LAKE ROOSEVELT FISHERIES MONITORING PROGRAM

Annual Report
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EXECUTIVE SUMMARY

The purpose of this study was to provide baseline data that can be used to evaluate the effectiveness of two kokanee salmon hatcheries that will produce 8 million kokanee salmon (*Oncorhynchus nerka*) fry (3.2 million adults) for stocking into Lake Roosevelt, the reservoir created by construction of Grand Coulee Dam. The hatcheries will also produce 500,000 rainbow trout (*Oncorhynchus mykiss*) fingerlings to support the Lake Roosevelt net pen program. At the present time, the principle sport fish in the reservoir are walleye (*Stizostedion vitreum*) and net pen rainbow trout. The project includes the following components:

(1) A year-round creel census survey to determine angler use, catch rates and composition, growth rates of fish and economic value of the fishery. Comparisons will be made before and after hatcheries are on line, to determine hatchery effectiveness;

(2) Assessment of kokanee, rainbow trout and walleye feeding habits, and densities of their preferred prey, at different locations in the reservoir; and how reservoir operations affect population dynamics of prey organisms. This information will be useful for planning long-term hatchery and net pen operations, including stocking levels, time when kokanee and rainbow are stocked, and locations of stocking; and

(3) A mark-recapture study designed to assess the effectiveness of the time and location where hatchery-raised kokanee and rainbow trout are released in terms of minimizing loss over Grand Coulee Dam, increased harvest to anglers, and homing to egg collection sites.

The first years study objectives were to determine:

(1) Angling pressure, catch-per-unit effort, total harvest and 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 gill net and electrofishing surveys at nine index stations, six on the Columbia mainstem, two on the Spokane Arm and one on the San Poil Arm:

(3) Feeding habits of rainbow trout, kokanee and walleye;

(4) Growth rates of rainbow trout, kokanee and walleye;

(5) Densities, biomass, and sizes of different categories of zooplankton and how reservoir operations affect zooplankton population dynamics, and;

(6) Migration patterns of net-pen raised rainbow trout and walleye.

From August to December 1988, total harvest (± 95% confidence intervals) was estimated at 125,891 ± 74,629 fish, comprised of 86,107 ± 31,940 rainbow trout, 9,362 ± 3,873 kokanee, 23,005 ± 8,731 walleye 1,210 ± 312 yellow perch, and 6,207 ± 2,773 smallmouth bass.

From January to December 1989, the annual total harvest (± 95% confidence intervals) was estimated at 164,227 ± 63,035 fish, comprised of 65,515 ± 25,373 rainbow trout, 11,906 ± 3,597 kokanee, 248 ± 54 chinook salmon, 83 ± 18 lake whitefish, 80,626 ± 33,513 walleye, 3,600 ± 1,631 yellow perch, 8 ± 3 largemouth bass, 1,538 ± 578 smallmouth bass, 691 ± 323 black crappie, and 12 ± 5 burbot.

In 1988, the mean lengths of fish harvested were: rainbow trout (391 mm), kokanee (432 mm), walleye (436 mm), yellow perch (222 mm), and smallmouth bass (309 mm). In 1988, mean weights of fish harvested were: rainbow (767 g), kokanee (739 g), walleye (508 g), yellow perch (154 g), and smallmouth bass (489 g).

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

Angling pressure was estimated at 261,913 angler hours from August through December 1988 and 756,397 angler hours from January through December 1989.

The number of angler trips was estimated at 70,308 from August to December 1988 and 173,871 from January to December 1989. Economic value of the Lake Roosevelt sport fishery was calculated at $2,031,901 from August to December 1988 and $5,198,271 from January to December 1989, based on a figure of $28.90 spent per angler trip. The $28.90 figure was based on statistics compiled in a national survey conducted by the U.S. Fish and Wildlife Service in 1985, which estimated that anglers in inland waters of Washington State spent an average of $26.00/angler trip in 1985. The 1985 figure was adjusted for inflation through 1988 using the regional consumer price index.

From August 1988 to December 1989, 10,894 fish (26 species) were collected during gill net and electrofishing surveys. Total number (and relative abundance) of each species captured in descending order of relative abundance was:

Yellow perch	*(Perca flavescens)*	3,947	(36.2)
Walleye	*(Stizostedion vitreum)*	2,017	(18.5)
Largescale sucker	*(Catostomus macrocheilus)*	1,309	(12.0)
Sucker fry	*(Catostomus spp.)*	724	(6.6)
Rainbow trout	*(Oncorhynchus mykiss)*	714	(6.6)
Squawfish	*(Ptychocheilus oregonensis)*	449	(4.1)
Kokanee salmon	*(Oncorhynchus nerka)*	310	(2.8)
Lake whitefish	*(Coregonus clupeaformis)*	296	(2.7)
Smallmouth bass	*(Micropterus dolomieu)*	205	(1.9)
Piute sculpin	*(Cottus beldingi)*	190	(1.7)
Carp	*(Cyprinus carpio)*	160	(1.5)
Bridgelip sucker	*(Catostomus columbianus!*	146	(1.4)
Black crappie	*(Pomoxis nigromacula tus)*	116	(1.1)
Brown trout	*(Salmo trutta)*	49	(0.5)
Largemouth bass	*(Micropterus salmoides)*	96	(0.9)
Peamouth	*(Mylocheilus caurinus)*	46	(0.4)
Burbot	*(Lota lota)*	36	(0.2)
Longnose sucker	*(Catostomus catostomus)*	26	(0.2)
Mountain whitefish	*(Prosopium williamsoni)*	16	(0.1)
Chinook salmon	*(Oncorhynchus tshawytscha)*	12	(0.1)
Pumpkinseed	*(Lepomis gibbosus)*	9	(0.1)
Yellow bullhead	*(Ictalurus na talis)*	7	(0.1)
Tench	*(Tinca tinca)*	5	(>0.1)
Brook trout	*(Salvelinus fontinalis)*	4	(>0.1)
Chiselmouth	*(Acrocheilus alutaceus)*	2	(>0.1)
Cutthroat trout	*(Oncorhynchus clarki)*	1	(>0.1)
Bull trout	*(Salvelinus confluentus)*	1	(>0.1)

Kokanee comprised only 2.8 percent (310 fish) in relative abundance surveys. In creel surveys conducted in 1988 (August to December) and 1989 (January to December). total kokanee harvest was estimated at 9,362 ± 3,873 and 11.906 ± 3,597 fish. respectively. In summary, both fisheries survey and creel survey data indicated that kokanee were not abundant in Lake Roosevelt during the baseline period before the Lake Roosevelt kokanee hatcheries come on line.

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, the average length and weight of adult trout in Lake Roosevelt were: age 1+ (325 mm, 464 g), age 2+ (447 mm, 1,038 g), age 3+ (473 mm, 1,096 g), and age 4+ (508 mm, 1,096 g). In 1989, the average length and weight of adult trout in Lake Roosevelt were: age 1+ (256 mm, 218 g), age 2+ (394 mm, 572 g), age 3+ (429 mm, 902 g), and age 4+ (483 mm, 1,058 g).

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.

Back-calculated growth rates of kokanee were greater than 19 other kokanee producing lakes in Washington, Idaho, Oregon, Montana and British Columbia. In 1988, the average total length and weight of adult kokanee collected during electrofishing and gill net surveys were: age 2+ (368 mm, 494 g), age 3+ (463 mm, 1,052 g), and age 4+ (525 mm, 1,576 g). In 1989, the average length and weight of adult kokanee were: age 2+ (385 mm, 590 g), age 3+ (413 mm, 813 g) and age 4+ (425 mm, 905 g).

Comparison of kokanee caught by anglers also indicated that kokanee growth in Lake Roosevelt is 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, compared to ranges of 240-395 mm from 1954 to 1988 in Lake Coeur d'Alene, ID; 235-305 mm from 1980-1981 in Spirit Lake, ID; 220-304 mm from 1965-1975 in Odell Lake, OR; 292-369 mm from 1967-1985 in Flathead Lake, MT; 237-343 mm from 1954 to 1987 in Pend Oreille Lake, ID, 231-411 mm from 1941-1985 in Loon Lake, WA and 328-411 mm from 1940-1985 in Deer Lake, WA.

Mean densities of microcrustacean zooplankton collected at nine index stations in August and October 1988 were 6,589 cladocerans/m^3, 8,929 adult copepods/m^3 and 2,920 naupli/m^3. *Daphnia spp.* accounted for 92.6% of the cladocera density at 6,108 *Daphnia*/m^3. Mean densities of microcrustacean zooplankton collected at nine index stations in May, August and October 1989 were 4,378 cladocerans/m^3, 6,540 adult copepods/m^3 and 8,595 naupli/m^3. *Daphnia spp.* accounted for 90.4% of the cladoceran density at 3,957 *Daphnia*/m^3.

Mean annual densities of microcrustacean zooplankton collected at Porcupine Bay (on the Spokane Arm) from January to December 1989 were 6,246 cladoceran/m^3, 12,214 adult copepods/m^3 and 7,590 naupli/m^3. *Daphnia spp.* accounted for 94.9% of the cladoceran density at 5,926 *Daphnia*/m^3. Mean annual densities of microcrustacean zooplankton collected at Seven Bays (on the Columbia River) from January to December 1989 were 5,381 cladocerans/m^3, 6,194 adult copepods/m^3 and 2,264 naupli/m^3. *Daphnia spp.* accounted for 96.1% of the cladoceran density at 5,171 *Daphnia*/m^3.

Lake Roosevelt zooplankton samples contained numerous large-sized species of cladocerans *(e.g., Daphnia schødleri, Leptodora kindtii)* and copepoda (e.g., *Epischura nevadensis)* that are important to the diet of planktivorous fish.

In May, August and October 1989, microcrustacean zooplankton (excluding naupli) densities were highest in the lower mainstem Columbia stations. Mean annual values were: Spring Canyon (7,914/m^3), Keller Ferry (11,527/m^3), Seven Bays (9,274/m^3), Hunters (8,608/m^3), Gifford (5,632/m^3) and Kettle Falls (2,482/m^3). Distance upstream from Grand Coulee Dam to each site was: Spring Canyon (4.8 km), Keller Ferry (24 km), Seven Bays (59 km), Hunters (102 km), Gifford (126 km) and Kettle Falls (160 km). Highest recorded mean microcrustacean densities were on the Spokane Arm stations, including Porcupine Bay (27,325/m^3) and Little Falls (12,613/m^3). Microcrustacean density was also higher on the San Poil Arm (11,527/m^3) than at mainstem stations. *Daphnia* biomass was highest in the Spokane Arm and central portion of the reservoir at Hunters and Seven Bays.

In both 1988 and 1989, zooplankton densities and biomass were reiatively high compared to other kokanee producing lakes and comparable to those previously reported for Lake Roosevelt. Beckman et *al.* (1985) calculated that, at zooplankton levels observed in 1980 and 1982, the forage base in Lake Roosevelt could support about 16 million kokanee fingerlings and 5.9 million adult kokanee (0.5 kg body weight), so results of the present study were compared to those collected in 1980 and 1982 to determine if zooplankton levels had changed significantly.

Only one station (Porcupine Bay) was directly comparable in all three years. Mean cladocera densities reported for samples collected from May through September was 1,081 in 1980, 3,578 in 1982 and 9,521 in 1989. Mean copepod density was 2,407 in 1980, 7,437 in 1982 and 15,450 in 1989. At other stations cladoceran density was slightly higher and copepod density was slightly lower in 1989 than 1980 or 1982. From these data, it appears that microcrustacean abundance in Lake Roosevelt was higher in 1989 than previous years.

Microcrustacean biomtss in Lake Roosevelt was considerably higher than reported for other local productive kokanee lakes: 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), and Spirit Lake (39.7 mg/m^3). Values were reported as growing season means. In comparison, mean *Daphnia* biomass recorded for nine index stations in Lake Roosevelt in May, August and October 1989 was 128.6 mg/m^3. Mean annual (January to December 1989) *Daphnia* biomass at Porcupine Bay (Index Station 4) was 184.8 mg/m^3. Mean annual (January to December 1989) *Daphnia* biomass at Seven Bays (index Station 6) was 153.1 mg/m^3. *Daphnia* was the prey item with the highest relative importance in Lake Roosevelt kokanee diets in both 1988 (70%) and 1989 (58.4%). Thus, the present study confirms previous investigations that zooplankton biomass in Lake Roosevelt is sufficient to support the proposed 3.2 million adult kokanee produced by the Lake Roosevelt kokanee hatcheries.

Zooplankton densities and biomass were high when water retention time in the reservoir was high, and low when water retention time was low. Water retention time of about 30-35 days appeared to be of critical importance in the timing of the establishment of microcrustacean standing crops during the summer growing season. In terms of supporting the operation of the Lake Roosevelt kokanee hatcheries, water retention times and microcrustacean densities should be monitored weekly from May to July to ensure that kokanee fry are stocked in the reservoir coinciding with peak standing crops of microcrustaceans.

Feeding habits of kokanee, rainbow trout and walleye were different. Kokanee were principally planktivorous, walleye picivorous and rainbow omnivorous, feeding on zooplankton, fish, benthic macroinvertebrates and terrestrial insects. Feeding habits were assessed by combining numerical percentages, weight percentages and frequency of occurence for particular prey items into an index of relative importance.

In 1988, the predominant prey items in the diet of kokanee, based on relative importance index values, were three species of *Daphnia* (70.0%), organic detritus (8.2%) and *Leptodora kindtii* (6.0%). In 1989, the predominant prey items of kokanee were *Daphnia schødleri* (58.4%), *L. kindtii* (6.7%) larval and pupal chironomids (11.5%) and walleye eggs (9.4%).

In 1988, the predominant prey items in the diet of rainbow trout, based on index of relative importance, were *Daphnia schødleri* (34.0%), Osteichthyes (12.1%) and *L. kindtii* (8.1%). In 1989, predominant prey in rainbow trout diets included fish eggs (34.5%), organic detritus (28.1%) and terrestrial insects (12.0%). Identifiable fish remains in trout stomachs included sculpins and cyprinids. Trout stomachs contained relatively few *Daphnia (3.3%)* in 1989.

In 1988, the predominant prey items consumed by walleye were: Osteichthyes (46.2%), *Daphnia* (12.8%) and chironomid larvae and pupae (9.1%). In 1989, prey included: Osteichthyes (56.2%) chironomid larvae and pupae (13.6%) and *Daphnia (8.45%). Daphnia* were consumed principally by younger age classes of walleye while older walleye preferred a fish diet. Types of fish eaten by walleye in 1988 included: Percidae (yellow perch 13.4%), Cottidae (sculpin 10.4%), unidentifiable fish remains (10.0%), Cyprinidae (5.4%) and Salmonidae (5.0%). Types of fish eaten by walleye in 1989 included: unidentifiable fish remains (21 .0%), Percidae (16.3%) sculpins (10.2%), and Salmonidae (6.7%). Walleye did not appear to be preying on kokanee in significant amounts, in part because they occupy benthic habitats whereas kokanee were found in pelagic habitats.

Diet overlaps between kokanee, rainbow and walleye were relatively minor. These data suggest that it may be feasible to successfully manage all three species in Lake Roosevelt. Lack of forage fish in the reservoir precludes expansion of walleye. The abundance of large zooplankton make it feasible to enhance populations of planktivorous species such as kokanee.

Results of net-pen rainbow trout tagging studies conducted at Seven Bays in 1988 indicated that most of the fish were recaptured within six months (58.1% of total recaptures) to one year (88.1% of total recaptures) of release. Angler harvest rate of tagged fish was 9.9%, including all recoveries for two years after release. The majority (57.2%) of the tagged fish recovered were recaptured within 20 km of the Seven Bays net pen site. Fewer than 1% (one fish) of the recaptured fish were recovered below Coulee Dam.

In contrast, in 1989, fish released at both Seven Bays and Hunters evidenced much lower harvest rates compared to 1988, respectively 3.0% and 1.9%, which included all recaptures made within one year of release. For comparison, if just the first year after release data are used for fish released in 1988, harvest was 8.7%. Fewer fish released in 1989 were recovered near the net-pen site (only 38.2% at Seven Bays and 27.2% at Hunters). More fish were recovered below Grand Coulee Dam (26.4% from Seven Bays and 33.3% from Hunters). Six fish from Seven Bays (21.4% of total recoveries) and five fish from Hunters (17.6% of total recoveries) were collected at the fish counting facility at Rock Island Dam between May 10 and June 6, 1989. Three fish (8.8% of total recoveries) from Seven Bays and two fish (9.5% of total recoveries) from Hunters were recovered in Rufus Woods Reservoir during the following year. These data suggest that large numbers of net-pen fish were lost over Grand Coulee Dam in 1989 but not in 1988.

Reservoir operations were markedly different in 1988 and 1989. Drawdown was prolonged and more pronounced in 1989 than in 1988. Part of the reason that drawdown occurred earlier than normal was because of extreme cold weather in February that severely taxed the energy supply of the Columbia Basin. This caused Lake Roosevelt to be lowered by about 0.5 m/day (1.5 ft/day) for a period of several weeks in February and March. At the start of this period the reservoir was already at a lower level than normal owing to three consecutive years of drought conditions. Net-pen operators were worried that rapidly declining water levels would ground their net pens, so they released their fish earlier than normal -- in March (at Hunters) and April (at Seven Bays) instead of in May or June. At Seven Bays, although fish could have been held longer, lower reservoir elevations reduced boat mooring space, so a decision was made to release the fish early to free up boat dock space.

Therefore, we recommend that net pen operators retain their fish until May or June to allow trout to become residualized and site imprinted. This should increase the percentage harvested by anglers in Lake Roosevelt. Management agencies providing fish for Lake Roosevelt net-pens should have a mutually agreeable contract with the net-pen operators that specifies a release date ranging from about May 10 to June 10.

In 1988, a total of 841 walleye were marked and eight were recaptured for a 1% recovery rate. Walleye tagged in the Spokane Arm during the spawning season on May 4, 1988 were recovered at Keller Ferry and the San Poil River in September 1988 and at Gifford in July 1989. One fish tagged at Kettle Falls on October 20, 1988 was recaptured at Grand Coulee Dam on July 5, 1989.

In 1989, a total of 1 ,158 walleye were marked and 43 were recaptured for a 3.7% recovery rate. A total of 602 walleye were marked during their spawning migration in the Spokane Arm in May 1989 and 26 of these fish were subsequently recaptured by anglers for a 4.3% recovery rate. Of the 26 Spokane Arm fish recaptured, 3 (11.5%) were recovered in Canada, 6 (23%) near Kettle Falls, 1 (3.8%) near Gifford, 1 (3.8%) near Hunters, 10 (38.5%) near the release location at Porcupine Bay in the Spokane Arm, 2 (7.6%) near Seven Bays/Hawk Creek, and 3 (115%) near Grand Coulee Dam.

Five walleye tagged at Porcupine Bay in the Spokane Arm during spawning season on May 5-6, 1989 were recovered in the vicinity of Kettle Falls, a distance of 153 km upstream in June and July 1989 (29, 34, 67, 70 and 71 days after release). Three walleye tagged at Porcupine Bay on May 5-6, 1989 were recaptured in British Columbia, two in the vicinity of Waneta Dam and one in the tailrace of Keenleyside Dam, respectively distances of 201 km and 224 km upstream, in July 1989. Four walleye marked at Porcupine Bay on May 5-6, 1989 were recovered in the vicinity of Grand Coulee Dam, a distance of 89 km downstream, in June 1989 (35, 42 and 43 days after release).

Other long distance walleye migrations recorded in 1989 included: (1) A walleye tagged at Kettle Falls on August 7, 1989 was recovered near Seven Bays on May 4, 1990; and (2) A walleye tagged in the San Poil River on May 9, 1989 was recovered in Canada on September 28, 1989. Collectively, these data indicate that walleye migrate extensively throughout Lake Roosevelt.

In 1988, 50 sets of egg skein samples were collected from female kokanee salmon to determine fecundity. Sexually mature 2+ kokanee averaged 399 mm in total length, 588 g in weight and contained a mean number of 1,303 eggs. Sexually mature 3+ kokanee averaged 472 mm in length, 1,092 g in weight and contained a mean number of 1,728 eggs. In 1989, 51 sets of egg skein samples were collected from kokanee salmon. Sexually mature 2+ kokanee averaged 348 mm in length, 419 g in weight and contained a mean number of 1,390 eggs. Sexually mature 3+ kokanee averaged 460 mm in length, 954 g in weight and contained a mean number of 1,615 eggs.

Lake Roosevelt kokanee total length and fecundity was compared to other lakes in Idaho, Washington, Oregon and Montana. Egg production in Lake Roosevelt kokanee was the highest reported for any of the lakes in the Inland Northwest. This observation is encouraging from the standpoint of collecting a sufficient number of eggs to support hatchery operations. Assuming an 83% survival rate from egg to release, 9.6 million eggs will be required to raise 8 million fry for release. Assuming 1,615 eggs/female, 5,968 females would be required to support hatchery operations. Assuming a ratio of 1 male:1 female, 11,936 individuals would be needed. If 1.5 million kokanee are stocked at the Sherman Creek imprinting facility, 11,936 individuals represent an adult return rate of 0.8% required to support hatchery operations.

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1.0 INTRODUCTION

In the Northwest Power Planning Council's 1987 Columbia River Basin Fish and Wildlife Program (NPPC 1987), the Council directed the Bonneville Power Administration (BPA) to construct two kokanee salmon *(Oncorhynchus nerka)* hatcheries as partial mitigation for the loss of anadromous salmon and steelhead incurred by construction of Grand Coulee Dam [Section 903 (g)(l)(C)]. The hatcheries will produce kokanee salmon for outplanting into Lake Roosevelt as well as rainbow trout *(Oncorhynchus mykiss)* for the Lake Roosevelt net-pen program. 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) a year-round, reservoir-wide, creel survey to determine angler use, catch rates and composition, and growth and condition of fish; 2) assessment of kokanee, rainbow, and walleye *(Stizostedion vitreum)* feeding habits and densities of their preferred prey, and; 3) a mark and recapture study designed to assess the effectiveness of different locations where hatchery-raised kokanee and net pen reared rainbow trout are released. The above measures were adopted by the Council based on a management plan, developed by the Upper Columbia United Tribes Fisheries Center, Spokane Indian Tribe, Colville Confederated Tribes, Washington Department of Wildlife, and National Park Service, that 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. The projected duration of the monitoring program is through 1995. This report contains the results of the monitoring program from August 1988 to December 1989.

1.1 MANAGEMENT HISTORY OF LAKE ROOSEVELT

Relatively little information exists on the fisheries resources of Lake Roosevelt (reviewed by Bennett and White 1977, and Scholz et *al.* 1986). Before impoundment by Grand Coulee Dam in 1939, the Columbia and Spokane Rivers, in the region now occupied by Lake Roosevelt, produced large numbers of salmon, steelhead and resident rainbow and cutthroat trout (Gangmark and Fulton 1949; Bryant and Parkhurst 1950; Fulton 1968, 1970; Fulton and Laird 1967; Scholz et *al.* 1985). Earnest *et a/.* (1966) reported that carp, introduced into the watershed during the 19th century, became abundant immediately after the river was impounded. By 1949-- eight years after Grand Coulee Dam became operational-- carp, squawfish, and other species of cyprinids were the dominant fish in the reservoir (Gangmark and Fulton 1949; Earnest et *al.* 1966).

A fisheries survey to evaluate the feasibility of developing a sport fishery in Lake Roosevelt was conducted by the Washington Department of Wildlife from December 1962 through November 1963 (Earnest et *al.* 1966). Relative abundance of rough fish was 98%. These results, combined with an unfavorable impression of the amount of food resources available for sport fish, caused the authors to conclude that, "it is *unlikely that any game fishes with which we now work will or can develop* suitable *populations to support sportfishing in Roosevelt Lake."*

However, more recent investigations conducted by the U.S. Fish and Wildlife Service from 1980-1983 (Beckman *et al.* 1985) provided a different picture. In a reservoir-wide creel survey conducted from April 15 to September 15, 1981, they estimated that 56,496 anglers fished 256,491 hours on Lake Roosevelt. Anglers harvested an estimated 126,174 fish at a catch rate of 0.49 sportfish per hour, including: 121,143 walleye, 2,568 yellow perch, 1,517 rainbow, 284 kokanee, 284 whitefish, 190 smallmouth bass and a combined total of 47 cutthroat trout, sturgeon, crappie and largemouth bass. The total amount of biomass harvested was 63,352 kg. Catch rates (number harvested per hour) of walleye in Lake Roosevelt ranged from 0.35 (in 1983) to 0.53 (in 1980), compared to 0.32 for productive Minnesota Walleye Lakes (Beckman *et al.* 1985). Beckman *et al.* (1985) also reported that the Spokane Arm was the primary spawning area for walleye in Lake Roosevelt. From these more recent studies it is apparent that the conclusions formulated by Earnest *et al.* (1966) were premature. It is clear that Lake Roosevelt is reasonably productive and can support a viable fishery. However, by 1980 the walleye fishery was beginning to decline owing to *over* harvest and relatively poor growth rate caused by lack of forage fish in the reservoir (Beckman *et al.* 1985).

Kokanee salmon were abundant in Lake Roosevelt prior to the construction of the third power house at Grand Coulee Dam, as evidenced by the capture of 24,940 kokanee by purse seine (30 sets) and 3,465 by gill net in the forebay at Grand Coulee Dam in 1966 (Snyder 1969, cited in Bennett and White 1977, and Stober *et al.* 1977). These observations indicate that ecological conditions during the early to mid-1960's were favorable for successful reproduction and survival of kokanee. Kokanee abundance declined in 1968, after the reservoir was drawn down for the construction of the third powerhouse. Stober *et al.* (1977) believed the reason kokanee declined after 1968 was because lower reservoir elevations reduced egg and fry survival.

Since completion of the third powerhouse, the magnitude and duration of reservoir level fluctuations has been altered. Analysis of the annual reservoir drawdown record from 1941 to 1976 showed a trend of increasing drawdown over time. Three periods were identified: 1941-1951, when drawdown did not exceed 30 feet; 1952-1965, when drawdown was relatively constant at 40 feet; and 1966-1976, when drawdown reached extremes of 130 and 133 feet in 1969 and 1974 respectively, but ranged from 64 to 88 feet during the remaining years (Stober et *al.* 1977).

Stober et *al.* (1977) evaluated the historical drawdown patterns of Lake Roosevelt in relation to spawning and incubation timing of kokanee and walleye, and concluded that the decline in kokanee and increase in walleye abundance during the 1960's and 1970's could be explained by the differential impact of the annual drawdown regime on the reproductive success of these two species. Because the timing of walleye spawning and incubation in Lake Roosevelt occurs primarily at low pool or during rising water levels, reservoir drawdown has less severely affected walleye reproduction. This factor was considered to be the primary reason for the survival and expansion of walleye populations in Lake Roosevelt (Stober et a/. 1977). In contrast, since kokanee spawn in late fall when water levels are high, maintenance of reservoir levels in the winter and spring are of critical importance to the normal development of eggs and the early life history stages. Currently, reservoir elevations decline earlier and to lower levels than before 1968 in order to produce more power during the winter. Eggs and alevins of kokanee have extended incubation periods in lakeshore spawning gravels, which are directly affected by this early reservoir drawdown (Stober et *al.* 1977). Thus, given current reservoir operations, any type of natural production would be nearly impossible.

Comparison of zooplankton standing crops in Lake Roosevelt to those of other good kokanee producing lakes indicated that zooplankton densities in Lake Roosevelt were greater than, or comparable to, other kokanee lakes (Jagielo 1984, Beckman et *al.* 1985). Jagielo (1984) pointed out that many people had considered Lake Roosevelt relatively unproductive for raising resident fish, yet when he quantitatively compared zooplankton standing crops in Lake Roosevelt with other local productive kokanee lakes, e.g., Lake Pend Oreille which supports a population of 16 million, 0.1 - 0.2 kg kokanee, he found that *Daphnia* were higher in density, larger in size, and higher in biomass in Lake Roosevelt. Jagielo stated, *"though* *drawdown currently limits the expansion of a reservoir spawning kokanee population in Lake Roosevelt, the abundance of crustacean zooplankton [e.g., Daphnia sp.] in the reservoir indicated a forage base comparable to other productive kokanee lakes. "* Beckman et *al.* (1985) also reported an average total benthic macroinvertebrate density of 6,198 organisms/m^2, of which 1,189 were chironomids, a favorite prey item in fish diets. Beckman et *al.* **(1985)** estimated that the forage base in Lake Roosevelt could support about **16** million fingerling and 5.9 million adult kokanee (mean wt. 0.5 kg) or 180 adults/hectare.

Nigro et *al.* (1983) determined that 27,200 m of suitable natural spawning habitat was available for kokanee in Lake Roosevelt and tributaries, and calculated that 181,000 adult fish or 5.4 fish/hectare could be produced by natural spawning if the habitat was fully utilized. Thus, the ability of naturally spawned kokanee to populate the reservoir was far less than the number that could be produced given the food availability in the reservoir. The primary (phytoplankton) and secondary (zooplankton) biological productivity of the reservoir can support 5.9 million adults, whereas the maximum number that can be produced, if all natural spawning habitat is used, is 0.18 million adults. Based on these estimates, Scholz et *al.* (1986) proposed that hatchery production would be necessary to take maximum advantage of the biological productivity of the reservoir and increase angler harvest.

Jagielo (1984) suggested that naturally spawned kokanee entering the reservoir in March to May are faced with low food availability because densities of large zooplankton, *e.g., Daphnia,* do not begin to increase in Lake Roosevelt until July. This factor may limit kokanee population due to increased competition during this critical life history stage. Beckman et *al.* (1985) concluded that zooplankton densities in Lake Roosevelt are related to water retention time. Increased discharge, combined with drafting of the reservoir during the spring drawdown, impacted nutrient levels. Beckman et *al.* (1985) reported that, *"the length of time nutrients are available in the reservoir affects the densities of [phytoplankton, which* are *grazed by zooplankton] -- longer retention times are associated with increased numbers of plankton while shorter times are associated with lower plankton densities, "* **and,** *"the threshold retention time that starts to effect zooplankton densities [in Lake Roosevelt] is about 30* days." The principle reason why zooplankton do not increase in lake Roosevelt until July is that the period from March to June coincides with spring drawdown, which is correlated with minimum water retention times -- frequently less than 30 days. Relatively cool floodwaters entering the reservoir during this period may also contribute to reduced zooplankton densities. The spring drawdown is related to flood control, a lucrative market for non-firm energy sales from power generated by Grand Coulee Dam, and the water budget. The "water budget" refers to water stored in Grand Coulee Reservoir that is released in the spring to provide flushing flows that aid in the downstream passage of salmon and steelhead smolts to the ocean (NPPC 1987).

Taking these observations into account, Scholz et al. (1986) formulated a management plan for Lake Roosevelt, centered around artificial propagation of kokanee salmon. The principle advantage of hatchery production is that it would complement power production, flood control and "water budget" functions of the reservoir, since artificially propagated kokanee could be retained in the hatchery during the period of low food abundance, then stocked into the reservoir in July to coincide with peak food resources after zooplankton levels increase. In 1987, the NPPC included the two kokanee hatcheries proposed for Lake Roosevelt in its 1987 Fish and Wildlife Program. BPA is now implementing this measure.

The principle aim of the Lake Roosevelt fisheries restoration plan is to provide a dual kokanee/walleye fishery that would attract different types of anglers and promote the regional economy (Scholz et al. 1986). In Lake Roosevelt, walleye and kokanee occupy different biological zones and feed on different prey organisms. Walleye are predominantly piscivorous whereas kokanee are planktivorous (Beckman et *al.* 1985).

Net-pen rearing of rainbow trout in Lake Roosevelt was initiated in 1985 by Mr. Winn Self, owner of Seven Bays Marina, who released 5,000 trout from one net pen that year. By 1989, five net-pen sites -- at Keller Ferry, Seven Bays, Hunters, Kettle Falls and Northport -- with a combined total of 15 net pens, at a rearing capacity of 15,000 -20,000 fish per pen, were operating in support of the Lake Roosevelt Sport fishery. Trout hatched and raised in Washington Department of Wildlife or U.S. Fish and Wildlife Service hatcheries are transferred into net-pens in October at approximately 17 to 34 g individual body weight. In the net-pens individual trout grow to 141 to 247 g in weight and 221 to 262 mm in **total length before release into Lake Roosevelt during the following May** or June (8-9 months later).

Tagging studies conducted by the Upper Columbia United Tribes Fisheries Center at the Seven Bays and Kettle Falls net-pen sites in 1986 and 1987 indicated that **angler harvest** rates for individual groups of tagged fish ranged from 12.9% to 23.3% (UCUT, unpublished data). After release in the reservoir, tag returns from anglers indicated that trout grew in length at rates ranging from 22 to 36 mm/month, so that by October (6-7 months after release) total lengths ranged from 386 to 418 mm. Individual body weights reported by anglers in October ranged from **673** to 840 g. By the following summer individual fish had attained total lengths ranging from 457 to 508 mm and weights ranging from 1,073 to 1,205 g. Most of the fish harvested by anglers were caught within 14 months after release. However, fish were occasionally caught two years after release. These fish measured 527 to 579 mm in total length and weighed 1.5 to 2.0 kg. Only three fish were caught three years after release, ranging from 608 to 657 mm in total length and 2.3 to 2.7 kg in weight.

Prompted by excellent harvest returns and growth rates of net-pen reared rainbow trout, the Spokane Indian Tribe installed two net-pen sites on the Spokane River in 1990, bringing current total net-pen rearing capacity on Lake Roosevelt to approximately 500,000 trout per year. One ongoing problem with the net pen program is that trout production levels at state and federal hatcheries is insufficient to provide 500,000 fish for Lake Roosevelt. Consequently, sufficient space was incorporated in the design of the BPA kokanee hatcheries to rear the 500,000 rainbow trout needed for the Lake Roosevelt net-pen program.

1.2 STUDY OBJECTIVES

The purpose of the monitoring program for Lake Roosevelt is to evaluate the effectiveness of two kokanee salmon *(Oncorhynchus* ***nerka*)** hatcheries, one at Galbraith Springs on the Spokane Indian Reservation, and the second at Sherman Creek near Kettle Falls, that will produce fish for stocking into Lake Roosevelt. The two hatcheries are complimentary, with the Sherman Creek hatchery being used predominantly as an egg collection and imprinting site, and the Spokane Indian hatchery used for egg incubation and rearing approximately 8 million kokanee and 500,000 rainbow trout for Lake Roosevelt and 5 million kokanee for Banks Lake. The Washington Department of Wildlife has stocked about one million kokanee per year **into** Lake Roosevelt since 1988 in an attempt to provide spawners to support hatchery operations. The Spokane Indian hatchery is scheduled for completion in January 1991. The Sherman Creek hatchery is scheduled for completion in 1991. The study objectives of this project include the following components:

(1) A year-round creel census survey to determine angler use, catch rates and composition, growth and condition of fish, and

economic value of the fishery. Comparisons will be made before and after hatcheries are on line, so that hatchery effectiveness can be determined;

(2) 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 prey organisms. This data will enable fish managers to determine the potential for inter-and-intra-specific competition, predatory impact on prey organisms, seasonal fluctuations in prey abundance, and geographical distribution of kokanee, rainbow, walleye, and their preferred prey. This information will be useful for planning long-term hatchery and net-pen operations, including stocking levels, time when kokanee and rainbow are stocked, and locations of stocking; and

(3) A mark-recapture study designed to assess the effectiveness of the time and location where hatchery-raised kokanee and net-pen reared rainbow trout are released. This study will focus on kokanee and rainbow migratory tendencies and distribution after their release, to determine release sites and time of release that minimize loss over Grand Coulee Dam and provide increased harvest to anglers, as well as homing to egg collection sites during the spawning migration.

During the initial years of the monitoring program, the principle focus was to collect baseline data that can be used for comparison after the fish hatcheries are on line. The first years study objectives were to determine:

1. Angling pressure, catch per unit effort, total harvest and 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 gill net and electrofishing surveys at nine index stations;

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

4. Growth rates of rainbow trout, kokanee and walleye;

5. Densities, biomass, and sizes of different categories of zooplankton and how reservoir operations affect zooplankton population dynamics, and;

6. Migration patterns of net-pen raised rainbow trout and walleye.

2 .O MATERIALS AND METHODS

2.1 DESCRIPTION OF STUDY AREA

Lake Roosevelt is a mainstem Columbia River impoundment formed by Grand Coulee Dam in 1941 (Fig.5 2.1, 2.2). The reservoir, located in Northeast Washington, inundates 33,490 hectares at a full pool elevation of 393 m above mean sea level. Lake Roosevelt has a maximum width of 3.4 km, and maximum depth of 122 m (Stober et *a/.* 1981). Reservoir elevations and water retention times during the study period are recorded in Fig. 2.3. To construct these graphs, daily midnight reservoir elevation (ft) and total outflow (KCFS) were obtained from daily summary reports for Grand Coulee Dam prepared each month in 1988 and 1989 by the U.S. Army Corps of Engineers, Reservoir Control Center in Portland, OR (Appendix A). Additionally a U.S. Army Corps of Engineers (1981) reservoir storage table that converts reservoir elevation (ft) to volume of water stored (KCSFD) was used to calculate water retention time, using the storage replacement method. The formula was:

Water retention time (days) = Reservoir volume (kcfsd) ÷ Outflow(kcfs)

Daily values for reservoir elevation and water retention time were added and divided by the number of days in each month to obtain average monthly reservoir elevation and water retention times. The graphs indicate a pronounced difference in reservoir operation between 1988 and 1989. In general, reservoir elevations were lower and water retention times were reduced in the winter and spring months of 1989 as compared to 1988. Summer and fall seasons were similar in each year.

2.2 CREEL SURVEY DESIGN AND PROCEDURES

To determine annual fishing pressure, catch-per-unit-effort (CPUE) and harvest of sport fish on Lake Roosevelt, a two-stage probability sampling scheme (Lambou 1961, 1966; Malvestuto 1983) was used. Random days and hours were selected to sample weekday and weekend/holiday stratums for angler pressure and catch composition. The mean (±S.D.) boat and shore angler pressure, CPUE of total captured and harvested (by species), and total number of fish captured and harvested for days sampled in each stratum were calculated and then expanded by multiplying these values by the total number of days in the sampling interval.

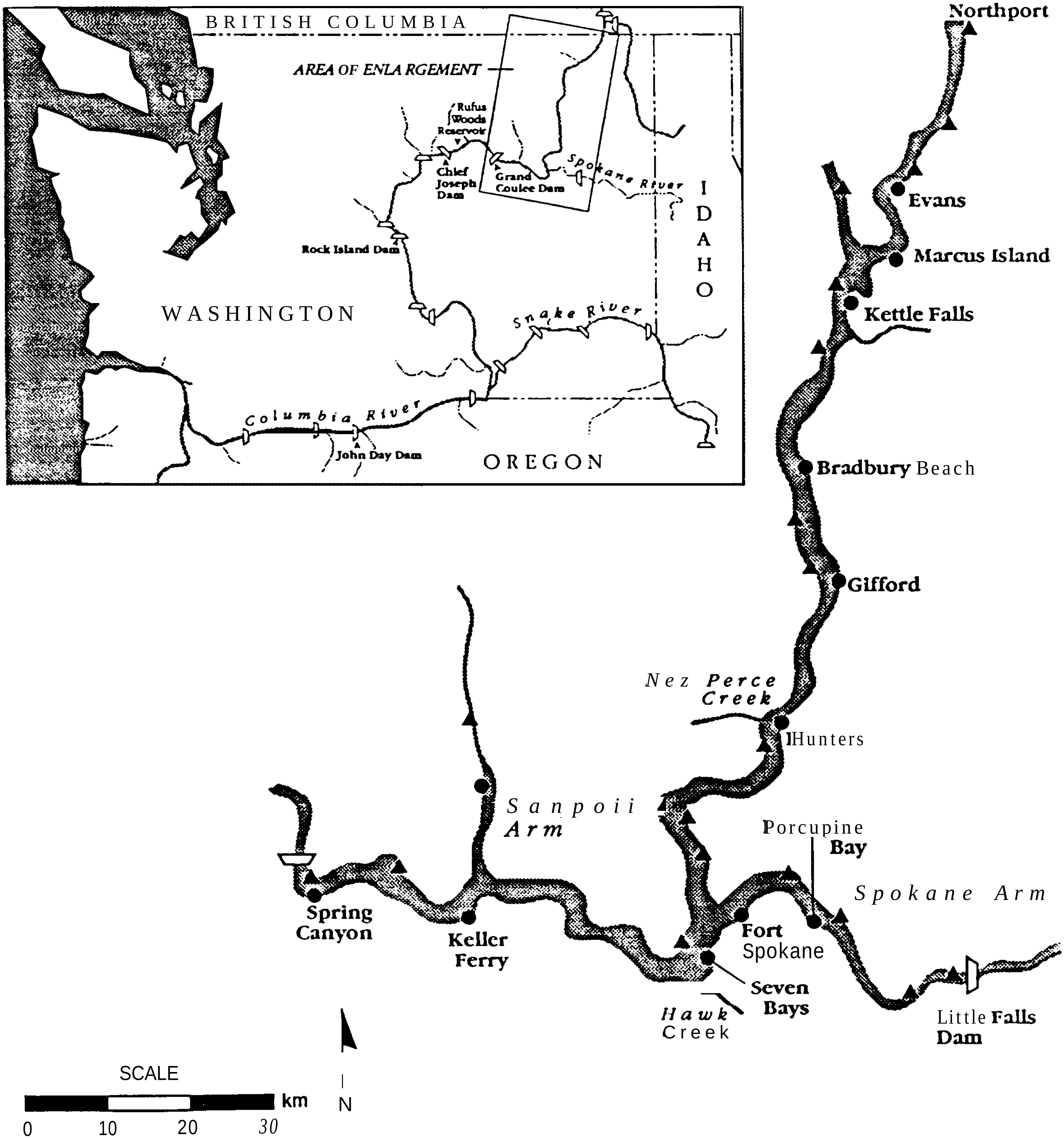


Fig. 2.1 Lake Roosevelt, (Columbia River), indicating locations of primary (●) and secondary (▲) creel locations.

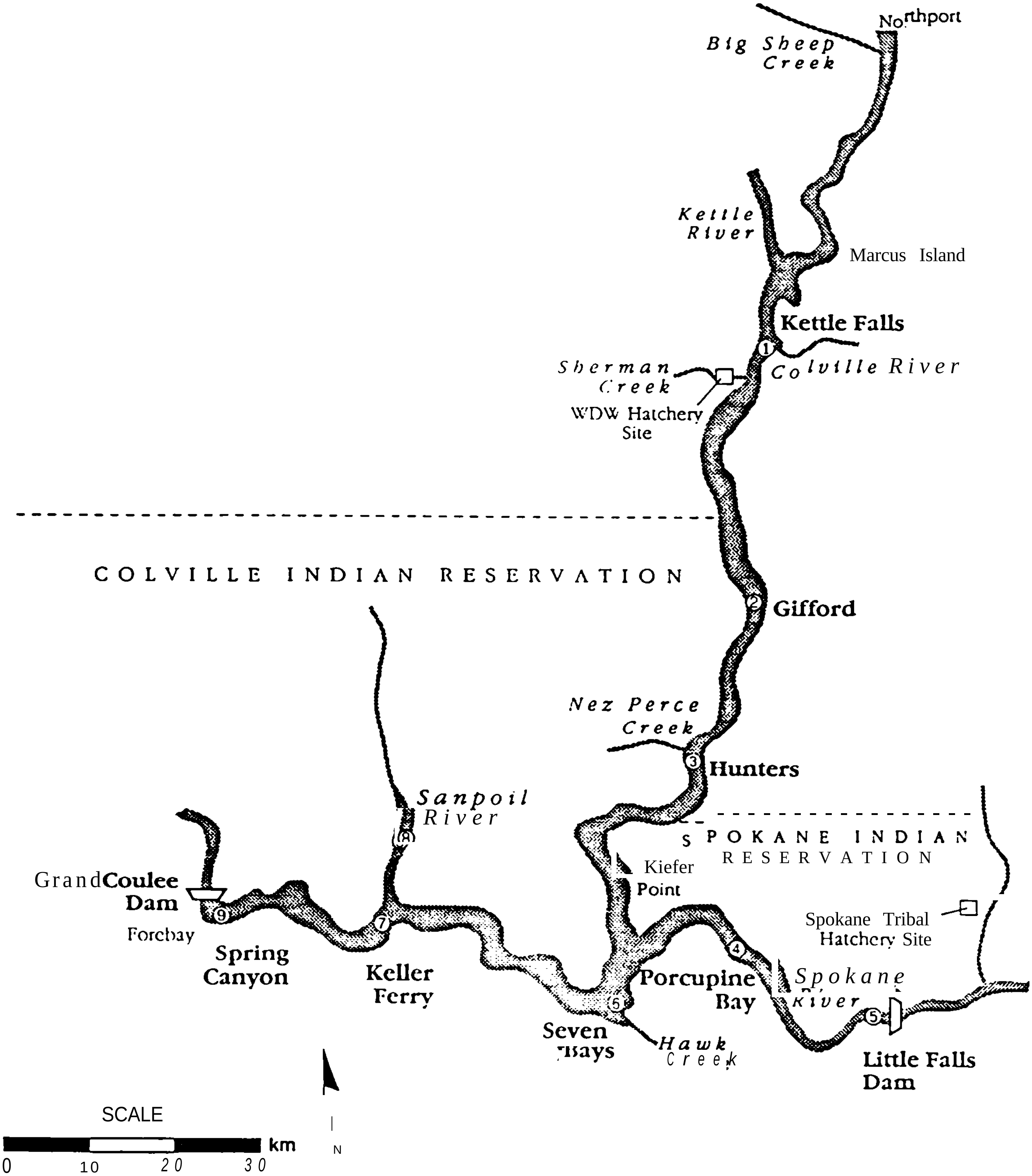


Fig. 2.2 Lake Roosevelt, (Columbia River), indicating location of nine index stations used for sampling fish and zooplankton.

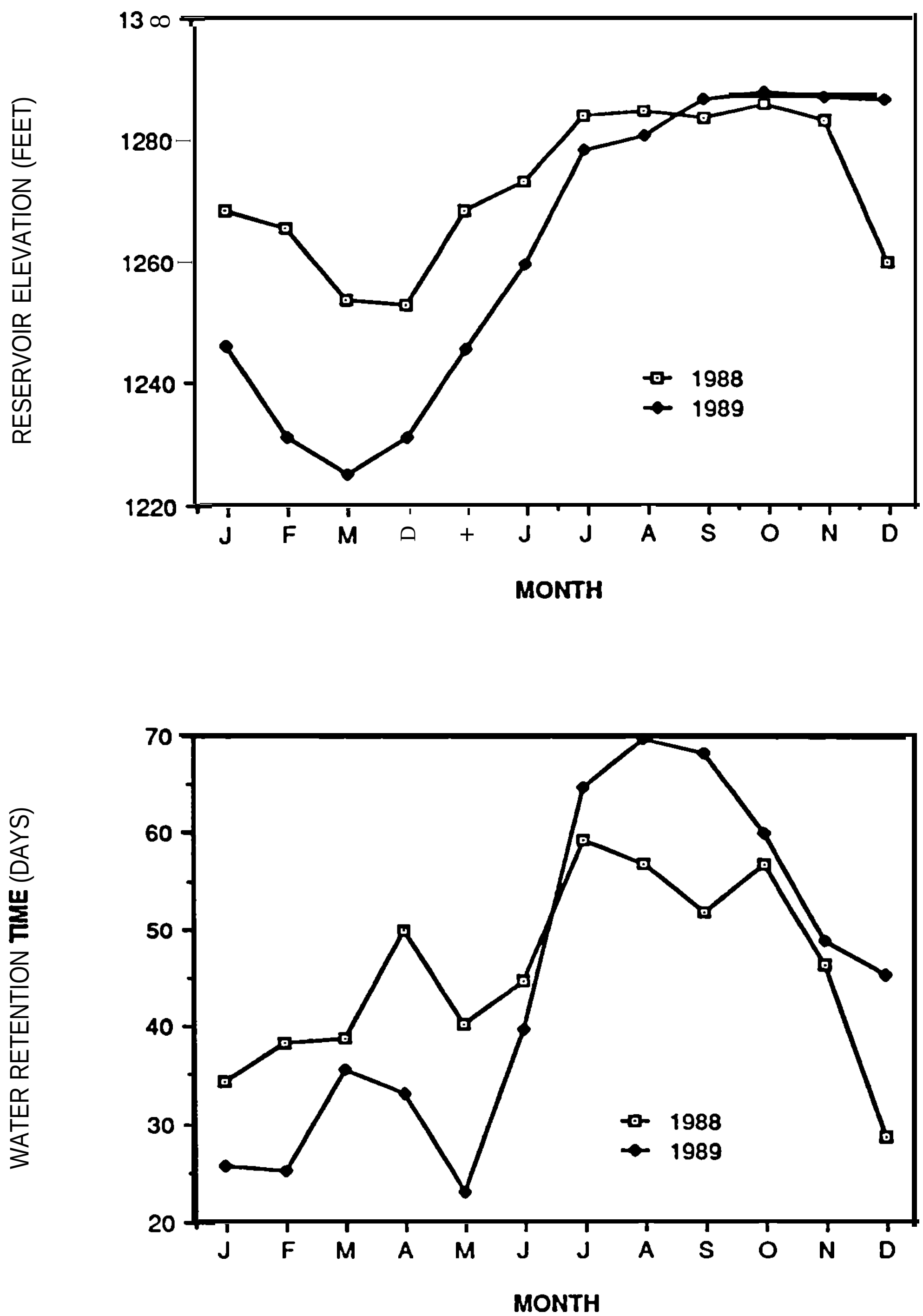


Figure 2.3. **Monthly mean water elevations (feet) and water retention time (days) for Lake Roosevelt in 1988 and 1989.**

Three creel clerks were employed to survey Lake Roosevelt year round for an average of 20 days per month. Days of each month were stratified into weekdays and weekend/holidays. Survey dates for week days or weekend/holidays were randomly selected. Days were stratified into a.m. (sunrise to 12 p.m.) and p.m. (12 p.m. to sunset) time periods. The times for sunrise to sunset for Lake Roosevelt were determined from the Nautical Almanac.

During each randomly selected a.m. and p.m. creel period, counts of number of boat trailers and shore anglers were determined. All incoming boaters were surveyed to determine: (1) the percentage of boats that were angling and (2) the number of anglers per boat. These two numbers were employed as correction factors to calculate boat angler fishing pressure, using the formula:

total number of boat anglers per stratum	=	boat trailer counts (corrected by airflight observations)	x	percentage of boats making fishing trips	x	# of anglers/boat for boats making fishing trips

Additional instantaneous pressure counts of the entire reservoir were made four times per month (weekday a.m./p.m. and weekend/holiday a.m./p.m.) using a Cessna 172 aircraft. The number of boat trailers at each boat access launch was also recorded by aircraft. This data was compared to boat trailer counts in order to develop a correction factor that accounted for boats on the lake that could not be estimated by boat trailer counts, e.g., boats moored at marinas or private docks. In this case only boats actually on the reservoir were counted.

Angler interviews on Lake Roosevelt were conducted at every National Park Service (NPS) boat access and campground site, as well as Colville and Spokane tribal boat access points and campgrounds for a total of 50 survey sites (Fig. 2.1). For each angler interviewed creel clerks identified species caught, measured length (mm), and weight (g) of each fish, and examined it for identifying marks, such as floy tags, fin clips, and unique marks, such as stubbed dorsal fins and eroded pectoral and pelvic fins, that could be used to determine if rainbow trout were of native or hatchery (net-pen) origin. Additional information was collected on hours fished, target species, zone (river mile) for captured fish. Species number and size of released fish was also recorded. Scale and stomach samples were also collected from representative rainbow trout, kokanee, and walleye examined by creel clerks.

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 a/. 1989) were used to calculate strata estimates and associated confidence intervals for angling pressure, CPUE, and harvest.

Pressure was estimated for each day type (week day or weekend/holiday) and time interval (a.m. or p.m.) for boat and shore anglers for each month by the formula:

$$PE_S = N_S X_S$$

where: PE_S = pressure estimate for stratum;
N_S = number of hours in stratum; and
X_S = mean number of anglers per hour in stratum.

The variance of the pressure estimate for each stratum was calculated by:

$$VPE_S = \frac{(N_S)}{n} S_S^2$$

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

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

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

where: C.I. = 95% confidence intervals;
PE = pressure estimate;
VPE = variance of the pressure estimate.

Annual angler pressure and 95% confidence estimates were calculated by summing the monthly pressure estimates and 95% confidence estimates for each stratum and Lake Roosevelt region.

CPUE for fish species in each stratum and survey location (boat access and campground areas) were determined from complete and incomplete angler trips. 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. CPUE was calculated independently for fish harvested (kept) and fish captured (kept or released) by dividing the number of fish species caught by the total number of hours spent fishing.

Harvest of fish species was determined monthly for each stratum and Lake Roosevelt region (i.e., northern, middle, southern and Spokane Arm). Harvest was calculated by multiplying the harvest CPUE times the pressure estimate. Monthly harvest estimates were combined to present an annual estimate for each fish species. The number of sturgeon harvested was determined independently by isolating all CPUE data for this species since sturgeon were primarily harvested at only one location, between Kettle Falls and Marcus Island.

2.2.2 Computation of Economic Value of the Lake Roosevelt Fishery

According to statistics compiled in a national survey conducted by the U.S. Fish and Wildlife Service in 1980 and 1985, a typical angler spent **$23.00/fishing** in 1980 and **$26.00/fishing** trip in 1985 inland waters of Washington State (USFWS 1989). The $26.00 figure was adjusted to account for the rate of inflation between 1985 and 1988 based on the Consumer Price Index. This value was $28.90 in 1988. This value was multiplied by the total number of angler trips in 1988 and 1989 to provide an estimate of the economic value of the fishery. The number of angler trips was determined by dividing the total number of angler hours by the average length of a completed fishing trip for each year.

2.3 FISHERIES AND ZOOPLANKTON SURVEYS

Fish and zooplankton samples were collected in August 1988, October 1988, May 1989, August 1989, and October 1989 at nine index stations in the reservoir, including: (1) Kettle Falls (Colville); (2) Gifford; (3) Hunters; (4) Porcupine Bay; (5) Little Falls Dam; (6) Seven Bays; (7) Keller Ferry; (8) San Poil, and; (9) Spring Canyon (Fig. 2.2). The Kettle Falls (Colville), Gifford, Porcupine Bay, and San Poil stations are the same used by the U.S. Fish and Wildlife Service in their 1979-1983 study of Lake Roosevelt. Approximately 24-36 hours were spent at each index station collecting fisheries data at each interval. Fisheries data was collected over a 24 hour period. Principle target species included kokanee, rainbow, and walleye. Other species of interest included lake whitefish, yellow perch, and any other species recovered. Additional zooplankton sampling was conducted at Porcupine Bay (Index Station 4), and Seven Bays (Index Stations 6) each month from August 1988 through December 1989.

2.3.1 Fisheries Surveys

Relative abundance surveys were performed in littoral areas and tributaries by making 10 minute transects along 0.5 km of shoreline using and SR 18 and SR 22 electrofishing boats (Smith Root, Inc., Vancouver, WA) according to procedures outlined by Reynolds **(1983)** and Novotany and Priegel **(1974).** Voltage was adjusted to produce a pulsating DC current of approximately 5 amperes. Fish attracted to the anodes off the bow of the electrofishing boats were collected using dip nets and put into live wells on the boat for examination and data collection.

Additional relative abundance surveys were performed in pelagic zones using bottom and surface monofilament gill nets following methodologies described by Hubert (1983). The following horizontal and vertical gill nets were used: (1) two horizontal surface set gill nets 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; (2) two horizontal bottom set gill nets 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, and; (3) one vertical gill net measuring 15.2 m in length by 30.5 m deep, with four 7.6 m long panels graded from 1.3 to 8.9 cm stretch mesh. Gill nets were set from late afternoon (4:00 p.m.) until the following morning (9:00 a.m.) and checked at sunset (about 9:00 p.m.) and 9:00 a.m. On some occasions nets were checked at 2 to 4 hour intervals to collect fresh fish for stomach samples.

Each fish captured by electrofishing and gill netting was identified using the taxonomic key of Wydoski and Whitney (1980). Total length was measured to the nearest millimeter using a metric measuring board and a scale sample was removed from target fish species for age and growth determination. Target **fish species were also weighed to the nearest** gram using either a triple beam balance or an electronic balance. Sex was determined when possible. Stomach samples were collected from representative sizes of target species. Some of the remaining target species were marked with floy tags and released.

2.3.2 Zooplankton Surveys

Duplicate zooplankton samples were collected in mid-channel at each index station in August 1988, October 1988, May 1989, August 1989, and October 1989, and at index stations 4 (Porcupine Bay) and 6 (Seven Bays) every month from August 1988 to December 1989. Water column zooplankton samples were taken by making an oblique tow either using a Clark-Bumpas quantitative sampler with a No. 20 (76 μ mesh) or a Wisconsin vertical tow plankton net (76 μ mesh) with 80 mm silk net bucket. The Clark-Bumpas was used August to October 1988 and May to December 1989, while the Wisconsin vertical tow net was used November 1988 to April 1989. Water column tows using the Clark-Bumpas were made from 33 m to the surface at a constant boat speed of about 5 knots. Vertical tows were made with the Wisconsin net from 33 m to the surface. The organisms were washed into a 253 ml bottle containing 10 ml of 37% formaldehyde. Organisms were stained with 1 .0 ml of five percent Lugol's solution and 1 .O 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), 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. A minimum of four subsamples was counted using a modified counting chamber (Ward 1955) until 100 organisms or 25 ml of sample had been counted (Edmondson and Windberg 1971; Downing and Rigler 1984). Volume of sample to be subsampled depended on the density of organisms in the sample.

The counts for each species in each subsample were recorded in Microsoft Excell on a Macintosh SE computer. Densities (# organisms/l) were calculated in the program using the following equations. First, the volume of the sample was calculated. For samples collected by the Wisconsin plankton sampler, the sample volume was calculated by the following equation:

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

where: v = volume;
r^2 = radius of sampler; and
h = depth of sample.
π = pi (3.414)

The volume of the sample collected by the Clark-Bumpas sampler was determined in a different manner. The Clark-Bumpas sampler was field calibrated as described by Clark and Bumpas (1940). A theoretical volume of 56 liters per unit count was determined. The formula for calculating the theoretical volume sampled by the sampler was:

$$TV = \pi\ r^2\ d/CF,$$

where: TV = theoretical volume (liters/unit count);
r^2 = radius of sampler (m);
d = distance of plankton tow (m);
CF = calibration factor; and
π = 3.414

Entire sample volume was calculated by multiplying theoretical volume and change in counter reading recorded during plankton tow. The following equation was used:

$$V = TV(CC)$$

where: V = volume of entire sample (liters)
TV = theoretical volume (56 liters/unit count)
CC = Change in Clark-Bumpass counter reading

Volume of entire sample was used to determine the plankton density. Density (# organisms/l) was calculated using the number of subsamples taken, volume of subsample, volume of entire sample, dilution factor (if diluted) and total number counted of each species. The following equation was used:

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

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

The lengths of predominant cladocerans were measured from the top of the head to the base of the carapace, excluding the spine. Cladoceran biomass was determined using the length-weight regression equations summarized by Downing and Rigler (1984). If more than one regression equation was available for an organism then the regression equation with a mean length closest to the mean length of that organism in this study was used. The length-weight regression equation, the equations used for each species, and sources of the equations are listed in Table 2.3.1. After the mean weight of an organisms was calculated with the appropriate equation, the biomass of the organisms in the sample was calculated by multiplying the mean weight of an organism by the total number of those organisms in the sample.

2.4 AGE DETERMINATION, BACK CALCULATIONS, AND CONDITION FACTORS

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, backcalculation measurements and age class of each fish were determined simultaneously. To obtain the data, scales were removed from the envelope and placed between two microscope slides. The slides were then placed in a Realist Vantage 5, Model 3315 microfiche reader. The scale image was then projected onto the screen and a non-regenerated, uniform scale was selected to determine age and backcalculation using the following procedures:

Table 2.3.1 Length weight relationships for crustacean zooplankton (Cladocera) collected from the literature as summarized by Downing and Rigler (1984). The slope (b), intercept (ln a), and range of length measurements (mm) are presented for the relationship:

$$\ln w = \ln a + b\ \overline{\ln}\ L$$

where $\ln w =$ **the logarithim of the dry weight estimate (μg); and**
$\ln L =$ **total length from top of the head to the base of the carapace (natural log).**

Species	ln A	b	Range
Daphnia schodleri	2.30	3.10	1.00-2.50
Daphnia re trocurva	1.4322	3.129	0.50-2.00
Daphnia galeata mendota	1.51	2.56	
Daphnia thorata	2.64	2.54	0.60-2.20
Daphnia ambigua	1.54	2.29	
Leotodora kindtii	-0.8220	2.670	1.00-5.00

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 then 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.

