# DWORSHAK DAM IMPACT ASSESSMENT AND FISHERY INVESTIGATION

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## ABSTRACT

Kokanee abundance, estimated from July trawl data, was 1.2 million fish in 1988, including 553,000 fry, 501,000 yearlings and 156,000 subadults. Spawning trend data indicated escapement was up threefold compared to 1987, despite a sport harvest of 207,000 kokanee averaging 258 mm caught at a rate of 1.5 fish per hour.

An estimated 40,000 kokanee were counted during the September peak of spawning in five tributaries of the reservoir. Size of adult fish was below average at 293 mm.

Zooplankton densities averaged 10.3 organisms/L in 1988 and ranged from 0.3 organisms/L during April at the Little North Fork station to 26.2 organisms/L in November at the Elk Creek station. Densities were similar to values obtained prior to the development of the primary kokanee fishery; however, cladocerans made up only 34.9% of the zooplankton sampled.

*Daphnia* and *Cyclons* were the most important food items; *Daphnia* became the prime food organism as its seasonal abundance increased.

Concentrations of ortho-phosphate and nitrate, lower than in the 1970s, indicated Dworshak may have become more oligotrophic.

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# INTRODUCTION

The Bonneville Power Administration funded two 4-year research projects to develop management programs for improving the sport fishery on Dworshak Reservoir. Research was initiated during 1987 as a cooperative effort between the Idaho Department of Fish and Game and the Nez Perce Tribe of Idaho. The Nez Perce Tribe examined smallmouth bass and rainbow trout fisheries. The Department of Fish and Game evaluated kokanee population dynamics and documented changes in reservoir productivity.

Dworshak Reservoir was initially filled during 1971 and has declined in productivity resulting in some dramatic changes in the sport fishery initially evaluated by Pettit et al. (1975), Ball and Cannon (1974), and Horton (1980, 1981). Limnology of the reservoir was examined by Falter et al. (1979) and Falter (1982). Comparison of new data to earlier information should indicate effects of reservoir ageing and changes in the sport fishery.

In 1989, hydroacoustics, including a verification system for species and size differentiation, will be used to evaluate fish losses through the dam. Losses will be correlated with discharge parameters (timing, rates, selector gate elevation) and reservoir levels. Similarly, zooplankton losses will be measured and correlated with dam operation. A zooplankton sampling site will be established 0.5 km below Dworshak Dam.

Kokanee management will be addressed at the completion of the project in recommendations based on stock status, entrainment losses, reservoir productivity and operation, and zooplankton abundance.

# OBJECTIVES

1. Assess kokanee stock status: age, growth, recruitment, harvest, mortality, abundance and escapement.

2. Document losses of kokanee through the dam. Relate to discharge and reservoir levels.

3. Assess basic limnological parameters. Relate to fish production.

4. Evaluate zooplankton size, species composition, relative abundance, and distribution.

5. Evaluate impacts of reservoir management on primary productivity, zooplankton, and kokanee.

6. Recommend management programs for the kokanee fishery.

## STUDY AREA

Dworshak Dam was constructed on the North Fork of the Clearwater River 3.2 km upstream from its mouth (Figure 1). The dam is approximately 5.2 km northeast of Orofino in Clearwater County, Idaho. At 219 m, it is the largest straight axis concrete dam in the United States. Three turbines have a total operating capacity of 450 megawatts. Water passes through the turbines, outlet gates, or tainter gates on the spillway.

Dworshak Reservoir is 86.2 km long and has 295 km of steep shoreline. Maximum depth is 194 m with a corresponding volume of 4.28 x $10^9$ $m^3$ at full pool. Surface area when full is 6,644 hectares and mean depth 56 m. Mean annual outflow is 162 $m^3/s$ and the reservoir has a mean retention time of 10.2 months. Retention time is quite variable and has ranged from 22 months in 1973 to 6 months during 1974 (Falter 1982). Drawdowns of up to 47 m reduce surface area as much as 52% to 3,663 hectares. Dworshak Reservoir initially reached full pool on July 3, 1973.

Horton (1981) documented the presence of 19 fish species in the reservoir. Primary sport fish include kokanee Oncorhvnchus nerka, rainbow trout Oncorhvnchus mykiss and smallmouth bass Microoterus dolomieui. Largemouth bass Micropterus salmoides, bull trout Salvelinus confluentus, westslope cutthroat trout Oncorhvnchus clarki lewisii, brook trout Salvelinus fontinalis, mountain whitefish Prosopium williamsoni, and brown bullhead Ictalurus nebulosus are also present.

## METHODS

### Kokanee Abundance

We used a midwater trawl to estimate kokanee densities. The net was 13.7 m long with a 3 x 3 m mouth. Stretch meshes graduated from 32, 25, 19, and 13 mm in the body of the net, to 6 mm in the cod end.

Trawling was conducted on the nights of July 11, 12, and 13 during the dark phase of the moon to reduce net avoidance. Tow speed was 1.1 m/s using a 8.5 m boat powered with a 140 horsepower engine. Timed tows were made in 3.5 m strata through the vertical distribution of kokanee as determined by echosounding. The number of tows necessary to sample the band of kokanee made up an oblique haul.

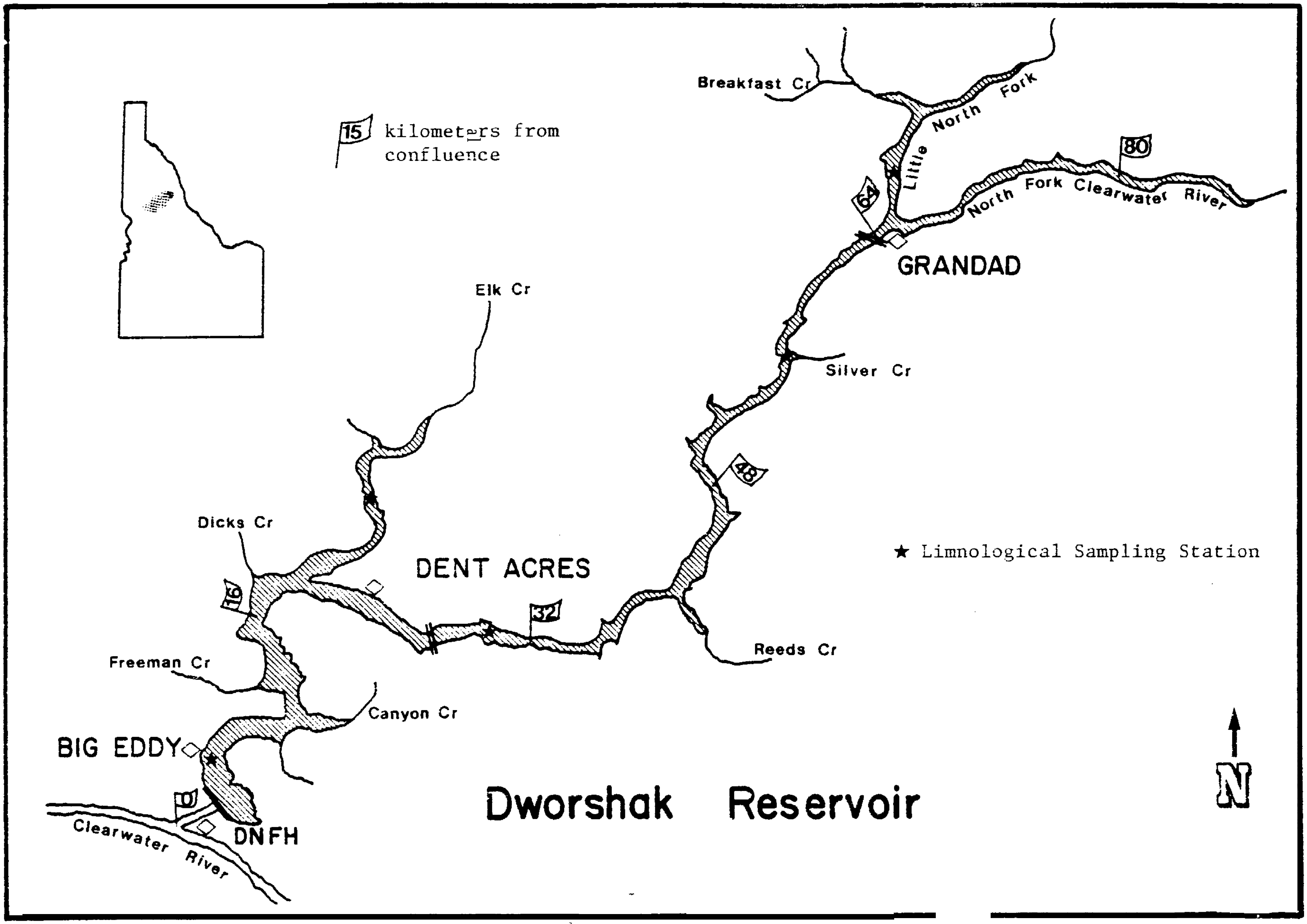



Figure 1. Dworshak Reservoir and major tributaries, North Fork Clearwater River, Idaho.

The ratio of volume of water encompassing the band of kokanee to average trawl volume was used to expand kokanee densities to abundance estimates for the reservoir (Scheaffer et al. 1979).

## Angler Use and Harvest

We used a stratified, two-stage probability creel survey to count and interview anglers (Malvestuto 1983). Census days were stratified into weekend and week-days, and the reservoir was divided into three sections: the dam to Dent Bridge, Dent Bridge to Grandad Bridge and Grandad Bridge to the inflow (Figure 1). One section was chosen for census on a given day. The random selection of each area was weighted by the expected pressure an area was to receive (Maiolie 1988). Ten survey days were selected per month, and pressure and harvest were estimated for monthly intervals.

Reservoir drawdown eliminated access to all but one boat ramp during winter. Under these conditions a creel survey clerk remained at the Big Eddy boat ramp throughout the day and obtained completed trip information for all boat anglers. A second clerk traveled to the Dent area and Canyon Creek to check bank anglers. Creel surveys were conducted in cooperation with the Nez Perce Tribe.

## Spawning Trends

Kokanee spawners were counted on September 20-23 and 29, 1988 in Isabella, Skull, Quartz, Dog, Breakfast, Beaver, and Elk creeks. We counted fish in Isabella, Skull, Quartz, and Dog creeks from each creek mouth upstream to kokanee migration barriers. Other streams were surveyed for the distances indicated.

## Limnology

Five limnological stations used by Falter et al. (1979) were sampled monthly (Figure 1). Three stations were on the main body of the reservoir at river-kilometers 5 (RK5), 31 (RK31), and 56 (RK56). Two stations were located in major arms of the reservoir; 6 km up Elk Creek (EC6) and 2 km up the Little North Fork (LNF2).

At each station,we took dissolved oxygen and temperature readings at the surface, 1 m, and at even meter depths thereafter to 60 m. Transparency was measured with a 20 cm Secchi disk. We sampled plankton with a 0.5 m net of 130-150 micron mesh (size 10), equipped with a pygmy flowmeter. Vertical tows were from 12.2 m to the surface. Zooplankters were enumerated by family and measured to the nearest 0.05 mm with an ocular micrometer in a dissecting scope at 30 power.

Water samples were collected from the surface at river kilometer 5 (RK5) and analyzed by the Idaho Public Health Department for nitrates and ortho-phosphates.

## Food Habits

Kokanee stomachs were obtained from hook-and-line caught fish from anglers and project fishing. Stomachs were removed and preserved in ethanol until analyzed. Stomachs were cut open and washed free of all contents which were examined under a binocular microscope. Items were enumerated and a subsample of these measured to the nearest 0.1 mm.

