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Quantification of Libby Reservoir Levels Needed to Maintain or Enhance Reservoir Fisheries

Annual Report 1985

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Quantification of Libby Reservoir Levels Needed to Maintain or Enhance Reservoir Fisheries

Annual Report 1985

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EXECUTIVE SUMMARY

This study is part of the Northwest Power Planning Council's resident fish and wildlife plan to mitigate damages to fishery resources caused by hydroelectric development on the Columbia River System. The goal of this study is to quantify seasonal water levels needed to maintain or enhance the reservoir fishery in Libby. This report summarizes data collected from July1984 through July 1985, and, where appropriate, presents data collected since 1983.

The Canada, Rexford, and Tenmile areas of the reservoir are differentially affected by drawdown. Relative changes in water volume and surface area are greatest in the Canada area and smallest in the Tenmile area. Reservoir morphology and hydraulics probably play a major role in fish distribution through their influence on water temperature. Greatest areas of habitat with optimum water temperature for Salmo spp. and kokanee occurred during the spring and fall months. Dissolved oxygen, pH and conductivity levels were not limiting during any sampling period.

Habitat enhancement work was largely unsuccessful. Littoral zone vegetation plantings did not survive well, primarily the result of extreme water level fluctuations. Sedge sod plots showed greater survivorship than did the willow or dogwood plantings.

Relative abundances of fish species captured by floating and sinking horizontal gill nets varied seasonally within and between the three areas. Water temperature is thought to be the major influence in fish distribution patterns. Other factors, such as food availability and turbidity, may mitigate its influence. Gill net trend sampling since 1975 illustrates a continued increase in kokanee numbers and a dramatic decline in redside shiners. Salmo spp., bull trout, and burbot abundances are relatively low while peamouth and coarsescale sucker numbers remain high. Kokanee dominated the vertical gill net catch in the lower two areas of the reservoir.

The 1985 hydroacoustic estimate of kokanee abundance in the reservoir was 2,385,742 fish. This represents a slight decrease from the 1984 estimate (2,574,333), but seems fully plausible when angler mortality and recruitment from a weaker year-class is taken into account. Highest densities of kokanee during the August sampling period were found in the Peck Gulch and Rexford areas.

A total of 2,347 anglers were interviewed during the reservoir creel survey. Most anglers caught kokanee, which comprised over 95% of the gamefish creeled. The mean catch rate for kokanee was 0.84 fish kept per hour, and ranged from 0.30 to 2.15 fish per hour. Mean catch rate for Salmo spp. was 0.03 fish per hour. The most successful kokanee anglers came from the Eureka-Rexford area,

Idaho, Washington, and Flathead County, Montana, indicating the regional importance of this reservoir fishery.

There is some evidence for density dependent growth of kokanee in the reservoir. Kokanee in the 1984 year class are less numerous, but slightly larger than last years spawners.

Trout otolith analysis showed that size-at-age was partially a function of when fish emigrated from their natal stream to the reservoir. Growth was rapid the first year following reservoir entry and slowed after two years. Fish emigrating to the reservoir after one growing season in the natal stream seemed predestined to do so because of a large initial size.

The 1985 Young Creek spawning run was 71 adult cutthroat trout, approximately 28% of the previous years run (354 fish). Increased fishing pressure is believed to be the major cause of this dramatic decline. Peak downstream migration of juveniles occurred between late May and late June for all tributaries trapped.

Since 1983, 1,903 adult trout and 7,698 juvenile trout have been tagged. Approximately 11% of the adult and 0.7% of the juvenile trout have been recaptured to date. Tagged trout move throughout the reservoir, generally in the downstream direction, towards the dam.

During fall 1983, Daphnia spp. were found to be the single most important food item for trout. Comparison of mean available zooplankton size with that ingested by major fish species in the reservoir indicated that trout selected larger Daphnia than did kokanee and mountain whitefish. Most Daphnia consumed by Salmo spp. were greater than 1.5 mm, while kokanee consumed Daphnia smaller than 1.5 mm. Length distributions of Daphnia spp. indicated that the greatest percentage of Daphnia in the water column were between 0.5 and 1.5 mm. During most months, less than 10% of the sampled Daphnia were greater than 1.5 mm in the Tenmile and Rexford areas.

Highest densities and biomass of benthic macroinvertebrates were found in the permanently wetted and occasionally dewatered zones of the reservoir. Statistical analysis indicated that benthic macroinvertebrate densities in these zones were higher than those found in the frequently dewatered zone, but did not differ from each other.

Seasonal densities of terrestrial and aquatic surface macroinvertebrates were generally greater in the near shore zones of the reservoir. Statistical comparison of nearshore and limnetic zone densities revealed there was no significant difference between the two, a consequence of high variances resulting from the patchy distribution of the insects.

We have contracted with the U.S. Geological Survey and Dr. Daniel Goodman (Montana State University) to refine a thermal dynamics model and develop a trophic level components model. These models will be used to quantify the impact of reservoir operation on the reservoir habitat, primary production, secondary production and fish populations. Particulate carbon will be used to track energy flow through trophic levels. A growth-driven population dynamics simulation model that will estimate the impacts of reservoir operation on fish population dynamics is also being considered. Validation of the models created by this project will require long term monitoring and evaluation beyond the March 31, 1988 completion date of the study.

ACKNOWLEDGMENTS

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INTRODUCTION

Libby Reservoir was created in March 1972 under an International Columbia River Treaty between the United States and Canada for cooperative water development of the Columbia River Basin (Columbia River Treaty, 1964). The impoundment was designed as a multipurpose project to provide power, flood control, and recreation benefits (Storm et al. 1982). The Pacific Northwest Power Act of 1980 recognized possible conflicts stemming from hydroelectric projects in the northwest and directed Bonneville Power Administration to "protect, mitigate, and enhance fish and wildlife to the extent affected by the development and operation of any hydroelectric project of the Columbia River and its tributaries..."(4(h)(10)(A)). Under the Northwest Power Act, the Northwest Power Planning Council was created and recommendations for a comprehensive fish and wildlife program were solicited from the region's federal, state, and tribal, fish and wildlife agencies. Among Montana's recommendations was the proposal that research be initiated to quantify acceptable seasonal minimum pool elevations to maintain or enhance the existing fisheries (Graham et al. 1982).

This study began May 1983 to determine how operations of Libby Dam impact the reservoir fishery and to suggest ways to lessen these impacts. The specific study objectives are:

1) Quantify available reservoir habitat

2) Determine abundance, growth and distribution of fish within the reservoir and potential recruitment of salmonids from Libby Reservoir tributaries within the U.S.

3) Determine abundance and availability of food organisms for fish in the reservoir

4) Quantify fish use of available food items

5) Develop relationships between reservoir drawdown and reservoir habitat for fish and fish food organisms

6) Estimate impacts of reservoir operation on the reservoir fishery.

DESCRIPTION OF STUDY AREA

Libby Reservoir is located in northwest Montana and southeast British Columbia (Figure 1). The dam site is on the Kootenai River, the second largest tributary to the Columbia River, about 27 km (17 mi) upstream from Libby, Montana. The Kootenai River is 780 km in length and drains an area of 49,987 sq km (19,300 sq. mi) (Bonde and Bush 1975). Libby Reservoir and its tributaries receive drainage from 47% of the Kootenai River drainage basin. Three Canadian rivers, the Kootenai, Elk and Bull, supply 87 percent of the reservoir's inflow (Woods 1982). Figure 2 presents the profile of the Kootenai River.

At ull pool, Libby Reservoir is 148 km (92 mi) long, contains 7.16 km^3 (5.869 millionacre ft) of water with a surface area of 18,801 ha (46,456 acres), and has a mean and maximum water depth of 38.5 m (126 ft) and 107 m (351 ft), respectively. The surface elevation at full pool is 749.5 m(2,459 ft) above mean sea level (m .s.l.).

Prior to impoundment, Bonde and Bush (1975) used a nutrient loading model to predict a eutrophic reservoir; however, based on primary productivity, Libby Reservoir is considered oligotrophic, primarily the result of large-scale annual water fluctuations (Woods and Falter 1982). Annual vertical water fluctuations of up to 52.4 m (172 ft) occur in Libby Reservoir, at which point reservoir volume is reduced nearly 85 percent, surface area by 69 percent and mean depth by 51 percent. The reservoir has maintained its maximum water surface altitude for less than five months during the past four years (Figure 3). In 1985, full pool elevation was not attained; the relatively long lake-fill time (0.55 years) indicates insufficient inflow to compensate for the 35.7 m (117 ft) drawdown that occurred (Table 1).

Seventeen species of fish are present in the impoundment (Shepard 1985). Libby Reservoir currently supports an important fishery for westslope cutthroat trout, rainbow trout, bull trout, kokanee, and burbot. The Montana Department of Fish, Wildlife and Parks has historically managed the reservoir fisheries for the enhancement of westslope cutthroat trout stocks (Huston et al. 1984). However, relative abundances of major fish species in the reservoir are changing (Table 2), with possible impacts on present management strategies.

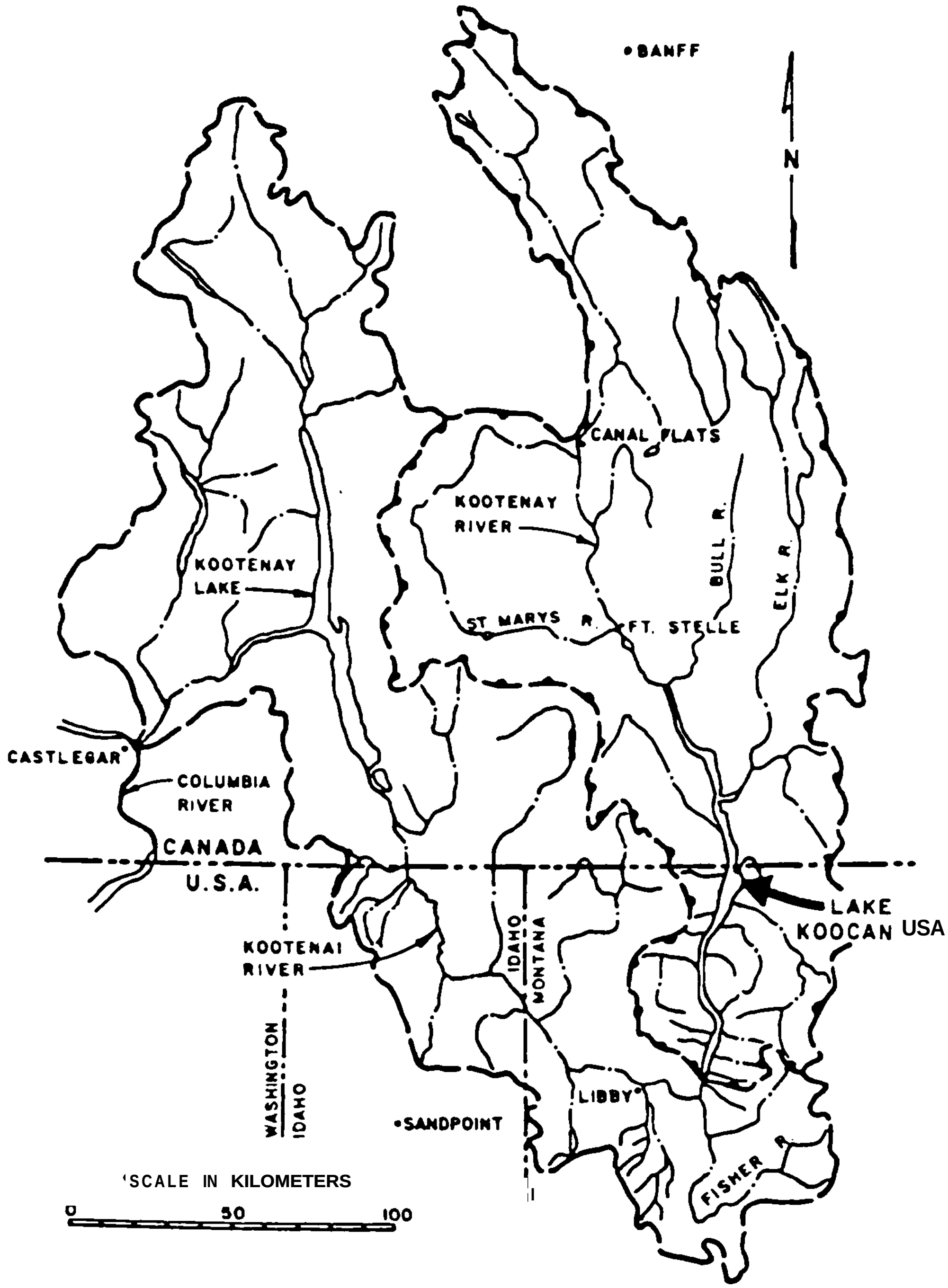


Figure 1. Map of the Kootenai River Basin showing the location of Libby Reservoir (Lake Koocanusa)(from Wocds and Falter 7982).

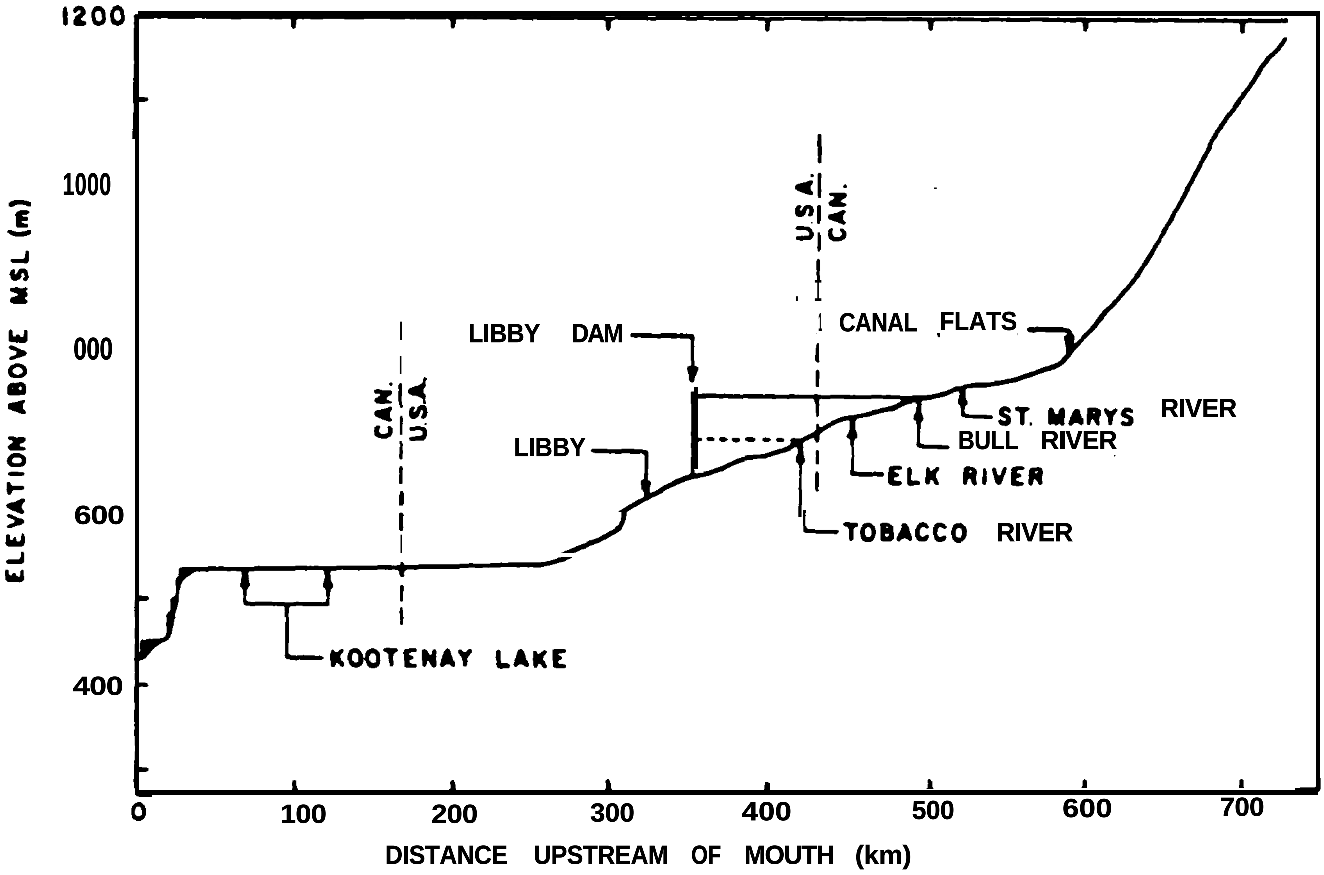


Figure 2. Longitudinal profile of the Kootenai River (from Woods and Falter 1982).

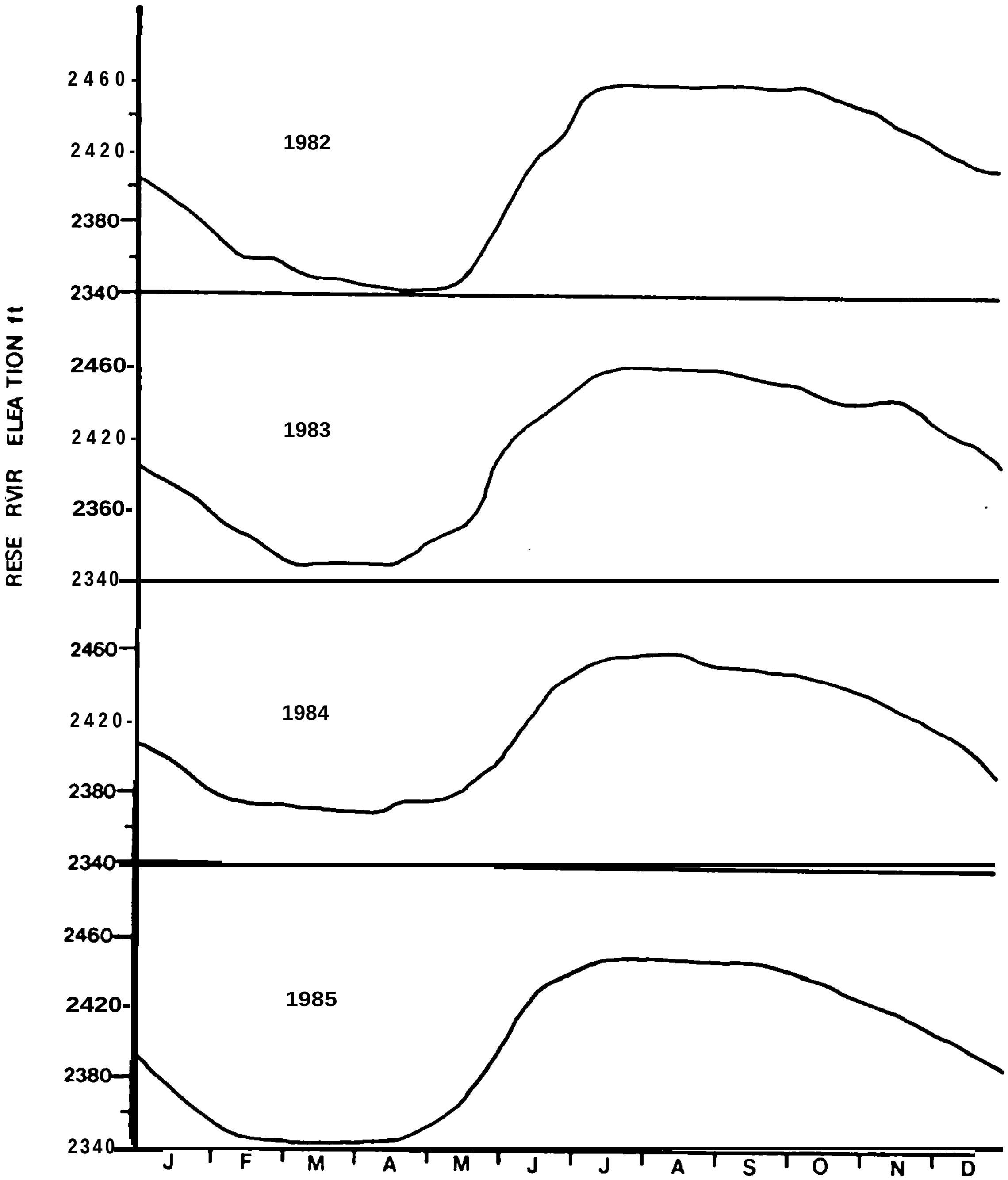


Figure 3. Monthly changes in water surface elevations of Libby Reservoir during 1982 to 1985.

Table 1. Lake-fill time (yrs.), hydraulic-residence time (yrs.), maximum drawdown, number of days held at full pool, and maximum reservoir elevation for Libby Reservoir by year from 1972 through 1985.

Year	Lake-fill time (yrs)				Hydraulic-residence (yrs)				Maximum drawdown		No. days at full pool	Max. pool elevation (ft.)
	annual	Monthly mean	Monthly min.	Monthly max.	annual	monthly mean	monthly max.	monthly min.	ft.	m.		
1972	0.14	0.17	0.04	0.52	0.14	0.14	0.02	0.37				
1973	0.22	0.40	0.10	0.88	0.33	0.49	0.11	1.29	230	70.3	0	2417
1974	0.28	0.61	0.09	1.28	0.29	0.33	0.13	0.67	153	46.6	66	2459
1975	0.37	0.63	0.11	1.13	0.41	0.78	0.10	2.66	172	52.4	0	2454
1976	0.38	0.71	0.13	1.54	0.38	0.55	0.13	1.56	152	46.2	61	2459
1977	0.64	0.93	0.26	1.64	0.50	0.59	0.24	1.42	100	30.5	0	2414
1978	0.43	0.75	0.18	1.33	0.48	0.63	0.24	1.28	129	39.3	44	2459
1979	0.66	1.08	0.22	1.78	0.62	0.97	0.22	2.08	95	28.9	0	2451
1980	0.52	0.94	0.17	1.47	0.58	0.78	0.29	2.07	106	32.3	65	2459
1981	0.33	0.89	0.12	1.77	0.41	0.59	0.23	1.29	110	33.5	58	2459
1982	0.46	0.84	0.11	1.53	0.46	0.49	0.24	0.89	117	35.7	61	2459
1983	0.50	0.81	0.13	1.96	0.51	0.61	0.22	1.57	111	33.8	54	2459
1984	0.61	1.02	0.16	1.78	0.56	0.74	0.25	1.53	89	27.1	23	2459
1985	0.55	0.86	0.13	1.36	0.54	0.80	0.19	1.96	117	35.7	0	2450
Average (Post 1974)									118		33.3	

Table 2. Present relative abundance (A=abundant, C=common, R=rare) and abundance trend from 1975 to 1982 (I=increasing, S=stable, D=decreasing) of fish species present in Libby Reservoir.

Comnon Name	Scientific name	Relative abundance	Abundance trend
Gamefish species			
Westslope cutthroat trout	Salmo clarki lewisi	A	S
Rainbow trout	Salino gairdneri	A	I
Bull trout	Salvenlinus confluentus	C	S
Brook trout	Salvenlinus fontinalis	R	S
Lake trout	Salvenlinus namaycush	R	S
Kokanee salmon	Oncorhynchus nerka	C	I
Mountain whitefish	Proscpium williamsoni	C	D
Burbot	Lota lota	C	I
Largemouth bass	Micropterus salmoides	R	S
White sturgeon	Acipenser transmontanus	R	D[a]
Nongame fish species			
Pumpkinseed	Lepomis gibbosus	R	S
Yellow perch	Perca flavescens	R	I
Redside shiner	Richardsoniusi balteaus	C	D
Peamouth	Mylocheilus caurinus	A	I
Northern squawfish	Ptychocheilus oregonensis	A	S
Largescale sucker	Catostomus macrocheilus	A	S
Longnose sucker	Catostomus catostomus	C	D

[a] Five white sturgeon were relocated from below Libby Dam to the reservoir. At least one of these fish moved up-river out of the reservoir and two were reported caught by anglers.

METHODS

SEASONS

The year was stratified into four seasons based on reservoir operation and surface water temperature criteria for gill netting:

1) Winter (January - March). The reservoir was being drawn down Surface water temperatures dropped below 8° C.

2) Spring (April - June). The reservoir was refilled. Surface water temperatures increased to 9° - 13°C.

3) Summer (July - September). The reservoir was held at full pool. Surface water temperatures increased to above 17°C.

4) Fall (October - December). Drafting of the reservoir began Surface water temperatures dropped to 13° - 9°C.

RESERVOIR HABITAT

Physical and Chemical Limnology

Libby Reservoir has been divided into three areas for study purposes by the Montana Department of Fish, Wildlife and Parks (Huston etal. 1984, Shepard 1985). Segregation into three geographic areas was based on reservoir morphometry, effects of reservoir drawdown, and political boundaries (Figures 4 and 5).

A permanent sampling buoy was placed within each area (an established U.S.G.S. buoy was used in the Tenmile area) where water quality and zooplankton sampling were conducted. In addition, eight to twelve transects were established between recognizable landmarks in each area. These transects were further subdivided into east, west, and mid-reservoir stations for random sampling.

The "nearshore" zone was defined as that portion of the reservoir within 100 m of the shoreline. The remaining area of the reservoir was designated as the limnetic zone.

Vertical layers of the water column were defined using measurements of light penetration, water temperature, dissolved oxygen, pH, and conductivity (umohs·cm^{-1}). A Martek Mark V digital water quality analyzer and a protomatic photometer were used to measure the above variables. Sampling was conducted in each geographic area biweekly from May through October and monthly from November through April unless dewatering of boat ramps or ice formation prohibited access.

Martek sampling was done using methods accepted by the U.S.G.S. (Greeson et al. 1977). Water quality measurements were

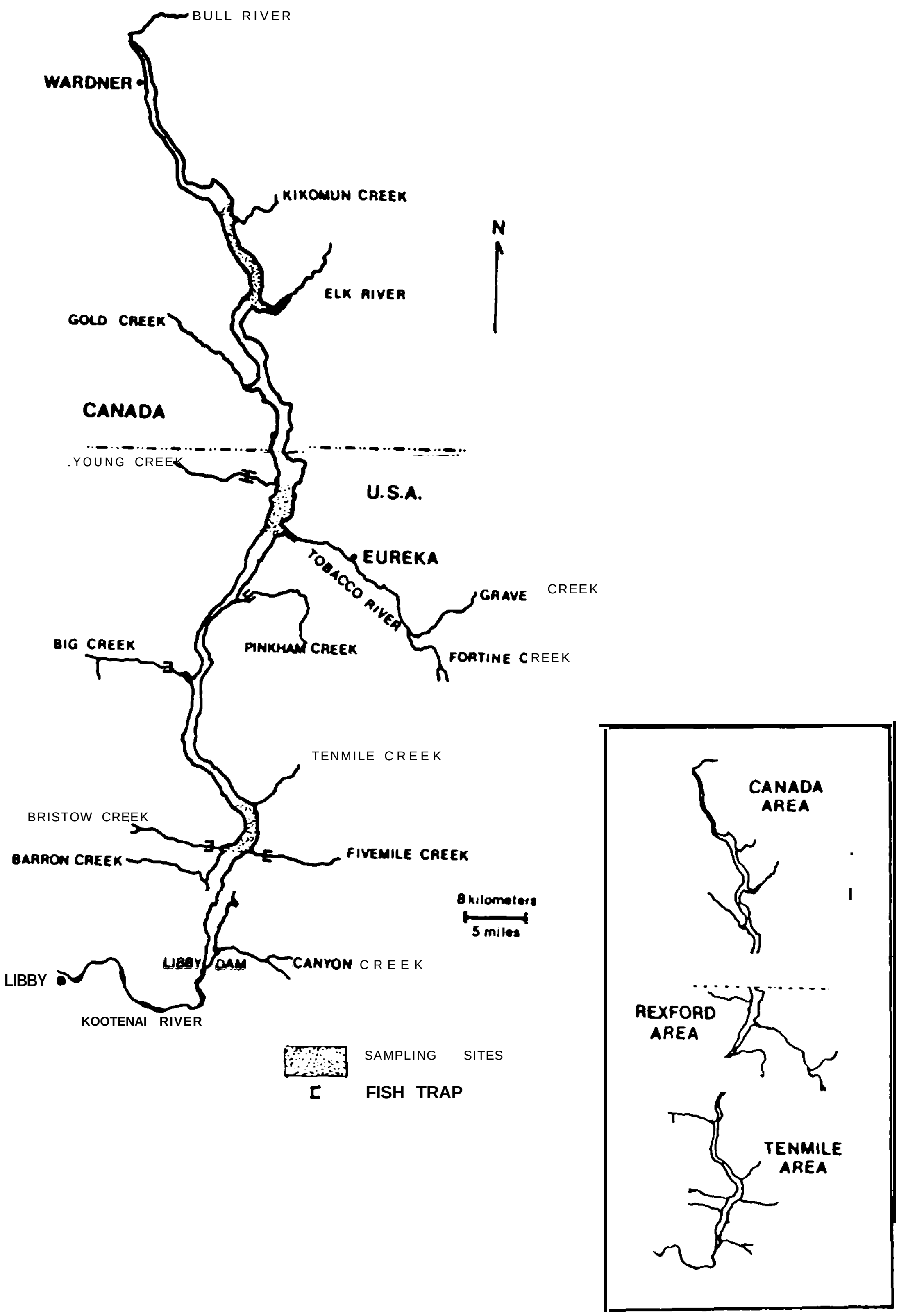


Figure 4. Sampling stations, fish trap locations, and principal tributaries of Libby Reservoir. Inset delineates geographic study areas.

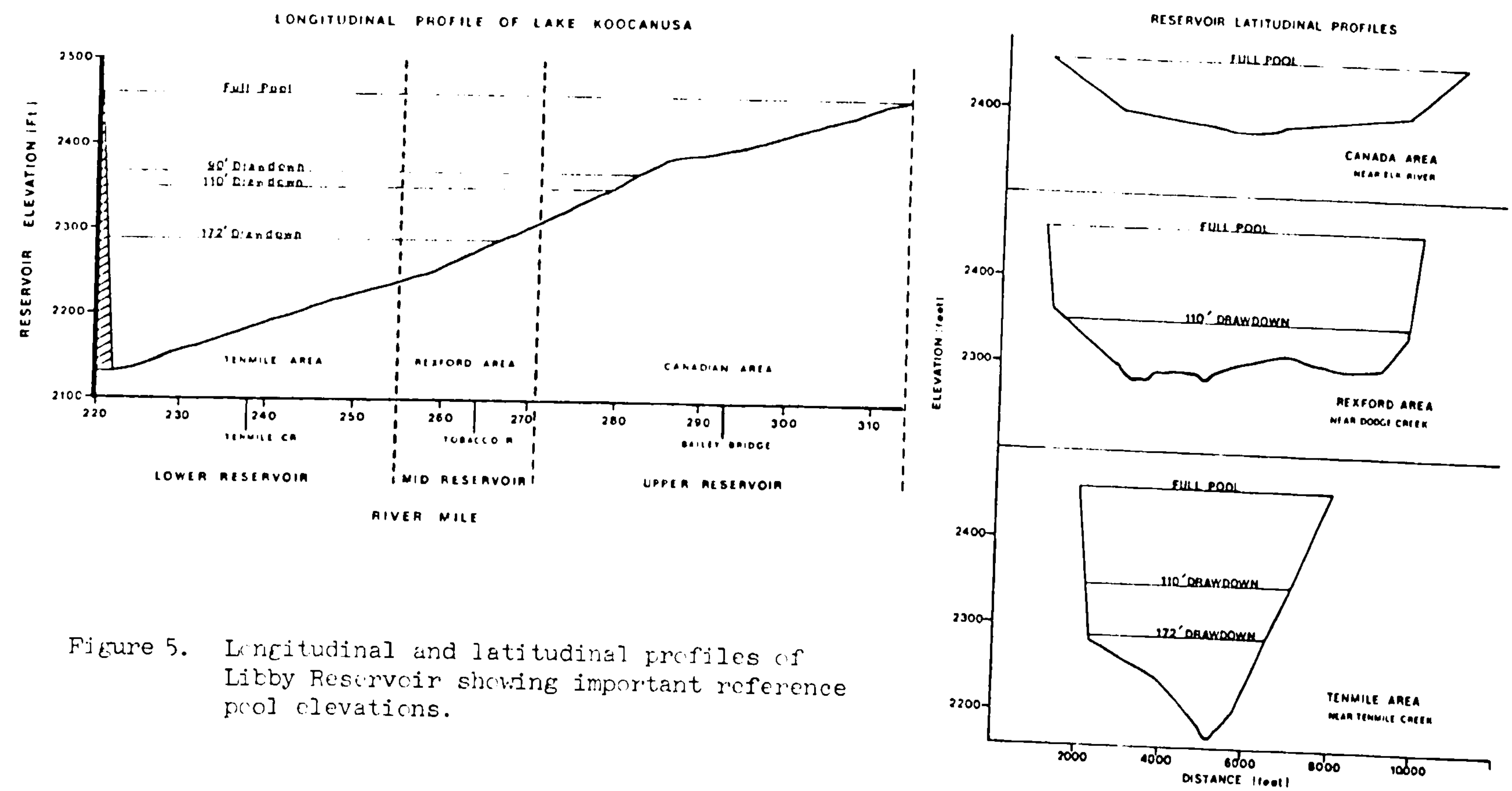


Figure 5. Longitudinal and latitudinal profiles of Libby Reservoir showing important reference pool elevations.

taken at the surface, atone meter, at every two meters to 15 m, at every three meters to 60 m, and at every five meters to 95 m or the bottom. Laboratory calibrations of the Martek were done prior to and following field measurements using manufacturer's instructions. Water samples were also taken with a VanDorn sampler (Wildco, Model #1120D40) at the surface, 11 m, and 21 m. A modified Winkler titration (A.P.H.A., 1975) was used to determine the dissolved oxygen (D.O.) content of these samples. These D.O. values were used to verify proper calibration of the Martek Meter. Incident light was recorded above the water's surface and at one meter intervals to a depth of 30 m or until light intensity was one percent or less of the surface light; defined as the lower boundary of the euphotic zone (Greeson et al. 1977).

Isopleths of temperature, pH, dissolved oxygen, and conductivity by sample station through time, and by date across sample stations, were plotted using the USGS program STAMPEDE.

Contour maps of the area impounded by Libby Dam [(U.S. Army Corps of Engineers, File Number E53-1-154, Sheets l-37, 1972, and British Columbia Ministry of the Environment, Drawings M-249-C, Sheets l-63, 1969)] were digitized using a Bausch and Lomb digitizer (Model 7048, Huston Instruments) connected to a Discovery computer. Each ten foot contour interval was entered by geographic reservoir area. Digitized data for the above maps were used to proof our data entry and edit our computer data files. Water surface area and volume, wetted reservoir bed area, and shoreline length were calculated using the MDFWP program GEOSCAN and will be available in June 1986.

Habitat Enhancement

Bristow Creek and Tobacco River bays were selected as potential revegetation sites. In April, 1984, approximately thirty willow (Salix spp.) and thirty red osier dogwood (Cornus sericea) cuttings were planted in plots located 5, 10, 15 and 20 feet below full pool. Three pieces of sedge (Carex spp.) dominated sod were also planted in each of the four plots at the two sites. Survival was evaluated in June 1984 prior to full pool inundation and again in June 1985.

FISH ABUNDANCE, GROWTH AND DISTRIBUTION

Trout field identifications were based on scale size, presence or absence of basibranchial teeth, spotting pattern and presence or absence of the red slash on each side of the jaw along the dentary. We recognize the difficulty in distinquishing between rainbow trout, cutthroat trout and hybrids of these, using morphological criteria as reported by Leary et al. (1983) and where appropriate have reported results for Salmo spp.

Abbreviations used throughout this report for the various species of Libby Reservoir are as follows: rainbow trout (RR), westslope cutthroat trout (WCT), hybrids between rainbow and cutthroat trout (HB), members of the genus salmo spp. (SALMO), kokanee salmon (KOK), bull trout (DV), mountain whitefish (MWF), burbot (LING), Columbia River chub (CRC), northern squawfish (NSQ), redside shiner (RSS), largescale sucker (CSU), longnose sucker (FSU), and yellow perch (YP).

Near Shore Zone Fish Abundance

Seasonal and annual changes in fish abundance within the near shore zone were assessed using floating and sinking horizontal gill nets. These nets were 38.1 m long and 1.8 m deep and consisted of five equal panels of 19, 25, 32, 38 and 51 mm mesh

One to seven double floating and two sinking gill nets were set seasonally from August 1984 through August 1985. Nets were set perpendicular from the shoreline just before sunset and were retrieved shortly after sunrise. All fish were removed from the nets, and species, length, weight, sex and state of maturity were recorded. Scale samples and a limited number of otoliths were collected for age and growth analysis.

A spring sinking and fall floating gill netting series have been used by the MDFWP since 1975 to assess annual trends in fish abundance. These yearly sampling series were continued using criteria established by Huston et al. (1984).

Electrofishing

The near shore reservoir zone was segregated using habitat mapping information (including cover type, substrate, and reservoir bed gradient) within the 1984 drawdown zone. Standard boat electrofishing gear was used to sample these near shore zones in the spring and fall of 1985. Electrofishing was conducted at night in both the Rexford and Tenmile areas. In the spring of 1985, electrofishing was also conducted in the Canadian area for tagging purposes. Captured fish were measured, weighed, tagged and released.

