06	7.70	8.91	0.147	0.162
15	19.00	7.79	8.66	0.148	0.166
18	18.85	7.50	8.53	0.147	0.169
21	18.50	7.43	8.47	0.146	0.171
24	18.09	7.43	8.64	0.146	0.172
27	18.00	7.44	8.75	0.145	0.172
30	17.90	7.44	8.80	0.145	0.173
33	17.70	7.44	8.87	0.144	0.174

Table C.55;

SPRING CANYON

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	20.80	7.93	8.97	0.150	0.139
3	20.72	7.93	9.01	0.150	0.141
6	20.40	7.94	9.05	0.149	0.142
9	20.02	7.91	9.05	0.149	0.144
12	19.83	7.82	8.92	0.149	0.148
15	19.67	7.76	8.78	0.149	0.151
18	19.57	7.69	8.64	0.148	0.154
21	19.26	7.61	8.47	0.148	0.158
24	18.84	7.52	8.33	0.146	0.161
27	18.55	7.48	8.29	0.145	0.163
30	18.36	7.46	8.35	0.146	0.165
33	18.19	7.44	8.38	0.144	0.166

Tables **C.56-C.63** Water quality measurements taken with a Hydrolab Surveyor II at Kettle Falls, Gifford, Hunters, Porcupine Bay, Seven Bays, Keller Ferry, San Poil and Spring Canyon in October, 1995.

Table C.56;

KETTLE FALLS

Depth (m)	Temp. (°C)	PH	**D.O. (mg/L)**	Conduct. mmho/cm	**ORP (V)**
0	14.09	7.67	10.05	0.155	0.207
3	14.08	7.71	9.93	0.154	0.204
6	14.08	7.74	9.88	0.153	0.203
9	14.07	7.75	9.84	0.153	0.203
12	14.06	7.76	9.85	0.154	0.203
15	14.07	7.76	9.84	0.153	0.203
18	14.06	7.76	9.85	0.152	0.203
21	14.06	7.76	9.89	0.154	0.204
24	14.06	7.77	9.89	0.153	0.204
27	14.06	7.77	9.89	0.153	0.204
30	14.06	7.77	9.93	0.154	0.204
33	14.06	7.77	9.93	0.151	0.204

Table C.57;

GIFFORD

Depth (m)	Temp. (°C)	PH	**D.O. (mg/L)**	Conduct. mmho/cm	ORP (V)
0	14.96	7.64	10.01	0.152	0.163
3	14.98	7.22	10.24	0.151	0.187
6	14.98	7.39	9.63	0.151	0.178
9	14.98	7.47	9.51	0.151	0.173
12	14.98	7.53	9.47	0.151	0.170
15	14.98	7.57	9.48	0.152	0.168
18	14.94	7.59	9.46	0.151	0.167
21	14.88	7.61	9.49	0.152	0.167
24	14.85	7.62	9.50	0.153	0.166
27	14.81	7.63	9.49	0.151	0.166
30	14.97	7.64	9.50	0.153	0.166
33	14.78	7.64	9.50	0.150	0.167

Table C.58;

HUNTERS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	15.73	7.37	9.63	0.148	0.201
3	15.73	7.42	9.36	0.148	0.196
6	15.73	7.45	9.24	0.148	0.193
9	15.73	7.50	9.21	0.147	0.190
12	15.71	7.54	9.17	0.146	0.188
15	15.69	7.56	9.15	0.148	0.187
18	15.64	7.57	9.22	0.148	0.187
21	15.62	7.61	9.21	0.149	0.187
24	15.69	7.61	9.19	0.147	0.187
27	15.69	7.62	9.19	0.148	0.187
30	15.67	7.62	9.20	0.146	0.187
33	15.65	7.62	9.21	0.147	0.188

Table C.59;

PORCUPINE BAY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	15.70	7.55	8.76	0.211	0.203
3	15.70	7.56	8.75	0.210	0.203
6	15.78	7.56	8.70	0.209	0.203
9	15.67	7.56	8.69	0.210	0.203
12	15.66	7.55	8.70	0.210	0.203
15	15.64	7.56	8.67	0.209	0.204
18	15.45	7.53	8.63	0.211	0.205
21	15.15	7.49	8.56	0.218	0.207
24	14.47	7.46	8.47	0.221	0.208
27	14.33	7.44	8.45	0.221	0.208
30	14.24	7.43	8.41	0.220	0.209
33	14.19	7.42	8.39	0.223	0.209

Table C.60;

SEVEN BAYS					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	16.46	7.50	9.61	0.138	0.184
3	16.46	7.51	9.25	0.146	0.183
6	16.45	7.51	9.11	0.147	0.183
9	16.45	7.52	9.03	0.146	0.183
12	16.43	7.52	9.00	0.146	0.183
15	16.42	7.52	8.97	0.147	0.183
18	16.42	7.52	8.97	0.145	0.184
21	16.41	7.53	8.95	0.146	0.184
24	16.40	7.52	8.95	0.146	0.184
27	16.39	7.53	8.95	0.145	0.185
30	16.39	7.53	8.95	0.144	0.185
33	16.37	7.53	8.96	0.145	0.185

Table C.61;

KELLER FERRY					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	14.79	7.46	9.12	0.149	0.189
3	14.82	7.46	9.12	0.148	0.189
6	14.83	7.47	9.07	0.148	0.189
9	14.83	7.46	9.07	0.148	0.189
12	14.82	7.46	9.07	0.147	0.190
15	14.82	7.46	9.08	0.147	0.190
18	14.83	7.46	9.07	0.148	0.190
21	14.83	7.47	9.07	0.147	0.191
24	14.82	7.46	9.07	0.147	0.191
27	14.82	7.46	9.07	0.147	0.191
30	14.82	7.47	9.07	0.146	0.191
33	14.83	7.47	9.08	0.145	0.191

Table C.62;

SAN POIL RIVER					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	16.54	7.51	9.28	0.148	0.120
3	16.49	7.53	9.12	0.147	0.120
6	16.48	7.54	9.06	0.148	0.121
9	16.44	7.53	8.96	0.146	0.123
12	16.44	7.52	8.93	0.148	0.124
15	16.43	7.52	8.93	0.147	0.125
18	16.43	7.52	8.93	0.147	0.126
21	16.42	7.52	8.93	0.146	0.127
24	16.41	7.52	8.94	0.145	0.129
27	16.41	7.52	8.94	0.145	0.130
30	16.40	7.52	8.94	0.146	0.131
33	16.40	7.52	8.94	0.144	0.132

Table C.63;

SPRING CANYON					
Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	16.61	7.48	8.99	0.148	0.169
3	16.62	7.50	8.95	0.146	0.168
6	16.62	7.50	8.95	0.146	0.168
9	16.61	7.49	8.92	0.146	0.168
12	16.60	7.49	8.92	0.145	0.169
15	16.59	7.48	8.92	0.146	0.169
18	16.59	7.48	8.89	0.145	0.170
21	16.59	7.48	8.89	0.145	0.170
24	16.59	7.48	8.89	0.146	0.170
27	16.59	7.48	8.89	0.145	0.171
30	16.59	7.48	8.89	0.144	0.171
33	16.59	7.48	8.89	0.143	0.171

Table C.64 Monthly secchii disk depths in meters for nine index stations on Lake Roosevelt in 1995.

	LOCATION								
	1	2	3	4	Confluence	6	7	8	9
Jan		3.5		0.4	4.8	5.3	5.9		8.1
Feb		7.0		0.3	3.0	3.8	4.8		3.5
Mar				1.3	1.5	1.5	3.1		2.5
Apr		3.5		2.0	0.5	1.5	2.5		2.6
May						2.7	2.4	1.3	2.5
Jun							4.5	.	3.5
Jul	4.8	3.3	3.0	4.3		6.3	7.1	4.5	9.0
Aug		4.0		3.5	5.5	6.5	9.3		7.5
Sep		7.0		5.0	6.5	6.0	8.5		8.5
Oct	3.5	7.3	5.5	7.0		6.0	7.0	7.0	7.0
Mean	4.2	5.1	4.3	3.0	3.6	4.4	5.5	4.3	5.5

SECTION 2

LAKE ROOSEVELT FISHERIES MONITORING PROGRAM

1995 ANNUAL REPORT

Prepared by:

Keith D. Underwood
and
John P. Shields

Department of Natural Resources
Spokane Tribe of Indians
Wellpinit, WA 99040

and

Mary Beth Tilson

Upper Columbia United Tribes Fisheries Research Center
Biology Department
Eastern Washington University
Cheney, WA 99004

Prepared for:

Charlie Craig, Project Manager
U.S. Department of Energy
Bonneville-Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR. 97208-3621

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ABSTRACT

The purpose of the Lake Roosevelt Monitoring Program was to evaluate the effects of releasing hatchery origin kokanee salmon and rainbow trout on the fishery and to determine stocking strategies which increases fish harvest while maximizing the return of spawning kokanee to egg collection facilities. Two hatcheries stock kokanee and rainbow trout into lake Roosevelt, the Spokane Tribal Hatchery and the Sherman Creek Hatchery. The Spokane Tribal Hatchery began stocking fish in 1991 and Sherman Creek Hatchery began stocking in 1992. Approximately, 2.5 million kokanee salmon and 400,000 rainbow trout have been released annually since both hatcheries went on line. We estimated that 231,202 angler trips were taken to Lake Roosevelt spending a total of $8,697,819. The harvest of kokanee increased steadily from 8,021 fish in 1992 to 32,353 fish in 1995. Rainbow trout harvest was estimated to be 122,939 fish in 1995. Walleye harvest was down slightly from 53,589 fish in 1994 to 40,185 fish in 1995. The relative abundance of kokanee increased from 3% in past years to 20% in 1995. On the other hand, the relative abundance of yellow perch has steadily decreased from 40% in 1989 to 7% in 1995. Growth of kokanee salmon, rainbow trout and walleye appeared to be similar to previous years. Kokanee salmon and rainbow trout exceed the mean growth per age class of fish in area lakes, but walleye growth was significantly less than fish in area lakes. The feeding habits of kokanee and walleye in 1995 were similar to previous years, but rainbow trout feeding habits differed. Kokanee fed mainly on *Daphnia* spp. and chironomids, and walleye mainly feed on fish. Rainbow trout fed primarily on *Daphnia* spp., chironomids and a new food item yellow perch. Food habits and growth suggest that kokanee and rainbow had ample food, but the reduced walleye growth may be the result of food shortages. The continued decline of yellow perch may be contributing to the reduced growth rates of walleye.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Project History

The primary objective of this project was to determine stocking strategies of hatchery origin kokanee salmon (*Oncorhynchus nerka*) and rainbow trout (*Oncorhynchus mykiss*) which maximized angler harvest and return of kokanee to egg collection facilities; and collect baseline data on the fishery to evaluated effects of stocking kokanee and the rainbow trout on the environment. Another responsibility of this program was to assess the effectiveness of kokanee hatcheries and rainbow trout program funded by BPA. Tasks of the Monitoring Program were: to conduct a year round reservoir wide creel survey; sample the fishery by electroshocking boat during spring, summer and fall; and collect information on diet, length, weight and age information. The data generated from sampling was analyzed to determine food availability, utilization, growth rates, and angler use information (e.g. harvest). This 1995 annual report marks the sixth report produced by the Lake Roosevelt Monitoring Program (Monitoring Program). Peone et al. (1990), Griffith and Scholz (1991), Thatcher et al. (1993), Thatcher et al. (1994) and Underwood and Shields (1996), and Underwood et al. (1996) wrote previous Monitoring Program reports.

1.2 History of Kokanee and Rainbow Trout Stocking

From 1988 to 1990, kokanee reared at the Ford Hatchery by the Washington Department of Fish and Wildlife were stocked into Lake Roosevelt. Approximately 750,000 kokanee fry were stocked into Sherman Creek and 100,000 kokanee fiy were stocked into the Spokane River at Little Falls Dam each year during July or May. Rainbow trout fry were provided to the Lake Roosevelt Net Pen Program by the Spokane Hatchery (WDFW operated) from 1986 to 1990. The number of rainbow trout provided by the Spokane Hatchery began at 50,000 increasing to 276,500 by 1990. The rainbow trout were stocked in net pens during October. Rainbow trout were held in net pens until May or June and then released as yearlings. The Net Pen Program was operated by the Lake Roosevelt Development Association, a nonprofit volunteer group.

The Spokane Tribal Hatchery went on line in 1990 and began stocking kokanee and rainbow trout into Lake Roosevelt in 199 1. The Sherman Creek Hatchery began rearing and releasing kokanee in 1992. Construction and operation of these hatcheries was funded by the Bonneville Power Administration as partial mitigation for the loss of anadromous salmon and steelhead. The loss occurred in the 1939 when the Grand Coulee Dam was installed The dam was not equipped with a fish ladder, thus blocking the migration path of anadromous salmon and steelhead. The blockage caused the permanent loss of anadromous stocks upstream from the dam.

The Spokane Tribal Hatchery was a full production facility operated by the Spokane Tribe and located on their reservation. The Sherman Creek Hatchery was a part time (spring to fall) rearing facility operated by the Washington Department of Fish and Wildlife and located near Kettle Falls, Washington. The Sherman Creek Hatchery imprinted juvenile kokanee to the creek water, then released the juveniles and collected eggs from returning adults. The collected eggs were transferred to the Spokane Tribal Hatchery for incubation and rearing. To initiate production a majority of the kokanee eggs have come from Lake Whatcom Hatchery near Bellingham, WA (operated by WDFW). Also, due to limited returning adults to egg collection sites in Lake Roosevelt, kokanee eggs continue to be supplemented by the Lake Whatcom Hatchery. A portion of the kokanee reared in the Spokane Tribal Hatchery were transferred to Sherman Creek Hatchery in early Spring for imprinting and later released. The hatcheries original production goals were 8 million kokanee salmon fry for release into Lake Roosevelt and 500,000 rainbow trout fry for the Lake Roosevelt Net Pen Program. However, due to a limited water supply at the Spokane Tribal Hatchery, approximately 2.5 million kokanee and 250,000 rainbow trout fiy have been released annually.

1.3 1995 Study Goals

Goals of the Lake Roosevelt Monitoring Program for 1995 were as follows:

1) Determine angler pressure, number of fish harvested, average size of fish harvested and economic value of the fishery;

2) Estimate the relative abundance of fish in the lake;

3) Determine diet of kokanee, rainbow trout and walleye;

4) Back calculate length at age using scales from kokanee, rainbow trout and walleye; and

5) Compare and contrast data collected during 1995 with previous years to identify changes in the fishery.

2.0 MATERIALS AND METHODS

2.1 Study Area

Lake Roosevelt is a mainstem Columbia River impoundment formed by the installation of Grand Coulee Dam in 1939 (Figure 2.1). Filled in 1941, the reservoir inundated 33,490 hectares at a full pool elevation of 393 m (1,290 ft) above mean sea level. It has a maximum width of 3.4 km and a maximum depth of 122 m (Stober et al. 198 1).

2.2 Creel Design and Procedures

A two-stage probability sampling scheme was used to determine annual fishing pressure, catch-per-unit-effort (CPUE), and sport fish harvest by species on Lake Roosevelt (Lambou 1961;1966, Malvestuto 1983). Creel surveys were conducted at Spokane and Colville tribal campgrounds and National Park Service boat launches for a total of 48 survey locations (Figure 2.1).

Three creel clerks were employed to interview anglers at access points along Lake Roosevelt. The lake was split into three sections an upper, middle and lower section (Figure 2.1). One creel clerk was permanently assigned to a section. Each creel clerk was scheduled approximately 21 days per month to make roving instantaneous pressure and effort counts at access points.

Schedules were constructed by dividing each month into weekday and weekend/holiday stratum and days were stratified into a.m. (sunrise to 12:00) and p.m. (12:00 to sunset) time periods. Eighteen weekdays and four weekend/holidays with were randomly selected to schedule roving instantaneous pressure counts with half of the surveys conducted during the a.m. and the other half were conducted during the p.m.. The remaining a.m. or p.m. time slots over the 21 day time period were used to conduct five hour access point surveys. The schedules were developed monthly by randomly pulling index cards from a hat that specified the time, day, survey type (roving instantaneous pressure count or access point survey) and, if an access type of survey, the location. Roving instantaneous pressure counts and access point survey schedules differed among creel clerks both spatially and temporally.

During roving instantaneous pressure counts, each creel clerk recorded the number of boat trailers and shore anglers at the access points in their section. The creel clerk reached the access points by road. No angler interviews were performed during roving instantaneous pressure counts.

During each access point survey creel clerks interviewed anglers. The following data was collected from the anglers during the interviews: angler type, hours fished, completed trip, satisfaction, zip code of origin, target species, and number of fish caught and released. Fish harvested were identified to species, measured in millimeters, weighed in grams and examined for floy tags, fin clips, and physical markings such as eroded pectoral and pelvic fins, and stubbed dorsal fins. Physical marks were used to differentiate rainbow trout of net-pen or hatchery origin from wild fish. Scale samples were collected from representative kokanee, rainbow trout, and walleye, and stomach samples were collected from kokanee. Heads were taken from fin clipped kokanee for coded wire tag analysis. Additionally, incoming boaters (angler or non angler) were surveyed to determine the number of boats angling and the number of anglers per boat.

During 1990 through 1993, four air flights (one flight per stratum) were scheduled to coincide with roving instantaneous pressure counts monthly. The three creel clerks recorded the number of boat trailers and shore anglers in their section while concurrently the surveyor in the airplane recorded the number of boats on the water and the number of shore anglers. This information was used to compute a correction factor for the number of boats on the water versus the number of boat trailers at access points:

$$CF_b = \left(\frac{B_a}{B_c}\right)$$

Where:

CF_b = boat trailer correction factor for each stratum per month;
B_a = boat count from air survey for each stratum; and
B_c = number of boat trailers counted by creel clerks during air flights for each stratum.

The correction factor for boat trailers versus boats on the water that was determined during 1990 through 1993 was averaged among years and then applied to 1995 due to the facts that a limitation of funds negated our ability to conduct regularly scheduled air flights.

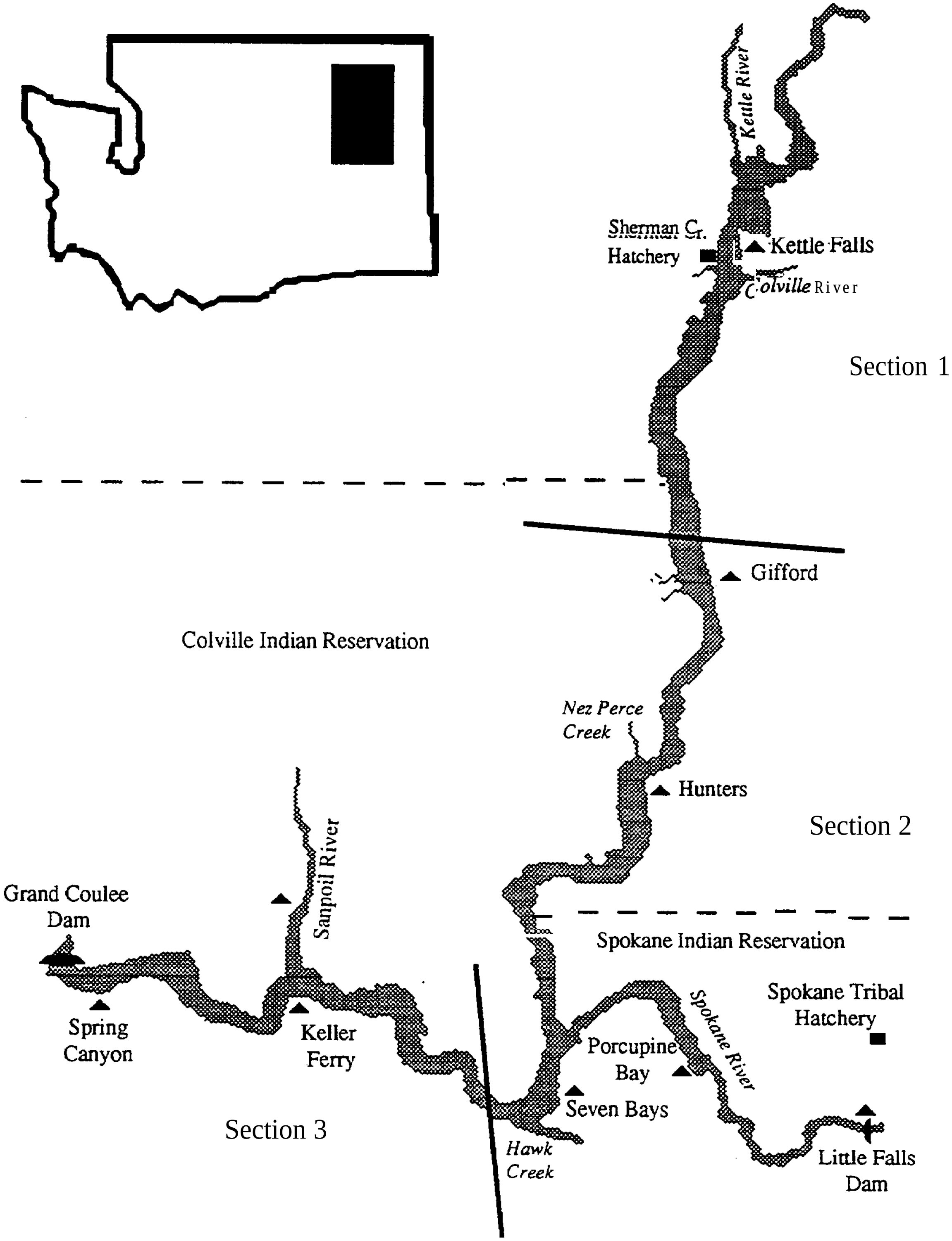

Figure 2.1. Map of Lake Roosevelt, Washington. "▲" indicates fish sampling stations.

Table A. 1 and A.2 of Appendix A summarize the correction factors determined in past years and the correction factor applied to 1995 data

The number of boats on the reservoir was determined for the stratum weekday/weekend, section and month by completing the following calculation:

$$T_b = (C_{bt})(CF_b)$$

Where:

Tb = number of boats on the water for each stratum per month;
Cbt = mean boat trailer count from pressure counts for each stratum per month; and
CFb = boat trailer correction factor for each stratum per month.

The number of boats fishing for the strata weekday/weekend, section and month was calculated by using the formula:

$$B_f = (T_b)(\%B_f)$$

Where:

Bf = number of boats fishing for each stratum per month;
Tb = number of boats on the water for each stratum per month; and
$\%Bf$ = percent of boats fishing for each stratum per month (number is in decimal form).

The adjusted mean number of boat anglers per day for the strata weekday/weekend, section and month was estimated using the formula:

$$X_d = (Ad)(B_f)$$

Where:

Xd = adjusted mean number of anglers per boat per day for each stratum per month;
Ad = mean number of anglers per boat from effort counts for each stratum per month; and
Bf = number of boats fishing for each stratum per month.

The above calculations used to estimate the instantaneous number of boat anglers were estimated separately by section then summed to obtain a full lake estimate.

The number of hours available for fishing (sunrise to sunset) was estimated using the following formula:

$$N_s = (D_s)(H_d)$$

Where:

N_S = number of hours per weekend, weekday per month;
D_S = number of days per month a weekday or weekend, and
H_d = average number of hours per day for each stratum per month.

The number of hours sampled for each stratum per month was estimated using the formula:

$$n = \sum_{i=1}^{D_s} (H_{ci})$$

Where:

n = number of hours sampled for each stratum per month;
D_S = number of days per month within each stratum; and
H_{ci} = mean number of hours creeled per day for each stratum per month.

The number of shore anglers per day for each stratum per month was estimated using the formula:

$$Xd = \sum_{i=1}^{Pd} (Spi)$$

Where:

Xd = mean number of shore anglers per day for each stratum per month from pressure counts;
Pd = number of pressure counts conducted for each stratum per month; and
Spi = total number of shore anglers counted during pressure counts for each stratum per month.

The mean number of anglers (boat or shore) for each stratum per month was estimated using the formula:

$$X_s = (X_d)(D_s)$$

Where:

X_S = mean number of anglers for each stratum per month;
X_d = mean number of anglers for each stratum per day; and
D_S = number of days per month within the stratum.

The standard deviation of anglers (boat or shore) for each stratum per month was estimated using the formula:

$$S_s = (S_d)(D_s)$$

Where:

S_s = standard deviation of anglers for each stratum per month;
S_d = standard deviation of anglers per day for each stratum per month; and
D_s = number of days per month for each stratum per month.

The mean number of angler hours per angler for each stratum was estimated using the formula:

$$H_a = \left(\frac{T_h}{A_i}\right)$$

Where:

H_a = mean number of angler hours per angler for each stratum per month;
T_h = total hours spent fishing for each stratum per month; and
A_i = total number of anglers interviewed for each stratum per month.

Pressure (hours fished) was estimated for day stratum (week day or weekend/holiday) for boat and shore anglers for each month by section by the formula:

$$PE_s = \left(\frac{N_s}{n}\right)(X_s)(H_a)$$

where:

PE_s = pressure estimate for each stratum per month;
N_s = number of hours for each stratum per month;
n = number of hours sampled for each stratum per month;
X_s = mean number of anglers for each stratum per month; and
H_a = mean number of angler hours per angler for each suatum per month.

The variance of the pressure (hours fished) estimate for each stratum per month was calculated by:

$$VPE_s = \left(\frac{N_s}{n}\right)S_s^2$$

where:

VPE_S = variance of pressure estimate for each stratum per month;
N_S = number of hours for each stratum per month;
n = number of hours sampled for each stratum per month; and
S_S = standard deviation of mean number of angler hours for each stratum per month.

Ninety-five percent confidence intervals for each stratum per month were calculated by:

$$C.I. = PE \pm \sqrt{(VPE_s)}1.96$$

where:

$C.I.$ = 95% confidence intervals for each stratum per month;
PE = pressure estimate for each stratum per month; and
VPE_S = variance of the pressure estimate for each stratum per month.

Monthly angler pressure and 95% C.I. was determined by calculating by weekend/weekday, boat/shore anglers, per month by section. If data gaps existed in any suata the quarterly averages were used to fill the gaps. Annual angler pressure and 95% C.I. estimates were calculated by summing monthly angler pressure estimates and 95% C.I. estimates for that section. Each section was added together to get full lake estimates.

Studies by Fletcher (1988) and Malvestuto et al. (1978) have shown that CPUE values calculated independently from complete and incomplete trip data are not statistically different. Therefore, complete and incomplete angler trips were used to compute CPUE for fish species in each stratum. CPUE was calculated independently for fish captured (kept and released) and fish harvested (kept) for each stratum for the month by the formula:

$$CPUE = \left(\frac{F}{T_h}\right)$$

where:

$CPUE$ = Catch per unit effort of a particular fish species for each stratum per month;
F = number of fish captured (harvested) for each stratum per month; and
T_h = total hours spent fishing for each stratum per month.

Monthly CPUE of a particular fish species was calculated by dividing the total catch for the entire month (all stratum) by the total angler hours (all stratum) for each section. Annual CPUE values of a particular fish species were calculated by dividing the total catch for the year by the total number of angler hours for the year.

Harvest of fish species was determined for each stratum per month by the formula:

$$Harvest = (H_{cpue})(PE_s)$$

where:

$Harvest$ = harvest of a particular fish species for each stratum per month;
H_{cpue} = number of fish harvested of a particular fish species for each stratum per month for each stratum per month; and
PE_S = pressure (hours fished estimate for each stratum per month.

Monthly harvest estimates for a particular fish species by stratum were combined to calculate a total monthly harvest estimate by section. Monthly harvest estimates were combined to calculate annual estimates for each fish species by section. Section harvest estirnates were added by month to obtain full lake monthly harvest.

Data compiled by the U.S. Fish and Wildlife Service in 1980 and 1985, showed a typical angler spent \$23.00/fishing trip in 1980 and \$26.00/fishing trip in 1985 in inland waters of Washington State (USFWS 1989). To calculate current dollar amount spent by anglers per trip, the 1985 cost per fishing trip was adjusted for inflation using the regional consumer price index (CPI). The following formula was used:

$$D_{95} = \left(\frac{D_{85} x C_{95}}{C_{85}} \right)$$

where:

$D95$ = dollar value per fishing trip for the Lake Roosevelt Fishery in 1995;
$C85$ = regional CPI for 1985;
$C95$ = regional CPI for 1995; and
$D85$ = dollar value per fishing trip for the Lake Roosevelt Fishery in 1985 (\$26.00).

The 1995 dollar value was multiplied by total number of angler trips in 1995 to provide an estimate of the economic value of the fishery. The number of angler trips per month was determined by dividing the total number of angler hours per month by the average length of a completed fishing trip for the month. Annual angler trips were calculated by summing monthly angler trip values.

2.3 Fisheries Surveys and Relative Abundance

Fishery samples were collected at nine index stations in the reservoir, which included: Kettle Falls, Gifford, Hunters, Porcupine Bay, Little Falls Dam, Seven Bays, Keller Ferry, Sanpoil, and Spring Canyon (Figure 2.1). Fishery data was collected at each index station over 24 hour periods. Principle target species included kokanee salmon, rainbow trout, and walleye, although it was assumed that all fish captured were caught in proportion to their relative abundance in the lake.

Relative abundance surveys were performed in littoral areas and tributaries by electrofishing 10 minute transects along 0.5 km of shoreline using SR- 180 and SR-23 electrofishing boats (Smith Root, Inc., Vancouver, WA) according to procedures outlined by Reynolds (1983) and Novotany and Prigel(l974). Voltage was adjusted to produce a pulsating DC current of approximately 5 amperes. Fish were collected using dip nets and placed into live wells on the boat for examination and data collection. A minimum of six 10 minute transects were performed at each sample station.

Additional relative abundance surveys were performed in pelagic zones with bottom and surface monofilament gillnets using methodologies described by Hubert (1983). The following gillnets were used: two horizontal surface set gillnets measuring 61 m in length by 6.1 m deep, with four 15.2 m long panels graded from 1.3 to 7.6 cm stretch mesh; and two horizontal bottom set gillnets measuring 61 m in length by 6.1 m deep, with four 15.2 m long panels graded from 1.3 to 8.9 cm stretch mesh. Gillnets were set in early afternoon (2:00 p.m.) and pulled at 10:00 a.m. the next morning.

Fish captured were identified by species using the taxonomic key of Wydoski and Whimey (1979). Total lengths were measured to the nearest millimeter using a metric measuring board and scale samples were removed from target fish species to determine age and growth. Target species were weighed to the nearest gram using an spring scales. Sexes were determined when possible. Stomach samples were collected from representative sizes of target species. The heads of kokanee were cut off and sent to the Fisheries Research Center at Eastern Washington University, where coded wire tags (cwt) were dissected out and examined to determine the lot code. These results are discussed in chapter 3 of fish report.

2.4 Age, Back Calculations and Condition Factor

In the field, scales were taken from appropriate locations for each species as described by Jearld (1983) and placed in coin envelopes labeled with fish number, length, weight, location, date, and species for later analysis. In the laboratory, back-calculation measurements and age class of each fish were determined simultaneously. To obtain data, scales were removed from the envelope and placed between two microscope slides. Slides were then placed in a Realist Vantage 5, Model 33 15 microfiche reader. Scale images were projected onto the screen and a non-regenerated, uniform scale was selected to determine age and back calculate length at age. Age was determined by counting the number of annuli (Jearld 1983). For back calculations, the annulus distance was measured from the origin of the scale to the last circuli of each respective annulus. Each measurement was made under constant magnification to the nearest millimeter.

Lee's back-calculation method was used to determine the length of the fish at the formation of each annulus (Carlander 1950, 1981; Hile 1970). However, due to a small number of samples the "y" intercept was assumed to be zero.

Back-calculations were computed using the formula:

$$L_i = a + \left(\frac{L_c - a}{S_c}\right) S_i$$

where:

L_i = length of fish (in mm) at each annulus formation;
a = intercept of the body-scale regression line;
L_c = length of fish (in mm) at time of capture;
S_c = distance (in mm) from the focus to the edge of the scale; and
S_i = scale measurement to each annulus.

Condition factors were determined for each fish to serve as an indicator of fish condition (Hile 1970, Everhart and Youngs 1981). Condition factor describes how a fish adds weight in relation to incremental changes in length. The relationship is shown by the formula:

$$K_{TL} = \left(\frac{w}{l^3}\right)10^5$$

where:

K_{TL} = condition factor;
w = weight of fish (g); and
l = total length of fish (mm).

2.5 Feeding Habits

Fish stomachs were collected from kokanee, rainbow, and walleye at each index station. Additional kokanee stomachs were obtained by creel clerks from anglers throughout the year. Stomachs from representative sizes of fish were collected by making an incision into the body cavity, cutting the esophagus, and pinching the pyloric sphincter. The esophagus was clamped to keep prey items from being expelled and the stomach was placed in 10% formalin.

In the laboratory, stomachs were transferred to a 70% isopropyl alcohol solution. Contents were identified and enumerated by taxa using the taxonomic keys of Brooks (1957), Ward and Whipple (1966), Bon-or et al. (1976), Ruttner-Kolisko (1974), Edmonds et al. (1976), Wiggins (1977), Pennak (1978, 1989), and Merritt and Cummins (1984). Food organisms were identified using a Nikon SMZ- 1B dissecting microscope equipped with a fiber optics illumination system and 5 mm ocular micrometer.

Dry weights were obtained by drying sorted stomach contents in an oven at 105° for 24 hours on a stainless steel wire screen and weighing them on a Sartorius Model H51 analytical balance to the nearest 0.0001 g (Weber 1973, APHA 1976). Weight values were combined for each age class, annual mean and standard deviation.

Index of relative importance values were used to compensate for numerical estimate biases that tend to over-emphasize small prey groups consumed in large numbers and weight estimate biases that overemphasize large prey items consumed in small numbers (Bowen 1983). The index of relative importance (George and Hadley 1979) was calculated using the formula:

$$RI_a = \frac{100AI_a}{\sum_{a=1} AI_a}$$

where:

RI_a = relative importance of food item a;
AI_a = absolute importance of food item a (i.e., frequency of occurrence + numerical frequency + weight frequency of food item a); and
n = number of different food types.

Relative importance values range from zero to 100% with prey items near zero being relatively less important than those prey items near one hundred percent.

Diet overlap was calculated to determine the degree to which intra and inter species competition exists in Lake Roosevelt. Fish diet overlaps were computed by using the overlap formula of Morisita (1959) as modified by Horn (1966). Overlap values were based upon indices obtained from IRI calculations. Overlap index was expressed in the equation:

$$C_x = \frac{2\sum_{i=1}^{n}\left(P_{xi} x P_{yi}\right)}{\sum_{i=1}^{n} P_{xi}2 + \sum_{i=1}^{n} p_{yi}2}$$

where:

C_x = overlap coefficient;
n = number of food categories;
P_{xi} = proportion of food category (i) in the diet of species x; and
P_{yi} = proportion of food category (i) in the diet of species y.

Overlap coefficients were computed using IRI values in the equation for the variables Pxi and Pyi. Overlap coefficients range from 0 (no overlap) to 1 (complete overlap). Values of less than 0.3 are considered low and values greater than 0.7 indicate high overlap (Peterson and Martin-Robichaud 1982). High diet overlap indices may indicate competition if food items utilized by the species are limited (MacArthur 1968), or there may be an abundant food supply and therefore competition does not exist.

3.0 RESULTS

3.1 Creel Data

The angler pressure (hours fished) estimates for Lake Roosevelt are reported by section and month in Table 3.1 . Appendix A reports the pressure estimates by the lowest stratification levels.

The results of the creel analyses are reported for the time period December 1994 through November 1995. December 1994 was included in this report so that quarterly averages could be used to fill data gaps at the lowest stratification level. Quarters were split into December 1993 through February 1994 (winter), March 1994 through May 1994 (spring), June 1994 through August 1994 (summer), and September 1994 through November 1994 (fall). Quarters were established based on historic weather trends and angler use of the fishery. For example, a quarterly average was used if no boat anglers were surveyed during the month of January on a weekend in Section 1, but boat trailers were counted at the access points during the weekends. Since no boat anglers were surveyed, we were unable to estimate the average number of hours fished by boat anglers on a weekend in January without using some other means to estimate the number of boat angler hours. As a result, the quarterly average was used to fill the data hole, “weekend boat angler”.

