LAKE ROOSEVELT FISHERIES MONITORING PROGRAM

ANNUAL REPORT
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EXECUTIVE SUMMARY

The purpose of this study was to provide baseline data that could be used to evaluate the effectiveness of two kokanee salmon hatcheries that will produce 8 million kokanee salmon (Oncorhynchus nerka) fry or 3.2 million adults for stocking into Lake Roosevelt. The hatcheries will also produce 500,000 rainbow trout (Oncorhynchus mykiss) fingerlings to support the Lake Roosevelt net-pen programs. The baseline data will also be used to evaluate the effectiveness of the habitat improvement projects ongoing on a separate contract. At the present time, the principle sport fish in the reservoir are net-pen rainbow trout and walleye (Stizostedion vitreum). The goals of this study were to :

#I. Conduct a year-round creel census survey to determine angler pressure, catch rates and composition, growth of fish caught by anglers, and economic value of the fishery. Comparisons will be made before and after hatcheries are on-line to determine hatchery effectiveness:

2. Conduct an assessment of kokanee, rainbow trout, and walleye feeding habits, growth rates, and densities of their preferred prey at different locations in the reservoir and how reservoir operations affect population dynamics of preferred prey organisms. This information will be used to determine kokanee and rainbow trout stocking locations, stocking densities and stocking times;

#3. Conduct a mark-recapture study designed to assess the effectiveness of various release times and locations for hatchery-raised kokanee and net-pen raised rainbow so that fish-loss over Grand Coulee Dam will be minimized, homing to egg collection sites will be improved and angler harvest will be increased.

The objectives of the second year of the monitoring program were :

#I. To determine angling pressure, catch per unit effort, total harvest and the economic value of the

#2. To determine relative abundance of fish species in the reservoir by conducting electrofishing and gillnet surveys at nine index stations during May, August, and October;

#3. To determine growth rates of kokanee, rainbow trout, and walleye based upon backcalculations from scales collected during May, August and October and creel surveys;

#4. To determine density, size, and biomass of zooplankton and how reservoir operations affect their population dynamics;

#5. To determine feeding habits of kokanee, rainbow trout, and walleye and their preferred prey densities; and

#6. To determine migration patterns of tagged walleye and net-pen rainbow trout.

In 1990, the mean reservoir elevation was 1,288 feet for January, 1,286 in February, 1,279 in March, 1,262 in April, 1,260 in May, 1,272 in June, 1,288 in July, 2,289 in August, 1,286 in September, 1,287 in October, 1,288 in November, and 1,284 in December. The highest elevations occurred in June and November at 1,288 feet, and the lowest occurred in May at 1,260 feet.

The mean water retention time was 41 days in January, 36 days in February, 32 days in March, 31 days in April, 29 days in May, 28 days in June, 37 days in July, 45 days in August, 67 days in September, 66 days in October, 46 days in November, and 33 days in December. The highest water retention time occurred in September with 67 days and the lowest in May with 28 days.

Annual reservoir elevation was 1,281 feet and the mean water retention time was 41 days.

From January to December 1990, the estimated angler pressure was estimated at 539,743 ± 94,420 angler hours

Anglers spent an estimated 539,742 hours fishing on Lake Roosevelt in 1990 with an annual average trip length of 3.29 hours per angler. The annual number of angler trips was estimated at 171,725 trips from January to December 13th 1990.

The total annual catch CPUE for all species was 0.46 fish/hour and the mean annual harvest CPUE was 0.38 fish/hour. Kokanee salmon had a mean annual catch CPUE of 0.024 fish/hour and a mean annual harvest CPUE of 0.023 fish/hour. Rainbow trout had a mean annual catch CPUE of 0.127 fish/hour and a mean annual harvest CPUE of 0.124 fish/hour. Walleye had a mean annual catch CPUE of 0.111 fish/hour and a mean annual harvest CPUE of 0.080 fish/hour. Yellow perch had a mean annual catch CPUE of 0.026 fish/hour and a mean annual harvest CPUE of 0.005 fish/hour. Smallmouth bass had a mean annual catch CPUE of 0.033 fish/hour and a mean annual harvest CPUE of 0.024 fish/hour.

Annual estimated catch of all fish species was 240,185 ± 57,391 fish. An estimated 17,756 ± 1,433 kokanee, 81,562 ± 21,013 rainbow trout, 116,473 ± 26,322 walleye, 7,953 ± 3,903 yellow perch, 12,054 ± 3,929 smallmouth bass, and 23 sturgeon were caught in Lake Roosevelt in 1990.

Annual estimated harvest of all fish species was 197,480 ± 46,189 fish. 17,403 ± 1,382 kokanee, 79,683 ± 20,620 rainbow trout 82,284 ± 18,579 walleye, 3,641 ± 1,443 yellow perch, 10,033 ± 3,375 smallmouth bass, and 17 sturgeon were harvested in Lake Roosevelt in 1990.

The mean lengths and weights of fish harvested were 391 mm and 557 g for kokanee, 346 mm and 485 g for rainbow trout, 376 mm and 435 g for walleye, 266 mm and 293 g for yellow perch, 223 mm and 272 g for smallmouth bass, and 1383 mm for sturgeon.

The economic value of the Lake Roosevelt sport fishery was estimated to be 5.3 million dollars based upon a figure of $30.91 spent per angler trip in 1990.

In 1990, 8,561 fish In 1990, 8,561 fish (25 species) were collected during gillnet and electrofishing surveys. Percidae comprised 58%, of the relative abundance surveys followed by Catostomidae at 20%, Salmonidae at 17%, Cyprinidae at 7%, Centrarchidae at 4%, Cottidae at 2%, and Gadidae and Ictaluridae at <1%. Highest species relative abundance was yellow perch at 45%, followed by largescale sucker at 19% and walleye at 13%. Kokanee comprised <1% in relative abundance surveys and rainbow trout comprised 3 percent.

Growth rates of kokanee were greater than the average of 21 other kokanee producing waters in British Columbia, Idaho, Oregon, Montana, and Washington used for comparison. Mean lengths collected during relative abundance surveys were 276 mm, 380 mm, and 447 mm for age class 1+, 2+ and 3+ respectively. Mean weights collected during relative abundance surveys were 301 g, 607 g, and 923 g for age class 1+, 2+, and 3+ respectively. The mean condition factors were 0.98, 1.06, and 1 .00 for age class 1+, 2+, and 3+ respectively. The annual mean condition factor for all age classes combined was 1.01.

Mean lengths of kokanee harvested by anglers on Lake Roosevelt, indicated that kokanee growth is superior to that from other locations. The average size of kokanee harvested in Lake Roosevelt was 391 mm in 1990 compared to the mean lengths.of harvested fish in Lake Coeur d'Alene, ID was 317 mm; 270 mm at Spirit Lake, ID; 262 mm at Odell Lake, OR; 330 mm at Flathead Lake, MT; 290 mm at Pend Oreille Lake, ID. Collectively these data show that the kokanee harvested from Lake Roosevelt are of a larger size than those harvested from nearby lakes.

Growth rates of rainbow were greater than or equal to the average of 21 other rainbow producing waters in the western United States and British Columbia used for comparison. Mean lengths of rainbow collected during relative abundance surveys were 250 mm, 292 mm, 338 mm, 375 mm, 452 mm, 453 mm, and 493 mm for age class 0+, 1+, 2+, 3+, 4+, 5+, and 6+ respectively. The mean weights collected during relative abundance surveys were 233 g, 407 g, 551 g, 599 g, 828 g, 921 g, and 1020 g for age class 0+, 1+, 2+, 3+, 4+, 5+, and 6+ respectively. The condition factors were 1.16, 1.09, 1.04, 1.05, 0.91, 0.96, and 0.86 for age class 0+, 1+, 2+, 3+, 4+, 5+, and 6+ respectively. The annual mean condition factor for all age classes combined was 1 .01.

Mean size of rainbow harvested by anglers was 346 mm in length and 485 g in weight in 1990.

The growth of walleye was average when compared to walleye growth from 16 different walleye producing waters. Mean lengths of walleye collected during relative abundance surveys were 150 mm, 231 mm, 327 mm, 403 mm, 454 mm, 521 mm, 613 mm, 688 mm, 736 mm, and 765 mm for age class 0+, 1+, 2+, 3+, 4+, 5+, 6+, 7+, 8+, and 9+ respectively. Mean weights collected during relative abundance surveys were 39 g, 113 g, 303 g, 553 g, 792 g, 1317 g, 2170 g, 3222 g, 4011 g, and 2611 g for age class 0+, 1+, 2+, 3+, 4+, 5+, 6+, 7+, 8+, and 9+ respectively. The condition factors were 0.93, 1.05, 0.81, 0.81, 0.82, 0.89, 0.94, 1.00, 1.00, and 0.58 for age class 0+, 1+, 2+, 3+, 4+, 5+, 6+, 7+, 8+, and 9+ respectively. The annual mean condition factor for all age classes combined was 0.88.

Mean size of walleye harvested by anglers was 376 mm in length and 435 g in weight in 1990.

Lake Roosevelt zooplankton samples indicated an abundance of large copepods and cladocerans 1990. Adult Copepods comprised 30% of the population and Adult Cladocera comprised 16% of the population. *Daphnia* spp. accounted for 89% of the Cladocera density. Many large cladocerans were Daphnia *schødleri* and *L. kindti*, primary food sources for planktiverous fish. *Epischura* nevadensis was one of the large copepods found.

Mean annual density values collected during May, August, and October, were 482/m^3 at Kettle Falls, 3,277/m^3 at Gifford, 7,1 22/m^3 at Hunters, 18,622/m^3 at Porcupine Bay, 4,478/m^3 at Little Falls, 8,764/m^3 at Seven Bays, 9,372/m^3 at Keller Ferry, 10,229/m^3 at Sanpoil, and 8,954/m^3 at Spring Canyon. Mean annual microcrustacean zooplankton density (excluding nauplii) for the entire reservoir was 7,922/m^3 comprised of 2,71 1/m^3 adult Cladocera and 5,166 adult Copepod/m^3.

Mean annual density of microcrustacean zooplankton collected at Porcupine Bay (index station 4) on the Spokane Arm from January to December were 6,815/m^3 adult Copepoda, 2,890 adult Cladocera/m^3, and 11,069 nauplii/m^3. Daphnia spp. accounted for 89% of the Cladocera density at 2,585/m^3. Mean annual density of microcrustacean zooplankton collected at Seven Bays (index station 6) on the Columbia mainstem from January to December were 5,059/m^3 adult Copepoda, 2,117 adult Cladocera/m^3, and 7,248 nauplii/m^3. Daphnia spp. accounted for 78% of the Cladocera density at 1,656/m^3.

Mean annual biomass values of *Daphnia* spp. collected during May, August, and October, were 3,871 $\mu g/m^3$ at Kettle Falls, 33,763 $\mu g/m^3$ at Gifford, 144,469 $\mu g/m^3$ at Hunters, 134,740 $\mu g/m^3$ at Porcupine Bay, 412,293 $\mu g/m^3$ at Little Falls, 71,463 $\mu g/m^3$ at Seven Bays, 152,717 $\mu g/m^3$ at Keller Ferry, 162,408 $\mu g/m^3$ at Sanpoil, and 100,252 $\mu g/m^3$ at Spring Canyon. Mean annual biomass value for the entire reservoir was 90,664 $\mu g/m^3$.

Mean annual Cladocera biomass values collected at Porcupine Bay (index station 4) on the Spokane Arm from January to December were 68,667 $\mu g/m^3$. Daphnia spp. accounted for 99% of the Cladocera biomass at 68,136 $\mu g/m^3$. Mean annual Cladocera biomass values collected at Seven Bays (index station 6) on the Columbia mainstem from January to December were 47,604 $\mu g/m^3$. Daphnia spp. accounted for 99% of the Cladocera biomass at 47,090 $\mu g/m^3$.

In 1990, mean zooplankton biomass at 91 mg/m^3 was extremely high when compared to other kokanee producing lakes. Lake Pend Oreille, for example had a 5 year mean of 38.7 mg/m^3, Lake Coeur d'Alene showed a 3 year mean of 36.8 mg/m^3, Priest Lake had 27.7 mg/m^3, Upper Priest Lake had 25.5 mg/m^3, and Spirit Lake had a mean of 39.7 mg/m^3. This numbers indicated that lake Roosevelt had roughly 3 times the biomass of other kokanee producing lakes.

From the 1990 results it appears that current zooplankton levels are sufficient to support the proposed introduction of 8 million kokanee fry into Lake Roosevelt. From a previous study done by the U.S Fish and Wildlife Service, Cladocera density was 1,081/m^3 in 1980 and 3,578 /m^3 in 1982 copepod density was 2,407/m^3 in 1980, 7,437/m^3 in 1982. The 1990 density values fell in between these values at 2,71 1/m^3 adult Cladocera and 5,166 adult Copepod/m^3. It is important to note that the U.S. Fish and Wildlife Service proposed the stocking of 16 million kokanee fry or 8 million adults whereas current stocking levels are 8 million fry or 3.2 million adults. This reduced level of stocking is to ensure no harm will come to the zooplankton community or to the fishery from over stocking.

Zooplankton density and biomass levels did not increase until water retention times increased. However water retention times between April and September of 1990 were 82% of the 1989 water retention times for the same period. This resulted in 1990 density and biomass values that were 20 to 50% of 1989 values. Collectively, these data suggest that water retention times of 30 days in the spring is not only important in establishing the timing of the increases in zooplankton standing crops but may be critical in determining the density and biomass values that are found later in the year.

Feeding habits of kokanee, rainbow trout and walleye were found to differ. Kokanee were principally planktivorous, walleye picivorous and rainbow omnivorous, feeding on zooplankton, fish, benthic macroinvertebrates and terrestrial insects based on index of relative importance values.

The predominant prey items for all age classes of kokanee were 49% for *D. schødleri*, followed by Chironomidae at 17%, and *L. kindti* at 6 percent. Size selective predation by kokanee was not intensive with values ranging from +0.03 to +0.17.

The predominant prey items for all age classes of rainbow were 18% for D. *schødleri* followed by Chironomidae at 14%, and terrestrial and organic detritus at 11 percent. Positive electivity values of +0.01 to +0.18 were found but size selective predation was not intensive.

The predominant prey item for all age classes of walleye were 23% for Percidae, and 16% *L. kindti*, and 10% Cottidae.

Diet overlaps between fish species were low with the highest being 0.65 between kokanee and rainbow. Upon further inspection, age #3+ kokanee and rainbow demonstrated overlaps in the spring at 0.72 indicating competition. The second highest overlap occurred in summer between 0+ kokanee and rainbow at 0.61.

Tagging of net-pen reared rainbow was designed to determine the best release time of the net-pens to minimize fish loss over Grand Coulee Dam. March releases had the highest percent of fish recoveries below Grand Coulee Dam and the lowest percent of recoveries within Lake Roosevelt. May releases had the lowest percent of fish recoveries below Grand Coulee Dam and the highest percent of recoveries within Lake Roosevelt. This suggested the the best time to release net-pen rainbow is in late spring or early summer when water levels are rising and fish are not as susceptible to flushing.

Walleye tagged in Lake Roosevelt that were recovered in 1990 suggest that walleye continue to migrate throughout the reservoir utilizing the Spokane Arm as their primary spawning grounds.

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1 .0 INTRODUCTION

As partial mitigation for the loss of anadromous salmon and steelhead incurred by construction of Grand Coulee Dam, the Northwest Power Planning Council directed Bonneville Power Administration (BPA) to construct two kokanee salmon (*Oncorhynchus nerka*) hatcheries on Lake Roosevelt (NPPC 1987 [Section 903 (g)(l)(C)]). The hatcheries are to produce 8 million kokanee salmon fry or 3.2 million adults for outplanting into Lake Roosevelt as well as 500,000 rainbow trout (*Oncorhynchus mykiss*) for the Lake Roosevelt net-pen programs. In section 903 (g)(l)(E), the Council also directed BPA to fund a monitoring program to evaluate the effectiveness of the kokanee hatcheries. The monitoring program included the following components: 1) conduction of a year-round creel census survey to determine angler pressure, catch rates and composition, growth and condition of fish caught by anglers, and economic value of the fishery. Comparisons will be made before and after hatcheries are on-line to determine hatchery effectiveness; 2) conduct an assessment of kokanee, rainbow trout, and walleye feeding habits, growth rates, and densities of their preferred prey at different locations in the reservoir and how reservoir operations affect population dynamics of preferred prey organisms. This information will be used to determine kokanee and rainbow trout stocking locations, stocking densities and stocking times; 3) conduct a mark-recapture study designed to assess effectiveness of various release times and locations for hatchery-raised kokanee and net-pen raised rainbow so fish-loss over Grand Coulee Dam will be minimized, homing to egg collection sites will be improved and angler harvest will be increased. The above measures were adopted by the Council based on a management plan developed by Upper Columbia United Tribes Fisheries Center, Spokane Indian Tribe, Colville Confederated Tribes, Washington Department of Wildlife, and the National Park Service. This plan examined the feasibility of restoring and enhancing Lake Roosevelt fisheries (Scholz et al. 1986). In July 1988, BPA entered into a contract with the Spokane Indian Tribe to initiate the monitoring program and continue research through 1995. This report contains the results of the monitoring program from January to December 1990.

1.1 DESCRIPTION OF STUDY AREA

Lake Roosevelt is a mainstem Columbia River impoundment formed by the construction of Grand Coulee Dam in 1939 (Figure 1.1.1). Filled in 1941, the reservoir inundated 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 et *al.* 1981).

1.2 SUMMARY OF 1988 AND 1989 FISHERIES INVESTIGATIONS

1.2.1 Reservoir Operations

In 1988, mean monthly water retention times were; 34 days January, 38 days in February, 39 days in March, 50 days in April, 40 days in May, 45 days in June, 59 days in July, 57 days in August, 52 days in Septembers, 57 days in October, 47 days in November, and 29 days in December. In 1989, mean monthly water retention time was; 26 days January, 25 days in February, 35 days in March, 33 days in April, 23 days in May, 40 days in June, 65 days in July, 75 days in August, 68 days in Septembers, 60 days in October, 49 days in November, and 46 days in December. Differences in water retention time between 1988 and 1989 were attributed to difference in winter climate between the two years and the cessation of a three year drought period in 1989.

1.2.2 Creel Survey

In August through December of 1988, harvest was estimated at 125,891 fish, consisting of 9,400 kokanee salmon, 86,100 rainbow trout, 23,000 walleye, 1,210 yellow perch, and 6,207 smallmouth bass. In 1989, harvest was estimated at 164,227 fish, consisting of 12,000 kokanee salmon, 65,500 rainbow trout, 80,600 walleye, 1,631 yellow perch, 8 largemouth bass, 1,538 smallmouth bass, 691 black crappie, and 12 burbot. Additionally, 34 sturgeon were harvested as determined by actual counts performed during creel surveys in 1989.

Mean lengths and weights of fish harvested from August to December 1988 were: 432 mm and 739 g for kokanee, 391 mm and 767 g for rainbow trout, 436 mm and 508 g for walleye, 222 mm and 154 g for yellow perch, and 309 mm and 489 g for smallmouth bass.

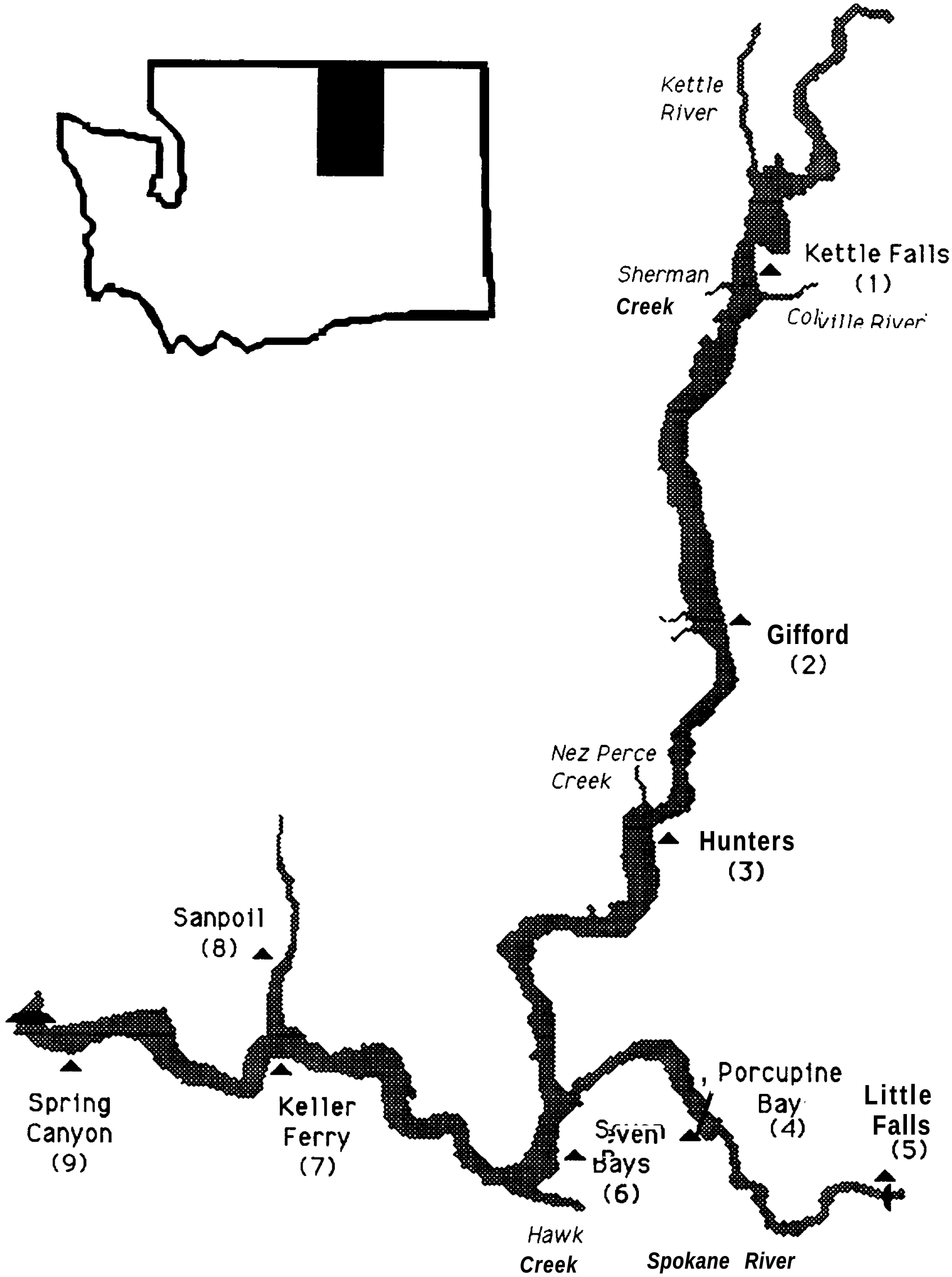


Figure 1.1.1 Lake Roosevelt, WA indicating location of nine index stations used for sampling fish and zooplankton

Mean lengths and weights of fish harvested in 1989 were: 411 mm and 580 g for kokanee, 403 mm and 710 g for rainbow trout, 447 mm and 723 g for walleye, 694 mm and 2,450 g for chinook salmon, 559 mm and 1,420 g for lake whitefish, 212 mm and 190 g for yellow perch, 326 mm and 605 g for largemouth bass, 313 mm and 359 g for smallmouth bass, 209 mm and 146 g for black crappie, 1,390 mm for sturgeon, and 680 mm for burbot.

In August to December of 1988, fishing pressure was estimated at 262,000 angler hours, (70,000 angler trips), and economic value of the fishery was estimated at $2.03 million. In 1989, fishing pressure was estimated at 756,400 angler hours, (140,000 angler trips), and economic value of the fishery was estimated at $4.04 million.

1.2.3 Relative Abundance Surveys

From August 1988 to December 1989, 10,907 fish (26 species) were collected during electrofishing and gillnet surveys. Yellow perch had the highest relative abundance at 36% (3,947 fish), followed by walleye at 19% (2,017 fish), largescale sucker at 7% (1,309), sucker fry at 6.6% (724), rainbow trout 6.6% (714), kokanee salmon 4.1% (449), lake whitefish 2.7% (296), smallmouth bass 1.9% (205), piute sculpin 1.7% (190), carp 1.5% (160), bridgelip sucker 1.4% (146), black crappie 1 .1 % (116), largemouth bass 0.9% (96), brown trout 0.5% (49), peamouth 0.4% (46), burbot 0.2% (36), longnose sucker 0.2% (26), mountain whitefish 0.1% (16), chinook salmon 0.1% (12), pumpkinseed 0.1% (9), yellow bullhead 0.1% (7), tench >0.1% (5), brook trout >0.1 % (4), chiselmouth >0.1% (2), cutthroat trout >0.1% (1), and bull trout >0.1% (1).

1.2.4 Growth Comparisons

In 1988, average total lengths and weights of adult kokanee collected during electrofishing and gillnet surveys were: **368** mm and 494 g for age 2+, 463 mm and 1,052 grams for age 3+, and 525 mm and 1,576 g for age 4+ fish. These values represented an average growth of 100 mm and 500 g per year. In 1989, average lengths and weights of adult kokanee were: 385 mm and 590 g for age 2+, 413 mm and 813 g for age 3+, and 425 mm and 905 g for age 4+ fish. These values represented an average growth of 150 mm and **300** g per year.

Back-calculated growth rates of kokanee were greater than the average of 19 kokanee producing lakes in Washington, Idaho, Oregon, Montana, and British Columbia. Comparison of kokanee caught by anglers also indicated that kokanee growth in Lake Roosevelt was superior to that from other locations. The average size of kokanee harvested in Lake Roosevelt was 432 mm in 1988 and 411 mm in 1989. For comparison, the mean length of fish harvested from Lake Coeur d'Alene, ID was 317 mm; 270 mm at Spirit Lake, ID; 262 mm at Odell Lake, OR; 330 mm at Flathead Lake, MT; and 290 mm at Pend Oreille Lake, ID.

In 1988, average lengths and weights of adult rainbow trout in Lake Roosevelt were: 325 mm and 464 grams for age 1+, 447 mm and 1,038 g for age 2+, 473 mm and 1,096 g for age 3+, and 508 mm and 1,096 g for age 4+ fish. This represented an average growth rate of 100 mm per year and 500 grams per year for 1+ and 2+ age fish. In 1989, average lengths and weights of adult rainbow trout were: 256 mm and 218 g for age 1+, 394 mm and 572 g for age 2+, 429 mm and 902 g for age 3+, 483 mm and 1,058 g for age 4+ fish. This represents an average growth rate of 100 mm per year and approximately 350 g per year for 1+ and 2+ age fish. Growth rates of rainbow trout, based on back-calculation from scales, were greater than the average of 20 other lakes and river systems in the western United States used for comparison.

In 1988, average lengths and weights of adult walleye in Lake Roosevelt were: 206 mm and 82 g for age 1+, 274 mm and 182 g for age 2+, 345 mm and 350 g for age 3+, 405 mm and 576 g for age 4+ fish, 478 mm and 923 g for age 5+ fish, 533 mm and 1,386 g for age 6+ fish, 742 mm and 4,050 g for age 9+ fish, and 761 mm and 4,250 g for age 10+ fish. In 1989, average lengths and weights of adult walleye were: 245 mm and 142 g for age 1+, 300 mm and 262 g for age 2+, 395 mm and 568 g for age 3+, 419 mm and 750 g for age 4+ fish, 496 mm and 1,037 g for age 5+ fish, 517 mm and 1,467 g for age 6+ fish, and 612 mm and 1,821 g for age 7+ fish. Growth rates of walleye in 1988 and 1989 were about average for walleye lakes in the midwestern United States, but lower than those reported for John Day Pool on the Columbia River.

1.2.5 Zooplankton Dynamics

Lake Roosevelt microcrustacean zooplankton samples indicated an abundance of large Copepoda and Cladocera in 1988 and 1989.

Adult Copepoda comprised 33% of the population followed by adult Cladocera which comprised 22% of the population. *Daphnia* spp. accounted for 90.4% of the Cladocera density. Large species of zooplankton included the cladocerans Daphnia *schødleri* and *Leptodora kindti*, and the copepod *Epischura nevadensis*.

Mean microcrustacean zooplankton densities collected from Lake Roosevelt in 1988 were 6,589 Cladocera/m^3, 8,929 adult Copepoda/m^3 and 2,920 nauplii/m^3. Daphnia spp. accounted for 92.6% of the Cladocera density at 6,108 *Daphnia*/m^3.

Mean microcrustacean zooplankton densities collected from Lake Roosevelt in 1989 were 4,378 Cladocera/m^3, 6,540 adult Copepoda/m^3 and 8,595 nauplii/m^3. Daphnia spp. accounted for 90.4% of the Cladocera density at 3,957 *Daphnia*/m^3.

Mean annual microcrustacean zooplankton density values for 1989 were: 2,482/m^3 at Kettle Falls, 5,632/m^3 at Gifford, 8,608/m^3 at Hunters, 27,325/m^3 at Porcupine Bay, 12,613/m^3 at Little Falls, 9,274/m^3 at Seven Bays, 11,527/m^3 at Keller Ferry, 11,527/m^3 on the Sanpoil Arm, and 7,914/m^3 at Spring Canyon. Highest densities were found on the Reservoir Arms which included Porcupine Bay, Little Falls, and the Sanpoil Arm.

Mean annual Daphnia spp. biomass values for 1988-89 were: 77,480 $\mu g/m^3$ at Kettle Falls, 154,050 $\mu g/m^3$ at Gifford, 171,166 $\mu g/m^3$ at Hunters, 308,048 $\mu g/m^3$ at Porcupine Bay, 50,086 $\mu g/m^3$ at Little Falls, 135,693 $\mu g/m^3$ at Seven Bays, 42,585 $\mu g/m^3$ at Keller Ferry, 139,628 $\mu g/m^3$ on the Sanpoil Arm, and 78,626 $\mu g/m^3$ at Spring Canyon. Highest biomass values were found on the Spokane Arm and the central portion of the reservoir at Hunters and Seven Bays. Biomass values were extremely high when compared to other kokanee producing lakes. Lake Pend Oreille, for example, had a 5 year mean of 38.7 mg/m3, Lake Coeur d'Alene had a 3 year mean of 36.8 mg/m^3, Priest Lake had 27.7 mg/m^3, Upper Priest Lake had 25.5 mg/m^3, and Spirit Lake had a mean of 39.7 mg/m^3. This indicated that Lake Roosevelt had 3 to 4 times the biomass of other kokanee producing lakes at 128.6 mg/m^3.

Data indicated that reservoir operations had an effect on zooplankton density and biomass. Once water retention time within the reservoir increased to 30-35 days in the spring, significant increases in zooplankton densities were observed. A threshold water retention time of 30 days in the spring appeared to be the key in establishing an increase in zooplankton standing crops.

1.2.6 Feeding Habits

Feeding habits of kokanee, rainbow trout, and walleye were found to differ. Kokanee were principally planktivorous, walleye picivorous and rainbow omnivorous, feeding on zooplankton, fish, benthic macroinvertebrates, and terrestrial insects. In 1988, kokanee demonstrated an index of relative importance (IRI) of 67% for Daphnia *schødleri*, 8.2% for organic detritus, and 6.1% for Cladocera ephippia. Rainbow trout demonstrated an IRI value of 34% for Daphnia *schødleri*, 8.1% for *Leptodora* kindti, and 6.6% for Chironomidae pupae. Walleye demonstrated an IRI value of 13.4% for Percidae, 10.4% for Cottidae, and 10.3% for unidentifiable fish. In 1989, kokanee demonstrated an IRI value of 58% for Daphnia *schødleri*, 9.4% for walleye eggs, and 9.1% for Chironomidae pupae. Lake whitefish demonstrated an IRI value of 23.6% for Daphnia *schødleri*, 11.6% for Chironomidae pupae, and 9.1% for organic detritus. Rainbow trout demonstrated an IRI value of 34.6% for walleye. eggs, 28.6% for organic detritus, and 12.4% for terrestrial insects. Walleye demonstrated an IRI value of 21 .1% for unidentifiable fish, 16.3% for Percidae, and 10.2% for Cottidae.

Kokanee size selectively preyed on Daphnia spp. as evidenced by positive electivity indices ranging between + 0.01 and + 0.35 for Daphnia spp. ranging between 1.6 mm and 2.4 mm in 1988 and 1989. Size selective predation was not intensive in either year for rainbow trout. Daphnia spp. were consumed principally by younger age classes of walleye while older walleye preferred a fish diet consisting primarily of Percidae and Cottidae, and did not appear to be preying on salmonids in significant amounts.

Diet overlaps between kokanee, rainbow, and walleye were relatively low. In 1988, kokanee and rainbow had the highest overlap with 0.786. In 1989, the highest overlap was 0.669 between kokanee and lake whitefish. These overlaps occurred due to the consumption of Daphnia spp. between kokanee, rainbow, and lake whitefish. However, overlaps occurred during seasons of high Daphnia spp. densities and were therefore considered to be relatively low overlaps.

1.2.7 Tagging Studies

1.2.7.1 Net-Pen Tagging Studies

Results of tagging studies with net-pen reared rainbow trout indicated that trout released in early spring migrated faster downstream than those released in late spring. In June 1986, 446 rainbow trout were tagged and released from the Seven Bays net-pen. From this release, 21.3% were harvested, 66.3% of these fish were captured within 20 km of the net-pen and 0.9% were captured below Grand Coulee Dam. In May 1987, 613 trout were tagged and released from Seven Bays. From this release, 13.7% were harvested, 71.4% of these were captured within 20 km of the net-pen and 0.0% were captured below Grand Coulee Dam. In June 1987, 199 trout were tagged and released from Seven Bays. From this release, 16.6% were harvested, 72.0% of these were captured within 20 km of the net-pen and 0.0% were captured below Grand Coulee Dam. In May 1988, 1 ,1 11 trout were tagged and released from Seven Bays. From this release, 9.9% were harvested, 57.2% of these were captured within 20 km of the net-pen and 1.8% were captured below Grand Coulee Dam. In May 1988, 918 trout were tagged and released from Seven Bays. From this release, 3.0% were harvested, 38.2% of these were captured within 20 km of the net-pen and 26.4% were captured below Grand Coulee Dam. In May 1988, 845 trout were tagged and released from Hunters. From this release, 1.9% were harvested, 27.2% of these were captured within 20 km of the net-pen and 33.3% were captured below Grand Coulee Dam. Reservoir operation in 1989 was determined to be the main cause for percentages of fish lost over Grand Coulee Dam compared to the 1988 loss. Water retention time in March, April, and May of 1988 was 39, 50, and 40 days respectfully, whereas water retention time in March, April, and May of 1989 was 36, 33, and 23 days respectively. This caused the reservoir to be more riverine in nature and “flushed” the fish through the system. Therefore it was recommended that the trout be held in the net-pens until May or June when water retention time within the reservoir is greater than 30 days, to decrease fish loss over Grand Coulee Dam.

1.2.7.2 Walleye Migration

Results of tagging studies with walleye conducted on the Spokane Arm and at each sampling station indicated that walleye migrated extensively throughout the reservoir. Tag return data indicated that 38.5% of the fish tagged at Porcupine Bay (their spawning grounds) in 1988 and 1989 were recovered in the same vicinity, and 61.5% were recaptured outside the Spokane Arm. Travel estimates of fish migrating from the Spokane Arm to Kettle Falls, showed an average travel time of 3.3 km/day.

1.2.8 Kokanee Fecundity Estimates

Lake Roosevelt kokanee total length and fecundity was the highest reported for any of the lakes in the Inland Northwest. Mean fecundity for 3+ kokanee in 1988 was 1,728 eggs/female, and 1,615 eggs/female in 1989. This observation was encouraging from the standpoint of collecting a sufficient number of eggs to support hatchery operations.

1.3 STUDY OBJECTIVES-1990

The objectives of the second year of the monitoring program were to determine:

#1. Angling pressure, catch per unit effort, total harvest, and the economic value of the fishery by conducting a year-round, reservoir-wide creel survey;

#2. Relative abundance of fish species in the reservoir by conducting electrofishing and gillnet surveys at nine index stations during May, August, and October;

#3. Growth rates of kokanee, rainbow trout, and walleye based upon back-calculations from scales collected during the May, August, and October and creel surveys;

#4. Densities, size, and biomass of zooplankton and how reservoir operations affect their population dynamics; and

#5. Feeding habits of kokanee, rainbow trout, and walleye and their preferred prey densities;

#6. Migration patterns of tagged walleye and net-pen reared rainbow trout from tag returns sent in by anglers.

2.0 MATERIALS AND METHODS

2.1 RESERVOIR ELEVATION AND WATER RETENTION

Reservoir elevation and water retention time were calculated by obtaining daily midnight reservoir elevation (ft) and total outflow (KCFS) from daily summary reports for Grand Coulee Dam prepared monthly in 1990 by the U.S. Army Corps of Engineers, Reservoir Control Center in Portland, OR. Reservoir elevation (ft) was converted to volume of water stored (KCSFD) using a U.S. Army Corps of Engineers (1981) reservoir water storage table. Water retention time was calculated using the formula:

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

Mean reservoir elevation and water retention time for the month were calculated by adding the daily values for each category and dividing by the number of days in each month.

2.2 CREEL SURVEY DESIGN AND PROCEDURES

A two-stage probability sampling scheme (Lambou 1961;1966, Malvestuto 1983) was used to determine annual fishing pressure, catch-per-unit-effort (CPUE), and sport fish harvest by species on Lake Roosevelt. Creel surveys were conducted at Spokane and Colville tribal campgrounds and National Park Service (NPS) boat launches for a total of 48 survey locations (Fig 2.2.1) (Appendix B).

Three creel clerks were employed to interview anglers at access points along Lake Roosevelt according to monthly schedules for an average of 21 days per month for each creel clerk. Creel schedules consisted of instantaneous pressure counts of the entire reservoir and effort counts at access points. Schedules were constructed by dividing each month into weekday and weekend/holiday stratum. Four weekdays and four weekend/holidays were randomly selected to schedule pressure counts and remaining days were scheduled as effort counts. Days were stratified into a.m. (sunrise to 12:00) and p.m. (12:00 to sunset) time periods. Four air flights (one flight per stratum) were scheduled to coincide with pressure counts. Index cards printed with major access locations were used to determine effort count schedules (Appendix B). Random days were selected and cards drawn determined scheduling location

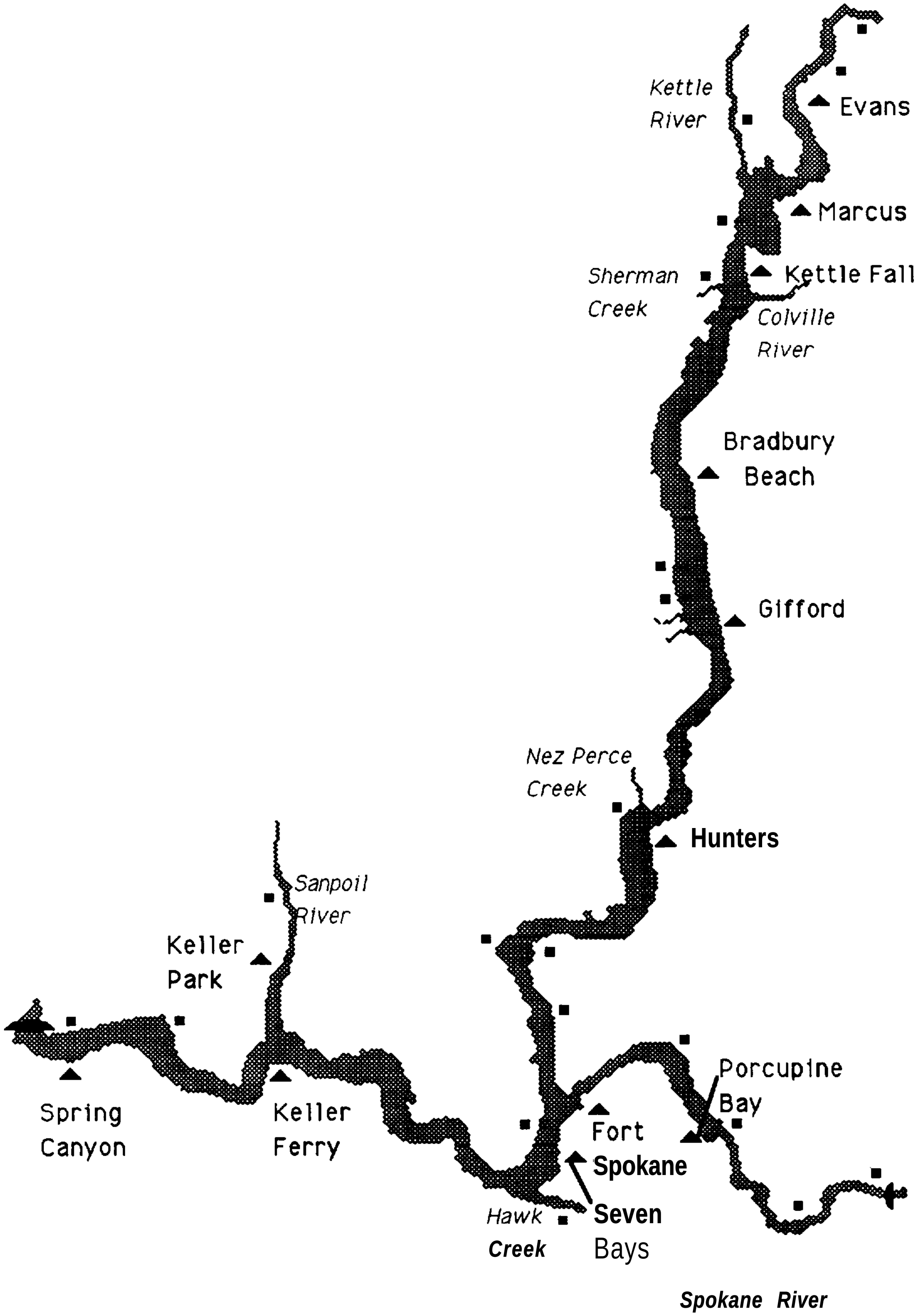


Figure 2.2.1 Primary (▲) and secondary (■) creel locations on Lake Roosevelt, WA.

and time. Location cards were used once for weekend/holiday stratum and twice for weekday stratum. Effort count schedules were different for each creel clerk.

During each a.m. and p.m. instantaneous pressure count, boat trailer and shore angler counts were recorded at all access points along the reservoir by all three creel clerks. No interviews were preformed during instantaneous pressure counts. Number of boats on the water and shore anglers were counted concurrently during aerial surveys of the reservoir using a Cessna 172 aircraft.

During each a.m. and p.m. effort count, boat trailers and shore anglers were counted. Interview data collected included 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 (mm), weighed (g), 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 identify rainbow trout of net-pen or hatchery origin. Scale samples were collected from representative kokanee, rainbow trout, and walleye, and stomach samples were collected from kokanee. Additionally, incoming boaters were surveyed to determine the number of boats angling and the number of anglers per boat.

A correction factor that accounted for boats on the water that could not be contacted by creel clerks was developed by conducting surveys by air, to estimate the number of boat anglers on Lake Roosevelt for each stratum. For each day (weekday or weekend/holiday) and time (a.m. or p.m.) stratum the following formulas were used to determine the number of boat anglers per day:

Boat count data from air flights was compared to boat trailer counts on land by creel clerks on the same day to develop a boat correction factor for each stratum per month. The formula used was:

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

Where:

CF_b = boat trailer correction factor for each stratum per month;

Ba = 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 number of boats on the reservoir for each stratum per month was calculated by the formula:

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

Where:

T_b = number of boats on the water for each stratum per month;

C_{bt} = mean boat trailer count from pressure counts for each stratum per month; and

CF_b = boat trailer correction factor for each stratum per month.

The number of boats fishing for each stratum per month was calculated by the formula:

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

Where:

B_f = number of boats fishing for each stratum per month;

T_b = number of boats on the water for each stratum per month; and

$\%B_f$ = percent of boats fishing for each stratum per month (number is in decimal form).

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

$$X_d = (Ab)(B_f)$$

Where:

X_d = adjusted mean number of anglers per boat per day for each stratum per month;

Ab = 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.

2.2.1 Computation of Angler Pressure, CPUE, and Harvest

Statistical sampling formulas (Lewis 1975, Wonnacott and Wonnacott 1977, Mendel and Schuck 1987, and Willms et *al.* 1989) were used to calculate stratum estimates and confidence intervals for angling pressure, CPUE, and harvest.

For each day (weekday or weekend/holiday) and time (a.m. or p.m.) stratum the following formulas were used to determine the number of hours sampled for each stratum per month:

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

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

Where:

N_s = number of hours for each stratum per month;

D_s = number of days per month within the stratum; and

H_d = average number of hours per day for each stratum per month.*

*The times for sunrise to sunset for Lake Roosevelt were determined from the Nautical Almanac (1990) using the mean latitude of the reservoir (Appendix B).

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:

$$Xd = \sum_{i=1}^{P_d} (S_{pi})$$

Where:

X_d = mean number of shore anglers per day for each stratum per month from pressure counts;

P_d = number of pressure counts conducted for each stratum per month; and

S_{pi} = 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:

$$X_s = (Xd)\ (Ds)$$

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:

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

Where:

Ha = 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 was estimated for day stratum (week day or weekend/holiday) and stratum time (a.m. or p.m.) for boat and shore anglers for each month 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 within 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,

Ha = mean number of angler hours per angler for each stratum per month.

The variance of the pressure 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:

$$C.I. = PE \pm \sqrt{VPE_S} \times 1.96$$

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% confidence estimates were calculated by summing the eight stratum values for angler pressure and summing the 95% confidence intervals.

Annual angler pressure and 95% confidence estimates were calculated by summing monthly angler pressure estimates and 95% confidence 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 specie was calculated by dividing the total catch for the entire month (all stratum) by the total angler hours (all stratum). Annual CPUE values of a particular fish species were calculated by averaging the monthly values.

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;

Hcpue = number of fish harvested of a particular fish species for each stratum per month for each stratum per month; and

PE_s = pressure 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. Monthly harvest estimates were combined to calculate annual estimates for each fish species.

2.2.2 Computation of Economic Value of the Lake Roosevelt Fishery

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) (Appendix B). The following formula was used:

$$D_{90} = \left(\frac{C_{85} \times C_{90}}{D_{85}} \right)$$

where:

D_{90} = dollar value per fishing trip for the Lake Roosevelt Fishery in 1990;
C_{85} = regional CPI for 1985;
C_{90} = regional CPI for 1990; and
D_{85} = dollar value per fishing trip for the Lake Roosevelt Fishery in 1985 ($26.00).

The 1990 dollar value was multiplied by total number of angler trips in 1990 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

Fishery samples were collected in May, August, and October 1990 at nine index stations in the reservoir, which included: 1. Kettle Falls; 2. Gifford; 3. Hunters; 4. Porcupine Bay; 5. Little Falls Dam; 6. Seven Bays; 7. Keller Ferry; 8. Sanpoil, and 9. Spring Canyon (Figure 2.3.1). Fishery data was collected at each index station over 24 hour periods broken down into morning, afternoon, and night stratum. Principle target species included kokanee salmon, rainbow trout, and walleye, although all fish were captured in proportion to their relative abundance.