Body length, scale length, and length of each annulus of all fish were then entered into StatView 512 (Brainpower 1986) on the Apple Macintosh SE computer for linear regression calculation. Lee's backcalculation method was used to determine the length of the fish at the formation of each annulus. (Carlander 1950,1981; Hile 1970).

Backcalculations were computed by 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;
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.

The proportional method of back-calculation was used for some species, e.g., kokanee, when small sample size of certain age classes resulted in poor regressions. This method does not take into account the size of fish at scale formation. The following equation was used:

$$L_i = \frac{S_i(L_c)}{S_C}$$

where: Li = length of fish at each annulus (mm);
Lc = length of fish at time of capture (mm);
Si = scale measurement to each annulus (mm); and
SC = distance from the focus to the edge of the scale (mm).

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 general condition of the fish (Hile 1970, Everhart and Youngs 1981). Condition factors describe 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 in grams: and
L = total length of fish in millimeters.

2.5 FISH FEEDING HABITS

2.5.1 Field Collection

Fish stomachs were collected from kokanee, rainbow, walleye and lake whitefish at each index station in August and October 1988, and May, August and October 1989. Stomachs from representative sizes of fish were collected by making an incision into the body cavity, cutting the pyloric sphincter and esophagus, while clamping the esophagus to keep prey items from being expelled, and preserving the stomach in 10 percent formalin.

2.5.2 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), Merritt and Cummings (1984).

Food organisms were identified using a Nikon SMZ-1B dissecting microscope equipped with fiber optics illumination system and 5 mm ocular micrometer. Identification of particular zooplankton species was made using a Nikon S-Ke phase contrast microscope.

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

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

where: DV = total diluted volume (100 ml);
s v = total subsample volume (2 ml); and
Tn = total number of zooplankton (or dipterans) in the subsample.

The above subsample and total diluted volume was determined by comparing actual counts of zooplankton contents in 15 stomach samples with calculated estimates using various subsample volumes and diluted volumes. The above subsample and total diluted volume showed the least variance and therefore was used.

Length measurements of cladocerans were made from the top of the head to the base of the carapace, excluding the spine. This permitted comparison of the size of cladocerans in fish stomachs versus their size in the water column to determine if size selective predation was occurring.

Dry weights were obtained by drying the sorted stomach contents in an oven at 105° for 24 hours and weighing them on a Sartorius Model H51 analytical balance to the nearest .0001 g (Weber 1973, APHA 1976). Weight values were combined for each age class for each season to obtain seasonal means and standard deviations. The mean seasonal data was then averaged to obtain unbiased annual means.

2.5.3 Number and Weight Indices

For each Seasonal means for numerical frequency and weight frequency of the prey items (± standard deviation) were obtained for each age class of walleye, rainbow, and kokanee collected during each sampling interval. Nonmeasureable trace amounts were given the value of 0.0001 grams for calculating percentages by weight.

Seasonal mean data were 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 walleye, rainbow and kokanee.

2.5.4 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 in small numbers (Bowen 1983). The index of relative importance (George and Hadley 1979) was calculated using the formula:

$$RIa = \frac{100AIa}{\sum_{a=1}^{n} AIa}$$

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 item near one hundred.

2.5.5 Diet Overlap

Diet overlap was calculated to determine the degree to which intra-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 the indices obtained from the IRI calculations. The 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:
- C_x = the overlap coefficient,
- P_{xi} = the proportion of food category (i) in the diet of species x,
- P_{yi} = the proportion of food category (i) in the diet of species y, and
- n = the number of food categories.

The overlap coefficients were computed by using the IRI values in the equation for the variables Pxi and Pyi. The 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 the food items utilized by the species are limited (MacArthur 1968). High diet overlap indices may also indicate that there is an abundant food supply and competition does not exist.

2.5.6 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* 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* 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 = the measure of food selection;
r_i = the relative abundance of prey i in the gut;
p_i = the relative abundance of same prey i in the environment.

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

Some advantages of using this index are: (1) it is not biased by unequal sample sizes; and (2) 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).

2.6 TAGGING STUDIES

Tagging studies were conducted with net pen rainbow trout and walleye via inserting individually numbered floy tags into the musculature at the posterior base of the dorsal fin. The floy tags contained a return address. Rainbow trout were marked and released at the Seven Bays net pen in 1988 and at the Seven Bays and Hunters in 1989. The fish at Hunters were marked with the assistance of students from the Hunters High School. Representative samples of about 100 fish from each group were measured and weighed to determine the average length and weight of the group at time of release.

Walleye were marked in the Spokane Arm in May 1988 and May 1989. Large numbers of walleye were marked at this site where they congregated to spawn. Walleye were also marked at other index stations during each month when fisheries samples were collected but relatively fewer fish were caught. Lengths were recorded for each walleye marked.

A poster campaign was conducted by placing posters at marina's, boat launches, public fishing areas, National Park Service campgrounds, fish cleaning stations, and businesses that sold fishing licences or tackle in the communities surrounding Lake Roosevelt. The poster contained information about the Lake Roosevelt monitoring program project and requested that anglers return tags along with the following information: date of recapture, location of recapture, and length and weight (if possible) of fish at time of recapture. Anger clubs in the vicinity of Grand Coulee Reservoir, as well as groups such as the Lake Roosevelt Development Association and the Lake Roosevelt Forum, were also notified about the project.

Tag return data was compiled and analyzed to determine migration patterns and growth rates. Fish lengths, generally reported by anglers in inches, were converted into mm, to assess growth rates in mm/month. Because anglers usually measured fish to the nearest 0.5 inch, whereas at marking they were measured to the nearest mm, fish were occasionally reported with lower total lengths or much higher total lengths than when they were originally marked. Therefore, only walleye which were caught at least 10 months after tagging were used for calculating growth rates.

2.7 KOKANEE FECUNDITY ESTIMATES

Egg skeins were removed from female kokanee that were nearly ripe and preserved with 10% formalin. Fish that appeared to have spawned were discarded. In the laboratory, eggs were carefully dissected from the skein and counted using a tally counter and Nikon SMZ-1B dissecting microscope with fiber optics illuminator. The mean and standard deviation of the number of eggs for each age class and linear regression plots of the total length/fecundity and weigh/fecundity relationships were calculated using Statview 512+ (Brainpower 1986) on a Macintosh SE computer.

3.0 RESULTS

3.1 CREEL SURVEY

Results of annual creel survey data, including angler pressure (± 95% Cl), CPUE, and harvest estimates (± 95% Cl) for each fish species, are summarized in Tables 3.1 .1 through 3.1.13. Results of all monthly creel survey data for northern, middle, southern, and Spokane Arm designated areas of Lake Roosevelt are listed in Appendix B.

From August through December 1988, surveys were conducted on 97 days and 786 boat and 250 shore anglers were interviewed. In 1989, surveys were conducted on 233 days, and 1,137 boat and 2,131 shore anglers were interviewed. The average trip length from August to December, 1988, was 4.1 hours for boat anglers and 3.7 hours for shore anglers. The annual average trip length in 1989 was 4.5 hours for boat anglers and 3.3 hours for shore anglers (Appendix B).

Angler pressure estimates for August to December 1988, and January to December 1989 are listed in Tables 3.1.2 and 3.1.3. Angling pressure was estimated at 261,913 angler hours from August through December 1988. Angling pressure from January through December 1989 was estimated at 756,397 angler hours. The peak angling pressure in 1989 occurred in August with 182,409 angler hours. The next two highest months were June with 175,812 angler hours and July with 146,641 angler hours.

The mean CPUE for for all species (harvested and released) was 0.19 fish/h from August to December 1988, and 0.05 fish/h in 1989. The mean CPUE for all species (harvested only) was 0.14 fish/h 1988 and 0.03 fish/h in 1989 (Table 3.1.4). Individual fish species CPUE estimates for total catch and harvest are summarized monthly in Tables 3.1.5 through 3.1.8.

From August to December 1988, total harvest (± 95% confidence intervals) was estimated at 125,891 ± 47,629 fish, comprised of 86,107 ± 31,940 rainbow trout, 9,362 ± 3,873 kokanee, 23,005 ± 8,731 walleye, 1,210 ± 312 yellow perch, and 6,207 ± 2,773 smallmouth bass (Table 3.1.9). In 1989, the annual total harvest (± 95% confidence intervals) was estimated at 164,227 ± 63,035 fish, comprised of 65,515 ± 25,373 rainbow trout, 11,906 ± 3,597 kokanee, 248 ± 54 chinook salmon, 83 ± 18 lake whitefish, 80,626 ± 33,513 walleye, 3,600 ± 1,631 yellow perch, 8 ± 3 largemouth bass, 1,538 ± 578 smallmouth bass, 691 ± 323 black crappie,

Table 3.1 .1. Estimates of number of angler hours and angler trips based on average trip length for Lake Roosevelt August to December, 1988 and January to December, 1989.

1988		AUG	SEP	OCT	NOV	DEC
Angler Hours		120,559	58,404	47,865	17,003	18,082
Ave. Trip length		3.2	4.5	4.2	4.3	4.2
No. Angling Trips		37,674	12,979	11.396	3.954	4.305

AUG-DEC 1988 TOTALS: ANGLER HOURS 261,913
NO. ANGLING TRIPS 70,308

1989	JAN	FEB	MAR	APR	MAY	JUN
Angler Hours	13,729	9,482	22,139	44.037	53,961	175,812
Ave. Trip length	3.0	3.4	3.8	4.3	3.6	4.3
No. Angling Trips	4,576	2,789	5,826	10,241	14.989	40.887

1989	JUL	AUG	SEP	OCT	NOV	DEC
Angler Hours	146,641	182,409	42,012	29,425	27,524	9,226
Ave. Trip length	4.6	4.1	4.2	4.7	4.8	4.2
No. Angling Trips	31,878	44,490	10.003	6,261	5.734	2,197

JAN-DEC 1989 TOTALS: ANGLER HOURS 756,397
NO. ANGLING TRIPS 179,871

Table 3.1.2. Angler pressure estimates (±95%CI) for each stratum on Lake Roosevelt, August to December 1988.

	AUG		SEP		OCT		NOV		DEC	
LAKE ROOSEVELT '89	Angler h	(±95%CI)	Angler h	(±95%CI)	Angler h	(±95%CI)	Angler h	(±95%CI)	Angler h	(±95%CI)
Weekday (AM) Boat	26,505	(±6,865)	13,388	(±3,983)	7,834	(±2,171)	5,213	(±1,509)	4,394	(±1,761)
Weekday (AM) Shore	137	(±40)	165	(±46)	615	(±235)	974	(±223)	2,519	(±498)
Weekday (PM) Boat	18,563	(±10,042)	16,999	(±5,400)	15,382	(±4,400)	4,665	(±1,458)	1.989	(f816)
Weekday (PM) Shore	396	(±130)	286	(±57)	989	(±371)	595	(f114)	3,105	(f445)
Weekend (AM) Boat	47,264	(±23,274)	13,817	(±5,144)	9,400	(±2,350)	2,395	(f691)	2,554	(±909)
Weekend (AM) Shore	169	(±63)	31	(fll)	515	(f121)	811	(f228)	1,720	(f534)
Weekend (PM) Boat	26,777	(±15,586)	12,628	(±6,962)	12,203	(f210)	2.118	(f627)	779	(f215)
Weekend (PM) Shore	748	(f470)	92	(±37)	921	(±210)	232	(±42)	1,022	(f315)
TOTAL	1120,559	(±56,470)	58,404	(±21,640)	47,865	(±12,887)	17,003	(±4,892)	18,082	(±5,493)

Table 3.1.3. Angler pressure estimates (±95%CI) for each stratum on Lake Roosevelt, January to December 1989.

	JAN	FEB	MAR	APR	MAY	JUN
LAKE ROOSEVELT '89	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)
Weekday (AM) Boat	2,191 (±693)	342 (±70)	1,528 (±465)	1,477 (±384)	10,218 (±3,230)	43,486 (±21,652)
Weekday (AM) Shore	3,034 (±816)	1,672 (±806)	1,241 (±338)	1,882 (±311)	2,039 (±432)	801 (±168)
Weekday (PM) Boat	2,467 (±825)	435 (±41)	4,823 (±2,548)	13,671 (±3,991)	12,923 (±5,490)	39,953 (±13,994)
Weekday (PM) Shore	2,152 (±730)	855 (±325)	4,366 (±1,845)	3,111 (±374)	3,478 (±847)	9,145 (±6,047)
Weekend (AM) Boat	1,150 (±369)	504 (±181)	3,020 (±1,943)	11,407 (±3,683)	10,935 (±7,264)	3,700 (±11,651)
Weekend (AM) Shore	1,613 (±430)	1,872 (±476)	2,366 (±658)	1,438 (±416)	2,091 (f915)	497 (f130)
Weekend (PM)Boat	757 (±312)	789 (f521)	2,375 (f305)	5,950 (±4,412)	10,555 (±2,811)	77,577 (±37,414)
Weekend (PM) Shore	365 (f87)	2,469 (f371)	2,420 (f556)	5,100 (±870)	1,721 (±672)	653 (±154)
TOTAL	13,729 (±4,262)	9,482 (±2,791)	22,139 (±8,658)	44,037(±14,441)	53,961(±21,661)	175,812 (±91,210)

	JUL	AUG	SEP	OCT	NOV	DEC
LAKE ROOSEVELT '89	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)	Angler h (±95%CI)
Weekday (AM) Boat	36,514 (±16,532)	21,860(±10,760)	4,758 (21,256)	7,249 (±2,263)	1,746 (f651)	1,706 (f693)
Weekday (AM) Shore	103 (±21)	864 (±259)	518 (±148)	565 (±127)	760 (f189)	737 (f216)
Weekday (PM) Boat	43,437 (±19,075)	55,057(±13,042)	22,745 (±4,580)	13,647 (±2,158)	1,172 (±342)	552 (±178)
Weekday (PM) Shore	5,489 (±994)	1,360 (±458)	1,751 (±589)	174 (±15)	135 (f40)	1,014 (f246)
Weekend (AM) Boat	35,713 (±13,105)	52,539(±15,954)	6,981 (±1,638)	3,335 (±1,504)	21,252 (±7,989)	2,283 (±705)
Weekend (AM) Shore	0	838 (f385)	334 (±120)	206 (f47)	14 (±3)	529 (±120)
Weekend (PM) Boat	24,907 (±2,841)	19,735(±11,694)	2,217 (f476)	3,873 (±2,192)	2,286 (51,201)	1,736 (±866)
Weekend (PM) Shore	478 (f113)	424 (±794)	2,709 (f370)	375 (±53)	161 (f50)	669 (f140)
TOTAL	146,641 (±52,681)	182,409(±52,723)	42,012 (±9,177)	29,425 (±8,359)	27,524(±10,465)	9,226 (±3,164)

Table 3.1.4. Mean annual CPUE based on total catch (kept and released fish) and harvested fish (kept) for Lake Roosevelt, August to December 1988 and January to December 1989.

LAKE ROOSEVELT 1988 (AUG-DEC)	TOTAL CATCH CPUE (fish/h)	HARVESTED CPUE (fish/h)
Rainbow trout	0.37	0.36
Kokanee	0.11	**0.12**
Walleye	0.34	0.08
Yellow Perch	0.05	0.05
Smallmouth Bass	0.09	0.08
AUG-DEC, 1 988 MEAN	**0.1 9(fish/h)**	**0.1 4(fish/h)**

1989 (Jan-Dec)	CPUE (fish/h)	CPUE (fish/h)
Rainbow trout	0.16	0.15
Kokanee	0.04	0.04
Chinook Salmon	0.03	0.03
Lake Whitefish	**0.01**	**0.01**
Walleye	0.20	**0.09**
Yellow Perch	0.02	0.006
Largemouth Bass	0.001	**0.001**
Smallmouth Bass	0.02	0.02
Black Crappie	0.02	0.02
Sturgeon	**0.01**	**0.01**
Burbot	**0.005**	0.005
Brown Bullhead	0.03	0.0
ii989 Annual Mean	**0.05(fish/h)**	**0.03(fish/h)**

Table 3.1.5. Monthly mean and total CPUE (fish/hr) of fish harvested (kept) for Lake Roosevelt in 1988.

Lake Roosevelt '88	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow trout	0.23	0.27	0.25	0.22	0.59	0.47
Kokanee	0.04	0.03	0.12	0.28		0.06
Walleye	0.13	0.10	0.08	0.08	0.09	0.06
Yellow Perch			0.05			
Smallmouth Bass		0.13	0.04	0.09		
CPUE MEAN JUL-DEC 1988	0.13	0.17	0.11	0.17	0.34	0.20

Table 3.1.6. Monthly mean and total CPUE (fish/hr) of total catch (kept and released fish) for Lake Roosevelt in 1988.

Lake Roosevelt '88	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow trout	0.48	0.27	0.25	0.23	0.62	0.47
Kokanee	0.04	0.03	0.12	0.28		
Walleye	0.30	0.82	0.31	0.26	0.19	0.14
Yellow Perch			0.05			
Smallmouth Bass			0.05	0.12		
CPUE MEAN JUL-DEC 1988	0.27	0.37	0.16	0.22	0.41	0.31

Table 3.1.7. Monthly mean and total CPUE (fish/hr) of fish harvested (kept) for Lake Roosevelt in 1989.

LAKE ROOSEVELT '89	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout	0.34	.24	.11	.16	.16	.04	.08	.05	.04	.17	.17	.20
Kokanee	.04	.02	.06	.04	.02	.01	.02	.01	.14	.07	.004	
Chinook Salmon										.03		
Lake Whitefish										.01		
Walleye	.02		.05	.14	.16	.13	.07	.10	.05	.11	.05	.09
Yellow Perch			.005	.01	.01	.01			.001		.003	
Smallmouth Bass				.003	.08		.01	.002				
Largemouth Bass						.001						
Black Crappie							.03					
Sturgeon				.02	.004	.01	.003		.006	.04		
Burbot			.005									
MONTHLY MEAN	0.13	0.13	0.05	0.06	0.07	0.03	0.04	0.04	0.05	0.07	0.06	0.15

Table 3.1.8. Monthly mean and total CPUE (fish/hr) of total catch (kept and released fish) for Lake Roosevelt in 1989.

LAKE ROOSEVELT '89	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout	0.34	.24	.11	.16	.18	.04	.06	.05	.04	.21	.25	.20
Kokanee	.04	.02	.06	.04	.02	.03	.02	.01	.14	.07	.004	
Chinook Salmon										.03		
Lake Whitefish										.01		
Walleye	.02	.03	.53	.20	.27	.29	.42	.16	.11	.12	.07	.14
Yellow Perch			.005	.01	.01	.01	.06		.003		.003	.07
Smallmouth Bass				.003	.08	.01	.01	.003				
Largemouth Bass						.001						
Black Crappie							.03					
Sturgeon				.01	.01	.01	.005	.003	.01	.05		
Burbot			.005									
Brown Bullhead							.03					
MONTHLY MEAN	0.13	0.10	0.14	0.07	0.10	0.06	0.08	0.05	0.06	0.08	0.08	0.14

Table 3.1.9. Monthly and annual estimate of total fish species harvested (± 95% C.I.) for Lake Roosevelt August 1988 to December 1988.

	TOTAL HARVEST (± 95% C.I.)					
1988	Rainbow	Kokanee	Walleye	Yellow Perch	Smallmouth Bass	Total
August	38,957 (±16,176)	1,049 (1503)	11,957 (±5,092)		4,544 (±2,179)	56,507 (223,950)
September	13.642 (±7,287)	4,412 (±2,202)	5,702 (±2,205)	1,210 (±312)	1,254 (±461)	26.220 (±12,467)
October	(±2,683)	(±1,168)	4,669 (±1,274)		409 (±133)	19,165 (±5,258)
November	11.863 (±3,245)		169 (±59)			12,032 (±3,304)
December	11,459 (52,549)		508 (±101)			11.967 (±2,650)
AUG - DEC TOTAL	(±31,940)	(±3,873)	23,005 (±8,731)	1,210 (±312)	6,207 (22,773)	125,891 (±47,629)

Table 3.1 .10. Monthly and annual estimate of total fish species harvested (± 95% C.I.) for Lake Roosevelt, January to December 1989.

	TOTAL HARVEST (± 95% C.I.)										
1989	Rainbow Trout	Kokanee	Chinook	Lake-white fish	Walleye	Yellow Perch	Large mouth bass	Small mouth bass	Black crappie	Burbot	TOTAL
January	4.504 (±1,430)	429 (f129)			121 (±30)						5,054 (±1,589)
February	2,426 (f782)	94 (±37)								12 (±5)	2,532 (f824)
March	2,246 (±927)	2,033 (±707)			1,363 (f476)	12 (±5)					5,654 (±2,115)
April	6,440 (±2,252)	1,201 (f428)			14.287 (±4,297)	107 (±43)		24 (±10)			22,059 (17.030
May	7.970 (±2,822)	656 (±231)			3.719 (±1,341)	406 (±196)		952 (±298)			13,703 (~4,888)
June	8,936 (k3.653)	585 (±180)			31,998 (±15,009)	312 (±95)	8 (±3)	289 (±86)			42,128 (±19,026)
July	8,545 (23.933)	1,602 (f481)			10.847 (f3.924)	2,763 (±1,292)		230 (f108)	691 (±323)		24,678 (±10,061)
August	12,952 (±5,426)	1.964 (±627)			12,013 (f4.403)			43 ±16			26,972 (~10.472)
September	2,031 (±809)	2,422 (±576)			1.341 (f368)						5,794 (z1.753)
October	4.475 (±1,373)	909 (±198)	248 (±54	83 (±18)	2,699 (f770)						8,414 (±2,413)
November	3.108 (11.123)	11 (±3)			1,651 (±656)						4.770 (11.782)
December	1,882 (±843)				587 (±239)						2,469 (11.082)
ANNUAL TOTAL	65,515 (±25,373)	11.906 (r3.597)	248 ±54	83 ±18	80.626 (±31.513)	3.600 (±1,631)	8 (±3)	1,538 (1518)	691 (±323)	12 (±5)	164,227 (163.035)

Table 3.1.11. Average (±S.D.) total length (mm) and weight (g) of fish measured during Lake Roosevelt creel surveys in 1988 (n = sample size).

	JUL		AUG		SEP		OCT		NOV		DEC		ANNUAL MEAN	
1988	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)
Rainbow	403 (±56)	13	390 (±27)	53	362 (±35)	58	372 (±24)	23	389 (±25)	72	432 (±21)	130	391 (±25)	347
Kokanee	483 (±0)	1	407 (±40)	3	426 (±43)	29	466 (±34)	34	414 (±24)	3	397 (±76)	2	432 (±35)	72
Walleye	418 (±26)	5	438 (±15)	44	438 (±13)	23	430 (±14)	2	438 (±6)	6	438 (±6)	6	436 (±12)	103
Yellow Perch					222 (±52)	7							222 (±52)	7
Smallmouth Bass			284 (±37)	5	335 (±3)	3							309 (±36)	8

	JUL		AUG		SEP		OCT		NOV		DEC		ANNUAL MEAN	
1988	Weight (g)±SD	(n)	Weight (g)±SD	(n)	Weight (g)±SD	(n)	Weight (g)±SD	(n)	Weight (g)±SD	(n)	Weight (g)±SD	(n)	Weight (g)±SD	(n)
Rainbow	471 (±275)	13	624 (±89)	27	473 (±153)	18	738 (±113)	10	627 (±36)	23	940 (±85)	119	646 (±177)	210
Kokanee	1120 (±0)	1	581 (±27)	2	735 (±219)	4	796 (±227)	[illegible]	606 (±5)	[illegible]	598 (±10)	1	739 (±205)	22
Walleye	373 (±0)	1	558 (±21)	13	448 (±15)	13	573 (±144)	[illegible]	560 (±78)	2	540 (±54)	6	508 (±80)	46
Yellow Perch					154 (±89)	7							154 (±89)	7
Smallmouth Bass			389 (±49)	4	589 (±127)	3							489 (±141)	7

Table 3.1.12. Average (±S.D.) total length (mm) of fish measured during Lake Roosevelt creel surveys in 1989 (n = sample size).

	JAN		FEB		MAR		APR		MAY		JUN	
1989	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)
Rainbow	428 (± 73)	62	412 (±86)	48	413 (± 55)	66	372 (f74)	30	368 (±176)	17	326 (±117)	25
Kokanee	388 (± 80)	2	393 (±47)	2	397 (± 86)	16			412 (± 54)	2	398 (± 29)	2
Walleye	615 (± 296)	2	408 (±19)	2	471 (± 39)	6	434 (±42)	4	421 (± 36)	14	448 (±124)	44
Yellow Perch							293 (±37)	4	194 (± 0)	1		
Largemouth Bass											326 (± 0)	1
Sturgeon							1803 (±0)	1	1486 (± 198)	2	1009 (±651)	7
Burbot					680 (± 226	2						

	JUL		AUG		SEP		OCT		NOV		DEC		ANNUAL MEAN	
1989	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)	Length(mm)±SD	(n)
Rainbow	428 (±65)	2[illegible]	405 (±95)	31	404 (±34)	17	412 (±87)	22	427 (f16)	7	442 (±47)	154	403 (± 33)	507
Kokanee	426 (±84)	4	429 (f39)	2	446 (±83)	46	421 (±23)	10	395 (± 0)	1			411 (± 29)	87
Chinook Salmon							694 (±0)	1					694 (± 0)	1
Lake Whitefish							559 (±0)	1					559 (± 0)	1
Walleye	469 (±147)	4	441 (±39)	44	409 (±30)	67	421 (±19)	4	414 (± 7)	4	410 (±16)	9	447 (± 57)	247
Yellow Perch	250 (±0)	1											212 (± 33)	7
Largemouth Bass													326 (± 0)	1
Smallmouth Bass	347 (±118)	2	279 (±24)	2									313 (± 48)	4
Black Crappie	209 (±23)	3											209 (± 23)	3
Sturgeon	1115 (±209)	3			1439 (±194)	6	1490 (±96)	15					1390 (±287)	34
Burbot													680 (±226)	2

Table 3.1.13. Average (±S.D.) weight (g) of fish measured during Lake Roosevelt creel surveys in 1989 (n = sample size).

	JAN		FEB		MAR		APR		MAY		JUN	
1989	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)
Rainbow	818 (± 286)	55	877 (±148)	44	876 (± 314)	24	712 (±376)	17	622 (±489)	11	543 (± 86)	11
Kokanee	690 (± 152)	2	454 (± 26)	2	522 (± 238)	16	516 (± 0)	1	500 (± 72)	2	323 (± 0)	1
Walleye	2228 (±2660)	2	376 (± 0)	1	747 (± 110)	6			405 (± 83)	5	525 (±106)	23
Yellow Perch							212 (± 4)	4				
Largemouth Bass											605 (± 0)	1
Smallmouth Bass												
Black Crappie												
Burbot					1270 (± 229)	2						

	JUL		AUG		SEP		OCT		NOV		DEC		ANNUAL MEAN	
1989	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)	Weight(g) ± SD	(n)
Rainbow	684 (±184)	18	643 (±218)	26	771 (±267)	11	621 (±37)	14	627 (±63)	5	720 (±129)	62	710 (±107)	300
Kokanee	793 (±388)	3	589 (± 0)	1	829 (±345)	44	680 (±30)	10	484 (± 0)	1			580 (±153)	83
Chinook Salmon							2450 (± 0)	1					2450 (± 0)	1
Lake Whitefish							1420 (± 0)	1					1420 (± 0)	1
Walleye	678 (±199)	31	841 (±332)	27	620 (±355)	49	560 (±16)	4	579 (±21)	4	399 (± 33)	5	723 (±520)	157
Yellow Perch	168 (± 0)	1											190 (± 31)	5
Smallmouth Bass	399 (±153)		319 (±63)	2									359 (± 57)	4
Black Crappie	146 (±37)	2											146 (± 37)	2
Largemouth Bass													605 (± 0)	1
Burbot													1270 (±229)	2

and 12 ± 5 burbot (Table 3.1 .10). The angling pressure was higher August to December in 1989 (estimated at 290,596 angler hours) than in 1988 (estimated at 211,913 angler hours). However, fish harvest in August to December was comparatively lower in 1989 (estimated at 48,558 fish) than 1988 (estimated at 125,891 fish).

Mean lengths and weights from samples of fish harvested August to December 1988 and January to December, 1989, are listed in Tables 3.1 .1 1 to 3.1.13. In 1988, the mean lengths of fish harvested were: rainbow trout (391 mm), kokanee (432 mm), walleye (436 mm), yellow perch (222 mm), and smallmouth bass (309 mm). In 1988, mean weights of fish harvested were: rainbow (676 g), kokanee (739 g), walleye (508 g), yellow perch (154 g), and smallmouth bass (489 g). In 1989, the mean lengths of fish harvested were: rainbow trout (403 mm), kokanee (411 mm), walleye (447 mm) chinook salmon (694 mm), lake whitefish (559 mm), yellow perch (212 mm) largemouth bass (326 mm), smallmouth bass (313 mm), black crappie (209 mm), sturgeon (1,390 mm), and burbot (680 mm). In 1989, mean weights of fish harvested were: rainbow (710 g), kokanee (580 g), walleye (723 g), chinook salmon (2,450 g), lake whitefish (1,420 g), yellow perch (190 g), smallmouth bass (359 g), largemouth bass (605), and black crappie (146 g).

A total of 4,635 anglers were surveyed from August 1988 through December 1989 for sport fish preference. Creel data shows 2,568 (55%) of the anglers surveyed targeted rainbow trout, 1,311 (28%) targeted walleye, 464 (10%) targeted sturgeon, 240 (5%) targeted kokanee, and 40 (1%) targeted smallmouth bass. Yellow perch, black crappie, burbot, and lake whitefish were each targeted by less than 1% of the anglers. (Appendix B).

3.2 RELATIVE ABUNDANCE OF FISH

A synoptic list of species captured during electrofishing and gill net surveys on Lake Roosevelt from August 1988 to December 1989 is recorded in Table 3.2.1. Tables 3.2.2 through 3.2.5 list the annual total numbers and relative abundance of fish captured during electrofishing and gillnetting surveys from nine index stations sampled during the 1988 and 1989 study period. Appendix B lists the total numbers and relative abundance of fish captured at each index station during electrofishing and gillnetting surveys from Lake Roosevelt during August 1988, October 1988, May 1989, August 1989, and October 1989.

Table 3.2.1. **Synoptic list of fish species and total numbers of fish collected during electrofishing and gillnet surveys on Lake Roosevelt, August 1988 to December 1989.**

FAMILY	COMMON NAME	SCIENTIFIC NAME	TOTAL NO.
Ascipenseridae	White sturgeon	*Acipenser transmontanus*	1
Salmonidae	Kokanee salmon	*Oncorhynchus nerka*	310
	Chinook salmon	*Oncorhynchus tshawytscha*	12
	Rainbow trout	*Oncorhynchus mykiss*	714
	Cutthroat trout	*Oncorhynchus clarki*	1
	Brown trout	*Salmo trutta*	49
	Bull trout	*Salvelinus confluentus*	1
	Brook trout	*Salvelinus fontinalis*	4
	Lake whitefish	*Coregonus clupeaformis*	296
	Mountain whitefish	*Prosopium williamsoni*	16
Cyprinidae	Carp	*Cyprinus carpio*	160
	Squawfish	*Ptychocheilus oregonensis*	449
	Tench	*Tinca tinca*	5
	Chiselmouth	*Acrocheilus alutaceus*	2
	Peamouth	*Mylocheilus caurinus*	46
Catostomidae	Bridgelip sucker	*Catostomus columbianus*	146
	Largescale sucker	*Catostomus macrocheilus*	1,309
	Longnose sucker	*Catostomus catostomus*	26
	Sucker fry	*Catostomus spp.*	724
Ictaluridae	Yellow bullhead	*Ictalurus na talis*	7
Gadidae	Burbot	*Lola lota*	36
Percidae	Walleye	*Stizostedion vitreum*	2,017
	Yellow perch	*Perca flavesens*	3,947
Centrarchidae	Largemouth bass	*Micropterus salmonides*	96
	Smallmouth bass	*Micropterus dolomieu*	205
	Black crappie	*Pomoxis nigromaculatus*	116
	Pumpkinseed	*Lepomis gibbosus*	9
Cottidae	Piute sculpin	*Cottus beldingi*	190

Table 3.2.2. Total number and (percent relative abundance) of fish captured during electrofishing surveys at each Lake Roosevelt sample site August and October 1988.

Site Number	1	2	3	4	5	6	7	8	9	TOTAL
Shock Time (min)	84.1	50.0	144.8	100.0	151.3	111.4	50.7	90.0	79.0	861.6
Chinook Salmon		1 (1.2)			9 (1.2)	1 (.2)				11 (.3)
Kokanee					148 (19.8)	23 (3.8)	1 (.7)		5 (5.5)	177 (5.6)
Rainbow Trout	68 (17.2)	5 (6.2)	83 (18.3)	7 (2.2)	31 (4.1)	50 (8.4)	7 (5.0)	43 (12.1)	16 (17.6)	310 (9.8)
Brown Trout	1 (.3)				27 (3.6)					28 (.9)
Brook Trout	1 (.3)									1
Cutthroat Trout	1 (.3)									1
Lake Whitefish					1 (.1)					1
Mountain Whitefish										
Walleye	103 (26.1)	23 (28.4)	72 (15.9	98 (31.2)	128 (17.1)	35 (5.9)	44 (31.4)	40 (11.3)	31 (34.1)	574 (18.1)
Yellow Perch	82 (20.8)	21 (25.9)	101 (22.2)	108 (34.4)	165 (22.0)	360 (60.2)	12 (8.6)	166 (46.9)	3 (3.3)	1018 (32.1)
Largemouth Bass	1 (.3)	1 (1.2)			38 (5.1)	2 (.3)		5 (1.4)		47 (1.5)
Smallmouth Bass			2 (.4)	4 (1.3)		1 (.2)	17 (12.1)	33 (9.3)	8 (8.8)	65 (2.0)
Pumpkinseed	1 (.3)			3 (1.0)						4 (.1)
Black Crappie				61 (19.4)	9 (1.2)	3 (.5)				73 (2.3)
Largescale Sucker	29 (7.3)	9 (11.1)	8 (1.8)	10 (3.2)	50 (6.7)	75 (12.5)	44 (31.4)	38 (10.7)	19 (20.9)	282 (8.9)
Longnose Sucker					3 (.4)					3 (.1)
Bridgelip Sucker	6 (1.5)	3 (3.7)			20 (2.7)	8 (1.3)			4 (4.4)	41 (1.3)
Sucker Fry	47 (11.9)	2 (2.5)	152 (33.6)	6 (1.9)	39 (5.2)	1 (.2)				247 (7.8)
Northern Squawfish	53 (13.4)	10 (12.3)	12 (2.6)	10 (3.2)	21 (2.8)	11 (1.8)	9 (6.4)	22 (6.2)	5 (5.5)	153 (4.8)
Peamouth		4 (4.9)			20 (2.7)		1 (.7)			25 (.8)
Carp	1 (.3)	1 (1.2)	6 (1.3)	3 (1.0)	3 (.4)	25 (4.2)	3 (2.1)	1 (.3)		43 (1.4)
Tench	1 (.3)					1 (.2)				2 (.1)
Chiselmouth				1 (.3)	1 (.1)					2 (.1)
Yellow Bullhead							1 (.7)			1
Sculpin			16 (3.5)	3 (.4)	33 (4.4)	1 (.2)		5 (1.4)		58 (1.8)
Burbot		1 (1.2)	1 (1.2)		3 (.4)	1 (.2)	1 (.7)	1 (.3)		8 (.3)
TOTAL	395	81	453	314	749	598	140	354	91	3175

Table 3.2.3. Total number and (percent relative abundance) of fish captured during gillnetting surveys at each Lake Roosevelt sample site for August and October 1988.

Site Number	1	2	3	4	5	6	7	8	9	TOTAL
Soak Time (hrs)	27.5	30.0	96.5	27.0	48.3	30.5	42.3	38.5	24.0	346.6
Kokanee					1 (11.1)					1 (0.3)
Rainbow Trout			6 (6.0)						2 (13.3)	8 (2.0)
Lake Whitefish	4 (11.0)	1 (3.0)	1 (1.0)	5 (10.0)	1 (11.1)	2 (50.0)		10 (15.6)		24 (6.1)
Largemouth Bass	1 (3.0)									1 (0.3)
Smallmouth Bass			1 (1.0)				23 (28.0)	1 (1.6)		25 (6.3)
Walleye	24 (65.0)	18 (58.0)	39 (38.0)	13 (26.0)	4 (44.4)	2 (50.0)	11 (13.4)	23 (36.0)	6 (40.1)	140 (36.0)
Yellow Perch	2 (5.0)	5 (16.0)	3 (3.0)	5 (10.0)			4 (4.9)	9 (14.1)		28 (7.1)
Pumpkinseed								1 (1.6)		1 (0.3)
Largescale sucker	5 (4.0)		45 (44.0)	24 (48.0)	3 (33.4)		32 (39.0)	13 (20.3)	5 (33.3)	127 (32.2)
Longnose sucker	1 (3.0)	3 (10.0)	1 (1.0)							5 (1.3)
Bridgelip sucker			4 (4.0)	1 (2.0)						5 (1.3)
Peamouth		4 (13.0)					1 (1.2)	2 (3.1)		7 (1.8)
Northern squawfish			2 (2.0)	2 (4.0)			10 (12.2)	5 (7.8)	2 (13.3)	21 (5.3)
Burbot							1 (1.2)			1 (0.3)
TOTAL	37	31	102	50	9	4	82	64	15	394

Table 3.2.4. Total number and (percent relative abundance) of fish captured during electrofishing surveys at each Lake Roosevelt sample site for May, August and October 1989.

Site Number	1	2	3	4	5	6	7	8	9	TOTAL
Shock Time (min)	124.2	144.7	203.2	143.5	339.0	112.4	163.7	145.6	90.9	1467.2
Chinook Salmon					1 (.1)					1
Kokanee		1 (.2)	1 (.2)	1	41 (4.2)	31 (7.9)	1 (.2)	39 (2.5)	12 (3.0)	127 (1.9)
Rainbow Trout	24 (4.9)	23 (5.7)	32 (5.5)	36 (3.2)	32 (3.2)	36 (9.2)	41 (6.7)	102 (6.5)	51 (12.6)	377 (5.7)
Brown Trout	5 (1.0)				16 (1.6)					21 (.3)
Brook Trout		1 (.2)	1 (.2)		1 (.1)					3
Dolly Varden								1		1
Lake Whitefish	6 (1.2)	2 (.5)	14 (2.4)	1		7 (1.8)		2 (.1)		32 (.5)
Mnt. Whitefish		2 (.5)	2 (.3)		1 (.1)			9 (.5)		14 (.2)
Largemouth Bass			1 (.2)	14 (1.2)	32 (3.2)			1		48 (.7)
Smallmouth Bass		1 (.2)	4 (.7)	13 (1.2)	7 (.7)	6 (1.5)	11 (1.8)	17 (1.1)	12 (3.0)	71 (1.1)
Walleye	95 (19.2)	49 (12.0)	203 (35.0)	127 (11.3)	253 (25.7)	107 (27.2)	40 (6.5)	135 (8.6)	44 (10.9)	1053 (16.0)
Yellow Perch	73 (14.8)	41 (10.1)	127 (21.9)	743 (65.9)	193 (19.6)	75 (19.1)	389 (63.6)	1093 (69.8)	128 (31.6)	2862 (43.6)
Black Crappie		2 (.5)	1 (.2)	18 (1.6)	17 (1.7)			5 (.3)		43 (.7)
Pumpkinseed	4 (.8)		1 (.2)							5
Largescale Sucker	89 (18.0)	53 (13.0)	102 (17.6)	62 (5.5)	175 (17.8)	69 (17.6)	49 (8.0)	113 (7.2)	72 (17.8)	784 (11.9)
Longnose Sucker	2 (.4)	2 (.5)	4 (.7)		2 (.2)				1 (.2)	11 (.2)
Bridgelip Sucker	5 (1.0)	7 (1.7)	7 (1.2)	19 (1.7)	25 (2.5)	3 (.8)	9 (1.5)	3 (.2)	14 (3.5)	92 (1.4)
Sucker Fry	79 (16.0)	118 (29.0)	37 (6.4)	50 (4.4)	97 (9.8)	14 (3.6)	44 (7.2)	13 (.8)	24 (5.9)	476 (7.2)
North. Squawfish	69 (14.0)	42 (10.3)	18 (3.1)	21 (1.9)	33 (3.4)	22 (5.6)	13 (2.1)	11 (.7)	30 (7.4)	259 (3.9)
Carp	23 (4.7)	37 (9.1)	8 (1.4)	11 (1.0)	9 (.9)	13 (3.3)	6 (1.0)	8 (.5)	2 (.5)	117 (1.8)
Tench		1 (.2)	1 (.2)	1						3
Peamouth		8 (2.0)	1 (.2)						1 (.2)	10 (.2)
Yellow Bullhead	1 (.2)	1 (.2)					2 (.3)	1		5
Sculpin	18 (3.6)	14 (3.4)	8 (1.4)	9 (.8)	50 (5.1)	4 (1.0)	5 (.8)	10 (.6)	14 (3.5)	132 (2.0)
Burbot	1 (.2)	2 (.5)	7 (1.2)	2 (.1)		6 (1.5)	2 (.3)	3 (.2)		23 (.3)
TOTAL	1494	407	580	1128	1985	1393	612	1566	405	6570

Table 3.2.5. Total number and (percent relative abundance) of fish captured during gillnetting surveys at each Lake Roosevelt sample site for May, August and October 1989.

Site Number	1	2	3	4	5	6	7	8	9	TOTAL
Net Soak Time/hrs	45.3	63.9	73.5	62.3	15.5	39.3	49.0	44.5	64.5	457.8
Chinook Salmon										
Kokanee	4 (3.7)	1 (1.8)								5 (.6)
Rainbow Trout	6 (5.6)	1 (1.8)		3 (2.0)		3 (6.5)	1 (1.4)	5 (2.3)		19 (2.4)
Lake Whitefish	49 (45.8)	9 (16.4)	26 (39.4)	51 (34.5)	1 (11.1)	21 (45.7)	2 (2.9)	80 (36.2)		239 (30.7)
Mountain Whitefish								2 (.9)		2 (.3)
Smallmouth Bass				5 (3.4)			17 (24.6)	8 (3.6)	14 (24.6)	44 (5.7)
Walleye	27 (25.2)	24 (43.6)	31 (47.0)	50 (33.8)	7 (77.8)	16 (34.8)	36 (52.2)	28 (12.7)	31 (54.4)	250 (32.1)
Yellow Perch	1 (.9)	5 (9.1)	1 (1.5)	10 (6.8)			2 (2.9)	17 (7.7)	3 (5.3)	39 (5.0)
Largescale Sucker	9 (8.4)	4 (7.3)	2 (3.0)	17 (11.5)		6 (13.0)	3 (4.3)	67 (30.3)	8 (14.0)	116 (14.9)
Longnose Sucker	5 (4.7)	4 (7.3)	1 (1.5)							10 (1.3)
Bridgelip Sucker	1 (.9)	2 (3.6)		5 (3.4)						8 (1.0)
North. Squawfish	3 (2.8)		4 (6.1)	7 (4.7)	1 (11.1)		7 (10.0)	14 (6.3)		36 (4.6)
Peamouth		4 (7.3)								4 (.5)
Yellow Bullhead									1 (1.8)	1 (.1)
Burbot	1 (.9)	1 (1.8)	1 (1.5)				1 (1.4)			4 (.5)
1Sturgeon	(.9)									1 (.1)
TOTAL	107	55	66	148	9	46	69	221	57	778

During the 1988 to 1989 study period, 10,907 fish were collected while performing relative abundance surveys along shorelines, tributaries, and in pelagic zones. The majority of the fish were collected by electrofishing littoral areas at night, although equal effort was spent during all hours of the day performing the surveys. Gill nets were set throughout the day and night but were less effective in capturing fish.

During relative abundance surveys performed in 1988, a total of 3,175 fish were captured by electrofishing and 392 by gillnetting (Tables 3.2.2 and 3.2.3). Electroshocking surveys were performed for 862 minutes and gill nets were set for 347 hours for a CPUE of 221 fish/h electroshocking and 1 .1 fish/h gillnetting. Total number and relative abundance of each species captured during electrofishing surveys included 1,018 yellow perch (32.1%), 574 walleye (18.1%), 310 rainbow trout (9.8%), 282 largescale suckers (8.9%), 248 sucker fry (7.8%), 177 kokanee (5.6%), 153 northern squawfish (4.8%), 73 black crappie (2.3%), 65 smallmouth bass (2.0%), 58 sculpins (1.8%), 47 largemouth bass (1.5%). 43 carp (1.4%), 41 bridgelip suckers (1.3%), and 28 brown trout, 25 peamouth, 11 chinook salmon, 8 burbot, 4 pumpkinseed, 2 tench, 2 chiselmouth, 1 brook trout, 1 cutthroat trout, 1 lake whitefish, and 1 yellow bullhead (each <1%). Total number and relative abundance of each species captured during gillnetting surveys included 140 walleye (36%), I27 largescale suckers (32.2%), 28 yellow perch (6.4%) 25 smallmouth bass (6.3%), 24 lake whitefish (6.2%), 21 northern squawfish (5.3%), 8 rainbow trout (2.1%), 7 peamouth (1.8%), 5 longnose suckers, 5 bridgelip suckers, 1 kokanee, 1 largemouth bass and 1 burbot (each < 1%).

During relative abundance surveys performed in 1989, a total of 6,570 fish were captured by electrofishing and 778 by gillnetting (Tables 3.2.4 and 3.2.5). Electrofishing surveys were performed for 1,467 minutes and gillnets were set for 458 hours for a CPUE of 269 fish/h electrofishing and 1.7 fish/h gillnetting. Total number and relative abundance of fish captured during electrofishing surveys included 2,862 yellow perch (43.6%), 1,053 walleye (16%), 784 largescale suckers (11.9%), 476 sucker fry (7.2%), 377 rainbow trout (5.7%), 259 northern squawfish (3.9%), 132 sculpins (2%), 127 kokanee (1.9%), 117 carp (1.8%), 92 bridgelip suckers (1.4%), 71 smallmouth bass (1 .1%), 48 largemouth bass, 43 black crappie, 32 lake whitefish, 23 burbot, 21 brown trout, 14 mountain whitefish, 11 longnose suckers, 10 peamouth, 5 yellow bullhead, 5 pumpkinseed, 3 brook trout, 3 tench, 1 chinook salmon and 1 bull trout (each <1%). Total number and relative abundance of each species captured during gillnetting surveys included 250 walleye (32.1%), 239 lake whitefish (30.7%), 116 largescale suckers (14.9%), 44 smallmouth bass

(5.7%), 39 yellow perch (5.0%), 36 northern squawfish (4.6%), 19 rainbow trout (2.4%), 10 longnose suckers (1.3%), 8 bridgelip suckers (1 .0%), 5 kokanee, 4 peamouth, 4 burbot, 2 mountain whitefish, 1 sturgeon and 1 yellow bullhead (each <1%).

Monthly relative abundance of each species was also determined. During 393 minutes spent electroshocking in August 1988, 1,334 fish were captured for a CPUE of 204 fish/h total number captured (and relative abundance) included: 385 yellow perch (28.9%), 271 walleye (20.3%), 147 sucker fry (11%), 122 largescale sukers (9.1%), 91 northern squawfish (6.8%), 59 black crappie (4.4%), 42 rainbow trout (3.1%), 33 smallmouth bass (2.5%), 30 sculpins (2.2%), 22 carp and bridgelip suckers (1.6%), 20 peamouth (1.5), 14 largemouth bass (1 .0%), 13 kokanee (0.9%), 9 brown trout (0.7%), 3 longnose suckers (0.2%) and 1 or 2 (0.1% each) chinook salmon, lake whitefish, pumpkinseed, tench and chiselmouth (Appendix C).

In 204.5 hours of gill net sets in August 1988, a total of 226 fish were captured for a CPUE of 1 .1 fish per hour. Number and relative abundance of fish captured in gill nets included: 82 walleye (36.3%), 81 largescale sucker (35.8%), 20 smallmouth bass (8.8%), 15 northern squawfish (6.6%), 7 lake whitefish (3.1%), 6 yellow perch (2.7%), 5 longnose sucker and 5 yellow bullhead (2.2% each), 3 bridgelip sucker (1.3%), and 1 largemouth bass and 1 burbot (0.4% each) (Appendix C).

During 469 minutes spent electroshocking in October 1988, 1,841 fish were captured for a CPUE of 236 fish per hour. The number captured and relative abundance included: 633 yellow perch (34.4%), 303 walleye (16.5%). 268 rainbow trout (14.6%), 164 kokanee (8.9%), 160 largescale (8.7%), 100 sucker fry (5.4%), 62 northern squawfish (3.4%), 28 sculpin (1.5%), 26 largemouth bass (1.4%), 14 black crappie (0.8%), 11 carp (0.6%) 10 chinook salmon (0.5%) 8 burbot (0.4%), 5 smallmouth bass and 5 peamouth (0.3% each), 3 pumpkinseed (0.2%) and 1 yellow bullhead (0.1%) (Appendix C).

In 160.1 hours of gill net sets during October 1988, 172 fish were captured for a CPUE of 1.07 fish per hour. The number and relative abundance of each species were: 58 walleye (33.7%), 46 largescale suckers (26.7%), 22 yellow perch (12.8%), 17 lake whitefish (9.9%), 8 rainbow trout (4.7%) 6 peamouth and 6 northern squawfish (3.5% each), 5 smallmouth bass (2.9%), 2 bridgelip sucker (1.2 %), and 1 kokanee and 1 pumpkinseed (0.6% each) (Appendix C).

During May 1989, 460.5 minutes were spent electroshocking to capture 1,21 9 fish for a CPUE of 159 fish per hour. The number and relative abundance of each species were: 482 walleye (39.5%) 265 largescale sucker (21.7%), 137 rainbow trout (11.2%), 83 northern squawfish (6.8%), 56 yellow perch (4.6%), 52 sucker fry (4.3%), 37 bridgelip sucker (3.0%), 23 carp (1.9%), 20 smallmouth bass (1.6%), 18 kokanee (1.5%), 14 sculpin (1 .1%), 7 peamouth (0.6%), 6 brown trout (0.5%), 5 longnose sucker (0.4%), 4 pumpkinseed (0.3%), 3 lake whitefish, 3 brook trout and 3 largemouth bass (0.2% each), and; 1 Dolly Varden and 1 burbot (0.1% each) (Appendix C).

Gillnets set for 129.6 hours in May 1989 captured a total of 154 fish for a CPUE of 1.2 fish per hour. Number and relative abundance of each species were: 44 walleye (28.6%), 31 lake whitefish (20.1%), 28 largescale sucker (18.2%), 23 smallmouth bass (14.9%), 15 northern squawfish (9.7%) 5 yellow perch (3.2%) 3 rainbow trout and 3 bridgelip sucker (1.9% each) and 1 burbot and 1 longnose sucker (0.6%) (Appendix C).

In August 1989, a total of 546.8 minutes were spent electroshocking and a total of 2,814 fish were captured for a CPUE of 309 fish per hour. The number and relative abundance of each species were: 1,191 yellow perch (42.3%), 399 walleye (14.2%), 358 sucker fry (12.7%), 244 largescale sucker (8.7%) 146 northern squawfish (5.2%), 119 rainbow trout (4.2%) 84 carp and 80 sculpin (2.9%) 46 smallmouth bass (1.6%), 42 black crappie (1.5%), 29 bridgelip sucker (1 .0%), 25 largemouth bass (0.9%), 11 brown trout and 11 burbot (0.4%), 6 lake whitefish, 6 mountain whitefish and 6 longnose sucker (0.2%), and 3 or 4 each yellow bullhead, tench, peamouth, and kokanee (0.1%) (Appendix C).

Gill nets set for 222.3 hours in August 1989 captured 414 fish for a CPUE of 1.9 fish per hour. The number and relative abundance of each species were: 156 lake whitefish (37.8%), 131 walleye (31.7%), 64 largescale sucker (15.5%), 16 smallmouth bass (3.9%) 14 northern squawfish (3.4%), 11 rainbow trout (2.7%), 8 yellow perch (1.9%), 6 longnose sucker (1.4%), 3 kokanee (0.7%), 2 burbot and 2 peamouth (0.5%), and 1 sturgeon (0.2%) (Appendix C).

During 459.9 minutes spent electroshocking in October 1989, 2,538 fish were captured for a CPUE of 331 fish per hour. The number and relative abundance of each species were: 1615 yellow perch (63.6%), 275 largescale suckers (10.8%), 172 walleye (6.8%), 121 rainbow trout (4.8%), 106 kokanee (4.2%), 66 sucker fry (2.6%), 38 sculpin (1.5%), 31 northern squawfish (1.2%), 26 bridgelip sucker (1 .0%), 23 lake whitefish (0.9%), 20 largemouth bass (0.8%), 11 burbot, 10 mountain whitefish, and 9 carp (0.4%), 5 brown trout and 4 smallmouth bass (0.2%), and 1 each chinook salmon, brook trout, black crappie, pumpkinseed, peamouth and yellow bullhead (all less than 0.1%) (Appendix C).

Gill nets set for 111.9 hours during October 1989 captured 210 fish for a CPUE of 1.9 fish per hour. The number and relative abundance of each species captured were: 75 walleye (35.7%), 52 lake whitefish (24.8%), 26 yellow perch (12.4%), 24 largescale sucker (11.4%), 7 northern squawfish (3.3%), 5 each rainbow trout, smallmouth bass, and bridgelip sucker (2.4%), 3 longnose sucker (1.4%) 2 each kokanee, mountain whitefish, and peamouth (1 .0% each), and 1 each yellow bullhead and burbot (0.5% each) (Appendix C).

3.3 AGE, GROWTH AND CONDITION

3.3.1 Rainbow Trout

Table 3.3.1 lists the mean lengths, weight and condition factors of five age classes of rainbow trout determined from 1988 scale samples. Mean back-calculated lengths estimated at annulus formation are shown in Table 3.3.2. Information on individual fish is contained in Appendix D.

Mean length, weight, and condition factors were determined from 246 rainbow trout captured during August and October 1988 at nine index stations. The mean size and condition for each age class were: 0+ (139 mm total length, 41 g weight, condition factor of 1.12); 1+ (325 mm length, 464 g weight, condition factor of 1.33); 2+ (447 mm length, 1038 g weight, condition factor of 1.16); 3+ (473 mm length, 1096 g in weight, condition factor of 1.04); 4+ (508 mm length, 1,245 g weight, condition factor of 0.95) and; 5+ (475 mm length, and 1,131 g weight, condition factor of 1.06).

The mean back-calculated lengths for all cohorts at the formation of the first annulus ranged from 185 mm to 208 mm with a grand mean of 195 mm. Estimated mean lengths at the formation of the second annulus ranged from 264 to 375 mm with a grand mean of 318 mm. Mean lengths at the formation of the third annulus ranged from 328 to 410 mm with a grand mean of 377 mm. Mean lengths at the formation of the fourth annulus ranged from 387 to 459 mm with a grand mean of 423 mm. The back-calculated length at formation of the fifth annulus was 434 mm.

Table 3.3.1. Mean lengths (mm), weights (g), and condition factor (K_{TL}) (± standard deviations) of rainbow trout collected during 1988. N = sample size.

Age class	N	$\bar{X}$ Length (mm)		$\bar{X}$ Weight (g)		$\bar{X}$ K_{TL}	
0+	21	139.3	(k42.8)	41.1	(± 38.6)	1.12	(± 0.24)
1+	89	325.4	(69.9)	464.4	(±209.0)	1.33	(± 0.85)
2+	59	446.6	(±49.4)	1038.4	(±352.0)	1.16	(± 0.32)
3+	60	472.6	(±32.5)	1096.3	(±214.6)	1.04	(± 0.16)
4+	16	508.3	(k49.3)	1245.4	(±358.5)	0.95	(± 0.11)
5+	1	475	(± 0.0)	1131	(± 0.0)	1.06	(± 0.00)
TOTAL	246					1.11	(± 0.28)

Table 3.3.2. Estimated mean total lengths (mm) ± standard deviations at annulus formation back-calculated for each age class of rainbow trout collected during 1988. N = sample size.

		Mean ± S.D. Back-calculated length (mm) at Annulus				
Cohort	N	1	2	3	4	5
1987	89	189.3±21.6				
1986	58	207.9±22.5	375.0±40.6			
1985	28	190.9±20.8	327.5±35.4	409.8±32.3		
1984	16	184.7±13.9	306.4±28.0	393.1±56.4	459.3±45.9	
1983	1	200.0±00.0	264.4±00.0	328.7±00.0	387.2±00.0	434.0±0.0
Grand Mean	192	194.6±19.7	318.3±34.7	377.2±44.4	423.3±45.9	434.0±0.0
Mean Annual Growth		195	123	59	46	11

In 1989, scale samples were collected with length and weight measurements recorded from 347 rainbow trout for determination of condition, age analysis, and back-calculation of length at annulus formation (Tables 3.3.3 and 3.3.4).

The following mean lengths, weights, and condition factors for six age classes of rainbow trout were recorded from May, August, and October, 1989 samples at nine index stations: 0+ (120 mm length, 31 g weight, condition factor of 1.16); 1+ (256 mm length, 218 g weight, condition factor of 1.23); 2+ (394 mm length, 572 g weight, condition factor of 1.24); 3+ (429 mm length, 902 g weight, condition factor of 1.12); 4+ (483 mm length, 1058 g weight, condition factor of 0.97); 5+ (495 mm length, 1155 g weight, condition factor of 0.96); and, 6+ (525 mm length, 1,039 g weight, condition factor of 0.72).

Estimated mean length of rainbow at the formation of the first annulus ranged from 146 to 186 mm with a grand mean of 166 mm. At the formation of the second annulus, mean length ranged from 186 to 291 mm with a grand mean of 235 mm. Mean length at the formation of the third annulus ranged from 313 to 377 mm, with a grand mean of 344 mm. Mean length at the formation of the fourth annulus ranged from 422-434 mm with a grand mean of 429 mm. Mean length at the formation of the fifth annulus ranged from 470-476 mm with a grand mean of 473 mm.

3.3.2 Walleye

Mean lengths, weights and condition factors determined from measurements of walleye collected in 1988 are summarized in Table 3.3.5. A total of 369 scale samples were analyzed for age. Estimated mean back-calculated lengths are shown in Table 3.3.7. Mean lengths, weights, and condition factors determined from measurements of walleye collected in 1989 are summarized in Table 3.3.6. A total of 467 scale samples were analyzed for age. Estimated mean back-calculated lengths of seven walleye cohorts are shown in Table 3.3.8. Information on individual fish is contained in Appendix D.

Mean condition factors of walleye collected in 1988 ranged from 0.84 to 1.05 and the overall mean was 0.92 (Table 3.3.5). In 1989, the mean condition factor ranged from 0.74 to 0.90 and the overall mean was 0.84 (Table 3.3.6). In 1988, 1+ walleye averaged 206 in length, 82 g in weight and 0.89 for condition factor. In 1989. 1+ walleye averaged 245 mm in length, 142 g in weight and 0.90 for condition factor. In 1988, 2+ walleye averaged 275 mm in length, 182 g in weight and 0.95 for condition

Table 3.3.3. Mean lengths (mm), weights (g), and condition factor (K_{TL}) (± standard deviations) of rainbow trout collected during 1989. N = sample size.

Age class	N	$\bar{X}$ Length (mm)	$\bar{X}$ Weight (g)	$\bar{X}$ K_{TL}
0+	41	120.4 (± 52.5)	30.7 (± 45.2)	1.16 (± 0.46)
1+	57	255.5 (± 90.6)	218 (f302.4)	1.23 (± 0.94)
2+	102	394.3 (k482.1)	572.1 (±368.8)	1.24 (± 0.46)
3+	76	429.4 (± 54.1)	902.1 (±400.8)	1.12 (± 0.33)
4+	55	482.8 (± 49.1)	1058.3 (±244.0)	0.97 (± 0.20)
5+	15	495.4 (± 34.9)	1154.9 (±200.5)	0.96 (± 0.19)
6+	1	525.0 (± 0.0)	1039.0 (± 0.0)	0.72 (± 0.00)
TOTAL	347			1.06 (± 0.37)

Table 3.3.4. Estimated mean total lengths (mm) ± Standard deviations at annulus formation back-calculated for each age class of rainbow trout collected during 1989. N = sample size.