Fishing pressure (angler hours) was greatest in Section 3 (684,026 hrs) followed by Section 2 (512,730 hrs) and then Section 1 (152,773 hrs). The annual pressure for the lake was estimated to be 1.3 million hours. Total pressure was greatest during June (243,852 hrs) and August (203,724 hrs). Pressure was least during November (12,299) and January (39,018 hrs).

The number of angler trips to Lake Roosevelt were estimated by dividing the estimated number of angler hours fished by the mean trip length for each section and month (Table 3.2). The total number of trips estimated from the period December 1994 through November 1995 was 231,202 angler trips. A total of 24,223 trips (11%) were made in Section 1; 109,709 angler trips (47%) in Section 2 and 97,270 angler trips (42%) were in Section 3. The greatest number of trips was during February (33,962 trips), June (33,387 trips) and May (29,015 trips).

Table 3.1. Total monthly angler pressure estimates in hours (± 95% CI), by creel section on Lake Roosevelt from December 1994 through November 1995.

	Section			
	1	2	3	Total
Dec	2,009 ± 87	36,923 ± 1,854	6,966 ± 388	45,898 ± 2,329
Jan	1,589 ± 144	20,152 ± 1,146	17,277 ± 564	39,018 ± 1,854
Feb	1,528 ± 195	94,308 ± 1,738	72,490 ± 3,025	168,326 ± 4,958
Mar	5,913 ± 199	44,784 ± 2,672	35,282 ± 2,007	85,979 ± 4,878
Apr	10,807 ± 612	52,297 ± 1,729	56,248 ± 1,687	119,352 ± 4,028
May	20,514 ± 690	62,152 ± 2,012	94,690 ± 2,969	177,356 ± 5,671
Jun	19,948 ± 520	47,427 ± 684	176,477 ± 2,893	243,852 ± 4,097
Jul	55,896 ± 2,275	31,883 ± 1,150	22,579 ± 1,249	110,358 ± 4,674
Aug	5,772 ± 983	60,269 ± 3,116	137,683 ± 1,715	203,724 ± 5,814
Sep	23,215 ± 807	36,464 ± 1,619	32,991 ± 1,232	92,670 ± 3,658
Oct	3,456 ± 135	22,188 ± 655	25,053 ± 553	50,697 ± 1,343
Nov	2,126 ± 207	3,883 ± 339	6,290 ± 23	12,299 ± 569
Total	152,773 ± 6,854	512,730 ± 18,714	684,026 ± 18,305	1,349,529 ± 43,873

Table 3.2. Angler trip estimates by section based on angler hours (hrs) and average trip length for Lake Roosevelt from December 1994 through November 1995.

	Section	Mean Trip Length	No. Angler Hours	No. Angler Trips
December	1	3.2	2,009	628
	2	3.3	36,923	11,189
	3	4.5	6,966	1,548
January	1	3.7	1,589	429
	2	5.0	20,152	4,030
	3	5.0	17,277	3,455
February	1	5.0	1,528	306
	2	5.0	94,308	18,862
	3	4.9	72,490	14,794
March	1	5.1	5,913	1,159
	2	4.8	44,784	9,330
	3	5.2	35,282	6,785
April	1	5.3	10,807	2,039
	2	4.7	52,297	11,127
	3	7.7	56,248	7,305
May	1	6.1	20,514	3,363
	2	5.3	62,152	11,727
	3	6.8	94,690	13,925
June	1	5.9	19,948	3,381
	2	5.0	47,427	9,485
	3	8.6	176,477	20,521
July	1	6.8	55,896	8,220
	2	4.2	31,883	7,591
	3	6.0	22,579	3,763
August	1	6.6	5,772	875
	2	5.3	60,269	11,372
	3	8.9	137,683	15,470
September	1	8.0	23,215	2,902
	2	3.9	36,464	9,350
	3	6.6	32,991	4,997
October	1	6.1	3,456	567
	2	4.7	22,188	4,721
	3	6.7	25.053	3,739
November	1	6.0	2,126	354
	2	4.2	3,883	925
	3	6.5	6,290	968
Total		5.62	1,349,529	231,202

Table 3.3 reports the harvest rates by catch per unit effort (CPUE) for fish harvested during 1995. The annual mean harvest rate for rainbow trout was 0.089 HPUE (11 angler hrs/fish); 0.060 HPUE (17 angler hrs/fish) for walleye; 0.018 HPUE (55 angler hrs/fish) for kokanee and 0.004 (250 angler hrs/fish) for smallmouth bass. Section 3 had the quickest harvest rate for rainbow trout (0.154 HPUE (6 angler hrs/fish)) and smallmouth bass (0.010 HPUE (100 angler hrs/fish)). Section 1 had the highest mean annual harvest rate for walleye (0.154 HPUE (6 angler hrs/fish)) and Section 2 had the highest for kokanee (0.042 HPUE (23 angler hrs/fish)). The HPUE was 0.000 for sturgeon due to the fact that Washington Department of Fish and Wildlife closed harvest of sturgeon in 1995 as a means to conserve the remnant Lake Roosevelt population.

The 1995 catch (kept and released fish) estimates were similar to harvest estimates for most species (Table 3.4). However, walleye harvest was 0.060 HPUE (17 angler hrs/fish), and the catch was 0.131 CPUE (8 angler hrs/fish). The difference between the harvest and catch rates for walleye were due to a slot limit enforced by the Washington Department of Fish and Wildlife. The walleye slot limit specified that no more than one fish over 20 inches and only walleye less than 16 inches may be kept. This meant that it took approximately 17 hours for each angler to harvest a legal sized walleye, but 8 angler hours for each fish to catch a walleye within or outside of the slot limit.

The largest contribution to the fishery in terms of harvested (kept only) was rainbow trout (122,939 fish) followed by walleye (40,185) and kokanee (32,353). Smallmouth bass harvest was estimated to be 9,558 fish. Among lake sections, a majority of the rainbow trout (87,428) were harvested in Section 3 and a majority of walleye (28,743) were harvested in Section 1. Of the walleye observed in the creel, 6% of the fish were outside of the legal size limit, which was between 406 mm (16 in) and 508 mm (20 in). The number of walleye harvested outside of the legal size was estimated to be 2,411 fish. Section 1 was the only area where sturgeon (297) were harvested. However, the estimated number of sturgeon captured must be viewed with caution. One sturgeon were seen by creel clerks in 1995. The small sample size may have caused significant errors in the estimate. The estimated number of fish harvested with 95% confidence intervals are reported in Table 3.5. Appendix A also reports harvest by section, month and species.

Table 3.3. Harvest (kept fish) catch per unit effort (HPUE) by section from December 1994 through November 1995 at Lake Roosevelt.

	Section			
	1	2	3	Annual
kokanee	<0.001	0.004	0.042	**0.018**
rainbow trout	0.033	0.064	0.143	0.083
walleye	0.154	0.008	0.009	0.060
smallmouth bass	0.000	0.000	0.010	0.004
sturgeon	0.000	0.000	0.000	0.000
other species	0.003	0.000	0.000	0.001
Annual HPUE	0.190	0.076	0.204	0.173

Table 3.4. Catch (kept and released fish) catch per unit effort (CPUE) by section from December 1994 through November 1995 at Lake Roosevelt.

	Section			
	1	2	3	Annual
kokanee	0.000	0.004	0.042	0.018
rainbow trout	0.034	0.065	0.145	0.084
walleye	0.312	0.014	0.010	0.131
smallmouth bass	0.000	0.001	0.100	0.040
sturgeon	CO.001	0.000	0.000	**<0.001**
other species	0.003	0.000	0.000	0.001
Annual CPUE	0.350	0.084	0.298	0.276

Table 3.5. Number of fish harvested (kept), with ± 95% confidence intervals, for Lake Roosevelt during December 1994 through November 1995.

	Section 1	Section 2	Section 3	Total
kokanee	175 (± 7)	3,076 (± 140)	29,102 (± 938)	32,353 (± 1,085)
rainbow trout	4,497 (± 251)	31,014 (± 1,143)	87,428 (± 2,505)	122,939 (± 3,899)
walleye	28,743 (± 1,132)	6,008 (± 146)	5,434 (± 116)	40,185 (± 1,394)
smallmouth bass	0 (± 0)	0 (± 0)	9,558 (± 162)	9,558 (± 162)
sturgeon	0 (± 0)	0 (± 0)	0 (± 0)	**0** (± **0**)
other species	537 (± 25)	0 (± 0)	0 (± 0)	**537** (± **25**)
Annual Harvest	33,952 (± 1,417)	40,098 (± 1,429)	131,759 (± 3,734)	205,809 (± 6,580)

Table 3.6. Number of fish caught (kept and released), with ± 95% confidence intervals, for Lake Roosevelt during December 1994 through November 1995.

	Section			
	1	2	3	Total
kokanee	175 (± 7)	3,076 (± 140)	29,102 (± 938)	32,353 (± 1,085)
rainbow trout	4,609 (± 255)	32,305 (± 1,186)	89,044 (± 2,537)	125,958 (± 3,978)
walleye	58,602 (± 2,234)	9,002 (± 239)	6,063 (± 136)	73,667 (± 2,609)
smallmouth bass	0 (± 0)	681 (± 10)	75,543 (± 2,120)	76,224 (± 2,130)
sturgeon	13 (± 2)	0 (± 0)	0 (±) 0	13 (± 2)
other species	624 (± 28)	0 (± 0)	0 (± 0)	624 (± 28)
Annual Catch	64,024 (± 2,526)	45,065 (± 1,575)	199,990 (± 5,740)	309,079 (± 9,841)

Table 3.7. Annual numbers (n), mean lengths (mm) and weights (g) with standard deviations for all fish harvested on Lake Roosevelt from December 1994 through November 1995.

	Kokanee	Rainbow	Walleye	Small-mouth Bass	Burbot	Yellow Perch
See 1						
n	1	87	409	-	4	4
Ln	221± -	384±66	372.3	-	563±47	267±53
Wt	85± -	643±359	388±258	-	1,054±224	245±129
Sec 2						
n	5	83	11	-		
Ln	507±87	431±55	396±90	-		
Wt	1,380±657	928±322	451±64	-		
Sec 3						
n	112	375	24	26	-	
Ln	468±48	41 lf84	321±83	265±57	-	
Wt	1,219±327	1,017±474	418±238	625±519	-	
Total **n**	118	545	444	**26**	4	4
Ln	**467±55**	**410±79**	**370±58**	**265±57**	**563±47**	**267±53**
Wt	**1,216±362**	**948±457**	**390±255**	**625±519**	**1,054±224**	**245±129**

The number of fish in the catch (kept and released) was similar to the harvest numbers. However, the walleye harvest deviated from catch due to the slot limit. Table 3.6. identifies the catch numbers by section and species with 95% confidence intervals. Appendix A reports catch by section, month and species.

The average length and weight of fish observed in the creel are reported in Table 3.7 by section and species. Section 2 contained the largest rainbow trout (length 43 1 mm and weight 928 g). Walleye were larger in Section 2 than in Section 1 or 3. The mean length of walleye in Section 1 was 360 mm (n = 370) for fish classified in the smaller than 16 inch slot limit. Fish harvested in the 20 inches slot limit had a mean length of 561 mm (n = 13). In Section 2 walleye smaller than 16 inches had a mean length of 360 mm (n = 9) and walleye larger than 20 inches had a mean length of 559 mm (n = 2). In Section 3 walleye smaller than 16 inches had a mean length of 319 mm (n = 22) and walleye larger than 20 inches had a mean length of 508 mm (n = 1). There were 26 illegally sized walleye measured in Section 1, averaging 458 mm long.

Table 3.8 identifies the percent of anglers satisfied with the fishery by species, section and season. Based on annual time step, a majority of anglers (100%) were satisfied with the smallmouth bass fishery. However, fewer anglers were satisfied with the walleye (12%), kokanee (40%), rainbow trout (36%) and sturgeon (20%) fisheries. Anglers fishing during the summer and fall appeared to have a higher satisfaction then anglers fishing in the winter and spring.

Of all the anglers who fished on Lake Roosevelt during 1995, 49% targeted rainbow, 26% targeted walleye, 19% targeted kokanee and the rest targeted other species (Table 3.9). The Other species were mainly smallmouth bass. The winter fishery consisted of mainly of rainbow trout anglers (82%) with fewer kokanee anglers (10%) and very few walleye anglers (3%). In spring, the percent of rainbow trout anglers began tailing off in Sections 1 and 2 while the percent of walleye anglers increased. The majority of anglers in Section 3 during spring targeted kokanee (68%). In the summer period, walleye anglers made up the majority in Sections 1 (83%) and 2 (53%) while (53%) of the anglers were fishing for kokanee in Section 3. During the fall, 60% of the anglers were fishing for rainbow trout (60%), compared to 27% fishing for walleye and 11% fishing for kokanee.

Table 3.10 shows the economic value of the sport fishery based on total number of angler trips of 231,202 at $37.62 for each trip. The economic value was $8,697,819.

Table 3.8. Percent of anglers that were satisfied with the fishery by species, section and season from December 1994 through November 1995.

Quarter Section	Kokanee	Rainbow Trout	Walleye	Sturgeon	Small-mouth Bass
Winter					
One		23%	33%	0%	
Two		12%			
Three	27%	43%			
Spring					
One		45%	56%	20%	
Two	-	19%	5%		
Three	33%	72%			
Summer					
One		50%	80%	0%	
Two	-	33%	25%	-	
Three	62%	74%	83%	0%	100%
Fall					
One		42%	71%	0%	
Two	100%	17%	0%		
Three	12%	86%			
Qrtly Totals					
Winter	27%	22%	14%	0%	0%
Spring	33%	44%	41%	20%	0%
Summer	62%	59%	77%	0%	100%
Fall	22%	56%	56%	0%	0%
Annual Total	40%	36%	12%	20%	100%

Table 3.9. Percent of anglers targeting various fish species by section and season on Lake Roosevelt from December 1994 through November 1995.

Quarter Section	Kokanee	Rainbow	Walleye	Other*
Winter				
One	0%	95%	4%	1%
Two	0%	91%	3%	6%
Three	53%	31%	0%	6%
Spring				
One	0%	30%	62%	8%
Two	0%	51%	41%	8%
Three	68%	25%	0%	6%
Summer				
One	0%	16%	83%	1%
Two	0%	37%	53%	10%
Three	58%	26%	8%	8%
Fall				
One	0%	56%	41%	3%
Two	10%	54%	34%	2%
Three	27%	73%	0%	0%
Qrtly Totals				
Winter	10%	82%	3%	5%
Spring	29%	36%	28%	7%
Summer	22%	22%	52%	4%
Fall	11%	60%	27%	2%
Annual Total	19%	49%	26%	6%

Table 3.10 Economic value of the sport fishery at Lake Roosevelt during December 1994 through November 1995.

	1985	1995
Consumer Price Index	$167.87	$242.90
Dollars Spent per Angler Trip	$26.00	$37.62
Number of Angler Trips		23 1,202
Economic .Value of Fishery		**$8,697,819**

3.2 Fisheries Surveys

Electrofishing and gillnet sets were used to estimate the relative abundance of each fish species in Lake Roosevelt. The most common fish species was the largescale sucker (*Catostomus macrocheilus*) at 27% based on all fish sampled (Table 3.11). The second most abundant fish was kokanee salmon (20%), followed by walleye (12%), smallmouth bass (10%), yellow perch (7%) and rainbow trout (5%).

The catch per unit effort, based on duration of effort only, was determined for electrofishing and gillnet surveys (Table 3.12). These efforts were from all sampling during 1995. The annual sampling effort was 118 hrs electrofishing and 2,099 hrs of gillnetting totaling 2,217 hrs of sampling effort. Appendix B lists the number of fish captured, relative abundance, and CPUE by site, month and species.

Table 3.11 Relative abundance of fish collected by electrofishing boat and gillnets in Lake Roosevelt during 1995.

Family species	Common Name	Electro-	Gillnet	Total Annual
Catostomidae				
Catostomus macrocheilus	largescale sucker	30%	4%	27%
Catostomus catostomus	longnose sucker	<1%	2%	<1%
Catostomus columbianus	bridgelip sucker	<1%	3%	1%
Catostomus spp.	sucker spp.	<1%	0%	<1%
Centrarchidae				
Micropterus dolomieui	smallmouth bass	10%	3%	10%
Lepomis gibbosus	pumpkinseed	<1%	0%	<1%
Pomoxis sp.	crappie sp.	c1%	0%	<1%
Cottidae				
Cottus beldingi	piute sculpin	6%	0%	6%
Cyprinidae				
Cyprinus carpio	carp	2%	2%	2%
Richardsonius balteatus	redside shiner	<1%	0%	<1%
Tinca tinca	tench	0%	<1%	<1%
Ptychocheilus oregonensis	squawfish	2%	2%	2%
Gadidae				
Lota iota	burbot	<1%	4%	<1%
Ictaluridae				
Ictalurus nebulosus	brown bullhead	<1%	0%	<1%
Percidae				
Stizostedion vitreum vitreum	walleye	11%	18%	12%
Perca flavescens	yellow perch	7%	7%	7%
Salmonidae				
Savelinus fontinalis	brown trout	<1%	0%	<1%
Salvelinus confluentus	bull trout	c1%	0%	<1%
Salmo trutta	brook trout	<1%	0%	<1%
Oncorhynchus tshawytscha	chinook salmon	<1%	0%	<1%
Oncorhynchus nerka	kokanee salmon	22%	5%	20%
Coregonus clupeaformis	lake whitefish	<1%	46%	5%
Prosopium williamsoni	mt. whitefish	<1%	<1%	<1%
Oncorhynchus mykiss	rainbow trout	5%	4%	5%

Table 3.12. Catch per unit effort based on time (hours) for fish captured by electrofishing boat or **gillnets** during 1995.

	Electrofish		Gillnet		Total	
	CPUE	No.	CPUE	No.	CPUE	No.
largescale sucker	22.73	2,680	0.06	41	1.30	2,721
Cottus spp.	4.73	558	0.00	0	0.27	558
walleye	8.74	1,030	0.26	182	0.58	1,212
smallmouth bass	7.96	939	0.04	30	0.46	969
rainbow trout	3.88	458	0.06	44	0.24	502
squawfish	1.81	213	0.03	20	0.11	233
carp	1.75	206	0.03	20	0.11	226
yellow perch	5.45	643	0.10	71	0.34	714
brown trout	0.31	37	<0.01	1	0.02	38
kokanee salmon	17.01	2,006	0.07	47	0.98	2,053
chinook salmon	0.02	2	0.00	0	co.01	2
crappie	0.08	10	0.00	0	co.01	10
bull trout	0.01	1	0.00	0	co.01	1
brook trout	0.18	21	0.00	0	0.01	21
burbot	0.26	31	0.07	46	0.04	77
lake whitefish	0.34	40	0.68	482	0.25	5 2 2
mountain whitefish	0.08	10	CO.01	1	0.01	11
brown bullhead	0.05	6	0.00	0	co.01	6
longnose sucker	0.21	25	0.03	19	0.02	44
bridgelip sucker	0.70	83	0.05	33	0.06	116
redside shiner	0.01	1	0.00	0	co.01	1
tench	0.00	0	CO.01	1	co. 01	1
Totals	76.39	9,006	1.47	1,038	4.79	10,044

3.3 Age, Back Calculations and Condition Factor

Length, weight and condition of kokanee collected by electrofishing or gillnet surveys are reported in Table 3.13. The length, weight, and scales of 180 kokanee were collected during 1995. The condition factor of the kokanee was greater than 1.00 for age classes two through three, age one fish was slightly lower than 1.00. The back calculated growth of kokanee indicated an average annual growth of 134 mm for the first year of life, 151 mm for the second year and 126 mm for the third year (Table 3.14). This translated into a mean total length of 134 mm for age 1+ fish, 285 mm for age 2+ fish and 411 mm for age 3+ fish.

Table 3.13. Lengths, weights, and condition factors (mean ± standard deviation) of kokanee salmon collected during 1995.

Age	n	Length (mm)	Weight (g)	Condition Factor
1+	5	219 ± 35	92 ± 38	0.96 ± 0.06
2+	62	385 ± 81	437 ± 207	1.01 ± 0.15
3+	113	472 ± 60	1,180 ± 559	1.13 ± 0.14

Table 3.14. Back calculated total length (mean ± standard deviation) of kokanee salmon sampled during 1995.

		Back Calculated Total Length (mm) at **Annulus**		
Cohort	n	1	2	3
1994	5	132 ± 20		
1993	62	159 ± 51	291 ± 83	
1992	113	121 4 36	283 ± 56	411 ± 70
Grand Mean	180	134 f 45	**285** ± 67	**411** ± 70
Annual Growth		134	151	126

The lengths, weights and condition factors of rainbow trout collected during 1995 are identified in Table 3.15. The condition factor of rainbow trout ages one through four was greater than 1.00 with ages 0+ and **5+** slightly under 1.00. A condition factor close to 1.00 suggests that the rainbow trout population in Lake Roosevelt is healthy. The back calculated lengths indicate no significant growth differences among cohorts (Table 3.16). The incremental growth for age one through four year old rainbow ranged from 96 mm to 124 mm. The growth rates of rainbow between ages one through four appears to be relatively constant, however, growth seems to slow dramatically at age 5. The incremental growth of age 5 rainbow was 37 mm.

Table 3.15. Lengths, weights, and condition factors (mean ± standard deviation) of rainbow trout collected during 1995.

Age	n	Length (mm)	Weight (g)	Condition Factor
o+	7	169 ± 21	55 ± 7	0.93 ± 0.15
1+	44	206 ± 52	102 ± 79	1.15 ± 0.30
2+	51	340 ± 68	490 ± 237	1.17 ± 0.18
3+	58	416 ± 56	922 ± 254	1.21 ± 0.16
4+	13	504 ± 32	1,325 ± 203	1.08 ± 0.18
5+	4	537 ± 20	1,572 ± 117	0.93 ± 0.08

Weight for 5+ fish based on 2 fish.

Table 3.16. Back calculated total length (mean ± standard deviation) of rainbow trout sampled during 1995.

		Back Calculated Total Length (mm) at **Annulus**				
Cohort	n	**1**	2	3	4	5
1994	44	116 ± 36				
1993	51	121 ± 38	256 ± 60			
1992	58	122 ± 35	239 ± 52	354 ± 48		
1991	13	116 ± 33	248 ± 49	369 ± 39	459 ± 34	
1990	4	106 ± 44	190 ± 27	272 ± 57	385 ± 59	479 ± 31
Grand Mean	170	**119** ± 36	**243** ± 59	**339** ± 84	**442** ± 51	479 ± 31
Annual Growth		**119**	124	96	103	37

The length, weight and condition factor of walleye sampled by electrofishing and gillnet sets are summarized in Table 3.17. The length, weight and scales of 372 walleye were measured in 1995. The walleye condition factor ranged from 0.67 to 1.01 depending on the age of the fish. Mean lengths ranged from 149 mm for walleye age 0+ to 766 mm for age 11+ fish. The back calculated length by cohort is reported in Table 3.18. The mean annual growth was 66 mm per year for cohorts covering the last eleven years. Growth was quickest for the first three years of ranging from 121 mm to 91 mm a year. In general, the older the fish the slower the growth.

Table 3.17. Lengths, weights, and condition factors (mean ± standard deviation) of walleye collected during 1995.

Age	n	Length (mm)	Weight (g)	Condition Factor
0+	13	149 ± 43	28 ± 22	0.67 ± 0.12
1+	82	211 ± 55	85 ± 58	0.76 ± 0.22
2+	101	277 ± 53	192 ± 103	0.83 ± 0.21
3+	76	359 ± 41	411 ± 140	0.87 ± 0.20
4+	45	440 ± 44	811 ± 356	0.90 ± 0.18
5+	29	513 ± 67	1,267 ± 511	0.88 ± 0.17
6+	12	507 ± 55	1,346 ± 444	0.92 ± 0.18
7+	7	621 ± 114	2,374 ± 365	1.01 ± 0.40
8+	3	600 ± 79	2,310 ± 0	0.90 ± 0.00
9+	2	633 ± 74	2,840 ± 1,640	1.05 ± 0.27
10+	1	723 ± 0	-- ± --	-- ± --
11+	1	766 ± 0	3,358 ± 0	0.75 ± 0.00

Table 3.18. Back calculated total length (mean ± standard deviation) of walleye sampled during 1995.

		Back Calculated Total Length (mm) at Annulus										
Cohort	n	1	2	3	4	5	6	7	8	9	10	11
1994	82	115 ± 30										
1993	102	120 ± 78	227 ± 100									
		126 ± 67	230 ± 150	329 ± 227								
199199476		121 ± 25	219 ± 36	310 ± 44	379 ± 69							
1990	29	124 ± 26	225 ± 53	312 ± 65	398 ± 71	460 ± 73						
1989	12	122 ± 20	210 ± 41	289 ± 53	369 ± 52	423 ± 58	474 ± 58					
1988	7	130 ± 20	239 ± 38	319 ± 53	393 ± 69	462 ± 84	528 ± 97	576 ± 114				
1987	3	114 ± 11	194 ± 43	295 ± 17	366 ± 26	428 ± 22	472 ± 32	523 ± 45	575 ± 70			
1986	2	74 ± 18	142 ± 4	220 ± 10	268 ± 23	343 ± 17	394 ± 40	450 ± 51	512 ± 46	589 ± 100		
1985	1	114 ± 0	202 ± 0	264 ± 0	341 ± 0	422 ± 0	481 ± 0	536 ± 0	580 ± 0	668 ± 0	697 ± 0	
1984	1	73 ± 0	125 ± 0	198 ± 0	290 ± 0	351 ± 0	435 ± 0	504 ± 0	564 ± 0	597 ± 0	693 ± 0	726 ± 0
Grand Mean		121f 55	**224 ± 102**	**315 ± 155**	**380 ± 68**	**444 ± 71**	**481 ± 72**	**539 ± 93**	556 ± **54**	**611 ± 69**	695 ± 3	726 ± -
Annual Growth		121	103	91	**65**	**64**	**37**	**58**	**17**	**55**	**84**	**31**

3.4 Feeding Habits

Feeding habits were based on fish sampled during electrofishing and gillnet sets. A total of 50 kokanee, 90 rainbow trout and 153 walleye stomachs were collected and the contents of the stomachs were enumerated by taxa. The annual index of relative importance (IRI) is reported in Table 3.19 for each species regardless of age by food item. Appendix C lists the index of relative importance, percent of food items by number and weight and the frequency of food item occurring for each fish species and age.

According to the IRI, kokanee's primary food item was *Daphnia* spp. (70.21). The two most important food items for rainbow trout *were Daphnia* spp (36.69) and percidae (13.83). The most important food items for walleye were fish (totalling 51.90) and *Leptodora kindtii (22.26).*

Diet overlap analysis predicted that kokanee and rainbow trout overlap was 0.80 (high overlap). Kokanee and walleye diet overlap was 0.15 (low overlap) and rainbow and walleye diet overlap was 0.45 (moderate overlap).

Table 3.19. Index of relative importance for kokanee (n = 50), rainbow trout (n = 90), and walleye (n = 153) from fish collected during 1995. '--' indicates no organisms found.

	Index of Relative Importance		
PREY ITEM	Kokanee	Rainbow	Walleye
Osteichthyes			
Catostomidae	--	--	1.17
Cottidae	--	--	15.62
Cyprinidae	--	2.30	4.02
Percidae	--	13.83	16.4
Sahnonidae	--	--	11.19
Unidentified fish	3.06	7.65	18.98
Fish eggs	--	0.93	--
Amphipoda			
Gammeras sp.	--	--	0.38
Cladocera			
L. kindtii		1.82	10.72
Daphnia spp.	70.21	36.69	4.49
Eucopepoda			
E. nevadensis	--	0.29	--
L. ashlandi	0.62	0.29	0.94
Copepoda *sp.*	0.59	--	--
Basommatophora			
Planordidae	--	0.29	--
Physidae	--	0.51	--
Diptera			
Chironomidae pupa	13.10	10.60	--
Chironomidae larvae	5.31	4.37	--
Sciomyzidae	--	0.29	--
Simulidae larvae	0.57	--	--
Trichoptera			
Hydroptilidae	--	0.60	--
Lepidostomatidae		0.58	--
Hydropyschidae	0.64	0.29	--
Decapoda			
Astacidae	--	--	0.37
Hemiptera			
Corixidae	0.58	1.78	0.26
Plecoptera			
Perlodidae	--	0.29	0.23
Nemouridae	--	0.29	--
Ephemeroptera			
Baetidae	--	0.29	
Leptophlebiidae	--	0.69	0.23
Odonata			
Anisoptera	--	1.16	0.48
Zygoptera	--	0.33	0.46
Coleoptera			
Elmidae	--	0.29	--
Lepidoptera			
Pyralidae	--	--	--
Oligochaeta			
Lumbriculidae	--	--	1.15
Hydrachnellae			
Hydracharina	--	0.88	--
Terrestrial	5.33	10.14	3.74

4.0 DISCUSSION

The main objective of this study was to monitor and evaluate the effects of stocking hatchery reared kokanee salmon and rainbow trout into Lake Roosevelt on the ecosystem and the fishery. Sub-objectives were to identify stocking strategies which: maximize the numb& of hatchery kokanee and rainbow trout harvested or captured by anglers; maximize the collection of kokanee eggs at egg collection facilities and maximize the quality of fish harvested (large size and good condition). We evaluated the effects of the stocking program on the fishery by comparing data collected prior to stocking Spokane Tribal and Sherman Creek Hatcheries fish (pre hatchery) with data collected after stocking began (post hatchery).

4.1 Historical Stocking and Lake Operations

There were two general factors effecting the recruitment of hatchery origin rainbow trout and kokanee salmon into the fishery. The first was stocking strategies conuolled by the Hatchery Coordination Team (Team). One member each from the Washington Department of Fish and Wildlife (WDFW), the Colville Confederated Tribes (CCT) and the Spokane Tribe of Indians (STOI) made up the Team. The Team's job was to determine: the number of fish stocked; the size of fish stocked; the time of year to stock the fish; location in the lake to stock the fish and method of stocking (e.g.. by truck). The other variables, not under Lake Roosevelt Fish Managers control, were lake operations. Lake operations were controlled by mother nature (i.e.. rainfall, snowmelt), economics and politics (i.e., power demand, irrigation).

Stocking of rainbow trout began in 1986 when the WDFW started supplying rainbow trout fry to the Lake Roosevelt Net Pen Program (operated by a volunteer organization, Lake Roosevelt Development Association). Table 4.1 indicates the number and the source of rainbow trout provided to the net pen operators. By July of 1988, the WDFW began stocking kokanee into the lake (Table 4.2). The kokanee were stocked at Sherman Creek (760,000 fry) and at Little Falls Dam on the Spokane River (141,000 fry). WDFW continued stocking approximately the same number of kokanee at Sherman Creek and Spokane River in 1989 and 1990. The Spokane Tribal Hatchery went on line in 1990 and began releasing rainbow trout and kokanee in 1991. Sherman Creek went on line

Table 4.1 Summary of hatchery origin rainbow trout released into Lake Roosevelt from 1988 though 1995.

Year	Hatchery	Number
1986	Spokane (WDFW)	50,000
1987	Spokane (WDFW)	80,000
1988	Spokane (WDFW)	150,00
1989	Spokane (WDFW)	175,00
1990	Spokane (WDFW)	276,500
1991	Spokane Tribal	326,461
1992	Spokane Tribal	424,395
1993	Spokane Tribal	446,798
1994	Spokane Tribal	448,992
1995	Spokane Tribal	415,844

Table 4.2 Summary of hatchery origin kokanee released into Lake Roosevelt from 1988 though 1995.

Year	Hatchery	Number	Life Stage	Size (#/LB)
1988	Ford	872,150	fry	500
1989	Ford	861,442	fry	280
1990	Ford	1,025,400	fry	247
1991	Spokane Tribal	1,674,577	fry	119
1992	Spokane Tribal	71,256	yearling	9
1992	Spokane Tribal	8 19,220	fry	158
1992	Sherman Creek	68,552	yearling	22
1992	Sherman Creek	1,099,000	fry	616[a]
1993	Spokane Tribal	21,190	yearling	7
1993	Spokane Tribal	1,024,293	fry	225
1993	Sherman Creek	72,508	yearling	15
1993	Sherman Creek	675,572	fry	228
1994	Spokane Tribal	29,111	yearling	8
1994	Spokane Tribal	540,220	fry	425
1994	Sherman Creek	90,881	yearlings	11[a]
1994	Sherman Creek	1,087,161	fry	372[a]
1995	Spokane Tribal	1,401	brood	1
1995	Spokane Tribal	59,825	yearling	10
1995	Spokane Tribal	515,425	fry	202
1995	Sherman Creek	210,643	yearlings	15[a]
1995	Sherman Creek	164,328	yearlings	28[a]

a size transferred from Spokane Tribal Hatchery not at release.

and began releasing kokanee in 1992. Once the new hatcheries were operational, close to 450,000 rainbow trout and 2 million kokanee were released annually. Of the kokanee released approximately 100,000 were yearlings and the rest were fry. In 1994, Tilson et al. (1995) recommended that we discontinue fry releases and instead release the kokanee as yearlings. This recommendation was made due to the fact that only 1% of all tagged fish recovered as adults from 1993 through 1994 were fish releases as fry and the remaining 99% were released as yearlings. As a result, the hatcheries released 434,796 yearlings and 515,425 fry in 1995. Shifting to a yearling release program caused a reduction in the total number of kokanee being stocked from the hatcheries because the yearlings require more hatchery space for rearing.

Lake operations for the time period 1990 through 1995 are depicted in Figures 4.1 and 4.2. Figure 4.1 identifies the monthly mean lake elevation above sea level in feet. Figure 4.2 shows the monthly mean water retention time of Lake Roosevelt in days. Generally, when the elevation of the lake fell below 1,240 feet elevation the water retention time fell below thirty days, however, this was dependent on the volume of water flowing into and out of the lake. The year 1991 was considered to be extraordinarily bad for the fishery (Thatcher et al. 1993, 1994). The lake elevation fell below 1,240 feet and the water retention time was below 30 days. Griffith and Scholz (1991) and Thatcher et al.'s (in press) 1991 and 1992 annual reports identified that water retention times less than thirty days had dramatic effects on the biota of Lake Roosevelt. The zooplankton population decreased and the entrainment of fish out of the lake through Grand Coulee Dam increased. The resulting decrease of fish food (zooplankton) and decrease of fish (fish entrainment) negatively impacted the fishery.