2.3.1 Relative Abundance

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 (1974). Voltage was

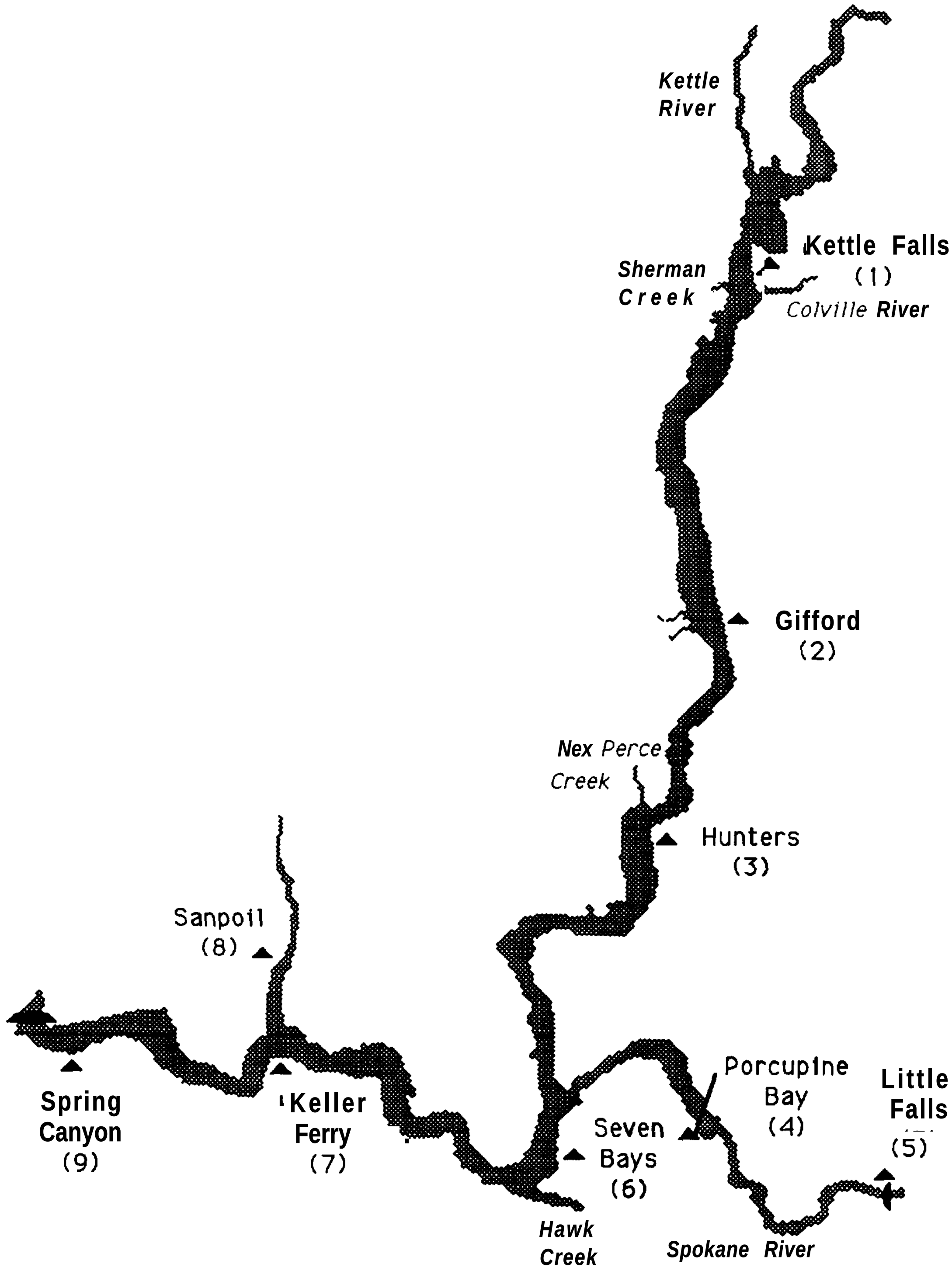


Figure 2.3.1 Lake Roosevelt, WA indicating location of nine index stations used for sampling fish and zooplankton

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 two 10 minute transects were performed during morning, afternoon, and night stratum.

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 from early afternoon (2:00 p.m.), checked at sunset, and pulled at 10:00 p.m. Nets were managed this way to collect fresh fish for stomach samples.

Fish captured were identified to species using the taxonomic key of Wydoski and Whitney (1979). Total lengths were measured to the nearest millimeter using a metric measuring board and a scale sample was removed from target fish species to determine age and growth. Target species were weighed to the nearest gram using an electronic balance. Sexes were determined when possible. Stomach samples were collected from representative sizes of target species. Remaining fish were marked with floy tags and released.

2.4 AGE DETERMINATION, BACK-CALCULATION, AND CONDITION

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 3315 microfiche reader. Scale image was projected onto the screen and a non-regenerated, uniform scale was selected to determine age and back-calculation using the following procedures:

1. Age was determined by counting the number of annuli (Jearld 1983).

2. Backcalculation measurements were determined using a T-square metric ruler.

   a. Scale length was determined by placing the 0 mm mark at the center of the focus with the T perpendicular to the longitudinal axis of the scale.

   b. Annulus distance was measured from the same origin to the last circuli of each annulus with the T square in the same position.

Each measurement was made under constant magnification to the nearest millimeter.

Capture length, scale length, and length of each annulus of all fish of same species were entered into StatView 512 (Brainpower 1986) on the Apple Macintosh SE computer for linear regression calculations. 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).

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.

Age, size, and measurements used for back-calculations for each target species are listed in Appendix C.

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 Zooplankton Surveys

Duplicate mid-channel zooplankton samples were collected at Porcupine Bay (Location 4), and Seven Bays (Location 6) monthly and at each index station in May, August, and October in 1990. Samples were taken by making an oblique tow using a Clarke-Bumpus quantitative sampler with a No. 20 (76 µm mesh) or a Wisconsin vertical tow plankton net (76 µm mesh) with 80 mm silk net bucket. Water column tows using the Clarke-Bumpus were made from 25-33 m to the surface at a constant boat speed of approximately 5 knots. Vertical tows were made with the Wisconsin tow from 25-33 m to the surface. The organisms were washed into a 253 ml bottle containing 10 ml of 37% formaldehyde and 0.5 g sugar (Rigler 1978). Organisms were stained with 1 .0 ml of five percent Lugol's solution and 1 .0 ml of saturated eosin-y ethanol stain.

In the lab, zooplankton were identified to genus and 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. Two subsamples were counted using a modified counting chamber (Ward 1955) until 100 organisms or 25 ml of sample had been counted (Edmondson and Winberg 1971, Downing and Rigler 1984). Volumes of subsamples depended on organism density in the sample.

Species counts in each subsample were recorded in Microsoft Excel on a Macintosh SE computer. Density (# organisms/m^3) was calculated in the program using the following sets of equations. Volume of the sample collected by the Wisconsin plankton sampler was calculated using the following formula:

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

where:

V	=	volume of the sample;
Π	=	pi (3.414);
r^2	=	radius of sampler; and
h	=	depth of sample.

Volume of the sample collected by the Clarke-Bumpus sampler was determined in a different manner. The Clarke-Bumpus sampler was field calibrated as described by Clarke and Bumpus (1940). A theoretical volume of 56 liters per unit count was determined. The theoretical volume sampled by the sampler was calculated using the formula:

$$TV = \left(\frac{(\Pi)(r^2)d}{CF}\right)$$

where:

TV	=	theoretical volume (liters/unit count);
Π	=	3.414;
r^2	=	radius of sampler (m);
d	=	distance of plankton tow (m); and
a=	=	calibration factor.

Volume of the entire sample was calculated using the formula:

$$V = TV(CC)$$

where:

V	=	volume of entire sample (liters);
TV	=	theoretical volume (56 liters/unit count); and
cc	=	change in Clarke-Bumpus counter reading.

Microcrustacean zooplankton density (# organisms/m^3) was calculated using the following calculation:

$$D = \frac{\left(\frac{Tc}{Sn} x \frac{SV}{SSV}\right)}{V} DF*1000$$

where: D = density (# organisms/m^3) ;
Sn = number of subsamples;
sv = sample volume;
ssv = subsample volume;
V = volume of entire sample;
DF = dilution factor; and
Tc = total number counted of each species of organisms.

Predominant cladocerans were randomly chosen and measured from the top of the head to the base of the carapace, excluding the spine. Cladoceran biomass was determined using length-weight regression equations summarized by Downing and Rigler (1984). The formula used to calculate dry weight estimate was:

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

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

The following slope (b) and intercept (In a) values were used with the dry weight estimate calculation:

Cladocera Species	In a	b
Daphnia *ambigua*	1.54	2.29
Daphnia *galea* ta mendota	1.51	2.56
Daphnia *re* trocurva	1.4322	3.129
Dap hnia *schødleri*	2.30	3.10
Daphnia thorata	2.64	2.54
Leptodora kindti	-0.822	2.670

Cladocera biomass **was** calculated using the formula:

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

where:

B = biomass ($\mu g/m^3$) ;
$\ln w$ = log of the dry weight estimate for the Cladocera species (μg); and
D = density (# organisms/m^3).

2.6 FEEDING HABITS

2.6.1 Field Collection

Fish stomachs were collected from kokanee, rainbow and walleye at each index station in May, August, and October 1990. 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 pyloric sphincter. The esophagus was clamped to keep prey items from being expelled and the stomach placed in 10% formalin.

2.6.2 Diet Analysis

In the lab, stomachs were transferred to a 70% isopropyl alcohol solution. Contents were identified to family for benthic macroinvertebrates and to species for zooplankton using the taxonomic keys of Brooks (1957), Ward and Whipple (1966), Borror 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-1 B dissecting microscope equipped with **a** fiber optics illumination system and 5 mm ocular micrometer.

Stomachs containing large numbers of zooplankton were subsampled or counted, depending on diversity of prey organisms. Subsamples were made by diluting zooplankton contents to 100 ml in a beaker, stirring contents to uniformity, and collecting three 2 ml samples with **a** calibrated pipet. The following formula was used to determine the total number of a particular zooplankton species:

$$\text{Total No.} = \frac{\sum_{n=1}^{3}\left(\frac{DV}{SV} \times T_n\right)}{3}$$

where:

DV = total diluted volume (100 ml);
SV = total subsample volume (2 ml); and
Tn = total number of zooplankton in the subsample.

Length measurements of randomly chosen Cladocera were made from the top of the head to the base of the carapace, excluding the spine. This permitted calculation of electivity indices.

Dry weights were obtained by drying sorted stomach contents in an oven at 105° for 24 hours 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 for each season to obtain seasonal means and standard deviations. Mean seasonal data was then averaged to obtain unbiased annual means.

2.6.3 Number and Weight Indices

Numerical and weight frequencies of prey items (± standard deviation) were obtained for each age class of target species collected during each sampling season to obtain seasonal mean values. Unidentifiable prey items and organic detritus were given numerical values of 1 (minimal), 2 (medium), or 3 (maximum) depending upon amounts found in stomachs. Non-measurable trace amounts were given the value of 0.0001 grams for calculating percentages by weight.

Seasonal mean data was combined to obtain unbiased estimates of annual average number and weight, percent composition by number and weight, frequency of occurrence, and index of relative importance for each age class of target species.

2.6.4 Index of Relative Importance (IRI)

Index of relative importance was used to compensate for numerical estimate biases that tend to overemphasize 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:

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

where:

RIa = relative importance of food item a;
AIa = 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.

2.6.5 Diet Overlap

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:

$$C_x = \frac{2\sum_{i=1}^{n}(P_{xi} \times P_{yi})}{\sum_{i=1}^{n} P_{xi}^2 + \sum_{i=1}^{n} P_{yi}^2}$$

where: Cx = 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 is an abundant food supply and competition does not exist.

2.6.6 Electivity Index

The electivity index is a method of measuring the degree of selection that a fish has for a particular size category of prey compared to the availability of the same size category of the prey species in the environment (Ivlev 1961). Data obtained from zooplankton samples and stomach samples were used to compute selectivity for different size ranges of Daphnia spp. by planktivorous fish. species (kokanee and rainbow trout). Mean annual number frequencies from the fishes' diet and percentage by number of different size ranges of Daphnia spp. in the water column were used to calculate the linear index of electivity (Strauss 1979). The electivity index was calculated using the equation:

$$L = r_i - P_i$$

where:

L = measure of food selection;
r_i = relative abundance of prey i in the gut; and
P_i = relative abundance of same prey i in the environment.

Food selection values range from +1 to -1. Values near zero indicate fish are feeding on that size category of Daphnia spp. in relation to its abundance, or randomly. Positive values indicate fish are selecting those size categories. Negative values indicate fish are either avoiding or can't discern those size categories.

Advantages of using this index are: it is not biased by unequal sample sizes, and extreme values are obtained only when a prey item is very abundant in the environment and rare in the diet or when a prey item is rare in the environment and very abundant in the diet (Strauss 1979).

2.7 TAGGING STUDIES

Tagging studies were conducted with net-pen rainbow trout and walleye by inserting individually numbered floy tags into the musculature at the posterior base of the dorsal fin. Rainbow trout were marked, measured, and released at the Kettle Falls, Hunters, Seven Bays, and Keller Ferry net-pens in 1990. Approximately 500 fish were tagged at each location during March, April, and May. Representative samples of approximately 100 fish from each group were weighed to determine the average length and weight of the group at time of release. Scale samples were also taken to aid in determination of check marks laid down by fish at time of release.

Walleye were marked in the Spokane Arm in late April and early May 1990 during spawning migration. Walleye were also marked at other index stations each month when fishery samples were collected. Lengths were recorded for each walleye marked.

A poster campaign was conducted by distributing posters at locations frequented by anglers in the area surrounding Lake Roosevelt. Posters contained information about the Lake Roosevelt monitoring program and requested that anglers return tags with the following information: recapture date and location, and length and weight of fish. Anglers returning tag information were sent a letter informing them of the release date, release location, and length of fish.

Tag return data was compiled and analyzed to determine migration patterns and growth rates. Migration patterns were analyzed by noting recapture location and plotting it against release location and date. Growth rates (mm/month) were calculated using the formula:

$$G = \left(\frac{L_c - L_r}{M_c - M_r}\right)$$

where:

G = Growth of fish per month (mm);
L_c = length of fish at time of capture (mm);
L_r = length of fish at time of release (mm);
M_c = month of recapture; and.
M_r = month of release.

Occasionally lower total lengths or much higher total lengths were reported at recapture when compared to original capture length due to the conversion of inches to mm. This was because anglers usually reported fish length to the nearest 0.5 inches whereas, the fish was originally measured in mm. Therefore, only fish which were caught at least 6 months (180 days) after tagging were used for calculating growth rates.

3.0 RESULTS

3.1 RESERVOIR ELEVATION AND WATER RETENTION

Reservoir elevations and water retention times from January to December 1990 are shown in Table 3.1 .1. Appendix A contains daily reservoir elevations and water retention times for each month.

Mean reservoir elevations were 1,288 feet in January, 1,286 feet in February, 1,279 feet in March, 1,262 feet in April, 1,260 feet in May, 1,272 feet in June, 1,288 feet in July, 1,289 feet in August, 1,286 feet in September, 1,287 feet in October, 1,288 feet in November, and 1,284 feet in December (Table 3.1.1). The highest elevations occurred in June and November at 1,288 feet, and the lowest occurred in May at 1,260 feet.

Mean water retention times were 41 days in January, 36 days in February, 32 days in March, 31 days in April, 29 days in May, 28 days in June, 37 days in July, 45 days in August, 67 days in September, 66 days in October, 46 days in November, and 33 days in December (Table 3.1 .1). The highest water retention time occurred in September with 67 days and the lowest in May with 28 days.

Annual reservoir elevation was 1,281 feet and the mean water retention time was 41 days.

3.2 CREELSURVEY

Annual creel survey data are summarized in Tables 3.2.1 through 3.2.10. Monthly creel survey and specific stratum data are listed in Appendix B. Creel surveys were conducted an average of 21 days per month from January 1st to December 13th 1990. Interviews collected during creel surveys from 1,351 shore anglers and 1,664 boat anglers provided the information needed to calculate the following estimates.

3.2.1 Angler Pressure Estimates

Angler pressure estimates ± 95% confidence intervals for each stratum category from January to December 13th are listed in Table 3.2.1. Data used to calculate angler pressure estimates are located in Appendix B.

Table 3.1 .1 **Annual and monthly means for reservoir elevation (ft) and water retention time (days) for Lake Roosevelt in 1990.**

Month	Elevation (ft)	Water Retention Time (days)
January	1,287.70	41.08
February	1,285.52	36.02
March	1,279.22	32.16
April	1,262.47	31.06
May	1,259.72	29.04
June	1,271.96	28.12
July	1,287.52	36.82
August	1,288.63	44.59
September	1,286.46	66.75
October	1,287.25	65.71
November	1,288.08	45.93
December	1,283.74	32.71
Annual Mean	**1,280.69**	40.83

Table 3.2.1. Angler pressure estimates (±95%CI) for each stratum on Lake Roosevelt, January to December 13th, 1990.

	JAN		FEB		MAR		APR		MAY		JUN	
Stratum	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)
Weekday a.m. Shore	516	(±136)	1,523	(±27)	548	(±261)	949	(±491)	1,060	(±38)	1,334	(±261)
Weekday p.m. Shore	1,294	(±346)	2,248	(±167)	1,920	(±269)	1,738	(±392)	323	(±0)	390	(±542)
Weekday a.m. Boat	3,870	(±95)	1,407	(±0)	5,111	(±204)	11,998	(±2,016)	2,405	(±1,057)	5,471	(±1,492)
Weekday p.m. Boat	9,867	(±0)	731	(±0)	9,816	(±696)	22,879	(±898)	10,787	(±967)	27,279	(±2,523)
Weekend a.m. Shore	445	(±126)	482	(±37)	196	(±160)	1,676	(±756)	273	(±113)	554	(±289)
Weekend p.m. Shore	544	(±1[illegible])	258	(±23)	3,585	(±409)	311	(±150)	619	(±207)	1,321	(±372)
Weekend a.m. Boat	275	(±0)	1,152	(±0)	230	(±83)	3,455	(±1,058)	3,018	(±226)	16,051	(±0)
Weekend p.m. Boat	437	(±42)	634	(±0)	14,019	(±529)	9,682	(±549)	3,194	(±264)	19,951	(±3,440)
TOTAL	17,248	(±857)	8,435	(±254)	35,425	(±2,611)	52,688	(±6,310)	21,679	(±2,872)	72,351	(±8,919)

	JUL		AUG		SEP		OCT		NOV		DEC	
Stratum	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)	Angler hours	(±95%CI)
Weekday a.m. Shore	822	(±469)	722	(±45)	480	(±177)	685	(±68)	644	(±211)	725	(±0)
Weekday p.m. Shore	1,469	(±435)	906	(±334)	1,584	(±296)	1,443	(±33)	63	(±151)	340	(±0)
Weekday a.m. Boat	76,754	(±11,929)	44,074	(±19,384)	4,845	(±1,948)	2,239	(±0)	8,661	(±0)	43	(±229)
Weekday p.m. Boat	71,028	(±15,045)	6,005	(±1,457)	11,670	(±2,112)	5,688	(±1,126)	681	(±86)	1,041	(±40)
Weekend a.m. Shore	1,679	(±357)	121	(±13)	704	(±108)	253	(±208)	107	(±13)	151	(±0)
Weekend p.m. Shore	541	(±79)	280	(±81)	317	(±93)	1,213	(±64)	2,277	(±191)	84	(±0)
Weekend a.m. Boat	11,299	(±4,082)	2,442	(±1,395)	14,528	(±1,385)	1,716	(±443)	832	(±0)	241	(±0)
Weekend p.m. Boat	10,689	(±2,752)	1,762	(±871)	24,063	(±3,965)	10,687	(±779)	2,401	(±144)	917	(±0)
TOTAL	174,281	(±35,148)	56,312	(±23,580)	58,191	(±10,084)	23,924	(±2,721)	15,666	(±796)	3,542	(±269)

Total angler pressure estimate for all stratum in January was 17,248 ± 857 angler hours (Table 3.2.1). Weekday p.m. boat hours had the highest angler pressure at 9,867 hours, followed by 3,870 weekday a.m. boat hours,1,294 weekday p.m shore hours, 516 weekday a.m. shore hours, 544 weekend p.m. shore hours, 445 weekend a.m. shore hours, 437 weekend p.m. boat hours, and 275 weekend a.m. boat hours.

Total angler pressure estimate for all stratum in February was 8,435 ± 254 angler hours (Table 3.2.1). Weekday p.m. shore hours had the highest angler pressure at 2,248 hours, followed by 1,523 weekday a.m. shore hours, 1,407 weekday a.m. boat hours, 1,152 weekend a.m. boat hours, 731 weekday p.m. boat hours, 634 weekend p.m. boat hours, 482 weekend a.m. shore hours, and 258 weekend p.m. shore hours.

The total angler pressure estimate for all stratum in March was 35,425 ± 2,611 angler hours (Table 3.2.1). Weekend p.m. boat hours had the highest angler pressure at 14,019 hours, followed by 9,816 weekday p.m. boat hours, 5,1 11 weekday a.m. boat hours, 3,585 weekend p.m. shore hours, 1,920 weekday p.m. shore hours, 548 weekday a.m. shore hours, 230 weekend a.m. boat hours, and 196 weekend a.m. shore hours.

The total angler pressure estimate for all stratum in April was 52,688 ± 6,310 angler hours (Table 3.2.1). Weekday p.m. boat hours had the highest angler pressure at 22,879 hours followed by, 11,998 weekday a.m. boat hours, 9,682 weekend p.m. boat hours, 3,455 weekend a.m. boat hours, 1,738 weekday p.m. shore hours, 1,676 weekend a.m. shore hours, 949 weekday a.m. shore hours, and 311 weekend p.m. shore hours.

The total angler pressure estimate for all stratum in May was 21,679 ± 2,872 angler hours (Table 3.2.1). Weekday a.m. boat hours had the highest angler pressure at 10,787 hours followed by, 3,194 weekend p.m. boat hours, 3,018 weekend a.m. boat hours, 2,405 weekday a.m. boat hours, 1,060 weekday a.m. shore hours, 619 weekend p.m. shore hours, 323 weekday p.m. shore hours, and 273 weekend shore a.m. hours.

The total angler pressure estimate for all stratum in June was 72,351 ± 8,919 angler hours (Table 3.2.1). Weekday p.m. boat hours had the highest angler pressure at 27,279 hours followed by, 19,951 weekend p.m. boat hours, 16,051 weekend a.m. boat hours, 5,471 weekday a.m. boat hours, 1,334 weekday a.m. shore hours, 1,321 weekend p.m. shore hours, 554 weekend a.m. shore hours, and 390 weekday p.m. shore hours.

The total angler pressure estimate for all stratum in July was 174,281 ± 35,148 angler hours (Table **3.2.1)**. Weekday a.m. boat hours had the highest angler pressure at 76,754 hours followed by, 71,028 weekday p.m. boat hours, 11,299 weekend a.m. boat hours, 10,689 weekend p.m. boat hours, 1,679 weekend a.m. shore hours, 1,469 weekday p.m. shore hours, 822 weekday a.m. shore hours, and 541 weekend p.m. shore hours.

The total angler pressure estimate for all stratum in August was 56,312 ± 23,580 angler hours (Table 3.2.1). Weekday a.m. boat hours had the highest angler pressure at 44,074 hours followed by, 6,005 weekday p.m. boat hours, 2,442 weekend a.m. boat hours, 1,762 weekend p.m. boat hours, 906 weekday p.m. shore hours, 722 weekday a.m. shore hours, 280 weekend p.m. shore hours, and 121 weekend a.m. shore hours.

The total angler pressure estimate for all stratum in September was 58,191 ± 10,084 angler hours (Table 3.2.1). Weekend p.m. boat hours had the highest angler pressure at 24,063 hours, followed by, 14,528 weekend a.m. boat hours, 11,670 weekday p.m. boat hours, 4,845 weekday a.m. boat hours, 1,584 weekday p.m. shore hours, 704 weekend a.m. shore hours, 480 weekday a.m. shore hours, and 317 weekend p.m. shore hours.

The total angler pressure estimate for all stratum in October was 23,924 ± 2,721 angler hours (Table **3.2.1)**. Weekend p.m. boat hours had the highest angler pressure at 10,687 hours followed by, 5,688 weekday p.m. boat hours, 2,239 weekday a.m. boat hours, 1,716 weekend a.m. boat hours, 1,443 weekday p.m. shore hours, 1,213 weekend p.m. shore hours, 685 weekday a.m. shore hours, and 253 weekend a.m. shore hours.

The total angler pressure estimate for all stratum in November was 15,666 ± 796 angler hours (Table 3.2.1). Weekday a.m. boat hours had the highest angler pressure at 8,661 weekday a.m. boat hours followed by, 2,401 weekend p.m. boat hours, 2,277 weekend p.m. shore hours, 832 weekend a.m. boat hours, 681 weekday p.m.

boat hours, 644 weekday a.m. shore hours, 107 weekend a.m. shore hours, and 63 weekday p.m. shore hours.

The total angler pressure estimate for all stratum from December 1st to December 13th was 3,542 ± 269 angler hours (Table 3.2.1). Weekday p.m. boat anglers had the highest angler pressure at 1,041 hours followed by, 917 weekend p.m. boat hours, 725 weekday a.m. shore hours, 340 weekday p.m. shore hours, 241 weekend a.m. boat hours, 51 weekend a.m. shore hours, 184 weekend p.m. shore hours, and 43 weekday a.m. boat hours.

Highest angler pressure for all stratum combined occurred in July at 174,281 angler hours, followed by June at 72,351 angler hours, and September at 58,191 angler hours. Lowest angler pressure for all stratum combined occurred in December at 3,542 angler hours, followed by February with 8,435 angler hours, and November at 15,666 angler hours.

Angler Trip Estimates

Anglers spent an estimated 539,742 hours fishing on Lake Roosevelt in 1990 with an annual average trip length of 3.29 hours per angler (Table 3.2.2). The annual number of angler trips was estimated at 171,765 trips from January to December 13th 1990.

Anglers in January spent approximately 17,248 hours fishing, with an average trip length of 3.01 hours (Table 3.2.2). The number of angler trips was estimated at 5,730 trips.

Anglers in February spent approximately 8,435 hours fishing, with an average trip length of 3.44 hours (Table 3.2.2). The number of angler trips was estimated at 2,452 trips.

Anglers in March spent approximately 35,425 hours fishing, with an average trip length of 3.54 hours (Table 3.2.2). The number of angler trips was estimated at 10,007 trips.

Anglers in April spent approximately 52,688 hours fishing, with an average trip length of 3.41 hours (Table 3.2.2). The number of angler trips was estimated at 15,451 trips.

Anglers in May spent approximately 21,679 hours fishing, with an average trip length of 3.38 hours (Table 3.2.2). The number of angler trips was estimated at 6,414 trips.

Table 3.2.2 **Angler trip estimates based on angler hours and average trip length for Lake Roosevelt January to December, 1990.**

	JAN.	FEB.	MAR.	APR.	MAY	JUN.
Angler hours	17,248	8,435	35,425	52,688	21,679	72,351
Average trip length	3.01	3.44	3.54	3.41	3.38	3.42
Number of angler trips	5,730	2,452	10,007	15,451	6,414	21,155

	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Angler hours	174,281	56,312	58,191	23,924	15,666	3,542
Average trip length	3.54	2.00	2.81	3.63	3.12	4.18
Number of angler trips	49,232	28,156	20,709	6,591	5,021	847

January to December 1990 totals:

Angler hours	**539,742**
Average trip length	**3.29**
Number of angler trips	**171,765**

Anglers in June spent approximately 72,351 hours fishing, with an average trip length of 3.42 hours (Table 3.2.2). The number of angler trips was estimated at 21,155 trips.

Anglers in July spent approximately 174,281 hours fishing, with an average trip length of 3.54 hours (Table 3.2.2). The number of angler trips was estimated at 49,232 trips.

Anglers in August spent approximately 56,312 hours fishing, with an average trip length of 2.00 hours (Table 3.2.2). The number of angler trips was estimated at 28,156 trips.

Anglers in September spent approximately 58,191 hours fishing, with an average trip length of 2.81 hours (Table 3.2.2). The number of angler trips was estimated at 20,709 trips.

Anglers in October spent approximately 23,924 hours fishing, with an average trip length of 3.63 hours (Table 3.2.2). The number of angler trips was estimated at 6,591 trips.

Anglers in November spent approximately 15,666 hours fishing, with an average trip length of 3.12 hours (Table 3.2.2). The number of angler trips was estimated at 5,021 trips.

Anglers in December spent approximately 3,542 hours fishing, with an average trip length of 4.18 hours (Table 3.2.2). The number of angler trips was estimated at 847 trips from December 1 through December 13.

The largest amount of fishing pressure occurred in July with 174,281 angler hours, and the lowest occurred in December with 3,542 angler hours. Anglers spent the longest time fishing in December with 4.18 hours and the shortest time was 2.00 hours in August. July had the highest number of angler trips with 49,232 trips, and December had the lowest with 847 trips.

3.2.2 Catch Per Unit Effort

Catch CPUE

The mean catch per unit effort (fish/hour) for fish caught (fish harvested and released) for all stratum combined is presented in Table 3.2.3. Information on catch CPUE per stratum is presented in Appendix B.

Table 3.2.3 Monthly mean and total catch per unit effort (fish/hour) of total catch (harvest and release) on Lake Roosevelt, January to December, 1990.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Kokanee	0.001	0.006	0.059	0.102	0.011	0.014	-	0.002	0.003	0.006	0.034	-
Rainbow trout	0.232	0.115	0.077	0.038	0.050	0.061	0.123	0.079	0.108	0.199	0.158	0.281
Walleye	0.006	0.011	0.003	0.046	0.238	0.358	0.242	0.147	0.093	0.044	0.032	-
Yellow perch		0.002	-					0.061	0.015	-		
Smallmouth bass	-	-	-	-	-	0.003	0.010	0.081	0.063	0.006	-	
Largemouth bass	-	-	-	-	-	-	-	0.002	-			
Suckers	0.003	0.007	0.001	-	-							
Squawfish									0.002	-		0.011
Black crappie									0.107	-		
Chinook									0.002	-		
Bullhead			0.001	-								
Sturgeon					0.013	0.014	0.018	-	0.020	0.015	-	
Monthly Mean	0.061	0.028	0.028	0.062	0.078	0.090	0.098	0.062	0.046	0.054	0.075	0.146

The mean catch CPUE for all species was 0.061 fish/hour in January (Table 3.2.3). Highest individual species catch CPUE was 0.232 fish/hour for rainbow trout, followed by 0.006 fish/hour for walleye, 0.003 fish/hour for suckers, and 0.001 fish/hour for kokanee.

The mean catch CPUE for all species in February was 0.028 fish/hour (Table 3.2.3). Highest individual species catch CPUE was 0.115 fish/hour for rainbow trout, followed by 0.011 fish/hour for walleye, 0.007 fish per/hour for suckers, 0.006 fish/hour for kokanee, and 0.002 fish/hour for yellow perch.

The mean catch CPUE for all species in March was 0.028 fish/hour (Table 3.2.3). Highest individual species catch CPUE was 0.077 fish/hour for rainbow trout, followed by 0.059 fish/hour for kokanee, 0.003 fish/hour for walleye, 0.001 fish/hour for suckers, and 0.001 fish/hour for bullhead.

The mean catch CPUE for all species in April was 0.062 fish/hour (Table 3.2.3). Highest individual species catch CPUE was 0.102 fish/hour for kokanee, followed by 0.046 fish/hour for walleye, and 0.038 fish/hour for rainbow trout.

The mean catch CPUE for all species in May was 0.078 fish/hour (Table 3.2.3). Highest individual species catch CPUE was 0.238 fish/hour for walleye, followed by 0.050 fish/hour for rainbow trout, 0.013 fish/hour for sturgeon, and 0.011 fish/hour for kokanee.

The mean catch CPUE for all species in June was 0.090 fish/hour (Table 3.2.3). Highest individual species catch CPUE was 0.358 fish/hour for walleye, followed by 0.061 fish/hour for rainbow trout, 0.014 fish/hour for kokanee, 0.014 fish/hour for sturgeon, and 0.003 fish/hour for smallmouth bass.

The mean catch CPUE for all species in July was 0.098 fish/hour (Table 3.2.3). Highest individual species catch CPUE was 0.242 fish/hour for walleye, followed by 0.123 fish/hour for rainbow trout, 0.018 fish/hour for sturgeon, and 0.010 fish/hour for smallmouth bass.

The mean catch CPUE for all species was 0.062 fish/hour in August (Table 3.2.3). Highest individual species catch CPUE was

0.147 fish/hour for walleye, followed by 0.081 fish/hour for smallmouth bass, 0.079 fish/hour for rainbow trout, 0.061 fish/hour for yellow perch, 0.002 fish/hour for kokanee, and 0.002 fish/hour for largemouth bass.

The mean catch CPUE for all species was 0.046 fish/hour in September (Table 3.2.3). Highest individual species catch CPUE was 0.108 fish/hour for rainbow trout, followed by 0.107 fish/hour for black crappie, 0.093 fish/hour for walleye, 0.063 fish/hour for smallmouth bass, 0.020 fish/hour for sturgeon, 0.015 fish/hour for yellow perch, 0.003 fish/hour for kokanee, and 0.002 fish/hour for chinook.

The mean catch CPUE for all species was 0.054 fish/hour in October (Table 3.2.3). Highest individual species catch CPUE was 0.199 fish/hour for rainbow trout, followed by 0.044 fish/hour for walleye, 0.015 fish/hour for sturgeon, 0.006 fish/hour for kokanee, and 0.006 fish/hour for smallmouth bass.

The mean catch CPUE for all species was 0.075 fish/hour in November (Table 3.2.3). Highest individual species catch CPUE was 0.158 fish/hour for rainbow trout, followed by 0.034 fish/hour for kokanee, and 0.032 fish/hour for walleye.

The mean catch CPUE for all species was 0.146 fish/hour from December 1 st to December 13th (Table 3.2.3). The mean catch CPUE for rainbow trout was 0.281 fish/hour. Highest individual species catch CPUE was 0.281 fish/hour for rainbow trout, followed by 0.011 fish/hour for squawfish.

The highest catch CPUE for all species was recorded in December at 0.146 fish/hour and the lowest were recorded in February and March at 0.028 fish/hour (Table 3.2.3). The highest catch CPUE for walleye occurred in June at 0.358 fish/hour and the lowest in December when no fish were caught. The highest catch CPUE for rainbow trout occurred in December at 0.281 fish/hour and the lowest in April at 0.038 fish/hour. The highest catch CPUE for kokanee occurred in April at 0.102 fish/hour and the lowest in December and July when no fish were caught. The highest catch CPUE for sturgeon occurred in September at 0.020 fish/hour and the lowest in January, February, March, April, August, November, and December when no fish were caught.

Harvest CPUE

The mean catch per unit effort (fish/hour) for fish harvested (kept) for all stratum combined is presented in Table 3.2.4. Information on harvest CPUE for individual stratum is presented in Appendix B.

The mean harvest CPUE for all species was 0.079 fish/hour in January (Table 3.2.4). Highest individual species catch CPUE was 0.232 fish/hour for rainbow trout, followed by 0.003 fish/hour for walleye, and 0.001 fish/hour for kokanee.

The mean harvest CPUE for all species in February was 0.034 fish/hour (Table 3.2.4). Highest individual species catch CPUE was 0.115 fish/hour for rainbow trout, followed by 0.011 fish/hour for walleye, 0.006 fish/hour for kokanee, and 0.002 fish/hour for yellow perch.

The mean harvest CPUE for all species in March was 0.035 fish/hour (Table 3.2.4). Highest individual species catch CPUE was 0.076 fish/hour for rainbow trout, followed by 0.059 fish/hour for kokanee, 0.003 fish/hour for walleye, and 0.001 fish/hour for suckers.

The mean harvest CPUE for all species in April was 0.057 fish/hour (Table 3.2.4). Highest individual species catch CPUE was 0.102 fish/hour for kokanee, followed by 0.038 fish/hour for rainbow trout, and 0.031 fish/hour for walleye.

The mean harvest CPUE for all species in May was 0.046 fish/hour (Table 3.2.4). Highest individual species catch CPUE was 0.121 fish/hour for walleye, followed by 0.050 fish/hour for rainbow trout, 0.007 fish/hour for kokanee, and 0.005 fish/hour for sturgeon.

The mean harvest CPUE for all species in June was 0.070 fish/hour (Table 3.2.4). Highest individual species catch CPUE was 0.263 fish/hour for walleye, followed by 0.061 fish/hour for rainbow trout, 0.014 fish/hour for kokanee, 0.009 fish/hour for sturgeon, and 0.003 fish/hour for smallmouth bass.

The mean harvest CPUE for all species in July was 0.084 fish/hour (Table 3.2.4). Highest individual species catch CPUE was 0.205 fish/hour for walleye, followed by 0.112 fish/hour for

Table 3.2.4 Monthly mean and total catch per unit effort (fish/hour) of total harvest (kept) on Lake Roosevelt, January to December, 1990.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Kokanee	0.001	0.006	0.059	0.102	0.007	0.014	-	0.002	0.002	0.006	0.034	-
Rainbow trout	0.232	0.115	0.076	0.038	0.050	0.061	0.112	0.073	0.108	0.182	0.158	0.281
Walleye	0.003	0.011	0.003	0.031	0.121	0.263	0.205	0.114	0.072	0.031	0.020	-
Yellow perch		0.002	-					0.002	0.012	-		
Smallmouth bass	-	-	-	-	-	0.003	0.003	0.063	0.047	0.004	-	
Largemouth bass	-	-	-	-	-	-	-	0.002	-			
Suckers			0.001	-								
Squawfish									0.001	-		
Black crappie									0.107	-		
Chinook									0.002	-		
Bullhead												
Sturgeon					0.005	0.009	0.016	-	0.020	0.015	-	
Monthly Mean	0.079	0.034	0.035	0.057	0.046	0.070	0.084	0.043	0.041	0.048	0.071	0.281

rainbow trout, 0.016 fish/hour for sturgeon, and 0.003 fish/hour for smallmouth bass.

The mean harvest CPUE for all species was 0.043 fish/hour in August (Table 3.2.4). Highest individual species catch CPUE was 0.114 fish/hour for **walleye,** followed by' 0.073 fish/hour for rainbow trout, 0.063 fish/hour for **smallmouth bass,** 0.002 fish/hour for kokanee, 0.002 fish/hour for largemouth bass, and 0.002 fish/hour for yellow perch.

The mean harvest CPUE for all species was 0.041 fish/hour in September (Table 3.2.4). Highest individual species catch CPUE was 0.108 fish/hour for rainbow trout, followed by 0.107 fish/hour for black crappie, 0.072 fish/hour for walleye, 0.047 fish/hour for smallmouth bass, 0.020 fish/hour for sturgeon, 0.012 fish/hour for yellow perch, 0.002 fish/hour for chinook, 0.002 for kokanee, and 0.001 fish/hour for squawfish.

The mean harvest CPUE for all species was 0.048 fish/hour in October (Table 3.2.4). Highest individual species catch CPUE was 0.182 fish/hour for rainbow trout, followed by 0.031 fish/hour for walleye, 0.015 fish/hour for sturgeon, 0.006 fish/hour for kokanee, and 0.004 fish/hour for smallmouth bass.

The mean harvest CPUE for all species was 0.071 fish/hour in November (Table 3.2.4). Highest individual species catch CPUE was 0.158 fish/hour for rainbow trout, followed by 0.034 fish/hour for kokanee, and 0.020 fish/hour for walleye.

The mean harvest CPUE from December 1 st to December 13th was 0.281 fish/hour for rainbow trout (Table 3.2.4). There were no other fish harvests recorded by creel clerks.

The highest harvest CPUE for all species was recorded in December at 0.281 fish/hour and the lowest was recorded in February at 0.034 fish/hour (Table 3.2.4). The highest harvest CPUE for kokanee occurred in April at 0.102 fish/hour and the lowest in December and July when no fish were harvested. The highest harvest CPUE for rainbow trout occurred in December at 0.281 fish/hour and the lowest in April at 0.038 fish/hour. The highest harvest CPUE for walleye occurred in June at 0.263 fish/hour and the lowest in December when no fish were **harvested.** The highest harvest CPUE for sturgeon occurred in September at 0.020 fish/hour and the lowest in January, February, March, April, August, November, and December when no fish were harvested.

Annual Catch and Harvest CPUE Estimates

The mean annual catch CPUE and harvest CPUE for each fish species is presented in Table 3.2.5. Monthly catch and harvest CPUE values for individual stratum are found in Appendix B. The mean annual catch CPUE for all species was 0.46 fish/hour and the mean annual harvest CPUE was 0.38 fish/hour.

Kokanee salmon had a mean annual catch CPUE of 0.024 fish/hour and a mean annual harvest CPUE of 0.023 fish/hour (Table 3.2.5). Rainbow trout had a mean annual catch CPUE of 0.127 fish/hour and a mean annual harvest CPUE of 0.124 fish/hour. Walleye had a mean annual catch CPUE of 0.111 fish/hour and a mean annual harvest CPUE of 0.080 fish/hour. Yellow perch had a mean annual catch CPUE of 0.026 fish/hour and a mean annual harvest CPUE of 0.005 fish/hour. Smallmouth bass had a mean annual catch CPUE of 0.033 fish/hour and a mean annual harvest CPUE of 0.024 fish/hour. Largemouth bass had a mean annual catch CPUE of 0.002 fish/hour and a mean annual harvest CPUE of 0.002 fish/hour. Suckers had a mean annual catch CPUE of 0.002 fish/hour and had a mean annual harvest CPUE of 0.001 fish/hour Squawfish had a mean annual catch CPUE of 0.007 fish/hour and a mean annual harvest CPUE of 0.001 fish/hour. Black crappie had a mean annual catch CPUE of 0.107 fish/hour and a mean annual harvest CPUE of 0.107 fish/hour. Chinook salmon had a mean annual catch CPUE of 0.002 fish/hour and a mean annual harvest CPUE of 0.002 fish/hour. Bullheads had a mean annual catch CPUE of 0.001 fish/hour and did not have a mean annual harvest CPUE estimate value. Sturgeon had a mean annual catch CPUE of 0.016 fish/hour and a mean annual harvest CPUE of 0.013 fish/hour.

3.2.3 Catch Estimates

Monthly and annual catch estimates and 95% confidence intervals for all fish species harvested by all anglers are presented in Table 3.2.6. Catch estimates and 95% C.I. for all species from individual stratum are presented in Appendix B.

Table 3.2.5 **Annual catch-per-unit-effort (CPUE) based on total catch (fish kept and released) and harvest (fish kept) for Lake Roosevelt, from January to December, 1990.**

Species	Catch CPUE (fish/hour)	Harvest CPUE (fish/hour)
Kokanee	0.024	0.023
Rainbow trout	0.127	0.124
Walleye	0.111	0.080
Yellow perch	0.026	0.005
Smallmouth bass	0.033	0.024
Largemouth bass	0.002	0.002
Suckers	0.004	0.001
Squawfish	0.007	0.001
Black crappie	0.107	0.107
Chinook	0.002	0.002
Bullhead	0.001	
Sturgeon	0.016	0.013
Total CPUE	0.46	0.38

Table 3.2.6 **Monthly and annual catch estimates ± 95% confidence intervals for all fish species during all stratum on Lake Roosevelt, from January to December, 1990.**

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Kokanee	116 ±3	70 ±2	5,006 ±168	10,372 ±945	204 * l a	1,091 ±101	- -	18 ±4	483 ±137	228 ±45	168 ±10	- -	17,756 ±1,433
Rainbow trout	3,204 ±198	2,028 ±26	1,885 ±190	2,124 ±266	849 ±216	7,057 ±472	18,623 ±3,856	30,549 ±13,334	7,623 ±1,482	4,763 ±831	886 ±102	1,971 ±40	81,562 ±21,013
Walleye	2,052 * a	750 ±0	204 * a	3,436 ±332	6,383 ±993	23,692 ±3,051	43,189 ±8,519	28,495 ±12,359	6,737 ±979	983 ±72	552 ±1	-	116,473 ±26,322
Yellow perch		15 ±0	-					7,383 ±3,812	555 ±91	- -			7,953 ±3,903
Smallmouth bass	-		-	-	-	219 ±60	1,353 ±379	6,787 ±2,915	3,623 ±571	72 ±4	-		12,054 ±3,929
Largemouth bass	-	-	-	-	-	-	-	l a ±4	-				l a ±4
Suckers	13 ±4	17 ±2	19 ±3	- -									49 ±9
Squawfish									20 ±7	- -		5 ±0	25 ±7
Black crappie									4,201 ±760	- -			4,201 ±760
Chinook									63 ±10	- -			63 ±10
Bullhead			a ±1	-									a ±1
Sturgeon					5	6	10	-	1	1			23
Monthly Total	5,385 ±213	2,880 ±30	7,122 ±370	15,932 ±1,543	7,441 ±1,227	32,065 ±3,684	63,175 ±12,754	73,250 ±32,428	23,306 ±4,037	6,047 ±952	1,606 ±113	1,976 ±40	240,185 ±57,391

Estimated catch of all fish species for January was 5,385 ± 213 fish, comprised of 3,204 ± 198 rainbow trout, 2,053 ± 8 walleye, and 116 ± 3 kokanee (Table 3.2.6).

Estimated catch of all fish species for February was 2,880 ± 30 fish, comprised of 2,028 ± 26 rainbow trout, 750 ± 0 walleye, 70 ± 2 kokanee, 17 ± 2 suckers, and 15 ± 0 yellow perch (Table 3.2.6).

Estimated catch of all fish species for March was 7,122 ± 370 fish, comprised of 5,006 ± 168 kokanee, 1,885 ± 190 rainbow, 204 ± 8 walleye, 19 ± 3 suckers, and 8 ± 1 bullhead (Table 3.2.6).

Estimated catch of all fish species for April was 15,932 ± 1,543 fish, comprised of 10,372 ± 945 kokanee, 3,436 ± 332 walleye, and 2,124 ± 266 rainbow (Table 3.2.6).

Estimated catch of all fish species for May was 7,441 ± 1,227 fish, comprised of 6,383 ± 993 walleye, 849 ± 216 rainbow, 204 ± 18 kokanee, and 5 sturgeon (Table 3.2.6).

Estimated catch of all fish species for June was 32,065 ± 3,684 fish, comprised of, 23,692 ± 3,051 walleye, 7,057 ± 472 rainbow trout, 1,091 ± 101 kokanee, 219 ± 60 smallmouth bass, and 6 sturgeon (Table 3.2.6).

Estimated catch of all fish species for July was 63,175 ±1 2,754 fish, comprised of 43,189 ± 8,519 walleye, 18,623 ± 3,856 rainbow, 1,353 ± 379 smallmouth bass, and 10 sturgeon (Table 3.2.6).

Estimated catch of all fish species for August was 73,250 ± 32,428 fish, comprised of 30,549 ± 13,334 rainbow trout, 28,495 ± 12,359 walleye, 7,383 ± 3,812 yellow perch, 6,787 ± 2,915 smallmouth bass, 18 ± 4 kokanee, and 18 ± 4 largemouth bass. (Table 3.2.6).

Estimated catch of all fish species for September was 23,306 ± 4,037 fish, comprised of 7,623 ± 1,482 rainbow trout, 6,737 ± 979 walleye, 4,201 ± 760 black crappie, 3,623 ± 571 smallmouth bass, 555 ± 91 yellow perch, 483 ± 137 kokanee, 63 ± 10 chinook, 20 ± 7 squawfish, and 1 sturgeon (Table 3.2.6).

Estimated catch of all fish species for October was 6,047 ± 952 fish, comprised of 4,763 ± 831 rainbow trout, 983 ± 72 walleye, 228 ± 45 kokanee, 72 ± 4 smallmouth bass, and 1 sturgeon (Table **3.2.6).**

Estimated catch of all fish species for November **was** 1,606 ± 113 fish, comprised of, 886 ± 102 rainbow trout, and 552 ± 1 walleye, 168 ± 10 kokanee (Table 3.2.6).

Estimated catch of all fish species for December 1st to December 13th was 1,976 ± 40 fish, comprised of 1.971 ± 40 rainbow trout, and 5 ± 0 squawfish (Table 3.2.6).