Limnetic Zone Fish Abundance

Vertical gill nets were used to assess the relative abundance and depth distribution of fish species in the limnetic zone of each area. An overnight set of four 45.7 m deep by 3.7 m wide vertical gill nets of mesh sizes 19, 25, 32 and 38 mm were set monthly in each area. Each net was marked at one meter intervals. As the vertical nets were retrieved, fish were removed and depth of capture, species, length, weight, sex, and state of maturity were recorded and scale samples were collected.

Relative abundance of the various fish species in the limnetic and near shore zones were compared using vertical and horizontal gill netting data. Vertical distributions of fish were also compared to thermal profiles and vertical distributions of zooplankton.

Hydroacoustic Estimate of Kokanee

Kokanee abundance was estimated using hydroacoustic sampling during four moonless nights in August 1985. Visual isolation during moonless nights results in an even dispersal of kokanee which increases the reliability of the technique (Hanzel 1984).

A Honda Sitex depth recorder (Model HE 356A) with a transducer beam angle of 10 degrees was used. Field calibration of the sonar cone width was not possible so it was assumed that cone width was consistent with the 10 degree beam angle. Thirty-eight transects covering four discrete reservoir areas were surveyed for a total sampling distance of 65 km. All targets within each 10 meter depth interval were counted The number of kokanee per transect was calculated using vertical gill net species composition proportions. Numbers of kokanee per 1,000 m^3 were calculated for each depth interval. These estimates were then converted to numbers per area and expanded to total surface area using methods and assumptions explained by Shepard (1985).

Growth

Fish collected in Libby reservoir and its tributaries were measured (total maximum length) and weighed. Scale samples were collected using techniques described by Lagler (1956). Age was assigned based on interpretation of annulus formation on scales (Jearld1983). Otoliths were taken from a limited number of fish. Otolith analysis was conducted by Dr. Ed Brothers to provide information on seasonal and differential growth of two migration classes of rainbow trout in the reservoir.

Movement

Fish movement within the Libby Reservoir drainage was assessed using tag return and tributary fish trapping information Trout over 99 mm captured purse seining, electrofishing, or stream trapping were tagged with either a Floy anchor tag (fish length 250 mm or larger) or with a Floy dangler tag (fish length 100-249 mm). Kokanee captured purse seining in spring 1984 were adiposed clipped. Rokanee sampled after that date were either adipose clipped (fish length 249 mm or less) or marked with a color coded flag tag (fish length 250 mm or larger). Tags were recovered by voluntary angler compliance and our sampling efforts.

An upstream box trap and a downstream Wolf-type trap (Huston et al. 1984) were operated in Young Creek from May 1 through July 19, 1985 (Figure 4). Downstream box traps were also operated in Big (June 21 -July 16), Bristow (June 3 - July 16), Fivemile (June 10 - July 17), Pinkham (June 11 - July 15) and Sinclair Creeks (June 11 -July 15) (Figure 4). Trap operators occasionally used hook and line techniques to capture and tag fish above the downstream traps.

Food Habits

Stomachs of various fish species captured in gill nets during 1984 and 1985 were collected and emptied into labeled plastic vials with preservative. Stomach contents were sorted into taxonomic groups, counted and weighed (Table 3). Subsampling was used when analyzing zooplankton and other abundant, small food items. Wet weights of all food categories except zooplankton were measured to the nearest 0.01 grams after removing excess water by blotting.

Dry and wet weights of zooplankton ingested by fish were estimated using length-weight regressions (Bottrell et al. 1976) and length weight tables (Cummins et al. 1969). Dry weights were converted to wet weights using a multiplication factor of 10. This multiplication factor is applicable for wet weights between 10 and 300 mg (Bottrell et al. 1976), the range most frequently found in Libby Reservoir. Tables developed by Cummins et al. (1969) were used to estimate wet and dry weights of *Leptodora* spp. by one millimeter length classes.

The majority of zooplankton ingested by fish were fragmented, and identifiable body parts were used to estimate the number of each genus within each stomach. Lengths of *Bosmina* spp., *Diatomus* spp., *Epischura* spp. and *Cyclops* spp. were estimated as 0.3, 0.7, 1.2, and 0.5 mm, respectively, based on average lengths found in zooplankton collections at the time fish stomach were sampled. All dry weights were converted into wet weights. We assumed an average length of six millimeters for all *Leptodora* spp. and used this length to enter length weight tables developed by Cummins et al. (1969) to estimate the wet weights of *Leptodora* spp.. Body lengths of *Daphnia* spp. were estimated using measurements of the post-abdominal claw following methods presented by Leathe and Graham (1981).

An index of relative importance (IRI) was calculated to estimate the importance of particular food items in the diet (George and Hadley 1979). The IRI is the arithmetic mean of the number, frequency of occurance, and weight of a food item in the diet, expressed as a percentage. IRI values range from zero to

Table 3. Number of stomachs collected for food habits analyses from three areas of Libby Reservoir during 1983-85.

	SPECIES															
	RB		WCT		RB x WCT											
Season	<330	>330	<330	>330	<330	>330	DV	KOK	MWF	Ling	RSS	NSQ	CSU	FSU	YP	PM
Tenmile																
Summer/1983	1	16	0	2	0	3	0	0	5	0	4	4	6	3	0	4
Fall/1983	8	10	4	6	2	11	1	2	11	2	1	5	0	0	0	5
Winter/l984	7	10	4	4	4	6	4	8	2	4	0	4	5	2	0	5
Spring/1984	11	10	5	11	10	4	5	15	1	0	6	5	5	5	0	5
Fall/1984	14	12	6	7	6	8	15	9	4	4	0	6	5	4	2	5
Spring/1985	5	12	3	10	2	6	7	10	8	1		5	5	-	2	5
Summer/1985	5	8	6	- -	7	5	2	22	9	2		5	4	3	2	5
Fall/1985	15	12	9	6	8	1	2	5	11	3		5				5
Rexford																
Summer/1983	4	40	11	10	5	4	0	0	2	0	5	5	4	2	0	5
Fall/1983	8	10	2	5	3	9	3	1	5	0	2	4	0	0	0	5
Winter/l984	9	10	13	7	11	10	3	25	10	1	0	5	5	2	0	5
Spring/1984	5	11	1	6	2	11	13	10	8	4	6	5	5	6	5	5
Fall/1984	11	11	7	10	11	3	25	11	6	0	0	5	5	0	1	5
Winter/l985	12	9	12	9	11	9	10	9	11	4		5	2	4		5
Spring/l985	10	4	4	1	7		3	12	7	5			-		2	
Summer/1985	9	8	10	1	5	7	-	3	12		5	5	-		9	5
Fall/l985	12	11	12	8	12	5	10	10	9		-	5	-		4	3
Canada																
summer/1983	0	6	2	0	0	0			4	0	4	5	5	1	0	5
Fall/1983	8	9	10	6	13	8	3	2	10	0	1	6	0	0	0	6
Winter/l984	frozen -			-		-	-	-			-		-	-		
Spr ing/l984	dewatered			-		-	-	-			-		-	-		
Fall/1984	12	10	9	4	10	4	3	11	14	1	0	5	5	1	0	6
Summer/1985	8	13	8	-	3	7	1	17	13	1	1	5				5
Fall/1985	12	6	10	2	2	2	-	-	1							

100, with a value of 100 indicating exclusive use of a food item in the diet. Frequency of occurance and weight data were used to calculate IRI's for insect parts, algae, and debris.

ABUNDANCE AND AVAILABILITY OF FISH FOOD ORGANISMS

Zooplankton Standing Crop

Three 30 M (or the entire water column when depth was less than 30 M) vertical plankton tows were made bi-weekly from April through October and monthly from November through April in each geographic area of the reservoir. A 0.3 M diameter Wisconsin plankton net was used for all tows. One tow was made at the permanent sampling buoy and two tows were made at randomly selected points on established transects in each area.

Zooplankton Vertical Distribution

A plankton trap similar to that described by Schindler (1969) was used monthly to sample the vertical plankton distribution at permanent sample buoys in each geographic area. The trap sampled a 28.1 liter volume of water and each sampling series consisted of nine discrete samples collected at the surface, 3, 6, 9, 12, 15, 20, 25, and 30 M.

All zooplankton samples were preserved in a solution of water, methyl alcohol, formalin, and acetic acid. Vertical tow samples were diluted in the laboratory to a solution in which five milliliter subsamples contained approximately 80 to 100 organisms. Schindler trap samples were concentrated to 25 ml. Five subsamples (5 mm) were counted and averaged to estimate densities (number per liter) of zooplankton classified to genus, Carapace lengths of individual plankton from one randomly selected five milliliter subsample were measured. Carapace lengthdata were segregated into 0.5 mm length groups for each genus and each group was averaged. Biomass of zooplankton was estimated using the length-weight relationships previously described.

Schindler (1969) and Bottrell et al. (1976) considered the plankton trap to be an efficient sampling device. Densities of zooplankton estimated from vertical tow and plankton trap samples were compared to evaluate the efficiency of the vertical tow method.

Benthos

Three replicate samples were collected seasonally from three elevational strata in each area using a Peterson benthic dredge. The three elevational strata were classified as: frequently dewatered (between full pool and the 2,369 foot contour), occasionally dewatered (between 2,368 and 2,287 foot contours), and permanently wetted (below the 2,287 foot contour).

Benthos samples were wet-sieved using 5.6, 0.85 and 0.52 mm sieves. The material retained in the 0.52 mm sieve was preserved and brought to the laboratory where all macroinvertebrates were picked from the sample and identified to order or class (Diptera and Oligocheatea). The number and total blotted wet weights of each order or class were recorded. Densities were expressed as number per square meter and weights as grams per square meter of reservoir bed by elevational strata and geographic area.

Surface Macroinvertebrates

Macroinvertebrates on the surface of the reservoir were sampled using a net made of 3.17 mm mesh which tapered to 1.59 mm mesh that tapered to a 100 mm collar. The mouth of the net was held open by a rectangular frame 1.0 m wide by 0.3 M high. A removable plastic bucket with a panel of 80 micron nitex netting was attached to the collar at the cod end of the net. The net sampled a one meter swath of the reservoir's surface.

Three sites were sampled bi-weekly in each geographic area from May through October and monthly from November through April. Sample sites were selected randomly using established transects as startingpoints,Surface tows were made by towing the net for ten minutes at a fixed speed of one meter per second Each ten minute tow covered approximately 600 square meters. As of July 1985, this method was simplified with the use of a digital knotmeter (Signet, Model MK 267). This instrument accurately measured the sampling distance of 600 meters. At each sample site, one tow was made in the nearshore zone and another in the limnetic zone.

All macroinvertebrates were removed from the bucket and net after each tow and placed in a labeled vial containing preservative. Macroinvertebrates in each sample were identified to order and counted in the laboratory. Blotted wet weights were measured in grams. Densities of surface macroinvertebrates were expressed as number per hectare and grams per hectare. A matched pair T-test (Lund 1983) was used to compare total numbers of macroinvertebrates per hectare in the limnetic and nearshore zones of each geographic area.

CREEL AND ECONOMIC CENSUS

An intensive creel and economic census was conducted from May 18 (opening of the general fishing season) through November 1, 1985 in the three geographic areas of Libby Reservoir. Census techniques incorporated direct interviews and car counters installed at boat ramp access sites. Interview data were collected at car counter sites, check stations on major access roads, and on the reservoir by boat using methods described by Graham and Fredenberg (1982). Car counter data were collected according to methods presented by Mischon and Wyatt (1979).

Categories of angling (shore or boat) were stratified into weekday, weekend day, and holiday time periods and each day was segregated by four hour time blocks starting at 6:00 a.m. All weekends and holidays and three weekdays were censused so a minimum of 40 hours/week were sampled. Interview weekdays, time blocks, and geographic locations were selected randomly. Economic and creel interviews were performed on a party basis with emphasis on completed trips. Interview and car counter information will be used to establish catch rates, harvest, catch composition, size of catch, angling methods, angler origin and economic values.

RESULTS AND DISCUSSION

RESERVOIR HABITAT

Physical - Chemical Limnology

The three reservoir areas are differentially affected by drawdown, a function of the basic morphology and proximity to the dam Relative changes in water volume and surface area are largest in the Canada area and smallest in the Tenmile area (Figures 5 & 6). During August 1984 through July 1985, euphotic zone depths averaged 9.5, 8.5, and 12.7 meters for the Canada, Rexford and Tenmile areas, respectively (Figure 7). The overall average euphotic zone depth for this period was 10.0 meters. A decrease in euphotic zone depth for all areas from April through July probably reflects turbid tributary inflows due to runoff.

Reservoir temperature profiles representative of the fall, winter, and summer periods are presented in Figure 8. The relatively even spacing of the isopleths during all periods indicates a weak thermal structure - even during the summer period. Greatest areas of habitat with o timum water temperature for Westslope cutthroat trout (11-16°C, Hickman and Raleigh 1982), rainbow trout (12-18°C, Raleigh et al. 1984), and kokanee (10-15°C, Piper et al. 1982) occur during the spring and fall months. The reservoir was homothermous from November 1984 through April 1985 in the Tenmile and Rexford areas (Figure 9). During winter 1984-85, the entire reservoir froze over; the Canada and Rexford areas were ice-covered in December and the Tenmile areabylate January.

Monthly profiles from October 1984 through November 1985 for dissolved oxygen, pH, conductance, incident light, and temperature are presented in Appendix A. Dissolved oxygen and pH values in the reservoir were within the range considered optimum (10-160) for trout growth (Piper et al. 1982).

Digitized contour maps of the reservoir at 3.1 m (10 ft.) intervals down to 58 m (190 ft.) drawdown have been created using the computer program Geoscan. When proofed, these maps will provide information on the areas and volumes of water at each drawdown level and more detailed information on the amount and types of habitat lost as the reservoir is drafted.

Habitat Enhancement

Overall survival of vegetation plantings in the littoral zone was poor. Willow, dogwood and sedge plantings did not survive in the Tobacco Bay area to June 1985 (Table 4). Plantings in the Bristow Bay area were somewhat more successful; one of four green willow plots had 33% survival by June 1985 and two of eight sedge sod plots had 66% or greater survival. None of the other 13 plots

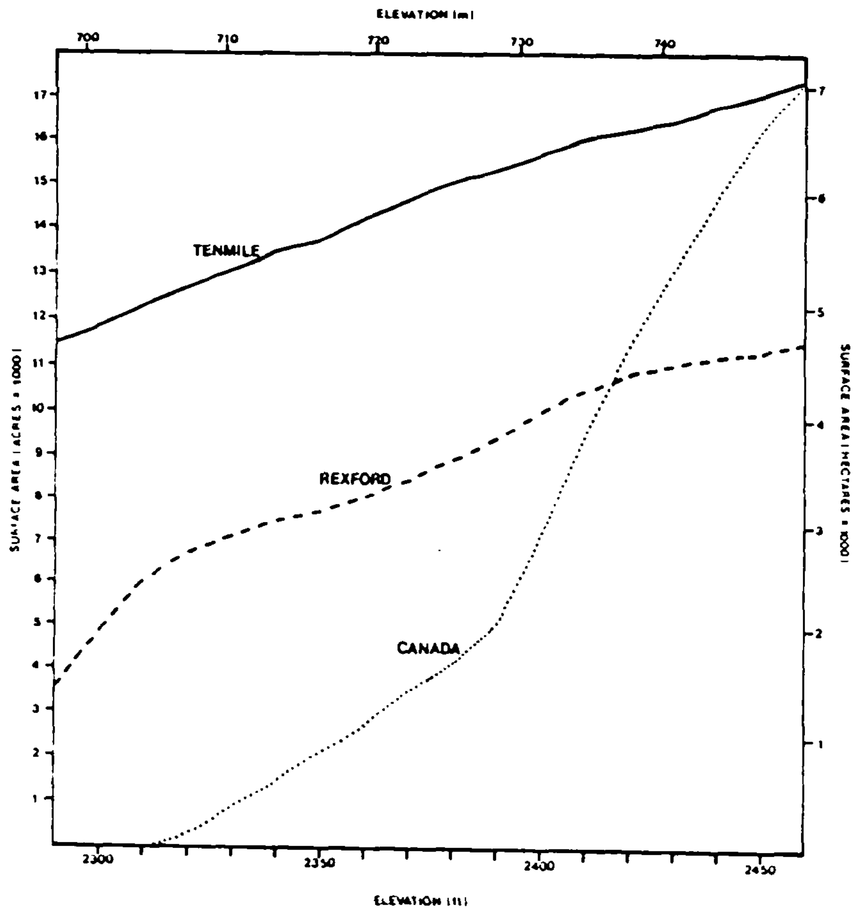


Figure 6. Relationships between changes in Libby Reservoir elevations and surface area of each geographic area within the reservoir.

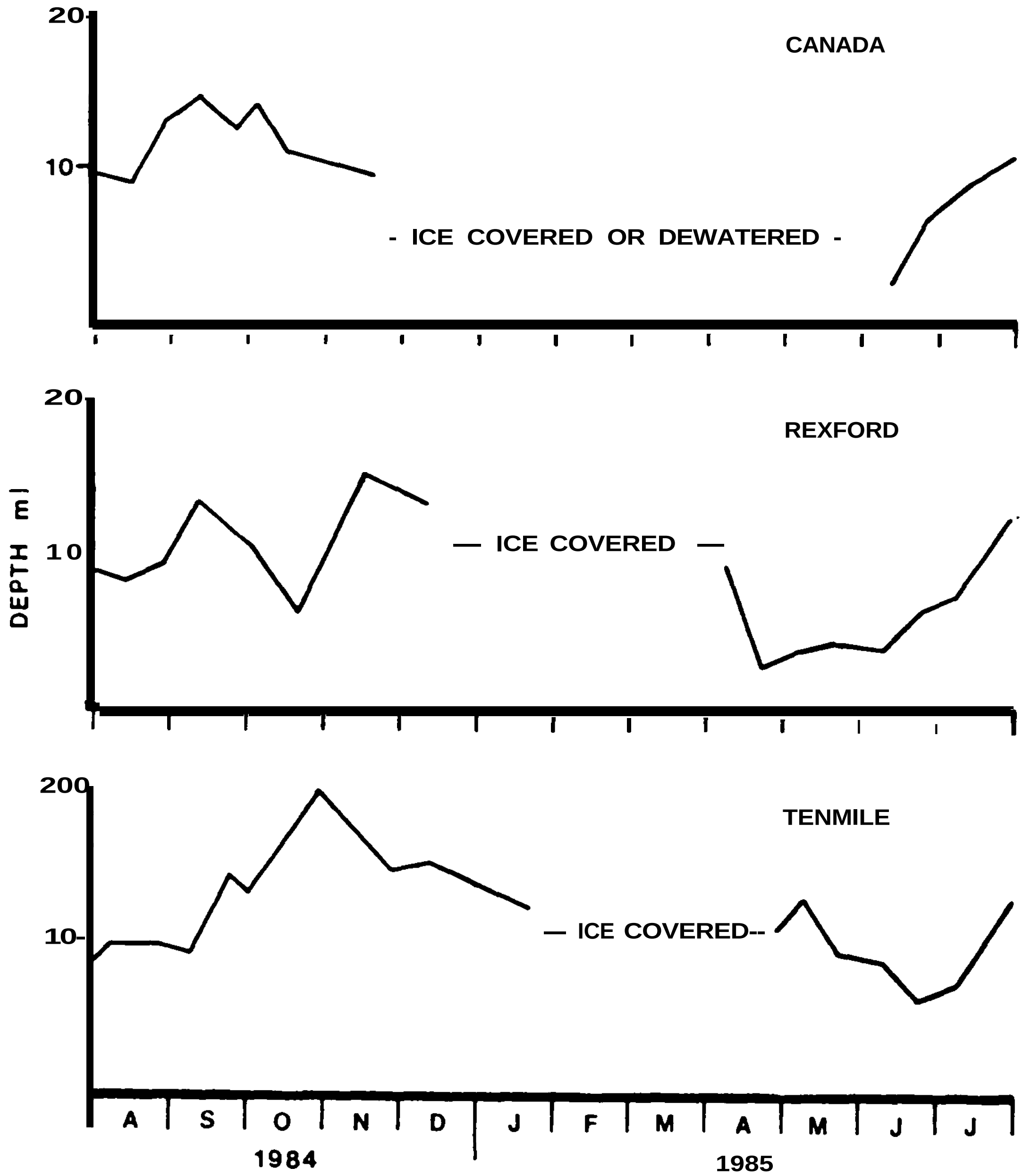


Figure 7. Euphotic zone depths measured in the three areas of Libby Reservoir from August 1384 through July 1985.

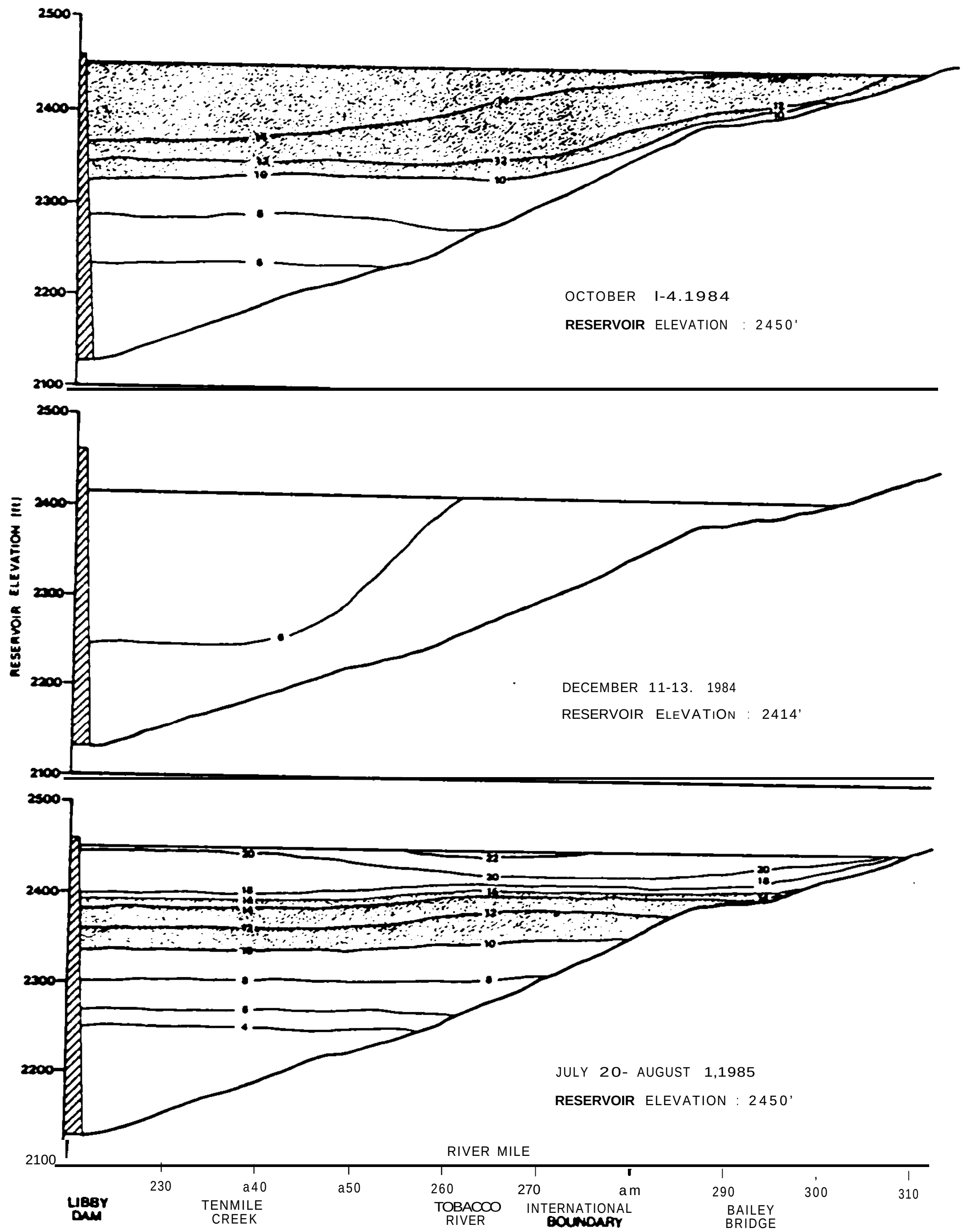


Figure 8. Temperature isopleths in Libby Reservoir in Fall 1984, Winter 1984 and Summer 1985. Shaded area delineates amount and location of optimum temperature for trout and salmon.

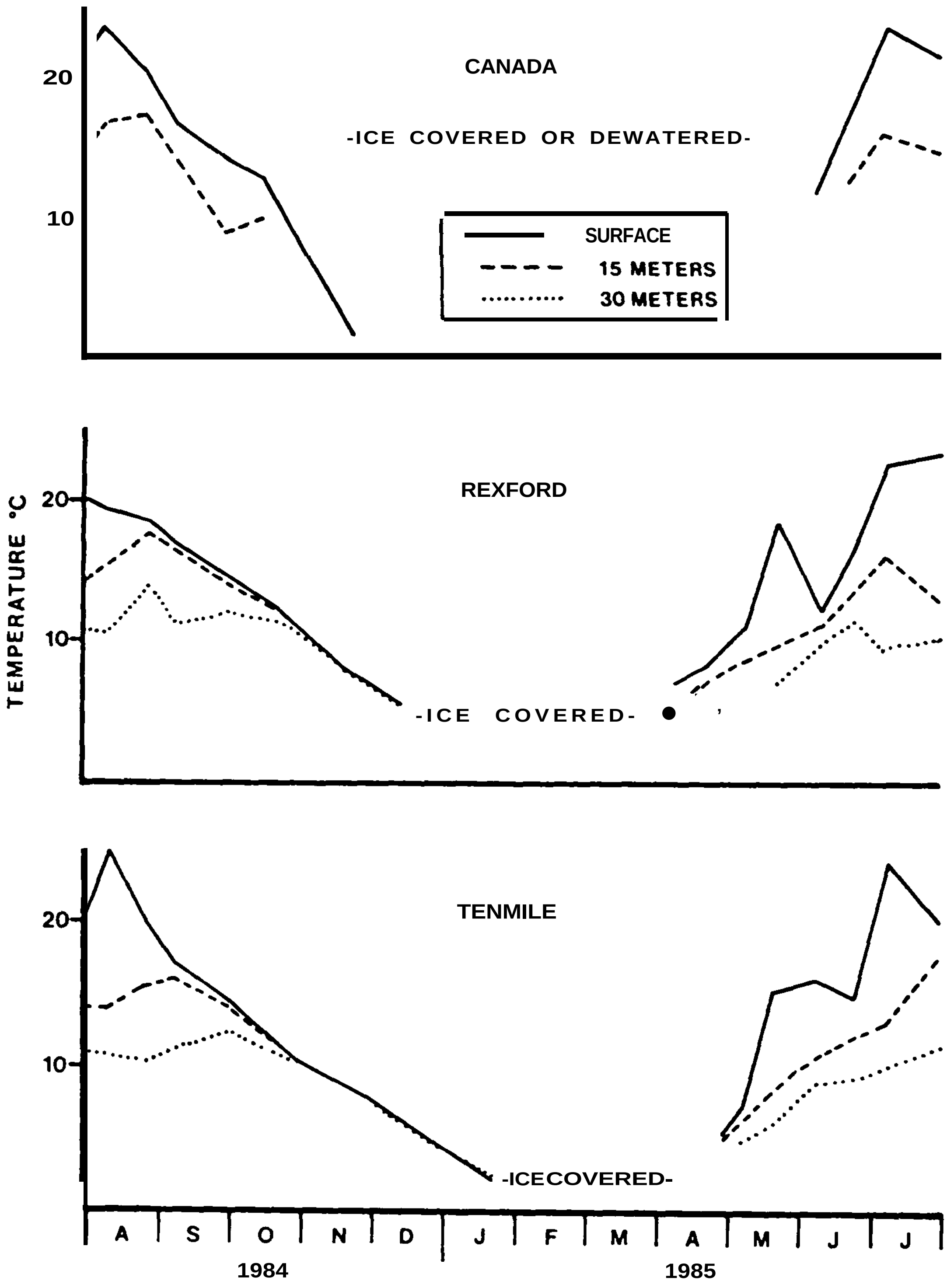


Figure 9. Water temperatures at three specific depths in the three areas of Libby Reservoir from August, 1384 through July 1985.

Table 4. Survival of planted willow, sedge, and red ozier dogwood from planting in May, 1984 to June, 1985 prior to inundation by Libby Reservoir.

Area Species	Plot[a]	Date Planted	Date Inventoried	Number Planted	Number (%) of Survivors 6/14/84	Number (%) of Survivors 6/14/85
Bristow Bay						
Red Willow	5	04/06/84	06/14/84	24	11 (46)	0 (0)
	10	"	"	24	15 (62)	0 (0)
	15	"	"	24	17 (71)	0 (0)
	20	"	"	24	19 (79)	0 (0)
Green Willow	5	"	"	24	23 (96)	8 (33)
	10	"	"	24	22 (92)	0 (0)
	15	"	"	24	23 (96)	0 (0)
	20	"	"	24	23 (96)	0 (0)
Sedge	5 A	05/02/84	06/16/84	3	3 (100)	2 (66)
	5 B	"	"	3	3 (100)	0 (0)
	10 A	"	"	3	3 (100)	0 (0)
	10 B	"	"	3	3 (100)	0 (0)
	15 A	"	"	3	3 (100)	0 (0)
	15 B	"	"	3	3 (100)	0 (0)
	20 A	"	"	3	3 (100)	0 (0)
	20 B	"	"	3	3 (100)	3 (100)
Tobacco Bay						6/20/85
Red Willow	5 A	04/05/84	06/23/84	24	16 (67)	0 (0)
	5 B	"	"	24	7 (29)	0 (0)
	10 A	"	"	24	8 (33)	0 (0)
	10 B	"	"	24	9 (37)	0 (0)
	15 A	"	"	24	10 (42)	0 (0)
	15 B	"	"	24	7 (29)	0 (0)
	20 A	"	"	24	8 (33)	0 (0)
	20 B	"	"	24	13 (54)	0 (0)
Dogwood	5 A	"	"	24	18 (75)	0 (0)
	5 B	"	"	24	8 (33)	0 (0)
	10 A	"	"	24	12 (50)	0 (0)
	10 B	"	"	24	2 (8)	0 (0)
	15 A	"	"	24	11 (46)	0 (0)
	15 B	"	"	24	5 (21)	0 (0)
	20 A	"	"	24	8 (33)	0 (0)
	20 B	"	"	24	4 (17)	0 (0)
Sedge	5 A	05/02/84	"	3	3 (100)	0 (0)
	5 B	"	"	3	3 (100)	0 (0)
	10 A	"	"	3	3 (100)	0 (0)
	10 B	"	"	3	3 (100)	0 (0)
	15 A	"	"	3	3 (100)	0 (0)
	15 B	"	"	3	3 (100)	0 (0)
	20 A	"	"	3	3 (100)	0 (0)
	20 B	"	"	3	3 (100)	0 (0)

[a] Number indicates approximate depth at full pool (ft.) and letter indicates replicate.

survived to June 1985. Extreme water level fluctuation is thought to be the major cause of the plantings' poor survival.

FISH ABUNDANCE, GROWTH AND DISTRIBUTION

Nearshore Zone

Relative abundances of fish captured by floating and sinking horizontal gill nets varied seasonally within and between the three areas (Figures 10 & 11). Floating gill net catch rates in the three areas (no fish/net) were highest in spring for trout, char, and largescale suckers (Appendix B). Highest catch rates of kokanee occurredduringthe fall sampling period. Northern squawfish and redside shiners were more frequently captured during the summer months in the Tenmile area. The relative abundance of Salmo spp., kokanee, and other gamefish (mountain whitefish and bull trout) in the catch increased during the fall. Peamouth were the most frequently caught species in the gill nets which probably reflects their numerical predominance in the reservoir. The exception in November 1984, when more Salmo spp. and kokanee were caught in the Rexford and Canada areas could be a consequence of movement towards deeper water as suggested by Shepard (1985), or a change in behavior (i.e. reduced movement) induced by lower water temperatures resulting in a lowered susceptability to capture (Hubert 1983). Seasonal peamouth catches were lower during fall sampling in all areas for all study years and no increase in fall vertical gillnet catches of peamouth has been noted (Appendix B).

Sinking gillnet catches consisted of higher numbers of bull trout, mountain whitefish, and largescale suckers (Figure 11, Appendix B). Greatest numbers of Salmo spp, mountain whitefish, and bull trout were caught in the Rexford area during spring sampling and in the Canada area during the fall. An increase in Salmo spp. sinking gill net catches in the Tenmile area during summer 1985 could reflect an active migration by these species towards steeper sloped shorelines associated with deeper, cooler water.

Annual floating gill net sampling from 1975 through 1985 illustrates a continued increase in kokanee abundance and a dramatic decline in redside shiner numbers (Figure 12, Table 5). In 1985, average length of kokanee captured was 351 mm, down from the 440 mm average length reported for the 1982 catch, when fish were less numerous. This could indicate the existence of a density dependent growth relationship as reported by Goodlad et al. (1974), Rogers (1973), and others. Salmo SPP. abundance continues to be lower than in 1980 and preceding years. Northern Squawfish numbers appear to be steadily declining. However, direct comparison of 1985 data with antecedent years may be tenuous; sampling in relatively cooler water may have increased or decreased the efficiency of the shoreline gill net sets, depending on an individual species thermal preferences and associated behavior.

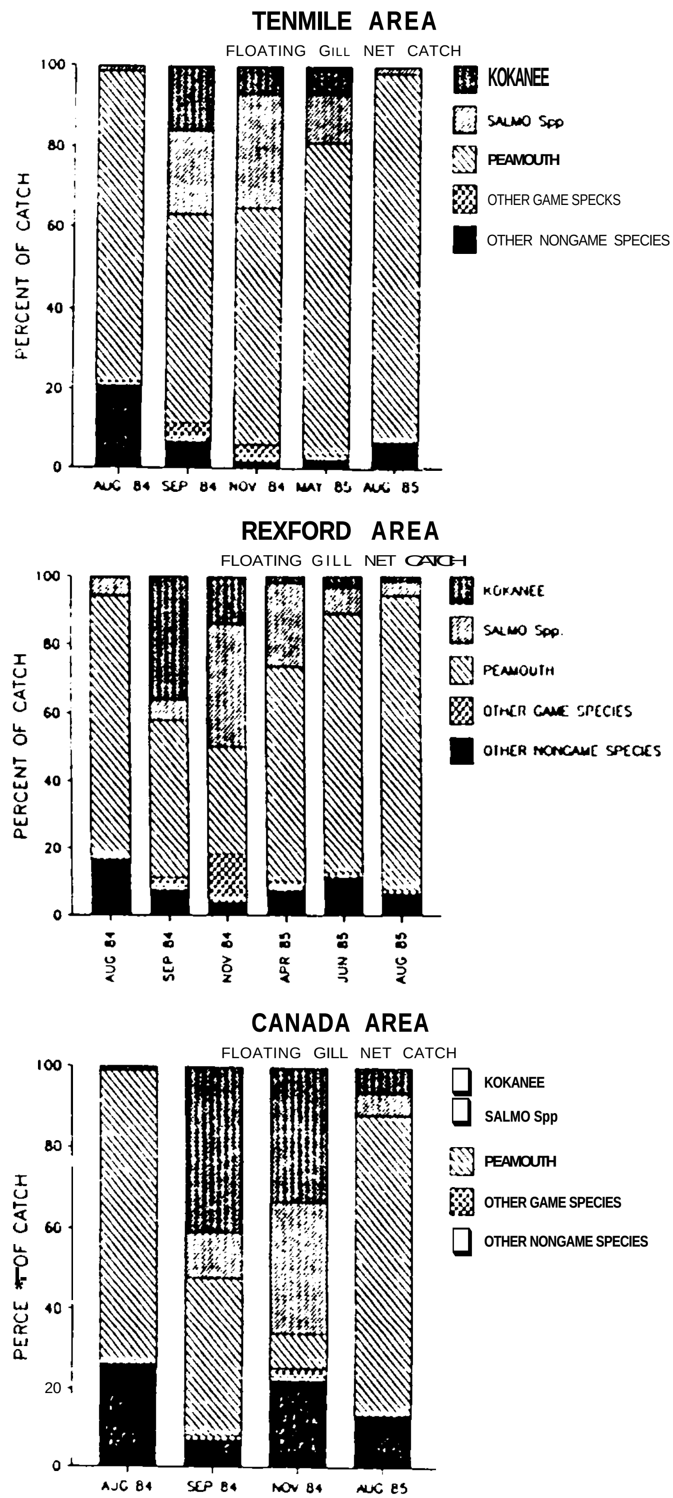


Figure 10. Relative abundance of various fish species captured in floating gill nets in the three areas of Libby Reservoir from August 1984 through August 1985.