		Mean (mm) ± S.D. Back-calculated length (mm) at Annulus					
Cohort	N	1	2	3	4	5	6
1988	64	185.5 (±64.7)					
1987	113	181.4 (±34.2)	290.7 (±80.3)				
1986	83	174.5 (±28.2)	277.4 (±65.5)	376.6 (±28.5)			
1985	59	157.9 (±23.9)	226.2 (±50.7)	358.8 (±57.3)	431.1 (±65.4)		
1984	15	145.6 (±14.4)	194.5 (±22.2)	327.0 (±24.9)	422.5 (±20.4)	476.6 (±23.4)	
1983	1	149.6 (±0.0)	185.9 (±0.0)	313.1 (±0.0)	434.2 (±0.0)	470.5 (±0.0)	500.8 (±0.0)
Grand Mean	335	165.8 (±33.1)	234.9 (±54.7)	343.9 (±36.9)	429.3 (±42.9)	473.6 (±23.4)	500.8 (±0.0)
Mean Annual Growth		166	68	109	85	45	27

Table 3.3.5. **Mean lengths (mm), weights (g), and condition factors (K_{TL}) ± standard deviations of walleye collected during 1988. N = sample size.**

Age class	N	$\bar{X}$ Length (mm)		$\bar{X}$ Weight (g)		$\bar{X}$ K_{TL}
0+	38	117.0	(±25.3)	18.0	(± 13.3)	1.05 (± 0.42)
1+	38	206.0	(±39.8)	81.7	(± 35.1)	0.89 (± 0.16)
2+	26	274.5	(549.9)	181.7	(± 73.3)	0.95 (± 0.37)
3+	103	345.3	(±24.5)	349.9	(± 94.0)	0.84 (± 0.19)
4+	133	405.5	(±25.7)	576.1	(±150.1)	0.86 (± 0.13)
5+	17	478.1	(236.6)	923.2	(±177.1)	0.85 (± 0.12)
6+	3	532.5	(±14.4)	1386.0	(± 49.5)	0.91 (± 0.03)
7+	0					
8+	0					
9+	1	742	(± 0)	4050	(± 0)	0.99 (± 0)
10+	1	761	(± 0)	14250	(± 0)	0.96 (± 0)
Total	360					0.92 (± 0.20)

Table 3.3.6. **Mean lengths (mm), weights (g), and condition factors (K_{TL}) (± standard deviations) of walleye collected during 1989. N = sample size.**

Age class	N	$\bar{X}$ Length (mm)		$\bar{X}$ Weight (g)		$\bar{X}$ K_{TL}	
0+	71	125	(k21.7)	3714	(± 15.5)	0.81	(± 0.16)
1+	74	244.7	(ir31.8)	142.1	(± 50.0)	0.90	(± 0.50)
2+	122	300.4	(±58.6)	261.9	(±109)	0.89	(± 0.29)
3+	143	394.5	(±47.8)	568.5	(k216.7)	0.88	(± 0.18)
4+	86	418.8	(±37.4)	750.3	(±221.7)	0.87	(± 0.20)
5+	22	496.4	(±87.1)	1036.6	(±442.4)	0.85	(± 0.09)
6+	2	516.7	(±38.89)	1467.2	(k312.5)	0.74	(± 0.04)
7+	1	612	(± 0.01	1821.0	(± 0.0)	0.79	(± 0.0)
Total	521					0.84	(± 0.21)

Table 3.3.7. Estimated mean total lengths (mm) (± standard deviations) at annulus formation back-calculated for each age class of walleye collected during 1988. N = sample size.

		Mean (mm) ± S.D. Back-Calculated lengths (mm) at Annulus Formation									
Cohort	N	1	2	3	4	5	6	7	8	9	10
1987	41	173.9 (±35.9)									
1986	34	185.3 (±30.9)	241.7 (±44)								
1985	133	193.2 (k18.1)	258.3 (±31.7)	313.1 (±29.9)							
1984	139	208 (±14.2)	274.8 (f18.2)	337.2 (k21.2)	390.7 (t23.9)						
1983	17	206.6 (k18.6)	268.4 (±21.1)	340.3 (±31.6)	390.8 (k35.3)	438.9 (±35.1)					
1982	3	213.5 (±2.8)	259.3 (±3.9)	329 (±5.4)	384.3 (±4)	436 (±5)	479.2 (k0.6)				
1981	1	226.2 (±0)	309.8 (±0)	388.8 (±0)	430.6 (±0)	491.1 (±0)	574.7 (±0)	588.6 (±0)	663 (±0)	714.1 (±0)	
1980	1	224.1 (±0)	295.9 (±0)	379.1 (±0)	450.9 (±0)	515.2 (±0)	541.7 (±0)	590.8 (±0)	606 (±0)	662.7 (±0)	689.2 (±0)
Grand Mean	369	203.9 (±15.1)	272.6 (±17)	347.9 (f14.7)	409.5 (±12.6)	470.3 (±10.0)	531.9 (±2)	589.7 (±0)	634.5 (LO)	688.4 (±0)	689.2 (±0)
Mean Annual Growth		204	69	75	62	60	62	58	45	53	1

Table 3.3.8. **Estimated mean total lengths (mm) (± standard deviations) at annulus formation back-calculated for each age class of walleye collected during 1989. N = sample size.**

		Mean ± S.D. Back-Calculated lengths (mm) at Annulus Formation						
Cohort	N	1	2	3	4	5	6	7
1988	77	190.6 (±36.9)						
1987	125	184.5 (±35.4)	257.5 (±54.6)					
1986	150	197.9 (±30.4)	280.7 (±36.3)	348.1 (±42.0)				
1985	91	196.7 (±25)	277.1 (f28.7)	341.6 (±30.6)	395.9 (±37.5)			
1984	22	206.7 (k14.6)	288.7 (f40.7)	357.0 (±66.0)	415.0 (t75.8)	461.3 (±75.3)		
1983	1	256.2 (±0)	300.9 (±0)	363.5 (±0)	446.2 (±0)	533.4 (LO)	591.6 (±0)	
1982	1	239.8 (±12.2)	289.2 (f20.8)	346.2 (f24.9)	413.6 (±8.2)	483.6 (±5.5)	550.6 (t8.3)	602.6 (±4.8)
Grand Mean	467	210.3 (±22.1)	282.4 (±30.2)	351.3 (k32.7)	417.7 (f30.4)	492.8 (k26.9)	571.1 (±4.2)	602.6 (k4.8)
Mean Annual Growth		210	72	69	67	75	78	32

factor. In 1989, 2+ walleye averaged 300 mm in length, 262 g in weight, and 0.89 for condition factor. In 1988, 3+ walleye averaged 345 mm in length, 350 g in weight and 0.84 for condition factor. In 1989, 3+ walleye averaged 395 mm in length, 569 g in weight and 0.88 for condition factor. In 1988, 4+ walleye averaged 406 mm in length, 576 g in weight and 0.86 for condition factor. In 1989, 4+ walleye averaged 419 mm in length, 750 g in weight and 0.87 for condition factor. In 1988, 5+ walleye averaged 478 mm in length, 923 g in weight and 0.85 for condition factor. In 1989, 5+ walleye averaged 496 mm in length, 1,037 g in weight and 0.85 for condition factor. In 1988, 6+ walleye averaged 532 mm in length, 1386 g in weight and 0.91 for condition factor. In 1989, 6+ walleye averaged 517 mm in length, 1,467 g in weight and 0.74 for condition factor. The single 7+ walleye captured in 1989 was 612 mm in length, 1821 g in weight and had a condition factor of 0.79. No walleye in the 8+ age class were captured either year. In 1988, the single 9+ walleye captured was 742 mm in length, 4,050 g in weight and had a condition factor of 0.99. The single 10+ walleye was captured in 1988 and was 761 mm in length, 4,250 g in weight and had a condition factor of 0.96.

In 1988, the mean back-calculated length (Table 3.3.7) estimated for all cohorts at the formation of the first annulus ranged from 174 to 226 mm with a grand mean of 204 mm. Mean length at the formation of the second annulus ranged from 242 to 310 mm with a grand mean of 273 mm. Mean length at the formation of the third annulus ranged from 314 to 389 mm with a grand mean of 348 mm. Mean length at the formation of the fourth annulus ranged from 384 to 451 mm with a grand mean of 410 mm. Mean length at the formation of the fifth annulus ranged from 436 to 515 mm with a grand mean of 470 mm. Mean length at the formation of the sixth annulus ranged from 479 to 575 mm with a grand mean of 532 mm. Mean length at the formation of the seventh annulus ranged from 589 to 591 mm with a grand mean of 590 mm. Mean length at the formation of the eighth annulus ranged from 606 to 663 mm with a grand mean of 635 mm. Mean length at the formation of the ninth annulus ranged from 663 to 714 mm with a grand mean of 688 mm. Length at the formation of the 10th annulus was 689 mm.

In 1989, the mean estimated back-calculated length (Table 3.3.8) for all cohorts at the formation of the first annulus ranged from 184 to 256 mm with a grand mean of 210 mm. Mean length at the second annulus ranged from 258 to 301 mm at the formation fo the second annulus with a grand mean of 282 mm. Mean length at formation of the third annulus ranged from 342 to 364 mm with a grand mean of 351 mm. Mean length at the formation of the fourth annulus ranged from 396 to 446 mm with a grand mean of 418 mm. Mean length at the formation of the fifth annulus ranged from 461 to 533 mm with a grand mean of 493 mm. Mean length at the formation of the sixth annulus ranged from 551 to 592 mm with a grand mean of 572 mm. Mean length at the formation of the seventh annulus was 603 mm.

3.3.3 Kokanee Salmon

Mean size, condition, and back-calculated growth was determined from 49 kokanee collected in 1988. No 0+ and 1+ age classes were captured (Table 3.3.9). Age 2+ kokanee averaged 368 mm in length, 494 g in weight, and 0.99 for condition factor. The 3+ age class averaged 463 mm in length, 1052 g in weight, and 1.07 for condition factor. The 4+ age class averaged 525 mm in length, 1576 g in weight and 1.07 for condition factor. Information on individual fish is contained in Appendix D.

The mean back-calculated length estimated at the formation of the first annulus ranged from 115 to 176 mm with a grand mean of 142 mm (Table 3.3.10). Mean length at the formation of the second annulus ranged from 238 to 318 mm with a grand mean of 274 mm. Mean length at formation of the third annulus ranged from 352 to 391 mm with a grand mean of 372 mm. Estimated length at the formation of the fourth annulus was 457 mm.

A total of 42 kokanee were collected for determination of mean size, condition, and back-calculation of growth in 1989 (Table 3.3.11). The single kokanee 0+ in age was 88 mm in length and 5 g in weight with a condition factor of 0.73. The 1+ age class averaged 240 mm in length, 111 g in weight and 0.70 for condition factor. The 2+ in age class averaged 385 mm in length, 590 g in weight and 1 .01 for condition factor. The 3+ age class averaged 413 mm in length, 824 g in weight and 1.02 for condition factor. The single 4+ kokanee was 425 mm in length and 905 g in weight, with a condition factor of 0.92.

Back-calculated length estimated at the formation of the first annulus ranged from 116 to 131 mm with a grand mean of 124 mm (Table 3.3.12). Mean length at the formation of the second annulus ranged from 225 to 281 mm with a grand mean of 259 mm. Mean length at formation of the third annulus ranged from 344 to 365 mm with a grand mean of 354 mm. The estimated length at the formation of the fourth annulus was 406 mm.

Table 3.3.9. Mean lengths (mm), weights (g), and condition factor (K_{TL}) (± standard deviations) of kokanee salmon collected during 1988. N = sample size.

Age class	N	$\bar{X}$ Length (mm)	$\bar{X}$ Weight (g)	$\bar{X}$ K_{TL}
o +	0	-	-	
2+	5	367.7 (f15.8)	493.9 (± 39.1)	0.99 (± 0.12)
3+	42	463.1 (±23.3)	1052.3 (k155.3)	1.07 (± 0.17)
4+	2	525.0 (±77.8)	1575.5 (±600.3)	1.07 (± 0.06)
TOTAL	49			1.04 (4 0.12)

Table 3.3.10. Estimated mean total lengths (mm) ± standard deviations at annulus formation back-calculated for each age class of kokanee salmon collected during 1988. N = sample size.

		Mean (mm) ± S.D. Back-calculated length at Annulus			
Cohort	N	1	2	3	4
1986	5	176.4(±17.7)	318.1(±18.3)		
1985	39	134.0(±24.7)	265.6(±31.8)	391.0(±38.6)	
1984	2	115.0(±58.2)	237.9(±42.1)	352.7(±4.5)	456.9(±47.9)
Grand Mean	46	141.8(±33.5)	273.9(±30.7)	371.9(±21.6)	456.9(±47.9)
Mean Annual Growth		142	132	98	85

Table 3.3.11. Mean lengths (mm), weights (g), and condition factor (K_{TL}) (± standard deviations) of kokanee salmon collected during 1989. N = sample size.

Age class	N	$\bar{X}$ Length (mm)	$\bar{X}$ Weight (g)	$\bar{X}$ K_{TL}
0+	1	88.0 (± 0.0)	5.0 (± 0.0)	0.73 (± 0.0)
1+	5	240.2 (± 28.6)	110.8 (± 43.1)	0.70 (± 0.41)
2+	10	385.1 (± 35.9)	590.4 (± 164.2)	1.01 (± 0.11)
3+	23	413.0 (± 56.3)	823.5 (± 173.5)	1.02 (± 0.12)
4+	1	425.0 (± 0.0)	905.0 (± 0.0)	0.92 (± 0.0)
TOTAL	40			0.88 (± 0.13)

Table 3.3.12. Estimated mean total lengths (mm) ± standard deviations at annulus formation back-calculated for each age class of kokanee salmon collected during 1989. N = sample size.

		Mean ± S.D. Back-calculated length at Annulus			
Cohort	N	1	2	3	4
1988	6	130.8(±16.7)			
1987	12	116.3(±25.5)	271.9(±40.8)		
1986	23	130.6(±25.5)	281.2(±29.1)	364.8(±41.6)	
1985	1	118.8(±0.0)	225.0(±0.0)	343.8(±0.0)	406.3(±0.0)
Grand Mean	42	124.1(±22.6)	259.4(±35.0)	354.3(±41.6)	406.3(±0.0)
Mean Annual Growth		124	135	95	52

3.3.4 Lake Whitefish

A total of 168 lake whitefish scale samples were collected for age analysis and back-calculation of growth in 1989. Table 3.3.13 summarizes the mean lengtn, weight, and condition factors by age class for lake whitefish from Lake Roosevelt. Table 3.3.14 lists the estimated mean total lengths (mm) of lake whitefish cohorts. Information on individual fish is contained in Appendix D.

Mean condition factor for all age classes of lake whitefish collected in 1989 ranged from 0.94 to 1.15 with an overall mean of 1.10 (Table 3.3.13). Mean capture length averaged 220 mm for age 1+, 282 mm for age 2+, 452 mm for age 3+, 520 mm for age 3+, 523 mm for age 4+, and 544 mm for age 6+ lake white fish. Mean capture weight averaged 125 g for age 1+, 327 g for age 2+, 1,099 g for age 3+, 1,611 g for age 4+, 1,857 g for age 5+,and 1,839 g for age 6+ lake whitefish.

Mean length at the formation of the first annulus ranged from 191 to 248 mm with a grand mean of 239 mm (Table 3.3.14). At the formation of the second annulus estimated mean length ranged from 251 to 335 mm, and the overall mean was 326 mm. Estimated length at the formation of the third annulus ranged from 405 to 429 mm with a grand mean of 419 mm. Estimated length ranged from 458 to 487 mm at the formation of the fourth annulus, and the grand mean was 478 mm. At the formation of the fifth annulus, mean length ranged from 494 to 496 mm with an overall mean of 496 mm. The estimated length at the formation of the sixth annulus was 524 mm.

3.4 ZOOPLANKTON

3.4.1 Zooplankton Density

A total of 58 species from 41 genera of zooplankton was identified in Lake Roosevelt during 1988 and 1989 (Table 3.4.1). Rototoria was the most diverse taxon, comprised of 30 species. Nineteen species of Cladocera and 6 species of Copepoda of were found. Mean density (#/m^3) of zooplankton families calculated for all index stations sampled during seasonal intervals (August and October 1988, and May, August, and October 1989) are shown in Tables 3.4.2 to 3.4.6. Mean densities for monthly samples collected from Porcupine Bay and Seven Bays (representitive Spokane River and Columbia River sample locations) are shown in Tables 3.4.7 through 3.4.10. Also included are values for *Daphnia* and *Leptodora kindtii* which were frequent prey items found in the

Table 3.3.13. Mean lengths (mm), weights (g), and condition factor (K_{TL}) (± standard deviations) of lake whitefish collected during 1989. N = sample size.

Age class	N	$\bar{X}$ Length (mm)	$\bar{X}$ Weight (g)	$\bar{X}$ K_{TL}
1+	13	220 (±42)	125 (± 72)	1 .15 (± 0.39)
2+	5	282 (±68)	327 (fl86)	0.94 (± 0.10)
3+	23	452 (±52)	1099 (±323)	1.12 (± 0.20)
4+	85	520 (±42)	1611 (±349)	1.12 (± 0.20)
5+	33	523 (±62)	1857 (±503)	1.15 (± 0.15)
6+	6	544 (±76)	1839 (±655)	1.09 (± 0.09)
TOTAL	1168			1.10 (± 0.19)

Table 3.3.14. Estimated mean total lengths (mm) ± standard deviations at annulus formation back-calculated for each age class of lake whitefish collected during 1989. N = sample size.

		Mean ± S.D. Back-calculated length at Annulus					
Cohort	N	1	2	3	4	5	6
1988	13	191(±28)					
1987	5	210(±31)	251(±43)				
1986	23	238(±40)	324(±53)	406(±56)			
1985	85	248(±45)	335(±56)	429(±46)	487(±43)		
1984	33	242(±37)	321(±45)	405(±49)	458(±57)	494(±78)	
1983	6	222(±16)	293(±36)	397(±78)	460(±82)	496(±62)	524(±78)
Grand Mean	168	239(±43)	326(±54)	419(±5)	478(±51)	496(±64)	524(±78)
Mean Annual Growth		239	87	93	59	18	28

Table 3.4.1. Synoptic list of zooplankton taxa identified in Lake Roosevelt during 1988 and 1989 study period.

Phylum Anthropoda

Class Crustacea

Subclass Brachipoda

Order Cladocera

Family Oaphnidae

1. *Ceriodaphnia quadranqula*
2. *Daphnia ambigua*
3. *Daphnia galeata mendota*
4. *Daphnia retrocurva*
5. *Daphnia schedleri*
6. *Daphnia thorata*
7. *Scapholeberis aurita*
8. *Simocephalus serrulatus*
9. *Alona guttata*
10. *Alona quadrangularis*
11. *Camptocerus rectirostris*
12. *Chydorus sphaericus*
13. *Eurycerus lamellatus*
14. *Pleuroxus denticulatus*

Family Sididae

15. *Diaphanosoma brachyurum*
16. *Diaphanosoma birgei*
17. *Sida crystallina*

Family Macrothricidao

18. *Macrothrix laticornis*
19. *Streblocerus pygmaeus*
20. *Streblocerus serricaudatus*

Family Bosminidae

21. *Bosmina longirostris*

Family Leptodoriidae

22. *Leptodora kindtii*

Subclass Copspoda

Order Eucopepoda

Suborder Calanoida

Family Diaptomidae

23. *Leptodiaptomus ashlandi*
24. *Skistodiaptomus oregonensis*

Family Temoridae

25. *Epischura nevadensis*

Suborder Cyciopoida

Family Cyciopoidae

26. *Diicyciops biwspidatus thomasi*
27. *Mesocyclop edax*

Suborder Harpacticoida

Family Harpacticoidae

26. *Bryocamptus spp.*

Phylum Rotifera

Class Monogononta

Order Flosculariacea

Family Conochilidao

29. *Conochilus unicornis*

Family Testudineliidae

30. *Testudinella patina f. triloba*

Family Filiniidae

31. *Filinia terminalis*
32. *Tetramastix opoliensis*

Order Collothecacea

Family Collothecidae

33. *Collotheca mutabilis*

Order Plioma

Family Synchaetidae

34. *Pleosoma truncatum*
35. *Polyarthra dolichoptera*
36. *Polyarthra major*
37. *Polyarthra vulgaris*
38. *Synchaeta pectinata*

Family Aspianchidae

39. *Asplanchna herricki*
40. *Asplanchna priodonta*

Family Brachionidae

41. *Agnotholca foliacea*
42. *Brachionus quadridentata*
43. *Kellicottia longispina*
44. *Keratella cochlearis cochlearis*
45. *Keratella cochlearis* recta
46. *Keratella crassa*
47. *Keratella hiemalis*
48. Keratella quadrata
49. *Notholca spp.*

Family Notommatidae

50. *Cephalodella gibba*

Family Epiphanidae

51. *Epiphanes spp.*

Family Euchlanidae

52. *Euchlanis dilatata*
53. *Euchlanis triquetra*

Family Trichotriidae

54. *Trichotria tetractis*

Family Trichocercidae

55. *Trichocerca porcellus*
56. *Trichocerca spp.*

Family Lecanidae

57. *Lecane spp.*
58. *Monostyla lunaris*

INDEX STATION										
TAXON	01	02	03	04	05	06	07	06	09	MONTHLY AVERAGE MEAN
Daphnia #/m^3 (±SD)		6,830 (4,299)	12,857 (2,970)	10,399 (2,391)	7,046 (495)	5,115 (815)	1,897 (403)	4,102 (226)	4,904 (141)	6,644
Mean *Daphnia* size mm (±SD)		1.51 (0.50)	1.68 (0.58)	1.89 (0.64)	1.48 (0.41)	1.84 (0.51)	1.84 (0.40)	1.93 (0.50)	1.84 (0.50)	1.76 mm
Leptodora #/m^3 (±SD)		2 (0)	23 (6)	49 (11)	9 (0)	4 (0)	2 (0)	7 (3)	3 (0)	12
Mean *Leptodora* size mm (±SD)		4.21 (1.44)	4.85 (1.85)	6.10 (1.93)	4.51 (1.41)	4.63 (1.99)	4.46 (2.31)	8.21 (3.46)	3.91 (1.53)	5.43 mm
Cladocera #/m^3 (±SD)		6,938 (4,148)	13,050 (2,936)	10,980 (2,362)	8,048 (466)	5,223 (796)	2,058 (536)	4,328 (330)	6,360 (41)	7,123
Adult Copepoda #/m3 (±SD)		2,137 (1,814)	3,898 (298)	22,713 (5,137)	1,2611 (1,086)	6,763 (3,849)	10,539 (5,273)	19,724 (1,520)	26,161 (2,100)	13,068
Mean Copepoda size mm (±SD)		- -	- -	- -	- -	- -	- -	- -	- -	-
Naudi #/m^3 (±SD)		105 (14)	537 (192)	554 (435)	463 (18)	36 (13)	7 (9)	235 (42)	117 (84)	257
Rotifera #/m^3 (±SD)	**Rotifers for August '88 not enumerated	0	0	0	0	0	0	0	0	- -
Total *Daphnia* Biomass (μg/m^3)		186,433.7	457,750.5	445,964.8	85,070.9	198,864.8	111,703.6	314,502.9	321,253.8	265,193
Total *Leptodora* Biomass (μg/m^3)		31.5	264.8	2712.7	213.6	116.7	46.1	840.8	52.3	535
Total Zooplankton #/m^3 (±SD)		9,180.2 (5,982.1)	17,485.1 (3,047.6)	34,246.5 (7,934)	21,122.0 (1,576.9)	12,026.6 (4,658.3)	12,603.2 (5,805.4)	24,287.2 (1,817.3)	32,637.6 (2,057.7)	20,449

Table 3.4.2. Mean densities (#/m^3±S.D.) of different categories of zooplankton and biomass (μg/m^3) values of *Daphnia* spp. and *Leptodora kindtii* at nine Index stations in August 1988.

TAXON	INDEX STATION 01	02	03	04	05	06	07	08	09	MONTHLY AVERAGE MEAN
Daphnia $\#/m^3$ (±SD)	53 (1)	775 (191)	20,149 (10,578)	7,504 (1,706)	2,493 (21)	9,662 (2,499)	2,039 (523)	3,490 (64)		5,771
Mean Daphnia sire mm (±SD)	1.13 (0.35)	1.54 (0.52)	1.52 (0.61)	1.74 (0.62)	1.38 (0.36)	1.51 (0.57)	1.51 (0.46)	1.60 (0.42)		1.50 mm
Leptodora $\#/m^3$ (±SD)	0 (0)	1 (0)	52 (5)	10 (1)	0	0	23 (7)	4 (0)		11
Mean *Leptodora* size (±SD)	9.80 (0.00)	4.58 (4.58)	7.31 (1.73)	4.78 (1.85)	- -	- -	- -	5.96 (2.96)		6.21 mm
Cladocera $\#/m^3$ (±SD)	162 (11)	891 (243)	20,352 (10,500)	7,815 (1,450)	3,230 (123)	9,662 (2,499)	2,303 (449)	4,038 (197)		6,056
Adult Copepoda $\#/m^3$ (±SD)	63 (1)	314 (21)	4,631 (42)	19,400 (1732)	10,254 (1773)	13,896 (4,011)	3,170 (360)	8,189 (2,295)		7,490
Mean Copepoda size mm (±SD)	- -	- -	- -	- -	- -	- -	- -	- -		- -
Naupli $\#/m^3$ (±SD)	302 (25)	433 (101)	938 (149)	22,563 (5415)	588 (37)	8,681 (668)	4,130 (263)	7,023 (811)		5,582
Rotifera $\#/m^3$ (±SD)	862 (35)	1 (2)	551 (408)	2,964 (1,094)	174 (100)	432 (187)	1106 (190)	4,328 (397)		1,302
Total *Daphnia* Biomass ($\mu g/m^3$)	292.8	24,637.1	887,962.2	426,425.3	29,632.0	421,997.43	83,282.06	154,641		253,609
Total *Leptodora* Biomass ($\mu g/m^3$)	36.9	22.0	4670.2	278.8	- -	- -	- -	199.4		651
Total Zooplankton $\#/m^3$ (±SD)	1,388.0 (42.4)	1,639.7 (367.7)	26,472.4 (9899.5)	52,741.2 (6,792.3)	14,245.7 (1,838.5)	3,2671 .1 (6,991.9)	10,709.6 (1,258.7)	23,577.6 (3,698.2)		20,431

Table 3.4.3. Mean densities ($\#/m^3 \pm$S.D.) of different categories of tooplankton and biomass ($\mu g/m^3$) values of ***Daphnia*** spp. and ***Leptodora kindtii*** at nine index stations in October 1988.

INDEX STATION										
TAXON	01	02	03	04	05	06	07	08	09	MONTHLY AVERAGE MEAN
Daphnia #/m^3 (±SD)	5 (7)	45 (64)	20 (14)	8 (11)	95 (120)	127 (36)	20 (28)	38 (6)	30 (42)	43
Mean *Daphnia* size mm (±SD)	0.61 (0.16)	0.88 (0.34)	0.77 (0.19)	0.64 (0.00)	0.93 (0.04)	0.83 (0.38)	1.26 (0.00)	1.12 (0.56)	1.45 (0.30)	0.86 mm
Leptodora #/m^3 (±SD)	0	14 (8)	16 (3)	1 (1)	0	9 (3)	0	11 (1)	7 (1)	6
Mean *Leptodora* size mm (±SD)	- -	1.07 (0.55)	1.70 (1.10)	0.68 (0.00)	- -	1.88 (1.56)	- -	2.39 (0.59)	1.58 (0.62)	1.57 mm
Cladocera #/m^3 (±SD)	86 (24)	189 (110)	68 (33)	106 (31)	135 (163)	254 (71)	155 (7)	86 (11)	250 (77)	147
Adult Copepoda #/m3 (±SD)	79 (35)	184 (90)	308 (123)	3,778 (158)	472 (559)	3,625 (949)	2,821 (745)	898 (87)	5,268 (1,725)	1,937
Mean Copepoda size mm (±SD)	- -	- -	- -	- -	0.81 (0.28)	- -	0.90 (0.32)	0.91 (0.34)	1.01 (0.33)	0.94 mm
Naupli #/m^3 (±SD)	1,970 (765)	5,689 (4,014)	5,238 (1,899)	6,319 (58)	720 (468)	11,826 (608)	7,508 (318)	4,238 (555)	26,151 (1,403)	7,740
Rotifera #/m^3 (±SD)	6,358 (1,637)	29,786 (18,521)	11,273 (2,960)	44,134 (524)	21,214 (19,151)	147,476 (19,777)	156,937 (2,944)	64,178 (1,285)	240,661 (20,447)	80,224
Total *Daphnia* Biomass (µg/m^3)	7.4	308.5	67.1	19.9	36.7	549.2	407	227.4	939.2	285
Total *Leptodora* Biomass (µg/m3)	- -	13.8	28.6	0.1	- -	21.1	- -	48.2	9.8	14
Total Zooplankton #/m^3 (±SD)	8,493.5 (883.9)	35,846.9 (22,740.6)	16,887.3 (4,956.8)	54,335.8 (771.6)	22,540.2 (20,343.5)	163,181 (20,189.7)	167,420.2 (1,873.8)	69,400.0 (1,930.4)	272,330.0 (23,645.7)	90,048

Table 3.4.4. Mean densities (#/m^3±S.D.) of different categories of zooplankton and biomass (µg/m^3) values of *Daphnia* spp. and ***Leptodora*** *kindtii* at nine index stations In May 1989.

INDEX STATION										
TAXON	01	02	03	04	05	06	07	08	09	MONTHLY AVERAGE MEAN
Daphnia #/m^3(±SD)	7,452 (919)	12,010 (1,499)	15,283 (332)	13,342 (2,962)	4,320 (877)	3,739 0	1,508 (283)	2,952 (1068)	1,443 (85)	6,894
Mean *Daphnia* size mm (±SD)	1.72 (0.64)	1.74 (0.65)	1.49 (0.49)	1.60 (0.65)	1.39 (0.42)	1.69 (0.63)	1.85 (0.51)	1.88 (0.63)	1.86 (0.48)	1.67 mm
Leptodora #/m^3(±SD)	2,346 (968)	338 (179)	35 (5)	28 (5)	3 (0)	25 (0)	0	0	0	308
Mean *Leptodora* size mm (±SD)	7.59 (3.23)	6.69 (1.46)	7.37 (3.46)	6.07 (2.65)	5.00 (0.91)	5.54 (2.13)	- -	3.20 (0.14)	- -	6.54 mm
Cladocera #/m^3 (±SD)	9,843 (1,892)	12,469 (1,678)	15,440 (286)	13,745 (3,005)	5,479 (1,183)	5,545 (2,482)	1,736 (270)	3,077 (1,022)	1,577 (109)	7,657
Adult Copepoda #/m3 (±SD)	244 (29)	712 (267)	1,396 (9)	19,328 (4,324)	19,131 (6,616)	5,134 (3,053)	17,986 (2,456)	12,791 (3,897)	10,664 (2,148)	9,710
Mean Copepode size mm (±SD)	1.09 (0.52)	0.88 (0.32)	1.54 (0.53)	1.07 (0.49)	0.89 (0.23)	1.19 (0.51)	1.18 (0.44)	1.35 (0.46)	1.25 (0.45)	1.16 mm
Naupli #/m^3 (±SD)	799 (247)	3,646 (390)	8,735 (454)	34,011 (7,561)	32,224 (11,249)	16,718 (480)	6,172 (25)	6,594 (892)	3,331 (124)	12,470
Rotifera #/m^3 (±SD)	12,492 (1376)	47,005 (164)	45,929 (4645)	2,114 (581)	53,323 (9695)	1,186 (397)	972 (141)	870 (180)	420 (104)	18,257
Total *Daphnia Biomass* (μg/m^3)	220,552.2	391,872	232,577.6	565,545.4	45,841.8	18,027.65	87,639.1	267,285.1	82,336.4	230,436
Total *Leptodora* Biomass (μg/m^3)	231 ,1 16.1	23,776.1	3,161.7	1,531.93	105.6	1,050.5	- -	1.7	- -	28,972
Total Zooplankton #/m^3 (±SD)	23,377.5 (240.4)	63,831.3 (855.6)	71,500.4 (4,829.5)	69,198.7 (15,470.6)	110,158.2 (28,750.0)	28,583.5 (6,411.7)	26,867 (2,071.8)	23,331.8 (5,996.3)	15,991.0 (2,227.4)	48,093

Table 3.4.5. Mean densities (#/m^3±S.D.) of different categories of zooplankton and biomass (μg/m^3) values of *Daphnia* spp. and *Leptodora* ***kindtil*** at nine index stations in August 1989.

INDEX STATION										
TAXON	01	02	03	04	05	06	07	08	09	**MONTHLY AVERAGE MEAN**
Daphnia #/m^3(±SD)	1,161 (1,039)	2,263 (28)	5,463 0	22,185 (43)	2,555 (346)	4,240 (497)	830 0	3,021 (198)	2,701 (1,188)	4,935
Mean *Daphnia* size mm (±SD)	1.31 (0.43)	1.43 (0.58)	1.51 (0.56)	1.72 (0.53)	1.58 (0.40)	1.62 (0.60)	1.65 (0.51)	1.64 (0.52)	1.74 (0.48)	1.53 mm
Leptodora #/m^3 (±SD)	3 (3)	3 (1)	8 0	8 (1)	6 (1)	0	0	0.42 (0)	0	3
Mean *Leptodora* size mm (±SD)	4.48 (2.20)	5.65 (2.65)	6.66 (2.48)	5.71 (3.40)	5.11 (1.73)	- -	- -	8.85 (4.37)	- -	5.91 mm
Cladocera #/m^3 (±SD)	1,998 (1,672)	2,705 (8)	5,866 0	22,530 (99)	3,280 (366)	4,406 (442)	979 0	3,699 (136)	3,066 (1254)	5,392
Adult Copepoda #/m^3 (±SD)	236 (255)	637 (27)	925 0	22,489 (743)	9,343 (1114)	8,448 (136)	4,144 0	14,030 (367)	2,915 (307)	7,018
Mean Copepoda size mm (±SD)	1.11 (0.38)	- -	1.44 (0.45)	1.06 (0.34)	1.12 (0.12)	1.09 (0.35)	1.09 (0.29)	- -	1.09 (0.37)	1.13 mm
Naupli #/m^3 (±SD)	369 (185)	1,519 (143)	946 0	16,101 (724)	10,199 (617)	5,786 (1,186)	4,488 0	7,294 (361)	3,466 (989)	5,574
Rotifera #/m^3 (±SD)	17,198 (13,221)	8,376 (2,577)	1,268 0	7,491 (1,406)	16,858 (338)	2,101 (504)	1,087 0	2,924 (374)	2,501 (1,154)	6,645
Total *Daphnia* Biomass (ug/m^3)	11,879.9	69,968.8	280,858.6	358,577.5	104,379.2	226,254.6	39,707.3	151,371.3	152,602.7	155,067
Total *Leptodora* Biomass (ug/m3)	60.0	151.94	570.7	353.1	214.1	- -	- -	62.3	- -	157
Total Zooplankton #/m^3 (±SD)	19,799.7 (15,330.1)	13,236.9 (2,404.2)	9,005.4 0	68,610.6 (1,288.3)	39,678.7 (1,209.2)	20,741.8 (1,112.2)	10,696.8 0	27,947.5 (961.7)	11,948.1 (3,691.1)	24,630

Table 3.4.6. Mean densities (#/m^3±S.D.) of different categories of zooplankton and biomass (μg/m^3) values of *Daphnia* spp. and ***Leptodora kindtii*** at nine index stations In October, 1989.

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MONTHLY MEAN
Daphnia #/m^3 (±SD)								10,398 (2,391)	7,072 (149)	7,504 (1,706)	2,550 (525)	2,105 (0)	5,926
Mean *Daphnia* size mm (±SD)								1.89 (0.64)	1.67 (0.50)	1.74 (0.62)	1.57 (0.65)	1.36 (0.43)	1.68
Leptodora #/m^3 (±SD)								49 (11)	1 (1)	10 (1)	0	0	12
Mean *Leptodora* size mm (±SD)								6.10 (1.93)	4.34 (1.33)	4.78 (1.85)	--	--	5.59
Cladocera #/m^3 (±SD)								10,980 (2,362)	7,294 (46)	7,815 (1,450)	2,884 (299)	2,257 (9)	6,246
Adult Copepoda #/m^3 (±SD)								22,713 (5,137)	8,938 (742)	19,400 (1,732)	5,106 (379)	4,913 (86)	12,214
Mean Copepoda size mm (±SD)								--	--	--	--	--	
Naupli #/m^3 (±SD)								554 (435)	256 (90)	22,563 (5,415)	6,755 (1,827)	7,823 (590)	7,590
Rotifera #/m^3 (±SD)								0	0 (1,094)	2,964 (298)	458 (1,104)	4,205	1,525
Total *Daphnia* biomass (ug/m^3)								445,964.8	330,782.2	426,425.3	30,341.4	54,415.3	257,586
Total *Leptodora* biomass (ug/m^3)								2712.7	31.3	278.8	--	--	605
Total Zooplankton #/m^3 (±SD)								34,246.5 (7,934)	16,487.4 (877.5)	52,741.2 (6,792.3)	15,202.7 (2,204.9)	19,196.7 (1,788.2)	27,575

Table 3.4.7. Mean monthly densities (#/m^3±S.D.) of different categories of zooplankton and biomass ($\mu g/m^3$) of *Daphnia* spp. and ***Leptodora kindtii*** at Porcupine Bay (Index Station 4) from August to December 1988.

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MONTHLY MEAN
Daphnia #/m³ (±SD)								5,115 (815)	4,668 (738)	9,662 (2,499)	6,219 (2,384)	190 0	5,171
Mean *Daphnia* size mm (±SD)								1.84 (0.51)	1.64 (0.54)	1.51 (0.57)	1.65 (0.63)	1.40 (0.51)	1.65
Leptodora #/m³ (±SD)								4 (0)	3 (1)	0	0	0	2
Mean *Leptodora* size mm (±SD)								4.63 (1.99)	- -	- -	- -	- -	4.63
Cladocera #/m³ (±SD)								5,223 (796)	4,811 (771)	9,662 (2,499)	7,003 (2,630)	207 (8)	5,381
Adult Copepoda #/m³ (±SD)								6,763 (3,849)	8,306 (496)	13,896 (4,011)	1,337 (390)	670 (174)	6,194
Mean Copepoda size mm (±SD)								- -	- -	- -	- -	- -	- -
Naupli #/m³ (±SD)								36 (13)	83 (89)	8,681 (668)	1,482 (267)	1,039 (237)	2,264
Rotifera #/m³ (±SD)								0	0	432 (187)	291 (41)	1,826 (671)	510
Total *Daphnia* biomass (µg/m³)								198,864.8	237,321 .0	421,997.4	8,349.4	4,071.5	174,121
Total *Leptodora* biomass (µg/m³)								116.7	24.6	- -	- -	- - 3,742.0	28
Total Zooplankton #/m³ (±SD)								12,026.6 (4,658.3)	13,199.8 (1,355.6)	32,671.1 (6,991.9)	10,112.9 (3,246.7)	3,742.0 (268.6)	14,351

Table 3.4.8. Mean monthly densities (#/m³±S.D.) of different categories of tooplankton and biomass (µg/m³) values of *Daphnia* spp. and *Leptodora kindtil* at Seven Bays (Index Station 6) from August to December 1988.

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MONTHLY MEAN
Daphnia	91	0	0	0	0	8.085	10.167	13,342	12,321	22,185	507	79	5,618
#/m3 (*SD)	(10)				(11)	(4,735)	(275)	(2.962)	0	(43)	0	(104)	
Mean *Daphnia* size	1.67	- -	_-	- -	0.64	1.52	1.69	1.60	1.52	1.72	1.33	1.58	1.59
mm (±SD)	(0.43)				(0.00)	(0.40)	(0.72)	(0.65)	(0.56)	(0.53)	(0.58)	(0.54)	
Leptodora	0	0	0	0	1	473	337	28	0	8	0	0	71
#/m3 (±SD)					(1)	(172)	(3)	(5)		(1)	0		
Mean *Leptodora* size	- -	- -	- -	- -	0.68	4 00	6.43	6.07	- -	5.71	6.20	- -	5.61
mm (±SD)					(0)	(2.24)	(3.34)	(2.65)		(3.40)	(0)		
Cladocera	120	0	7	0	106	10,060	10.605	13.745	13,087	22,530	615	1,C?4	5,992
#/m3 (±SD)	(10)		(10)		(31)	(4667)	(262)	(3.005)	0	(99)	0	(24)	
Adult Copepoda	543	102	387	4,265	3.778	12,986	7.508	19.320	33,648	22,489	933	2,573	9,045
#/m3 (±SD)	(89)	(21)	(89)	(1,387)	(158)	(7.231)	(316)	(4,324)	0	(743)	0	(211)	
Mean Copepoda size	- -	- -	- -	- -	- -	- -	1.31	1.07	1.01	1.06	1.02	1.15	1 03
mm (±SD)							(0.43)	(0.49)	(0.30)	(0.34)	(0.43)	(0.29)	
Naupli	1357	806	808	1.693	6.319	20,619	21,573	34.011	31,403	16,101	2,332	5,311	11,861
#/m3 (±SD)	(189)	(195)	(249)	(51)	(58)	(9.977)	(2.188)	(7.561)	0	(724)	0	(444)	
Rotifera	10.489	12.351	5.561	4.301	44.134	169.161	42.076	2,114	6,888	7,491	5,205	4,175	26,164
#/m3 (±SD)	(199)	(2,466)	(1.123)	(226)	(524)	(21,217)	(391)	(581)	0	(1406)	0	(618)	
Told *Daphnia* Biomass (µg/m3)	4452.5	- -	- -	- -	19.9	169.007.7	245.961.9	565.545.4	446,440.3	358,577.5	15,156.5	31,940.6	153,092
Total *Leptodora* Biomass (µg/m3)	- -	- -	- -	- -	0.1	8.441.7	21.335.3	1.531.9	- -	353.1	8.0	- -	2639
Total Zooplankton	12.506.4	13,258 6	6.762.9	10,258.2	54.335.8	12.845.5	81.762.3	69.198.7	85,024.8	68,610.6	9.085.4	13,083.7	53061
#/m3 (±SD)	(288.3)	(2.340 5)	(1.45 1.5)	(1,109.6)	(771 6)	4,3092.9)	(1,219.6)	(15,470.6)	0	(1,288.3)	0	(1,296.3)	

Table 3.4.9. Mean monthly densities (#/m3±S.D.) of different categories of zooplankton and biomass (µg/m3) values of *Daphnia* spp. and *Leptodora kindtii* at Porcupine Bay (Index Station 4) In 1989.

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Monthly Meal
Daphnia #/m3 (±SD)	33 (47)	0	0	6 (9)	127 (36)	4,388 (1.223)	14.877 (33)	3,739	2,558 0	4.240 (497)	7.067 (3.728)	7,907.65 (1.170)	3.745
Mean *Daphnia* size mm (±SD)	1.56 (0.12)	--	--	0.92 (0.00)	0.83 (0 38)	1.51 (0.44)	1.89 (0.67)	1 . 6 9 (0.63)	1 65 (0.69)	1.62 (0 60)	1.77 (0.77)	1.95 (0.52)	1.66
Leptodora $\#/m^3$ (±SD)	0	0	0		9 (3)	403 (22)	262 (1)	25 (0)	1 0	0	0.65 (0)	5 (0)	59
Mean *Leptodora* sue m m (±SD)	- -	- -	- -	. .	1.88 (1.56)	3.72 (2 06)	6.41 (2.57)	5.54 (2.13)	2.55 (1.20)	- -	8.29 (1.41)	7.09 (1.65)	5.06
Cladocera $\#/m^3$(±SD)	185 (19)	7 (9)	0	13 0	254 (71)	5.270 (1.245)	15.258 (78)	5,545 (2,482)	2,701 0	4,406 (442)	7,486 (3.847)	8,360 (1,208)	4,124
Adult Copepoda #/m3 (±SD)	152 (65)	125 (28)	380 (80)	753 (26)	3,625 (949)	6.361 (1.465)	8,373 (134)	5.134 (3,053)	7,307 0	8,448 (136)	3,657 (1,875)	2,274 (962)	3,882
Mean Copepoda size mm (±SD)	- -	- -	- -	- -	- -	- -	1.32 (0.40)	1.19 (0.51)	1.16 (0.40)	1.09 (0.35)	1.30 (1.41)	1.27 (1.41)	1.22
Naupli $\#/m^3$ (±SD)	469 (1 0 3)	660 (75)	1,076 (169)	1.631 0	11,826 (608)	8,787 (819)	19.281 (705)	16.718 (480)	6,425 0	5,786 (1.186)	3,206 (120)	2,290 (840)	6,513
Rotifera $\#/m^3$ (±SD)	1,604 (65)	5,742 (1,120)	4,921 (6 0)	8.099 (291)	147.476 (19.777)	260,635 (5,982)	50.195 (2,107)	1.186 (397)	1,251 0	2,101 (504)	3,862 (2,525)	4,187 (246)	4,094
Total *Daphnia* Biomass ($\mu g/m^3$)	1,294.9	- -	- -	15 2	549.2	68.592.2	415.647.t	180,276.5	104,664.2	226,254.6	613,836.3	606,755.4	184,824
Total *Leptodora* Biomass ($\mu g/m^3$)	-	- -	- -	. .	21.1	59.0	16.440.1	1,050.5	6.1	- -	80.9	391 1	1,504
Total Zooplankton $\#/m^3$ (±SD)	2.409.0 (46 7)	6,534.0 (1.026.7)	6,376.7 (1,49.1)	10.495.4 (316.9)	163.181 0 (20,189.7)	281,053.4 (2.453.3)	93.103.7 1,190.4	28.583.5 (6,411.7)	17.683 5 0	20,741.8 (1 ,112.2)	18.211.1 (3,076.7)	17.111.1 (3,256 9)	55,457

TABLE 3.4.10. **Mean monthly densities (#/m^3±S.D.) of different categories of zooplankton and biomass ($\mu g/m^3$) values of *Daphnia* spp. and *Leptodora kindtii* at Seven Bays (Index Station 6) in 1989.**

stomachs of planktivorous fish. Mean densities of individual species of zooplankton are listed in Appendix E.

All locations were sampled in August 1988. Mean density of zooplankton per site was estimated at 20,449/m^3 in August 1988. Zooplankton composition was 64% Copepoda (13,068/m^3), 35% Cladocera (7,123/m^3), and 1% Copepoda nauplii (257/m^3) (Table 3.4.2). Rotifers were present but not enumerated this month. Cladocera density was highest at Hunters (13,050/m^3) and Porcupine Bay (10,980/m^3), and lowest at Keller Ferry (2,058/m^3) and San Poil (4,328/m^3). Copepoda density was highest at Spring Canyon (26,161/m^3), Porcupine Bay (22,713/m^3), and San Poil (19,724/m^3), and lowest at Gifford (2,137/m^3) and Hunters (3,898/m^3). *Daphnia* comprised 93% (6,644/m^3) of the mean Cladocera density. *Leptodora kindtii* were present in low abundance, averaging 12/m^3 for all locations. Mean density of *Daphnia sp.* was highest at Hunters (12,857/m^3) and Porcupine Bay (10,398/m^3), and lowest at Keller Ferry (1,897/m^3). Mean *Daphnia* size ranged from 1.48 to 1.93 mm with an overall mean of 1.76 mm.

Mean zooplankton density at Porcupine Bay in September 1988 was estimated at 16,487/m^3 (Table 3.4.7). Zooplankton density was comprised of 54% Copepoda (8,938/m^3), 44% Cladocera (7,294/m^3), and 2% Copepoda nauplii (256/m^3). Rotifers were present but not enumerated this month. *Daphnia* comprised 97% of the Cladocera taxa and 43% of total zooplankton. *Leptodora kindtii* comprised less than 1% (1/m^3) of Cladocera density. The mean *Daphnia* size was 1.67 mm.

Mean zooplankton for Seven Bays in September 1988 was estimated at 13,200/m^3, comprised of 63% Copepoda (8,306/m^3), 36% Cladocera (4,81 1/m^3), and 1% Copepoda nauplii (83/m^3) (Table 3.4.8). Rotifers were present but not enumerated this month. *Daphnia* comprised 97% of the Cladocera and 35% of the total zooplankton. *Leptodora kindtii* were not found in samples from this location. Mean *Daphnia* size was 1.65 mm.

All locations were sampled in October 1988. However, samples were not collected from Spring Canyon because of a malfunction of the sampling apparatus. Mean zooplankton density per site in October 1988, was estimated at 20,431/m^3 (Table 3.4.3). Copepoda comprised 37% (7,490/m^3) of the mean density of zooplankton per site, followed by Cladocera at 30% (6,056/m^3), Copepoda nauplii at 27% (5,582/m^3),and rotifers at 6% (1,302/m^3). The highest mean density of zooplankton was estimated at 52,741/m^3 from Porcupine Bay. Copepoda density was also highest at Porcupine Bay estimated at 19,400/m^3. Highest Cladocera density was at Hunters (20,352/m^3). *Daphnia* made up 95% (5,771/m^3) of mean Cladocera density. *Leptodora kindtii* comprised less than 1% (11 /m^3) of Cladocera density. Mean *Daphnia* size ranged from 1.13 mm to 1.74 mm with an overall mean of 1.50 mm.

Mean zooplankton density for Porcupine Bay in November 1988 was estimated at 15,203/m^3 (Table 3.4.7). Zooplankton abundance included 44% Copepoda nauplii (6,755/m^3), 34% Copepoda (5,106/m^3), 19% Cladocera (2884/m^3), and 3% rotifers (458/m^3). Mean density of Cladocera was comprised of *88%* (2,550/m^3) *Daphnia. Leptodora kindtii* were not found in November samples from this location. Mean size of *Daphnia* size was 1.57 mm.

Mean zooplankton density for Seven Bays in November 1988 was estimated at 10,113/m^3 comprised of 69% Cladocera (7,003/m^3), 15% Copepoda nauplii (1,482/m^3), 13% Copepoda (1,337/m^3), and 3% rotifers (291/m^3) (Table *3.4.8). Daphnia* comprised 93% (6,219/m^3) of mean Cladocera density. *Leptodora kindtii* were not found in samples this month. Mean size of *Daphnia* was 1.65 mm.

Mean zooplankton density for Porcupine Bay in December 1988 was estimated at 19,197/m^3 (Table 3.4.7). Zooplankton abundance included 41% Copepoda nauplii (7,823/m^3), 26% Copepoda (4,913/m^3), 22% Rotifers (4,205/m^3), and 12% Cladocera (2,257/m^3). ***Daphnia*** comprised 93% (2,105/m^3) of the Cladocera density. *Leptodora kindtii* were not found in December samples from this location. Mean *Daphnia* size was 1.36 mm.

Mean zooplankton density for Seven Bays in December 1988 was estimated at 3,742/m^3 (Table 3.4.8). Zooplankton abundance included 49% rotifers (1,826/m^3), 28% Copepoda nauplii (1,039/m^3), 18% Copepoda (670/m^3), and 6 % Cladocera (207/m^3). *Daphnia* comprised 93% (190/m^3) of the Cladocera density. *Leptodora kindtii* were not found in December samples from this location. Mean *Daphnia* size was 1.40 mm.

Mean zooplankton density at Porcupine Bay in January 1989 was estimated at 12,506/m^3 comprised of 84% rotifers (10,489/m^3), 11% Copepoda nauplii (1,357/m^3), 4% Copepoda (543/m^3), and 1% Cladocera (120/m^3) (Table *3.4.9). Daphnia* comprised 76% of the Cladocera density. Leptodora ***kindtii*** were not found in January samples from this location. Mean size of Daphnia was 1.67 mm.

Mean zooplankton density at Seven Bays in January 1989 was estimated at 2,409/m^3 (Table 3.4.10). Zooplankton abundance included

67% rotifers (1604/m^3), 19 % Copepoda nauplii (469/m^3), 8% Cladocera (185/m^3), and 6% Copepoda (152/m^3). *L eptodora kindtii* were not found in January samples from this location. Daphnia comprised 18% of the Cladocera density. Mean Daphnia size was 1.56 mm.

Mean zooplankton density at Porcupine Bay in February 1989 was estimated at 13,259/m^3 (Table 3.4.9). Zooplankton abundance included 93% rotifers (12,351/m^3), 6% Copepoda nauplii (806/m^3), and 1% Copepoda (102/m^3). Cladocera were not found in samples from this location in February 1989 at this location.

Mean zooplankton density at Seven Bays in February 1989 was estimated at 6,534/m^3 comprised of 88% rotifers (5,742/m^3), 10% Copepoda nauplii (660/m^3), 2% Copepoda (125/m^3), and less than 1% Cladocera (7/m^3) (Table 3.4.10). *Daphnia* and *Leptodora kindtii* were not found in February 1989 at this location.

Mean zooplankton density at Porcupine Bay in March 1989 was estimated at 6,763/m^3 (Table 3.4.9). Zooplankton abundance included 82% rotifers (5,561/m^3), 12% Copepoda nauplii (808/m^3), 6% Copepoda (387/m^3), and less than 1% Cladocera (7/m^3). Daphnia and *Leptodora kindtii* were not found in March 1989 at this location.

Mean zooplankton density at Seven Bays in March 1989 was estimated at 6,377/m^3 (Table 3.4.10). Zooplankton abundance included 77% rotifers (4,921/m^3), 17% Copepoda nauplii (1,076/m^3), and 6% Copepoda (380/m^3). Cladocera were not found in March 1989 at this location.

Mean density of zooplankton at Porcupine Bay in April 1989 was estimated at 10,258/m^3 (Table 3.4.9). Zooplankton abundance included 42% rotifers (4,301/m^3), 41% Copepoda (4,265/m^3), and 17% Copepoda nauplii (1 ,693/m^3). Cladocera were not found in April 1989 at this location.

Mean zooplankton density at Seven Bays in April 1989 was estimated at 10,495/m^3 comprised of 77% rotifers (8,099/m^3), 16% Copepoda nauplii (1,631/m^3), 7% Copepoda (753/m^3), and less than 1% Cladocera (13/m^3) (Table 3.4.10). *Daphnia* comprised 50% of the Cladocera density. *Leptodora kindtii* were not found in April 1989 at this location. Mean *Daphnia* size was 0.92 mm.

Mean zooplankton density of all 9 sites sampled in May 1989 was estimated at 90,048/m^3 per site (Table 3.4.4). Densities were highest near the lower end of the reservoir at Spring Canyon (272,330/m^3), Keller Ferry (167,420/m^3) , and Seven Bays (163,181/m^3). Lowest density occurred in the upper part of the reservoir at Kettle Falls (8,493/m^3). Mean zooplankton density was comprised of 89% rotifers (80,224/m^3), 9% Copepoda nauplii (7,740/m^3), 2% Copepoda (1,937/m^3), and less than 1% Cladocera (147/m^3). Mean density of *Daphnia* was highest at Seven Bays (127/m^3) and lowest at Kettle Falls (5/m^3). *Leptodora kindtii* mean density per site was 6/m? Mean *Daphnia* size ranged from 0.61 to 1.45 mm with an overall mean of 0.86 mm.

Mean zooplankton density at Porcupine Bay in June 1989 was estimated at 21 2,846/m^3 (Table 3.4.9). Zooplankton abundance included 79% rotifers (169,181/m^3), 10% Copepoda nauplii (20,619/m^3), 6% Copepoda (12,986/m^3), and 5% Cladocera (1 0,060/m^3). Cladocera densty was comprised of *80%* (8,085/m^3) *Daphnia* and *5% Leptodora kindtii* (473/m^3) Mean *Daphnia* size was 1.52 mm.

Mean zooplankton density at Seven Bays in June 1989 was estimated at 281,053/m^3 (Table 3.4.10). Zooplankton abundance included 93% rotifers (260,635/m^3), 3% Copepoda nauplii (8,787/m^3), 2% Copepoda (6,361/m^3), and 2% Cladocera (5,270/m^3). Cladocera density included 83% *Daphnia* (4,388/m^3) and *8% Leptodora kindtii* (403/m^3). Mean *Daphnia* size was 1.51 mm.

Mean zooplankton density at Porcupine Bay in July 1989 was estimated at 81,762/m^3 (Table 3.4.9). Zooplankton abundance included 51% rotifers (42,076/m^3), 26% Copepoda nauplii (21,573/m^3), 12% Cladocera (10,605/m^3), and 9% Copepoda (7,508/m^3). Cladocera density was comprised of *96%* ***Dahpnia*** and *3% Leptodora kindtii.* Mean *Daphnia* size was 1.69 mm.

Mean zooplankton density at Seven Bays in July 1989 was estimated at 93,104/m^3 (Table 3.4.10). Zooplankton abundance included 54% rotifers (50,1 95/m^3), 21% Copepoda nauplii (19,281 /m^3), 16% Cladocera (15,258/m^3), and 9% Copepda (8,373/m^3). Cladocera density was comprised of 97% Daphnia (14,877/m^3) and 2% ***Leptodora kindtii*** (262/m^3). Mean *Daphnia* size was 1.89 mm.

Mean zooplankton density of all sites sampled in August 1989 was estimated at 48,093/m^3 (Table 3.4.5). Highest zooplankton density was at Little Falls (110,158/m^3) and lowest at Spring Canyon (15,991/m^3).

Zooplankton abundance included 38% rotifers ($18,257/m^3$), 25% Copepoda nauplii ($12,470/m^3$), 20% Copepoda ($9,710/m^3$), and 16% Cladocera ($7,657/m^3$). Cladocera density was highest at Hunters ($15,440/m^3$) and Porcupine Bay ($13,745/m^3$), and lowest at Spring Canyon ($1,577/m^3$) and Keller Ferry ($1,736/m^3$). Copepoda density was highest at Porcupine Bay ($19,328/m^3$) and Little Falls ($19,131/m^3$), and lowest at Kettle Falls ($244/m^3$) and Gifford ($712/m^3$). *Daphnia* and *Leptodora kindtii* respectively comprised 90% ($6,894/m^3$) and 4% ($308/m^3$) of mean Cladocera density. Density of *Daphnia* was highest at Hunters ($15,283/m^3$) and Porcupine Bay ($13,342/m^3$), and lowest at Spring Canyon ($1,443/m^3$) and Keller Ferry ($1,508/m^3$). Mean density of *Leptodora kindtii* was highest at Kettle Falls ($2,346/m^3$) and Gifford ($2,338/m^3$); however, they were not found in samples from Spring Canyon and Keller Ferry (lower end of the reservoir). Mean *Daphnia* size ranged from 1.49 to 1.88 mm, with an overall mean of 1.67 mm.

Mean zooplankton density at Porcupine Bay in September 1989 was estimated at $85,024/m^3$ (Table 3.3.9). Zooplankton abundance included 40% Copepoda ($33,648/m^3$), 37% Copepoda nauplii ($31,403/m^3$), 15% Cladocera ($13,087/m^3$), and 8% rotifers ($6,888/m^3$). *Daphnia* comprised 94% ($12,321/m^3$) of Cladocera density. *Leptodora kindtii* were not found in samples from this location. Mean *Daphnia* size was 1.52 mm.

Mean zooplankton density at Seven Bays in September 1989 was estimated at $17,683/m^3$ (Table 3.3.10). Zooplankton abundance included 41% Copepoda ($7,307/m^3$), 36% Copepoda nauplii ($6,425/m^3$), 15% Cladocera ($2,701/m^3$), and 7% rotifers ($1,251/m^3$). *Daphnia* comprised 95% ($2,558/m^3$) of Cladocera density. *Leptodora kindtii* density was low estimated at 1 per m^3. Mean *Daphnia* size was 1.65 mm.

Mean zoopiankton density for all sites sampled in October 1989 was estimated at $24,360/m^3$ (Table 3.4.6). Zooplankton density was highest at Porcupine Bay ($68,61 1/m^3$) and lowest at Hunters ($9,005/m^3$). Mean zooplankton abundance was comprised of 28% Copepoda ($7,018/m^3$), 27% rotifers ($6,645/m^3$), 23% Copepoda nauplii ($5,574/m^3$), and 22% Cladocera ($5,392/m^3$). Cladocera density was highest at Porcupine Bay ($22,530/m^3$) and lowest at Keller Ferry ($979/m^3$). Copepoda density was highest at Porcupine Bay ($22,489/m^3$) and lowest at Kettle Falls ($236/m^3$). *Daphnia* comprised 92% ($4,935/m^3$) of mean Cladocera density. *Daphnia* density was highest at Porcupine Bay ($22,185/m^3$) and lowest at Keller Ferry ($830/m^3$). *Leptodora kindtii* density was low, averaging $3/m^3$ for all sites. Mean *Daphnia* size ranged from 1.31 to 1.74 mm with an overall mean of 1.53 mm.

Mean zooplankton density at Porcupine Bay in November 1989 was estimated at 9,085/m^3 (Table 3.4.9). Zooplankton abundance included 57% rotifers (5,205/m^3), 26% Copepoda nauplii (2,332/m^3), 10% Copepoda (933/m^3), and 7% Cladocera (615/m^3). *Daphnia* comprised 82% (507/m^3) of Cladocera density. *Leptodora kindtii* density was low, estimated at 0.14/m^3. Mean *Daphnia* size was 1.33 mm.