Annual estimated catch of all fish species **was 240,185** ± 57,391 fish. Estimated annual catch of kokanee salmon was 17,756 ± 1,433 fish (Table 3.2.6). Highest estimated catch of kokanee occurred in April with 10,372 ± 945 fish and lowest catch occurred in July and December when no fish were caught. Estimated annual catch of rainbow trout was 81,562 ± 21,013 fish. Highest estimated catch of rainbow occurred in August with 30,549 ± 13,334 fish and lowest catch occurred in May with 849 ± 216 fish. Estimated annual catch of walleye was 116,473 ± 26,322 fish. Highest estimated catch of walleye occurred in July with 43,189 ± 8,519 fish and lowest catch occurred in December when no fish were caught. Estimated annual catch of yellow perch was 7,953 ± 3,903 fish. Highest estimated catch of yellow perch occurred in August with 7,383 ± 3,812 fish and lowest harvest occurred in January, March, April, May, June, July, October, November, and December when no fish were caught. Estimated annual catch of smallmouth bass was 12,054 ± 3,929 fish. Highest estimated catch of smallmouth bass occurred in August with 6,787 ± 2,915 fish and lowest catch occurred in January, February, March, April, May, November, and December when no fish were caught. Sturgeon anglers caught 23 fish in Lake Roosevelt as counted by creel clerks.

3.2.4 Harvest Estimates

Monthly and annual harvest estimates and 95% confidence intervals for all fish species harvested by all anglers are presented in Table 3.2.7. Harvest estimates and 95% C.I. for all species from individual stratum are presented in Appendix B.

Estimated harvest of all fish species for January was 3,351 ± 205 fish, comprised of 3,204 ± 198 rainbow trout, 116 ± 3 kokanee, and 31 ± 4 walleye (Table 3.2.7).

Table 3.2.7 Monthly and annual harvest estimates ± 95% confidence intervals for all fish species harvested by all anglers on Lake Roosevelt, from January to December, 1990.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Kokanee	116 ±3	70 ±2	5,006 ±168	10,372 ±945	204 ±18	1,091 ±101	- -	l a ±4	242 ±97	228 ±45	168 ±10	- -	17,515 ±1,393
Rainbow trout	3,204 ±198	2,028 ±26	1,866 ±187	2,124 ±266	849 ±216	7,057 ±472	17,486 ±3,596	30,462 ±13,310	7,623 ±1,482	4,127 ±725	886 ±102	1,971 ±40	79,683 ±20,620
Walleye	31 ±4	750 ±0	204 * a	2,217 ±227	2,675 ±692	16,494 ±1,880	34,401 ±6,808	18,992 ±8,151	5,417 ±760	662 ±49	441 ±0	-	82,284 *la,579
Yellow perch		15 ±0	- -					3,085 ±1,357	541 ±86	- -			3,641 ±1,443
Smallmouth bass	-	-	-	-	-	219 ±60	107 ±28	6,672 ±2,883	3,006 ±403	29 ±1	- -		10,033 ±3,375
Largemouth bass	-	-						l a ±4	-				l a ±4
Suckers			19 ±3	-									19 ±3
Squawfish									6 ±2	-			6 ±2
Black crappie									4,201 ±760	- -			4,201 ±760
Chinook									63 ±10	- -			63 ±10
Sturgeon •					2	4	9	-	1	1			17
Monthly Total	3,351 ±205	2,863 ±28	7,095 ±366	14,713 ±1,438	3,730 ±296	24,865 ±2,513	52,003 ±10,432	59,247 ±25,709	21,100 ±3,600	5,047 ±820	1,495 i l l 2	1,971 ±40	197,480 ±46,189

• Actual harvest numbers as counted by creel clerks

Estimated harvest of all fish species for February was 2,863 ± 28 fish, comprised of 2,028 ± 26 rainbow trout, 750 ± 0 walleye, 70 ± 2 kokanee, and 15 ± 0 yellow perch (Table 3.2.7).

Estimated harvest of all fish species for March was 7,095 ± 366 fish, comprised of 5,006 ± 168 kokanee, 1,866 ± 187 rainbow, 204 ± 8 walleye, and 19 ± 3 suckers (Table 3.2.7).

Estimated harvest of all fish species for April was 14,713 ± 1,438 fish, comprised of 10,372 ± 945 kokanee, 2,217 ± 227 walleye, and 2,124 ± 266 rainbow (Table 3.2.7).

Estimated harvest of all fish species for May was 3,730 ± 926 fish, comprised of 2,675 ± 692 walleye, 849 ± 216 rainbow, 204 ± 18 kokanee, and 2 sturgeon (Table 3.2.7).

Estimated harvest of all fish species for June was 24,865 ± 2,513 fish, comprised of, 16,494 ± 1,880 walleye, 7,057 ± 472 rainbow trout, 1,091 ± 101 kokanee, 219 ± 60 smallmouth bass, and 4 sturgeon (Table 3.2.7).

Estimated harvest of all fish species for July was 52,003 ±10,432 fish, comprised of 34,401 ± 6,808 walleye, 17,486 ± 3,596 rainbow, 107 ± 28 smallmouth bass, and 9 sturgeon (Table 3.2.7).

Estimated harvest of all fish species for August was 59,247 ± 25,709 fish, comprised of 30,462 ± 13,310 rainbow trout, 18,992 ± 8,151 walleye, 6,672 ± 2,883 smallmouth bass, 3,085 ± 1,357 yellow perch, 18 ± 4 kokanee, and 18 ± 4 largemouth bass. (Table 3.2.7).

Estimated harvest of all fish species for September was 21,100 ± 3,600 fish, comprised of 7,623 ± 1,482 rainbow trout, 5,417 ± 760 walleye, 4,201 ± 760 black crappie, 3,006 ± 403 smallmouth bass, 541 ± 86 yellow perch, 242 ± 97 kokanee, 63 ± 10 chinook, 6 ± 2 squawfish, and 1 sturgeon (Table 3.2.7).

Estimated harvest of all fish species for October was 5,047 ± 820 fish, comprised of 4,127 ± 725 rainbow trout, 662 ± 49 walleye, 228 ± 45 kokanee, 29 ± 1 smallmouth bass, and 1 sturgeon (Table 3.2.7).

Estimated harvest of all fish species for November was 1,495 ± 112 fish, comprised of 886 ± 102 rainbow trout, and 441 ± 0 walleye, 168 ± 10 kokanee (Table 3.2.7).

Estimated harvest of all fish species for December 1st to December 13th was 1,971 ± 40 fish, comprised entirely of rainbow trout (Table 3.2.7).

Annual estimated harvest of all fish species **was** 197,480 ± 46,189 fish. Estimated annual harvest of kokanee salmon was 17,403 ± 1,382 fish (Table 3.2.7). Highest estimated harvest of kokanee occurred in April with 10,372 ± 945 fish and lowest harvest occurred in July and December when no fish were harvested. Estimated annual harvest of rainbow trout was 79,683 ± 20,620 fish. Highest estimated harvest of rainbow occurred in August with 30,462 ± 13,310 fish and lowest harvest occurred in May with 849 ± 216 fish. Estimated annual harvest of walleye was 82,284 ± 18,579 fish. Highest estimated harvest of walleye occurred in July with 34,401 ± 6,808 fish and lowest harvest occurred in December when no fish were taken. Estimated annual harvest of yellow perch was 3,641 ± 1,443 fish. Highest estimated harvest of yellow perch occurred in August with 3,085 ± 1,357 fish and lowest harvest occurred in January, March, April, May, June, July October, November and' December with zero fish. Estimated annual harvest of smallmouth bass was 10,033 ± 3,375 fish. Highest estimated harvest of smallmouth bass occurred in August with 6,672 ± 2,883 fish and lowest harvest occurred in January, February, March, April, May, November, and December when no fish were kept. Sturgeon anglers harvested 17 fish from Lake Roosevelt as counted by creel clerks.

3.2.5 Harvest Lengths and Weights

Lengths and weights of fish harvested from Lake Roosevelt by anglers were collected by creel clerks to determine average harvest length and weight. Monthly averages for each fish species are listed in Appendix B. Annual mean lengths and weights of harvested fish are presented in Table 3.2.8.

Mean lengths of fish were: 391 ± 42 mm for kokanee, 346 ± 85 mm for rainbow trout, 376 ± 61 mm for walleye, 266 ± 38 mm for yellow perch, 223 ± 76 mm for smallmouth bass, 508 mm for squawfish, 205 ± 0 mm for black crappie, 787 ± 25 mm for chinook,

Table 3.2.8 Annual mean length (mm), weight (g), and standard deviation, of all fish species harvested from Lake Roosevelt as measured by creel clerks in 1990.

	N	Mean Length (mm)		± S.D. (mm)	Mean Weight (g)		± S.D. (g)
Kokanee	174	391	±	42	557	±	205
Rainbow trout	698	346	±	85	485	±	287
Walleye	411	376	±	61	435	±	317
Yellow perch	9	266	±	38	293	±	51
Smallmouth bass	94	223	±	76	272	±	76
Squawfish	1	508	±	-	-	±	-
Black crappie	100	205	±	0	136	±	14
Chinook	2	787	±	25	4229	±	1244
Sturgeon	12	1383	±	225	-	±	-

and 1,383 ± 225 mm for sturgeon (Table 3.2.8). Mean weights of fish harvested were 557 ± 205 g for kokanee, 485 ± 287 g for rainbow trout, 435 ± 317 g for walleye, 293 ± 51 g for yellow perch, 272 ± 76 g for smallmouth bass, 136 ± 14 g for black crappie, and 4,229 ± 1,244 g for chinook.

3.2.6 Angler Preference

Creel data was analyzed to determine angler satisfaction, and target species as compiled from angler interviews. Percent and number of shore and boat anglers satisfied with fishing is presented in Table 3.2.9. Table 3.2.10 shows the percent and number of anglers that targeted a particular fish species while fishing on Lake Roosevelt.

Of weekday shore anglers and weekend shore anglers, 56% (223 fishermen) and 58% (89 fishermen) were satisfied with fishing respectively (Table 3.2.9). Approximately 56% of all shore anglers (312 fishermen) were satisfied with fishing. Of weekday boat anglers and weekend boat anglers, 57% (147 fishermen) and 71% (135 fishermen) were satisfied with fishing. Approximately 63% of all boat anglers (282 fishermen) were satisfied with fishing.

Approximately 64% of a.m. shore anglers targeted rainbow trout, followed by 12% for sturgeon, 11% for walleye and any fish type, 1% for kokanee and smallmouth bass, and <1% for chinook. Approximately 41% of a.m. boat anglers targeted rainbow trout, followed by 29% for walleye, 15% for kokanee, 13% for anything, 1% for smallmouth bass, and <1% for yellow perch (Table 3.2.10). Approximately 51% of p.m. shore anglers targeted rainbow trout, followed by 26% for sturgeon, 13% for walleye, 7% for any fish type, 2% for kokanee, 1% for smallmouth bass, and <1% for yellow perch. Approximately 39% of p.m. boat anglers targeted walleye, followed by 31% for rainbow trout, 13% for any fish type, 12% for kokanee, 4% for smallmouth bass, 1% for sturgeon, <1% for yellow perch and black crappie. Annual data showed 45% of the fishermen targeted rainbow trout, followed by 24% for walleye, 11% for sturgeon and any fish type, 7% for kokanee, 2% for smallmouth bass, <1% for yellow perch, black crappie, and chinook.

Table 3.2.9 Percent and number (N) of shore and boat anglers in weekday and weekend stratum, satisfied with fishing on Lake Roosevelt from January to December, 1990.

Month		Shore Anglers Satisfied	(N)	Shore Anglers Not satisfied	(N)	Boat Anglers Satisfied	(N)	Boat Anglers Not satisfied	(N)
Jan.	weekday	54%	(53)	46%	(45)	100%	(2)	-	(0)
	weekend	49%	(21)	51%	(22)	63%	(5)	37%	(3)
Feb.	weekday	47%	(30)	53%	(34)	25%	(1)	75%	(3)
	weekend	44%	(12)	56%	(15)	75%	(3)	25%	(1)
March	weekday	51%	(26)	49%	(25)	49%	(35)	51%	(36)
	weekend	40%	(4)	60%	(6)	55%	(15)	45%	(12)
April	weekday	-	(0)	100%	(7)	-	(0)	-	(0)
	weekend	100%	(7)	-	(0)	100%	(8)	-	(0)
May	weekday	44%	(4)	56%	(5)	44%	(7)	56%	(9)
	weekend	-	(0)	-	(0)	47%	(8)	53%	(9)
June	weekday	100%	(2)	-	(0)	77%	(10)	23	(3)
	weekend	100%	(2)	-	(0)	100%	(2)	-	(0)
July	weekday	50%	(5)	50%	(5)	100%	(9)	-	(0)
	weekend	100%	(2)	-	(0)	100%	(4)	-	(0)
Aug.	weekday	21%	(4)	79%	(15)	65%	(13)	35%	(7)
	weekend	06%	(6)	14%	(1)	100%	(5)	-	(0)
Sept.	weekday	54%	(34)	46%	(29)	61%	(47)	39%	(30)
	weekend	64%	(16)	36%	(9)	59%	(35)	71%	(24)
Oct.	weekday	89%	(24)	11%	(3)	57%	(20)	43%	(15)
	weekend	50%	(3)	50%	(3)	92%	(22)	8%	(2)
Nov.	weekday	82%	(37)	1a%	(8)	-	(0)	100%	(5)
	weekend	33%	(2)	67%	(4)	87%	(26)	13%	(4)
Dec.	weekday	80%	(4)	20%	(1)	60%	(30)	40%	(2)
	weekend	78%	(14)	22%	(4)	67%	(2)	33%	(1)
Total	**Weekday**	56%	(223)	44%	(177)	57%	(147)	43%	(110)
	Weekend	58%	(89)	42%	(64)	71%	(135)	29%	(56)
Annual Total		56%	(312)	44%	(241)	63%	(282)	37%	(166)

Table 3.2.10 Annual percent and number (n) of target species for all angler types on Lake Roosevelt in 1990.

	a.m. Shore %	a.m. Shore (n)	a.m. Boat %	a.m. Boat (n)	p.m. Shore %	p.m. Shore (n)	p.m. Boat %	p.m. Boat (n)	Annual Numbers %	Annual Numbers (n)
Kokanee	1.2	(6)	15	(85)	1.5	(916)	12	(119)	7	(226)
Rainbow	64	(232)	41	(233)	51	(534)	31	(310)	45	(1400)
Walleye	11	(53)	29	(165)	13	(135)	39	(390)	24	(743)
Yellow perch	-	(0)	0.5	(3)	0.2	(2)	0.5	(5)	0.3	(10)
Smallmouth bass	0.8	(4)	0.9	(5)	1.4	(15)	3.9	(39)	2.0	(63)
Black crappie	-	(0)	-	(0)	-	(0)	0.3	(3)	0.1	(3)
Chinook	0.2	(1)	-	(0)	-	(0)		(0)	0.03	(1)
Sturgeon	12	(61)	-	(0)	26	(267)	0.6	(6)	11	(334)
Anything	11	(55)	13	(73)	7	(78)	13	(125)	11	(331)

3.2.7 Economic Value of the Lake Roosevelt Sport Fishery

The economic value of the Lake Roosevelt fishery is presented in Table 3.2.11. Regional consumer price indices used to calculate this value are presented in Appendix B.

The economic value of the Lake Roosevelt sport fishery was estimated at $5,309,256.20 in 1990 (Table 3.2.11).

3.3 RELATIVE ABUNDANCE OF FISH

A synoptic list of all fish species, total number and percent composition, captured during electrofishing and gillnet surveys on Lake Roosevelt from May, August and October 1990 is presented on Table 3.3.1. Annual total numbers and relative abundance of fish captured at each index station during electrofishing and gillnet surveys are presented on Tables 3.3.2 through 3.3.4. Appendix C contains total numbers and relative abundance of fish captured at each index station during electrofishing and gillnet surveys from Lake Roosevelt for the individual sampling seasons of May, August, and October.

In 1990, 8,561 fish were collected during relative abundance surveys along shorelines, tributaries, and in pelagic zones (Table 3.3.2). Total number and relative abundance of fish captured during electrofishing and gillnet surveys for 1990 included: 3,861 yellow perch (45.1%), 1,655 largescale sucker (19.3%), 1,137 walleye (13.3%), 464 squawfish (5.4%), 268 smallmouth bass (3.1%), 248 rainbow trout (2.9%), 221 lake whitefish (2.6%), 188 longnose sucker (2.2%), 152 carp (1.8%), 130 piute sculpin (1.5%), 61 kokanee salmon (0.7%), 61 pumpkinseed (0.7%), 27 largemouth bass (0.3%), 17 tench (0.2%), 16 brown trout (0.2%), 15 mountain whitefish (0.2%), 12 burbot (0.1%), 9 white crappie (0.1%), 8 bridgelip sucker (0.1%), 5 chiselmouth (0.1%), 2 brown bullhead (< 0.1%), 1 black crappie (< 0.1%), 1 redside shiner (< 0.1%), 1 brook trout (< 0.1%), and 1 chinook salmon (< 0.1%). The highest number of fish was collected at location 7 (Keller Ferry) with 2,017 fish and the lowest number collected at location 9 (Spring Canyon) with 245 fish.

Electrofishing surveys were performed for 2,567 minutes, catching 7,903 fish for a catch per unit effort (CPUE) of 184 fish/hour (Table 3.3.3). Total number and relative abundance of fish

3.2.11 Economic value of the Lake Roosevelt sport fishery from January to December 13th, 1990.

	1985	1990
Consumer Price Index	167.87	199.57
Dollars spent per angler trip	$26.00	$30.91
Angler Trips		171,765
Economic Value		**$5,309,256.20**

Table 3.3.1 Synoptic list of fish species, total numbers and % relative abundance of fish collected during electrofishing and gillnet surveys on Lake Roosevelt, in May, August, and October of 1990.

FAMILY	COMMON NAME	SCIENTIFIC NAME	TOTAL No.	% REL. ABUND.
Catostomidae	Bridgelip sucker	*Catostomus columbianus*	8	0.09%
	Longnose sucker	*Catostomus catostomus*	188	2.20%
	Largescale sucker	*Catostomus macrocheilus*	1,655	19.33%
Centrarchidae	Black crappie	*Pomoxis nigromaculatus*	1	0.01%
	Largemouth bass	*Micropterus salmonides*	27	0.32%
	Pumpkinseed	*Lepomis gibbosus*	61	0.71%
	Smallmouth bass	*Micropterus dolomieul*	268	3.13%
	White crappie	*Pomoxis annularis*	9	0.11%
Cottidae	Piute sculpin	*Co ttus beldingi*	130	1.52%
Cyprinidae	Carp	*Cyprinus carpio*	152	1.78%
	Chiselmouth	*Acrocheilus alutaceus*	5	0.06%
	Redside shiner	*Richardsonius balteatus*	1	0.01%
	Squawfish	*Ptychocheilus oregonensis*	464	5.42%
	Tench	*Tinca tinca*	17	0.20%
Gadidae	Burbot	*Lota lota*	12	0.14%
Ictaluridae	Brown bullhead	*Ictalurus nebulosus*	2	0.02%
Percidae	Walleye	*Stizostedion vitreum vitreum*	1,137	3.28%
	Yellow perch	*Perca flavesens*	3,861	45.10%
Salmonidae	Brook trout	*Salvelinus fontinalis*	1	0.01%
	Brown trout	*Salmo trutta*	16	0.19%
	Chinook salmon	*Oncorhynchus tshawytscha*	1	0.01%
	Kokanee salmon	*Oncorhynchus nerka*	61	0.71%
	Lake whitefish	*Coregonus clupeaformis*	221	2.58%
	Mountain whitefish	*Prosopium williamsoni*	15	0.18%
	Rainbow trout	*Oncorhynchus mykiss*	248	2.90%
TOTAL			8,561	

Table 3.3.2 Total number and percent relative abundance of fish captured during electrofishing and gillnet surveys at each location on Lake Roosevelt, 1990.

Site Number	1		2		3		4		5		6		7		8		9		TOTAL	
Species	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Bridgelip sucker							3	0.5	2	0.2			2	0.1			1	0.4	8	0.1
Longnose sucker	155	12.9	10	2.5	6	1.1			15	1.2			1	0.1	1	0.1			188	2.2
Largescale sucker	201	16.8	169	41.6	155	27.2	160	25.3	226	18.5	405	26.7	242	12.0	59	7.8	38	14.9	1,655	19.3
Black crappie									1	0.1									1	0.0
Largemouth bass	5	0.4					2	0.3	20	1.6									27	0.3
Pumpkinseed	4	0.3	1	0.2							54	3.6					2	0.8	61	0.7
Smallmouth bass	5	0.4					45	7.1	28	2.3	26	1.7	21	1.0	50	6.6	93	36.7	268	3.1
White crappie							2	0.3			3	0.2	3	0.1	1	0.1			9	0.1
Piute sculpin	10	0.8			3	0.5			54	4.4	46	3.0			16	2.1	1	0.4	130	1.5
Carp	93	7.8	2	0.5	9	1.6	2	0.3	7	0.6	24	1.6	2	0.1	8	1.1	5	1.9	152	1.8
Chiselmouth	5	0.4																	5	0.1
Redside shiner	1	0.1																	1	0.0
Squawfish	299	25.0	13	3.2	11	1.9	14	2.2	18	1.5	88	5.8	10	0.5	9	1.2	2	0.8	464	5.4
Tench	15	1.2			2	0.3													17	0.2
Burbot	1	0.2	4	1.0	1	0.2	2	0.3	1	0.1	1	0.1	2	0.1					12	0.1
Brown bullhead																	2	0.8	2	0.0
Walleye	146	12.2	93	22.9	150	26.3	181	28.6	319	26.1	115	7.6	53	2.6	34	4.5	46	18.1	1,137	13.3
Yellow perch	184	15.4	88	21.7	204	35.8	93	14.7	440	36.0	666	44.2	1,657	82.1	498	65.9	31	12.2	3,861	45.1
Brown trout	2	0.2			1	0.2	1	0.2	12	0.9									16	0.2
Brook trout	1	0.1																	1	0.0
Chinook salmon									1	0.1									1	0.0
Kokanee salmon							1	0.2	42	3.4	11	0.7	2	0.1	4	0.5	1	0.4	61	0.7
Lake whitefish	38	3.2	11	2.7	4	0.7	101	15.9	1	0.1	23	1.5			41	5.4	2	0.8	221	2.6
Mountain whitefish	6	0.5			1	0.2			6	0.5					2	0.3			15	0.2
Rainbow trout	25	2.1	15	3.7	23	4.0	25	3.9	29	2.4	46	3.0	22	1.1	33	4.4	30	11.8	248	2.9
TOTAL	11,196		406		570		632		11,222		1,508		12,017		756		254		6,561	

Table 3.3.3 Total number and percent relative abundance of fish captured during electrofishing surveys at each location on Lake Roosevelt, 1990.

Site Number	1		2		3		4		5		6		7		8		9		TOTAL	
Shock Time (min)	400		245		215		216		546		291		272		175		207		2,567	
Species	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Bridgelip sucker							3	0.6	2	0.2			2	0.1			1	0.4	8	0.1
Longnose sucker	148	13.1	7	1.9	2	0.4			15	1.4									172	2.2
Largescale sucker	200	17.7	163	44.7	145	26.5	150	29.6	158	14.3	374	27.2	240	12.1	54	8.0	38	17.2	1,522	19.3
Black crappie									1	0.1									1	0.0
Largemouth bass	5	0.4					2	0.4	20	1.8									27	0.3
Pumpkinseed	4	0.3	1	0.3							54	3.9					2	0.9	61	0.8
Smallmouth bass	2	0.2					45	8.9	28	2.5	24	1.7	10	0.5	50	7.4	91	41.2	250	3.2
White crappie	1	0.1					2	0.4			2	0.1	3	0.1	1	0.1			9	0.1
Piute sculpin	10	0.9			3	0.5			53	4.8	46	3.3			16	2.4	1	0.4	129	1.6
Carp	93	8.2	2	0.5	9	1.7	2	0.4	1	0.1	22	1.6	2	0.1	8	1.2	5	2.3	144	1.8
Chiselmouth	5	0.4																	5	0.1
Redside shiner	1	0.1																	1	0.0
Squawfish	299	26.5	13	3.6	9	1.6	11	2.2	15	1.4	81	5.9	7	0.3	6	0.9			441	5.6
Tench	15	1.3			2	0.4													17	0.2
Burbot	1	0.1	3		1	0.2	1	0.2	1	0.1	1	0.1	2	0.1					10	0.1
Brown bullhead																	2	0.9	2	0.0
Walleye	127	11.2	81	22.2	146	26.7	172	33.9	286	25.9	83	6.0	52	2.6	18	2.7	33	14.9	998	12.6
Yellow perch	184	16.3	81	22.2	204	37.3	93	18.4	438	39.6	652	47.4	1,657	83.6	482	71.7	31	14.0	3,822	48.4
Brown trout	2	0.2			1	0.2	1	0.2	12	1.1									16	0.2
Brook trout	1	0.1																	1	0.0
Chinook salmon									1	0.1									1	0.0
Kokanee salmon							1	0.2	42	3.8	3	0.2			3	0.4	1	0.4	50	0.6
Lake whitefish	1	0.1			1	0.2			1	0.1	3	0.2							6	0.1
Mountain whitefish	6	0.5			1	0.2			6	0.5					2	0.3			15	0.2
Rainbow trout	25	2.2	14	3.8	23	4.2	23	4.5	25	2.3	30	2.2	7	0.3	32	4.8	16	7.2	195	2.5
TOTAL	1,130		365		547		506		1,105		1,375		1,982		672		221		7,903	

captured during electrofishing surveys included: 3,822 yellow perch (48.4%), 1,522 largescale sucker (19.3%), 998 walleye (12.6%), 441 squawfish (5.6%), 250 smallmouth bass (3.2%), 195 rainbow trout (2.5%), 172 longnose sucker (2.2%), 144 carp (1.8%), 129 piute sculpin (1.6%), 61 pumpkinseed (0.8%), 50 kokanee salmon (0.6%), 27 largemouth bass (0.3%), 17 tench, 16 brown trout, 15 mountain whitefish (0.2% each), 10 burbot (0.1%), 9 white crappie (0.1%), 8 bridgelip sucker (0.1%), 6 lake whitefish (0.1%), 5 chiselmouth (0.1%), 2 brown bullhead (<0.1%), 1 black crappie (<0.1 %), 1 redside shiner (<0.1%), 1 brook trout (<0.1%), and 1 chinook salmon (<0.1%). The highest number of fish was collected at location 7 (Keller Ferry) with 1,982 fish and the lowest number was collected at location 9 (Spring Canyon) with 221 fish.

Gillnets were set for 538.1 hours, catching 658 fish for a CPUE of 1.2 fish/hour (Table 3.3.4). Total number and relative abundance of each species captured during gillnet surveys included: 215 lake whitefish (32.7%), 139 walleye (21 .1%), 133 largescale sucker (20.2%), 53 rainbow trout (8.0%), 39 yellow perch (5.9%), 23 squawfish (3.5%), 18 smallmouth bass (2.7%), 16 longnose sucker (2.4%), 11 kokanee salmon (1.7%), 8 carp (1.2%), 2 burbot (0.3%), and 1 piute sculpin (0.1%). The highest number of fish was collected at location 6 (Seven Bays) with 132 fish and the lowest number was collected at location 3 (Hunters) with 23 fish.

Monthly relative abundance of each species was determined for the 1990 sampling seasons (Appendix C). Electrofishing surveys were conducted for 708.2 minutes in May, capturing 740 fish for a CPUE of 62.7 fish/hour. Total number and relative abundance included: 289 largescale sucker (39%), 212 walleye (28.7%), 64 rainbow trout (8.6%), 45 smallmouth bass (6.1%), 41 yellow perch (5.5%), 37 squawfish (5.0%), 18 carp (2.4%), 6 longnose sucker (0.8%), 6 piute sculpin (0.8%), 6 brown trout (0.8%), 4 bridgelip sucker (0.5%), 4 mountain whitefish (0.5%), 3 tench (<0.1%), 3 kokanee salmon (<0.1%), and 2 lake whitefish (<0.1%). The highest number of fish was collected at location 4 (Porcupine Bay) with 119 fish and the lowest number was collected at location 6 (Seven Bays) with 38 fish.

Gillnets were set for a total 152.7 hours in May, capturing 104 fish for a CPUE of 0.68 fish/hour (Appendix C). Total number and relative abundance included: 48 lake whitefish (46.1%), 26 largescale sucker (25.0%), 11 walleye (10.6%), 8 squawfish (7.7%), 7

Table 3.3.4 Total number and percent relative abundance of fish captured during gillnet surveys at each location on Lake Roosevelt, 1990.

Site Number	1		2		3		4		5		6		7		8		9		TOTAL	
Soak Time (hrs)	79.6		52.3		38.8		65.9		24.3		87.7		50		54.4		85.1		538.1	
Species	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Bridgelip sucker																				
Longnose sucker	7	10.4	3	7.3	4	17.4							1	2.9	1	1.2			16	2.4
Largescale sucker	1	1.5	6	14.6	10	43.5	10	7.9	68	58.1	31	23.5	2	5.7	5	5.9			133	20.2
Black crappie																				
Largemouth bass																				
Pumpkinseed																				
Smallmouth bass	3	4.5									2	1.5	11	31.4			2	6.1	18	2.7
White crappie																				
Piute sculpin									1	0.9									1	0.1
Carp									6	5.1	2	1.5							8	1.2
Chiselmouth																				
Redside shiner																				
Squawfish					2	8.7	3	2.4	3	2.6	7	5.3	3	8.6	3	3.6	2	6.1	23	3.5
Tench																				
Burbot			1	2.4			1	0.8											2	0.3
Brown bullhead																				
Walleye	19	28.4	12	29.3	4	17.4	9	7.1	33	28.2	32	24.2	1	2.9	16	19.0	13	39.4	139	21.1
Yellow perch			7	17.1					2	1.7	14	10.6			16	19.0			39	5.9
Brown trout																				
Brook trout																				
Chinook salmon																				
Kokanee salmon											8	6.1	2	5.7	1	1.2			11	1.7
Lake whitefish	37	55.2	11	26.8	3	13.0	101	80.2			20	15.1			41	48.8	2	6.0	215	32.7
Mountain whitefish																				
Rainbow trout			1	2.4			2	1.6	4	3.4	16	12.1	15	42.9	1	1.2	14	42.4	53	8.0
TOTAL	67		41		23		126		117		132		35		84		33		658	

longnose sucker (6.7%), 2 burbot (1.9%), and 2 rainbow trout (1.9%). The highest number of fish was collected at location 4 (Porcupine Bay) with 33 fish and the lowest number was collected at location 9 (Spring Canyon) with 3 fish. No gill nets were set at location 5 (Little Falls Dam) due to low water levels.

Electrofishing surveys were conducted for 851.3 minutes in August, capturing 1,347 fish for a CPUE of 94.9 fish/hour (Appendix C). The total number captured and relative abundance included: 477 walleye (35.4%), 322 yellow perch (23.9%), 250 largescale sucker (18.5%), 152 smallmouth bass (11.3%), 68 squawfish (5.0%), 33 rainbow trout (2.4%), 14 carp (1 .0%), 12 white crappie (0.9%), 6 brown trout (0.4%), 3 bridgelip sucker (0.2%), 2 largemouth bass (0.1%), 2 pumpkinseed (0.1%), 2 kokanee salmon (0.1%), and 1 brown bullhead (0.1%). The highest number of fish was collected at location 5 (Little Falls) with 242 fish and the lowest number was collected at location 7 (Keller Ferry) with 47 fish.

Gillnets were set for 211.4 hours in August, capturing 322 fish for a CPUE of 1.5 fish/hour (Appendix C). The total number and relative abundance included: 89 lake whitefish (27.6%), 75 walleye (23.3%), 51 rainbow trout (15.8%), 10 kokanee salmon (3.1%), 8 carp (2.5%), 6 squawfish (1.9%), 3 longnose sucker (0.9%), 2 smallmouth bass (0.6%), 2 yellow perch (0.6%), and 1 piute sculpin (0.3%). The highest number of fish was collected at location 5 (Little Falls) with 116 fish and the lowest number was collected at location 8 (Sanpoil arm) with 4 fish.

Electrofishing surveys were conducted for 1,008 minutes in October, capturing 5,816 fish for a CPUE of 346.2 (Appendix C). The total number and relative abundance included: 3,459 yellow perch (59.5%), 983 largescale sucker (16.9%), 336 squawfish (5.8%), 309 walleye (5.3%), 166 longnose sucker (2.8%), 111 piute sculpin and 112 carp (1.9% each), 98 rainbow trout (1.7%), 59 pumpkinseed (1 .0%), 53 smallmouth bass (0.9%), 45 kokanee salmon (0.7%), 25 largemouth bass (0.4%), 14 tench (0.2%), 10 burbot (0.2%), 9 white crappie (0.1%), 8 mountain whitefish (0.1%), 5 chiselmouth (0.1 %), 4 brown trout (0.1%), 4 lake whitefish (0.1%), 1 bridgelip sucker (<0.1%), 1 black crappie (<0.1%), 1 redside shiner (<0.1%), 1 brown bullhead (<0.1%), 1 brook trout (<0.1%), and 1 chinook salmon (<0.1%). The highest number of fish was collected at location 7 (Keller Ferry) with 1,850 fish and the lowest number was collected at location 9 (Spring Canyon) with 38 fish.

Gillnets were set for 174 hours in October, capturing 232 fish for a CPUE of 1.3 fish/hour (Appendix C). The total number and relative abundance included: 78 lake whitefish (33.6%), 53 walleye (22.8%), 37 yellow perch (15.9%), 32 largescale sucker (13.8%), 16 smallmouth bass (6.9%), 9 squawfish (3.9%) 6 longnose sucker (2.6%), and 1 kokanee salmon (0.4%). The highest number of fish was collected at location 6 (Seven Bays) with 72 fish and the lowest numbers were collected at location 5 (Little Falls) and location 3 (Hunters) with 1 fish each.

3.4 AGE, GROWTH, AND CONDITION

3.4.1 Kokanee Salmon

Table 3.4.1 lists the mean lengths, weights and condition factors of three age classes of kokanee salmon determined from 1990 scale samples collected during the May, August, and October sampling seasons. Estimated mean back-calculated lengths at annulus formation are shown in Table 3.4.2. Information on individual fish is contained in Appendix D.

Mean lengths, weights, and condition factors were determined from 33 kokanee salmon collected at the nine index stations during the May, August, and October sampling seasons (Table 3.4.1). The mean lengths were 276 mm, 380 mm, and 447 mm for age class 1+, 2+ and 3+ respectively. The mean weights were 301 g, 607 g, and 923 g for age class 1+, 2+, and 3+ respectively. The mean condition factors were 0.98, 1.06, and 1.00 for age class 1+, 2+, and 3+ respectively. The annual mean condition factor for all age classes combined was 1.01.

Estimated total lengths at annulus formation were calculated for each age class of kokanee salmon captured (Table 3.4.2). Back-calculated lengths for all cohorts at the formation of the first annulus ranged from 156 mm to 189 mm with a grand mean of 172 mm. Lengths at the formation of the second annulus ranged from 301 to 305 mm with a grand mean of 303 mm. Length of the third annulus was 409 mm which represented one fish. The mean annual growth increments were 137 mm from 0+ to 1+, 131 mm from 1+ to 2+, and 106 mm from 2+ to 3+.

Table 3.4.1. Mean lengths (mm), weights (g), and condition factors (K_{TL}) ± standard deviation of kokanee salmon collected during 1990 sampling season. N = sample size.

Age class	N	$\bar{X}$ Length mm	± S.D.	$\bar{X}$ Weight g	± S.D.	$\bar{X}$ K_{TL}	± S.D.
1 +	4	276	± 123.9	301	± 203.1	0.98	± 0.12
2 +	11	380	± 56.7	607	± 256.1	1.06	± 0.12
3 +	18	447	± 54.9	923	± 327.9	1.00	± 0.09
TOTAL	33					1.01	

Table 3.4.2. Estimated mean total lengths (mm) ± standard deviation at annulus formation back-calculated for each age class of kokanee collected during 1990 sampling season. N = sample size.

		Mean Back-Calculated Length (mm) at Annulus		
Cohort	N	1	2	3
1989	4	170 ± 66.8		
1988	11	189 ± 62.2	305 ± 79.9	
1987	18	156 ± 57.1	301 ± 62.7	409 ± 62.2
Grand Mean	33	172	303	409
Mean Annual Growth		137	131	106

3.4.2 Rainbow Trout

Mean lengths, weights, and condition factors determined for 6 age classes of rainbow trout collected in 1990 are summarized in Table 3.4.3. Estimated mean back-calculated lengths are shown in Table 3.4.4. Information on individual fish is contained in Appendix D.

Mean lengths, weights, and condition factors of 208 rainbow trout were collected in 1990 (Table 3.4.3). The mean lengths were 250 mm, 292 mm, 338 mm, 375 mm, 452 mm, 453 mm, and 493 mm for age class 0+, 1+, 2+, 3+, 4+, 5+, and 6+ respectively. The mean weights were 233 g, 407 g, 551 g, 599 g, 828 g, 921 g, and 1020 g for age class 0+, 1+, 2+, 3+, 4+, 5+, and 6+ respectively. The condition factors were 1.16, 1.09, 1.04, 1.05, 0.91, 0.96, and 0.86 for age class 0+, 1+, 2+, 3+, 4+, 5+, and 6+ respectively. The annual mean condition factor for all age classes combined was 1 .01.

Total lengths at annulus formation were estimated for each age class of rainbow trout captured (Table 3.4.4). Back-calculated lengths for all cohorts at the formation of the first annulus ranged from 124 mm to 239 mm with a grand mean of 158 mm. Lengths at the formation of the second annulus ranged from 172 to 280 mm with a grand mean of 207 mm. Lengths at the formation of the third annulus ranged from 256 to 334 mm with a grand mean of 302 mm. Lengths at the formation of the fourth annulus ranged from 333 to 420 mm with a grand mean of 377 mm. Lengths at the formation of the fifth annulus ranged from 420 to 435 mm with a grand mean of 427 mm. Lengths at the formation of the sixth annulus had a grand mean of 472 mm which represented one fish. The mean annual growth increments were 49 mm from 1+ to 2+, 95 mm from 2+ to 3+, 74 mm from 3+ to 4+, 51 mm from 4+ to 5+, and 45 mm from 5+ to 6+.

3.4.3 Walleye

Mean lengths, weights, and condition factors determined for nine age classes of walleye collected in 1990 are summarized in Table 3.4.5. Estimated mean back-calculated lengths are shown in Table 3.4.6. Information on individual fish is contained in Appendix D.

Table 3.4.3 Mean lengths (mm), weights (g), and condition factors (K_{TL}) ± standard deviation of rainbow trout collected during 1990 sampling season. N = sample size.

Age class	N	$\bar{X}$ Length mm	± S.D.	$\bar{X}$ Weight g	± S.D.	$\bar{X}$ K_{TL}	± S.D.
0+	50	250	± 80.9	233	± 161.1	1.16	± 0.48
1+	87	292	± 108.4	407	± 343.6	1.09	± 0.20
2+	30	338	± 122.9	551	± 489.7	1.04	± 0.14
3+	20	375	± 64.8	599	± 301.3	1.05	± 0.13
4+	8	452	± 51.0	828	± 198.4	0.91	± 0.21
5+	10	453	± 53.4	921	± 269.3	0.96	± 0.44
6+		493	± 36.9	1020	± 198.1	0.86	± 0.22
TOTAL	208					1.01	

Table 3.4.4 Estimated mean total lengths (mm) ± standard deviation at annulus formation back-calculated for each age class of rainbow trout collected during 1990 sampling season. N = sample size.

		Mean Back-Calculated Length (mm) at Annulus					
Cohort	N	1	2	3	4	5	6
1989	87	239 ± 97.2					
1988	30	191 ± 94.7	280 ± 119.3				
1987	20	136 ± 60.1	209 ± 85.4	326 ± 69.4			
1986	8	129 ± 15.0	201 ± 41.5	334 ± 69.8	420 ± 55.4		
1985	10	125 ± 16.0	172 ± 24.5	293 ± 46.3	377 ± 43.3	435 ± 49.1	
1984	3	124 ± 9.0	172 ± 19.0	256 ± 37.8	333 ± 65.3	420 ± 32.7	473 ± 28.3
Grand Mean	158	158	207	302	377	428	472
Mean Annual Growth		91	49	95	74	51	45

Mean lengths, weights, and condition factors of 333 walleye were collected in 1990 (Table 3.4.5). The mean lengths were 150 mm, 231 mm, 327 mm, 403 mm, 454 mm, 521 mm, 613 mm, 688 mm, 736 mm, and 765 mm for age class 0+, 1+, 2+, 3+, 4+, 5+, 6+, 7+, 8+, and 9+ respectively. The mean weights were 39 g, 113 g, 303 g, 553 g, 792 g, 1317 g, 2170 g, 3222 g, 4011 g, and 2611 g for age class 0+, 1+, 2+, 3+, 4+, 5+, 6+, 7+, 8+, and 9+ respectively. The condition factors were 0.93, 1.05, 0.81, 0.81, 0.82, 0.89, 0.94, 1.00, 1.00, and 0.58 for age class 0+, 1+, 2+, 3+, 4+, 5+, 6+, 7+, 8+, and 9+ respectively. The annual mean condition factor for all age classes combined was 0.88. Estimated total lengths at annulus formation were estimated for each age class of walleye captured (Table 3.4.6). Back-calculated lengths for all cohorts at the formation of the first annulus ranged from 167 mm to 210 mm with a grand mean of 184 mm. Lengths at the formation of the second annulus ranged from 276 to 314 mm with a grand mean of 295 mm. Lengths at the formation of the third annulus ranged from 354 to 403 mm with a grand mean of 380 mm. Lengths at the formation of the fourth annulus ranged from 385 to 470 mm with a grand mean of 439 mm. Lengths at the formation of the fifth annulus ranged from 427 to 543 mm with a grand mean of 511 mm. Lengths at the formation of the sixth annulus ranged from 578 to 610 mm with a grand mean of 597 mm. Lengths at the formation of the seventh annulus ranged from 647 to 655 mm with a grand mean of 651 mm. Lengths at the formation of the eighth annulus ranged from 693 to 703 mm with a grand mean of 698 mm. The length of the ninth annulus was estimated at 734 mm which represented one fish. The mean annual growth increments were 110 mm from 1+ to 2+, 86 mm from 2+ to 3+, 59 mm from 3+ to 4+, 72 mm from 4+ to 5+, 86 mm from 5+ to 6+, 55 mm from 6+ to 7+, 47 mm from 7+ to 8+, and 36 mm from 8+ to 9+.

3.5 ZOOPLANKTON

3.5.1 Zooplankton Density

A total of 44 species from 36 genera of zooplankton were identified in Lake Roosevelt during 1990 (Table 3.5.1). The order Cladocera were the most diverse group, comprised of 19 species, the order Plioma was second, with 15 species. Six species of Eucopepoda were found, 3 species of Flosculariacea, and 1 species of Collothecacea.

Table 3.4.5 Mean lengths (mm), weights (g), and condition factors (K_{TL}) ± standard deviations of walleye collected during 1990 sampling season. N = sample size.

Age class	N	$\bar{X}$ Length mm	± S.D.	$\bar{X}$ Weight g	± S.D.	$\bar{X}$ K_{TL}	± S.D.
0+	22	150	± 39.4	39	± 50.5	0.93	± 0.77
1+	97	231	± 58.1	113	± 65.1	1.05	± 2.61
2+	75	327	± 44.9	303	± 119.0	0.81	± 0.10
3+	53	403	± 45.0	553	± 182.7	0.81	± 0.07
4+	60	454	± 47.5	792	± 294.1	0.82	± 0.11
5+	16	521	± 60.2	1317	± 494.7	0.89	± 0.10
6+	3	613	± 13.3	2170	± 340.8	0.94	± 0.09
7+	3	688	± 165.2	3222	± 1398.6	1.00	± 0.31
8+	3	736	± 29.5	4011	± 457.7	1.00	± 0.04
9+	1	765		2611		0.58	
TOTAL	333					0.88	

Table 3.4.6 Estimated mean total lengths (mm) ± standard deviation at annulus formation back-calculated for each age class of walleye collected during 1990 sampling season. N = sample size.

		Mean Back-Calculated Length (mm) at Annulus								
Cohort	N	1	2	3	4	5	6	7	8	9
1989	97	167 ± 38.1								
1988	75	175 ± 24.4	289 ± 38.4							
1987	53	175 ± 30.8	276 ± 51.2	354 ± 69.6						
1986	60	181 ± 27.3	279 ± 36.1	358 ± 42.6	421 ± 49.0					
1985	16	182 ± 18.0	282 ± 47.0	364 ± 45.4	385 ± 69.9	427 ± 122.6				
	3	205 ± 15.8	314 ± 19.4	396 ± 26.9	470 ± 10.0	525 ± 10.2	578 ± 7.8			
1983	3	195 ± 40.8	300 ± 85.1	392 ± 124.2	424 ± 177.0	543 ± 133.3	610 ± 156.2	655 ± 173.3		
1982	3	210 ± 14.0	311 ± 8.0	395 ± 37.4	468 ± 38.7	522 ± 37.0	588 ± 33.3	647 ± 23.2	703 ± 21.1	
1981	1	170 ± 0.0	305 ± 0.0	403 ± 0.0	465 ± 0.0	537 ± 0.0	610 ± 0.0	651 ± 0.0	693 ± 0.0	734 ± 0.0
Grand Mean	**311**	**184**	**295**	**380**	**439**	**511**	**597**	**651**	**698**	734
Mean Annual Growth		144	110	86	59	72	86	55	47	36

Table 3.5.1. Synoptic list of zooplankton taxa identified in Lake Roosevelt during the 1990 study period.

Phylum Anthropoda
- **Class Crustacea**
  - **Subclass Brachipoda**
    - **Order Cladocera**
      - **Family Daphnidae**
        1. *Ceriodaphnia quadranqula*
        2. *Daphnia galeata mendotae*
        3. *Daphnia retrocurva*
        4. *Daphnia schødleri*
        5. *Daphnia thora ta*
        6. *Megafenestra aurita*
        7. *Simocephalus serrulatus*
      - **Family Chydoridae**
        8. *Alona guttata*
        9. *Alona quadrangularis*
        10. *Chydorus sphaericus*
        11. *Eurycerus lamellatus*
        12. *Pleuroxus den ticula tus*
      - **Family Sididae**
        13. *Diaphanosoma brachyurum*
        14. *Diaphanosoma birgei*
        15. *Sida crystallina*
      - **Family Macrothricidae**
        16. *Macrothrix laticornis*
        17. *Streblocerus serricaudatus*
      - **Family Bosminidae**
        18. *Bosmina longiros tris*
      - **Family Leptodoriidae**
        19. *Leptodora kindti*
  - **Subclass Copepoda**
    - **Order Eucopepoda**
      - **Suborder Calanoida**
        - **Family Diaptomidae**
          20. *Leptodiaptomus ashlandi*
          21. *Skistodiaptomus oregonensis*
        - **Family Temoridae**
          22. *Epischura nevadensis*
      - **Suborder Cyclopoida**
        - **Family Cyclopoidae**
          23. *Diacyclops bicuspidatus thomasi*
          24. *Mesocyclop edax*
        - **Suborder Harpacticoida**
        - **Family Harpacticoidae**
          25. *Bryocamptus* spp.