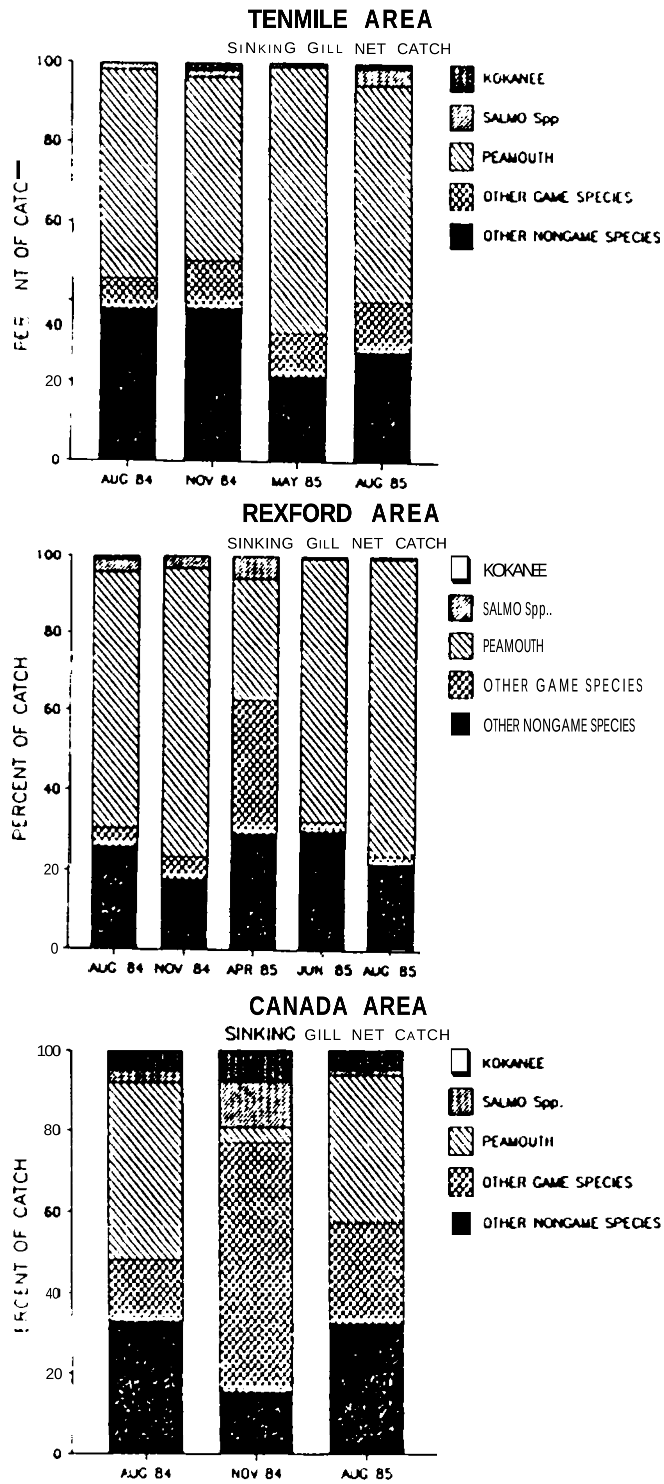
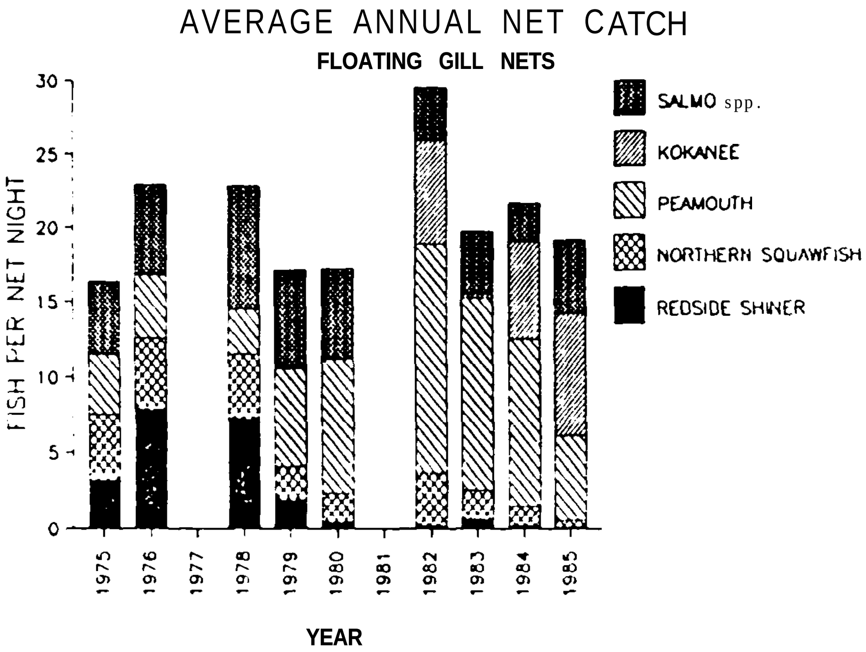


Figure 11. Relative abundance of various species captured in sinking gill nets in the three areas of Libby Reservoir from August 1984 through August 1985.



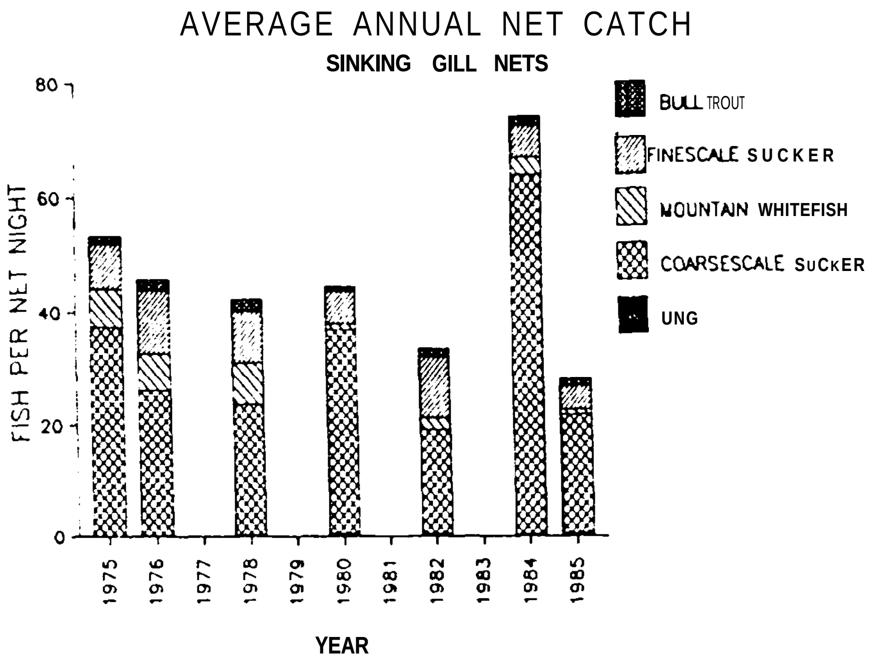


Figure 12. Annual catches of fish (number of fish per net night) in floating gill nets set dur1r.g the fall and sinking gill nets set during the spring in Libby Reservoir from 1975 through 1985.

Table 5. Average catch per net night in floating gill nets set during the fall in the Tenmile and Rexford areas of Libby Reservoir in 1975, 1976, 1978, 1979, 1980, 1982, 1983, 1984, and 1985. a/

Parameter	Year 1975	1976	1978	1979	1980	1982	1983	1984	1985
Surface temperature(°C)	16.1	17.2	15.6	16.7	15.6	16.7	16.3	15.6	11.4
Number of nets	129	91	78	73	79	70	24	28	40
Average catch of: b/									
RB	2.8	3.6	6.3	4.9	4.8	2.4	1.9	1.5	2.5
WCT	2.0	2.5	2.0	1.4	1.2	1.2	0.7	0.7	1.4
RB x WCT c/	0.0	0.0	0.1	<0.1	<0.1	<0.1	1.6	0.4	1.0
Total Salmo	4.8	6.1	8.4	6.3	6.0	3.6	4.2	2.6	4.9
MWF	2.0	2.3	1.2	1.4	0.6	1.0	0.4	0.8	0.2
CRC	4.0	4.2	3.0	6.5	8.8	15.1	12.6	11.0	5.5
NSQ	4.2	4.7	4.2	2.1	1.9	3.5	1.9	1.3	0.5
RSS	3.3	7.9	7.3	2.0	0.5	0.2	0.7	0.2	0.1
DV	<0.1	<0.1	<0.1	0.1	0.2	<0.1	0.0	0.1	0.2
CSU	1.9	2.4	0.9	1.1	1.2	1.2	0.4	0.2	0.1
KOK	0.0	0.0	0.0	0.2	0.0	7.1	0.3	6.5	8.1
Total	20.2	27.6	25.0	19.7	19.2	31.7	20.5	22.7	19.6

a/ Catches prior to 1983 reported by Huston et al. (1984)

b/ Abbreviations explained in "Methods" section under "Fish Abundance..."

c/ Prior to 1983 very few hybrids were identified as such, although they were probably present in the samples.

Spring sampling through the same years with sinking gill nets indicates that bull trout and burbot abundance has remained fairly constant (Figure 12, Table 6). Mountain whitefish and finescale sucker numbers appear to be declining and there has been an increase in yellow perch caught, However, 1985 sampling temperature may be too disparate from previous years and confounded interpretation of catch rates over time (Table 6).

As in 1984, nighttime shoreline electrofishing of areas containing various habitat types revealed no distinct trends in habitat preference by Salmo spp. (Appendix C). Highest catch rates of peamouth were along shorelines with low gradient slopes in both areas sampled. These data support the general observation of Scott and Crossman (1973) that the peamouth "is a fish of the weedy shallows of lakes and rivers...". Lack of consistent habitat associations by other fish species suggests that the habitat variables we measured were not important factors determining fish distribution or that the sampling methods used confounded existing habitat associations

Limnetic Zone

Kokanee dominated the vertical gill net catch during all months sampled in the lower two areas of the reservoir (Figure 13, Appendix D), a reflection of the pelagic nature of the species. Vertical gill nets in the Canada area caught mainly peamouth and coarsescale sucker, except during October 1985, when the 1983 year class of kokanee returned to Canada to spawn

Purse seine catch was also dominated by kokanee (Table 7). Highest average catch of kokanee occurred during spring in both the Tenmile (63.5 fish/haul) and Rexford (57.7 fish/haul) areas. The high standard deviations associated with these catch rates reflect the schooling and therefore patchy distribution of this species. Fall sampling yielded the highest catch rates of Salmo spp. and mountain whitefish while most peamouth were captured during spring purse seine sampling.

Comparative Depth Distributions

Comparison of depth distributions of plankton and kokanee with temperature profiles from July 1984 through July 1985 revealed the seasonally changing importance of temperature as a factor regulating kokanee distribution (Appendix E). During the summer months (late June through September), kokanee were found almost exclusively at those depth strata with optimum temperatures (10-15°C, Piper et al. 1982). When water temperatures were below 10°C, kokanee depth distribution appeared to be more strongly influenced by Daphnia abundances. This interpretation applied to all three areas. Generally, the greatest percentage of plankton

Table 6. Average catch per net night in sinking gill nets set during the spring in the Rexford area of Libby Reservoir in 1975, 1976, 1978, 1980, 1982, 1984, and 1985.[a/]

Parameter	Year						
	1975	1976	1978	1980	1982	1984	1985
Surface temperature ((C)	12.8	12.2	11.1	11.1	11.7	12.7	15.0
Number of nets	111	41	41	38	36	20	23
Average catch of:[b/]							
RB	0.8	0.3	1.4	0.7	1.4	2.5	0.3
WCT	0.2	0.04	0.4	0.2	0.4	<0.1	0.1
RB x WCT[c/]	0.0	0.0	0.0	0.0	<0:1	0.6	0.1
MWF	6.6	6.4	7.2	1.0	2.1	2.9	0.8
CRC	0.3	1.0	0.7	7.2	24.3	59.2	79.7
NSQ	2.3	1.2	5.8	2.8	4.3	8.0	8.9
RSS	d/	1.4	2.8	0.7	1.9	2.5	1.4
DV	1.4	1.9	2.2	0.8	1.5	1.8	1.3
LING	<0.1	0.2	0.3	0.6	0.5	0.4	0.6
CSU	37.3	26.1	23.5	36.3	18.6	63.2	21.3
FSU	7.9	11.1	9.1	5.8	10.9	5.6	4.3
YP	0.0	0.0	0.0	0.0	0.2	0.8	1.0
Total	56.8	50.0	53.4	56.1	66.0	147.5	119.8

a/ Catches prior to 1984 reported by Huston et al. (1984)

b/ Abbreviations explained in "Methods" .

c/ Prior to 1984 very few hybrids were identified as such, although they were probably present in the samples

d/ Numbers of redside shiners were not recorded in 1975, although several hundred were caught

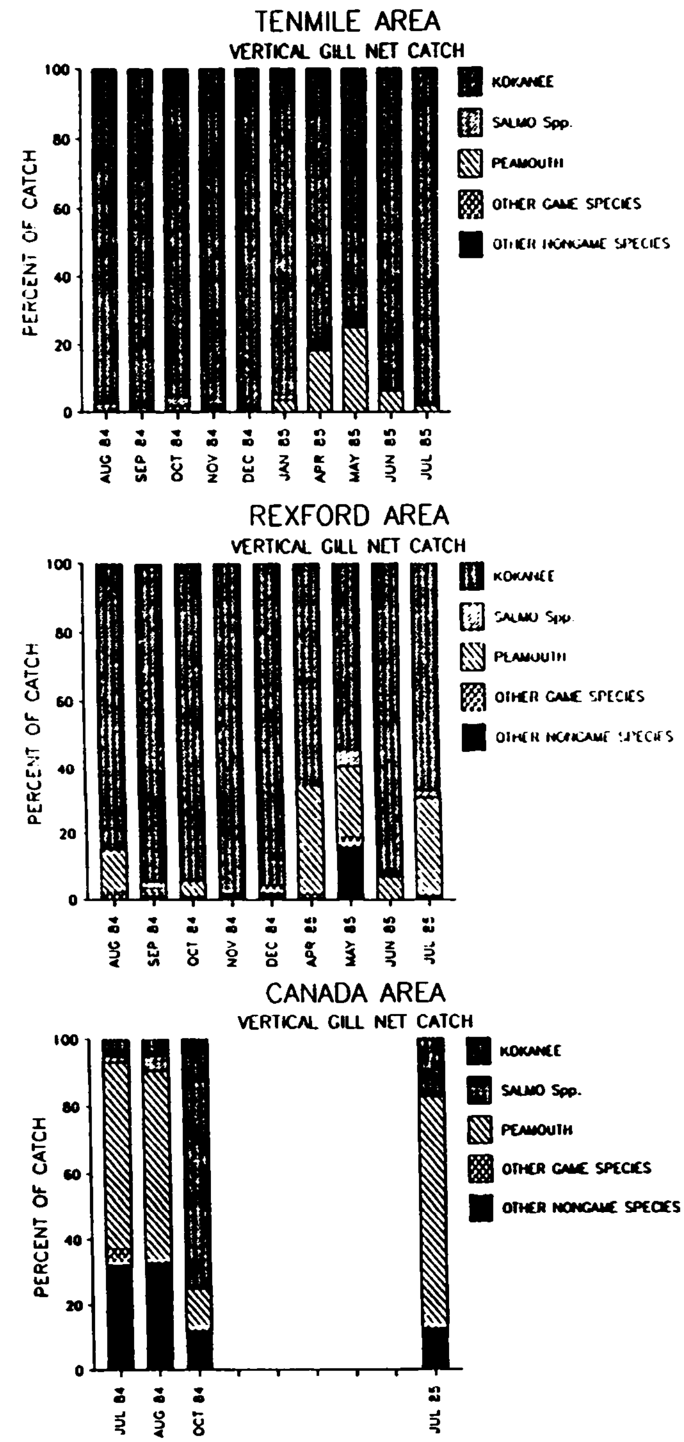


Figure 13. Relative abundance of various fish species captured in vertical gill nets in the three areas of Libby Reservoir from August 1984 through July 1985.

Table 7. Mean catch (standard error) of fish by area in purse seine hauls conducted in Libby Reservoir during 1984 and 1985.

Area	Season	n[a]	RB[b]	WCT	HB	SALMO	KOK	MWF	CSU	CRC
			Mean Catch (SE)							
TENMILE										
	Spring '84	2	4.0 (2.0)	0.5 (0.5)	0.5 (0.5)	5.0 (3.0)	331.5 (14.5)	1.0 (--)	0.5 (0.5)	— (--)
	Summer '84[c]	5	1.0 (0.6)	0.6 (0.4)	0.4 (0.4)	2.0 (0.7)	35.0 (33.5)	0.4 (0.4)	0.2 (0.2)	4.2 (1.1)
	Fall '84	19	0.1 (0.1)	0.1 (0.1)	-- (--)	0.2 (0.2)	24.7 (6.0)	-- (--)	-- (--)	(--)
	Spring '85	14	0.6 (1.16)	0.3 (0.83)	— --	0.9 (1.88)	54.8 (63.92)	0.1 (0.27)	0.1 (0.36)	--
REXFORD										
	Spring '84	37	3.0 (0.6)	1.7 (0.4)	1.3 (0.3)	6.0 (1.0)	120.3 (55.3)	3.0 (0.6)	9.4 (3.6)	1.6 (1.3)
	Summer '84[c]	6	0.5 (0.3)	0.7 (0.3)	— (--)	1.2 (0.6)	7.8 (5.0)	0.2 (0.2)	0.2 (0.2)	2.8 (2.2)
	Fall '84	27	0.2 (0.1)	0.04 (0.04)	0.1 (0.1)	0.4 (0.1)	20.6 (2.7)	0.1 (0.1)	— (--)	-- (--)
	Spring '85	12	0.3 (0.45)	0.2 (0.39)	0.2 (0.39)	0.6 (1.00)	54.2 (58.17)	0.1 (0.29)	1.9 (2.27)	13.6 (10.60)
	Fall '85	23	1.2 (1.50)	0.3 (0.71)	0.2 (0.52)	1.7 (1.86)	2.3 (2.34)	1.0 (1.31)	-- --	-- --
CANADA										
	Fall '84	22	1.1 (0.3)	0.3 (0.2)	0.4 (0.2)	1.9 (0.4)	7.7 (1.9)	— (--)	(3.8)	-- (--)

[a] n = number of hauls

[b] Abbreviations were described in the "Methods" section.

[c] Summer sampling was done during the evening and night all other sampling MS done during the day.

were found at or below the euphotic zone depth, especially during the summer.

Hydroacoustic Estimate of Kokanee

Estimated densities of kokanee in the reservoir during August 1985 differed by area (Table 8). Sonar transect volumes and lengths sampled are presented in Appendix F. Peck Gulch and Rexford areas had the highest estimated densities (128/acre and 109/acre, respectively) and the number present differed statistically from the Tenmile and Canada areas. The Canada area had the lowest density of kokanee (5/acre) and this also differed statistically from the other areas. These densities varied from those reported in 1984 for the same areas (Shepard 1985), but given the pelagic habit of kokanee this is not unexpected. The expanded total population estimate of 2,385,742 kokanee (Table 9) suggests a decline in kokanee numbers from 1984 (2,574,333), prior to fall spawning losses. However, taking into account natural and fishing mortality over the year and a weaker year-class recruitment, the estimate seems fully plausible. The 1986 sonar kokanee estimate should be much reduced from this number, following the spawning loss of a very strong 1983 year class.

Preliminary Creel Survey Results

A summary of creel interview data is presented only; analysis of car counter data and other information needed to calculate fishing pressure was not completed. A future report will detail total harvest, fishing pressure, average length creeled, economic values and other information not presented here.

A total of 2,347 anglers were interviewed during the reservoir creel survey. Most anglers contacted were fishing for kokanee. The mean catch rate for this species during the interview period was 0.84 fish per hour (Table 10). Catch rates ranged from a high of 2.15 fish per hour from 27 May through 9 June 1985 and a low of 0.30 fish per hour in late September, just prior to the spawning period. The catch rate for kokanee was 1.2 fish/hour in the Rexford area of the reservoir, compared with 0.95 fish/hour in the Tenmile area and 0.55 fish per hour in the Canada area. The overall average catch rate (0.84 fish/hour) during the creel interview period was significantly higher than that in 1981 (0.04 fish/hour, Huston et al. 1984), when kokanee first appeared in the catch. The most successful kokanee anglers came from the Eureka-Rexford area, Idaho, Washington, and Flathead County, Montana, indicating the regional importance of the reservoir fishery (Table 11).

Table 8. Kokanee density estimates in four areas of Libby Reservoir, August 1985, as determined by hydroacoustic sampling.

	Estimated Density		
Area	Number/acre	Number/ha	Newman-Keuls* Multiple Comparison
Tenmile	46.5	114.9	A**
Peck Gulch	128.0	316.2	B
Rexford	109.5	270.5	B
Canada	5.1	12.6	C

* Anova test indicated significant difference among areas ($F_{3,34}$ = 39.80; p<.0001)

** Number/area values that are significantly different are indicated by different capital letters.

Table 9. Expanded estimates of kokanee numbers in Libby Reservoir determined by hydroacoustic sampling during August, 1985.

Geographic Area	Total ha	Surface area acres	Area	Sampled acres	Estimated Number	95% Confidence Interval
Tenmile	4,680.l	11,564.l	8.5	20.9	537,731	± 28,425.5
Peck Gulch	1,912.l	4,724.7	5.7	14.2	604,762	± 23,883.3
Rexford	4,379.3	10,820.7	9.7	24.1	1,184,867	± 66,680.3
Canada	4,632.g	11,447.5	7.7	19.1	58,382	± 10,031.o
Total	15,604.4	38,557	31.7	78.3	2,385,742	± 129,020.1

Table 10. Summary of completed trip creel interviews by two week time blocks conducted on Libby Reservoir from 27 May through 13 October 1985.

1985 Period	Number anglers	Angling hours	Number Creeled (Fish kept per Hour) Salmo sp.	KOK	w
Nay 27 - June 9	12	60	10(0.17)	129(2.15)	1(0.02)
June 10 -June 23	113	665	7(0.01)	705(1.06)	0(--)
June 24 - July 7	952	4,659	61(0.01)	4,341(0.93)	1(<.01)
July 8 - July 21	31	167	1(0.01)	132(0.79)	0(-)
July 22 -Aug.4	84	449	8(0.02)	526(1.17)	0(-)
Aug. 5 - Aug. 18	323	1,550	40(0.03)	1,501(0.97)	2(<.01)
Aug. 19 - Sept. 1	281	1,253	59(0.05)	876(0.70)	0(-)
Sept. 2- Sept. 15	335	1,473	66(0.04)	917(0.62)	0(-)
Sept. 16 - Sept. 29	214	824	111(0.13)	250(0.30)	0(-)
Sept. 30 - Oct. 13	2	1	0(-)	0(-)	0(-)
Total	2,347	11,101	363(0.03)	9,377(0.84)	4(<.01)

Table 11. Residency and fishing success of anglers contacted during the creel survey conducted on Libby Reservoir, 27 May through 13 October, 1985.

Angler Origin	Number Anglers	(%)	Hours	Salmo sp.	KOK	DW
Libby	348	(14.9)	1,495	47	949	1
Eureka-Rexford	774	(33.2)	3,297	197	2,037	2
Lincoln Co.- other	73	(3.1)	268	17	137	0
Flathead Co.	275	(11.8)	1,351	19	1,386	1
Sanders Co.	33	(1.4)	259	2	148	0
Other - Western MT	79	(3.4)	256	1	386	0
Eastern MT	143	(6.1)	601	22	359	0
Idaho	290	(12.4)	1,687	33	1,932	0
Washington	253	(10.8)	1,512	25	1,720	0
Other States	28	(1.2)	135	0	145	0
Canada	14	(0.6)	94	0	42	0
Foreign	23	(1.0)	109	0	75	0
Total	2,333	99.9	11,064	363	9,316	4

Salmo spp. catch rates declined considerably from the 0.26 fish/hour rate reported in 1981 (Huston et al. 1984). Whether the decline in catch rates is wholly due to a decreased abundance of trout in the reservoir or a function of decreased angler interest has not yet been examined. Mean catch rates for westslope cutthroat, rainbow, and hybrid trout was <.01, .02, and <.Ol (fish kept per hour), respectively. Seventy percent of the Salmo spp. creeled were identified as rainbow trout. Most cutthroat and rainbow were caught in the Canada area of the reservoir after 19 August. Hybrid trout were most often creeled in the spring, in the Tenmile area.

GROWTH

Examination of empirical growth curves for the 1983 and 1984 year classes of kokanee show that growth was strong for both year classes during 1985 (Figure 14). Kokanee in the 1984 year class appear to be larger during July of their second growing season; averaging 250 mm long compared to 239 mm for the 1983 year-class at the same life stage. As explained in the Hydroacoustic Estimates section, there were markedly more kokanee in the 1983 year class, a consequence of relatively higher numbers of spawners (1980 year class) and recruitment rates. Corresponding weights for the 1983 and 1984 year classes during July of their second growing season of 136 g and 139 g help substantiate a density dependent growth relationship for kokanee in the reservoir. However, if Johnson's (1965) contention that sockeye schools are composed of mixed age classes applies to kokanee, density dependent growth in Libby Reservoir would probably be the result of an age-based size selectivity for plankton Variation in prey selection among different age classes of kokanee and even within the same age group was noted by Leathe and Graham (1982). More sensitive size increments in food habits analysis would address this question.

Seasonal growth of two migration classes of rainbow trout in the reservoir was evaluated by Dr. Edward Brothers using otoliths, and illustrates some of the difficulties of assigning ages to reservoir fish. Depending on migration class, trout may have markedly different sizes at the same age (Figure 15). However, both migration classes show similar growth patterns: strong, almost uninterrupted growth through the first year after reservoir entry. After two years in the reservoir, there appears to be retardation of growth and age is extremely difficult to decipher. Fish emigrating to the reservoir after one growing season in the natal stream seemed predestined to do so because of a larger initial size. Regardless of migration class, most trout analyzed entered the reservoir in the last week of May to the first two weeks in June.

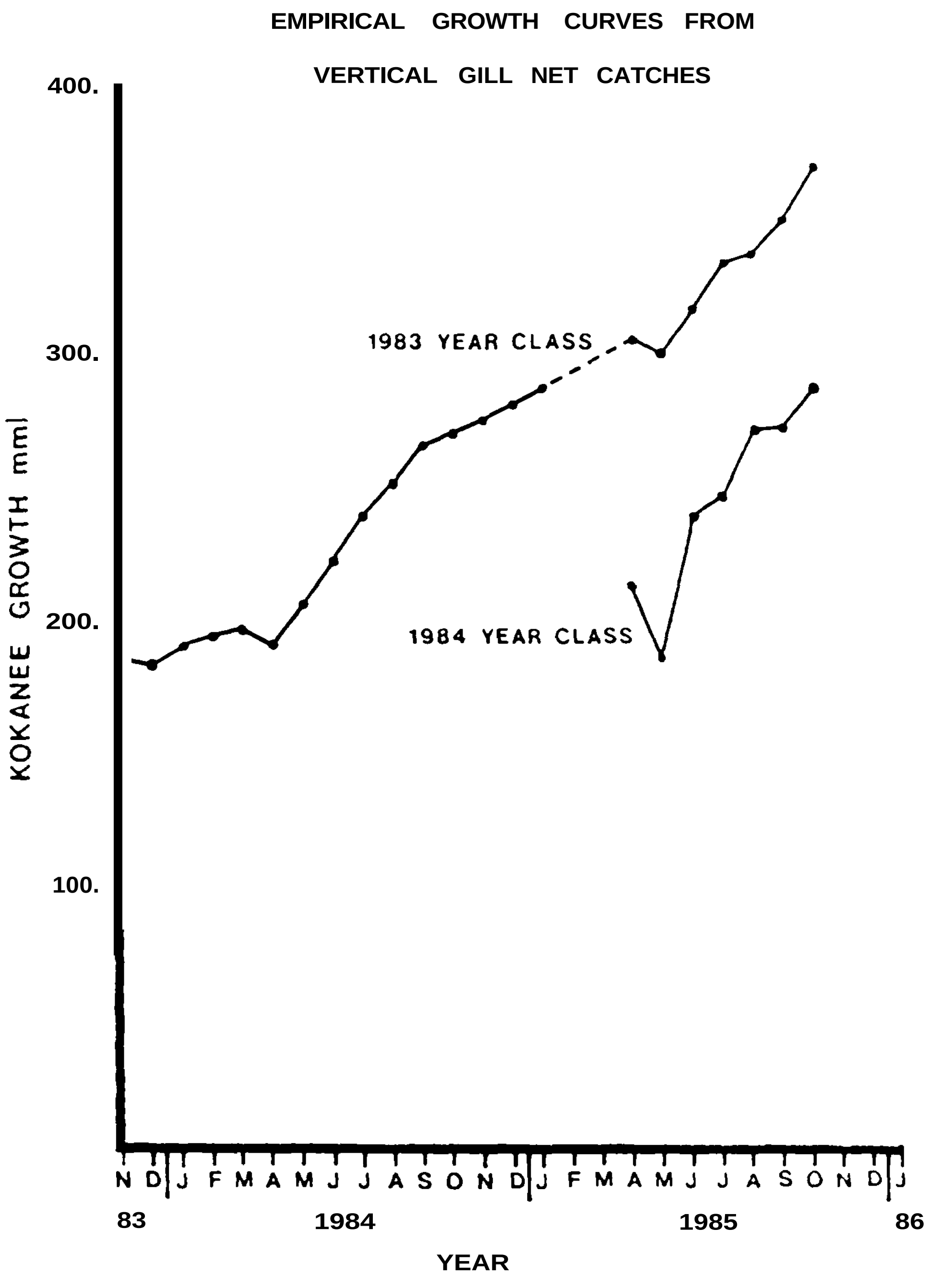


Figure 14. Empirical growth curves of the 1983 and 1984 year classes of kokanee salmon captured by vertical gill nets in Libby Reservoir.

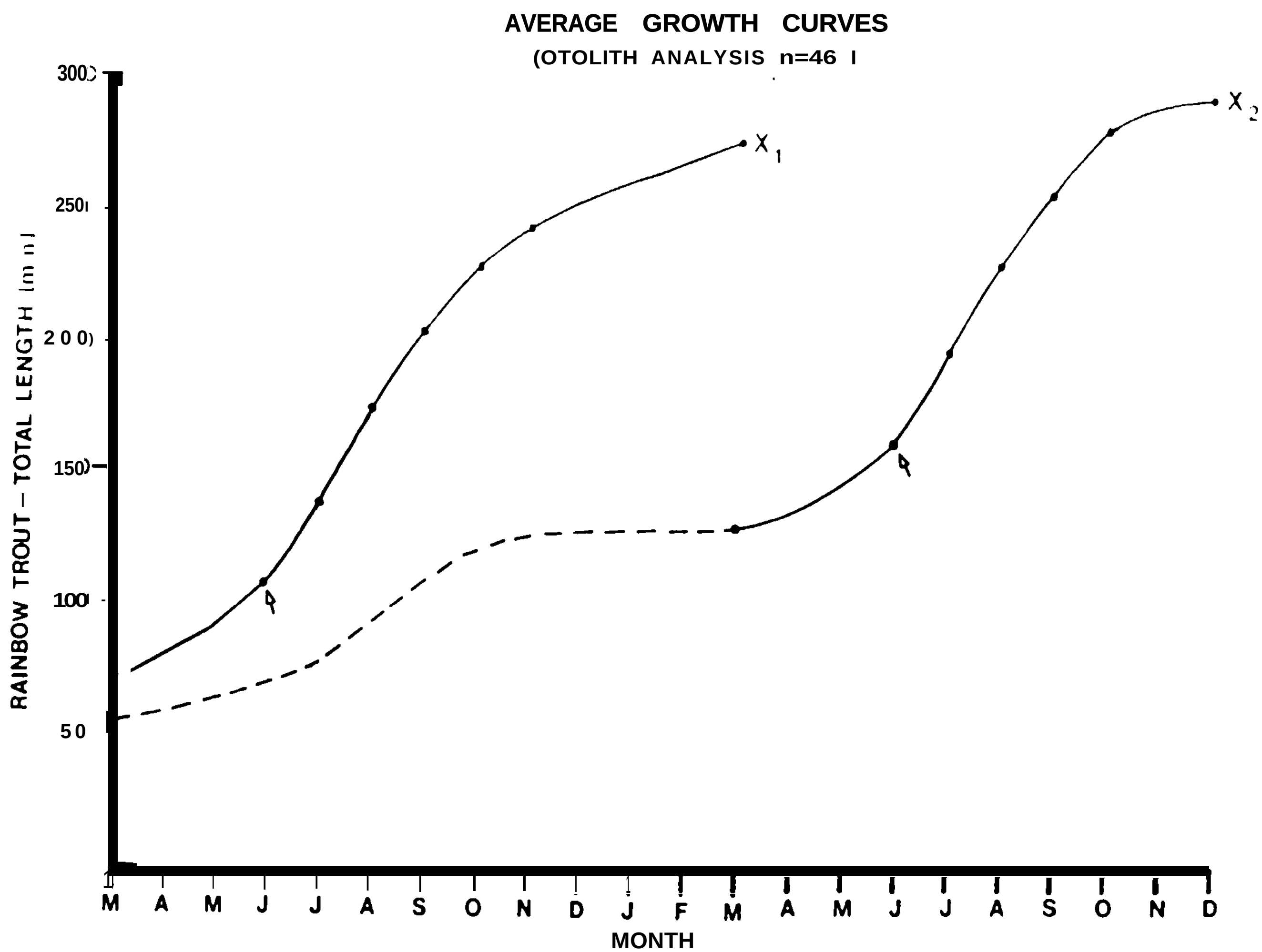


Figure 15. Average growth curves from otolith analysis taken from Rainbow trout during November 1984. X_1 and X_2 represent those fish spending one and two years, respectivley in their natal stream before emigrating to Libby Reservoir. The arrows indicate emigration date.

Tributary Spawning Runs

Young Creek

The 1985 Young Creek spawning run was estimated at 71 adult westslope cutthroat trout, approximately 20% of the previous years run (354 fish). Increased fishing pressure is believed to be the major cause for this dramatic decline. The sex ratio of adult trout in the spawning run was 1:2.3 (♂:♀). Eighteen rainbow trout and hybrids were also captured in the trap and released downstream The spawning run lasted from 11 May through 6 July, and peak numbers were recorded on 15 May (Appendix G). Subsequent adult emigration to the reservoir occurred from late May through June.

An estimated 1,280 juvenile westslope cutthroat trout emigrated downstream in Young Creek. Downstream migration peaked on 22 June, with the majority emigrating between mid-May and early July (Appendix G). Fifty-five percent of these juvenile trout were dangler-tagged.

Big Creek

The downstream post-spawning run in Big Creek was estimated at 73 trout. Beak numbers of westslope cutthroat trout emigrated on 25 June (Appendix F). The sex ratio of these fish was 1:1.9 (♂:♀). We tagged all but two of these fish

An estimated 1,060 juvenile trout emigrated downstream in Big Creek between 22 June and 15 July (Appendix G). Beak downstream movement occurred between 25 June and 27 June.

Bristow Creek

Atotalof 50 adult trout were captured in the Bristow Creek downstream trap after spawning. Sex ratios were 1:3.5 (♂:♀) for all <u>Salmo</u> spp. combined. Almost all adults emigrated downstream by the end of June and westslope cutthroat trout movement peaked on 14 June (Appendix G).

Four hundred and thirty-one juveniles were trapped emigrating from Bristow Creek from 6 June through 3 July. A majority of these were identified as westslope cutthroat trout and all but five fish were tagged.

Fivemile Creek

Rainbow trout dominated the downstream catch of adult trout in FivemileCreek. The estimated total spawning run was 63 fish, of which 48% were rainbow, 27% were westslope cutthroat, and 25% were hybrid (RBT x WCT) trout. Downstream movement occurred between 11 June and 15 July, with the catch peaking on 20 June (Appendix G). Sex ratios were 1:2.1 for all Salmo spp. combined.

An estimated 43 juvenile trout migrated downstream in Fivemile Creek from 12 June to 16 July. This number represented 16% of the emigrating juvenile trout in 1984. Peak downstream movement occurred on 29 June.

Pinkham Creek

The trap location was changed to prevent problems with low stream discharge caused by subsurface flow occurring in 1984. Again, low streamflows prevented proper trap operation and catches don't accurately show timing of post spawning movements. The adult catch consisted of 9 cutthroat, 8 hybrids, and one rainbow trout. The juvenile catch, which passed through the trap during the last two weeks of June, (Appendix G). All eighteen adults and 23 of the 34 juveniles were tagged.

Sinclair Creek

Only four adults and 78 juveniles Salmo spp. were captured in this tributary to the Tobacco River: The majority of the juveniles captured were cutthroat trout (78%) which emigrated during the last two weeks of June (Appendix G). A total of four adults and 65 juveniles were tagged.

Tag Returns

Since 1983, 1,903 adult fish and 7,698 juvenile trout have been tagged (Table 12). Approximately 11% of the adult and 0.7% of the juvenile trout have been recaptured. The juvenile return rate has increased from 1984 (0.3%); this could reflect an increase in juvenile numbers being captured or a decrease in tag loss.

Adult and juvenile trout tagged and recaptured between 1983 and 1985 moved throughout the reservoir, generally in the downstream direction (Table 13). Most floy tagged adults were returned by anglers but the purse seine also effectively recaptured tagged fish (Appendix H). Tag return information provided by anglers was occasionally unreliable; fish reportedly shrunk or doubled their weight within two weeks of their release. Kokanee tagged in purse seine hauls exhibited no distinct directional movement trends (Table 14). A total of four percent of the fish tagged were recaptured, one of these below the dam. No fish were returned from the Canada area of the reservoir, although this could reflect the relatively infrequent use of the purse seine there.

Table 12. Summary of tagging information (by species) for adult and juvenile fish tagged in Libby Reservoir and its tributaries from 1983 through 1985.