Mean zooplankton density at Seven Bays in November 1989 was estimated at 18,211 /m^3 (Table 3.4.10). Zooplankton abundance included 41% Cladocera (7,486/m^3), 21% rotifers (3,862/m^3), 20% Copepoda (3,657/m^3), and 18% Copepoda nauplii (3,206/m^3). *Daphnia* comprised 94% (7,067/m^3) of Cladocera density. *Leptodora kindtii* density was 1/m^3. Mean *Daphnia* size was 1.77 mm.

Mean zooplankton density at Porcupine Bay in December 1989 was estimated at 13,084/m^3 (Table 3.4.9). Zooplankton abundance included 41% Copepoda nauplii (5,31 1/m^3), 32% rotifers (4,175/m^3), 20% Copepoda (2.573/m^3), and 8% Cladocera (1,024/m^3). *Daphnia* comprised 8% (79/m^3) of Cladocera density. *Leptodora kindtii* were not found in December 1989 at this location. Mean *Daphnia* size was 1.58 mm.

Mean zooplankton density at Seven Bays in December 1989 **was** estimated at 17,11 1/m^3 (Table 3.4.10). Zooplankton abundance included 49% Cladocera (8,360/m^3), 24% rotifers (4,187/m^3), and 13% each Copepoda nauplii (2,290/m^3) and Copepoda (2,274/m^3). *Daphnia* comprised 95% (7,908/m^3) of Claodcera density. *Leptodora kindtii* density was 5/m^3. Mean *Daphnia* size 1.95 mm.

3.4.2 Zooplankton Biomass

Biomass ($\mu g/m^3$) of *Daphnia sp.* and *Leptodora kindtii* was calculated at all index stations sampled during seasonal intervals (August and October 1988, and May, August, and October 1989), and also for monthly samples collected from Porcupine Bay and Seven Bays (representitive Spokane and Columbia River sample sites). Seasonal biomass values of *Daphnia* and *Leptodora kindtii* for all index station are shown in Tables 3.4.2 through 3.4.6. Monthly biomass for Porcupine Bay and Seven Bays are shown in Tables 3.4.7 through 3.4.10. Biomass of individual *Daphnia* species are listed in Appendix E.

Mean biomass for all sample sites in August 1988 was 265,193 $\mu g/m^3$ for *Daphnia* and *535* $\mu g/m^3$ for *Leptodora kindtii* (Table 3.4.2).

Biomass of *Daphnia* ranged from a high of 457,750 μg/m³ at Hunters to a low of 85,071 μg/m³ at Little Falls. *Leptodora kindtii* biomass ranged from a high of 2,713 μg/m³ at Porcupine Bay to a low of 31 μg/m³ at Gifford.

In September 1988, at Porcupine Bay, *Daphnia* biomass was 330,782 μg/m³, and *Leptodora kindtii* biomass was 31 μg/m³ (Table 3.4.7). At Seven Bays, *Daphnia* biomass was 237,321 μg/m³ and *Leptodora kindtii* biomass was 25 μg/m³ (Table 3.4.8).

Mean biomass for all sample sites, excluding Spring Canyon, in October, 1988 was *253,609* μg/m³ for *Daphnia* and 651 μg/m³ for *Leptodora kindtii* (Table 3.4.3). Biomass for *Daphnia* ranged from a high of 887,962 μg/m³ at Hunters to a low of 293 μg/m³ at Kettle Falls. Biomass of *Daphnia* was also high at Porcupine Bay (426,425 μg/m³) and Seven Bays (421,997 μg/m³). Biomass of *Leptodora kindtii* was highest at Hunters *(4,670* μg/m³). *Leptodora kindtii* were not found at Little Falls, Seven Bays, and Keller Ferry this month.

In November 1988 biomass of *Daphnia* was 30,341 μg/m³ at Porcupine Bay and 8,349 μg/m³ at Seven Bays. *Daphnia* biomass was 54,415 μg/m³ at Porcupine Bay, and 4,071 μg/m³ at Seven Bays in December, 1988 (Tables 3.4.7 and 3.4.8). In January, 1989 *Daphnia* biomass was 4,453 μg/m³ at Porcupine Bay, and 1,295 μg/m³ at Seven Bays. From February to April, 1989, *Daphnia* were not found at Porcupine Bay. From February to March, 1989 *Daphnia* were not found at Seven Bays. In April 1989 *Daphnia* biomass was 15 μg/m³ at Seven Bays (Tables 3.4.9 and 3.4.10). *Leptodora kindtii* were not found in samples from November 1988 to April 1989 at these locations.

Mean biomass for all sample sites in May 1989 was 285 μg/m³ for *Daphnia* and 14 μg/m³ for *Leptodora kindtii* (Table 3.4.4). Biomass levels of *Daphnia* ranged from a high of 939 μg/m³ at Spring Canyon to a low of 7 μg/m³ at Kettle Falls. *Leptodora kindtii* biomass ranged from a high of 48 μg/m³ at San Poil to a low of 0 μg/m³ at Kettle Falls, Little Falls, and Keller Ferry.

In June 1989 biomass of *Daphnia* was 169,008 μg/m³ at Porcupine Bay and 68,592 μg/m³ at Seven Bays. Leptodora *kindtii* biomass was 8,442 μg/m³ at Porcupine Bay and 59 μg/m³ at Seven Bays (Tables 3.4.9 and 3.4.10).

In July 1989 biomass of *Daphnia* was 245,962 μg/m^3 at Porcupine Bay and 415,648 μg/m^3 Seven Bays. *Leptodora kindtii* biomass was 21,335 μg/m^3 at Porcupine Bay and 16,440 μg/m^3 at Seven Bays (Tables 3.4.9 and 3.4.10).

Mean biomass for all sites sampled in August 1989 was 230,436 μg/m^3 for *Daphnia* and 28,972 μg/m^3 for Leptodora *kindtii* (Table 3.4.5). *Daphnia* biomass levels ranged from a high of 565,545 μg/m^3 at Porcupine Bay to a low of 45,842 μg/m^3 at Little Falls. *Leptodora kindtii* biomass levels ranged from a high of 231 ,116 μg/m^3 at Kettle Falls to a low of 0 μg/m^3 at Keller Ferry and Spring Canyon.

In September 1989 *Daphnia* biomass was 446,440 μg/m^3 at Porcupine Bay and 104,664 μg/m^3 at Seven Bays. *Leptodora kindtii* biomass was 0 μg/m^3 at Porcupine Bay (not found in samples) and 1,051 μg/m^3 at Seven Bays (Tables 3.4.9 and 3.4.10).

Mean biomass for all sample sites in October 1989 was 155,067 μg/m^3 for *Daphnia* and 157 μg/m^3 for *Leptodora kindtii* (Table 3.4.6). Biomass levels of *Daphnia* ranged from a high of 358,577 μg/m^3 at Porcupine Bay to a low of 11,880 μg/m^3 at Kettle Falls. *Leptodora kindtii* biomass ranged from a high of 353 μg/m^3 at Porcupine Bay to a low of 0 μg/m^3 at Seven Bays, Keller Ferry, and Spring Canyon.

In November 1989 biomass of *Daphnia* was 15,156 μg/m^3 at Porcupine Bay and 613,836 μg/m^3 at Seven Bays. *Leptodora kindtii* biomass was 8 μg/m^3 at Porcupine Bay and 81 μg/m^3 at Seven Bays (Tables 3.4.9 and 3.4.10).

In December 1989 biomass of *Daphnia* was 31,941 μg/m^3 at Porcupine Bay and *606,755* μg/m^3 at Seven Bays. *Leptodora kindtii* biomass was 0 μg/m^3 at Porcupine Bay and 391 μg/m^3 at Seven Bays (Tables 3.4.9 and 3.4.10).

3.5 FISH FEEDING HABITS

3.5.1 Annual Feeding Habits of Rainbow Trout for 1988

Information for yearly feeding habits of all age classes of rainbow trout is presented in Table 3.5.1. Monthly values for all age classes can be found in Appendix F.

Table 3.5.1 The annual food preferences of Rainbow trout from Lake Roosevelt in 1988.

	RAINBOW TROUT (N=190)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
rey Item	(X̄±S.D.)	(%)	(X̄±S.D.)	(%)	(%)	)%
STEICHTHYES (fish)						
Catastomidae	0.08±(0.98)	1.01	0.04±(0.45)	44	1.1	0.99
Centrachidae	0 005±(0.07)	3.00	0.005±(0.05)	0.57	0.53	0.02
Cottidae	2.2±(16)	3.18	0 21±(2.0)	23.00	5.3	5.2
Cyprinidae	0 23±(1.5)	0.02	0.09±(0.78)	9.8	26	23
Percidae	0.06±(0.57)	0.01	0.07±(0.58)	0.4	21	1.9
Unidentifiable fish	0.28±(1.9)	0.02	0.06±(0.52)	74	4.7	22
IPHIPODA (scuds)						
Gammerus	0 005~0.07)	0.00	0 0±(0.0)	0.00	0.53	0.1
Hyalella	0.005±(0.07)	0.00	0.0±(0.0001)	0.00	053	0.1
ЭPODA (sow bugs)						
Asellus	0 005±(.07)	0.00	0 0±(0.0001)	0.00	0.53	0.1
ADOCERA (water fleas)						
Daphnia schadleri	1045±(2340)	5.3	0.30±(2.2)	33.00	70.00	34.00
Daphnia thorata	5.2±(43)	0.43	0.0004±(0.004)	0 05	5.9	1.1
Daphnia retrocurva	0.005±(0.07)	0.00	0.0±(0.0)	0.00	0.53	0.1
Daphnia galeata mendota	1 3±(9.8)	0.10	0.0002±(0.002)	0.03	4.2	0.79
L eptodora kindtii	137±(477)	1.2	0.01±(0.05)	1.6	32.00	9.1
Alona affins	0.15±(1.8)	0.01	0.0±(0.0003)	0.00	1.1	0.19
Chydorus sphaericus	0.15±(1.7)	0.01	0.0±(0.0004)	0.00	21	0.38
Eurycerus lamellatus	0.26±(2.2)	0.02	0 0±(0.0002)	0.00	3.7	0.67
Sida crystallina	0.02±(0.26)	0.00	0.0±(0.0002)	0.00	1.0	0.19
ICOPEPODA (copepods)						
Cyclops spp.	0.04±(0.35)	0.01	0.0±(0.0004)	0.00	1.6	0.57
Diaptomus sop.	0 06±(0.68)	0.01	0.0±(0.0001)	0.00	1.0	0.19
Epischura spp.	25±(335)	2 00	0.0007±(0.008)	0.08	6.0	1.6
ISOMMATOPHORA (snail)						
Lymnaidae	0.02±(0.16)	0.00	0.003±(0.02)	0.36	26	0.54
Planorbidae	0 02±(0.12)	0.00	0.0003±(0.003)	0.04	1.6	0.4
ЭLLUSKA (clam)						
Sphaeriidae	0.01±(0.10)	0.00	0.001±(0.01)	0.14	1.00	0.21
PTERA (midges)						
Chironomidae pupae	2.3±(7.1)	0.19	0.001±(0.009)	0.19	36.00	6.6
Chironomidae larvae	1.8±(5.6)	0.15	0.0006±(0.004)	0.07	32.00	5.8
Tipulidae pupae	0.005±(0.07)	0.00	0 0±0(0.0)	0 00	0.53	0.1
Tipulidae larvae	0.01±(.16)	0.00	0.0±(.0001)	0.00	0.53	0.19
Tabanidae	0.005±(0.07)	0.00	0.0002±(0.002)	0.03	0.53	0.1
Stratiomyidae	0 01±(.14)	0.00	0.0±(0.0001)	0.00	0.53	0.1
Sciomyzidae	0.005±(0.07)	0.00	0.0±(0.0005)	0.01	0.53	0.1
Heleomyzidae	0 01±(0.21)	0.00	0 0±(0.0001)	0.00	0.53	0.38
RICOPTERA (caddisflies)						
Leptoceridae	0.01±(0.14)	0.00	0.0±(0.0001)	0.00	0.53	0.1
Hydropsychidae	0.06±(0.45)	0.01	0.0±(0.0005)	0 01	26	0.48
Hydroptilidae	0.Mf(0.20)	0.00	0.0005±(0.006)	0.06	21	0.39
Psychomyidae	0.09±(0.90)	0.01	0.0001±(0.001)	0 02	1.6	0.29
Polycentropidae	0 Olt(0.16)	0.00	0.0±(0.0001)	0.00	1.00	0.19
Brachycentridae	0 005f~0.07)	0.00	0.0±(0.0)	0.00	0.53	0.1
LECOPTERA (stoneflies)						
Capniidae	0.01±(0.10)	0.00	0.0±(0.0001)	0.00	1.0	0.19
Nemouridae	0 Olf(0.12)	0.00	0.0±(0.0002)	0 00	16	0.29
EMIPTERA (bugs)						
Corixidae	2.1±(10)	0.17	0 009±(0.07)	1.00	20.0	3.9
PHEMEROPTERA (mayflies)						
Baetidae	0.05±(0.36)	0.00	0.0003±(0.003)	0.04	3.7	0.67
Ephemerellidae	0.12±(1.2)	0.01	0.0±(0.0004)	0.00	26	0.48
Trichorythidae	0.01±(0.14)	0.00	0.0±(0.0)	0.00	0.53	0.1
Heptagenidae	0.02±(0.29)	0.00	0 0±(0.0001)	0 00	0.53	0.1
IDONATA (dragonflies)						
Zygoptera	0.03±(.30)	0.00	0.0±(.0008)	0.01	1.00	0.19
OLEOPTERA (beetles)						
Elmidae	0 005±(0.07)	0.00	0.0±(0.0002)	0.00	0.53	0.1
ILIGOCHEATA (worms)						
Lumbriculidae	0 11±(1.1)	0.01	0 01~0.12)	0.13	21	0.61
IYDRACHNELLLAE (spider)						
Hydracarina	0 27±(1.5)	0.02	0.0±(0.0006)	0.01	1.00	1.7
ITHER						
Cestoda	0 01±(0.10)	0.00	0.001±(0.01)	0 15	1.00	0.22
Terrestrial	1.1±(4.2)	0.09	0.008±(0.06)	0.93	25.00	4.7
Organic Detritus	0.37±(0.77)	0.03	0.04±(0.21)	4.9	24.00	52
Inorganic Detritus	0.07±(0.29)	0.01	0.01±(0.07)	1.4	6.00	1.4
Unidentifiable bodies	0.26±(0.64)	0.02	0.004±(0.02)	0.52	17.00	3.1

Table 3.5.2 The annual food preferences of 0+ Rainbow trout from Lake Roosevelt in 1988.

	RAINBOW TROUT (N-190)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	%	%
OSTEICHTHYES (fish)						
Cottidae	0.1±(0.11)	0.04	0.002±(0.008)	2.6	5.0	1.2
Cyprinidae	0.3±(1.3)	0.12	0.02±(0.09)	30.0	5.0	5.6
Unidentifiable fish	0 35±(1.1)	0.14	0.02±(0.07)	23.0	10.0	5.3
CLADOCERA (water fleas)						
Daphnia schødleri	230±(395)	93.6	0.02±(0.03)	19.9	55.0	26.7
Daphnia thorata	1.1±(2.3)	0.45	0.0±(0.0001)	0.04	20.0	3.2
EUCOPEPODA (copepoda)						
Cyclops spp.	0.2±(0.61)	0.08	0.0001±(0.0003)	0.12	10.0	1.6
Epischura spp.	0.7±(2.6)	0.28	0.0001±(0.0004)	0.17	15.0	2.4
BASOMMATOPHORA (snarl)						
Lymnaidae	0.05±(.22)	0.02	0.0±(.0003)	.01	30.0	4.7
DIPTERA (midges)						
Chironomidae pupae	5.9±(10)	2.4	0.001±(0.007)	1.6	55.0	19.3
Chironomidae larvae	1.3±(1.4)	0.51	0.0±(0.001)	0.01	55.0	8.8
TRICOPTERA (caddisflies)						
Hydropsychidae	0.5±(1.3)	0.20	0.0004±(0.001)	0.51	15.0	2.4
Psycttomyidae	0.9±(2.7)	0.37	0.001±(0.004)	1.8	15.0	2.7
Polycentropidae	0.15±(0.48)	0.06	0.0001±(0.0006)	0.20	10.0	1.6
PLECOPTERA (stoneflies)						
Capniidae	0.05±(.22)	0.02	0.0±(0.0)	0.28	5.0	0.84
Nemouridae	0.1±(.30)	0.02	0.0002±(0.0008)	0.01	5.0	0.8
HEMIPTERA (bugs)						
Corixidae	1.1±(2.4)	0.45	0.001±(0.004)	2.2	20.0	3.5
EPHEMEROPTERA (mayflies)						
Baetidae	0.05±(0.22)	0.02	0.0±(0.0008)	0.01	5.0	0.80
Ephemerellidae	0.05±(0.22)	0.02	0.0±(0.0006)	0.01	5.0	0.80
Heptagenidae	0.2±(0.89)	0.08	0.0±(0.0004)	0.01	5.0	0.81
OLIGOCHEATA (worms)						
Lumbricutidae	0.95±(3.4)	0.39	0.01±(0.02)	13.1	20.0	5.3
HYDRACHNELLLAE (spider)						
Hydracarma	0.6±(2.2)	0.24	0.0001±(0.0003)	0.12	10.0	1.6
OTHER:						
Terrestrial	0.6±(2.2)	0.24	0.0009±(0.003)	1.0	20.0	3.3
Organic Detritus	0.1f(0.30)	0.04	0.0±(0.0001)	0.01	5.0	0.8
Unidentifiable bodies	0.55±(0.82)	0.22	0.001±(0.003)	2.1	30.0	5.1

Table 3.5.3 The annual food preferences of 1+ Ralnbow trout from Lake Roosevelt In 1988.

	RAINBOW TROUT (N=77)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X±S.D.)	(%)	(X±S.D.)	%	%	%
OSTEICHTHYES (fish)						
Centrachidae	0.01±(0.11)	0.0	0.01±(0.09)	3.5	1 3	0.93
Cottidae	0.10±(0.80)	0.0	0.0005±(0.003)	0.11	2 6	0.52
Percidae	0.09±(0.69)	0.0	0.17±(0.94)	39.8	2.6	8.2
Unidentifiable fish	0.06±(0.47)	0.0	0.001±(0.10)	3.8	2 6	1.2
AMPHIPODA (scuds)						
Hyalella	0.01±(0.11)	0.0	0.0±(0.0002)	0 0	1 3	0.25
ISOPODA (sow bugs)						
Asellus	0.01±(0.11)	0.0	0.0±(0.0002)	0 0	1 3	0.25
CLADOCERA (water fleas)						
Daphnia schødleri	1150±(1903)	82.0	0.13±(17)	29.8	44 2	30.3
Daphnia thorata	1 5±(11)	0.1	0.001±(0.007)	0.3	5.2	1.0
Daphnia galeata mendot	1 2±(5.5)	0.1	0.0006±(0.004)	0 1	9.1	1.8
Leptodora kindtii	180±(480)	12.8	0.02±(0.07)	5.1	468	13.0
Alona affins	0.05±(0.46)	0.0	0.0±(0.0005)	0.0	1 3	0.25
Chydorus sphaericus	0.04±(0.34)	0.0	0.0±(0.0002)	0.0	1.3	0.25
Eurycerus lamellatus	0.61±(3.5)	0.0	0.0001±(0.0004)	0.0	7.8	1.5
Sida crystallina	0.06±(0.41)	0.0	0.0001±(0.0004)	0 0	2.6	0.50
EUCOPEPODA (copepoda)						
Cyclops spp.	0 16±(0.96)	0.0	0.0±(0.0008)	0.0	3.9	0.76
Diaptomus spp.	0.016±(1.0)	0.0	0.0±(0.0002)	0.0	2.6	0.50
Epischura spp.	60±(526)	4.3	0.002±(0.01)	0.5	6.5	2.2
MOLLUSKA (clam)						
Sphaeriidae	0 01±(0.11)	0.0	0.0004±(0.002)	0 1	1.3	0.27
DIPTERA (midges)						
Chironomidae pupae	2.7±(9.3)	0.2	0.002±(0.009)	0.5	42.9	0.4
Chironomidae larvae	1.3±(5.9)	0.1	0.0±(0.0008)	0.0	19.5	3.8
Tipulidae pupae	0.01±(0.11)	0.0	0.0±(0.0001)	0 0	1.3	0.25
Tabanidae	0.01±(0.11)	0.0	0.0008±(0.005)	0 2	1.3	0.29
TRICOPTERA (caddisflies)						
Hydroptilidae	0 01±(0.11)	0.0	0.0±(0.0001)	0.0	1.3	0.25
PLECOPTERA (stoneflies)						
Capniidae	0.01±(0.11)	0.0	0.0±(0.0003)	0.0	1.3	0.25
Nemouridae	0 01±(0.11)	0.0	0.0±(0.0)	0.0	1.3	0.25
HEMIPTERA (bugs)						
Corixidae	1.3±(5.9)	0.1	0.002±(0.01)	0.5	18.2	3.6
EPHEMEROPTERA (mayflies)						
Baetidae	0 06±(0.47)	0.0	0.0±(0.0004)	0.0	2.6	0.50
Ephemerellidae	0.01±(0.11)	0.0	0.0±(0.00045)	0.0	1.3	0.25
OLIGOCHEATA (worms)						
Lumbriculidae	0.01±(0.11)	0.0	0.03±(0.20)	7.0	1 3	1.6
HYDRACHNELLLAE (spider)						
Hydracarina	0 10±(0.45)	0.0	0 0001±(0.0006)	0.0	6.5	1.3
OTHER:						
Cestoda	0 03±(0.16)	0.0	0.004±(0.02)	0 9	2.6	0.66
Terrestrial	1.6±(6.1)	0.1	0.01±(0.10)	4.1	32.5	7.1
Organic Detritus	0.19±(0.46)	0.0	0.001±(0.03)	0.2	16.9	3.3
Inorganic Detritus	0.10±(0.38)	0.0	0.01±(0.04)	2.4	7.8	2.0
Unidentifiable bodies	0.16±(0.46)	0.0	0.003±(0.008)	13.8	13.0	2.7

Table 3.5.4 The annual food preferences of 2+ Rainbow trout from Lake Roosevelt in 1988.

	RAINBOW TROUT (N=32)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X±S.D.)	(%)	(X±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Catastomrdae	0.36±(1.9)	0.03	0.16±(0.89)	12.0	4.3	3.2
Cottidae	7 9±(32)	0.56	0 69±(3.9)	52.0	8.7	12.3
Cyprinidae	0.21±(1.0)	0.02	0 07±(0.44)	5.9	4.3	2.0
Percidae	0 13±(0.74)	0.01	0 06±(0.38)	5.1	4.3	1.9
Unidentifiable fish	0.04±(0 29)	0.00	0 05±(0.29)	3 9	2.1	1.2
AMPHIPODA (scuds)						
Gammerus	0 02±(0.14)	0.00	0 0±(0.0)	0.0	2.1	0.43
CLADOCERA (water fleas)						
Daphnia schødleri	1261±(2750)	88.9	0.11±(21)	8.8	58.7	31.3
Daphnia thorata	18±(85)	1.3	0 0001±(0 0005)	0.01	6.5	1.5
Daphnia retrocurva	0.02±(0.14)	0.0	0.0±(0.0)	0.0	2.1	0.43
Daphnia galeata mendota	3.0±(18)	0.22	0.0001±(0.0006)	0.01	4.3	0.92
Leptodora kindtii	119±(440)	8.5	0 009±(0.03)	0.73	23.9	6.6
Chydorus sphaencus	0 04±(0.20)	0.00	0 0±(0.0006)	0.00	4 3	0.87
EUCOPEPODA (copepoda)						
Epischura spp.	0 06±(0.32)	0.00	0 0±(0.0007)	0 00	4 3	0.87
BASOMMATOPHORA (snarl)						
Lymnaidae	0.04±(0.20)	0.00	0.001±(0.008)	0.11	4.3	0.89
Planorbidae	0.02±(0.14)	0 00	0.0±(0.0003)	0 00	2 1	0.43
DIPTERA (midges)						
Chironomidae pupae	1 5±(3.6)	0.11	0.002±(0.01)	0.22	28.0	5.7
Chironomidae larvae	1 Ok(2.3)	*0.08*	0.0002±(0.001)	0.02	32.6	6.5
Tipulidae larvae	0.06±(0.32)	0 00	0 0±(0.0002)	0.00	4 3	0 87
TRICOPTERA (caddisflies)						
Leptoceridae	0.04±(0.29)	0.00	0 0±(.0002)	0.00	2.1	0.43
Hydropsychidae	0.02±(0.14)	0.00	0.0±(.0003)	0.00	2.1	0.43
Hydroptrlidae	0.02±(0.14)	0.00	.002±(.01)	0.16	2.1	0.47
Brachycentridae	0.02±(0.14)	0.00	0 0±(0.0)	0.00	2.1	0.43
HEMIPTERA (bugs)						
Corixidae	3 0±(18)	0.21	0.003±(0.01)	0.25	130	2 7
EPHEMEROPTERA (mayflies)						
Baetidae	0.02±(0.14)	0.0	0.001±(0.007)	0.10	4.3	0.89
Ephemerellidae	0 47±(2.3)	0 03	0.0001±(0.0005	0.01	6.5	1.3
Trichoryrthidae	0.04±(0.29)	0 0	0.0±(0.0)	0.00	2.1	0 43
HYDRACHNELLLAE (spider)						
Hydracarma	0 04±(0 29)	0.0	0.0±(0.0001)	0.00	2.1	0 43
OTHER:						
Terrestrial	0.26±(0.85)	0.02	0.004±(0.01)	0.33	10.8	2.2
Organic Detritus	0.58±(1.0)	0.04	0.12±(0.40)	9.50	*30.4*	*8.0*
Inorganic Detritus	0.04±(0.20)	0.0	0.006±(0.03)	0.52	4.3	0.97
Unidentifiable bodies	0.13±(0.40)	0.01	0.0009±(0.004)	0.07	10.8	*2 2*

Table 3.5.5 The annual food preferences of 3+ Rainbow trout from Lake Roosevelt in 1988.

	RAINBOW TROUT (N=29)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X±S.D.)	(%)	(X±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Cottidae	0.03±(0.18)	0.0	0.0004±(0.001)	0.12	3 4	0.59
Unidentifiable fish	0 06±(0.37)	0.0	0.01 ±(0.04)	3.1	3 4	1 0
CLADOCERA (water fleas)						
Daphnia schodleri	1450±(3672)	87.9	0.14±(0.29)	40.6	65.5	32.2
Daphnia thorata	0.06±(0.37)	0.0	0.0±(0.0)	0.0	3.4	0.57
Leptodora kindtii	184±(742)	11.2	0.02±(0.07)	6.3	34.5	8.6
Alona affins	0.86±(4.6)	0.05	0.0±(0.0001)	0.01	3.4	0.58
Chydorus sphaericus	0.82±(4.4)	0.05	0.0±(0.0008	0.0	3.4	0.58
Eurycerus lamella tus	0.06±(0.37)	0.0	0.0±(0.0)	0.0	3.4	0.57
EUCOPEPODA (copepoda)						
Epischura spp.	0.06±(0.37)	0.0	0.0±(0.0001)	0.0	3.4	0.57
BASOMMATOPHORA (snarl)						
Lymnaidae	0.20±(0.94)	0.01	0.01±(0.06)	4.2	6.9	1.8
Planorbidae	0.37±(2.0)	0.02	0.0006±(0.002)	0.18	3.4	0.61
MOLLUSKA (clam)						
Sphaeriidae	0.03±(.18)	0.0	0.007±(0.03)	2.1	3.4	0.93
DIPTERA (midges)						
Chironomidae pupae	1.1±(2.7)	0.07	0.0005±(0.003)	0.16	27.5	4.6
Chironomidae larvae	4.3±(8.1)	0.2[illegible]	0.003±(0.01)	1.0	55.2	9.4
Stratiomyidae	0.06±(0.37)	0.0	0.0±(0.0002)	0.02	3.4	0.58
TRICOPTERA (caddisflies)						
Hydropsychidae	0.03±(0.18)	0.0	0.0±(0.0)	0.0	3.4	0.57
Hydroptilidae	0.10±(0.40)	0.01	0.0001±(0.0003)	0 0:	6.9	1.1
HEMIPTERA (bugs)						
Corixidae	3.1±(8.6)	0.1[illegible]	0.04±(0.18)	11.9	24.0	6.0
EPHEMEROPTERA (mayflies)						
Baetidae	0.10±(0.40)	0.01	0.0001±(0.0004)	0.03	6.9	1.1
ODONATA (dragonflies)						
Zygoptera	0.17±(0.75)	0.01	0 0004±(0.001)	0.12	6.9	1.1
OLIGOCHEATA (worms)						
Lumbriculidae	0.03±(0.18)	0.0	0.0±(0.0001)	0.01	3.4	0.57
HYDRACHNELLLAE (spider)						
Hydracarina	0.93±(3.0)	0.0[illegible]	0.0002±(0.001)	0.0[illegible]	24.0	4.0
OTHER:						
Terrestrial	0.93±(2.6)	0.0[illegible]	0.001±(0.006)	0.4[illegible]	27.5	4.6
Organic Detritus	0.62±(1.0)	0.0[illegible]	0.05±(0.16)	14.5	34.0	8.1
Inorganic Detritus	0.1 0±(0.30)	0.0'	0.04±(0.16)	11 .o	10.0	3.6
Unidentifiable bodies	000.55±(0.98)	0 0:	0 008±(0.03)	2.5	27.5	5.0

Table 3.5.6 The annual food preferences of 4+ Rainbow trout from Lake Roosevelt in 1988.

	RAINBOW TROUT (N=16)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X̄±S.D.)	(%)	(X̄±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Cottidae	2.1±(5.8)	0.52	0.28±(1.0)	9.5	12.5	4.0
Cyprinidae	1.7±(4.8)	0.42	0.55±(2.1)	18.8	12.5	5.6
Unidentifiable fish	2.3±(6.3)	0.58	0.37±(1.4)	12.7	18.7	5.7
CLADOCERA (water fleas)						
Daphnia schødleri	315±(688)	76.4	1 6±(6.4)	57.4	68.8	36.4
Leptodora kindtii	79±(205)	19.3	0.006±(0.01)	0.24	18.7	1.1
EUCOPEPODA (copepoda)						
Epischura spp.	3 3±(13)	0.82	0.0±(0.0002)	0.0	6.2	1 2
BASOMMATOPHORA (snail)						
Lymnaidae	0.06±(0.25)	0.02	0.003±(0.01)	0 13	6.2	1.1
DIPTERA (midges)						
Chironomidae pupae	0.37±(0.88)	0.09	0.0003±(0.001)	0.01	18.7	3.3
Chironomidae larvae	1.5±(4.7)	0.36	0.0007±(0.002)	0.02	25.0	4.5
Sciomyzidae	0.06±(0.25)	0.02	0.0004±(0.001)	0.01	6.2	1.1
Heleomyzidae	0.18±(0.75)	0.05	0.0002±(0.0008)	0 01	6.2	1.1
HEMIPTERA (bugs)						
Corixidae	2.8±(8.3)	0.70	0.005±(0.01)	0.19	31.2	5.7
EPHEMEROPTERA (mayflies)						
Baetidae	0.06±(0.25)	0.02	0.0±(0.0003)	0.0	6 2	1.1
ODONATA (dragonflies)						
Zygoptera	0.06±(0.25)	0.02	0.0±(0.0004)	0.0	6 2	1.1
COLEOPTERA (beetles)						
Elmidae	0 06±(0.25)	0 02	0.0001±(0.0006)	0 01	6 2	1.1
HYDRACHNELLLAE (spider)						
Hydracarina	0 06±(0.25)	0.02	0 0±(0 0003)	0 0	6 2	1 1
OTHER:						
Terrestrial	02±(3.3)	0.48	0.007±(0.01)	0 24	31.3	5.7
Organic Detritus	5±(0.89)	0.14	0.01 ±(0.02)	0 34	37.5	6.8
Inorganic Detritus	0 06±(0.25)	0.02	0.0001±(0.0007)	0 01	6 2	1.l
Unidenbfiable bodies	000.31 ±(0 79)	0 08	0 01 f(0.04)	0 44	18 7	3 4

Tables 3.5.7 The annual food preferences of 5+ Rainbow trout from Lake Roosevelt in 1988.

	RAINBOW TROUT (N-2)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X̄±S.D.)	%	(X̄±S.D.)	(%)	%	%
CLADOCERA (water fleas)						
Daphnia schødleri	140±(191)	88.6	0.003±(0.005)	4.4	100.0	27.6
Leptodora kindtii	1±(1.4)	0.63	0.0±(0.0002)	0.07	50.0	7.2
Alona affins	0.5±(.71)	0.32	0.0008±(0.001)	1.1	50.0	7.3
BASOMMATOPHORA (snail)						
Lymnaidae	0.5±(0.71)	0.32	0.0±(0.001)	0.07	50.0	7.2
DIPTERA (midges)						
Chironomidae pupae	0.5±(0.71)	0.32	0.0008±(0.001)	1.0	50.0	7.3
Chironomidao larvae	13±(18)	0.82	0.002±(0.002)	2.1	50.0	8.6
TRICOPTERA (caddisflies)						
Hydroptilidae	0.5±(0.71)	0.32	0.0±(0.002)	0.07	50.0	7.2
HYDRACHNELLLAE (spider)						
Hydracarina	1.5±(2.1)	0.95	0.0±(0.0007)	0.07	50.0	7.2
OTHER:						
Organic Detritus	0.5±(0.71)	0.32	0.07±(0.09)	91.0	50.0	20.2

The highest number frequency values were for ***Daphnia schødleri*** (water fleas) at 1045 ± ***2340*** per stomach, followed by *Leptodora kindtii* (water fleas) at 137 ± 477 and *Epischura* (copepod water fleas) at 25 ± ***335.*** The highest percent compostition by number values were for ***D. schødleri*** at 85.3%, followed by L. *kindtii* at 11.2% and ***Epischura*** at 2.0%. (Table 3.5.1).

The highest weight frequency values were for *D. schødleri* at .30 ± 2.2 mg per stomach, followed by Cottidae (sculpins) at .21 ± 2.0 mg and Cyprinidae (minnows) at 0.09 ± 0.78 mg. The highest percent composition by weight values were for *D. schødleri* at 33.3%, followed by Cottidae at 23.3% and Cyprinidae at 9.8%. (Table 3.5.1).

The highest frequency of occurrence values were for *D. schødleri* at 70.0%, followed by Chironomidae pupae (midges) at 36.0% and Chironomidae larvae (midges) at 32.0%. (Table 3.5-l).

The highest index of relative importance (IRI) values were for *D. schødleri* at 34%, followed by *L. kindtii* at 8.1% and Chironomidae pupae at 6.6%. (Table 3.5.1).

Annual Feeding Habits of 0+ Rainbow Trout for 1988

Information for feeding habits of 0+ rainbow trout in 1989 (August and October combined) is presented in Table 3.5.2.

The highest number frequency values were for *D. schødleri* at 230 ± 395 per stomach, followed by Chironomidae pupae at 5.9 ± 10 and Chironomidae larvae at 1.3 ± 1.4. The highest percent compostition by number values were for *D. schødleri* at 93.6%, followed by Chironomidae pupae at 2.4% and Chironomidae larvae at 0.51%.

The highest weight frequency values were for Cyprinidae at .0261 ± 0.09 mg dry weight per stomach, followed by unidentifiable fish at 0.02 ± 0.07 mg and *D. schødleri* at 0.02 ± 0.03 mg. The highest percent composition by weight values were for Cyprinidae at 30.6%, followed by unidentifiable fish at 23.2% and *D. schødleri* at 19.9%.

The highest frequency of occurrence values were for *D. schødleri*, Chironomidae pupae and Chironomidae larvae all at 55.0%.

The highest IRI values were for *D. schødleri* at 26.7%, followed by Chironomidae pupae at 19.4% and Chironomidae larvae at 8.8%.

Annual Feeding Habits of I+ Rainbow Trout for 1988

Information for yearly feeding habits of 1+ rainbow trout is presented in Table 3.5.3.

The highest number frequency values were for *D. schødleri* at 1150 ± 1903 per stomach, followed by *L. kindtii* at 180 ± 480 and *Epischura* at 60 ± 526. The highest percent compostition by number values were for *D. schødleri* at 82.0%, followed by *L. kindtii* at 12.8% and *Epischura* at 4.3%.

The highest weight frequency values were for Percidae (perch or walleye) at 0.1756 ± 0.94 mg dry weight per stomach, followed by *D. schødleri* at 0.13 ± 0.17 mg and Lumbriculidae (earthworms) at 0.03± 0.20 mg. The highest percent composition by weight values were for Percidae at 39.8%, followed by *D. schødleri* at 29.8% and Lumbriculidae at 5.3%.

The highest frequency of occurrence values were for *L. kindtii* at 46.8%, followed by *D. schødleri* at 44.2% and Chironomidae pupae at 42.9%.

The highest IRI values were for *D. schødleri* at 30.3%, followed by *L. kindtii* at 13.0% and Percidae at 8.2%.

Annual Feeding Habits of 2+ Rainbow Trout for 7988

Information for yearly feeding habits of 2+ rainbow trout is presented in Table 3.5.4.

The highest number frequency values were for *D. schødleri* at 1261 ± 2750 per stomach, followed by *L. kindtii* at 119 ± 440 and *D. thorata* (water fleas) at 18 ± 85. The highest percent compostition by number values were for *D. schødleri* at 88.9%, followed by *L. kindtii* at 8.5% and *D. thorata* at 1.3%.

The highest weight frequency values were for Cottidae at 0.69 ± 3.92 mg dry weight per stomach, followed by Catastomidae (suckers) at 0.16 ± 0.89 mg and organic detritus (plant matter) at 0.12 ± 0.40 mg. The highest percent composition by weight values were for Cottidae at 52.2%, followed by Catastomidae at 12.0% and organic detritus at 9.5%.

The highest frequency of occurrence values were for *D. schødleri* at 58.7%, followed by Chironomidae larvae at 32.6% and organic detritus at 30.4%.

The highest IRI values were for *D. schødleri* at **31.3%**, followed by Cottidae at 12.3% and organic detritus at 8.0%.

Annual Feeding Habits of 3+ Rainbow Trout for 1988

Information for yearly feeding habits of 3+ rainbow trout is presented in Table 3.5.5.

The highest number frequency values *were* for ***D. schødleri*** at 1450 ± 3672 per stomach, followed by *L. kindtii* at 184 ± 742 and Chironomidae larvae at 4.3 ± 8.1. The highest percent compostition by number values were for *D. schødleri* at **87.9%**, followed by *L. kindtii* at 11.2% and Chironomidae larvae at 0.3%.

The highest weight frequency values were for ***D.*** *schodleri* at 0.14 ± 0.29 mg dry weight per stomach, followed by organic detritus at 0.05 ± 0.16 and Corixidae (bugs) at 0.04 ± 0.18. The highest percent composition by weight values were for ***D.*** *schodleri* at **40.6%**, followed by organic detritus at 14.5% and Corixidae at 11.9%.

The highest frequency of occurrence values were for ***D. schødleri*** at **65.5%**, followed by Chironomidae larvae at 55.2% and *L. kindtii* and organic detritus both at 34.5%.

The highest IRI values were for ***D. schødleri*** at **32.2%**, followed by Chironomidae larvae at 9.4% and *L. kindtii* at 8.6%.

Annual Feeding Habits of 4+ Rainbow Trout for 1988

Information for yearly feeding habits of 4+ rainbow trout is presented in Table 3.5.6.

The highest number frequency values were for ***D.*** *schodleri* at 315 ± 688 per stomach, followed by *L. kindtii* at 79 ± 205 and *Epischura* at 3.3 ± 13. The highest percent compostition by number values were for ***D.*** *schodleri* at **76.4%**, followed by *L. kindtii* at 19.3% and *Epischura* at 0.82%.

The highest weight frequency values were for ***D. schødleri*** at 1.69 ± 6.45 mg dry weight per stomach, followed by Cyprinidae at 0.55 ± 2.14 mg and unidentifiable fish at 0.37 ± 1.42. The highest percent composition by weight values were for ***D.*** *schodleri* at **57.4%**, followed by Cyprinidae at 18.8% and unidentifiable fish at 12.7%.

The highest frequency of occurrence values were for *D. schødleri* at 68.8%, followed by organic detritus at 37.5% and Corixidae and terrestrial insects both at 31.3%.

The highest IRI values were for *D. schødleri* at 36.4%, followed by organic detritus at 6.8% and unidentifiable fish, Corixidae, and terrestrial insects all at 6.0%.

Annual Feeding Habits of 5+ Rainbow Trout for 1988

Information for yearly feeding habits of 5+ rainbow trout is presented in Table 3.5.7.

The highest number frequency values were for *D. schødleri* at 140 ± 191 per stomach, followed by Chironomidae larvae at 13 ± 18 and Hydracarina (aquatic spider) at 1.5 ± 2.12. The highest percent compostition by number values were for *D. schødleri* at 88.6%, followed by Chironomidae larvae at 8.2% and Hydracarina at 1 .0%.

The highest weight frequency values were for organic detritus at 0.07 ± 0.09 mg dry weight per stomach, followed by *D. schødleri* at 0.003 ± 0.005 mg and Chironomidae larvae at 0.002 ± 0.002 mg. The highest percent composition by weight values were for organic detritus at 91 .0%, followed by *D. schødleri* at 4.4% and Chironomidae larvae at 2.1%.

The highest frequency of occurrence values were for *D. schødleri* at 100.0%, followed by all other prey items at 50.0%.

The highest IRI values were for *D. schødleri* at 27.6%, followed by organic detritus at 20.2% and Chironomidae larvae at 8.6%.

3.5.2 Annual Feeding Habits of Rainbow Trout for 1989

Information for yearly feeding habits of all age classes of rainbow trout is presented in Table 3.5.8. Monthly values for all age classes can be found in Appendix F.

The highest number frequency values were for *D. schødleri* (water fleas) at 191 ± 652 per stomach, followed by walleye eggs (fish eggs) at 148 ± 818 and *L. kindtii* (water fleas) at 46 ± 204. The highest percent compostition by number values were for *D. schødleri* at 43.8%, followed by Walleye eggs at 33.8% and *L. kindtii* at 10.6%. (Table 3.5.8).

Table 3.5.8 The annual food preferences of Rainbow trout from Lake Roosevelt in 1989.

	RAINBOW TROUT (N=223)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
'RN ITEM	(X±S.D.)	(%)	(X±S.D.)	(%)	(%)	(%)
)STEICHTHYES (fish)						
Catastomidae	0.0004±(0.06)	0.0	0.0003±(0.005)	0.03	0.45	0.06
Cottidae	0.0004±(0.06)	0.18	0.001±(0.02)	0.08	0.45	0.16
Percidae	0.03±(0.25)	0.01	0.02±(0.24)	1.7	1.8	3.2
Unidentifiable fish	0.04±(0.19)	0.01	0.003±(0.02)	0.2	4.0	0.44
Walleye eggs	148±(818)	33.8	0.28±(1.47)	18.0	70	34.6
.MPHIPODA (scuds)						
Gammerus	0.01±(0.13)	0.0	0 0±(0.0001)	0.0	1.8	0.03
SOPODA (sow bugs)						
Asellus	0 01 ±(0.20)	0 0	0.0002±(0.003)	0.02	0 45	0.04
:LADOCERA (water fleas)						
Daphnia schadleri	19 1±(652)	13.6	0.01±(0.03)	0.97	40.6	3.3
L eptodora kindtii	46±(204)	106	0 008±(0.04)	0 56	12.0	1.5
UCOPEPODA (copepoda)						
Cyclops spp.	0.15±(1.8)	0.04	0 0±(0.0001)	0.0	1.4	0.03
Epischura sop.	1.0±(15)	0 25	0 02±(0.33)	1.5	1.4	27
)ECAPODA (crayfish)						
Pacifiasticus	0 004±(0.06)	0.0	0.0008±(0.013)	0.06	0.45	0.12
IASOMMATOPHORA (snail)						
Lymnaidae	0.03±(0.25)	0.01	0.0003±(0.003)	0.02	1.6	0.07
Planorbidae	0 01±(0.14)	0 0	0.0±(0.0003)	0 0	0.9	0.02
4OLLUSKA (Clam)						
Sphaeriidae	0 02±(0.17)	0.01	0 0001±(0.001)	0.01	18	0.05
)IPTERA (midges)						
Chironomidae pupae	18±(148)	4.0	0 008±(0.08)	0.54	26.0	1.6
Chironomidae larvae	16±(213)	3.6	0.006±(0.06)	0.4	22.0	1.2
Similidae *larvae*	1.3±(14)	0.3	0.0005±(0.006)	0.04	1.4	0.10
Tipulidae pupae	0.17±(1.0)	0.04	0.0002±(0.001)	0.02	5.0	0.13
Tipulidae larvae	0.28±(0.17)	0 06	0 0002±(0.001)	0.02	4 0	0.11
'RICOPTERA (caddisflies)						
Leptoceridae	0.02±(0.33)	0.01	0.0±(0.0001)	0.0	0.45	0.01
Leptostomotidae	0.004±(0.06)	0.0	0.0±(0.0)	0.0	0.45	0.01
Lymnephilidae	0.008±(.013)	0.0	0.001±(0.01)	0.09	0.45	0.17
Hydropsychidae	2.2±(9.3)	0.51	0.002±(0.008)	0.13	12.0	0.46
Brachycentridae	0.15±(1.3)	0.04	0.0003±(0.003)	0.02	2 2	0.08
Heliophsychidae	0.008±(0.13)	0.0	0.0±(0.0004)	0.0	0.45	0.01
Rhyacophilidae	0 02±(0.18)	0.01	0 0±(0.0001)	0.0	2.2	0 04
'LECOPTERA (stoneflies)						
Perlodidae	0.3±(1.8)	0.07	0.0002±(0.001)	0.01	4.50	0.10
Pteronarcidae	0.14±(1.4)	0 03	0.0008±(0.007)	0.06	4 5 0	0.19
iEMIPTERA (bugs)						
Corixidae	0.40±(2.7)	0.09	0.0007±(0.005)	0 05	11.0	0.29
Notonectidae	0.004±(.006)	0.0	0.0±(0.0004)	0.0	0 45	0 01
:PHEMEROPTERA (mayflies)						
Baetidae	0.29±(1.5)	0.07	0 0±(0.0009)	0.01	7 6	0.16
Ephemerellidae	0.008±(0.09)	0.0	0.0±(0.0001)	0.0	1.4	0.02
Heptagenidae	0.04±(0.48)	0.01	0 0±(0.0002)	0 0	3 6	0.07
)DONATA (dragonflies)						
Zygoptera	0.02±(0.22)	0.01	0.0±(0.0004)	0.0	1.4	0.02
Anisoptera	0 01±(0.21)	0.0	0 0±(0.0004)	0 0	0 90	0 02
:OLEOPTERA (beetles)						
Elmidae	0.04±(0.40)	0.01	0.0009±(0.009)	0.06	1.8	0.14
)LIGOCHEATA (worms)						
Lumbriculidae	0.08±(0.93)	0.02	0 01±(0.05)	1 0.27	6	0.52
1YDRACHNELLLAE (spider)						
Hydracarina	0 07±(0.56)	0.02	0 0±(0.0001)	0.0	5.0	0 09
)THER						
Cestoda	0 008±(0.09)	0 0	0.0±(0.0001)	0.0	2.2	0.04
Terrestrial	10±(36)	2.3	0.09±(0.68)	6.3	39.0	12.4
Organic Detritus	0.66±(1.0)	0.15	0.23±(1.2)	15.0	34.1	28.6
Inorganic Detritus	0.12±(0.41)	0.03	0.05±(0.49)	3.4	9.0	6.3
Unidentifiable bodies	0 22±(0.68)	0.05	0 005±(0.02)	0.36	14.0	0.92

Table 3.5.9 The annual food preferences of 0+ Rainbow from Lake Roosevelt in 1989.

	RAINBOW (N=39)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X̄±S.D.)	(%)	(X̄±S.D.)	%	%	%
OSTEICHTHYES (fish)						
Unidentified fish	0.03±(0.16)	0.02	0.0029±(0.0179)	5.09	2.56	1.49
Walleye eggs	0.10±(.64)	0.08	0.0003±(0.002)	0.40	2.56	0.61
AMPHIPODA (scuds)						
Gammerus	0 05±(0.22)	0.04	0.0±(.0004)	0.00	5.13	1.00
CLADOCERA (water fleas)						
Daphnia schødleri	109.18±(322.65)	82.15	0.01±(0.02)	16.8	38.5	26.7
Leptodora kindtii	0.90±(5.60)	0.68	0 0±(0.0003)	0.08	2.56	0.64
EUCOPEPODA (copepoda						
Cyclops spp.	0.03±(0.16)	0.02	0.0±(0.0004)	0.00	2.56	0.50
BASOMMATOPHORA (snarl)						
Lymnaidae	0.05±(0.32)	0.04	0.0±(0.0002)	0.06	2.56	0.52
DIPTERA (midges)						
Chironomidae pupae	6.0±(16.62)	4.51	0.0032±(0.0162)	5.60	41.0	9.92
Chironomidae larvae	2.97±(7.98)	2.24	0.0±(0.0019)	0.08	28.21	5.92
Simulidae larvae	0.08±(0.48)	0.06	0.0±(0.0004)	0.00	2.56	0.51
TRICOPTERA (caddisflies)						
Hydropsychidae	0.26±(0.82)	0.19	0.0002±(0.0011)	0.44	10.26	2.11
Brachycentridae	0.44±(1.93)	0.33	0.0004±(0.0016)	0.64	5.13	1.18
HEMIPTERA (bugs)						
Corixidae	0.21±(0.47)	0.15	0.0008±(0.0054)	1.40	17.95	3.70
EPHEMEROPTERA (mayflies)						
Baetidae	0 21±(0.83)	0.15	0.0±(0.0005)	0.00	10.26	2.02
Ephemerellidae	0.03±(0.16)	0.02	0.0±(0.0002)	0.05	2.56	0.51
Heptagenidae	0 18±(1.12)	0.14	0.0001±(0.0007)	0.19	17.95	3.55
ODONATA (dragonflies)						
Zygoptera	0.08±(0.48)	0.06	0.0001±(0.0007)	0.20	2.56	0.55
HYDRACHNELLLAE (spider)						
Hydracarina	0.03±(0.16)	0.02	0.0±(4.8038)	0.01	2.56	0.50
OTHER:						
Terrestrial	11 f(33)	8.35	0.005±(0.02)	8.85	56.4	14.3
Organic Detritus	0.44±(0.75)	0.33	0.03±(0.08)	45.18	28.21	14.3
Inorganic Detritus	0.03±(0.16)	0.02	0.0005±(0.003)	0.89	2.56	0.67
Unidentifiable bodies	0.54±(1.02)	0.41	0.01±(0.02)	13.9	30.77	8.76

Table 3.5.10 The annual food preferences of 1+ Rainbow from Lake Roosevelt in 1989.

	RAINBOW (N=40)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X̄±S.D.)	(%)	(X̄±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Percidae	0 05±(0.32)	0.01	0.06±(0.36)	42.5	2.50	9.5
AMPHIPODA (scuds)						
Gammerus	0.03±(0.16)	0.01	0 0±(3.16)	0 00	2.50	0.53
CLADOCERA (water fleas)						
Daphnia schadleri	353±(950)	92.1	0.03±(0.05)	20.2	62.5	37.0
Leptodora kindtii	12±(52)	3.3	0.002±(0.008)	1 20	17.5	4.65
EUCOPEPODA (copepoda)						
Cyclops spp.	0 65±(4.11)	0.17	0.0±(9.49)	0.00	2.50	0 57
Epischura spp.	0.13±(0.79)	0.03	0.0±(0.0002)	0 03	2.50	0.54
DIPTERA (midges)						
Chironomidae pupae	6.8±(22)	1.8	0.002±(0.009)	1 85	25.0	6.06
Chironomidae larvae	0.78±(2.99)	0.20	0.0±(0.0005)	0.00	15.0	3.22
TRICOPTERA (caddisflies)						
Hydropsychidae	1.43±(4.80)	0.37	0.001±(0.005)	0.81	12.5	2.90
Rhyacophilid	0 08±(0.27)	0.02	0.0±(0.0002)	0.00	7.50	1.59
PLECOPTERA (stoneflies)						
Pteronarcyidae	0.03±(0.16)	0.01	0.0±(0.0001)	0.02	2.50	0.54
Perlodidae	0.2±(1.11)	0.05	0.0±(0.0002)	0 03	5.00	1 39
HEMIPTERA (bugs)						
Corixidae	1 6±(6.18)	0.42	0 002±(0.01)	1.52	12.5	2.74
COLEOPTERA (beetles)						
Elmidae	0.08±(0.47)	0.02	0.0002±(0.001)	0.14	2.50	0.56
ODONATA (dragonflies)						
Antsoptera	0.08±(0.47)	0.02	0.0002±(0.001)	0 12	2.50	0.56
OLIGOCHEATA (worms)						
Lumbriculidae	0 03±(0 16)	0.01	0 0003±(0.002)	0 24	2 50	0.58
HYDRACHNELLLAE (spider)						
Hydracarina	0 23±(1 12)	0.06	0.0±(0 0001)	0 01	15 0	3 19
OTHER:						
Cestoda	0.03±(0.16)	0.01	0.0±(0.0003)	0.0	10.0	2.12
Terrestrial	5.03±(11.25)	1 31	0.04±(0.09)	27.1	40.0	14.5
Organic Detritus	0.23±(0.58)	0 06	0.002±(0.01)	1.89	15.0	3.59
Unidentifiable bodies	000.23±(0.62)	0 06	0.003±(0.01)	2 34	15.0	3.68

Table 3.511 The annual food preferences of 2+ Rainbow from Lake Roosevelt in 1989.

	RAINBOW (N=51)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Catastomidae	0.02±(0.14)	0.00	0.001±(0.01)	0.37	1.96	0.49
Cottidae	0 02±(0.14)	0.00	0.005±(0.04)	1.17	1.96	0.66
Unidentified fish	0 06±(0.24)	0.01	0.001±(0.006)	0.30	5.88	1.3
Walleye eggs	41.53±(296.58)	7.38	0.10±(0.72)	22.4	1.96	6.65
CLADOCERA (water fleas)						
Daphnia schadleri	337±(839)	60.0	0.02±(0.05)	5.45	56.9	25.7
Leptodora kindtii	45.24±(198.56)	8.04	0.0008±(0.009)	0.18	9.80	3.78
EUCOPEPODA (copepoda)						
Cyclops spp.	0.16±(1.12)	0.03	0.0±(2.80)	0.00	1.96	0.42
BASOMMATOPHORA (snail)						
Lymnaidae	0.06±(0.42)	0.01	0.0±(0.0002)	0.00	1.96	0.41
Planorbidae	0.02±(0.14)	0.00	0.0±(0.0)	0.00	1.96	0.41
DIPTERA (midges)						
Chironomidae pupae	65±(306)	11.7	0.03±(0.17)	7.05	29.4	10.1
Chironomidae larvae	64.65±(447.15)	11.5	0.009±(0.06)	2.10	29.4	9.03
Tipulidae pupae	0.10±(0.41)	0.02	0.0001±(0.0005)	0.03	5.88	1.25
Tipulidae larvae	0.27±(1.96)	0.05	0.0003±(0.002)	0.07	1.96	0.44
Simulidae larvae	2.08±(14.84)	0.37	0.0008±(0.006)	0.19	1.96	0.53
TRICOPTERA (caddisflies)						
Leptoceridae	0.10±(0.70)	0.02	0.0±(0.0004)	0.01	1.96	0.42
Hydropsychidae	0.57±(3.78)	0.10	0.0008±(0.004)	0.18	3.92	0.88
Leptostomatidae	0.0±(0.0)	0.00	0.0±(5.60)	0.00	1.96	0.41
Brachycentridae	0.06±(0.31)	0.01	0.0003±(0.002)	0.07	3.92	0.84
Rhyacophilidae	0.02±(0.14)	0.00	0.0±(0.0003)	0.01	1.96	0.41
PLECOPTERA (stoneflies)						
Pteronarcyidae	0.43±(2.94)	0.08	0.002±(0.01)	0.39	5.88	1.34
HEMIPTERA (bugs)						
Corixidae	0 22±(0.70)	0.04	0 0003±(0.002)	0.07	11.7	2.5
EPHEMEROPTERA (mayflies)						
Baetidae	0 27±(1.18)	0.05	0.0001±(0.002)	0.03	9.80	2.07
Ephemerellidae	0.0±(0.0)	0.00	0.0±(0.0)	0.00	1.96	0.41
ODONATA (dragonflies)						
Anisoptera	0.02±(0.14)	0.00	0.0±(0.0)	0.00	1.96	0.41
Zygoptera	0.02±(0.14)	0.00	0.0±(0.0005)	0.02	1.96	0.42
COLEOPTERA (beetles)						
Elmidae	0.02±(0.14)	0.00	0 0±(0.0)	0.00	1.96	0.41
HYDRACHNELLLAE (spider)						
Hydracarina	0 02±(0.14)	0.00	0 0±(0.0)	0.00	1.96	0.41
OTHER:						
Terrestrial	2.51±(7.48)	0.45	0 03±(0.12)	6.49	25.5	6.81
Organic Detritus	0.55±(0.92)	0.10	0.19±(1.04)	42.8	31.4	15.6
Inorganic Detritus	0.12±(0.43)	0.02	0.04±(0.25)	9.7	7.84	3.68
Unidentifiable bodies	0.18±(0.65)	0.03	0 004±(0.02)	0.97	7 94	1.86

Table 3.5.12 The annual food preferences of 3+ Rainbow from Lake Roosevelt in 1989.

	RAINBOW (N=35)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	%	%	%
OSTEICHTHYES (fish)						
Percidae	0.09±(0.51)	0.03	0.08±(0.49)	14.49	2.78	3.54
Unidentified fish	0.11±(0.32)	0.04	0.01±(0.05)	1.81	11.11	2.65
CLADOCERA (water fleas)						
Daphnia schødleri	191±(680)	62.37	0.02±(0.04)	2.66	27.78	19.02
Leptodora kindtii	77±(182)	25.19	0.02±(0.04)	2.96	22.22	10.30
EUCOPEPODA (copepoda)						
Epischura spp.	0.14±(0.85)	0.05	0.0±(0.0)	0.00	2.78	0.58
DIPTERA (midges)						
Chironomidae pupae	2.14±(5.82)	5.98	0.0004±(0.002)	0.08	0.70	6.41
Chironomidae larvae	1.34±(3.58)	0.44	0.03±(0.15)	4.52	22.22	5.56
TRICOPTERA (caddisflies)						
Hydropsychidae	8±(18.72)	2.60	0.007±(0.02)	1.27	19.44	4.77
Rhyacophilidae	0.06±(0.34)	0.02	0.0±(0.0)	0.00	2.78	0.57
PLECOPTERA (stoneflies)						
Perlodidae	1.34±(4.14)	0.44	0.002±(0.006)	0.33	13.89	3.00
Pteronarcyidae	0.09±(0.28)	0.03	0.0001±(0.0008)	0.02	8.33	1.71
HEMIPTERA (bugs)						
Corixidae	0.14±(0.43)	0.05	0.001±(0.008)	0.19	11.11	2.32
Notonectidae	0.03±(0.17)	0.01	0.0002±(0.001)	0.04	2.78	0.58
EPHEMEROPTERA (mayflies)						
Baetidae	0.74±(2.65)	0.24	0.0002±(0.0008)	0.03	8.33	1.76
ODONATA (dragonflies)						
Zygoptera	0.03±(0.17)	0.01	0.0±(0.0005)	0.01	2.78	0.57
COLEOPTERA (beetles)						
Elmidae	0.14±(0.85)	0.05	0.003±(0.02)	0.51	2.78	0.68
HYDRACHNELLLAE (spider)						
Hydracarina	0.14±(0.69)	0.05	0.0±(0.0002)	0.00	5.56	1.15
OTHER:						
Cestoda	0.03±(0.17)	0.01	0.0±(0.0002)	0.00	2.78	0.57
Terrestrial	23±(71)	7.5	0.35±(1.66)	60.29	41.67	22.38
Organic Detritus	0.51±(0.92)	0.17	0.04±(0.12)	6.86	30.56	7.69
Inorganic Detritus	0.17±(0.51)	0.06	0.02±(0.05)	3.01	11.11	2.90
Unidentifiable bodies	0.03±(0.17)	0.01	0.004±(0.02)	0.72	5.56	1.29

Table 3.5.13 The annual food preferences of 4+ Rainbow from Lake Roosevelt in 1989.