Phylum Rotifera
- **Class Monogononta**
  - **Order Flosculariacea**
    - **Family Conochilidae**
      26. *Conochilus unicornis*
    - **Family Testudinellidae**
      27. *Testudinella* spp.
    - **Family Filiniidae**
      28. *Filinia terminalis*
  - **Order Collothecacea**
    - **Family Collothecidae**
      29. *Collotheca mutabilis*
  - **Order Plioma**
    - **Family Synchaetidae**
      30. *Pleosoma truncatum*
      31. *Polyarthra* spp.
      32. *Synchaeta pectina ta*
    - **Family Asplanchidae**
      33. *Asplanchna herricki*
      34. *Asplanchna priodonta*
    - **Family Brachionidae**
      35. *Brachionus quadridenta ta*
      36. *Kellicottia longispina*
      37. *Keratella* spp.
      38. *Notholca* spp.
    - **Family Epiphanidae**
      39. *Epiphanes* spp.
    - **Family Euchlanidae**
      40. *Euchlanis dila tata*
      41. *Euchlanis triquetra*
    - **Family Trichotriidae**
      42. *Trichotria tetractis*
    - **Family Trichocercidae**
      43. *Trichocerca* spp.
    - **Family Lecanidae**
      44. *Monostyla lunaris*

Monthly mean densities (#/m^3) of microcrustacean zooplankton collected from Porcupine Bay and Seven Bays are shown in Tables 3.5.2 and 3.5.3. Mean density (#/m^3) of microcrustacean zooplankton collected at nine index stations sampled during May, August, and October sampling seasons are shown in Tables 3.5.4 to 3.5.6. Rotifers were not enumerated in 1990 or included in density or biomass calculations. Information on individual zooplankton samples is presented in Appendix E.

Mean microcrustacean zooplankton density for Porcupine Bay in January was estimated at 6,1 63/m^3 (Table 3.5.2). This volume was comprised of 78% Copepoda nauplii (4792/m^3), 20% adult Copepoda (1,255/m^3), and 2% Cladocera (116/m^3). Daphnia spp. comprised 69% (80/m^3) of mean Cladocera density.

Mean microcrustacean zooplankton density for Seven Bays in January was estimated at 689/m^3 (Table 3.5.3). This volume was comprised of 71% Copepoda nauplii (488/m^3), 20% adult Copepoda (140/m^3), and 9% Cladocera (61/m^3). Daphnia spp. comprised 69% (42/m^3) of mean Cladocera density.

Mean microcrustacean zooplankton density for Porcupine Bay in February was estimated at 1,694/m^3 (Table 3.5.2). This volume was comprised of 77% Copepoda nauplii (1,310/m^3), 22% adult Copepoda (369/m^3), and 1% Cladocera (15/m^3). Daphnia spp. comprised 13% (2/m^3) of mean Cladocera density.

Mean microcrustacean zooplankton density for Seven Bays in February was estimated at 390/m^3 (Table 3.5.3). This volume was comprised of 76% Copepoda nauplii (295/m^3), 23% adult Copepoda (91/m^3), and 1% Cladocera (4/m^3). Daphnia spp. comprised 25% (1/m^3) of mean Cladocera density.

Mean microcrustacean zooplankton density for Porcupine Bay in March was estimated at 1,591/m^3 (Table 3.5.2). This volume was comprised of 86% Copepoda nauplii (1,365/m^3), 14% adult Copepoda (21 9/m^3), and <1% Cladocera (7/m^3). Daphnia spp. comprised 14% (1/m^3) of mean Cladocera density.

Mean microcrustacean zooplankton density for Seven Bays in March was estimated at 944/m^3 (Table 3.5.3). This volume was comprised of 72% Copepoda nauplii (677/m^3), 27% adult Copepoda

Table 3.5.2 Mean monthly density values (#/m^3) and standard deviation of different categories of zooplankton at Porcupine Bay (Index Station 4) in 1990.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Mean
Daphnia spp. #/m^3	80	2	1	7	77	7,802	4,303	3,214	4,657	9,564	1,283	25	2,585
±S.D.	14	0	0	7	35	3,939	1,315	2,963	134	4,108	28	11	
Leptodora #/m^3	0	0	0	5	9	134	20	52	6	28	1	0	21
±S.D.	0	0	0	7	0	21	0	7	0	35	0	0	
Cladocera #/m^3	116	15	7	72	238	8,398	4,800	3,624	5,991	9,756	1,424	240	2,890
±S.D.	7	0	7	28	35	7,009	1,393	3,274	184	4,186	21	113	
Adult Copepoda #/m^3	1,255	369	219	329	6,004	2,727	10,657	12,265	19,041	23,980	2,655	2,283	6,815
±S.D.	50	0	14	113	629	445	354	4964	1,146	12,862	134	1,777	
Nauplii #/m^3	4,792	1,310	1,365	1,928	3,809	2,526	53,254	20,031	14,146	18,810	2,174	8,681	11,069
±S.D.	28	0	64	297	78	1,146	3,260	9,603	106	12,862	134	7,038	
Total Zooplankton #/m^3	6,163	1,694	1,591	2,329	10,051	13,651	68,711	35,920	39,178	52,546	6,253	11,204	20,774
±S.D.	85	0	42	438	672	5,600	5,006	17,840	1,067	22,790	502	8,928	

Table 3.5.3 Mean monthly density values (#/m^3) and standard deviation of different categories of zooplankton at Seven Bays (Index Station 6) in 1990.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Daphnia spp. #/m^3	42	1	0	1	138	3,233	220	3,687	7,307	4,150	700	398	**1,656**
± S.D.	0	0	0	14	14	813	35	863	438	368	14	113	
Leptodora #/m^3	0	0	0	1	35	10	10	28	21	4	0	0	9
± S.D.	0	0	0	7	7	14	14	7	0	0	0	0	
Cladocera #/m^3	61	4	8	17	292	5,383	1,183	3,762	8,022	5,076	1,063	534	2,117
± S.D.	0	0	14	7	14	1,492	440	870	247	205	21	84	
Adult Copepoda #/m^3	140	91	259	67	884	3,302	5,468	4,872	29,344	11,408	2,769	2,099	5,059
± S.D.	0	0	0	0	57	728	648	566	57	1216	205	57	
Nauplii #/m^3	488	295	677	512	1,709	7,045	5,706	9,566	43,955	7,026	4,282	5,720	7,248
± S.D.	0	0	226	21	184	1,548	2,737	827	5,084	78	410	354	
Total Zooplankton #/m^3	689	390	944	596	2,885	15,730	12,357	18,200	81,321	23,510	8,114	8,353	14,424
± S.D.	0	0	240	14	1,183	785	1,344	2,263	5,275	1,089	177	325	

($259/m^3$), and 1% Cladocera ($8/m^3$). Daphnia spp. and L. kindti were not found in March samples.

Mean microcrustacean zooplankton density for Porcupine Bay in April was estimated at $2,329/m^3$ (Table 3.5.2). This volume was comprised of 83% Copepoda nauplii ($1,928/m^3$), 14% adult Copepoda ($329/m^3$), and 3% Cladocera ($72/m^3$). The mean Cladocera density was comprised of 10% ($7/m^3$) Daphnia spp. and 7% ($5/m^3$) L. kindti.

Mean microcrustacean zooplankton density for Seven Bays in April was estimated at $596/m^3$ (Table 3.5.3). This volume was comprised of 86% Copepoda nauplii ($512/m^3$), 11% adult Copepoda ($67/m^3$), and 3% Cladocera ($17/m^3$). The mean Cladocera density was comprised of 6% ($1/m^3$) Daphnia spp. and 6% ($1/m^3$) L. kindti.

Mean microcrustacean zooplankton density of the entire reservoir was estimated to be $3,658/m^3$ in May 1990 (Table 3.5.4). Mean microcrustacean zooplankton density was comprised of 54% Copepoda nauplii ($1,974/m^3$), 38% adult Copepoda ($1,400/m^3$), and 8% Cladocera ($285/m^3$). The mean Cladocera density was comprised of 33% ($94/m^3$) Daphnia spp. and 3% ($8/m^3$) L. kindti. Microcrustacean zooplankton density was highest at location 4 (Porcupine Bay) at 10,051 $/m^3$, followed by location 8 (the Sanpoil arm) at 4,599/m? Lowest density occurred in the upper part of the reservoir at location 1 (Kettle Falls) at $1,299/m^3$ followed by location 2 (Gifford) at $1,909/m^3$. Mean density of Daphnia spp. was highest at location 8 (the Sanpoil arm) at $467/m^3$ and lowest at location 1 (Kettle Falls) at $1/m^3$. Mean density of *L.* kindti was highest at location 6 (Seven Bays) at $35/m^3$ and lowest at location 9 (Spring Canyon) at $1/m^3$.

Mean microcrustacean zooplankton density for Porcupine Bay in May was estimated at $10,051/m^3$ (Table 3.5.2). This volume was comprised of 60% adult Copepoda ($6,004/m^3$), 38% Copepoda nauplii ($3,809/m^3$), and 2% Cladocera ($238/m^3$). The mean Cladocera density was comprised of 32% ($77/m^3$) Daphnia spp. and 4% ($9/m^3$) *L.* kindti.

Mean microcrustacean zooplankton density for Seven Bays in May was estimated at $2,885/m^3$ (Table 3.5.3). This volume was comprised of 59% Copepoda nauplii ($1,709/m^3$), 31% adult Copepoda ($884/m^3$), and 10% Cladocera ($292/m^3$). The mean Cladocera density was comprised of 47% ($138/m^3$) Daphnia spp. and 12% ($35/m^3$) *L.* kindti.

Table 3.5.4 Mean density values (#/m^3) and standard deviation of different categories of zooplankton at nine index stations in May 1990.

Taxon	Index Station 01	02	03	04	05	06	07	08	09	Reservoir Mean
Daphnia spp. #/m^3	1	5	5	77	2	138	77	467	75	94
± S.D.	0	7	0	35	0	14	7	212	7	
Leptodora #/m^3	0	14	7	9	2	35	3	4	1	8
± S.D.	0	7	0	0	0	7	0	7	0	
Cladocera #/m^3	39	54	45	238	120	292	330	1,131	314	285
± S.D.	14	7	28	35	0	14	21	233	14	
Adult Copepoda #/m^3	35	23	134	6,004	1,763	884	1,492	1,038	1,225	1,400
± S.D.	7	0	7	629	0	57	219	71	42	
Nauplii #/m^3	1,225	1,832	1,889	3,809	1,571	1,709	1,599	2,430	1,699	1,974
± S.D.	276	120	71	78	0	184	141	283	163	
Total Zooplankton #/m^3	1,299	1,909	2,068	10,051	3,454	2,885	3,421	4,599	3,238	3,658
± S.D.	283	134	106	672	0	113	382	21	106	

Mean microcrustacean zooplankton density for Porcupine Bay in June was estimated at 13,651/m^3 (Table 3.5.2). This volume was comprised of 62% Cladocera (8,398/m^3), 20% adult Copepoda (2,727/m^3), and 18% Copepoda nauplii (2,526/m^3). The mean Cladocera density was comprised of 93% (7,802/m^3) Daphnia spp. and 2% (134/m^3) L. kindti.

Mean microcrustacean zooplankton density for Seven Bays in June was estimated at 15,730/m^3 (Table 3.5.3). This volume was comprised of 45% Copepoda nauplii (7,045/m^3), 34% Cladocera (5,383/m^3), and 21% adult Copepoda (3,302/m^3). The mean Cladocera density was comprised of 60% (3,233/m^3) Daphnia spp. and <1% (1 0/m^3) L. kindti.

Mean microcrustacean zooplankton density for Porcupine Bay in July was estimated at 68,71 1/m^3 (Table 3.5.2). This volume was comprised of 77% Copepoda nauplii (53,254/m^3), 16% adult Copepoda (10,657/m^3), and 7% Cladocera (4,800/m^3). The mean Cladocera density was comprised of 90% (4,303/m^3) Daphnia spp. and <1% (20/m^3) L. kindti.

Mean microcrustacean zooplankton density for Seven Bays in July was estimated at 12,357/m^3 (Table 3.5.3). This volume was comprised of 46% Copepoda nauplii (5,706/m^3), and 44% adult Copepoda (5,468/m^3), 10% Cladocera (1 ,1 83/m^3). The mean Cladocera density was comprised of 19% (220/m^3) Daphnia spp. and 1% (1 0/m^3) L. kindti.

Mean microcrustacean zooplankton density for the entire reservoir was estimated to be 30,618/m^3 in August 1990 (Table 3.5.5). Mean microcrustacean zooplankton density was comprised of 63% Copepoda nauplii (19,405/m^3), 25% adult Copepoda (7,579/m^3), and 12% Cladocera (3,634/m^3). The mean Cladocera density was comprised of 95% (3,439/m^3) Daphnia spp. and 1% (39/m^3) L. kindti. Density was highest at location 8 (the Sanpoil arm) at 79,81 1/m^3 followed by location 7 (Keller Ferry) at 67,095/m^3. Lowest density occurred in the upper part of the reservoir at location 2 (Gifford) at 1 ,696/m^3 followed by location 1 (Kettle Falls) at 2,715/m^3. Mean density of Daphnia spp. was highest at location 7 (Keller Ferry) at 8,750/m^3 and lowest at location 2 (Gifford) at 34/m? Mean density of L. kindti was highest at location 7 (Keller Ferry) at 106/m^3 and lowest at location 1 (Kettle Falls) at 2/m^3.

Table 3.5.5 Mean density values ($\#/m^3$) and standard deviation of different categories of zooplankton at nine index stations in August 1990.

Taxon	Index Station 01	02	03	04	05	06	07	08	09	Reservoir Mean
Daphnia spp. $\#/m^3$	71	*34*	*492*	3,214	575	3,687	8,750	8,663	5,466	3,439
± S.D.	21	0	*50*	2,963	197	863	523	2,263	1,669	
Leptodora $\#/m^3$	2	3	57	52	25	28	106	71	7	39
± S.D.	0	0	7	7	0	7	14	14	0	
Cladocera $\#/m^3$	313	97	749	3,624	896	3,762	8,957	8,786	5,523	3,634
± S.D.	35	0	78	3,274	163	870	530	2,263	1663	
Adult Copepoda $\#/m^3$	616	575	4,031	12,265	3,379	4,872	12,863	15,694	13,918	7,579
± S.D.	7	0	417	4,964	35	566	1,167	42	870	
Nauplii $\#/m^3$	1,786	1,024	4,599	20,031	7,962	9,566	45,275	55,331	29,066	19,405
± S.D.	163	0	509	9,603	1,768	827	2,326	6,307	2,199	
Total Zooplankton $\#/m^3$	2,715	1,696	9,397	35,920	12,237	18,200	87,095	79,811	48,507	30,818
± S.D.	120	0	1004	17,840	1,640	2,263	1,690	8,528	304	

Mean microcrustacean zooplankton density for Porcupine Bay in August was estimated at 35,921/m^3 (Table 3.5.2). This volume was comprised of 56% Copepoda nauplii (20,031/m^3), 34% adult Copepoda (12,265/m^3), and 10% Cladocera (3,624/m^3). The mean Cladocera density was comprised of 89% (3,214/m^3) Daphnia spp. and 1% (52/m^3) L. kindti.

Mean microcrustacean zooplankton density for Seven Bays in August was estimated at 18,200/m^3 (Table 3.5.3). This volume was comprised of 52% Copepoda nauplii (9,566/m^3), 27% adult Copepoda (4,872/m^3), and 21% Cladocera (3,762/m^3). The mean Cladocera density was comprised of 98% (3,687/m^3) Daphnia spp. and 1% (28/m^3) L. kindti.

Mean microcrustacean zooplankton density for Porcupine Bay in September was estimated at 39,178/m^3 (Table 3.5.2). This volume was comprised of 49% adult Copepoda (19,041/m^3), 36% Copepoda nauplii (14,146/m^3), and 15% Cladocera (5,991/m^3). The mean Cladocera density was comprised of 78% (4,657/m^3) Daphnia spp. and <1% (6/m^3) L. kindti.

Mean microcrustacean zooplankton density for Seven Bays in September was estimated at 81,321/m^3 (Table 3.5.3). This volume was comprised of 54% Copepoda nauplii (43,955/m^3), 36% adult Copepoda (29,344/m^3), and 10% Cladocera (8,022/m^3). The mean Cladocera density was comprised of 91% (7,307/m^3) Daphnia spp. and <1 % (21/m^3) *L.* kindti.

Mean microcrustacean zooplankton density for the entire reservoir was estimated to be 16,772/m^3 in October 1990 (Table 3.5.6). Mean microcrustacean zooplankton density was comprised of 39% adult Copepoda (6,520/m^3), 36% Copepoda nauplii (6,036/m^3), and 25% Cladocera (4,216/m^3). The mean Cladocera density was comprised of 88% (3,698/m^3) Daphnia spp. and 1% (23/m^3) *L.* kindti. Density was highest at location 4 (Porcupine Bay) at 52,546/m^3 followed by location 3 (Hunters) at 20,632/m^3. Lowest density occurred at location 1 (Kettle Falls) at 584/m^3 followed by location 7 (Keller Ferry) at 8,109/m^3. Mean density of Daphnia spp. was highest at location 4 (Porcupine Bay) at 9,564/m^3 and lowest at location 1 (Kettle Falls) at 356/m^3. Mean density of L. kindti was highest at location 2 (Gifford) at 172/m^3 and lowest at location 6 (Seven Bays) at 4/m^3.

Table 3.5.6 Mean density values (#/m^3) and standard deviation of different categories of zooplankton at nine index stations in October 1990.

Taxon	Index Station 01	02	03	04	05	06	07	08	09	Reservoir Mean
Daphnia spp. #/m^3	356	6,412	9,288	9,564	1,173	4,150	457	878	1,008	3,698
± S.D.	71	332	3,302	4,108	191	368	113	488	50	
Leptodora #/m^3	0	7	172	28	0	4	0	0	0	23
± S.D.	0	7	57	35	0	0	0	0	0	
Cladocera #/m^3	401	7,236	10,835	9,756	1,513	5,076	842	1,129	1,155	4,216
± S.D.	50	658	3,429	4,186	219	205	148	509	72	
Adult Copepoda #/m^3	41	652	5,572	23,980	5,763	11,408	3,633	2,910	4,725	6,520
± S.D.	7	134	884	12,862	721	1,216	438	856	587	
Nauplii #/m^3	142	1,866	4,225	18,810	11,389	7,026	3,634	3,705	3,531	6,036
± S.D.	14	615	771	5,742	665	78	78	587	99	
Total Zooplankton #/m^3	584	9,754	20,632	52,546	18,685	23,510	8,109	7,744	9,411	16,772
± S.D.	57	1,138	3,543	22,790	163	1,089	368	1,952	560	

Mean microcrustacean zooplankton density for Porcupine Bay in October was estimated at 52,546/m^3 (Table 3.5.2). This volume was comprised of 46% adult Copepoda (23,980/m^3), 36% Copepoda nauplii (18,81 0/m^3), and 18% Cladocera (9,756/m^3). The mean Cladocera density was comprised of 33% (3,214/m^3) Daphnia spp. and <1% (28/m^3) *L.* kindti.

Mean microcrustacean zooplankton density for Seven Bays in October was estimated at 23,510/m^3 (Table 3.5.3). This volume was comprised of 48% adult Copepoda (11,408/m^3), 30% Copepoda nauplii (7,026/m^3), and 22% Cladocera (5,076/m^3). The mean Cladocera density was comprised of 82% (4,150/m^3) Daphnia spp. and <1% (4/m^3) L. kindti.

Mean microcrustacean zooplankton density for Porcupine Bay in November was estimated at 6,254/m^3 (Table 3.5.2). This volume was comprised of 42% Copepoda nauplii (2,655/m^3), 35% adult Copepoda (2,174/m^3), and 23% Cladocera (1,424/m^3). The mean Cladocera density was comprised of 90% (1,283/m^3) Daphnia spp. and <1% (1/m^3) *L.* kindti.

Mean microcrustacean zooplankton density for Seven Bays in November was estimated at 8,114/m^3 (Table 3.5.3). This volume was comprised of 53% Copepoda nauplii (4,282/m^3), 34% adult Copepoda (2,769/m^3), and 13% Cladocera (1,063/m^3). Daphnia spp. comprised 66% (700/m^3) of the mean Cladocera density.

Mean microcrustacean zooplankton density for Porcupine Bay in December was estimated at 11,204/m^3 (Table 3.5.2). This volume was comprised of 78% Copepoda nauplii (8,681/m^3), 20% adult Copepoda (2,283/m^3), and 2% Cladocera (240/m^3). Daphnia spp. comprised 10% (25/m^3) of the mean Cladocera density.

Mean microcrustacean zooplankton density for Seven Bays in December was estimated at 8,353/m^3 (Table 3.5.3). This volume was comprised of 69% Copepoda nauplii (5,720/m^3), 25% adult Copepoda (2,099/m^3), and 6% Cladocera (534/m^3). Daphnia spp. comprised 75% (398/m^3) of the mean Cladocera density.

Annual mean microcrustacean zooplankton density was estimated to be 20,774/m^3 for Porcupine Bay in 1990 (Table 3.5.2). This density was comprised of 53% Copepoda nauplii (11,069/m^3), 33% adult Copepoda (6,815/m^3), and 14% Cladocera (2,890/m^3). The mean Cladocera density was comprised of 89% (2,585/m^3) Daphnia spp. and 1% (21/m^3) L. kindti. Highest density occurred in July (68,711/m^3) followed by October (52,546/m^3). Lowest density occurred in March (1,591/m^3) followed by February (1,694/m^3). Mean density of Daphnia spp. was highest in October (9,564/m^3) and lowest in March (1/m^3). Mean density of L. kindti was highest in June (134/m^3) and densities were lowest in January, February, March, and December when none were found.

Annual mean microcrustacean zooplankton density was estimated to be 14,424/m^3 for Seven Bays in 1990 (Table 3.5.3). This density was comprised of 50% Copepoda nauplii (7,248/m^3), 35% adult Copepoda (5,059/m^3), and 15% Cladocera (2,117/m^3). The mean Cladocera density was comprised of 78% (1,656/m^3) Daphnia spp. and <1% (9/m^3) *L.* kindti. Highest density occurred in September (81,321/m^3) followed by October (23,510/m^3). Lowest density occurred in February (390/m^3) followed by April (596/m^3). Mean density of Daphnia spp. was highest in September (7,307/m^3) and lowest in March when none were found. Mean density of L. kindti was highest in May (35/m^3) and were lowest in January, February, March, November, and December when none were found.

3.5.2 Microcrustacean Zooplankton Lengths

Monthly mean lengths (mm) of microcrustacean zooplankton collected from Porcupine Bay and Seven Bays are shown in Tables 3.5.7 and 3.5.8. Mean lengths (mm) of microcrustacean zooplankton collected at nine index stations sampled during May, August, and October sampling seasons are shown in Tables 3.5.9 to 3.5.11. Individual lengths of all species found are given in Appendix E

Mean microcrustacean zooplankton length for Porcupine Bay in January was estimated at 1.58 mm for Daphnia *schødleri* (Table 3.5.7). Lengths ranged from 0.78 mm to 2.46 mm. No other Cladocera species were found.

Mean microcrustacean zooplankton length for Seven Bays in January was estimated at 1.37 mm for D. *schødleri* (Table 3.5.8). Lengths ranged from 0.60 mm to 2.46 mm. No other Cladocera species were found.

Mean microcrustacean zooplankton length for Porcupine Bay in February was estimated at 1.08 mm for D. *schødleri* (Table 3.5.7).

Table 3.5.7 Mean monthly size values (mm) (±S.D.) of different Cladocera species at Porcupine Bay (Index Station 4) in 1990.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Art	Nov	Dec	Yearly Mean
D. galeata mendota mm		-	-	0.53	0.91	1.23	1.29	1.00	1.37	1.36	1.23	-	1.12
(±S.D.)	-	-	-	(±0.09)	(±0.19)	(±0.62)	(±0.59)	(±0.35)	(±0.50)	(±0.46)	(±0.40)		
D. retrocurva mm	-	-		-	1.26	1.53	1.51	1.80	1.89	-		-	1.60
(±S.D.)	-	-		-	(±0.35)	(±0.62)	(±0.54)	(f0.62)	(±0.18)	-		-	
D. schødleri mm	1.58	1.08	0.79	0.66	0.99	1.64	1.52	1.62	1.74	1.63	1.28	1.17	1.31
(±S.D.)	(f0.52)	(±0.00)	(±0.13)	(±0.03)	(±0.18)	(f0.78)	(±0.60)	(±0.81)	(±0.70)	(f0.61)	(f0.65)	(±0.38)	
D. thorata mm					1.30	2.31	1.73	1.83	1.94	1.54	1.90	-	1.79
(±S.D.)	-	-	-	-	(f0.44)	(±0.50)	(±0.51)	(±0.98)	(±0.52)	(±0.54)	(±0.00)	-	
L. kindti mm				0.73	1.63	3.09	3.21	6.79	6.43	4.68	3.00	-	3.70
(±S.D.)				(±0.05)	(±0.96)	(±2.24)	(f0.69)	(±2.64)	(±1.98)	(f1.33)	(±0.00)	-	

Table 3.5.8 Mean monthly size values (mm) (±S.D.) of different Cladocera species at Seven Bays (Index Station 6) in 1990.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
D. galeata mendota mm					0.76	1.04	0.73	0.99	1.35	1.30	1.02	-	1.03
(±S.D.)					(±0.00)	(fO.OO)	(f0.24)	(±0.38)	(f0.54)	(k0.37)	(k0.36)	-	
D. retrocurva mm					1.04	1.20	1.46	1.16	1.09	-			1.19
(±S.D.)					(f0.32)	(f0.44)	(±0.62)	(f0.48)	(±0.08)	-			
D. schødleri mm	1.37	0.70	1.00	0.61	2.04	1.22	0.99	1.25	1.82	1.63	1.50	1.85	1.33
(±S.D.)	(±0.59)	(±0.00)	(±0.21)	(±0.07)	(±0.00)	(f0.59)	(±0.34)	(±0.61)	(k0.72)	(i0.47)	(±0.70)	(±0.66)	
D. thorata mm					0.86	1.45	2.09	1.73	1.94	1.80	-	1.88	1.65
(±S.D.)					(±0.00)	(±0.64)	(f0.65)	(±0.70)	(f0.40)	(±0.25)	-	(f0.08)	
L. kindti mm					2.17	4.80	2.62	3.25	7.08	5.63	1.31	-	3.84
(±S.D.)					(±0.12)	(±1.22)	(±3.17)	(k1.86)	(f1.79)	(±2.61)	(±0.00)	-	

There were no ranges in length values and no other Cladocera species were found.

Mean microcrustacean zooplankton length for Seven Bays in February was estimated at 0.70 mm for *D. schødleri* (Table 3.5.8). There were no ranges in length values and no other Cladocera species were found.

Mean microcrustacean zooplankton length for Porcupine Bay in March was estimated at 1.08 mm for D. *schødleri* (Table 3.5.7). Lengths ranged from 0.70 mm to 0.88 mm. No other Cladocera species were found.

Mean microcrustacean zooplankton length for Seven Bays in March was estimated at 1.00 mm for D. *schødleri* (Table 3.5.8). Lengths ranged from 0.85 mm to 1.15 mm. No other Cladocera species were found.

Mean microcrustacean zooplankton lengths for Porcupine Bay in April were estimated at 0.53 mm for Daphnia *galeata* mendotae, 0.66 mm for D. *schødleri*, and 0.73 for *Leptodora* kindti (Table 3.5.7). Lengths for D. *schødleri* ranged from 0.62 mm to 0.70 mm and from 0.64 mm to 0.79 mm for L. kindti.

Mean microcrustacean zooplankton length for Seven Bays in April was estimated at 0.61 mm for *D. schødleri* (Table 3.5.8). Lengths ranged from 0.56 mm to 0.66 mm. No other Cladocera species were found.

Mean microcrustacean zooplankton lengths for the entire reservoir in May were estimated at 0.71 mm for *D. galeata* mendotae, 1.29 mm for Daphnia *retrocurva,* 1.20 mm for *D. schødleri,* 1.10 mm for Daphnia thorata, and 2.21 for L. kindti (Table 3.5.9). The largest size D. *schødleri* was found at location 5 (Little Falls) at 2.04 mm and the smallest at location 2 (Gifford) at 0.55 mm. The largest size *L.* kindti was found at location 6 (Seven Bays) at 3.71 mm and the smallest at location 2 (Gifford) at 1.17 mm.

Mean microcrustacean zooplankton lengths for Porcupine Bay in May were estimated at 0.91 mm for *D. galeata* mendotae, 1.26 mm for D. *retrocurva*, 0.99 mm for D. *schødleri*, 1.30 for D. *thorata*, and 1.63 for L. kindti (Table 3.5.9). Lengths for *D. schødleri* ranged from 0.68 mm to 1.24 mm and from 0.40 mm to 4.00 mm for *L.* kindti.

Table 3.5.9 **Mean monthly size values (mm) (±S.D.) of different Cladocera species at nine index stations in May 1990.**

	Index Station									
Taxon	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**Reservoir Mean**
D. galeata mendota mm		0.52	-	0.91	0.76	0.64	-	0.80	0.60	
(± S.D.)		(±0.00)	-	(±0.19)	(±0.00)	(±0.15)	-	(fO.OO)	(±0.00)	
D. retrocurva mm				1.26	1.04	1.50	1.37	-	-	1.29
(± S.D.)				(±0.35)	(±0.32)	(k0.53)	(k0.23)	-	-	
D. schødleri mm		0.55	0.76	0.99	2.04	1.37	1.20	1.39	1.33	1.20
(± S.D.)		(fO.O1)	(±0.23)	(k0.18)	(±0.00)	(±0.50)	(k0.39)	(±0.55)	(±0.48)	
D. thorata mm	0.74	0.74	1.09	1.30	0.86	1.60	1.20	1.17	1.17	1.10
(± S.D.)	(±0.03)	(±0.20)	(±0.42)	(k0.44)	(±0.00)	(f0.22)	(f0.37)	(±0.31)	(±0.45)	
L. kindti mm		1.17	1.42	1.63	2.17	3.71	1.94	2.76	2.87	2.21
(± S.D.)		(±0.44)	(±0.44)	(±0.96)	(±0.12)	(±2.51)	(k0.87)	(±1.35)	(±1.00)	

Mean microcrustacean zooplankton lengths for Seven Bays in May were estimated at 0.64 mm for D. *galeata* mendotae, 1.50 mm for *D. retrocurva,* 1.37 mm for D. *schødleri*, 1.60 for D. thorata, and 3.71 for L. kindti (Table 3.5.9). Lengths for D. *schødleri* ranged from 0.56 mm to 2.00 mm and from 0.55 mm to 10.80 mm for *L.* kindti.

Mean microcrustacean zooplankton lengths for Porcupine Bay in June were estimated at 1.23 mm for D. *galeata* mendotae, 1.53 mm for D. retrocurva, 1.64 mm for D. *schødleri*, 2.31 for D. thorata, and 3.09 for L. kindti (Table 3.5.7). Lengths for D. *schødleri* ranged from 0.72 mm to 2.98 mm and from 0.02 mm to 9.30 mm for *L.* kindti.

Mean microcrustacean zooplankton lengths for Seven Bays in June were estimated at 1.04 mm for D. *galeata* mendotae, 1.20 mm for D. retrocurva, 1.22 mm for D. *schødleri*, 1.45 for D. thorata, and 4.80 for L. kindti (Table 3.5.8). Lengths for D. *schødleri* ranged from 0.80 mm to 1.64 mm and from 2.50 mm to 6.00 mm for *L.* kindti.

Mean microcrustacean zooplankton lengths for Porcupine Bay in July were estimated at 1.29 mm for D. *galeata* mendotae, 1.51 mm for *D.* retrocurva, 1.52 mm for D. *schødleri*, 1.73 for D. thorata, and 3.21 for *L.* kindti (Table 3.5.7). Lengths for *D. schødleri* ranged from 0.60 mm to 2.46 mm and from 2.40 mm to 4.20 mm for L. kindti.

Mean microcrustacean zooplankton lengths for Seven Bays in July were estimated at 0.73 mm for D. *galeata* mendotae, 1.46 mm for *D.* retrocurva, 0.99 mm for D. *schødleri*, 2.09 for D. thorata, and 2.62 for L. kindti (Table 3.5.8). Lengths for *D. schødleri* ranged from 0.56 mm to 1.38 mm and from 0.65 mm to 8.00 mm for L. kindti

Mean microcrustacean zooplankton lengths for the entire reservoir in August were estimated at 1.29 mm for D. *galeata* mendotae, 1.36 mm for D. retrocurva, 1.56 mm for D. *schødleri*, 1.83 mm for D. thorata, and 4.73 for L. kindti (Table 3.5.10). Largest lengths of D. *schødleri* were found at location 8 (the Sanpoil Arm) at 1.95 mm and the smallest at location 2 (Gifford) at 0.88 mm. Largest lengths of L. kindti were found at location 4 (Porcupine Bay) at 6.79 mm and the smallest at location 2 (Gifford) at 2.17 mm.

Mean microcrustacean zooplankton lengths for Porcupine Bay in August were estimated at 1.00 mm for *D. galeata* mendotae, 1.80 mm for D. retrocurva, 1.62 mm for *D. schødleri*, 1.83 for *D.* thorata, and 6.79 for L. kindti (Table 3.5.10). Lengths for *D. schødleri* ranged

Table 3.5.10 Mean monthly size values (mm) (±S.D.) of different Cladocera species at nine index stations in August 1990.

	Index Station									
Taxon	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**Reservoir Mean**
D. galeata mendota										
mm	1.27	0.95	1.00	1.00	1.37	0.99	1.77	1.41	1.59	1.29
(± S.D.)	(±0.40)	(f0.28)	(±0.36)	(k0.35)	(±0.29)	(f0.33)	(±0.56)	(±0.61)	(±0.55)	
D. retrocurva										
mm	1.05	1.22	1.42	1.80	1.33	1.16	1.39	1.57	1.30	1.36
(± S.D.)	(±0.28)	(±0.34)	(k0.54)	(±0.62)	(f0.45)	(±0.48)	(±0.60)	(±0.57)	(±0.33)	
D. schødleri										
mm	1.80	0.88	1.48	1.62	1.54	1.25	1.83	1.95	1.67	1.56
(± S.D.)	(±1.47)	(±0.29)	(f0.66)	(±0.81)	(±0.44)	(±0.61)	(±0.65)	(k0.63)	(k0.57)	
D. thorata										
mm	1.49	1.40	1.81	1.83	2.08	1.73	2.06	2.01	2.08	1.83
(± S.D.)	(±0.38)	(±0.55)	(±0.66)	(±0.98)	(±0.49)	(±0.70)	(±0.70)	(f0.58)	(f0.27)	
L. kindti										
mm	2.73	2.17	4.88	6.79	-	3.25	6.06	5.85	6.14	4.73
(± S.D.)	(±0.43)	(f2.18)	(±2.59)	(±2.64)	-	(±1.86)	(±2.10)	(k1.93)	(±1.60)	

from 0.60 mm to 3.40 mm and from 0.40 mm to 10.00 mm for *L*. kindti.

Mean microcrustacean zooplankton lengths for Seven Bays in August were estimated at 0.99 mm for *D*. galeata mendotae, 1.16 mm for *D*. retrocurva, 1.25 mm for D. *schødleri*, 1.73 for *D*. thorata, and 3.25 for *L*. kindti (Table 3.5.10). Lengths for D. schodleri ranged from 0.80 mm to 2.76 mm and from 0.64 mm to 7.00 mm for L. kindti.

Mean microcrustacean zooplankton lengths for Porcupine Bay in September were estimated at 1.37 mm for D. galeata *mendotae*, 1.89 mm for D. retrocurva, 1.74 mm for D. schodleri, 1.94 for D. thorata, and 6.43 for L. kindti (Table 3.5.7). Lengths for D. *schødleri* ranged from 0.80 mm to 3.40 mm and from 2.60 mm to 9.50 mm for L. kindti.

Mean microcrustacean zooplankton lengths for Seven Bays in September were estimated at 1.35 mm for *D*. galeata mendotae, 1.09 mm for D. retrocurva, 1.82 mm for *D. schødleri*, 1.94 for D. thorata, and 7.08 for L. kindti (Table 3.5.8). Lengths for D. *schødleri* ranged from 0.70 mm to 2.94 mm and from 3.00 mm to 11.10 mm for L. kindti.

Mean microcrustacean zooplankton lengths for the entire reservoir in October were estimated at 1.35 mm for *D*. galeata mendotae, 1.15 mm for D. retrocurva, 1.75 mm for D. *schødleri*, 1.62 mm for D. thorata, and 5.84 for L. kindti (Table 3.5.11). The largest size *D. schødleri* was found at location 1 (Kettle Falls) at 2.86 mm and the smallest at location 5 (Little Falls) at 1.38 mm. The largest size L. kindti was found at location 2 (Gifford) at 6.60 mm and the smallest at location 4 (Porcupine Bay) at 4.68 mm.

Mean microcrustacean zooplankton lengths for Porcupine Bay in October were estimated at 1.36 mm for D. galeata mendotae, 1.63 mm for D. *schødleri*, 1.54 for D. thorata, and 4.68 for L. kindti (Table 3.5.11). Lengths for *D. schødleri* ranged from 0.74 mm to 3.12 mm and from 3.00 mm to 8.00 mm for L. kindti.

Mean microcrustacean zooplankton lengths for Seven Bays in October were estimated at 1.30 mm for D. galeata mendotae, 1.63 mm for *D. schødleri*, 1.80 for D. thorata, and 5.63 for L. kindti (Table 3.5.11). Lengths for D. *schødleri* ranged from 1.38 mm to 2.18 mm and from 3.20 mm to 10.80 mm for *L*. kindti.

Table 3.5.11 Mean monthly size values (mm) (±S.D.) of different Cladocera species at nine index stations in October 1990.

Taxon	Index Station 01	02	03	04	05	06	07	08	09	Reservoir Mean
D. galeata mendota mm	0.99	1.13	1.11	1.36	1.27	1.30	1.36	1.85	1.79	1.35
(± S.D.)	(f0.22)	(f0.40)	(±0.30)	(k0.46)	(±0.45)	(±0.37)	(±0.23)	(±0.07)	(±0.42)	
D. re trocurva mm	0.90	1.21	1.33	-						1.15
(± S.D.)	(±0.14)	(±0.44)	(±0.50)	-						
D. schødleri mm	2.86	1.47	1.92	1.63	1.38	1.63	1.65	1.48	1.71	1.75
(± S.D.)	(±0.00)	(±0.60)	(±0.64)	(±0.61)	(k0.37)	(±0.47)	(±0.59)	(±0.55)	(f0.51)	
D. thorata mm	1.37	1.41	1.78	1.54	1.53	1.80	-		1.94	1.62
(± S.D.)	(±0.59)	(±0.50)	(±0.53)	(±0.54)	(±0.54)	(±0.25)	-		(±0.16)	
L. kindti mm		6.60	6.46	4.68	-	5.63	-			5.84
(± S.D.)		(±2.40)	(±3.12)	(±1.33)	-	(±2.61)	-			

Mean microcrustacean zooplankton lengths for Porcupine Bay in November were estimated at 1.23 mm for *D. galeata mendotae*, 1.28 mm for *D. schødleri*, 1.90 for *D.* thorata, and 3.00 for L. *kindti* (Table 3.5.7). Lengths for *D. schødleri* ranged from 0.52 mm to 2.92 mm. There were no range values for *L.* kindti.

Mean microcrustacean zooplankton lengths for Seven Bays in November were estimated at 1.02 mm for *D. galeata* mendotae, 1.50 mm for *D. schødleri*, and 1.31 for *L. kindti* (Table 3.5.8). Lengths for *D. schødleri* ranged from 0.68 mm to 2.82 mm and from 0.70 mm to 1.80 mm for L. kindti.

Mean microcrustacean zooplankton lengths for Porcupine Bay in December were estimated at 1.17 mm for *D. schødleri* (Table 3.5.7). Lengths for *D. schødleri* ranged from 0.66 mm to 1.80 mm. No other Cladocera species were found

Mean microcrustacean zooplankton lengths for Seven Bays in December were estimated at 1.85 mm for *D. schødleri* and 1.88 mm for *D.* thorata (Table 3.5.8). Lengths for *D. schødleri* ranged from 0.50 mm to 3.00 mm.

Annual mean microcrustacean zooplankton lengths for Porcupine Bay in 1990 were estimated at 1.12 mm for *D. galeata* mendotae, 1.60 mm for *D. retrocurva*, 1.31 mm for *D. schødleri*, 1.79 for *D.* thorata, and 3.70 for *L.* kindti (Table 3.5.7). Lengths for *D. schødleri* ranged from 0.66 mm in April to 1.74 mm in September. Lengths for *L.* kindti ranged from 0.73 mm in April to 6.79 mm in August.

Annual mean microcrustacean zooplankton lengths for Seven Bays in 1990 were estimated at 1.03 mm for *D. galeata* mendotae, 1.19 mm for *D. retrocurva*, 1.33 mm for *D. schødleri*, 1.65 mm for *D.* thorata, and 3.83 mm for L. kindti (Table 3.5.8). Lengths for *D. schødleri* ranged from 0.6 mm in April to 1.85 mm in December. Lengths for L. kindti ranged from 1.31 mm in November to 7.08 mm in September.

3.4.3 Microcrustacean Zooplankton Biomass

Monthly biomass values (µg/m^3) of *Daphnia* spp., Leptodora kindti, and total Cladocera collected from Porcupine Bay and Seven Bays are shown in Tables 3.5.12 and 3.5.13. Mean biomass values

($\mu g/m^3$) of Daphnia spp., *L.* kindti, and total Cladocera collected at nine index stations sampled during May, August, and October sampling seasons are shown in Tables 3.5.14 to 3.5.16. Biomass for individual species of Daphnia are shown in Appendix E.

Mean microcrustacean zooplankton biomass values for Porcupine Bay in January were estimated at 3,294 $\mu g/m^3$ for Daphnia spp., 0 $\mu g/m^3$ for *Leptodora* kindti, and 3,294 $\mu g/m^3$ for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in January were estimated at 1 ,1 12 $\mu g/m^3$ for Daphnia spp., 0 $\mu g/m^3$ for L. kindti, and 1 ,112 $\mu g/m^3$ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in February were estimated at 25 $\mu g/m^3$ for Daphnia spp., 0 $\mu g/m^3$ for L. kindti, and 25 $\mu g/m^3$ for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in February were estimated at 3 $\mu g/m^3$ for Daphnia spp., 0 $\mu g/m^3$ for L. kindti, and 3 $\mu g/m^3$ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in March were estimated at 5 $\mu g/m^3$ for Daphnia spp., 0 $\mu g/m^3$ for *L.* kindti, and 5 $\mu g/m^3$ for total Cladocera (Table 3.5.12)

Mean microcrustacean zooplankton biomass values for Seven Bays in March were estimated at 0 $\mu g/m^3$ for Daphnia spp., 0 $\mu g/m^3$ for L. kindti, and 0 $\mu g/m^3$ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in April were estimated at 18 $\mu g/m^3$ for Daphnia spp., 1 $\mu g/m^3$ for *L.* kindti, and 19 $\mu g/m^3$ for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in April were estimated at 2 $\mu g/m^3$ for Daphnia spp., 0 $\mu g/m^3$ for L. kindti, and 2 $\mu g/m^3$ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for all sample sites in May were estimated at 2,139 $\mu g/m^3$ for Daphnia spp., 66 $\mu g/m^3$ for *L.* kindti, and 2,205 $\mu g/m^3$ for total Cladocera

Table 3.5.12 Mean monthly biomass values (µg/m^3) of different Cladocera at Porcupine Bay (Index Station 4) in 1990.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Daphnia spp. µg/m^3	3,294	25	5	18	879	128,308	81,246	84,536	173,463	318,804	26,654	398	68,136
L. kindti µg/m^3	0	0	0	1	15	1,198	198	3,810	379	759	12	0	531
Total Cladocera µg/m^3	3,294	25	5	19	893	129,506	81,444	88,346	173,842	319,563	26,666	398	68,667

Table 3.5.13 Mean monthly biomass values (µg/m^3) of different Cladocera at Seven Bays (Index Station 6) in 1990.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Daphnia spp. µg/m^3	1,112	3	0	2	2,640	17,550	8,318	51,438	280,966	160,310	16,211	26,529	47,090
L. kindti µg/m^3	0	0	0	0	510	290	57	286	1,714	177	3,136	0	514
Total Cladocera µg/m^3	1,112	3	0	2	3,150	17,840	8,375	51,724	282,680	160,487	19,347	26,529	47,604

(Table 3.5.14). Biomass values of Daphnia spp. ranged from a high of 12,599 µg/m³ at location 8 (Spring Canyon) to a low of 7 µg/m³ at location 1 (Kettle Falls). L. kindti biomass values ranged from a high of 510 µg/m³ at location 6 (Seven Bays) to a low of 0 µg/m³ at location 1 (Kettle Falls). Total Cladocera biomass values ranged from a high of 12,625 µg/m³ at location 8 (Spring Canyon) to a low of 7 µg/m³ at location 1 (Kettle Falls).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in May were estimated at 879 µg/m³ for Daphnia spp., 15 µg/m³ for L. kindti, and 893 µg/m³ for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in May were estimated at 2,640 µg/m³ for Daphnia spp., 510 µg/m³ for L. kindti, and 3,150 µg/m³ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in June were estimated at 128,308 µg/m³ for Daphnia spp., 1,198 µg/m³ for L. kindti, and 129,506 µg/m³ for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in June were estimated at 17,550 µg/m³ for Daphnia spp., 290 µg/m³ for L. kindti, and 17,840 µg/m³ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in July were estimated at 81,246 µg/m³ for Daphnia spp., 198 µg/m³ for *L.* kindti, and 81,444 µg/m³ for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in July were estimated at 8,318 µg/m³ for Daphnia spp., 57 µg/m³ for *L.* kindti, and 8,375 µg/m³ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for all sample sites in August were estimated at 141,039 µg/m³ for Daphnia spp., 1,715 µg/m³ for L. kindti, and 142,758 µg/m³ for total Cladocera (Table 3.5.15). Biomass values of Daphnia spp. ranged from a high of 435,713 µg/m³ at location 7 (Keller Ferry) to a low

Table 3.5.14 Mean biomass values (µg/m^3) of different Cladocera at nine index stations in May 1990.

	Index Station									
Taxon	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**Reservoir Mean**
Daphnia spp. µg/m^3	7	17	91	879	9	2,640	1,332	12,599	1,680	2,139
L. kindti µg/m^3	0	9	8	15	7	510	8	26	7	66
Total Cladocera µg/m^3	7	26	99	893	16	3,150	1,340	12,625	1,687	2,205

Table 3.5.15 Mean biomass values (μg/m^3) of different Cladocera at nine index stations in August 1990.

Taxon	Index Station 01	02	03	04	05	06	07	08	09	Reservoir Mean
Daphnia spp. μg/m^3	1,228	252	6,873	84,536	8,853	51,438	435,713	435,669	244,826	141,039
L. kindti μg/m^3	13	10	1,729	3,810	0	286	5,731	3,458	398	1,715
Total Cladocera μg/m^3	1,241	262	8,602	88,346	8,853	51,724	441,444	439,127	245,218	142,758

of 252 μg/m3 at location 2 (Gifford). L. kindti biomass values ranged from a high of 5,731 μg/m3 at location 7 (Keller Ferry) to a low of 0 μg/m3 at location 5 (Little Falls). Total Cladocera biomass values ranged from a high of 441,444 μg/m3 at location 7 (Keller Ferry) to a low of 262 μg/m3 at location 2 (Gifford).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in August were estimated at 84,536 μg/m3 for Daphnia spp., 3,810 μg/m3 for L. kindti, and 88,346 μg/m3 for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in August were estimated at 51,438 μg/m3 for Daphnia spp., 286 μg/m3 for L. kindti, and 51,724 μg/m3 for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in September were estimated at 173,463 μg/m3 for Daphnia spp., 379 μg/m3 for L. kindti, and 173,842 μg/m3 for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in September were estimated at 280,966 μg/m3 for Daphnia spp., 1,714 μg/m3 for L. kindti, and 282,680 μg/m3 for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for all sample sites in October were estimated at 128,809 μg/m3 for Daphnia spp., 1,381 μg/m3 for *L.* kindti, and 130,190 μg/m3 for total Cladocera (Table 3.5.16). Biomass values of Daphnia spp. ranged from a high of 426,442 μg/m3 at location 3 (Hunters) to a low of 10,377 μg/m3 at location 1 (Kettle Falls). *L.* kindti biomass values ranged from a high of 11,017 μg/m3 at location 3 (Hunters) to a low of 0 μg/m3 at locations 5 (Little Falls), 7 (Keller Ferry), 8 (Sanpoil arm), and 9 (Spring Canyon). Total Cladocera biomass values ranged from a high of 426,442 μg/m3 at location 3 (Hunters) to a low of 10,377 μg/m3 at location 1 (Kettle Falls).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in October were estimated at 318,804 μg/m3 for Daphnia spp., 759 μg/m3 for L. kindti, and 319,563 μg/m3 for total Cladocera (Table 3.5.12).