Food habits were analyzed with respect to season and location. Percent composition by number was calculated. Section 1 data were used because sample sizes were minimal elsewhere. Sample fish ranged from 161-343 mm and averaged 248 mm total length.

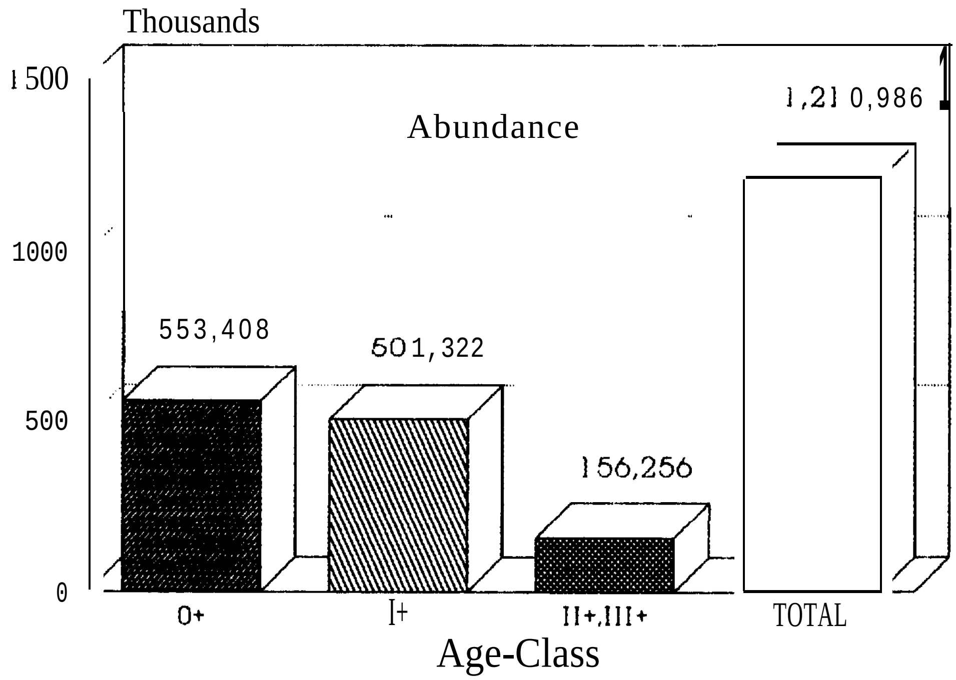
# RESULTS

## Kokanee Abundance

Kokanee density was 190 fish/hectare in July, with a total abundance of 1,211,OOO fish, including 553,000 kokanee fry, 501,000 yearlings and 156,000 II+ and III+ fish. Young-of-the-year kokanee ranged from 30 to 69 mm, I+ from 120 to 209 mm, and older kokanee measured 230 to 299 mm (Figure 2).

## Angler Use and Harvest

Anglers fished 140,416 hours to harvest 206,976 kokanee at a rate of 1.5 fish/h. Kokanee harvest peaked at 74,789 fish in May, declined to 40,726 fish in June, and increased to 69,538 fish in July. The remainder of the year, harvest levels were below 7,600 kokanee/month. The majority of harvest occurred in Section 1 with low levels of effort in Sections 2 and 3. The majority of angler effort occurred in March-July, May-August, and June-September in Sections 1, 2, and 3, respectively (Figure 3).



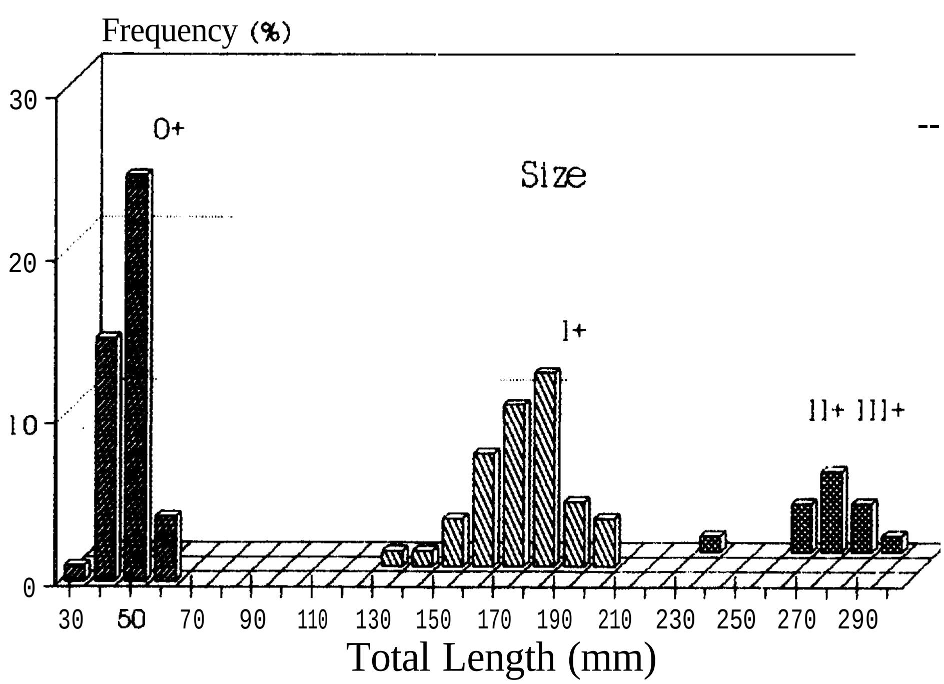




Figure 2. Estimated abundance and length-frequency distribution of trawl-caught kokanee from Dworshak Reservoir in July, 1988.

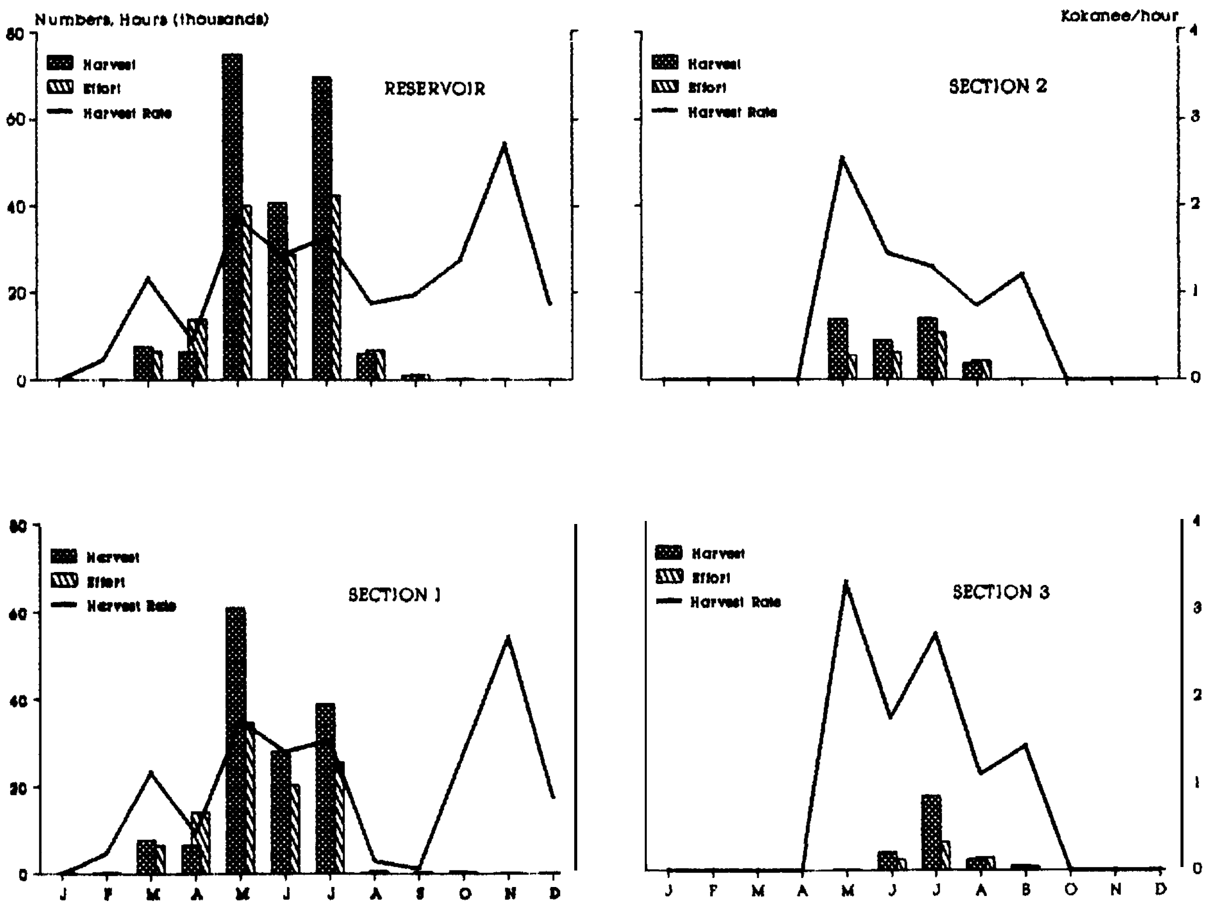



Figure 3. Estimated monthly harvest, effort, and catch rate for kokanee creeled from Dworshak Reservoir, 1988.

Mean total lengths of kokanee in the harvest increased from May to August. Creeled kokanee averaged 258 mm in 1988 (Figure 4).

## Spawning Trends

A total of 40,040 adult kokanee were counted in 1988 surveys (Table 1). We found 14,760 fish in the lower 4.5 km of Breakfast Creek and 10,960 kokanee spawners in Isabella Creek. Remaining streams supported fewer than 6,000 fish each. Highest density of kokanee occurred in Dog Creek, a tributary of Isabella Creek. Escapement increased threefold over 1987, with the exception of Breakfast, Beaver, and Elk creeks; in 1987, Breakfast Creek was counted after spawning was completed. Beaver and Elk creeks supported few spawners. Age distribution of adult kokanee spawners consisted of 94% III+ and 6% II+ fish in 1988; a distinct difference from the significant contribution of II+ spawners in 1987 (Figure 5).

## Limnology

### Nutrients

Nitrate nitrogen at 25 ug/L was 37% of the 1977 mean epilimnial value of 67 ug/L (Falter, 1982). Nitrate concentrations varied between <1 ug/L (January and May) and 84 ug/L (March). Mean ortho-phosphate, at 2.0 ug/L, was 2.5 times less than the 1977 mean and 5 times less than the 1972-74 mean. Ortho-phosphate levels varied from <1 ug/L (September and October) to 4 ug/L (May).

### Transparency

Transparency was lowest in April and May, and increased thereafter until October-November at all but two stations. Greatest clarity occurred in March at RK5, and in August at RK56 (Appendix A). Values ranged from 1.2 m at EC6 in May, to 6.5 m at RK56 in August. Mean secchi depths for the year varied from 2.5 m at EC6 to 4.3 m at RK5 (Table 2).

### Zooplankton

Zooplankton exhibited two seasonal density peaks, May-June and November-December (Figure 6). At RK56, the winter peak extended into January. At LNF2, density peaked in June at 12.6 organisms/L, and maintained through September at 11.1 organisms/L. Plankton densities never exceeded 27 organisms/L, and mean annual values were as follows: RK5-11.3 organisms/L, EC6-10.6 organisms/L, RK31-7.4 organisms/L, RK56-7.1 organisms/L, LNF2-8.0 organisms/L.