In contrast to 1991 operations, overall lake operations in 1995 appeared to be the best for fish over the life of this project . The mean lake elevation during 1995 was 1,277 ft with the lowest elevation occurring in March at 1,259 ft. The mean water retention time during 1995 was 47 days with the fewest days water retention in December at 32 days. However, in August 1995 a ten foot drawdown was employed to benefited Snake River salmon which had not occurred in previous years. We were unable and unequipped to make a determination as to whether a summer drawdown had a significant effect on the fishery. Lake operations during the summer may significantly impact fish growth. The summer period (June - August) is considered the most important growing period for fish in the lake due to the rise in water temperature and food availability. The rise in temperature increases the metabolism of the fish and the high availability of food provides the fish with nutrient

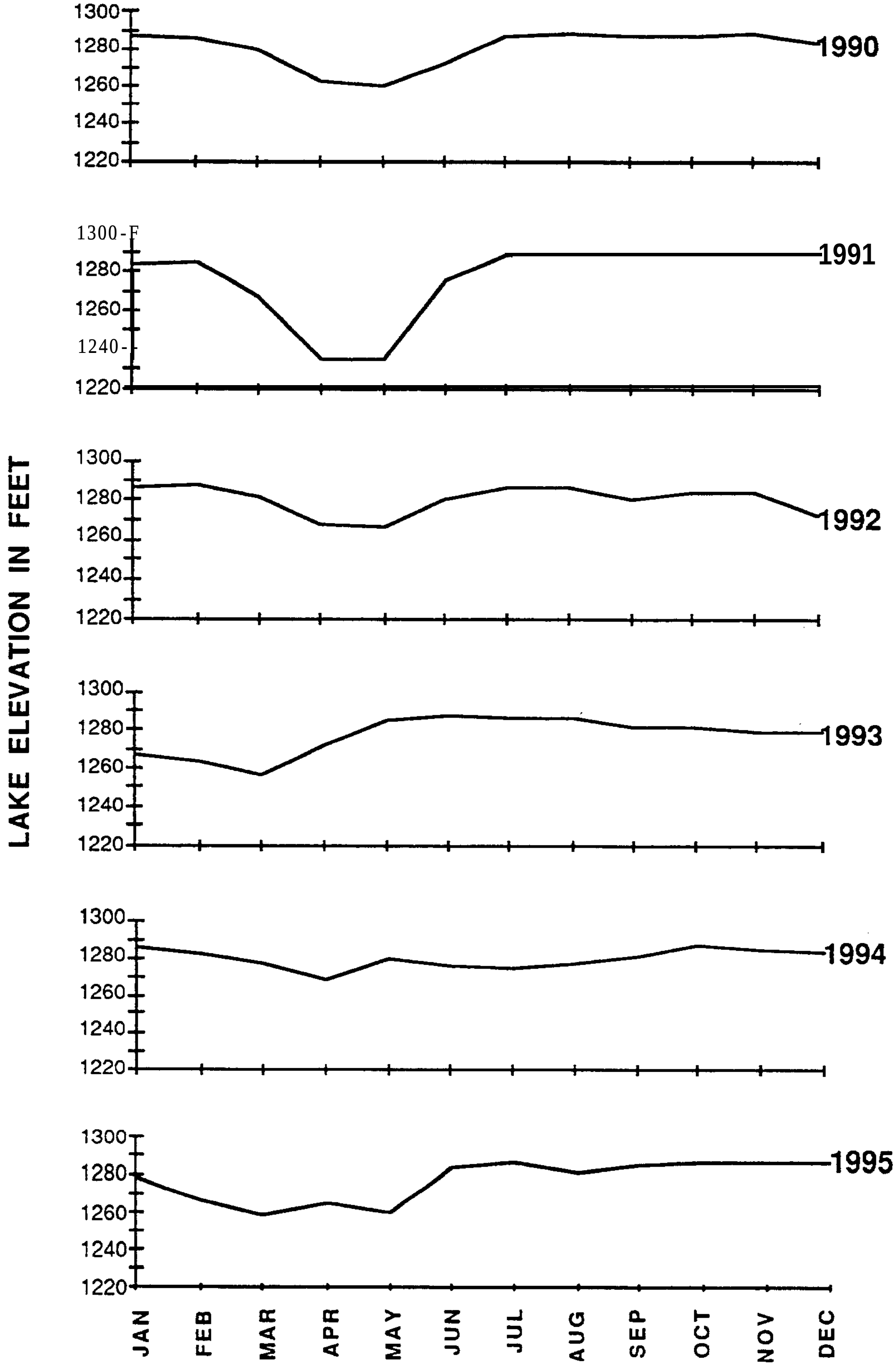

Figure 4.1 Lake elevations for Lake Roosevelt from 1990 through 1995.

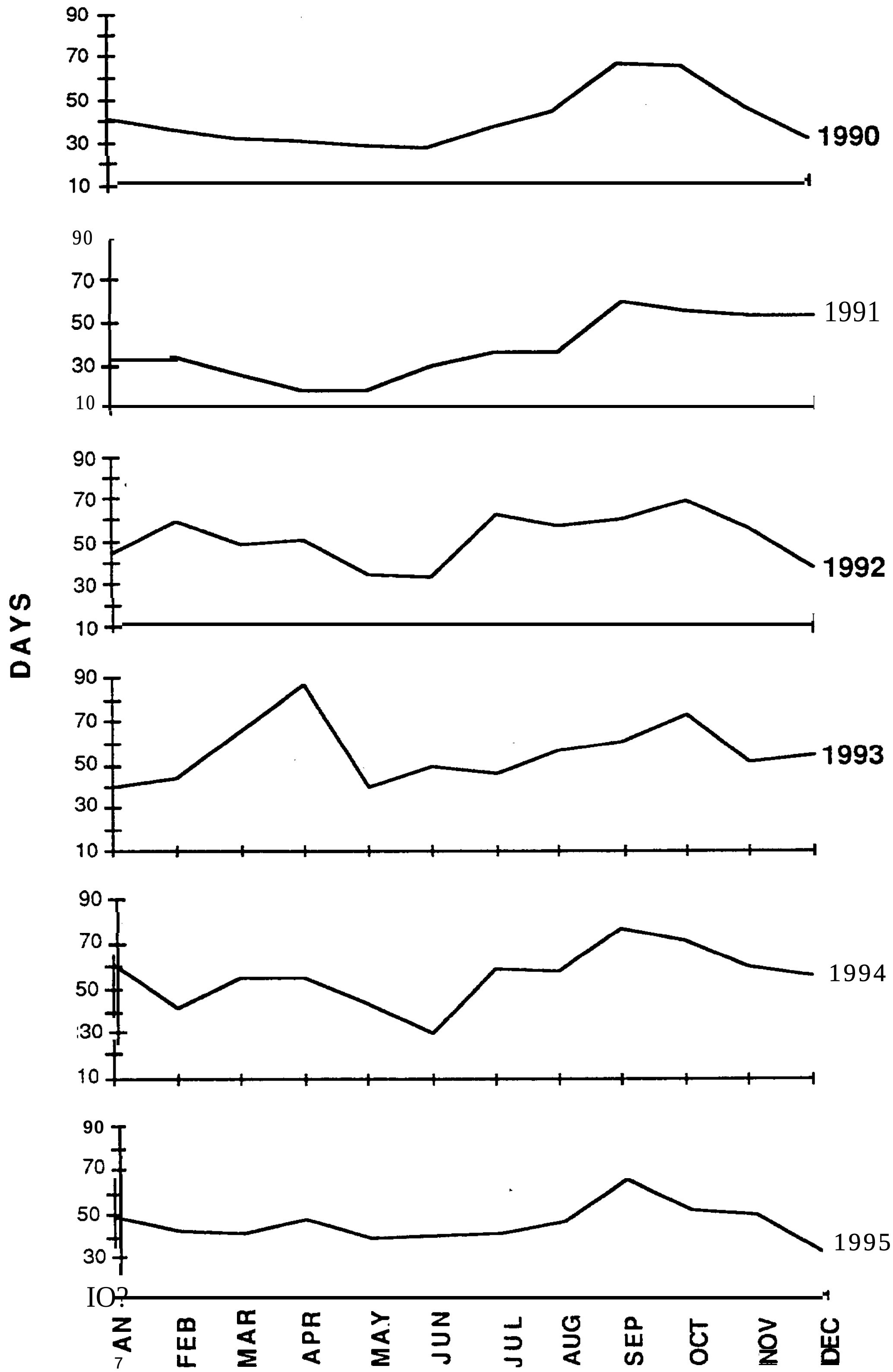

Figure 4.2 Water retention times for Lake Roosevelt from 1990 through 1995.

input for growth. The combination of increased metabolism and nutrient input results in fast growth. Thus, we believe that lake operations have the greatest potential for negatively impacting fish growth during the summer months because of decreased food availability. Lake operation in 1994 was similar to 1995 with the exception that 1994 did not have an August drawdown. The water retention time in August, 1994 was 59 days and in Augusts, 1995 was 47 days. The reduced water retention time may have an effect on food availability and therefore fish growth. The abundance of fish food (i.e.. zooplankton, fry fish) in comparison to fish growth may help determine the effect of August drawdowns on the fishery.

4.2 Creel Survey Trends

The number of angler trips, economic worth of the fishery and the number of fish harvested in 1995 was down slightly from 1992, but the number of hours fished, the mean length of an angler trip and the catch per unit of effort was up (Table 4.3). In 1995, the total number of angler trips was 231,202 which was down slightly to the 291,380 angler trips made in 1992 (Table 4.3). The number of kokanee harvested in 1995 (32,323) was four times greater than the number of kokanee harvested (8,021) in 1992. The number of rainbow trout harvested (122,939) in 1995 was down slightly to the number harvested (140,609) 1992. The most dramatic change was the number of walleye harvested. The harvest went from 118,863 fish in 1992 to 40,185 fish in 1995. The 1995 economic worth of the fishery was close to $ 8.7 million which was down in comparison to the 1992 economic worth of $9.7 million. The total number of fish harvested was 205,809 fish with a total annual harvest rate of 0.173 harvest per unit effort (HPUE). In 1992, the number of fish harvested was 291,886 with a total annual harvest rate of 0.377 HPUE. The mean annual angler trip length had increased steadily from 3.3 hours per trip in 1992 to 5.1 hour in 1995.

Overall, the number of angler trips appear to be down due to the increased trip length. Angler trips are determined by dividing average trip lengths by total estimated hours fished. Angler trips may be increasing due to the lower catch rate resulting in more angler hours in order to obtain bag limits or at least accustomed number of fish harvest per trip.

4.2.1 Kokanee Salmon

Table 4.3 indicates that the kokanee fishery is building. Since 1992, the number of kokanee harvested per year has steadily increased from 8,021 kokanee in 1992 to 32,353 kokanee in 1995 and the harvest rate has increased from <0.01 HPUE in 1994 to 0.02 HPUE in 1995. The increased harvest rate suggests that anglers were catching more kokanee with less effort due to either an increase in the abundance of kokanee causing greater availability or kokanee anglers had become more proficient at catching kokanee which would reduce the amount of time spent by anglers between catches. Lake operations during 1993 though 1995 were relatively fish friendly. The drawdowns were limited and water retention time did not fall below thirty days. This led us to believe that kokanee were more abundant in 1995 than in years past. However, angler proficiency could not be mled out. The information collected by the survey does not provide for determining whether anglers were becoming better fisherman thereby requiring less time to catch the same number of fish.

Another factor contributing to the kokanee harvest was the stocking of hatchery reared fish. Of the 112 kokanee observed by the creel clerks in 1995, one kokanee (0.8%) had a mark identifying it as a hatchery origin fish. In addition, Eastern Washington University (EWU) conducted an augmented creel during 1995 targeting kokanee anglers. EWU's creel clerks observed 282 kokanee of which 19 (6.7%) had marks identifying them as hatchery origin fish (Tilson et al 1996). Approximately 12% of the kokanee stocked by the hatcheries from 1992 through 1994 bore adipose fin clips. If we assume that all fish released during 1992 through 1994 had an equal probability of being recruited into the fishery during 1995, and that all of the kokanee harvested by anglers were of hatchery origin, then we would expect 12% of the kokanee observed by the creel clerks to bear marks identifying them as hatchery origin fish. Instead the creel clerks observed between 0.08% and 6.7% of the kokanee bearing hatchery origin markings. the estimated percentages of hatchery fish caught could be calculated by dividing the percentage of hatchery fish (marked) seen by the creel clerks by the percentage of marked fish stocked from the hatcheries. Therefore, the estimated percentage of hatchery fish harvested could be as low as 7% (0.8% / 12%) or as high as 56% (6.7% / 12%) depending on the survey. Thus, from 7% to 56% of the estimated harvest were hatchery origin fish which suggests that of the 32,353 harvested kokanee 2,265 to 18,118 kokanee were of hatchery origin. In order to obtain better composition estimates, beginning in 1995 all hatchery origin fish released into the lake have been adipose clipped. The marked fish will enable us to make positive identification of hatchery versus wild origin fish. This will allow for more precise estimates of the hatchery origin contribution to the fishery.

4.2.2 Rainbow trout

The number of rainbow trout harvested (122,929) in 1995 appeared to be significantly lower than that estimated for 1993 (398,943) and for 1994 (499,460) (Table 4.3). We identified two possible reasons for the large change among years. The 1993 and 1994 harvest may have been overestimated and/or the rainbow trout were overharvested. During 1992, 1993 and 1994 lake operations were relatively fish friendly in comparison to previous years which led us to believe that harvest had increased in those years. However, to achieve the harvest estimated for 1993 and 1994 virtually every rainbow stocked in those years would have to have been harvested. We do not believe this was true due to the abundance of fish predators in the lake, know to feed on newly stocked rainbow trout. On the other hand, if the 1993 and 1994 estimates were accurate, than the rainbow trout population was probably overharvested. The overharvest would have caused a reduction in the total number rainbow available for harvest, thus, resulting in a decreased harvest. However, according to 1995 rainbow trout tag results (see chapter 1) approximately 56% of the fish released in 1995 recruited into the fishery and the remaining 44% were rainbow trout released one to three years prior to 1995. If overharvest had occurred, we would not expect to see almost half of the tag rainbow trout to be from the years in which overharvest occurred. We do not recommend altering our current management strategy of rainbow. Instead, we plan to reanalyze the 1993 and 1994 creel data to determine if the rainbow harvest was overestimated. Furthermore, another year of data collection will help to establish the harvest trend for rainbow trout.

4.2.3. Walleye

The number of walleye harvested in 1994 and 1995 appears to be significantly lower than the number harvested in previous years (Table 4.3). As a result, we have hypothesized that either the walleye population was overharvested in previous years or factors unknown to us have impeded the recruitment of walleye to the fishery over the past two years. The estimated number of walleye harvested in 1991 was 168,736 the number of walleye harvested fell to 118,863 in 1992. In 1993, the number of walleye harvested grew to 307,663 fish. We question the magnitude of the harvest, but accept that the harvest was

Table 4.3 Summary of angler trips, number of fish caught and harvested, catch and harvest per unit of effort and mean lengths of kokanee, rainbow trout and walleye from 1990 through 1995.

	1990	1991	1992	1993	1994	1995
Angler Trips	17 1,725	398,408	29 1,380	594,508	469,998	23 1,202
No. Caught						
kokanee	17,756	31,651	8,146	13,986	16,567	32,353
rainbow	81,560	81,529	167,156	402,277	499,460	125,958
walleye	116,473	231,813	163,995	337,413	123,612	73,667
No. Harvested						
kokanee	17,515	31,651	8,021	13,960	16,567	32,353
rainbow	79,683	73,777	140,609	398,943	499,293	122,939
walleye	82,284	168,736	118,863	307,663	53,589	40,185
CPUE						
kokanee	0.03	0.06	0.03	0.01	co.01	0.02
rainbow	0.13	0.20	0.22	0.17	0.21	0.08
walleye	0.11	0.11	0.15	0.12	0.08	0.13
HPUE						
kokanee	0.02	0.06	0.03	0.01	co.01	0.02
rainbow	0.12	0.20	0.18	0.16	0.21	0.08
walleye	0.08	0.08	0.11	0.08	0.05	0.06
Mean Length						
kokanee	391	361	436	486	481	467
rainbow	346	348	422	471	473	410
walleye	376	397	361	382	385	370

likely greater than previous years (see section 4.2.4.). At any rate, the increased harvest may have caused the decrease of the walleye fishery in 1994 and 1995. The harvest per unit of effort has decreased from 0.08 to 0.11 in 199 1 and 1992 respectively and decreased further to 0.05 in 1994 and 0.06 in 1995. The reduced harvest rate indicates that the number of hours required to harvest a walleye has grown from 9 hours per fish in 1992 to 16 hours per fish in 1995.

The reduced number of walleye harvested over the past two years indicates that the walleye fishery is possibly in a long term slump. The exact reason for the reduced number of walleye is not known, however, overharvest is conceivable. Another year of data is necessary to attain more accurate trend data before making any management decisions, but reducing the bag limits of walleye may be necessary in future years.

4.2.4 Accuracy and Precision

The estimated harvest for rainbow trout and walleye in 1993 and 1994 has come into question. The number harvested seem to be greater than the number of fish available for harvest. Less than 10% of the rainbow trout harvest was composed of wild origin fish and the rest were from net pens according to accounts by the creel clerks. In 1993 and 1994, we estimated that 446,798 and 449,183 net pen origin rainbow were released, respectively. The harvest estimates for 1993 and 1994 were 398,943 and 499,294 trout respectively. If 90% of the rainbow trout harvested were of net pen origin then 79% of the released rainbow trout were harvested in 1993 and over 100% in 1994. We do not believe that all of the rainbow trout released were harvested. We have documented walleye prey on released rainbow, and entrainment of rainbow trout over the dam. These factors would reduce the available rainbow trout for harvest. As a result the harvested number of fish appears to be overestimated. There are also indications that a harvest in excess of 200,000 walleye was not probable. Beckman et al. (1985) estimated that Lake Roosevelt walleye fishery could sustain approximately 100,000 fish annually. For the duration of this project the relative abundance of walleye has decreased suggesting that the prevalence of walleye has decreased. Thus, the harvest of walleye in 1993 at three times the rate indicated by Beckman et al. (1985) is not unlikely.

In addition, the number of angler hours (pressure) seem to be overestimated. The National Park Service tracked the number of boats launched at access points along Lake Roosevelt.

The number of boats launched did not change appreciably from 1992 to 1993 (Scott Hebner, personal communication, NPS). This suggests that the number of anglers fishing did not change from 1992 to 1993. The overestimate of angler hours in 1993 may have been caused from the method of calculation. The Lake Roosevelt creel survey uses a count of the number of boat trailers as a method for estimating the number of boats fishing, but not all boat trailers equal boats fishing. Many boats during the summer contained persons not fishing, instead they were boating, sun bathing, water skiing, swimming, etc. The creel survey was designed to correct the number of boat anglers by comparing the number of boat anglers to non boat anglers. The creel clerks attempted to contact all boat at the access point to ask them whether they were fishing or not. When the number of angler hours were estimated a ratio was determined by comparing the number of boaters fishing to non fishing boaters as recorded by the creel clerks. However, the creel clerks contacted mainly anglers thereby biasing toward contacting anglers instead of non anglers. As a result, the percent of boaters angling versus not angling may be biased towards angling.

A large majority of the boats that were non anglers occurred during the summer in the mid to lower river. A substantial number of rainbow and walleye were harvested during the summer. Thus, if the estimate of angler hours during summer months was skewed, then the number of fish harvested would also be skewed. In 1994, the NPS estimated an 18% increase of boat launches at Spring Canyon during May through August when compared to 1993. It appears the influx of boats may have amplified the harvest estimates for rainbow trout if the percentage of angler boats versus non anglers were skewed. A more refined analysis pointed at determining the ratio of angler to non-angler boats is required.

4.3 Relative Abundance

The relative abundance of kokanee increased substantially ranging from <1 to 3% during 1989 through 1994 to 20% in 1995 (Table 4.4). The catch per unit of effort increased from as low as 0.08 catch per unit effort (CPUE) in past years to 0.98 CPUE (Table 4.5). The relative abundance, catch per unit of effort and harvest estimates all suggest that the kokanee populations have increased substantially. The hatchery program appears to be the cause for the increased population suggesting that hatchery stocking strategies have benefited the fishery. Before hatchery releases, relative abundance of kokanee salmon and rainbow trout in gillnet surveys was <1% (Beckman et al. 1985). In 1995, gill net relative abundance of kokanee salmon and rainbow trout increased to 4 and 5% respectively. Other

Table **4.4** Comparison of relative abundance **(%)** of fish collected during the 1989 through 1995 sampling periods via electroshocking and gillnetting.

	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Effort (hrs)	482	581	366	436	100	643	2,099
bridgelip sucker	1	<1	<1	<1		<1	[illegible]
brook trout	<1	<1	<1	<1	<1	<1	<1
brown bullhead	0	<1	<1	<1	<1	<1	<1
brown trout	<1	<1	<1	Cl	<1	<1	<1
bull trout	<1	0	0	0	0	<1	<1
burbot	<1	<1	<1	<1	<1	1	<1
carp	2	2	<1	2	1	1	2
chinook salmon	<1	<1	<1	<1	<1	<1	<1
chiselmouth	0	<1	0	0	0	0	0
Cottus spp.	2	2	c l	2	3	16	6
crappie	<1	<1	<1	<1	0	<1	<1
kokanee salmon	2	<1	<1	3	<1	3	20
lake whitefish	4	3	<1	1	c l	2	5
largemouth bass	<1	<1	<1	0	0	0	0
largescale sucker	12	19	34	43	45	35	27
longnose sucker	<1	2	<1	<1	0	2	<1
mountain whitefish	<1	<1	<1	<1	<1	<1	<1
peamouth	<1	0	<1	<1	0	0	0
pumpkinseed	Cl	<1	0	0	0	2	0
rainbow trout	5	3	5	6	9	<1	5
redside shiner	0	<1	0	0	0	<1	<1
smallmouth bass	2	3	15	11	9	8	10
squawfish	4	5	3	2	8	4	2
sturgeon	c l	0	0	0	0	0	0
Catostomus spp.	7	0	0	0	0	0	<1
tench	<1	<1	<1	<1	0	<1	<1
walleye	18	13	12	11	11	7	12
yellow bullhead	<1	0	0	0	0	0	0
yellow perch	40	45	29	17	11	12	7

Table 4.5 Comparison of catch per unit effort (No. fish per hour) for fish collected during the 1989 through 1995 sampling periods via electroshocking and gillnetting.

	1989	1990	1991	1992	1993	1994	1995
Effort (hrs)	482	581	366	436	100	643	2,099
bridgelip sucker	0.21	0.01	0.03	CO.01	0.00	x0.01	0.06
brook trout	0.01	CO.01	CO.01	0.01	0.02	0.02	0.01
brown bullhead	0.00	CO.01	co.01	0.07	0.03	0.00	0.00
brown trout	0.04	0.03	0.04	0.04	0.16	0.03	0.02
bull trout	CO.01	0.00	0.00	0.00	0.00	CO.01	0.01
burbot	0.06	0.02	0.05	0.02	0.03	0.14	0.04
carp	0.24	0.26	0.20	0.15	0.22	0.19	0.11
chinook salmon	<0.01	<0.01	0.01	0.01	0.01	co.01	co.01
chiselmouth	0.00	CO.01	0.00	0.00	0.00	0.00	0.00
Cottus spp.	0.27	0.22	0.06	0.16	0.62	2.13	0.27
crappie	0.09	0.02	CO.01	0.04	0.00	0.01	0.00
kokanee salmon	0.27	0.10	0.08	0.28	0.15	0.46	0.98
lake whitefish	0.56	0.38	0.20	0.10	0.15	0.26	0.25
largemouth bass	0.10	0.05	0.01	0.00	0.00	0.00	0.00
largescale sucker	1.87	2.85	7.51	3.91	10.12	4.76	1.30
longnose sucker	0.04	0.32	0.01	0.01	0.00	0.26	0.02
mountain whitefish	0.03	0.03	0.08	0.01	0.02	0.01	0.01
peamouth	0.03	0.00	CO.01	0.01	0.00	0.00	0.00
pumpkinseed	0.01	0.10	0.00	0.00	0.00	0.20	*0.00*
rainbow trout	0.82	0.43	1.02	0.56	2.03	0.88	0.24
redside shiner	0.00	<0.01	0.00	0.00	0.00	0.01	<0.01
smallmouth bass	0.24	0.46	3.22	1.01	2.08	1.12	0.46
squawfish	0.61	0.80	0.59	0.21	1.84	0.49	0.11
sturgeon	co.01	0.00	0.00	0.00	0.00	0.00	0.00
Catostomus spp.	0.99	0.00	0.00	0.00	0.00	0.00	0.00
tench	0.01	0.03	0.01	0.01	0.00	0.02	CO.01
walleye	2.70	1.96	2.60	0.99	2.34	1.00	0.58
yellow bullhead	0.01	0.00	0.00	0.00	0.00	*0.00*	*0.00*
yellow perch	6.02	6.65	6.40	1.55	2.48	1.63	0.34
TOTALS	15.24	14.73	22.13	9.15	22.29	13.61	4.79

fish populations in Lake Roosevelt appear to be relatively stable over the last seven years except for yellow perch. Both relative abundance and catch per unit effort indicated that yellow perch populations were declining. Walleye were documented by'previous Lake Roosevelt Monitoring Program Reports to feed on yellow perch (Underwood and Shields 1996). Walleye may be limiting the yellow perch through predation.

4.4 Growth and Feeding.

Peone et al. (1990) examined the growth of Lake Roosevelt kokanee, rainbow trout and walleye, in comparison to growth of these species in area lakes. The comparison was made using back calculated lengths from scales. Peone et al. concluded that fish in Lake Roosevelt grew to a larger size at a young age than fish in area lakes. Their statement still holds true in 1995 for rainbow trout and kokanee. However, their statement does not hold true for walleye. The back calculated length of walleye sampled in 1995 was below the walleye length average of area lakes by approximately five centimeters per year of life . The slower growth rates may be an early indicator that the food base for walleye was limited. One of the main prey items for walleye is yellow perch. The yellow perch population appears to be declining based on relative abundance and catch per unit effort.

The feeding habits of rainbow trout, kokanee and walleye differed slightly from previous years. Kokanee salmon utilized mostly *Daphnia* spp. and chironomids. Walleye fed primarily on fish. Rainbow trout fed primarily on *Daphnia* spp., chironnomids and a new food item, yellow perch. In 1995, the summer collection of fish for diet analysis changed from August to July in order to capture more fish. August water temperatures cause the fish to reside in deeper water limiting our ability to collect them. As a result, we observed for the first time rainbow trout with numerous yellow perch in their stomachs and yellow perch were estimated to be the second most important food item. Up to this point walleye were thought to be the cause for the reduction in the yellow perch population. Rainbow trout may have had a significant effect of the yellow perch as well. The availability of food should be considered prior to increasing the number of rainbow trout stocked annually.

Feeding habits and growth analysis both suggest that rainbow trout and kokanee populations had ample food. On the other hand, walleye growth appeared to be slowing and the food availability may be the cause. The condition factor of walleye was 0.84 which was not different than past years. The limitation of food may not be large enough to cause the walleye to starve, causing a reduced condition factor, but may cause a reduced overall fitness of population. This may be why the walleye harvest in 1995 was less than previous years. In addition, rainbow released from the net pens may be competing with walleye for food, the diet overlap between walleye and rainbow trout was moderate (45%). Competition between walleye and rainbow trout may be stronger than diet overlap suggests. This may be why the number of walleye harvested has decreased and the relative abundance of yellow perch has decreased, as the number of rainbow trout released from net pens increased over the few years.

The diet overlap among rainbow and kokanee had a high diet overlap (80%) meaning kokanee and rainbow trout used similar food types. However, growth of kokanee and rainbow trout appears to be good. Kokanee and walleye did not use similar food types (15%). Food does not appear to be limited for kokanee or rainbow trout.

5.0 RECOMMENDATIONS AND RESEARCH NEEDS

1) Quantify the impact of walleye on newly stocked kokanee. This will give us a better estimate of the actual number of kokanee stocked into the lake after walleye have reduced the population.

2) Record origin of every kokanee and rainbow sampled so that comparisons can be made between hatchery origin and wild origin fish. We were unable to determine the number of hatchery and wild origin kokanee harvested with any accuracy in past years.

3) Evaluate the scientific design of the creel survey and methods used to compute indices. Question accuracy of ratio estimating the number of boats containing anglers versus non-anglers

4) Conduct hydroacoustic surveys monthly to identify spatial and temporal accumulations of fish along the length and width of the lake.

5) Vertical net, beam trawl or purse seine in area of know fish assemblages to determine fish species, age structure, feeding habits and growth rates of fish contained within the assemblage.

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APPENDIX A

Creel Survey Data

Table A.1 Boat trailer to boats on the water correction factor split by quarters. Correction factors were establised during 1990 through 1993.

STRATA		YEAR 1990	1991	1992	1993	1990-1993 MEAN ± STDEV
WINTER	Dee-Feb	3.49	1.92	2.01	2.57	2.50 ± 0.72
SPRING	Mar-May	3.02	3.74	1.08	1.52	2.34 ± 1.25
SUMMER	Jun-Aug	3.71	3.17	1.10	1.01	2.25 ± 1.40
FALL	Aug-Nov	1.46	3.13	1.17	1.02	1.70 ± 0.97
ANNUAL	Dee-Nov	2.92	2.99	1.34	1.53	2.19 ± 0.88

Table A.2 Boat trailer to boats on the water correction factor split by quarters and by weekday (WD) and weekend (WE) strata. The average among years were applied to pressure estimates in 1993 through 1995.

STRATA		YEAR 1990	1991	1992	1993	1990-1993 MEAN ± STDEV
WINTER	WD	3.90	1.60	1.07	2.14	**2.18** ± 1.23
	WE	1.84	2.24	2.49	2.85	**2.35** ± 0.42
SPRING	WD	3.65	5.73	1.50	1.43	**3.08** ± 2.05
	WE	2.39	1.75	0.77	1.78	**1.67** ± 0.67
SUMMER	WD	3.37	2.96	1.13	0.66	**2.03** ± 1.33
	WE	4.12	3.59	1.05	1.35	**2.53** ± 1.55
FALL	WD	1.53	4.07	1.27	0.87	**1.93** ± 1.45
	WE	1.41	2.20	1.10	1.33	**1.51** ± 0.48
ANNUAL	WD	3.11	3.59	1.24	1.28	**2.30** ± 1.22
	WE	2.44	2.45	1.35	1.83	**2.02** ± 0.53

Table A.3 Section 1 pressure estimates in hours for boat anglers in **1995** with intermediate calculations.

STRATA		Correct. factor	Mean boat trailers for the day	% of boats fishing	# angler/ boat	# of angler/ boat S.D.	Corrected mean angler	Corrected x angler sd
December	WD	1.60	0.50	1.00	2.00	0.00	1.6	0.0
	WE	2.67	0.00	1.00	0.00	0.00	0.0	0.0
January	WD	1.60	0.17	1.00	2.00	0.00	0.5	0.0
	WE	2.67	0.00	1.00	1.23	0.00	0.0	0.0
February	WD	1.60	0.27	1.00	2.00	0.00	0.9	0.0
	WE	2.67	1.00	0.75	2.46	0.78	4.7	1.5
March	WD	1.46	1.36	1.00	2.33	0.58	4.6	1.2
	WE	1.28	4.43	1.00	3.00	0.00	17.0	0.0
April	WD	1.46	2.07	0.90	1.91	0.70	5.2	1.9
	WE	1.28	13.40	0.72	2.29	0.83	28.3	10.3
May	WD	1.46	2.35	0.59	1.88	0.81	3.8	1.6
	WE	1.28	30.40	0.58	3.00	0.82	67.7	18.5
June	WD	0.90	5.00	0.85	2.25	0.84	8.6	3.2
	WE	1.20	16.67	0.83	2.12	0.53	35.2	8.8
July	WD	0.90	18.75	0.71	2.61	1.12	31.3	13.4
	WE	1.20	35.00	0.50	3.25	1.75	68.3	36.8
August	WD	0.90	7.53	0.67	2.60	1.11	11.8	5.0
	WE	1.20	34.33	0.61	3.33	1.15	0.0	28.9
September	WD	1.07	6.75	0.86	2.25	0.89	14.0	5.5
	WE	1.21	28.33	0.38	2.95	1.25	38.4	16.3
October	WD	1.07	1.36	1.00	1.62	0.52	2.4	0.8
	WE	1.21	2.40	0.69	2.00	0.50	4.0	1.0
November	WD	1.07	0.22	1.00	1.94	0.52	0.5	0.1
	WE	1.21	0.00	1.00	2.47	0.50	0.0	0.0
Annual	WD	1.26	3.86	0.88	2.12	0.59	7.1	2.7
	WE	1.59	13.83	0.75	2.25	0.68	22.0	10.2

Table A.4 Section 2 pressure estimates for boat anglers in 1995 with intermediate calculations.