Table 3.5.16 Mean biomass values ($\mu g/m^3$) of different Cladocera at nine index stations in October 1990.

	Index Station									
Taxon	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**Reservoir Mean**
Daphnia spp. $\mu g/m^3$	10,377	101,020	426,442	318,804	28,016	160,310	21,105	38,956	54,251	128,809
L. kindti $\mu g/m^3$	0	475	11,017	759	0	177	0	0	0	1,381
Total Cladocera $\mu g/m^3$	10,377	101,495	437,459	319,563	28,016	160,487	21,105	38,956	54,251	130,190

Mean microcrustacean zooplankton biomass values for Seven Bays in October were estimated at 160,310 μg/m³ for *Daphnia* spp., 177 μg/m³ for *L. kindti,* and 160,487 μg/m³ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in November were estimated at 26,654 μg/m³ for Daphnia spp., 12 μg/m³ for L. kindti, and 26,666 μg/m³ for total Cladocera (Table 3.5.12).

Mean microcrustacean zooplankton biomass values for Seven Bays in November were estimated at 16,211 μg/m³ for Daphnia spp., 3,136 μg/m³ for L. kindti, and 19,347 μg/m³ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Porcupine Bay in December were estimated at 398 μg/m³ for Daphnia spp., 0 μg/m³ for *L.* kindti, and 398 μg/m³ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for Seven Bays in December were estimated at 26,529 μg/m³ for Daphnia spp., 0 μg/m³ for L. kindti, and 26,529 μg/m³ for total Cladocera (Table 3.5.13).

Mean microcrustacean zooplankton biomass values for the entire year at Porcupine Bay were estimated at 68,136 μg/m³ for Daphnia spp., 531 μg/m³ for L. kindti, and 68,667 μg/m³ for total Cladocera (Table 3.5.12). Biomass values of Daphnia spp. ranged from a high of 310,804 μg/m³ in October to a low of 5 μg/m³ in March. L. kindti biomass values ranged from a high of 3,810 μg/m³ in August to a low of 0 μg/m³ in January, February, March, and December. Total Cladocera biomass values ranged from a high of 319,563 μg/m³ in October to a low of 5 μg/m³ in March.

Mean microcrustacean zooplankton biomass values for the entire year at Seven Bays were estimated at 47,090 μg/m³ for Daphnia spp., 514 μg/m³ for L. kindti, and 47,604 μg/m³ for total Cladocera (Table 3.5.13). Biomass values of Daphnia spp. ranged from a high of 280,966 μg/m³ in September to a low of 0 μg/m³ in March. L. kindti biomass values ranged from a high of 1,714 μg/m³ in September to a low of 0 μg/m³ in January, February, March, April, and December. Total Cladocera biomass values ranged from a high of 282,680 µg/m³ in September to a low of 0 µg/m³ in March.

3.6 FISH FEEDING HABITS

3.6.1 Annual Feeding Habits of Kokanee Salmon for 1990

Annual Feeding Habits of 0+ Kokanee Salmon for 1990

Information for annual feeding habits of 0+ kokanee is presented in Table 3.6.1. Seasonal feeding habits of kokanee are found in Appendix F.

Number frequency value was highest for *Leptodora* kindti (water fleas) at 20 per stomach, followed by Daphnia *schødleri* (water fleas) at 18 per stomach. Percent composition by number value was highest for L. kindti at 52.63% followed by D. *schødleri* at 47.13 percent.

Weight frequency values were highest for *L.* kindti and D. *schødleri*, each with a dry weight value of 0.0001 g per stomach. Percent composition by weight values were highest for *L.* kindti and D. *schødleri*, both at 50 percent.

Frequency of occurrence values were highest for L. kindti and D. *schødleri*, both at 100 percent.

IRI value was highest for *L.* kindti at 52.5%, followed by *D. schødleri* at 47.5 percent.

Annual Feeding Habits of 1+ Kokanee Salmon for 1990

Information for annual feeding habits of 1+ kokanee is presented in Table 3.6.2.

Number frequency value was highest for Cyclopoidae (water fleas) at 2,320 per stomach, followed by Chironomidae pupae (midges) at *44* per stomach, and *Epischura* ***nevadensis*** (water fleas) at 18 per stomach. Percent composition by number value was highest for Cyclopoidae at 97.23%, followed by Chironomidae pupae at 1.84%, and *E.* nevadensis at 0.75 percent.

Weight frequency value was highest for Cyclopoidae at 0.0089 g dry weight per stomach, followed by unidentifiable prey items at

Table 3.6.1 The annual food preferences of 0+ kokanee from Lake Roosevelt in 1990.

	KOK (N=1)					
	NUMBER		WEIGHT (g)		FREQ. OCC.	IRI
PREY ITEM	$\bar{x}$	(%)	$\bar{x}$	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schødleri	18.00	47.13	0.0001	50.00	100.00	47.50
Leptodora kindti	20.00	52.63	0.0001	50.00	100.00	52.50

Table 3.6.2 The annual food preferences of 1+ kokanee from Lake Roosevelt in 1990.

	KOK (N=1)					
	NUMBER		WEIGHT (g)		FREQ. OCC.	IRI
PREY ITEM	$\bar{x}$	(%)	$\bar{x}$	(%)	(%)	(%)
EUCOPEPODA (water fleas)						
Cyclopoidae	2320.00	97.23	0.0089	55.63	100.00	31.61
E. nevadensis	18.00	0.75	0.0001	0.63	100.00	12.67
DIPTERA (midges)						
Chironomidae pupae	44.00	1.84	0.0008	5.00	100.00	13.36
Chironomidae larvae	1.00	0.04	0.0023	14.83	100.00	14.30
OTHER:						
Terrestrial	1.00	0.04	0.0009	5.63	100.00	13.21
Unidentifiable items	1.00	0.04	0.0030	18.75	100.00	14.85

0.0030 g per stomach, and Chironomidae larvae (midges) at 0.0023 g per stomach. Percent composition by weight value was highest for Cyclopoidae at 55.63%, followed by unidentifiable body parts at 18.75%, and Chironomidae larvae at 14.83 percent.

Frequency of occurrence for all prey items was 100 percent.

IRI value was highest for Cyclopoidae at 31.61%, followed by unidentifiable prey items at 14.85%, and Chironomidae larvae at 14.30 percent.

Annual Feeding Habits of 2+ Kokanee Salmon for 1990

Information for annual feeding habits of 2+ kokanee is presented in Table 3.6.3.

Number frequency value was highest for *D. schødleri* at 2927.67 per stomach, followed by Chironomidae pupae at 10.94 per stomach and *L. kindti* at 9.49 per stomach. Percent composition by number value was highest for *D. schødleri* at 99.02%, followed by *L. kindti* at 0.54%, and Chironomidae pupae at 0.16 percent.

Weight frequency value was highest for *D. schødleri* at 0.1743 g dry weight per stomach, followed by Hydracarina (aquatic spiders) at 0.0081 g per stomach, and Chironomidae pupae at 0.0041 g per stomach. Percent composition by weight value was highest for *D. schødleri* at 89.22%, followed by Hydracarina at 7.32%, and organic detritus at 1.20 percent.

Frequency of occurrence value was highest for *D. schødleri* at 75.00%, followed by Chironomidae pupae at 35.00% and Chironomidae larvae 34.17 percent.

IRI value was highest for *D. schødleri* at 66.42%, followed by Chironomidae pupae at 8.97%, and Chironomidae larvae at 8.76 percent.

Annual Feeding Habits of 3+ Kokanee Salmon for 1990

Information for annual feeding habits of 3+ kokanee is presented in Table 3.6.4.

Number frequency value was highest for *D. schødleri* at 1175.86 per stomach, followed by Chironomidae pupae at 112.86 per

Table 3.6.3 The annual food preferences of 2+ kokanee from Lake Roosevelt in 1990.

	KOK (N=36)					
	NUMBER		WEIGHT (g)		FREQ.OCC	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Fish eggs	0.02	≤0.01	10.0001	0.01	1.67	0.42
CLADOCERA (water fleas)						
Daphnia schødleri	2927.67	99.02	0.1743	89.22	75.00	66.42
Leptodora kindti	9.49	0.54	0.0004	0.42	10.84	2.98
Chydorus spp.	0.03	≤0.01	10.0001	≤0.01	1.67	0.42
EUCOPEPODA (water fleas)						
Cyclopoidae	0.23	0.01	10.0001	0.03	3.33	0.85
E. nevadensis	1.67	0.09	50.0001	0.02	8.81	2.25
DIPTERA (midges)						
Chironomidae pupae	10.94	0.1 6	0.0041	0.40	35.00	8.97
Chironomidae larvae	0.93	0.05	0.0006	0.51	34.17	8.76
Tipulidae pupae	3.79	0.09	0.0005	0.14	4.17	1.11
EPHEMEROPTERA (mayflies)						
Baetidae	0.04	≤0.01	10.0001	≤0.01	4.17	1.05
HYDRACHNELLLAE (spider)						
Hydracarina	0.47	0.03	0.0081	7.32	5.00	3.11
OTHER:						
Terrestrial	0.23	0.01	0.0005	0.14	5.84	1.51
Organic Detritus	0.05	≤0.01	0.0013	1.20	5.00	1.56
Inorganic Detritus	0.02	≤0.01	0.0007	0.55	10.01	0.14
Unidentifiable items	0.02	10.01	0.0001	0.05	1.67	0.43

Table 3.6.4 The annual food preferences of 3+ kokanee from Lake Roosevelt in 1990.

	KOK (N=7)					
	NUMBER		WEIGHT (g)		FREQ.OCC.	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schødleri	1175.86	90.77	0.0538	93.84	85.71	67.60
Leptodora kindti	0.71	0.06	0.0003	0.47	14.29	3.71
EUCOPEPODA (water fleas)						
Cyclopoidae	4.00	0.31	0.0006	1.07	28.57	7.49
DIPTERA (midges)						
Chironomidae pupae	1 12.86	8.71	0.0023	3.94	14.29	6.74
Chironomidae larvae	0.29	0.02	0.0003	0.57	28.57	7.29
OTHER:						
Terrestrial	1.57	0.12	10.0001	≤0.01	14.29	3.60
Unidentifiable items	0.14	0.01	10.0001	10.01	14.29	3.58

stomach and Cyclopoidae at 4.00 per stomach. Percent composition by number value was highest for *D. schødleri* at 90.77%, followed by Chironomidae pupae at 8.71%, and Cyclopoidae at 0.31 percent.

Weight frequency value was highest for *D. schødleri* at 0.0538 g dry weight per stomach, followed by Chironomidae pupae at 0.0023 g per stomach, and Cyclopoidae at 0.0006 g per stomach. Percent composition by weight value was highest for *D. schødleri* at 93.84%, followed by Chironomidae pupae at 3.94%, and Cyclopoidae at 1.07 percent.

Frequency of occurrence value was highest for *D. schødleri* at 85.71%, followed by Chironomidae larvae and Cyclopoidae, both at 28.57 percent.

IRI value was highest for *D. schødleri* at 67.60%, followed by Cyclopoidae at 7.49%, and Chironomidae larvae at 7.29 percent.

Annual Feeding Habits of All Age Classes of Kokanee Salmon for 1990

Information for annual feeding habits for all age classes of kokanee is presented in Table 3.6.5.

Number frequency value was highest for *D. schødleri* at 1030.38 per stomach, followed by Cyclopoidae at 581.06 per stomach and Chironomidae pupae at 41.95 per stomach. Percent composition by number value was highest for *D. schødleri* at 90.72%, followed by Cyclopoidae at 6.24%, and Chironomidae pupae at 2.32 percent.

Weight frequency value was highest for *D. schødleri* at 0.0571 g dry weight per stomach, followed by Cyclopoidae at 0.0024 g per stomach, and Hydracarina at 0.0020 g per stomach. Percent composition by weight value was highest for *D. schødleri* at 89.43%, followed by Hydracarina at 5.85%, and Chironomidae pupae at 1.12 percent.

Frequency of occurrence value was highest for *D. schødleri* at 65.18%, followed by Chironomidae larvae at 40.69%, and Chironomidae pupae at 37.32 percent.

IRI value was highest for *D. schødleri* at 49.16%, followed by Chironomidae pupae and Chironomidae larvae at 8.29% each.

Table 3.6.5 The annual food preferences of all age classes of kokanee taken from Lake Roosevelt in 1990.

	KOK (N=45)					
	NUMBER		WEIGHT (g)		FREQ.OCC.	IRI
PREY ITEM	x̄	(%)	x̄	%	%	%
OESTICHTHYES (fish)						
Fish eggs	0.01	10.01	≤0.0001	0.01	0.42	0.09
CLADOCERA (water fleas)						
Daphnia schødleri	1030.38	90.72	0.0571	89.43	65.18	49.16
Leptodora kindti	7.55	0.44	0.0002	0.43	31.28	6.44
Chydorus spp.	0.01	≤0.01	10.0001	10.01	0.42	0.08
EUCOPEPODA (water fleas)						
Cyclopoidae	581.06	6.24	0.0024	0.66	32.98	7.99
E. nevadensis	4.92	0.11	10.0001	0.02	27.2	5.48
DIPTERA (midges)						
Chironomidae pupae	41.95	2.32	0.0018	1.12	37.32	8.29
Chironomidae larvae	0.56	0.04	0.0008	0.63	40.69	8.29
Tipulidae pupae	0.95	0.06	0.0001	0.11	1.04	0.24
EPHEMEROPTERA (mayflies)						
Baetidae	0.01	0.06	≤0.0001	50.01	1.04	0.21
HYDRACHNELLLAE (spider)						
Hydracarina	0.12	0.02	0.0020	5.85	1.25	1.43
OTHER:						
Terrestrial	0.70	0.04	0.0004	0.16	30.03	6.06
Organic Detritus	0.01	≤0.01	0.0003	0.96	1.25	0.44
Inorganic Detritus	0.01	≤0.01	0.0002	0.44	≤0.01	0.09
Unidentifiable items	0.29	0.01	0.0008	0.19	28.99	5.85

3.6.2 Annual Feeding Habits of Rainbow Trout for 1990

Annual Feeding Habits of 0+ Rainbow Trout for 1990

Information for annual feeding habits of 0+ rainbow is presented in Table 3.6.6. Seasonal feeding habits of rainbow are found in Appendix F.

Number frequency value was highest for *D. schødleri* (water fleas) at 385.41 per stomach, followed by *L. kindti* (water fleas) at 50.14 per stomach, and terrestrials at 29.7 per stomach. Percent composition by number value was highest for *D. schødleri* at 79.83%, followed by *L.* kindti at 13.17%, and terrestrials at 3.55 percent.

Weight frequency value was highest for Chironomidae pupae (midges) at 0.0349 g dry weight per stomach, followed by terrestrials at 0.0209 g per stomach, and *D. schødleri* at 0.0182 g per stomach. Percent composition by weight value was highest for terrestrials at 28.17%, followed by Chironomidae pupae at 24.06%, and unidentifiable body parts at 18.09 percent.

Frequency of occurrence value was highest for Chironomidae pupae at 78.1%, followed by *D. schødleri* at 69.08%, and terrestrials at 35.91 percent.

IRI value was highest for *D. schødleri* at 30.36%, followed by Chironomidae pupae at 19.83%, and terrestrials at 12.95 percent.

Annual Feeding Habits of 1+ Rainbow Trout for 1990

Information for annual feeding habits of 1+ rainbow is uresented in Table 3.6.7.

Number frequency value was highest for *D. schødleri* at 609.82 per stomach, followed by *L.* kindti at 335.67 per stomach, and fish eggs at 24.51 per stomach. Percent composition by number value was highest for *D. schødleri* at 60.96%, followed by *L.* kindti at 32.37%, and fish eggs at 2.98 percent.

Weight frequency value was highest for organic detritus (plant matter) at 0.0716 g dry weight per stomach, followed by fish eggs at 0.0647 g per stomach, and L. kindti at 0.0481 g per stomach. Percent composition by weight value was highest for organic

Table 3.6.6 The annual food preferences of 0+ rainbow trout from Lake Roosevelt in 1990.

	RBT (N=33)					
	NUMBER		WEIGHT (g)		FREQ. OCC	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Cottidae	0.17	0.05	0.0007	0.34	7.25	1.46
Unidentified fish	0.06	0.02	0.0007	0.50	1.45	0.38
CLADOCERA (water fleas)						
Daphnia schødleri	385.41	79.83	0.0182	9.61	69.08	30.36
Leptodora kindti	50.14	13.71	0.0063	2.63	14.49	5.90
EUCOPEPODA (water fleas)						
Diaptomidae	0.06	0.02	10.0001	≤0.01	1.45	0.28
BASOMMATOPHORA (snail)						
Lymnaidae	1.12	0.31	0.0117	9.28	4.35	2.67
Planorbidae	0.26	0.07	0.0003	0.22	1.45	0.33
DIPTERA (midges)						
Chironomidae pupae	10.59	1.39	0.0349	24.06	78.10	19.83
Chironomidae larvae	3.25	0.40	0.0006	0.85	24.32	4.90
Simuliidae larvae	0.19	0.05	10.0001	≤0.01	2.90	0.57
TRICHOPTERA (caddisflies)						
Leptoceridae	0.01	≤0.01	50.0001	≤0.01	1.45	0.28
Glossosomatidae	0.04	≤0.01	0.0001	0.08	≤0.01	0.02
HEMIPTERA (bugs)						
Corixidae	1.72	0.42	0.0016	1.13	14.65	3.10
EPHEMEROPTERA (mayflies						
Baetidae	0.30	0.03	0.0004	0.56	7.41	1.53
ODONATA						
Anisoptera	0.01	≤0.01	≤0.0001	10.01	1.45	0.28
COLEOPTERA (beetles)						
Elmidae	0.07	0.01	0.0001	0.1 1	3.70	0.73
HY DRACHNELLLAE (spider)						
Hydracarina	0.21	0.05	10.0001	10.01	5.80	1.12
OTHER:						
Terrestrial	29.70	3.55	0.0209	28.17	35.91	12.95
Organic Detritus	0.13	0.02	0.0007	0.71	13.20	2.67
Inorganic Detritus	0.04	10.01	0.0024	3.65	3.70	1.41
Unidentifiable items	0.38	0.06	0.0147	18.09	30.11	9.24

Table 3.6.7 The annual food preferences of 1+ rainbow trout from Lake Roosevelt in 1990.

PREY ITEM	RBT (N=63) NUMBER x̄	NUMBER (%)	WEIGHT (g) x̄	WEIGHT (g) (%)	FREQ.OCC (%)	IRI (%)
OESTICHTHYES (fish)						
Unidentified fish	0.01	≤0.01	0.0105	3.21	1.39	0.89
Fish eggs	24.51	2.98	0.0647	23.82	5.75	6.31
CLADOCERA (water fleas)						
Daphnia schødleri	609.82	60.96	0.0470	14.28	40.51	22.45
Leptodora kindti	335.67	32.37	0.0481	14.02	27.50	14.33
EUCOPEPODA (water fleas)						
Cyclopoidae	0.14	0.02	≤0.0001	≤0.01	2.30	0.45
E. nevadensis	6.14	0.62	0.0001	0.04	1.39	0.40
BASOMMATOPHORA (snail)						
Lymnaidae	0.05	0.01	0.0007	0.24	3.69	0.76
Planorbidae	0.07	0.01	0.0002	0.06	3.45	0.68
DIPTERA (midges)						
Chironomidae pupae	11.40	1.31	0.0084	2.63	41.68	8.85
Chironomidae larvae	7.08	0.85	0.0052	1.91	24.15	5.22
Tipulidae pupae	0.01	≤0.01	≤0.0001	0.01	1.15	0.23
Tipulidae larvae	≤0.01	≤0.01	10.0001	≤0.01	1.15	0.22
Stratitomyidae	0.01	≤0.01	≤0.0001	≤0.01	1.15	0.22
Simuliidae pupae	0.02	≤0.01	50.0001	0.01	1.15	0.23
TRICHOPTERA (caddisflies)						
Limnephilidae	0.15	0.02	0.0002	0.09	3.45	0.69
Hydropsychidae	0.70	0.04	0.0003	0.07	5.63	1.11
PLECOPTERA (stoneflies)						
Perlodidae	0.01	≤0.01	≤0.0001	0.01	1.15	0.23
HEMIPTERA (bugs)						
Corixidae	1.17	0.12	0.0014	0.48	14.99	3.02
EPHEMEROPTERA (mayflies)						
Baetidae	1.99	0.24	0.0004	0.15	5.99	1.24
Heptagenidae	≤0.01	≤0.01	≤0.0001	0.01	1.15	0.22
ODONATA						
Zygoptera	0.02	≤0.01	≤0.0001	0.01	1.15	0.23
HYDRACHNELLLAE (spider)						
Hydracarina	0.04	≤0.01	≤0.0001	0.01	2.30	0.45
OTHER:						
Terrestrial	3.48	0.35	0.0260	5.02	44.54	9.68
Organic Detritus	0.38	0.04	0.0716	26.14	28.00	10.51
Inorganic Detritus	0.15	0.02	0.0048	1.68	13.12	2.87
Unidentifiable items	0.51	0.04	0.0202	6.10	37.60	8.49

detritus at 26.14%, followed by fish eggs at 23.82%, and *D. schødleri* at 14.28 percent.

Frequency of occurrence value was highest for terrestrials at 44.54%, followed by Chironomidae pupae at 41.68%, and *D. schødleri* at 40.51 percent.

IRI value was highest for *D. schødleri* at 22.45%, followed by *L. kindti* at 14.33%, and organic detritus at 10.51 percent.

Annual Feeding Habits of 2+ Rainbow Trout for 1990

Information for annual feeding habits of 2+ rainbow is presented in Table 3.6.8.

Number frequency value was highest for *D. schødleri* at 863.57 per stomach, followed by L. kindti at 229.50 per stomach, and terrestrials at 12.63 per stomach. Percent composition by number value was highest for *D. schødleri* at 74.97%, followed by L. kindti at 22.08%, and terrestrials at 1.05 percent.

Weight frequency value was highest for Physidae (snails) at 0.4680 g dry weight per stomach, followed by terrestrials at 0.0583 g per stomach, and organic detritus at 0.0291 g per stomach. Percent composition by weight value was highest for Physidae at 73.27%, followed by terrestrials at 7.78%, and organic detritus at 3.80 percent.

Frequency of occurrence value was highest for terrestrials at 59.52%, followed by *D. schødleri* at 55.12%, and unidentifiable body parts at 43.93 percent.

IRI value was highest for *D. schødleri* at 25.15%, followed by Physidae at 14.68%, and terrestrials at 12.86 percent.

Annual Feeding Habits of 3+ Rainbow Trout for 1990

Information for annual feeding habits of 3+ rainbow is presented in Table 3.6.9.

Number frequency value was highest for *D. schødleri* at 912.64 per stomach, followed by Simuliidae larvae (midges) at 202.44, per stomach and L. kindti at 197.72 per stomach. Percent composition

Table 3.6.8 The annual food preferences of 2+ rainbow trout from Lake Roosevelt in 1990.

	RBT (N=20)					
	NUMBER		WEIGHT (g)		FREQ. OCC.	IRI
PREY ITEM	$\bar{x}$	(%)	$\bar{x}$	(%)	(%)	(%)
OESTICHTHYES (fish)						
Cottidae	0.04	≤0.01	0.0010	0.16	4.17	0.82
AMPHIPODA (scuds)						
Gammerus	0.05	≤0.01	0.0025	0.39	4.76	0.97
CLADOCERA (water fleas)						
Daphnia schødleri	863.57	74.97	0.0262	3.62	55.12	25.15
Leptodora kindti	229.50	22.08	0.0227	3.54	16.19	7.87
BASOMMATOPHORA (snail)						
Lymnaidae	0.71	0.08	0.0077	1.35	4.17	1.05
Physidae	2.90	≤0.01	0.4680	73.27	4.76	14.68
DIPTERA (midges)						
Chironomidae pupae	8.15	0.79	0.0011	0.20	35.95	6.95
Chironomidae larvae	1.36	0.10	0.0005	0.06	27.02	5.11
Tipulidae pupae	0.07	≤0.01	0.0002	0.02	6.67	1.26
HEMIPTERA (bugs)						
Corixidae	7.71	0.74	0.0080	1.25	8.93	2.06
HYDRACHNELLLAE (spider)						
Hydracarina	1.18	0.08	0.0002	0.03	10.83	2.06
OTHER:						
Terrestrial	12.63	1.05	0.0583	7.78	59.52	12.86
Organic Detritus	0.48	0.04	0.0291	3.80	42.86	8.78
Inorganic Detritus	0.07	≤0.01	0.0089	0.99	6.67	1.44
Unidentifiable items	0.59	0.05	0.0283	3.54	43.93	8.94

by number value was highest for *D. schødleri* at 67.79%, followed by Simuliidae larvae at 15.26%, and *L. kindti* at 13.76 percent.

Weight frequency value was highest for *D. schødleri* at 0.1398 g dry weight per stomach, followed by Corixidae (bugs) at 0.0855 g, per stomach and Chironomidae pupae at 0.0837 g per stomach. Percent composition by weight value was highest for *D. schødleri* at 35.57%, followed by Corixidae at 22.42%, and Chironomidae pupae at 21.95 percent.

Frequency of occurrence value was highest for *D. schødleri* at 75.56%, followed by Chironomidae pupae at 58.89%, and Corixidae at 44.44 percent.

IRI value was highest for *D. schødleri* at 31.03%, followed by Chironomidae pupae at 14.08%, and Corixidae at 11.63 percent.

Annual Feeding Habits of 4+ Rainbow Trout for 1990

Information for annual feeding habits of 4+ rainbow is presented in Table 3.6.10.

Number frequency value was highest for terrestrials at 50.25 per stomach, followed by Physidae and organic detritus both at 0.75 per stomach. Percent composition by number value was highest for terrestrials at 94.64%, followed by organic detritus at 1.26%, and Physidae and unidentifiable body parts, both at 0.95 percent.

Weight frequency value was highest for terrestrials at 0.0412 g dry weight per stomach, followed by Physidae and organic detritus, both at 0.0339 g per stomach. Percent composition by weight value was highest for terrestrials at 36.92%, followed by unidentifiable body parts at 23.47%, and organic detritus at 22.71 percent.

Frequency of occurrence values were highest for terrestrials and organic detritus, both at 58.34%, followed by *Chydorus* spp. at 50.00 percent.

IRI value was highest for terrestrials at 35.61%, followed by organic detritus at 15.43%, and unidentifiable body parts at 12.39 percent.

Table 3.5.9 The annual food preferences of 3+ rainbow trout from Lake Roosevelt in 1990.

PREY ITEM	RBT (N=10) NUMBER x̄	(%)	WEIGHT (g) x̄	(%)	FREQ. OCC. %	IRI (%)
OESTICHTHYES (fish)						
Fish eggs	0.07	0.01	10.0001	0.04	6.67	1.17
CLADOCERA (water fleas)						
Daphnia schødleri	912.64	67.79	0.1398	35.57	75.56	31.03
Leptodora kindti	197.72	13.76	0.0172	3.53	38.89	9.74
DIPTERA (midges)						
Chironomidae pupae	6.29	0.38	0.0837	21.95	58.89	14.08
Chironomidae larvae	15.31	1.16	0.0016	0.37	17.78	3.35
Simuliidae pupae	1.53	0.13	0.0005	0.07	17.78	3.12
Simuliidae larvae	202.44	15.26	0.0248	5.63	11.11	5.55
HEMIPTERA (bugs)						
Corixidae	3.39	0.18	0.0855	22.42	44.44	11.63
HYDRACHNELLLAE (spider)						
Hydracarina	0.93	0.12	≤0.0001	≤0.01	13.33	2.33
LEPIDOPTERA (caterpillars)						
Pvralidae	0.07	0.01	≤0.0001	≤0.01	6.67	1.16
OTHER:						
Terrestrial	10.53	1.16	0.0282	7.39	31.11	6.88
Organic Detritus	0.41	0.03	0.0090	2.32	41.11	7.54
Inorganic Detritus	0.07	0.01	0.0017	0.48	6.67	1.24
Unidentifiable items	0.13	0.02	0.0007	0.22	6.67	1.20

Table 3.5.10 The annual food preferences of 4+ rainbow trout from Lake Roosevelt in 1990.

PREY ITEM	RBT (N=5) NUMBER x̄	(%)	WEIGHT (g) x̄	(%)	FREQ. OCC. (%)	IRI (%)
CLADOCERA (water fleas)						
Chydorus spp.	0.50	0.63	0.0001	0.02	50.00	9.50
E3ASOMMATOPHORA (snail)						
Physidae	0.75	0.95	0.0339	14.58	25.00	7.60
DIPTERA (midges)						
Chironomidae larvae	0.25	0.32	0.0001	0.02	25.00	4.75
Simuliidae larvae	0.25	0.32	0.0001	0.02	25.00	4.75
Tabanidae	0.17	0.32	0.0002	0.12	16.67	3.21
OTHER:						
Terrestrial	50.25	94.64	0.0412	36.92	58.34	35.61
Organic Detritus	0.75	1.26	0.0339	22.71	58.34	15.43
Inorganic Detritus	0.34	0.63	0.0024	2.15	33.34	6.77
Unidentifiable items	0.59	0.95	0.0313	23.47	41.67	12.39

Annual Feeding Habits of 5+ Rainbow Trout for 1990

Information for annual feeding habits of 5+ rainbow is presented in Table 3.6.11.

Number frequency value was highest for unidentifiable body parts at 1.67 per stomach, followed by Chironomidae pupae at 1 per stomach, and organic detritus at 0.75 per stomach. Percent composition by number value was highest for unidentifiable prey items at 29.41%, followed by organic detritus at 23.25%, and Chironomidae pupae at 17.65 percent.

Weight frequency value was highest for organic detritus at 0.2740 g dry weight per stomach, followed by unidentifiable prey items at 0.0500 g per stomach, and inorganic detritus (rocks) at 0.0080 g per stomach. Percent composition by weight value was highest for organic detritus at 81.94%, followed by unidentifiable prey items at 14.83%, and inorganic detritus at 2.32 percent.

Frequency of occurrence values were 100% for organic detritus, unidentifiable prey items, and inorganic detritus.

IRI value was highest for organic detritus at 32.45%, followed by unidentifiable prey items at 22.78%, and Chironomidae pupae at 18.63 percent.

Annual Feeding Habits of 6+ Rainbow Trout for 1990

Information for annual feeding habits of 6+ rainbow is presented in Table 3.6.12.

Number frequency value was highest for terrestrials at 90.00 per stomach, followed by Chironomidae pupae at 13.00 per stomach, and Hydracarina at 5.00 per stomach. Percent composition by number value was highest for terrestrials at 75.95%, followed by Chironomidae pupae at 11.02%, and Hydracarina at 4.22 percent.

Weight frequency value was highest for terrestrials at 0.6025 g dry weight per stomach, followed by unidentifiable prey items at 0.2432 g per stomach, and organic detritus at 0.0111 g per stomach. Percent composition by weight value was highest for terrestrials at 69.42%, followed by unidentifiable prey items at 28.01%, and organic detritus at 1.28 percent.

Table 3.6.11 The annual food preferences of 5+ rainbow trout from Lake Roosevelt in 1990.

	RBT (N=3)					
	NUMBER		WEIGHT (g)		FREQ.OCC.	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Fish eggs	0.33	5.88	0.0010	0.24	33.33	6.23
DIPTERA (midges)						
Chironomidae pupae	1.00	17.65	0.0010	0.31	100.00	18.63
OTHER:						
Terrestrial	0.67	11.76	0.0010	0.32	33.33	7.17
Organic Detritus	1.33	23.53	0.2740	81.94	100.00	32.45
Inorganic Detritus	0.67	11.76	0.0080	2.32	66.67	12.75
Unidentifiable items	1.67	29.41	0.0500	14.83	100.00	22.78

Table 3.6.12 The annual food preferences of 6+ rainbow trout from Lake Roosevelt in 1990.

	RBT (N=2)					
	NUMBER		WEIGHT (g)		FREQ.OCC.	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
DIPTERA (midges)						
Chironomidae pupae	13.0	11.02	0.0021	0.24	100.00	10.68
Chironomidae larvae	3.00	2.54	0.0014	0.16	50.00	5.06
Tipulidae pupae	1.00	0.85	0.0003	0.03	50.00	4.88
Tabanidae	0.50	0.42	0.0004	0.05	50.00	4.84
TRICHOPTERA (caddisflies)						
Hydropsychidae	1.00	0.85	0.0003	0.03	50.00	4.88
PLECOPTERA (stoneflies)						
Perlodidae	1.00	0.85	0.0004	0.04	50.00	4.88
EPHEMEROPTERA (mayflies)						
Ephemerillidae	0.50	0.42	0.0006	0.07	50.00	4.85
HYDRACHNELLLAE (spider)						
Hydracarina	5.00	4.22	0.0012	0.14	50.00	5.22
PYRALIDAE (caterpillars)						
Pyralidae	0.50	0.42	0.0003	0.03	50.00	4.84
OTHER:						
Terrestrial	90.00	75.95	0.6025	69.42	100.00	23.58
Organic Detritus	0.50	0.42	0.0111	1.28	50.00	4.96
Inorganic Detritus	0.05	0.42	0.0044	0.50	50.00	8.88
Unidentifiable items	2.00	1.69	0.2432	28.01	100.00	12.45

Frequency of occurrence values were 100% for Chironomidae pupae, terrestrials, and unidentifiable prey items.

IRI value was highest for terrestrials at 23.58%, followed by unidentifiable prey items at 12.45%, and Chironomidae pupae at 10.68 percent.

Annual Feeding Habits of All Age Classes of Rainbow Trout for 1990

Information for annual feeding habits for all age classes of rainbow is presented in Table 3.6.13.

Number frequency value was highest for *D. schødleri* at 395.92 per stomach, followed by *L.* kindti at 116.15 per stomach, and Simuliidae larvae at 28.98 per stomach. Percent composition by number value was highest for *D. schødleri* at 66.94%, followed by L. kindti at 25.10%, and terrestrials at 1.90 percent.

Weight frequency value was highest for terrestrials at 0.1112 g dry weight per stomach, followed by Physidae at 0.0717 g per stomach, and organic detritus at 0.0613 g per stomach. Percent composition by weight value was highest for Physidae at 19.82%, followed by organic detritus at 18.9%, and terrestrials at 13.7 percent.

Frequency of occurrence value was highest for Chironomidae pupae at 59.23%, followed by terrestrials at 51.82%, and unidentifiable prey items to 51.43 percent.

IRI value was highest for *D. schødleri* at 18.00%, followed by terrestrials at 10.94%, and organic detritus at 10.81 percent.

3.6.3 Annual Feeding Habits of Walleye for 1990

Annual Feeding Habits of 0+ Walleye for 1990

Information for annual feeding habits of 0+ walleye is presented in Table 3.6.14. Seasonal feeding habits of walleye can be found in Appendix F.

Number frequency value was highest for *D. schødleri* (water fleas) at 48.75 per stomach, followed by L. kindti (water fleas) at 6.25 per stomach, and Cottidae (fish) at 3.83 per stomach. Percent

Table 3.6.13 The annual food preferences of all age classes of rainbow trout from Lake Roosevelt in 1990.

	RBT (N=136)					
	NUMBER		WEIGHT (g)		FREQ. OCC.	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Cottidae	0.03	0.01	0.0002	0.06	1.63	0.28
Unidentified fish	0.01	≤0.01	0.0016	1.53	0.41	0.31
Fish eggs	3.56	1.62	0.0094	11.20	6.54	3.14
AMPHIPODA (scuds)						
Gammerus	0.01	≤0.01	0.0016	1.53	0.41	0.31
CLADOCERA (water fleas)						
Daphnia schødleri	395.92	66.94	0.0330	9.63	34.32	18.00
Leptodora kindti	116.15	25.10	0.0135	7.78	13.87	7.59
Chydorus spp.	0.07	≤0.01	≤0.0001	≤0.01	7.14	1.16
EUCOPEPODA (water fleas)						
Cyclopoidae	0.02	0.01	≤0.0001	≤0.01	0.33	0.05
Diaptomidae	0.01	≤0.01	≤0.0001	≤0.01	0.20	0.03
E. nevadensis	0.88	0.34	≤0.0001	0.02	0.20	0.09
BASOMMATOPHORA (snail)						
Lymnaidae	0.27	0.07	0.0029	0.80	1.74	0.43
Physidae	0.52	≤0.01	0.0717	19.82	4.25	3.91
Planorbidae	0.05	0.02	0.0001	0.03	0.70	0.12
DIPTERA (midges)						
Chironomidae pupae	7.2	1.21	0.0187	3.18	59.23	10.33
Chironomidae larvae	4.32	0.68	0.0013	0.98	24.04	4.17
Tipulidae pupae	0.15	0.01	0.0001	0.01	8.26	1.34
Tipulidae larvae	≤0.01	≤0.01	≤0.0001	≤0.01	0.16	0.03
Tabanidae	0.10	≤0.01	0.0001	0.01	9.52	1.55
Stratitomyidae	≤0.01	≤0.01	≤0.0001	≤0.01	0.16	0.03
Simuliidae pupae	0.22	0.01	0.0001	0.01	2.70	0.44
Simuliidae larvae	28.98	0.26	0.0036	0.26	9.52	1.55
TRICHOPTERA (caddisflies)						
Leptoceridae	≤0.01	≤0.01	≤0.0001	≤0.01	0.21	0.03
Limnephilidae	0.02	0.01	≤0.0001	0.04	0.49	0.09
Hydropsychidae	0.24	0.03	0.0001	0.04	7.95	1.30
PLECOPTERA (stoneflies)						
Perlodidae	0.14	0.01	0.0001	0.01	7.31	1.19
HEMIPTERA (bugs)						
Corixidae	2.00	0.29	0.0138	1.62	11.86	2.23
EPHEMEROPTERA (mayflies)						
Baetidae	0.33	0.14	0.0001	0.09	1.91	0.35
Ephemerillidae	0.07	≤0.01	0.0001	0.01	7.14	1.16
Heptagenidae	≤0.01	≤0.01	≤0.0001	≤0.01	0.16	0.03
ODONATA						
Anisoptera	≤0.01	≤0.01	≤0.0001	≤0.01	0.21	0.03
Zygoptera	≤0.01	≤0.01	≤0.0001	≤0.01	0.53	0.09
HYDRACHNELLLAE (spider)						
Hydracarina	1.05	0.06	0.0002	0.03	11.75	1.92
PYRALIDAE (caterpillars)						
Pyralidae	0.08	≤0.01	≤0.0001	≤0.01	8.10	1.32
OTHER:						
Terrestrial	28.18	1.90	0.1112	13.70	51.82	10.94
Organic Detritus	0.57	0.05	0.0613	18.90	47.64	10.81
Inorganic Detritus	0.20	0.02	0.0047	1.43	25.74	4.41
Unidentifiable items	0.84	0.07	0.0555	8.71	51.43	9.77

composition by number value was highest for *D. schødleri* at 77.66%, followed by *L. kindti* at 11.09%, and Cottidae at 6.80 percent.

Weight frequency value was highest for unidentifiable fish at 0.1228 g dry weight per stomach, followed by Cottidae at 0.0416 g per stomach, and *D. schødleri* at 0.0016 g per stomach. Percent composition by weight value was highest for unidentifiable fish at 64.77%, followed by Cottidae at 32.02%, and *D. schødleri* at 1 .15 percent.

Frequency of occurrence value was highest for unidentifiable fish at 87.50%, followed by Cottidae at 50.00%, and unidentifiable body parts at 45.83 percent.

IRI value was highest for unidentifiable fish at 29.08%, followed by *D. schødleri* at 21.19%, and Cottidae at 16.79 percent.

Annual Feeding Habits of I+ Walleye for 1990

Information for annual feeding habits of 1+ walleye is presented in Table 3.6.15.

Number frequency value was highest for L. kindti (water fleas) at 76.41 per stomach, followed by *D. schødleri* at 11.77 per stomach, and Chironomidae pupae at 1.71 per stomach. Percent composition by number value was highest for *L.* kindti at 81.03%, followed by *D. schødleri* at 12.63%, and Cottidae at 1.89 percent.

Weight frequency value was highest for Cottidae at 0.0832 g dry weight per stomach, followed by Percidae (fish) at 0.0582 g per stomach, and unidentifiable prey items at 0.0313 g per stomach. Percent composition by weight value was highest for Cottidae at 42.06%, followed by Percidae at 22.83%, and unidentifiable prey items at 12.43 percent.

Frequency of occurrence value was highest for Cottidae at 29.40%, followed by unidentifiable fish at 26.14%, and Chironomidae pupae at 18.83 percent.

IRI value was highest for L. kindti at 27.33%, followed by Cottidae at 20.43%, and unidentifiable prey items at 12.43 percent.

Table 3.6.14 The annual food preferences of 0+ walleye from Lake Roosevelt in 1990.

	WE (N-20)					
	NUMBER		WEIGHT (g)		FREQ.OCC.	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Cottidae	3.83	6.80	0.0416	32.02	50.00	16.79
Unidentified fish	1.17	1.63	0.1228	64.77	87.5	29.08
AMPHIPODA (scuds)						
Gammerus	0.13	0.15	0.0014	0.69	12.50	2.52
CLADOCERA (water fleas)						
Daphnia schødleri	48.75	77.66	0.0016	1.15	33.33	21.19
Leptodora kindti	6.25	11.09	0.0002	0.16	8.33	3.70
DIPTERA (midges)						
Chironomidae pupae	0.58	0.89	0.0004	0.21	29.17	5.72
Chironomidae larvae	0.33	0.44	10.0001	0.01	29.17	4.02
OTHER:						
Terrestrial	0.08	0.15	≤0.0001	≤0.01	8.33	1.60
Organic Detritus	0.33	0.59	0.0004	0.29	33.33	6.46
Unidentifiable items	0.46	0.59	0.0013	0.70	45.83	8.90

Table 3.6.15 The annual food preferences of 1+ walleye from Lake Roosevelt in 1990.

	WE (N=56)					
	NUMBER		WEIGHT (g)		FREQ.OCC	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Cottidae	1.51	1.89	0.0832	42.06	29.40	20.43
Cyprinidae	0.02	0.04	0.0060	2.60	1.96	1.28
Percidae	0.14	0.13	0.0582	22.83	9.78	9.12
Unidentified fish	0.26	0.35	0.0181	7.25	26.14	9.40
CLADOCERA (water fleas)						
Daphnia schødleri	11.77	12.63	0.0008	0.36	8.39	5.96
Leptodora kindti	76.41	81.03	0.0130	5.65	11.41	27.33
DIPTERA (midges)						
Chironomidae pupae	1.71	1.75	0.0019	1.01	18.83	6.01
Chironomidae larvae	1.22	1.39	0.0003	0.12	10.74	3.41
Tabanidae	0.10	0.12	0.0001	0.04	1.96	0.59
OTHER:						
Terrestrial	0.18	0.19	0.0027	1.04	12.05	3.70
Organic Detritus	0.15	0.19	0.0029	1.14	12.43	3.84
Inorganic Detritus	0.02	0.04	0.0025	1.07	1.96	0.85
Unidentifiable items	0.15	0.19	0.0313	12.43	10.99	12.43

Annual Feeding Habits of 2+ Walleye for 1990

Information for annual feeding habits of 2+ walleye is presented in Table 3.6.16.

Number frequency value was highest for *L.* kindti at 1.78 per stomach, followed by Cottidae at 1.67 per stomach, and Chironomidae pupae at 0.80 per stomach. Percent composition by number value was highest for *L.* kindti at 24.74%, followed by Cottidae at 23.34%, and Chironomidae pupae at 17.77 percent.

Weight frequency value was highest for Percidae at 0.2937 g dry weight per stomach, followed by Cottidae at 0.0775 g per stomach, and unidentifiable fish at 0.0465 g per stomach. Percent composition by weight value was highest for Percidae at 66.59%, followed by Cottidae at 16.80%, and unidentifiable fish at 11.23 percent.

Frequency of occurrence value was highest for unidentifiable fish at 30.96%, followed by organic detritus at 26.24%, and Cottidae at 24.34 percent.

IRI value was highest for Percidae at 26.32%, followed by Cottidae at 17.73%, and unidentifiable fish at 14.29 percent.

Annual Feeding Habits of 3+ Walleye for 1990

Information for annual feeding habits of 3+ walleye is presented in Table 3.6.17.

Number frequency value was highest for Cottidae at 0.76 per stomach, followed by unidentifiable fish at 0.66 per stomach, and Percidae at 0.43 per stomach. Percent composition by number value was highest for Cottidae at 40.64%, followed by unidentifiable fish at 20.32%, and Chironomidae pupae at 10.70 percent.

Weight frequency value was highest for Cottidae at 0.4620 g dry weight per stomach, followed by unidentifiable fish at 0.4277 g per stomach and Percidae at 0.2081 g per stomach. Percent composition by weight value was highest for Cottidae at 41.19%, followed by unidentifiable fish at 36.74%, and Percidae at 20.26 percent.

Table 3.6.16 The annual food preferences of 2+ walleye from Lake Roosevelt in 1990.

	WE (N=52)					
	NUMBER		WEIGHT (g)		FREQ. OCC.	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	%
OESTICHTHYES (fish)						
Centrachidae	0.02	0.35	0.0013	0.26	2.22	0.78
Cottidae	1.67	23.34	0.0775	16.80	24.34	17.73
Percidae	0.45	7.67	0.2937	66.59	21.45	26.32
Unidentified fish	0.49	9.76	0.0465	11.23	30.96	14.29
CLADOCERA (water fleas)						
Daphnia schødleri	0.04	0.7	10.0001	≤0.01	2.22	0.80
Leptodora kindti	1.78	24.74	0.0004	0.07	4.79	8.14
DIPTERA (midges)						
Chironomidae pupae	0.80	17.77	0.0004	0.10	20.47	10.54
Chironomidae larvae	0.14	3.48	0.0002	0.07	6.94	2.89
EPHEMEROPTERA (mayflies)						
Baetidae	0.07	1.74	0.0001	0.03	2.78	1.25
OTHER:						
Organic Detritus	0.31	5.23	0.0085	1.93	26.24	9.18
Inorganic Detritus	0.05	1.05	0.0076	2.20	5.34	2.36
Unidentifiable items	0.19	4.18	0.0022	0.72	15.90	5.72

Table 3.6.17 The annual food preferences of 3+ walleye from Lake Roosevelt in 1990.

	WE (N=22)					
	NUMBER		WEIGHT (g)		FREQ. OCC.	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Cottidae	0.76	40.64	0.4620	41.19	35.19	35.70
Percidae	0.43	2.95	0.2081	20.26	17.65	12.47
Unidentified fish	0.66	20.32	0.4277	36.74	24.62	24.92
DIPTERA (midges)						
Chironomidae pupae	0.19	10.70	0.0001	0.01	3.70	4.40
OTHER:						
Organic detritus	0.23	7.47	0.0017	0.18	16.88	7.48
Inorganic detritus	0.13	6.42	0.0093	0.89	12.96	6.18
Unidentifiable items	0.16	7.23	0.0062	0.72	13.07	6.41

Frequency of occurrence value was highest for Cottidae at 35.19%, followed by unidentifiable fish at 24.62%, and Percidae at 17.65 percent.

IRI value was highest for Cottidae at 35.70%, followed by unidentifiable fish at 24.92%, and Percidae at 12.47 percent.

Annual Feeding Habits of 4+ Walleye for 1990

Information for annual feeding habits of 4+ walleye is presented in Table 3.6.18.