	RAINBOW (N=43)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X±S.D.)	(%)	(X±S.D.)	%	(%)	(%)
OSTEICHTHYES (fish)						
Percidae	0.05±(0.21)	0.01	0 01 f(0.06)	1.38	4.65	1.27
Unidentified fish	0.02±(0.15)	0.00	0.005±(0.03)	0.26	2.33	0.54
Walleye eggs	439±(1226)	82.56	1.10±(2.46)	58.20	20.93	33.9
ISOPODA (sow bugs)						
Asellus	0.07±(0.46)	0.01	0.002±(0.01)	0.09	2.33	0.51
CLADOCERA (water fleas)						
Daphnia schodleri	6.91±(30.61)	1.30	0.002±(0.006)	0.10	11.63	2.73
Leptodora kindtii	60±(239)	11.37	0.01±(0.03)	0.95	13.95	5.51
DECAPODA (crayfish)						
Pacifasticus	0 02±(0. 15)	0.00	0.01±(0.03)	0.31	2.33	0.55
BASOMMATOPHORA (snarl)						
Lymnaidae	0 02±(0. 15)	0 00	0.001±(0.006)	0.06	2.33	0.59
MOLLUSKA (dam)						
Sphaeriidae	0.07±(0.34)	0.01	0.0005±(0.003)	0.03	4.65	0.98
DIPTERA (midges)						
Chironomidae pupae	0.37±(1.00)	0.07	0.0001±(0.001)	0.01	18.60	3.92
Chironomidae larvae	0.56±(2.41)	0.10	0.0004±(0.002)	0.02	9.30	1.98
Tipulidae pupae	0.72±(2.20)	0.14	0.001±(0.005)	0.08	13.95	2.97
Tipulidae larvae	0.91±(3.27)	0.17	0.001±(0.003)	0.06	9.30	2.00
Simuliidae larvae	4.16±(27.30)	0.78	0.003±(0.015)	0.14	2.33	0.68
TRICOPTERA (caddisflies)						
Hydropsychidae	2.74±(10.30)	0.52	0.003±(0.01)	0.18	13.95	3.07
Brachycentridae	0.35±(2.29)	0.07	0.002±(0.01)	0.08	2.33	0.52
PLECOPTERA (stoneflies)						
Perlodidae	0.28±(1.40)	0.05	0.0003±(0.002)	0.01	6.98	1.48
Pteronarcyidae	0.14±(0.56)	0.03	0 0±(0.0)	0.10	6.98	1.49
HEMIPTERA (bugs)						
Corixidae	0.05±(0.21)	0.01	0.0±(0.0003)	0.00	4.65	0.98
EPHEMEROPTERA (mayflies)						
Baetidae	0.35±(1.99)	0.07	0.0002±(0.001)	0.01	6.98	1.48
Ephemerellidae	0.02±(0.15)	0.00	0.0±(0.0)	0.00	2.33	0.49
Heptagenidae	0 05±(0.30)	0.01	0.0±(0.0002)	0.00	2.33	4.9
OLIGOCHEATA (worms)						
Lumbriculidae	0.44±(2.10)	0.08	0.03±(0.15)	1.46	4.65	1.3
COLEOPTERA (beetles)						
Elmidae	0.02±(0.15)	0.00	0.003±(0.02)	0.18	2.33	0.52
OTHER:						
Terrestrial	12±(39)	2.36	0.18±(0.52)	9.40	34.88	9.78
Organic Detritus	1.16±(1.34)	0.22	0.27±(1.23)	14.58	48.84	13.34
Inorganic Detritus	0.19±(0.50)	0.03	0.23±(1.23)	12.11	13.95	5.47
Unidentifiable bodies	0.12±(0.50)	0.02	0 004±(0.02)	0.20	6.98	1.51

Table 3.5.14 The annual food preferences of 5+ Rainbow from Lake Roosevelt in 1989.

	RAINBOW (N=14)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X±S.D.)	(%)	(X±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Walleye eggs	858±(2276)	83.21	1.52±(3.95)	38.50	35.71	25.62
AMPHIPODA (scuds)						
Gammerus	0.07±(0.27)	0.01	0.0±(0.0002)	0.00	7.14	1.16
CLADOCERA (water fleas)						
Daphnia schadleri	2.79±(10.42)	0.27	0.0±(0.0003)	0.00	7.14	1.21
Leptodora kindtii	135±(507)	13.15	0.04±(0.15)	1.02	7.14	3.47
EUCOPEPODA (copepoda)						
Epischura spp.	16±(62)	1.61	0.0002±(0.0007)	0.00	7.14	1.43
BASOMMATOPHORA (snail)						
Lymnaidae	0.07±(0.27)	0.01	0.002±(0.009)	0.06	7.14	1.17
Planorbidae	0.14±(0.53)	0.01	0.0004±(0.001)	0.01	7.14	1.17
MOLLUSKA (clam)						
Sphaeriidae	0.14±(0.36)	0.01	0.001±(0.003)	0.03	14.29	2.33
DIPTERA (midges)						
Chironomidae pupae	2.5±(6.3)	0.24	0.0±(0.0005)	0.00	21.43	3.53
Clhironomidae larvae	0.86±(1.56)	0.08	0.0004±(0.001)	0.01	58.57	4.67
Tipulidae pupae	0.21±(0.58)	0.02	0.0002±(0.0005)	0.00	14.29	2.33
Tipulidae larvae	0.71±(1.27)	0.07	0.001±(0.002)	0.02	28.57	4.66
TRICOPTERA (caddisflies)						
Limnephilidae	0.14±(0.53)	0.01	0.02±(0.08)	0.53	7.14	1.25
Hydropsychidae	0.14±(0.36)	0.01	0.0004±(0.002)	0.01	14.29	2.33
Heliopsychidae	0.14±(0.53)	0.01	0.0005±(0.002)	0.01	7.14	1.17
EPHEMEROPTERA (mayflies)						
Baetidae	0.0±(0.0)	0.02	0.0004±(0.002)	0.01	50.00	2.33
HYDRACHNELLLAE (spider)						
Hydracarina	0.07±(0.27)	0.01	0.0±(0.0003)	0.00	7.14	1.16
OTHER:						
Terrestrial	10.14±(22.66)	0.98	0.07±(0.16)	1.76	42.86	7.42
Organic Detritus	1.79±(1.25)	0.17	2.19±(3.49)	55.51	78.57	21.87
Inorganic Detritus	0.43±(0.65)	0.04	0.08±(0.21)	1.97	35.71	6.14
Unidentifiable bodies	0.36±(0.84)	0.03	0.02±(0.08)	0.53	21.43	3.58

Table 3.5.15 The annual food preferences of 6+ Rainbow trout from Lake Roosevelt in 1989.

	RAINBOW TROUT (N=1)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schødleri	103±(0.0)	29.1	0.004±(0.0)	3.5	100	26.5
Leptodora kindtii	250±(0.0)	70.6	0.081±(0.0)	69.2	100	47.9
OTHER:						
Unidentifiable bodies	1±(0.0)	0.28	0.03±(0.0)	27.2	100	25.5

The highest weight frequency values were for walleye eggs at 0.28 ± 1.5 mg dry weight per stomach, followed by organic detritus (plant matter) at 0.23 ± 1.2 mg and terrestrial insects at 0.09 ± 0.68 mg. The highest percent composition by weight values were for walleye eggs at 18.0%, followed by organic detritus at 15.0% and terrestrial insects at 6.3% (Table 3.58).

The highest frequency of occurrence values were for *D. schødleri* at 40.8%, followed by terrestrial insects at 39.0% and organic detritus at 34.1% (Table 3.5.8)

The highest IRI values were for walleye eggs at 34.6%, followed by organic detritus at 28.6% and terrestrial insects at 12.4% (Table 3.5.8).

Annual Feeding Habits of 0+ Rainbow Trout for 1989

Information for yearly feeding habits of 0+ rainbow trout is presented in Table 3.5.9.

The highest number frequency values were for *D. schødleri* at 109 ± 323 per stomach, followed by terrestrial insects at 11 ± 33 and Chironomidae pupae (midges) at 6 ± 17. The highest percent compostition by number values were for *D. schødleri* at 82.2%, followed by terrestrial insects at 8.4% and Chironomidae pupae at 4.5%.

The highest weight frequency values were for organic detritus at 0.03 ± 0.08 mg dry weight per stomach, followed by *D. schødleri* at 0.01 ± 0.02 mg and unidentifiable body parts at 0.01 ± 0.02 mg. The highest percent composition by weight values were for organic detritus at 45.2%, followed by *D. schndleri* at 16.8% and unidentifiable body parts at 13.9%.

The highest frequency of occurrence values were for terrestrial insects at 56.4%, followed by Chironomidae pupae at 41 .0% and *D. schødleri* at 38.5%.

The highest IRI values were for *D. schødleri* at 26.7%, followed by organic detritus at 14.3% and terrestrial insects at 14.3%.

Annual Feeding Habits of 1+ Rainbow Trout for 1989

Information for yearly feeding habits of 1+ Rainbow trout is presented in Table 3.5.10.

The highest number frequency values were for *D. schndleri* at 353 ± 950 per stomach, followed by ***L. kindtii*** at 12 ± 52 and Chironomidae pupae at 6.8 ± 22. The highest percent compostition by number values were for ***D. schødleri*** at **92.1%,** followed by ***L. kindtii*** at 3.3% and Chironomidae pupae at 1.8%.

The highest weight frequency values were for Percidae (perch or walleye) at 0.06 ± 0.36 mg dry weight per stomach, followed by terrestrial insects at 0.04 ± 0.09 mg and ***D. schødleri*** at 0.03 ± 0.05 mg. The highest percent composition by weight values were for Percidae at **42.5%**, followed by terrestrial insects at 27.1% and D. *schndleri* at 20.2%.

The highest frequency of occurrence values were for ***D. schødleri*** at **62.5%,** followed by terrestrial insects at 40.0% and Chironomidae pupae at 25.0%.

The highest **IRI** values were for *D. schndleri* at **37.0%,** followed by terrestrial insects at 14.5% and Percidae at 9.5%.

Annual Feeding Habits of 2+ Rainbow Trout for 1989

information for yearly feeding habits of **2+** rainbow trout is presented in Table 3.5.11.

The highest number frequency values were for ***D. schødleri*** at 337 ± 839 per stomach, followed by Chironomidae pupae at 65 ± 306 and Chironomidae larvae (midges) at 64 ± 447. The highest percent compostition by number values were for *D. schndleri* at **60.0%,** followed by Chironomidae pupae at 11.7% and Chironomidae larvae at 11.5%.

The highest weight frequency values were for organic detritus at 0.19 ± 1.04 mg dry weight per stomach, followed by Walleye eggs at 0.10 ± 0.72 mg and inorganic detritus (rocks) at 0.04 ± 0.25 mg. The highest percent composition by weight values were for organic detritus at **42.8%,** followed by Walleye eggs at 22.4% and inorganic detritus at 9.7%.

The highest frequency of occurrence values were for ***D. schødleri*** at **56.9%,** followed by organic detritus at 31.4% and Chironomidae larvae and Chironomidae pupae, both at 29.4%.

The highest **IRI** values were for ***D. schødleri*** at **25.7%,** followed by organic detritus at 15.6% and Chironomidae larvae at 10.1%.

Annual Feeding Habits of 3+ Rainbow Trout for 1989

Information for yearly feeding habits of **3+** rainbow trout is presented in Table 3.5.12.

The highest number frequency values were for *D. schødleri* at 191 ± 680 per stomach, followed by *L. kindtii* at 77 ± 182 and terrestrial insects at 23 ± 71. The highest percent compostition by number values were for *D. schødleri* at **62.4%**, followed by *L. kindtii* at 25.2% and terrestrial insects at 7.5%.

The highest weight frequency values were for terrestrial insects at 0.35 ± 1.66 mg dry weight per stomach, followed by Percidae at 0.08 ± 0.49 mg and organic detritus at 0.04 ± 0.12 mg. The highest percent composition by weight values were for terrestrial insects at **60.3%**, followed by Percidae at 14.5% and organic detritus at 6.9%.

The highest frequency of occurrence values were for terrestrial insects at **41.7%**, followed by organic detritus and Chironomidae larvae at 30.6% and *D. schødleri* at 27.8%.

The highest **IRI** values were for terrestrial insects at **22.4%**, followed by *D. schødleri* at 19.0% and *L. kindtii* at 10.3%.

Annual Feeding Habits of 4+ Rainbow Trout for 1989

Information for yearly feeding habits of **4+** rainbow trout is presented in Table 3.513.

The highest number frequency values were for walleye eggs at 439 ± 1226 per stomach, followed by *L. kindtii* at 60 ± 239 and terrestrial insects at 12 ± 38. The highest percent compostition by number values were for Walleye eggs at **82.6%**, followed by *L. kindtii* at **11.4%** and terrestrial insects at 2.4%.

The highest weight frequency values were for walleye eggs at **1 .10** ± **2.46 mg dry weight per stomach, followed by organic detritus at 0.27** ± 1.23 mg and inorganic detritus at 0.23 ± 1.23 mg. The highest percent composition by weight values were for walleye eggs at **58.2%**, followed by **organic detritus at 14.6% and inorganic detritus at 12.1%.**

The highest frequency of occurrence values were for organic detritus at **48.8%**, followed by terrestrial insects at 34.9% and walleye eggs at 20.9%.

The highest **IRI values** were for walleye eggs at **33.9%**, followed by organic detritus at 13.3% and terrestrial insects at 9.8%.

Annual Feeding Habits of 5+ Rainbow Trout for 1989

Information for yearly feeding habits of **5+** rainbow trout is presented in Table 3.5.14.

The highest number frequency values were for walleye eggs at 858 ± 2276 per stomach, followed by *L. kindtii* at 135 ± 507 and *Epischura* (**copepod** water fleas) at 16 ± 62. The highest percent compostition by number values were for Walleye eggs at **83.2%**, followed by *L. kindtii* at 13.2% and *Epischura* at 1.6%.

The highest weight frequency values were for organic detritus at 2.19 ± 3.49 mg dry weight per stomach, followed by walleye eggs at 1.52 ± 3.95 mg and *L. kindtii* at 0.04 ± 0.15 mg. The highest percent composition by weight values were for organic detritus at **55.6%**, followed by Walleye eggs at 38.5% and inorganic detritus at 2.0%.

The highest frequency of occurrence values were for organic detritus at **78.6%**, followed by organic detritus at 58.6% and terrestrial insects at 42.9%.

The highest **IRI** values were for walleye eggs a? **25.6%**, followed by organic detritus at 21.9% and terrestrial insects at 7.4%.

Annual Feeding Habits of 6+ Rainbow Trout for 7989

Information for yearly feeding habits of **6+** rainbow trout is presented in Table 3.5.15.

The highest number frequency values were for *L. kindtii* at *250 ± 0.0* per stomach, followed by ***D. schødleri*** at 103 ± 0.0 and unidentifiable body parts at **1**± 0.0. The highest percent compostition by number values were for *L. kindtii* at **70.6%**, followed by *D.* ***schødleri*** at 29.1% and unidentifiable body parts at 0.3%.

The highest weight frequency values were for *L.* kindtii at 0.08 ± 0.0 mg dry weight per stomach, followed by unidentifiable body parts at 0.03 ± 0.0 mg and *D. schødleri* at 0.004 ± 0.0 mg. The highest percent composition by weight values were for *L. kindtii* at **69.2%,** followed by unidentifiable body parts at 27.2% and *D. schødleri* at 3.5%.

The highest frequency of occurrence values were for *L. kindtii,* unidentifiable body parts, and *D. schødleri* each at 100.0%.

The highest IRI values were for *L. kindtii* at **47.8%,** followed by *D. schødleri* at 26.5% and unidentifiable body parts at 25.5%.

3.5.3 Annual Feeding Habits of Walleye for 1988

Information for yearly feeding habits of walleye is presented in Table 3.5.16. Monthly values can be found in Appendix F.

The highest number frequency values were for *D. schødleri* (large water fleas) at 5.6 ± 67 per stomach, followed by Bosminidae (small water fleas) at 3 ± 48 and *L. kindtii* (large water fleas) at 1.6 ± 18. The highest percent **compostition** by number values were for *D. schødleri* at **32.5%**, followed by *Bosminidae* at 17.5% and *L. kindtii* at **9.3%,** (Table 3.5.16).

The highest weight frequency values were for Percidae (perch or walleye) at 0.42 ± 0.99 mg dry weight per stomach followed by Salmonidae (salmon, trout or whitefish) at 0.18 ± 0.93 mg and unidentifiable fish at 0.13 ± 0.32. The highest percent composition by weight values were for Percidae at **36.0%,** followed by Salmonidae at 15.7% and unidentifiable fish at **11.9%,** (Table 3.5.16).

The highest frequency of occurrence values were for unidentifiable body parts at **29.6%,** followed by unidentifiable fish at 24.1% and Cottidae (sculpins) at **22.6%,** (Table 3.5.16).

The highest IRI values were for Percidae at **13.4%,** followed by unidentifiable body parts at 10.6% and *D. schødleri* and Cottidae both at **10.4%,** (Table 3.5.16).

Annual Feeding Habits of 0+ Walleye for 1988

Information for yearly feeding habits of 0+ walleye is presented in Table 3.5.17.

Table 3.5.16 The annual food preferences of Walleye from Lake Roosevelt in 1988.

	WALLEYE (N=257)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
'RN ITEM	(X±S.D.)	%	(X±S.D.)	(%)	%	(%)
OSTEICHTHYES (fish)						
Catastomidae	0.03±(0.29)	0.20	0.04±(0.27)	3.90	1.60	1.50
Centrachidae	0 01±(0.10)	0.07	0.01±(0.09)	1.10	0.78	0.50
cottidae	1.1±(3.5)	6.60	0.11f(0.60)	10.00	22.60	10.40
Cyprinidae	0.15±(0.61)	0.89	0.12±(0.49)	10.00	9.00	5.40
Percidae	0.25±(1.0)	1.50	0.42±(0.99)	36.00	14 00	13.40
Salmonidae	0.03±(0.19)	0.18	0.18±(0.93)	15.70	3.00	4.90
Unidentified fish	0 58±(1.6)	3.40	0.13±(0.32)	11.90	24.10	10.30
AMPHIPODA (scuds)						
Gammerus	0.01±(0.06)	0.02	0.00±(0 0002)	0.00	0 39	0.10
ISOPODA (sow bugs)						
Asellus	0.01±(0.18)	0.07	0.00±(0.0001)	0.00	0.39	0.12
CLADOCERA (water fleas)						
Daphnia schødleri	5.6±(67)	32.50	0.00±(0.0009)	0.01	7.00	10.40
Daphnia thorata	0.25±(3.8)	1.50	0.00±(0.0004)	0.00	1.20	0.70
Daphnia galeata mendota	0.96±(12)	5.60	0.00±(0.0002)	0.03	0.78	1.70
Leptodwa kindtii	1.6±(18)	9.30	.0003±(0.002)	0.00	2.00	3.00
Polyphemius pediciulus	0 04±(0.52)	0.27	0.00±(0.00)	0.00	0.78	0.30
Eurycerus lamellatus	0.007±(0.12)	0.04	0.00±(0.00)	0.00	0.39	0.11
Sida crystalline	0.01±(0.14)	0.07	0.00±(0.00)	0.00	0.78	0.22
Bosmina spp.	3.0±(48)	17.50	0.00±(0.00)	0.00	0.39	4.70
Alona spp.	0.01±(0.15)	0.09	0.00±(0.0003)	0.00	1.20	0.33
EUCOPEPODA (copepoda)						
Cyclops spp.	0.01±(0.13)	0.17	0.00±(0.00)	0.00	0.78	0.22
Diaptomus spp.	0.07±(0.79)	0.40	0.00±(0.0001)	0.00	0.78	0.31
Epischura spp.	0.70±(8.8)	0.41	0.00±(0.0005)	0.00	2.00	1.60
Bryocamptus	0.003±(0.06)	0.02	0.00±(0.0003)	0.00	0.39	0.11
OSTRACODA (seed shrimp)						
Cypridae	0 05±(0.81)	0.31	0.0±(0.0)	0.00	0.78	0.30
DIPTERA (midges)						
Chiiommidae pupae	0.33±(1.4)	1.90	0.0004±(0.003)	0.04	14.00	4.20
Chironomidae larvae	1.4±(6.7)	8.10	0.0003±(0.002)	0.03	11.00	4.90
Tipuiidae larvae	0.007±(0.12)	0.04	0.00±(0.0001)	0.03	0.39	0.10
TRICOPTERA (caddisflies)						
Hydropsychidae	0.007±(0.12)	0.04	0.00±(0.0003)	0.00	0.39	0.10
HEMIPTERA (bugs)						
Corixidae	0.01±(0.11)	0.07	0.00±(0.0001)	0.00	1.20	0.30
OTHER:						
Cestoda	0.007±(0.08)	0.04	0.0005±(0.005)	0.05	0.78	0.20
Terrestrial	0 12±(0.60)	0.69	0.0002±(0.0009)	0.02	5.80	1.70
Organic Detritus	0.3±(0.66)	1.70	0.02±(0.12)	1.90	21.00	6.60
Inorganic Detritus	0.04±(0.31)	0.25	0.006±(0.04)	0.57	2.30	0.80
Unidentifiable bodies	0.45±(0.85)	2.60	0.09±0(.30)	8.00	29.60	10.60

Table 3.5.17 The annual food preferences of 0+ Walleye from Lake Roosevelt In 1988.

	WALLEYE (N=23)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	%	($\bar{X}$±S.D.)	%	%	(%)
OSTEICHTHYES (fish)						
Cottidae	0.08±0(.41)	0.07	0.005±(0.02)	24.1	4.4	6.4
Cyprinidae	0.34±(1.0)	0.28	0.01±(0.05)	56.7	13.0	15.8
Percidae	0.08±(0.28)	0.07	0.0005±(0.002)	2.6	9.0	3.0
Unidentified fish	0 04±(0.20)	0.03	0.0007±(0.002)	3.8	A A	1.8
AMPHIPODA (scuds)						
Gammerus	0.04±(0.20)	0.03	0.00±(0.0004)	0.03	A A	0.99
CLADOCERA (water fleas)						
Daphnia schødleri	61±(221)	48.3	0.0003±(0.002)	1.6	47.8	22.0
Daphnia thorata	2.8±(12)	2.2	0.00±(0.001)	0.03	13.0	3.4
Daphnia galeata mendota	1 Of(40)	8.6	0.0001±(0.0007)	0.88	9.0	4.0
Leptodora kindtii	1.6±(18)	0.9	0.00±(0.0005)	0.03	9.0	2.0
Polyphemius pediciulus	0.52±(1.7)	0.41	0.00±(0.0001)	0.18	8.7	2.1
Sida crys tallina	0.04±(0.20)	0.03	0.00±(0.00)	0.03	4.4	1.0
Bosmina spp.	34±(163)	26.9	0.00±(0.00)	0.03	4.4	7.1
EUCOPEPODA (copepods)						
Epischura *spp.*	7.8±(29)	6.2	0.0002±(0.001)	1.2	17.0	5.6
Bryocamptus spp.	0.04±(0.20)	0.03	0.0002±(0.0009)	1.1	4.4	1.2
DIPTERA (midges)						
Chironomidae pupae	0.47±(1.1)	0.38	0.00±(0.0007)	0.03	21.7	5.0
Chironomidae larvae	7±(17)	5.6	0.001±(0.004)	4.0	8.7	4.1
Tipulidae larvae	0.08±(0.41)	0.07	0.00±(0.0003)	0.03	A A	1.0
HEMIPTERA (bugs)						
Corixidae	0 04±(0.20)	0.03	0.00±(0.0001)	0.12	A A	1.0
OTHER:						
Organic Detritus	0.13±(0.34)	0.10	0.0006±(0.003)	3.3	13.0	3.7
Unidentifiable bodies	0.39±(0.49)	0.31	0.00±(0.0009)	0.03	39.1	8.9

Table 3.5.18 The annual food preferences of 1+ Walleye from Lake Roosevelt In 1988.

	WALLEYE (N=27)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Cottidae	1.1±(2.1)	5.7	0.06±(0.15)	24.8	40.7	16.9
Percidae	0.03±(0.19)	0.19	0.07±(0.29)	27.0	3.7	7.3
Unidentifiable fish	0.40±(1.0)	2.0	0.07±(0.13)	27.5	22.2	12.0
CLADOCERA (water fleas)						
Daphnia schodleri	.62±(2.0)	3.2	0.00±(0.0003)	0.04	11.0	3.4
Leptodora kindtii	14±(56)	72.6	0.002±(0.006)	0.91	7.4	19.2
Eurycerus lamellatus	0.07±(.38)	0.38	0.00±(0.0001)	0.00	3.7	1.0
Sida crystallina	0.07±(.38)	0.38	0.00±(0.0002)	0.00	3.7	1.0
Alona affins	0.07±(0.26)	0.38	0.00±(0.0001)	0.00	7.4	1.8
EUCOPEPODA (copepods)						
Diaptomus spp.	0.66±(2.4)	3.4	0.00±(0.0003)	0.03	7.4	2.6
Epischura	0.07±(.38)	0.38	0.00±(0.00)	0.00	3.7	1.0
OSTRACODA (seed shrimp)						
Cyptidae	0.51±(2.5)	2.6	0.0±(.0001)	0.00	7.4	2.3
DIPTERA (midges)						
Chironomidae pupae	0.22±(0.57)	1.1	0.0002±(0.001)	0.09	18.0	4.6
Chironomidae larvae	0.40±(1.2)	2.1	0.00±(0.0007)	0.03	18.0	4.8
OTHER						
Terrestrial	0.40±(1.3)	2.1	0.0007±(0.001)	0.27	11.0	3.2
Organic Detritus	0.18±(0.48)	0.95	0.004±(0.009)	1.6	14.0	4.1
Inorganic Detritus	0.03±(0.19)	0.19	0.00±(0.0003)	0.04	3.7	0.93
Unidentifiable bodies	0.44±(0.64)	2.2	0.04±(0.119)	18.0	37.0	13.5

Table 3.5.19 The annual food preferences of 2+ Walleye from Lake Roosevelt In 1988.

	WALLEYE (N=21)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Cottidae	0.61±(1.5)	17.0	0.08±(0.27)	16.1	28.6	16.6
Cyprinidae	0.04±(0.21)	1.3	0.02±(0.10)	5.2	4.8	3.1
Percidae	0.19±(0.67)	5.3	0.23±(0.71)	40.9	9.5	15.0
Salmonidae	0.09±(0.30)	2.6	0.004±(0.01)	0.83	9.5	3.5
Unidentified fish	0.57±(1.6)	15.8	0.05±(0.12)	10.0	38.1	17.4
CLADOCERA (water fleas)						
Daphnia schødleri	0.85±(3.9)	23.6	0.00±(0.0002)	0.01	4.8	7.6
Alona affins	0.09±(0.43)	2.6	0.00±(0.0009)	0.00	4.8	2.0
EUCOPEPODA (copepods)						
Cyclops spp.	0.09±(0.43)	2.6	0.00±(0.0001)	0.00	4.8	2.0
DIPTERA (midges)						
Chironomidae larvae	0.23±(0.88)	6.6	0.001±(0.004)	0.22	9.5	4.4
HEMIPTERA (bugs)						
Corixidae	0.04±(0.21)	1.3	0.0001±(0.0004)	0.02	4.8	1.6
OTHER:						
Terrestrial	0 14±(0.47)	3.9	0.0003±(0.0007)	0.06	9.5	3.6
Organic Detritus	0.57±(0.87)	15.0	0.11f(0.35)	20.5	38.1	20.0
Unidentifiable bodies	0 04±(0.21)	1.3	0.03±(0.10)	5.6	4.7	3.2

Table 3.5.20 The annual food preferences of 3+ Walleye from Lake Roosevelt in 1988.

PREY ITEM	WALLEYE (N=83) NUMBER ($\bar{X}$±S.D.)	(%)	WEIGHT (mg) ($\bar{X}$±S.D.)	%	OCCURRENCE %	IRI (%)
OSTEICHTHYES (fish)						
Catastomidae	0.01±(0.10)	0.23	0.04±(0.21)	2.3	1.2	1.0
Centrachidae	0.02±(0.15)	0.47	0.04±(0.19)	2.1	1.2	1.0
Cottidae	1.7±(3.7)	33.5	0.28±(0.85)	13.7	31.0	21.5
Cyprinidae	0.20±(0.80)	3.9	0.41±(1.0)	20.0	9.6	9.2
Percidae	0.42±(1.6)	8.2	0.65±(1.3)	31.4	16.8	15.0
Salmonidae	0.02±(0.21)	0.47	0.15±(0.70)	7.5	1.2	2.5
Unidentified fish	0.57±(1.5)	11.00	0.36±(0.56)	17.5	25.0	14.0
CLADOCERA (water fleas)						
Daphnia schødleri	0.12±(1.0)	2.3	0.0007±(0.0003)	0.00	1.2	0.97
EUCOPEPODA (copepods)						
Cyclops spp.	0.01±(0.10)	0.23	0.0001±(0.0005)	0.01	1.2	0.40
DIPTERA (midges)						
Chironomidae pupae	0.44±(1.6)	8.6	0.001±(0.007)	0.07	14.0	6.3
Chironomidae larvae	0.68±(4.6)	13.3	0.0001±(0.0003)	0.01	6.0	5.3
TRICOPTERA (caddisflies)						
Hydropsychidae	0.02±(0.21)	0.47	0.00±(0.0007)	0.00	1.2	0.46
HEMIPTERA (bugs)						
Corixidae	0.01±(1.0)	0.23	0.00±(0.0001)	0.00	1.2	0.39
OTHER:						
Terrestrial	0.13±(0.53)	2.5	0.00±(0.0004)	0.02	8.4	3.0
Organic Detritus	0.27±(0.66)	5.4	0.03±(0.07)	1.5	19.0	7.1
Inorganic Detritus	0.07±(0.40)	1.4	0.03±(0.10)	1.6	3.6	1.8
Unidentifiable bodies	0.36±(0.80)	7.0	0.04±(0.15)	1.9	21.6	8.4

Table 3.521 **The annual food preferences of 4+ Walleye from Lake Roosevelt in 1988.**

	WALLEYE (N=89)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	%	%	%
OSTEICHTHYES (fish)						
Catastomidae	0.02±(0.21)	0.42	0.007±(0.04)	0.53	1.1	0.56
Centrachidae	0.01±(0.10)	0.21	0.01±(0.09)	1.0	1.1	0.63
Cottidae	1.2±(4.5)	22.6	0.14±(0.81)	10.0	15.0	13.2
Cyprinidae	0.12±(0.39)	2.3	0.09±(0.32)	6.3	10.0	5.1
Percidae	0.20±(0.56)	3.8	0.56±(0.98)	38.5	15.0	15.5
Salmonidae	0.02±(0.14)	0.42	0.30±(1.35)	20.9	2.2	6.4
Unidentified fish	0.77±(2.1)	14.4	0.11±(0.24)	7.6	24.7	12.7
ISOPODA (sow bugs)						
Asellus	0.03±(0.31)	0.63	0.0007±(0.0004)	0.01	1.1	0.48
CLADOCERA (water fleas)						
Daphnia schødleri	0.01±(0.10)	0.21	0.00±(0.00)	0.00	1.1	0.36
Leptodora kindtii	0.25±(2.4)	4.8	0.0006±(0.0004)	0.00	1.1	1.6
DIPTERA (midges)						
Chironomidae pupae	0.32±(1.1)	6.0	0.0006±(0.003)	0.05	15.0	5.6
Chironomidae larvae	1.3±(4.8)	24.2	0.0001±(0.001)	0.01	13.0	10.0
OTHER:						
Cestoda	0.02±(0.14)	0.42	0.001±(0.009)	0.11	2.3	0.76
Terrestrial	0.06±(0.44)	1.2	0.0001±(0.0004)	0.01	3.3	1.3
Organic Detritus	0.34±(0.72)	6.5	0.01±(0.03)	0.87	24.7	8.7
Inorganic Detritus	0.03±(0.31)	0.63	0.0002±(0.001)	0.02	1.1	0.48
Unidentifiable bodies	0.60±(1.0)	11.0	0.21±(0.47)	14.1	34.8	16.4

Table 3.5.22 The annual food preferences of 5+ Walleye from Lake Roosevelt in 1988.

	WALLEYE (N=11)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Catastomidae	0.54±(1.2)	13.6	0.49±(0.90)	29.1	18.2	16.0
Cyprinidae	0.18±(0.60)	4.5	0.05±(0.15)	3.2	9.0	4.4
Percidae	0.09±(0.30)	2.2	0.09±(0.26)	5.5	9.0	4.4
Salmonidae	0.18±(0.40)	4.5	0.73±(1.35)	43.7	18.2	17.4
Unidentified fish	0.90±(1.8)	22.7	0.27±(0.45)	16.2	36.4	19.8
CLADOCERA (water fleas)						
Daphnia schødleri	0.18±(0.60)	4.5	0.00±(0.0002)	0.00	9.0	3.5
DIPTERA (midges)						
Chironomidae pupae	0.18±(0.60)	4.5	.00006±(0.0001)	0.00	9.0	3.5
Chironomidae larvae	1.1±(0.36)	27.3	0.00±(0.0001)	0.00	9.0	9.5
OTHER:						
Organic Detritus	0.09±(0.30)	2.2	0.001±(0.004)	0.09	9.0	3.0
Inorganic Detritus	0.09±(0.30)	2.2	0.009±(0.02)	0.59	9.0	3.1
Unidentifiable bodies	0.45±(0.52)	11.0	0.01±(0.03)	1.0	45.5	15.0

Table 3.5.23 The annual food preferences of 6+ Walleye from Lake Roosevelt in 1988.

	WALLEYE (N=3)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Cyprinidae	0.33±(0.57)	8.3	0.39±(0.67)	11.9	33.3	13.4
Percidae	1.6±(2.08)	41.7	2.71±(2.35)	83.5	66.1	48.0
OTHER:						
Organic Detritus	0.33±(0.57)	8.3	0.0004±(0.0008)	0.01	33.3	10.4
Unidentifiable bodies	1.6±(1.52)	41.7	0.15±(0.23)	4.5	66.1	28.2

The highest number frequency values were for ***D. schødleri*** at 61 ± 221 per stomach, followed by *Bosminidae* at 34 ± 163 and ***Daphnia galeata*** *mendota* (large water fleas) at 10 ± 40. The highest percent compostition by number values were for ***D. schødleri*** at **48.3%,** followed by *Bosminidae* at 26.9% and ***D. galeata*** *mendota* at 8.6%.

The highest weight frequency values were for Cyprinidae (minnows, carp, squawfish), at 0.01 ± 0.05 mg dry weight per stomach followed by Cottidae at 0.005 ± 0.02 mg and Chironomidae larvae (midges) at 0.001 ± 0.004 mg. The highest percent composition by weight values were for Cyprinidae at **56.7%,** followed by Cottidae at 24.1% and Chironomidae larvae at 4.0%.

The highest frequency of occurrence values were for ***D. schødleri*** at **47.8%,** followed by unidentifiable body parts at 39.1% and Chironomidae pupae (midges) at 21.7%.

The highest **IRI** values were for ***D. schødleri*** at 22.0%. followed by Cyprinidae at 15.8% and unidentifiable body parts at 8.9%.

Annual Feeding Habits of 1+ Walleye for 1988

Information for yearly feeding habits of **1+** walleye is presented in Table 3.5.18.

The highest number frequency values were for *L. kindtii* at 14 **±** 56 per stomach, followed by Cottidae at 1 **.1**± 2.1 and *Diaptomus* **(copepod** water fleas) at 0.66 ± 2.41. The highest percent compostition by number values were for *L. kindtii* at **72.6%,** followed by Cottidae at 5.7% and *Diaptomus* at 3.4%.

The highest weight frequency values were for unidentifiable fish at 0.07 ± 0.13 mg dry weight per stomach followed by Percidae at 0.07 ± 0.29 mg and Cottidae at **.06** ± 0.15 mg. The highest percent composition by weight values were for unidentifiable fish at **27.5%,** followed by Percidae at 27.0% and Cottidae at 24.8%.

The highest frequency of occurrence values were for Cottidae at **40.7%,** followed by unidentifiable body parts at 37.0% and unidentifiable fish at 22.2%.

The highest **IRI** values were for *L. kindtii* at **19.2%,** followed by Cottidae at 16.9% and unidentifiable body parts at 13.5%.

Annual Feeding Habits of 2+ Walleye for 1988

Information for yearly feeding habits of **2+** walleye is presented in Table 3.5.19.

The highest number frequency values were for ***D. schødleri*** at 0.85 ± 3.9 per stomach, followed by Cottidae at 0.61 ± 1.5 and organic detritus at 0.6 ± 0.9. The highest percent compostition by number values were for ***D. schødleri*** at **24%,** followed by Cottidae at **17%,** and organic detritus (plant matter) and unidentifiable fish both at 15.8%.

The highest weight frequency values were for Percidae at 0.23 ± 0.71 mg dry weight per stomach followed by organic detritus at 0.11 ± 0.35 mg and Cottidae at 0.08 ± 0.27 mg. The highest percent composition by weight values were for Percidae at **40.9%,** followed by organic detritus at 20.5% and Cottidae at 16.1%.

The highest frequency of occurrence values were for organic detritus and unidentifiable fish, both at **38.1%,** followed by Cottidae at *28.6%.*

The highest **IRI** values were for organic detritus at **20.0%,** followed by unidentifiable fish at 17.4% and Cottidae at 16.6%.

Annual Feeding Habits of 3+ Walleye for 1988

Information for yearly feeding habits of **3+** walleye is presented in Table 3.5.20.

The highest number frequency values were for Cottidae at 1.70 ± 3.7 per stomach, followed by Chironomidae larvae at 0.68 ± 4.6 and unidentifiable fish at 0.57 ± 1.5. The highest percent compostition by number values were for Cottidae at **34%,** followed by Chironomidae larvae at **13.3%,** and unidentifiable fish at 11%.

The highest weight frequency values were for Percidae at 0.65 ± 1.3 mg dry weight per stomach followed by Cyprinidae **at 0.41 ± 1 .O mg and** unidentifiable fish at 0.36 ± 0.56 mg. The highest percent composition by weight values were for Percidae at **31%,** followed by Cyprinidae at 20% and unidentifiable fish at 18%.

The highest frequency of occurrence values were for Cottidae at **31%**, followed by unidentifiable fish at 25% and unidentifiable body parts at 22%.

The highest IRI values were for Cottidae at **22%**, followed by Percidae at 16% and unidentifiable fish at 15%.

Annual Feeding Habits of 4+ Walleye for 1988

Information for yearly feeding habits of **4+** walleye is presented in Table 3.521.

The highest number frequency values were for Chironomidae larvae at 1.3 ± 4.8 per stomach, followed by Cottidae at 1.2 ± 4.5 and unidentifiable fish at 0.8 ± 2.1. The highest percent compostition by number values were for Chironomidae larvae at **24.2%**, followed by Cottidae at 22.6% and unidentifiable fish at 14.4%.

The highest weight frequency values were for Percidae at 0.56 ± 0.98 mg dry weight per stomach followed by Salmonidae at 0.30 ± 1.35 mg and unidentifiable body parts at 0.21 ± 0.47 mg. The highest percent composition by weight values were for Percidae at **38.5%**, followed by Salmonidae at 20.9% and unidentifiable body parts at 14.1%.

The highest frequency of occurrence values were for unidentifiable body parts at **34.8%**, followed by organic detritus and unidentifiable fish, both at 24.7%.

The highest IRI values were for unidentifiable body parts at **16.4%**, followed by Percidae at 15.5% and Cottidae at 13.2%.

Annual Feeding Habits of 5+ Walleye for 1988

Information for yearly feeding habits of **5+** walleye is presented in Table 3.5.22.

The highest number frequency values were for Chironomidae larvae at 1.1 ± 3.6 per stomach, followed by unidentifiable fish at 0.9 ± 1.81 and Catastomidae (suckers) at 0.54 ± 1.2. The highest percent compostition by number values were for Chironomidae larvae at **27.3%**, followed by unidentifiable fish at 22.7% and Catastomidae at 13.6%.

The highest weight frequency values were for Salmonidae at 0.73 ± 1.35 mg dry weight per stomach followed by Catastomidae at 0.49 ± 0.90 mg and unidentifiable fish at 0.27 ± 0.45 mg. The highest percent composition by weight values were for Salmonidae at 43.7%, followed by Catastomidae at 29.1% and unidentifiable fish at 16.2%.

The highest frequency of occurrence values were for unidentifiable body parts at 45.5%, followed by unidentifiable fish at 36.4%, and Catastomidae and Salmonidae, both at 18.2%.

The highest IRI values were for unidentifiable fish at 19.8%, followed by Salmonidae at 17.4% and Catastomidae at 16.0%.

Annual Feeding Habits of 6+ Walleye for 1988

Information for yearly feeding habits of 6+ walleye is presented in Table 3.5.23.

The highest number frequency values were for unidentifiable body parts at 1.6 ± 1.52 per stomach, followed by Percidae at 1.6 ± 2.08 and Cyprinidae and organic detritus, both at 0.3 ± 0.6. The highest percent compostition by number values were for unidentifiable body parts and Percidae, both at 41.7%, followed by Cyprinidae and organic detritus, both at 8.3%.

The highest weight frequency values were for Percidae at 2.71 ± 2.35 mg dry weight per stomach followed by Cyprinidae at 0.39 ± 0.67 mg and unidentifiable body parts at 0.15 ± 0.23. The highest percent composition by weight values were for Percidae at 83.5%, followed by Cyprinidae at 12.0% and unidentifiable body parts at 4.5%.

The highest frequency of occurrence values were for unidentifiable body parts and Percidae, both at 66.7%, followed by Cyprinidae and organic detritus, both at 33.3%.

The highest IRI values were for Percidae at 48.0%, followed by unidentifiable body parts at 28.2% and Cyprinidae at 13.4%.

3.5.4 Annual Feeding Habits of Walleye for 1989

Information for yearly feeding habits of walleye is presented in Table 3.5.24. Monthly values can be found in Appendix F.

The highest number frequency values were for ***D. schødleri*** (water fleas) at 3.1 ± 38 per stomach, followed by *L.* ***kindtii*** (water fleas) at 2.6 ± 24 and Chironomidae pupae (midges) at 1.7 ± 6.9. The highest percent compostition by number values were for ***D. schødleri*** at **27.2%**, followed by *L.* ***kindtii*** at 23.1% and Chironomidae pupae at 15.4% (Table 3.5.24).

The highest weight frequency values were for Percidae (yellow perch and walleye) at 0.23 ± 0.81 mg dry weight per stomach, followed by unidentifiable fish at 0.14 ± 0.51 mg and Salmonidae (salmon, trout, and white fish) at G.12 ± 0.88 mg. The highest percent composition by weight values were for Percidae at **40.6%**, followed by unidentifiable fish at 25.0% and Salmonidae at 21.0% (Table 3.5.24).

The highest frequency of occurrence values were for unidentifiable fish at **44.6%**, followed by Cottidae (sculpins) at 24.2% and organic detritus (plant matter) at 21.1% (Table 3.5.24).

The highest **IRI** values were for unidentifible fish at 21 **.1%**, followed by Percidae at 16.3% and Cottidae at 10.2% (Table 3.5.24).

Annual Feeding Habits of 0+ Walleye for 1989

Information for yearly feeding habits of 0+ walleye is presented in Table 3.5.25.

The highest number frequency values were for ***D. schødleri*** at 23 ± 103 per stomach, followed by *L.* ***kindtii*** at 20 ± 64 and Chironomidae pupae at 1.5 ± 3.4. The highest percent compostition by number values were for ***D. schødleri*** at **49.5%**, followed by *L.* ***kindtii*** at 42.1% and Chironomidae pupae at 3.3%.

The highest weight frequency values were for Catastomidae (suckers) at 0.02 ± 0.10 mg dry weight per stomach followed by unidentifiable fish at 0.02 ± 0.05 mg and Percidae at 0.02 ± 0.06 mg . The highest percent composition by weight values were for Catastomidae at **28.5%**, followed by unidentifiable fish at 27.0% and Percidae at 24.5%.

Table 3.5.24 The annual food preferences of Walleye from Lake Roosevelt in 1989.

	WALLEYE (N=289)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	%	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Catastomidae	0.006±(0.08)	0.06	0.002±(0.03)	0.45	0.69	0.33
Cottidae	0.67±(1.76)	6.0	0.04±(0.12)	7.7	24.2	10.2
Cyprinidae	0.09±(0.76)	0.83	O.OIf(O.IO)	1.9	3.1	1.6
Percidae	0.28±(0.87)	2.5	0.23±(0.81)	40.6	17.0	16.3
Salmonidae	.003±(0.20)	.30	0.12±(0.88)	21.0	3.4	6.7
Unidentified fish	0.91±(1.6)	7.9	0.14±(0.51)	25.0	44.6	21.1
AMPHIPODA (scuds)						
Gammerus	0.003±(0.05)	0.03	0.0±(0.0001)	0.0	0.35	0.10
Hyalella	0.006±(0.08)	0.06	0.0±(0.0001)	0.0	0.69	0.20
ISOPODA (sow bugs)						
Asellus	0.006±(0.08)	0.06	0.0±(0.0002)	0.0	0.69	0.20
CLADOCERA (water fleas)						
Daphnia schødleri	3.1±(38.0)	27.2	0.0002±(0.003)	0.04	2.0	8.0
Daphnia thorata	0.09±(1.6)	0.83	0.0±(0.0)	0.0	0.35	0.32
Daphnia galeata mendotz	0.01±(0.18)	0.12	0.0±(0.0)	0.0	0.35	0.13
Leptodora kindtii	1.6±(24.0)	23.0	0.0002±(0.002)	0 05	2.4	7.0
EUCOPEPODA (copepods)						
Bryocamptus spp.	0.003±(0.05)	0.03	0.0±(0.0)	0.0	0.35	0.10
BASOMMATOPHORA (snail)						
Phnorbidae	0.02±(0.47)	0.24	0.0003±(0.006)	0.06	0.35	0.18
MOLLUSKA (dam)						
Sphaeriidae	0.40±(6.7)	3.5	0.0005±(0.009)	0.10	1.0	1.2
DIPTERA (midges)						
Chironomidae pupae	1.7±(6.9)	15.4	0.0003±(0.002)	0.07	19.0	9.3
Chironomidae larvae	0.70±(4.4)	6.0	0.0001±(0.001)	0.03	11.0	4.6
Simulidae pupae	0.01±(0.13)	0.09	0.0±(0.0001)	0.0	0.69	0.21
Simulidae larvae	0.03±(0.50)	0.33	0.0±(0.0)	0.0	0.35	0.28
TRICOPTERA (caddisflies)						
Leptoceridae	0.003±(0.05)	0.03	0.0±(0.0)	0.0	0.35	0.10
Hydropsychidae	0.02±(0.29)	0.18	0.0±(0.0001)	0.0	0.69	0.24
PLECOPTERA (stoneflies)						
Perkdidae	0.03±(0.05)	0.03	0.0±(0.0002)	0.0	0.35	0.10
Pteronarcyidae	0.08±(0.83)	0.74	0.0±(0.0008)	0.02	2.0	0.77
EPHEMEROPTERA (mayflies)						
Baetidae	0.07±(0.83)	0.62	0.0±(0.0002)	0.0	2.0	0.73
Heptagenidae	0.05±(0.88)	0.45	0.0±(0.0002)	0.0	2.0	0.69
ODONATA (Dragonflies)						
Anisoptera	0.02±(0.19)	0.21	0.0±(0.0002)	0.0	0.35	0.15
COLEOPTERA (Beetles)						
Elmidae	0.003±(0.05)	0.03	0.0±(0.0)	0.0	0.35	0.10
OTHER:						
Cestoda	0.02±(0.18)	0.18	0.0006±(0.008)	0.12	1.0	0.36
Terrestrial	0.08±(0.73)	0.71	0.0±(0.0006)	0.01	3.0	1.1
Organic Detritus	0.24±(0.52)	02.1	0.01±(0.05)	2.0	21.1	6.8
Inorganic Detritus	0.02±(0.16)	0.18	0.004±(0.04)	0.85	1.7	0.75
Unidentifiable bodies	0.01±(0.14)	0.12	0.0±(0.0004)	0.01	0.69	0.22

Table 3.5.25 The annual food preferences of 0+ Walleye from Lake Roosevelt in 1989.

	WALLEYE (N=39)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	%	(%)
OSTEICHTHYES (fish)						
Catastomidae	0.05±(0.22)	0.11	0.02±(0.10)	28.5	5.13	1.71
Cottidae	0.25±(0.84)	0.54	0.009±(0.04)	13.0	15.0	8 9
Percidae	0.07±(0.26)	0.16	0.02±(0.06)	24.5	7.7	9.7
Unidentified fish	0.53±(0.64)	1.1	0 02±(0.05)	27.0	38.5	20.0
CLADOCERA (water fleas)						
Daphnia schødleri	23.0±(103.0)	49.5	0.001±(0.008)	2.6	13.0	19.5
Daphnia thorata	0.71±(4.4)	1.52	0.00±(0.10)	0.00	2.6	1.2
Daphnia galeata	0.10±(0.50)	0.22	0.00±(0.0001)	0.00	2.6	0.83
Leptodora kindtii	20.0±(64.0)	42.1	0.002±(0.006)	3.2	18.0	19.0
EUCOPEPODA (copepoda)						
Bryocamptus spp.	0.02±(0.16)	0.05	0.00±(0.00)	0.00	2.6	0.70
DIPTERA (midges)						
Chironomidae pupae	1.5±(3.4)	3.3	0.0001±(0.0009)	0.20	25.6	8.7
Chironomidae larvae	0.23±(0.77)	0.49	0.00±(0.0003)	0.00	10.0	3.2
TRICOPTERA (caddisflies)						
Hydropsychidae	0.07±(0.48)	0.16	0.00±(0.0002)	0.06	2.6	0.83
PLECOPTERA (stoneflies)						
Pteronarcyidae	0.15±(0.81)	0.32	0.00±(0.0003)	0.03	5.1	1.6
OTHER:						
Terrestrial	0.10±(0.38)	0.22	0.00±(0.001)	0.11	7.7	2.4
Organic Detritus	0.02±(0.16)	0.05	0.00±(0.0001)	0.00	2.6	0.78
Unidentifiable bodies	0.02±(0.16)	0.05	0.00±(0.0002)	0.07	2.6	0.80

Table 3.5.26 The annual food preferences of 1+ Walleye from Lake Roosevelt in 1989.

	WALLEYE (N=44)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X±S.D.)	%	(X±S.D.)	%	%	%
OSTEICHTHYES (fish)						
Cottidae	0.93±(2.42)	22.7	0.05±(0.13)	10.5	29.6	17.7
cyprinidae	0.0W(0.36)	2.2	0.04±(0.24)	8.6	9.0	5.6
Percidae	0.27±(0.58)	6.6	0.26±(0.65)	54.2	27.3	24.9
S a l - e	0.04±(0.21)	1.1	0.04±(0.27)	9.4	4.5	4.2
Unidentifiable fish	1.2±(2.5)	29.8	0.07±(0.15)	15.7	38.5	23.7
CLADOCERA (water fleas)						
Daphnia schødleri	0.02±(0.15)	0.55	0.00±(0.0001)	0.00	2.2	0.8
DIPTERA (midges)						
Chironomidae pupae	0.75±(2.7)	18.2	0.0002±(0.0008)	0.05	11.0	8.4
Chironomidae larvae	0.04±(0.21)	1.1	0.00±(0.0007)	0.02	4.5	1.6
EPHEMEROPTERA (mayflies)						
Baetidae	0.04±(2.1)	11.6	0.0001±(0.0005)	0.03	6.8	5.2
OTHER:						
Terrestrial	0.04±(0.21)	1.1	0.00±(0.0005)	0.00	4.5	1.6
Organic Detritus	0.20±(0.50)	4.9	0.007±(0.02)	1.5	15.9	6.3

Table 3.5.27 The annual food preferences of 2+ Walleye from Lake Roosevelt In 1989.

	WALLEYE (N=69)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Cottidae	0.60±(1.8)	8.9	0.54±(0.16)	11.7	22.5	11.1
Percidae	0.31±(.73)	4.7	0.28±(0.79)	60.9	18.0	21.7
Salmonidae	0.01±(0.12)	0.21	0.02±(0.22)	5.7	1.4	1.9
Unidentified fish	0.86±(1.7)	12.8	0.08±(0.29)	18.1	38.0	17.8
AMPHIPODA (scuds)						
Hyalella	0.01±(0.12)	0.21	0.00±(0.00)	0.00	1.4	0.42
ISOPODA (sow bugs)						
Asellus	0.01±(0.12)	0.21	0.00±(0.00)	0.00	1.4	0.42
MOLLUSKA (clam)						
Sphaeriidae	0.02±(0.16)	0.43	0.00±(0.00)	0.00	2.8	0.84
DIPTERA (midges)						
Chironomidae pupae	3.3±(8.7)	48.8	0.0007±(0.002)	0.16	29.6	20.3
Chironomidae larvae	0.59±(1.5)	8.7	0.0002±(0.001)	0.05	19.0	7.3
Simuliidae pupae	0.04±(0.26)	0.64	0.00±(0.0003)	0.01	2.8	1.0
Simuliidae larvae	0.04±(0.36)	0.64	0.00±(0.0001)	0.00	1.4	1.5
PLECOPTERA (stoneflies)						
Pteronarcyidae	0.30±(1.6)	4.5	0.0003±(0.001)	0.07	5.6	2.6
ODONATA (dragonflies)						
Anisoptera	0.02±(0.16)	0.43	0.00±(.0002)	0.01	2.3	0.84
OTHER:						
Cestoda	0.04±(0.26)	0.64	0.00±(0.00)	0.00	1.4	0.53
Terrestrial	0.17±(1.4)	2.6	0.0001±(0.001)	0.03	1.4	1.0
Organic Detritus	0.33±(0.53)	4.9	0.01±(0.04)	2.4	29.6	9.5
Inorganic Detritus	0.01±(0.12)	0.21	0.002±(0.02)	0.64	1.4	0.58
Unidentifiable bodies	0.02±(0.24)	0.43	0.0001±(0.0008)	0.03	1.4	0.48

Table 3.5.28 The annual food preferences of 3+ Walleye from Lake Roosevelt in 1989.

	WALLEYE (N=82)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Cottidae	0.80±(1.7)	10.0	0.04±(0.12)	8.0	27.2	12.9
Cyprinidae	0.20±(1.1)	2.8	0.01±(0.06)	2.3	4.5	0.28
Percidae	0.38±(1.3)	5.1	0.25±(1.05)	41.2	14.0	16.8
Salmonidae	0.03±(0.24)	0.50	0.13±(0.98)	21.2	3.7	7.1
Unidentified fish	0.93±(1.5)	12.5	0.13±(0.38)	22.2	51.9	24.3
AMPHIPODA (scuds)						
Hyalella	0.01±(0.11)	0.17	0.00±(0.0002)	0.00	1.2	0.4
ISOPODA (sow bugs)						
Asellus	0.01±(0.11)	0.17	0.00±(0.0003)	0.01	1.2	0.4
BASOMMATOPHORA (snail)						
Planorbidae	0.09±(0.88)	1.3	0.001±(0.01)	0.20	1.2	0.75
MOLLUSKA (clam)						
Sphaeriidae	1.4±(12)	18.9	0.001±(0.01)	0.32	1.2	5.7
DIPTERA (midges)						
Chironomidae pupae	1.7±(9.18)	23.9	0.0003±(0.003)	0.06	13.6	10.6
Chironomidae larvae	1.2±(6.3)	16.8	0.0001±(0.001)	0.02	8.6	7.0
Simuliidae larvae	0.1±(0.89)	1.3	0.00±(0.00)	0.00	1.2	0.72
TRICOPTERA (caddisflies)						
Leptoceridae	0.01±(0.11)	0.17	0.00±(0.00)	0.00	1.2	0.4
PLECOPTERA (stoneflies)						
Perlodidae	0.01±(0.11)	0.17	0.00±(0.0003)	0.01	1.2	0.4
Pteronarcyidae	0.01±(0.11)	0.17	0.00±(0.0003)	0.01	1.2	0.4
COLEOPTERA (beetles)						
Elmidae	0.01±(0.11)	0.17	0.00±(0.0001)	0.00	1.2	0.4
ODONATA (dragonflies)						
Anisoptera	0.06±(0.33)	0.83	0.00±(0.0003)	0.00	3.7	1.2
OTHER:						
Terrestrial	0.01±(0.11)	0.17	0.00±(0.0003)	0.01	1.2	0.4
Organic Detritus	0.23±(0.50)	3.1	0.01±(0.05)	2.0	20.9	7.3
Inorganic Detritus	0.06±(0.28)	0.83	0.01±(0.07)	2.3	5.0	2.3

Table 3.5.29 The annual food preferences of 4+ Walleye from Lake Roosevelt In 1989.

	WALLEYE (N=53)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	%	%	%
OSTEICHTHYES (fish)						
Cottidae	0.71±(1.5)	15.0	0.04±(0.11)	4.4	24.5	12.2
Cyprinidae	0.13±(0.96)	2.8	0.003±(0.02)	0 3	1.9	1.3
Percidae	0.28±(0.71)	6.0	0.29±(0.87)	27.3	19.0	14.5
Salmonidae	0.07±(0.26)	1.6	0.39±(1.63)	37.0	7.5	12.8
Unidentified fish	0.94±(1.3)	19 9	0.31±(0.91)	29.0	49.1	27.2
AMPHIPODA (scuds)						
Gammerus	0 01±(0.13)	0.40	0.00±(0.0003)	0.00	1.9	0.83
DIPTERA (midges)						
Chironomidae pupae	0 86±(4.3)	18.3	0.0002±(0.001)	0.02	11.0	8.3
Chironomidae larvae	0.90±(6.4)	19.1	0.0003±(0.002)	0 03	3.7	6.4
EPHEMEROPTERA (mayflies)						
Heptagenidae	0.28±(2.0)	6.0	0.00±(0.0005)	0.01	1.9	2.1
OTHER:						
Cestoda	0.01±(0.13)	0.40	0.001±(0.01)	0.00	1.9	0.64
Terrestrial	0.09±(0.29)	1.9	0.00±(0.0001)	0.14	9.4	3.2
Organic Detritus	0.35±(0.65)	7.5	0.01±(0.07)	1.7	26.4	9.9
Unidentifiable bodies	0.01±(0.13)	0.40	0.00±(0.0002)	0.00	1.9	0.64

Table 3.5.30 The annual food preferences of 5+ Walleye from Lake Roosevelt In 1989.

	WALLEYE (N=3)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Unidentified fish	1.1±(1.0)	27.3	1.5±(1.8)	92.1	66.67	39.9
DIPTERA (midges)						
Chironomidae pupae	1.0±(1.7)	27.3	0.001±(0.002)	0.10	66.67	20.2
Chironomidae larvae	0.67±(1.1)	18.2	0.001±(0.001)	0.07	66.67	18.2
OTHER:						
Cestoda	0.67±(1.1)	18.2	0.04±(0.07)	2.4	33.33	11.0
Organic Detritus	0.33±(0.58)	9.0	0.08±(0.15)	5.33	33.33	10.0

The highest frequency of occurrence values were for unidentifiable fish at **38.5%,** followed by Chironomidae pupae at 25.6% and *L. kindtii* at 18.0%.

The highest IRI values were for unidentifiable fish at **20.0%,** followed by *D. schødleri* at 19.5% and *L. kindtii* at 19.0%.

Annual Feeding Habits of 1+ Walleye for 1989

Information for yearly feeding habits of 1+ walleye is presented in Table 3.5.26.

The highest number frequency values were for unidentifiable fish at 1.2 ± 2.5 per stomach, followed by Cottidae at 0.9 ± 2.42 and Chironomidae pupae at 0.75 ± 2.7. The highest percent compostition by number values were for unidentifiable fish at **29.8%,** followed by Cottidae at 22.7% and Chironomidae pupae at 18.2%.

The highest weight frequency values were for Percidae at 0.26 ± 0.65 mg dry weight per stomach followed by unidentifiable fish at 0.07 ± 0.15 mg and Cottidae at 0.05 ± 0.13 mg. The highest percent composition by weight values were for Percidae at **54.2%,** followed by unidentifiable fish at 15.7% and Cottidae at 10.5%.

The highest frequency of occurrence values were for unidentifiable fish at **38.5%,** followed by Cottidae at 29.6% and Percidae at 27.3%.

The highest IRI values were for Percidae at **24.9%,** followed by unidentifiable fish at 23.7% and Cottidae at 17.7%.

Annual Feeding Habits of 2+ Walleye for 1989

Information for yearly feeding habits of 2+ walleye is presented in Table 3.5.27.

The highest number frequency values were for Chironomidae pupae at 3.3 ± 8.7 per stomach, followed by unidentifiable fish at 0.86 ± 1.7 and Cottidae at 0.6 ± 1.8. The highest percent compostition by number values were for Chironomidae pupae at **48.8%,** followed by unidentifiable fish at 12.8% and Cottidae at 8.9%.

The highest weight frequency values were for Cottidae at 0.54 ± 0.16 mg dry weight per stomach followed by Percidae at 0.28 ± 0.79 mg and unidentifiable fish at 0.08 ± 0.29 mg. The highest percent composition by weight values were for Percidae at **60.9%,** followed by unidentifiable fish at 18.1% and Cottidae at 11.7%.