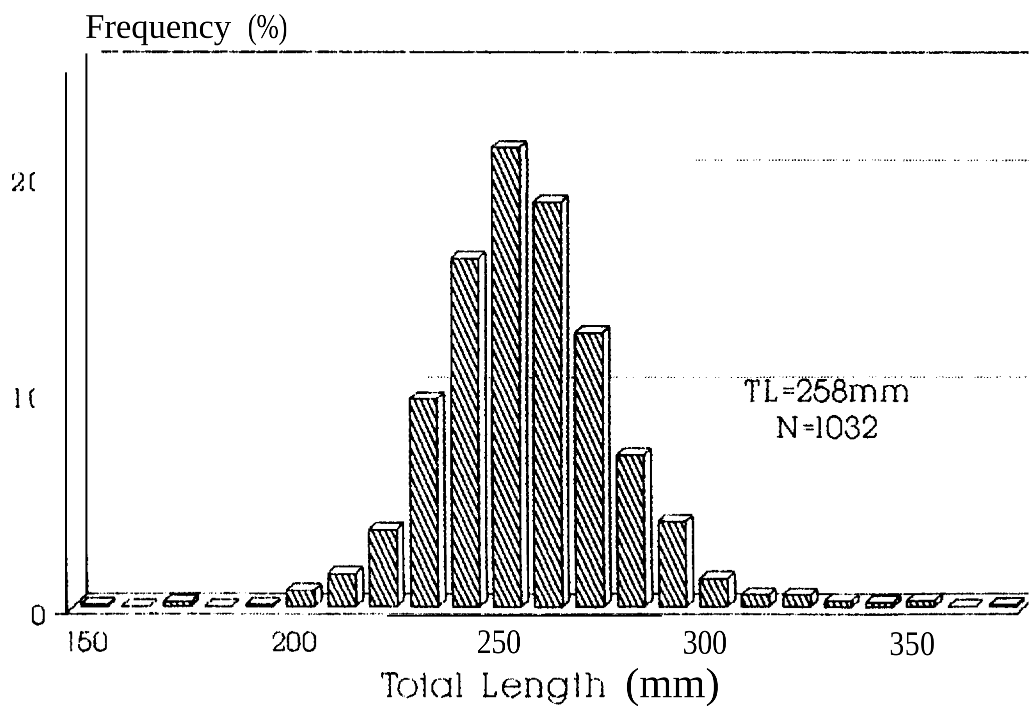
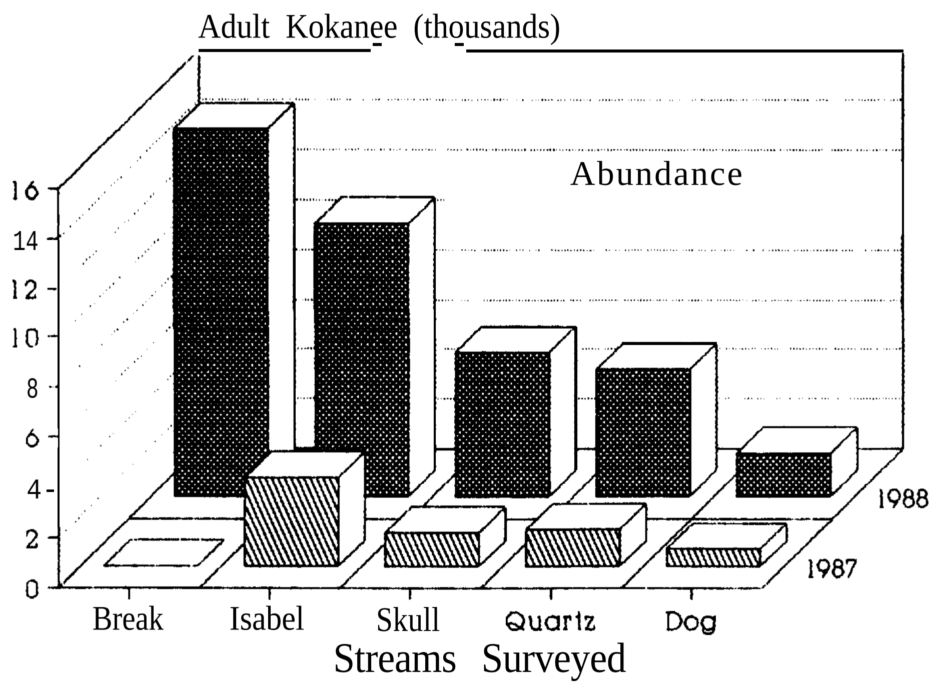



Figure 4. Length-frequency distribution of kokanee creeled from Dworshak Reservoir, 1988.

Table 1. Stream sections and estimated kokanee spawner abundance in tributaries of Dworshak Reservoir, 1987 and 1988.

| Stream | 1988 Date surveyed | 1988 Distance surveyed | 1988 To end of run? | Spawner abundance 1987 | Spawner abundance 1988 |
|---|---|---|---|---|---|
| Isabella Creek | 9/21/88 | 4.5 km | yes | 3,520 | 10,960 |
| Skull Creek | 9/21/88 | 1.4 km | yes | 1,350 | 5,780 |
| Quartz Creek | 9/20/88 | 1.9 km | yes | 1,470 | 5,080 |
| Dog Creek | 9/21/88 | 0.3 km | yes | 700 | 1,720 |
| Breakfast Creek | 9/22/88 | 0.3 km | no | 20* | 14,760 |
| Beaver Creek | 9/29/88 | 1.3 km | no | NC | 1,700 |
| Elk Creek | 9//28/88 | 1.9 km | no | NC | 30 |
| Totals | | | | 7,060 | 40,030 |

*-1987 count made after spawning was completed
NC-Not counted in 1987 for early spawners



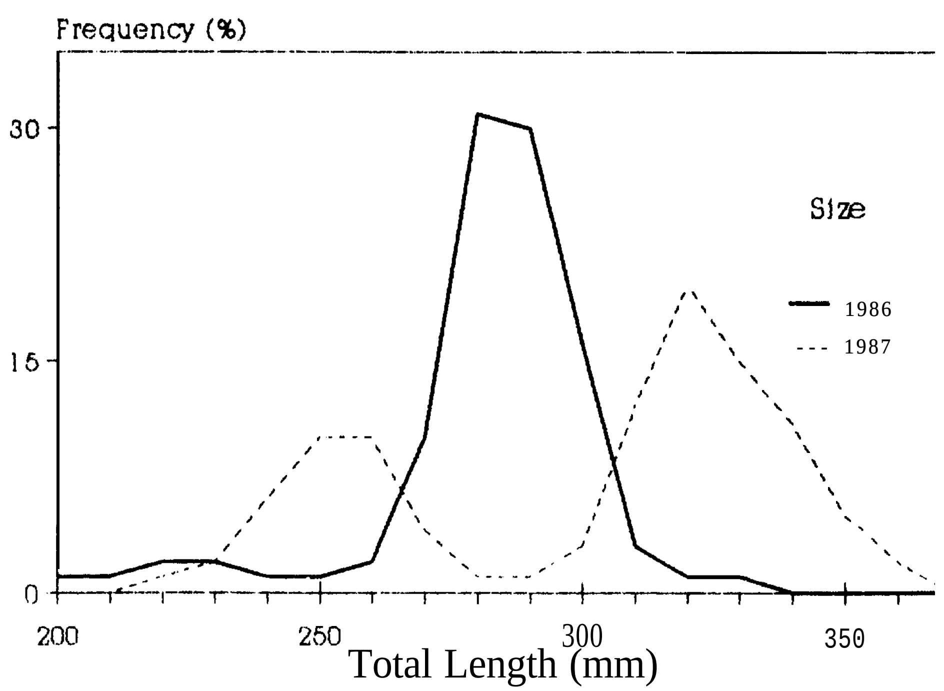




Figure 5. Dworshak kokanee spawner abundance and length distribution in selected tributary streams, 1987 and 1988.

Table 2. Minimum and maximum secchi transparency in Dworshak Reservoir, 1988.

| Station | Depth (m) Minimum | | Maximum | | Mean |
|---|---|---|---|---|---|
| RK5 | 2.1 | Apr. | 6.1 | Mar. | 4.3 |
| RK31 | 1.5 | May | 5.3 | Nov. | 3.9 |
| RK56 | 1.9 | May | 6.5 | Aug. | 3.8 |
| EC6 | 1.2 | May | 3.8 | Oct. | 2.5 |
| LNF2 | 1.9 | Apr. | 5.7 | Oct. | 4.2 |

Cladocerans displayed a trimodal seasonal pattern with peaks in May-June, September, and November. In general, early peaks were associated with lower reservoir stations, while the upper stations supported the later peaks. The Elk Creek arm was the primary contributor to the first and last peaks at 12.7 organisms/L (42%) and 9.7 organisms/L (47%), respectively. The Elk Creek and Little North Fork arms contributed equally in September with 6.3 organisms/L (25%) and 7.0 organisms/L (28%), respectively.

Cladocerans generally made their largest contribution (% by number) to the plankton community from May to September (Figure 7). In only nine instances did cladocerans comprise 50% or more of a sample; RK56 (3) and LNF2 (3) accounted for six of these occasions. Mean annual percentage compositions of cladocerans were as follows: **RK5-24.3,** EC6-37.5, RK31-32.9, RK56-41.8, LNF2-41.9. Reservoir-wide, cladocerans comprised 34.9% of the zooplankton community.

Temperature and Oxygen

Mean monthly temperatures were similar for all stations (Appendix B). Maximums and minimums occurred in June and February. Maximum values ranged from **13.8°C** at LNF2 to **11.4°C** at RK5. Minimum values varied between **3.9°C** at RK5 and **3.4°C** at EC6 and RK31.

Stratification first became evident in April at all stations and **was** most pronounced in August (Figure 8). Maximum temperatures were restricted to the upper two meters and clustered about the **24°C** mark in August (Table 3). The maximum depth of the thermocline typically extended to 20 m.

The upper two stations experienced ice cover and thermal inversion and could, therefore, be classified as dimictic (Maiolie 1987). The lower three stations were monomictic, experiencing isothermy only once a year during the winter.

Dissolved oxygen levels were highest in winter-spring, decreased in summer, and increased in autumn (Appendix B). At all but two stations, oxygen maximums occurred in April. At RK5 and RK31 oxygen readings were slightly higher in February and May. Maximum values ranged from 10.7 mg/L at RK5 to 11.9 mg/L at RK56.