Number frequency value was highest for Chironomidae pupae at 3.96 per stomach, followed by L. kindti at 1.56 per stomach, and Percidae at 0.83 per stomach. Percent composition by number value was highest for Chironomidae pupae at 43.37%, followed by L. *kindti* at 14.29%, and unidentifiable fish at 11.22 percent.

Weight frequency value was highest for Percidae at 0.9770 g dry weight per stomach, followed by Salmonidae (fish) at 0.4399 g per stomach, and Cottidae at 0.2445 g per stomach. Percent composition by weight value was highest for Percidae at 52.43%, followed by Cottidae at 20.89%, and Salmonidae at 16.87 percent.

Frequency of occurrence values were highest for Percidae and organic detritus, both at 37.96%, followed by unidentifiable fish at 24.54 percent.

IRI value was highest for Percidae at 28.19%, followed by Chironomidae pupae at 15.61%, and organic detritus at 13.00 percent.

Annual Feeding Habits of 5+ Walleye for 1990

Information for annual feeding habits of 5+ walleye is presented in Table 3.6.19.

Number frequency value was highest for Percidae at 1.25 per stomach, followed by terrestrials at 0.34 per stomach, and organic detritus at 0.33 per stomach. Percent composition by number value was highest for Percidae at 46.15%, followed by terrestrials and organic detritus, both at 15.38 percent.

Weight frequency value was highest for Percidae at 5.9819 g dry weight per stomach, followed by unidentifiable fish at 0.4700 g

Table 3.6.18 The annual food preferences of 4+ walleye from Lake Roosevelt in 1990.

PREY ITEM	WE (N=32) NUMBER (x̄±S.D.)	(%)	WEIGHT (g) (x̄±S.D.)	(%)	FREQ. OCC. (%)	IRI (%)
OESTICHTHYES (fish)						
Cottidae	0.37	8.16	0.2445	20.89	11.57	11.44
Cypri nidae	0.06	1.53	0.0552	4.76	1.85	2.29
Percidae	0.83	9.69	0.9770	52.43	37.96	28.19
Salmonidae	0.04	0.51	0.4399	16.87	4.17	6.07
Unidentified fish	0.47	11.22	0.0436	3.51	24.54	11.06
CLADOCERA (water fleas)						
Leptodora kindti	1.56	14.29	0.0003	0.01	5.56	5.59
DIPTERA (midges)						
Chironomidae pupae	3.96	43.37	0.0009	0.04	12.04	15.61
Chironomidae larvae	0.02	0.51	0.0001	50.01	1.85	0.67
OTHER:						
Terrestrial	0.04	0.05	≤0.0001	≤0.01	4.17	1.32
Organic Detritus	0.44	7.14	0.0160	1.06	37.96	13.00
Inorganic Detritus	0.02	0.51	0.0016	0.14	1.85	0.70
Unidentifiable items	0.12	2.55	0.0042	0.29	11.57	4.06

Table 3.6.19 The annual food preferences of 5+ walleye from Lake Roosevelt in 1990.

PREY ITEM	WE (N=8) NUMBER x̄	(%)	WEIGHT (g) x̄	(%)	FREQ. OCC. (%)	IRI (%)
OESTICHTHYES (fish)						
Cyprinidae	0.17	7.69	0.1246	2.23	16.67	6.65
Percidae	1.25	46.15	5.9819	89.07	83.34	54.64
Unidentified fish	0.17	7.69	0.4700	8.42	16.67	8.20
OTHER:						
Terrestrial	0.34	15.38	0.0002	≤0.01	33.34	12.18
Organic Detritus	0.33	15.38	0.0133	0.24	33.33	12.24
Inorganic Detritus	0.17	7.69	0.0016	0.03	16.67	6.10

per stomach, and Cyprinidae (fish) at 0.1246 g per stomach. Percent composition by weight value was highest for Percidae at 89.07%, followed by unidentifiable fish at 8.42%, and Cyprinidae at 2.23 percent.

Frequency of occurrence value was highest for Percidae at 83.34%, followed by terrestrials at 33.34%, and organic detritus at 33.33 percent.

IRI value was highest for Percidae at 54.64%, followed by organic detritus at 12.24%, and terrestrials at 12.18 percent.

Annual Feeding Habits of 6+ Walleye for 1990

Information for annual feeding habits of 6+ walleye is presented in Table 3.6.20.

Number frequency value was highest for Chironomidae pupae at 3.00 per stomach, followed by unidentifiable fish at 2.00 per stomach, and all other prey item at 0.50 per stomach. Percent composition by number value was highest for Chironomidae pupae at 50.00%, followed by unidentifiable fish at 33.33% and all other prey items at 8.33 percent.

Weight frequency value was highest for unidentifiable fish at 5.8612 g dry weight per stomach, followed by Percidae at 4.7798 g per stomach, and unidentifiable body parts at 0.1957 g per stomach. Percent composition by weight value was highest for unidentifiable fish at 54.08%, followed by Percidae at 44.1 0%, and unidentifiable prey items at 1.81 percent.

Frequency of occurrence values for all prey item were 50.00 percent.

IRI value was highest for unidentifiable fish at 34.35%, followed by Percidae at 25.61%, and Chironomidae pupae at 25.01 percent.

Annual Feeding Habits of All Age Classes of Walleye for 1990

Information for annual feeding habits for all age classes of walleye is presented in Table 3.6.21.

Table 3.6.20 The annual food preferences of 6+ walleye from Lake Roosevelt in 1990.

	WE (N=2)					
	NUMBER		WEIGHT (g)		FREQ. OCC.	IRI
PREY ITEM	x̄	%	x̄	%	(%)	(%)
OESTICHTHYES (fish)						
Percidae	0.50	8.33	4.7798	44.10	50.00	25.61
Unidentified fish	2.00	33.33	5.8612	54.08	50.00	34.35
DIPTERA (midges)						
Chironomidae pupae	3.00	50.00	0.0023	0.02	50.00	25.01
OTHER:						
Unidentifiable items	0.50	8.33	0.1957	1.81	50.00	15.03

Table 3.6.21 The annual food preferences of all age classes of walleye from Lake Roosevelt in 1990.

	WE (N=182)					
	NUMBER		WEIGHT (g)		FREQ.OCC	IRI
PREY ITEM	x̄	(%)	x̄	(%)	(%)	(%)
OESTICHTHYES (fish)						
Catastomidae	0.01	0.04	0.0006	0.12	0.41	0.15
Centrachidae	50.01	0.01	0.0002	0.02	0.32	0.09
Cottidae	1.16	4.31	0.1298	13.57	21.50	10.08
Cyprinidae	0.04	0.08	0.0265	1.86	2.93	1.25
Percidae	0.51	0.78	1.7570	53.69	31.45	21.99
Salmonidae	0.01	0.01	0.0628	4.43	0.60	1.29
Unidentified fish	0.75	1.58	0.9986	23.46	37.20	15.93
AMPHIPODA (scuds)						
Gammerus	0.02	0.04	0.0002	0.01	1.79	0.47
CLADOCERA (water fleas)						
Daphnia schødleri	8.65	28.49	0.0003	0.04	6.28	8.91
Leptodora kindti	12.29	58.22	0.0020	0.31	4.30	16.08
DIPTERA (midges)						
Chironomidae pupae	1.46	3.42	0.0009	0.08	19.17	5.80
Chironomidae larvae	0.25	1.21	0.0001	0.02	6.29	1.92
Tabanidae	0.01	0.08	10.0001	10.01	0.28	0.09
EPHEMEROPTERA (mayflies						
Baetidae	0.01	0.06	10.0001	≤0.01	0.40	0.12
OTHER:						
Terrestrial	0.09	0.22	0.0004	0.05	8.27	2.19
Organic Detritus	0.26	0.73	0.0061	0.59	22.88	6.19
Inorganic Detritus	0.06	0.13	0.0032	0.38	5.54	1.55
Unidentifiable items	0.23	0.58	0.0344	1.36	21.05	5.88

Number frequency value **was** highest for L. *kindti* at 12.29 per stomach, followed by *D. schødleri* at 8.65 per stomach, and Chironomidae pupae at 1.46 per stomach. Percent composition by number values were highest for L. *kindti* at 58.22%, followed by *D. schødleri* at 28.49% and Cottidae at 4.31 percent.

Weight frequency value was highest for Percidae at 1.7570 g dry weight per stomach, followed by unidentifiable fish at 0.9986 g per stomach, and Cottidae at 0.1298 g per stomach. Percent composition by weight value was highest for Percidae at 53.69%, followed by unidentifiable fish at 23.46%, and Cottidae at 13.57 percent.

Frequency of occurrence value was highest for unidentifiable fish at 37.20%, followed by Percidae at 31.45%, and organic detritus at 22.88 percent.

IRI value was highest for Percidae at 21.99%, followed by L. *kindti* at 16.08%, and unidentifiable fish at 15.93 percent.

3.6.4 Diet Overlap Between Species for 1990

Seasonal Diet Overlaps between Kokanee and Other Species

Seasonal diet overlaps between kokanee and other fish species were calculated within each age class (Table 3.6.22).

Summer diet overlaps between 0+ **age** fish were found to be 0.61 between kokanee and rainbow, 0.39 between kokanee and walleye, and 0.56 between rainbow and walleye (Table 3.6.22).

Spring diet overlaps between 1+ age fish were found to be 0.41 between kokanee and rainbow, 0.28 between kokanee and walleye, and 0.48 between rainbow and walleye (Table 3.6.22).

Spring diet overlaps between 2+ age fish were found to be 0.21 between kokanee and rainbow, 0.02 between kokanee and walleye, and 0.29 between rainbow and walleye (Table 3.6.22).

Summer diet overlaps between 2+ age fish were found to be 0.34 between kokanee and rainbow, 0.01 between kokanee and walleye, and 0.09 between rainbow and walleye (Table 3.6.22).

Table 3.6.22 Seasonal diet overlaps, analyzed from stomach contents, between fish species in Lake Roosevelt in 1990.

Summer 0+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.61	0.39
Rainbow		1.00	0.56
Walleye			1.00

Spring 1+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.41	0.28
Rainbow		1.00	0.48
Walleye			1.00

Spring 2+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.21	0.02
Rainbow		1.00	0.29
Walleye			1.00

Summer 2+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.34	0.01
Rainbow		1.00	0.09
Walleye			1.00

Fall 2+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.17	0.09
Rainbow		1.00	0.17
Walleye			1.00

Spring 3+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.72	0.03
Rainbow		1.00	0.10
Walleye			1.00

Fall diet overlaps between 2+ age fish were found to be 0.17 between kokanee and rainbow, 0.09 between kokanee and walleye, and 0.19 between rainbow and walleye (Table 3.6.22).

Spring diet overlaps between 3+ age fish were found to be 0.72 between kokanee and rainbow, 0.03 between kokanee and walleye, and 0.10 between rainbow and walleye (Table 3.6.22).

Annual Diet Overlaps within an Age Class

Diet overlaps between fish species within each age class were calculated for 1990 (Table 3.6.23).

Diet overlaps between 0+ age fish were found to be 0.52 between kokanee and rainbow, 0.35 between kokanee and walleye, and 0.54 between rainbow and walleye (Table 3.6.23).

Diet overlaps between 1+ age fish were found to be 0.30 between kokanee and rainbow, 0.16 between kokanee and walleye, and 0.56 between rainbow and walleye (Table 3.6.23).

Diet overlaps between 2+ age fish were found to be 0.62 between kokanee and rainbow, 0.07 between kokanee and walleye, and 0.23 between rainbow and walleye (Table 3.6.23).

Diet overlaps between 3+ age fish were found to be 0.72 between kokanee and rainbow, 0.02 between kokanee and walleye, and 0.08 between rainbow and walleye (Table 3.6.23).

Diet overlap between 4+ age fish was found to be 0.18 between rainbow and walleye (Table 3.6.23).

Diet overlap between 5+ age fish was found to be 0.20 between rainbow and walleye (Table 3.6.23).

Diet overlap between 6+ age fish was found to be 0.24 between rainbow and walleye (Table 3.6.23).

Annual Diet Overlaps Between Fish Species

Diet overlaps between fish species of all age classes were calculated for 1990 (Table 3.6.24).

Table 3.6.23 Annual diet overlaps, analyzed from stomach contents, between fish species of each age class, in Lake Roosevelt, WA for 1990.

0+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.52	0.35
Rainbow		1.00	0.54
Walleye			1.00

1+	Kokanee	Rain bow	Walleye
Kokanee	1.00	0.30	0.16
Rainbow		1 .00	0.56
Walleye			1.00

2+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.62	0.07
Rain bow		1.00	0.23
Walleye			1.00

3+	Kokanee	Rainbow	Walleye
Kokanee	1.00	0.72	0.02
Rainbow		1.00	0.08
Walleye			1.00

4+	Kokanee	Rainbow	Walleye
Kokanee	-	-	-
Rainbow		1.00	0.18
Walleye			1.00

5+	Kokanee	Rain bow	Walleye
Kokanee	-		
Rainbow		1.00	0.20
Walleye			1.00

6+	Kokanee	Rainbow	Walleye
Kokanee	-	-	-
Rainbow		1.00	0.24
Walleye			1.00

Table 3.6.24 **Annual diet overlaps, analyzed from stomach contents, between fish species of all ages, in Lake Roosevelt, WA for 1990.**

	Kokanee	Rain bow	Walleye
Kokanee	1.00	0.65	0.32
Rainbow		1.00	0.47
Walleye			1.00

Diet overlaps between all age classes of fish were found to be 0.65 between kokanee and rainbow, 0.32 between kokanee and walleye, and 0.47 between rainbow and walleye (Table 3.6.24).

3.6.5 Electivity Indices

Electivity indices and standard deviation for different size categories of Daphnia spp. were calculated for all age classes of kokanee and rainbow trout for the 1990 sampling season (Tables 3.6.25 and 3.6.26). Monthly electivity indices and standard deviation for each location are presented in Appendix F.

Kokanee had positive electivities (+0.14 to +0.31) for Daphnia spp. ranging in sizes from 1.6 to 2.49 mm for the month of May (Table 3.6.25). Negative electivities (-0.05 to -0.30) were found for Daphnia spp. ranging in size from 0.4 to 1.59 mm. In August, positive electivities (+0.03 to +0.26) were found for Daphnia spp. ranging in size from 1.9 to 2.79 mm. Negative electivities (-0.01 to -0.09) were found for Daphnia spp. ranging in sizes from 0.4 to 1.89 mm and from 2.8 to 3.39 mm. Annually, kokanee had positive electivities (+0.03 to +0.17) for Daphnia spp. ranging in size from 1.6 to 2.79 mm. Negative electivities (-0.01 to -0.17) were found for Daphnia spp. ranging in sizes from 0.4 to 1.59 mm and from 2.8 to 3.39 mm.

Rainbow trout had positive electivities (+0.11 to +0.32) for Daphnia spp. ranging in size from 1.6 to 2.49 mm for the month of May (Table 3.6.26). Negative electivities (-0.01 to -0.37) were found for Daphnia spp. ranging in sizes from 0.4 to 1.59 mm and from 2.5 to 2.79 mm. In August, positive electivities (+0.02 to +0.40) were found for Daphnia spp. ranging in size from 1.9 to 2.79 mm. Negative electivities (-0.01 to -0.26) were found for Daphnia spp. ranging in size from 0.4 to 1.89 mm. In October, positive electivities (+0.05 to +0.15) were found for Daphnia spp. ranging in size from 1.9 to 3.09 mm. Negative electivities (-0.04 to - 0.29) were found for Daphnia spp. ranging in size from 0.4 to 1.59 mm. Annually, rainbow trout had positive electivities (+0.01 to +0.18) for Daphnia spp. ranging in sizes from 1.6 to 3.09 mm. Negative electivities (-0.02 to -0.23) were found for Daphnia spp. ranging in size from 0.4 to 1.59 mm.

3.7 TAGGING STUDIES

In 1990, 5,580 rainbow trout and 411 walleye were tagged and released into Lake Roosevelt. Tables 3.7.1 to 3.7.5 show data on

Table 3.6.25 Mean electivities of kokanee for different size ranges of *Daphnia* spp. in 1990. (Data presented as mean ± S.D. for nine index stations).

Daphnia spp. size range (mm)	1990 Electivity ($\bar{x}$ ± S.D.) MAY			AUG			Annual		
0.1-0.3	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00
0.4-0.6	-0.06	±	0.01	-0.04	±	0.02	-0.05	±	0.02
0.7-0.9	-0.30	±	0.02	-0.04	±	0.02	-0.17	±	0.19
1.0-1.2	-0.19	±	0.14	-0.07	±	0.02	-0.13	±	0.08
1.3-1.5	-0.05	±	0.10	-0.06	±	0.07	-0.06	±	0.01
1.6-1.8	0.15	±	0.21	-0.09	±	0.22	0.03	±	0.17
1.9-2.1	0.31	±	0.34	0.03	±	0.27	0.17	±	0.20
2.2-2.4	0.14	±	0.15	0.03	±	0.05	0.09	±	0.08
2.5-2.7	0.00	±	0.00	0.26	±	0.52	0.13	±	0.18
2.8-3.0	0.00	±	0.00	-0.01	±	0.09	-0.01	±	0.01
3.1-3.3	0.00	±	0.00	-0.01	±	0.02	-0.01	±	0.01
3.4-3.6	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00

Table 3.6.26 Mean electivities of rainbow trout for different size range of *Daphnia* spp. in 1990. (Data presented as mean ± S.D. for nine index stations).

Daphnia spp size range (mm)	Electivity ($\bar{X}$ ± S.D.)			
	MAY	AUG	OCT	Annual
0.1-0.3	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
0.4-0.6	-0.06 ± 0.03	-0.01 ± 0.02	0.00 ± 0.00	-0.02 ± 0.03
0.7-0.9	-0.37 ± 0.05	-0.26 ± 0.30	-0.05 ± 0.01	-0.23 ± 0.17
1.0-1.2	-0.20 ± 0.10	-0.17 ± 0.13	-0.29 ± 0.14	-0.22 ± 0.06
1.3-1.5	-0.13 ± 0.08	-0.14 ± 0.13	-0.04 ± 0.22	-0.10 ± 0.06
1.6-1.8	0.14 ± 0.16	-0.11 ± 0.11	0.00 ± 0.05	0.01 ± 0.13
1.9-2.1	0.32 ± 0.21	0.02 ± 0.12	0.10 ± 0.11	0.15 ± 0.15
2.2-2.4	0.11 ± 0.01	0.28 ± 0.10	0.05 ± 0.15	0.15 ± 0.12
2.5-2.7	-0.01 ± 0.01	0.40 ± 0.10	0.15 ± 0.26	0.18 ± 0.20
2.8-3.0	0.00 ± 0.00	0.00 ± 0.28	0.08 ± 0.11	0.03 ± 0.05
3.1-3.3	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
3.4-3.6	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

rainbow trout tagging and recapture, and Tables 3.7.6 to 3.7.7 show data on walleye tagging and recapture. Non target species tagging data and information on individual tag returns can be found in Appendix G.

3.7.1 Rainbow Trout Tagging

In March 1990, a total of 1,489 rainbow were tagged and released from the Kettle Falls, Hunters and Seven Bays net-pens (Table 3.7.1). Six of these were recaptured for a recovery rate of 0.4 percent. In April 1990, a total of 1,925 rainbows were tagged and released into Lake Roosevelt from Kettle Falls, Hunters, Seven Bays, Little Falls, and Spokane Tribal net-pens. Thirty-one of these fish were recaptured for a recovery rate of 1.6 percent. In May 1,893 rainbow were tagged and released from Hunters, Seven Bays, and Keller Ferry net-pens and Porcupine Bay and Sanpoil index stations. Sixty-two of these fish have been recaptured for a recovery rate of 3.3 percent. In October 223 rainbow were tagged and released from Hunters net-pens and Hunters, Porcupine, Little Falls, Seven Bays, Sanpoil, and Spring Canyon index stations. One fish was recovered for a recovery rate of 0.4 percent.

In 1990, 61 rainbows were recaptured from 1988 and 1989 taggings (Table 3.7.2). One fish was recaptured from a May 1988 net-pen release of 1 ,1 11 fish at Seven Bays. Its length at recapture was 610 mm and represented a recovery rate of 0.1 percent. One fish was recovered from a March 1989 net-pen release of 845 fish at Hunters. The mean length of the fish at recapture was 470 mm and represented a recovery rate of 0.1 percent. Three fish were recaptured from an April 1989 release of 496 fish at Northport. The mean length of the fish at recapture was 454 mm and represented a recovery rate of 0.6 percent. Two fish were recovered from an April 1989 release of 993 fish at Seven Bays. The mean length of the fish at recapture was 439 mm and represented a recovery rate of 0.2 percent. Twelve fish were recovered from a September 1989 release of 604 fish at Kettle Falls. The mean length of the fish at recapture was 305 mm and represented a recovery rate of 2.0 percent. Ten fish were recovered from an October release of 492 fish at Hunters net-pens. The mean length of the fish as recapture was 328 mm and represented a recovery rate of 2.0 percent. Twenty-seven fish were recovered from a December 1989 release of 496 kamloops at Seven Bays. The mean length of the fish at recapture was 274 mm and represented a recovery rate of 5.4

Table 3.7.1 Summary of rainbow trout tagging effort and subsequent recoveries in 1990.

Month-Year	Release Type	Species	Release Location	Number Tagged	Number-Recovered
March 1990	Net-pen	Rainbow	Kettle Falls	**539**	1
March 1990	Net-pen	Rainbow	Hunters	501	3
March 1990	Net-pen	Rainbow	Seven Bays	449	2
April 1990	Net-pen	Rainbow	Kettle Falls	498	14
April 1990	Net-pen	Rainbow	Hunters	499	5
April 1990	Net-pen	Rainbow	Seven Bays	499	13
April 1990	Net-pen	Rainbow	Little Falls	425	
April 1990	Sampling	Rainbow	Spokane Arm	4	
May 1990	Net-pen	Rainbow	Hunters	500	4
May 1990	Sampling	Rainbow	Porcupine	3	
May 1990	Net-pen	Rainbow	Seven Bays	499	22
May 1990	Net-pen	Kam loop	Seven Bays	501	28
May 1990	Net-pen	Rainbow	Keller Ferry	388	13
May 1990	Sampling	Rainbow	Sanpoil	2	
October 1990	Net-pen	Rainbow	Hunters	198	
October 1990	Sampling	Rainbow	Hunters	3	1
October 1990	Sampling	Rainbow	Porcupine	1	-
October 1990	Sampling	Rainbow	Little Falls	4	-
October 1990	Sampling	Rainbow	Seven Bays	1	1
October 1990	Sampling	Rainbow	Sanpoil	4	
October 1990	Sampling	Rainbow	Spring Canyon	12	

Table 3.7.2 Summary of 1990 rainbow trout recaptures that were tagged and releases into Lake Roosevelt in 1988 and 1989.

Net-Pen Release Tagging					
Month/ Year	Location	Number Tagged	Number Recaptured	Mean Length (mm)	Water Retention Time
May 88	Seven Bays	1,111	1	610	40 days
March 89	Hunters	845	1	469	36 days
April 89	Northport	496	3	454	33 days
April 89	Seven Bays	993	2	439	33 days
Sept. 89	Kettle Falls	604	12	293	68 days
Oct. 89	Hunters	492	10	328	60 days
Dec. 89 *	Seven Bays	496	26	274	46 days

* Kamloop rainbow trout

Sampling Tagging					
Month/ Year	Location	Number Tagged	Number Recaptured	Mean Length (mm)	Water Retention Time
Oct. 88	Hunters	52	1	508	57 days
Oct. 88	Little Falls	6	1	546	57 days
May 89	Keller	17	1	457	23 days
Aug. 89	Seven Bays	17	1	483	70 days
Aug. 89	Hawk Creek	18	1	496	70 days
Oct. 89	Spring Can.	9	1	388	60 davs

percent. One fish was recovered from an October 1988 tagging of 52 fish at Hunters during a sampling season. The length of the fish was 508 mm and represented a recovery rate of 1.9 percent. One fish was recovered from an October 1988 tagging of 6 fish at Little Falls Dam during a sampling season. The length of the fish was 546 mm and represented a recovery rate of 16 percent. One fish was recovered from an May 1989 tagging of 17 fish at Keller Ferry during a sampling season. The length of the fish was 457 mm and represented a recovery rate of 5.9 percent. One fish was recovered from an August 1989 tagging of 17 fish at Seven Bays during a sampling season. The length of the fish was 483 mm and represented a recovery rate of 5.9 percent. One fish was recovered from an October 1989 tagging of 9 fish at Spring Canyon during a sampling season. The length of the fish was 388 mm and represented a recovery rate of 11 percent.

On March 27th 1990, 539 rainbow trout were tagged and released from the Kettle Falls net-pens (Table 3.7.3). One fish was recaptured 109 days later at Keller Ferry a distance of 152 km downstream for a recovery rate of 0.2 percent. Travel time for this fish was 1 km/day. The growth rate could not be calculated since the fish had not been in the reservoir 180 days between release and recapture.

On March 29th 1990, 501 rainbow trout were tagged and released from the Hunters net-pens (Table 3.7.3). Three fish were subsequently recaptured an average of 98 days after release for a recovery rate of 0.6 percent. Two fish were counted at McNary Dam Fish Passage Facility, 598 km downstream, 40 and 61 days after release. This represented a travel time of 15 and 10 km/day respectively. The growth rate of one fish could be calculated and showed the fish grew approximately 29 mm/month between net-pen release and recapture.

On March 22nd 1990, 449 rainbow trout were tagged and released from the Seven Bays net-pens (Table 3.7.3). Two fish were subsequently recaptured an average of 41 days after release for a recovery rate of 0.4 percent. One fish was counted at McNary Dam Fish Passage Facility, 598 km downstream, 41 days after release. This represented a travel time of 14.5 km/day. Growth rates could not be calculated since the fish had not been in the reservoir 180 days between release and recapture.

Table 3.7.3 Recovery locations of rainbow trout tagged and released in March 1990.

Location	Kettle Falls Net-Pen	Hunters Net-Pen	Seven Bays Net-Pen
Number Tagged	539	501	449
Mean Release Length	204 ± 13	209 ± 11	214 ± 12
Waneta Dam			
Northport			
Kettle Falls			
Gifford			
Hunters			
Porcupine Bay		1	
Little Falls			
Seven Bays			
Keller Ferry			
Sanpoil			
Spring Canyon			
Rufus Woods Res.			
Rock Island			
McNary Dam		2	1
Total Recaptured	1	3	2
Mean Length at Recapture	305 ± 0	288 ± 124	245 ± 0
Mean Days to Recapture	109	98	41
Mean Growth per Month (mm)		29	-
% Recovery	0.2%	0.6%	0.4%

On April 19th 1990, 498 rainbow trout were tagged and released from the Kettle Falls net-pens (Table 3.7.4). Fourteen fish were subsequently recaptured an average of 105 days after release for a recovery rate of 2.8 percent. Three fish were caught at Spring Canyon, 173 km downstream, 47, 59, and 61 days after release. This represented a travel time of 4, 3, and 2.5 km/day respectively. Growth rates could not be calculated since the fish had not been in the reservoir 180 days between release and recapture.

On April 19th 1990, 499 rainbow trout were tagged and released from the Hunters net-pens (Table 3.7.4). Five fish were subsequently recaptured an average of 82 days after release for a recovery rate of 1.0 percent. One fish was caught at Spring Canyon, 109 km downstream, 52 days after release representing a travel time of 2 km/day. Growth rates could not be calculated since the fish had not been in the reservoir 180 days between release and recapture.

On April 17th 1990, 499 rainbow trout were tagged and released from the Seven Bays net-pens (Table 3.7.4). Thirteen fish were subsequently recaptured an average of 73 days after release for a recovery rate of 2.6 percent. One fish was caught at Spring Canyon, 58 km downstream, 19 days after release representing a travel time of 3 km/day. Three fish were caught at McNary Dam Fish Passage Facility, 547 km downstream, 42 and 43 days after release representing a travel time of 13 km/day respectively. The growth rate of one fish could be calculated and showed the fish grew approximately 21 mm/month between net-pen release and recapture.

On May 19th 1990, 500 rainbow trout were tagged and released from the Hunters net-pens (Table 3.7.5). Four fish were subsequently recaptured an average of 125 days after release for a recovery rate of 0.8 percent. One fish was caught at Spring Canyon, 58 km downstream, 74 days after release representing a travel time of 3 km/day. The growth rate of one fish could be calculated and showed the fish grew approximately 23 mm/month between net-pen release and recapture.

On May 26th 1990, 499 rainbow trout were tagged and released from the Seven Bays net-pens (Table 3.7.5). Twenty-two fish were subsequently recaptured an average of 66 days after release for a recovery rate of 3.6 percent. Two fish were caught at Spring Canyon, 58 km downstream, 25 days after release representing a

Table 3.7.4 Recovery locations of rainbow trout tagged and released in April 1990.

Location	Kettle Falls Net-Pen	Hunters Net-Pen	Seven Bays Net-Pen
Number Tagged	**498**	**499**	**499**
Mean Release Length	219 ± 27	208 ± 14	235 ± 16
Waneta Dam			
Northport			
Kettle Falls			
Gifford			
Hunters			
Porcupine Bay			1
Little Falls			
Seven Bays	2	1	2
Keller Ferry	2	2	2
Sanpoil	1		
Spring Canyon	5	1	3
Rufus Woods Res.	4	1	2
Rock Island			
McNary Dam			[illegible]
Total Recaptured	**14**		**13**
Mean Length at Recapture	**359 ± 49**	**310 ± 41**	**290 ± 52**
Mean Days to Recapture	**105**	**82**	**73**
Mean Growth per Month (mm)	26.8	-	**21.1**
% Recovery	2.8%	**1.0%**	**2.6%**

travel time of 2 km/day. One fish was caught at Rock Island Dam, 253 km downstream, 27 days after release representing a travel time of 9.3 km/day. Two fish were caught at Rufus Woods Reservoir, 144 km downstream, 52 and 67 days after release representing a travel time of 3 and 2 km/day respectively. Growth rates could not be calculated since the fish had not been in the reservoir 180 days between release and recapture.

On May 26th 1990, 501 kamloop trout were tagged and released from the Seven Bays net-pens (Table 3.7.5). Twenty-six fish were subsequently recaptured an average of 64 days after release for a recovery rate of 5.2 percent. One fish was caught at Spring Canyon, 58 km downstream, 28 days after release representing a travel time of 2 km/day. However, the highest majority of fish were recaptured near Seven Bays, and those recaptured out of the reservoir had travel times in excess of 100 days. The growth rate of one fish could be calculated and showed the fish grew approximately 38 mm/month between net-pen release and recapture.

On May 12th 1990, 388 rainbow trout were tagged and released from the Keller Ferry net-pens (Table 3.7.5). Twelve fish were subsequently recaptured an average of 83 days after release for a recovery rate of 3.3 percent. Two fish were recaptured in Rufus Woods reservoir. One fish was caught at Rock Island Dam, 253 km downstream, 24 days after release representing a travel time of 10.5 km/day. The growth rate of one fish could be calculated and showed the fish grew approximately 22 mm/month between net-pen release and recapture.

3.7.2 Walleye Tagging

In April 1990, a total of 198 walleye were tagged and released on the Spokane Arm during their spawning migration (Table 3.7.6). Four of these fish were recaptured for a recovery rate of 2.0 percent. A total of 102 walleye were tagged and released during the May 1990 sampling season at various index stations. Five of these fish were recaptured for a recovery rate of 4.9 percent. A total of 28 and 83 walleye were tagged and released during the August and October sampling seasons respectively. None of these fish were recaptured in 1990.

Table 3.7.7 shows the release and recapture location of all walleye recovered in 1990. Sixteen walleye recaptured in 1990

Table 3.7.5 Recovery locations of rainbow trout tagged and released in May 1990.

Location	Hunters Net-Pen	Seven Bays Net-Pen	Seven Bays Net-Pen "Kamloops"	Keller Ferry Net-Pen
Number Tagge	500	499	501	388
Release Lengt	219 ± 18	240 ± 18	348 ± 25	241 ± 19
Waneta Dam				
Northport				
Kettle Falls	1			
Gifford				
Hunters			1	
Porcupine Ba		2	1	
Little Falls				
Seven Bays	1	1	10	2
Keller Ferry		8	4	1
Sanpoil	1	1	2	
Spring Canyo		5	6	7
Rufus Woods	1	4	2	2
Rock Island		1		1
McNary				
Total Recaptured	a	22	26	13
Mean Length at Recapture	345 ± 38	323 ± 53	416 ± 49	323 ± 37
Days to Recapture	125	66	64	78
Mean Growth per Month (mm)	23	-	38	22
% Recovery	0.8%	3.6%	5.2%	3.13%

Table 3.7.6 Summary of walleye tagging effort and subsequent recoveries in 1990.

Month-Year	Release Type	Species	Release Location	Number Tagged	Number Recovered
April 1990	Spawning	Walleye	Spokane Arm	198	4
May 1990	Sampling	Walleye	Kettle Falls	14	2
May 1990	Sampling	Walleye	Gifford	4	1
May 1990	Sampling	Walleye	Hunters	35	
May 1990	Sampling	Walleye	Porcupine	9	
May 1990	Sampling	Walleye	Little Falls	29	1
May 1990	Sampling	Walleye	Keller Ferry	11	1
Aug 1990	Sampling	Walleye	Kettle Falls	24	
Aug 1990	Sampling	Walleye	Hunters	3	
Aug 1990	Sampling	Walleye	Little Falls	1	
October 1990	Sampling	Walleye	Kettle Falls	16	
October 1990	Sampling	Walleye	Gifford	10	
October 1990	Sampling	Walleye	Hunters	29	
October 1990	Sampling	Walleye	Porcupine	4	
October 1990	Sampling	Walleye	Little Falls	11	
October 1990	Sampling	Walleye	Seven Bays	1	
October 1990	Sampling	Walleye	Spring Canyon	12	

I able 3.7.7 **Summary of walleye tagging effort in 1990 and subsequent** recoveries.

Month/ Year	Release Location	Recapture Location	Distance Traveled (km)	Time to Recapture (days)	Growth per Month (mm)
5/87	Porcupine Bay	Rufus woods	170	1,246	4
5/88	Porcupine Bay	Little Falls	24	901	1
5/89	Gifford	Gifford	0	371	1
5/89	Porcupine Bay	Hunters	46		
5/89	Porcupine Bay	Little Falls	24	409	2
5/89	Porcupine Bay	Little Falls	24	424	2
5/89	Porcupine Bay	Seven Bays	26	425	8
5/89	Porcupine Bay	Hunters	46	359	
5/89	Little Falls	Kettle Falls	134	495	0.3
5/89	Keller Ferry	Sanpoil	8	340	
5/89	Sanpoil	Keller Ferry	8	418	7
8/89	Kettle Falls	Seven Bays	115	163	
8/89	Porcupine Bay	Fort Spokane	21	308	2
1 Of89	Hunters	Sanpoil	96	165	3
10/89	Hunters	Kieffer point	46	148	0.4
10/89	Little Falls	Kettle Falls	134	238	4
4/90	Porcupine Bay	Waneta Dam	174	146	
4/90	Porcupine Bay	Porcupine Bay	0	84	
4/90	Porcupine Bay	Gifford	72	35	
4/90	Porcupine Bay	Little Falls	24	55	
5/90	Kettle Falls	Kettle Falls	0	82	
5/90	Kettle Falls	Little Falls	134	52	
5/90	Gifford	Gifford	0	6	
5/90	Little Falls	Porcupine Bay	24	29	
5/90	Keller Ferry	Sanpoil	8	66	

were tagged in 1987, 1988, and 1988. The distance between release and recapture ranged from 0 to 170 km with the average being 56 km. Time between release and recapture ranged from 148 to 1,246 days with the average being 433 days. Growth increment per month ranged from 0.3 to 8.12 mm/month with the average being 3 mm/month.

Of 411 walleye tagged and released in 1990, 9 were recaptured for a recovery rate of 2.2 percent. One hundred ninety eight walleye were tagged on the Spokane Arm during their spawning migration. Four of these fish were recaptured for a recovery rate of 2.0 percent. The farthest distance traveled by a walleye in 1990 was tagged at Porcupine Bay in April and was recaptured at Waneta Dam in British Columbia, 174 km upstream, 146 days later. This represented a travel time of 1 .1 km/day. The second farthest distance traveled was 134 km by a walleye tagged at Kettle Falls in May that traveled to Little Falls dam in 52 days. This represented a travel time of 2.5 km/day, the fastest travel time by a walleye tagged in 1990.

4.0 DISCUSSION

4.1 RESERVOIR OPERATIONS

In 1990 reservoir elevations were higher than the mean elevations for the past 10 years (Figure 4.1 .1). Reservoir water retention time was shorter during the spring and early summer months in comparison to 1988 and 1989 (Figure 4.1.2). In 1988, water retention time was below 30 days in the month of December only. In 1989, water retention time was below 30 days in January, February, and May. In 1990, water retention time was below 30 days in May and June. These differences in water retention time between 1989 and 1990 were due primarily to sales of nonfirm energy to California markets, combined with an above average discharge.

4.2 CREEL SURVEY

4.2.1 Trends in Angling Pressure, CPUE and Harvest Estimates

A slight decrease in angler pressure occurred in 1990 when compared to 1988 and 1989 (Table 4.2.1). This decrease was partly caused by an announcement by the Department of Ecology in August 1990 of high dioxin and furan content in Lake Roosevelt fish which later turned out to be incorrect. This was evidenced by a decrease in overall angler pressure from August to December 1990 when compared to 1989. Another possible reason for the decline could be due to a slight change in the way creel data was calculated. In 1988 and 1989, data **was** grouped and calculated by dividing the reservoir into four sections, Northern, Mid, Southern, and the Spokane Arm, whereas in 1990, no grouping of data occurred. The 1990 method of calculating creel data may have been more accurate as evidenced by lower 95% confidence intervals.

The number of angler trips and trip length decreased slightly between 1989 and 1990 (Table 4.2.1). Approximately 179,871 angler trips were made in 1989 compared to 171,725 trips in 1990. In 1990, January, July, September and October were the only months that had a higher number of angler trips than the same time period in 1989.

Mean annual catch-per-unit-effort for fish caught by anglers on Lake Roosevelt in 1990 showed a slight decrease when compared

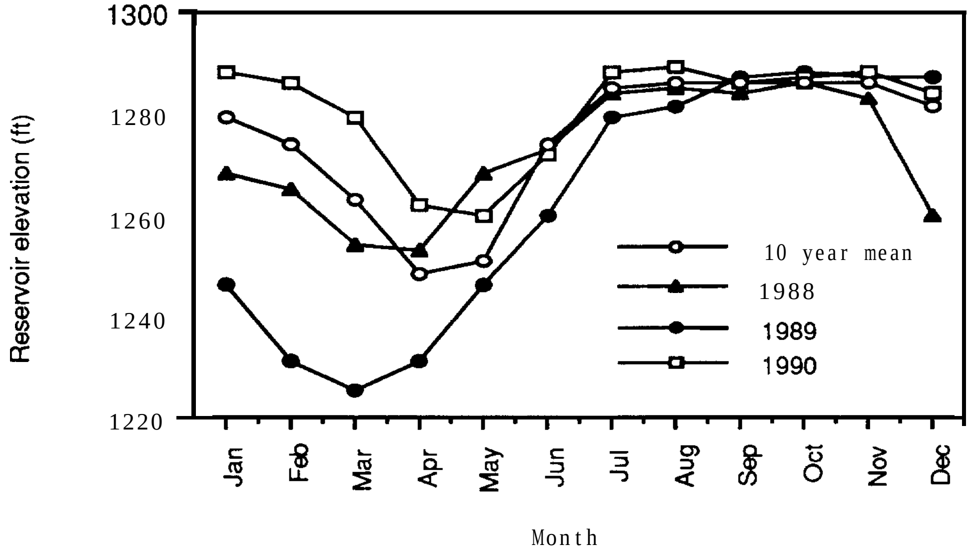


Figure 4.1.1 **Ten year average reservoir elevation in feet and yearly elevations for 1988, 1989, and 1990 on Lake Roosevelt, WA.**

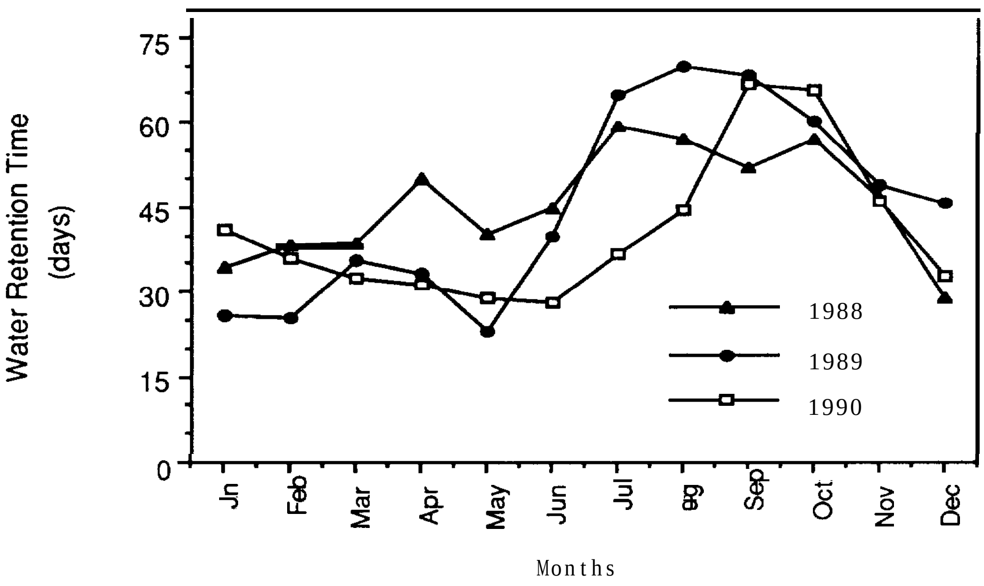


Figure 4.1.2 **Mean monthly water retention time in days for 1988, 1989, and 1990 on Lake Roosevelt, WA.**

Table 4.2.1 **Comparisons of creel data results for all stratum on Lake Roosevelt, for 1988, 1989, and 1990.**

	1988 a	1989	1990
Pressure estimate (angler hours) (± 95% Cl)	261,913 (± 101,382)	765,415 (± 207,592)	539,743 (± 94,420)
Angler trips	70,308	179,871	171,725
Catch CPUE	0.96	0.53	0.46
Harvest CPUE	0.69	0.38	0.38
Catch estimate (± 95% Cl)			240,185 (± 57,185)
Harvest estimate (± 95% Cl)	125,891 (± 47,629)	164,227 (±63,035)	197,480 (± 46,189)
Dollars spent per trip	$28.90	$28.90	$30.91
Economic Value (X 1,000,000)	$2.03	$5.20	$5.31

a August to December only

to 1989 (Table 4.2.1). The catch CPUE was 0.53 fish per hour in 1989 and 0.46 fish per hour in 1990. This decrease in CPUE might have been due to increased reservoir levels which distributed fish over a greater area, or a reduction of carry-over fish from 1989 that were not caught because they were flushed through the reservoir.

Mean annual catch-per-unit-effort for fish harvested on Lake Roosevelt in 1990 was equal to 1989 values (Table 4.2.1). The harvest CPUE was 0.38 fish per hour in 1989 and 0.38 fish per hour in 1990. Data compiled on fish harvested by anglers show the average lengths and weights of target species have decreased with the exception of yellow perch (Table 4.2.2). This decrease in size harvested fish was due to changes in fishing regulations by the Department of Wildlife and lack of carry-over.

The fluctuations in rainbow trout sizes were most likely due to lack of carry-over between 1989 and 1990 and a change in fishing regulations in 1990. Water retention time in the spring of 1988 ranged from 39 to 49 days which contributed to rainbow to carry-over to 1989. Water retention time in 1989 ranged from 29 to 40 days, which contributed to reduced rainbow carry-over to 1990. In 1988 the average harvest length of a rainbow trout was 391 mm, in 1989 it was 403 mm and in 1990 the average length was 346 mm. The greater harvest length in 1989 is due to the harvest of fish that remained in the reservoir from 1988 releases. The average harvest length decreased from 403 mm in 1989 to 346 mm in 1990 due to a smaller number of fish that remained in the reservoir from the 1989 releases. However, a change in fishing regulations in 1990 may have also played a role in the decrease in harvest size. Prior to 1990 an angler could harvest 8 rainbow with no restrictions on size. In 1990, the limit was changed to 5 fish, only two of which could be greater than 20 inches (508 mm). Walleye harvest lengths also decreased dramatically due to a change in fishing regulations also. In 1988 and 1989, only 8 walleye over 16 inches (406 mm) could be harvested; however, as of April 15th 1990, regulations were changed to include a slot limit with no harvest of fish between 16 and 20 inches (406 mm and 508 mm), and only one fish above 20 inches (508 mm).

Comparisons of harvest estimates between 1988, 1989, and 1990 showed an increased harvest of 33,253 fish in 1990 (Table 4.2.1). Anglers harvested approximately 125,891 fish in 1988, 164,227 fish in 1989, and 197,480 fish in 1990. Individual harvest

Table 4.2.2 **Comparisons of average lengths (mm) and weights (g) of fish harveted by anglers, as measured by creel clerks on Lake Roosevelt, for 1988, 1989, and 1990.**

Lengths (mm)			
Species	**1988**	**1989**	**1990**
Kokanee	432 ± 35	411 ± 29	391 ± 42
Rain bow	391 ± 25	403 ± 33	346 ± 85
Walleye	436 ± 12	447 ± 57	376 ± 61
Yellow Perch	222 ± 52	212 ± 33	266 ± 38
Smallmouth bass	309 ± 36	313 ± 48	223 ± 76

Weights (g)			
Species	**1988**	**1989**	**1990**
Kokanee	739 ± 205	580 ± 153	557 ± 205
Rainbow	646 ± 177	710 ± 107	485 ± 287
Walleye	508 ± 80	723 ± 520	435 ± 317
Yellow Perch	154 ± 89	190 ± 31	293 ± 317
Smallmouth bass	489 ± 141	359± 57	272 ± 76

estimates by anglers of all major target fish increased between 1989 and 1990 with the exception of chinook (Table 4.2.3).

Approximately 17,756 kokanee were caught for a catch CPUE of 0.02 fish per hour and 17,515 were harvested for a harvest CPUE of 0.02 fish per hour (Table 4.2.4). This is an increase in harvest by anglers from 9,362 in 1988 and 11,906 in 1989. Kokanee comprised 9% of the angler harvest in 1990 compared to 7% of the harvest in 1988 and 1989. In 1988 and 1989, approximately 5% of anglers fishing targeted kokanee whereas 7% targeted kokanee in 1990. It appears that there has been an increase in the popularity of kokanee fishing in Lake Roosevelt as evidenced by increased angler pressure for kokanee and increased harvest. Additionally, the Washington Department of Wildlife stocked one million kokanee fry into Lake Roosevelt in 1988. These fish did not contribute to the creel until 1990 when they reached sufficient size to be harvested by anglers. Therefore the increased harvest rate in 1990 might be the first evidence that stocked kokanee are contributing to the kokanee fishery.

Approximately 81,562 rainbow trout were caught for a catch CPUE of 0.13 fish per hour and 79,683 were harvested for a harvest CPUE of 0.12 fish per hour (Table 4.2.4). Rainbow comprised 34% of the angler catch and 40% of the angler harvest in 1990. Angler harvest of rainbow has fluctuated greatly between 1988 and 1990. In 1988 the harvest was estimated at 86,107 ± 31,940 fish, in 1989 the harvest was 65,515 ± 25,373 fish and in 1990 the harvest was 709,863 ± 20,620 fish. Differences in harvest estimates could be due to reservoir operations impacting the number of fish being flushed out of Lake Roosevelt. The highest harvest estimate occurred in 1988, the year with the most favorable water retention times for keeping fish within the reservoir. The second most favorable water retention times occurred in 1990, the year with the second highest harvest estimate. The worst year in terms of water retention times occurred in 1989, the year with the lowest harvest estimate. The numbers of anglers targeting in rainbow decreased from 55% in 1988 TO 1989 to 45% in 1990.