The highest frequency of occurrence values were for unidentifiable fish at **38.0%,** followed by Chironomidae pupae and organic detritus, both at 29.6%.

The highest IRI values were for Percidae at 21.7 followed by Chironomidae pupae at 20.3% and unidentifiable fish at 17.8%.

Annual Feeding Habits of 3+ Walleye for 1989

Information for yearly feeding habits of **3+** walleye is presented in Table 3.5.28.

The highest number frequency values were for Chironomidae pupae at 1.7 ± 9.2 per stomach, followed by Sphaeridae (clams) at **1.4** ± 12.8 and Chironomidae larvae (midges) at 1.2 ± 6.3. The highest percent compostition by number values were for Chironomid pupae at **23.9%,** followed by Sphaeriidae at 18.9% and Chironomidae larvae at 16.8%.

The highest weight frequency values were for Percidae at 0.25 ± 1.05 mg dry weight per stomach, followed by unidentifiable fish at 0.13 ± 0.38 mg and Salmonidae at 0.13 ± 0.98 mg. The highest percent composition by weight values were for Percidae at **41.2%,** followed by unidentifiable fish at 22.2% and Salmonidae at 21.2%.

The highest frequency of occurrence values were for unidentifiable fish at **51.9%,** followed by Cottidae at 27.2% and organic detritus at 20.9%.

The highest IRI values were for unidentifiable fish at **24.3%,** followed by Percidae at 16.8% and Cottidae at 13.0%.

Annual Feeding Habits of 4+ Walleye for 7989

Information for yearly feeding habits of **4+** walleye is presented in Table 3.5.29.

The highest number frequency values were for unidentifiable fish at 0.94 ± 1.3 per stomach, followed by Chironomidae larvae at 0.90 ± 6.4 and Chironomidae pupae at 0.86 ± 4.3. The highest percent compostition by number values were for unidentifiable fish at **19.9%,** followed by Chironomidae larvae at 19.1% and Chironomidae pupae at 18.3%.

The highest weight frequency values were for Salmonidae at **0.39**± 1.63 mg dry weight per **stcmach** followed by unidentifiable fish at 0.31 ± 0.91 mg and Percidae at 0.29 ± 0.87 mg. The highest percent composition by weight values were for Salmonidae at **37.0%,** followed by unidentifiable fish at 29.0% and Percidae at 27.3%.

The highest frequency of occurrence values were for unidentifiable fish at **49.1%,** followed by organic detritus at 26.4% and Cottidae at 24.5%.

The highest **IRI** values were for unidentifiable fish at **27.2%,** followed by Percidae at 14.5% and Salmonidae and Cottidae both at 12.2%.

Annual Feeding Habits of 5+ Walleye for 1989

Information for yearly feeding habits of **5+** walleye is presented in Table 3.5.30.

The highest number frequency values were for unidentifiable fish at 1 .O ± 1 .O per stomach, followed by Chironomidae pupae at 1 .O ± 1.7 and Chironomidae larvae and Cestoda both at 0.67 ± 1.1. The highest percent **compostition** by number values were for unidentifiable fish and Chironomidae pupae, both at **27.3%,** followed by Chironomidae larvae and Cestoda (nematoda), both at 18.2%.

The highest weight frequency values were for unidentifiable fish at 1.5 ± 1.8 per stomach followed by organic detritus at 0.1 ± 0.15 and Cestoda at **0.04 ± 0.07.** The highest percent composition by weight **values** were for unidentifiable fish at **92.1%,** followed by organic detritus at 5.3% and Cestoda at 2.4%.

The highest frequency of occurrence values were for unidentifiable fish, Chironomidae pupae and Chironomidae larvae all at 66.7%.

The highest **IRI** values were for unidentifiable fish at 39.9%. followed by Chironomidae pupae at 20.2% and Chironomidae larvae at 18.2%.

3.5.5 Annual Feeding Habits of Kokanee for 1988

Information for yearly feeding habits of kokanee is presented in Table 3.5.31. Monthly values can be found in Appendix F.

The highest number frequency values were for ***D. schødleri*** (water fleas) at 2,002 ± 3,898 per stomach, followed by Cladocera ephippia (water flea eggs) at 38 ± 204 and *L. kindtii* (water fleas) at 27 ± 122. The highest percent compostition by number values were for ***D. schødleri*** at **96.8%**, followed by Cladocera ephippia at 1.9% and *L. kindtii* at 1.3% (Table 3.531).

The highest weight frequency values were for ***D. schødleri*** at 0.09 ± 0.17 mg dry weight per stomach, followed by inorganic detritus (rocks) and Cladocera ephippia both at 0.002 ± 0.01 mg. The highest percent composition by weight values were for ***D. schødleri*** at **92.8%**, followed by inorganic detritus at 2.2% and Cladocera ephippia at 2.1% (Table 3.5.31).

The highest frequency of occurrence values were for ***D. schødleri*** at **46.4%**, followed by organic detritus (plant matter) at 28.6% and L. *kindtii* and Cladocera ephippium both at 17.9% (Table 3.5.31).

The highest **IRI** values were for ***D. schødleri*** at **67.0%**, followed by organic detritus at 8.2% and Cladocera ephippia at 6.1% (Table 3.5.31).

Annual Feeding Habits of 2+ Kokanee for 1988

Information for yearly feeding habits of **2+** kokanee is presented in Table 3.5.32.

The highest number frequency values were for ***D. schødleri*** at 6817 ± 6362 per stomach, followed by *L. kindtii* at 11 ± 19 and ***D.*** *retrocurva* (water fleas) at 2.6 ± 4.6. The highest percent compostition by number values were for ***D. schødleri*** at **99.8%**, followed by *L. kindtii* at 0.2% and ***D.*** *retrocurva* at **>0.1%**.

The highest weight frequency values were for ***D. schødleri*** at 0.32 ± 0.30 mg dry weight per stomach, followed by organic detritus and *L. kindtii* both at 0.001 ± 0.0001 mg. The highest percent composition by weight values were for ***D. schødleri*** at **99.5%**, followed by organic detritus and *L. kindtii* both at 0.2%.

Table 3.5.31 The annual food preferences of Kokanee from Lake Roosevelt for the year 1988.

	KOKANEE (N=28)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schødleri	2002±(3898)	96.8	0.09±(0.17)	92 .8	46.4	67.0
Daphnia retrocurva	0.39±(1.5)	0.02	0.00±(0.00)	0.01	11.0	3.0
Leptodora kindtii	27±(122)	1.3	0.002±(0.009)	2.0	17.9	6.0
Cladocera ephippia	38±(204)	1.9	0.002±(0.01)	2.1	17.9	6.1
EUCOPEPODA (copepoda)						
Diaptomus spp.	0.03±(0.18)	0.00	0.00±(0.00)	0.01	3.5	1.0
Epischura spp.	0.03±(0.18)	0.00	0.00±(0.00)	0.02	3.5	1.0
DIPTERA (midges)						
Chironomidae pupae	0.03±(0.18)	0.00	0.00±(0.0001)	0.00	3.5	1.0
HEMIPTERA (bugs)						
Corixidae	0.14±(0.75)	0.01	0.00±(0.00)	0.02	3.5	1.0
COLEOPTERA (beetles)						
Elmidae	0.03±(0.18)	0.00	0.00±(0.0004)	0.08	3.5	1.0
OTHER:						
Organic Detritus	0.32±(0.54)	0.02	0.0006±(0.001)	0.64	28.6	8.2
Inorganic Detritus	0.4±(0.5)	0.00	0.002±(0.01)	2.20	7.2	2.6
Unidentifiable bodies	0.03±(0.18)	0.00	0.00±(0.00)	0.01	3.5	1.o
Other	0.03±(0.18)	0.00	0.00±(0.00)	0.00	3.5	1.o

Table 3.5.32 The annual food preferences of 2+ Kokanee from Lake Roosevelt in 1988.

	KOKANEE (N=3)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	%	($\bar{X}$±S.D.)	%	%	%
CLADOCERA (water fleas)						
Daphnia schødleri	6817±(6362)	99.77	0.3238±(0.2986)	99.5	100.00	59.86
Daphnia retrocurva	2.67±(4.62)	0.04	0.00±(0.0001)	0.02	33.33	6.60
Leptodora kindtii	11±(19)	0.17	0.0007±(0.0012)	0.22	33.33	6.74
EUCOPEPODA (copepods)						
Diaptornus spp.	0.33±(0.58)	0.00	0.00±(0.0001)	0.02	33.33	6.67
OTHER:						
Organic Detritus	1.0±(1.0)	0.01	0.0007±(0.0009)	0.23	66.67	13.36

Table 3.5.33 The annual food preferences of 3+ Kokanee from Lake Roosevelt in 1988.

	KOKANEE (N=20)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schodleri	1242±(2863)	95.51	0.06±(0.14)	94.13	65.0	69.76
Daphnia retrocurva	0.15±(0.67)	0.01	0.00±(2.24)	0.01	10.0	2.75
Leptodora kindbi	3.6±(10.94)	0.28	0.0002±(0.0005)	0.27	15.0	4.26
Cladocera ephippia	54±(241)	4.15	0.0029±(0.013)	4.42	25.0	8.03
EUCOPEPODA (copepods)						
Epischura spp.	0.05±(0.22)	0.00	0.00±(0.0001)	0.04	5.0	1.38
DIPTERA (midges)						
Chironomidae pupae	0.05±(0.22)	0.00	0.00±(0.0002)	0.08	5.0	1.39
HEMIPTERA (bugs)						
Corixidae	0.2±(0.89)	0.02	0.00±(0.0001)	0.04	5.0	2.59
COLEOPTERA (beetles)						
Elmidae	0 05±(0.22)	0.00	0.0001±(0.0005)	0.17	5.0	1.38
OTHER:						
Organic Detritus	0.25±(0.44)	0.02	0.0006±(0.0012)	0.83	25.0	7.08
Unidentifiable bodies	0.05±(0.22)	0.00	0.00±(6.708)	0.02	5.0	1.38

Table 3.5.34 The annual food preferences of 4+ Kokanee from Lake Roosevelt in 1988.

	KOKANEE (N=5)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schødleri	2155±(4804)	94.28	0.071±(0.157)	75.11	80.0	69.27
Leptodora kindtii	130±(291)	5.69	0.01±(0.023)	10.89	20.0	10.16
OTHER:						
Organic Detritus	0.2±(0.45)	0.01	0.0009±(0.002)	0.95	20.0	5.82
Inorganic Detritus	0.4±(0.55)	0.02	0.012±(0.028)	13.06	40.0	14.74

The highest frequency of occurrence values were for ***D. schødleri*** at **100.0%**, followed by organic detritus at 66.7% and all other prey items in stomach at 33.3%.

The highest **IRI** values were for ***D. schødleri*** at **59.9%**, followed by organic detritus at 13.4% and *L. kindtii* at 6.7%.

Annual Feeding Habits of 3+ Kokanee for 1988

Information for yearly feeding habits of **3+** kokanee is presented in Table 3.5.33.

The highest number frequency values were for ***D. schødleri*** at 1,242 ± 2,863 per stomach, followed by Cladoceran ephippia at 54 ± 241 and ***L.*** *kindtii* at 3.6 ± 10.9. The highest percent compostition by number values were for ***D. schødleri*** at **95.5%**, followed by Cladoceran ephippia at 4.2% and *L. kindtii* at 0.3%.

The highest weight frequency values were for ***D. schødleri*** at 0.06 ± 0.14 mg dry weight per stomach, followed by Cladoceran ephippia at 0.003 ± 0.01 mg and organic detritus at 0.001 ± 0.001 mg. The highest percent composition by weight values were for ***D. schødleri*** at **94.1%**, followed by Cladoceran ephippia at 4.4% and organic detritus at 0.8%.

The highest frequency of occurrence values were for ***D. schødleri*** at **65.0%**, followed by organic detritus and Cladoceran ephippia both at 25.0% and *L. kindtii* at 15.0%.

The highest **IRI** values were for ***D. schødleri*** at **69.8%**, followed by Cladoceran ephippia at 8.0% and organic detritus at 7.0%.

Annual Feeding Habits of 4+ Kokanee for 1988

Information for yearly feeding habits of **4+** kokanee is presented in Table 3.5.34.

The highest number frequency values were for ***D. schødleri*** at 2,155 ± 4,804 per stomach, followed by *L. kindtii* at 130 ± 291 and inorganic detritus at 0.4 ± 0.6. The highest percent compostition by number values were for ***D. schødleri*** at **94.3%**, followed by *L. kindtii* at 5.7% and inorganic detritus at **>0.1%**.

The highest weight frequency values were for ***D. schødleri*** at 0.07 ± 0.16 mg dry weight per stomach, followed by inorganic detritus at 0.01 ± 0.03 mg and *L. kindtii* at 0.01 ± 0.02 mg. The highest percent composition by weight values were for ***D.*** *schodleri* at **75.1%,** followed by inorganic detritus at 13.1% and *L. kindtii* at 10.9%.

The highest frequency of occurrence values were for ***D.*** *schodleri* at **80.0%,** followed by inorganic detritus at 40.0% and organic detritus and *L. kindtii* both at 20.0%.

The highest **IRI** values were for ***D. schødleri*** at **69.3%,** followed by inorganic detritus at 14.7% and *L. kindtii* at 10.2%.

3.5.6 Annual Feeding Habits of Kokanee for 1989

Information for yearly feeding habits of kokanee is presented in Table 3.5.35. Monthly values can be found in Appendix F.

The highest number frequency values were for ***D. schødleri*** (water fleas) at 1 ,1 84 ± 2,338 per stomach, followed by Walleye eggs at 64 ± 368 and Chironomid pupae (midges) at 28 ± 82. The highest percent **compostition** by number values were for ***D.*** *schodleri* at **91.2%,** followed by Walleye eggs at 4.9% and Chironomid pupae at 2.2% (Table 3.5.35).

The highest weight frequency values were for ***D. schødleri*** at 0.08 ± 0.15 mg dry weight per stomach, followed by Walleye eggs at 0.03 ± 0.18 mg dry weight and *L. kindtii* (water fleas) at 0.003 ± 0.01 mg The highest percent composition by weight values were for ***D. schødleri*** at **66.4%,** followed by Walleye eggs at 27.7% and *L. kindtii* at 2.4% (Table 3.5.35).

The highest frequency of occurrence values were for ***D. schødleri*** at **63.4%,** followed by *L. kindtii* at 32.0% and Chironomid pupae at 30.0% (Table 3.5.35).

The highest **IRI values were for** *D. schodleri* at **58.4%,** followed by Walleye eggs at 9.4% and Chironomid pupae at 9.1% (Table 3.5.35).

Annual Feeding Habits of 0+ Kokanee for 1989

Information for yearly feeding habits of 0+ kokanee is presented in Table 3.5.36.

Table 3.5.35 The annual food preferences of Kokanee from Lake Roosevelt in 1989.

	KOKANEE (N=33)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Walleye eggs	64±(368)	4.9	0.03±(0.18)	27.7	3.0	9.4
ISOPODA (sow bugs)						
Asellus	0.06±(0.34)	0	0.00±(0.0002)	0.03	3.0	0.81
CLADOCERA (water fleas)						
Daphnia schødleri	1184±(2338)	91.2	0.08±(0.15)	66.4	63.4	58.4
Leptodora kindtii	20±(84)	1.6	0.003±(0.01)	2.4	32.0	8.0
EUCOPEPODA (copepods)						
Bryocampus spp.	0.33±(2.0)	0.03	0.00±(0.0003)	0.03	3.0	0.82
Diaptomus spp.	0.06±(0.24)	0.0	0.00±(0.00)	0.03	6.0	1.6
DIPTERA (midges)						
Chironomidae pupae	28±(82)	2.2	0.002±(0.006)	1.8	30.0	9.1
Chironomidae larvae	0.72±(2.7)	0.06	0.00±(0.0001)	0.01	9.0	2.4
HEMIPTERA (bugs)						
Corixidae	0.27±(0.8)	0.02	0.00±(0.0001)	0.01	15.0	4.0
OTHER:						
Terrestrial	0.27±(0.8)	0.02	0.00±(0.0003)	0.03	12.0	3.2
Organic Detritus	0.06±(0.24)	0.00	0.0004±(0.002)	0.36	6.0	1.7
Unidentifiable bodies	0.06±(0.24)	0.00	0.0009±(0.003)	0.83	3.0	1.6

Table 3.5.36 The annual food preferences of 0+ Kokanee from Lake Roosevelt in 1989.

	KOKANEE (N=2)					
	NUMBER		WEIGHT (mg)		OCCURENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	%	($\bar{X}$±S.D.)	%	%	%
CLADOCERA (water fleas)						
Daphnia schodleri	217±(306.0)	98.19	0.0078±(0.011)	88.57	50.0	67.65
DIPTERA (midges)						
Chironomidae pupae	0.5±(0.71)	0.23	0.0001±(0.0013)	5.71	50.0	15.98
Chironomidae larvae	3.5±(4.9)	1.58	0.0001±(0.0002)	5.71	50.0	16.37

Table 3.5.37 The annual food preferences of 1+ Kokanee from Lake Roosevelt in 1989.

	KOKANEE (N=6)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schodleri	2612.0±(3977.0)	96.78	0.20±(0.29)	94.52	100.0	75.99
Leptodora kindtii	86.0±(188.0)	3.20	0.01±(0.03)	5.45	66.67	19.65
DIPTERA (midges)						
Chironomidae pupae	0.66±(1.63)	0.02	0.0001±(0.0001)	0.02	16.67	4.36

Table 3.538 The annual food preferences of 2+ Kokanee from Lake Roosevelt in 1989.

	KOKANEE (N=11)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schodleri	1394.0±(1836.0)	98.34	0.06±(0.07)	92.89	81.82	73.26
Leptodora kindtii	13.0±(44.0)	0.95	0.0026±(0.0087)	4.32	9.09	3.85
EUCOPEPODA (copepods)						
Diaptomus spp.	0.09±(0.30)	0.01	0.0±(0.0)	0.15	9.09	2.48
DIPTERA (midges)						
Chironomidae pupae	7.9±(17.0)	0.56	0.0014±(.0036)	2.30	18.18	5.65
Chironomidae larvae	1.54±(4.23)	0.11	0.0±(.0003)	0.12	18.18	4.94
HEMIPTERA (bugs)						
Corixidae	0.27±(0.65)	0.02	0.0±(0.0002)	0.07	18.18	4.90
OTHER:						
Terrestrial	0.27±(0.65)	0.02	0.0±(0.0005)	0.15	18.18	4.92

Table 3.5.39 The annual food preferences of 3+ Kokanee from Lake Roosevelt in 1989.

PREY ITEM	KOKANEE (N=11) NUMBER ($\bar{X}$±S.D.)	(%)	WEIGHT (mg) ($\bar{X}$±S.D.)	(%)	OCCURRENCE (%)	IRI (%)
ISOPODA (sow bugs)						
Asellus	0.1818±(0.603)	0.02	0.0001±(0.0004)	0.19	9.09	2.38
CLADOCERA (water fleas)						
Daphnia schodleri	693.0±(2015.0)	91.10	0.049±(0.10)	84.70	36.36	54.28
Leptodora kindtii	1.54±(4.5)	0.20	0.05±(9.04)	0.05	18.18	4.72
EUCOPEPODA (copepods)						
Diaptomus spp.	0.09±(0.3015)	0.01	0.0±(0.0006)	0.15	9.09	2.37
Bryocampus spp.	1±(3.32)	0.13	0.0±(9.045)	0.15	9.09	2.40
DIPTERA (midges)						
Chironomidae pupae	63.0±(132.0)	8.36	0.0046±(0.0092)	7.87	45.46	15.78
HEMIPTERA (bugs)						
Corixidae	0.45±(1.21)	0.06	0.0±(0.0003)	0.15	18.18	4.71
OTHER:						
Terrestrial	0.55±(1.29)	0.07	0.0±(0.0002)	0.15	18.18	4.71
Organic Detritus	0.091±(0.3015)	0.01	0.0012±(0.0039)	2.01	9.09	2.84
Unidentifiable bodies	0.182±(0.4045)	0.02	0.0027±(0.006)	4.56	18.18	5.82

Table 3.5.40 The annual food preferences of 4+ Kokanee from Lake Roosevelt in 1989.

	KOKANEE (N=2)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia Schodleri	13.0±(19.0)	16.36	0.0009±(0.001)	3.48	50.00	17.46
DIPTERA (midges)						
Chironomidae pupae	68.0±(96.0)	82.42	.0039±(.0055)	15.09	50.00	36.88
HEMIPTERA (bugs)						
Corixidae	0.5±(0.70)	0.61	0.0±(0.0)	0.19	50.00	12.7
OTHER:						
Inorganic Detritus	0.5±(0.70)	0.61	0.021±(0.029)	81.24	50.00	32.96

Table 3.541 The annual food preferences of 5+ Kokanee from Lake Roosevelt in 1989.

	KOKANEE (N=1)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	%
Osteichthyes (fish)						
Walleye eggs	2119.0±(0.0)	100.0	0.9883±(0.0)	100.0	100.0	100.00

The highest number frequency values were for ***D. schødleri*** at 217 ± 306 per stomach, followed by Chironomidae larvae (midges) at 3.5 ± 4.9 and Chironomidae pupae at 0.5 ± 0.7. The highest percent compostition by number values were for *D. schødleri* at 98.2%, followed by Chironomidae larvae at 1.6% and Chironomidae pupae at 0.2%.

The highest weight frequency values were for *D. schødleri* at 0.01 ± 0.01 mg dry weight per stomach, followed by Chironomidae pupae at 0.0001 ± 0.001 mg and Chironomidae larvae at 0.0001 ± 0.0002 mg. The highest percent composition by weight values were for *D. schødleri* at 88.6%, followed by Chironomidae larvae and Chironomidae pupae both at 5.7% .

The highest frequency of occurrence values were for *D. schødleri*, Chironomidae larvae and Chironomidae pupae all at 50.0%.

The highest IRI values were for *D. schødleri* at 67.7%, followed by Chironomidae larvae at 16.4% and Chironomidae pupae at 16.0%.

Annual Feeding Habits of 1+ Kokanee for 1989

Information for yearly feeding habits of 1+ kokanee is presented in Table 3.5.37.

The highest number frequency values were for *D. schødleri* at 2,612 ± 3,977 per stomach, followed by *L. kindtii* at 86 ± 188 and Chironomidae pupae at 0.7 ± 1.6. The highest percent compostition by number values were for *D. schødleri* at 96.8%, followed by *L. kindtii* at 3.2% and Chironomidae pupae at >0.1%.

The highest weight frequency values were for *D. schødleri* at 0.20 ± 0.29 mg dry weight per stomach, followed by *L. kindtii* at 0.01 ± 0.03 mg and Chironomidae pupae at 0.0001 ± 0.0001 mg. The highest percent composition by weight values were for *D. schødleri* at 94.5%, followed by *L. kindtii* at 5.5% and Chironomidae pupae at >0.1 %.

The highest frequency of occurrence values were for *D. schødleri* at 100.0%, followed by *L. kindtii* at 66.7% and Chironomidae pupae at 16.7%.

The highest IRI values were for *D. schødleri* at 76.0%, followed by *L. kindtii* at 19.7% and Chironomidae pupae at 4.4%.

Annual Feeding Habits of 2+ Kokanee for 7989

Information for yearly feeding habits of 2+ kokanee is presented in Table 3.5.38.

The highest number frequency values were for *D. schødleri* at 1,394 ± 1,836 per stomach, followed by *L. kindtii* at 13 ± 44 and Chironomidae pupae at 7.9 ± 17. The highest percent compostition by number values were for *D. schødleri* at 98.3%, followed by *L. kindtii* at 0.9% and Chironomidae pupae at 0.6%.

The highest weight frequency values were for *D. schødleri* at 0.06 ± 0.07 mg dry weight per stomach, followed by *L. kindtii* at 0.003 ± 0.009 mg and Chironomidae pupae at 0.001 ± 0.004 mg. The highest percent composition by weight values were for *D. schødleri* at 92.9%, followed by *L. kindtii* at 4.3% and Chironomidae pupae at 2.3%.

The highest frequency of occurrence values were for *D. schødleri* at 81.8%, followed by Chironomidae pupae, Chironomidae larvae, Corixidae (bugs), and terrestrial insects all at 18.2%.

The highest IRI values were for *D. schødleri* at 73.3%, followed by Chironomidae pupae at 5.7% and Chironomidae pupae and terrestrial insects both at 4.9%.

Annual Feeding Habits of 3+ Kokanee for 1989

Information for yearly feeding habits of 3+ kokanee is presented in Table 3.5.39.

The highest number frequency values were for *D. schødleri* at 693 ± 2,015 per stomach, followed by Chironomidae pupae at 63 ± 132 and *L. kindtii* at 1.5 ± 4.5. The highest percent compostition by number values were for *D. schødleri* at 91 .1%, followed by Chironomidae pupae at 8.4% and *L. kindtii* at 0.2%.

The highest weight frequency values were for *D. schødleri* at 0.05 ± 0.10 mg dry weight per stomach, followed by Chironomidae pupae at 0.005 ± 0.009 mg and unidentifiable body parts at 0.003 ± 0.006 mg. The highest percent composition by weight values were for *D. schødleri* at 84.7%, followed by Chironomidae pupae at 7.9% and unidentifiable body parts at 4.6%.

The highest frequency of occurrence values were for Chironomidae pupae at **45.5%**, followed by *D. schødleri* at 36.4%.

The highest **IRI** values were for *D. schødleri* at **54.3%**, followed by Chironomidae pupae at 15.8% and unidentifiable body parts at 5.8%.

Annual Feeding Habits of 4+ Kokanee for 1989

Information for yearly feeding habits of **4+** kokanee is presented in Table 3.5.40.

The highest number frequency values were for Chironomidae pupae at 68 ± 96 per stomach, followed by *D. schødleri* at 13 ± 19 and Corixidae and inorganic detritus (rocks), both at 0.5 ± 0.7. The highest percent compostition by number values were for Chironomidae pupae at **82.4%**, followed by *D. schødleri* at 16.4% and Corixidae and inorganic detritus, both at 0.6%.

The highest weight frequency values were for inorganic detritus at 0.02 ± 0.03 mg dry weight per stomach, followed by Chironomidae pupae at 0.004 ± 0.006 mg and *D. schødleri* at **.001** ± 0.001 mg. The highest percent composition by weight values were for inorganic detritus at **81.2%**, followed by Chironomidae pupae at 15.1% and *D. schødleri* at 3.5%.

The highest frequency of occurrence values were for inorganic detritus, Chironomidae pupae and *D. schødleri* all at 50.0%.

The highest **IRI** values were for Chironomidae pupae at **36.9%**, followed by inorganic detritus at 33.0% and *D. schødleri* at 17.5%.

Annual Feeding Habits of 5+ Kokanee for 1989

Information for yearly feeding habits of **5+** kokanee is presented in Table 3.5.41.

The highest number frequency values were for walleye eggs at 2,119 ± 0.0 per stomach. The highest percent compostition by number values were for walleye eggs at **100.0%.**

The highest weight frequency values were for walleye eggs at 0.99 ± 0.0 mg dry weight per stomach. The highest percent composition by weight values were for walleye eggs at 100.0%.

The highest frequency of occurrence values were for walleye eggs at 100.0%.

The highest IRI values were for walleye eggs at 100.0%.

3.5.7 Annual Feeding Habits of Lake Whitefish for 1989

Information for yearly feeding habits of lake whitefish is presented in Table 3.5.42. Monthly values can be found in Appendix F.

The highest number frequency values were for ***D. schødleri*** (water fleas) at 453 ± 1,574 per stomach, followed by ***D. thorata*** (water fleas) at 42 ± 349 and ***L. kindtii*** (water fleas) at 29 ± 212. The highest percent compostition by number values were for ***D. schødleri*** at **76.7%,** followed by *D. thorata* at 7.2% and ***L. kindtii*** at 5.0% (Table 3.5.42).

The highest weight frequency values were for organic detritus (plant matter) at 0.03 ± 0.10 mg dry weight per stomach, followed by ***D. schødleri*** at 0.02 ± 0.07 and inorganic detritus (rocks) at 0.01 ± 0.12 mg. The highest percent composition by weight values were for organic detritus at **25.7%,** followed by ***D. schødleri*** at 17.4% and inorganic detritus at 12.6%. (Table 3.5.42).

The highest frequency of occurrence values were for Chironomidae pupae (midge) at **59.0%,** followed by Chironomidae larvae (midge) at 46.1% and ***D. schødleri*** at 41 **.0%.** (Table 3.5.42).

The highest IRI values were for ***D. schødleri*** at **23.6%,** followed by Chironomidae pupae at 11.6% and organic detritus at 9.1% (Table 3.5.42).

Annual Feeding Habits of 1+ Lake Whitefish

Information for yearly feeding habits of **1+** lake whitefish is presented in Table 3.5.43.

The highest number frequency values were for ***D. schødleri*** at 2200 ± 1625 per stomach, followed by *L. kindtii* at 14.7 ± 14.9 and Lepidostomatidae (caddisflies) at 5.9 ± 20.4. The highest percent composition by number values were for ***D. schødleri*** at 98.6% followed by *L. kindtii* at 0.66% and Lepidostomatidae at 0.27%.

The highest weight frequency values were for ***D. schødleri*** at 0.11 ± 0.10 mg dry weight per stomach, followed by Lepidostomatidae at 0.002 ±

Table 3.5.42 The annual food preferences of Lake whitefish from Lake Roosevelt in 1989.

	LAKE WHITEFISH (N=118)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
'RN ITEM	(X̄±S.D.)	(%)	(X̄±S.D.)	(%)	(%)	(%)
)STEICHTHYES (fish)						
Fish eggs	1.1±(12.5)	0.20	0.001±(0.01)	0.86	0.85	0.33
SOPODA (sow bugs)						
Asellus	0.13±(.88)	0.02	0.002±(0.001)	0.14	4.27	0.77
:LADOCERA (water fleas)						
Daphnia schødleri	453±(1574)	76.67	0.020±0(.068)	17.40	41.03	23.58
Daphnia thorata	42±(349)	7.22	0.0007±(0.005)	0.62	4.27	2.11
Daphnia retrocurva	0.06±(0.36)	0.01	0.00±(0.0003)	0.03	8.55	1.50
Daphnia galeata mendota	0.11±(0.59)	0.02	0.00±(0.0003)	0.04	4.27	0.75
L eptodora kindtii	29±(212)	5.00	0.002±(0.01)	1.63	32.48	6.78
Sida crystallina	0.008±(0.09)	0.00	0.00±(0.0001)	0.00	0.85	0.15
Alona affins	0 03±(0.22)	0.01	0.00±(0.0003)	0.00	2.56	0.44
:UCOPEPODA (copepods)						
Diaptomus spp.	0.01±(0.13)	0.00	0.00±(0.0001)	0.08	1.71	0.31
Epischura spp.	0.008±(0.09)	0.00	0.00±(0.00)	0.00	1.85	0.32
)STRACODA (seed shrimp)						
Cypridae	0.008±(0.09)	0.00	0.00±(0.0002)	0.00	1.85	0.32
IASOMMATOPHORA (snail)						
Lymnaidae	0.07±(0.61)	0.01	0.001±(0.008)	0.88	1.71	0.45
Planorbidae	0.73±(5.3)	0.12	0.003±(0.026)	2.92	5.13	1.42
IOLLUSKA (clam)						
Sphaeriidae	8.8±(27)	1.49	0.01±(0.04)	10.11	23.08	6.01
)IPTERA (midges)						
Chironomidae pupae	14±(40)	2.38	0.006±(0.015)	5.74	58.97	11.62
Chironomidae larvae	10±(51)	1.85	0.001±(0.008)	1.56	46.15	8.60
Simuliidae larvae	0.03±(0.37)	0.01	0.00±(0.0001)	0.00	0.85	0.15
'RICOPTERA (caddisflies)						
Leptoceridae	0.41±(3.2)	0.07	0.0001±(0.001)	0.06	3.42	0.61
Hydropsychidae	0.52±(3.05)	0.09	0.0005±(0.0032)	0.38	7.69	1.41
Hydroptilidae	0.008±(0.09)	0.00	0.00±(0.0001)	0.00	0.85	0.15
Lepidostomatidae	0.60±(6.56)	0.10	0.0002±(0.003)	0.21	0.85	0.20
Brachycentridae	3.5±(36)	0.60	0.008±(0.084)	6.7	2.56	1.71
'LECOPTERA (stoneflies)						
Pteronarcyidae	0.02±(0.20)	0.00	0.0001±(0.0005)	0.04	1.71	0.30
IEMIPTERA (bugs)						
Corixidae	0.008±(0.09)	0.00	0.0001±(0.0006)	0.04	0.85	0.15
:PHEMEROPTERA (mayflies)						
Baetidae	0.17±(1.24)	0.03	.0001±(0.002)	0.11	6.84	1.21
Ephemerellidae	0.17±(1.94)	0.03	.0003±(0.004)	0.29	0.85	0.20
Heptagenidae	0.75±(4.03)	0.13	.0006±(0.004)	0.53	5.13	1.00
)LIGOCHEATA (worms)						
Lumbricoidies	0.008±(0.092)	0.00	0.00±(0.0001)	0.00	0.85	0.15
:OLEOPTERA (beetles)						
Elmidae	0.01±(0.13)	0.00	0.00±(0.0002)	0.02	1.71	0.30
IYDRACHNELLAE (spider)						
Hydracarina	21.78±(135)	3.68	0.0051±(0.037)	4.4	38.46	8.06
'YRALIDAE (catepillars)						
Pyralidae	0.41±(4.3)	0.07	0.0004±(0.004)	0.33	1.71	0.37
)THER:						
Terrestrial	0.05±(0.23)	0.01	0.00±(0.0003)	0.01	5.13	0.89
Organic Detritus	0.40±(0.73)	0.07	0.03±(0.10)	25.7	26.50	9.06
Inorganic Detritus	0.22±(0.87)	0.04	0.01±(0.12)	12.6	10.26	3.97
Unidentifiable bodies	0.28±(0.55)	0.05	0.007±(0.05)	6.57	22.22	5.00

Table 3.5.43 The annual food preferences of 1+ Lake whitefish from Lake Roosevelt in 1989.

	LAKE WHITEFISH (N=12)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
ISOPODA (sow bugs)						
Asellus	0.16±(0.57)	0.01	0.0006±(0.002)	0.52	8.33	1.48
CLADOCERA (water fleas)						
Daphnia schødleri	2200±(1625)	98.63	0.11±(0.096)	95.02	83.33	46.16
Leptodora kindtii	14.7±(14.9)	0.66	0.0007±(0.002)	0.61	66.67	11.32
BASOMMATOPHORA (snail)						
Planorbidae	0.16±(0.38)	0.01	0.0001±(0.0009)	0.08	16.67	2.79
MOLLUSKA (clam)						
Sphaeriidae	2.0±(6.32)	0.09	0.0005±(0.002)	0.38	16.67	2.86
DIPTERA (midges)						
Chironomidae pupae	1.1±(1.8)	0.05	0.0001±(0.0008)	0.08	50.00	8.35
Chironomidae larvae	1.9±(4.5)	0.09	0.0001±(0.0005)	0.08	41.67	6.97
TRICOPTERA (caddisflies)						
Leptoceridae	3.1±(9.4)	0.14	0.0008±(0.004)	0.64	25.00	4.30
Lepidostomatidae	5.9±(20.4)	0.27	0.0024±(0.008)	2.03	8.33	1.77
Brachycentridae	.41±(1.4)	0.02	0.003±(0.001)	0.23	8.33	1.43
EPHEMEROPTERA (mayflies)						
Baetidae	0.5±(0.90)	0.02	0.0001±(0.0005)	0.08	33.33	5.57
HYDRACHNELLAE (spider)						
Hydracarina	0.25±(0.62)	0.01	0.0001±(0.0009)	0.08	16.67	2.79
OTHER:						
Terrestrial	0.08±(0.28)	0.00	0.00±(0.0001)	0.08	8.33	1.40
Organic Detritus	0.08±(0.28)	0.00	0.00±(0.0006)	0.08	8.33	1.40
Unidentifiable bodies	0.08±(0.28)	0.00	0.00±(0.0012)	0.08	8.33	1.40

Table 3.5.44 The annual food preferences of 2+ Lake whitefish from Lake Roosevelt in 1989.

	LAKE WHITEFISH (N=3)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
MOLLUSKA (clam)						
Sphaeriidae	0.67±(1.15)	1.20	0.0001±(0.0002)	0.17	33.33	6.51
DIPTERA (midges)						
Chironomidae pupae	15.3±(24.0)	27.54	0.014±(0.025)	17.84	33.33	14.28
Chironomidae larvae	5.7±(8.1)	10.18	0.0001±(0.001)	0.13	100.00	20.01
TRICOPTERA (caddisflies)						
Hydropsychidae	5.7±(9.8)	10.18	0.009±(0.015)	10.95	33.33	9.88
HYDRACHNELLLAE (spider)						
Hydracarina	11 3±(19.6)	20.36	0.0005±(0.0009)	0.64	33.33	9.86
PYRALIDAE (catepillars)						
Pyralidae	15.7±(27.1)	28.14	0.015±(0.026)	19.50	16.67	11.67
OTHER:						
Terrestrial	0.33±(0.57)	0.60	0.0009±(0.002)	1.11	33.33	6.36
Organic Detritus	0.66±(1.15)	1.20	0.038±(0.067)	49.53	33.33	15.25
Unidentifiable bodies	0.33±(0.57)	0.60	0.0001±(0.0008)	0.13	33.33	6.18

Table 3.545 The annual food preferences of 3+ lake whitefish from Lake Roosevelt in 1989.

	LAKE WHITEFISH (N=10)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schødleri	1765±(4429)	98.23	0.07±(0.169)	66.09	40.00	40.06
Daphnia retrocurva	0.1±(0.32)	0.01	0.0001±(0.0003)	0.09	10.00	1.98
Leptodora kindtii	0.5±(.85)	0.03	0.0001±(0.0009)	0.09	30.00	5.91
MOLLUSKA (clam)						
Sphaeriidae	14.1±(45)	0.78	0.01±(0.03)	9.26	10.00	3.93
DIPTERA (midges)						
Chironomidae pupae	4.7±(5.8)	0.26	0.003±(0.004)	3.03	50.00	10.40
Chironomidae larvae	7.2±(19)	0.40	0.002±(0.005)	1.88	30.00	6.33
Simuliidae pupae	0.4±(1.2)	0.02	0.0001±(0.0002)	0.09	10.00	1.96
TRICOPTERA (caddisflies)						
Hydropsychidae	0.2±(0.63)	0.01	0.0002±(0.0006)	0.17	10.00	2.00
HEMIPTERA (bugs)						
Corixidae	0.1±(0.32)	0.01	0.0006±(0.002)	0.58	10.00	20.8
EPHEMEROPTERA (mayflies)						
Baetidae	1.3±(4.11)	0.07	0.0003±(0.0009)	0.26	10.00	2.03
HYDRACHNELLAE (spider)						
Hydracarina	2.5±(3.1)	0.14	0.0001±(0.0007)	0.05	50.00	9.84
OTHER:						
Organic Detritus	0.3±(0.67)	0.02	0.019±(0.059)	17.74	20.00	7.40
Inorganic Detritus	0.1±(0.31)	0.01	0.0005±(0.002)	0.43	10.00	2.05
Unidentifiable bodies	0.3±(0.48)	0.02	0.0002±(0.0005)	0.23	20.00	3.98

Table 3.5.46 The annual food preferences of 4+ Lake whitefish from Lake Roosevelt in 1989.

	LAKE WHITEFISH (N=65)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	(X±S.D.)	(%)	(X±S.D.)	(%)	(%)	(%)
OSTEICHTHYES (fish)						
Fish eggs	2±(16)	0.74	0.002±(0.015)	t.63	1.54	0.70
ISOPODA (sow bugs)						
Asellus	0.06±(0.35)	0.02	0.0001±(0.0009)	0.12	3.08	0.58
CLADOCERA (water fleas)						
Daphnia schødleri	109±(470)	38.58	0.005±(0.022)	4.17	32.31	13.40
Daphnia thorata	68±(466)	24.21	0.001±(0.007)	0.98	1.54	4.77
Daphnia retrocurva	0.06±(0.30)	0.02	0.0001±(0.0004)	0.05	4.62	0.84
Daphnia galeata mendota	0.09±(0.63)	0.03	0.0001±(0.0003)	0.05	3.08	0.56
Leptodora kindtii	47±(284)	16.82	0.003±(0.016)	2.81	27.69	8.45
Alona affins	0.04±(.0.28)	0.02	0.00±(0.0003)	0 01	3.08	0.56
Sida crystallina	0.02±(0.12)	0.01	0 00±(0.0001)	0.00	1.54	0.28
EUCOPEPODA (copepods)						
Diaptomus spp.	0.02±(0.12)	0.01	0.00±(0.0001)	0.00	1.54	0.28
Epischura sop.	0.02±(0.12)	0.01	0 00±(0.00)	0 00	1.54	0.28
OSTRACODA (seed shnmp)						
Cypridae	0.02±(0.12)	0.01	0.00±(0.0003)	0.00	1.54	0.28
BASOMMATOPHORA (snail)						
Lymnaidae	0.05±(0.37)	0.02	0.0013±(0.011)	1.19	1.54	0.49
Planorbidae	0.45±(2.65)	0.16	0 002±(0.012)	1.77	3.08	0 89
MOLLUSKA (clam)						
Sphaeriidae	8.0±(25)	2.81	0.012±(0.037)	11.02	24.62	6.86
DIPTERA (midges)						
Chironomidae pupae	13±(30)	4.54	0.005±(0.014)	5.98	63.08	13.14
Chironomidae larvae	16±(69)	5.71	0.003±(0.012)	2.71	47.69	10.02
TRICOPTERA (caddisflies)						
Hydropsychidae	0.63±(3.51)	0.22	0.0004±(0.003)	0.36	9.23	1.75
Lepidostomatidae	6.3±(49)	2.23	0.014±(0.113)	12.65	3.08	3.20
PLECOPTERA (stoneflies)						
Pteronarcyidae	0.04±(0.28)	0.02	0.0001±(0.0007)	0 09	3.08	0.57
EPHEMEROPTERA (mayflies)						
Baetidae	0.03±(0.17)	0.01	0.00±(0.0003)	0.00	3.08	0.55
Ephemerellidae	0.32±(2.60)	0.11	0.0006±(0.005)	0.55	1.54	0.39
Heptagenidae	1.3±(5.35)	0.47	0.001 ±(0.005)	1 .00	7.69	1.64
COLEOPTERA (beetles)						
Elmidae	0.02±(0.12)	0.01	0.00±(0.0002)	0.02	1 54	0.28
HYDRACHNELLAE (spider)						
Hydracarina	8.1±(23.7)	2.87	0 0005±(0.003)	0.48	43.08	8.29
OTHER						
Terrestrial	0.05±(0.21)	0.02	0.00±(0.0002)	0.01	4.62	0.83
Organic Detritus	0.4±(0.77)	0.14	0.044±(0. 134)	39.10	24.62	11.40
Inorganic Detritus	0.32±(1.12)	0.11	0.007±(0.032)	5.85	12.31	3.26
Unidentifiable bodies	0.29±(0.58)	0.10	0.008±(.0.064)	7.51	23.08	5.48

Table 3.5.47 The annual food preferences of 5+ Lake whitefish from Lake Roosevelt In 1989.

PREY ITEM	LAKE WHITEFISH (N=22) NUMBER ($\bar{X}$±S.D.)	NUMBER (%)	WEIGHT (mg) ($\bar{X}$±S.D.)	WEIGHT (mg) (%)	OCCURRENCE (%)	IRI (%)
ISOPODA (sow bugs)						
Asellus	000.45±(1.392)	0.23	0.0002±(0.0007)	0.10	9.09	1.48
CLADOCERA (water fleas)						
Daphnia schodleri	17±(63)	8.63	0.0008±(0.004)	0.45	50.00	9.29
Daphnia thorata	24±(68)	12.37	0.0007±(0.002)	0.42	13.64	4.15
Daphnia retrocurva	0.13±(0.34)	0.07	0.0001±(0.0004)	0.04	4.55	0.73
Daphnia galeata mendota	0.32±(0.84)	0.16	0.0001±(0.0004)	0.05	13.64	2.18
Leptodora kindtii	8±(20)	4.11	0.0007±(0.003)	0.40	31.82	5.71
Alona affins	0.05±(0.21)	0.02	0.0001±(0.0003)	0.06	4.55	0.73
EUCOPEPODA (copepods)						
Diaptanus spp	0.05±(0.21)	0.02	0 0001 f(0.003)	0.06	4.55	0.73
BASOMMATOPHORA (snail)						
Lymnaidae	0.27±(1.28)	0.14	0.002±(0.007)	0.91	4.55	0.88
Planorbidae	2.5±(11)	1.27	0.013±(0.058)	7.21	9.09	2.76
MOLLUSKA (dam)						
Sphaeriidae	16±(35)	8.06	0.022±(0.066)	12.79	31.82	8.28
DIPTERA (midges)						
Chironomidae pupae	32±(77)	16.09	0.013±(0.025)	7.60	63.64	13.73
Chironomidae larvae	5±(10)	2.68	0.0002±(0.002)	0.12	50.00	8.30
TRICOPTERA (caddisflies)						
Leptoceridae	0.5±(2.3)	0.25	0.0001±(0.0003)	0.06	4.55	0.76
Hydroptilidae	0.05±(0.21)	0.02	0.0001±(0.0003)	0.06	4.55	0.73
EPHEMEROPTERA (mayflies)						
Heptagenidae	0.04±(0.21)	0.02	0.00±(0.0002)	0.02	4.55	0.72
OLIGOCHEATA (worms)						
Lumbriwlidae	0.04±(0.21)	0.02	0.0001±(0.0003)	0.06	4.55	0.73
COLEOPTERA (beetles)						
Elmidae	0.04±(0.21)	0.02	0.0001±(0.0003)	0.04	4.55	0.73
HYDRACHNELLLAE (spider)						
Hydracarina	89±(306)	45.20	0 026±(0.085)	14.90	40.91	15.88
PYRALIDAE (caterpillars)						
Pyralidae	0.05±(0.21)	0.02	0.00±(0.0001)	0.00	4.55	0.72
OTHER:						
Terrestrial	0.05±(0.21)	0.02	0.00±(0.00)	0.00	0.01	0.00
Organic Detritus	0.60±(0.80)	0.30	0.02±(.0.06)	t 0.44	40.91	8.12
Inorganic Detritus	0.18±(0.50)	0.09	0.06±(0.26)	34.31	13.64	7.55
Unidentifiable bodies	0.32±(0.65)	0.16	0 02±(0.06)	9.44	22.73	5.08

Table 3.5.48 The annual food preferences of 6+ Lake whitefish from Lake Roosevelt in 1989.

	LAKE WHITEFISH (N=5)					
	NUMBER		WEIGHT (mg)		OCCURRENCE	IRI
PREY ITEM	($\bar{X}$±S.D.)	(%)	($\bar{X}$±S.D.)	(%)	(%)	(%)
CLADOCERA (water fleas)						
Daphnia schødleri	301±(514)	98.75	0.003±(0.004)	53.76	40.00	40.14
Daphnia thorata	0.2±(0.44)	0.07	0.0001±(0.0008)	1.88	20.00	4.58
Leptodora kindtii	0.8±(1.10)	0.26	0.0001±(0.0003)	1.88	40.00	8.79
DIPTERA (midges)						
Chironomidae pupae	1.0±(1.73)	0.33	0.0001±(0.0004)	1.88	40.00	8.80
Chironomidae larvae	0.6±(1.34)	0.20	0.0001±(0.0005)	1.88	20.00	4.60
TRICOPTERA (caddisflies)						
Hydroptilidae	0.2±(0.44)	0.07	0.0001±(0.0004)	1.88	20.00	4.58
OTHER:						
Terrestrial	0.20±(0.45)	0.07	0.0001±(0.0004)	1.88	20.00	4.58
Organic Detritus	0.40±(0.55)	0.13	0.001±(0.003)	27.07	40.00	14.01
Unidentifiable bodies	0.40±(0.55)	0.13	0.0004±(0.0006)	7.89	40.00	10.01

0.008 mg and Leptoceridae (caddisflies) at 0.001 ± 0.004 mg. The highest percent composition by weight values were for *D. schødleri* at 95% followed by Lepidostomatidae at 2% and Leptoceridae at 0.60%.

The highest frequency of occurrence values were for *D. schødleri* at **83%,followed** by *L. kindtii* at 66.7% and Chironomidae pupae at 50%.

The highest IRI values were for *D. schødleri* at 46% followed by *L. kindtii* at 11% and Chironomidae pupae at 8.4%.

Annual Feeding Habits for 2+ Lake Whitefish

Information for yearly feeding habits of **2+** lake whitefish is presented in Table 3.5.44.

The highest number frequency values were for Pyralidae (aquatic caterpillars) at 15.7 ± 27.1 per stomach, followed by Chironomid pupae at 15.3 ± 24 and Hydracarina (aquatic spiders) at 11.3 ± 19.6. The highest percent composition by number values were for Pyralidae at 28.1% followed by Chironomid pupae at 27.5% and Hydracarina at 20.4%.

The highest weight frequency values were for organic detritus at 0.04 ± 0.07 mg dry weight per stomach, followed by Pyralidae at 0.01 ± 0.03 mg and Chironomid pupae at 0.01 ± 0.03 mg. The highest percent composition by weight values were for organic detritus at 49.5% followed by Pyralidae at 19.5% and Chironomid pupae at 17.8%.

The highest frequency of occurrence values were for Chironomid larvae at **100.0%,** followed by Sphaeriidae, (clams) Chironomid pupae, Hydropsychidae (caddisflies), Hydracarina, terrestrial insects, organic detritus, and unidentifiable body parts all at 33.33%.

The highest IRI values were for Chironomidae larvae at 20% followed by organic detritus at 15.3% and Chironomidae pupae at 14.3%.

Annual Feeding Habits for 3+ Lake Whitefish

Information for yearly feeding habits of **3+** lake whitefish is presented in Table 35.45.

The highest number frequency values were for *D. schødleri* at 1,765 ± 4,429 per stomach, followed by Sphaeriidae at 14.1 ± 45 and Chironomid larvae at 7.2 ± 19. The highest percent composition by number values were for *D. schødleri* at 98.2% followed by Sphaeriidae at 0.8% and Chironomid larvae at 0.4%.

The highest weight frequency values were for *D. schødleri* at 0.07 ± 0.17 mg dry weight per stomach, followed by organic detritus at 0.02 ± 0.06 mg and Sphaeriidae at 0.01 ± 0.03 mg. The highest percent composition by weight values were for *D. schødleri* at 66.1% followed by organic detritus at 17.7% and Sphaeriidae at 9.3%.

The highest frequency of occurrence values were for Chironomid pupae and Hydracarina which had equal values of 50.0% followed by *D. schødleri* at 40.00%.

The highest IRI values were for *D. schødleri* at 40.1% followed by Corixidae (bugs) at 20.8% and Chironomidae pupae at 10.4%.

Annual Feeding Habits of 4+ Lake Whitefish

Information for yearly feeding habits of 4+ lake whitefish is presented in Table 3.5.46.

The highest number frequency values were for *D. schødleri* at 109 ± 470 per stomach, followed by *D. thorata* (water fleas) at 68 ± 466 and *L. kindtii* at 47 ± 284. The highest percent composition by number values were for *D. schødleri* at 38.6% followed by *D. thorata* at 24.2% and *L. kindtii* at 16.8%.

The highest weight frequency values were for organic detritus at 0.049 ± 0.13 mg dry weight per stomach, followed by Lepidostomatidae at 0.014 ± 0.11 mg and Sphaeriidae at 0.012 ± 0.04 mg. The highest percent composition by weight values were for organic detritus at 39.1% followed by Lepidostomatidae at 12.6% and Sphaeriidae at 11.0%.

The highest frequency of occurrence values were for Chironomidae pupae at 63.1% followed by Chironomid larvae at 47.7% and Hydracarina at 43.1%.

The highest IRI values were for *D. schødleri* at 13.4% followed by Chironomid pupae at 13.1% and organic detritus at 11.4%.

Annual Feeding Habits of 5+ Lake Whitefish

Information for yearly feeding habits of 5+ lake whitefish is presented in Table 3.5.47.

The highest number frequency values were for Hydracarina at 89 ± 306 per stomach, followed by Chironomid pupae at 32 ± 77 and ***D. thorata*** at 24 ± 68. The highest percent composition by number values were for Hydracarina at 45.2% followed by Chironomid pupae at 16.1% and *D. thofata* at 12.4%.

The highest weight frequency values were for inorganic detritus at 0.06 ± 0.26 mg dry weight per stomach, followed by Hydracarina at 0.03 ± 0.09 mg and Sphaeriidae at 0.022 ± 0.07 mg. The highest percent composition by weight values were for inorganic detritus at 34.3% followed by Hydracarina at 14.9% and Chironomid pupae at 12.8%.

The highest frequency of occurrence values were for Chironomidae pupae at 63.6% followed by Chironomid larvae and ***D. schødleri*** both at **50.0%.**

The highest IRI values were for Hydracarina at 15.9% followed by Chironomid pupae at 13.7% and ***D. thorata*** at 9.3%.

Annual Feeding Habits for 6+ Lake Whitefish

Information for yearly feeding habits of 6+ lake whitefish is presented in Table 3.5.48.

The highest IRI values were for ***D. schødleri*** at **301±** 514 per stomach, followed by Chironomid pupae at 1 .O ± 1.7 and *L. kindtii* at 0.8 ± 1 .1. The highest percent composition by number values were for ***D. schødleri*** at 98.7% followed by Chironomid pupae at 0.33% and *L. kindtii* at **0.3.**

The highest weight frequency values were for ***D. schødleri*** at 0.003 ± 0.004 mg dry weight per stomach, followed by organic detritus at 0.001 ± **0.003 mg and unidentifiable body parts at 0.0004 ± 0.0006 mg. The** highest percent composition by weight values were for ***D. schødleri*** at 53.8% followed by organic detritus at 27.1% and unidentifiable body parts at 7.9%.

The highest frequencies of occurrence values were for *D. schødleri*, *L. kindtii,* Chironomidae pupae, organic detritus and unidentifiable body parts all at 40.00%.

The highest IRI values were for *D. schødleri* at 40.1% followed by organic detritus at 14.0%, and unidentifiable body parts at 10.0%.

3.5.0 Diet Overlap between Species for 1988

The diet overlap between rainbow trout and walleye in 1988 was 0.569. The overlap between rainbow trout and kokanee **was 0.786.** The overlap between walleye and kokanee was 0.289 (Table 3.5.49).

3.5.9 Diet Overlap between Species for 1989

The diet overlap between rainbow trout and walleye in 1989 **was** 0.199. The overlap between rainbow trout and kokanee was 0.216. The overlap between rainbow trout and lake whitefish was 0.262. The overlap between walleye and kokanee was 0.259. The overlap between walleye and lake whitefish was 0.421. The overlap between kokanee and lake whitefish **was** 0.669. (Table 3.5.49).

3.5.10 Electivity Indices

Electivities of kokanee and rainbow trout for different size categories of *Daphnia* were calculated for all age classes captured at each index station in August 1988, October 1988, May 1989, August 1989 and October 1989. *Daphnia* sizes in fish stomachs from a particular station were compared to *Daphnia* sizes observed in the water column at the same station on the same dates that the fish were collected. The mean electivity value and standard deviation were calculated for all stations in each month (Appendix F). The resulting electivities are presented in Table 3.5.50 (kokanee) and Table 3.5.51 (rainbow trout).

In August 1988, kokanee had positive electivities (+0.03 to +0.33) for *Daphnia* sizes ranging from 1.6 to 2.4 mm and negative electivities for *Daphnia* <1.5 mm or > 2.5 mm (Table 3.5.50). Similar results occured in October 1988, and May, August and October 1989. Positive electivity values were indicative of size-selective predation. However, positive electivity values in the range observed (+0.01 to +0.35) suggest that the intensity of size-selective predation by kokanee on *Daphnia* was not high in either 1988 or 1989.

Table 3.5.49 Annual diet overlaps between fish species, analyzed from stomach contents, in Lake Roosevelt, WA. Overlaps based on relative importance values for 1988 and 1989 separately.

SPECIES OVERLAPS FOR 1988

	Rainbow trout	Walleye	Kokanee
Rainbow trout	1.0	.569	.786
Walleye		1.0	.289
Kokanee			1.0

SPECIES OVERLAPS FOR 1989

	Rainbow trout	Walleye	Kokanee	Lake Whitefish
Rainbow trout	1.0	.199	.216	.262
Walleye		1.0	.259	.421
Kokanee			1.0	,669
Lake Whitefish				1.0

Table 3.5.50. Mean electivities of kokanee salmon for different size ranges of *Daphnia* in 1988 and 1989. (Data presented as mean ± S.D. for nine index stations).

Daphnia size Range (mm)	Electivity (X ± S.D.)				
	1988		1989		
	AUG	OCT	MAY	AUG	OCT
0.1-0.3	0.0 ± 0	0.0 ± 0	0.0 ± 0	0.0 ± 0	0.0 ± 0
O-4-0.6	-0.005 ± 0.007	-0.09 ± 0.05	0.0 ± 0.0	-0.02 ± 0.0	-0.005 ± 0.01
0.7-0.9	-0.08 ± 0.0	-0.25 ± 0.05	0.0 ± 0.0	-0.15 ± 0.0	-0.14 ± 0.08
1.0-1.2	-0.24 ± 0.007	-0.19 ± 0.10	-0.21 ± 0.30	-0.14 ± 0.0	-0.14 ± 0.03
1.3-1.5	-0.08 ± 0.04	0.32 ± 0.32	-0.23 ± 0.51	0.04 ± 0.0	-0.05 ± 0.15
1.6-1.8	0.10 ± 0.06	0.04 ± 0.18	0.35 ± 0.26	0.03 ± 0.0	0.08 ± 0.21
1.9-2.1	0.33 ± 0.16	0.15 ± 0.23	0.24 ± 0.25	0.29 ± 0.0	0.23 ± 0.16
2.2-2.4	0.03 ± 0.09	0.01 ± 0.06	0.06 ± 0.08	-0.06 ± 0.0	0.04 ± 0.12
2.5-2.7	-0.03 ± 0.04	0.003 ± 0.04	0.03 ± 0.04	0.02 ± 0.0	-0.008 ± 0.06
2.8-3.0	-0.005 ± 0.007	0.0 ± 0.0	0.0 ± 0.0	-0.01 ± 0.0	-0.003 ± 0.03
3.1-3.3	-0.005 ± o.ooi	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
3.4-3.6	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0

Table 3.5.51. Mean electivities of rainbow trout for different size range of *Daphnia* in 1988 and 1989. (Data presented as mean ± S.D. for nine index stations).

Daphnia size' Range (mm)	Electivitv ($\bar{X}$ ± S.D.)				
	1988		1989		
	AUG	OCT	MAY	AUG	OCT
0.1-0.3	0.0 ± 0	0.0 ± 0	0.0 ± 0	0.0 ± 0	0.0 ± 0
0.4-0.6	-0.01 ± 0	0.0 ± 0	-0.06 ± 0.05	·0.0 ± 0.01	·0.07± 0.08
0.7-0.9	-0.08 ± 0.05	-0.25 ± 0.05	-0.18 ± 0.25	·0.07 ± 0.07	·0.15± 0.04
1.0-1.2	-0.03 ± 0.18	-0.19 ± 0.10	-0.24 k0.18	·0.10 fO.10	·0.14± 0.05
1.3-1.5	-0.03 f0.28	-0.02 ± 0.11	-0.20 ± 0.47	0.05 ± 0.07	·0.50± 0.10
1.6-1.8	-0.00 ± 0.10	0.11 ± 0.13	0.37 ± 0.09	0.06 ± 0.01	0.13± 0.16
1.9-2.1	0.03 ± 0.18	0.19 f0.07	0.43 f0.09	0.10 ± 0.03	0.16± 0.19
2.2-2.4	0.02 ± 0.19	0.17 ± 0.11	0.07 ± 0.11	0.06 ± 0.01	0.03± 0.12
2.5-2.7	0.04 ± 0.09	0.03 ± 0.07	0.01 ± 0.02	·0.01 ± 0.10	0.03± 0.09
2.8-3.0	0.00 ± 0.04	0.01 ± 0.02	0.0 ± 0	0.01 ± 0.03	0.00± 0.02
3.1-3.3	-0.01 ± 0.02	0.01 ± 0.01	0.0 ± 0	-0.01 ± 0.01	0.01± 0.01

In August 1988, rainbow trout electivity for all size categories were near zero, indicating that trout preyed on different sizes of *Daphnia* in relative proportion to their abundance in the reservoir (Table 3.551). In October 1981, rainbow trout had positive electivities (+0.11 to +0.19) for *Daphnia* in sizes ranging from 1.6 to 2.4 mm, negative electivities (-*.0.20* to *-0.18)* for *Daphnia* <1.5 mm, and neutral electivity for *Daphnia* >2.5 mm. In 1989, electivities were similar to those observed in October 1988. Again, positive electivities in the range observed (+0.07 to +0.43) suggest that the intensity of size-selective predation by rainbow trout on *Daphnia* was not high in either 1988 or 1989. Only one month was marginally high, May 1989, when electivity for *Daphnia* 1.6 to 2.1 mm ranged from +0.37 to +0.43. For all other months the maximum positive electivity observed was +0.19.