	Number Tagged	Number Returned	Percent Returned
ADULT:			
Salmo spp.	1,657	175	10.6
Mountain Whitefish	138	2	1.5
Bull Trout	80	4	5.0
Eastern Brook Trout	2	- -	0.0
Kokanee Salmon	5		0.0
Burbot	21	1	4.8
	8=1,903	8=182	9.6
JUVENILE:			
Salmo spp.	7,685	51	0.7
Mountain Whitefish	---	--	0.0
Bull Trout	4	--	0.0
Eastern Brook Trout	9	--	0.0
Kokanee Salmon	- -	--	0.0
Burbot	---	--	0.0
	8=7,698	8=51	0.7

Table 13. Summary of tagging information (by location) for adult and juvenile fish tagged in Libby reservoir and its tributaries from 1983 through 1985.

Tagging Location	Return Location: Reservoir (area) Tenmile	Reservoir (area) Rexford	Reservoir (area) Canada	Tributary (to area) Tenmile	Tributary (to area) Rexford	Tributary (to area) Canada	Kootenai River	Unknown
ADULT:								
LIBBY RESERVOIR								
Tenmile area	5	2	2	--	--	--	--	1
Rexford area	18	10	5	--	4	6	--	5
Canada area	3	5	10	--	--	10	--	2
TENMILE AREA TRIBUTARIES								
Big Creek	10	--	--	3	1	2	--	1
Bristow Creek	6	--	1	--	--	--	--	1
Fivemile Creek	8	--	1	1	--	--	1	1
REXFORD AREA TRIBUTARIES								
Pinkham Creek	--	3	1	--	1	--	1	--
Sinclair Creek								
Young Creek	22	16	2	3	--	1	--	7
TOTAL ADULTS (182 total returns)	72	36	22	7	6	19	2	18
JUVENILE:								
TENMILE TRIBUTARIES								
Big Creek	8	3	1	8	--	--	1	4
Bristow Creek	1	3	--	--	--	--	--	--
REXFORD								
Fortine Creek	--	1	--	--	--	--	--	1
Young Creek	8	6	3	--	--	--	2	--
TOTAL JUVENILES (50 total returns)	17	13	4	8	--	--	3	5

Table 14. Tag return data for kokanee salmon tagged while purse seining in the three areas of Libby Reservoir during Fall 1984 and Spring 1985. Numbers and percent return ( ) are current through October 1985.

Area	Tagging Date	Number Tagged	Tenmile	Rexford	Canada	Below Dam	No Info.	Total(%)
Tenmile	10/29-11/12/84	468	5(1.1)	4(0.9)	0(0.0)	1(0.2)	1(0.2)	11(2.4)
Rexford	10/23-10/26/84	530	9(1.7)	8(1.5)	0(0.0)	0(0.0)	0(0.0)	17(3.2)
Canada	10/16-10/19/84	160	0(0.0)	0(0.00)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Tenmile	4/29-5/1/85 5/28-5/31/85	1,978	58(2.9)	29(1.5)	0(0.0)	0(0.0)	6(0.3)	93(4.7)
Rexford	4/22-4/25/85	647	18(2.8)	13(2.0)	0(0.0)	0(0.0)	1(0.1)	32(4.9)
Total		3,778	90(2.4)	54(1.4)	0(0.0)	1(<.1)	8(0.2)	153(4.0)

RESERVOIR FOOD HABITS

Food habits data have been summarized for fish collected during fall 1983 (Appendix I). Plots of IRI values indicated that Daphnia was the single most important food item, followed by terrestrial insects and insect parts, for all sizes and trout species examined (Figure 16). Relatively high amounts of debris and algae in rainbow trout greater than 330 mm long probably was incident to bottom or shoreline foraging.

Comparison of mean available zooplankton size with that ingested by major fish species in the reservoir during fall1983 indicated that trout selected larger Daphnia than kokanee and mountain whitefish (Table 15). If this trend continues, kokanee and whitefish could have a competitive advantage over Salmo spp for a major food resource. All fish species consumed plankton larger than the mean available size in the water column indicating that selectivity was occurring.

FISH FOOD AVAILABILITY

Zooplankton

Standing Crop

Zooplankton densities peaked in June in the Tenmile and Rexford areas (4.59/l and 5.17/l, respectively) and in October in the Canada area (6.71/l) (Figure 17, Appendix J). Arealdensity differences seemed to exist throughout the year, with the Canada area having consistently higher numbers of Daphnia spp. Monthly plots of species composition by area showed that Cyclops generally made up the largest percentage of the samples (41-70%) (Figure 18). The bimodal increases in Cladocera (Bosmina spp. and Daphnia spp.) during late spring and again in early fall is not unusual population dynamics for these zooplankton and has been reported by Wetzel (1975).

Length distributions of Daphnia spp. indicated that the greatest percentage of Daphnia were between 0.5 and 1.5 mm (Figure 19). During most months, less than 10% of the sampled Daphnia spp. were greater than 1.5 mm in the Tenmile and Rexford areas, and all samples contained less than 20% of this size class Daphnia. Clearly, fish species in the reservoir that select Daphnia spp. greater than 1.5 mm are at a competitive disadvantage with those that crop smaller zooplankton, and anything that affects the larger, less numerous size classes of zooplankton may have serious impacts on the fishery.

A comparison of the efficiency of a Wisconsin net and Schindler plankton trap indicated that 60% of the time the Schindler trap was more efficient (Appendix K). Increased

Key: DAPHNIA = Daphnia
OTH ZOO = Other zooplankton
TER INS = terestrial insects
DIPTERA = Diptera larvae
OTH INS = other insects
FISH = fish
INS PTS = insect parts
DEB/ALG = debris & algae

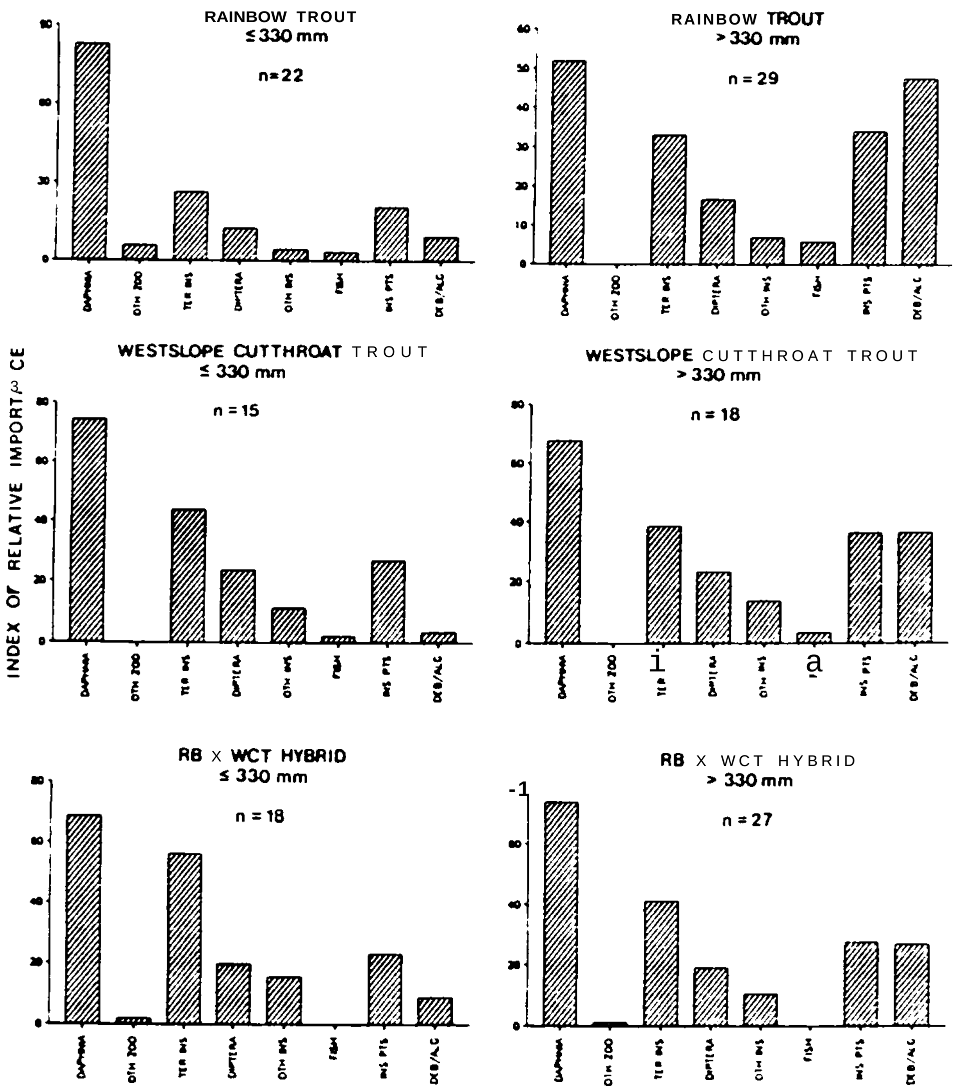


Figure 16. Indices of relative importance for item in the diet of trout collected in Libby Reservoir (all three areas combined) during October 1983.

Table 15. Size composition (%), mean lengths, and mean estimated weights of Daphnia spp, ingest d by gamefish and available in the zooplankton population [a] in Libby Reservoir during October 1983.

Size Class (mm)	RB		WCT		HB	KOK	MWF	Available
	≤330 mm	>330 mm	≤330 mm	>330 mm	All sizes	All sizes	All sizes	Zooplankton
0.5 to 0.99	---	---	---	---	--	2	29	64
1.0 to 1.49	---	8	6	2	16	68	29	36
1.5 to 1.99	---	54	60	50	57	30	29	---
≥2.0	--	38	34	48	27	---	14	---
Mean length (mm)	--	1.86	1.87	1.97	1.77	1.35	1.40	0.92
Mean weight (mg)	---	261.23	267.37	309.81	226.30	100.60	115.34	34.32

[a] available zooplankton as sampled by Wisconsin tows during October.

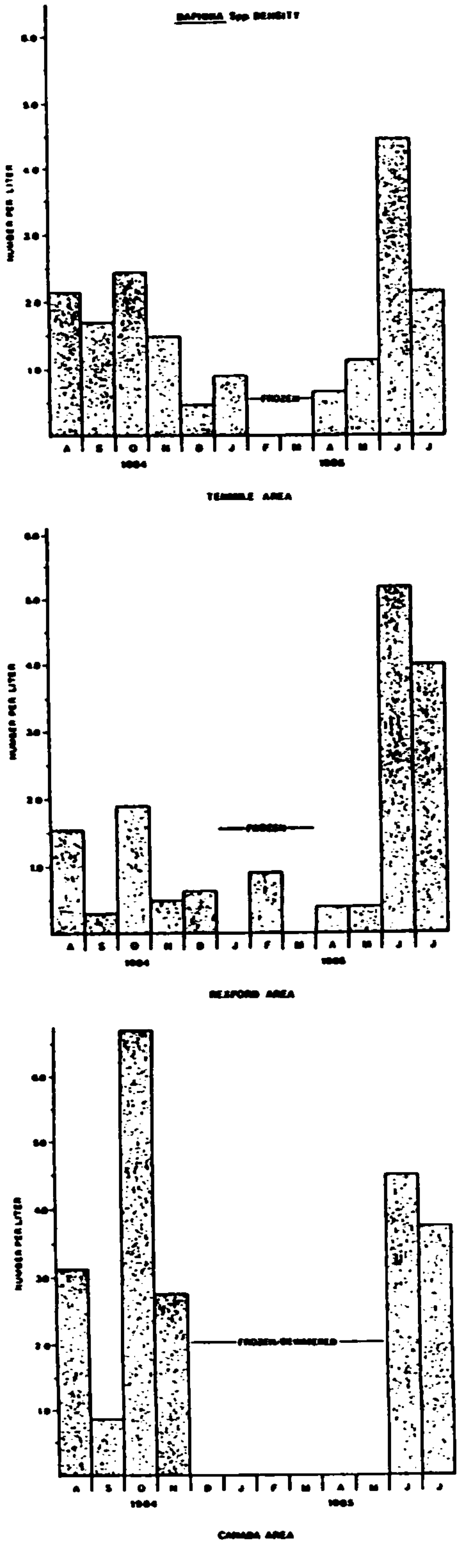


Figure 17. Densities (number per liter) of Daphnia Spp. in the three areas of Libby Reservoir from August 1984 through July 1985.

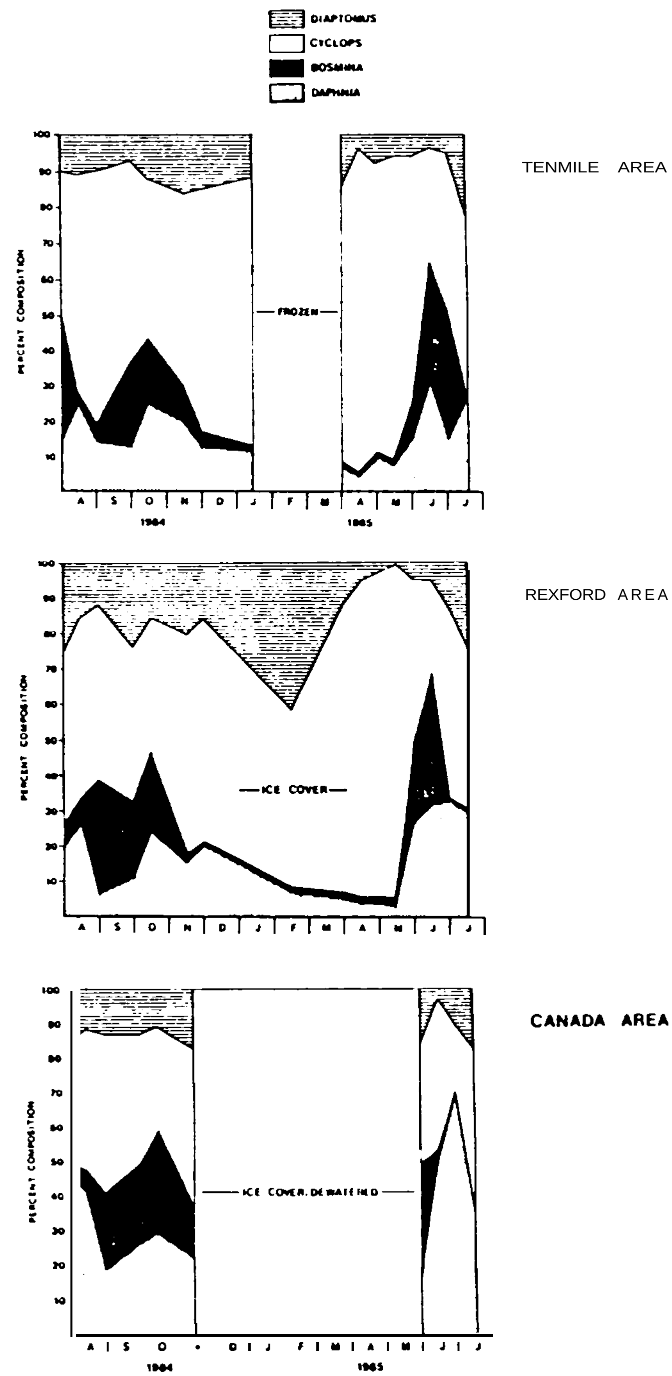


Figure 18. Densities (Relative Abundance) of the four most abundant general of zooplankton in the three areas of Libby Reservoir from August 1984 through July 1985 based on 30 m vertical tow samples.

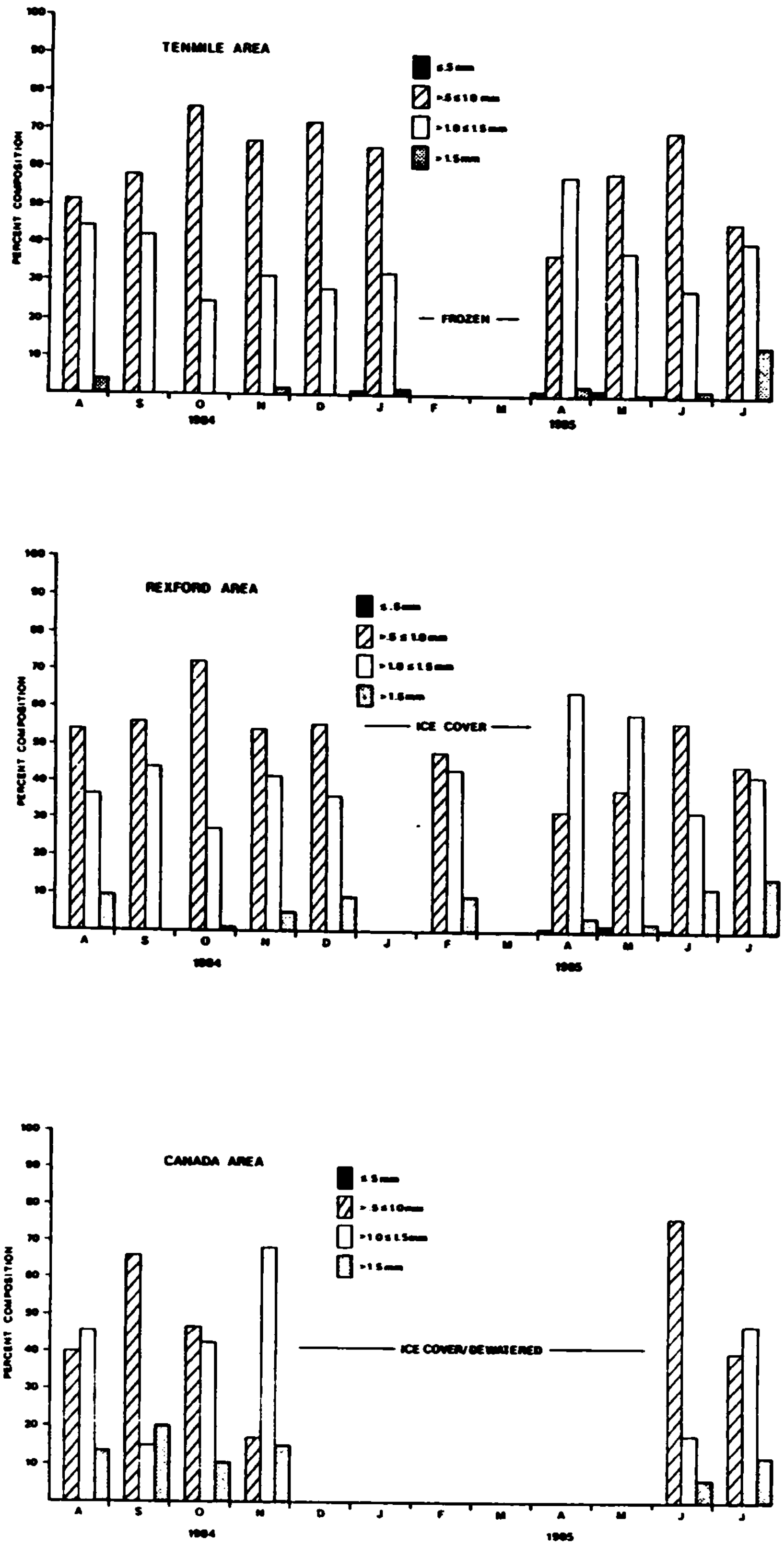


Figure 19. Length frequency distributions (by 0.5 mm length classes) of Daphnia Spp. captured in 30 m vertical tows in the three areas of Libby Reservoir from August 1984 through July 1985.

efficiency of the Schindler trap over last year could be a result of acquiring a new trap and familiarization of personnel with its operation.

Benthos

Densities and biomass of Diptera larvae and oligochaetes in the Tenmile and Rexford areas were lowest in the frequently de-watered zone of the reservoir (Figures 20, 21). Statistical analysis of the mean density in each zone revealed that there was a significant difference ($p<.05$) between Diptera abundances in the frequently dewatered zone and the occasionally dewatered and permanently wetted zones, but not between the latter two. Diptera densities did not differ statistically between the Tenmile and Rexfordareas. Average densities of Oligochaeta were also lowest in the frequently dewatered zone. Peak density of Diptera larvae occurred during spring or fall, while Oligochaeta densities peaked during summer (Appendix L).

Surface Macroinvertebrates

Seasonal densities of terrestrial and aquatic surface insects were generally greater in the near shore zones of all three areas of the reservoir (Figures 22,231. Highest average densities of aquatic surface insects occurred during the spring, corresponding to peak emergence times, and highest densities of terrestrial surface insects occurred during summer and fall (Appendix M). Statistical comparison of mean densities in near shore limnetic zones indicated there was no significant difference between the two in any area of the reservoir. Composition of the surface tow by order varied seasonally, but was generally consistent across the three geographic reservoir areas (Appendix N). Terrestrial insects belongingtothe Orders Homoptera and Hymenoptera were generally most numerous in the fall: during spring Coleoptera numbers were high, and during summer, Homoptera and Hymenoptera were again the dominant orders numerically. Diptera comprised the highest numbers of aquatic insects in the samples.

RELATIONSHIPS BETWEEN RESERVOIR OPERATION AND RESERVOIR HABITAT

By June 1986 a computer map data base will be proofed which will allow estimation of amounts of habitat available for fish and fish food organisms based on reservoir elevation. The computer program GEOSCAN will quantify volumes of water by 3.1 m (10 ft.) depth intervals and enable estimation of changes in habit used by fish and fish food organisms.

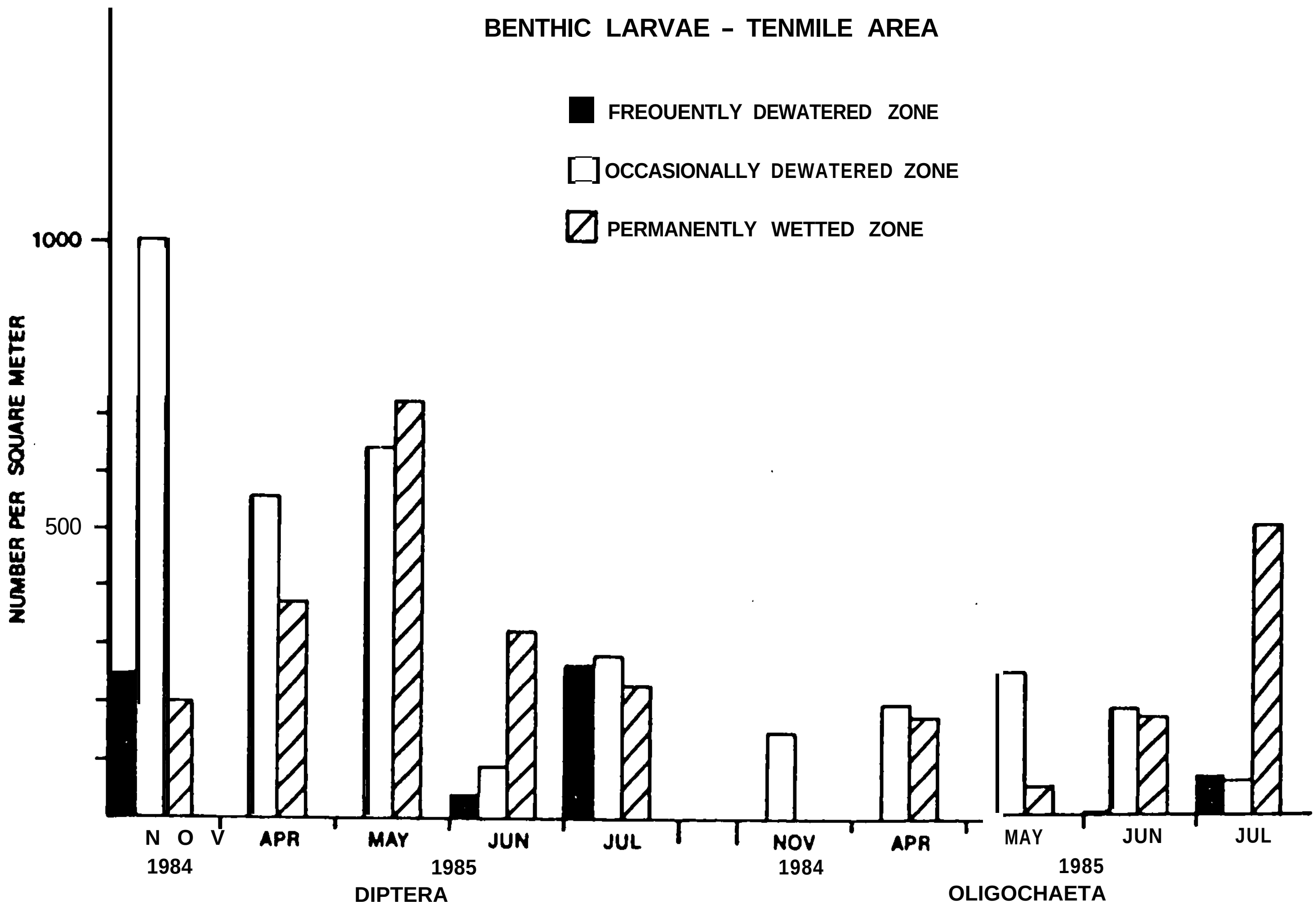


Figure 20. Estimated densities of diptera and oligochaeta larvae in frequently dewatered, occasionally dewatered and permanently wetted substrates in the Tenmile are from November 1984 through July 1985.

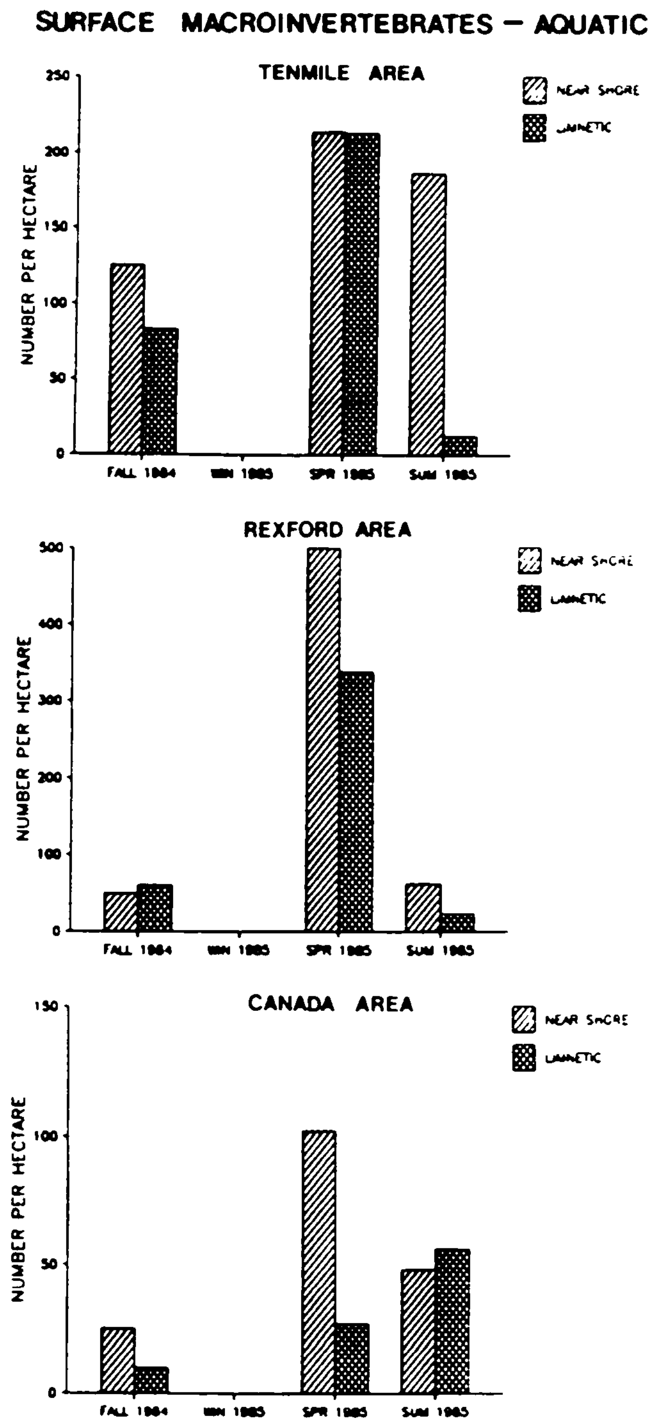


Figure 22. Estimated densities of aquatic macroinvertebrates on the surface of Libby Reservoir, by area, from Fall 1984 through Summer 1985.

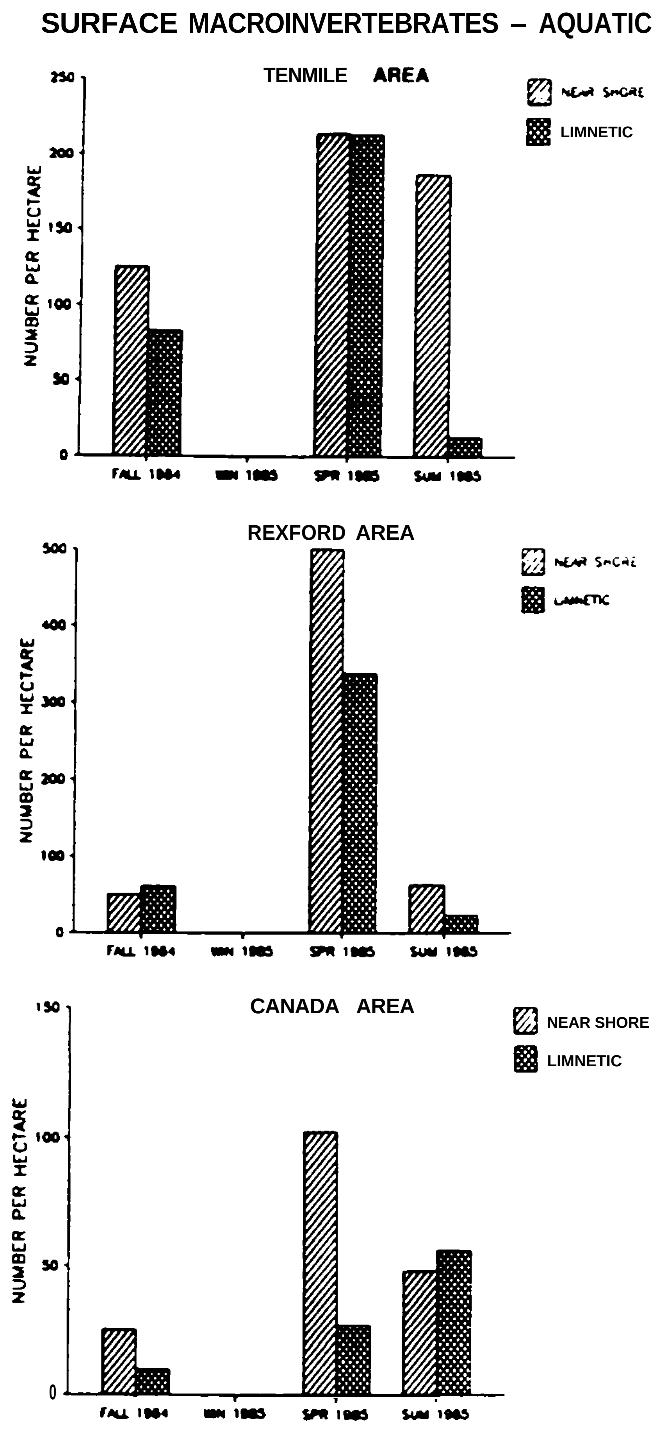


Figure 22. Estimated densities of aquatic macroinvertebrates on the surface of Libby Reservoir, by area, from Fall 1984 through Summer 1935.

SURFACE MACROINVERTEBRATES – TERRESTRIAL

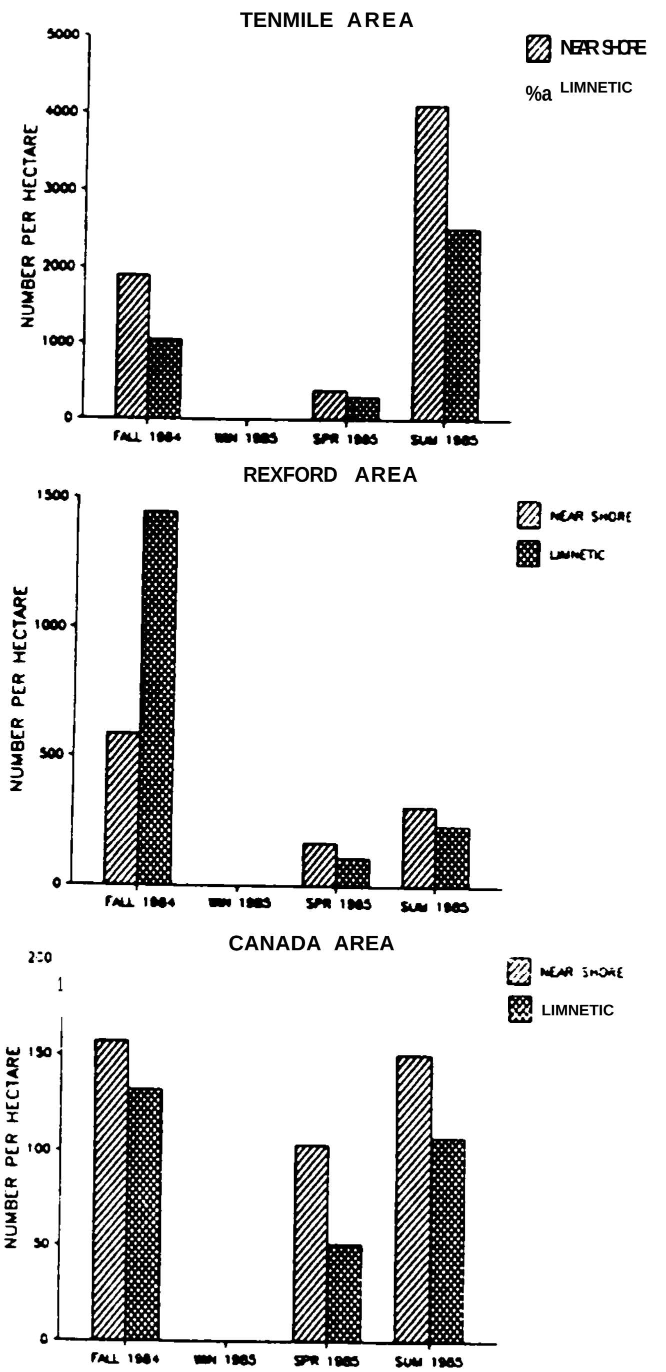


Figure 23. Estimated dnnsitics of terrestrial macroinvertebrates on the surface of Libby Reservoir, by area, from Fall 1984 through Summer 1985.

IMPACTS OF RESERVOIR OPERATION ON THE FISHERY

Model Development

A thorough theoretical and practical discussion of the effects of reservoir operation on the components of the fishery was presented by Shepard (1985) and will not be repeated here. The goal of this study is to quantify impacts of various reservoir operational regimes on the reservoir fishery. We have contracted with the USGS and Dr. Daniel Goodman (Montana State University, Bozeman, Montana) to refine a thermal predictive model (Adams 1974) and develop a trophic level components model, respectively, to address this goal. The reliability of these models is dependent on the accuracy of input data, submodel integrity, and the level of understanding interactions between components.

As stated above, a thermal predictive model developed by Adams (1974) will be used to predict the effects of reservoir operation on thermal regimes in Libby and Hungry Horse Reservoirs. The model will be modified for the Libby selective withdrawal system beginning in August, 1985. The final report is scheduled for completion on September 30, 1986 and will include a users manual for operation of the model, results of validation tests, and a summary of the simulation tests.

To predict reservoir operation effects on fisheries, a component model will be developed This approach entails the use of several component models corresponding specifically to the hypothesized mechanisms of the effects of dam operation upon the reservoirs biota. The component models, by virtue of their simplicity are less likely to generate inappropriate predictions and are more accessible to assessment of reliability, than are complex full system models. The model will use particulate carbon to track energy flow through the trophic levels, identify limiting factors and enable a sensitivity analysis. It will indicate the direction of change caused by reservoir operation in production of organisms in the various trcphic levels.

Physical Framework Model

Evaluation of the consequences of the various reservoir management options requires a common physical framework within which the submodels can operate. This framework must be a three-dimensional representation of the reservoir basin, coupled to a day-by-day representation of the inflow, turbidity, solar radiation and air temperature. The model will have a provision for specifying the annual schedule of water withdrawals. The structure of the model will allow for a day-by-day inventory of the amount of reservoir area representing each depth of water column with a temperature profile for that water column.

The effect of reservoir operation on thermal regimes within the reservoir will be evaluated using the predictive thermal model.The model will enable us to hold environmental variables (volume of inflow, temperature of inflow, and solar radiation) constant, while determining impacts of operational variables (discharge volume, depth of discharge and timing of discharge) on the thermal regime in the reservoir. We can evaluate the effect of these predicted thermal regimes on primary productivity, secondary productivity and fish growth by incorporating them into the physical framework model.

Primary Production

The primary production submodel includes area, stratification and washout effects. The area component predicts the annual schedule of primary productivity for the entire lake by area. The input data includes local primary production estimates by area, season and depth of water column. These data will be provided by a primary productivity study conducted in 1986. A generalized seasonal fish growth model will be used to estimate fish growth via a two-step average conversion efficiency from primary production through secondary to tertiary production. Particulate carbon will be used to track energy flow through the trophic levels.