STRATA		Correct. factor	Mean boat trailers for the day	% of boats fishing	# angler/ boat	# of angler/ boat S.D.	Corrected mean angler	Corrected x angler sd
December	WD	1.60	7.18	1.00	1.67	0.58	19.2	6.7
	WE	2.67	12.00	1.00	1.83	0.40	58.6	12.8
January	WD	1.60	4.63	1.00	2.00		14.8	0.0
	WE	2.67	8.00	1.00	1.67	0.58	35.7	12.4
February	WD	1.60	6.92	1.00	2.00	0.00	22.1	0.0
	WE	2.67	18.75	1.00	2.00		100.1	0.0
March	WD	1.46	8.27	1.00	1.92	0.90	23.2	10.9
	WE	1.28	15.67	1.00	2.75	1.29	55.2	25.9
April	WD	1.46	4.29	1.00	2.00	0.00	12.5	0.0
	WE	1.28	21.00	0.78	2.57	1.13	53.9	23.7
May	WD	1.46	10.00	0.79	2.00	0.82	23.1	9.5
	WE	1.28	32.00	0.64	2.75	0.96	72.1	25.2
June	WD	0.90	16.11	0.67	2.50	0.55	24.3	5.3
	WE	1.20	30.50	0.67	2.00	0.00	49.0	0.0
July	WD	0.90	62.00	0.04	3.19	1.28	7.1	2.9
	WE	1.20	115.00	0.06	3.27	1.03	27.1	8.5
August	WD	0.90	74.62	0.20	2.71	1.08	36.4	14.5
	WE	1.20	149.50	0.28	3.21	1.19	161.2	59.8
September	WD	1.07	17.00	0.91	2.00	0.41	33.1	6.8
	WE	1.21	37.80	1.00	2.25	0.50	102.9	22.9
October	WD	1.07	8.67	1.00	1.75	0.46	16.2	4.3
	WE	1.21	21.25	0.78	1.83	0.41	36.7	8.2
November	WD	1.07	4.42	1.00	2.17	0.83	10.3	3.9
	WE	1.21	2.33	1.00	2.04	0.40	5.8	1.1
Annual	**WD**	**1.26**	**18.68**	**0.80**	**2.16**	**0.63**	**20.2**	**5.4**
	WE	**1.59**	**38.65**	**0.77**	**2.35**	**0.72**	**63.2**	**16.7**

Table A.5 Section 3 pressure estimates in hours for boat anglers in 1995 **with intermediate calculations.**

STRATA		Correct. factor	Mean boat trailers for the day	% of boats fishing	# angler/ boat	# angler/ boat S.D.	Corrected mean angler	Corrected x angler sd
December	WD	1.60	4.13	1.00	1.44	0.53	9.5	3.5
	WE	2.67	2.00	1.00	2.00	0.00	10.7	0.0
January	WD	1.60	5.55	1.00	1.50	0.76	13.3	6.7
	WE	2.67	14.50	1.00	2.00		77.4	0.0
February	WD	1.60	13.50	1.00	1.83	0.41	39.5	8.9
	WE	2.67	39.00	1.00	2.00	0.71	208.3	73.9
March	WD	1.46	14.90	1.00	1.40	0.55	30.5	12.0
	WE	1.28	23.43	1.00	2.17	1.03	65.1	30.9
April	WD	1.46	3.91	1.00	1.67	0.52	9.5	3.0
	WE	1.28	73.57	0.78	1.53	0.52	112.4	38.2
May	WD	1.46	19.78	0.79	1.36	0.56	31.0	12.8
	WE	1.28	80.75	0.64	1.36	0.49	90.0	32.4
June	WD	0.90	33.85	0.67	1.61	0.66	32.9	13.5
	WE	1.20	82.25	0.67	1.89	0.33	125.0	21.8
July	WD	0.90	84.86	0.04	1.50	0.76	0.0	0.0
	WE	1.20	160.40	0.06	1.91	0.54	22.1	6.2
August	WD	0.90	105.58	0.20	2.50	0.80	47.5	15.2
	WE	1.20	113.00	0.28	1.90		72.1	0.0
September	WD	1.07	11.42	0.91	1.17	0.41	13.0	4.6
	WE	1.21	99.13	0.50	1.67	0.58	100.2	34.8
October	WD	1.07	14.80	1.00	1.88	0.35	29.8	5.5
	WE	1.21	17.43	0.78	1.88	0.35	30.9	5.8
November	WD	1.07	3.85	1.00	1.00	0.00	4.1	0.0
	WE	1.21	6.00	1.00	1.77		12.9	0.0
Annual	**WD**	**1.26**	**21.02**	**0.80**	**1.57**	**0.53**	**21.7**	**7.1**
	WE	**1.59**	**59.29**	**0.73**	**1.84**	**0.51**	**77.2**	**20.3**

Table A.6 Section 1 angling pressure estimates (hrs) from December, 1994 to November, 1995 with intermediate calculations.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correction factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
DECEMBER													
WEEKDAY													
Shore	8.40	22	184.80	76.50	2.42	2.94	4.3	93.5	1.5	33.0	664	2.631	72
Boat	8.40	22	184.80	76.50	2.42	6.50	1.6	35.2	0.0	0.0	553	0	0
WEEKEND													
Shore	8.40	9	75.60	18.00	4.20	3.31	6.3	57.0	0.6	5.2	792	114	15
Boat	8.40	9	75.60	18.00	4.20	0.00	0.0	0.0	0.0	0.0	0	0	0
TOTAL	8.40	31	260.40	94.50			12.2	185.7	2.1	38.2	2,009	2,745	87
JANUARY													
WEEKDAY													
Shore	8.83	19	167.77	62.90	2.67	3.89	3.7	69.7	1.5	28.5	723	2,166	65
Boat	8.83	19	167.77	62.90	2.67	6.50	0.5	9.5	0.0	0.0	165	0	0
WEEKEND													
Shore	8.83	9	79.47	19.10	4.16	3.30	5.7	51.0	3.1	27.5	701	3,156	79
Boat	8.83	9	79.47	19.10	4.16	5.78	0.0	0.0	0.0	0.0	0	0	0
TOTAL	8.83	28	247.24	82.00			9.8	130.3	4.6	56.0	1,589	5,322	144
FEBRUARY													
WEEKDAY													
Shore	10.25	19	194.75	53.50	3.64	2.83	1.6	29.5	2.2	41.8	303	6.360	112
Boat	10.25	19	194.75	53.50	3.64	4.38	0.9	17.1	0.0	0.0	273	0	0
WEEKEND													
Shore	10.25	9	92.25	28.70	3.21	4.10	1.4	12.6	2.2	19.7	166	1,249	49
Boat	10.25	9	92.25	28.70	3.21	5.78	4.7	42.3	1.5	13.5	786	586	34
TOTAL	10.25	28	287.00	82.20			8.6	101.5	5.9	75.0	1,528	8,195	195

Table A.6 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correction factor Nsln	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estlmate per month VPE	95% C .I. per month CI
MARCH													
WEEKDAY													
Shore	11.97	23	275.3 1	43.00	6.40	0.68	0.5	11.5	1.0	23.5	SO	3,524	83
Boat	11.97	23	275.3 1	43.00	6.40	5.21	4.6	105.8	1.2	27.6	3,529	4,877	98
WEEKEND													
Shore	11.97	8	95.76	37.00	2.59	3.00	I.0	0.0	I.0	8.0	0	166	18
Boat	11.97	8	95.76	37.00	2.59	6.63	17.0	136.0	0.0	0.0	2,334	0	0
TOTAL	11.97	31	371.07	80.00			23.1	253.3	3.2	59.1	5,913	8,567	199
APRIL													
WEEKDAY													
Shore	13.68	20	273.60	71.50	3.83	2.60	1.0	20.0	1.8	35.4	199	4,795	91
Boat	13.68	20	273.60	71.50	3.83	6.20	5.2	104.0	1.9	38.0	2,467	5,526	104
WEEKEND													
Shore	13.68	10	136.80	29.20	4.68	3.84	2.8	28.0	3.3	32.7	504	5,010	99
Boat	13.68	10	136.80	29.20	4.68	5.76	28.3	283.0	10.3	103.0	7,637	49,702	312
TOTAL	13.68	30	410.40	100.70			37.3	435.0	17.2	209.1	10,807	65,033	612
MAY													
WEEKDAY													
Shore	15.20	22	334.40	84.50	3.96	6.85	0.5	10.3	0.9	20.7	280	1,692	58
Boat	15.20	22	334.40	84.50	3.96	6.41	3.8	83.6	1.6	35.2	2,121	4,903	98
WEEKEND													
Shore	15.20	9	136.80	26.00	5.26	0.00	0.0	0.0	0.0	0.0	0	0	0
Boat	15.20	9	136.80	26.00	5.26	5.65	67.7	609.3	18.5	166.5	18,113	145,862	535
TOTAL	15.20	31	471.20	110.50			72.0	703.2	21.0	222.4	20,514	152,457	690
JUNE													
WEEKDAY													
Shore	16.02	22	352.44	80.20	4.39	5.93	0.1	1.2	0.2	5.3	32	123	15
Boat	16.02	22	352.44	80.20	4.39	5.94	8.6	189.2	3.2	70.4	4,939	21,780	207
WEEKEND													
Shore	16.02	8	128.16	14.00	9.15	0.00	0.0	0.0	0.0	0.0	0	0	0
Boat	16.02	8	128.16	14.00	9.15	5.81	35.2	281.6	8.8	70.4	14,977	45,370	298
TOTAL	16.02	30	480.60	94.20			43.9	472.0	12.2	146.1	19,948	67,273	520

Table A.6 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Tlme correction factor Nsln	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month Ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
JULY													
WEEKDAY													
Shore	15.67	20	313.40	46.50	6.74	0.00	0.0	0.0	0.0	0.0	0	0	0
Boat	15.67	20	313.40	46.50	6.74	6.7 1	31.5	630.0	13.4	268.0	28,491	484,078	974
WEEKEND													
Shore	15.67	11	172.37	32.70	5.27	0.00	0.0	0.0	0.0	0.0	0	0	0
Boat	15.67	11	172.37	32.70	5.27	6.92	68.3	751.3	36.8	404.8	27,405	863,764	1,301
TOTAL	15.67	31	485.77	79.20			99.8	1381.3	50.2	672.8	55,896	1,347,842	2,275
AUGUST													
WEEKDAY													
Shore	14.38	23	330.74	98.50	3.36	0.00	0.0	0.0	0.0	0.0	0	0	0
Uoat	14.38	23	330.74	98.50	3.36	5.93	11.8	271.4	5.0	115.0	5,404	44,406	295
WEEKEND													
Shore	14.38	8	115.04	30.00	3.83	12.00	1.0	8.0	2.5	19.6	368	1,473	54
Boat	14.38	8	115.04	30.00	3.83	6.3 1	0.0	0.0	28.9	231.2	0	204.976	634
TOTAL	14.38	31	445.78	128.50			12.8	279.4	36.4	365.8	5,772	250,856	983
SEPTEMBER													
WEEKDAY													
Shore	12.45	21	261.45	45.00	5.81	6.22	0.0	0.0	0.0	0.0	0	0	0
Boat	12.45	21	261.45	45.00	5.81	8.17	14.0	294.0	5.5	115.5	13,956	77,507	390
WEEKEND													
Shore	12.45	9	112.05	30.00	3.74	12.00	0.3	3.0	0.8	7.4	133	203	20
Boat	12.45	9	112.05	30.00	3.74	7.07	38.4	345.6	16.3	146.7	9,126	80,381	397
TOTAL	12.45	30	373.50	75.00			52.7	642.6	22.6	269.6	23,215	158,091	807
OCTOBER													
WEEKDAY													
Shore	10.73	20	214.60	58.00	3.70	6.68	0.3	5.4	0.9	18.0	133	1,199	48
Boat	10.73	20	214.60	58.00	3.70	5.63	2.4	48.0	0.8	16.0	1,000	947	43
WEEKEND													
Shore	10.73	11	118.03	15.00	7.87	6.68	0.0	0.0	0.0	0.0	0	0	0
Boat	10.73	11	118.03	15.00	7.87	6.71	4.0	44.0	1.0	11.0	2,323	952	43
TOTAL	10.73	31	332.63	73.00			6.7	97.4	2.7	45.0	3,456	3,098	135

Table A.6 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correction factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estlmate per month PE	Variance of pressure estlmate per month VPE	95% C.I. per month CI
NOVEMBER													
WEEKDAY													
Shore	9.20	20	184.00	42.50	4.33	6.00	0.6	11.2	0.9	17.6	291	1.341	51
Boat	9.20	20	184.00	42.50	4.33	6.90	0.5	10.0	0.1	2.0	299	17	6
WEEKEND													
Shore	9.20	10	92.00	10.00	9.20	6.68	2.5	25.0	3.5	35.3	1.536	11,464	150
Boat	9.20	10	92.00	10.00	9.20	6.90	0.0	0.0	0.0	0.0	0	0	0
TOTAL	9.20	30	276.00	52.50			3.6	46.2	4.5	54.9	2,126	12,822	207
ANNUAL TOTAL	146.78	362.00	4441.59	1052.30			382.4	4,727.8	182.7	2,214.0	152,773	2,082,301	6,854

Table A.7 Section 2 angling pressure estimates (hrs) from December, 1994 to November, 1995 with intermediate calculations.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correction factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
DECEMBER													
WEEKDAY													
Shore	8.40	22	184.80	44.60	4.14	2.60	22.6	496.1	12.5	273.9	5,345	310.850	781
Boat	8.40	22	184.80	44.60	4.14	4.00	19.2	422.4	6.7	147.4	7,001	90,025	420
WEEKEND													
Shore	8.40	9	75.60	10.80	7.00	4.29	36.3	326.7	6.8	61.2	9,811	26,218	227
Boat	8.40	9	75.60	10.80	7.00	4.00	58.6	527.4	12.8	115.2	14.767	92,897	427
TOTAL	8.40	31	260.40	55.40			136.7	1772.6	38.8	597.7	36,923	5 19,990	1,854
JANUARY													
WEEKDAY													
Shore	8.83	19	167.77	34.70	4.83	4.24	10.9	206.5	8.3	157.9	4,234	120,530	486
Boat	8.83	19	167.77	34.70	4.83	4.50	14.8	281.2	0.0	0.0	6,118	0	0
WEEKEND													
Shore	8.83	9	79.47	23.20	3.43	5.89	19.0	171.0	15.9	143.3	3,450	70,321	371
Boat	8.83	9	79.47	23.20	3.43	5.77	35.7	321.3	12.4	111.6	6,350	42,662	289
TOTAL	8.83	28	247.24	57.90			80.4	980.0	36.6	412.8	20,152	233,513	1,146
FEBRUARY													
WEEKDAY													
Shore	10.25	19	194.75	27.60	7.06	5.15	8.4	160.0	10.9	207.1	5,814	302,642	770
Boat	10.25	19	194.75	27.60	7.06	5.38	22.1	419.9	0.0	0.0	15,940	0	0
WEEKEND													
Shore	10.25	9	92.25	7.70	11.98	1.00	30.3	272.3	22.2	199.7	3,262	477.832	968
Boat	10.25	9	92.25	7.70	11.98	6.42	100.1	900.9	0.0	0.0	69,293	0	0
TOTAL	10.25	28	287.00	35.30			160.9	1753.0	33.1	406.8	94,308	780,474	1,738

Table A.7 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correction factor NsIn	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
MARCH													
WEEKDAY													
Shore	11.97	23	275.31	24.90	11.06	4.22	6.9	157.8	7.3	167.2	7,362	309.134	778
Boat	11.97	23	275.31	24.90	11.06	5.05	23.2	533.6	10.9	250.7	29,794	694,914	1,167
WEEKEND													
Shore	11.97	8	95.76	26.50	3.61	4.79	14.7	0.0	8.2	65.7		15,589	175
Boat	11.97	8	95.76	26.50	3.61	4.78	55.2	441.6	25.9	207.2	7.6028	155,138	551
TOTAL	11.97	31	371.07	51.40			99.9	1133.0	52.3	690.8	44,784	1,174,775	2,672
APRIL													
WEEKDAY													
Shore	13.68	20	273.60	16.90	16.19	4.46	2.3	45.8	1.9	37.8	3,307	23,132	213
Boat	13.68	20	273.60	16.90	16.19	5.03	12.5	250.0	0.0	0.0	20,358	0	0
WEEKEND													
Shore	13.68	10	136.80	18.00	7.60	4.46	27.7	276.7	15.6	155.7	9,379	184,243	601
Boat	13.68	10	136.80	18.00	7.60	4.70	53.9	539.0	23.7	237.0	19,253	426,884	915
TOTAL	13.68	30	410.40	34.90			96.4	1111.5	41.2	430.5	52,297	634,259	1,729
MAY													
WEEKDAY													
Shore	15.20	22	334.40	67.20	4.98	4.10	2.5	53.9	4.2	91.5	1,100	41,680	286
Boat	15.20	22	334.40	67.20	4.98	6.22	23.1	508.2	9.5	209.0	15,730	217,365	653
WEEKEND													
Shore	15.20	9	136.80	15.30	8.94	4.10	4.3	38.3	3.3	29.7	1,402	7,887	124
Boat	15.20	9	136.80	15.30	8.94	7.57	72.1	648.9	25.2	226.8	43,921	459,918	949
TOTAL	15.20	31	471.20	82.50			101.9	1249.3	42.2	557.0	62,152	726,850	2,012
JUNE													
WEEKDAY													
Shore	16.02	22	352.44	37.70	9.35	6.00	I.1	24.4	2.0	43.1	1,370	17,382	185
Boat	16.02	22	352.44	37.70	9.35	5.11	24.3	534.6	5.3	116.6	25,538	127,099	499
WEEKEND													
Shore	16.02	8	128.16	9.50	13.49	6.00	0.0	0.0	0.0	0.0	0	0	0
Boat	16.02	8	128.16	9.50	13.49	3.88	49.0	392.0	0.0	0.0	20,519	0	0
TOTAL	16.02	30	480.60	47.20			74.4	951.0	7.3	159.7	47,427	144,481	684

Table A.7 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correction factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
JULY													
WEEKDAY													
Shore	15.67	20	313.40	14.70	21.32	6.00	0.7	13.2	1.2	23.0	1,689	11,278	149
Boat	15.67	20	313.40	14.70	21.32	4.48	7.1	142.0	2.9	58.0	13,563	71,720	375
WEEKEND													
Shore	15.67	11	172.37	13.50	12.77	6.00	1.7	18.4	2.9	31.8	1,407	12,904	159
Boat	15.67	11	172.37	13.50	12.77	4.00	27.1	298.1	8.5	93.5	15,225	111.622	468
TOTAL	15.67	31	485.77	28.20			36.5	471.7	15.4	206.3	31,883	207,524	1,150
AUGUST													
WEEKDAY													
Shore	14.38	23	330.74	60.60	5.46	6.00	3.1	70.8	4.4	101.0	2,320	55.641	330
Boat	14.38	23	330.74	60.60	5.46	6.15	36.4	837.2	14.5	333.5	28,101	607,024	1.091
WEEKEND													
Shore	14.38	8	115.04	21.10	5.45	6.00	4.2	33.4	5.0	40.0	1,091	8,723	131
Boat	14.38	8	115.04	21.10	5.45	4.09	161.2	1289.6	59.8	478.4	28,757	1,247,811	1,564
TOTAL	14.38	31	445.78	81.70			204.9	2231.0	83.7	952.9	60,269	1,919,200	3,116
SEPTEMBER													
WEEKDAY													
Shore	12.45	21	261.45	52.10	5.02	4.20	0.7	15.3	1.6	32.8	323	5,386	103
Boat	12.45	21	261.45	52.10	5.02	3.99	33.1	695.1	6.8	142.8	13,918	102,331	448
WEEKEND													
Shore	12.45	9	112.05	18.30	6.12	3.00	5.8	52.2	11.4	102.3	959	64,116	354
Boat	12.45	9	112.05	18.30	6.12	3.75	102.9	926.1	22.9	206.1	21,264	260.086	714
TOTAL	12.45	30	373.50	70.40			142.5	1688.7	42.6	484.0	36,464	431,919	1,619
OCTOBER													
WEEKDAY													
Shore	10.73	20	214.60	30.60	7.01	4.20	0.0	0.0	0.0	0.0	0	0	0
Boat	10.73	20	214.60	30.60	7.01	4.22	16.2	324.0	4.3	86.0	9,589	51,869	319
WEEKEND													
Shore	10.73	11	118.03	22.90	5.15	3.00	3.0	33.0	1.4	15.5	510	1,240	49
Boat	10.73	11	118.03	22.90	5.15	5.81	36.7	403.7	8.2	90.2	12,089	41.934	287
TOTAL	10.73	31	332.63	53.50			55.9	760.7	13.9	191.7	22,188	95,043	655

Table A.7 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correctlon factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estlmate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
NOVEMBER													
WEEKDAY													
Shore	9.20	20	184.00	68.70	2.68	5.17	1.3	26.6	2.7	54.8	368	8,043	126
Boat	9.20	20	184.00	68.70	2.68	4.11	10.3	206.0	3.9	78.0	2,268	16,295	179
WEEKEND													
Shore	9.20	10	92.00	0.00	5.00	3.50	0.0	0.0	0.0	0.0	0	0	0
Boat	9.20	10	92.00	0.00	5.00	4.30	5.8	58.0	1.1	11.0	1,247	605	34
TOTAL	9.20	30	276.00	68.70			17.4	290.6	7.7	143.8	3,883	24,943	339
ANNUAL TOTAL	146.8	362.00	4441.59	667.10			1,207.7	14393.1	414.7	5,234.0	512,731	6,892,970	18,713

Table A.8 Section 3 angling pressure estimates (hrs) from December, 1994 to November, 1995 with intermediate calculations.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correction factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month YE	Variance of pressure estimate per month VPE	95% C.I. per month CI
DECEMBER													
WEEKDAY													
Shore	8.40	22	184.80	50.30	3.67	3.00	2.0	44.0	2.3	51.5	485	9,737	138
Boat	8.40	22	184.80	50.30	3.67	4.28	9.5	209.0	3.5	77.0	3,286	21,783	207
WEEKEND													
Shore	8.40	9	75.60	16.80	4.50	3.00	1.3	12.0	1.6	14.7	162	968	44
Boat	8.40	9	75.60	16.80	4.50	7.00	10.7	96.3	0.0	0.0	3,033	0	0
TOTAL	8.40	31	260.40	67.10			23.5	361.3	7.5	143.2	6,966	32,488	388
JANUARY													
WEEKDAY													
Shore	8.83	19	167.77	43.20	3.88	6.00	2.1	39.9	2.2	41.2	930	6,602	114
Boat	8.83	19	167.77	43.20	3.88	4.95	13.3	252.7	6.7	127.3	4,858	62,934	351
WEEKEND													
Shore	8.83	9	79.47	26.20	3.03	4.92	7.7	69.0	4.5	40.5	1.030	4,975	99
Boat	8.83	9	79.47	26.20	3.03	4.95	77.4	696.6	0.0	0.0	10,459	0	0
TOTAL	8.83	28	247.24	69.40			100.5	1,058.2	13.4	209.0	17,277	74,511	564
FEBRUARY													
WEEKDAY													
Shore	10.25	19	194.75	30.40	6.41	4.50	4.6	87.4	3.7	69.4	2,520	30,810	246
Boat	10.25	19	194.75	30.40	6.41	4.66	39.5	750.5	8.9	169.1	22.405	183,186	599
WEEKEND													
Shore	10.25	9	92.25	20.00	4.61	4.00	9.7	87.0	6.7	59.9	1,606	16,572	180
Boat	10.25	9	92.25	20.00	4.61	5.31	208.5	1876.5	73.9	665.1	45.960	2,040,376	2,000
TOTAL	10.25	28	287.00	50.40			262.3	2801.4	93.1	963.5	72,490	2,270,944	3,025

Table A.8 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correctlon factor Nsln	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
MARCH													
WEEKDAY													
Shore	11.97	23	275.31	40.30	6.83	3.50	5.8	133.4	2.9	67.4	3,190	31,025	247
Boat	11.97	23	275.31	40.30	6.83	4.58	30.5	701.5	12.0	276.0	21.949	520,397	1,010
WEEKEND													
Shore	11.97	8	95.76	29.50	3.25	4.44	11.6	0.0	6.3	50.3	0	8,219	127
Boat	11.97	8	95.76	29.50	3.25	6.00	65.1	520.8	30.9	247.2	10,143	198.362	624
TOTAL	11.97	31	371.07	69.80			113.0	1,355.7	52.1	640.9	35,282	758,004	2,007
APRIL													
WEEKDAY													
Shore	13.68	20	273.60	33.70	8.12	6.00	6.6	132.0	2.4	47.4	6,430	18,241	189
Boat	13.68	20	273.60	33.70	8.12	6.88	9.5	190.0	3.0	60.0	10,613	29,227	239
WEEKEND													
Shore	13.68	10	136.80	33.20	4.12	6.00	11.7	117.1	6.1	61.0	2,895	15.332	173
Boat	13.68	10	136.80	33.20	4.12	7.84	112.4	1124.0	38.2	382.0	36,310	601,277	1,086
TOTAL	13.68	30	410.40	66.90			140.2	1,563.1	49.7	550.4	56,248	664,078	1,687
MAY													
WEEKDAY													
Shore	15.20	22	334.40	34.20	9.78	6.00	3.4	75.7	2.1	46.9	4,440	21,471	205
Boat	15.20	22	334.40	34.20	9.78	7.17	31.0	682.0	12.8	281.6	47,813	775,364	1,233
WEEKEND													
Shore	15.20	9	136.80	19.00	7.20	6.00	13.8	123.8	12.9	116.0	5,346	96.900	436
Boat	15.20	9	136.80	19.00	7.20	6.36	90.0	810.0	32.4	291.6	37,092	612,220	1,095
TOTAL	15.20	31	471.20	53.20			138.2	1,691.4	60.2	736.1	94,690	1,505,954	2,969
JUNE													
WEEKDAY													
Shore	16.02	22	352.44	29.70	11.87	7.08	5.0	110.0	5.3	116.4	9,242	160,726	561
Boat	16.02	22	352.44	29.70	11.87	9.20	32.9	723.8	13.5	297.0	79.020	1,046,747	1,432
WEEKEND													
Shore	16.02	8	128.16	11.00	11.65	7.08	2.5	20.0	1.7	13.8	1,650	2,232	66
Boat	16.02	8	128.16	11.00	11.65	7.43	125.0	1000.0	21.8	174.4	86,566	354,367	833
TOTAL	16.02	30	480.60	40.70			165.4	1,853.8	42.3	601.6	176,477	1,564,071	2,893

Table A.8 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Tlme correction factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
JULY													
WEEKDAY													
Shore	15.67	20	313.40	23.20	13.51	7.08	3.3	65.8	4.5	90.0	6,293	109,420	463
Boat	15.67	20	313.40	23.20	13.51	5.12	0.0	0.0	0.0	0.0	0	0	0
WEEKEND													
Shore	15.67	11	172.37	21.00	8.21	7.08	5.0	55.0	11.6	127.8	3,196	134,103	513
Boat	15.67	11	172.37	21.00	8.21	6.56	22.1	243.1	6.2	68.2	13,090	38.178	274
TOTAL	15.67	31	485.77	44.20			30.4	363.9	22.3	286.0	22,579	281,701	1,249
AUGUST													
WEEKDAY													
Shore	14.38	23	330.74	53.80	6.15	7.08	4.3	97.8	4.3	99.1	4,255	60.4 11	344
Boat	14.38	23	330.74	53.80	6.15	8.87	47.5	1092.5	15.2	349.6	59,573	751.359	1,214
WEEKEND													
Shore	14.38	8	115.04	8.30	13.86	7.08	3.8	30.0	3.8	30.2	2,944	12,608	157
Boat	14.38	8	115.04	8.30	13.86	8.87	72.1	576.8	0.0	0.0	70,912	0	0
TOTAL	14.38	31	445.78	62.10			127.6	1,797.1	23.3	478.9	137,683	824,377	1,715
SEPTEMBER													
WEEKDAY													
Shore	12.45	21	261.45	51.40	5.09	3.00	0.3	6.9	0.7	13.7	106	948	43
Uoat	12.45	21	261.45	51.40	5.09	6.29	13.0	273.0	4.6	96.6	8,735	47,466	305
WEEKEND													
Shore	12.45	9	112.05	29.80	3.76	3.00	0.8	6.8	1.4	12.5	76	588	34
Boat	12.45	9	1 12.05	29.80	3.76	7.10	100.2	901.8	34.8	313.2	24,075	368,841	850
TOTAL	12.45	30	373.50	81.20			114.3	1,188.5	41.4	436.0	32,991	417,843	1,232
OCTOBER													
WEEKDAY													
Shore	10.73	20	214.60	53.10	4.04	3.00	0.4	8.4	1.0	20.0	102	1,617	56
Boat	10.73	20	214.60	53.10	4.04	6.78	29.8	596.0	5.5	110.0	16,331	48,901	310
WEEKEND													
Shore	10.73	11	118.03	30.50	3.87	3.00	0.1	1.5	0.4	4.2	18	68	12
Boat	10.73	11	118.03	30.50	3.87	6.54	30.9	339.9	5.8	63.8	8,602	15,752	176
TOTAL	10.73	31	332.63	83.60			61.3	945.8	12.7	198.0	25,053	66,337	553

Table A.8 Continued.

STRATA	Hours per day (naut) Hd	Days per month (cal) Ds	Hours per month Ns	Hours creeled per month n	Time correctlon factor Ns/n	Angler hours per angler Ha	Mean anglers per day Xd	Mean anglers per month xs	± anglers per day Sd	± anglers per month ss	Pressure estimate per month PE	Variance of pressure estimate per month VPE	95% C.I. per month CI
NOVEMBER													
WEEKDAY													
Shore	9.20	20	184.00	50.80	3.62	3.00	0.2	4.6	0.4	8.8	50	280	23
Boat	9.20	20	184.00	50.80	3.62	5.79	4.1	82.0	0.0	0.0	1,720	0	0
WEEKEND													
Shore	9.20	10	92.00	15.20	6.05	0.00	0.0	0.0	0.0	0.0	0	0	0
Boat	9.20	10	92.00	15.20	6.05	5.79	12.9	129.0	0.0	0.0	4,521	0	0
TOTAL	9.20	30	276.00	66.00			17.2	215.6	0.4	8.8	6,290	280	23
ANNUAL TOTAL	146.78	362.00	4,442	754.60			1,293.8	15,196	418.4	5,252	684,028	8,460,589	18,307

Table A.9 Section 1 catch per unit effort (fish/hour) of the harvest (fish kept) in Lake Roosevelt from December, 1994 through November, 1995.

Species	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	Annual Mean
kokanee salmon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
rainbow trout	0.073	0.084	0.011	0.023	0.030	0.021	0.004	0.028	0.063	0.035	0.050	0.143	0.033
walleye	0.000	0.000	0.038	0.058	0.111	0.153	0.290	0.225	0.105	0.205	0.078	0.000	0.154
smallmouth bass	.0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0 .000
sturgeon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
other species*	0.000	0.000	0.005	0.000	0.003	0.009	0.000	0.003	0.005	0.005	0.000	0.000	0.003
Monthly Mean	**0.012**	**0.014**	**0.009**	**0.014**	**0.024**	**0.031**	**0.049**	**0.043**	**0.029**	**0.041**	**0.021**	**0.024**	**0.032**

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.10 Section 2 catch per unit effort (fish/hour) of the harvest (fish kept) in Lake Roosevelt from December, 1994 through November, 1995.

Species	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	Annual Mean
kokanee	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0,000	0.007	0.073	0.000	0.000	0.004
rainbow trout	0.060	0.153	0.099	0.052	0.111	0.030	0.000	0.000	0.057	0.036	0.063	0.040	0.064
walleye	0.000	0.000	0.000	0.000	0.000	0.010	0.086	0.000	0.021	0.000	0.000	0.000	0.008
smallmouth bass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
sturgeon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
other species*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Monthly Mean	**0.010**	**0.026**	**0.017**	**0.009**	**0.019**	**0.007**	**0.014**	**0.000**	**0.014**	**0.018**	**0.011**	**0.007**	**0.013**

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.11 Section 3 catch per unit effort (fish/hour) of the harvest (fish kept) in Lake Roosevelt from December, 1994 through November, 1995.

Species	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	Annual Mean
kokanee	0.034	0.105	0.114	0.046	0.091	0.050	0.019	0.033	0.025	0.000	0.000	0.000	0.042
rainbow trout	0.479	0.315	0.079	0.190	0.091	0.079	0.073	0.025	0.097	0.352	0.510	0.386	0.143
walleye	0.000	0.013	0.000	0.000	0.000	0.002	0.015	0.030	0.013	0.000	0.000	0.000	0.009
smallmouth bass	0.000	0.000	0.000	0.000	0.000	0.009	0.025	0.010	0.030	0.000	0.000	0.000	0.010
sturgeon	0.000	0.000	0.000	0.000	0.000	0,000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
other species*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Monthly Mean	**0.086**	**0.072**	**0.032**	**0.039**	**0.031**	**0.023**	**0.022**	**0.016**	**0.028**	**0.059**	**0.085**	**0.064**	**0.034**

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.12 Section 1 catch per unit effort (fish/hour) of the total catch (harvest and release) in Lake Roosevelt from December, 1994 through November, 1995.

Species	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	Annual Mean
kokanee	0.000	0.000	0,000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
rainbow trout	0.073	0.084	0.011	0.023	0.030	0.026	0.004	0.028	0.063	0.035	0.057	0.143	0.034
walleye	0.000	0.000	0.066	0.081	0.168	0.349	0.703	0.481	0.149	0.295	0.114	0.000	0.312
smallmouth bass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
sturgeon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000
other species*	0.000	0.000	0.005	0.000	0.003	0.013	0.000	0.003	0.005	0.005	0.000	0.000	0.003
Monthly Mean	**0.012**	**0.014**	**0.014**	**0.018**	**0.034**	**0.058**	**0.118**	**0.086**	**0.037**	**0.056**	**0.029**	**0,024**	**0.058**

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.13 Section 2 catch per unit effort (fish/hour) of the total catch (harvest and release) in Lake Roosevelt from December, 1994 through November, 1995.

Species	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	Annual Mean
kokanee	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.073	0.000	0.000	0.004
rainbow trout	0.060	0.153	0.099	0.052	0.136	0.030	0.000	0.000	0.057	0.036	0.063	0.040	0.065
walleye	0.000	0.000	0.000	0.000	0.012	0.025	0.086	0.000	0.021	0.000	0.063	0.000	0.014
smallmouth bass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.001
sturgeon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
other species*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Monthly Mean	**0.010**	**0.026**	**0.017**	**0.009**	**0.025**	**0.009**	**0.017**	**0.000**	**0.014**	**0.018**	**0.021**	**0.007**	**0.014**

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.14 Section 3 catch per unit effort (fish/hour) of the total catch (harvest and release) in Lake Roosevelt from December, 1994 through November, 1995.

Species	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	Annual Mean
kokanee	0.034	0.105	0.114	0.046	0.091	0.050	0.019	0.033	0.025	0.000	0.000	0.000	0.042
rainbow trout	0.479	0.315	0.079	0.194	0.091	0.079	0.081	0.025	0.097	0.352	0.510	0.386	0.145
walleye	0.000	0.013	0.000	0.004	0.000	0.002	0.017	0.035	0.013	0.000	0.000	0.000	0.010
smallmouth bass	0.000	0.000	0.000	0.000	0.020	0.187	0.141	0.115	0.034	0.742	0.000	0.000	0.100
sturgeon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
other species*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Monthly Mean	**0.086**	**0.072**	**0.032**	**0.244**	**0.202**	**0.053**	**0.043**	**0.035**	**0.028**	**0.182**	**0.085**	**0.064**	**0.050**

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.15 **Total monthly and annual harvest estimates with ± 95% confidence intervals from fish harvested by anglers on all sections of Lake Roosevelt from December, 1994 through November, 1995.**

SPECIES	DEC	JAN	FED	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
kokanee	238	1,814	8,281	1,635	5,137	4,705	3,302	912	3,921	2,647	0	0	32,353
	±13	±59	f346	±93	±154	±148	±54	±48	±65	±118	±0	±0	±1,085
rainbow trout	5,700	8,660	15,291	9,156	11,275	9,816	12,912	2,139	17,181	13,736	14,363	2,891	122,939
	f303	±365	±198	±658	±365	±311	f212	±95	±407	±520	f330	±53	±3,899
walleye	0	227	58	344	1,198	3,989	12,436	13,257	3,639	4,766	271	0	40,185
	±0	±7	±7	±12	±68	±133	±252	Lt.550	±192	f166	f11	±0	±1,397
smallmouth bass	0	0	0	0	0	855	4,402	227	4,073	0	0	0	9,558
	±0	±0	±0	±0	±0	±27	±72	±13	±51	±0	±0	±0	±162
sturgeon	0	0	0	0	0	0	0	0	0	0	0	0	0
	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0
other species*	0	0	8	0	36	175	0	175	27	116	0	0	537
	±0	±0	±1	±0	±2	±6	±0	±7	±5	±4	±0	±0	±25
Monthly Total	5,938	10,700	23,460	11,134	17,646	19,538	33,052	16,709	28,842	21,265	14,634	2,891	205,809
	f316	f431	f769	f629	±588	f624	±591	f712	f719	±807	f340	±53	±6,580

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.16 Monthly and annual harvest estimates ± 95% confidence intervals for all fish species surveyed in Section 1 of Lake Roosevelt from December, 1994 through November, 1995.

SPECIES	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
kokanee	0	0	0	0	0	0	0	175	0	0	0	0	175
	±0	±0	±0	±0	±0	±0	±0	±7	±0	±0	±0	±0	± 7
rainbow trout	148	134	17	138	327	437	73	1,572	363	814	173	304	4,497
	±6	±12	±2	±5	±19	±15	±2	±64	±62	±28	±7	±30	±251
walleye	0	0	58	344	1,198	3,144	5,779	12,577	605	4,766	271	0	28,743
	±0	±0	±7	±12	±68	±106	±151	±512	±103	±166	f11	±0	±1,135
smallmouth	0	0	0	0	0	0	0	0	0	0	0	0	0
bass	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	± 0
sturgeon	0	0	0	0	0	0	0	0	0	0	0	0	0
	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	±0	± 0
other species*	0	0	8	0	36	175	0	175	27	116	0	0	537
	±0	±0	±1	±0	±2	±6	±0	±7	±5	±4	±0	±0	±25
Monthly	148	134	83	481	1,561	3,755	5,852	14,498	996	5,696	444	304	33,952
Total	±6	±12	f11	±16	±88	±126	±153	±590	±170	f198	±17	±30	±1,417

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.17 Monthly and annual harvest estimates ± 95% confidence intervals for all fish species surveyed in Section 2 of Lake Roosevelt from December, 1994 through November, 1995.

SPECIES	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	sEP	OCT	NOV	TOTAL
kokanee	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	429 ±22	2,647 f118	0 ±0	0 ±0	3,076 ±140
rainbow trout	2,218 f111	3,084 ±175	9,363 ±173	2,327 ±139	5,811 f192	1,894 ±61	0 ±0	0 ±0	3,434 ±178	1,324 ±59	1,402 ±41	157 ±14	31,014 ±1,143
walleye	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	631 ±20	4,089 ±59	0 ±0	1,288 ±67	0 ±0	0 ±0	0 ±0	6,008 ±146
smallmouth bass	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
sturgeon	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
other species*	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
Monthly Total	2,218 ±111	3,084 ±175	9,363 f173	2,327 f139	5,811 ±192	2,525 ±82	4,089 ±59	0 ±0	5,151 ±266	3,971 ±176	1,402 ±41	157 ±14	40,098 ±1,429

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.18 Monthly and annual harvest estimates ± 95% confidence intervals for all fish species surveyed in Section 3 of Lake Roosevelt from December, 1994 through November, 1995.

SPECIES	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
kokanee	238 ±13	1,814 ±59	8,281 ±346	1,635 ±93	5,137 ±154	4,705 ±148	3,302 ±54	737 ±41	3,492 ±43	0 ±0	0 ±0	0 ±0	29,102 ±938
rainbow trout	3,334 ±186	5,442 ±178	5,733 ±239	6,691 ±381	5,137 ±0154	7,485 ±235	12,839 ±210	567 ±31	13,384 ±167	11,598 ±433	12,788 ±282	2,430 ±9	87,428 ±2,505
walleye	0 ±0	227 ±7	0 ±0	0 ±0	0 ±0	214 ±7	2,568 ±42	680 ±38	1,746 ±22	0 ±0	0 ±0	0 ±0	5,434 ±116
smallmouth bass	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	855 ±27	4,402 ±72	227 ±13	4,073 ±51	0 ±0	0 ±0	0 ±0	9,558 ±162
sturgeon	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
other species*	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
Monthly Total	3,572 f199	7,482 ±244	14,014 ±585	8,326 ±474	10,274 ±308	13,258 ±416	23,111 ±379	2,211 ±122	22,695 ±283	11,598 ±433	12,788 ±282	2,430 ±9	131,759 ±3,734

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.19 Total monthly and annual catch estimates ± 95% confidence intervals from all fish observed by creel clerks on all sections of Lake Roosevelt from December, 1994 through November, 1995.