## Food Habits

Daphnia and **Cyclops** were the most important kokanee food items; Cyclops dominated the diet in late winter-early spring. The predominance of Daphnia as a food item from May to December reflects its availability in the environment (Figure 9). Although

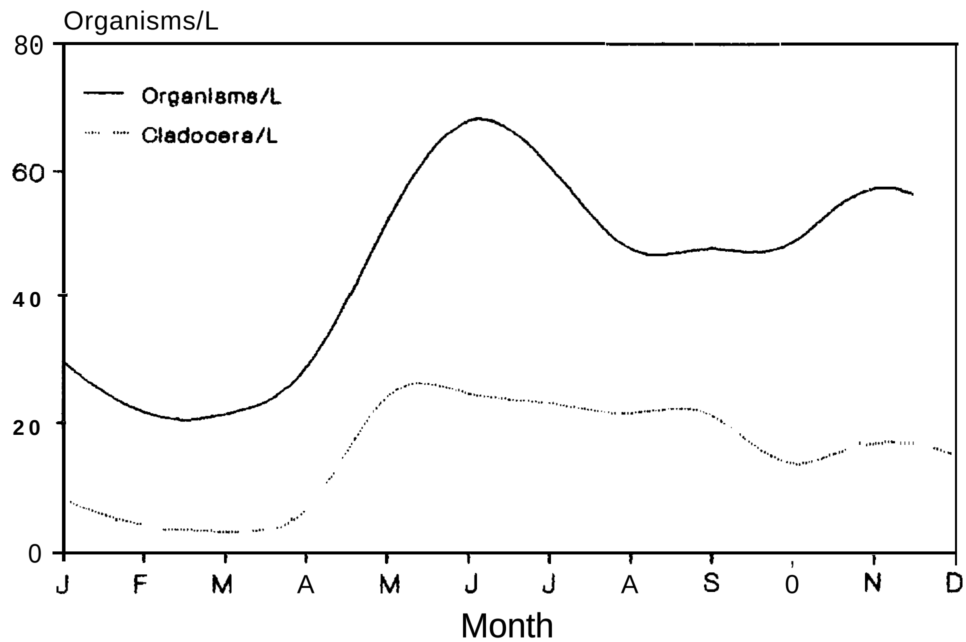


Figure 6. Monthly zooplankton patterns in Dworshak Reservoir, 1988.

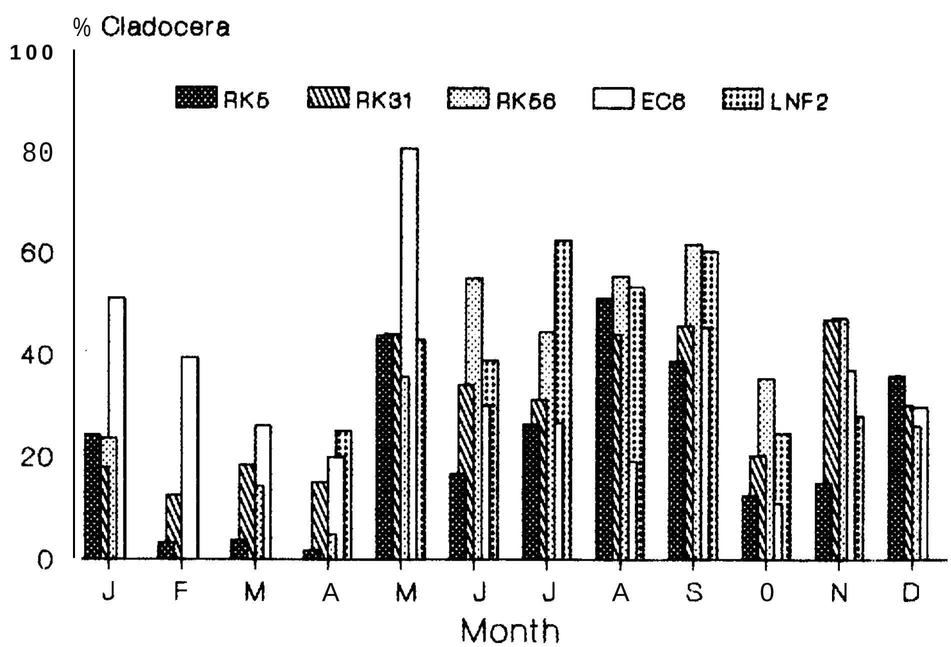
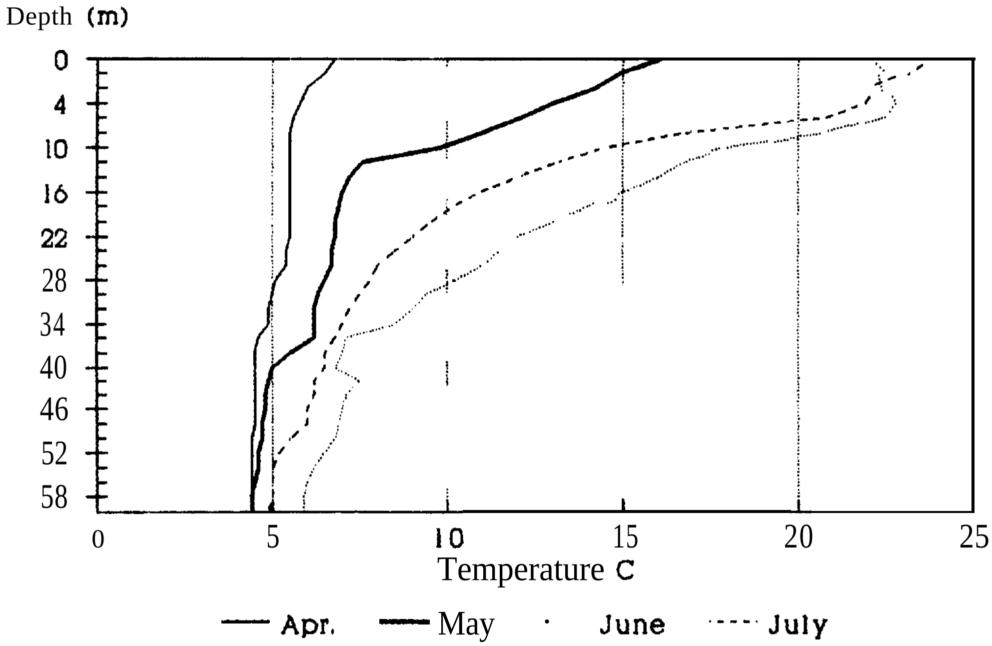


Figure 7. Monthly cladoceran contribution to the zooplankton community in Dworshak Reservoir, 1988.



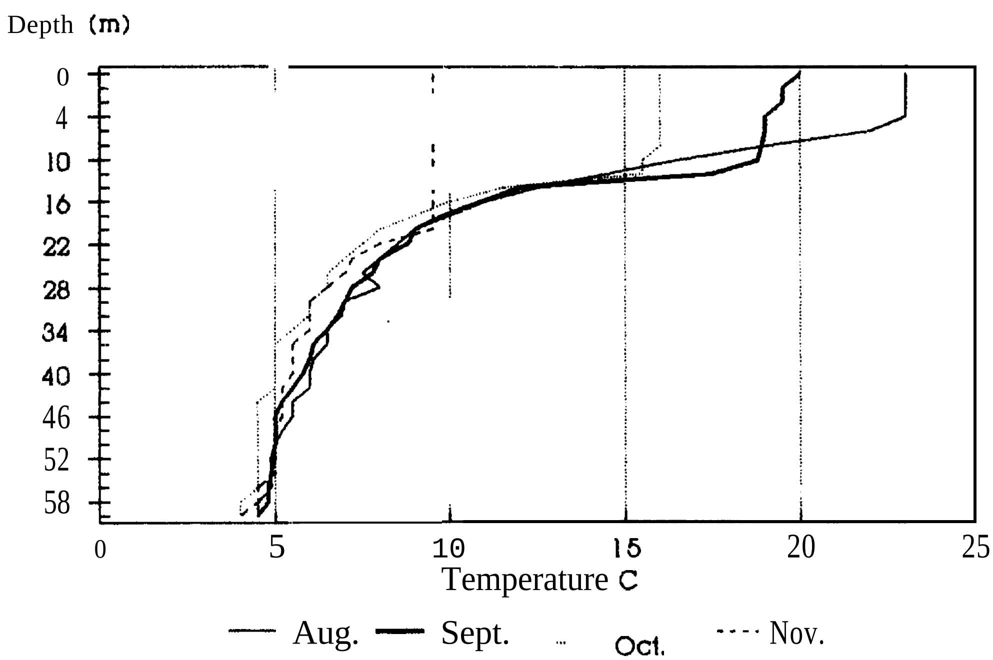




Figure 8. Typical temperatures stratification pattern for Dworshak Reservoir, 1988.

Table 3. Minimum and maximum temperature and dissolved oxygen readings in Dworshak Reservoir, 1988.

| Station | Temperature °C Min. | Temperature °C Max. | DO mg/L Min. | DO mg/L Max. |
|---|---|---|---|---|
| RK5 | 3.9 Feb. | 24.0 Aug. | 1.0 Aug.* | 12.2 Apr. |
| RK31 | 3.1 Feb. | 23.8 Aug. | 0.7 Aug. | 11.2 Feb. |
| RK56 | ice Feb. | 24.0 Aug. | 0.6 Aug. | 12.0 Apr. |
| EC6 | 1.0 Feb. | 23.5 Aug. | 1.5 Aug. | 12.2 Feb. |
| LNF2 | ice Jan. Feb. | 24.5 Aug. | 1.4 Oct. | 11.2 Apr. |

*-DO readings are probably underestimated in August due to equipment malfunction.

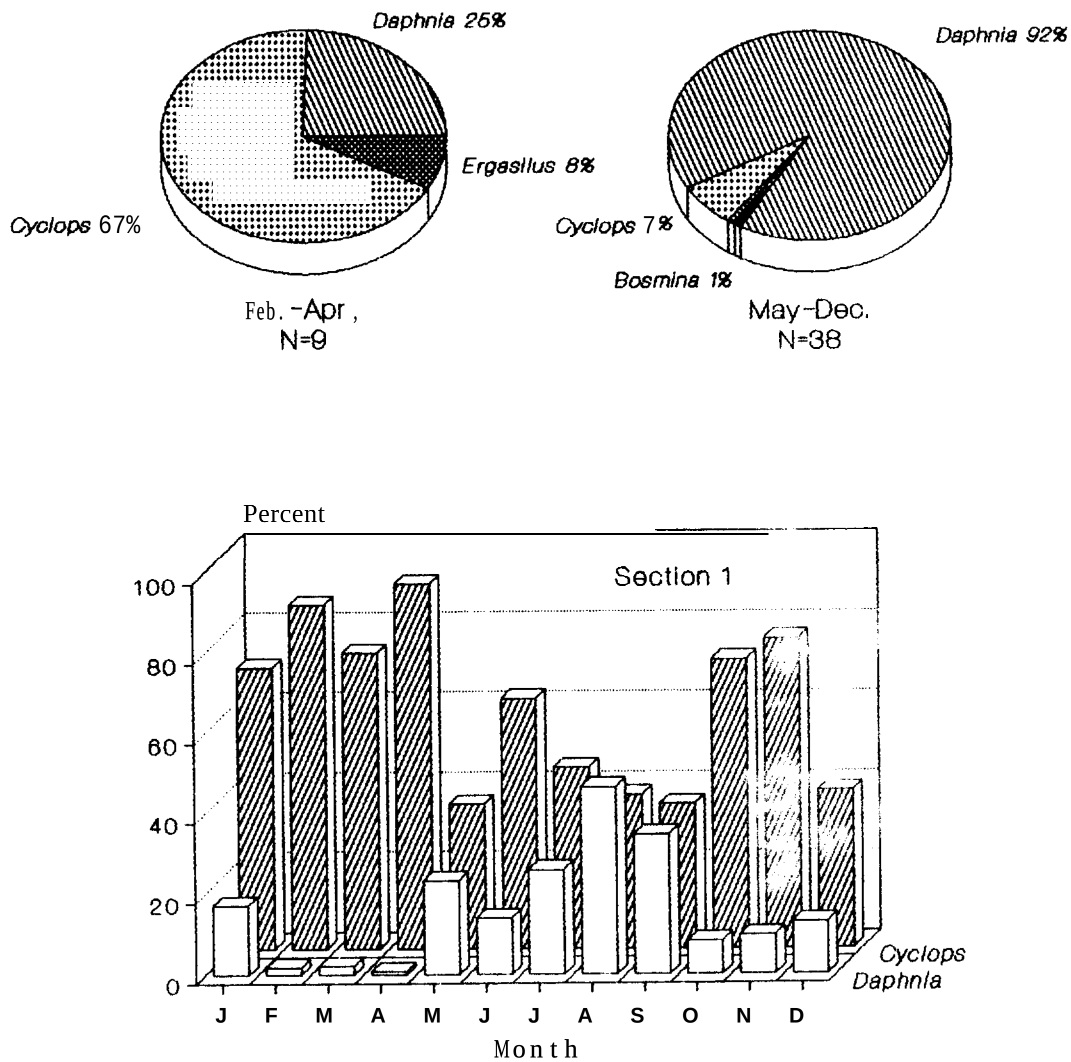



Figure 9. Seasonal composition (percent by number) of major kokanee food items in the diet and in the environment in Dworshak Reservoir, 1988.

cyclopods were relatively abundant throughout the year, 0.9-4.5 organisms/L in Section 1, they were utilized only when Daphnia densities were low. The May density for Daphnia in Section 1 was 3.2 organisms/L.