3.6 TAGGING STUDIES

3.6.1 Net-Pen Rainbow Trout Tagging

On May 4, 1988, 1 ,111 marked rainbow trout were released at the Seven Bays net-pen site and a total of 110 were subsequently recaptured by anglers between May 1988 and April 1990, for a 9.9% recovery rate. Of the 110 fish recaptured, 58.1% (64 individuals) were recaptured within 6 months and 88.1% (97 individuals) were recaptured within one year after release (Table 3.6.1). The majority (57.2% 63 individuals) of the recaptured fish were recovered in the vicinity (± 20 km) of the Seven Bays net-pen site, 10% (11 fish) were recaptured further upstream as far as Gifford (64 km), and 32.7% (36 fish) were recaptured further downstream as far as Grand Coulee Dam (40 km) (Table 3.6.1). Only one (0.9%) of the 110 fish recovered was recaptured outside of Lake Roosevelt in Rufus Wood Reservoir, the impoundment of Chief Joseph Dam.

Individual trout weighed 28 g when put into the net-pens on 29 October 1987 and grew to a mean length of 229 ± 16 mm and weight of 167 ± 41 g by the time they were released from the net pens on May 4, 1988. After release into the reservoir, growth rates of recaptured fish reported by anglers indicated that the fish attained lengths of 418 ± 17 mm and weights of 764 ± 70 g by October 1988. Fish growth slowed over the winter months: mean lengths and weights reported in April 1989 were respectively 469 ± 27 mm and 885 ± 59 g. By October 1989, length was 542 ± 20 mm and weight was 1,547 ± 121 g. In March 1989, the single fish recaptured was 609 mm in total length and 2,239 g in weight. This individual was released at a length of 268 mm in May 1988.

Table 3.6.1. Dates and locations of recaptures of rainbow trout stocked in Seven Bays Net-Pen (Location 6) on 29 October 1987 and released into Lake Roosevelt on 4 May 1988. Mean total lengths (mm) and weights (g) at time of stocking, release and recapture are also presented. Recapture lengths and weights are for fish captured in April or October only. Number tagged = 1,111.

	Index Station Recovered at												
Date Recaptured	Kettle Falls (1)	Gifford (2)	Hunters (3)	Porcupine Bay (4)	Little Falls Dam (5)	Seven Bays/ Hawk Creek (6)	Keller Ferry (7)	San Poil (8)	Grand Coulee/ Dam Spring Canyon (9)	Rufus Woods Res.	Rock Island Dam	$\bar{X}$(±SD) Length (mm)	$\bar{X}$(±SD) Weight (g)
Stocking													28
Release												229±16	167±41
5/88-10/88		3	3	1		42	11	1	3			418±37	764±70
17/88-4/89			2			15	9		6	1		469±27	885±89
5/89-10/89			7			4	1		2			542±30	1547±121
17/89-4/90			1			2	1		1			609	2239
Total		3	7	1		63	22	1	12	1			

Total # tagged: 1,111
Total # recovered by anglers: 110 [+0 fish collected at Rock Island Dam fish passage facllity]
% Recovered by anglers: 9.9%

Table 3.6.2. Dates and locations of recaptures of rainbow trout stocked in Seven Bays Net Pen (Location 6) on 18 October 1988 and released into Lake Roosevelt on 12 April 1989. Mean total lengths (mm) and weights (g) at time of stocking, release and recapture are also presented. Recapture lengths and weights are for fish captured in April or October only. Number tagged = 918.

	Index Station Recovered at												
Date Recaptured	Kettle Falls (1)	Gifford (2)	Hunters (3)	Porcupine Bay (4)	Little Falls Dam (5)	Seven Bays/ Hawk Creek (6)	Keller Ferry (7)	San Poil (8)	Grand Cculee Dam Spring canyon (9)	Rufus Woods Res.	Rock Island Dam	$\bar{X}$(±SD) Length (mm)	$\bar{X}$(±SD) Weight (g)
Stocking													17
Release												202±15	87±27
4/89									2			212	
5/89-10/89						6	2		4	2	6	401±13	681±98
11/89-4/90			7			7	2		1	1		432	995
Total			7			13	4		7	3	6		

Total # tagged: 918
Total # recovered by anglers: 28 [+6 fish collected at Rock Island Dam fish passage facility]
% Recovered by anglers: 3.0%

Table 3.6.3. Dates and locations of recaptures of rainbow trout stocked in Hunters Net-Pen (Location 3) on 26 October 1988 and released into Lake Roosevelt on 10 March 1989. Mean total lengths (mm) and weights (g) at time of stocking, release and recapture are also presented. Recapture lengths and weights are for fish captured in April or October only. Number tagged = 845.

	Index Station Recovered at												
Date Recaptured	Kettle Falls (7)	Gifford (2)	Hunters (3)	Porcupine Bay (4)	Little Falls Dam (5)	Seven Bays/ Hawk Creek (6)	Keller Ferry (7)	San Poil (8)	Grand Coulee Dam Spring Canyon (9)	Rufus Woods Res.	Rock Island Dam	$\bar{X}$(±SD) Length (mm)	$\bar{X}$(±SD) Weight (g)
Stocking													30
Release												209±16	89±16
3/89-4/89						2			1			210±3	89±14
5/89-10/89			4			1			3	1	5	390±58	817±296
11/89-4/90			2						1	1		393	850
Total			6			3			5	2	5		

Total # tagged: 845
Total # recovered by anglers: 16 [+5 fish collected at Rock Island Dam fish passage facility]
% Recovered by anglers: 1.9%

On April 12, 1989, 918 marked rainbow trout were released at the Seven Bays net pen site and a total of 28 were subsequently recaptured by anglers between April 1989 and April 1990, for a recovery rate of 3.0% (Table 3.6.2). Additionally, six fish were collected at the Rock Island Dam fish counting facility in May and June 1989. Of the 34 fish recovered, 38.2% (13 fish) were recaptured in the vicinity (± 20 km) of the Seven Bays net pen site; 2.9% (1 fish) was recovered upstream at Hunters (40 km) and 58.8% (20 fish) were recovered downstream at Grand Coulee Dam, Rufus Woods Reservoir and Rock Island Dam. Nine (26.4%) of the 34 fish recaptured were recaptured below Grand Coulee Dam.

Individual trout weighed 17 g when put into the net pen on 18 October 1988 and grew to a mean length of 202 ± 15 mm and weight of 87 ± 27 g by the time they were released from the net pens on April 12, 1989. By October 1989 they had reached lengths of 401 ± 13 mm and weights of 681 ± 98 g. One fish released at 189 mm in total length in April 1989 had attained a length of 432 mm and a weight of 995 g at the time of recovery in March 1990.

On March 10, 1989, 845 marked rainbow trout were released at the Hunters net pen site and a total of 16 were subsequently recaptured by anglers between March 1989 and April 1990, for a recovery rate of 1.9% (Table 3.6.3). Also, five fish were collected at the Rock Island Dam fish counting facility in May 1989. Of the 21 fish recovered, 27.2% (6 fish) were recovered in the vicinity (± 20 km) of the Hunters net pen site, 0% were recovered upstream from Hunters, and 72.8% (15 fish) were recovered downstream at Seven Bays, Grand Coulee Dam, Rufus Woods Reservoir and Rock island Dam. Seven (33.3%) of the 21 fish recaptured were recovered below Grand Coulee Dam.

Individual trout weighed 30 g when put into the Hunters net pen on October 26, 1988 and grew to a mean length of 209 ± 16 mm and weight of 89 ± 16 g by the time they were released from the net pens on March 10, 1989. By October 1989, mean length was 390 ± 58 mm and mean weight was 817 ± 296 g. One individual released at a length of 191 mm in March 1989 and recovered in October 1989 reportedly grew to a total length of 431 mm and weight of 1026 g.

3.6.2 Walleye Tagging

Table 3.6.4 summarizes the number of walleye marked at each index station in 1988 and 1989, as well as number of tagged fish recovered from each marking.

Table 3.6.4. Summary of walleye marked with floy tags and released into Lake Roosevelt in 1988 and 1989.

YEAR	DATE	Capture and Release Location	# Tagged	# Recovered
1988	May	4	521	3
1988	May	5	91	
1988	Aug	1	9	1
1988	Aug	4	43	
1988	Aug	5	5	1
1988	Aug	6	4	
1988	Oct	1	40	1
1988	Oct	2	10	
1988	Oct	3	19	
1988	Oct	5	102	2
1988	Oct	7	1	
1988	Oct	8	2	
1989	May	1	4	1
1989	May	2	7	
1989	May	3	2	1
1989	May	4	602	25
1989	May	5	83	
1989	May	6	3	3
1989	May	7	10	
1989	May	8	99	5
1989	Jun	5	11	
1989	Aug	1	53	1
1989	Aug	2	20	
1989	Aug	3	62	1
1989	Aug	4	15	
1989	Aug	5	25	2
1989	Aug	6	4	
1989	Aug	7	11	
1989	Aug	8	5	
1989	Oct	1	3	
1989	Oct	2	8	
1989	Oct	3	18	4
1989	Oct	5	14	1
1989	Oct	6	7	
1989	Oct	8	10	
1989	Oct	9	3	

LOCATION CODES:

(1) Kettle Falls	(4) Porcupine Bay	(7) Keller
(2) Gifford	(5) Little Falls Dam	(6) San Poil
(3) Hunters	(6) Seven Bays	(9) Spring Canyon

Table 3.6.5. Summary of walleye tag recoveries in Lake Roosevelt for fish marked in 1988.

Release Data				Recapture Data			
Tag No.	Loc	Date	Length (mm)	Loc	Date	Length (mm)	Length Increase (mm)
24029	1	10/88	395	9	7/89	533	138
08053	4	5/88	392	8	6/89	432	40
10764		5/88	247	7	9/88		
08803		5/88	296	3	7/89	393	97
10505	5	8/88	290	5	6/89	314	24
22120		10/88	400	5	10/88	399	
21129		10/88	345	4	5/89	346	8

LOCATION CODES:

(1) Kettle Falls
(2) Gifford
(3) Hunters
BC British Columbia
(4) Porcupine Bay
(5) Little Falls Dam
(6) Seven Bays
(7) Keller
(8) San Poil
(9) Spring Canyon

lag No.	Months between capture and recapture	Growth between capture and recapture (mm)	Growth Increment (mm/mo)
24029	10	138	13.8
08803	14	97	6.9
10505	10	34	2.4
Average			7.7

Table 3.6.6. Summary of walleye tag recoveries in Lake Roosevelt for fish marked in 1989.

Release Data				Recapture Data			
'ag No.	LOC	Date	Length (mm)	LOC	Date	Length (mm)	Length Increase (mm)
5588	1	5/89	371	1	7/89	368	-4
:1795		8/89	390	6	6/89	457	67
88/89							
5575	3	5/89	381	3	8/89	355	-33
5089		8/89	390	3	9/89	457	67
!5013		10/89	323	3	5/89	340	17
!5114		10/89	372	3		432	
!5132		10/89	455	3	3/90	457	2
!5118		10/89	475	3	3/90	490	15
!0176	4	5/89	395	4	6/89	394	-1
!0574		5/89	456	1	6/89	482	26
!0521		5/89	410	1	6/89	431	21
!0785		5/89	401	9	6/89	533	132
!0886		5/89	395	4	6/89	400	5
21902		5/89	385	4	6/90	406	21
20591		5/89	448	9	6/89	457	9
20727		5/89	447	4	6/89		
20134		5/89	430	4	6/89		
20034		5/89	370	9	6/89	406	36
20250		5/89	385	4	6/89	406	26
20400		5/89	406	6	7/89	520	114
20202		5/89	380	3	7/89	381	1
20568		5/89	428	1	7/89	413	-15
20768		5/89	430	4	7/89	444	14
20858		5/89	376	1	7/89	412	36
20142		5/89	410	1	7/89	406	-4
20053		5/89	393	BC	7/89	406	13
20334		5/89	442	4	7/89	431	-11
20088		5/89	435	4	8/89	457	22
20526		5/89	410	2	8/89		
20556		5/89	382	6	11/89	6	
20517		5/89	457	BC	7/89	457	
20665		5/89	405	BC	7/89	405	
20250		5/89	385	4	6/89	406	21
19149	5	8/89	412	5	5/90	415	13
19198		8/89	350	6	6/90	368	18
15545	6	5/89	402	3	7/89	414	16
15522		5/89	420	9	7/89	419	-1
15523		5/89	410	2	7/89	432	22
88/89							
12796	8	5/89	430	6	6/89	457	27
05507		5/89	530	8	7/89	508	-22
12801		5/89	455	3	7/89	533	11
05501		5/89	328	BC	9/89	368	40
05521		5/89	420	7	7/90	520	100

Tag No.	Months between capture and recapture	Growth between capture and recapture (mm)	Growth Increment (mm/mo)
21795	10	67	6.7
15089	11	67	6.1
19198	10	18	1.8
21902	13	21	1.6
05521	13	100	7.7
Average			4.8

Table 3.6.7. Distribution of walleye recaptures marked at nine index stations in May, August and October 1989. The majority of the fish marked in the Spokane Arm at Porcupine Bay (Index Station #4) were captured during their spawning migration in May 1989. Recapture locations indicate their subsequent dispersal throughout Lake Roosevelt.

			Recapture Location (Index Station #)									
Index Station	Capture Location	# marked	Canada	01	02	03	04	05	06	07	08	09
	Canada											
01	Kettle Falls	60		1					1			
02	Gifford	35										
03	Hunters	82				6						
04	Porcupine Bay	617	3	6	1	1	10		2			3
05	Little Falls	122						1	1			
06	Seven Bays	78			1	1						1
07	Keller Ferry	21										
08	San Poil	114	1			1			1	1	1	
09	Spring Canyon (Grand Coulee)	3										

In 1988, a total of 841 walleye were marked and seven were recaptured for a 1% recovery rate (Table 3.6.4). Walleye tagged in the Spokane Arm during the spawning season on May **4,** 1988 were recovered at Keller Ferry and the San Poil River in September 1988 and at Gifford in July 1989 (Table 3.6.5). One fish tagged at Kettle Falls on October 20, 1988 was recaptured at Grand Coulee Dam on July 5, 1989 (Table 3.6.5). Growth increments calculated for walleye captured at least 10 months after release ranged from **2.4** to 13.8 mm/mo with a mean value of 7.7 mm/mo (Table 3.65).

In 1989, a total of 1,158 walleye were marked and 44 were recaptured for a 3.7% recovery rate (Tables 3.6.4 and 3.6.6). A total of 602 walleye were marked during their spawning migration in the Spokane Arm in May 1989 and 26 of these fish were subsequently recaptured by anglers for a 4.3% recovery rate (Table 3.6.7). Of the 26 Spokane Arm fish recaptured 3 (11.5%) were recovered in Canada, 6 (23%) near Kettle Falls, 1 (3.8%) near Gifford, 1 (3.8%) near Hunters, 10 (38.5%) near the release location at Porcupine Bay in the Spokane Arm, 2 (7.6%) near Seven Bays/Hawk Creek, and 3 (11.5%) near Grand Coulee Dam (Table 3.6.7).

Five walleye tagged at Porcupine Bay in the Spokane Arm during the spawning season on May 5-6, 1989, were recovered in the vicinity of Kettle Falls, a distance of 153 km (95 miles), upstream in June and July 1989 (29, 34, 67, 70 and 71 days after release) (Table 3.6.7)). Travel time for the fish making the trip in 29 days computed to 5.3 km/day or 0.22 km/h. Average travel time for the five fish was 3.3 km/day. Four walleye marked at Porcupine Bay on May 5-6, 1989 were recovered in the vicinity of Grand Coulee Dam, a distance of 89 km (55 miles) downstream, in June 1989 (35, 42 and 43 days after release) (Table 3.6.7). Three walleye tagged at Porcupine Bay on May 5-6, 1988 were recaptured in British Columbia, two in the vicinity of Waneta Dam and one in the tailrace of Keenleyside Dam, respectively distances of 201 km (125 miles) and 224 km (140 miles) upstream, in July 1989 (Table 3.6.7).

Other long distance walleye migrations recorded in 1989 included:

(1) One walleye tagged at Kettle Falls on August 7, 1989 was recovered **near Seven Bays on May 4, 1990;**

(2) One walleye tagged at Seven Bays on May 16, 1989 was recaptured near Grand Coulee Dam on July 3, 1989;

(3) Two walleye tagged in the San Poil River on May 9, 1989 were recovered at Hunters on July 28, 1989 and in Canada on September 28, 1989.

Growth increments for walleye collected at least 10 months after release ranged from 1.6 to 7.7 mm/mo with a mean of 4.8 mm/mo (Table 3.6.6). Growth increments for walleye captured in October 1989 and recaptured before April 1990 ranged from 0.4 mm to 3 mm/mo and averaged 1.7 mm/mo.

3.7 Kokanee Fecundity

Tables 3.7.1 and 3.7.2 lists lengths, weights, and fecundity estimates for kokanee collected in 1988 and 1989. Regression plots of kokanee fecundity versus length and weight are presented in Appendix G.

In 1988, 50 sets of egg skein samples were collected from female kokanee salmon. Sexually mature **2+** kokanee averaged 399 mm in total length, 588 g in weight and contained a mean number of 1,303 eggs. Sexually mature **3+** kokanee averaged 472 mm in length, 1,092 g in weight and contained a mean number of 1,728 eggs. In 1989, 51 sets of egg skein samples were collected from kokanee salmon. Sexually mature **2+** kokanee averaged 348 mm in length, 419 g in weight and contained a mean number of 1,390 eggs. Sexually mature **3+** kokanee averaged 460 mm in length, 954 g in weight and contained a mean number of 1,615 eggs.

Table 3.7.1. Length, weight, and fecundity of kokanee salmon collected in Lake Roosevelt, August to October 1988.

Fish No.	Age	Total Length (mm)	Weight (g)	Fecundity (# eggs)
1	2+	389	548	1332
2	2+	470	849	1592
3	2+	338	366	984
4	3+	481	1246	1955
5	3+	485	1200	1191
6	3+	465	1107	2204
7	3+	432	1210	1402
8	3+	495	1046	1786
9	3+	485	998	951
10	3+	460	958	1134
11	3+	451	1020	1282
12	3+	487	1151	1249
13	3+	478	1110	1855
14	3+	464	1086	1619
15	3+	480	1064	1830
16	3+	500	1378	2351
17	3+	475	1145	1324
18	3+	465	998	2225
19	3+	502	1168	2366
20	3+	481	1042	2064
21	3+	502	1168	1963
22	3+	486	1027	1620
23	3+	465	963	1249
24	3+	457	1149	2065
25	3+	448	1000	1521
26	3+	463	1108	2039
27	3+	443	1145	1883
28	3+	486	1027	1454
29	3+	425	833	1608
30	3+	443	1169	1952
31	3+	470	1048	1567
32	3+	481		1810
33	3+	482		1716
34	3+	452		919
35	3+	462		1428
36	3+	481		2567
37	3+	439		1216
38	3+	475		2054
39	3+	481		1386
40	3+	491		1591
41	3+	457		1996
42	3+	495		1770
43	3+	431		1643
44	3+	446		1761
45	3+	455		1826
46	3+	490		2020
47	3+	525		1733
48	3+	465		2720
49	3+	473		1632
50	3+	528		1700
Mean	2+	399	588	1303
(±S.D.)		(±67)	(±244)	(±305)
Mean	3+	472	1092	1728
(±S.D.)		(±23)	(±107)	(±398)

Table 3.7.2. Length, weight, and fecundity of kokanee salmon collected in Lake Roosevelt, May to December 1989.

Fish No.	Age	Total Length (mm)	Weight (g)	Fecundity (# eggs)
1	1+	245	141	987
2	1+	250	154	956
3	1+	280	169	1004
4	1+	206	80	920
5	1+	346	455	1131
6	2+	262	138	1034
7	2+	280	200	1148
8	2+	348	586	2119
9	2+	335	470	1228
10	2+	370	476	1385
11	2+	385	500	1332
12	2+	380	555	1402
13	2+	369	365	1624
14	2+	381	480	1137
15	2+	361	420	1043
16	2+	379	540	1644
17	2+	380	493	1830
18	2+	339	405	1889
19	2+	354	447	1343
20	2+	244	119	1107
21	2+	393	505	979
22	3+	420	705	1211
23	3+	375	491	1102
24	3+	363	492	1636
25	3+	395	580	1522
26	3+	425	698	1781
27	3+	512	1150	2201
28	3+	412	978	1674
29	3+	402	560	1576
30	3+	503	1245	1850
31	3+	535	1340	2133
32	3+	380	565	1567
33	3+	490	1020	2026
34	3+	506	1120	1654
35	3+	502	1160	1876
36	3+	465	900	1376
37	3+	512	1145	2054
38	3+	510	1140	2165
39	3+	487	960	1811
40	3+	510	1240	1407
41	3+	496	850	1590
42	3+	550	1550	2334
43	3+	463	945	1861
44	3+	446	916	1122
45	3+	445	1010	1242
46	3+	482	1139	1227
47	3+	455	406	1656
48	3+	395	531	1419
49	3+	416	954	1963
50	3+	435	1225	1250
51	3+	481	1226	1434
52	3+	493	1346	1357
Mean	1+	265	200	1000
(±S.D.)		(±47)	(±131)	(±72)
Mean	2+	348	419	1390
(±S.D.)		(±45)	(±139)	(±330)
Mean	3+	460	954	1615
(±S.D.)		(±50)	(±295)	(±422)

4.0 DISCUSSION

4.1 CREEL SURVEYS

4.1.1 Trends in Angling Pressure, CPUE and harvest estimates

A U.S. Fish and Wildlife Service (USFWS) creel survey (Harper et *al.* 1981) estimated that, from April 15 to September 15, 1981, approximately 56,496 anglers fished 256,491 hours on Lake Roosevelt. In contrast, results of the 1989 creel survey during the same period (April 15 to September 15, 1989) indicated a 1.7 fold increase in the number of anglers (95,919) and 2.5 fold increase in angler hours (644,872). Angling pressure also increased from 1988 to 1989. From August to December, 1988, an estimated 31,672 anglers fished 261,913 hours on Lake Roosevelt. From August to December 1989 an estimated 49,706 anglers fished 290,596 hours on Lake Roosevelt, respectively a 1.6 and 1.1 fold increase over 1988 angler trips and angler hours.

Although the angling pressure has increased significantly, catch rates (CPUE) and harvest numbers have fluctuated erratically. Before 1985, walleye were the primary sport fish in Lake Roosevelt. A Washington Department of Wildlife (WDW) survey conducted in 1973 determined that Lake Roosevelt anglers were catching walleye at a rate of 0.40 fish/h (Nielsen 1974a, b). Walleye CPUE increased to a rate of 0.53 fish/h in 1980, which was the highest recorded catch rate on the reservoir, and then decreased to 0.43 fish/h in 1982 and 0.38 fish per hour in 1983 (Beckman et al. 1985). In the present creel survey, walleye CPUE was estimated at 0.34 fish/h from August to December, 1988 and 0.20 fish/h from January to December 1989.

Walleye harvest rates over the past decade have also fluctuated. WDW estimated a total catch of 2,797 walleye from June 1 to September 30, 1973 (Nielsen 1974a, b; Fletcher 1985). USFWS creel surveys estimated the walleye harvest at 128,156 from April 15 to September 15, 1981 and 108,532 from April 15 to September 15, 1982 (Harper et al. 1981; Beckman et *al.* 1985). Results of creel survey data collected in the present study from January to December 1989 show a further decrease to only 80,626 walleye harvested. In part, this decrease was related to minimum size regulations (16 inch minimum length) established by WDW. Total catch (harvest + released) of walleye was 151,794 ± 37,676 fish in 1989.

From August to December 1988, anglers caught rainbow trout at a rate of 0.37 fish/h and harvested 86,107 fish. In 1989, the rainbow trout catch rate was 0.15 fish/h and 65,515 fish were harvested. In comparison, from April 15 to September 15, 1981, anglers harvested only 1,517 rainbow (Harper et *al.* 1981). This large increase in rainbow trout harvest was attributed to the Lake Roosevelt rainbow trout net pen program. This assumption is supported by net pen raised (i.e., hatchery origin) rainbow outnumbering native rainbow observed in angler creels by a ratio of 3:1. In 1985, net pen operations commenced and anglers began catching net pen reared rainbow trout at a rate of about two fish per day, or a catch rate of 0.25 fish/h (Jackson 1985).

Little information exists on catch rates and harvest numbers of kokanee salmon in Lake Roosevelt. Catch rates are currently extremely low at 0.08 fish/h from August to December, 1988 and 0.04 fish/h in 1989, which is probably a direct correlation with the low population size. The catch rates are also erratic as shown by catch rates as high as 0.28 fish/h in October 1988 and 0.14 fish/h in September 1989, months when sexually mature adults congregate for spawning.

In terms of kokanee harvest, an estimated 126,174 fish harvested in 1981 included only 284 kokanee (Harper et *al.* 1981). From August to December, 1988, an estimated 125,891 fish were harvested comprised of 9,362 kokanee; while in 1989, an estimated 164,598 fish were harvested comprised of 11,906 kokanee. In both 1988 and 1989, kokanee comprised 7% of the total harvest compared to 1981 when kokanee was less than 1% of the total harvest. The greater percent seen in the current harvest size is partly related to the difference in creel survey techniques. The 1981 USFWS creel survey was conducted for a six month period from April 15 to September 15. As mentioned, the highest catch rate recorded August to December, 1988, was 0.28 fish per hour in October. The 1989 annual creel survey indicated that the high catch rate season occurred in late winter and the low catch rates season occurred in the summer. However, in 1989 an estimated 7,229 kokanee were harvested from April through September. This indicates that kokanee abundance in the reservoir has increased (See Section 4.2.4 for details about factors contributing to this increase).

Sturgeon fishing on Lake Roosevelt was predominantly confined to the upper reaches of the lake above the Kettle Falls area, although there have been recorded catches near Gifford Ferry and Fort Spokane. Sturgeon angling in 1989 was compared to results of surveys performed by the National Park Service from 1985 to 1987 (Chilcoat and Appling 1985, Appling 1986, and NPS 1987) (Table 4.1.1). Creel surveys were conducted

Table 4.1.1. Summary of sturgeon fishery survey data for Lake Roosevelt from 1985-l 989. Data from 1985 to 1987 collected by National Park Service.

	NPS Survey 1985	NPS Survey 1986	NPS Survey 1987	Present study 1989
No. days surveyed	67	145	163	233
No. anglers surveyed	424	894	956	447
No. hours fished	3293	10,181	8463	5,671
No. harvested	39	34	71	34
No. released	20	21	31	17
Total catch	59	55	102	51
CPUE (Total Catch) (# hr to catch one sturgeon)	55.8	188.5	83	111.2
CPUE (Harvest only) (# hr to harvest one sturgeon)	84.4	299.4	119.2	166.8

for 8 months by the NPS in 1985 and 1986, and ten months in 1987, while our 1989 survey **was** performed for twelve months. The NPS surveys showed that an angler spent 55.8 hours in 1985, 188.5 hours in 1986, and 82.9 hours in 1987 to catch one sturgeon and 88.4 hours in 1985, 299.4 hours in 1986, and 119.2 hours in 1987 to harvest one sturgeon. Results of the 1989 survey indicate that an angler spent 111.2 hours to catch and 166.8 hours to harvest one sturgeon. The number of sturgeon examined during surveys was **also** lower in 1989 at 51 fish compared to 59 in 1985, 55 in 1986 and 102 fish in 1987. The increasing time to catch one sturgeon and the fewer fish harvested may be an indication of a decline in the sturgeon population of Lake Roosevelt.

4.1.2 Economic Value of the Lake Roosevelt Fishery

Past and present economic values of the Lake Roosevelt sport fishery were estimated by multiplying the number of angler trips by the dollar amount spent per angler trip for inland waters of the Pacific Northwest (U.S. Fish and Wildlife Service 1989). Data on angler trips from 1980 and 1982 **was** obtained from Beckman et *a/.* (1985) who estimated that about **75,000 angler trips were made from April** 15 to **September** 15 each year. Results of the present creel survey estimated the number of angler trips at 70,308 from August to December 1988, and 179,871 from January to December 1989 (Table 4.1.2).

The estimated revenue generated in 1980, 1982, 1988 and 1989 is recorded in Table 4.1.2. In 1980 and 1981 the fishery produced about $1.73 million for the regional economy. This represents a minimum estimate because the fishery was surveyed only between April and September. A larger amount ($2.03 million) was estimated for the period August to December 1988. The net economic value of the 1989 fishery (January-December) was estimated at $5.20 million. Thus, the Lake Roosevelt fishery contributes significantly to the regional economy.

4.2 RELATIVE ABUNDANCE OF LAKE ROOSEVELT FISH POPULATIONS

After impoundment by Grand Coulee Dam in 1939, composition and populations of fish species in the Columbia, Spokane. and San Poil river systems that form Lake Roosevelt have simultaneously changed as biological characteristics of the reservoir have changed. These river systems, that once produced large quantities of anadromous salmon and steelhead, as well as resident rainbow, cutthroat and bull trout, mountain whitefish, and kokanee salmon, were immediately overrun by carp and

Table 4.1.2. Estimates of the economic value of the Lake Roosevelt sport fishery.

Date	# Angler Trips	Net Value of Sport Fishery
Apr-Ott, 1980	75,000	$1,725,500
Apr-Ott, 1982	75,000	1,725,500
Aug-Dee, 1988	70,308	2,031,901
Jan-Dee, 1989	179,871	5,198,271

other undesirable species. By 1949, eight years after Grand Coulee Dam became operational, a USFWS gill net survey of Lake Roosevelt determined that carp, squawfish and other species of cyprinids and catastomids were the dominant fish in the reservoir (Gangmark and Fulton 1949). Similar observations were reported in a gill net survey conducted by WDW from December 1962 to November 1963 (Earnest et al. 1963).

Table 4.2.1 presents the relative abundance of different families of fish captured in Lake Roosevelt from 1949 to 1989. The results indicate two major alterations in the fish community of Lake Roosevelt since construction of Grand Coulee Dam.

First, walleye, illegally introduced into Lake Roosevelt probably around 1962, became abundant, and, as population levels increased, a viable sport fishery developed by 1973 (Beckman et al. 1985; Fletcher 1985). Results of gill net surveys performed on the Spokane Arm of Lake Roosevelt by the Washington Water Power Company in 1973 showed that walleye comprised 11% of the relative abundance. A gill net survey conducted by USFWS from 1980-1982 estimated that walleye comprised 29% and yellow perch comprised 8% of the relative abundance (Beckman *et al.* 1985). According to their creel survey the walleye sport fishery increased markedly. Anglers caught walleye at a rate of 0.53 fish/h and harvested 128,156 walleye in 1980 (Beckman et al. 1985), indicating that a large population of walleye existed. Cyprinids and catostomids were still abundant in the USFWS survey at 23% and 34% respectively. In the present 1988 gill net survey, relative abundance was 36.3% walleye, 2.7% yellow perch, 38% catostomids and 8.8% cyprinids. In the 1989 gill net survey, relative abundance was 33.7% walleye, 12.8% yellow perch, 27.9% catostomid and 7% cyprinids.

Second, in all of the studies reported above through 1983, salmonids accounted for less than 1% of the relative abundance. In contrast, in the present survey, salmonids accounted for 25.6% of the relative abundance. This increased abundance of salmonids was also noted in creel surveys. The USFWS survey conducted in 1980 and 1982 reported that salmonids comprised about 4% of the harvest each year (5,126 fish in 1980 and 4,341 fish in 1982), whereas, in the present study, salmonids comprised 60% (172,890 fish) of the harvest from August 1988 to December 1989. In part, this difference is owing to different techniques used in the surveys. For example, the USFWS survey was conducted from April 15 to September 15 each year, whereas the present survey was conducted from January 1 to December 31.

Table 4.2.1. Summary of relative abundance of families of fish captured in Lake Roosevelt from 1949 to 1989. Percentage of total numbers are presented for USFWS (1980-1 982) and present study (1988-1 989).

FAMILY	PERCENT RELATIVE ABUNDANCE FOR EACH TYF'E OF SURVEY							
	USFWS (1949)	WDW (1963)	WWP (1973)	USFWS (1980-1982)		Present Study (1 988-1 989)		
	gill net	gill net	gill net	gillnet	creel	gillnet	electrofishing	creel
SALMONIDAE	<1	<1	cl	<1	4	25.6	11.3	60
PERCIDAE	3	4	32	37	94	39.9	56.5	37
CENTRARCHIDAE	1	>1		1	<1	5.0	3.7	3 %
CATASTOMIDAE	10	20	44	34		23.3	19.9	
CYPRINIDAE	83	72	22	23		5.9	6.3	
ICTALURIDAE						0.1	0.1	
ACIPENSERIDAE					<1	0.1	0	cl
GADIDAE						0.4	0.3	

However, we believe that the results reflect a true increase of salmonid populations in the reservoir, resulting from the rainbow trout net pen program, which was initiated in 1985. From August 1988 to December 1989, a total of 151,622 rainbow were harvested, composed of 65% net pen fish, 14% wild fish and 21% whose origin could not be determined. Creel clerks determined origin in the field by observing if fish had characteristic hatchery marks, e.g., stubbed dorsal fin, and eroded pectoral and pelvic fins.

4.2.1 Yellow Perch Abundance

In 1949 and 1963, yellow perch relative abundance was 3% and 4% respectively (Gangmark and Fulton 1949, Earnest et *al.* 1966). In 1973, yellow perch relative abundance was 20% (WWP 1973). In 1980 to 1983, yellow perch relative abundance had declined to 8% of the total catch (Beckman et *al.* 1985). The decline in relative abundance of yellow perch in the 1980 to 1983 surveys was attributed to increased reservoir fluctuations owing to construction and operation of the third power house at Grand Coulee Dam,

Beckman et *al.* (1985) reported that, in Lake Roosevelt, peak yellow perch spawning occurred during late April to mid-May with eggs hatching from mid-May to early June. Beckman et al. were able to demonstrate a correlation between water level fluctuations during the spawning season with larval catch. In 1980, water levels increased steadily after reaching a low of 373.3 m on 10 April. Larval catch was 94.5 perch/l00 m^3. In 1981, reservoir level was higher, but after reaching a minimum of 383.3 m on 22 April, and increasing to 385.6 m on 3 May, reservoir elevation declined to 383.8 m on 17 May before beginning to increase to full pool. Larval catch was reduced to 8.4 perch/l00 m^3. Reservoir levels were lowest in 1982 (369.1 m) and did not begin to increase until 20 April but rose steadily. Larval catch was 73.2 perch1100 m^3. Beckman et al. (1985) concluded that, *"Spawning success of yellow perch was better in years* when the *minimum water elevation was achieved* earlier, and the *increase was consistent once begun, than in* years when water ***levels*** fluctuated of *did not begin to **rise*** until *later in the spring."*

In the present study, yellow perch was the overall most abundant species captured, comprising 36% in relative abundance of the total catch from August 1988 to December 1989. In 1988, the majority of the yellow perch were young-of-the-year (YOY) fry. Our studies were conducted after three consecutive years (1986-1988) of drought. During this period relatively minimal drawdowns for flood control occurred on Lake

Roosevelt and once refill was initiated, water levels steadily increased (Fig. 2.3).

In 1989, a more pronounced and earlier drawdown occurred, but after refill was initiated water levels steadily increased and YOY yellow perch fry were again abundant (Fig. 2.3). Thus, results of the present study are consistent with those reported by Beckman et *al.* (1985). Adult perch were rarely encountered in the present survey. Virtually all adult (>2+) yellow perch were captured in pelagic zones or near mouths of embayments and tributaries, while the dominant younger fish were found in littoral areas associated with woody debris. Yellow perch were an important forage species for walleye. In 1988 and 1989, the ratio of yellow perch to walleye captured in gillnet and electrofishing surveys was 1.96:1 (3,947 yellow perch and 2,017 walleye). This is better than the 1:3 ratio reported in 1980 to 1982, but less than the 3:1 ratio needed for good walleye growth (Beckman et *al.* 1985). If just 1989 gillnet survey data, which is more comparable to Beckman et *al.* (1985), is used the ratio of yellow perch to walleye was 1:2.6 (relative abundance = 33.7% walleye and 12.8% yellow perch). This result is uniform with those of Beckman et *al.* (1985). These data suggest that lack of forage fish currently limits walleye production in Lake Roosevelt.

4.2.2 Walleye Abundance

Although walleye were the second most abundant species collected in the present electrofishing and gill net surveys, their populations appear to be on the decline in Lake Roosevelt. Evidence stems from comparisons of gill net catch-per-effort (CPE) statistics reported by USFWS (Beckman et *al.* 1985) and the present study. The mean CPE for four stations (San Poil, Porcupine Bay, Gifford and Kettle Falls) was 9.8 fish/net in 1980, 4.9 fish/net in 1981, 4.5 fish/net in 1988 and 3.9 fish/net in 1989.

The rapid decline of walleye during the early 1980's was attributed to over harvest by anglers, poor recruitment and a declining prey (yellow perch) base (Beckman et *al.* 1985). In 1985, WDW enacted stricter harvest regulations, including establishment of both catch and minimum size limits, as well as closure of the Spokane Arm -- the principle spawning and rearing area in the reservoir -- during the spawning season (April 1 - May 31). This action appears to have stabilized the decline in walleye abundance. The slight reduction in CPE between 1988 and 1989 may be related to a difference in reservoir operations between the two years (Fig. 2.3). The reservoir was drawn down for an extended period and to a lower reservoir elevation in 1989 as compared to 1988. This could have increased entrainment of walleye through Grand Coulee Dam. Additionally, gill net surveys were conducted in May 1989 but not May 1988, so the data are not strictly comparable.

4.2.3 Rainbow Trout Abundance

Rainbow trout populations have increased to their highest level since the impoundment by Grand Coulee Dam. The majority of rainbow were captured near pet pen locations, although considerable numbers were also captured at the mouths of tributaries. The present abundance is attributed to fish from two different origins: artificial production of net-pen reared rainbow and native production in tributary streams.

Examination for native or hatchery origin (i.e., stubbed dorsal and eroded pectoral fins) showed that hatchery (net-pen reared) trout outnumbered native rainbow trout by a ratio of 3:1 in gill net and electrofishing surveys. This was also seen in the creel surveys, which estimated 65% hatchery, 14% native, and 21% of unknown origin rainbow trout. The majority of net-pen trout were found in the southern portion of Lake Roosevelt, excluding the San Poil Arm, while the majority of native trout were found in the San Poil and Spokane Arms of Lake Roosevelt, and at the mouths of several tributaries.

Results of past fishery surveys on Lake Roosevelt indicated the scarcity of rainbow trout. In 1949, the USFWS sampled six locations throughout Lake Roosevelt with gill nets which resulted in the total absence of any salmonid species (Gangmark and Fulton 1949). Fishery surveys performed over the following three decades showed similar results; rainbow trout comprised less than 1% of the total abundance. The small population of rainbow trout that existed in Lake Roosevelt has been limited by the amount of spawning habitat and possibly the over harvest of spring spawners in tributaries. Beckman et *al.* (1985) determined that naturally produced rainbow trout sustained a relatively small population of harvestable size rainbow trout. Beak Consultants (1980) operated a trap in the San Poil river and caught 51 migratory adult rainbow trout 3 to 4 years old, averaging 412 mm and 0.8 kg, on their upstream spawning migration (March 21 - June 1, 1979). They also captured 312 juvenile (1+ age class) rainbow which moved downstream in large numbers between June 15 and July 15, 1979. Subsequent tag recoveries indicated that these fish scattered through the lower reservoir (Beak Consultants, 1980).

The limited spawning habitat (Stober *et al.* 1977, Beckman *et al.* 1985) is a result of natural barriers on most tributary streams which make them inaccessible to reservoir fish populations. There is a considerable amount of spawning and rearing habitat in many Lake Roosevelt tributaries, but natural barriers (i.e., waterfalls at the mouth, dead falls and log jams) impedes access to migratory fish. Also, rainbow trout seeking access to spawning tributaries during the spring find ascent difficult because of drawdown effects. These observations suggest that manipulations to improve spawning and rearing habitat and access to spawning tributaries would substantially increase the population levels of wild rainbow trout in the reservoir (Scholz et *al.* 1986).

4.2.4 Kokanee Salmon Abundance

The current abundance of kokanee in Lake Roosevelt is lower than it was before construction of the third powerhouse in 1968 (Stober et *al.* 1977). In 1966 and 1967 large numbers of kokanee were collected in the forebay of Grand Coulee Dam via gill nets and purse seine (Snyder 1967). Snyder (1969) reported that, *"Sizeable kokanee populations were present in the lake. In 7966, 35,000 kokanee were captured in Cfesent Bay and transplanted below Chief Joseph Dam."*

In contrast, in the fisheries survey performed by USFWS from 1980 - 1982, kokanee comprised less than 1% of their total gill net catch (Beckman *et a/.* 1985). In the present study kokanee comprised about 1% of the gillnet catch in both 1988 and 1989, 3.5% of electrofishing catch in 1988 and 1.9% of the electrofishing catch in 1989. Stober et *al.* (1977) concluded that, with increased drawdown after construction of the third powerhouse at Grand Coulee Dam, redds of shoreline spawning kokanee would be exposed to dessication. This could account for the decline in kokanee abundance observed from the 1960's to the 1980's.

From 1980 to 1982, USFWS collected a total of only 19 kokanee (Beckman *et al.* 1985) present study 310 kokanee were collected in fisheries surveys from August 1988 to December 1989. In 1981, anglers harvest 284 kokanee from April 15 through September 15 (Harper et *al.* 1981). In 1989, anglers harvest 7,229 kokanee from April through September. These data indicate that kokanee abundance has increased from 1980 to 1989. In part, this increase is attributed to the difference in reservoir operation prior to and during the two studies. From 1979 to 1982, the reservoir was drawn down to low levels. In contrast, from 1987 to 1989, the reservoir was operated to retain as much water as possible because of drought conditions. In 1986 and 1987 the reservoir was operated more like it was during the 1950's and early 1960's.

A second factor contributing to the increased abundance of kokanee in Lake Roosevelt is an influx of kokanee from Lake Coeur d'Alene, ID. Kokanee migrating downstream from Lake Coeur d'Alene into Lake Roosevelt was evidenced from juveniles observed in the forebay of Little Falls Dam by UCUT and Washington Water Power Company personnel in December 1989. No known natural spawning or stocking of kokanee occurs between Little Falls Dam and Lake Coeur d'Alene, so it is likely that the juvenile fish observed in the forebay had migrated downstream from Lake Coeur d'Alene. In 1988 and 1989 mature kokanee were recorded at the base of Little Falls Dam, appearing to be migrating upstream. Lake Coeur d'Alene became overpopulated from 1979 to 1985 when the population increased from 6.04 million to 9.38 million fish (Partridge 1988). The adult spawners observed at Little Falls Dam in 1988 may have been progeny of the 1985 cohort. Age analysis of kokanee scales collected from Little Falls Dam in 1988 revealed that these spawners were predominantly the 3+ age class.

Never-the-less, kokanee were still not very abundant in 1988 and 1989. Only 310 kokanee were captured in gillnet and electrofishing surveys. In creel surveys conducted in 1988 (August-December) and 1989, (January-December), total kokanee harvest was estimated at only 9,362 ± 3,873 and 11,906 ± 3,597 fish respectively. In summary, both fisheries survey and creel survey data indicated that kokanee were not abundant in Lake Roosevelt during the baseline period before the Lake Roosevelt kokanee hatcheries come on line.

Both USFWS and present surveys found comparable distribution of kokanee with the majority of kokanee captured in the lower reaches of the reservoir except during the autumn when sexually mature adults migrated to spawning grounds and distributed throughout the reservoir. In our surveys, spawning populations were noted at Little Falls Dam, San Poil River, Hawk Creek, Sheep Creek, Nez Perce creek and Hunters Creek. Possible shoal spawning sites were located at Kieffer Point in the mainstem Columbia on the Spokane Indian Reservation and about 1.5 km below Little Falls Dam in the Spokane Arm.

4.2.5 Lake Whitefish Abundance

Lake whitefish abundance in Lake Roosevelt appears to be increasing as evidenced by increased relative abundance in gill net surveys from 1% in 1963 (Earnest et *al.* 1966) to 3% in 1980-l 982 (Beckman et *al.* 1985), to 6.1% (24 fish) in 1988 and 30.7% (239 fish) in 1989 (present study). The increased abundance of whitefish may be related to reduced predation by adult yellow perch and walleye. Whitefish were reported in the diets of adult yellow perch and walleye in Lake Roosevelt (Harper et *al.* 1981, Nigro et *al.* 1983). Lake whitefish abundance is of concern to the operation of the kokanee hatcheries because of the high diet overlap between kokanee and lake whitefish.

4.2.6 **Notes on other Sport Fish Species**

Twelve chinook salmon were captured in the present electrofishing and gill net surveys. The majority of these were captured in the late summer and autumn at Little Falls Dam on the Spokane Arm (Index Station 5). In 1982, the Idaho Department of Fish and Game (IDFG) introduced chinook salmon into Lake Coeur d'Alene, Idaho. It seems likely that the chinook we observed emigrated from Lake Coeur d'Alene as juveniles and grew to maturity in Lake Roosevelt. Chinook salmon lengths and weights respectively ranged from 400 to 665 mm and 1,195 g (495 mm fish) to 1,605 g (510 mm fish). See Appendix D (Table D5).

Forty nine brown trout were captured in 1988 and 1989. Nearly all were captured either at the base of Little Falls Dam or in the Colville River near Kettle Falls (Index Station 1). Brown trout lengths and weights ranged from 145 to 732 mm and 106 to 5,783 g, respectively (Appendix D, Table D6).

In 1988 and 1989, 96 largemouth bass and 205 smallmouth bass were captured in electrofishing and gill net surveys. Adult bass of both species were concentrated in the southern portion of the reservoir at Spring Canyon, Keller Ferry, and the Sanpoil River (Index Stations 7, 8, and 9). Some adult bass were collected at Porcupine Bay in the Spokane Arm (Index Station 4). Most young-of-the-year bass were collected in the Spokane Arm, Sanpoil Arm and Hawk Creek (Index Station 4, 6 and 8). Largemouth bass ranged from 116 to 390 mm in total length (Appendix D, Table D7). Smallmouth bass ranged from 130 to 385 mm in total length and 181 g (225 mm) to 499 g (315 mm) in weight (Appendix D, Table D8).

4.3 AGE, GROWTH, AND CONDITION

4.3.1 **Rainbow Trout**

Mean estimated total length at annulus formation of rainbow trout in Lake Roosevelt was compared to that reported from other rainbow producing lakes and rivers in the western United States and Canada (Table 4.3.1). At each annulus, rainbow lengths from Lake Roosevelt trout

Table 4.3.1. Comparisons of estimated total lengths at annulus formation for rainbow trout in Lake Roosevelt -v- rainbow trout waters in the western United States and British Columbia.

Location	Average total length (mm) at annulus formation 1	2	3	4	5	6	Reference
Okanogan Lake, B.C.	114	305	431	571			Wydoski 8 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 (1984)
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, WA[1]	89	196	274	368	419	470	Bailey & Saltes (1982)
Spokane River, WA*	123	219	318	397	419	-	Kleist (1987)
Lake Roosevelt, WA 1977[3]	97	255	322	-			Stober *et al.* (1977)
MEAN TOTALS	110	217	307	386	441	498	
Lake Roosevelt, WA 1988	**195**	318	377	423	434	-	Present Study
Lake Roosevelt, WA 1989	166	235	344	429	474	501	Present Study

[1]Upstream of Lake Roosevelt, river mile 79 to 97

[2]Upstream of Lake Roosevelt, river mile 58 to 74

3Lake Roosevelt (San Poil Arm) Fork length. These fish were wild fish. Trout captured in the present study were predominantly(65%) net pen raised fish.

collected in 1989 were greater than the average of 20 lakes used for comparison: 166-v-l 10 mm at Age I, 235-v-217 mm at age II, 344-v-207 mm at age III, 429-v-386 mm at age IV, 474-v-441 mm at age V, and 501-v-498 mm at age VI.

The excellent growth rates of Lake Roosevelt rainbow is further reflected in creel survey results. Mean length and weight of rainbow harvested from August to December 1988 were respectively 391 mm and 676 g. Mean length and weight of rainbow harvested from January to December 1989 was 403 mm and 710 g. Most of these fish were net pen rainbow harvested during the first six to twelve months after release. Tagging studies indicated that rainbow trout, tagged at the Seven Bays net pen in May 1988 achieved total lengths of 418 ± 37 mm and weights of 764 ± 70 g by October 1988. Rainbow trout tagged at the Seven Bays net pen in April 1989 attained lengths of 401 ± 13 mm and weights of 681 ± 98 g by October 1989. Rainbow trout tagged at Hunters net pen in March 1989 attained lengths of 390 ± 58 mm and weights of 817 ± 296 g by October 1989.

4.3.2 Walleye

Walleye collected during this study were of average size and condition. Growth estimates back-calculated from scale samples collected during the present study were compared to estimates reported for walleye in past surveys of Lake Roosevelt and from other walleye waters in the United States and British Columbia (Table 4.3.2).

From age I to VI, Lake Roosevelt walleye were average in size, whereas from age VII to IX Lake Roosevelt walleye were above average. Lake Roosevelt walleye growth for all ages was lower in comparison to mid-Columbia River and Lake Umatilla estimates, but greater than estimates reported for northern Wisconsin and Minnesota lakes.

Growth estimates reported in studies conducted by the WDW in 1973 (Nielson 1974a, b), and USFWS from 1979-1980 (Harper et al. 1980) and 1981 (Nigro et *al.* 1983) were greater for all age classes of walleye than found in the present study (Table 4.3.2). However, 1988 to 1989 growth estimates were comparable to those reported by Beckman et *al.* (1985), which included scale data from 1979 to 1983. Beckman et *al.* (1985) reported walleye size had declined from 1969 to 1983 but had stabilzed between 1980 and 1983. The decline in walleye size from 1969 to 1983 appeared to be a result of the population overextending its forage base. Mean condition factor of walleye collected from 1980-l 983 was 0.87,

Table 4.3.2. Comparisons of estimated total lengths at annulus formation for walleye in Lake Roosevelt -v- other walleye lakes in the western United States and British Columbia.

Location	Sample Size	Average total length (mm) at annulus formation 1	2	3	4	5	6	7	8			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	-	-	-	-	Willrns et *al.* (1989)
Mid-Columbia River, WA		229	363	460	528	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	1,248	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	Present Study
Lake Roosevelt, WA 1989	467	210	282	351	418	493	571	603	-	-	-	Present Study

which is very close to the 1988-I 989 mean of 0.88. Thus, it appears that walleye growth has been relatively stable from about 1980 to 1989. Further support for this claim stems from growth comparisons of fish collected in 1988 and 1989 fisheries surveys. Mean length, weight and condition factor for a particular age class was similar in both 1988 and 1989, although growth was slightly greater in 1989 (Tables 3.3.5 and 3.3.6).

4.3.3 Kokanee Salmon

Back-calculated lengths at annulus formation for kokanee from Lake Roosevelt were compared to estimates from other kokanee lakes in the western United States and British Columbia (Table 4.3.3). Mean total length of Lake Roosevelt kokanee was significantly greater at the end of each year than the mean of 19 other lakes used for comparison: 124-v-121 mm at age I, 259-v-207 mm at age II, 354-v-256 mm at age III and 406-v-272 at age IV. In fact, Lake Roosevelt kokanee exhibited the best growth among the compared lakes for all age classes, with the exception of the first year.

Comparison of kokanee caught by anglers also indicated that kokanee growth in Lake Roosevelt is 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 compared to ranges of 240-395 mm from 1954 to 1988 in Lake Coeur d'Alene, ID, 235-305 mm from 1980 to 1981 in Spirit Lake, ID, 220-304 mm from 1965 to 1975 in Odell Lake, OR, 292-369 mm from 1967 to 1985 in Flathead Lake, MT, 237-343 mm from 1954 to 1987 in Pend Oreille Lake, ID, 231-411 mm from 1941 to 1985 in Loon Lake, WA and 328-411 mm from 1940 to 1985 in Deer Lake, WA (Lewis 1975; Rieman and Bowler 1980; Cochnauer 1983, Chisolm and Fraley 1985, Scholz et *al.* 1988). Because kokanee are size selective predators of zooplankton, the growth of kokanee is greatly influenced by the relationship between kokanee population density and amount of food resources, i.e., intraspecific competition (Pfeiffer 1978; Scholz et *al.* 1988).

Cochnauer (1983) reported that the kokanee population in Lake Coeur d'Alene, ID steadily increased from 1954 to 1982. This population increase was accompanied by steadily decreasing individual growth. Mean lengths of kokanee decreased from 394 millimeters in 1954 to 236 millimeters in 1982. Rieman et *al.* (1980) reported that by 1979 no large zooplankton were left in the lake. In 1972, the cladoceran, *Daphnia* (1.37-2.16 mm), and the copepod, *Epischura* (1.7-2.3 mm), were present in

Table 4.3.3. Comparisons of estimated total lengths at annulus formation for kokanee salmon in Lake Roosevelt -v- 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	a4	163	249	- -	Ricker (1938)
Moore Creek, BC	- -	- -	170	237	245	Lorz and Northcole (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	**Present Study**
Lake Roosevelt; WA 1989	42	124	259	354	406	**Present Study**

significant numbers, but by 1979, the cladocerans *Diaphanosoma* (0.6-l .O mm) and *Bosminia* (0.3-0.4 mm)-- and copepods, *Cyclops* (0.5-0.7 mm) and *Diapromus* (0.7 mm), were the dominant forms and larger zooplankton were absent. From 1979 to 1985, kokanee populations increased from 6.04 million to 9.38 million fish.

In 1985, the average kokanee length in Lake Coeur d'Alene had declined to 188 mm (Partridge 1988). In 1982, chinook salmon predators were introduced into Lake Coeur d'Alene. Introduction of chinook had the following effects on the kokanee: (1) the kokanee population decreased by 2.06 million fish (from 9.38 million fish in 1985 to 7.31 million fish in 1986); and (2) the mean size of kokanee in the fishery increased from 188 millimeters in 1985 to 216 millimeters in 1986 (Horner et *al.* 1986, 1987; Partridge 1988).

A study of two adjacent lakes, Loon and Deer Lakes, WA, provided similar results. At Loon Lake, WA mean size of kokanee in the creel decreased from 403 ± 16 mm in 1947 to 234 ± 15 mm in 1985 (Scholz et *al.* 1988). The mean size of kokanee harvested was relatively constant from 1947 to 1975. In 1975, the mean size was 411 ± 16 mm. However, after 1975, accelerating eutrophication and hypolimnetic oxygen depletion caused the lake trout population to decline. Accompanying this decline in predator levels, kokanee increased in abundance (as evidenced by a CPUE of 0.3 kokanee/angler hour from 1969-1973 compared to a CPUE of 3.3 kokanee/angler hour from 1980-1983 and 4.4 kokanee/angler hour in 1984-l 985 -- Scholz et *a/.* 1988). The mean size of kokanee decreased to 333 ± 13 mm by 1982 and 244 ± 28 mm in 1983 (Scholz *et al.* 1988). Introduction of picivorous lake trout and brown trout in 1985 caused a reduction in the kokanee population. By 1988, CPUE decreased to approximately 2.0 kokanee/angler hour and size had increased to approximately 368 mm (Scholz *et a/.* 1988). The decline in growth rate was related to food availability and intraspecific competition. In 1985, in Loon Lake *Daphnia* biomass was 13.8 µg/l and mean size was 0.8 ± 0.1 mm. By comparison, in Deer Lake where the kokanee population was relatively low, kokanee growth was excellent (410 mm), *Daphnia* biomass was 156.1 µg/l and mean size was 1.4 ± *0.2* mm (Scholz *et al.* 1988). *Daphnia* was the principle item in the diet of kokanee from both lakes with an index of relative importance of 49.1% in Loon Lake and 68.3% in Deer Lake (Scholz *et al.* 1988).

Collectively, these studies indicate that kokanee growth is profoundly affected by kokanee density relative to selected prey organisms, and that kokanee growth can fluctuate rapidly in response to changes in these variables. Since natural spawning of kokanee in Lake Roosevelt is limited (Nigro et a/. 1983), population levels are currently low and density of preferred prey is high. We infer that these factors contribute to the relatively high growth rates of kokanee in Lake Roosevelt. One of the objectives of our management plan is to continue to produce kokanee with relatively high growth rates. Stocking of 8 million fingerlings in Lake Roosevelt from the approved hatcheries is anticipated to produce 3.2 million adults or 54% of the 5.9 million adult population that the. Lake could theoretically support (Beckman *et al.* 1985). This was an intentional part of the mangement plan, aimed at maintaining good growth rates.

4.3.4 Lake Whitefish

Table 4.3.4 presents a comparison of the estimated total lengths at annulus formation for lake whitefish in Lake Roosevelt -v- other Lake whitefish waters in North America. The estimated mean total length at annulus formation for lake whitefish from Lake Roosevelt in 1989 were 239 ± 43, 326 ± 54, 419 ± 50, 478 ± 51, 496 ± 64, and 524 ± 78 mm for age class I, II, Ill, IV, V, and VI respectively. The mean values from other Lake whitefish producing lakes were 146 ± 43, 246 ± 73, 326 ± 81, 381 ± 87, 423 ± 93, and 455 ± 104 for age class I, II, Ill, IV, V, and VI respectively. Thus, Lake whitefish in Lake Roosevelt were larger than average at the formation of each annulus. Our findings for Lake whitefish were similar to those reported by Beckman *et a/.* (1985). Condition factor of Lake whitefish was 1 .17 from 1979 to 1983 (Beckman *et al.* 1985) and 1.10 in 1989 (present study).

4.4 ZOOPLANKTON

4.4.1 Zooplankton Abundance and Distribution

Mean microcrustacean zooplankton (excluding nauplii) density was determined for May, August and October 1989 at nine index stations (Table 4.4.1). Microcrustacean zooplankton densities were highest in the lower mainstem Columbia stations (Fig. 4.4.1). Mean annual values were: Spring Canyon (7,914/m^3), Keller Ferry (11,527/m^3) Seven Bays (9,274/m^3), Hunters (8,608/m^3), Gifford (5,632/m^3) and Kettle Falls (2,482/m^3). Distance upstream from Grand Coulee Dam to each site was: Spring Canyon (4.8 km), Keller Ferry (24 km), Seven Bays (59 km), Hunter (102 km), Gifford (126 km) and Kettle Falls (160 km). Highest recorded mean microcrustacean densities were on the Spokane Arm stations, including

Table 4.3.4. Comparisons of estimated total lengths at annulus formation for lake whitefish in Lake Roosevelt versus other lake whitefish waters in the western United States and British Columbia.

Location	Sample Size	Average total length (mm) at annulus formation 1	2	3	4	5	6	Reference
Upper Churchill, BC	827	122	239	338	396	434	465	Miller 1949
Altin Lake, BC	22	97	178	262	371	475	584	Whithler 1956
Okanangan Lake, BC	83	155	264	306	358	396		McHugh 1939
Upper Churchill, BC	89	165	213	259	297	330	368	Rawson 1953
Lake Huron	1438	104	155	193	229	259	248	Van Osten 1929
Maine Lakes			262	318	330	340	358	Everhart 1958
Lake Vermillion	228	104	168	254	310	353	376	Eddy & Carlander 1942A
Lake Erie	3553	173	312	406	460	503	538	Van Oosten & Hile 1949
Green Bay, WI	2653	168	300	401	462	508		Mraz 1964
Lake Huron	4516	127	226	312	409	488		Van Oosten 1939
Lake Michigan	4729	132	229	330	406	470		Caraway 1951
Lake Michigan	886	142	249	351	434	495		Mraz 1964
Lake Michigan	2722	135	239	330	417	480	528	Van Oosten 1929
Lake Superior	178	140	183	213	239	257	274	Edsall 1960
Lake Superior	1569	142	231	310	368	401	414	Dryer 1963
Trout Lake, WI	243	97	137	178	213	244		Hile & Deason 1934
Lake Roosevelt, WA	619	246	410	480	518	546	559	Beckman et *al.* 1985
Lake Roosevelt, WA	40	224	378	468	511	542	537	Nigro *et al.* 1983
Lake Roosevelt, WA	301	250	419	487	524	553	572	Harper 1982
MEAN TOTALS		146	246	326	381	423	455	
Lake Roosevelt, WA	**169**	239	326	**419**	478	496	524	Present Study

Table 4.4.1. Density (#/m^3) of microcrustacean zooplankton collected in Lake Roosevelt in May, August and October 1989, and mean annual density ($\bar{X}$), at each index station.