An estimated 116,473 walleye were caught in 1990 for a catch CPUE of 0.11 fish per hour and 82,284 fish were harvested for a harvest CPUE of 0.08 fish per hour (Table 4.2.4). Walleye comprised approximately 48% of the angler catch and 42% of the angler harvest in 1990. The percent of anglers targeting walleye has decreased

Table 4.2.3 Comparisons of target species harvest estimates (± 95% C.I.) for all stratum on Lake Roosevelt, for 1988, 1989, and 1990.

Month	1988	1989	1990
Kokanee	9,362	11,906	17,515
(± 95% C.I.)	(± 3,873)	(± 3,597)	(± 1,393)
Rain bow	86,107	65,515	79,683
(± 95% C.I.)	(± 31,940)	(± 25,373)	(± 20,620)
Walleye	23,005	80,626	82,284
(± 95% C.I.)	(± 8,731)	(± 31,513)	(± 18,579)
Yellow Perch	1,210	3,600	3,641
(± 95% C.I.)	(± 312)	(± 1,631)	(± 1,443)
Smallmouth bass	6,207	1,538	10,033
(± 95% C.I.)	(± 2,773)	(± 518)	(± 3,375)
Largemouth bass	-	8	18
(± 95% C.I.)	(-)	(± 3)	(± 4)
Black crappie		691	4,201
(± 95% C.I.)	(-)	(± 323)	(± 760)
Chinook		248	63
(± 95% C.I.)	(-)	(± 54)	(± 10)

Table 4.2.4 Comparisons of relative abundance, harvest estimates and percent of anglers targeting sport fish for 1988, 1989, and 1990.

	1988	1989	1990
Kokanee			
% Anglers Targeting	5%	5%	7%
Catch CPUE	0.11	0.04	0.02
Harvest CPUE	0.12	0.04	0.02
Catch Estimate			17,756
(± 95%)			(± 1,433)
Harvest Estimate	9,362	11,906	17,515
(± 95%)	(± 3,873)	(± 3,597)	(± 1,393)
Rainbow			
% Anglers Targeting	55%	55%	45%
Catch CPUE	0.37	0.16	0.13
Harvest CPUE	0.36	0.15	0.12
Catch Estimat			81,562
(± 95%)			(± 21,013)
Harvest Estimate	86,107	65,515	79,683
(± 95%)	(± 31,940)	(± 25,373)	(± 20,620)
Walleye			
% Anglers Targeting	20%	20%	24%
Catch CPUE	0.34	0.20	0.11
Harvest CPUE	0.08	0.09	0.028
Catch Estimate			116,473
(± 95%)			(± 26,322)
Harvest Estimate	23,005	80,626	82,284
(± 95%)	(± 8,731)	(± 231,513)	(± 18,579)

from 28% in 1988 to 1989 to 24% in 1990, however harvest has increased from 80,626 in 1989 to 82,284 fish in 1990. While fishing pressure has decrease for walleye over the past three years, harvest of the fish had increased. This is most likely due to the change in fishing regulations for harvesting walleye. The 1988 and 1989 regulations favored the harvest of large size walleye whereas the 1990 regulations favored the harvest of smaller walleye.

Two hundred eighty one sturgeon anglers spent 1,952 hours angling (Table 4.2.5). Seventeen fish were harvested, 6 were released for a total catch of 23 fish in 1990. The catch CPUE was 0.02 fish per hour and the harvest CPUE was 0.01 fish per hour. The 1990 observed sturgeon harvest was approximately half the number of fish harvested in 1989, owing primarily to a lower number of sturgeon anglers checked. Catch CPUE for sturgeon in 1990 was double that of 1989, while harvest CPUE was identical in both years (Table 4.2.5).

Percentages calculated between harvest and catch estimates indicated that 82% of the fish caught in Lake Roosevelt were harvested (Table 4.2.6). Largemouth bass, black crappie, and chinook had the highest harvest/catch percentage at 100%. Kokanee had a harvest/catch percentage of 99%, followed by rainbow with 98%. Walleye had a harvest/catch percentage of 71%, which was a reflection of Washington Department of Wildlife game regulations for the harvest of walleye (see above).

4.2.2 Economic Value of the Lake Roosevelt Sport Fishery

Data compiled from creel surveys indicated that 171,725 angler trips were made to Lake Roosevelt in 1990. Calculating that anglers spent approximately $30.91 per trip, the value of the Lake Roosevelt sport fishery was estimated at $5.3 million and was similar to the 1989 economic value of $5.2 million (Table 4.2.1).

4.3 RELATIVE ABUNDANCE OF LAKE ROOSEVELT FISH

Impoundment of the Columbia, Spokane, and Sanpoil rivers by Grand Coulee Dam in 1939 changed not only the physical characteristics of the waters but also the relative abundance of fish populations within these systems. Historically, these rivers produced large numbers of anadromous salmon and steelhead as well

Table 4.2.5 **Comparisons of sturgeon angler data for all stratum on Lake Roosevelt, for 1989 and 1990.**

	1989	1990
No. anglers surveyed	447	281
Total hours spent fishing	5,671	1,952
No. sturgeon harvested	34	17
No. sturgeon released	17	6
Total sturgeon catch	51	23
Catch CPUE	0.01	0.02
Harvest CPUE	0.01	0.01

Table 4.2.6 Percent of a particular fish species harvested after being caught on Lake Roosevelt from January to December for all stratum.

Species	Catch Estimate	Harvest Estimate	Percent Harvested
Kokanee	17,756	17,515	99%
Rain bow	81,562	79,683	98%
Walleye	116,473	82,284	71%
Yellow Perch	7,953	3,641	46%
Smallmouth bass	12,054	10,033	83%
Largemouth bass	18	18	1 00%
Suckers	49	19	39%
Squawfish	25	6	24%
Black crappie	4,201	4,201	1 00%
Chinook	63	63	100%
Sturgeon	23	17	74%
All Fish Species	**240,185**	**197,480**	82%

as resident rainbow, cutthroat, bull trout, and mountain whitefish (Gangmark and Fulton 1949, Bryant and Parkhurst 1950, Fulton 1968; 1970, Fulton and Laird 1967, Scholz et *al.* 1985).

Table 4.3.1 shows the changes in fish family relative abundance from 1949 to 1990. Comparisons indicate several changes have occurred in the fish community of Lake Roosevelt since construction of Grand Coulee Dam. Upon impoundment, water dynamics of the system changed in favor of carp, suckers and other rough fish which became the predominant species by 1949 (Gangmark and Fulton). Around 1973 another change in relative abundance occurred, this time in favor of Percidae. This was thought to be **a** result of the illegal introduction of walleye into the system around 1963 (Beckman et *al.* 1985, Fletcher 1985). With rough fish providing a large forage base, walleye have been able to thrive thus establishing the first viable sport fishery in Lake Roosevelt since impoundment. A third change in relative abundance can be seen in the rise of Salmonidae numbers as evidenced by Peone et *al.* (1990) and the present study. They have risen from <1% between 1949 and 1982, to 16%, 12% and 7% in 1988, 1989, and 1990 respectively. Much of the increase in salmonid populations is related to the establishment of net-pen programs on Lake Roosevelt in 1985 and Washington Department of Wildlife stockings of 1 million kokanee annually since 1988. In 1990, 41% of the rainbow trout captured during relative abundance surveys were of net-pen or hatchery origin, 25% were native, and 34% were of unidentified origin.

4.3.1 Kokanee Salmon Abundance

Kokanee salmon abundance as determined by relative abundance surveys has decreased from 5% in 1988 to 1% in 1990 (Table 4.3.2). The numbers of kokanee collected have decreased from 178 in 1989, to 132 in 1989 to 61 in 1990. Gillnet and electrofishing catch-per-unit-efforts and respective efforts were 0.5 fish per hour with 361 hours effort in 1988, 0.3 fish per hour with 482 hours effort in 1989, and 0.1 fish per hour with 581 hours effort. Decrease in relative abundance of kokanee in 1990 could be the result of a 25 foot drawdown of the reservoir that occurred between October and December of 1988. Any natural spawning effort that occurred during this time could have been lost due to dewatering of the redds. This would have caused **a** decrease in the numbers of 1+ fish that would have been captured in 1990. Additionally, reservoir operations that

Table 4.3.1 Comparisons of fish family relative abundance in Lake Roosevelt from 1948 to 1990.

Family Name	USFWS 1949 (gillnet)	WDW 1963 (gillnet)	WWP 1973 (gillnet)	USFWS 1980 - 1982 (gillnet)	Peone *et al.* 1988 (gillnet and electrofishing)	Peone *et al.* 1989	Present Study 1990
Aspinceridae						<1%	
Catostomidae	10%	20%	44%	34%	20%	20%	21%
Centrarchidae	1%	<1%		1%	6%	3%	4%
Cottidae					2%	2%	2%
Cyprinidae	83%	70%	22%	23%	7%	6%	7%
Gadidae					<1%%	<1%	<1%
Ictaluridae					<1%%	<1%	<1%
Percidae	3%	4%	32%	37%	49%	57%	58%
Salmonidae	<1%	<1%	<1%	<1%	16%	11%	7%

Table 4.3.2 Comparisons of percent relative abundance, number caught, and CPUE as determined from relative abundance surveys for 1988, 1989, and 1990.

	1988	1989	1990
Kokanee			
Relative Abundance	5%	2%	1%
Number Caught	**178**	132	61
CPUE	0.5	0.3	0.1
Rainbow			
Relative Abundance	9%	5%	3%
Number Caught	318	396	**248**
CPUE	0.9	**0.8**	**0.4**
Walleye			
Relative Abundance	**20%**	18%	13%
Number Caught	714	**1303**	1137
CPUE	**2.0**	**2.7**	**2.0**
Total Effort (hours)	**361**	**482**	**581**

caused a prolonged periods of drawdown and short water retention time for most of the winter and spring of 1989 may have contributed to flushing kokanee over Grand Coulee Dam, thereby reducing the number of kokanee adults in the reservoir in 1990.

4.3.2 Rainbow Trout Abundance

Rainbow trout relative abundance decreased over the past three years from 9% in 1988, to 5% in 1989, and 3% in 1990 (Table **4.3.2).** The numbers of rainbow collected have fluctuated from 318 in 1989, to 396 in 1989 to 248 in 1990. Gillnet and electrofishing catch-per-unit-efforts and respective efforts were 0.9 fish per hour with 361 hours effort in 1988, 0.8 fish per hour with 482 hours effort in 1989, and 0.4 fish per hour with 581 hours effort. This decrease might be attributed to decreased water retention times in the spring of 1989 and 1990 which caused rainbow to be flushed from the reservoir. Water retention time of 30 days or greater in the spring seems to be of importance in maintaining a stable rainbow trout population within the reservoir.

The results of tagging studies indicated that many fish of net-pen origin were lost in 1989 and 1990 but not in 1988. In 1988, water retention times for January to June ranged from 34 days to 50 days with the average being 41 days. Net-pen releases in 1988 occurred in May and June at low pool or rising pool elevations. As a result a small number of fish were recovered from below Grand Coulee Dam. In 1989, water retention times from January to June ranged from 23 days to 40 days with the average being 31 days. Extensive drawdowns in the early part of 1989 threatened to ground net-pens, so many net-pen operators released fish into the reservoir in February and March. This resulted in the loss of approximately 41,695 fish over Grand Coulee Dam (Scholz 1989). In 1990, water retention times for January to June ranged from 28 to 41 days with an average of 33 days. In 1990, one net-pen was released in April and the others were released in May. Tagging studies from 1990 indicated that another fish loss occurred in Lake Roosevelt although not to the extent of the 1989 fish loss (See Section 4.7.1).

From May 5 to July 15, 390 rainbow (7 tagged) were examined at McNary Dam Fish Passage Facility. From these numbers the Washington State Department of Fisheries estimated that 6,907 rainbow of Lake Roosevelt origin passed through the fish passage facility or were spilled at McNary Dam (Hillson 1990). This number was expanded by 15% for every dam upstream from McNary to Grand Coulee to obtain an estimate of 18,370 rainbow lost over Grand Coulee (Table 4.3.3). This tagging data is further evidence that there is a need for increased water retention time in the spring to prevent the flushing of fish through the reservoir and over Grand Coulee Dam.

4.3.3 Walleye Abundance

In 1990, walleye had a relative abundance of 13% compared to 18% in 1989 and 20% in 1988 (Table 4.3.2). In 1988, 714 walleye were captured in relative abundance surveys at **a** CPUE of 2.0 fish per hour compared to 1989 where 1,303 fish were caught at a rate of 2.7 per hour, and 1990 where 1,137 fish were caught at a rate of 2.0 fish per hour. These numbers indicate that walleye populations are remaining relatively stable. However, out of the 333 walleye that were aged from the relative abundance surveys in 1990, 22 were 0+, 97 were 1+, and 75 were 2+ in age. This was an increase in numbers of younger age class fish obtained when compared to 1989 numbers where 38 were 0+, 38 were 1+, and 26 were 2+ in age. The increase in numbers of fish in the younger age class indicated that walleye recruitment may be increasing in Lake Roosevelt.

4.4 AGE, GROWTH, AND CONDITION

4.4.1 Kokanee Salmon

Mean estimated total length at annulus formation of kokanee salmon in Lake Roosevelt was compared to that reported from other kokanee producing waters in the western United States and Canada (Table 4.4.1). At each annulus, kokanee lengths from Lake Roosevelt collected in 1990 were greater than the average of 21 lakes used for comparison. For example, 172-vs-121 mm at age I, 303-vs-207 mm at age II, and 409-vs-256 mm at age II I.

Figure 4.4.1 compares the average back-calculated growth of kokanee from Lake Roosevelt to the average back-calculated growth from area waters. The difference in growth ranges from 50 mm at age I to 150 mm at age III. The large difference in growth may be attributed to the large size and abundance of zooplankton in Lake Roosevelt and relatively little intraspecific competition (Pfeiffer 1978, Scholz et al. 1988, Peone et al. 1990).

Table 4.3.3 Estimated number of rainbow lost over Grand Coulee Dam and mortality at each dam.

Dam	Number of fish passing over dam	Estimated mortality
Grand Coulee	18,370	2,756
Chief Joseph	15,974	2,396
Wells	13,891	2,084
Rocky Reach	12,080	1,812
Rock Island	10,504	1,576
Wanapum	9,134	1,370
Priest Rapids	7,943	1,191
McNary	6.907	1,036

Table 4.4.1. Comparisons of estimated total lengths at annulus formation for kokanee salmon in Lake Roosevelt -vs- other kokanee lakes in the western United States and British Columbia.

Location	Sample Size	Average total length (mm) at annulus formation 1	2	3	4	Reference
Cultus Lake, BC (M)	31	74	163	224	- -	Ricker (1938)
Cultus Lake, BC (F)	198	84	163	249	- -	Ricker (1938)
Moore Creek, BC	- -	- -	170	237	245	Lorz and Northcote (1965)
Grandby Lake, CO	- -	130	224	264	- -	Finnell (1966)
Coeur d'Alene Lake, ID	- -	- -	220	237	295	Cochnauer (1983)
Pend Oreille Lake, ID	- -	63	190	216	279	Buss (1957)
Pend Oreille Lake, ID	- -	- -	175	221	234	Whitt (1958)
Pend Oreille Lake, ID	237	74	160	202	229	Rieman and Bowler (1979)
Pend Oreille Lake, ID	- -	92	178	216	244	Rieman and Bowler (1980)
Priest Lake, ID	205	79	180	216	239	Bjorn (1957)
Priest Lake, ID	- -	81	175	216	246	Bjorn (1961)
Priest Lake, ID	- -	195	255	320	- -	Mauser *et al.* (1988)
Round Lake, ID	- -	93	157	201	- -	Howser (1966)
Spirit Lake, ID	- -	- -	215	267	283	Cochnauer (1983)
Upper Priest Lake, ID	96	89	193	264	297	Bjorn (1957)
Upper Priest Lake, ID	- -	91	203	269	307	Bjorn (1961)
Libby Reservoir, MT	- -	189	265	330	- -	Chisholm and Fraley (1985)
Elk Lake, OR	- -	147	196	249	- -	Chapman and Fourtune (1963)
Odell Lake, OR	- -	178	259	356	- -	Chapman and Fourtune (1963)
Odell Lake, OR	- -	190	255	305	- -	Lewis (1975)
Lake Roosevelt, WA	55	113	262	251	365	Stober et *al.* (1977)
MEAN TOTALS		121	207	257	272	
Lake Roosevelt, WA 1988	46	142	274	372	457	Peone et *al.* (1990)
Lake Roosevelt, WA 1989	42	124	259	354	406	Peone et *al.* (1990)
Lake Roosevelt, WA 1990	33	**172**	303	409	- .	**Present Study 1990**

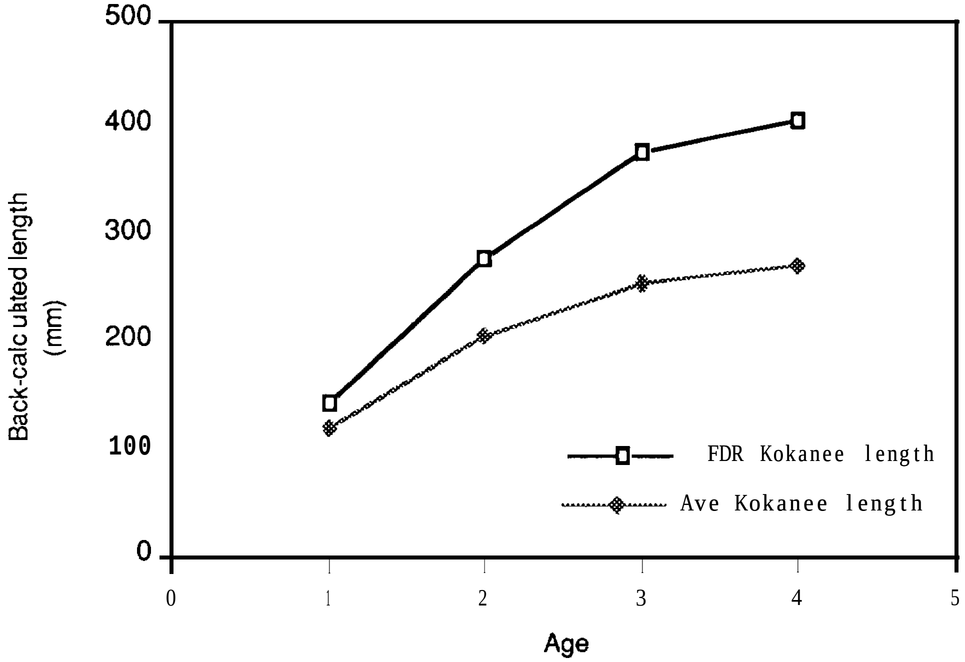


Figure 4.4.1 **Comparisons of estimated total lengths from back-calculations for a three year average of Lake Roosevelt kokanee (1988-1 990) and the average of 21 kokanee producing waters in the northwest and British Columbia.**

Length data from creel surveys indicated that size of kokanee harvested in Lake Roosevelt was superior when compared to other locations (Table 4.4.2). The average size of kokanee harvested in Lake Roosevelt was 432 mm in 1988, 411 mm in 1989, and 391 in 1990 for an overall average of 411 mm. The average size of kokanee harvested by anglers from 11 area waters **was 296** mm.

Length data from 1990 when compared to 1988 and 1989 shows a decrease in the lengths of kokanee harvested by anglers (Table 4.2.2). This decrease in length might be attributed to reduced zooplankton densities in 1990 than 1989, which, in turn, are correlated with lower water retention times during the summer of 1990 as compared to 1989 (See 4.5.2 for details).

4.4.2 Rainbow Trout

Mean estimated total length at annulus formation of rainbow trout in Lake Roosevelt was compared to that reported from other rainbow producing waters in the western United States and British Columbia (Table 4.4.3). Rainbow lengths from Lake Roosevelt collected in 1990 compared favorable to the average lengths of rainbow from 21 lakes. For example, 158-vs-110 mm at age I, 207-vs-217 mm at age I I, 302-vs-307 mm at age III, 377-vs-386 mm at age IV, 428-vs-441 mm at age V, and 472-vs-498 mm at age VI.

Figure 4.4.2 compares the average back-calculated growth of rainbow from Lake Roosevelt to the average back-calculated growth from area waters. The difference in growth ranged from 75 mm at age I to relatively no difference by age V. The difference in growth patterns may be attributed to zooplankton abundance in Lake Roosevelt and the utilization of this food source while young. Rainbow were predominantly omnivorous, feeding upon zooplankton, benthics, and terrestrials. However while the fish were 0+ to 3+ years old their diet consisted primarily of zooplankton and chironomids. As the fish aged the diet gradually changed to include more benthic and terrestrial invertebrates. Decreased growth between age 3+ and 4+ may be related to this changeover.

Length data from creel surveys indicated that size of rainbow harvested in Lake Roosevelt was excellent when compared to other locations (Table 4.4.4). The average size of rainbow harvested in Lake Roosevelt was 391 mm in 1988, 403 mm in 1989, and 346 in

Table 4.4.2 Comparisons of mean lengnths of kokanee harvested by anglers on Lake Roosevelt -vs- those taken from nearby waters.

Locat ion	Mean ength (mm)	Study Period	References
Lake Coeur d'Alene, ID	318	1954-1988	Cochnauer (1983)
Odell Lake, OR	262	1965-1975	Lewis (1975)
Flathead Lake, MT	331	1967-1985	Chisolm and Fraley (1985)
Pend Orielle Lake, ID	310	1954-1987	Rieman and Bowler (1980)
Loon Lake, WA	321	1941-1985	Scholz et al. (1988)
Granite Creek, ID.	331		Bowler et *al.* (1978)
Lake Coeur d'Alene, ID	220		Cochnauer (1984)
Pend Orielle Lake, ID.	223		Bowler et *al.* (1978)
Spirit Lake, ID.	270		Cochnauer (1984)
S. Fork Boise River, ID.	400		Partridge (1988)
MEAN TOTALS	296		
Lake Roosevelt, WA	422	1988-I 989	Peone et *al. 1990*
Lake **Roosevelt, WA.**	**391**	1990	**Present Study**

Table 4.4.3 Comparisons of estimated total lengths at annulus formation for rainbow trout in Lake Roosevelt -vs- rainbow trout waters in the western United States and British Columbia.

Location	Average total length (mm) at annulus formation						Reference
	1	2	3	4	5	6	
Okanogan Lake, B.C.	114	305	431	571			Wydoski & Whitney (1979)
Moyie River, ID	96	160	228	297			Horner & Rieman (1984)
Box Canyon, ID	155	277	364	431	493	532	Angradi & Contour (1989)
Spokane River, ID	139	222	306	371			Bennet & Underwood (1987)
Henry Forks, ID	126	243	362	450	493	532	Angradi & Contour (1989)
Worm River, ID	113	192	265	313	363	381	Bronstrom (1987)
Fall River, ID	103	179	251	307			Bronstrom & Spateholts (1985)
Henrys Fork, ID	129	211	297	369	458	555	Bronstrom & Spateholts (1985)
Snake River, ID	130	257	353	462	495		Wydoski & Whitney (1979)
Coeur d'Alene River, ID	69	111	171	256	370	433	Lewynsky (MS)
Pend Oreille Lake, ID	78	161	290	446	562	662	Pratt (1985)
Missouri River, MT	81	201	282	343	404	421	Katherin (1951)
Montana Lakes, MT	89	206	323	406	465		Carlander (1969)
Kootenai River, MT	97	262	353	406			May & Huston (1983)
Firehole River, WY	135	234	328	396			Carlander (1969)
Madison River, WY	127	244	356	417			Carlander (1969)
Ross Lake, WA	122	266	345	383	406		Wydoski & Whitney (1979)
Box Canyon Reservoir, WA	105	154	233	321	387		Barber et *al.* (1989)
Spokane River, W	89	196	274	368	419	470	Bailey & Saltes (1982)
Spokane River, WA[2]	123	219	318	397	419		Kleist (1987)
Lake Roosevelt, WA 1977	97	255	322				Stober et *al.* (1977)
MEAN TOTALS	110	217	307	386	441	498	
Lake Roosevelt, WA 1988	195	318	377	423	434		Peone et *al.* (1990)
Lake Roosevelt, WA 1989	166	235	344	429	474	501	Peone et *al.* (1990)
Lake Roosevelt, WA 1990	**158**	207	302	**377**	**428**	**472**	**Present Study 1990**

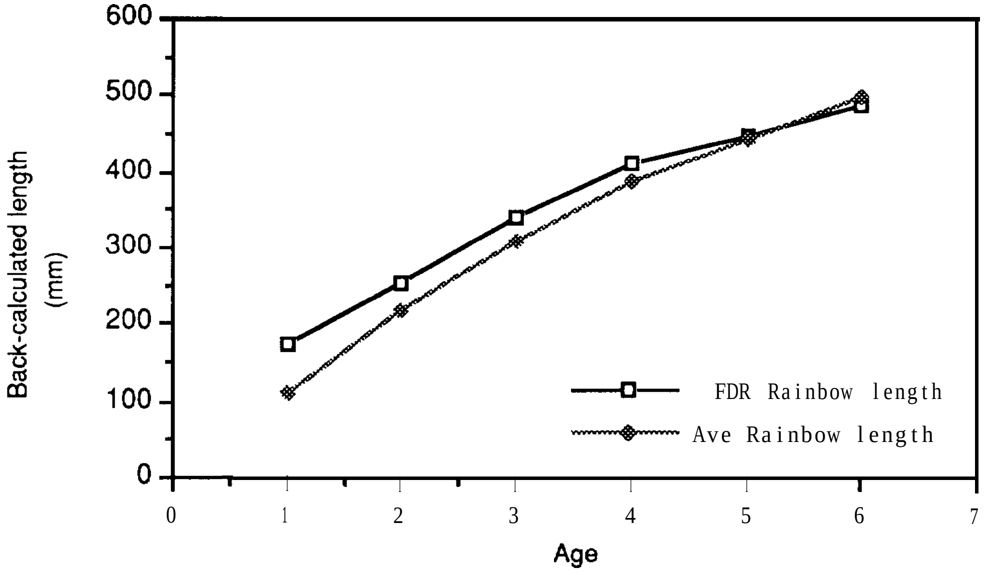


Figure 4.4.2 **Comparisons of estimated total lengths from back-calculations for a three year average of Lake Roosevelt rainbow (1988-1990) and the average of 21 rainbow producing waters in the west and British Columbia.**

Table 4.4.4 Comparisons of mean lengths of rainbow trout taken from Lake Roosevelt -v- rainbow trout found in waters of Idaho.

Location	Average length (mm)	References
Big Wood River, ID.	220	Thurow (1988)
Box Canyon Creek, ID.	158	Partridge *et al.* (1990)
Cold Springs Creek, ID.	148	Grunder *et al.* (1987)
Devils Corral Creek, ID.	168	Grunder et a/. (1987)
Fivemile Creek, ID.	176	Reingold and Davis (1987)
Lime Creek, ID.	153	Partridge et *al.* (1990)
Mormon Resevoir, ID.	325	Partridge (1988)
Rock Creek, ID.	127	Grunder et *al.* (1987)
Snake River, ID.	344	Luken (1988)
Williams Lake, ID.	336	Reingold and Davis (1987)
Willow Creek, ID.	104	Partridge *et al.* (1990)
MEAN TOTALS	205	
Lake Roosevelt, WA	397	Peone *et al.* (1989)
Lake Roosevelt, WA.	**346**	**Present Study (1990)**

1990 for an overall average of 380 mm. The average size of rainbow harvested by anglers from 11 area waters was 205 mm.

4.4.3 Walleye

Mean estimated total length at annulus formation of walleye in Lake Roosevelt **was** compared to that reported from other walleye producing waters in the United States and British Columbia (Table 4.4.5). Walleye lengths from Lake Roosevelt collected in 1990 compared favorable to the average lengths of walleye from 16 systems. For example, 199-vs-177 mm at age I, 283-vs-280 mm at age II, 360-vs-368 mm at age III, 422-vs-431 mm at age IV, 491-**vs-483** mm at age V, 567-vs-530 mm at age VI, 615-vs-554 mm Ft age VII, 667-vs-548 mm at age VIII, 71 l-vs-675 mm at age IX, and 689-vs-728 mm at age X.

Figure 4.4.3 compares the average back-calculated growth of walleye from Lake Roosevelt to the average back-calculated growth from area waters. The data indicates that Lake Roosevelt walleye growth is average to growth in other waters. The differences in growth at ages 6 to 10 may be due to small sample sizes and not actual differences.

Length data from creel surveys indicated that size of walleye harvested in Lake Roosevelt was good at 376 mm and 435 grams

4.5 ZOOPLANKTON

4.5.1 Zooplankton Abundance and Distribution

Mean microcrustacean zooplankton (excluding nauplii) density was determined for May, August and October 1990 at nine index stations (Table 4.5.1). Densities of microcrustacean zooplankton were highest in the lower mainstem Columbia stations and reservoir arms (Figure 4.5.1). Mean annual density values were: 482/m3 at Kettle Falls, 3,277/m3 at Gifford, 7,122/m3 at Hunters, 18,622/m3 at Porcupine Bay, 4,478/m at Little Falls, 8,764/m^3 at Seven Bays, 9,372/m^3 at Keller Ferry, 10,229/m^3 at Sanpoil, and 8,954/m^3 at Spring Canyon. Highest recorded mean microcrustacean densities were on the reservoir arm stations at Porcupine Bay and Sanpoil Arm. Mean annual microcrustacean zooplankton density (excluding nauplii) for the entire reservoir was 7,922/m^3.

Table .4.4.5 Comparisons of estimated total lengths at annulus formation for walleye in Lake Roosevelt -vs- other walleye lakes in the western United States and British Columbia.

Location	Sample Size	Average total length (mm) at annulus formation										Reference
Salmon Falls, ID	105	179	297	424	514	583	628	667				Partridge (1988)
Oneida Reservoir, ID	39	221	311	392	448	491	530					Partridge (1988)
Minnesota Lakes, MN		117	218	304	381	459	520					Wydoski & Whitney (1979)
N. Wisconsin Lakes, WI		145	241	312	371	421	472					Snow (1969)
Utah Lake, UT		170	294	340	386	421	431					Wydoski & Whitney (1979)
Lake of the Woods, B.C.		141	203	253	295	326	366	400	437			Carlander (1943)
Lake Erie		201	284	414	513	566	632					Scholl (1965)
Lake Gogebic		117	236	307	361	401	437	457	478			Eschmeyer (1950)
Saginaw Bay, MI		175	277	351	406	452	490	576	533			Hile (1954)
Lake Umatilla, WA		258	390	486	547	610	661					Maule (1982)
Sprague Lake, WA		169	245	373	416	494	570					Willms *et al.* (1989)
Mid-Columbia River, WA		229	363	460	526	577	622	665	688	706	770	Williams & Brown (1984)
Lake Roosevelt, WA 1973		213	344	432	528	568	605					Nielson (1974)
Lake Roosevelt, WA 1979-80	680	205	343	423	476	523	562	606	640	695		Harper et *al.* (1981)
Lake Roosevelt, WA 1979-81	393	223	373	471	539	589	627	674	698	712	729	Nigro *et al.* (1983)
Lake Roosevelt, WA 1979-83	3,248	189	307	385	450	515	569	629	668	702	742	Beckman *et al.* (1985)
MEAN TOTALS		177	280	368	431	483	530	554	548	675	728	
Lake Roosevelt, WA 1988	369	204	273	348	410	470	532	590	635	688	689	Peone et *al.* (1990)
Lake Roosevelt, WA 1989	467	210	282	351	418	493	571	603	-	-	-	Peone et *al.* (1990)
Lake Roosevelt, WA 1990	311	**184**	295	380	439	**511**	597	651	698	734	-	Present Study 1990

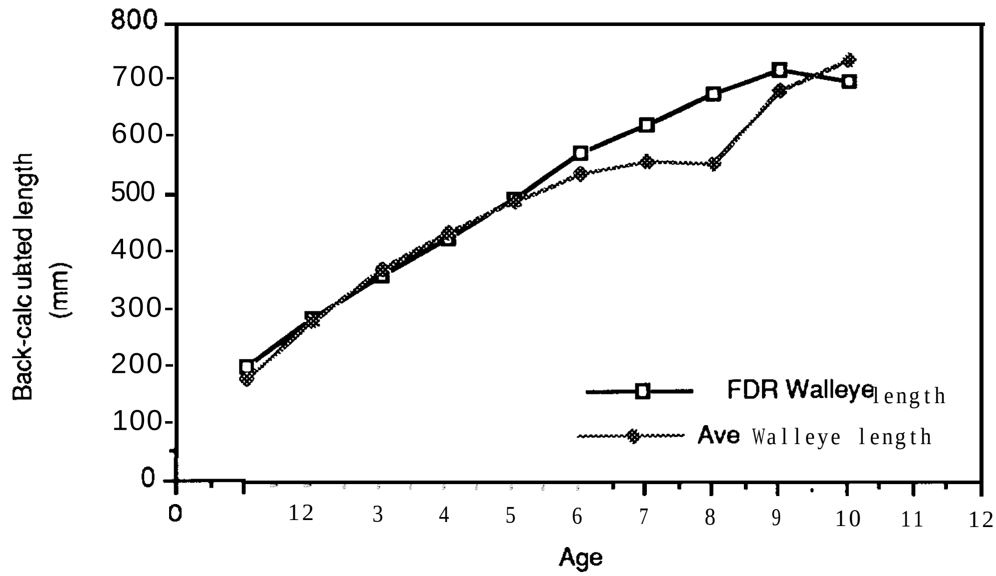


Figure 4.4.3 **Comparisons of estimated total lengths from back-calculations for a three year average of Lake Roosevelt walleye (1988-1 990) and the average of 16 walleye producing waters in the United States.**

Table 4.51 Density (#/m3) of zooplankton collected in Lake Roosevelt in May, August, and October 1990, and mean annual density, at each index station.

Sampling Month	Taxa	Kettle (1)	Gifford Falls (2)	Hunters (3)	Porcupine Bay (4)	Little Falls (5)	Seven Bays (6)	Keller Ferry (7)	Sanpoil (8)	Spring Canyon (9)
		Index Station								
May 1990	Cladocera	39	54	45	238	120	292	330	1,131	314
	Copepoda	35	23	134	6,004	1,763	884	1,492	1,038	1,225
	Total	74	77	179	6,242	1,883	1,176	1822	2,169	1,539
August 1990	Cladocera	313	97	749	3,624	896	3,762	8,957	8,786	5,523
	Copepoda	616	575	4,031	12,265	3,379	4,872	12,863	15,694	13,918
	Total	929	672	4,780	15,889	4,275	8,634	21,820	24,480	19,441
October 1990	Cladocera	401	7,236	10,835	9,756	1,513	5,076	842	1,129	1,155
	Copepoda	41	652	5,572	23,980	5,763	11,408	3,633	2,910	4,725
	Total	442	7,888	16,407	33,736	7,276	16,484	4,475	4,039	5,880
Seasonal Means for 1990	Cladocera	251	2,462	3,876	4,539	843	3,043	3,376	3,682	2,331
	Copepoda	231	815	3,246	14,083	3,635	5,721	5,996	6,547	6,623
	Total	482	3,277	7,122	18,622	4,478	8,764	9,372	10,229	8,954

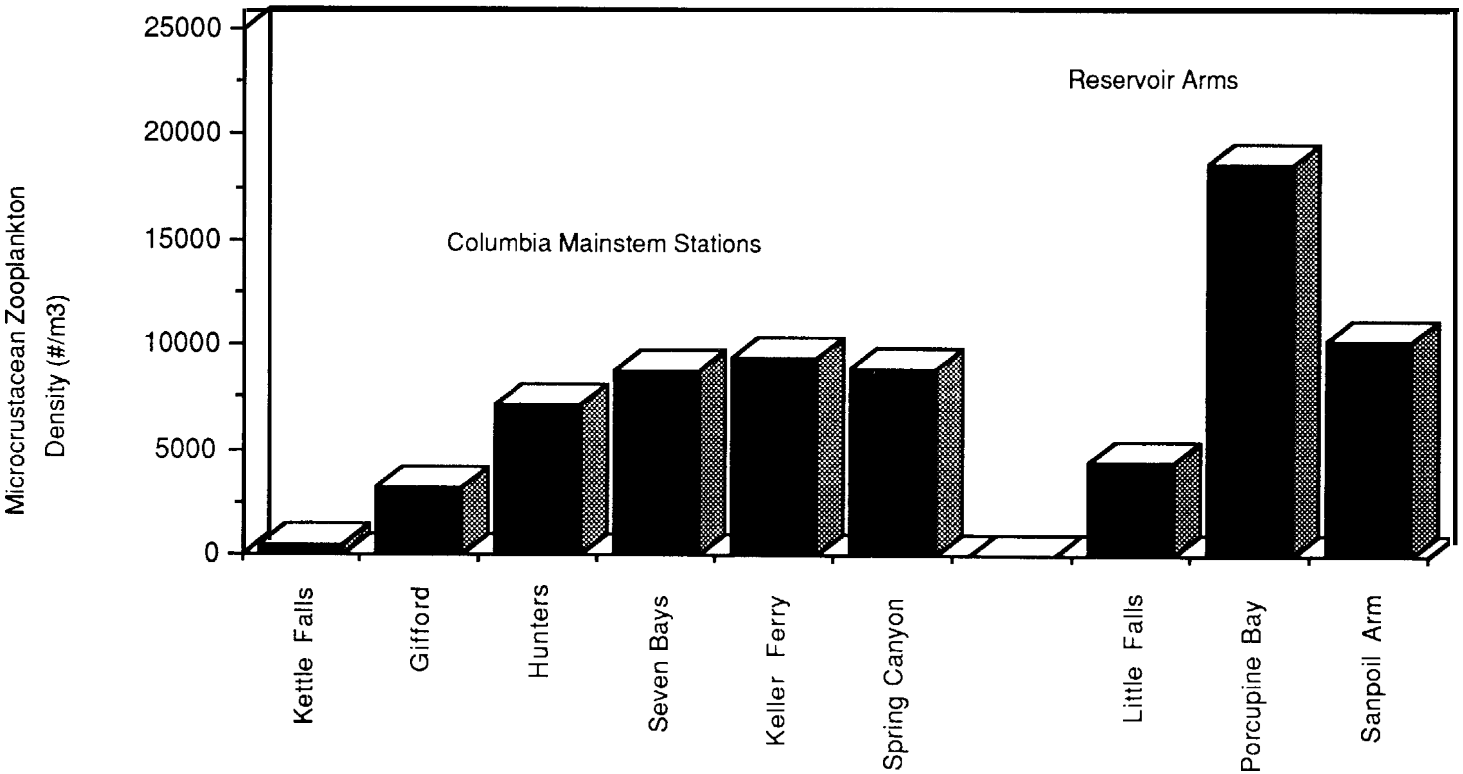


Figure 4.5.1 **Mean microcrustacean zooplankton density (#/m3) excluding nauplii, collected at nine index stations in May, August, and October 1990.**

Beckman et *al.* (1985) and Peone et *al*. (1990) calculated that microcrustacean zooplankton levels observed in Lake Roosevelt in 1980, 1982, and 1989, were high enough to support approximately 16 million kokanee fingerlings and 5.9 million adult kokanee (0.5 kg body weight). Density range values collected in 1990 were comparable to the range values reported in previous reports and should be high enough to support the 2 million kokanee fry scheduled to be released in June 1991 (Table 4.5.2).

Comparisons between percentage composition of Copepoda and Cladocera densities indicated that relatively little change occurred over the past 10 years (Table 4.5.3). Between 1980 and 1990 the density of copepods has ranged from 62% to 69% of the population. Cladocera density has ranged from 31% to 38% of the population. This relative stability of Cladocera populations is favorable when examining the diets of kokanee which have exhibited index of relative importance values for Cladocera of 76% in 1988, 65% in 1989 and 56% in 1990.

Mean biomass of Daphnia spp. was determined for May, August and October 1990 at nine index stations (Table 4.5.4). High biomass values were intermittent within the reservoir with high biomass occurring adjacent to a low biomass area (Figure 4.5.2). Mean annual biomass values were: 3,871 $\mu g/m^3$ at Kettle Falls, 33,763 $\mu g/m^3$ at Gifford, 144,469 $\mu g/m^3$ at Hunters, 134,740 $\mu g/m^3$ at Porcupine Bay, 412,293 $\mu g/m^3$ at Little Falls, 71,463 $\mu g/m^3$ at Seven Bays, 152,717 $\mu g/m^3$ at Keller Ferry, 162,408 $\mu g/m^3$ on the Sanpoil, and 100,252 $\mu g/m^3$ at Spring Canyon. Highest recorded mean Daphnia spp. biomass values were found on the Sanpoil arm, Keller Ferry, Hunters, and Porcupine Bay. Mean annual biomass value for the entire reservoir for 1990 was 90,664 $\mu g/m^3$.

The mean biomass value for Daphnia spp. found in Lake Roosevelt was considerably higher than biomass values documented for other local kokanee lakes, as found in Rieman and Bowler (1980) (Table 4.5.5). Mean annual Daphnia spp. biomass at Porcupine Bay was 68.1 mg/m^3. Mean annual Daphnia spp. biomass at Seven Bays was 47.1 mg/m^3. Daphnia *schødleri* had the highest index of relative importance in kokanee diets at 70% in 1988, 58.4% in 1989, and 49% in 1990. Again, biomass values the present study support previous investigations that zooplankton biomass in Lake Roosevelt is sufficient to support the proposed 3.2 million adult kokanee

Table 4.5.2 **Density range comparisons reported for Cladocera and Copepoda at four index stations in Lake Roosevelt in 1980, 1982, 1989, and 1990.**

Station	1980[a]	1982[b]	1989[c]	1990[d]
Kettle Falls				
Cladocera	25 - 172	65 - 1,056	86 - 9,842	24 - 7,894
Copepoda	0 - 100	45 - 1,477	79 - 244	28 - 623
Gifford				
Cladocera	4 - 1,557	87 - 15,578	189 - 12,469	47 - 451
Copepoda	275 - 1,268	482 - 5,615	184 - 712	23 - 786
Porcupine Bay				
Cladocera	8 - 1,777	56 - 10,258	106 - 22,530	203 - 13,942
Copepoda	691 - 4.275	341 - 17.690	3,778 - 33,648	5,375 - 36,842
Sanpoil				
Cladocera	14 - 2,450	110 - 19,557	86 - 3,669	798 - 11,049
Copepoda	3,489 - 9,505	3,580 - 47,825	898 - 14,030	1,109 - 15,736
Means				
Cladocera	13 - 1,489	80 - 11,612	117 - 12,135	357 - 11,112
Copepoda	1,114 - 3,787	1,112 - 18,152	1,235 - 12,159	2,178 - 17,996

a Stober et al. 1981. Data collected from May to September 1980.

b Beckman et al. 1985. Data collected from May to September 1982.

c Peone et al. 1990, Data collected in May, August and October of 1989 at Kettle Falls, Gifford, and Sanpoil, and from May to October at Porcupine Bay.

d Present study. Data collected in May, August and October of 1990 at Kettle Falls, Gifford, and Sanpoil, and from May to October at Porcupine Bay.

Table 4.5.3 Comparison of Copepoda and Cladocera density by percentage, as reported at Porcupine Bay from may to September 1980, 1982, 1989, and 1990.

Year	Percent Copepoda Density	Percent Cladocera Density	Reference
1980	**69%**	31%	Strober et *al.* (1981)
1982	38%	32%	Beckman et a/. (1985)
1989	62%	38%	Peone et al. (1990)
1990	69%	31%	Present study (1990)

Table 4.5.4. *Daphnia* spp. biomass ($\mu g/m^3$) at nine index stations in May, August, and October 1990.

Sampling Month	Index Stations								
	Kettle Falls (1)	Gifford (2)	Hunters (3)	Porcupine Bay (4)	Little Falls (5)	Seven Bays (6)	Keller Ferry (7)	Sanpoil (8)	Spring Canyon (9)
May 1990	7	17	91	879	9	2,640	1,332	12,599	1,680
August 1990	1,228	252	6,873	84,536	8,853	51,438	435,713	435,669	244,826
October 1990	10,377	101,020	426,442	318,804	28,016	160,310	21,105	38,956	54,251
Seasonal Means for 1990	3,871	33,763	144,469	134,740	12,293	71,463	152,717	162,408	100,252

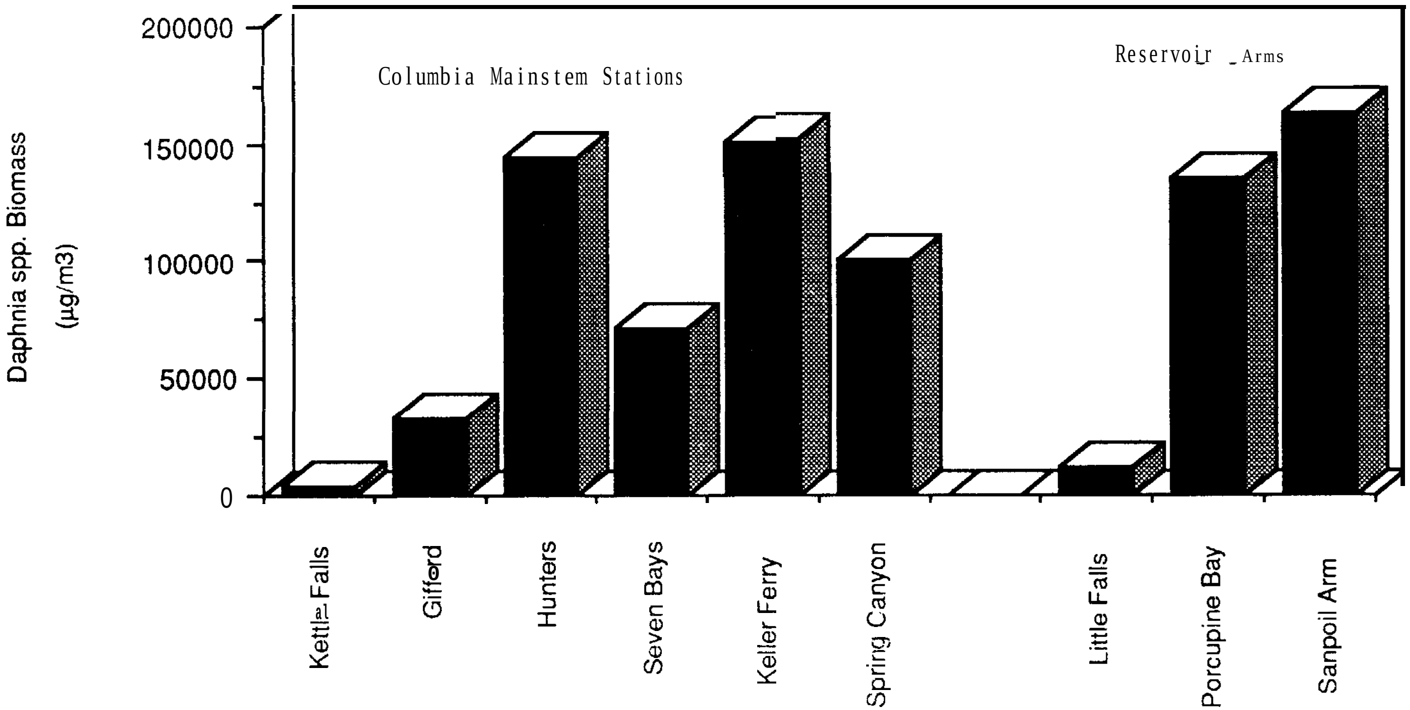


Figure 4.5.2 **Mean *Daphnia* spp. biomass (µg/m3) from nine sampling locations on Lake Roosevelt for May, August, and October** 1990"

Table 4.5.5 Comparisons of Lake Roosevelt *Daphnia* spp. to biomass values reported for area lakes in Reiman and Bowler (1980).