SPECIES	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
kokanee	238 ±13	1,814 ±59	8,281 ±346	1,635 ±93	5,137 ±154	4,705 ±148	3,302 ±54	912 ±48	3,921 ±65	2,647 f118	0 ±0	0 ±0	32,353 ±1,085
rainbow trout	5,700 ±303	8,660 ±365	15,291 f198	9,304 f.525	12,566 ±408	9,903 ±314	14,380 f237	2,139 ±95	17,181 ±407	13,736 ±520	14,387 ±34	2,891 ±53	125,958 ±3,978
walleye	0 ±0	227 ±7	100 ±13	640 ±24	2,462 ±124	8,953 ±292	2 1,054 ±473	27,694 il.139	3,895 f236	6,858 ±238	1,796 ±56	0 ±0	73,667 ±2,609
smallmouth bass	0 ±0	0 ±0	0 ±0	0 ±0	1,101 ±33	17,749 ±557	25,626 ±419	2,608 ±144	4,655 ±58	24,486 ±914	0 ±0	0 ±0	76,224 ±2,125
sturgeon	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	13 ±2	0 ±0	0 ±0	0 ±0	13 ± 2
other species*	0 ±0	0 ±0	8 ±1	0 ±0	36 ±2	262 ±9	0 ±0	175 ±7	27 ±5	116 ±4	0 ±0	0 ±0	624 ±28
Monthly Total	5,938 ±316	10,700 ±431	23,502 ±774	11,569 ±651	21,301 ±720	41,571 ±1,324	64,361 ±1,183	33,526 ±1,433	29,693 ±741	47,843 ±1,795	16,184 ±388	2,891 ±53	309,079 ±9,841

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.20 Monthly and annual catch estimates ± 95% confidence intervals for all fish species surveyed in Section 1 of Lake Roosevelt from December, 1994 through November, 1995.

SPECIES	DEC	JAN	FED	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
kokanee	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	175 ±7	0 ±0	0 ±0	0 ±0	0 ±0	175 ±7
rainbow trout	148 ±6	134 ±12	17 ±2	138 ±5	327 ±19	524 ±18	73 ±2	1,572 ±64	363 ±62	814 ±28	197 ±8	304 ±30	4,609 ±255
walleye	0 ±0	0 ±0	100 ±13	481 ±16	1,816 ±103	7,161 ±241	14,030 f366	26,900 ± 1,095	861 ±147	6,858 f238	394 ±15	0 ±0	58,602 ±2,234
smallmouth bass	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
sturgeon	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	13 ±2	0 ±0	0 ±0	0 ±0	13 ±2
other species*	0 ±0	0 ±0	8 ±1	0 ±0	36 ±2	262 ±9	0 ±0	175 ±7	27 ±5	116 ±4	0 ±0	0 ±0	624 ±28
Monthly Total	148 ±6	134 ±12	125 ±16	619 ±21	2,179 f123	7,947 ±267	14,103 ±368	28,821 ±1,173	1,265 ±215	7,788 f271	592 ±23	304 ±30	64,024 ±2,526

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.21 Monthly and annual catch estimates ± 95% confidence intervals for all fish species surveyed in Section 2 of Lake Roosevelt from December, 1994 through November, 1995.

SPECIES	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
kokanee	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	429 ±22	2,647 ±118	0 ±0	0 ±0	3,076 ±140
rainbow trout	2,218 ±111	3,084 ±175	9,363 f173	2,327 ±139	7,102 ±235	1,894 ±61	0 ±0	0 ±0	3,434 f178	1,324 ±59	1,402 ±41	157 ±14	32,305 ±1,186
walleye	0 ±0	0 ±0	0 ±0	0 ±0	646 ±21	1,578 ±51	4,089 ±59	0 ±0	1,288 ±67	0 ±0	1,402 ±41	0 ±0	9,002 f239
smallmouth bass	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	681 ±10	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	681 ±10
sturgeon	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
other species*	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
Monthly Total	2,218 ±111	3,084 ±175	9,363 f173	2,327 ±139	7,748 ±256	3,472 ±112	4,770 ±69	0 ±0	5,151 ±266	3,971 ±176	2,804 ±83	157 ±14	45,065 ±1,575

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table A.22 Monthly and annual catch estimates ± 95% confidence intervals for all fish species surveyed in Section 3 of Lake Roosevelt from December, 1994 through November, 1995.

SPECIES	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
kokanee	238 ±13	1,814 ±59	8,281 f346	1,635 ±93	5,137 ±154	4,705 ±148	3,302 ±54	737 ±41	3,492 ±43	0 ±0	0 ±0	0 ±0	29,102 f938
rainbow trout	3,334 ±186	5,442 ±178	5,733 f239	6,839 ±389	5,137 ±0154	7,485 ±235	14,307 ±235	567 ±31	13,384 ±167	I 1,598 ±433	12,788 ±282	2,430 ±9	89,044 ±2,537
walleye	0 ±0	227 ±7	0 ±0	149 ±8	0 ±0	214 ±7	2,568 ±42	794 ±44	1,746 ±22	0 ±0	0 ±0	0 ±0	6,063 ±136
smallmouth bass	0 ±0	0 ±0	0 ±0	0 ±0	1,101 ±33	17,749 ±557	24,945 ±409	2,608 ±144	4,655 ±58	24,486 ±914	0 ±0	0 ±0	75,543 ±2,115
sturgeon	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
other species*	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
Monthly Total	3,572 f199	7,482 ±244	14,014 ±585	8,623 ±491	11,374 ±341	30,152 ±945	45,488 ±746	4,705 ±260	23,277 f290	36,084 ±1,348	12,788 ±282	2,430 ±9	199,990 ±5,740

*Includes yellow perch, largemouth bass, suckers, squawfish, black crappie, chinook, bullhead, etc...

Table B.l Annual electrofishing results for 1995 split by month including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).

	May			July			October			Total		
Effort (hrs)	35.4			24.5			58.0			117.9		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	*0*	*0*	*0.00*	83	2	1.43	83	<1	0.70
brook trout	2	<1	0.06	0	0	*0.00*	19	<1	0.33	21	<1	0.18
brown bullhead	4	<1	0.11	2	<1	0.08	0	0	0.00	6	<1	0.05
brown trout	0	0	0.00	10	<1	0.41	27	<1	0.47	37	<1	0.31
bull trout	0	0	0.00	0	0	0.00	1	0	0.02	1	<1	0.01
burbot	0	0	0.00	15	<1	0.61	16	<1	0.28	31	<1	0.26
carp	126	4	3.56	49	2	2.00	31	<1	0.53	206	2	1.75
chinook salmon	0	<1	0.00	0	<1	0.00	2	<1	0.03	2	<1	0.02
Cottus spp.	181	6	5.11	84	4	3.43	293	8	5.05	558	6	4.73
crappie	9	<1	0.25	0	0	0.00	1	<1	0.02	10	<1	0.08
kokanee salmon	95	3	2.68	82	4	3.35	1,829	48	31.53	2,006	22	17.01
lake whitefish	31	1	0.88	0	0	0.00	9	<1	0.16	40	<1	0.34
largescale sucker	1,046	36	29.55	1,057	47	43.14	577	15	9.95	2,680	30	22.73
longnose sucker	12	<1	0.34	1	<1	0.04	12	<1	0.21	25	<1	0.21
mountain whitefish	4	<1	0.11	1	<1	0.04	5	<1	0.09	10	<1	0.08
rainbow trout	144	5	4.07	110	5	4.49	204	5	3.52	458	5	3.88
redside shiner	1	<1	0.03	0	0	0.00	0	0	0.00	1	<1	0.01
smallmouth bass	506	17	14.29	416	18	16.98	17	<1	0.29	939	10	7.96
squawfish	113	4	3.19	72	3	2.94	28	<1	0.48	213	2	1.81
Catostomus spp.	0	0	0.00	0	0	0.00	6	<1	0.10	6	<1	0.05
walleye	557	19	15.73	275	12	11.22	198	5	3.41	1,030	11	8.74
yellow perch	93	3	2.63	97	4	3.96	453	12	7.81	643	7	5.45
Totals	**2,938**		**82.99**	**2,271**		**92.69**	**3,811**		**65.71**	**9,006**		**76.39**

Table B.2 May electrofishing results for 1995 split by location including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).

	Kettle Falls			Gifford			Hunters			Porcupine Bay		
Effort (hrs)		2.2			5.2			3.6			4.1	
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brook trout	0	0	0.00	0	0	0.00	1	<1	0.28	1	<1	0.25
brown bullhead	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	0	0	0.00	0	0	0.00	0	0	0.00	2	<1	0.49
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
carp	1	<1	0.45	4	3	0.77	7	6	1.94	6	3	1.48
chinook salmon	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
Cottus spp.	2	3	0.90	1	<1	0.19	1	<1	0.28	5	3	1.23
crappie	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
lake whitefish	7	10	3.13	1	<1	0.19	3	3	0.83	0	0	0.00
largescale sucker	6	9	2.69	22	15	4.22	9	8	2.49	5	3	1.23
longnose sucker	1	<1	0.45	4	3	0.77	0	0	0.00	0	0	0.00
mountain whitefish	0	0	0.00	2	<1	0.38	1	<1	0.28	0	0	0.00
rainbow trout	4	6	1.79	12	8	2.30	3	3	0.83	4	2	0.98
redside shiner	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
smallmouth bass	0	0	0.00	2	<1	0.38	1	<1	0.28	40	20	9.84
squawfish	2	3	0.90	16	11	3.07	1	<1	0.28	3	2	0.74
Catostomus spp.	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	44	66	19.70	75	52	14.38	76	65	21.01	87	44	21.39
yellow perch	0	0	0.00	4	3	0.77	14	12	3.87	44	22	10.82
TOTALS	67		30.00	143		27.41	117		32.35	197		48.44

Table B.2 Continued.

	Little Falls			Seven Bays			Keller Ferry			Sanpoil		
Effort (hrs)	3.5			3.8			2.4			3.8		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brook trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown bullhead	1	<1	0.29	0	0	0.00	2	2	0.83	0	0	0.00
brown trout	12	8	3.48	0	0	0.00	0	0	0.00	0	0	0.00
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
carp	0	0	0.00	1	<1	0.27	1	<1	0.41	15	15	3.95
chinook salmon	0	0	0.00	1	<1	0.27	0	0	0.00	0	0	0.00
Cottus spp.	4	3	1.16	4	4	1.07	0	0	0.00	0	0	0.00
crappie	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	92	58	26.67	1	<1	0.27	0	0	0.00	0	0	0.00
lake whitefish	0	0	0.00	12	13	3.20	0	0	0.00	0	0	0.00
largescale sucker	8	5	2.32	0	0	0.00	2	2	0.83	7	7	1.84
longnose sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
mountain whitefish	1	<1	0.29	0	0	0.00	0	0	0.00	0	0	0.00
rainbow	1	c1	0.29	4	4	1.07	17	20	7.03	28	27	7.37
redside shiner	0	0	0.00	0	0	0.00	0	0	0.00	1	<1	0.26
smallmouth bass	6	4	1.74	18	19	4.80	51	59	21.10	29	28	7.63
squawfish	1	<1	0.29	2	2	0.53	2	2	0.83	7	7	1.84
Catostomus spp.	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	33	21	9.57	49	52	13.07	11	13	4.55	16	16	4.21
yellow perch	0	0	0.00	1	<1	0.27	0	0	0.00	0	0	0.00
TOTALS	**159**		46.09	94		25.07	86		35.59	103		**27.11**

Table B.2 Continued.

	Spring Canyon		
Effort (hrs)		6.8	
Species	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00
brook trout	0	0	0.00
brown bullhead	1	<1	0.15
brown trout	0	0	0.00
bull trout	0	0	0.00
burbot	0	0	0.00
carp	13	5	1.91
chinook salmon	0	0	0.00
Cottus spp.	3	<1	0.44
crappie	0	0	0.00
kokanee salmon	2	<1	0.29
lake whitefish	0	0	0.00
largescale sucker	9	4	1.32
longnose sucker	0	0	0.00
mountain whitefish	0	0	0.00
rainbow	44	18	6.47
redside shiner	0	0	0.00
smallmouth bass	137	55	20.15
squawfish	1	0	0.15
Catostomus spp.	0	0	0.00
walleye	37	15	5.44
yellow perch	2	<1	0.29
TOTALS	249		36.62

Table B.3 July electrofishing results for 1995 split by location including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).

	Kettle Falls			Gifford			Hunters			Porcupine Bay		
Effort (hrs)		2.3			3.0			3.0			2.8	
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brook trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown bullhead	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	1	2	0.43	0	0	0.00	0	0	0.00	0	0	0.00
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	2	4	0.86	3	7	0.99	2	3	0.67	0	0	0.00
carp	0	0	0.00	3	7	0.99	4	5	1.35	1	<1	0.35
chinook salmon	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
Cottus spp.	0	0	0.00	3	7	0.99	0	0	0.00	0	0	0.00
crappie	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	10	18	4.29	0	0	0.00	0	0	0.00	0	0	0.00
lake whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
largescale sucker	0	0	0.00	6	15	1.99	7	9	2.36	6	7	2.12
longnose sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
mountain whitefish	0	0	0.00	1	2	0.33	0	0	0.00	0	0	0.00
rainbow trout	1	2	0.43	2	5	0.66	3	4	1.01	6	7	2.12
redside shiner	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
smallmouth bass	3	5	1.29	5	12	1.66	3	4	1.01	22	27	7.76
squawfish	8	14	3.43	2	5	0.66	0	0	0.00	0	0	0.00
Catostomus spp.	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	30	53	12.86	15	37	4.97	35	47	11.80	30	37	10.59
yellow perch	2	4	0.86	1	2	0.33	21	28	7.08	16	20	5.65
TOTALS	57		24.43	41		13.59	75		25.28	81		28.59

Table B.3 Continued.

	Little Falls			Seven Bays			Keller Ferry			Sanpoil R.		
Effort (hrs)	2.5			2.8			2			4.2		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	No.	%	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	**0.00**
brook trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	**0.00**
brown bullhead	0	0	0.00	0	0	0.00	1	2	0.50	0	0	**0.00**
brown trout	9	17	3.67	0	0	0.00	0	0	0.00	0	0	**0.00**
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	**0.00**
burbot	0	0	0.00	0	0	0.00	0	0	0.00	2	<1	0.48
carp	0	0	0.00	4	3	1.41	0	0	0.00	1	<1	0.24
chinook salmon	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
Cottus spp.	1	2	0.41	1	<1	0.35	0	0	0.00	0	0	0.00
crappie	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	11	21	4.49	0	0	0.00	0	0	0.00	0	0	0.00
lake whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
largescale sucker	8	15	3.27	5	4	1.76	4	6	2.00	9	7	2.15
longnose sucker	1	2	0.41	0	0	0.00	0	0	0.00	0	0	0.00
mountain whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
rainbow trout	4	8	1.63	35	27	12.35	3	5	1.50	28	20	6.69
redside shiner	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
smallmouth bass	7	13	2.86	39	30	13.76	26	42	13.00	48	35	11.47
squawfish	0	0	0.00	0	0	0.00	0	0	0.00	7	5	1.67
Catostomus spp.	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	10	19	4.08	42	32	14.82	28	45	14.00	30	22	7.17
yellow perch	1	2	0.41	6	5	2.12	0	0	0.00	12	9	2.87
TOTALS	**52**		**21.22**	**132**		**46.59**	**62**		**31.00**	**137**		**32.75**

Table B.3 Continued.

	Spring Canyon		
Effort (hrs)		1.9	
Species	No.	%	CPUE
bridgelip sucker	0	0	0.00
brook trout	0	0	0.00
brown bullhead	0	0	0.00
brown trout	0	0	0.00
bull trout	0	0	0.00
burbot	0	0	0.00
carp	5	7	2.68
chinook salmon	0	0	0.00
Cottus spp.	0	0	0.00
crappie	0	0	0.00
kokanee salmon	0	0	0.00
lake whitefish	0	0	0.00
largescale sucker	4	6	2.14
longnose sucker	0	0	0.00
mountain whitefish	0	0	0.00
rainbow trout	3	4	1.61
redside shiner	0	0	0.00
smallmouth bass	47	70	25.18
squawfish	1	<1	0.54
Catostomus spp.	0	0	0.00
walleye	6	9	3.21
yellow perch	1	<1	0.54
TOTALS	67		35.89

Table B.4 **October electrofishing results for 1995 split by location including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).**

	Kettle Falls			Gifford			Hunters			Porcupine Bay		
Effort (hrs)		6.0			4.4			4.3			4.8	
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	2	1	0.47	5	4	1.05
brook trout	0	0	0.00	9	9	2.04	6	4	1.41	1	c l	0.21
brown bullhead	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	2	c l	0.33	0	0	0.00	0	0	0.00	1	<1	0.21
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	1	<1	0.21
burbot	0	0	0.00	4	4	0.91	2	1	0.47	2	1	0.42
carp	0	0	0.00	0	0	0.00	1	c l	0.24	1	<1	0.21
chinook salmon	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
Cottus spp.	0	0	0.00	0	0	0.00	2	1	0.47	0	0	0.00
crappie	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	583	88	96.90	21	21	4.75	104	69	24.47	88	62	18.40
lake whitefish	2	<1	0.33	0	0	0.00	1	c l	0.24	1	<1	0.21
largescale sucker	15	2	2.49	9	9	2.04	5	3	1.18	6	4	1.25
longnose sucker	0	0	0.00	1	1	0.23	0	0	0.00	1	<1	0.21
mountain whitefish	2	<1	0.33	0	0	0.00	0	0	0.00	0	0	0.00
rainbow	4	<1	0.66	5	5	1.13	9	6	2.12	3	2	0.63
redside shiner	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
smallmouth bass	2	<1	0.33	1	1	0.23	1	<1	0.24	2	1	0.42
squawfish	3	<1	0.50	2	2	0.45	1	<1	0.24	2	1	0.42
Catostomus spp.	0	0	0.00		0	0.00	0	0	0.00	0	0	0.00
walleye	32	5	5.32	18	18	4.08	12	8	2.82	22	16	4.60
yellow perch	8	1	1.33	30	30	6.79	4	3	0.94	6	4	1.25
TOTALS	660		109.70	**100**		**18.57**	**150**		35.29	142		29.69

Table B.4 Continued.

	Little Falls			Seven Bays			Keller Ferry			Sanpoil R.		
Effort (hrs)	24.5			8.2			2.1			1.9		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	2	<1	0.24	1	4	0.48	1	1	0.53
brook trout	0	0	0.00	2	c1	0.24	0	0	0.00	0	0	0.00
brown bullhead	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	16	4	0.65	3	<1	0.37	0	0	0.00	0	0	0.00
bull trout	0	0	0.00	1	<1	0.12	0	0	0.00	0	0	0.00
burbot	0	0	0.00	11	3	1.34	4	17	1.90	2	3	1.05
carp	1	<1	0.04	4	1	0.49	0	0	0.00	0	0	0.00
chinook salmon	2	<1	0.08	0	0	0.00	0	0	0.00	0	0	0.00
Cottus spp.	0	0	0.00	3	<1	0.37	0	0	0.00	0	0	0.00
crappie	1	<1	0.04	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	243	65	9.92	322	81	39.35	0	0	0.00	29	37	15.26
lake whitefish	2	<1	0.08	2	<1	0.24	0	0	0.00	1	1	0.53
largescale sucker	12	3	0.49	3	<1	0.37	0	0	0.00	0	0	0.00
longnose sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
mountain whitefish	1	<1	0.04	0	0	0.00	0	0	0.00	2	3	1.05
rainbow	29	9	1.18	34	9	4.15	9	39	4.29	41	52	21.58
redside shiner	4	1	0.16	0	0	0.00	0	0	0.00	0	0	0.00
smallmouth bass	0	0	0.00	1	<1	0.12	1	4	0.48	1	1	0.53
squawfish	4	1	0.16	1	<1	0.12	0	0	0.00	0	0	0.00
Catostomus spp.	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	51	14	2.08	6	2	0.73	6	26	2.86	1	1	0.53
yellow perch	7	2	0.29	3	<1	0.37	2	9	0.95	1	1	0.53
TOTALS	373		15.22	398		48.64	23		10.95	79		41.58

Table B.4 Continued.

	Spring Canyon		
Effort (hrs)	**1.1**		
Species	**No.**	**%**	**CPUE**
bridgelip sucker	2	29	1.82
brook trout	0	*0*	*0.00*
brown bullhead	*0*	*0*	*0.00*
brown trout	*0*	*0*	*0.00*
bull trout	*0*	*0*	*0.00*
burbot	*0*	*0*	*0.00*
carp	*0*	*0*	*0.00*
chinook salmon	*0*	*0*	*0.00*
Cottus spp.	*0*	*0*	*0.00*
crappie	*0*	*0*	*0.00*
kokanee salmon	1	14	0.91
lake whitefish	0	0	0.00
largescale sucker	0	0	0.00
longnose sucker	0	0	0.00
mountain whitefish	0	0	0.00
rainbow	3	43	2.73
redside shiner	0	0	0.00
smallmouth bass	0	0	0.00
squawfish	0	0	0.00
Catostomus spp.	0	0	0.00
walleye	0	0	0.00
yellow perch	1	14	0.91
TOTALS	7		6.36

Table B.5. **Annual gillnet set results for 1995 split by sampling period including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).**

	May			July			October			Total		
Effort (min)	704			730			547			1,981		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	33	9	0.05	33	3	0.05
brown trout	0	0	0.00	1	<1	0.00	0	0	0.00	1	c l	co.01
burbot	20	8	0.03	12	3	0.02	14	4	0.02	46	4	0.07
carp	11	4	0.02	0	0	0.00	9	2	0.01	20	2	0.03
kokanee salmon	5	2	0.01	33	8	0.05	9	2	0.01	47	5	0.07
lake whitefish	131	51	0.19	223	55	0.32	128	34	0.18	482	46	0.68
largescale sucker	20	8	0.03	5	1	0.01	16	4	0.02	41	4	0.06
longnose sucker	4	2	0.01	14	3	0.02	1	<1	0.00	19	2	0.03
mountain whitefish	0	0	0.00	1	<1	0.00	0	0	0.00	1	<1	co.01
rainbow trout	4	2	0.01	39	10	0.06	1	<1	0.00	44	4	0.06
smallmouth bass	2	<1	0.00	2	<1	0.00	26	7	0.04	30	3	0.04
squawfish	5	2	0.01	5	1	0.01	10	3	0.01	20	2	0.03
tench	1	<1	0.00	0	0	0.00	0	0	0.00	1	c l	<0.01
walleye	48	19	0.07	52	13	0.07	82	22	0.12	182	18	0.26
yellow perch	7	3	0.01	19	5	0.03	45	12	0.06	71	7	0.10
TOTALS	**258**		**0.37**	**406**		**0.58**	**374**		**0.53**	**1038**		**1.47**

Table B.6 May gillnet results for 1995 split by location including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).

	Kettle Falls			Gifford			Hunters			Porcupine Bay		
Effort (hrs)	72			192			15.8			47.1		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	3	13	0.04	3	4	0.02	0	0	0.00	1	4	0.02
carp	1	4	0.01	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
lake whitefish	14	61	0.19	40	53	0.21	34	81	2.15	8	30	0.17
largescale sucker	0	0	0.00	15	20	0.08	2	5	0.13	1	4	0.02
longnose sucker	1	4	0.01	1	1	0.01	1	2	0.06	0	0	0.00
mountain whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
rainbow trout	1	4	0.01	0	0	0.00	0	0	0.00	0	0	0.00
smallmouth bass	0	0	0.00	0	0	0.00	0	0	0.00	1	4	0.02
squawfish	1	4	0.01	1	1	0.01	1	2	0.06	0	0	0.00
tench	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	2	9	0.03	15	20	0.08	3	7	0.19	15	56	0.32
yellow perch	0	0	0.00	0	. 0	0.00	1	2	0.06	1	4	0.02
TOTALS	23		0.32	75		0.39	42		2.66	27		0.57

Table B.6 Continued.

	Seven Bays			Keller Ferry			Sanpoil R.			Spring Canyon		
Effort (hrs)	**190.6**			52.9			54.2			79.6		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	5	17	0.03	0	0	0.00	6	12	0.11	2	29	0.03
carp	0	0	0.00	0	0	0.00	10	19	0.18	0	0	0.00
kokanee salmon	2	7	0.01	0	0	0.00	0	0	0.00	3	43	0.04
lake whitefish	15	50	0.08	1	50	0.02	19	37	0.35	0	0	0.00
largescale sucker	0	0	0.00	0	0	0.00	0	0	0.00	2	29	0.03
longnose sucker	1	3	0.01	0	0	0.00	0	0	0.00	0	0	0.00
mountain whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
rainbow trout	0	0	0.00	1	50	0.02	2	4	0.04	0	0	0.00
smallmouth bass	0	0	0.00	0	0	0.00	1	2	0.02	0	0	0.00
squawfish	2	7	0.01	0	0	0.00	0	0	0.00	0	0	0.00
tench	0	0	0.00	0	0	0.00	1	2	0.02	0	0	0.00
walleye	5	17	0.03	0	0	0.00	8	15	0.15	0	0	0.00
yellow perch	0	0	0.00	0	0	0.00	5	10	0.09	0	0	0.00
TOTALS	30		0.16	2		0.04	52		0.96	7		009 .

Table B.7 July gillnet results for 1995 split by location including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).

	Kettle Falls			Cifford			Hunters			Porcupine Bay		
Effort (hrs)		94			119			79			78	
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	0	0	0.00	0	0	0.00	0	0	0.00	1	2	0.01
burbot	2	3	0.02	3	4	0.03	4	6	0.05	1	2	0.01
carp	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	15	26	0.16	2	3	0.02	0	0	0.00	2	3	0.03
lake whitefish	24	41	0.26	52	77	0.44	53	76	0.68	42	72	0.54
largescale sucker	4	7	0.04	2	3	0.02	0	0	0.00	2	3	0.03
longnose sucker	2	3	0.02	2	3	0.02	0	0	0.00	0	0	0.00
mountain whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
rainbow trout	0	0	0.00	0	0	0.00	1	1	0.01	2	3	0.03
smallmouth bass	1	2	0.01	0	0	0.00	0	0	0.00	0	0	0.00
squawfish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
tench	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	8	14	0.09	6	9	0.05	4	6	0.05	8	14	0.10
yellow perch	2	3	0.02	1	2	0.01	8	11	0.10	0	0	0.00
TOTALS	58		0.62	68		0.57	70		0.89	58		0.74

Table B.7 Continued.

	Seven Bays			Keller Ferry			Sanpoil			Spring Canyon		
Effort (hrs)	104			57			65			134		
Species	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
brown trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	2	4	0.02	2	4	0.04	0	0	0.00	0	0	0.00
carp	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
kokanee salmon	0	0	0.00	0	0	0.00	0	0	0.00	13	38	0.10
lake whitefish	35	65	0.34	35	65	0.62	6	13	0.09	1	3	0.01
largescale sucker	0	0	0.00	0	0	0.00	5	10	0.08	0	0	0.00
longnose sucker	0	0	0.00	0	0	0.00	1	2	0.02	0	0	0.00
mountain whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
rainbow trout	7	13	0.07	7	13	0.12	11	23	0.17	18	53	0.13
smallmouth bass	0	0	0.00	0	0	0.00	0	0	0.00	1	3	0.01
squawfish	3	6	0.03	3	6	0.05	1	2	0.02	0	0	0.00
tench	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	6	11	0.06	6	11	0.11	17	35	0.26	1	3	0.01
yellow perch	1	2	0.01	1	2	0.02	7	15	0.11	0	0	0.00
TOTALS	54		0.52	54		0.95	48		0.74	34		0.25

Table B.8 October gillnet results for 1995 split by location including number of fish collected (No.), relative abundance (%) and catch per unit effort (CPUE) based on time (hrs).

	Kettle Falls			Gifford			Hunters			Porcupine Bay		
Effort (hrs)		76			99			69			52	
Species	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE
bridgelip sucker	0	0	0.00	0	0	0.00	0	0	0.00	31	48	0.60
brown trout	0	0	0.00	0	0	0.00	2	3	0.03	0	0	0.00
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	3	5	0.04	2	4	0.02	0	0	0.00	1	2	0.02
carp	0	0	0.00	0	0	0.00	0	0	0.00	2	3	0.04
kokanee salmon	1	2	0.01	6	12	0.06	0	0	0.00	0	0	0.00
lake whitefish	49	79	0.64	14	27	0.14	12	20	0.17	22	34	0.42
largescale sucker	2	3	0.03	2	4	0.02	11	19	0.16	0	0	0.00
longnose sucker	0	0	0.00	1	2	0.01	0	0	0.00	0	0	0.00
mountain whitefish		0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
rainbow trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
smallmouth bass	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
squawfish	2	3	0.03	5	10	0.05	0	0	0.00	0	0	0.00
tench	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	5	8	0.07	12	23	0.12	23	39	0.33	8	13	0.15
yellow perch	0	0	0.00	10	19	0.10	11	19	0.16	0	0	0.00
TOTALS	62		0.81	52		0.53	59		**0.85**	**64**		**1.23**

Table B.8 Continued.

	Seven Bays			Keller Ferry			Sanpoil R.			Spring Canyon		
Effort (hrs)	59			56			82			55		
Species	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**	**No.**	**%**	**CPUE**
bridgelip sucker	0	0	0.00	1	4	0.02	0	0	0.00	1	14	0.02
brown trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
bull trout	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
burbot	5	16	0.09	1	4	0.02	2	3	0.02	0	0	0.00
carp	2	7	0.03	1	4	0.02	3	4	0.04	1	14	0.02
kokanee salmon	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
lake whitefish	21	68	0.36	1	4	0.02	12	16	0.15	0	0	0.00
largescale sucker	0	0	0.00	0	0	0.00	1	1	0.01	0	0	0.00
longnose sucker	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
mountain whitefish	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
rainbow trout	0	0	0.00	0	0	0.00	1	1	0.01	0	0	0.00
smallmouth bass	0	0	0.00	14	50	0.25	8	11	0.10	4	57	0.07
squawfish	0	0	0.00	1	4	0.02	2	3	0.02	0	0	0.00
tench	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
walleye	2	7	0.03	9	32	0.16	22	30	0.27	1	14	0.02
yellow perch	1	3’	0.02	0	0	0.00	23	31	0.28	0	0	0.00
TOTALS	31		0.53	28		0.50	74		0.91	7		0.13

APPENDIX C

Feeding Habits

Table C.1 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for all kokanee (n = 50) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Unidentified fish	0.00	8.71	2.00	3.06
Cladocera				
Daphnia spp.	97.41	80.33	68.00	70.21
Eucopepoda				
L. Ashlandi	0.14	0.03	2.00	0.62
Copepoda	0.02	0.05	2.00	0.59
Diptera				
Chironimade pupa	2.25	9.59	34.00	13.10
Chironomidae larvae	0.10	0.48	18.00	5.31
Simuliidae larvae	0.01	0.00	2.00	0.57
Trichoptera				
Hydrop yschidae	0.00	0.22	2.00	0.64
Hemiptera				
Corixidae	0.00	0.02	2.00	0.58
Terrestrial				
Insects	0.07	0.57	18.00	5.33

Table C.2 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **1+** year old kokanee (n = 2) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Cladocera				
Daphnia spp.	63.16	16.67	50.00	43.27
Diptera				
Chironimade pupa	36.84	83.33	50.00	56.73

Table C.3 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for 2+ year old kokanee (n = 22) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Cladocera				
Daphnia spp.	69.61	21.89	31.82	30.48
Eucopepoda				
L. Ashland	1.65	0.19	4.55	1.58
Copepoda	0.27	0.37	4.55	1.28
Diptera				
Chironimade pupa	26.24	68.18	68.18	40.19
Chironomidae larvae	1.20	3.45	40.91	11.26
Simuliidae larvae	0.09	0.03	4.55	1.15
Trichoptera				
Hydropyschidae	0.04	1.62	4.55	1.54
Hemiptera				
Corixidae	0.04	0.13	4.55	1.17
Terrestrial				
Insects	0.85	4.14	40.91	11.35

Table C.4 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for 3+ year old kokanee (n = 26) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Unidentified fish	0.00	10.12	3.85	4.54
Cladocera				
Daphnia spp.	99.98	89.85	100.00	94.19
Diptera				
Chironimade pupa	0.02	0.03	3.85	1.26

Table C.5 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for all rainbow trout (**n** = 90) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Cyprinidae	0.11	6.62	2.22	2.30
Percidae	0.87	51.81	1.11	13.83
Unidentified fish	0.02	27.50	2.22	7.65
Fish eggs	2.18	0.34	1.11	0.93
Cladocera				
L. kindtii	2.43	0.19	4.44	1.82
Daphnia spp.	85.39	3.96	53.33	36.69
Eucopepoda				
E. nevadensis	0.01	*0.00*	1.11	0.29
L. ashlandi	0.01	*0.00*	1.11	0.29
Basommatophora				
Planorbidae	0.01	0.02	1.11	0.29
Physidae	0.01	0.88	1.11	0.51
Diptera				
Chironomidae pupa	6.20	1.70	33.33	10.60
Chironomidae larvae	0.28	0.07	16.67	4.37
Sciomyzidae	0.01	0.02	1.11	0.29
Trichoptera				
Hydropyschidae	0.01	*0.00*	1.11	0.29
Hydroptilidae	0.02	0.10	2.22	0.60
Lepidostomatidae	0.01	0.01	2.22	0.58
Hemiptera				
Corixidae	0.17	0.09	6.67	1.78
Plecoptera				
Nemouridae	*0.01*	0.01	1.11	0.29
Perlodidae	0.01	0.02	1.11	0.29
Ephemeroptera				
Baetidae	0.02	*0.00*	1.11	0.29
Leptophlebiidae	0.35	0.10	2.22	0.69
Odonata				
Anisoptera	0.04	0.02	4.44	1.16
Zygoptera	0.11	0.05	1.11	0.33
Coleoptera				
Elmidae	0.01	0.02	1.11	0.29
Oligochaeta				
Lumbriculidae	0.05	3.03	5.56	2.22
Hydrachnellae				
Hydracharina	0.07	0.01	3.33	0.88
Terrestrial				
Insects	1.59	3.39	34.44	10.14
Other	0.03	0.03	1.11	0.30

Table C.6 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for 0+ year old rainbow trout (n = 5) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Cladocera				
Daphnia spp.	68.73	27.95	40.00	24.41
Diptera				
Chironomidae pupa	7.75	3.84	60.00	12.78
Chironomidae larvae	0.52	0.17	40.00	7.27
Trichoptera				
Lepidostomatidae	0.26	0.11	20.00	3.64
Hemiptera				
Corixidae	1.55	3.84	40.00	8.11
Ephemeroptera				
Baetidae	0.78	0.40	20.00	3.78
Leptophlebiidae	12.66	10.78	20.00	7.76
Odonata				
Anisoptera	0.78	1.64	40.00	7.57
Terrestrial				
Insects	6.98	51.27	80.00	24.69

Table C.7 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for 1+ year old rainbow trout (n = 31) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Cyprinidae	0.23	45.85	3.23	13.06
Cladocera				
Daphnia spp.	84.90	16.83	51.61	40.63
Eucopepoda				
E. nevadensis	0.03	0.02	3.23	0.87
L. ashlandi	0.03	0.02	3.23	0.87
Basommatophora				
Planorbidae	0.01	0.21	3.23	0.91
Diptera				
Chironomidae Pupa	11.80	16.00	29.03	15.06
Chironornidae larvae	0.34	0.40	22.58	6.18
Trichoptera				
Lepidostomatidae	0.01	0.09	3.23	0.88
Hemiptera				
Corixidae	0.27	0.63	6.45	1.95
Odonata				
Anisoptera	0.01	0.06	3.23	0.87
Zygoptera	0.24	0.56	3.23	1.07
Coleoptera				
Elmidae	0.01	0.21	3.23	0.91
Oligochaeta				
Lumbriculidae	0.01	7.11	3.23	2.74
Hydrachnellae				
Hydracharina	0.01	0.03	3.23	0.87
Terrestrial				
Insects	2.09	11.99	35.48	13.13

Table **C.8** Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **2+** year old rainbow trout (n = 21) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Fish eggs	10.78	16.28	4.76	9.03
Cladocera				
L. kindtii	7.19	5.64	9.52	6.34
Daphnia spp .	80.23	45.42	71.43	55.93
Diptera				
Chironomidae pupa	0.39	1.59	23.81	7.32
Chironomidae larvae	0.12	0.19	9.52	2.79
Hydrachnellae				
Hydracharina	0.27	0.19	4.76	1.48
Terrestrial				
Insects	1.02	30.70	28.57	17.11