## DISCUSSION

### Kokanee Abundance

July density estimates were 24-81% lower than other Idaho large lake kokanee populations (Figure 10), possibly a result of error in the Dworshak estimate. Trawl speed was lower than the 1.5 m/s used on other lakes (Bowles et. al. 1988), and the nighttime distribution of kokanee less concentrated on Dworshak. It may be necessary to calibrate the gear against another trawl, or increase sampling effort to get reliable abundance estimates.

The 1989 fishery will be supported primarily by II+ kokanee because III+ fish represent a weak year class. Futhermore, the size of the spawning run will be determined by the number of II+ fish reaching maturity. This parameter is variable as reflected by 1987 and 1988 data (Figure 5).

### Angler Use and Harvest

The Dworshak kokanee fishery in 1988 was one of the best in Idaho in terms of total catch, angler participation and success, and size of kokanee harvested (Figure 10). Early spawners produced a concentrated fishery as the maturing kokanee migrated up the reservoir throughout the summer. As a result, fall fishing was limited to early September at the head of the pool.

### Spawning Trends

Agreement of counts among years and streams appeared sufficient to use spawning surveys as indices of year-class strength (Maiolie 1988). Size and abundance of adult kokanee were below normal in 1988. Adults averaged 293 mm, similar to 1984 (300 mm) and 1982 (310 mm); somewhat larger than 1985 (260 mm) and smaller than 1987 (326 mm), 1981 (340 mm) and 1983 (370 mm). The negative relationship between kokanee spawner size and abundance (Maiolie 1988) may be strong enough to index with trawl data to provide estimates of adult abundance in years when trawling is not conducted (Figure 11).

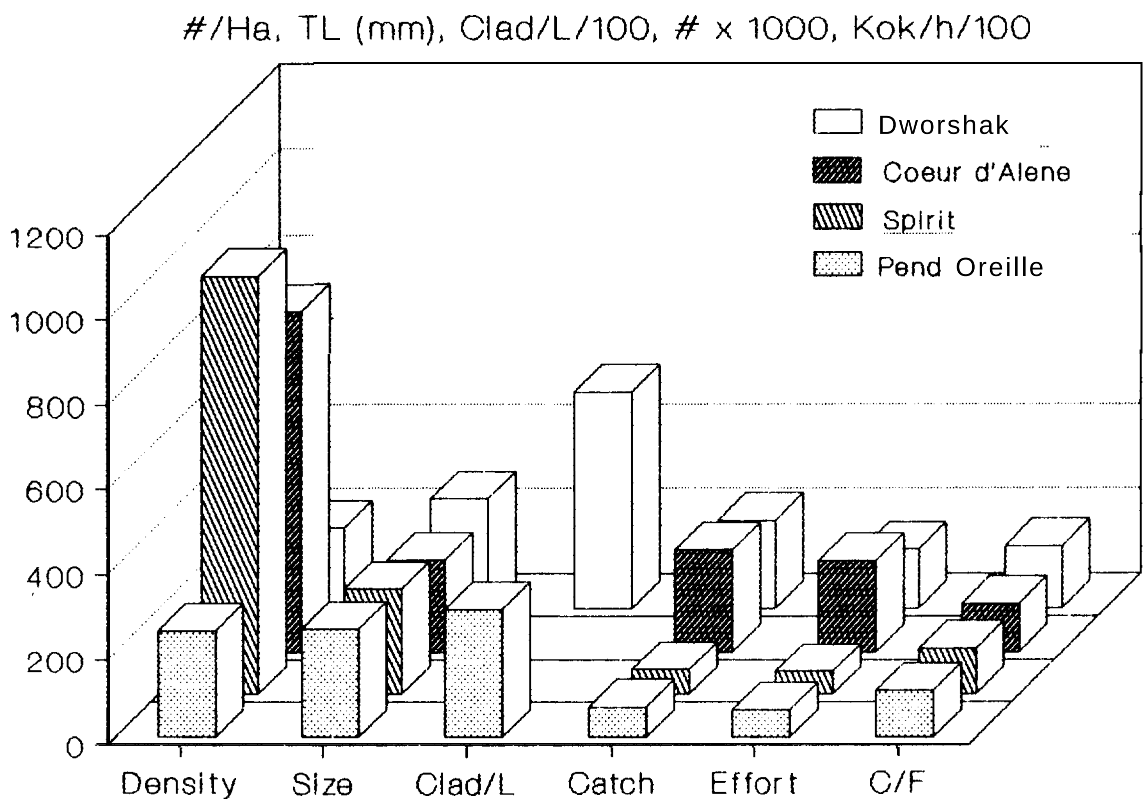
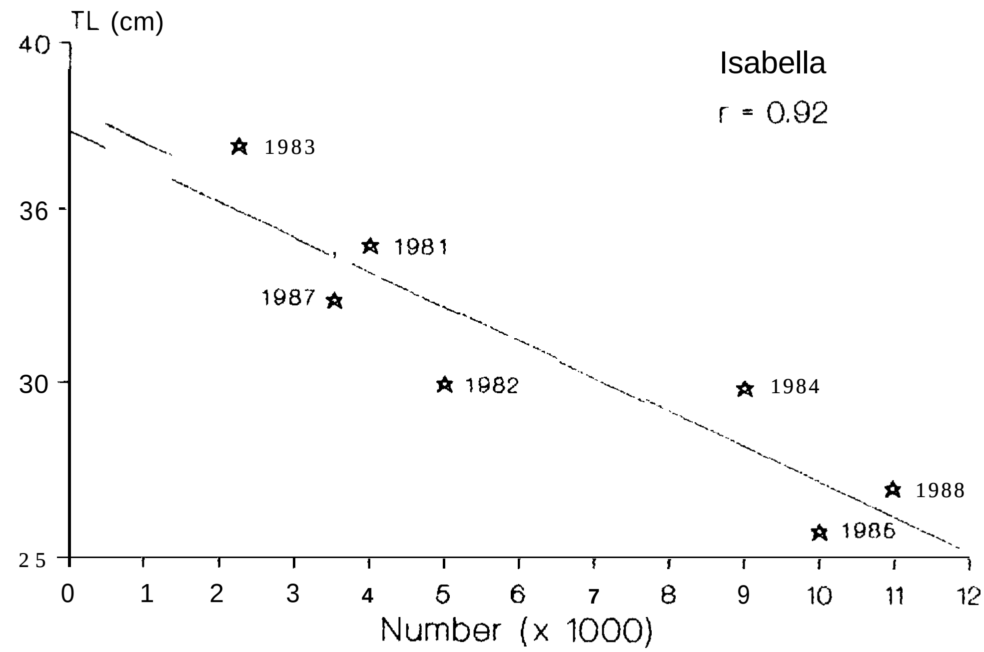



Table 10. Density, mean size in harvest, cladoceran abundance, total estimated angler catch, effort, and success for kokanee fisheries on Pend Oreille, Spirit, Coeur d'Alene lakes and Dworshak Reservoir.



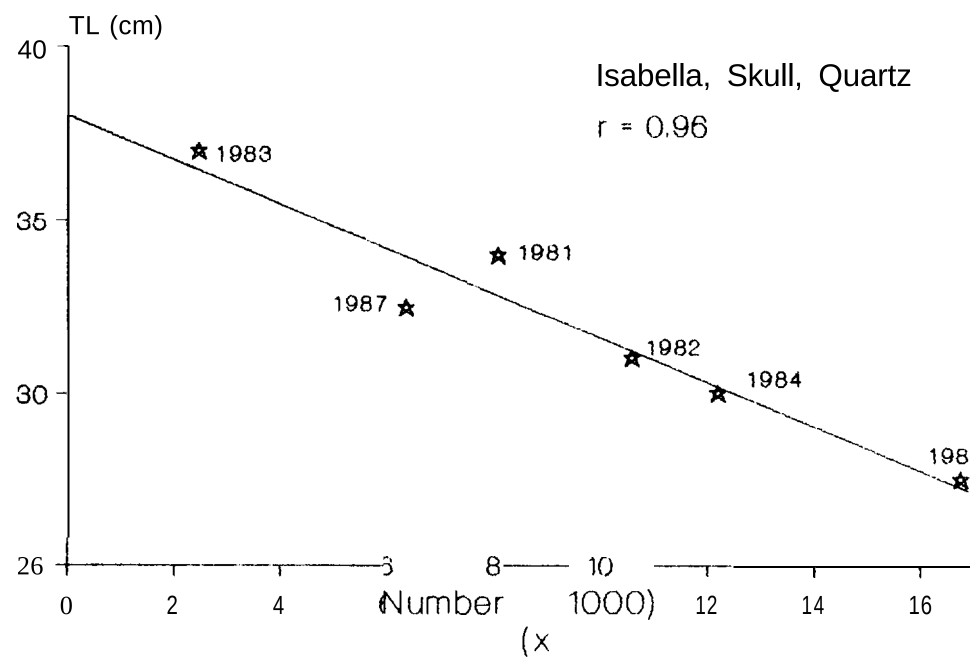




Figure 11. Correlation of mean length and number of kokanee spawners in selected tributaries and years in Dworshak Reservoir.

## Limnology

### Nutrients

Productivity and physical characteristics of the reservoir form the basis for the quality and nature of the fishery. Dworshak was typical of an ageing, temperate reservoir, with declining nutrient levels and fluctuating water levels controlling food production and availability.

Deep, coldwater reservoirs such as Dworshak are typically phosphorus limited (Paul Woods, USGS, personal communication). Wetzel (1975) states that total phosphorus is the most important entity with regard to the metabolic characteristics of lakes; organic phosphorus typically comprises more than 90% of the phosphorus in lake water. Analysis of total phosphorus was initiated in August of 1988. Total phosphorus values were consistently reported at <50 ug/L, demonstrating the need for greater resolution in future analysis. Samples should also be analyzed for NH4 NO2 + N03, and total Kjeldahl nitrogen. Expanded water analysis would provide more accurate information about the trophic status of Dworshak; information to date indicates that the reservoir has become slightly more oligotrophic since 1972-74.