Body of Water	Time period	Biomass
Lake Pend Oreille	5 year mean	38.7 mg/m^3
Lake Coeur d'Alene	3 year mean	36.8 mg/m^3
Priest Lake		27.7 mg/m^3
Upper Priest Lake		25.5 mg/m^3
Spirit Lake		39.7 mg/m^3
Lake Roosevelt	1989[a]	128.6 mg/m^3
Lake Roosevelt	**1990**	**90.6 mg/m^3**

a Peone *et al.* (1990)

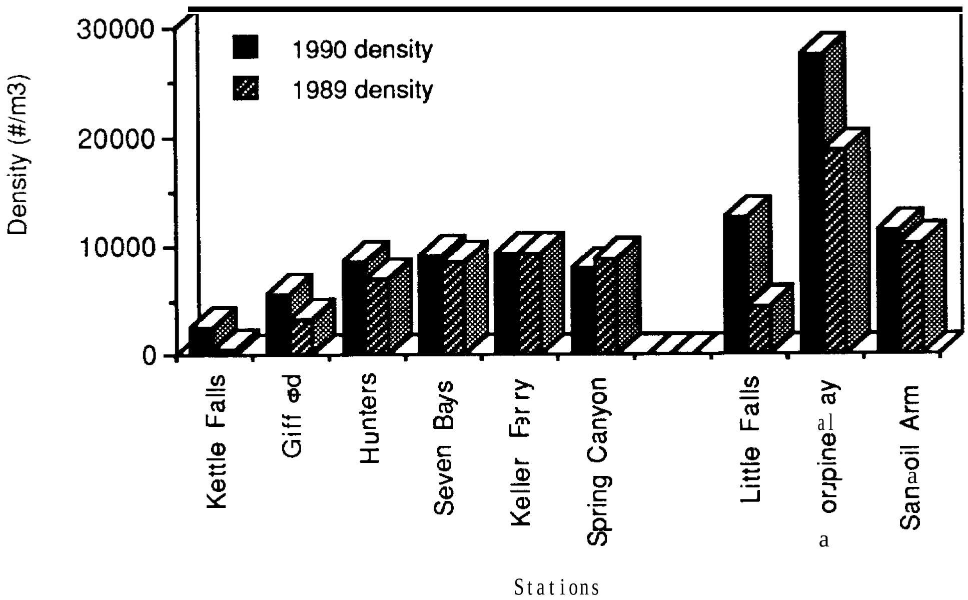
produced by the Lake Roosevelt kokanee hatcheries. The above average zooplankton biomass values might be attributed high nutrient loading from Coeur d'Alene, ID, and Spokane, WA, upstream of the Spokane Arm, and lack of impact by size selective predation by planktivorous fish (See Section 4.6.2).

Distribution of zooplankton densities and biomass values were similar to distribution found in 1989 but values were lower (Figure **4.5.3).**

4.5.2 Effect of Reservoir Operations on Zooplankton Dynamics

To determine the effect of reservoir operations on zooplankton and biomass, monthly samples collected at Porcupine Bay (station 4) and Seven Bays (station 6) were compared to mean monthly reservoir elevations and water retention times (Figures 4.5.4 through 4.5.7). In previous years, a water retention time of 30 days in the spring was determined to be critical in the timing of increases in zooplankton standing crops in Lake Roosevelt (Beckman et *al.* 1985, Peone et *al.* 1990). The data from 1990 supports this hypothesis since significant increases were not observed observed until May when water retention time was 29 days (Tables 4.5.6 and 4.5.7).

Mean water retention time was 41 days from April to September in 1990, or 82% of the 50 day average observed in 1989. The shorter retention time in 1990 was owing primarily to a two month delay in longer water retention time in 1990 as compared to 1989 i.e., water retention time increased to > 60 days by July 1989 and September 1990 (Figure 4.2.1). This correlated with a reduction in the total microcrustacean density and *Daphnia* spp. biomass in Lake Roosevelt in 1990 when compared to 1989 (Table 4.5.8). Decreased water retention times in reservoir systems lead to flushing of nutrients through the system that normally stimulate and increase phytoplankton growth. If nutrients are flushed through the system phytoplankton growth does not increase at normal times or rates. Because phytoplankton is the primary food source of zooplankton, decreased phytoplankton levels result in decreased zooplankton populations at times when population increases would normally be seen. The mean water retention time between April and September was 50 days in 1989, and 41 days in 1990. This represented an 18% decrease between the two years. Mean *Daphnia* spp. biomass values from April to September experienced a 67%



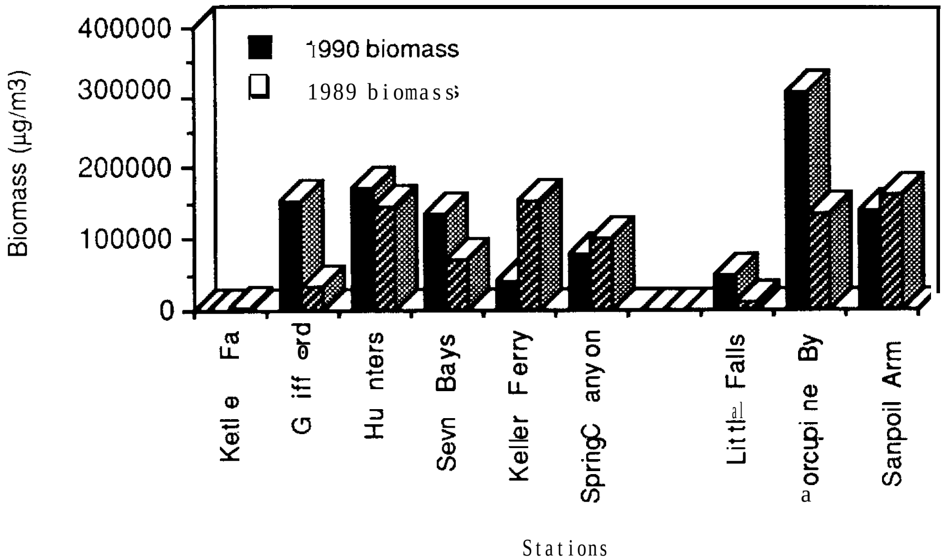


Figure 4.5.3 **Comparisons of microcrustacean zooplankton densities and *Daphnia* spp. biomass values between 1989 and 1990.**

Figure 4.5.4.a

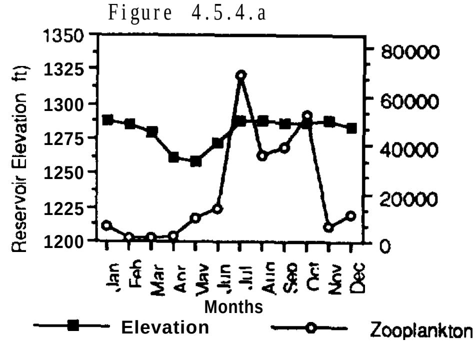


Figure 4.5.4.b

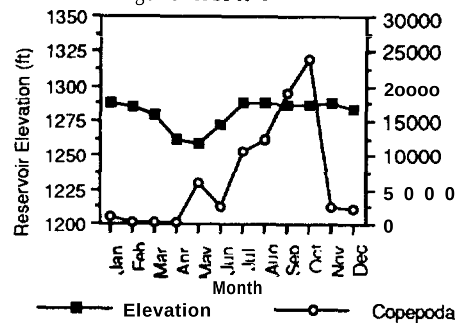


Figure 4.5.4.c

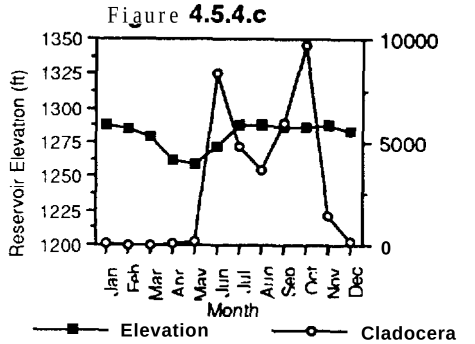


Figure 4.5.4.d

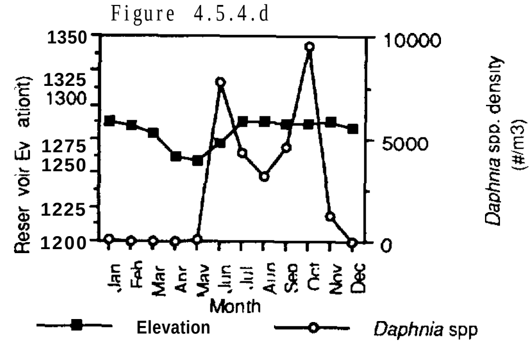


Figure 4.5.4.e

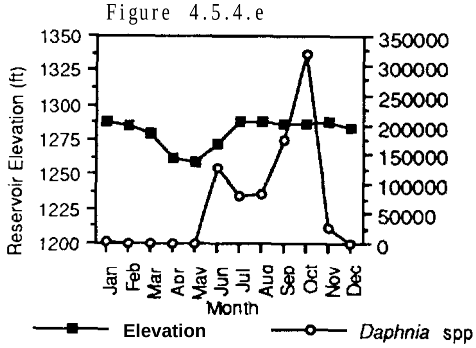
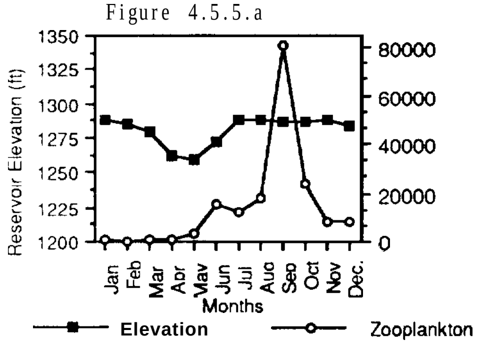


Figure 4.5.4 Mean monthly reservoir **elevation** (ft) **-vs- microcrustacean** density **(#/m3),** Copepoda density, Cladocera density, ***Daphnia* spp.** density, and ***Daphnia*** spp. biomass at Porcupine Bay (location 4) in 1990.

Figure 4.5.5.a



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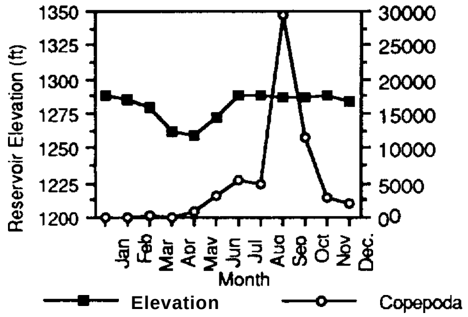

Figure **4.5.5.c**

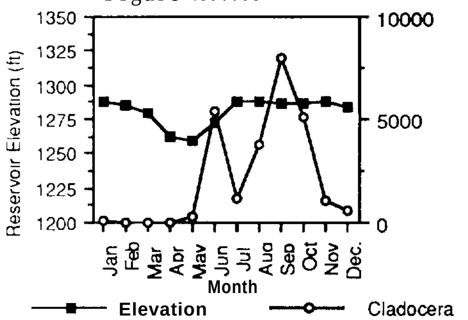

Figure 4.5.5.d

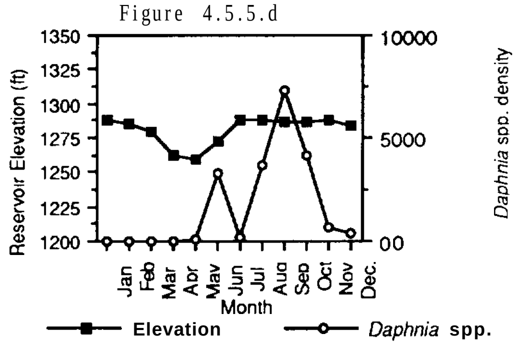

Figure 4.5.5-e

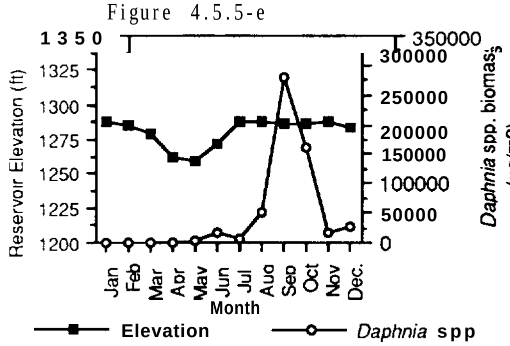

Figure 4.5.5 Mean monthly reservoir elevation (ft) **-vs-** microcrustacean density **(#/m3),** Copepoda dently, Cladocera density, ***Daphnia*** spp. density, and ***Daphnia* spp.** biomass **(µg/m3)** at Seven Bays (location 6) in 1990.

Figure 4.5.6.a

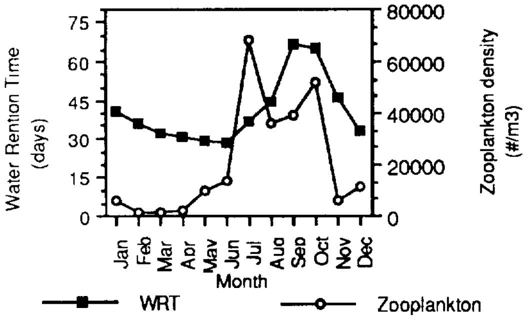

Figure 4.5.6.b

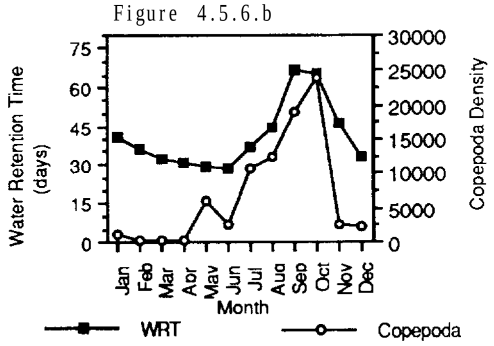

Figure **4.5.6.c**

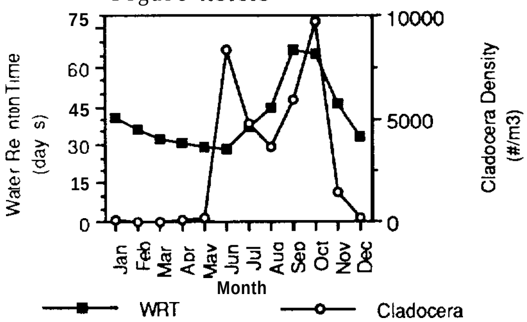

Figure 4.5.6.d

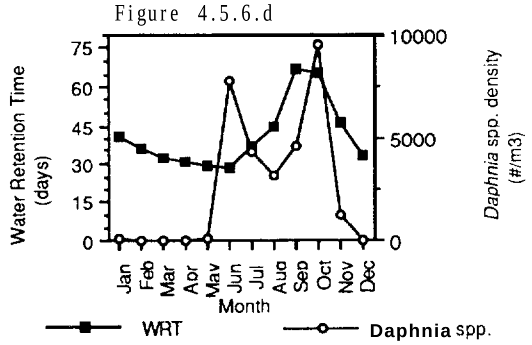

Figure 4.5.6.e

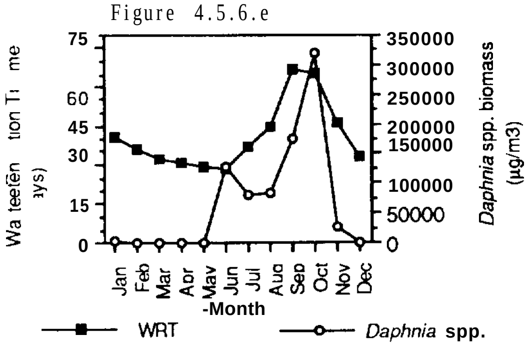

Figure 4.5.6 Mean monthly water retention time (days) **-vs-** microcrustacean density **(#/m3),** Copepoda density, Cladocera density, ***Daphnia*** spp. density, and ***Daphnia*** spp. biomass at Porcupine Bay (location 4) in 1990.

Figure **4.5.7.a**

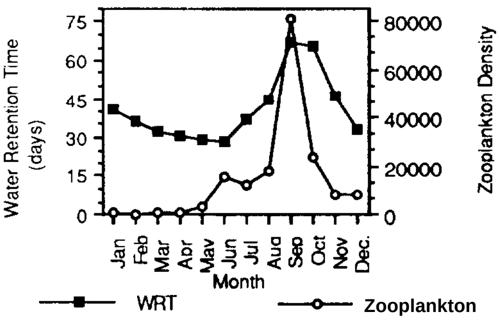

Figure 4.5.7. **b**

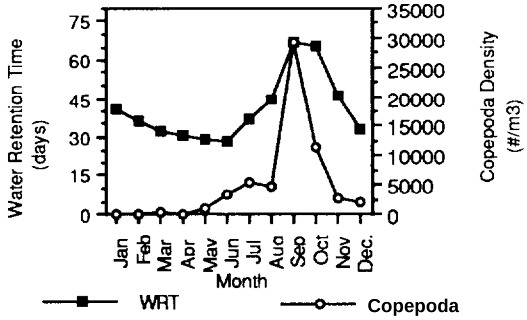

Figure **4.5.7.c**

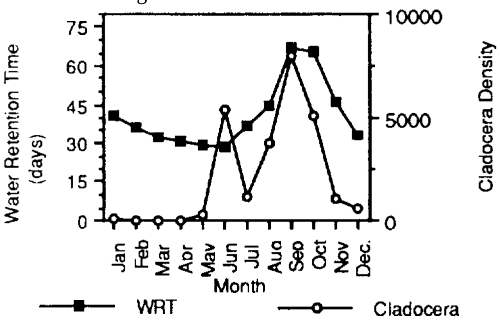

Figure 4.5.7.d

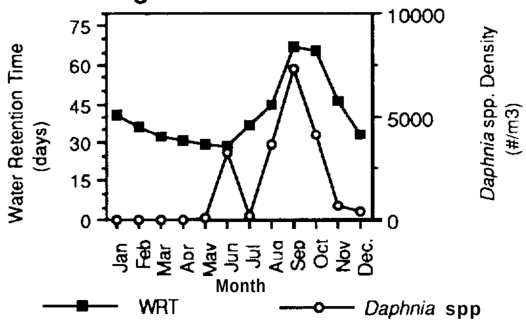

Figure 4.5.7.e

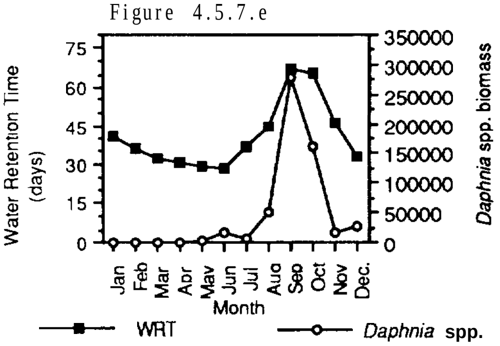

Figure 4.5.7 Mean monthly water retention time (days) **-vs- microcrustacean** density **(#/m3),** Copepoda density, Cladocera density, ***Daphnia*** spp. density, and ***Daphnia*** spp. biomass at Seven Bays (location 6) in 1990.

Table 4.5.6 Reservior elevation, water retention time, Copepoda and Cladocera density, and *Daphnia* spp. biomass collected at monthly intervals at Porcupine Bay.

Porcupine Bay							
Month	Reservoir Elevation	Water Retention Time	Cladocera density (#/m^3)	Copepoda density (#/m^3)	Total density (#/m^3)	*Daphnia* spp. density (#/m^3)	*Daphnia* spp. biomass (µg/m^3)
January	1287.7	41.1	116	1,255	1,371	80	3,294
February	1285.5	36.0	15	369	384	2	25
March	1279.2	32.2	7	219	226	1	5
April	1262.5	31.1	72	329	401	7	18
May	1259.7	29.0	238	6,004	6,242	77	879
June	1272.0	28.1	8,398	2,727	11,125	7,802	12,308
July	1287.5	36.8	4,800	10,657	15,457	4,303	81,246
August	1288.6	44.6	3,624	12,265	15,889	3,214	84,536
September	1286.5	66.7	5,991	19,041	25,032	4,657	173,463
October	1287.[illegible]	65.7	9,756	23,980	33,736	9,564	318,804
November	1288.1	45.9	1,424	2,655	4,079	1,283	26,654
December	1283.7	32.7	240	2,283	2,523	25	398

Table 4.5.7 Reservior elevation, water retention time, Copepoda and Cladocera density, and *Daphnia* spp. biomass collected at monthly intervals at Seven Bays.

Seven Bays							
Month	Reservoir Elevation	Water Retention Time	Cladocera density (#/m^3)	Copepoda density (#/m^3)	Total density (#/m^3)	*Daphnia* spp. density (#/m^3)	*Daphnia* spp. biomass (µg/m^3)
January	1287.7	41.1	61	140	201	42	112
February	1285.5	36.0	4	91	95	1	3
March	1279.2	32.2	8	259	267	0	0
April	1262.5	31.1	17	67	84	1	2
May	1259.7	29.0	292	884	1,176	138	2,640
June	1272.0	28.1	5,383	3,302	8,685	3,233	17,550
July	1287.5	36.8	1,183	5,468	6,651	220	8,318
August	1288.6	44.6	3,762	4,872	8,634	3,687	51,438
September	1286.5	66.7	8,022	29,344	37,366	7,307	280,966
October	1287.3	65.7	5,076	11,408	16,484	4,150	160,310
November	1288.1	45.9	1,063	2,769	3,832	700	16,211
December	1283.7	32.7	534	2,099	2,633	398	26,529

Table 4.5.8 Comparisons between 1989 and 1990 total microcrustacean zooplankton density (including nauplii), *Daphnia* spp. biomass values, and water retention time.

Location	1989 Totals	1990 Totals	Percent Difference
Porcupine Bay Density	85,571/m^3	28,307/m^3	67%
Seven Bays Density	99,016/m^3	21,848/m^3	78%
(Mean of April to September)			
Porcupine Biomass	237,829 µg/m^3	78,075 µg/m^3	67%
Seven Bays Biomass	128,291 µg/m^3	60,152 µg/m^3	53%
(Mean of April to September)			
Water Retention Time	50 days	41 days	18%
(Mean of April to September)			
Reservoir Density	54,257/m^3	17,016/m^3	69%
(Mean of May, August, and October)			
Reservoir Biomass	128,596 µg/m^3	90,662 µg/m^3	30%
(Mean of May, August, and October)			
Water Retention Time	51 days	46 days	10%
(Mean of May, August, and October)			

decrease at Porcupine Bay, and a 53% decrease at Seven Bays between 1989 and 1990. The mean water retention time for May, August, and October, the main sampling months, **was 5**1 days in 1989 and 46 days in 1990. This represented a 10% decrease in water retention time between the two years. Mean Daphnia spp. biomass collected at nine index stations experienced a 30% decrease between 1989 and 1990. Collectively, these data suggest that water retention times of 30 days in the spring and early summer is not only important in establishing the timing of the increases in zooplankton standing crops but may be critical in determining the density and biomass values that are found later in the year.

4.6 FISH FEEDING HABITS

4.6.1 Principle Prey Items in Fish Diets

Based on relative importance index values greater than 10%, kokanee were primarily planktivorous in 1990 (Figure 4.6.1). Age 0+ kokanee diet consisted of 53% *L. kindti* at and 47% D. *schødleri*. Age 1+ kokanee diet consisted of 32% Cyclopoidae and 28% Chironomidae. Age 2+ and 3+ kokanee diet consisted of 66% and 68% *D. schødleri* respectively. With all age classes combined, kokanee diet was comprised of 49% *D. schødleri* (Figure 4.6.4). A heavy reliance upon zooplankton throughout its entire life may be the reason kokanee from Lake Roosevelt exhibit such tremendous growth compared to kokanee from other areas (See section 4.4.1).

Kokanee size selectivity preyed on Daphnia spp. as evidenced by positive electivities (+0.03 to +0.17) for Daphnia spp. ranging from 1.60 to 2.79 mm. Kokanee avoided or could not discern Daphnia spp. ranging in size from 0.40 to 1.59 mm and from 2.80 to 3.39 mm, as evidenced by -0.01 to -0.17 electivity indices.

The degree of size selective predation on Daphnia spp. by kokanee in Lake Roosevelt was not particularly intensive in either 1989 (+0.35) or 1990 (+0.17). However, electivity indices should be monitored to a greater degree as hatchery kokanee are added to the reservoir to determine incremental impacts on microcrustacean zooplankton population dynamics.

In 1990, rainbow primarily were omniverous feeding mainly upon zooplankton, chironomids, and terrestrials as evidenced by relative importance index values greater than 10% (Figure 4.6.2).

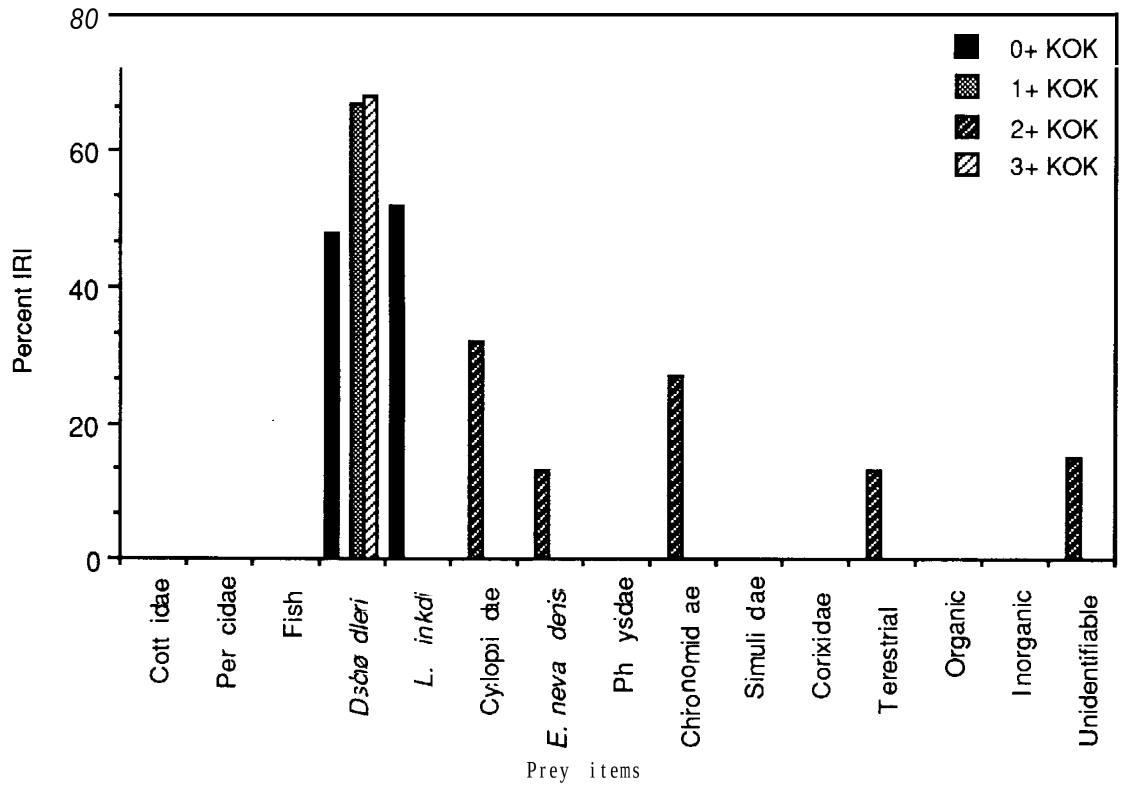

Figure 4.6.1 **Index of relative importance values greater than 10% for prey items consumed by various age classes of kokanee in Lake Roosevlet in 1990.**

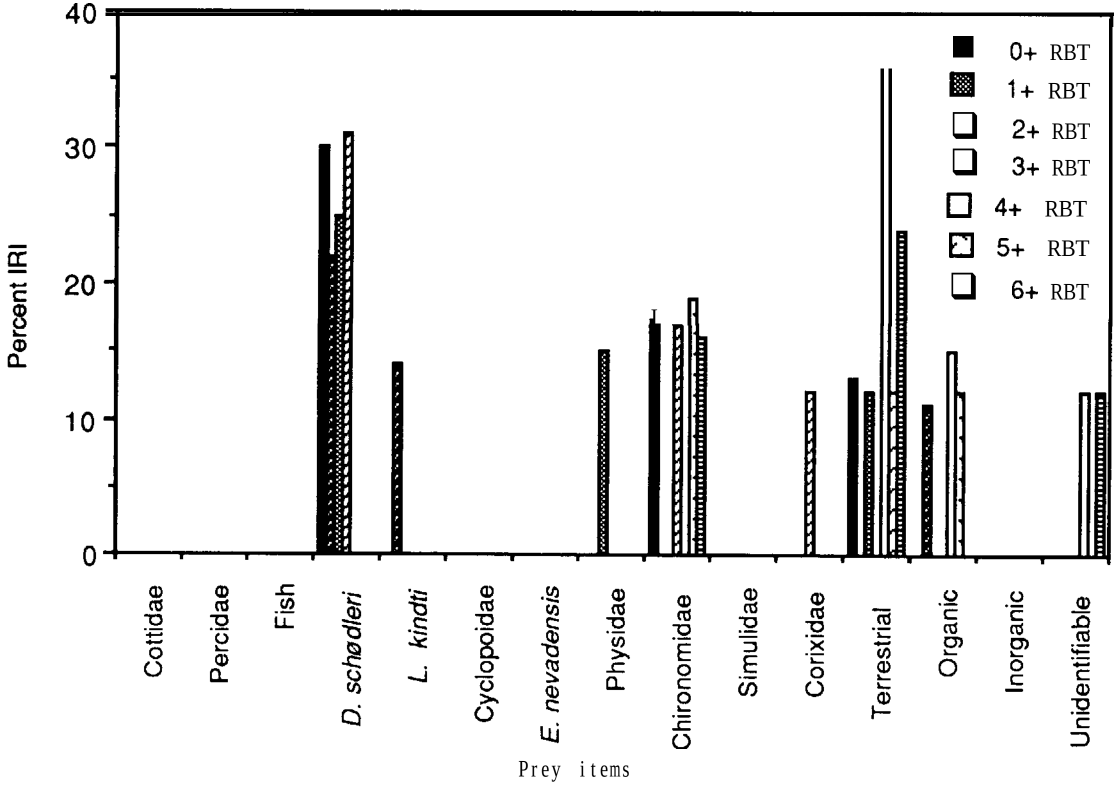

Figure 4.6.2 **Index of relative importance values greater than 10% for prey items consumed by various age classes of rainbow in Lake Roosevlet in 1990.**

Age 0+ rainbow diet consisted of 30% D. schodleri, 25% Chironomidae, and 12% terrestrials. Age 1+ rainbow diet consisted of 22% *D. schødleri*, 14% *L. kindti* and Chironomidae, and 11% organic detritus. Age 2+ rainbow diet consisted primarily of 25% D. *schødleri*, 15% Physidae, 13% terrestrials, and 12% Chironomidae. Age 3+ rainbow diet consisted primarily of 31% D. *schødleri*, 17% Chironomidae, and 12% Corixidae. Age 4+ rainbow diet consisted primarily of 36% terrestrials, 16% organic detritus, and 13% unidentifiable items. Age 5+ rainbow diet consisted primarily of 33% organic detritus, 23% unidentifiable items, 19% Chironomidae, and 13% inorganic detritus. Age 6+ rainbow diet primarily consisted of 24% terrestrial insects, 19% Chironomidae, and 12% unidentifiable items. With all age classes combined, rainbow diets were comprised of 18% D. *schødleri*, 14% Chironomidae, and 11% terrestrials and organic detritus (Figure 4.6.4). The data seems to suggest a change over in diet at age 4+ when D. schodleri no longer represent the highest IRI value. This change over in diet could be the reason that rainbow growth increments begin to decrease at age 4+ and the rainbow begin to match the growth of rainbow from other areas (See section 4.4.2).

Overall, rainbow stomachs had an IRI value of 18% for D. *schødleri* in 1990, an increase from the 1989 value of 3.3%. However size selective predation was minimal ranging from +0.01 to +0.18 for Daphnia spp. ranging from 1.6 to 3.09 mm in length. These values were less than the 1989 values (+0.18 -vs- 0.43) for the same size range. Negative electivity values ranged from -0.02 to -0.23 for sizes 0.4 to 1.59 mm.

While kokanee and rainbow preyed upon the same size organism, electivity indices of +0.17 and +0.18 suggest that size selective predation by the two fish species was not intense.

Walleye were predominantly piscivorous in their feeding habits as determined by index of relative importance values greater than 10% (Figure 4.6.3). Age 0+ walleye diet consisted of 29% unidentifiable fish, 21% D. *schødleri*, and 17% Cottidae. Age 1+ walleye diet consisted of 27% *L. kindti*, 20% Cottidae, and 12% unidentifiable prey items. Age 2+ walleye diet consisted of 26% Percidae, 17% Cottidae, and 14% unidentifiable fish and Chironomidae. Age 3+ walleye diet consisted primarily of 36% Cottidae, 25% unidentifiable fish, and 12% Percidae. Age 4+ walleye diet consisted primarily of 28% Percidae, 16% Chironomidae, 13%

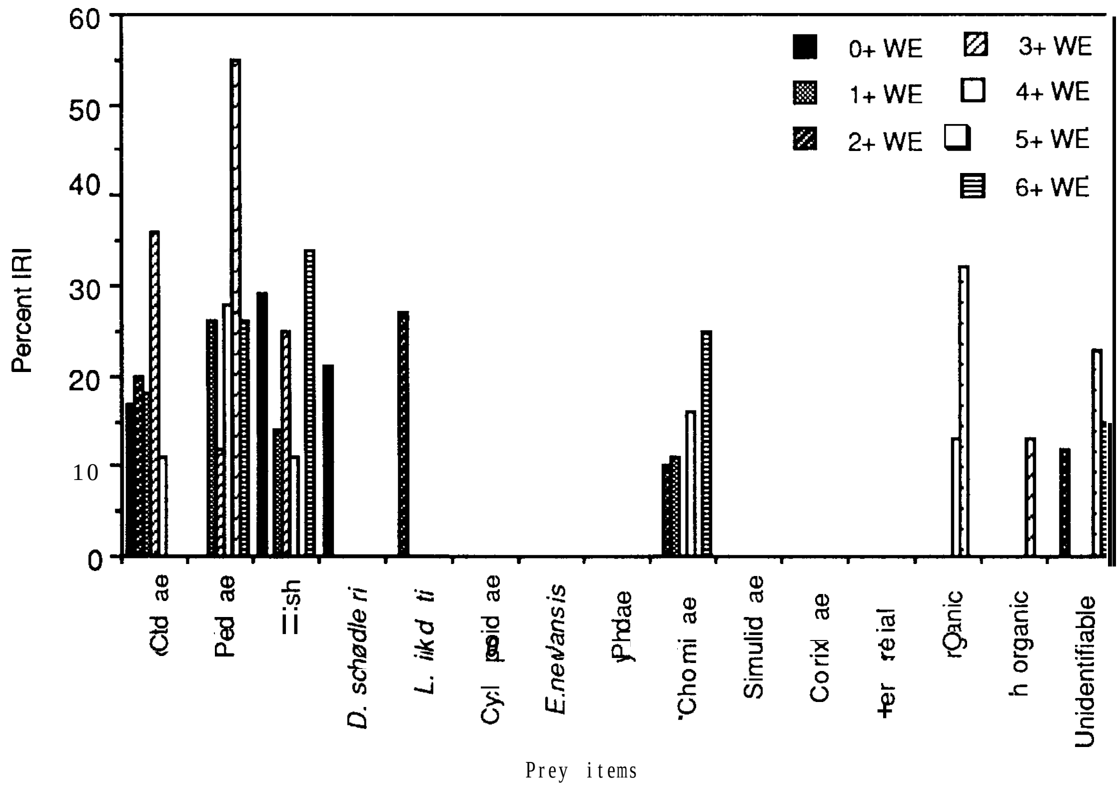

Figure 4.6.3 **Index of relative importance values greater than 10% for prey items consumed by various age classes of walleye in Lake Roosevlet in 1990.**

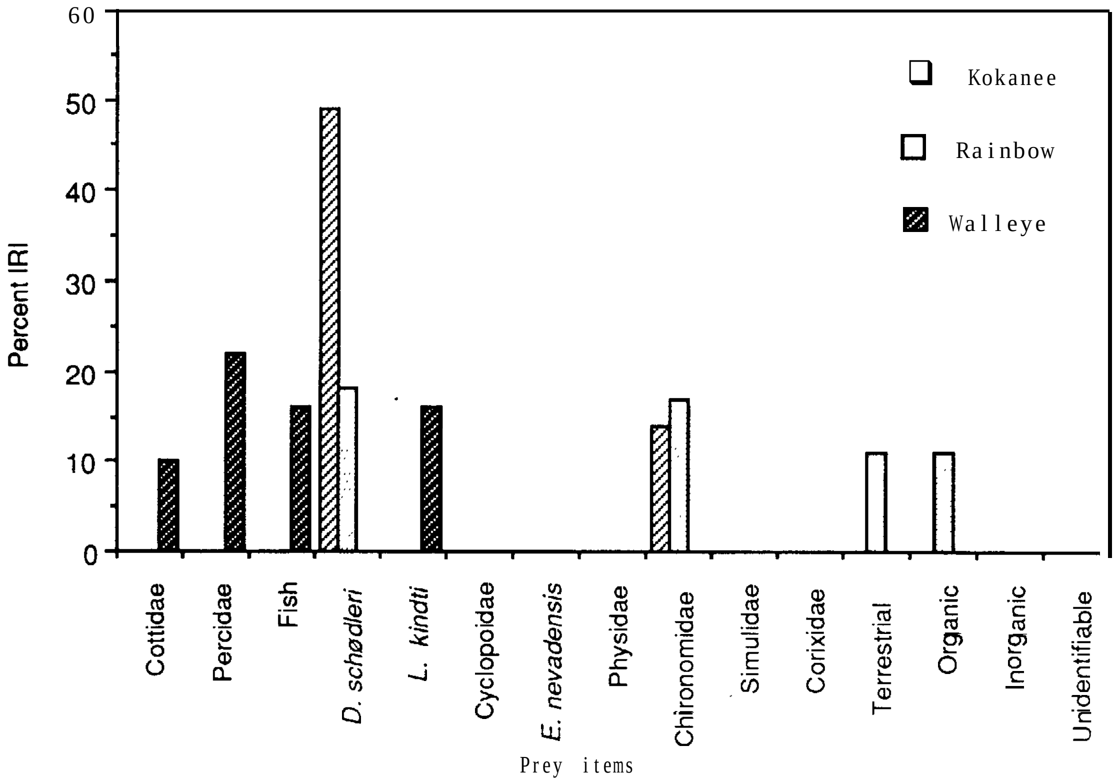

Figure 4.6.4 **Index of relative importance values greater than 10% for prey items consumed by kokanee, rainbow, and walleye of various age classes in Lake Roosevlet in 1990.**

Organic detritus, and 11% Cottidae and unidentifiable fish. Age 5+ walleye diet consisted primarily of 55% Percidae, and 12% terrestrial and organic detritus each. Age 6+ walleye diet consisted primarily of 34% unidentifiable fish, 26% Percidae, 25% Chironomidae, and 15% unidentifiable items. With all age classes combined, the average walleye diet was comprised of 23% Percidae, 16% L. *kindti* and unidentifiable fish, and 10% Cottidae.

4.6.2 Diet Overlap and Potential for Competitive Interactions

A high diet overlap of 0.65 between all age classes of kokanee and rainbow was found in 1990. Diet overlaps were broken down to determine at what age class the highest competition occurs. Values ranged from 0.30 for 1+ to 0.72 for 3+ fish. These values were further broken down into seasonal age overlaps to determine if there was differential competition within the year. Highest overlap was 0.72 and occurred in the spring between 3+ fish. The highest summer overlap was 0.61 and occurred between 0+ fish. A diet overlap of 0.17 was found for the fall and indicated that little competition existed. This data indicates that adult fish are competing for food resources in the spring when zooplankton levels are decreased, and young of the year fish are competing in the summer. Because rainbow utilize other food resources between age 3+ and 4+ the competition between kokanee and rainbow at age 3+ might not be much cause for alarm (see section 4.61.). However, the competition between age 0+ fish might become detrimental if young hatchery kokanee are released into the reservoir in the summer when competition is already high. Some possible solutions to this potential problem might be to identify if competition involves size selective predation and monitor zooplankton levels in early summer and release kokanee as zooplankton levels increase.

Diet overlaps between kokanee and walleye were minor in 1990 at 0.32. When broken down into competition between age classes the highest competition (0.35) occurred between 0+ fish and was considered to be low.

Diet overlaps between rainbow and walleye were minor in 1990 at 0.47. Competition between age classes of these fish was highest between 1+ (0.56) and 0+ (0.54) fish.

The overlaps between the young age classes of kokanee, rainbow and walleye were due to a common dependence of zooplankton in the diet of the young fish. However due to the generally low degree of competition that existed between the fish, the low electivity indices exhibited, and the high populations of large sized zooplankton, the competition is not of direct concern at this time.

4.7 TAGGING STUDIES

4.7.1 **Net Pen Rainbow Trout**

Tagging effort in 1990 was aimed at determining the best spring release time for net-pen reared rainbow trout to minimize fish loss over Grand Coulee Dam. Recovery data showed a steady decrease in numbers of fish recovered below Grand Coulee Dam at release times later in the year (Table 4.7.1). Fifty percent of the recoveries for fish released in March of 1990 were recovered below Grand Coulee Dam at the McNary Fish Passage Facility. Thirty-one percent of the recoveries for fish released in April were recovered below Grand Coulee Dam, and 25% of the recoveries for fish released in May were recovered below Grand Coulee Dam. In 1990, the percent of fish recaptured below Grand Coulee Dam from a particular release location and month was greater than in 1988 and 1989 (Table 4.7.2). Reservoir water retention times were very different in 1988, 1989 and 1990 (section 3.1 and 4.1). The constant lowering of Lake Roosevelt combined with a steady decrease of water retention time could have been a combination that was unsuitable for the early release of net-pen rainbow when compared to previous years releases. The overall higher percentage may be attributed to the much shorter water retention time observed through the early summer of 1990 as compared to 1988 and 1989. The mean water retention time from April to September in 1988 was 51 days, 50 days in 1989, and 41 days in 1990.

Using the figures calculated for percentage lost over Grand Coulee Dam and release times of net-pen fish in Roosevelt net-pen fish loss can be estimated for 1990. Kettle Falls net-pens containing 66,000 fish were released in April at a 31% loss of fish. This results in an estimated loss of 20,460 fish through Grand Coulee Dam. Hunters, Seven Bays, and Keller Ferry net-pens were released in May at 23% fish loss. Hunters and Seven Bays each contained an estimated 60,200 fish lost 13,846 fish each over Grand

Table 4.7.1 Effect of release time on net-pen rainbow trout recaptures in 1990.

Release Month	Number Tagged	Percent Recovered	% Recovered ± 20 km of net-pen	% Recovered within FDR	% Recovered below Grand Coulee
March	1,489	0.4%		50%	50%
April	1,496	2.1%		69%	31%
May	1,387	2.8%	5%	72%	23%
Total	4,372	1.7%	3%	69%	28%

Table 4.7.2 Comparisons of net-pen release times and recapture location between 1988, 1989, and 1990.

Release Location	Release Time	Water Retention Time (days)	Percent Recapture ± 20 km of net-pen	Percent Recapture below Grand Coulee
Hunters	March 89	35	27%	33%
	March 90	32	0%	66%
Seven Bays	April 89	33	38%	26%
	April 90	31	15%	38%
Seven Bays	May 88	40	57%	2%
	May 90	29	4%	23%

Coulee, and Keller Ferry which contained an estimated 20,000 fish lost 4,600 fish over Grand Coulee. These figures indicated that a total of about 52,752 rainbow were lost over Grand Coulee Dam, compared to an estimate 18,370 based on fish recovered at McNary Fish Passage Facility (see section 4.3.3). It is possible that a large number of the fish stopped migrating at other reservoirs. For example, One hundred percent of the fish recovered below Grand Coulee Dam from March releases were recovered at McNary Dam. Thirty of the fish recovered below Grand Coulee from April releases were recovered at McNary Dam and 70% in Rufus Woods Reservoir. Eighteen percent of the fish recovered below Grand Coulee Dam from May releases were recovered at Rock Island Dam, and 82% were recovered in Rufus Woods Reservoir.

Information from individual releases is presented in Table 4.7.3 for purposes of determining the most suitable release time and site for kokanee and rainbow in Lake Roosevelt. In terms of least number of fish lost over Grand Coulee Dam while maintaining the highest recovery rate, Seven Bays release in May of 1990 was the best release site in the reservoir.

4.7.2 Walleye Migration

Results of 1990 tagging studies indicated that walleye migrated throughout the reservoir to and from spawning sites despite a decline in the number of walleye recaptured compared to previous years. This could be due to a lower number of walleye tagged on the Spokane Arm.

Approximately 50% of the fish tagged on the Spokane Arm were recovered in the vicinity of the release site, while 50% were recaptured outside the Spokane Arm which was comparable to previous studies (Table 4.7.4) (Nigro et *al.* 1983, Beckman *et* al. 1985, Peone et *al.* 1990). Fifty percent of all recaptures were within 25 km of the initial tagging site, and occurred at least 55 days after tagging except for one which was recovered 6 days after tagging. This data is comparable to activity patterns described by Hall et *al*. (1985) as summer home range and is characterized by walleye movement in an area less than 25 river km long occupied by the fish for more than 2 consecutive weeks.

Data from walleye tagged and recovered on the Sanpoil and Keller Ferry suggests that the Sanpoil may serve as home range and

Table 4.7.3 Comparisons of release times and recapture rates for rainbow trout from the same net-pen in 1990.

Kettle Falls					
Release Month	Number Tagged	Percent Recovered	% Recovered ± 20 km of net-pen	% Recovered within FDR	% Recovered below Grand Coulee
March	539	0.2%		100%	
April	498	2.8%		71%	28%

Hunters					
Release Month	Number Tagged	Percent Recovered	% Recovered ± 20 km of net-Pen	% Recovered within FDR	% Recovered below Grand Coulee
March	501	0.6%		33%	66%
April	499	1.0%		80%	20%
May	500	0.8%		75%	25%

Seven Bays					
Release Month	Number Tagged	Percent Recovered	% Recovered ± 20 km of net-pen	% Recovered within FDR	% Recovered below Grand Coulee
March	449	0.4%		50%	50%
April	499	2.6%	15%	46%	38%
May	499	3.6%	4%	73%	23%

Keller Ferry					
Release Month	Number Tagged	Percent Recovered	% Recovered ± 20 km of net-pen	% Recovered within FDR	% Recovered below Grand Coulee
May	388	3.1%	7%	69%	24%

Table 4.7.4 Distribution of 1990 walleye recaptures marked between May 1987 and May 1990.at nine index stations on Lake Roosevelt, WA.

Loc. No.	Release Location	No. Recap	Recapture Location B.C.	01	02	03	04	05	06	07	08	09 or below
B.C.	Canada											
01	Kettle	3		1				1	1			
02	Gifford	2				2						
03	Hunters	2				1					1	
04	Porcupine	12	1		1	2	2	4	1			1
05	Little Falls	3		2			1					
06	Seven Bays											
07	Keller Ferry	2									2	
08	Sanpoil	1								1		
09	Spring Canyon											

spawning grounds for the Southern reservoir. Two walleye tagged in May of 1989 and 1990 at Keller were recaptured in the Sanpoil in May of 1990 and July 1990 respectively. One fish tagged in the Sanpoil in May 1989 was recaptured at Keller in July 1990. Another walleye tagged at Gifford in October of 1989 was recaptured in the Sanpoil in April of 1990. While this data is not conclusive more tagging effort might be concentrated in that area to determine if the Sanpoil is a secondary spawning area in Lake Roosevelt.

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