The stratification component uses a physical framework to generate a description of profiles of temperature and light with passive distribution of nutrients. Diatom biomass is assigned to the mixed layer and primary production is calculated from light, temperature, and nutrients. The intermediate output is a schedule of depth of light compensation, and depth and temperature of the mixed layer. The final output is an annual schedule of primary productivity.

The model will compute net biomass loss to washout and incorporates this loss in an annual primary production model. The final output is a schedule of primary production as affected by washout loss. The model data-needs include: 1) phytoplankton biomass concentrations throughout the reservoir and at the inflows and outflows, and 2) schedule of depths and volumes of withdrawal.

Secondary Production

The benthos submodel uses a life history model for aquatic Diptera to obtain the rate of production of emergers by date. This rate is calibrated against the observed standing stock of emergers. Data required for the model consists of local benthic insect standing crop estimates and local insect pupae and emerger standing stock in water column. The output will be a schedule of incremental dipteran production for the entire lake over the course of the year. If adequate sampling of the emerging forms is achieved, the results should be reliable and readily interpreted

The generalized seasonal fish growth will be used to carry through secondary production to tertiary production. The estimate is refined by allocating the increased production to particular species on the basis of food habits data.

The zooplankton submodel for Libby Reservoir will include a "washout effect" which may not be part of the HHR model. The zooplankton model will produce a schedule of zooplankton production by area and month as influenced by primary production, living space, and temperature. Data needed to run the model will be bi-weekly zooplankton densities and biomass concentrations in each area throughout the growing season. Production estimates will be by genera except for Daphnia pulex. The generalized seasonal fish growth model will carry through zooplankton production to fish growth.

Fish Community

The fish component model is comprised of four parts. A recruitment subroutine will estimate the number of juvenile westslope cutthroat emigrating to the reservoir from selected tributary streams. Data needs include number of spawners ascending selected tributaries, fecundity of individual fish and instream mortalities of juvenile cutthroat.

A growth model will predict a trajectory of differential growth for the salmonid stocks in the reservoir. Fish stocks will be allowed to grow in response to food availability and to place proportionate demands on food resources as indicated by food habits data. Treating the competition between the salmonids as resource-based scramble competition should lead to reasonable predictions with respect to growth for a period of one growing season.

The effect of volume (living space) reductions on juvenile trout predation will be estimated. The model will compute consumption rates on the basis of diet composition and temperature corrected metabolic rates. The final output will be a loss rate of young trout due to winter predation. A range of reservoir drawdown levels will be needed to accurately attribute the predation losses to dam operation.

We are also evaluating a population simulation model developed for adfluvial rainbow trout (Serchuk et al. 1980). This is an age-structured simulation model of the growth and population dynamics of a migratory rainbow trout population. It includes all principal life-history intervals and incorporates food-density and temperature relationships of salmonid growth efficiency. The core of the simulation involves individual fish growth efficiency.

Factors directly affecting the growth processes of trout such as food availability, water temperature, and intraspecific competition have been incorporated. Population size, mean weight and biomass are estimated monthly in age, sex and location categories. A variety of environmental and biological parameters are utilized in the simulation which can be altered as a user option. The crucial determinant of the utility of this model in our system will be availability of data that allow us to tailor the parameters to represent local conditions.

RECOMMENDATIONS

1. Conduct creel survey to index the significant winter fishery which occurs during December through March.

2. Continue sampling as modified below:

   a. Sample carbon through the zooplanktontrophic level to quantify assimilation efficiencies.

   b. Conduct insect emergence trapping on reservoir surface to quantify differential rate of benthic insect emergence dependent on reservoir zone.

   c. Discontinue food habits sampling for trout; continue sampling for those fish whose food habits are not fully quantified (burbot, peamouth, suckers).

   d. Continue zooplankton sampling, shifting emphasis of analysis from densities to size and species compositional changes.

   e. Reconsider diurnal sampling of both fish and fish food organism distribution in at least one area of Libby Reservoir.

   f. Begin measuring discharge while trapping spawners in reservoir tributaries. Present corresponding water temperature data.

   g. Refine data collection to needs of trophic dynamic model.

3. Continue to develop strategies for evaluation/monitoring of the fishery, and validation of quantitative model beyond March 1988.

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APPENDIX A

Isopleths of water temperature, conductivity,
dissolved oxygen, pH and incident light,
1984 through 1985

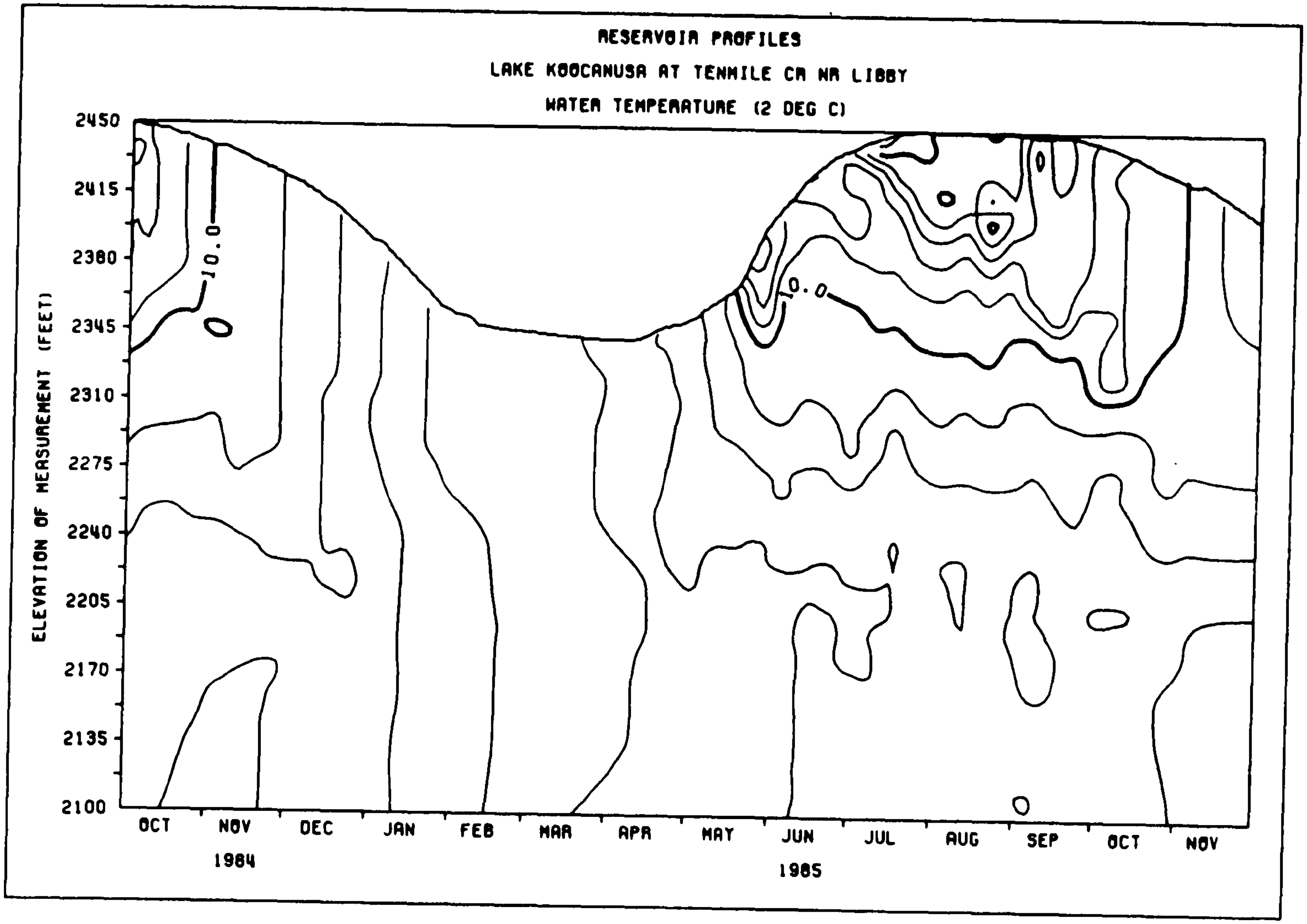


Figure A1. Isopleths of water temperature measured in the Tenmile area of Libby Reservoir during 1984 and 1985.

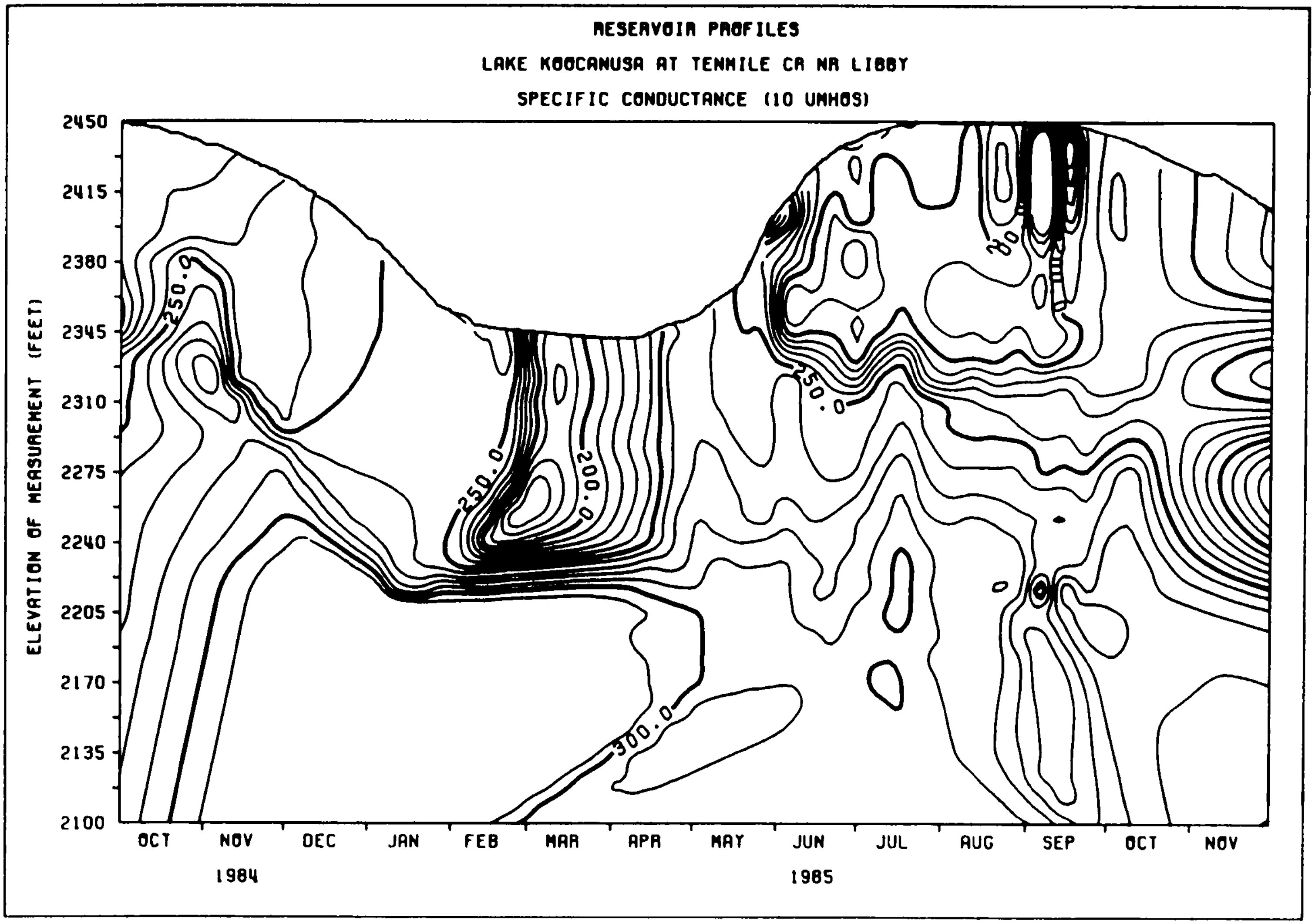


Figure A2. Isopleths of specific conductance measured in the Tenmile area of Libby Reservoir during 1984 and 1985.

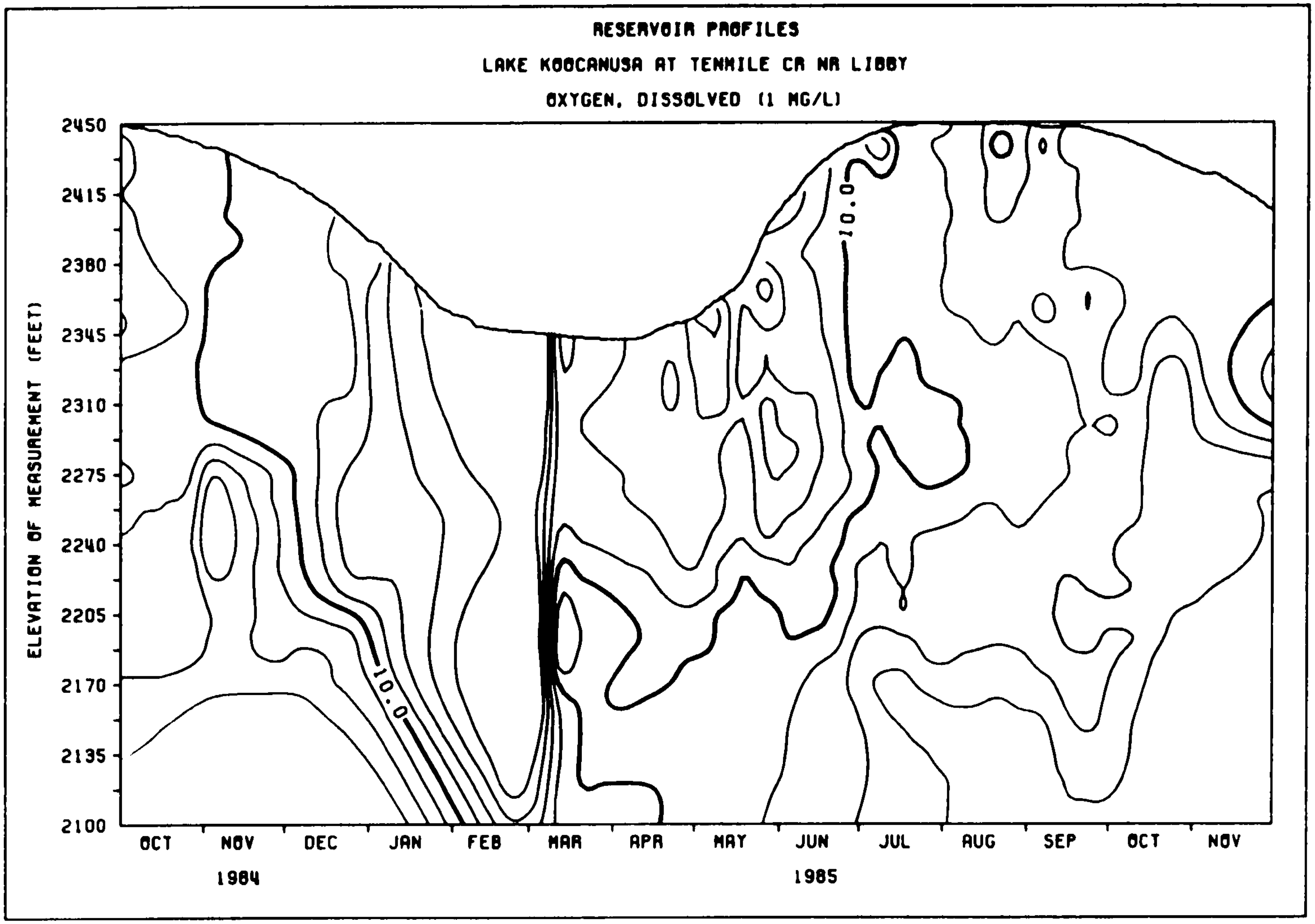


Figure A3. Isopleths of dissolved oxygen measured in the Tenmile area of Libby Reservoir during 1984 and 1985.

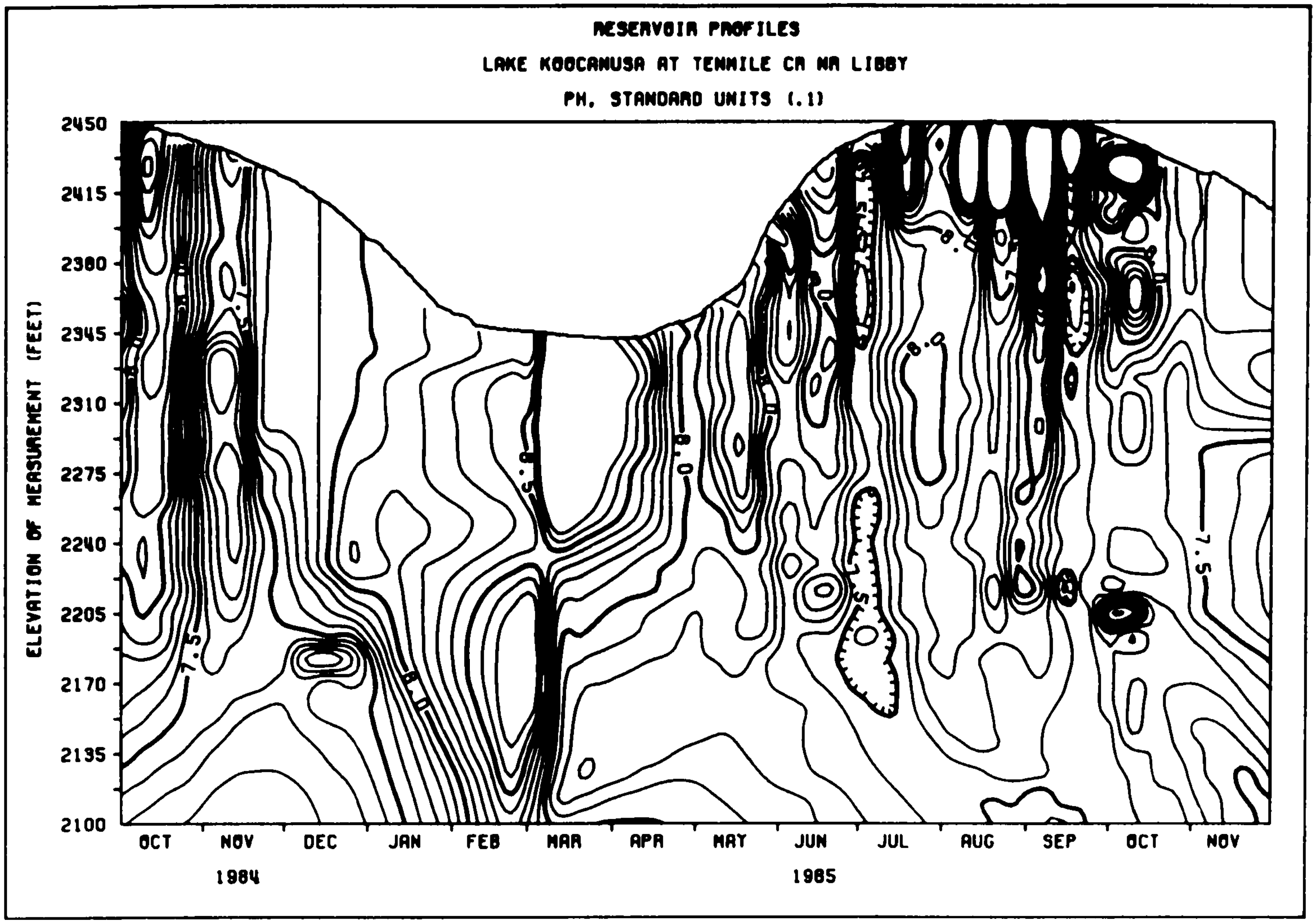


Figure A4. Isopleths of pH measured in the Tenmile area of Libby Reservoir during 1984 and 1985.

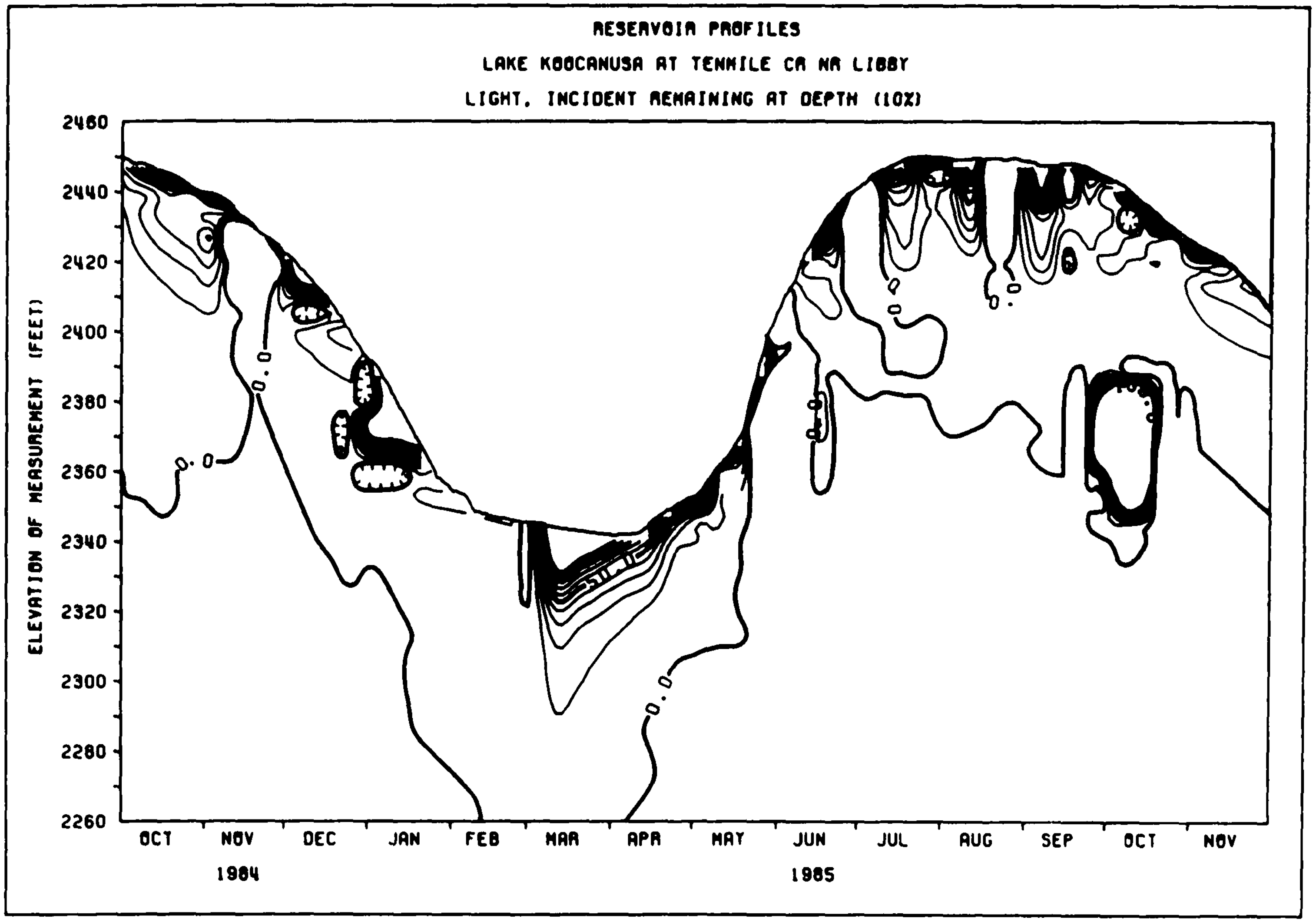


Figure A5. Isopleths of incident light measured in the Tenmile area of Libby Reservoir during 1984 and 1985.

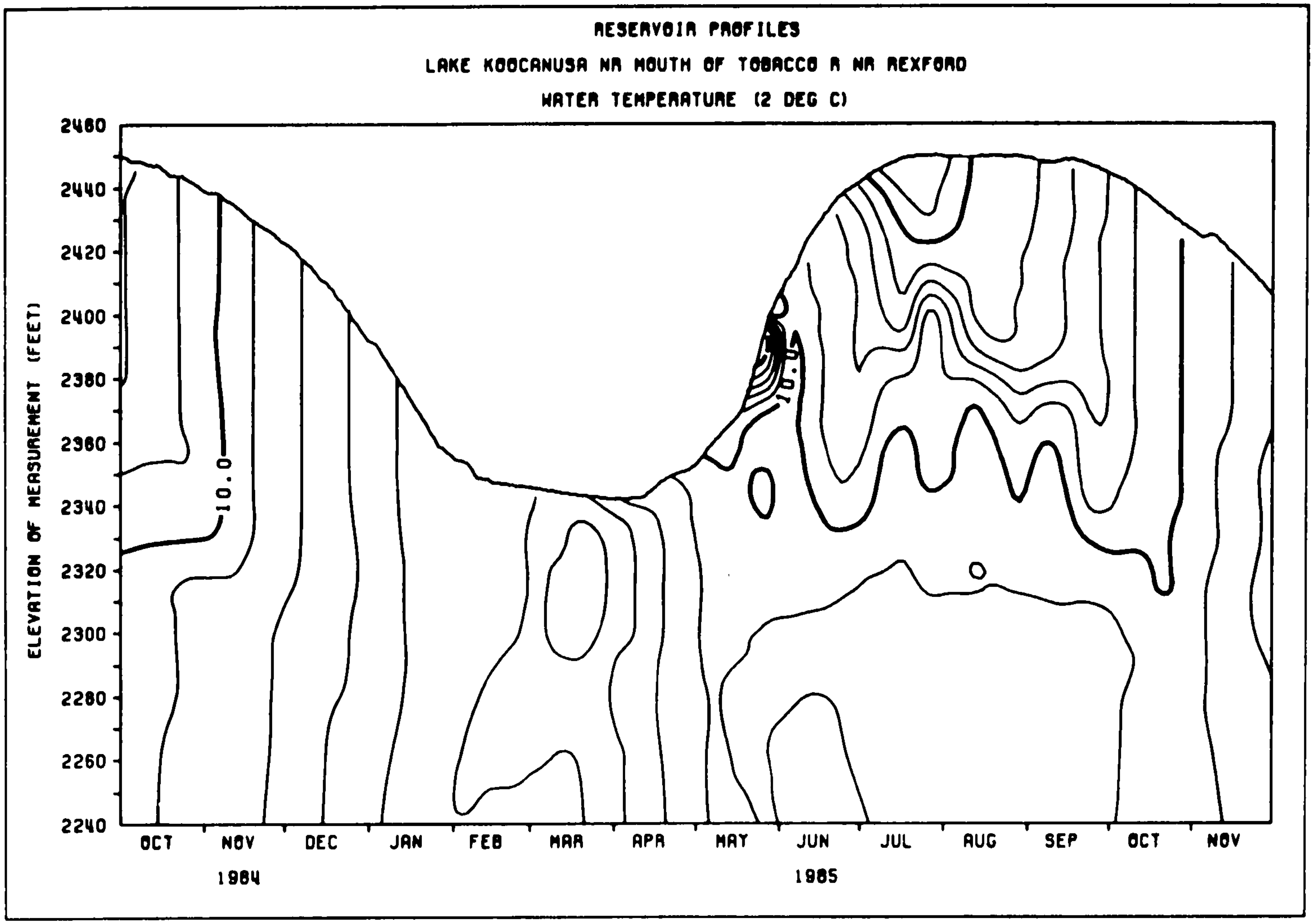


Figure A6. Isopleths of water temperature measured in the Tenmile area of Libby Reservoir during 1984 and 1985.

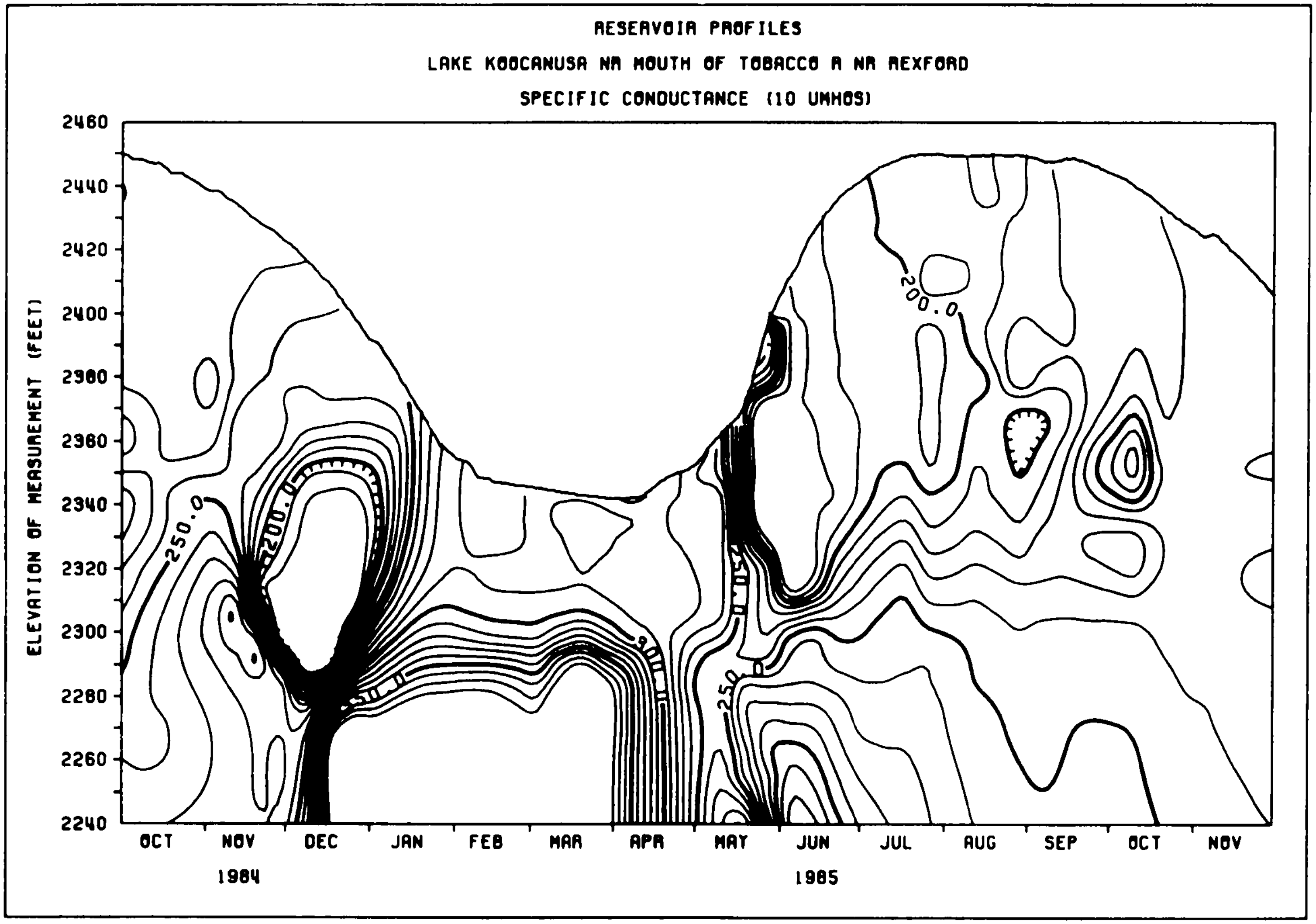


Figure A7. Isopleths of specific conductance measured in the Rexford Area of Libby Reservoir during 1984 and 1985.

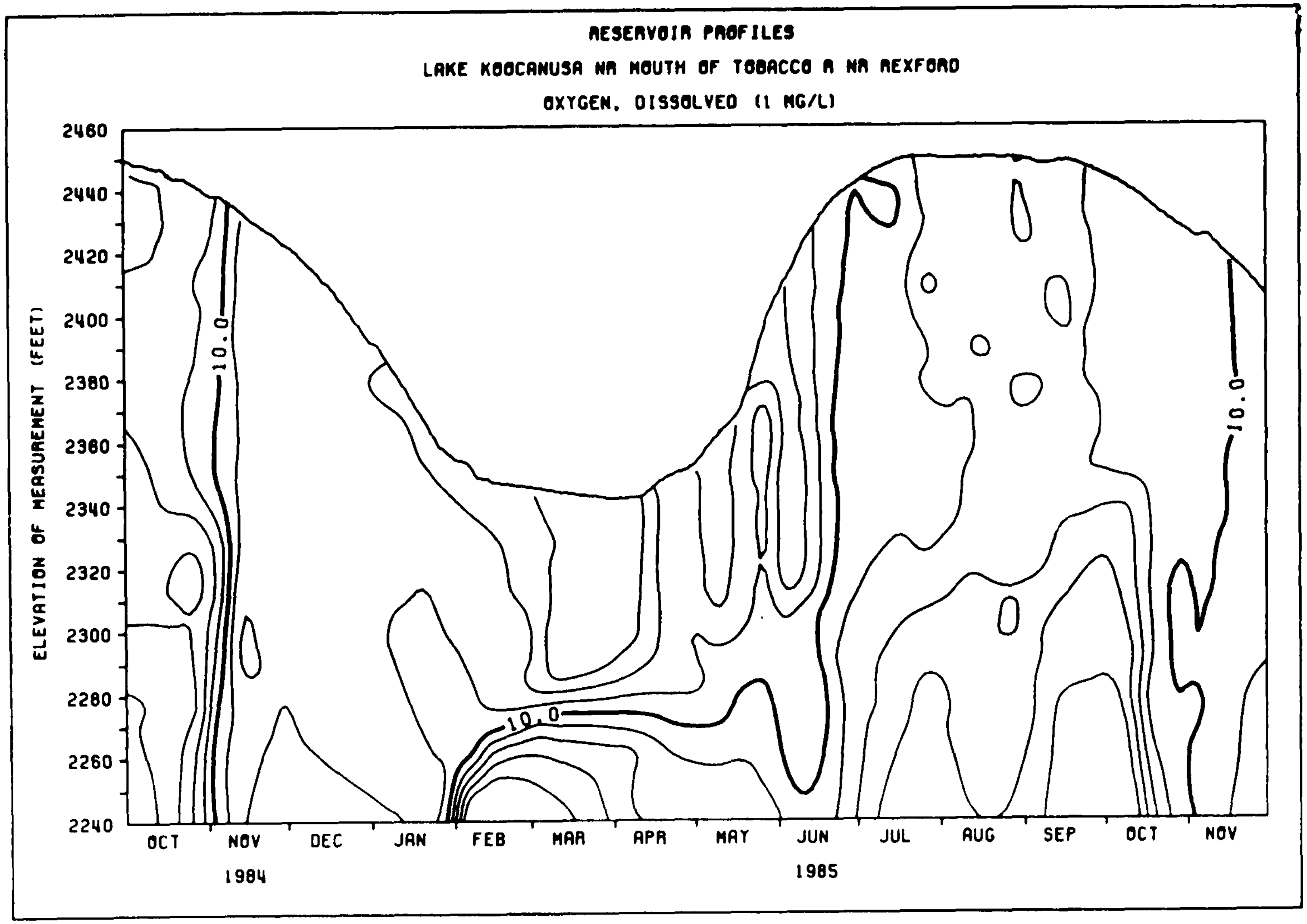


Figure A8. Isopleths of dissolved oxygen measured in the Rexford area of Libby Reservoir during 1984 and 1985.

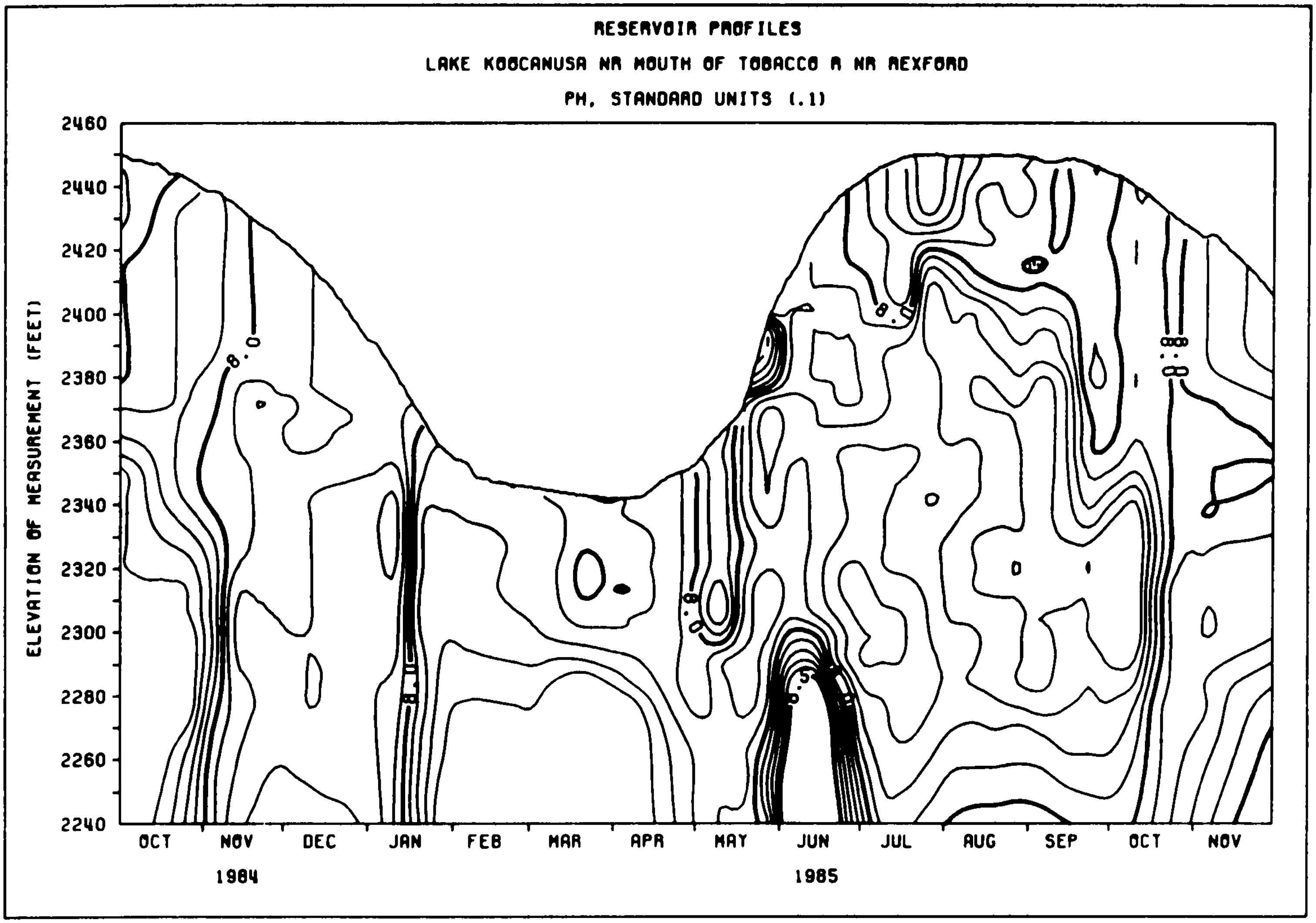


Figure A9. Isopleths of pH measured in the Rexford area of Libby Reservoir during 1984 and 1985.