Table C.9 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **3+** year old rainbow trout (n = 24) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Percidae	2.99	61.84	4.17	16.56
Unidentified fish	0.04	32.51	4.17	8.81
Cladocera				
L. kindtii	1.53	0.05	4.17	1.38
Daphnia spp.	91.98	1.26	50.00	34.38
Diptera				
Chironomidae pupa	1.72	0.12	37.50	9.44
Chironomidae larvae	0.29	0.03	16.67	4.08
Sciomyzidae	0.02	0.02	4.17	1.01
Trichoptera				
Hydropyschidae	0.02	0.00	4.17	1.01
Hydroptilidae	0.06	0.12	8.33	2.04
Hemiptera				
Corixidae	0.04	0.01	8.33	2.01
Plecoptera				
Nemouridae	0.02	0.01	4.17	1.01
Perlodidae	0.02	0.02	4.17	1.01
Ephemeroptera				
Leptophlebiidae	0.17	0.02	4.17	1.05
Odonata				
Anisoptera	0.04	0.00	4.17	1.01
Oligochaeta				
Lurnbriculidae	0.15	2.81	16.67	4.71
Hydrachnellae				
Hydracharina	0.02	0.00	4.17	1.01
Terrestrial				
Insects	0.77	1.12	33.33	8.46
Other	0.10	0.04	4.17	1.03

Table **C.10** Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **4+** year old rainbow trout (n = 9) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Cyprinidae				
Unidentified fish	0.22 0.44	57.89 6.86	11.11 11.11	20.10 5.35
Cladocera				
L. kindti	19.47	0.89	11.11	9.14
Daphnia spp.	76.11	3.95	33.33	32.92
Basommatophora				
Physidae	0.44	22.57	11.11	9.91
Diptera				
Chironomidae pupa	1.77	0.37	44.44	13.53
Terrestrial				
Insects	1.55	7.46	22.22	9.07

Table C.ll Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for all walleye (n = 153) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Catostomidae	0.38	1.46	1.96	1.17
Cottidae	10.12	14.58	26.14	15.62
Cyprinidae	2.58	4.61	5.88	4.02
Percidae	10.22	25.53	17.65	16.40
Salmonidae	0.67	31.85	3.92	11.19
Unidentified fish	7.45	19.67	34.64	18.98
Amphipoda				
Gammeras	0.57	0.00	0.65	0.38
Cladocera				
L. kindtii	30.95	0.02	3.92	10.72
Daphnia spp.	10.03	0.01	4.58	4.49
Eucopepoda				
L..ashlandi	2.39	0.00	0.65	0.94
Decapoda				
Astacidae	0.10	0.45	0.65	0.37
Diptera				
Chironomidae pupa	13.56	0.06	9.15	7.00
Chironomidae larvae	1.91	0.01	3.92	1.79
Hemiptera				
Corixidae	0.19	0.01	0.65	0.26
Plecoptera				
Perlodidae	0.10	0.00	0.65	0.23
Ephemeroptera				
Leptophlebiidae	0.10	0.00	0.65	0.23
Odonata				
Anisoptera	0.19	0.05	1.31	0.48
Zygoptera	0.19	0.00	1.31	0.46
Oligochaeta				
Lumbriculidae	0.67	1.12	1.96	1.15
Terrestrial				
Insects	7.55	0.04	4.58	3.74
Other	0.10	0.53	0.65	0.39

Table C.12 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for 0+ year old walleye (n = 8) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Cotticlae	7.14	99.76	37.50	42.79
Unidentified fish	2.38	0.01	12.50	4.41
Cladocera				
Daphnia spp.	14.29	0.06	25.00	11.66
Eucopepoda				
L..ashlandi	59.52	0.11	12.50	21.37
Diptera				
Chironomidae pupa	14.29	0.04	37.50	15.36
Chironomidae larvae	2.38	0.01	12.50	4.41

Table C.13 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **1+** year old walleye (n = 37) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Cottidae	0.97	28.13	31.82	16.15
Percidae	0.19	17.71	4.55	5.95
Unidentified fish	0.97	21.47	36.36	15.59
Amphipoda				
Gammeras	0.10	0.05	4.55	1.24
Cladocera				
L. kindtii	0.10	0.05	4.55	1.24
Daphnia spp.	51.40	1.91	18.18	18.95
Diptera				
Chironornidae pupa	12.37	3.10	27.27	11.33
Chironomidae larvae	32.95	6.40	18.18	15.25
Terrestrial				
Insects	0.39	0.09	13.64	3.74

Table C.14 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **2+** year old walleye (n = 42) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Catostomidae	0.87	0.24	2.38	1.06
Cottidae	30.43	31.61	35.71	29.75
Cyprinidae	0.87	1.26	4.76	2.10
Percidae	13.04	48.80	16.67	23.89
Salmonidae	0.43	7.23	2.38	3.06
Unidentified fish	6.96	7.55	33.33	14.56
Cladocera				
L. kindti	0.43	0.01	2.38	0.86
Diptera				
Chironomidae pupa	35.65	0.36	11.90	14.58
Chironomidae larvae	2.17	0.01	4.76	2.11
Plecoptera				
Perlodidae	0.43	0.01	2.38	0.86
Ephemeroptera				
Leptophlebiidae	0.43	0.00	2.38	0.86
Oligochaeta				
Lumbriculidae	0.87	2.66	2.38	1.80
Terrestrial				
Insects	7.39	0.26	7.14	4.50

Table **C.15** Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **3+** year old walleye (n = 31) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Catostomidae	0.67	5.68	3.23	3.00
Cottidae	9.33	22.76	29.03	19.14
Cyprinidae	1.33	0.36	6.45	2.55
Percidae	11.33	21.38	19.35	16.30
S almonidae	0.67	24.66	3.23	8.94
Unidentified fish	10.67	17.59	29.03	17.94
Diptera				
Chironomidae pupa	19.33	0.07	3.23	7.09
Hemiptera				
Corixidae	1.33	0.03	3.23	1.44
Odonata				
Anisoptera	0.67	0.00	3.23	1.22
Zygoptera	0.67	0.00	3.23	1.22
Oligochaeta				
Lumbriculidae	3.33	4.59	6.45	4.50
Terrestrial				
Insects	40.00	0.08	6.45	14.57
Other	0.67	2.81	3.23	2.10

Table C.16 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **4+** year old walleye (n = 21) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Cotticlae	13.33	10.59	23.81	14.12
Cyprinidae	30.00	4.89	9.52	13.14
Percidae	21.67	13.76	28.57	18.93
Salmonidae	3.33	48.82	9.52	la.24
Unidentified fish	21.67	20.25	47.62	26.48
Decapoda				
Astacidae	1.67	1.69	4.76	2.40
Diptera				
Chironomidae pupa	6.67	0.00	9.52	4.79
Odonata				
zygoptera	1.67	0.00	4.76	1.90

Table C.17 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **5+** year old walleye (n = 13) sampled in 1995.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Catostomidae	3.45	0.96	7.69	3.74
Cottidae	3.45	0.03	7.69	3.46
Cyprinidae	17.24	8.09	23.08	14.98
Percidae	31.03	31.48	15.38	24.11
Salmonidae	10.34	35.02	15.38	18.80
Unidentified fish	31.03	24.29	46.15	31.41
Odonata				
Anisoptera	3.45	0.13	7.69	3.49

Table C.18 Percentage by number, percentage by weight, frequency of occurrence and index of relative importance (IRI) of food items for **6+** year old walleye (n = 4) sampled in 1994.

PREY ITEM	% by Number	% by Weight	Frequency of Occurrence	IRI
Osteichthyes				
Unidentified fish	100.00	100.00	100.00	100.00

SECTION 3

ARTIFICIAL IMPRINTING OF JUVENILE KOKANEE SALMON *(Oncorhynchus* ***nerka*****):** IMPLICATIONS FOR OPERATING LAKE ROOSEVELT KOKANEE SALMON HATCHERIES

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Prepared by:

Mary Beth Tilson
Allan T. Scholz
Jennifer L. Miller

Upper Columbia United Tribes Fisheries Research Center
Eastern Washington University
Department of Biology
Cheney, Washington

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EXECUTIVE SUMMARY

The Lake Roosevelt Monitoring Program was designed in 1988 to evaluate the effectiveness of Lake Roosevelt reservoir kokanee salmon hatcheries which were operational in 1991 and 1992. From 1991 to 1994, most of the kokanee released into Lake Roosevelt were released as fry. Poor adult returns to egg collection and release sites prompted investigations to determine if there was a critical period for thyroxine induced olfactory imprinting in kokanee salmon. These imprinting investigations have shown that there are two critical periods for imprinting, at the alevin/swimup stage and the smolt stage. Additionally, past investigations indicated that kokanee salmon undergo smoltification and residualization similar to anadromous salmonids. Kokanee have been observed in past years emigrating out of Lake Roosevelt as far downstream as Rock Island Dam. Therefore, hatchery managers changed their release strategies from primarily fry releases to smolt releases. This improved the number of adult recoveries substantially (99% of the fish recovered were released as residualized smolts).

The objectives of the present investigation were to: (1) determine the critical period(s) for olfactory imprinting and (2) assess the best times and locations to release kokanee in order to prevent entrainment, and improve returns to creel and egg collection sites. From 1992 to 1995, coded wire tagged (CWT) fish were released as residualized smolts into Lake Roosevelt. These fish were imprinted at different life stages and were given an adipose clip and a distinctive coded wire tag. These returning adults would enable us to determine (1) the number entrained below Grand Coulee Dam, (2) the number harvested by anglers; (2) the number homing to egg collection sites, and (4) the number straying to other locations.

Results of the present investigation continued to show that kokanee can be successfully imprinted to artificial odors - morpholine and phenethyl alcohol - as juveniles from hatch to swimup and again as smolts. Fish double exposed to synthetic chemicals at alevin/swimup and smolt stages had the highest rate of homing to egg collection sites (85% of the morpholine exposed fish returned to morpholine scented streams and 88% of the phenethyl alcohol exposed fish returned to phenethyl alcohol streams). Additionally, fish exposed to synthetic chemicals were recovered in greater numbers and displayed higher homing ability to egg collection sties than fish that were not exposed to synthetic chemicals. Results also indicated that smolt releases continued to provide better adult recoveries than fry releases. Although there were approximately equal percentages of fry and smolts released (42% and 58% respectively) from 1992 to 1994, almost all recoveries in 1995 (99%) came from fish released as smolts.

Based on the results of this investigation, we recommend the following measures for Lake Roosevelt kokanee hatcheries:

1) Make an effort to release more fish into the reservoir. This should be done by (a) drilling a new well at the Spokane Tribal Hatchery to deliver additional flow needed to raise more smolt sized fish; (b) provide new net pen sites; (c) initiate experiments with induction of spawning by injecting females with inducing hormones.
2) Monitor entrainment from Lake Roosevelt.
3) Modify holding facilities and hatchery ladder system at Sherman Creek Hatchery to attract spawning kokanee.
4) Set up an egg collection site at Hawk Creek since 286 fish were recovered at that site.
5) Locate alternative stocks of kokanee with better genetic adaptations than Lake Whatcom fish for the Lake Roosevelt Program.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The Lake Roosevelt Monitoring Program was designed in 1988 to evaluate the effectiveness of Lake Roosevelt reservoir kokanee salmon hatcheries. In 1995, one of the objectives of this program was to identify temporal and spatial release sites for hatchery reared kokanee salmon which would minimize entrainment through Grand Coulee Dam, maximize angler harvest, and maximize homing. The specific objectives were to:

(1) Determine the critical period(s) for olfactory imprinting in kokanee salmon via investigations in Lake Roosevelt. Knowing the time of imprinting in kokanee is essential for developing a successful Lake Roosevelt Kokanee Hatchery outplanting program. For the hatcheries to be self-sustaining, sufficient numbers of kokanee need to return to egg collection sites. Successful imprinting could improve returns to egg collection sites.

(2) Assess the best times and locations to release kokanee in terms of preventing entrainment below Grand Coulee Dam, and improving returns to creel and egg collection sites.

Both of these objectives were addressed through experiments that were initiated in 1992, 1993, 1994 and 1995 (Scholz et al. 1992, 1993; Tilson et al. 1994, 1995). Fish were released from 1992 to 1995 and monitoring occurred from 1993 to 1995. Table 1 shows that fish released as fry from 1992-1995 could be recovered from 1993-1995. Also, fish released as smolts from 1992-1995 could be recaptured from 1993-1997. During the release years kokanee were exposed to synthetic chemicals, morpholine and phenethyl alcohol, at different life history stages to determine the critical period for imprinting in kokanee. The life stages were: (1) fertilized egg to eyed egg, (2) eyed egg to hatch, (3) time of hatch, (4) hatch to swimup, (5) time of swimup, (6) fry O-l month post swimup, (7) fry l-2 months post swimup, (8) fry 3-6 months post swimup, and (9) smolt (about 16-18 months post fertilization). Thyroid hormone levels monitored in these fish indicated peaks at hatch to swimup and smolt stages (Scholz et al. 1992, 1993; Tilson *et al.* 1994). A portion of these fish were held until maturity at age 2 and 3. Experiments were conducted with these fish to determine if kokanee could be imprinted to synthetic chemicals at different life stages and then home back to their appropriate chemical as mature adults. In these experiments (Tilson *et al.* 1994, 1995), fish were exposed to synthetic chemicals in 1992 and 1993 and behavioral tests were conducted in 1994 with 2 year old sexually mature fish (1992 cohort) and in 1995 with 2 year old (1993 cohort) and 3 year old (1992 cohort) sexually mature fish (Tilson et *al.* 1994, 1995). Sexually mature fish were released into a stream with a natural

Table 1. Summary of coded wire tagged kokanee exposed to synthetic chemicals **released** from 1992 - 1995 and recovered from 1993 - 1995.

Cohort	Year of Release	Life stage at Release	Life stage Exposed	Year of recapture at age		
				2	3	4
1990	1992	Smolt	Smolt	--	1993	1994
1991	1992	Fry	Eyed egg	1993	1994	1995
			Hatch	1993	1994	1995
			Alevin	1993	1994	1995
			Swimup	1993	1994	1995
			Fry (Feb-Jul)	1993	1994	1995
1991	1993	Smolt	Smolt	1993	1994	1995
1992	1993	Fry	Eyed egg	1994	1995	1996
			Hatch	1994	1995	1996
			Alevin	1994	1995	1996
			Swimup	1994	1995	1996
			Fry (Feb-Jul)	1994	1995	1996
1992	1994	Smolt	Hatch	1994	1995	1996
			Alevin	1994	1995	1996
			Swimup	1994	1995	1996
1993	1994	Fry	Hatch-Swimup	1995	1996	1997
		Fry	Alevin-Swimup	1995	1996	1997
1993	1995	Smolt	Hatch-Swimup	1995	1996	1997
			Alevin-Swimup	1995	1996	1997
			Hatch-Swimup and Smolt	1995	1996	1997
			Alevin-Swimup and Smolt	1995	1996	1997
1994	1995	Fry	Hatch-Swimup	1996	1997	1998
			Alevin-Swimup	1996	1997	1998

Y-maze, and traps located at each arm of the maze at the upstream end. Results suggested that imprinting coincided with elevated thyroxine levels. For example, zero age fish (199 1 and 1992 cohort) displayed basal whole body thyroxine levels of 6.5 ± 1.3 ng/g body weight (BW) and 8.3 ± 1.1 ng/g B W respectively and peak levels at the time of swimup of 22.1 ± 5.2 ng/g B W and 15.1 ± 2.1 ng/g BW respectively. Fish exposed at hatch and swimup displayed 66 and 81% homing respectively as 2 year olds (1991 and 1992 cohort) and 68 and 92% homing respectively as 3 year olds (1991 cohort). When plasma thyroxine was measured in yearling fish (1990 and 1991 cohort) the basal levels were 2.2 ng/ml and 10.6 ng/ml respectively with peak levels at the smolt stage (early spring) of 20 ng/ml and 15.2 ng/ml respectively (Tilson *et al.* 1994). When these fish (1990 cohort) were tested as mature adults, they displayed 59% homing as 3 year olds. Fish exposed at pre-hatch and post-swimup stages had whole body thyroxine levels of <8.0 ng/g BW and <1.0 ng/g BW respectively. These groups displayed less than 30% homing when tested as mature adults. Therefore, thyroxine concentration was elevated at both hatch to swimup stage and also at the smolt stage. The highest percentage of fish homing to their exposure odor as mature adults (1990 and 1991 cohort tested in 1993, and 1991 and 1992 cohort tested in 1994) were fish exposed at hatch to swimup and the smolt stage.

To determine if the results in these behavioral experiments could be duplicated in the field (Lake Roosevelt), most of the fish which were imprinted at different life stages were marked with an adipose clip and a distinctive coded wire tag that uniquely identified: (1) exposure chemical, (2) life stage exposed, (3) release location, (4) life stage released, and (5) date released. A total of 1,243,774 coded wire tagged fish were released into Lake Roosevelt from 1992 to 1995. These fish will become sexually mature spawners from 1994 to 1998. Field tests in Lake Roosevelt were conducted to determine the following information for each group of coded wire tagged fish: (1) number entrained below Grand Coulee Dam, (2) number harvested by anglers in Lake Roosevelt; (3) number homing to egg collection sites scented with the appropriate imprinting chemical, and (4) number straying to other locations.

1.1 Study Strategy

The field tests were conducted in 1994 and 1995. During 1994, the following tasks were completed (Tilson *et al.* 1995):

(1) Kokanee were exposed at Spokane Tribal Hatchery to synthetic chemicals from hatch to swimup stage in January - February 1994. The odor delivery system was set up and monitored throughout this period.

(4) Kokanee entrainment below Grand Coulee Dam was monitored at Rocky Reach Dam and at Rock Island Dam. If any adipose clipped kokanee outmigrants were collected during the season, 4/1-8/31, the biologists at these facilities were to freeze the fish so we could check for coded wire tags.

(5) Kokanee returns to egg collection sites were monitored by augmenting the creel survey at Little Falls Dam, and by augmenting the electrofishing surveys at Little Falls Dam and Sherman Creek during the spawning season. These augmented electrofishing surveys were conducted by EWU biologists and by EWU Environmental Biology Club volunteers. Additionally, EWU monitored Big Sheep Creek, Colville River, Blue Creek, Hawk Creek, and Barnaby Creek.

(6) Information about tagged kokanee captured in Lake Roosevelt was augmented by conducting a site specific creel survey. Biologists from EWU interviewed anglers at specific sites on Lake Roosevelt from January to July at times (usually evening) when anglers were likely to be catching kokanee and when the scheduled creel clerk was not at those sites.

(7) Recommendations were made about exposure times and release locations and dates that (a) reduce entrainment below Grand Coulee Dam, and/or (b) increase harvest rates in Lake Roosevelt and/or (c) increase returns of adults to egg collection sites.

2.0 METHODS AND MATERIALS

2.1 Rearing Conditions

Eggs for producing kokanee to be reared at the Spokane Tribal Hatchery near Wellpinit, WA were obtained from two sources: 1) Lake Whatcom stock eyed eggs transferred from the Lake Whatcom Hatchery in Bellingham WA (WDFW); and 2) spawn take from kokanee captive brood held at the Spokane Tribal Hatchery (Figure 1). Water supply to the raceways was a combination of Metamooteles Springs water and well water at 8-11°C. After swimup, zero age fry were feed trained on Biodiet semi-moist mash (starter feed). Older fry were fed a combination of Biodiet semi-moist grower feed (1.0 - 2.5 mm crumbles) and Silvercup size l-4 mm crumbles. Yearling fish were fed Biodry 1000 pellets (3.0 - 4.0 mm) obtained from Bioproducts, Inc. Photoperiod was maintained at natural daylength as each raceway was partially exposed to natural conditions of light and weather.

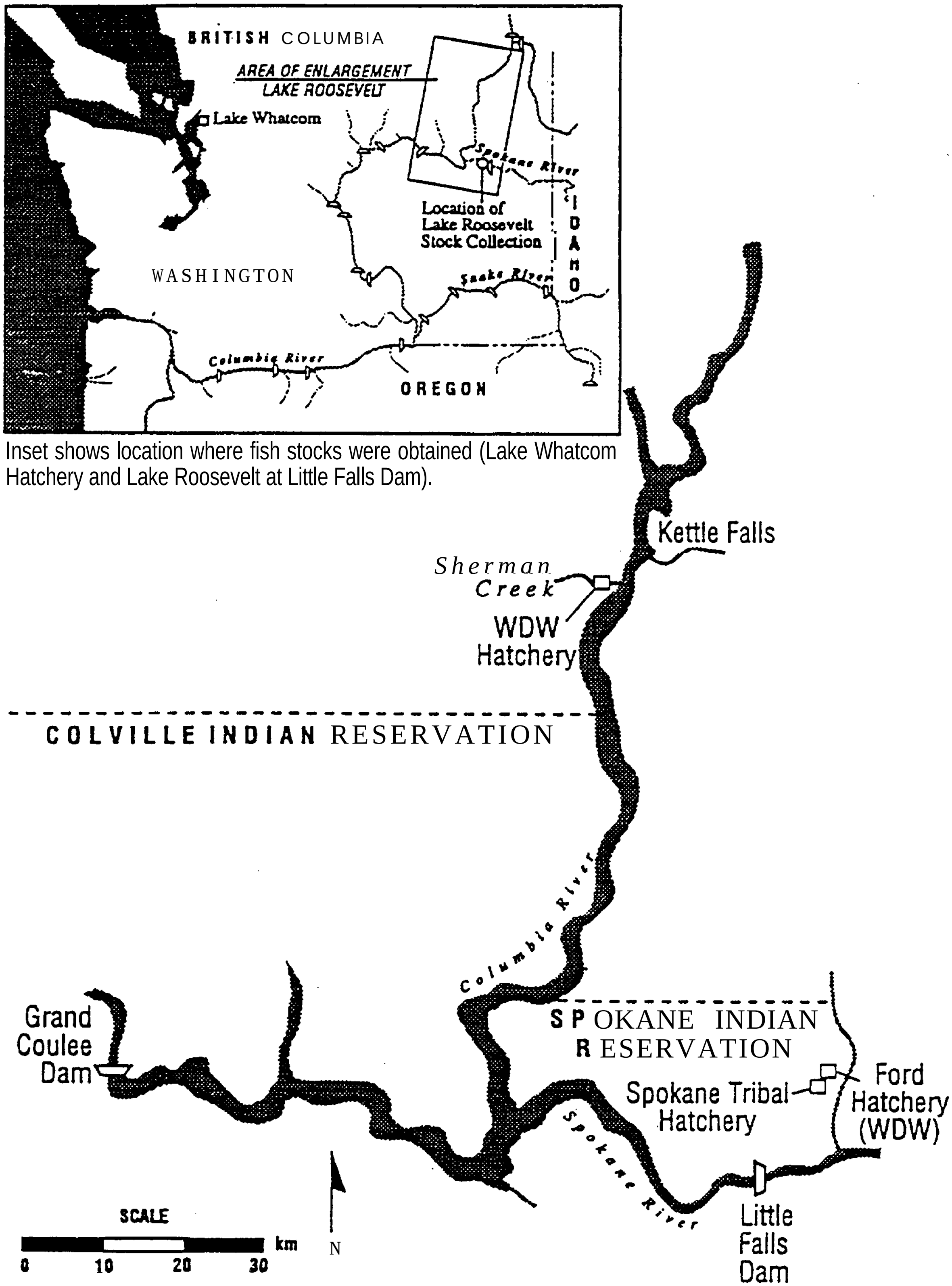
2.2 Olfactory Imprinting Investigations

From 1991 to 1994, fish were exposed to either morpholine (C_4H_9NO) or phenethyl alcohol ($C_8H_{10}O$) at various developmental stages. The life stages were: (1) fertilized egg to eyed egg, (2) eyed egg to hatch, (3) time of hatch, (4) hatch to swimup, (5) time of swimup, (6) fry O-l month post swimup, (7) fry l-2 months post swimup, (8) fry 3-6 months post swimup, (9) smolt (about 16-18 months post fertilization) (Appendix A). At each life stage, one group of fish was exposed to morpholine (5×10^{-5} mg/l) and a second to phenethyl alcohol (5×10^{-3} mg/l). In 1994 and 1995, fish were "double imprinted", initially at the hatch through swimup stages (i.e. alevin) in 1994 and a second time at the smolt stage in 1995. These fish received the double imprint because our earlier investigations had demonstrated that both the alevin/swimup and smolt stages were sensitive periods for imprinting. Two imprinting chemicals were employed in this experiment so that one odor could act as a control for the other. Details of the synthetic chemical imprinting procedure and methods for calculating steady state concentration of imprinting chemicals were described in a previous annual report (Scholz *et al.* 1993).

2.3 Coded Wire Tagging Program

From 1992 to 1995, most of the hatchery kokanee were exposed to synthetic chemicals and released into Lake Roosevelt at various locations. A portion of each group released were tagged with distinctive coded wire tags. During the spawning season in autumn 1995, both morpholine (at a steady state concentration of 5×10^{-5} mg/l) and phenethyl alcohol (5×10^{-3}

Figure 1. Location of Lake Roosevelt kokanee hatcheries operated by Spokane Tribe and Washington Department of Fish & Wildlife.



Inset shows location where fish stocks were obtained (Lake Whatcom Hatchery and Lake Roosevelt at Little Falls Dam).

mg/l) were metered into the ladder trap at Sherman Creek. This protocol was changed from that of 1992 through 1994 when only morpholine was metered into Sherman Creek. Due to a management decision by the Lake Roosevelt Kokanee Hatchery Steering Committee, it was decided to drip both morpholine and phenethyl alcohol into Sherman Creek in order to attract as many adult spawners as possible at that site. Phenethyl alcohol was also metered into the Spokane River at a site below Little Falls Dam from 1992 through 1995. For marking experiments, kokanee were dipnetted out of hatchery raceways and mildly anesthetized with a 50 mg/l concentration of tricaine methanesulfonate (MS-222). Coded wire tags (CWT) were then injected into the rostrum using a model MK4 CWT machine (Northwest Marine Technology, Inc.), equipped with two different nose hoods specially fitted for fry and fingerling-sized fish. Lengths and weights of fry which were marked for release in 1995 ranged from 52 to 78 mm and 1.4 to 4.6 g respectively. Lengths and weights of fingerlings ranged from 116 to 124 mm and 15 to 18.6 g respectively (Appendix A). All hatchery fish were given an adipose fin clip as an external identification mark. Marked fish were counted using a tally counter, then released back into hatchery raceways through a quality control device (QCD) (Northwest Marine Technology, Inc.) equipped with a CWT detector. The fish were retained for approximately three weeks before release to estimate mortality rates and tag retention. In 1995, mortality rates were uniformly low (<1%) (T. Peone, Spokane Tribal Hatchery, personal communication). The mean percent tag retention after 20 days was 96%, and ranged from 93 to 99.1% (Appendix A).

Reservoir wide'creel surveys were conducted throughout the year by individuals from the Spokane Tribe, Colville Confederated Tribe, and the Washington Department of Fisheries and Wildlife (See section 2.2 of Underwood *et al.* 1996). Also, a site specific creel survey at Spring Canyon Campground near Coulee Dam, Washington was conducted from January through July 1995 by individuals from the UCUT Fisheries Center at EWU. These augmented creel surveys were conducted on days and/or times when the regularly scheduled creel clerk would not be at that site and when kokanee were most likely to be observed. The augmented surveys at Spring Canyon were conducted on January 9, 10, 11, 12, 13; April 9, 12, 15, 17, 23, 30; May 7, 13; and July 11, 17. At Little Falls Dam the creel survey was augmented on April 14, 25; May 1 and September 30. At other sites, the creel was conducted on September 13, 20 and October 5, 6. In addition, electrofishing/gill net surveys were conducted throughout the year (See Section 2.3 of Underwood et *al.* 1996) and the electrofishing surveys were augmented by an EWU crew during the spawning season (September-November, 1995). This EWU crew consisted mainly of vollunteers from the EWU EnvironThese augmented electroshocking surveys were done ten days in September (9/6 to 9/29), 9 days in October (10/3 to 10/27) and 8 days in November (1 l/l to 1 1/30) at various locations in the reservoir and concentrated at Little Falls Dam and Sherman

Creek. Additionally, a ladder trap was monitored by WDFW personnel at Sherman Creek Hatchery.

The heads of kokanee with adipose clips were cut off and sent to the Fisheries Research Center at Eastern Washington University, where CWT's were dissected out and examined with a dissecting microscope to determine the lot code. The number of fish from each lot returning to Sherman Creek, Little Falls Dam, and other locations was determined.

Percent error of coded wire tags read was determined by having two individuals read all of the tags. If there was a discrepancy on a tag code, both people re-read those tags until they were in agreement. In 1995, a total of 1,578 adipose clipped fish were examined for coded wire tags. There were 1,243 heads which contained tags. However, 2% (n=23 tags) were lost in the extraction process. All tags were read by two individuals. After Reader 1 and Reader 2 read the tags, there was a discrepancy on 89 of 1,218 tag codes. After those 89 tags were re-read by both readers and a tag code was agreed upon, Reader 1 was incorrect on 67/1,218 tags for a 5.5% error. Reader 2 was incorrect on 22/1,218 tags for a 1.8% error. However, the total percent error was 0% since all tags were read twice and all were agreed upon.

To monitor kokanee entrainment from Lake Roosevelt, a creel survey was conducted by boat for two days in February on Rufus Woods Reservoir (directly below Grand Coulee Dam). However, this was a trial survey which resulted in very few angler interviews. In addition, budget constraints prohibited a more in-depth angler survey.

Therefore, in order to collect coded wire tagged fish below Grand Coulee Dam, we coordinated efforts with the Fish Passage Center's Smolt Monitoring Program at both Rocky Reach Dam (three dams downstream from Grand Coulee Dam) and at Rock Island Dam (four dams down from Grand Coulee Dam) to collect kokanee migrants from April 1 to August 30, 1995. At Rocky Reach Dam, we had technicians examine adipose clipped kokanee salmon of any size. At Rock Island Dam, we had technicians look for adipose clipped kokanee which were 250 mm or larger. The reason for the size differentiation was because Lake Wenatchee stock sockeye were also adipose clipped and coded wire-tagged. It would not be possible to separate the adipose clipped age 1+ Lake Roosevelt kokanee from adipose clipped age 1+ anadromous sockeye passing Rock Island Dam without sacrificing both species. The larger kokanee (>250 mm) would have been 2 to 4 year old fish which had remained in one of the reservoirs after release until they migrated downstream or had been entrained as subadults. However, there were no adipose clipped kokanee of any size seen at either of the collection facilities (Robert McDonald, Fish Biologist, Chelan County PUD, personal communication). In addition, there were no adult coded wire tagged fish turned in at the Washington Department of Fish and Wildlife Head Lab (Ken Johnson, Pacific States Marine Fisheries Commission, personal communication).

2.4 Statistical Analysis

Statistical evaluation was determined via a chi-squared test at $p \leq 0.05$. The null hypothesis (H_O) stated, *"Chemically exposedjish were random in their movements. They were recaptured in equal numbers in scented and unscented streams during the spawning migration."* If the calculated probability was greater than 0.05 ($p > 0.05$), then we interpreted this to mean that fish were not attracted to their exposure odor. If p 20.05, then we accepted the alternative hypothesis *(HA), "Chemically exposed fish moved to the scented stream in greater number than the unscented stream."* A statistical significance would imply that the fish were homing to their exposure odor.

3.0 RESULTS

3.1 Kokanee Salmon Recoveries

Recoveries of kokanee salmon captured in gill net, electrofishing, ladder trap and creel surveys in 1995 are shown in Table 2. A total of 2,815 fish were recovered. Of those, 60% (n=1,689) were fin clipped.

Of the fish recovered in the creel surveys (n=467), 185 fish were recovered by the Lake Roosevelt Monitoring Program's year round creel survey and 282 fish (60.4%) were recovered by EWU's augmented, site specific creel survey. Most fish were recovered in fish surveys (n=2,348) including gill netting (n=45), ladder traps (n=3) and electroshocking (n=2,300). Many of these fish were recovered during their fall spawning migration at sites scented with synthetic chemicals, including 1,003 at Sherman Creek and 593 at Little Falls (Table 2).

3.1.1 Lake Whatcom Brood Recoveries

From 1992-95 a total of 5,413,270 fish were released into Lake Roosevelt, of which 1,041,355 were tagged with CWT/fin clips. Total coded wire tag releases included 507,319 fry and 534,036 smolts (Table 3). However, only 445,778 fry releases were considered recoverable (1990-1993 cohort) in 1995. The other 51,411 fish were released as fry in 1995 and thus would not have been adults in 1995. Kokanee in Lake Roosevelt attain lengths of about 250 - 350 mm by age 2 and spawn principally at age 2, age 3 and sometimes age 4. A portion of the total number of coded wire tagged fish (88%), including 497,189 fry and 418,432 smolts were Lake Whatcom stock fish that had been exposed to either morpholine or phenethyl alcohol. The remainder (12%) were not exposed to a chemical and were from captive brood stock fish (Table 3).

A total of 1,643 CWT/fin clipped fish were recaptured from 1992 to 1995 including 1,205 recaptured at egg collection sites at Sherman Creek and Little Falls Dam/Spokane River (Tables 4-8). Of the total 1,643 CWT/fin clip recoveries, 1,634 fish (99.4%) had been stocked as smolts or residualized smolts and 9 fish (0.6%) were stocked as fry. Therefore, the ratio of smolts to recoverable fry released was approximately 1.2 to 1 respectively, the ratio of smolts to fry recovered as adults was approximately 182.5 to 1 respectively. Clearly, smolt releases produced substantially more adults than fry releases.

From 1992-1995, a total of 339 (76%) morpholine-exposed fish (released at the smolt stage) were recovered as adult spawners at Sherman Creek compared to 46 (10%) recovered at

Table 2. **Kokanee salmon recoveries in Lake Roosevelt by electrofishing, gill net, trap and creel surveys from January through December 1995[1].**

Location	Fish Surveys Total #	Fish Surveys Adipose clip only	Fish Surveys Other clips	Creel Surveys Total #	Creel Surveys Adipose Clip only	Creel Surveys Other Clips	Totals Total # recovered	Totals Total # Clipped
0 Northport	5	1	1	0	0	0	5	2
1 Kettle Falls	995	874	53	8	0	0	1,003	927
2 Gifford[2]	29	20	0	0	0	0	29	20
3 Hunters	109	90	0	0	0	0	109	90
4 Porcupine Bay	110	76	9	0	0	0	110	85
5 Little Falls	577	107	70	16	10	2	593	189
6 Seven Bays2	473	331	15	6	2	1	479	349
7 Kellers Ferry	1	0	0	22	0	0	23	0
8 San Poil	30	18	0	1	0	0	31	18
9 Spring Canyon	19	2	0	414	7	0	433	9
TOTALS	2,348	**1,519**	148	467	19	3	2,815	1,689

1 Totals include regularly scheduled electroshocking and creel surveys, and augmented electroshocking and creel surveys conducted by Eastern Washington University.

2 Gifford location includes Barnaby Creek; Seven Bays location includes Hawk Creek and Blue Creek.

Table 3. Number of recoverable coded wire tagged (1991 to 1993 **cohort)** kokanee salmon released into Lake Roosevelt from 1992 through 1995[1].

Imprinted - Lake Whatcom brood

Stage at Release	1992	1993	1994	1995
fry	171,452	204,328	69,998	51,411[2]
smolt	0	53,979	108,602	255,851

Non-imprinted - Captive brood

Stage at Release	1992	1993	1994	1995
fry	0	0	10,130	0
smolt	0	26,489	22,584	66,531

1 These numbers represent kokanee that can be positively identified with coded wire tag data codes which have not been duplicated.

2 These fish were 94 cohort fry and were only 1+ in 1995. Therefore, they were not counted in the total number released.

Table 4. Recoveries by location of coded wire tagged kokanee salmon from releases made in 1992. Recoveries are total number recovered from creel and fisheries surveys conducted from 1992 to 1995.