		Index Station								
Date	Taxa	Kettle Falls (1)	Gifford (2)	Hunters (3)	Porcupine Bay (4)	Little Falls (5)	Seven Bays (6)	Keller Ferry (7)	San Poil (8)	Spring Canyon (9)
May 89	Cladocera	86	189	68	106	135	254	155	86	250
	Copepoda	79	184	308	3,778	472	3,625	2,821	898	5,268
	Total	165	373	376	3,884	607	3,879	2,976	984	5,518
Aug 89	Cladocera	9,843	12,469	15,440	13,745	5,479	5,545	1,736	3,077	1,577
	Copepoda	244	712	1,396	19,328	19,131	5,135	17,986	12,791	10,664
	Total	10,087	13,181	16,836	33,073	24,610	10,680	19,722	15,868	12,241
Oct89	Cladocera	1,998	2,705	5,866	22,530	3,280	4,406	979	3,699	3,066
	Copepoda	236	637	925	22,489	9,343	8,448	4,144	14,030	2,916
	Total	2,234	3,342	6,791	45,019	12,623	12,854	5,123	17,729	5,982
$\bar{X}$ 89	Cladocera	3,976	5,121	7,125	12,127	2,964	3,402	957	2,287	1,631
	Copepoda	802	1,200	876	15,198	9,649	5,736	8,317	9,240	6,283
	Total	2,482	5,632	8,608	27,325	12,613	9,138	9,274	11,527	7,914

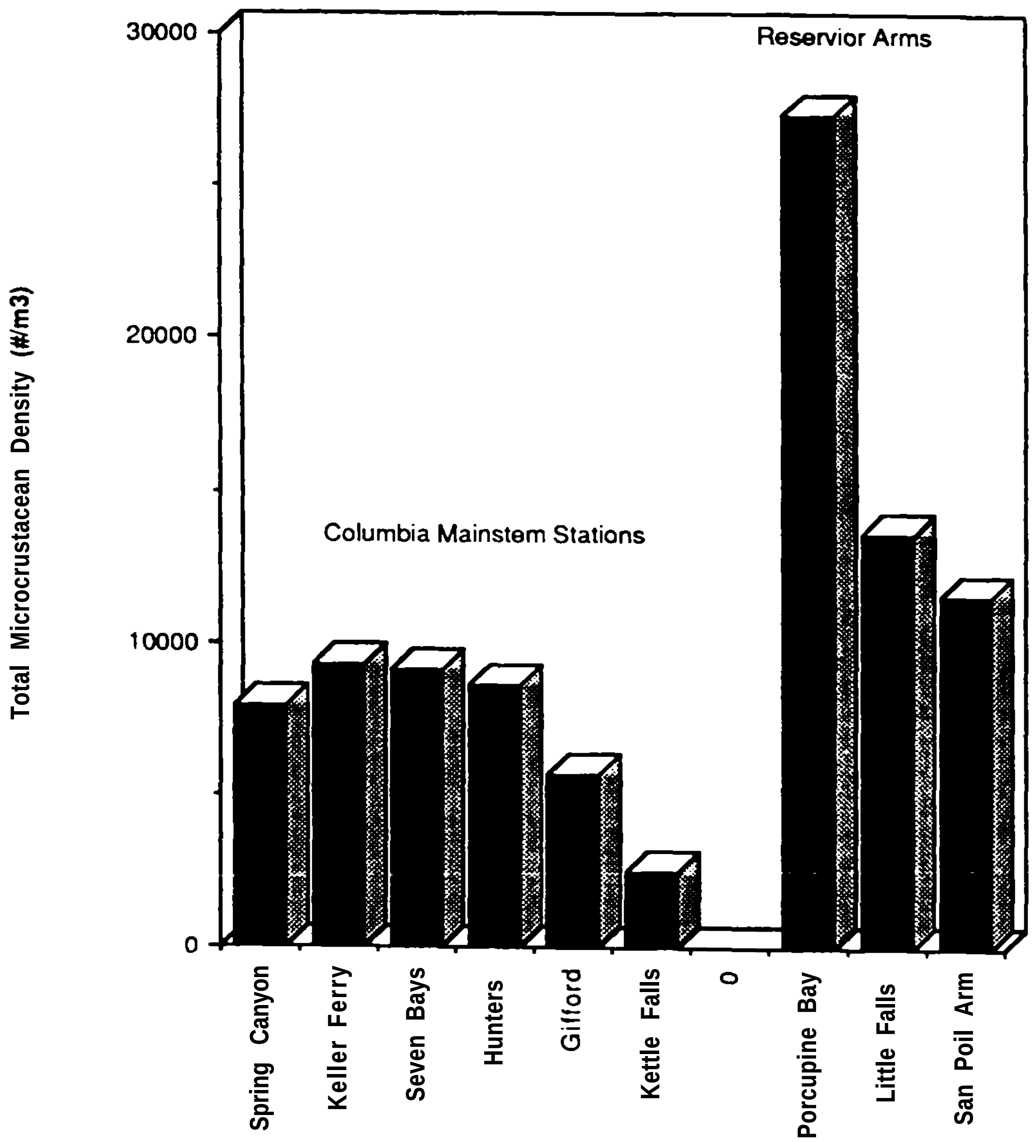


Fig. 4.1 Mean total microcrustacean density (excluding naupli) collected at mainstem Columbia stations and reservoir arm stations in May, August and October 1989.

Porcupine Bay (27,325/m³) and Little Falls (12,613/m³). Microcrustacean density was also higher on the San Poil Arm (11,527/m³) than at mainstem stations.

Zooplankton density distribution observed in the present study was similar to that observed by Beckman et al. (1985), who reported that mean number of cladocera, calanoid copepods and cyclopoid copepods was lower in the upper reservoir and higher in the Spokane and San Poil Arms.

In the present study mean annual *Daphnia* biomass estimates in 1989 for the Columbia mainstem were highest in the middle portion of the reservoir at Hunters (171 ,166.1 μg/m³), Gifford (154,049.8 μg/m³) and Seven Bays (135,693.4 μg/m³) (Table 4.4.2, Fig. 4.4.2). Biomass was lower at Keller Ferry (42,584.6 μg/m³), Spring Canyon (78,626.1 μg/m³) and Kettle Falls (77,479.9 μg/m³). Highest *Daphnia* biomass reported in the reservoir was in the Spokane Arm at Porcupine Bay (308,047.6 μg/m³). In the San Poil Arm mean *Daphnia* biomass was 139,627.9 μg/m³. Annual (May to October) mean *Daphnia* biomass for all stations was 128,595.7 μg/m³.

Beckman et *al.* (1985) calculated that, at zooplankton levels observed in 1980 and 1982, the forage base in Lake Roosevelt could support about 16 million kokanee fingerlings and 5.9 million adult kokanee (0.5 kg body weight); so results of the present study were compared to those collected in 1980 and 1982 to determine if zooplankton levels had changed significantly.

Range of densities of cladocera and copepods collected at four stations (San Poil, Porcupine Bay, Gifford and Kettle Falls) were compared from samples collected from May to September 1980 (Stober et *al.* 1981), May to September 1982 (Beckman et *al.* 1985), and May, August, and October 1989 (present study) (Table 4.4.3). Ranges were thought to be the most useful measure for comparison because reservoir operations each year influenced zooplankton abundance on a particular date. Mean Cladocera ranges reported for the four stations were 13 to 1,489 in 1980, 80 to 11,612 in 1982 and 117 to 12,135 in 1989. Mean copepod ranges reported were 1 ,114 to 3,787 in 1980, 1 ,112 to 18,152 in 1982 and 1,235 to 12,519 in 1989. **Thus, microcrustacean** abundance **in 1989 was** comparable to that reported in 1982. Cladocerans were slightly higher and copepods were slightly lower.

Only one station was directly comparable in all three years (Table 4.4.4). At the Porcupine Bay station, mean Cladocera densities reported

Table 4.4.2. Daphnia biomass ($\mu g/m^3$) at nine index stations in May, August and October 1989.

	Index Station								
Date	Kettle Falls (1)	Gifford (2)	Hunters (3)	Porcupine Bay (4)	Little Falls (5)	Seven Bays (6)	Keller Ferry (7)	San Poil (8)	Spring Canyon (9)
May	7.4	308.5	67.1	19.9	36.7	549.2	407.0	227.4	939.2
Aug	220,552.2	391,872.0	232,572.6	565,545.8	45,841.8	180,276.5	87,639.4	267,285.1	82,336.4
od	11,880.0	69,968.8	280,858.6	358,577.5	104,379.2	226,254.6	39,707.3	151,371.3	152,602.7
x	77,479.9	154,049.8	171,166.1	308,047.6	50,085.9	135,693.4	42,584.6	139,627.9	78,626.1

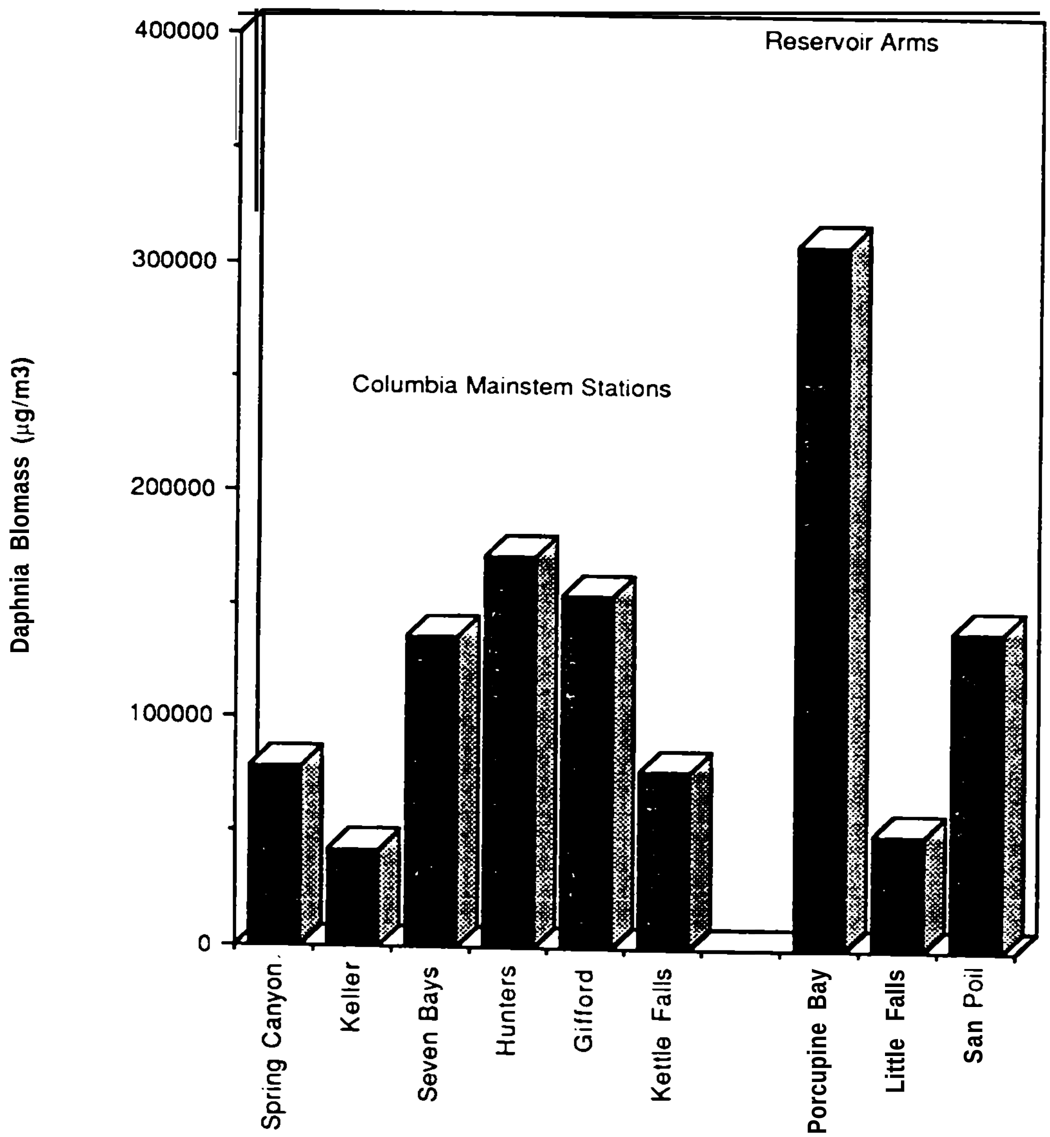


Fig. 4.4.2. Mean Daphnia biomass (µg/m^3) at nine index stations in Lake Roosevelt. Values reported are mean for May, August and October samples.

Table 4.4.3. Comparisons of range of densities reported for Cladocera and Copepoda at four index stations in Lake Roosevelt in 1980, 1982 and 1989. Range is reported for samples collected from May to September in 1980 and 1982, and May to October in 1989.

Station	1980[1]	1982[2]	1989[3]
San Poil			
Cladocera	14 - 2450	110 - 19,557	86 - 3,699
Copepoda	3,489 - 9,505	3,580 - 47,825	898 - 14,030
Porcupine Bay			
Cladocera	8 - 1,777	56 - 10,258	106 - 22,530
Copepoda	691 - 4,275	341 - 17,690	3,778 - 33,648
Gifford			
Cladocera	4 - 1,557	87 - 15,578	189 - 12,469
Copepoda	275 - 1,268	482 - 5,615	184 - 712
Kettle Falls			
Cladocera	25 - 172	65 - 1,056	86 - 9,842
Copepoda	0 - 100	45 - 1,477	79 - 244
$\bar{x}$ Cladocera	13 - 1,489	80 - 11,612	117 - 12.13[5]
Copepoda	1,114 - 3,787	1,112 - 18,152	1,235 - 12,159

1 Data from Stober *et al.* (1980). Data collected May to September 1980.
2 Data from Beckman et *al.* (1985). Data collected May to September 1982.
3 Data from percent study. Data collected May to October 1989 at Porcupine Bay and May, August and October 1989 at San Poil, Gifford, and Kettle Falls.

Table 4.4.4. Comparison of copepod and cladocera densities reported at Porcupine Bay (Index Station #4) from May to September 1980, 1982 and 1989.

	1980 Stober et *al.* (1980) (#/m^3)	1982 Beckman et *al.* (1985) (#/m^3)	1989 Present Study (#/m^3)
COPEPODA			
MAY	875	341	3,778
JUN	691	1,131	12,986
JUL	1,742	10,752	7,508
AUG	4,451	17,690	19,328
SEP	4,275	7,000	33,648
$\bar{X}$	2,407	7,437	15,450
CLADOCERA			
MAY	8	56	106
JUN	682	1,293	10,060
JUL	1,716	10,258	10,605
AUG	1,228	2,572	13,745
SEP	1,772	3,712	13,087
$\bar{X}$	1,081	3,578	9,521

for samples collected from May through September was 1,081 in 1980, 3,578 in 1982 and 9,521 in 1989. In each year, the majority of cladocerans were *Daphnia spp.* Mean copepod density was 2,407 in 1980, 7,437 in 1982 and 15,450 in 1989. From these data it appears that microcrustacean abundance was higher in 1989 than previous years.

In both comparisons, cladocerans were higher in 1989 than 1980 or 1982. This was particularly encouraging from the standpoint of enhancing kokanee populations, because Cladocera (particularly *Daphnia spp.)* were the prey item with the highest index of relative importance values in kokanee diets (76% in 1988 and 65.1% in 1989).

Microcrustacean biomass in Lake Roosevelt was considerably higher than reported for other local productive kokanee lakes. Rieman and Bowler (1980) reported that summer mean microcrustacean biomass for five north Idaho kokanee producing lakes was: Lake Pend Oreille (5 year mean = 38.7 mg/m^3), Lake Coeur d'Alene (3 year mean = 36.8 mg/m^3), Preist Lake (27.7 mg/m^3), Upper Priest Lake (25.5 mg/m^3), and Spirit Lake (39.7 mg/m^3). In comparison, mean *Daphnia* biomass recorded for nine index stations in Lake Roosevelt in May, August and October 1989 was 128.6 mg/m^3. Mean annual (January to December 1989) *Daphnia* biomass at Porcupine Bay (Index Station 4) was 184. 8 mg/m^3. Mean annual (January to December 1989) *Daphnia* biomass at Seven Bays (index Station 6) was 153.1 mg/m^3. *Daphnia* was the prey item with the highest relative importance in Lake Roosevelt kokanee diets in both 1988 (70%) and 1989 (58.4%) Thus, the present study confirms previous investigations that zooplankton biomass in Lake Roosevelt is sufficient to support the proposed 3.1 million adult kokanee produced by the Lake Roosevelt kokanee hatcheries. The difference in zooplankton biomass between Lake Roosevelt and the above mentioned Idaho Lakes can be attributed to two factors: (1) Lake Roosevelt, being downstream of a major urban center at Spokane, WA and Coeur d'Alene, ID, contains more nutrients and (2) zooplankton in the north Idaho lakes has been affected by size selective predation whereas zooplankton in Lake Roosevelt have not been impacted by size selective predation (See Section 4.3.3).

4.4.2 Effect of Reservoir Operation on Zooplankton Dynamics

Zooplankton densities and biomass collected at monthly intervals at index stations 4 (Porcupine Bay) and 6 (Seven Bays) were compared to mean monthly reservoir elevations and water retention times (Tables 4.4.5 and 4.4.6; Fig.'s 4.4.3 to 4.4.6) to determine the effect of reservoir operations on zooplankton dynamics. In 1988 and 1989, *Daphnia* densities

Table 4.4.5. Reservoir elevation, water retention time and density or biomass of selected 20 I categories of zooplankton collected at monthly intervals at Porcupine Bay (Index Station 4). Total = total microcrustaceans (Cladocera + Copepoda).

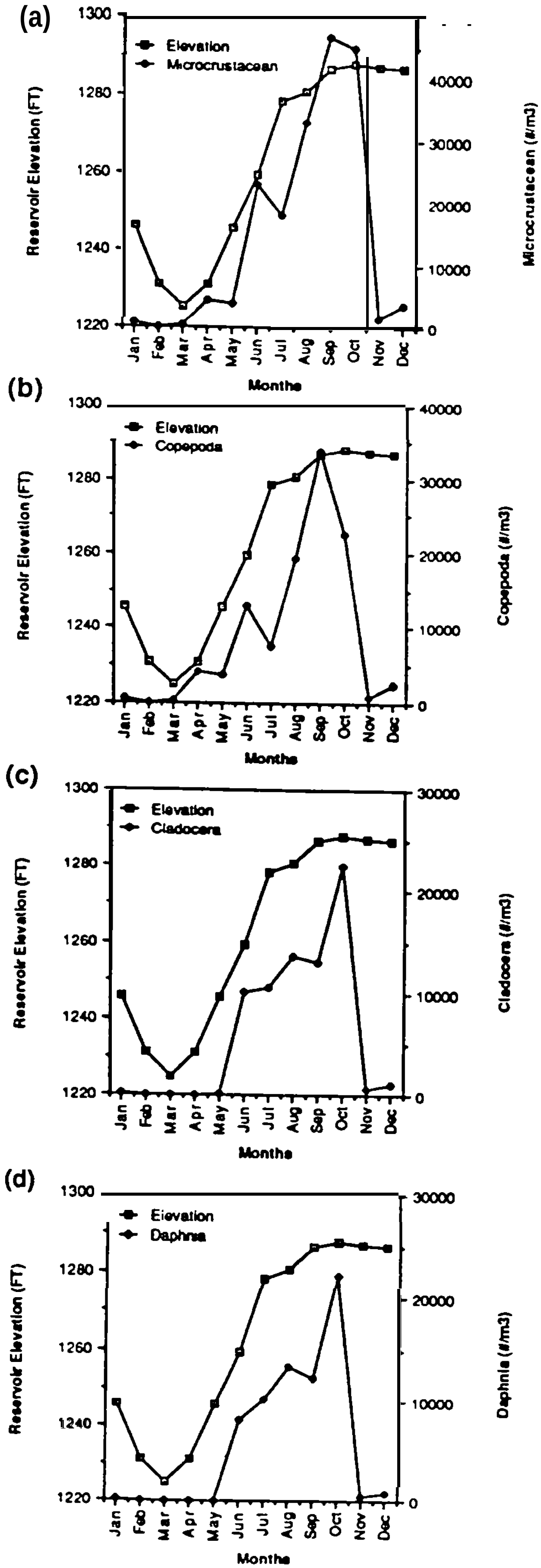
1988	Reservoir Elevation	Water Retention Time (days)	*Daphnia* (#/m^3)	Cladocera (#/m^3)	Copepoda (#/m^3)	Total	*Daphnia* Biomass
88 Jan	1268.3	34.4					
Feb	1265.4	38.4					
Mar	1253.6	38.7					
Apr	1252.8	49.9					
May	1268.3	40.3					
Jun	1273.2	44.8					
Jul	1283.8	59.4					
Aug	1284.9	56.9	10,399	10,980	22,713	33,693	445,965
Sep	1283.5	52.0	7,072	7,294	8,938	16,232	330,782
Oct	1285.9	56.9	7,504	7,815	19,400	27,215	426,425
Nov	1283.1	46.6	2,550	2,884	5,106	7,990	30,341
Dec	1260.1	29.0	2,105	2,257	4,913	7,170	54,415

1989	Reservoir Elevation	Water Retention Time (days)	*Daphnia* (#/m^3)	Cladocera (#/m^3)	Copepoda (#/m^3)	Total	*Daphnia* Biomass
89 Jan	1245.8	25.8	91	120	541	661	4453
Feb	1231.0	25.3	0	0	102	102	0
Mar	1225.1	35.5	0	7	387	394	0
Apr	1231.0	33.1	0	0	4,265	4,265	0
May	1245.5	23.2	8	106	3,778	3,884	20
Jun	1259.5	39.9	8,085	10,060	12,986	23,046	169,008
Jul	1278.6	64.8	10,167	10,605	7,508	18,113	245,962
Aug	1280.8	69.8	13,342	13,745	19,328	33,073	565,545
Sep	1286.7	68.3	12,321	13,087	33,648	46,735	446,440
Oct	1287.9	60.0	22,185	22,530	22,489	45,019	359,578
Nov	1287.1	48.9	507	615	933	1,548	151,157
Dec	1286.7	45.5	719	1,024	2,573	3,597	31,941

Table 4.4.6. **Reservoir elevation, water retention time and density or biomass of selected categories of zooplankton collected at monthly intervals at Seven Bays (Index Station 6). Total = total microcrustaceans (Cladocera + Copepoda).**

	Reservoir Elevation	Water Retention Time (days)	*Daphnia* (#/m^3)	Cladocera (#/m^3)	Copepoda (#/m^3)	Total	*Daphnia* Biomass
88 Jan	1268.3	34.4					
Feb	1265.4	38.4					
Mar	1253.6	38.7					
Apr	1252.8	49.9					
May	1268.3	40.3					
Jun	1273.2	44.8					
Jul	1283.8	59.4					
Aug	1284.9	56.9	5,115	5,223	6,763	11,986	198,864
Sep	1283.5	52.0	4,668	4,811	8,306	13,117	237,321
Oct	1285.9	56.9	9,662	9,662	13,896	23,558	421,997
Nov	1283.1	46.6	6,219	7,004	1,337	8,431	8,349
Dec	1260.1	29.0	190	207	670	877	4,072

	Reservoir Elevation	Water Retention Time (days)	*Daphnia* (#/m^3)	Cladocera (#/m^3)	Copepoda (#/m^3)	Total	*Daphnia* Biomass
89 Jan	1245.8	25.8	33	185	152	337	1,295
Feb	1231 .O	25.3	0	7	125	132	0
Mar	1225.1	35.5	0	0	380	380	0
Apr	1231.0	33.1	6	13	753	766	15
May	1245.5	23.2	127	254	3625	3879	549
Jun	1259.5	39.9	4,388	5,270	6,361	11,631	68,592
Jul	1278.6	64.8	14,877	15,258	8,373	23,631	415,648
Aug	1280.8	69.8	3,739	5,545	5,134	10,679	180,276
Sep	1286.7	68.3	2,559	2,701	7,307	10,008	104,664
Oct	1287.9	60.0	4,240	4,406	8,448	12,854	226,255
Nov	1287.1	48.9	7,067	7,486	3,657	11,143	613,836
Dec	1286.7	45.5	7,908	8,360	2,274	10,634	606,755



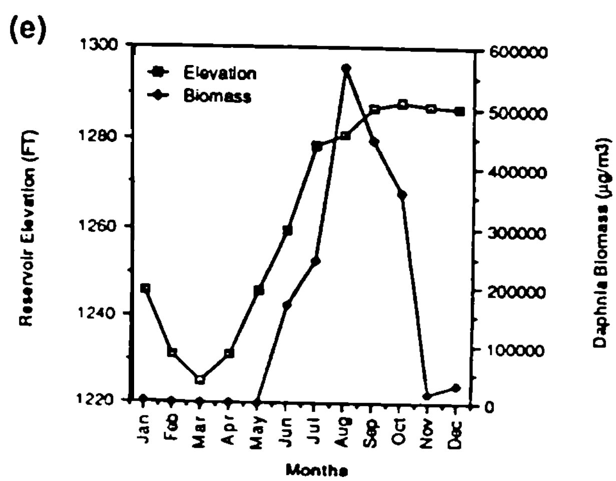
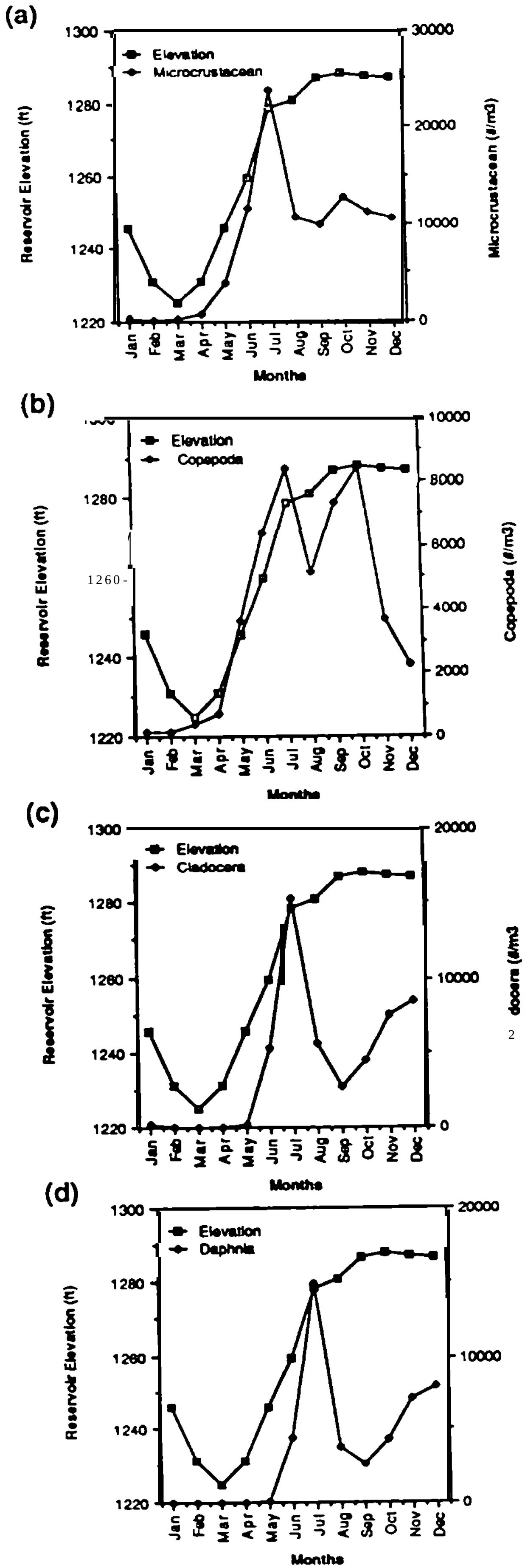


Figure 4.4.3. **Plots of mean monthly reservoir elevation (ft) in 1989 -v- (a) Total microcrustacean density (excluding naupli) (#/m^3), (b) Cyclopoid and Calanoid copepod density (#/m^3), (c) Cladocera density (#/m^3), (d) *Daphnia* density (#/m^3) and *(e) Daphnia* biomass (µg/m^3) at Porcupine Bay (Index Station 4).**



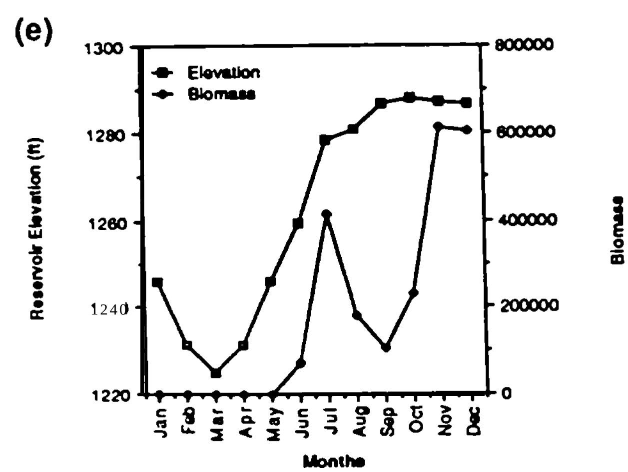
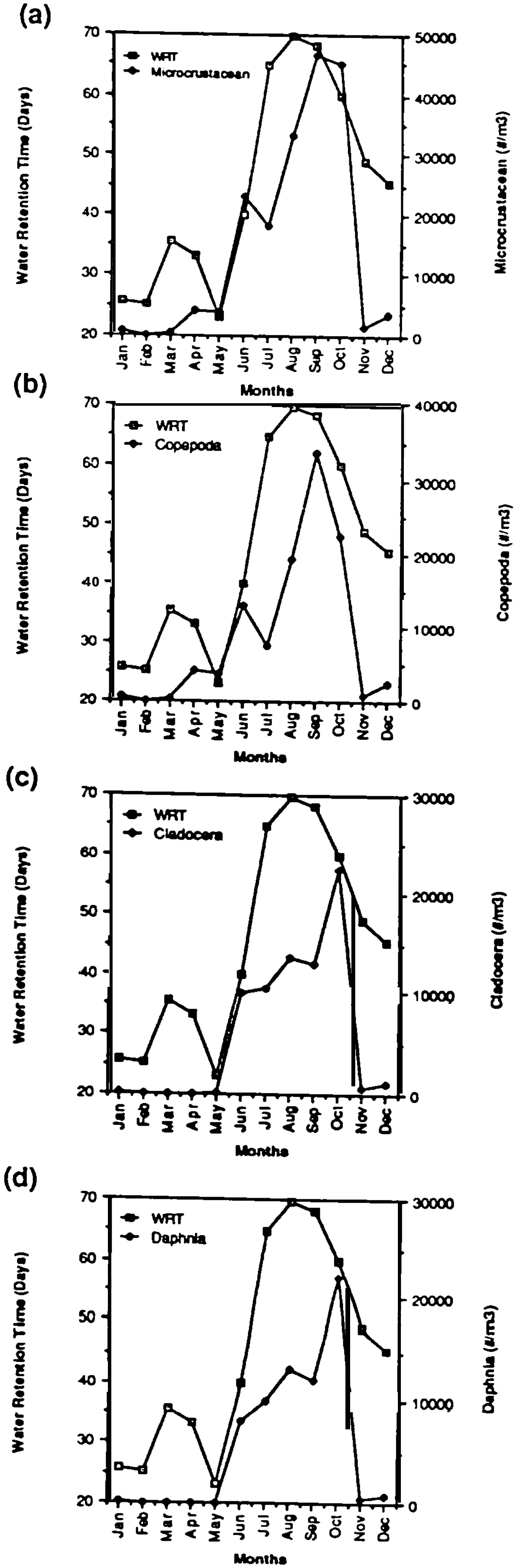


Figure 4.4.4. Plots of mean monthly reservoir elevation (ft) in 1989 -v- (a) Total microcrustacean density (excluding naupli) (#/m^3), (b) Cyclopoid and Calanoid copepod density (#/m^3), (c) Cladocera density (#/m^3), (d) *Daphnia* density (#/m^3) and (e) *Daphnia* biomass (µg/m^3) at Seven Bays (Index Station 6).



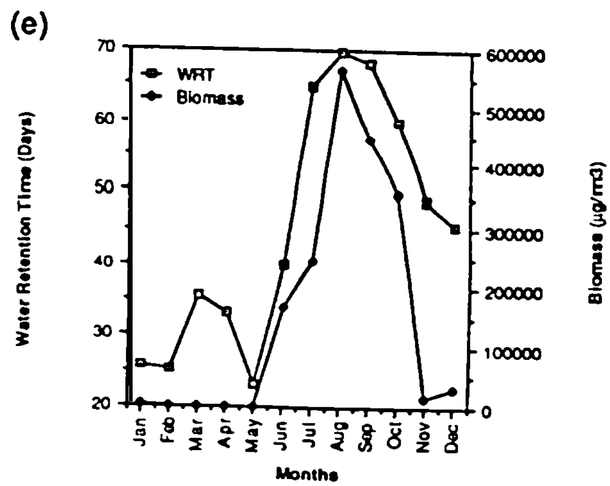
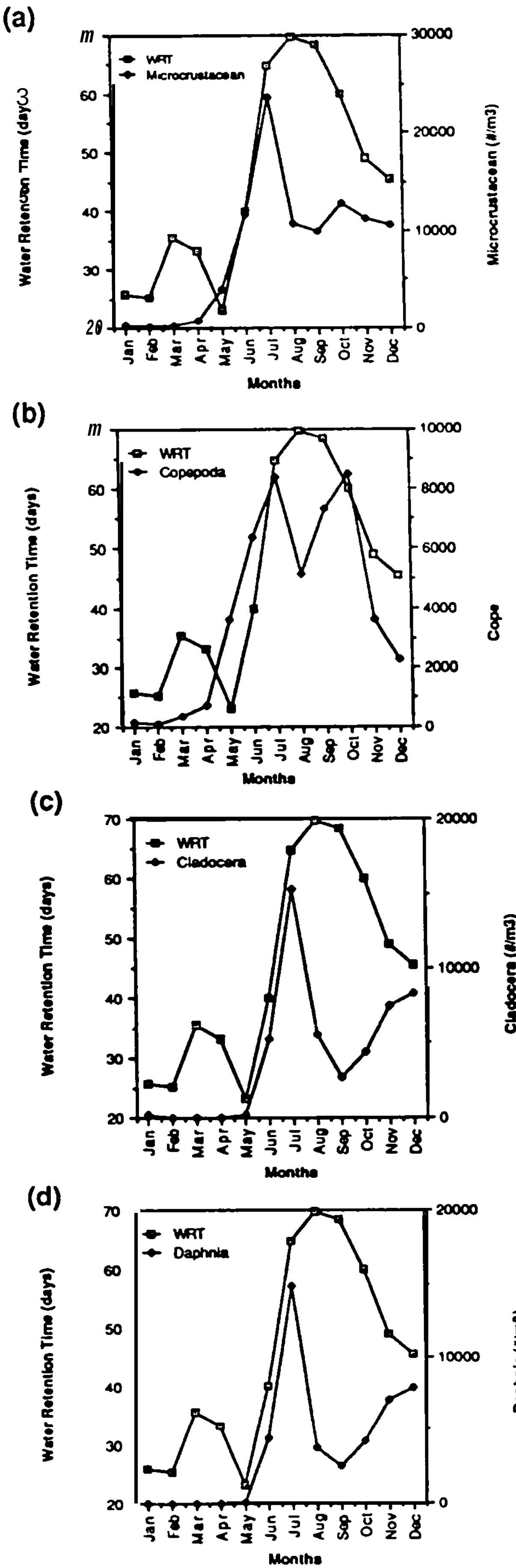


Figure 4.4.5. Plots of mean monthly water retention time (days in 1989 -v- (a) Total microcrustacean density (excluding naupli) (#/m^3), (b) Cyclopoid and calanoid copepod density (#/m^3), (c) Cladocera density (#/m^3), (d) *Daphnia* density (#/m^3) and (e) *Daphnia* biomass (μg/m^3) at Porcupine Bay (index station 4).



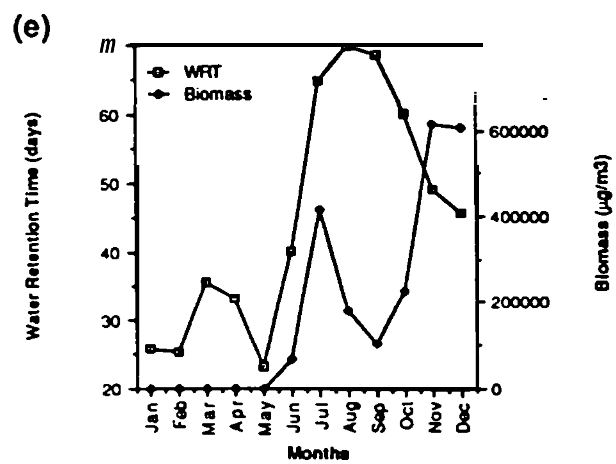


Figure 4.4.6. Plots of mean monthly water retention time (days in 1989 -v- (a) Total microcrustacean density (excluding naupli) (#/m^3), (b) Cyclopoid and calanoid copepod density (#/m^3), (c) Cladocera density (#/m^3), (d) *Daphnia* density (#/m^3) and (e) *Daphnia* biomass (μg/m^3) at Seven Bays (Index Station 6).

at Seven Bays (Index Station 6) were below 200 individuals/ma and *Daphnia* biomass was less than 5000 $\mu g/m^3$ during months when water retention time was less than 35 days (Table 4.4.6; Fig. 4.4.6). In contrast, in months when water retention time was greater than 39.9 days Daphnia density ranged from 3,739 to 14,877 individuals/m3 and biomass ranged from 68,592 to 613,836 $\mu g/m^3$. In 1988, *Daphnia* densities and biomass peaked in August and October, the two months with the highest water retention times. In 1989, *Daphnia* density and biomass increased between June and July when water retention time increased from 39.9 to 64.8 days and remained high for the remainder of the year. In December 1988, water retention time was *29.0* days, *Daphnia* density was $190/m^3$ and *Daphnia* biomass was 4,072 $\mu g/m^3$. In December 1989, water retention time was *45.5* days, *Daphnia* density was $7,908/m^3$ and *Daphnia* biomass was 606,755 $\mu g/m^3$.

At Porcupine Bay, in 1988, *Daphnia* density and biomass peaked in August and October, the two months with highest water retention times (Table 4.45; Fig. 4.4.5). In 1989, *Daphnia* density and biomass peaked in August and September, the two months with highest water retention times. In months when water retention time was over *60* days, *Daphnia* densities ranged from 10,167 to 22,185 individuals/ma. On months when water retention times were *39.9* to *48.9* days, *Daphnia* densities ranged from 507 to 8,085 individuals/m? In months when water retention times were *23.2* to *35.5* days, *Daphnia* densities ranged from 0 to 91 individuals/ma.

In the present study it was not possible to separate seasonal effects (e.g., photoperiod, water temperature, life cycle) from water retention effects on microcrustacean zooplankton. Water retention time was lowest during the winter months when microcrustacean abundance would normally be depressed.

However, we suspect that water retention time is of critical importance in the timing of establishment of the microcrustacean standing crop during the summer growing season.

Our findings are similar to those of Beckman et *al.* (1985), who compared water retention times and mean number of pelagic microcrustaceans in Lake Roosevelt in May to August, 1981 and 1982. In their study, zooplankton sample were collected at weekly intervals in May and June. Water retention times were higher (>30 days) in each week through mid-June in 1981 than the corresponding weeks in 1982 (18-20 days). At each interval microcrustacean density was higher in 1981 than

1982. By mid-June water retention time was uniform in both years and steadily increased over the remainder of the summer. Microcrustacean abundance then increased at a similar rate in both years.

Beckman et *al.* (1985) reported than the threshold water retention time that starts to affect microcrustacean densities appeared to be about *30* days. Results of the present study support a threshold retention in the range of 30-35 days. Beckman et ***al.*** concluded, *"minimal water retention times would have an adverse impact on numbers of zooplankton in Lake Roosevelt, especially during the spring when the primary influx of nutrients enters the reservoir from the watershed."*

In terms of supporting the operation of the Lake Roosevelt kokanee hatcheries, water retention times and microcrustacean densities should be monitored weekly from May to July to ensure that kokanee fry are stocked in the reservoir coinciding with peak standing crops of microcrustaceans.

4.5 FISH FEEDING HABITS

4.5.1 Principle Prey Items in Fish Diets

Tables 4.5.1 and 4.5.2 present a comparison of the feeding habitats of kokanee, rainbow trout, walleye and lake whitefish in 1988 and 1989. Kokanee were primarily planktivorous. In 1988, the predominant prey items in the diet of kokanee, based on relative importance index values, were, *Daphnia spp.* **(70.0%)**, organic detritus (8.2%) and *Leptodora kindtii* (6.0%). In 1989, the predominant prey items of kokanee were *Daphnia* ***schødleri*** **(58.4%)**, *L. kindtii* **(8.0%)**, larval and pupal chironomids **(11.5%)**, and walleye eggs (9.41%). Walleye eggs were consumed in large numbers by only one fish, so were not an important prey item.

Daphnia and *Leptodora* are large species of cladocerans that are frequently found in the diets of planktivorous fish. Density and biomass of *Daphnia* in Lake Roosevelt were higher than those reports for other productive kokanee lakes in the Pacific Northwest (See Section 4.4.1). *Leptodora* was also abundant. In terms of prey availability, conditions in Lake Roosevelt appear to be ideal for hatchery introduction of planktivorous kokanee. Kokanee size selectivity preyed on Daphnia. Kokanee evidenced positive electivities **(+0.03** to **+0.35)** for *Daphnia* ranging from 1.6 to 2.4 mm and negative electivities, ranging from 0 to - *0.24* for *Daphnia* below 1.5 mm. Eleotivity values for *Daphnia* ranging from

Table 4.5.1. Mean index of relative importance of prey items found in the diets of Lake Roosevelt fish- in 1988 having values of greater than 2%. n = sample size.

Prey	Kokanee (n=28)	Rainbow Trout (n-1 90)	Walleye (n=257)
OSTEICHTHYES (fish)			
Cottidae		5.2	10.4
Cyprinidae		2.3	5.4
Percidae			13.4
Salmonidae			4.9
Unidentified fish		2.2	10.3
CLADOCERA			
Daphnia.schødleri	67.0	34.0	10.4
Daphnia retrocurva	3.0		
Leptodora kindtii	6.0	8.1	3.0
Bosminidae spp.			4.7
Cladocera ephippia	6.1		
DIPTERA			
Chironomid pupa		6.6	4.2
Chironomid larva		5.8	4.9
HEMIPTERA			
Corixidae		3.8	
OTHER			
Terrestrial insects		4.7	
Organic Detritus	8.2	5.2	6.6
Inorganic Detritus	2.6		
Unidentified body		3.1	10.0

Table 4.5.2. Mean index of relative importance of prey items found in the diets of Lake Roosevelt fish in 1989 having values of greater than 2%. n = sample size.

Prey	Kokanee (n=33)	Lake Whitefish (n=118)	Rainbow Trout (n=223)	Walleye (n=289)
OESTICHTHYES (fish)				
Cottidae				10.2
Percidae			3.2	16.3
Salmonidae				6.7
Unidentified fish				21.1
Walleye eggs	9.4		34.6	
CLADOCERA				
Daphnia schødleri	58.4	23.6	3.3	8.0
Daphnia thorata		2.1		
Leptodora kindtii	8.0	6.8		7.0
EUCOPEPODA				
Epischura spp.			2.7	
MOLLUSKA				
Spheariidae		6.0		
DIPTERA				
Chironomid pupa	9.1	11.6		9.3
Chironomid larva	2.4	8.6		4.6
HEMIPTERA				
Corixidae	4.0			
HYDRACHNELLAE				
Hydracarina		8.0		
OTHER				
Terrestrial insects	3.2		12.4	
Organic Detritus		9.1	28.6	6.8
Inorganic Detritus		4.0	6.3	
Unidentifiable body		5.0		

2.5 to 3.6 mm were near zero, indicating that kokanee consumed these sizes in proportion to their availability in the environment.

The key feature of size-selective predation is that the fish preys upon the largest, most reproductively fit individuals of the selected species and, thereby, can first lower the average size, then lower the reproduction potential and ultimately cause a decline in the population of a particular species of zooplankton (Brooks and Dodson 1965). For example, Taylor (1980) reported that the minimum size for reproduction in *Daphnia* is 1.3 mm. Fecundity in *Daphnia* increased geometrically with size: with a 1.3 mm individual containing 2 eggs/clutch, a 1.7 mm individual containing 5 eggs/clutch and a 2.0 mm individual containing 18 eggs/clutch. Hence, a geometric decrease in reproductive potential would occur concomitantly with a decrease in the average size of *Daphnia* in the water column, ultimately leading to a collapse of the *Daphnia* population (Taylor and Slatkin 1981, Scholz et *al.* 1985b). Zooplankton species in competition with *Daphnia* would then have a competitive advantage, so zooplankton population dynamics would be altered. In typical situations, intensive size-selective predation will cause a shift to greater abundance of smaller-sized zooplankton with less biomass and corresponding reduced growth rates of planktivorous fish (Brooks and Dodson 1965; Kitchell and Kitchell 1980; Scholz et *al.* 1985).

In Lake Roosevelt, these problems do not appear to be occurring at the present time. The abundance of large-sized *Daphnia* in the water column was higher than most kokanee producing lakes in northeastern Washington and north Idaho. Growth of all planktivorous fish species -- kokanee, rainbow trout, and lake whitefish -- was above average. Kokanee growth rates were higher than those reported for twenty lakes used for growth comparisons.

Additionally, the degree of size selective predation on *Daphnia* by kokanee in Lake Roosevelt was not particularly intensive, so we do not believe it represents a problem over the short term. However, as additional hatchery produced kokanee are added to the lake, kokanee feeding habits and zooplankton abundance should be carefully monitored to determine the incremental impact on microcrustacean population dynamics.

In 1988, the predominant prey items in the diet of rainbow trout, based on index of relative importance, were *Daphnia schødleri* (34.0%), chironomid larvae and pupae (12.4%), and Osteichthyes (9.7%), organic and inorganic detritus (6.8%), and terrestrial insects (4.7%). In 1989, predominant prey in rainbow trout diets included organic and inorganic detritus (34.9%), walleye eggs (34.6%), terrestrial insects (12.4%), and Osteichthyes (3.2%). Identifiable fish remains in trout stomachs included percidae. Trout stomachs contained relatively few *Daphnia* (relative importance = 3.3%) in 1989. Rainbow trout size selectively preyed on *Daphnia* ranging from 1.6 to 3.0 mm. **Electivity** values typically ranged from +0.01 to +0.43. Electivities for Daphnia from 0.1 to 1.5 mm were generally negative (range -0.24 to +0.06). For *Daphnia* above 3 mm electivities were near zero. In some months, electivities of rainbow trout for all size categories of *Daphnia* were near zero, indicating that trout preyed on different size categories of *Daphnia* in proportion to their densities in the reservoir. The degree of size selection was not intensive and currently does not present a problem in terms of managing the Lake Roosevelt fishery.

Walleye were mainly piscivorous in their feeding habits. In 1988, the predominant prey items consumed by walleye based on index of relative importance, were; Osteichthyes (46.2%), *Daphnia* (12.8%), and chironomid larvae and pupae (9.1%). In 1989, prey included: Osteichthyes (56.2%), chironomid larvae and pupae (13.6%), and *Daphnia (8.45%). Daphnia* were consumed principally by younger age classes of walleye while older walleye preferred a fish diet. Types of fish eaten by walleye in 1988 included: cottidae (sculpin -- 10.4%), percidae (yellow perch -- 13.4%), salmonidae (4.9%), and unidentifiable fish remains (10.3%). Types of fish eaten by walleye in 1989 included: sculpins (10.2%), yellow perch (16.3%), salmonidae (6.7%) and unidentifiable fish remains (21 .1%). Our findings were similar to those reported by Harper et *al.* (1981) and Nigro et *al.* (1983), who determined that the major prey items of walleye in Lake Roosevelt in 1980 and 1982 were yellow perch, sculpins, Catostomids (suckers), and chironomid larvae and pupae. Small numbers of *Daphnia* were also encountered frequently in walleye stomachs in 1980 and 1982.

Adult lake whitefish fed primarily on zooplankton and benthic organisms. In 1989, the principle prey items in the diets of lake whitefish, based on index of relative importance, were *Daphnia* ***schødleri*** (23.6%) chironomid larvae and pupae (20.2%), Hydracarina (8.0%), and *Leptodora* ***kindtii*** *(6.8%).* Nigro *et a/.* (1982) also reported that Lake whitefish preyed principally on zooplankton and bottom organisms in Lake Roosevelt.

4.5.2 Diet Overlap and Potential for Competative Interactions

Diet overlap was between kokanee and rainbow were high in 1988 (0.786) but low in 1989 (0.216). In 1988, the high diet overlap was due principally to consumption of *Daphnia schødleri* and *Leptodora kindtii*. Diet overlap between kokanee and walleye was low in both 1988 (0.289) and 1989 (0.259). Diet overlap between rainbow and walleye was marginal in 1988 (0.569) and low in 1989 (0.199). Diet overlap between lake whitefish and kokanee was moderate in 1989 (0.669). Both species preyed mainly on zooplankton and chironomids. However, kokanee and lake whitefish occupied different geographic regions of the lake. Kokanee were captured principally in mid-water or surface set gill nets whereas lake whitefish were captured mainly in bottom set gill nets and also preyed on benthic invertebrates. Therefore, kokanee appeared to be pelagic planktivores whereas lake whitefish were associated with benthic environments. Lake whitefish are normally considered to be primarily benthivorous feeders. However, they are also reported to be opportunistic in their feeding habits, preying on the most abundant organisms available (Scott and Crossman 1973; Becker 1983). In Lake Roosevelt, it appears that Lake whitefish fed on benthic organisms, but also preyed opportunistically on abundant zooplankton. Diet overlaps between Lake whitefish and walleye (0.421) or lake whitefish and rainbow (0.262) were low to moderate in 1989.

The only high diet overlaps observed in 1988 and 1989 were between planktivorous species. These diet overlaps are not of concern at the present time because of the relatively high densities of large-sized species of zooplankton e.g. *Daphnia spp.* and *Leptodora kindtii*. Diet overlaps between kokanee, rainbow and walleye were relatively minor. These data suggest that it may be feasible to successfully manage all three species in Lake Roosevelt.

4.6 TAGGING STUDIES

4.6.1 Net Pen Rainbow Trout

Results of net pen rainbow trout tagging studies conducted at Seven Bays in 1988 were similar to previous results (UCUT, unpublished data). Most of the fish were recaptured within six months (58.1% of total recaptures) to one year (88.1% of total recaptures) of release. Angler harvest rate was 9.9% including all recoveries for two years after release. The majority of the tagged fish recovered were recaptured within 20 km of the Seven Bays net pen site (57.2% in 1988). In 1986 and 1987, 66.3%

and 72.0% of the recoveries were within 20 km of the Seven Bays net pen site. In 1988, fewer than 1% (one fish) of the recaptured fish were recovered below Coulee Dam. None were recovered below Chief Joseph Dam. In previous tagging studies conducted in 1986 and 1987, less than 1% of the recoveries were made below Grand Coulee Dam and none below Chief Joseph Dam (UCUT, unpublished data; Table 4.6.1).

In contrast, in 1989, fish released at both Seven Bays and Hunters evidenced much lower harvest rates compared to 1988, respectively 3.0% and 1.9%, which included all recaptures made within one year of release. For comparison, if just the first year after release data are used for fish released in 1988, harvest was 8.7%.

Fewer fish released in 1989 were recovered near the net-pen site (only 38.2% at Seven Bays and 27.2% at Hunters). More fish were recovered below Grand Coulee Dam (26.4% from Seven Bays and 33.3% from Hunters). Six fish from Seven Bays (21.4% of total recoveries) and five fish from Hunters (17.6% of total recoveries) were collected at the fish counting facility at Rock Island Dam within a few months after release, between May 10 and June 6, 1989. In previous years no tagged fish from Lake Roosevelt had been observed at Rock Island Dam. Three fish (8.8% of total recoveries) from Seven Bays and two fish (9.5% of total recoveries) from Hunters were recovered in Rufus Woods Reservoir during the following year. These data suggests that large numbers of net pen fish were lost over Grand Coulee Dam in 1989 but not in 1988.

Reservoir operations were markedly different in 1988 and 1989 (Fig. 2.3). Drawdown was prolonged and more pronounced in 1989 than 1988. Part of the reason that drawdown occurred earlier than normal was because of extreme cold weather in February that severely taxed the energy supply of the Columbia Basin. This caused Lake Roosevelt to be lowered by about 0.5 m/day (1.5 ft/day) for a period of several weeks in February and March. At the start of this period the reservoir was already at a lower level than normal owing to three consecutive years of drought conditions. Net pen operators were worried that rapidly declining water levels would ground their net pens, so they released their fish earlier than normal -- in March (at Hunters) and April (at Seven Bays) instead of May or June. At Seven Bays, although fish could have been held longer, lower reservoir elevations reduced boat mooring space, so a decision was made to release the fish early to free up boat dock space.

Land-locked rainbow trout go through a distinct smolt stage in April similar to that of their anadromous steelhead counterparts. By undergoing

Table 4.6.1. Effect of release time on net pen rainbow trout site imprinting and percentage of recaptured below Grand Coulee Dam.

Location	Release Date	Total # Tagged	% Harvest	% Captured within ± 20 km of net pen site	% Captured below Grand Coulee Dam
Seven Bays	JUN 86	446	21.3	66.3	0.9
Seven Bays	MAY 87	613	13.7	71.4	0.0
Seven Bays	JUN 87	199	16.6	72.0	0.0
Seven Bays	MAY 88	1.111	9.9	57.2	1.8
Seven Bays	APR 89	918	3.0	38.2	26.4
Hunters	MAR 89	845	1.9	27.2	33.3

this process in the net pens they residualize and remain in the reservoir instead of migrating downstream. We suspect that the fish released in March and April of 1989 underwent morphological, physiological and behavioral transitions associated with smoltification after release into the reservoir, then traveled downstream; whereas fish released in May or June in 1986, 1987 and 1988 residualized in the net pens, which prevented their migration. Additionally, fish which residualize in net pens at **a** particular location experience a certain amount of "site imprinting". Site imprinted fish will often form a home range and remain near the release location. This would have the effect of concentrating fish for sport harvest -- an important consideration in a reservoir with a large surface area and relatively few anglers, as is the case on Lake Roosevelt. From 1986 to 1988, tag recoveries indicate that fish released in May or June did remain in the vicinity of the net pen site (Table 4.6.1).

Table 4.6.1 summarizes rainbow tagging studies conducted from 1986 to 1989 at Seven Bays and Hunters. In general, later release dates are correlated with greater percentages harvested by anglers, greater percentages captured near the net pen, and fewer fish captured below Grand Coulee Dam. Therefore, we recommend that net pen operators retain their fish until May or June to allow trout to become residualized and site imprinted. This should increase the percentage harvested by anglers. Management agencies providing fish for Lake Roosevelt net pens should have a mutually agreeable contract with the net pen operators that specifies a release date ranging from about May 10 to June 10.

4.6.2 Walleye Migration

Results of 1988 and 1989 tagging studies indicated that walleye rapidly dispearsed from their spawning sites on the Spokane Arm throughout the entire reservoir, from Grand Coulee Dam to Canada. Also, fish tagged at Kettle Falls were recaptured as far away as Grand Coulee Dam. About 38.5% of the fish tagged on their spawning grounds at Porcupine Bay in the Spokane Arm were recovered in the vicinity of the release site, while 61.5% were recaptured outside the Spokane Arm.

These results are comparable to previous walleye tagging studies conducted in Lake Roosevelt by the USFWS from 1980-1982. About 25% of the recaptured fish tagged in the Spokane Arm in April 1981 and 49% tagged in April 1982 were recovered outside the Spokane Arm (Nigro et al. 1983; Beckman et a/. 1985). In all three years -- 1981, 1982 and 1989 -- nearly twice as many tagged fish were recovered upstream of the mouth of the Spokane Arm than downstream. However, angler fishing effort for walleye was much greater upstream than downstream in all three years.

Hall *et al.* (1985) observed two types of behavior patterns in 10 radio-tagged walleye released in the Spokane Arm of Lake Roosevelt in 1983: (1) summer home range; and (2) excursion activity. Nine fish established home ranges at various locations throughout the reservoir. Mean size of the home range was 10.3 km. Seven walleye established home ranges in the Spokane Arm near their spawning grounds. Five of these fish never left the arm while two fish made excursions to the main reservoir and subsequently returned. Two fish migrated out of the Spokane Arm and established summer home ranges 45 km and 272 km away from their spawning grounds. Mean distance moved for five fish making excursions was 60 km (range 7.2 - 284.8 km), with a mean movement rate of 2.7 km/day. One fish displayed a pattern of continuous movement (excursion).

In the present study estimated travel times of five fish migrating from the Spokane Arm to Kettle Falls averaged 3.3 km/day (and ranged from 2.2 - 5.3 km/day) based on the interval recorded between time of capture and recapture. In comparison, radiotracking by USFWS in 1985 indicated that five walleye moved an average of 2.7 km/day while on excursions (Hall et *al.* 1985). One walleye traveled 352 km to Keenleyside Dam in British Columbia, during one 15-day period. This fish moved 173 km or 11.5 km/day (Hall et *al.* 1985).

Collectively, these data suggest that walleye migrate extensively throughout Lake Roosevelt.

4.7 Kokanee Fecundity Estimates

Lake Roosevelt kokanee total length and fecundity was compared to various lakes in western United States (Table 4.7.1). Fecundity of Lake Roosevelt 3+ kokanee (n=47) collected in 1988 averaged 1,728 eggs/female. In 1989, mean fecundity for 3+ kokanee in Lake Roosevelt was 1,615 eggs/female. The next highest fecundity reported was 1,676 eggs/female (n=7) at Grandby Lake, Colorado. Mean fecundity of 2+ kokanee (n=19) collected in 1988 (1,303 eggs/female) and in 1989 (1,390 eggs/female) was greater than estimates from other lakes with typical fecundity ranges of 301 to 984 eggs/female. Thus, production in Lake Roosevelt kokanee is presently the highest reported for any of the lakes in the Inland Northwest. This observation is encouraging from the standpoint of collecting a sufficient number of eggs to support hatchery operation.

Table 4.7.1. Comparison of total length and fecundity of spawning female kokanee in various lakes in the western United States and Canada.

LOCATION	Sample size (# of fish)	Total length (range in mm)	# Eggs/female Mean	# Eggs/female Range	Reference
Kootenay Lake, BC	2	221-232	--	360-375	Scatterwood (1949)
Salt Spring, CA	126	--	480	--	Curtis & Fraser (1948)
Arrowhead Lake, CA	--	291-346	--	400-534	Seeley & McCammon (1966)
Donner Lake, Ca	--	415-443	--	1174-1764	Seeley & McCammon (1966)
Grandby Lake, Co	7	388	1676	--	Seeley 8 McCammon (1966)
Flathead Lake, MT	121	269-353	701	309-963	Brunson *et al.* (1952)
Lake Pend Oreille, ID	--	254-272	--	297-499	Jeppson (1956)
Spirit Lake, ID	--	245-305	585		Cochnauer (1983)
Coeur d'Alene Lake, ID	--	205-335	335		Cochnauer (1983)
Bear Creek, WA	23	224-292	451	319-592	Scatterwood (1949)
Loon Lake, WA	2	221-237	301	287-314	Scholz *et al.* (1988)
Deer Lake, WA	1	425	984		Scholz *et al.* (1988)
Lake Roosevelt, WA (2+)	3	338-470	1303	984-1592	Present Study (1988)
Lake Roosevelt, WA (2+)	16	244-385	1390	1304-2119	Present Study (1989)
Lake Roosevelt, WA (3+)	47	425-528	1728	919-2720	Present Study (1988)
Lake Roosevelt, WA (3+)	31	363-550	1615	979-2334	Present Study (1989)

Previous kokanee egg and fry rearing at Ford Hatchery over a three-year period (1987-1990), which is supplied by the same aquifer as the proposed Spokane Tribal Hatchery (Bob Johns, WDW hatchery manager, Ford Fish Hatchery pers. comm.), as well as biological testing by Heath tray incubation and live box rearing of kokanee in the Spokane Tribal hatchery water supply in 1988 (UCUT unpublished data), indicated that survival from egg to release was approximately 83%. Eggs were not released until mid July.

Assuming an 83% survival rate from egg to release, 15.6 million eggs will be required to raise 13 million fry for release. Assuming 1,615 eggs/female, 9,659 females would be required to support hatchery operations. Assuming a ratio of 1 female:1 male, 19,318 individuals would be needed to support hatchery operations. If 1.5 million kokanee are stocked at the Sherman Creek imprinting facility, 19,318 individuals represent an adult return rate of 1.2% required to support hatchery operations.

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