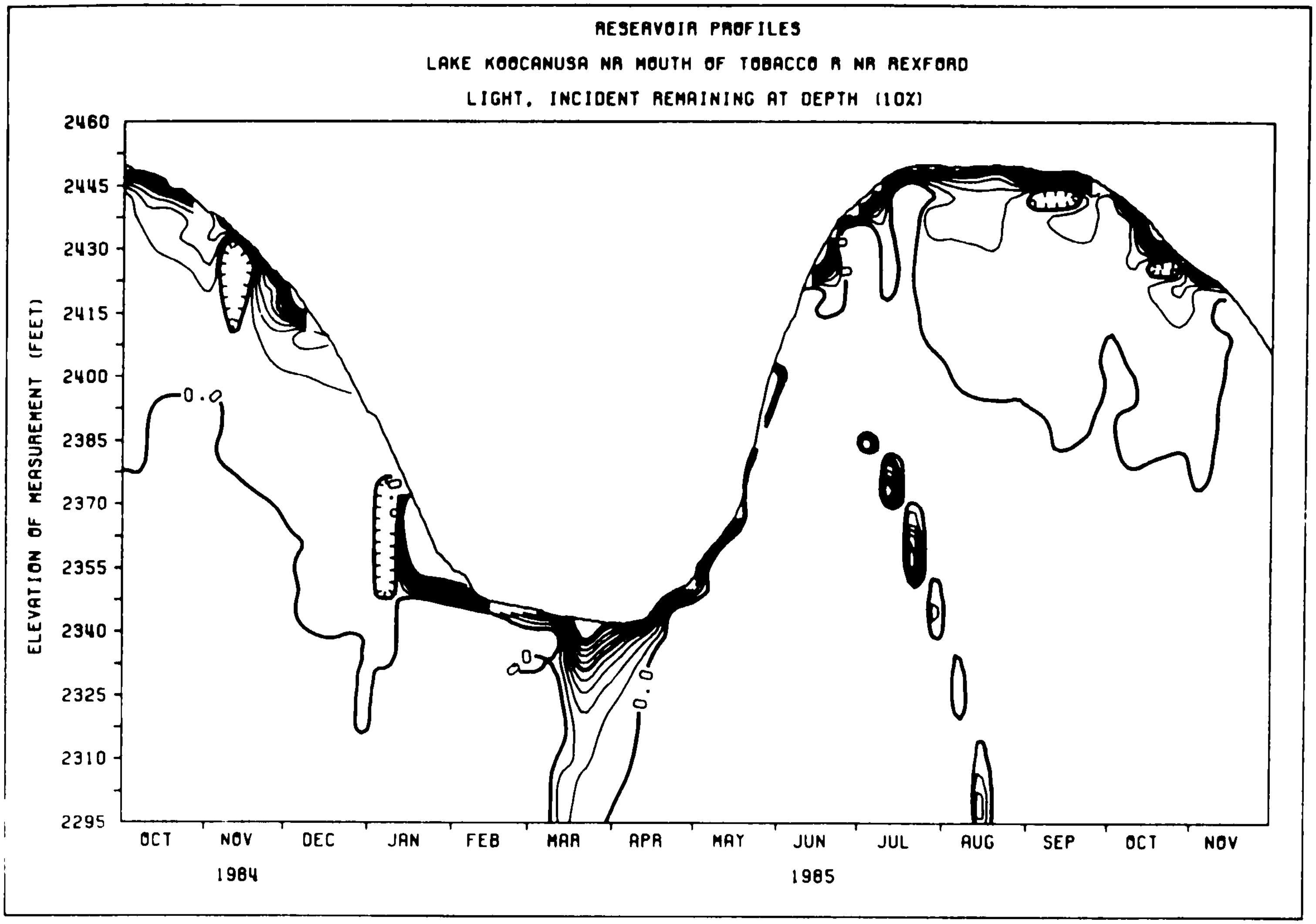


Figure A10. Isopleths of incident light measured in the Rexford area of Libby Reservoir during 1984 and 1985.

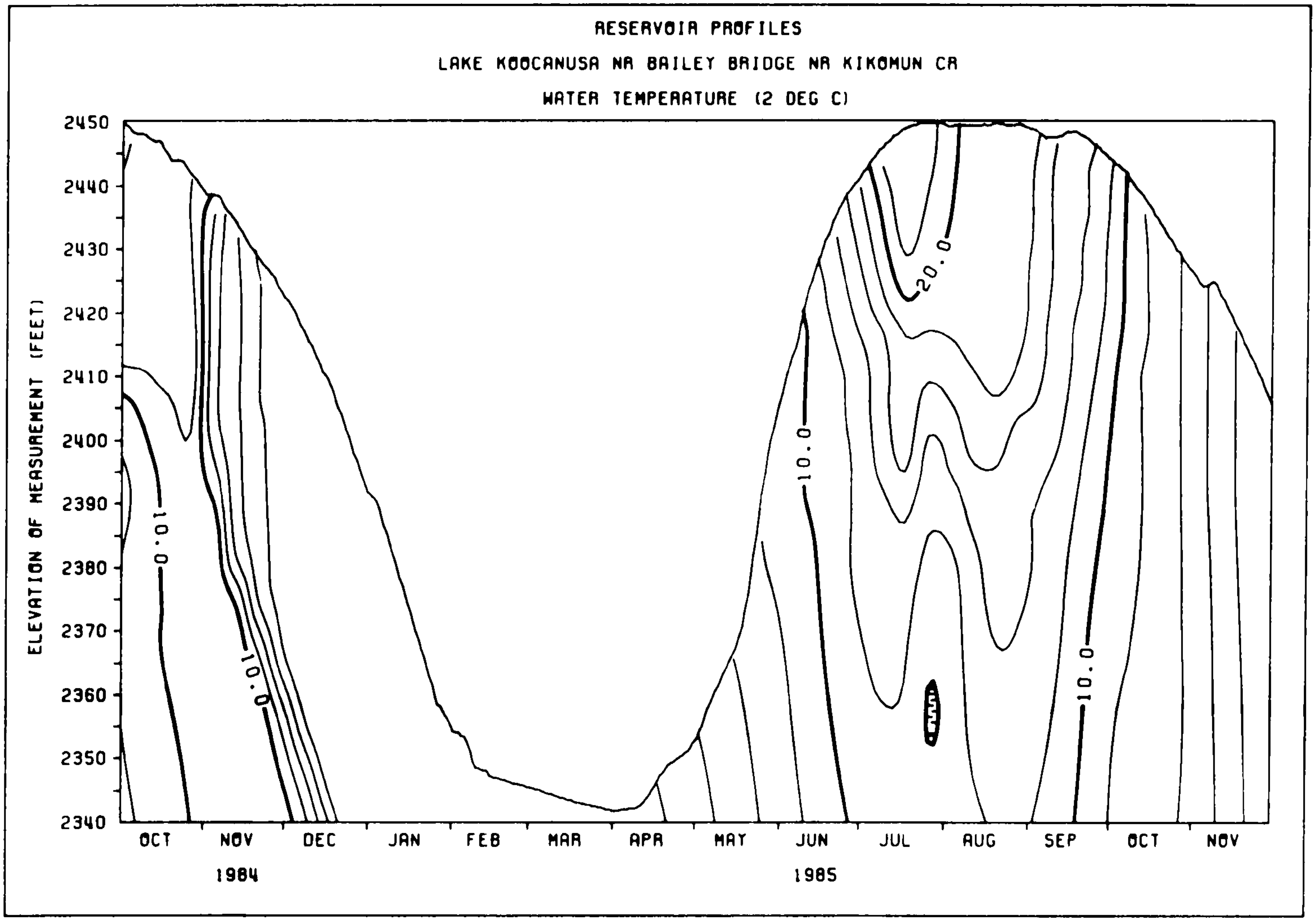


Figure A11. Isopleths of water temperature measured in the Canada area of Libby Reservoir during 1984 and 1985.

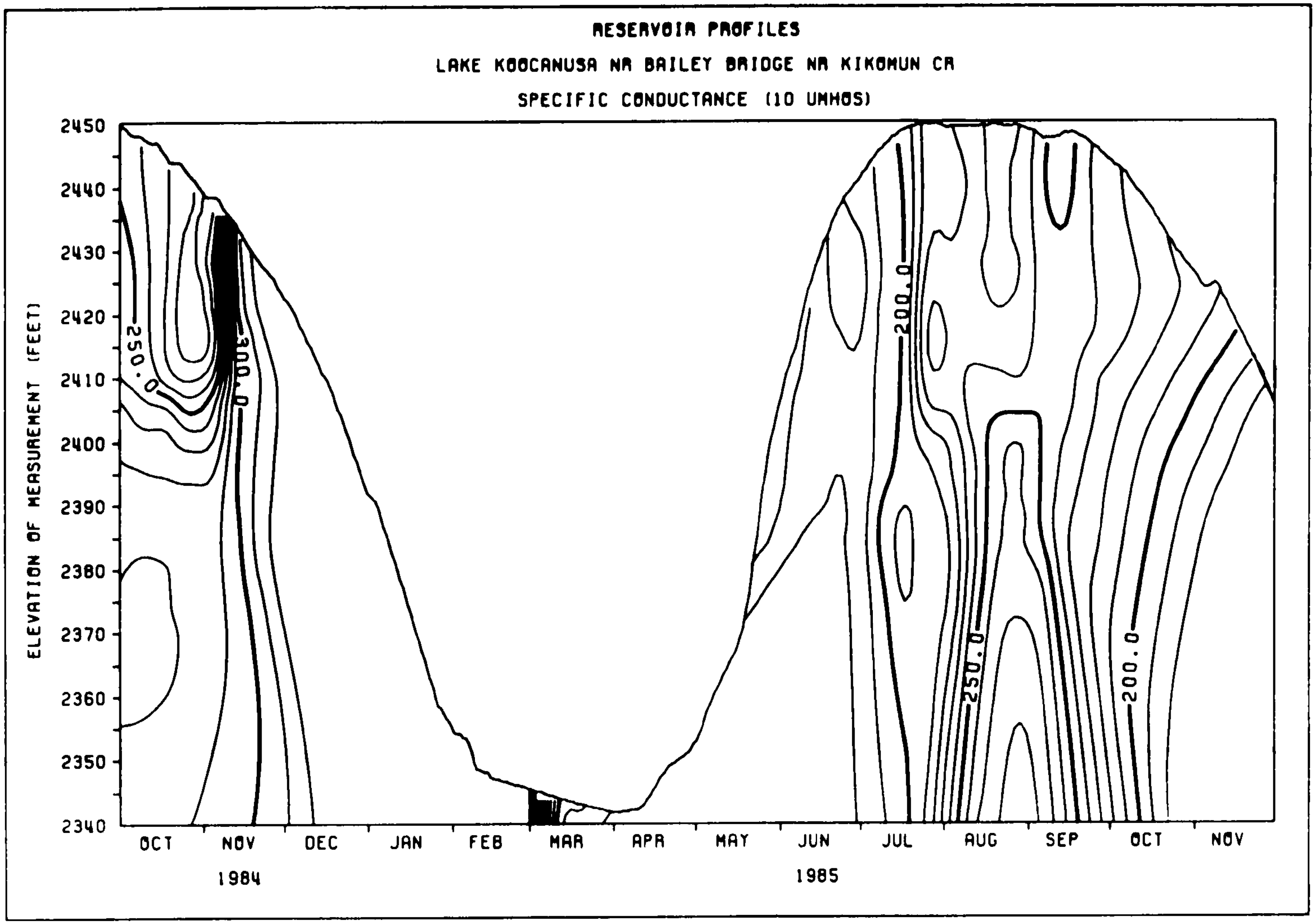


Figure A12. Isopleths of specific conductance measured in the Canada area of Libby Reservoir during 1984 and 1985.

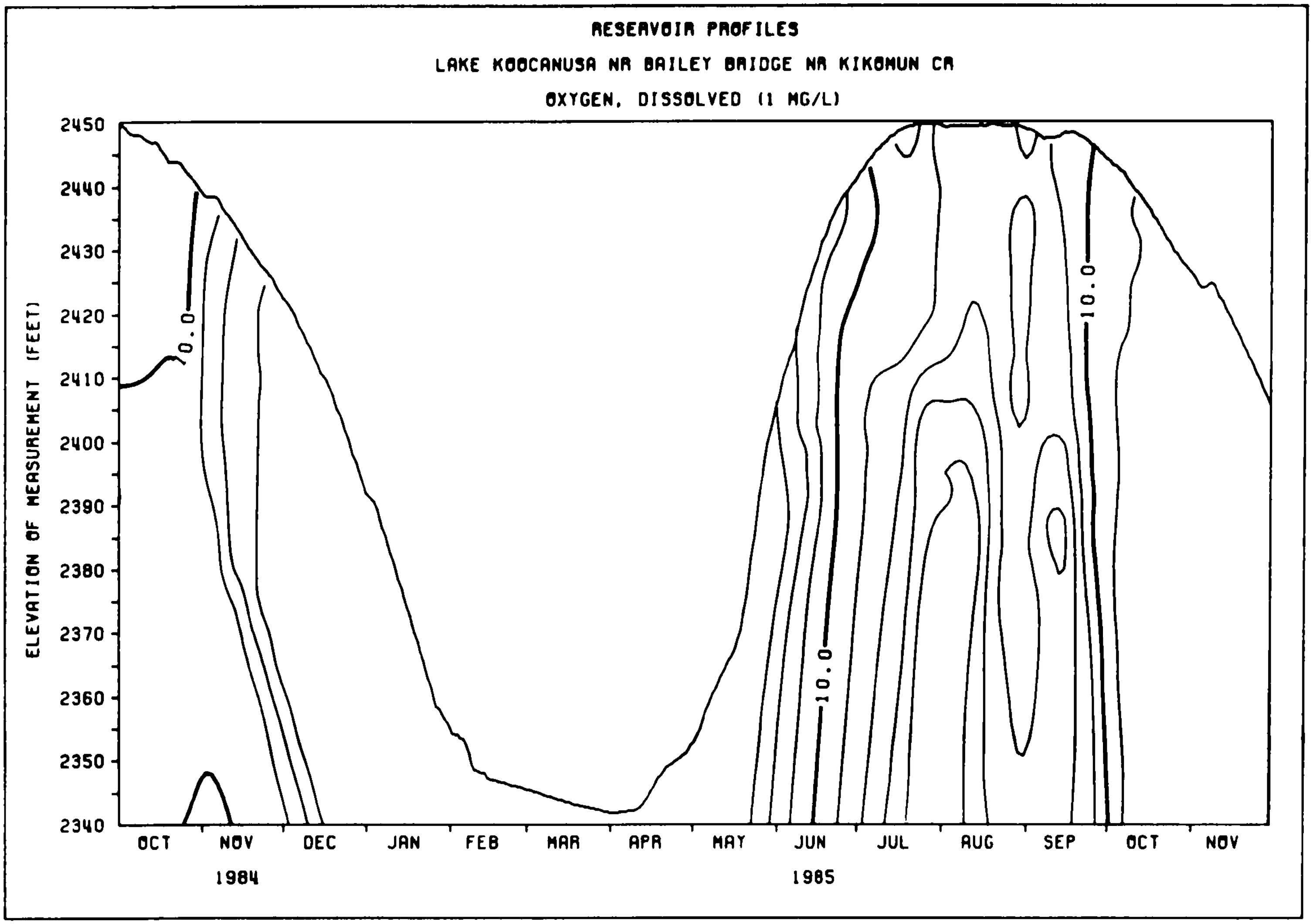


Figure A13. Isopleths of dissolved oxygen measured in the Canada area of Libby Reservoir during 1984 and 1985.

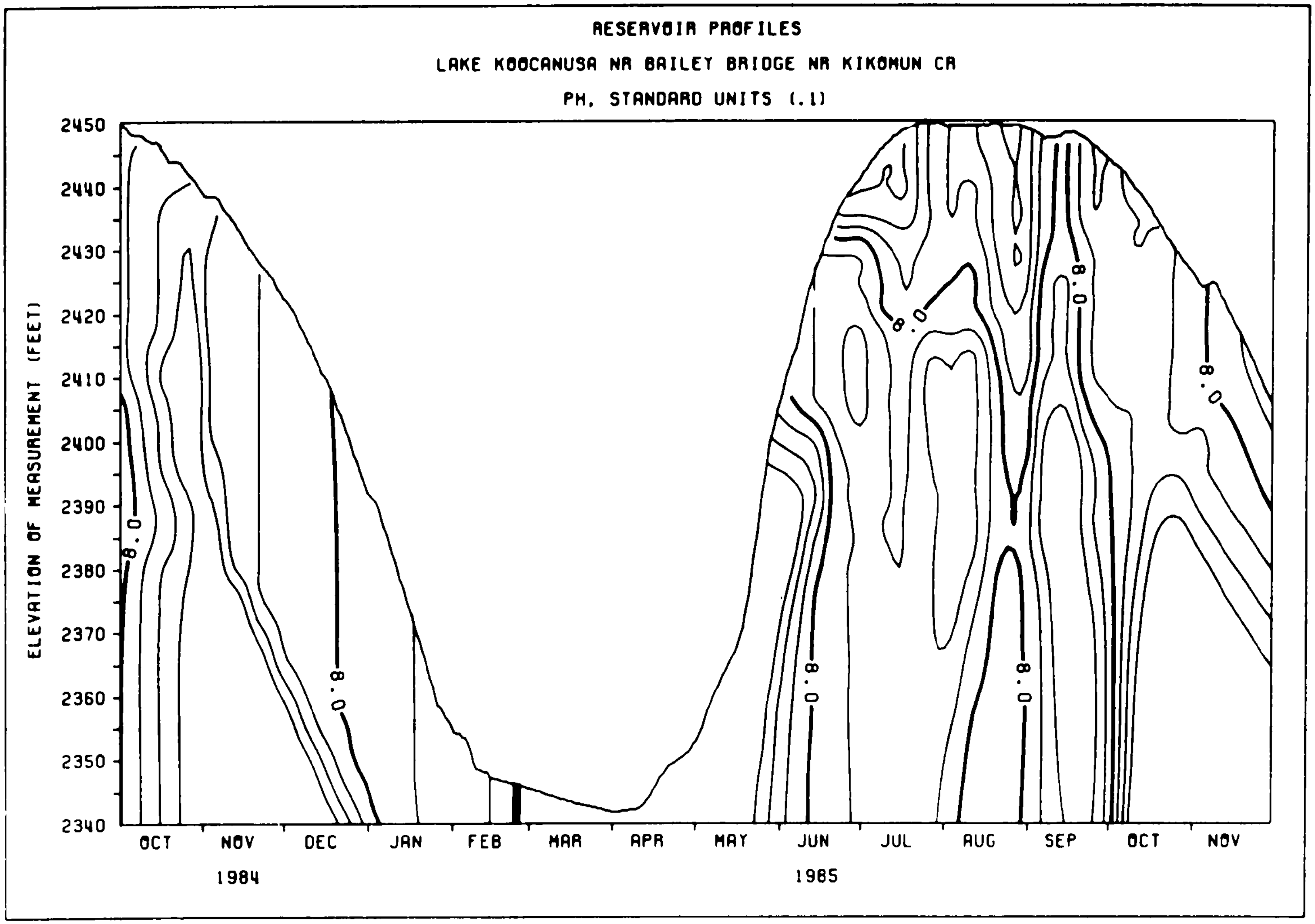


Figure A14. Isopleths of pH measured in the Canada area of Libby Reservoir during 1984 and 1985.

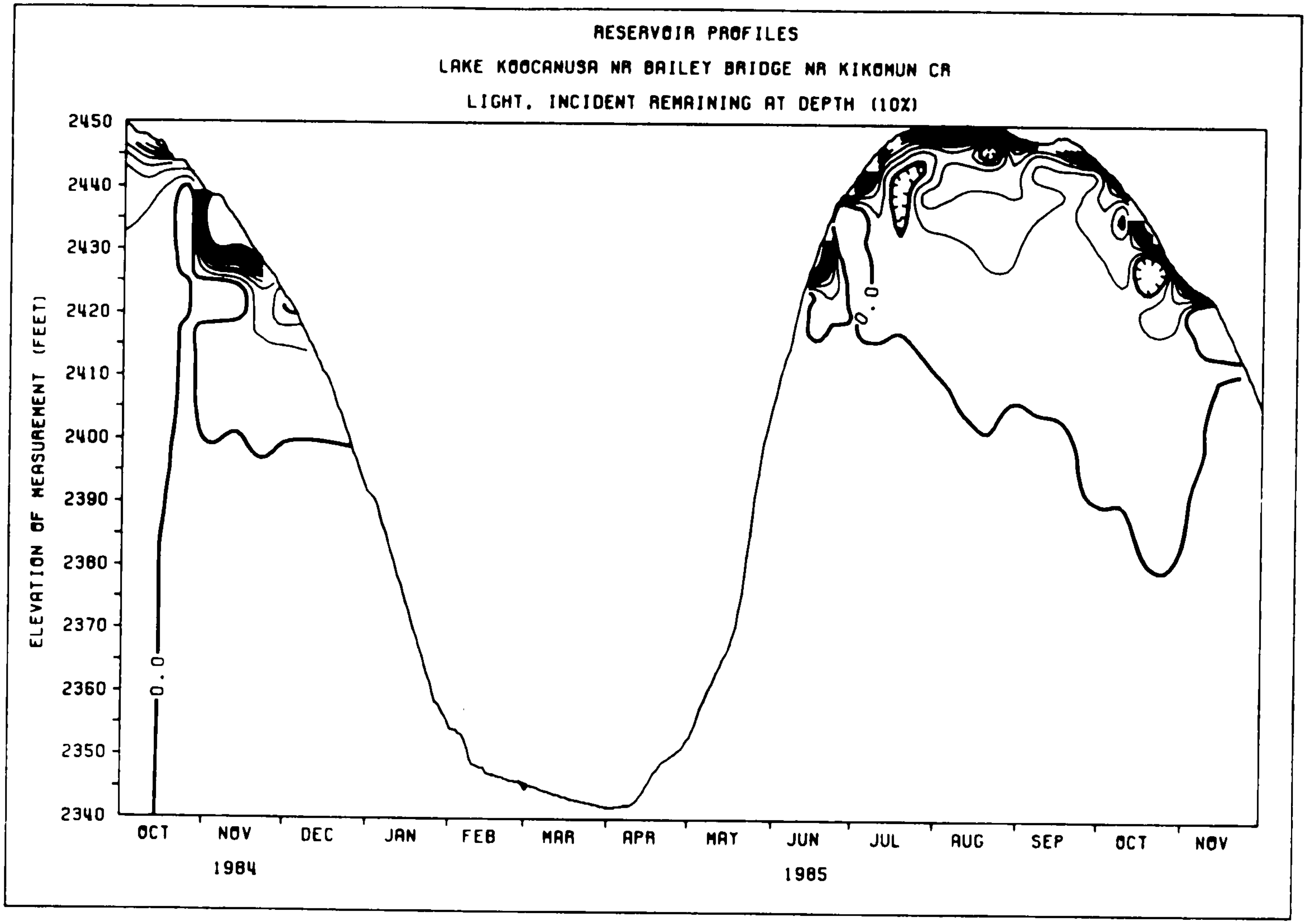


Figure A15. Isopleths of incident light measured in the Canada area of Libby Reservoir during 1984 and 1985.

APPENDIX B

Near-shore floating and sinking gill net catches
(number of fish per net night) by species in the
three areas of Libby Reservoir during 1983, 1984, and 1985.

Table B1. Floating gill net catches (# fish/net) in the Tenmile area of Libby Reservoir by date.

Date	(n)	RB	WCT	HB	Total Salmo sp.	KOK	DV	MWF	CRC	NSQ	RSS	CSU	FSU
July 1983	(12)	2.7	0.9	0.6	4.2	---	---	---	38.7	2.9	1.2	4.3	--
Aug. 1983	(14)	0.5	0.1	0.1	0.7	--	---	0.1	47.1	5.8	1.0	6.1	---
Sept. 1983	(14)	1.9	0.9	1.7	4.5	---	---	0.3	12.2	1.3	0.1	0.1	---
Oct. 1983	(10)	2.9	1.1	2.6	6.6	0.2	---	0.4	2.1	1.1	0.2	0.3	---
Nov. 1983	(10)	2.7	1.5	3.5	7.7	0.1	0.1	---	2.4	0.5	0.1	0.4	---
Dec. 1983	(10)	1.1	1.8	1.7	4.6	0.2	--	---	0.2	0.1	---	--	---
Jan. 1984	(10)	0.3	0.5	0.7	1.5	---	---	---	0.1	---	---	---	---
Feb. 1984	(10)	1.0	0.8	0.4	2.2	0.1	0.1	---	0.1	---	---	0.1	---
March 1984	(14)	1.3	0.6	0.6	2.5	0.1	0.1	---	---	---	---	---	---
April 1984	(10)	4.9	5.7	2.1	12.7	5.8	0.3	0.4	2.8	0.4	---	0.9	---
May 1984	(4)	15.5	19.8	2.5	37.8	1.9	1.9	0.1	30.3	1.6	0.3	1.6	---
June 1984	(10)	6.9	2.9	2.0	11.8	0.4	0.6	0.1	107.4	6.4	2.0	2.4	--
Aug. 1984	(24)	0.29	0.08	0.25	0.6	<0.1	---	<0.1	31.8	4.6	1.3	2.8	---
Sept. 1984	(14)	2.5	0.8	0.4	3.7	2.8	0.1	0.7	9.1	1.1	0.1	--	---
Nov. 1984	(20)	1.9	0.7	0.7	3.3	0.8	0.5	---	6.8	0.1	---	<0.1	---
May 1985	(10)	3.8	1.4	0.8	6.0	3.4	0.6	---	38.0	0.8	---	0.3	---
Aug. 1985	(24)	0.4	--	0.3	0.7	0.1	---	---	35.4	1.9	0.6	0.2	---
Oct. 1985	(20)	1.3	0.7	0.5	2.5	4.5	0.1	0.2	6.7	0.5	0.1	0.2	---

Table B2. Floating gill net catches (# fish/net) in the Rexford area of Libby Reservoir by date.

Date	(n)	RB	WCT	HB	Total Salmo sp.	KOK	DV	MWF	CRC	NSQ	RSS	CSU	FSU
July 27, 1983	(10)	2.6	0.3	1.7	4.6	---	0.1	---	70.1	5.3	2.8	6.7	---
Aug. 16, 1983	(14)	9.0	2.2	1.1	12.3	---	---	0.1	42.7	6.2	2.2	4.3	0.1
Sept. 20, 1983	(10)	2.0	0.4	1.5	3.9	0.6	---	0.5	13.2	2.8	1.5	0.7	---
Oct. 18, 1983	(10)	2.5	0.8	1.8	5.1	0.1	0.1	0.8	4.1	1.3	0.2	---	---
Nov. 15, 1983	(10)	3.7	4.4	3.3	11.4	0.1	0.2	---	1.9	0.7	---	0.3	---
Dec. 1983		FROZEN											
Jan. 2, 1984	(8)	4.7	5.0	4.7	14.4	2.2	---	0.2	0.1	---	---	0.2	---
Feb. 23, 1984	(8)	1.5	0.7	0.5	2.7	0.1	---	0.1	0.2	---	---	---	---
March 21, 1984	(10)	7.0	4.0	3.8	14.8	1.4	---	0.2	1.1	0.4	---	2.6	---
April 24, 1984	(6)	12.2	11.0	6.5	29.7	9.1	2.3	2.1	93.0	5.0	0.1	1.7	---
May 23, 1984	(4)	15.5	19.8	2.5	37.8	1.9	1.9	0.1	30.3	1.6	0.3	1.6	---
June 12, 1984	(2)	6.5	3.5	1.5	11.5	---	---	---	72.0	6.5	3.0	1.5	---
Aug. 13, 1984	(24)	1.5	0.3	0.9	2.7	<0.1	---	<0.1	38.0	4.1	1.9	2.3	---
Sept. 25, 1984	(14)	0.6	0.6	0.5	1.7	10.1	0.1	0.9	12.9	1.4	0.4	0.4	---
Nov. 8, 1984	(20)	1.3	0.9	1.1	3.3	1.3	1.0	0.3	2.9	0.4	---	---	---
April 8, 1985	(10)	9.2	3.9	5.1	18.2	1.5	1.1	0.8	46.3	3.5	0.1	2.2	---
June 5, 1985	(10)	4.3	1.3	2.2	7.8	3.0	1.0	0.4	72.7	4.8	1.9	4.6	0.1
Aug. 19, 1985	(24)	1.0	0.5	0.5	2.0	0.7	---	0.5	40.2	1.4	1.2	0.6	---
Oct. 20, 1985	(20)	3.5	2.1	1.5	7.1	11.7	0.4	0.1	4.3	0.6	0.3	0.1	---

Table B3. Floating gill net catches (# fish/net) in the Canada area of Libby Reservoir by date.

Date	(n)	RB	WCT	HB	Total Salmo sp.	KOK	DV	MWF	CRC	NSQ	RSS	CSU	FSU
July 28, 1983	(10)	1.4	0.6	---	2.0	---	---	---	32.4	4.8	---	7.3	---
Aug. 18,1983	(14)	0.4	--	---	0.4	0.1	---	--	17.1	10.6	0.9	4.4	- -
Sept.22,1983	(14)	1.6	0.6	0.3	2.5	0.2	---	0.2	21.4	4.6	0.3	1.6	---
Oct. 20,1983	(14)	1.7	1.7	1.8	5.2	0.2	0.2	0.3	0.8	1.0	- -	2.0	- -
Nov. 16, 1983	(8)	3.1	3.9	1.6	8.6	0.5	---	0.6	0.6	0.6	---	3.5	---
Dec. 1983		FROZEN OR DEWATERED THROUGH JUNE											
Aug. 16, 1984	(28)	0.3	---	0.1	0.4	---	---	0.1	30.4	8.2	0.5	2.2	<0.1
Sept. 22, 1984	(14)	2.0	1.5	1.8	5.3	19.3	0.2	0.3	18.6	2.6	0.3	0.4	---
Nov. 14,1984	(20)	2.1	2.1	1.3	5.5	5.6	0.2	0.3	1.4	0.4	---	3.3	---
Aug. 21, 1985	(22)	1.1	0.4	0.5	2.0	2.3	---	0.1	26.7	3.0	0.1	1.6	---
Oct. 25,,1985	(10)	1.9	1.2	0.4	3.5	76.8	---	0.2	1.4	0.2	--	1.2	---

Table B4. Sinking gill net catches (# fish/net) in the Tenmile area of Libby Reservoir by date.

Date	(n)	RB	WCT	HB	Total Salmo sp.	KOK	DV	Ling	MWF	CRC	NSQ	RSS	CSU	FSU
July 25, 1983	(2)	1.0	---	---	1.0	---	---	1.0	7.5	19.0	6.5	1.0	8.0	3.5
Aug. 15, 1983	(2)	5.5	0.5	0.5	6.5	---	---	---	4.5	7.5	1.0	0.5	19.5	3.0
Sept. 19, 1983	(2)	5.0	0.5	---	5.5	---	---	---	3.0	50.5	20.0	2.0	30.5	---
Oct. 17, 1983	(2)	1.5	---	---	1.5	---	0.5	1.0	4.0	13.5	11.0	---	17.5	---
Nov. 14, 1983	(2)	1.0	---	---	1.0	---	1.0	0.5	---	34.0	6.0	---	8.0	---
Dec. 19, 1983	(1)	1.0	1.0	---	2.0	---	---	---	3.0	19.0	9.0	---	6.0	---
Jan. 16, 1984	(2)	1.5	---	0.5	2.0	---	0.5	0.5	2.0	4.5	0.5	---	1.5	1.5
Feb. 21, 1984	(2)	2.0	---	---	2.0	---	0.5	3.0	2.0	2.0	---	---	5.0	0.5
March 18, 1984	(2)	1.0	---	0.5	1.5	---	1.5	---	1.0	5.0	2.0	---	8.0	1.0
April 23, 1984	(2)	0.5	---	---	0.5	0.5	1.0	---	4.5	14.0	1.0	---	4.0	---
May 21, 1984	(2)	---	---	---	0	---	0.5	0.5	5.5	24.5	9.5	1.5	10.5	1.5
June 14, 1984	(2)	0.5	---	---	0.5	---	0	---	---	46.0	3.5	0.5	16.5	10.0
August 13, 1984	(4)	0.7	---	---	0.7	---	0.2	0.5	2.0	19.0	3.2	---	9.5	1.2
Nov. 7, 1984	(4)	0.5	---	---	0.5	0.5	1.0	1.0	1.0	12.0	2.7	---	6.3	1.0
May 8, 1985	(2)	0.5	---	---	0.5	---	0.5	0.5	4.0	31.0	2.0	---	8.0	---
Aug. 5, 1985	(4)	0.8	0.3	0.8	1.9	0.5	0.5	0.3	4.5	23.0	3.0	---	7.0	1.8
Oct. 20, 1985	(2)	---	---	---	---	8.5	0.5	1.5	4.0	24.0	2.5	---	8.0	0.5

Table Sinking gill net catches (# fish/net) in the Rexford area of Libby Reservoir by date.

Date	(n)	RB	WCT	HB	Ttoal Salmo sp.	KOK	DV	Ling	MWF	CRC	NSQ	RSS	CSU	FSU
July 26, 1983	(2)	2.0	--	1.0	3.0	---	1.0	0.5	1.0	26.5	4.5	---	11.0	1.5
Aug. 16, 1983	(2)	3.0	--	0.5	3.5	---	---	---	--	24.0	1.5	---	25.5	0.5
Sept. 20, 1983	(2)	---	---	1.0	1.0	0.5	0.5	--	3.5	57.5	9.0	1.0	24.5	1.5
Oct. 18, 1983	(2)	2.5	--	--	2.5	---	1.0	--	6.0	55.5	8.5	---	13.0	0.5
Nov. 15, 1983	(2)	1.0	0.5	1.0	2.5	—	1.0	--	0.5	50.0	14.0	—	6.5	0.5
Dec.	ICE COVER													
Feb. 2, 1983	(2)	3.0	1.0	1.5	5.5	--	1.0	1.0	5.5	2.0	—	---	3.5	0.5
Feb. 23, 1983	(2)	4.0	--	3.0	7.0	--	2.5	0.5	9.0	6.5	0.5	--	5.5	1.0
March 21, 1983	(2)	1.5	--	--	1.5	--	1.5	—	14.0	17.0	3.0	--	11.5	1.0
April 24, 1984	(2)	1.5	0.5	--	2.0	3.0	3.0	1.0	19.0	32.5	7.5	1.0	10.0	--
May 23, 1984	(2)	4.5	2.0	9.5	16.0	--	2.5	1.5	5.0	20.0	2.0	0.5	6.0	0.5
June 12, 1984	(20)	2.5	0.1	0.6	3.2	--	1.8	0.4	2.9	59.2	8.0	2.5	63.2	5.6
Aug. 14, 1984	(4)	1.0	0.7	—	1.7	0.5	0.2	—	2.0	32.7	6.2	0.2	5.6	1.2
Nov. 12, 1984	(4)	1.7	--	0.3	2.0	--	1.7	--	1.5	43.3	3.5	0.2	7.0	---
April 8, 1985	(2)	2.5	--	1.0	3.5	--	3.0	—	16.0	18.0	8.0	--	7.0	2.0
June 5, 1985	(23)	0.3	0.1	0.1	0.5	0.5	1.3	0.6	0.8	79.7	8.9	1.4	21.3	4.3
Aug. 19, 1985	(4)	0.5	—	0.3	0.8	—	--	—	2.0	75.8	8.3	0.3	13.5	0.3
Oct. 22, 1985	(2)	2.5	0.5	--	3.0	1.0	1.5	—	3.5	40.5	5.5	0.5	4.5	---

15 in

Table B6. Sinking gill net catches (# fish/net) in the Canada area of Libby Reservoir by date.