Cohort	Stage Exposed	Exposure Odor	Release Location	Life Stage At Release	Total # CWT Released	# CWT recovered at		
						Sherman Creek (MOR[1])	Spokane River (PEA)	Other
1991	Eyed egg	MOR	Sherman Creek	Fry	6.414	1	0	0
		PEA	Sherman Creek	Fry	10,595	0	0	0
1991	Hatch	MOR	Sherman Creek	Fry	20,222	0	0	0
		PEA	Sherman Creek	Fry	21,264	0	0	0
1991	Alevin	MOK	Sherman Creek	Fry	10,411	0	0	0
		PEA	Sherman Creek	Fry	9,455	0	0	0
1991	Swimup	MOR	Sherman Creek	Fry	7,617	0	0	0
		PEA	Sherman Creek	Fry	9,323	0	0	0
1991	Fry (Feb)	MOR	Sherman Creek	Fry	16,963	2	0	0
		PEA	Sherman Creek	Fry	5,242	1'	0	0
1991	Fry (Mar)	MOR	Sherman Creek	Fry	8.916	0	0	0
		PEA	Sherman Creek	Fry	9,520	1	0	0
1991	Fry (Apr)	MOK	Sherman Creek	Fry	10,072	0	0	0
		PEA	Sherman Creek	Fry	10,142	0	0	0
1991	Fry (May-Jul)	MOR	Sherman Creek	Fry	5,144	0	0	0
		PEA	Sherman Creek	Fry	9,492	0	0	0
1990	Smolt	MOR	Sherman Creek	Smolt	7,501	10[i]	5[i]	0[i]
		PEA	Sherman Creek	Smolt	8,354	2[i]	3[i]	1[i]

1 In 1995, both morpholine (MOR) and phenethyl alcohol (PEA) were dripped at Sherman Creek, PEA was also dripped into the Spokane River at Little Falls.
l One of these fish was recovered as a 4 year old in 1995.
i These fish were recovered in 1992 to 1994 as 2 to 4 year old fish respectively.

Table 5. **Recoveries by location of coded wire tagged kokanee salmon from releases made in 1993. Recoveries are total number recovered from creel and fisheries surveys conducted in 1993, 1994 and 1995.**

Cohort	Stage Exposed	Exposure Odor	Release Location	Life Stage At Release	Total # CWT Released	# recovered at Sherman Creek (MOR[1])	# recovered at Spokane Rlver (PEA)	# recovered at Other
1992	Eyed egg	MOR	Sherman Creek	Fry	14.355	0	0	0
		MOR	Spokane River	Fry	10,903	0	0	0
		PEA	Sherman Creek	Fry	10,721	0	0	0
		PEA	Spokane River	Fry	10,960	0	0	0
1992	Hatch	MOR	Sherman Creek	Fry	7,988	0	1[t]	0
		MOR	Spokane River	Fry	31,416	0	0	0
		MOR	Bamaby Creek	Fry	21,784	0	0	0
		PEA	Sherman Creek	Fry	7,988	0	0	0
		PEA	Spokane River	Fry	21,993	0	0	0
1992	Alevin	MOR	Sherman Creek	Fry	10,938	0	0	0
		PEA	Sherman Creek	Fry	11,791	0	0	0
1992	Swimup	MOR	Sherman Creek	Fry	10,908	0	0	0
		PEA	Sherman Creek	Fry	10,885	0	0	0
1992	Fry (Feb)	MOR	Sherman Creek	Fry	10,802	0	0	0
		PEA	Sherman Creek	Fry	10,896	0	0	0
1991	Smolt	MOR	Sherman Creek	Smolt	38,030	36[i]	5	0
		PEA	Sherman Creek	Smolt	7,753	20	25	0
		PEA	Blue Creek	Smolt	8,196	0	92	8
		NONE	Sherman Creek	Smolt	26,489	1[i]	0	0

1 In 1995, both MOR and PEA were dripped into Sherman Creek.
t This fish was recovered as a three year old in 1995.
i One of these fish was recovered as a four year old in 1995.

Table 6. **Recoveries by location of coded wire tagged kokanee salmon from releases made in 1994, Recoveries are total number recovered from creel and fisheries surveys conducted in 1994 and 1995.[1]**

Cohort	Stage Exposed	Exposure Odor	Release Location	Life Stage At Release	Total # CWT Released	# recovered at: Sherman Creek (MOR[2])	Spokane River (PEA)	Hawk Creek	Other
1992	Hatch	MOR	Sherman Creek	Smoh	10,613	4	0	0	3
		MOR	Blue Creek	Smolt	10,291	14	1	6	3
		PEA	Spokane River	Smoh	8,352	0	6	0	0
		PEA or MOR	Spokane River	Smolt	11.140	10	2	7	2
1992	Alevin	MOR	Sherman Creek	Smolt	15,523	1	0	0	5
1992	Swimup	MOR	Sherman Creek	Smolt	20,739	3	0	0	2
		PEA	Sherman Creek	Smoh	31,944	1	4	0	0
1992	--	NONE	Kettle Falls Net Pen	Smolt	22,584	0	0	0	0
1993	Hatch through Swimup	MOR	Sherman Creek	Fry	20,261	0	0	0	0
		PEA	Sherman Creek	Fry	10.099	0	0	0	0
1993	Alevin through Swimup	MOR	Sherman Creek	Fry	18,696	0	0	0	0
		PEA	Sherman Creek	Fry	20,942	0	0	0	0
1993	__	NONE	Sherman Creek	Fry	10,130	3	0	0	0

1 1992 cohort fish were recovered at age 2 and 3 in 1994 and 1995 respectively. 1993 cohort fish were recovered as age 2 in 1995.
2 In 1995, both MOR and PEA were dripped at Sherman Creek, PEA was also dripped into the Spokane River at Little Falls Dam.

Table 7. Recoveries by location of coded wire tagged kokanee salmon from releases made in 1995. Recoveries are total number recovered from creel and fisheries surveys conducted in 1995[1].

Cohort	Stages Exposed	Exposure Odor	Release Location	Life Stage At Release	CWT/Adclip Released (n)	Ad clip only Released (n)	CWT recoveries: Sherman Cr (MOR/PEA) (n)	Spokane R (PEA) (n)	Hawk Cr (n)	Barnaby (n)	Other (n)
1994	Hatch-swimup	MOR	Sherman Creek	Fry	40,468	3,708	0	0	0	0	0
1994	Alevin-swimup	MOR	Chamokane Creek	Fry	10,943	386	0	0	0	0	0
1993	--	NONE	Bamaby Creek[2]	Smolt	21,534	625	1	56	96	43	1
	--	NONE	Spokane River	Smoh	37,654	987	5	80	133	26	0
	--	NONE	Kettle Falls Net Pen[3]	Smolt	7,343	429	5	0	1	0	0
1993	Hatch-swimup	MOR	Kettle Falls Net Pen	Smolt	17,103	1,097	11	0	0	2	0
		PEA	Kettle Falls Net Pen	Smolt	23,183	1,283	6	0	1	1	0
1993	Alevin-swimup	MOR	Kettle Falls Net Pen	Smolt	21,068	912	4	0	0	0	1
1993	Hatch-swimup and smolt	MOR	Sherman Creek	Smolt	16,576	280	110	2	12	4	2
		PEA	Sherman Creek	Smolt	124,906	6,398	388	6	28	13	12
1993	Alevin-swimup and smolt	MOR	Sherman Creek	Smoh	51,455	2,088	109	3	3	5	3
		PEA	Sherman Creek	Smolt	1,560	20	4	0	0	0	0

1 An additional 160,000 1994 cohort fry were released into Sherman Creek. These fish were unmarked and unexposed. Fish from the 1994 cohort are not expected to return until 1996. 1997 and 1998 as 2, 3 and 4 year olds respectively. Fish from the 1993 cohort returned as age 2 in 1995.

2 Bamaby Creek is located approximately 11 miles south of Sherman Creek.

3 The Kettle Falls net pen is located at the Kettle Falls Marina.

Table 8. **Recoveries by location of kokanee salmon with fin clips. These fish were exposed to synthetic chemicals in 1993, held at the Spokane Tribal Hatchery until July 1993, when they were released into the Spokane Arm of Lake Roosevelt as residualized smolts. Recoveries were made from September to November 1993, 1994 and 1995.**

Cohort	Stage Exposed	Exposure Odor	Fin Clip	Release Location	Life Stage At Release	Total # Released	# recovered at Sherman Creek[1] (MOR)	Little Falls (PEA)	Other	Percent Return
1992	Eyed egg	MOR	RP	Spokane River	Post-smolt	325	2	2		1.2
		PEA	LP	Spokane River	Post-smolt	325	0	2		0.9
1992	Hatch	MOR	RV	Spokane River	Post-smelt	325	0	4	0	1.2
		PEA	LV	Spokane River	Post-smolt	325		8		3.1
1991	Alevin	MOR	A-RV	Sherman Creek	Post-smolt	325	5	4	1	3.1
		PEA	A-LV	Sherman Creek	Post-smolt	325	0	15	0	4.6
1992	Alevin	MOR	LV	Spokane River	Post-smolt	325	12	8	2	6.8
		PEA	RV.	Spokane River	Post-smelt	325	4	25	0	8.9
1991	Swimup	MOR	A-RP	Sherman Creek	Post-smolt	325	6	3	0	2.8
		PEA	A-LP	Sherman Creek	Post-smelt	325	3	16	0	5.8
1992	Swimup	MOR	RP	Spokane River	Post-smolt	325	10	4	3	5.2
		PEA	LP	Spokane River	Post-smolt	325	5	10	3	5.5
1991	Fry (Feb)	MOR	LV-RP	Sherman Creek	Post-smolt	325	0	0	0	0
		PEA	RV-LP	Sherman Creek	Post-smolt	325	0		0	0.3
1991	Fry (Mar)	MOR	D-LV	Sherman Creek	Post-smolt	325	0	0	0	0
		PEA	D-LV	Sherman Creek	Post-smelt	325	0	1	1	0.6
1991	Fry (Apr)	MOR	D-RP	Sherman Creek	Post-smelt	325	1			0.9
		PEA	D-LP	Sherman Creek	Post-smolt	325	0		2	0.9
1991	Fry (May-Jul)	MOR	D	Sherman Creek	Post-smolt	325		4	0	1.2
		PEA	A	Sherman Creek	Post-smolt	325	0	0	0	0

1 In 1995, both morpholine and phenethyl alcohol were dripped at Sherman Creek, PEA was also dripped in the Spokane River at Little Falls Dam.

Little Falls Dam (phenethyl alcohol scented) and 59 (13%) at other locations (Tables 4-8). In contrast, 626 (85%) phenethyl alcohol exposed fish were recovered at phenethyl alcohol scented waters (Spokane River and Sherman Creek), 33 (5%) fish at Sherman Creek when only morpholine was present and 81 (10%) at other locations (Tables 4-8).

To determine which life stage was most sensitive to synthetic chemical imprinting, different groups of fish were exposed at different life history stages (see Tilson et al. 1994 for a detailed description of the origins of these fish). Although too few fish released as fry were recovered to assess imprinting effectiveness, we were able to assess imprinting effectiveness with fish released as fingerlings (smolts). Table 9 shows that there were no significant differences in distribution between exposed fish returning to their exposure odor and fish returning to other locations ($p>0.05$). The fish which were exposed between hatch and swimup and/or smolt stages showed a significant difference in distribution of chemically exposed fish returning to their exposure odor versus to other locations ($p<0.05$) (Table 9).

3.1.2 Captive Brood Fish (Unexposed) Recoveries

Of the 115,604 CWT fish that were not exposed to any chemical and released in the Spokane River as smolts, a total of 244 were recovered. Of these recoveries, 32.8% (n=80) were recovered at Little Falls Dam, 54.1% (n=133) were recovered at Hawk Creek, 10.7% (n=26) were recovered at Bamaby Creek and 2% (n=5) were recovered at Sherman Creek (Table 7). Of the 21,534 fish which were released in Bamaby Creek as smolts, a total of 197 fish were recovered (Table 7). Of these, 21.8% (n=43) were recovered at Barnaby Creek, 48.7% (n=96) at Hawk Creek, 28.4% (n=56) at the Spokane River and 0.5% (n=l) at Sherman Creek (Table 7). Of the 29,927 unexposed fish released from the Kettle Falls Net Pen as smolts, a total of 9 fish were recovered. Of these, 88.9% (n=8) were recovered at Sherman Creek, 11.1% (n=l) were recovered at Hawk Creek. None were recovered at other locations (Table 6, 7). Of the 26,489 unexposed fish released at Sherman Creek as smolts, 1 of 1 (100%) was recovered at Sherman Creek (Table 5).

Table 9. Statistical comparison of the number of kokanee salmon (1990-1993 cohort) recovered from 1992 to 1995 which were exposed to either morpholine (MOR) or phenethyl alcohol (PEA) and recovered at the morpholine egg collection site, phenethyl alcohol egg collection site or at other sites from 1992 to 1995. Separate tests were made for each condition. The null hypothesis stated that there was no difference in the distribution of the two set of fish exposed to different odors at a particular life history stage. The null hypothesis was rejected if $p \leq 0.05$. An asterisk signifies these groups of fish homed to their exposure odor.

Stage(s) Exposed	Exposure Odor	TOTAL RECOVERED AT						Chi Square
		MOR (#)	MOR (%)	PEA (#)	PEA (%)	Other (#)	Other (%)	
Eyed egg	MOR	3	50	2	33	1	17	$x^2=0.64$
	PEA	0	0	2	67	1	33	$p=0.82$ t
Hatch	MOR	29	52	6	11	21	38	$x^2=3.57$
	PEA	1	3	26	70	10	27	$p=0.05$ t*
Alevin	MOR	18	47	12	32	8	21	$x^2=9.17$
	PEA	4	9	40	85	3	6	$p<0.01$ t*
Hatch through swimup	MOR	11	85	0	0	2	15	$x^2=7.46$
	PEA	0	0	6	75	2	25	$p<0.01$ t*
Alevin through swimup	MOR	4	80	0	0	1	20	n/a
	PEA	0	0	0	0	0	0	n/a
Swimup	MOR	19	61	7	23	5	16	$x^2=6.53$
	PEA	9	21	30	71	3	7	$p<0.05$ t*
Fry	MOR	4	40	5	50	1	10	$x^2=0.235$
	PEA	2	25	3	37	3	38	$p=0.64$
Smolt	MOR	46	82	10	18	0	0	$x^2=66.38$
	PEA	22	15	120	80	9	6	$p<0.01$ t*
Hatch through swimup and Smolt	MOR	110	85	2	2	18	14	$x^2=263.03$
	PEA	0	0	394	88	53	12	$p<0.05$ t*
Alevin through swimup and Smolt	MOR	109	89	3	2	11	9	$x^2=25.01$
	PEA			4	100	*0*	*0*	$p<0.01$ t*

t Chi square values were calculated for these groups even though the rule stating, "no expected value may be less than 5" was violated.

4.0 DISCUSSION

This study has important implications for management of the Lake Roosevelt kokanee fishery. The results of the CWT investigations continue to show that kokanee can be successfully imprinted to artificial odors - morpholine and phenethyl alcohol - as juveniles from hatch to swimup and again as smolts. Fish double exposed to synthetic chemicals at alevin/swimup and smolt stages had the highest rate of homing to egg collection sites. In addition, the results of the present study continue to support results of previous investigations which show that fish released at the smolt/residualized smolt stage are recovered in greater numbers at egg collection sites than fish released as fry (Tilson et *al.* 1994, 1995). This information will be helpful in developing management strategies for the Lake Roosevelt kokanee fishery.

4.1 Imprinting Investigations

Results of laboratory imprinting investigations reported by Scholz et al. (1993) and Tilson *et* al. (1994, 1995) were similar to the results obtained from field investigations with imprinted, coded wire tagged kokanee released and recovered in Lake Roosevelt. These results show that:

1) Chemical imprinting coincided with elevated thyroxine levels (Scholz *et al.* 1993, Tilson *et al.* 1994, 1995). The group that had the highest whole body thyroxine content (swimup stage) also had the highest percentage of fish that were reliably attracted to their exposure odor as sexually mature 2 or 3 year old adults in behavioral tests conducted in a Y-maze in 1993 and 1994 (range 73-93%). In present field experiments in Lake Roosevelt, fish exposed at swimup exhibited 66% homing. Recently hatched eggs and alevins also had relatively high thyroxine content and displayed 69% and 81-87% homing respectively in the Y-maze test. In the field, these fish displayed 61 and 66% homing respectively. The other group that displayed accurate homing in the Y-maze test were fish that were exposed to the synthetic chemicals at the smolt stage. As adults in the Y-maze test, this group homed to their exposure odor 67% of the time. In the field, these fish displayed 61% homing. Pre-eyed eggs, eyed eggs and four fry stages all had relatively low thyroxine content at the time they were exposed to synthetic chemicals and displayed poor homing ability in laboratory experiments (<32%) (Scholz er *al.* 1993, Tilson *et al. 1994,*

1995). Fish exposed at these stages were all released as fry and were not recovered in field experiments so no comparison could be made between field and laboratory results for these groups of fish.

2) The groups which had the highest percent homing and were recovered in the greatest numbers were groups which were double-exposed to synthetic chemicals. These fish were exposed from hatch to swimup and again at the smolt stage. Morpholine exposed fish displayed 85% homing and phenethyl alcohol exposed fish displayed 88% homing.

3) Fish exposed to synthetic chemicals were recovered in greater numbers (% recovered) and displayed higher homing ability (% homing) to egg collection sites than fish that were not exposed to synthetic chemicals (Table 10). For example, 80% of chemically exposed fish released as smolts homed correctly to Sherman Creek with a recovery rate of 0.3%. Even though 100% of the unexposed fish homed correctly, the recovery rate was only 0.01%. At the Spokane River, 53% of the chemically exposed fish released as smolts homed correctly, while only 33% of the unexposed fish homed correctly. In Bamaby Creek, there were no recoveries from chemically exposed fish releases. However, these fish were all released as fry. At Bamaby Creek, 22% of the unexposed fish released as smolts homed correctly with a 1.1% recovery rate. However, it is not possible to compare the two groups of fish released at Barnaby Creek because all of the unexposed fish were smolt releases while the chemically exposed fish were fry releases. Both chemically exposed and unexposed fish from the Kettle Falls net pens displayed 0% homing to the net pen sites and displayed only 0.04 and 0.02% recovery rates (Table 10). However, these fish were recovered at Sherman Creek cove which is less than 1 mile downstream from the net pen sites.

4) Yearling (smolt) releases continued to provide better adult recoveries than fry releases. Although fish were released at different life stages, and there were approximately equal fry and smolt releases (42 and 58% respectively), almost all of the recoveries (99%) have come from fish released into the reservoir as smolts while only 1% of the recoveries were from fish released as fry.

Table 10. **Summary of chemically exposed - v - unexposed coded wire tagged/fin clipped kokanee salmon (1991-1993 cohorts) homing to release sites from 1993 to 1995.[1]**

Release Location	# Released Fry	# Released Smolt	# Released Total	# Recovered @ home stream	# Recovered @ other locations	% homing[1]	% recovered[2]
Sherman Creek							
Chem Exposed	43 1,722	321,699	753,421	743	185	80%	0.30%
No Chem	10,130	26,489	36,619	4	0	100%	0.01%
Spokane River							
Chem Exposed	75,272	23,392	98,664	71	135	53%	0.9%
No Chem	0	37,654	37,654	80	243	33%	0.9%
Blue Creek							
Chem Exposed	0	18,487	18,487	14	24	58%	0.1%
No Chem	0	0		0	0	0%	0.0%
Bamaby Creek							
Chem Exposed	21,784	0	21,784	0	0	0%	0.0%
No Chem	0	21,534	21,534	43	196	22%	1.1%
Kettle Falls Net Pens							
Chem Exposed	0	61,354	61,354	0		0%	0.04%
No Chem	0	29.927	29.927	0	26 6	0%	0.02%

1 Percent homing = total number captured in Lake Roosevelt in "home stream" + total number recovered in Lake Roosevelt.

2 Percent recovered = total number recovered + total number smolts released (since >99% of fish returning were from fish released as smolts).

5) Table 11 shows that catch per unit effort at egg collection sites (Sherman Creek and Spokane River) increased from 1994 to 1995. This means that although more effort was expended in 1995, the number of kokanee which were recovered was still 6 times higher than it was in 1994.

There are two possible explanations for the low number of recoveries of adult kokanee which were released as fry. One reason may be that fry are not able to avoid predators as well as smolt size fish. Walleye predation is known to occur when kokanee fry are released, as evidenced by observations of CWT kokanee fry in stomachs of walleye collected at release sites (Thatcher *et al.* 1993). Additionally, walleye collected from the reservoir were occasionally reported containing salmonids, presumably kokanee or rainbow trout in their stomachs (Peone *et al.* 1990; Griffith and Scholz 1991; Thatcher et al. 1993). In 1995, we observed large walleye (range 500 -720 mm and 4.2 kg) following schools of mature 2 year old kokanee during their spawning migration. One of those walleye (685 mm, 4 kg), had swallowed a 2 year old adipose clipped kokanee. Although walleye appeared to be preying on kokanee opportunistically during the spawning migration, the numbers seen during these migrations were relatively low (n=8 at Little Falls and n=6 at Sherman Creek). It is our impression that only walleye >600 mm could handle a 2 year old kokanee. We never saw walleye where 3 and 4 year old fish were congregating.

The second explanation for the poor adult returns of fish released as fry is that there may be entrainment from Lake Roosevelt when fish are released as fry. Thatcher et *al.* (1993) found a significant number of kokanee (721 fish) at Rock Island Dam between April and August 1991. In addition, Tilson *et* al. (1994, 1995) found that kokanee underwent partial smoltification and exhibited an increased downstream orientation and migratory activity in late winter and early spring. Fish released as 0+ fry (8 months old) in July could undergo smoltification during the following spring, and the higher flows could be sufficient to stimulate downstream displacement causing entrainment through Grand Coulee Dam. In the present study, biologists at both Rocky Reach and Rock Island Dams were looking for adipose clipped kokanee at the time of the regular smolt monitoring program (April 1 to August 31). Although no kokanee were seen at either of these facilities in 1995, it could be that they did not show up at the dams because of turbine-induced mortality. Skaar *et* al. (1996) investigated fish entrainment through Libby Dam in Montana from December 1990 to June 1994. Skaar et *al.* found that 8 1% of kokanee captured at Libby Dam had turbine-induced injuries, and 49% of these injuries were termed lethal, soon-to-be-lethal, or prolonged and damaging injuries. Therefore, it is possible that kokanee are being

Table 11. Catch per unit effort (CPUE) for kokanee salmon recovered at Kettle Falls and the Spokane River by **electroshocking** from September 1 to November **30, 1989** through 1995.

Year	# kokanee	# min	CPUE
1989	28	145.9	0.192
1990	39	323.7	0.120
1991	5	64	0.078
1992	108	208	0.5 19
1993	30	160	0.187
1994	31	177	0.175
1995	1,617	1,546.6	1.050

entrained through Grand Coulee Dam but are not making it to either of the collection facilities downstream.

Skaar et al. (1996) found that during a period of continuous monitoring at Libby Dam from January 1992 to January 1993, kokanee entrainment from Lake Koocanusa was estimated to be between 1.12 and 4.36 million kokanee with most fish being lost in December and January during drawdown for power production. The low estimate assumed that the rate of entrainment during unsampled periods was the mean of all measurements for the year. The high estimate assumed that rates from biweekly sampling applied to unsampled days preceding and following the netting session. Losses of 0+ fish were highest in January, with a maximum of 1,246 fish collected on one date. Another time that entrainment rates were high was in spring between late April and early July when withdrawal depth was shallow, and discharge high for sturgeon/salmon flows. Most of these fish (93%) were 0+ fish. In 1992, peaks of entrainment of age 1+ fish were from May - June and November - December. Age 2+ and older fish were entrained from June to October with peak numbers lost in September. Skaar et *al.* estimated the population of kokanee in Libby Reservoir to be about 4.8 million fish from January 1992 to January 1993 and the entrainment to be 1.15 to 4.47 million using the low and high estimates of entrainment respectively. Therefore, the loss of kokanee from the reservoir was estimated at a minimum of 23%, and could have been as high as 92% in 1992.

Due to lack of funding to effectively monitor entrainment from Lake Roosevelt in the present study, we were unable to estimate the number of kokanee being entrained from the reservoir. However, since <1% of fish released as fry were recovered as adults, we have been phasing out fry releases from the hatcheries. Instead we have been releasing more residualized smolts into the reservoir since 1994. This release strategy has probably reduced the amount of entrainment occurring from Lake Roosevelt since these fish are being allowed to residualize at the hatchery.

It is our perception that in years when there is low water retention time (WRT) and low reservoir elevation in Lake Roosevelt, entrainment is higher than in years when there is high WRT and high elevations. In 1991, Thatcher *et* al. (1993) reported that 721 kokanee were collected at Rock Island Dam’s passage facility and an estimate of 25,221 fish were lost over Grand Coulee Dam. During that year the reservoir was drawn down to 1,235 ft with a water retention time of 18 days (Figure 2). In 1995, the reservoir was drawn down 1,259 ft with a water retention time of 40 days and there were no kokanee seen at the fish Passage Facility at Rock Island (Figure 2). Higher flows in 1991 triggered kokanee smoltification and subsequently

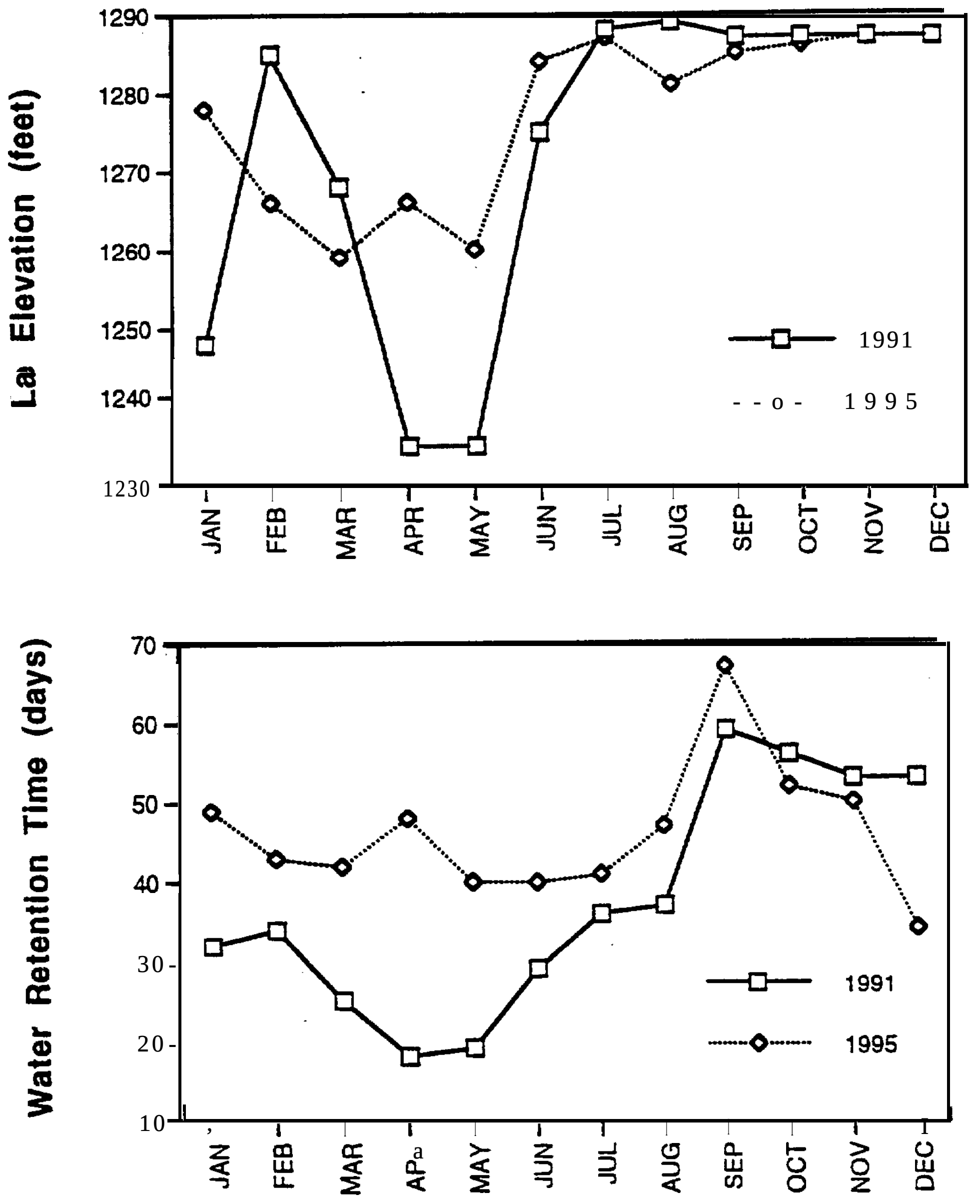


Figure 2. Lake elevation (feet) and water retention time (days) in Lake Roosevelt during 1991 and 1995.

entrainment, while the lower flows in 1995 together with the greater number of residualized smolts released, resulted in less entrainment from Lake Roosevelt. This is reflected in the high CPUE and high numbers of kokanee seen in 1995 when WRT and water elevations were low compared with low CPUE and low numbers of kokanee seen in 1991 when WRT and water elevations were high (Figure 2, Table 11).

The Colville Confederated Tribe is currently monitoring entrainment from Grand Coulee Dam by using hydroacoustic sonars and vertical gill nets in the forebay of Grand Coulee Dam. This will provide a more direct method of monitoring entrainment from Lake Roosevelt. Results of their investigations, combined with continued assessment of kokanee counted at Rocky Reach and Rock Island Dams will provide better information to assess both entrainment and fish losses in future years.

4.2 Kokanee Harvest

The second objective was to assess the best times and locations to release kokanee in order to improve angler harvest and returns to egg collection sites. Only 19 adipose clipped kokanee were observed in the creel and 8 of these had coded wire tags. Too few tagged kokanee were obtained from anglers to assess harvest. Therefore, we recommend intensifying the creel in order to see more adipose clipped/CWT fish.

The Lake Roosevelt Monitoring Program's year round creel survey was designed to expend approximately the same amount of effort each year [(40 hours/week for 50 weeks/year for each clerk (n=3)]. This effort was approximately 6,000 hours creeled each year. In 1995, the Monitoring Program's creel expended 9,055 hours. The kokanee harvest was estimated at 32,353 fish. There were 118 kokanee observed by the creel clerks. Out of these, only one fish was fin clipped and was not coded wire tagged.

In 1995, the site specific augmented creel conducted by EWU was designed to observe as many adipose clipped/CWT kokanee as possible. Therefore, we targeted the locations and times when anglers would be most likely to catch kokanee. We recognize that this biased the number of kokanee observed and we did not use this number to discuss trends between years. However, the number of hours of effort in the augmented creel was relatively low in comparison to the number of kokanee observed (282 kokanee for 37 hours creeled). Therefore, we recommend using this method in future years to try to collect more adipose clipped/CWT kokanee. Not only would it allow us to collect more heads for information on age and growth using CWT analysis, it would also allow us to collect more scales for age and growth determination.

Table 12 shows the mean length and weight of 2, 3 and 4 year old fish captured in 1995. These sizes can be compared to kokanee caught in previous years (Table 13). The mean length of age 2 fish decreased from 350 mm in 1993 to 321 ± 30 mm in 1995. However, the mean weight stayed approximately the same. The mean length and weight of age 3 fish in 1994 was 454 mm and 1,181 g compared to 389 mm and 650 g respectively in 1995 (Tables 12, 13). However, these data are misleading. The reason for the decrease in size could be because during sampling in autumn 1995, the investigators collected heads from the smaller spawners which they thought to be 2 year olds (less than approximately 370 mm). When a larger fish was caught, the investigators would transfer it to holding traps at Sherman Creek or Little Falls for future egg collection. These fish, thought to be primarily 3 and 4 year olds, had an average length and weight of 432 mm and 1,141 g (n=385), which is close to the size of 3 or 4 year old CWT fish in 1994 (Table 13). Unfortunately, many of these fish (approximately 250) were lost due to otter predation and other factors before coded wire tags could be extracted. Therefore, the information gathered from age 3 and 4 year old CWT fish sizes is not accurate because it represents only the smaller sized fish in those age classes.

Table 14 shows the ages of kokanee collected in 1995 based on scale analyses. This information shows that the age 3+ fish (which would be 4 year old spawners) averaged 472 mm and 1,180 g. In addition, Table 15 shows that when fish are sorted according to length (<371 mm = age 2; 371-469 mm = age 3; > 470 mm = age 4), the 3 year old fish averaged 416 mm and 867 g and the 4 year old fish averaged 5 16 mm and 1,403 g. Figure 3 shows a length frequency distribution of age 2, 3, and 4 year old CWT fish. We feel these data (Table 14, 15) portray a more accurate assessment of the sizes of kokanee in Lake Roosevelt than do the information from CWT fish presented in Tables 12 and 13. The distribution of lengths of age 2 and 3 kokanee show some overlap. However, as mentioned above, the data for age 3 fish could be biased toward small fish because of the loss of the larger spawners.

With the CWT kokanee, it is possible to confirm kokanee growth rates in Lake Roosevelt. However, without complete information from all kokanee collected, we cannot assess these growth rates. Lost tags also means other lost information about the effectiveness of the release strategies. We recommend building a new land-based holding system or using in-reservoir, predator proof traps to hold these large spawners until egg collection (See Section 4.3).

Table 12. Mean length (±SD), weight (±SD), range of length and number in sample for kokanee salmon collected in 1995. Ages are based on coded wire tag analyses.

	Length (mm)	Weight (g)	Range (mm)	Number in sample
Age 2	321 ± 30.4	486 ± 141	200-434	1,163
Age 3	389 ± 32.2	650 ± 116.4	310-462	46
Age 4	505 ± 57.2	806 ± 176.1	445-559	3

Table 13. Summary of age, mean length, mean weight of coded wire tagged kokanee caught from 1992 to 1995.

Age at recovery	Year recovered	Total length (mm)	Weight (g)	Number in sample
2	1992	320	347	2
	1993	350	490	66
	1994	337	418	37
	1995	321	486	i.163
	Mean	331	435	
3	1993	503	1,142	2
	1994	454	1,581	24
	1995	389	650	46
	Mean	449	1,124	
4	1994	447	1,508	5
	1995*	505	806	3
	Mean	465	1,060	

* Weight is based on only one fish.

Table 14. Mean length (±SD), weight (±SD), range of length and number in sample for kokanee salmon collected in 1995. Ages are based on scale analyses.

	Length (mm)	Weight* (g)	Range (mm)	Number in sample
Age 1+	219 ± 35	92 ± 38	169-260	5
Age 2+	385 ± 81	437 ± 207	230-520	62
Age 3+	472 ± 60	1,180 ± 559	318-570	113

Table 15. Mean length (±SD), weight (±SD), range of length and number in sample for kokanee salmon collected in 1995 from **electroshocking.** Ages are based on length **<371** mm = age **2, 371-469** mm = age 3, **>470** mm = age 4.