### Transparency

Transparency patterns were in agreement with Falter et al. (1979); minimum in spring, maximum in autumn. Increasing water clarity, between 1972-1974 and 1977, seems to have continued. Comparison between 1988 and 1977 data was possible at RK5, RK31, and EC6. Transparency was greater in 1988 than in 1977 at RK5 and RK31, but the same at EC6 (Figure 12). Increasing transparency supports the notion of oligotrophic progression in Dworshak. Based on this assumption, allocthonous input probably accounts for the relatively low transparency and consistency between years at EC6. The town of Elk River, located approximately 12 km upstream of slackwater, could be a source of nutrients to the Elk Creek arm; Elk Creek Reservoir was drawn down for dam repairs in 1987 (Melo Maiolie and Ted Meske, IDFG, personal communication). The consistent importance of the Elk Creek arm as a zooplankton contributor is in agreement with this postulate. The Little North Fork arm which is not impacted by domestication displays values similar to that of the main reservoir.

### Zooplankton

Total zooplankton densities have declined since the early studies. Dramatic changes in species composition have also

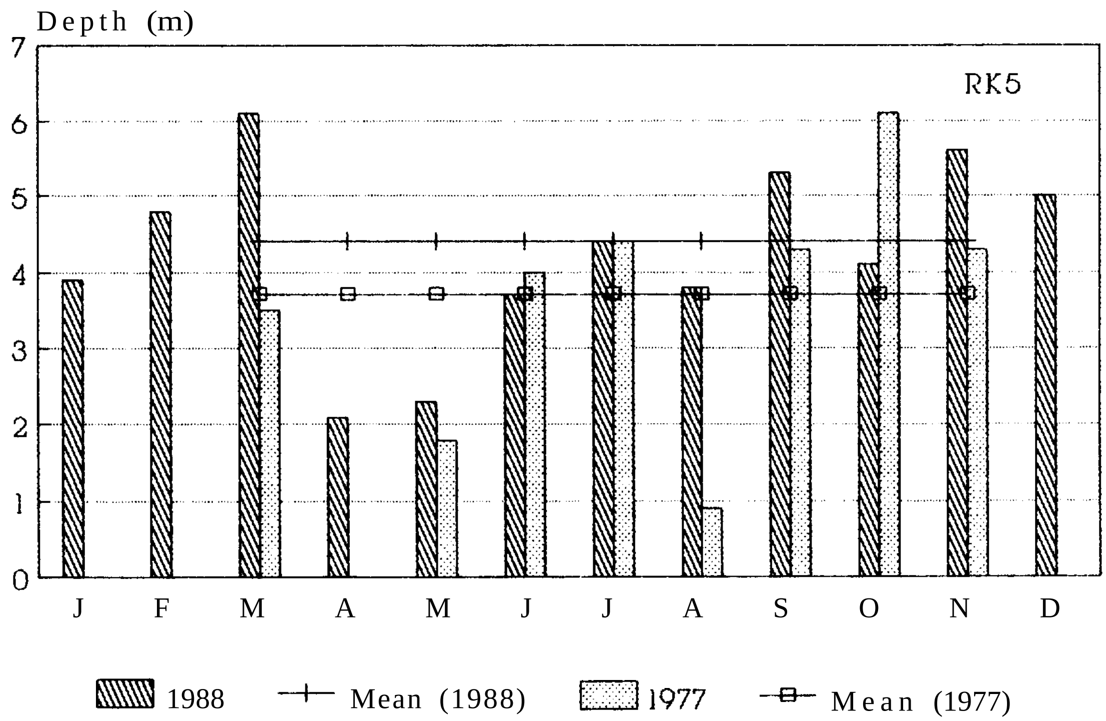



Figure 12. Monthly secchi transparency at station RK5 in Dworshak Reservoir, 1977 and 1988.

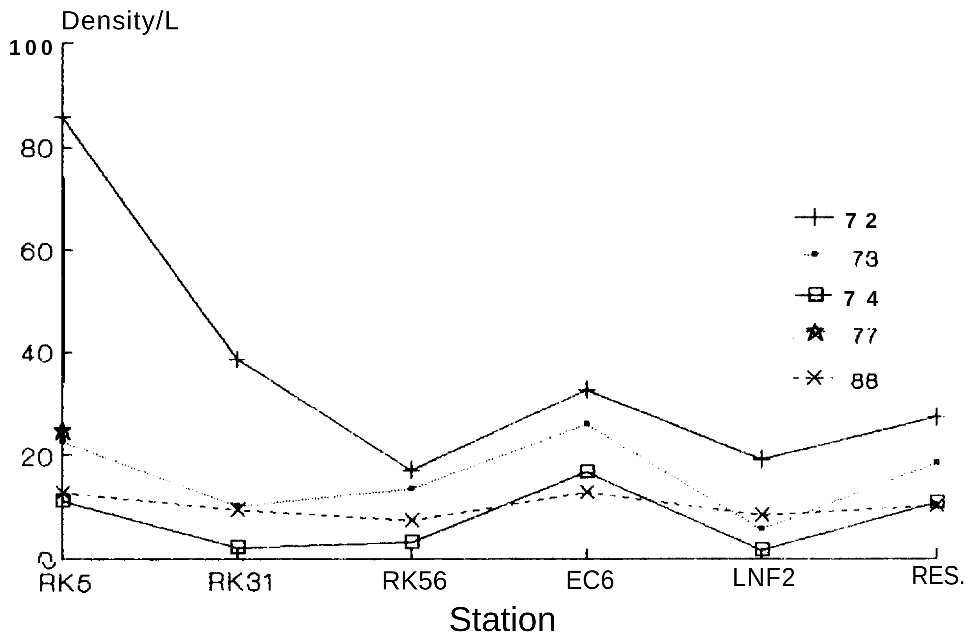
occurred (Figure 13). In 1988, cladocerans comprised about 35% of the reservoir-wide zooplankton community versus 92%, 56%, and 84% in 1972, 1973, and 1974, respectively. A decline in zooplankton densities and cladoceran contribution between 1977 and 1988 at RK5 was very obvious. Since only RK5 was sampled in 1977, any conclusions drawn are limited (Figure 14). Declining cladoceran abundance could impact the carrying capacity of the reservoir for kokanee of a certain size and may, in fact, represent cropping by kokanee.

The feeding preference of kokanee for large cladocerans has been demonstrated (Rieman and Bowler 1980). Though zooplankton densities were lower than recorded for numerous north Idaho lakes, cladoceran summer densities in Dworshak are about two and one half times greater (5.1 organisms/L vs 2.1 organisms/L) than those reported for Pend Oreille Lake (Rieman and Bowler 1980), (Table 4). We can safely reason that there is a critical density at which kokanee feeding on cladocerans becomes less efficient and growth declines. We would expect kokanee growth and food habits to reveal this critical density. This argument brings to light the need for site- and time-specific data, because while mean densities are valuable in revealing overall trends, instantaneous availability may be more critical to kokanee biology. Present zooplankton abundance and species composition seem adequate to support a viable kokanee fishery. Monitoring of zooplankton populations is warranted, however, in light of declining nutrient levels and current zooplankton trends.

## Temperature and Oxygen

Temperature and oxygen patterns were as expected for Dworshak Reservoir. Oxygen was not limiting in the preferred temperature range of kokanee (10.5-13'C, Carlander 1969), which deepened as summer progressed. The preferred temperature range first became available in May and dissipated in November. It was widest in June at all stations, except at LNF2 where it was widest in May. We expect neither temperature nor oxygen to limit the kokanee fishery.

Rieman and Bowler (1980) found nearly 100% of the macro-zooplankton in the upper 50 m throughout the day. Furthermore, from 45-74% of the total zooplankton biomass was found above 10 m, with the primary kokanee food (Daphnia, Bosmina, Dianhanosoma, and Epischura) found almost exclusively in that strata. Kokanee were found to optimize energy conversion during periods of thermal stratification by feeding in near-surface waters during periods of low light intensity and descending to cooler strata during the day (Bert Bowler, IDFG, personal communication). Considering the diurnal movements of kokanee and Daphnia, we expect no spatial segregation due to temperature or oxygen.



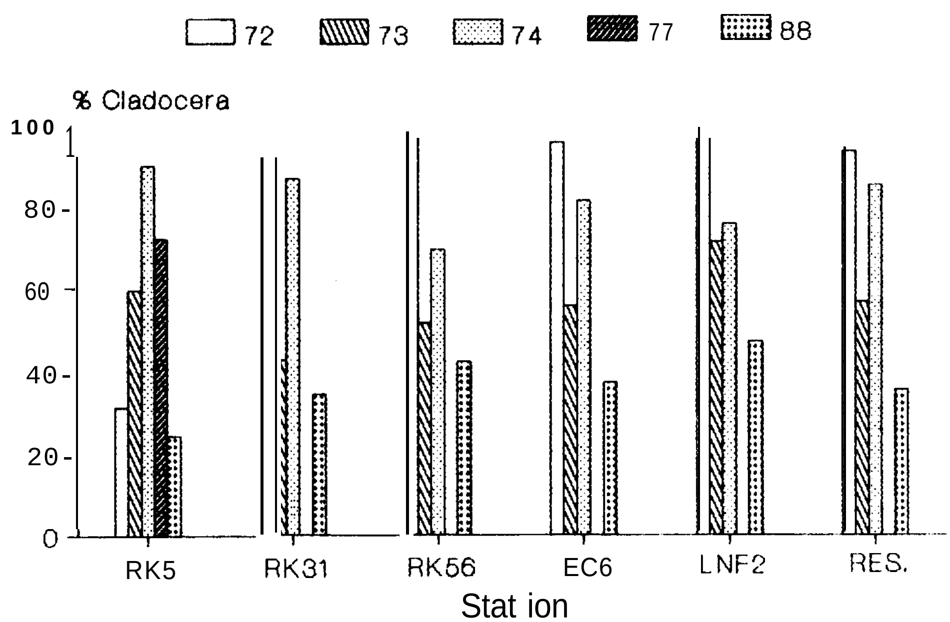




Figure 13. Comparative zooplankton densities and contribution of cladocerans to the zooplankton community in Dworshak Reservoir, 1972, 1973, 1974, and 1988.

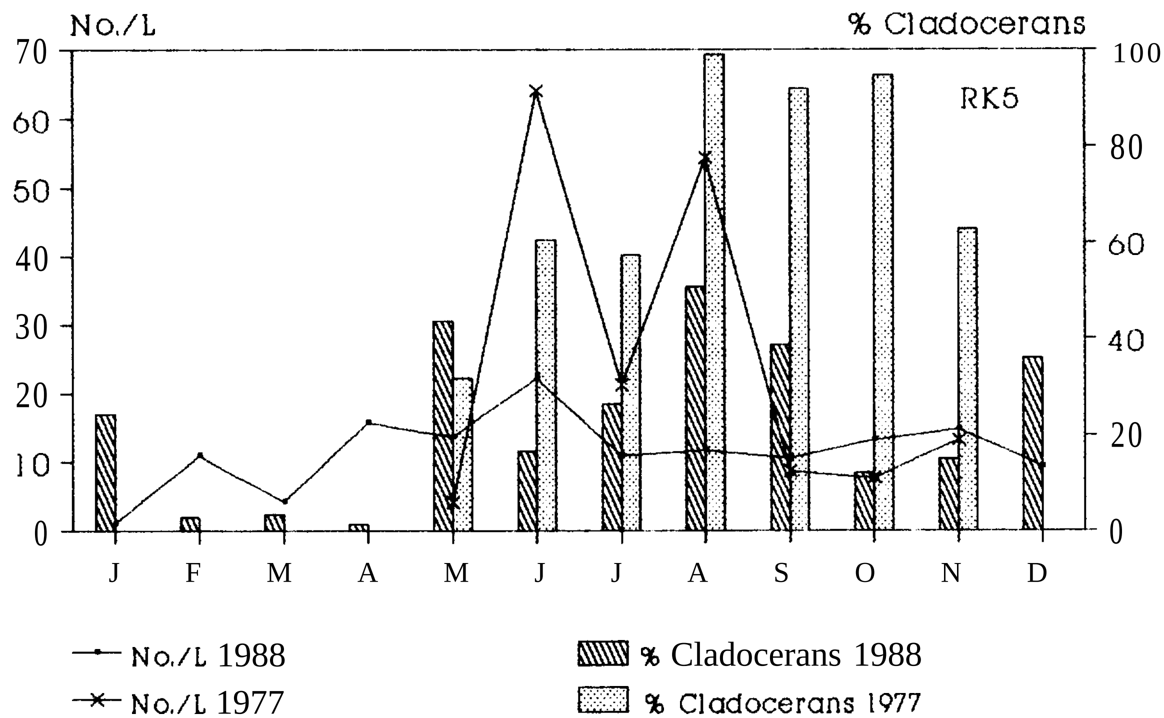



Figure 14. Monthly zooplankton density and contribution of cladocerans at station RK5 in Dworshak Reservoir, 1977 and 1988.