Date	(n)	RB	WCT	HB	Total Salmo sp.	KOK	w	Ling	MWF	CRC	NSQ	RSS	CSU	FSU
July 28, 1983	(2)	- -	- -	- -	0	—	0.5	—	0.5	9.5	1.0	—	7.5	- -
Aug. 18, 1983	(2)	1.0	1.0	---	2.0	---	- -	---	2.0	9.5	5.5	0.5	19.5	0.5
Sept. 22, 1983	(2)	0.5	- -	1.0	1.5	0.5	- -	7.0	17.5	3.5	0.5	12.5	1.0	
Oct. 20, 1983	(2)	1.5	- -	1.0	2.5	0.5	0.5	- -	5.5	2.5	3.0	0.5	8.0	0.5
Nov 16, 1983	(2)	2.0	- -	---	2.0	- -	1.5	- -	11.5	5.0	2.0	—	1.5	- -
Dec.	ICE													
Aug. 16, 1984	(4)	0.5	0.5	—	1.0	1.5	0.5	—	4.0	13.2	2.7	0.2	7.2	--
Nov. 14, 1984	(4)	0.5	1.0	0.7	2.2	1.5	—	0.3	11.3	0.7	1.0	--	1.7	0.3
Aug. 21, 1985	(2)	0.5	---	---	0.5	1.5	0.5	---	7.0	11.0	1.5	---	8.5	--

APPENDIX C

Summary of electrofishing catches (fish per hour) along shoreline of Libby Reservoir, by habitat type, during 1984 and 1985.

Table C1. Fish catch per hour of night electrofishing effort along the shoreline of Libby Reservoir during 1984. Shoreline areas were classified based on gradient (S=steep slope, M=moderate slope, L=low or slight slope), substrate type (S=sand and silt, G=gravel, C=cobble, R=boulder, D=bedrock), cover class (0=none, 1=little, 2=moderate, 3=moderately abundant, 4=abundant), and cover type (R=rock, D=debris).

Area	Season	Length (m)	Habitat Type: Gradient	Substrate	Cover Class	Cover Type	Catch per Hour: Salmo	MWF	CRC	RSS	CSU
Tenmile											
1	Summer	293	M	S	4	D	0	0	23.5	23.5	3.9
2	Summer	274	L	S	2	D	0	0	14.1	37.6	4.7
3	Summer	320	S	C	4	R	6.8	0	3.4	13.5	16.9
4	Summer	293	S	S,G,C	3	R,D	0	0	3.5	14.2	74.5
5	Summer	402	S	C,R	2	D,R	0	0	0	0	4.8
6	Summer	329	M				0	0	4.3	4.3	0
7	Summer	347	L	S	1	D	0	0	4.7	14.1	14.1
8	Summer	438					0	0	7.7	7.7	7.7
9	Summer	256	S	R,B	0		0	0	0	0	0
10	Summer	375	S	G,C	1	D	5.7	0	0	0	0
Rexford											
1	Summer	329	L	S,G,C	2	R,D	0	0	0	0	0
2	Summer	384	M	S	1	D	10.0	6.7	0	30.0	10.0
2	Fall						3.1	6.3	0	6.3	9.5
3	Summer	198	M	S	1	D	0	0	0	10.3	20.6
4	Summer	320	L	S	4	D	0	0	0	7.9	35.6
4	Fall						6.7	10.0	0	0	0
5	Summer	274	L	S	2	D	0	4.1	4.1	0	12.3
5	Fall						9.2	64.6	0	0	0
6	Summer	280	L	S	1	D	0	13.2	5.3	5.3	18.5
7 a/	Summer	192	S	R,B	3	R	0	0	0	0	0
8 a/	Summer	366	S	R,B	3	R	0	0	3.8	0	0

a/ Electrofished during the day

Table C2. Fish catch per hour of night electrofishing effort along the shoreline of Libby Reservoir during 1985. Shoreline areas were classified based on gradient (S=steep slope, M=moderate SLOPEI l=LOW or slight slope), substrate type (S=sand and silt, G=gravel , C=cobble, R=boulder, D=bedrock), cover class (O=none, l=little, 2=moderate 3=moderately abundant, 4=abundant) , and cover type (R=rock, D=debris)..

Area	Season	Length (m)	Habitat Type				Catch per hour						
			Gradient	Substrate	Cover Class	Cover Type	Salmo	MWF	Ling	PM	RSS		
Tenmile													
1	Spring	301	M	S	4	D	--	-	----	28.0	24.0	32.0	8.0
2	Spring	---	L	S	2	D							
3	Spring	518	S	C	4	R	1.7	6.7	___	1.7	5.0	56.7	1.7
4	Spring	411	S	S,G,C	3	R,D	--	5.7	----	14.3	---	34.3	5.7
5	Spring	411	S	C,R	2	D,R	---	---	---	2.7	--	109.1	5.5
6	Spring	375	M				--	2.9	----	5.7	5.7	22.9	5.7
7	Spring	411	L	S	1	D	---	3.3	----	53.3	16.7	100.0	26.7
8	Spring	302					8.6	5.7	----	14.3	8.6	142.9	11.4
9	Spring	329	S	R,B	0		3.0	----	---	---	15.0	33.0	3.0
10	Spring	411	S	G,C	1	D	---	3.5	----	----	24.7	28.2	3.5
Rexford													
1	Fall	366	L	S	1		9.2	18.5	4.6	9.2	4.6	----	----
2	Spring	356	L	S	0		8.1	2.7	8.1	35.4	54.5	73.3	2.7
2	Fall	366	S	S	1		--	5.0	---	----	10.0	10.0	---
4	Spring	335	L	S,G	2	R	22.1	15.8	---	9.5	66.3	78.9	9.5
4	Fall	366	L	S	1	D	--	24.0	---	4.0	40.0	----	----
6	Spring	329	S	S	2	D	3.5	----	---	----	3.5	----	3.5
6	Fall	360	S	S	2	D	4.6	----	---	----	----	---	----
8	Spring	329	S	R,D	2	R	6.6	----	---	16.7	16.7	20.0	6.7
8	Fall	360	S	R,D	2	R	--	----	3.3	---	13.3	10.0	----
9	Spring	329	S	G	1		48.0	9.0	---	9.0	45.0	48.0	6.0
9	Fall	366	M	G,C	1	R	---	7.5	---	---	----	7.5	----

APPENDIX D

Monthly vertical gill net catch
in Libby Reservoir from 1983
through July 1985.

Table D1. Monthly catches of fish (number of fish caught in four vertical gill nets set overnight) in the Tenmile area of Libby Reservoir during 1983, 1984 and 1985.

Date	RB	WCT	RBx WCT	Total Salmo sp.	DV	KOK	MWF	CRC	NSQ	RSS	CSU	FSU
Oct. 1983	2	-	1	3	1	4	-	1	-	-	-	-
Nov. 1983	-	-	1	1	1	12	-	-	-	-	-	-
Dec. 1983	-	-	-	-	-	15	-	2	-	-	-	-
Jan. 1984	1	-	-	1	2	36	-	-	-	-	-	-
Feb. 1984	1	-	-	1	2	49	-	1	-	-	-	-
March 1984	-	-	-	-	-	38	-	-	-	-	-	-
April 1984	1	-	-	1	1	69	-	-	-	-	-	-
May 1984	1	-	1	2	-	8	-	1	1	-	-	-
June 1984	-	-	1	1	3	22	-	1	-	-	1	-
July 1984	-	-	-	-	-	12	-	2	1	-	-	-
Aug. 1984	1	-	-	1	-	38	-	-	-	-	-	-
Sept. 1984	-	1	1	2	-	130	-	-	1	-	-	-
Oct. 1984	2	2	-	4	1	153	1	-	-	-	-	-
Nov. 1984	-	-	-	-	-	42	-	-	-	-	1	-
Dec. 1984	-	-	-	-	-	31	-	-	-	-	-	-
Jan. 1985	1	-	-	1	-	56	-	2	-	-	-	-
April 1985	-	-	-	-	-	9	-	2	-	-	-	-
May 1985	-	-	-	-	-	114	-	38	-	-	-	-
June 1985	-	-	-	-	-	75	-	5	-	-	-	-
July 1985	-	-	-	-	-	115	-	2	-	-	-	-

Table D2. Monthly catches of fish (number of fish caught in four vertical gill nets set overnight) in the Rexford area of Libby Reservoir during 1983, 1984 and 1985.

Date	RB	WCT	RBX WCT	Total Salmo sp.	DV	KOK	MWF	CRC	NSQ	RSS	CSU	FSU
Oct. 1983	12		-	3		-	-	3	2	-	-	-
Nov. 1983	-	-			1	2	-	l	-	-	-	-
Dec. 1983	-	-	-	-		6	-	l	l	-	-	-
Jan. 1984	-	-		-	1	4l	-	21		-	-	-
Feb. 1984	2	3	1	**6**		45	-	l	-	-	-	-
March 1984	l	-	3	**4**	2	62	-	3	1	-	-	-
April 1984	2	-	-	**2**		54	1	30	5	-	1	-
May 1984	4	-	-	**4**	2	92	-	4	3	-	2	-
June 1984	1	3	1	**5**	1	44	1	3	-	-	-	-
July 1984	1	1	-	**2**	1	30	2	11-		-	-	-
Aug. 1984	-	-		-	1	79	1	12	-	-	-	-
Sept. 1984		2	-	**2**	1	83	-	**1**	-	-	1	-
Oct. 1984		l	-	**l**	l	167	-	**8**	**l**	-	-	-
Nov. 1984	-	-	-	-		51	-	-	1	-	-	-
Dec. 1984	-	-	-	-	1	45	-	-	1	-	-	-
April 1985	-	-			2	114	-	58	1	-	-	-
May 1985	-	-	3	3		20	1	8	4	1	1	-
June 1985	-	-				53	-	4	-	-	-	-
July 1985	2	-	-	2		56	-	25	-	-	1	-

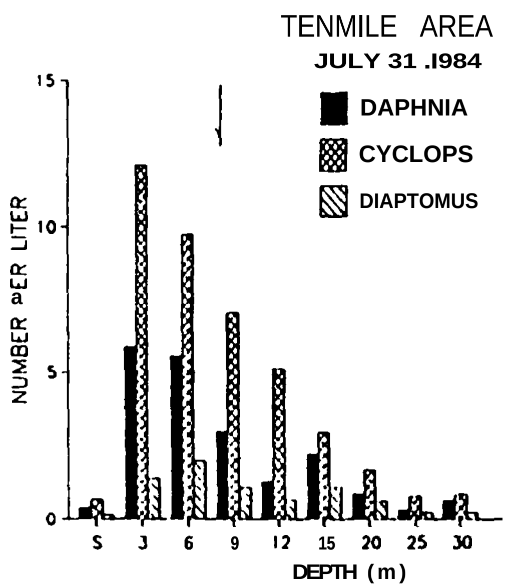
Table D3. Monthly catches of fish (number of fish caught in four vertical gill nets set overnight) in the Canada area of Libby Reservoir during 1983, 1984 and 1985.

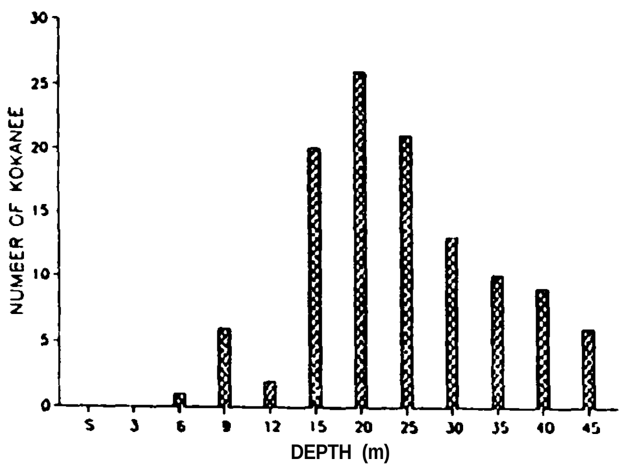
Date	RB	WCT	RBX WCT	Total salmo sp.	DV	KOK	MWF	CRC	NSQ	RSS	CSU	FSU
July 1984	1	-	-	1	-	2	2	24	1	-	11	2
Aug.1984	-	-	1	1	-	1	-	12	7	-	-	-
Oct.1984	-	-	-	-	-	6	-	1	1	-	-	-
July 1985	-	-	-	-	-	4	-	16	2	1	-	-
Aug. 1985	-	-	-	-	1	7	-	86	5	-	-	-

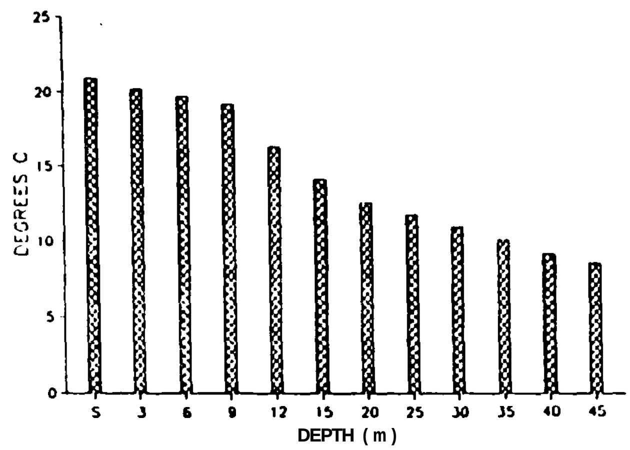
APPENDIX E

Vertical distributions of zooplankton and kokanee salmon compared to temperature profiles and euphotic zone depths by date in the three areas of Libby Reservoir during 1984 and 1985.

Arrow indicates euphotic zone depth.


TENMILE AREA
JULY 31 .I984
DAPHNIA
CYCLOPS
DIAPTOMUS
NUMBER PER LITER
0
5
10
15
S
3
6
9
12
15
20
25
30
DEPTH (m)


NUMBER OF KOKANEE
0
5
10
15
20
25
30
S
3
6
9
12
15
20
25
30
35
40
45
DEPTH (m)


DEGREES C
0
5
10
15
20
25
S
3
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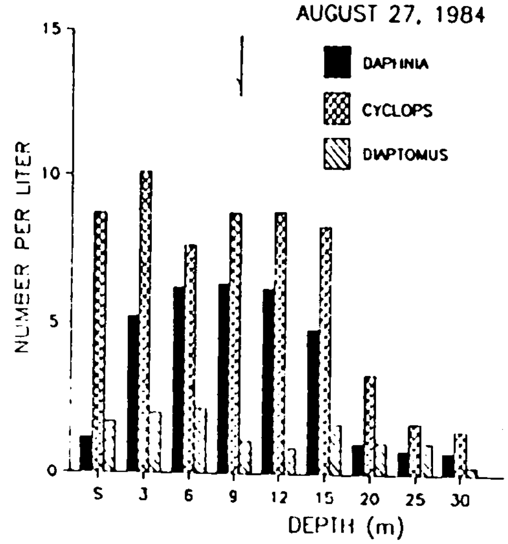
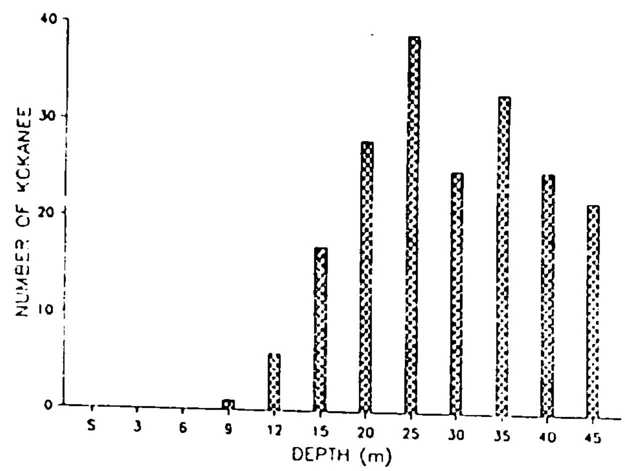
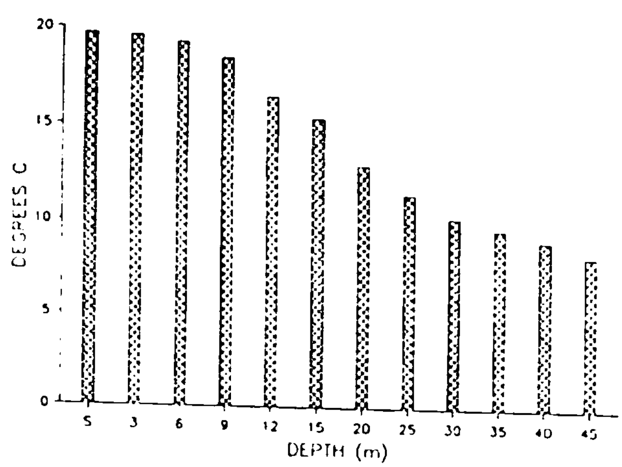
9
12
15
20
25
30
35
40
45
DEPTH (m)

TENMILE AREA
AUGUST 27, 1984

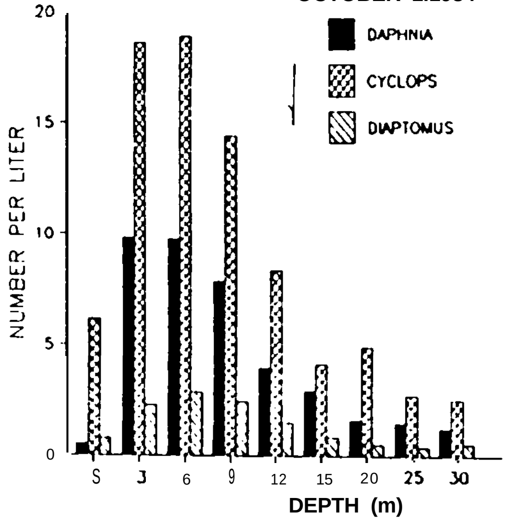


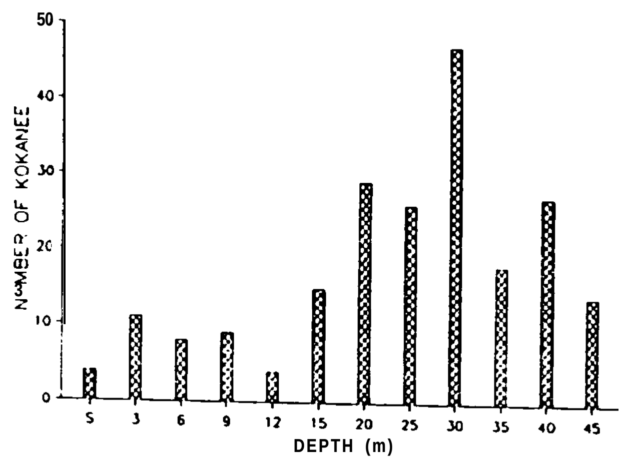


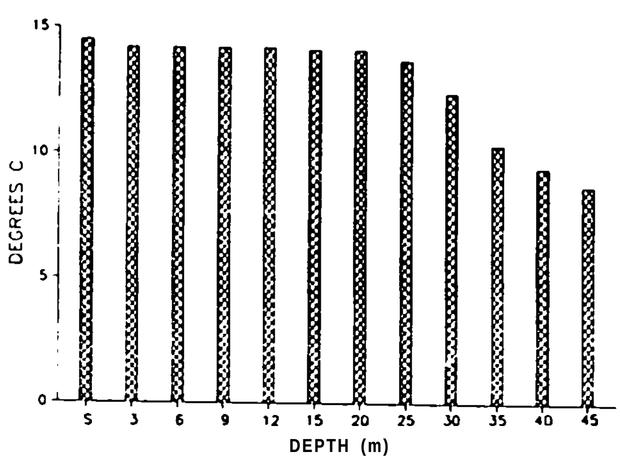


TENMILE AREA

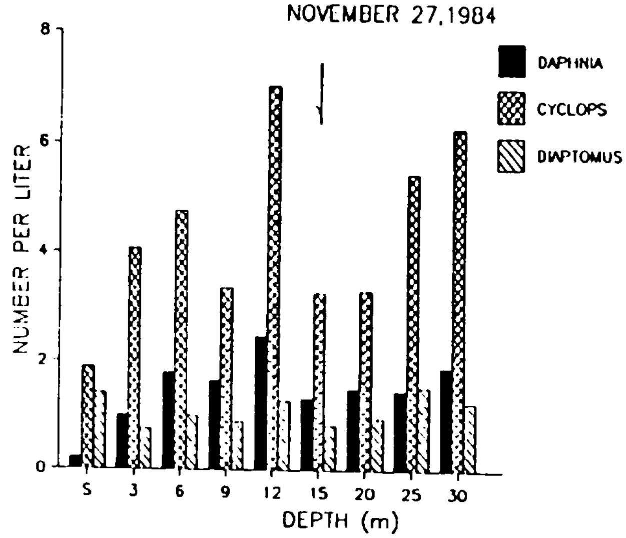
OCTOBER 1.1984

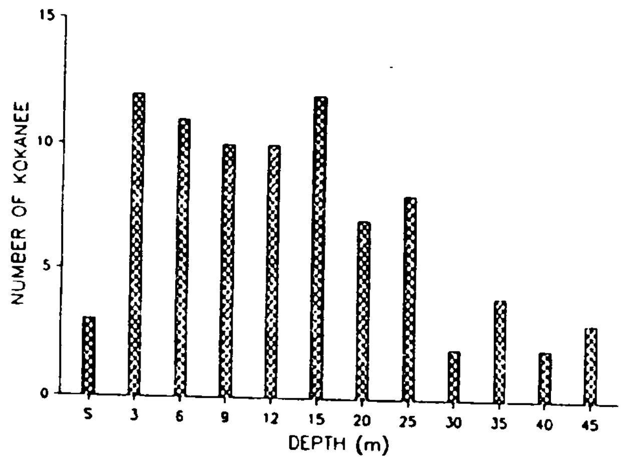


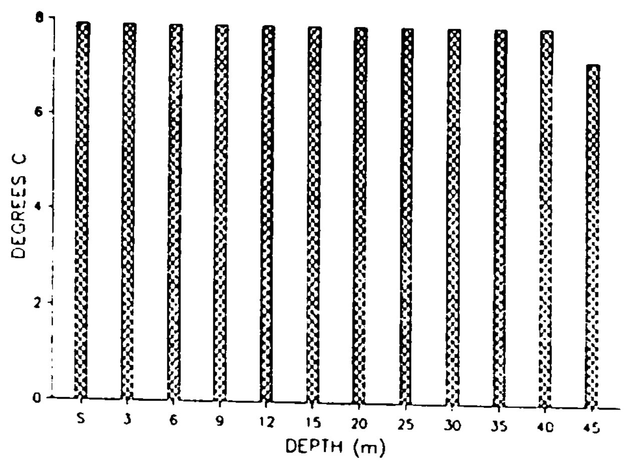




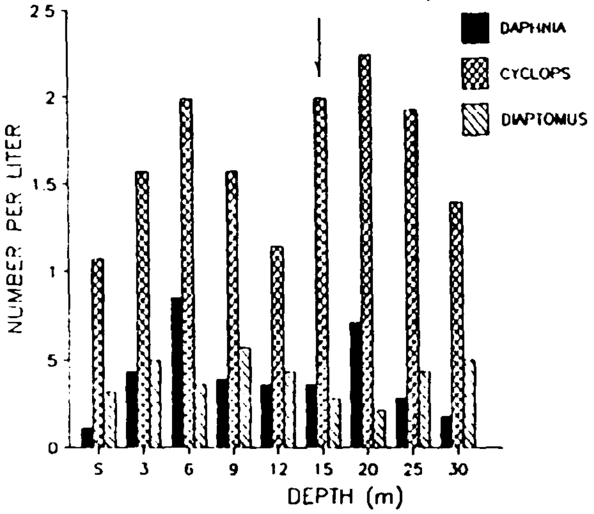
TENMILE AREA
NOVEMBER 27, 1984

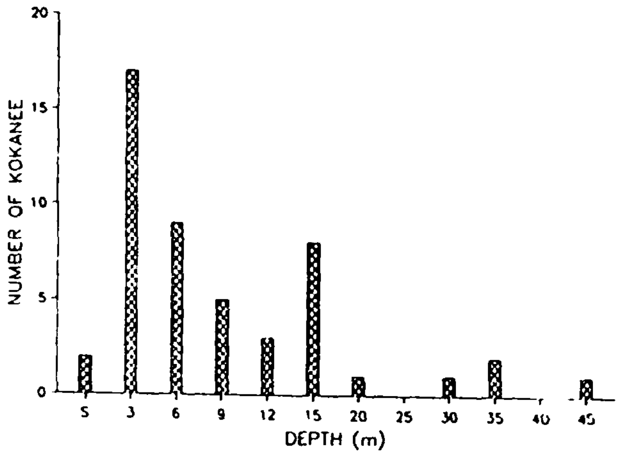


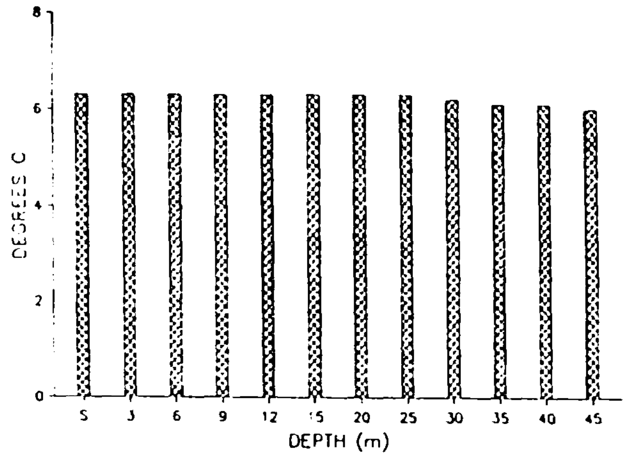




TENMILE AREA
DECEMBER 13,1984

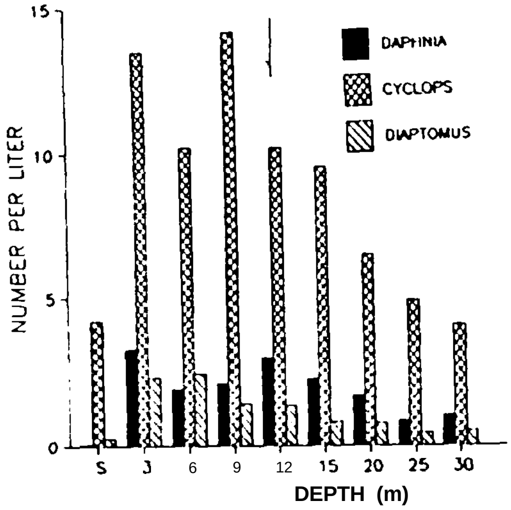


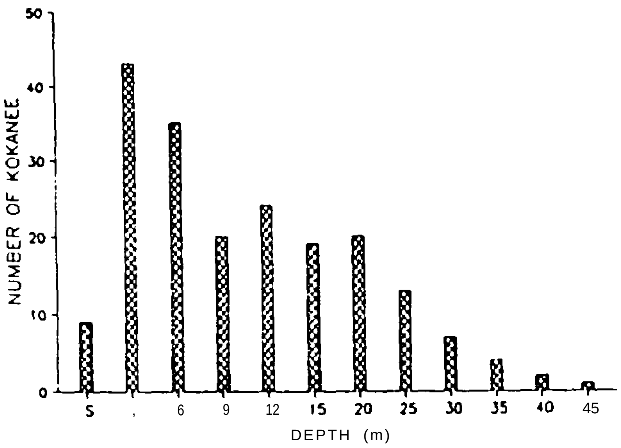


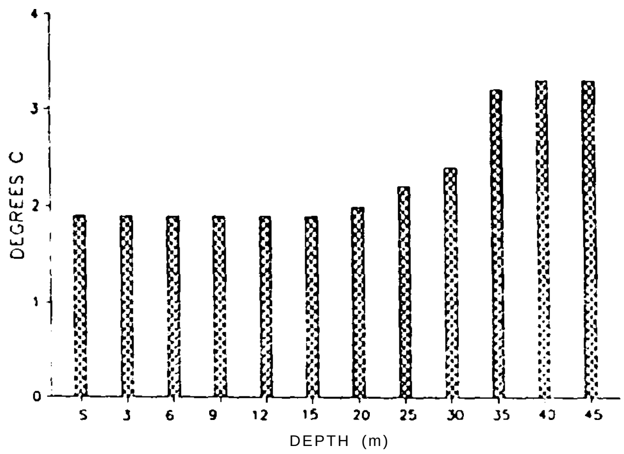


TENMILE AREA

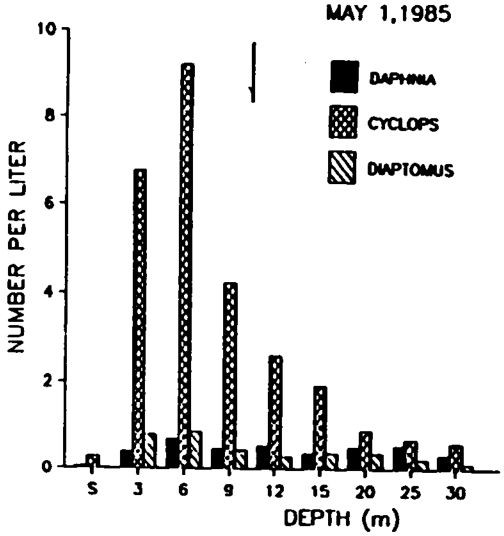
JANUARY 21,1985

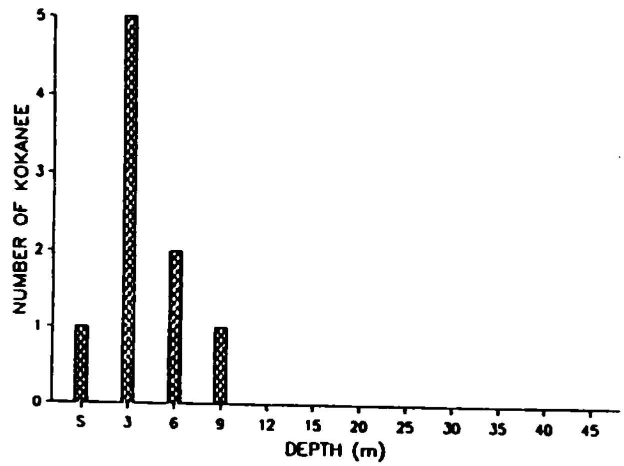


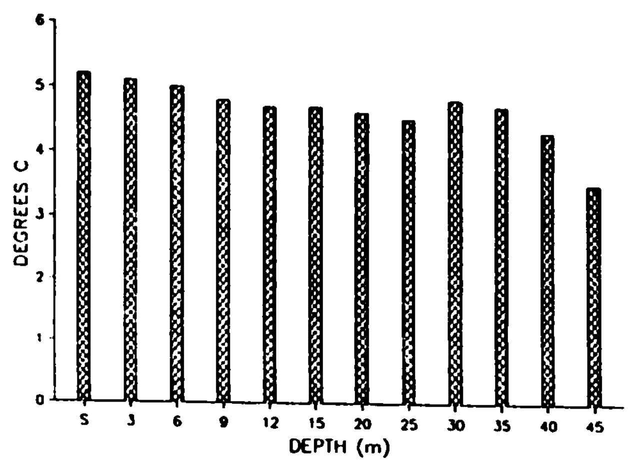




TENMILE AREA
MAY 1,1985

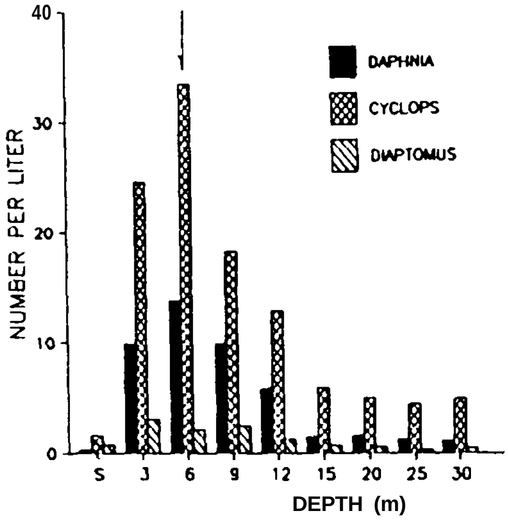


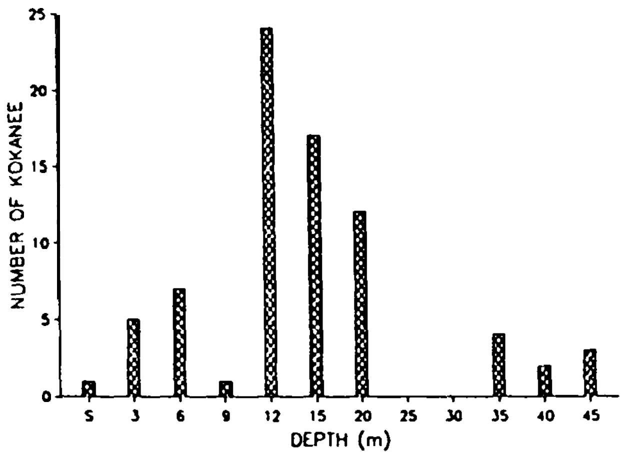


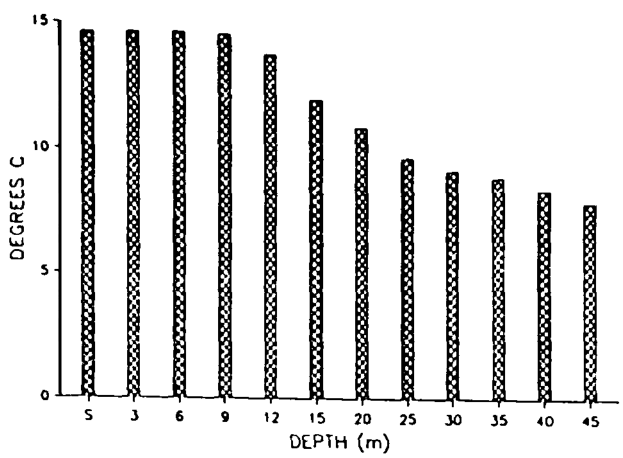


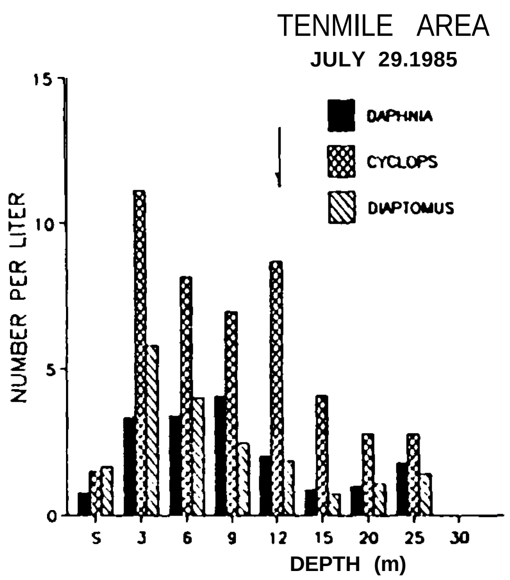
TENMILE AREA

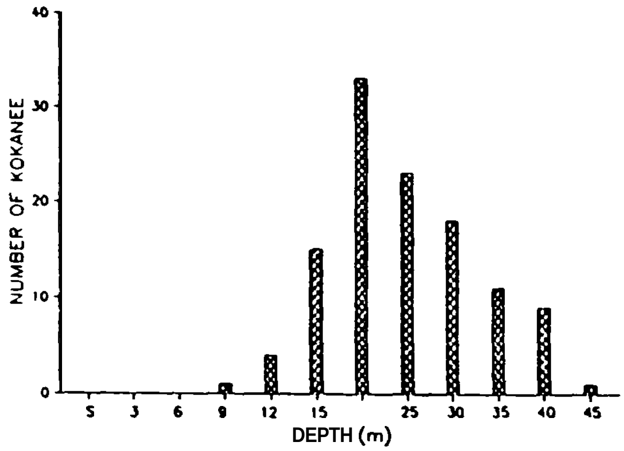
JUNE 24.1985

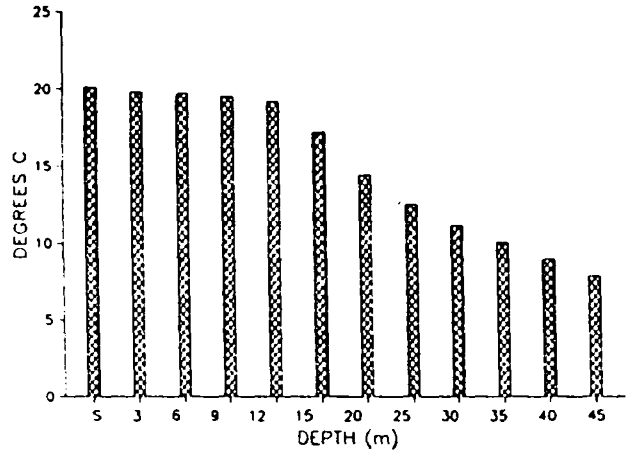






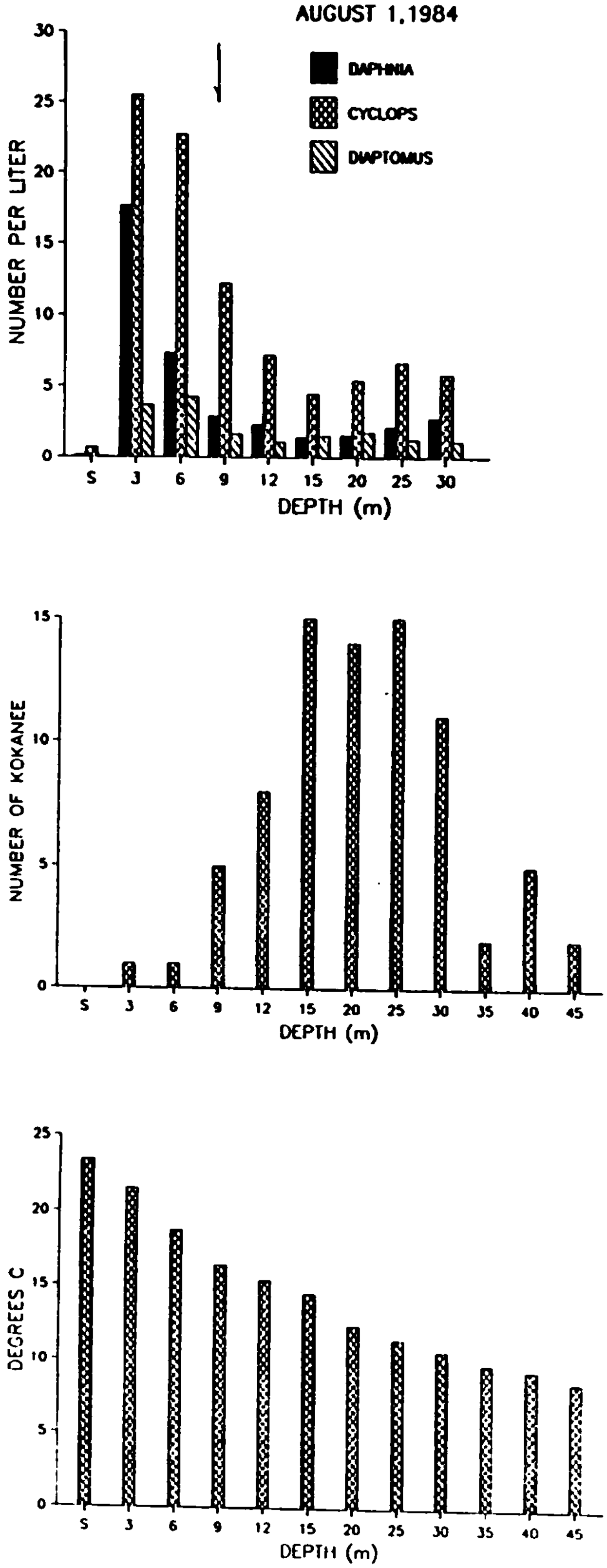

TENMILE AREA
JULY 29.1985
DAPHNIA
CYCLOPS
DIAPTOMUS
NUMBER PER LITER
DEPTH (m)