	Length (mm)	Weight (g)	Range (mm)	Number in sample
Age 2	318 ± 28.4	453 ± 117.6	116-370	1520
Age 3	416 ± 27.7	867 ± 216.3	371-468	496
Age 4	516 ± 35.2	1,403 ± 327.4	470-605	235

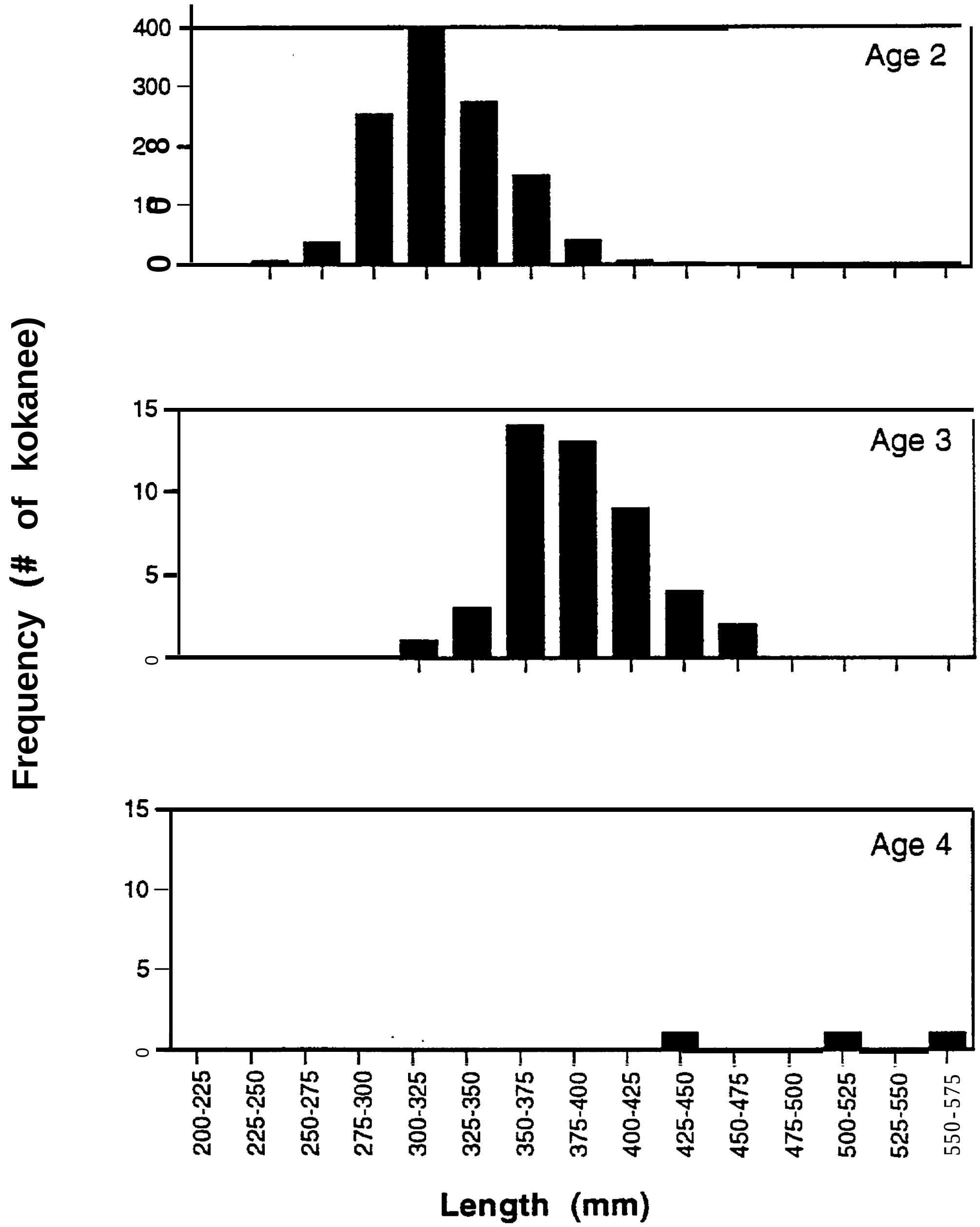


Figure 3. **Length frequency (mm) for coded wire tagged kokanee collected in 1995.**

4.3 Kokanee Egg Production Estimates

One of the goals of the Northwest Power Planning Council's Fish and Wildlife Plan (NPPC 1995) was to release 1 million residualized kokanee smolts into Lake Roosevelt which would provide a kokanee escapement of 1.45 million eggs. This estimate was based on data collected by Peone *et al.* (1990).

In 1988 and 1989, Peone *et al.* (1990) estimated fecundity of Lake Roosevelt kokanee. In 1988, the total length/fecundity regression equation was:

$$y = 4.246(x) - 283.321$$

where: y = number of eggs for individual female, and
x = length of individual fish captured in 1988.

In 1989, the total length/fecundity regression equation was:

$$y = 2.902(x) + 326.013$$

where: y = number of eggs for individual female, and
x = length of individual fish captured in 1988.

In the present report, we measured the potential total egg production to determine if we were on target to achieve the goals mentioned above. We calculated the potential fecundity of individual age 3 and 4 females with lengths >370 mm. The length of individual females recovered in autumn 1995 was substituted for (x) in the above equations and calculated to determine fecundity (y) of that individual. The fecundity of each individual was summed to provide a total estimate of the eggs that could have potentially been produced in 1995 using both the 1988 regression equation ($r^2 = 0.107$) and the 1989 regression equation ($r^2 = 0.416$) (Table 16).

Based on the data collected from Peone et al. (1990), the current estimate was about 523,000 eggs(n=3 18 females) based upon release of approximately 244,995 residualized smolts, so we are on target to achieve this goal (Table 16). A release of 224,995 fish is about 1/4 of our release goal, and it could have provided 1/3 of the egg goal. Therefore, we believe that there is a good probability that we can achieve our egg goal of 1.45 million if 1 million residualized smolt are stocked.

Table 16. Estimates of kokanee salmon fecundity based on females (>370 mm) recovered from September 1 to November 30, 1995. Fecundity was estimated using the 1988 regression equation and the 1989 regression equation (Peone et al. 1990).

Total #eggs using		
1988 regression equation	1989 regression equation	(n)
523,268	522,886	318

This information is encouraging from the standpoint of collecting a sufficient number of eggs to support hatchery operation. However, one of the problems associated with collecting eggs in 1995 was that when the females were electroshocked and moved to holding pens at Sherman Creek cove, the eggs quit developing and didn't ripen. This could have been due to the fact that Sherman Creek water is approximately 10°F colder than Lake Roosevelt temperatures. Therefore, one of our recommendations is to induce spawning with pituitary hormones or steroids.

Investigators have successfully induced spawning in a number of species of fish (Hamman 1985a,b 1986; Ako *et al.* 1994). In addition, several studies have shown that Pacific salmon can be induced to ovulate ahead of normal time using pituitary hormones and/or steroid hormones (Jalabert 1976; Hunter *et al.* 1978; Jalabert et *al.* 1978; Donaldson *et al.* 1981 a,b,c; Sower *et al.* 1982). Fitzpatrick *et al.* (1994) have shown that injections of 5 μg luteinizing hormone releasing hormone analog (LHRHa) followed by another injection of 5 μg induces spawning in coho salmon in 3 days or less. Therefore, we recommend inducing ovulation of kokanee salmon with LHRHa in an experimental lot of fish.

4.4 Management Recommendations

From information gathered in this report and from the previous investigations of Tilson *et al.* (1994, 1995), it was concluded that kokanee salmon released as yearlings (smolts) are recovered in greater numbers than fish released as fry. In addition, chemically exposed fish home more accurately and in greater numbers to egg collection sites. Based upon the results of our investigations, we make the following recommendations for managing Lake Roosevelt kokanee:

(1) To achieve the escapement goal of 1.45 million eggs, more fish must be released into the reservoir. For this to be accomplished, the following must be done:

   a) A new production well capable of delivering 2-4 CFS of additional flow would need to be drilled at the hatchery. This would allow approximately 500,000 fish to be raised to residualized smolt stage instead of the current 100,000 to 300,000 fish. [Note: At present, the hatchery can carryover about 300,000 fish until late March or April. However that is the height of smoltification. The hatchery can currently retain 130,000 to 150,000 fish for release in June.] See Tilson *et* al. (1994) for more discussion on this point.

b) Provide a net pen system that is moveable with three anchoring sites so the pens can be moved if there are drawdowns. One of these sites should be as far into Sherman Creek cove as possible for best site imprinting. The second should also be in Sherman Creek cove, but further out toward the reservoir where these fish could be moved in case of drawdowns. The third site should be in the reservoir off and slightly downstream from Sherman Creek in a place deep enough to withstand a minimum pool elevation of 1,208 feet.

c) We recommend placing 50,000 zero-age fish into net pens from October until the following June when they have residualized (Appendix D). Since there were only 32 recoveries out of 9 1,28 1 smolts released from the Kettle Falls Net Pens, we recommend building new net pens in Sherman Creek cove and discontinuing releases from Kettle Falls Marina. The hatcheries should hold as many kokanee smolts as possible before transferring any fish to the net pens since the best returns came from hatchery released fish. However, if there is not enough room at the hatcheries to hold these fish until release, we recommend using the Kettle Falls Net Pens until the Sherman Creek net pens have been constructed.

d) Initiate experiments with induction of spawning by injecting females with LHRHa or other inducing hormones.

(2) Make effort to monitor Rufus Woods Reservoir for entrained kokanee.

a) Continue to get information from Rock Island, Rocky Reach and McNary Dams on adipose clipped kokanee.

b) Monitor Rock Island Dam earlier in the year, preferably starting in January, instead of May which is the standard time in which the Fish Passage Center's Smolt Monitoring Program starts. We feel that kokanee are being entrained during the winter months through Grand Coulee and Rock Island Dams as well as in early spring.

c) Conduct electrofishing surveys in Rufus Woods reservoir.

d) Studies on entrainment being conducted by the Colville Confederated Tribes need to continue throughout the year. They have been studying entrainment with hydroacoustics at Grand Coulee Dam in the spring, as well as initiating gill net surveys in the forebay of Grand Coulee Dam. According to Skaar et *al.* (1996), most of the kokanee entrainment occurs in the winter months in Lake Koocanusa (See Section 4.2).

(3) Provide more adequate adult holding facilities at Sherman Creek so age 3 and age 4 fish are able to be kept for spawning purposes. In 1995, approximately 250 age 3 and 4 fish were lost owing to river otter predation in traps. We recommend using a land based system of tanks to ensure safety. Additionally, if it became necessary to hold large numbers of fish, we recommend building 4 or 5 otter proof wire holding cages in the reservoir so we can safely hold adults until spawning. That way, we could separate fish that were at different stages of maturity and/or separate sexes in different wire cages.

(4) Modify hatchery ladder entrance to attract spawning kokanee. There are two potential problems with the ladder trap system at Sherman Creek. The hatchery ladder enters Sherman Creek at a right angle instead of parallel to the stream and requires that the fish jump about 8 inches through a narrow slot in order to enter the first pool of the ladder. This construction may cause the fish to avoid the ladder. This is evidenced by the fact that only 3 fish were seen in the ladder. Bell (1986) noted that it is generally more effective to introduce attraction water (a) in parallel rather than perpendicular to the main current, (b) through a bottom diffusing area, so that fish jumping could be reduced to a minimum (kokanee are not known for their jumping). The second problem is that fish do not seem to want to move from the cove at the mouth of the creek, up into the creek. For example, about 70 fish were observed in Sherman Creek near the ladder entrance and about 1,500 fish were observed 100 feet downstream in the cove of the stream. There are two potential reasons these fish are not moving past the cove. One reason may be that the cove provides fish with lots of cover (logs, brush) and is about 12 ft deep whereas the creek is shallow (≈1 ft) with no cover. It could be that fish do not want to move from the covered, protected area of the cove to the open creek. The other reason may be that there is a temperature barrier between the cove and the creek. In past years, there has been a 15°F difference from water in the cove and water in the main creek (M. Combs, Hatchery Manager, Sherman Creek Hatchery). To correct this, we recommend initiating a feasibility study to determine the most effective method of trapping fish. We have identified the following recommendations:

a) Re-engineer the hatchery ladder so the fish can swim up through the steps instead of jumping by punching holes in the steps. We also recommend submerging the ladder entrance to eliminate the jump at the beginning of the ascent.

b) Construct a submerged culvert system to divert the fish from the cove, up to the ladder. To correct the temperature barrier problem, cove water, which is warmer, could be pumped into the fish ladder so it could mix with the colder creek water. Fish could then be lured to the warmer mix of water coming from the culvert, swim up the culvert directly into the ladder.

c) Construct a Merwin trap in the cove to trap fish before they ascended into the creek.

(5) Set up an egg collection site at Hawk Creek since 286 fish were recovered at that site.

(6) We encourage fish managers to locate alternative stocks of kokanee, with better genetic adaptations than Lake Whatcom fish for the Lake Roosevelt Program. This should be tested via coded wire tag investigations by a paired release strategy. For example, tag 20,000 fish from the Lake Whatcom brood stock and 20,000 fish from an alternative stock. Both groups would be subject to the same rearing conditions and release strategies. That way, we could determine which stock is recovered in greater numbers and exhibits better homing ability. We also recommend conducting smolt physiology tests for each stock to determine the time and degree of smoltification, so that they can be stocked into Lake Roosevelt as residualized smolts.

(7) Intensify efforts to recapture more CWT fish by both creel surveys and fisheries (electrofishing/gill net/trawl) surveys so we can compare augmented creel data between years.

(8) As part of the Lake Roosevelt Monitoring Program, further assess potential impacts of walleye predation at kokanee release sites. Since smallmouth bass are increasing dramatically in Lake Roosevelt, also examine smallmouth bass predation on kokanee.

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Appendix A. **Summary of kokanee salmon coded wire tagged at the Spokane Tribal Hatchery In 1994 and 1995. Tagging information includes stage at the time of tagging, mean length (mm) and mean weight (g) at time of tagging, number tagged and number released after retention estimate.**

CWT Code	Date Tagged	Stage @ Tagging	Mean Ln (mm)	Mean Wt (g)	# Injected	# Tagged QCD	% Tagged	% Retention (1)	# CWT Released	Year Released	Stage @ Release
62-52-21	Apr-94	smolt	156	36.7	11,253	11,101	98.6%	98.9	10,979	94	smolt
62-52-22	Apr-94	smolt	156	36.7	9,568	9,435	98.6%	99.0	9,341	94	smolt
62-52-23	Apr-94	smolt	156	36.7	11,128	10,904	98.0%	97.7	10,653	94	smolt
62-52-24	Apr-94	smolt	156	36.7	11,098	10,672	96.2%	97.5	10,405	94	smolt
62-52-25	Apr-94	smolt	157	37.8	11,168	11,029	98.8%	98.7	10,886	94	smolt
62-52-26	Apr-94	smolt	157	37.8	11,236	11,117	98.9%	97.7	10,861	94	smolt
62-52-27	Apr-94	smolt	157	37.8	11,497	11,439	99.5%	98.4	11,256	94	smolt
62-52-28	Apr-94	smolt	167	45.1	11,709	11,512	98.3%	98.4	11,328	94	smolt
62-52-29	May-94	smolt	167	45.1	11,242	11,139	99.1%	98.0	10,919	94	smolt
62-52-30	May-94	smolt	167	45.1	10,899	10,836	99.4%	98.0	10,613	94	smolt
62-52-31	May-94	smolt	168	46.2	11,255	11,169	99.2%	98.3	10,291	94	smolt
62-52-32	May-94	smolt	168	46.2	14,786	13,677	92.5%	98.3	11,140	94	smolt
62-52-33	May-94	smolt	184	60.7	8,484	7,445	87.8%	98.9	7,303	94	smolt
111-2-a	Jun-94	fry	58	1.9	12,750	11,643	91.3%	84.0	9,780	94	fry
111-2-g	Jun-94	fry	58	1.9	11,018	10,132	92.0%	88.0	8,916	94	fry
62-52-34	Jun-94	fry	58	1.9	10,935	10,813	98.9%	91.3	10,099	94	fry
62-52-35	Jun-94	fry	54	1.5	11,252	11,078	98.5%	91.3	10,114	94	fry
62-52-36	Jun-94	fry	54	1.5	11,197	11,072	98.9%	91.6	10,147	94	fry
62-52-37	Jun-94	fry	57	1.8	11,206	11,050	98.6%	94.8	10,475	94	fry
62-52-38	Jun-94	fry	57	1.8	11,218	11,041	98.4%	94.8	10,467	94	fry

(1) Percent retention is estimated by randomly capturing 500 fish after 1 O-20 days and counting the number of fish with tags.

Appendix A. Continued.

CWT Code	Date Tagged	Stage @ Tagging	Mean Ln (mm)	Mean Wt (g)	# Injected	# Tagged QCD [1]	% Tagged	% Retention [2]	# CWT Released [3]	Year Released	Stage @ Release
62-54-37	Jun-95	fry	70	3.4	10,855	10,670	98.3	93.0	9,923	95	fry
62-54-38	Jun-95	fry	70	3.4	11,152	10,004	89.7	93.0	10,271	95	fry
62-54-39	Jun-95	fry	70	3.4	11,397	11,223	98.5	93.0	10,437	95	fry
62-54-40	Jun-95	fry	70	3.4	10,772	10,577	98.2	93.0	9,837	95	fry
62-54-48	Jul-95	fry	75	4.1	11,329	11,281	99.6	97.0	10,943	95	fry
62-52-39	Jun-94	fry	57	1.8	7,896	7,763	98.3	94.8	1,507	95	smolt
62-52-40	Jun-94	fry	60	2.1	10,982	10,919	99.4	95.2	5,682	95	smolt
62-52-41	Jun-94	fry	60	2.1	11,181	11,030	98.6	95.2	10,501	95	smolt
62-53-35	Jul-94	fry	61	2.2	11,189	11,052	98.8	95.2	5,704	95	smolt
62-53-36	Jul-94	fry	61	2.2	11,208	11,070	98.8	95.2	5,713	95	smolt
62-53-37	Jul-94	fry	61	2.2	11,218	11,144	99.3	95.2	5,789	95	smolt
62-53-38	Jul-94	fry	61	2.2	11,114	11,052	99.4	95.2	5,752	95	smolt
62-53-39	Jul-94	fry	57	1.8	11,187	11,154	99.7	95.2	5,806	95	smolt
62-53-40	Jul-94	fry	57	1.8	11,194	11,151	99.6	95.2	5,836	95	smolt
62-53-41	Jul-94	fry	52	1.4	11,180	11,102	99.3	94.3	10,293	95	smolt
62-53-42	Jul-94	fry	52	1.4	11,228	11,131	99.1	94.3	10,197	95	smolt
62-53-43	Jul-94	fry	52	1.4	11,243	11,172	99.4	94.3	10,244	95	smolt
62-53-44	Jul-94	fry	52	1.4	11,238	11,151	99.2	94.3	10,228	95	smolt
62-53-45	Jul-94	fry	52	1.4	11,354	11,210	98.7	94.3	10,301	95	smolt
62-53-46	Jul-94	fry	52	1.4	11,199	11,155	99.6	94.3	10,204	95	smolt
62-53-47	Jul-94	fry	55	1.6	11,239	11,173	99.4	95.7	10,224	95	smolt
62-53-48	Jul-94	fry	55	1.6	11,308	11,268	99.6	96.6	10,410	95	smolt
62-53-49	Jul-94	fry	55	1.6	11,286	11,215	99.4	96.6	10,363	95	smolt
62-53-51	Jul-94	fry	55	1.6	11,169	11,113	99.5	96.6	10,173	95	smolt
62-53-50	Jul-94	fry	55	1.6	11,190	11,128	99.4	96.6	10,285	95	smolt
62-51-25	Aug-94	fry	66	2.8	2,995	2,959	98.8	98.1	1,560	95	smolt
62-53-52	Aug-94	fry	66	2.8	11,203	11,147	99.5	96.6	10,457	95	smolt
62-53-53	Aug-94	fry	66	2.8	11,192	11,143	99.6	96.6	10,590	95	smolt
62-53-54	Aug-94	fry	66	2.8	11,177	11,129	99.6	96.6	10,576	95	smolt

Appendix A. Continued.

CWT Code	Date Tagged	Stage @ Tagging	Mean Ln (mm)	Mean Wt (g)	# Injected	# Tagged QCD 1	% Tagged	% Retention 2	# CWT Released 3	Year Released	Stage @ Release
62-53-55	Aug-94	'fry	66	2.8	11,197	11,128	99.4	96.6	10,380	95	smolt
62-53-56	Aug-94	fry	78	4.6	11,192	11,081	99.0	96.6	10,542	95	smolt
62-53-57	Aug-94	fry	78	4.6	11,195	11,089	99.1	96.6	10,526	95	smolt
62-53-58	Aug-94	fry	66	2.8	11,183	11,136	99.6	97.9	10,725	95	smolt
62-53-59	Aug-94	fry	66	2.8	11,158	11,126	99.7	97.9	10,711	95	smolt
62-51-63	Nov-94	fingerling	116	15	11,658	11,574	99.3	95.4	10,939	95	smolt
62-51-26	Dee-94	fingerling	120	16.8	5,594	5,522	98.7	98.2	5,423	95	smolt
62-51-28	Dee-94	fingerling	120	16.8	8,375	8,301	99.1	98.9	8,210	95	smolt
62-51-34	Dee-94	fingerling	120	16.8	5,483	5,443	99.3	98.9	5,383	95	smolt
62-51-44	Dee-94	fingerling	116	15	6,007	5,960	99.2	95.4	5,637	95	smolt
62-51-24	Jan-95	fingerling	120	16.8	4,932	4,913	99.6	98.3	5,430	95	smolt
62-51-42	Jan-95	fingerling	120	16.8	4,712	4,669	99.1	97.5	4,552	95	smolt
62-51-48	Jan-95	fingerling	124	18.6	11,030	11	00.1	94.5	10,681	95	smolt
62-51-49	Jan-95	fingerling	124	18.6	8,081	8,056	99.7	98.0	7,895	95	smolt
62-51-50	Jan-95	fingerling	124	18.6	7,993	7,975	99.8	99.0	7,736	95	smolt
62-51-53	Feb-95	fingerling	124	18.6	452	448	99.1	99.1	444	95	smolt
62-51-54	Feb-95	fingerling	124	18.6	3,230	3,215	99.5	97.0	3,119	95	smolt

(1) Number actually tagged after running fish through quality control device.
(2) Percent retention is estimated by randomly capturing 500 fish 10-20 days after tagging and counting the number still tagged.
(3) Number cwt released is the number of fish released after mortality.

Appendix B. Total number of kokanee salmon released into Lake Roosevelt from 1992 to 1995. Numbers taken from Appendix C.

STAGE @ RELEASE	1992			1993			1994			1995		
	CWT (n)	AD ONLY (n)	TOTAL (n)	CWT (n)	AD ONLY (n)	TOTAL (n)	CWT (n)	AD ONLY (n)	TOTAL (n)	CWT (n)	AD ONLY (n)	TOTAL (n)
FRY	171,452	21,983	193,435	241,952	3,105	245,057	59,899	8,174	68,073	51,411	4,094	55,505
SMOLT	132,029	0	132,029	80,468	1,845	82,313	137,457	5,225	142,682	369,106	16,944	386,050

Appendix C. **Summary of marked kokanee salmon released into Lake Roosevelt from 1992 to 1995.**

Cohort	Exposure Odor	Exposure Stage	CWT Code	Number Tagged (n)	Adipose clipped only (n)	Release Location	Stage @ Release	Year Released	Comments
90	MOR	Smolt	62-51-12	7,501		Sherman Cr	Smolt	92	
90	MOR	Smolt	62-51-13	2,525		Sherman Cr	Smolt	92	
90	MOR	Smolt	62-51-14	5,392		Sherman Cr	Smolt	92	
90	MOR	Smolt	62-51-15	1,796		Sherman Cr	Smolt	92	
90	MOR	Smolt	62-51-16	3,734		Sherman Cr	Smolt	92	
90	MOR	Smolt	62-51-17	5,691		Sherman Cr	Smolt	92	
90	MOR	Smolt	62-51-18	4,491		Sherman Cr	Smolt	92	
90	MOR	Smolt	62-51-19	3,492		Sherman Cr	Smolt	92	
'90	PEA	Smolt	62-51-13	4,855		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-14	1,665		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-15	7,717		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-16	6,769		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-17	5,477		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-18	7,535		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-19	9,215		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-21	5,143		Sherman Cr	Smolt	92	
90	PEA	Smolt	62-51-22	3,211		Sherman Cr	Smolt	92	
90	NONE		62-51-12	9,756		Blue Cr	Smolt	92	captive brood
90	NONE	-	62-51-20	7,382		Sherman Cr	Smolt	92	captive brood
90	NONE	-	62-51-20	3,153		Lit Falls	Smolt	92	captive brood
90	NONE	-	62-51-21	6,299		Sherman Cr	Smolt	92	captive brood
90	NONE	-	62-51-22	4,124		Sherman Cr	Smolt	92	captive brood
90	NONE	-	62-51-22	4,075		Lit Falls	Smolt	92	captive brood
90	NONE	-	62-51-23	1,872		Sherman Cr	Smolt	92	captive brood
90	NONE	-	62-51-23	9,159		Lit Falls	Smolt	92	captive brood
			TOTAL	132,029	0				

Appendix C. Continued.

Cohort	Exposure Odor	Exposure Stage	CWT Code	Number Tagged (n)	Adipose clipped only (n)	Release Location	Stage @ Release	Year Released	Comments
91	MOR	eye-hatch	62-51-28	2,967	225	Sherman Cr	fry	92	
91	MOR	eye-hatch	62-51-44	3,507	668	Sherman Cr	fry	92	
91	PEA	eye-hatch	62-51-27	10,595	798	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	hatch	62-51-30	10,169	1,006	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	hatch	62-51-32	10,053	994	Sherman Cr	fry	92	Ad,RV 2,000
91	PEA	hatch	62-51-29	10,665	803	Sherman Cr	fry	92	Ad,RV 2,000
91	PEA	hatch	62-51-31	10,599	1,048	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	h-su	62-51-37	10,411	1,030	Sherman Cr	fry	92	Ad,RV 2,000
91	PEA	h-su	62-51-33	9,455	1,413	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	swlmup	62-51-36	7,617	753	Sherman Cr	fry	92	Ad,RV 2,000
91	PEA	swimup	62-51-35	9,323	1,393	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	Feb-fry	62-51-24	4,627	881	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	Feb-fry	62-51-25	6,247	1,190	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	Feb-fry	62-51-26	6,089	1,160	Sherman Cr	fry	92	Ad,RV 2,000
91	PEA	Feb-fry	62-51-34	5,242	783	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	Mar-fry	62-51-38	8,916	882	Sherman Cr	fry	92	Ad,RV 2,000
91	PEA	Mar-fry	62-51-39	9,520	1,298	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	Apr-fry	62-51-40	10,072	1,373	Sherman Cr	fry	92	Ad,RV 2,000
91	PEA	Apr-fry	62-51-41	10,142	1,383	Sherman Cr	fry	92	Ad,RV 2,000
91	MOR	May-fry	62-51-42	5,744	1,094	Sherman Cr	fry	92	
91	PEA	May-fry	62-51-43	9,492	1,808	Sherman Cr	fry	92	
			TOTAL	171,452	21,983				
91	PEA	Smolt	62-51-54	8,196	184	Blue Cr	smolt	93	
91	PEA	Smolt	62-51-48	732	19	Sherman Cr	smolt	93	
91	PEA	Smolt	62-51-49	3,454	89	Sherman Cr	smolt	93	
91	PEA	Smoit	62-51-50	3,567	91	Sherman Cr	smolt	93	
91	MOR	Smolt	62-51-45	12,396	318	Sherman Cr	smolt	93	
91	MOR	Smolt	62-51-46	12,664	325	Sherman Cr	smolt	93	
91	MOR	Smolt	62-51-47	12,970	333	Sherman Cr	smolt	93	
91	NONE	-	62-51-51	9,751	179	Sherman Cr	smolt	93	
91	NONE	-	62-51-52	9,800	180	Sherman Cr	smolt	93	
91	NONE	-	62-51-53	6,938	127	Sherman Cr	smolt	93	
			TOTAL	80,466	1,645	62,212			

Appendix C. Continued.

Cohort	Exposure Odor	Exposure Stage	CWT Code	Number Tagged (n)	Adipose clipped only (n)	Release Location	Stage @ Release	Year Released	Comments
92	PEA	hatch	62-52-32	325		Chamokane Cr	2 year old	94	
92	PEA	eye-hatch	62-52-31	325		Chamokane Cr	2 year old	94	
92	MOR	su-rel	62-52-07	10,870	121	Sherman Cr	fry	93	
92	MOR	su-ret	62-51-55	10,802	266	Sherman Cr	fry	93	
92	PEA	su-rel	62-52-06	10,896	121	Sherman Cr	fry	93	
92	MOR	eye-hatch	62-51-56	10,961	269	Sherman Cr	fry	93	
92	MOR	eye-hatch	62-52-09	3,394	38	Sherman Cr	fry	93	
92	MOR	eye-hatch	62-52-09	7,509	53	Sherman Cr	fry	93	
92	PEA	eye-hatch	62-51-57	10,721	264	Sherman Cr	fry	93	
92	PEA	eye-hatch	62-52-10	10,960	77	Sherman Cr	fry	93	
92	PEA	eye-hatch	62-52-16	10,863	121	Sherman Cr	fry	93	
92	MOR	hatch	62-52-13	11,001	78	Sherman Cr	fry	93	
92	MOR	hatch	62-52-17	10,863	121	Sherman Cr	fry	93	
92	MOR	hatch	62-52-14	10,916	77	Sherman Cr	fry	93	
92	MOR	hatch	62-52-15	9,499	67	Sherman Cr	fry	93	
92	MOR	hatch	62-51-59	10,086	221	Sherman Cr	fry	93	
92	PEA	hatch	62-51-58	10,767	265	Sherman Cr	fry	93	
92	PEA	hatch	62-52-11	10,971	78	Sherman Cr	fry	93	
92	PEA	hatch	62-52-12	11,022	78	Sherman Cr	fry	93	
92	MOR	h-su	62-51-60	10,938	122	Sherman Cr	fry	93	
92	PEA	h-su	62-51-61	11,791	144	Sherman Cr	fry	93	
92	MOR	swimup	62-52-03	10,908	121	Sherman Cr	fry	93	
92	PEA	swimup	62-52-05	10,885	121	Sherman Cr	fry	93	
92	MOR	swimup	62-52-18	2,712	31	Barnaby Cr	fry	93	
92	MOR	h-su	62-52-18	2,712	30	Barnaby Cr	fry	93	
92	PEA	eye-hatch	62-52-18	2,712	30	Barnaby Cr	fry	93	
92	MOR	eye-hatch	62-52-18	2,712’	30	Barnaby Cr	fry	93	
92	PEA	swimup	62-52-19	3,637	41	Barnaby Cr	fry	93	
92	MOR	hatch	62-52-19	3,637	40	Barnaby Cr	fry	93	

Appendix C. Continued.

Cohort	Exposure Odor	Exposure Stage	CWT Code	Number Tagged (n)	Adipose clipped only (n)	Release Location	Stage @ Release	Year Released	Comments
92	MOR	h-su	62-52-19	3,637	40	Barnaby Cr	fry	93	
92	PEA	swimup	62-52-20	1,190	13	Barnaby Cr	fry	93	
92	MOR	hatch	62-52-20	1,190	13	Barnaby Cr	fry	93	
92	MOR	h-su	62-52-20	1,190	14	Barnaby Cr	fry	93	
			TOTAL	241,952	3,105	246,057			
92	MOR	eye-hatch	62-52-31	10,291	975	Blue Cr	smolt	94	
92	MOR	eye-hatch	62-52-32	3,334	91	Blue Cr	smolt	94	
92	MOR	hatch	62-52-30	10,613	338	Sherman Cr	smolt	94	
92	MOR	hatch	62-52-22	2,822	46	Sherman Cr	smolt	94	
92	PEA	hatch	62-52-32	7,806	130	A-Frame	smolt	94	
92	PEA	eye-hatch	62-52-33	8,352	132	A-Frame	smolt	94	
92	MOR	h-su	62-52-26	4,604	232	Sherman Cr	smolt	94	
92	MOR	h-su	62-52-29	10,919	546	Sherman Cr	smolt	94	
92	MOR	swimup	62-52-21	10,979	274	Sherman Cr	smolt	94	
92	MOR	swlmup	62-52-22	6,938	190	Sherman Cr	smolt	94	
92	PEA	swimup	62-52-23	10,653	475	Sherman Cr	smolt	94	
92	PEA	swimup	62-52-24	10,405	694	Sherman Cr	smolt	94	
92	PEA	su-fry	62-52-25	10,886	282	Sherman Cr	smolt	94	
92	PEA	su-fry	62-52-26	6,271	198	Sherman Cr	smolt	94	
92	NONE		62-52-27	11,256	241	KF Net Pen	smolt	94	captive brood
92	NONE	-	62-52-28	11,328	381	KF Net Pen	smolt	94	captive brood
			TOTAL	137,457	5,225	142,662			
93	MOR	al-su	111-2-8	9,780	2,970	Sherman Cr	fry	94	
93	MOR	al-su	111-2-9	8,916	1,216	Sherman Cr	fry	94	
93	MOR	h-su	62-52-35	10,114	1,312	Sherman Cr	fry	94	
93	MOR	h-su	62-52-36	10,147	1,151	Sherman Cr	fry	94	
93	PEA	al-su	62-52-37	10,475	774	Sherman Cr	fry	94	
93	PEA	al-su	62-52-38	10,467	751	Sherman Cr	fry	94	
			TOTAL	59,699	6,174	66,073			

Appendix C. CqntInued.

Cohort	Exposure Odor	Exposure Stage	CWT Code	Number Tagged (n)	Adipose clipped only(n)	Release Location	Stage @ Release	Year Released	Comments
93	PEA	al-su/smolt	62-51-25	1,560	20	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-41	10,293	704	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-42	10,197	697	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-43	10,244	677	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-44	10,228	688	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-45	10,301	728	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-46	10,204	674	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-52	10,457	424	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-53	10,590	418	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-54	10,576	418	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-55	10,380	432	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-58	10,725	275	Sherman Cr	smolt	95	
93	PEA	h-su/smolt	62-53-59	10,711	263	Sherman Cr	smolt	95	
93	NONE		62-51-28	8,210	165	Spokane R	smolt	95	captive brood
93	NONE	-	62-51-34	5,383	100	Spokane R	smolt	95	captive brood
93	NONE	-	62-51-42	4,552	160	Spokane R	smolt	95	captive brood
93	NONE		62-51-49	8,210	165	Spokane R	smolt	95	captive brood
93	NONE	-	62-51-50	7,736	257	Spokane R	smolt	95	captive brood
93	NONE		62-51-53	444	8	Spokane R	smolt	95	captive brood
93	NONE		62-51-54	3,119	111	Spokane R	smoit	95	captive brood
93	NONE	-	62-51-24	5,430	102	Barnaby Cr	smolt	95	captive brood
93	NONE	-	62-51-26	5,423	174	Barnaby Cr	smolt	95	captive brood
93	NONE	-	62-51-48	10,681	349	Barnaby Cr	smolt	95	captive brood
93	NONE		62-52-40	10,295	573	KF Net Pen	smolt	95	captive brood
93	MOR	h-su	62-52-41	10,501	680	KF Net Pen	smoit	95	
93	MOR	h-su	62-53-35	10,522	667	KF Net Pen	smolt	95	
93	MOR	h-su	62-53-36	10,539	669	KF Net Pen	smolt	95	
93	PEA	h-su	62-53-37	10,609	609	KF Net Pen	smolt	95	
93	PEA	h-su	62-53-38	10,522	574	KF Net Pen	smolt	95	
93	PEA	h-su	62-53-39	10,619	568	KF Net Pen	smolt	95	
93	PEA	h-su	62-53-40	10,616	579	KF Net Pen	smolt	95	
93	MOR	al-su	62-53-56	10,542	439	KF Net Pen	smolt	95	

Appendix C. Continued.

Cohort	Exposure Odor	Exposure Stage	CWT Code	Number Tagged (n)	Adipose clipped only (n)	Release Location	Stage @ Release	Year Released	Comments
93	NONE	-	62-52-39	10,130	736	KF Net Pen	smolt	95	captive brood
93	MOR	h-su/smolt	62-51-44	5,637	68	Sherman Cr	smolt	95	
93	MOR	h-su/smolt	62-51-63	10,939	212	Sherman Cr	smolt	95	
93	MOR	al-su/smolt	62-53-47	10,224	426	Sherman Cr	smolt	95	
93	MOR	al-su/smolt	62-53-48	10,410	400	Sherman Cr	smolt	95	
93	MOR	al-su/smolt	62-53-49	10,363	432	Sherman Cr	smolt	95	
93	MOR	al-su/smolt	62-53-50	10,285	417	Sherman Cr	smolt	95	
93	MOR	al-su/smolt	62-53-51	10,173	413	Sherman Cr	smolt	95	
			TOTAL	**369,106**	**16,944**	366,050			
94	MOR	h-su	62-54-37	9,923	932	Sherman Cr	fry	95	
94	MOR	h-su	62-54-38	10,271	881	Sherman Cr	fry	95	
94	MOR	h-su	62-54-39	10,437	960	Sherman Cr	fry	95	
94	MOR	h-su	62-54-40	9,837	935	Sherman Cr	fry	95	
94	MOR	h-su	62-54-48	10,943	386	Chamokane Cr	fry	95	
			TOTAL	**51,411**	**4,094**	**55,505**			

Appendix D. **Recommended release strategy for 1995 cohort kokanee to be released as residualized smolts in 1997.**

Stock	Exposure Chemical	Number Released	Release Site
Captive brood	None	97,000	Little Falls
Lake Whatcom	MOR	241,000	Sherman Creek
Lake Whatcom	MOR	50,000	Net Pens