Table 4. Mean summer (May - Sept.) zooplankton densities (number/L) in Dworshak Reservoir and Lake Pend Oreille.

| Station | Cladocera | Copepoda | Total |
|---|---|---|---|
| RK5 | 4.5 | 8.4 | 12.7 |
| RK31 | 4.4 | 6.2 | 10.6 |
| RK56 | 4.5 | 4.0 | 8.6 |
| EC6 | 6.0 | 6.6 | 12.4 |
| LNF2 | 6.6 | 5.1 | 11.7 |
| Dworshak | 5.1 | 6.1 | 11.2 |
| Pend Oreille | 2.1 | 13.7 | 15.8 |

## ACKNOWLEDGEMENTS

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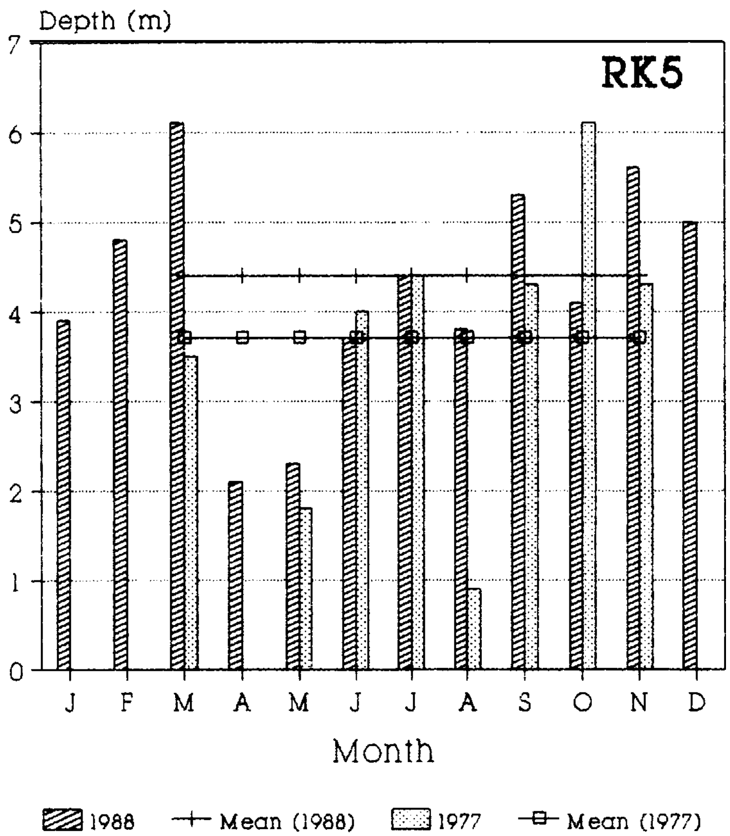
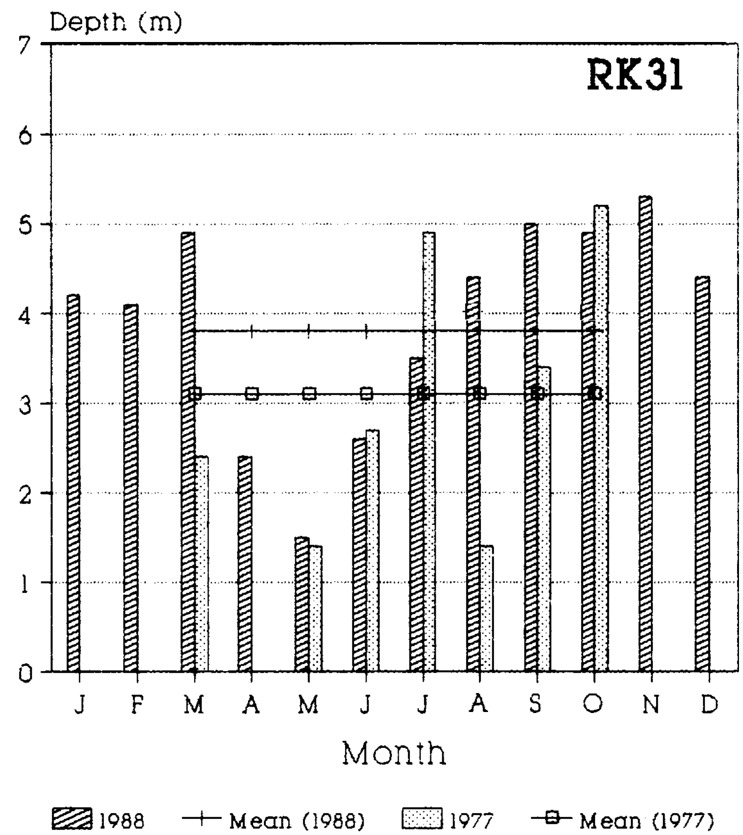
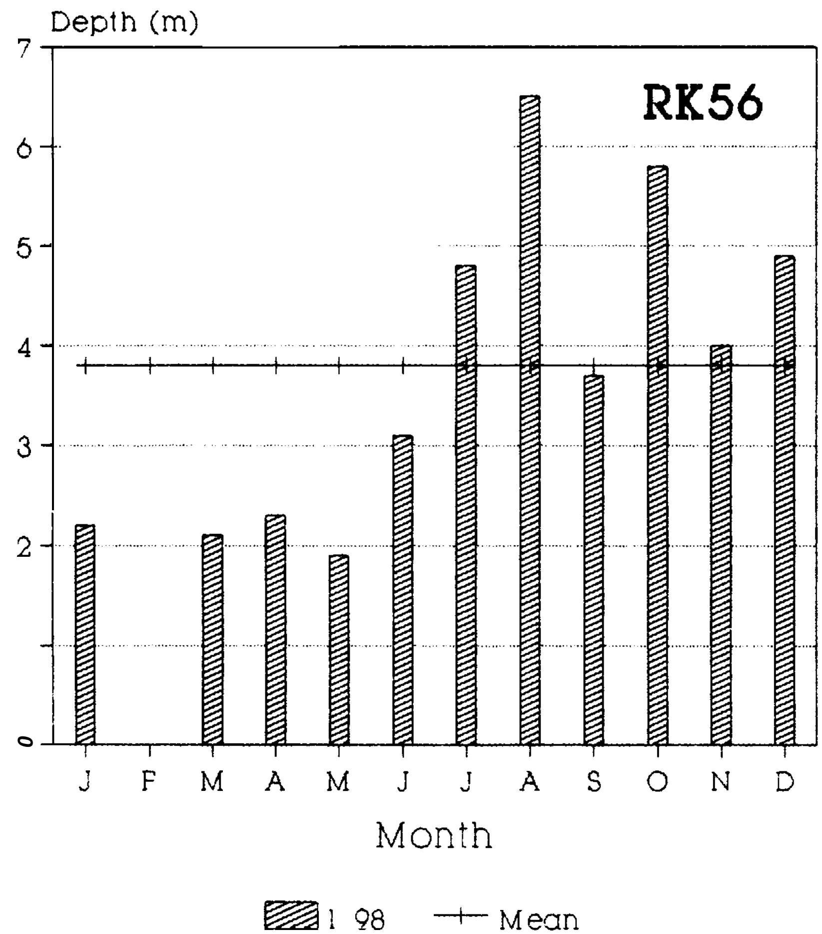
# APPENDICES

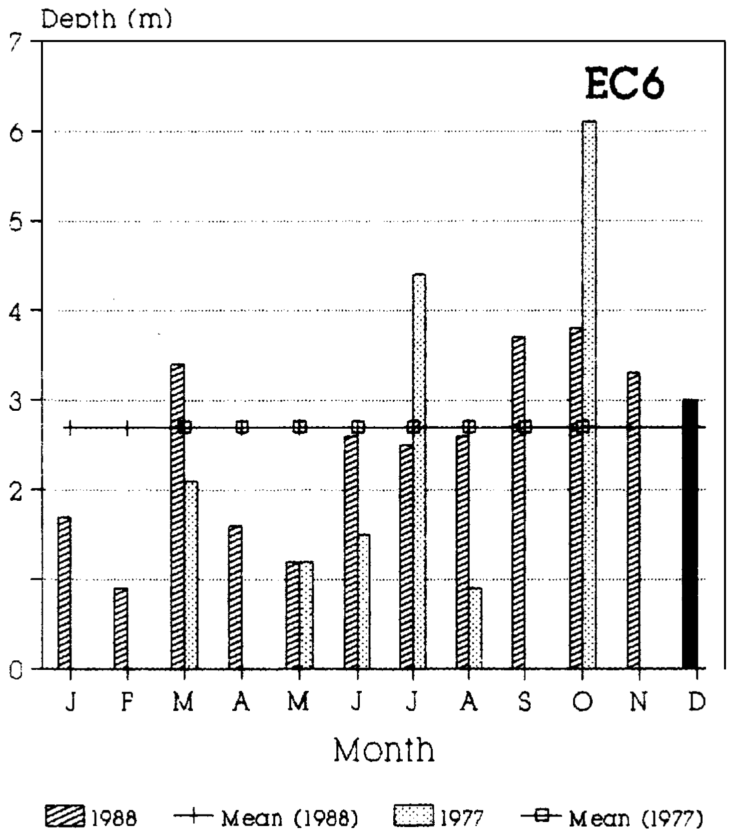


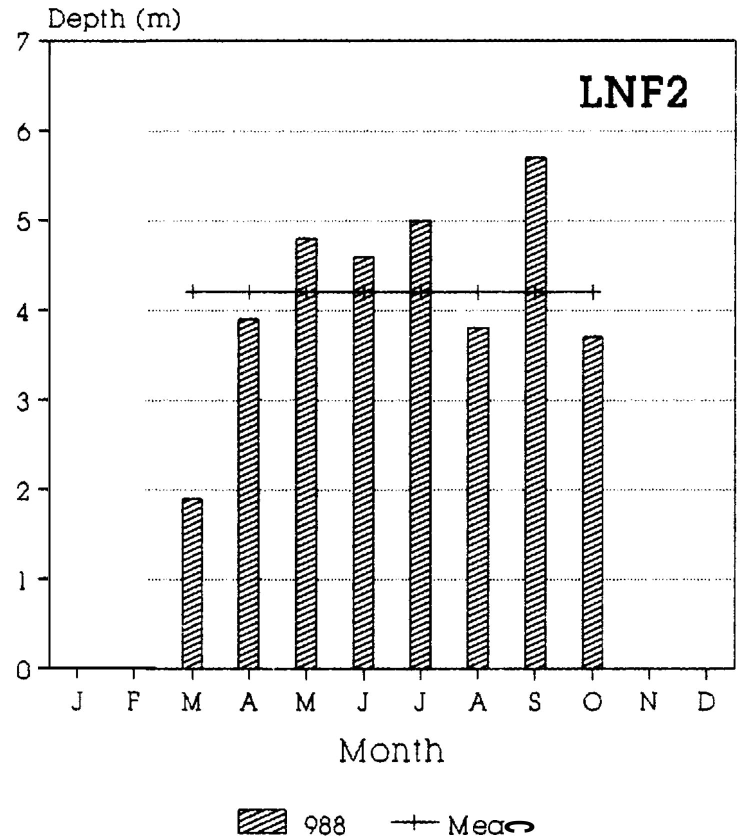




Appendix A. Monthly secchi transparency in Dworshak Reservoir, 1988.

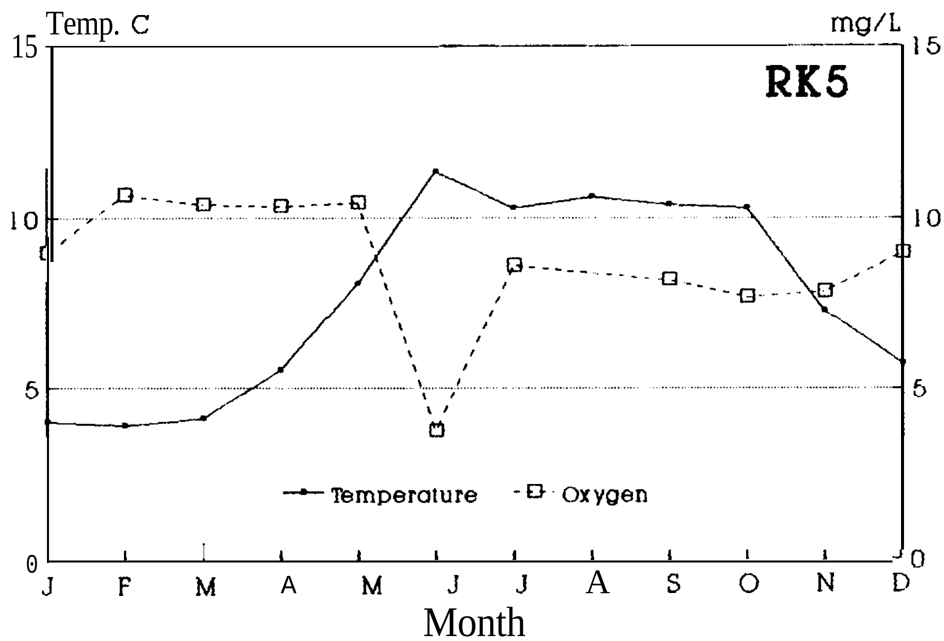


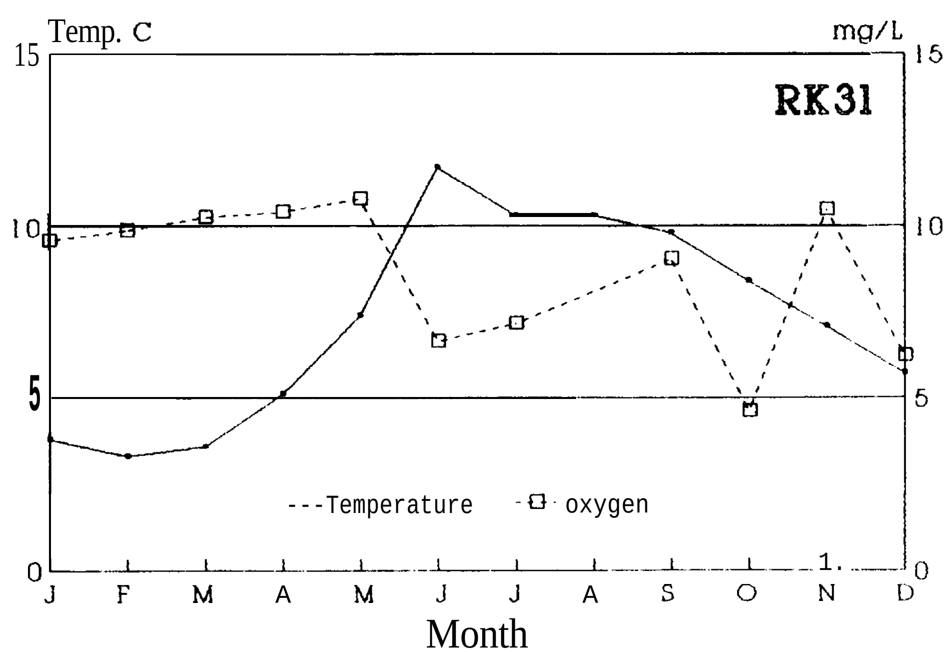

Appendix A. Continued.



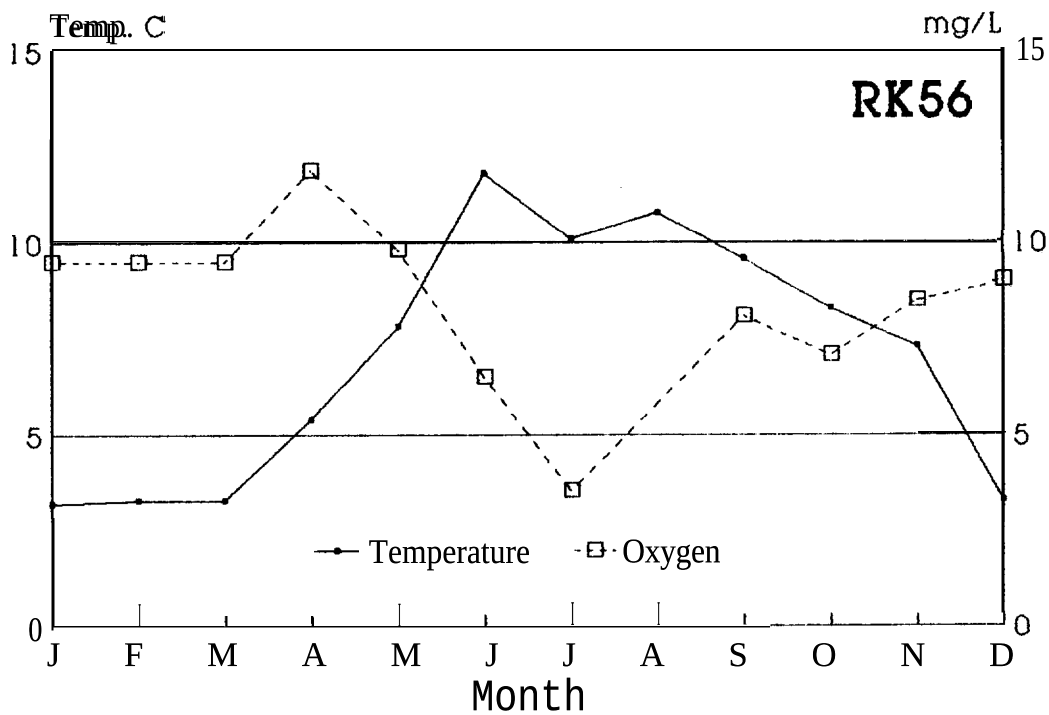




Appendix A. Continued.




Appendix B. Mean monthly temperature and dissolved oxygen in Dworshak Reservoir, 1988.

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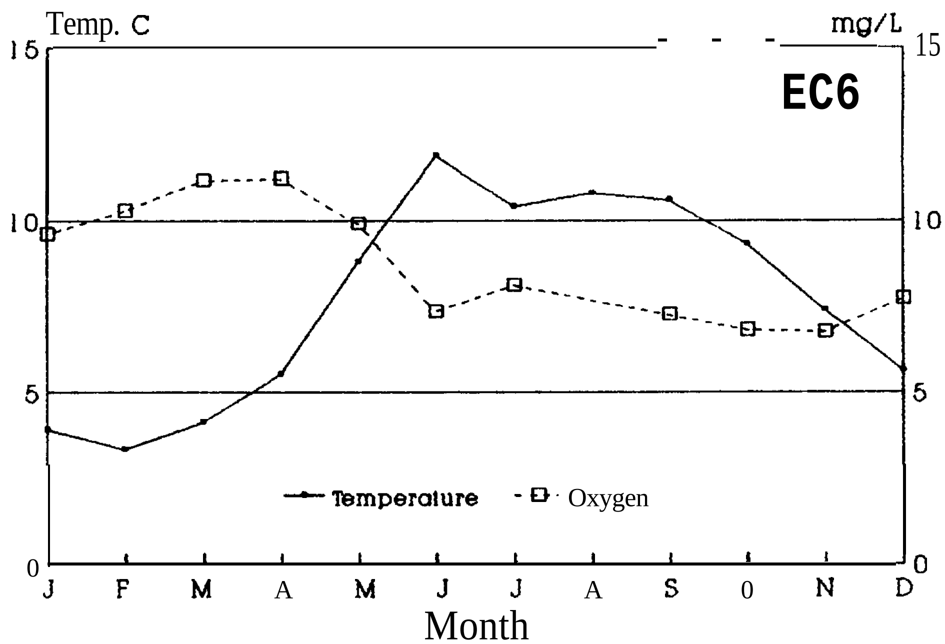


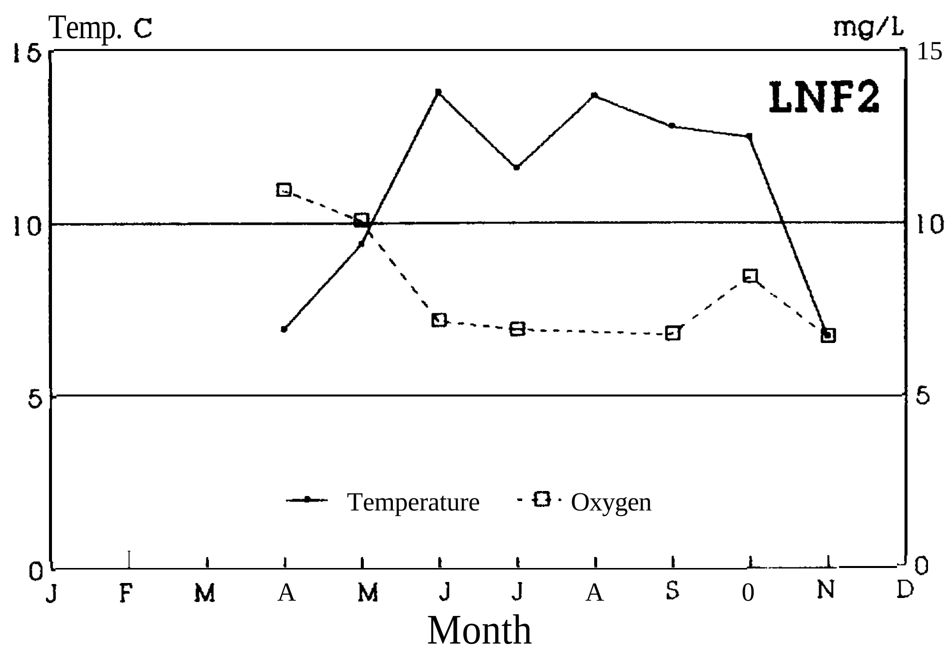


Appendix B. Continued.