NUMBER OF KOKANEE
DEPTH (m)

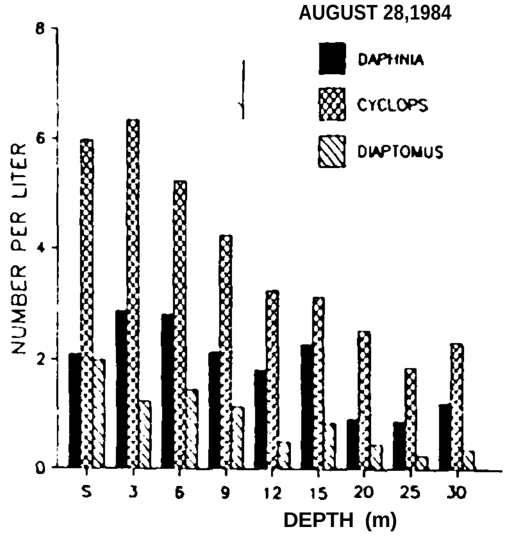

DEGREES C
DEPTH (m)

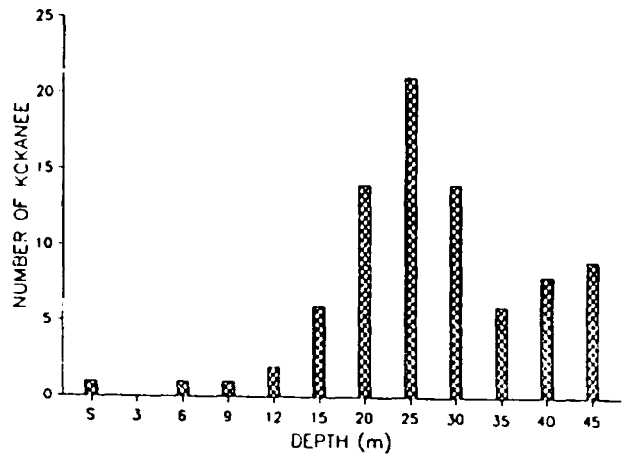
REXFORD AREA

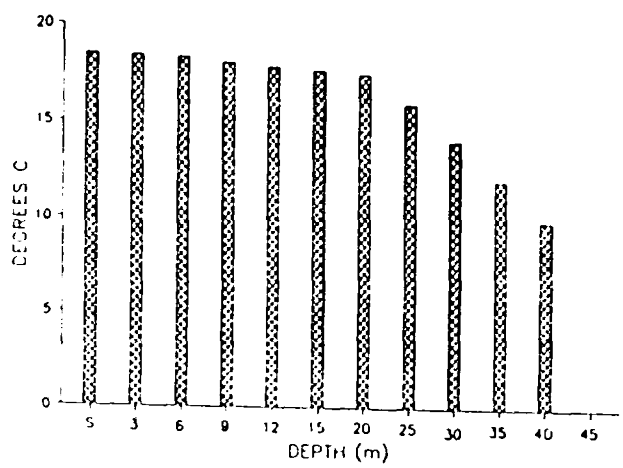
AUGUST 1, 1984



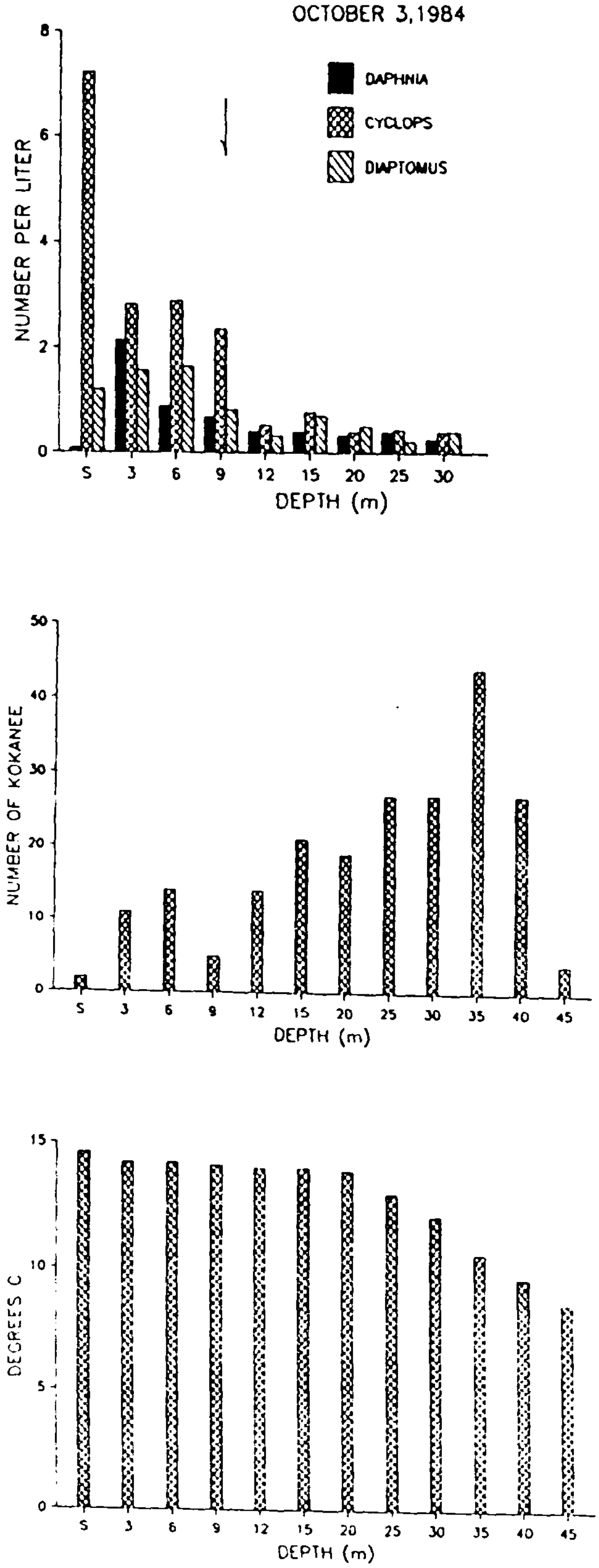
REXFORD AREA
AUGUST 28,1984







REXFORD AREA
OCTOBER 3,1984



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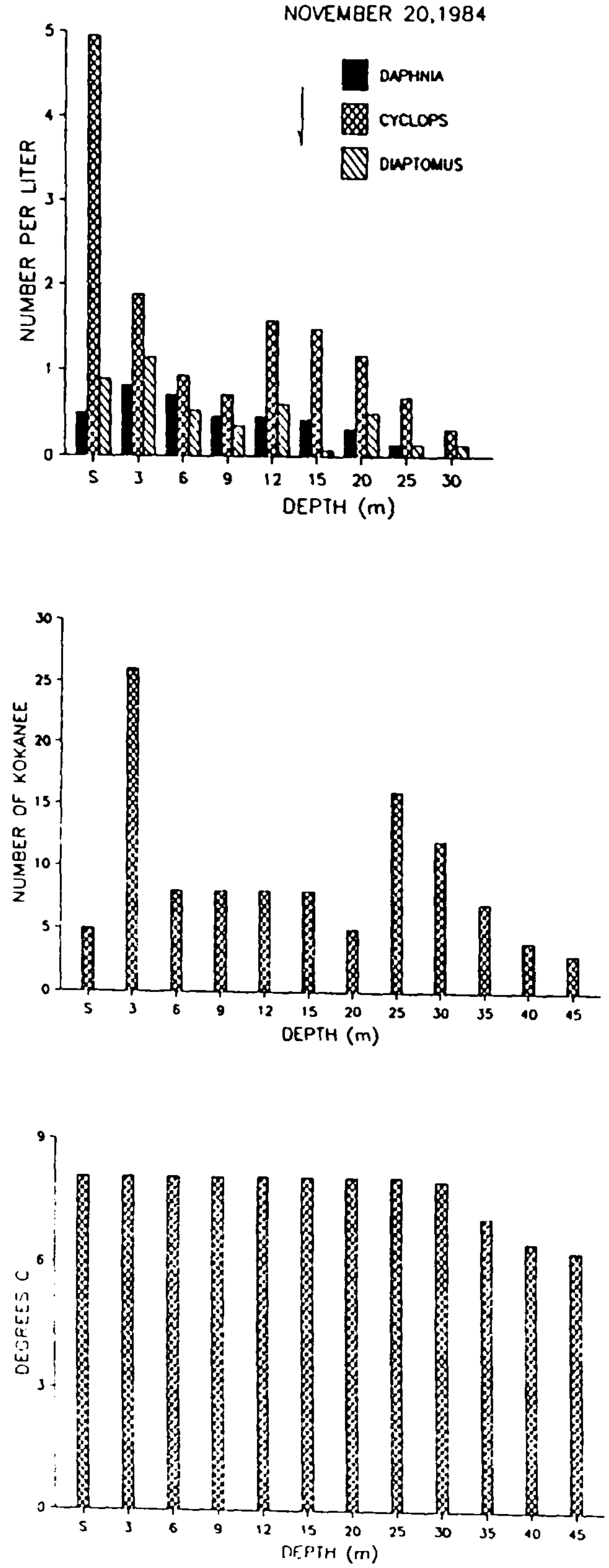
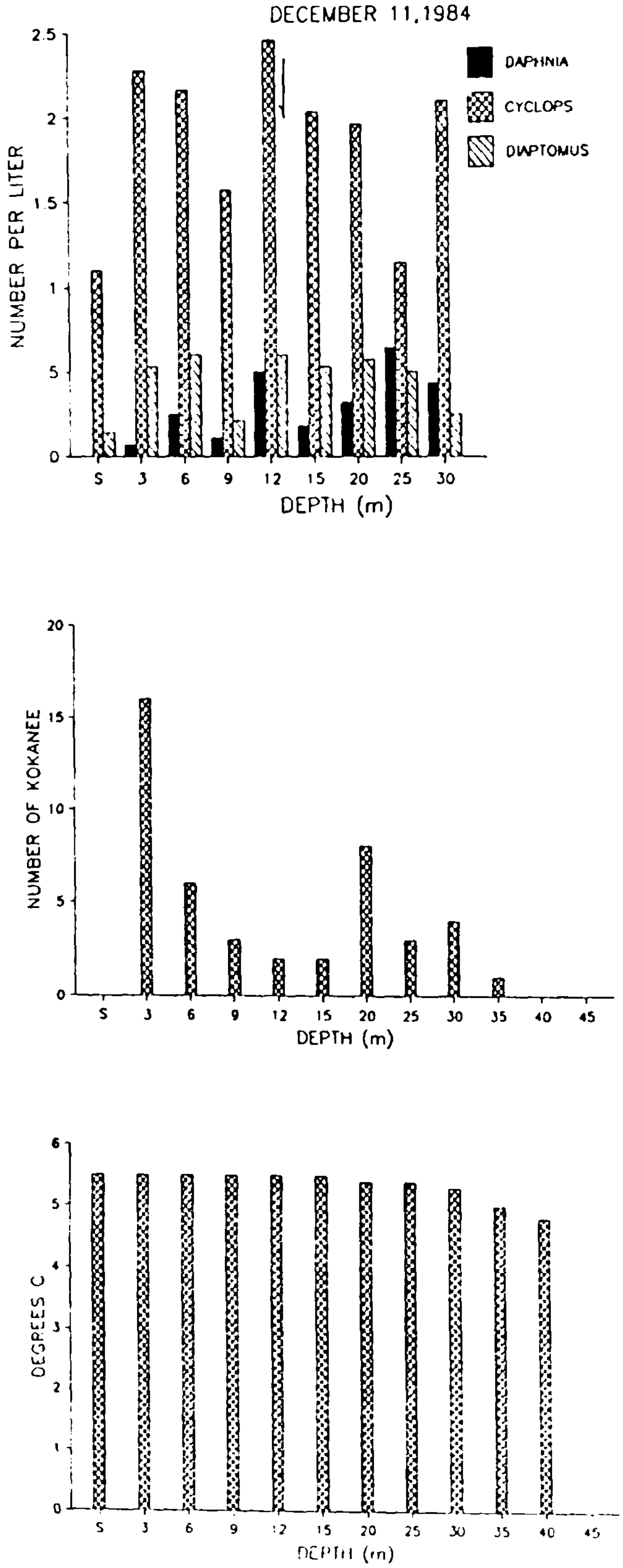
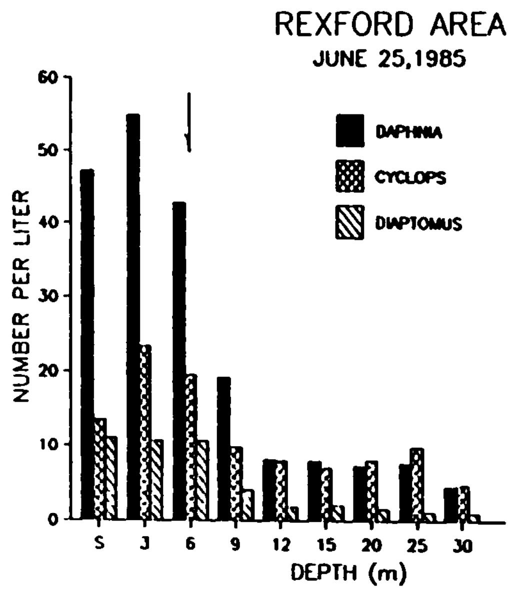
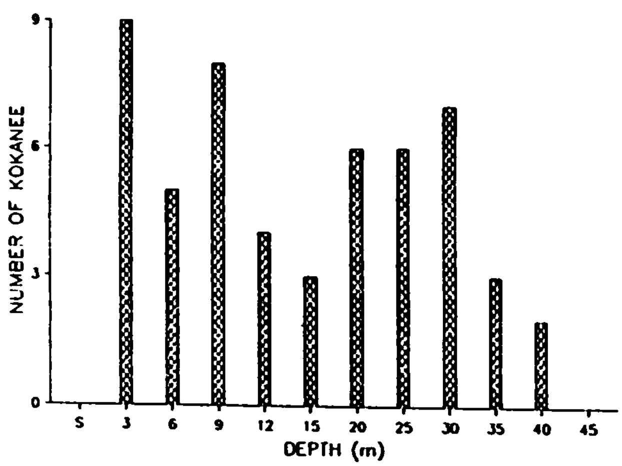
NOVEMBER 20,1984

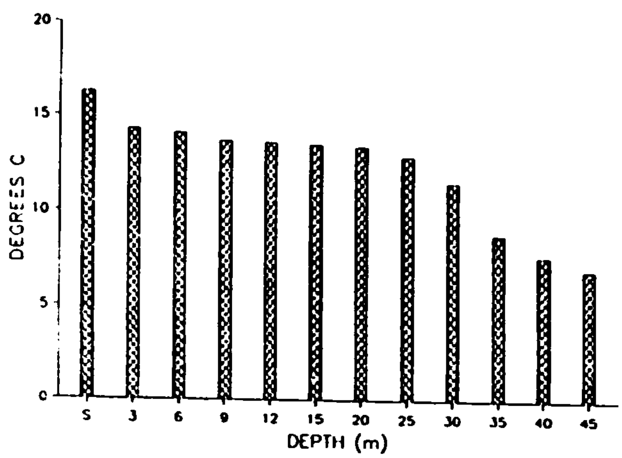


REXFORD AREA
DECEMBER 11,1984

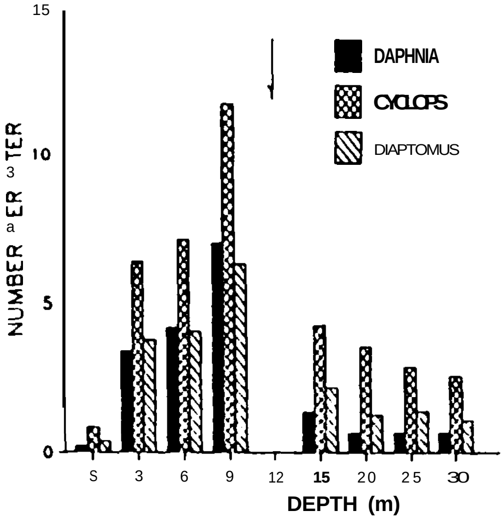


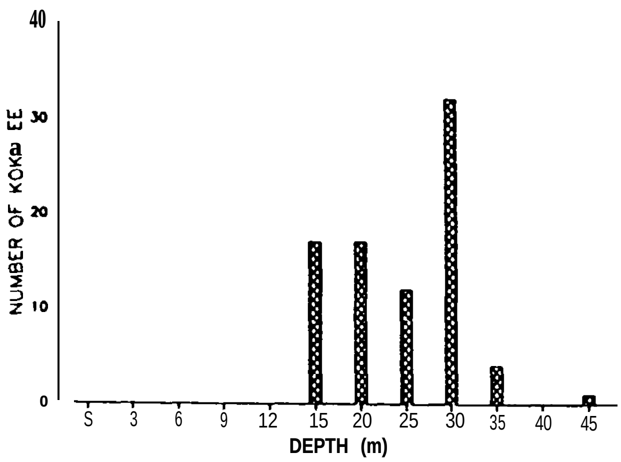

REXFORD AREA
JUNE 25,1985
DAPHNIA
CYCLOPS
DIAPTOMUS
NUMBER PER LITER
0
10
20
30
40
50
60
S
3
6
9
12
15
20
25
30
DEPTH (m)

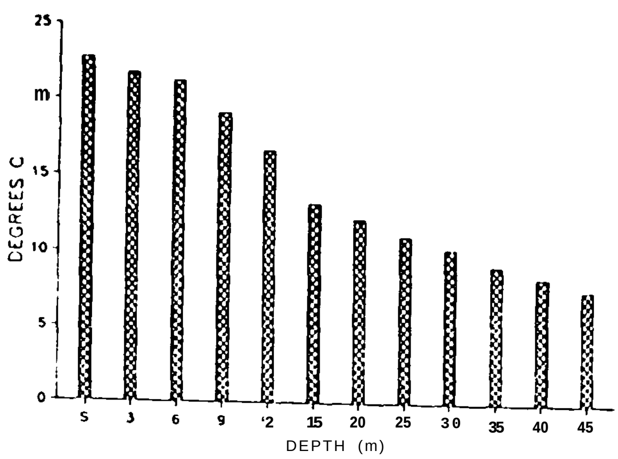

NUMBER OF KOKANEE
0
3
6
9
S
3
6
9
12
15
20
25
30
35
40
45
DEPTH (m)


DEGREES C
0
5
10
15
20
S
3
6
9
12
15
20
25
30
35
40
45
DEPTH (m)

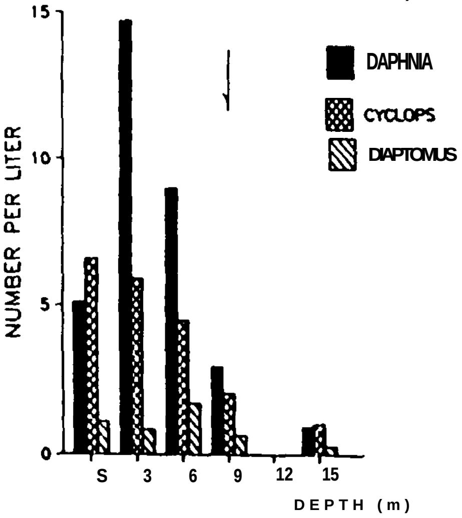
REXFORD AREA
JULY 31.1985

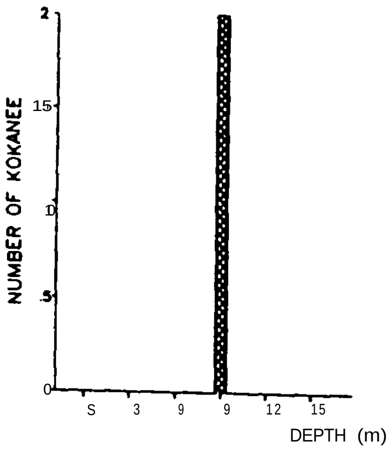


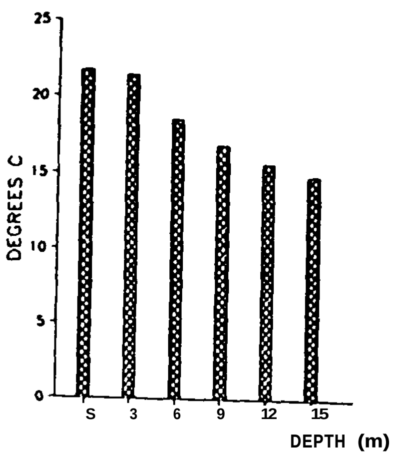




CANADA AREA
AUGUST 2, 1984

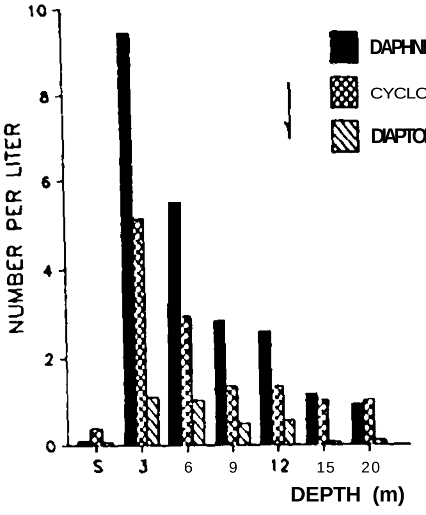


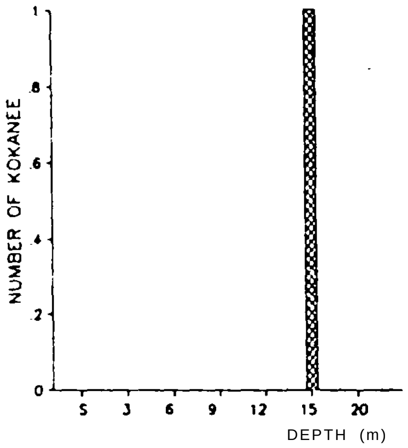


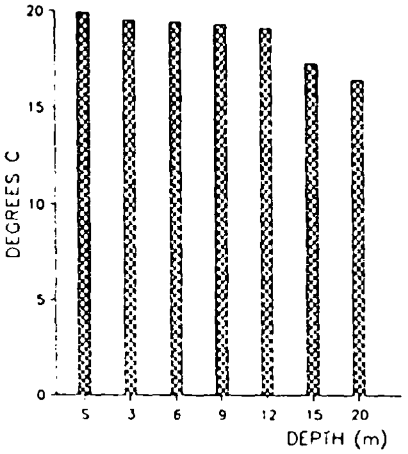


CANADA AREA

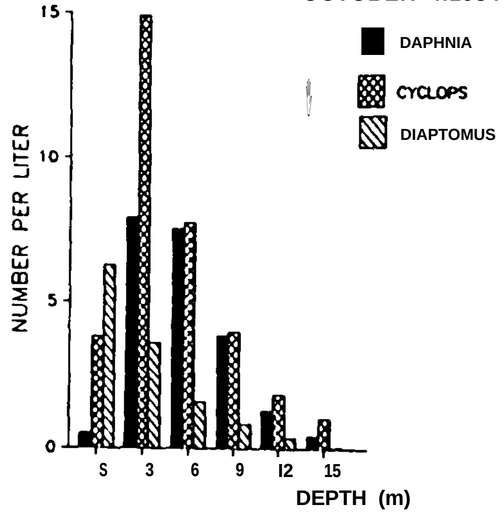
AUGUST 29.1984

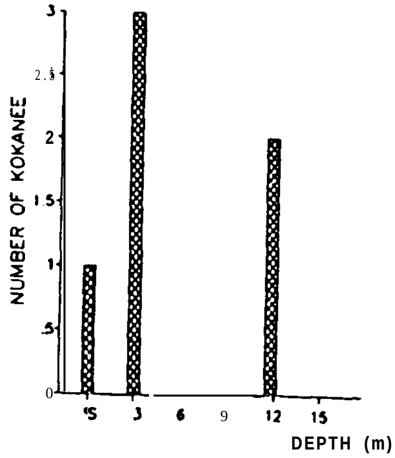


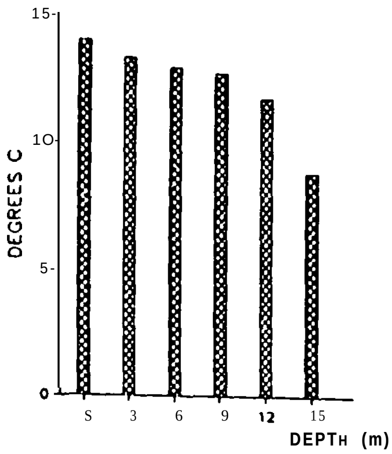




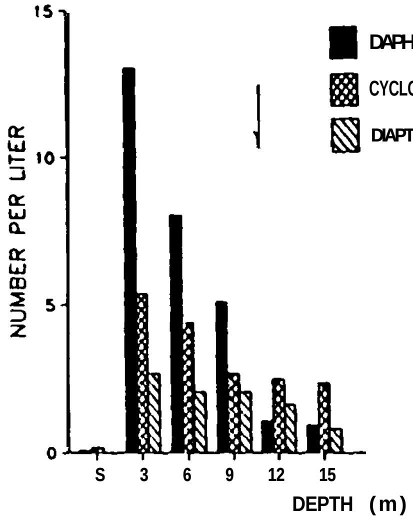
CANADA AREA
OCTOBER 4.1984

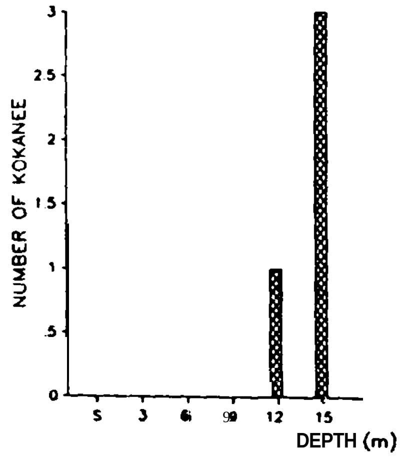


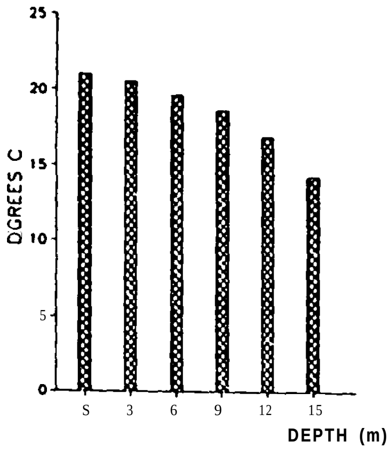




CANADA AREA
AUGUST 1.1985







APPENDIX F

Lengths of hydroacoustic sample transects,
cross-sectional area of each depth strata covered
by the 10° cone width, and volume of water
sampled by depth strata for hydroacoustic transects
sampled in Libby Reservoir during August, 1984.

Appendix F. Lengths and volumes across 38 hydroacoustic transects in Libby Reservoir sampled during August 1985.

Area Transect	Transect Length (m)	Total Volume (Area x length) by depth interval (m^3 x 100) 0-10	10-20	20-30	30-40	40-50	50-60	60-70
	area(M^2)	a.75	26.25	43.75	61.25	78.75	96.25	113.75
Tenmile								
1	1577	138.0	414.0	689.9	965.9	1241.9	1517.9	1793.8
2	1851	162.0	485.9	809.8	1133.7	1457.7	1781.6	2105.5
3	1400	122.5	367.5	612.5	857.5	1102.5	1347.5	1592.5
4	1513	132.4	397.2	661.9	926.7	1191.5	1456.3	1721.0
5	1690	147.9	443.6	739.4	1035.1	1330.9	1626.6	1922.4
6	1658	145.1	435.2	725.4	1015.5	1305.7	1595.8	1886.0
7	1867	163.4	490.1	816.8	1143.5	1470.3	1797.0	2123.7
8	1706	149.3	447.8	746.4	1044.9	1343.5	1642.0	1940.6
9	2060	180.3	540.8	901.3	1261.8	1622.3	1982.8	2343.3
10	1609	140.8	422.4	703.9	985.5	1267.1	1548.7	1830.2
Peck Gulch								
11	1304	114.1	342.3	570.5	798.7	1026.9	1255.1	1483.3
12	1336	116.9	350.7	584.5	818.3	1052.1	1285.9	1519.7
13	950	83.1	249.4	415.6	581.9	748.1	914.4	1080.6
14	1223	107.0	321.0	535.1	749.1	963.1	1177.1	1391.2
15	1770	154.9	464.6	774.4	1084.1	1393.9	1703.6	2013.4
16	1545	135.2	405.6	675.9	946.3	1216.7	1487.1	1757.4
17	1448	126.7	380.1	633.5	886.9	1140.3	1393.7	1647.1
18	644	56.4	169.1	281.8	394.5	507.2	619.9	732.6
19	789	69.0	207.1	345.2	483.3	621.3	759.4	a97.5
20	483	42.3	126.8	211.3	295.8	380.4	464.9	549.4
Rexford								
21	772	67.6	202.7	337.8	472.9	608.0	743.1	878.2
22	708	62.0	185.9	309.8	433.7	557.6	681.5	805.4
23	2993	261.9	785.7	1309.4	1883.2	2357.0	2880.8	3404.5
24	1207	105.6	316.8	528.1	739.3	950.5	1161.7	1373.0
25	2816	246.4	739.2	1232.0	1724.8	2217.6	2710.4	3203.2
26	1625	142.2	426.6	710.9	995.3	1279.7	1564.1	1848.1
27	1609	140.8	422.4	703.9	985.5	1267.1	1548.7	1830.2
28	1738	152.1	456.2	760.4	1064.5	1368.7	1672.8	1977.0
29	2849	249.3	747.9	1246.4	1745.0	2243.6	2742.2	3240.7
30	3187	278.9	836.6	1394.3	1952.0	2509.8	3067.5	3625.2
Canada								
31	805	70.4	211.3	352.2	493.1	633.9	774.8	915.7
32	1159	101.4	304.2	507.1	709.9	912.7	1115.5	1318.4
33	2253	197.1	591.4	985.7	1380.0	1774.2	2168.5	2562.8
34	1577	**133.0**	**414.0**	**689.9**	**965.9**	**1241.9**	**1517.9**	**1793.9**
35	1159	101.4	304.2	507.1	709.9	912.7	1115.5	1318.4
36	4088	357.7	1073.1	1788.5	2503.9	3219.3	3934.7	4650.1
37	2028	177.5	532.4	887.3	1242.2	1597.1	1952.0	2306.9
38	2414	211.2	633.7	1056 .l	1478.6	1901.0	2323.5	2745.9
TOTAL	63.41km							

APPENDIX G

Timing of juvenile and adult trout movement
through traps set in Big, Bristow, Fivemile,
Pinkham, Sinclair, and Young Creeks
during 1985.

BIG CREEK DOWNSTREAM TRAP — 1985

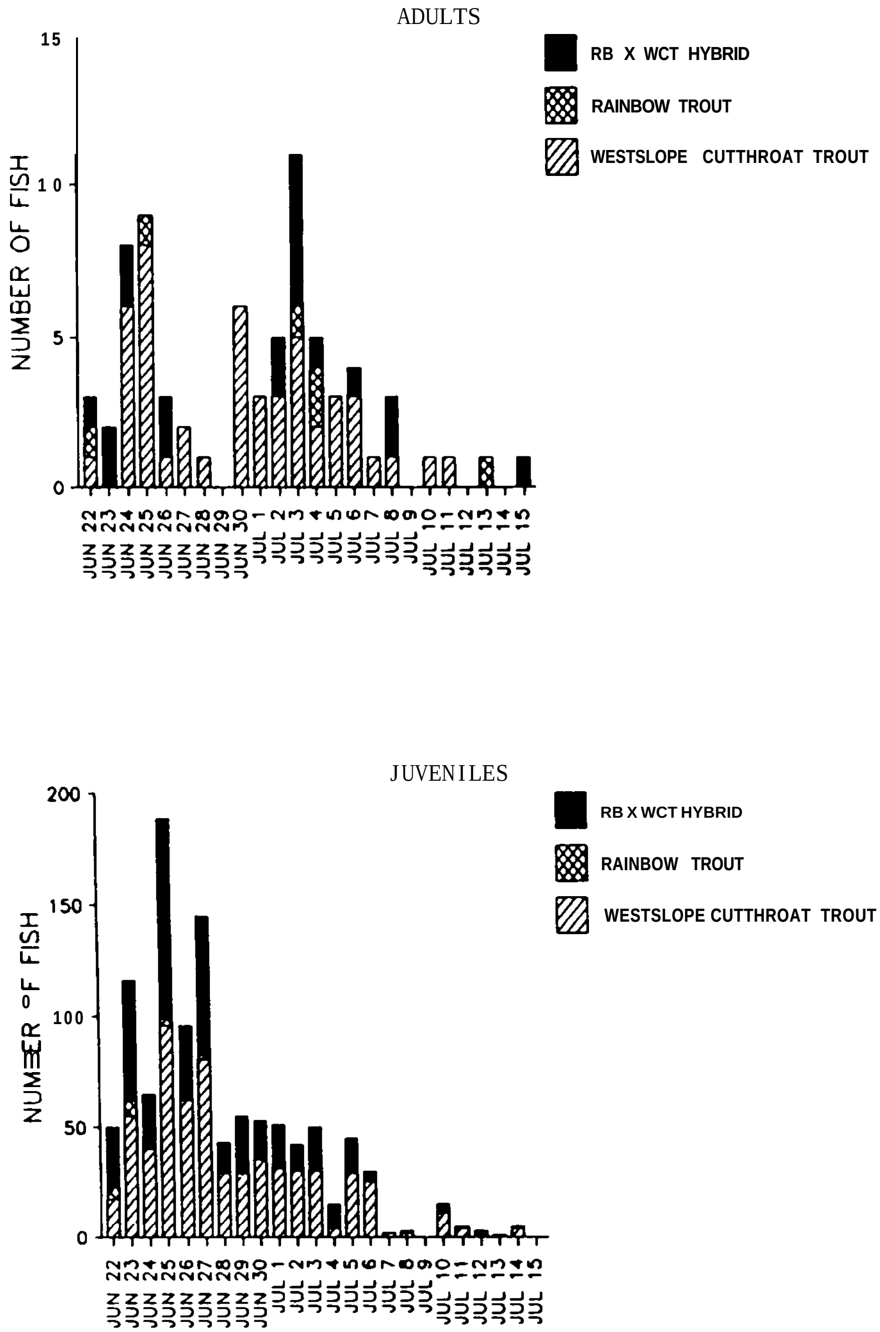


Figure G1. Timing of adult and juvenile trout movement downstream through a trap located in Big creek during 1985.

BRISTOW CREEK DOWNSTREAM TRAP – 1985

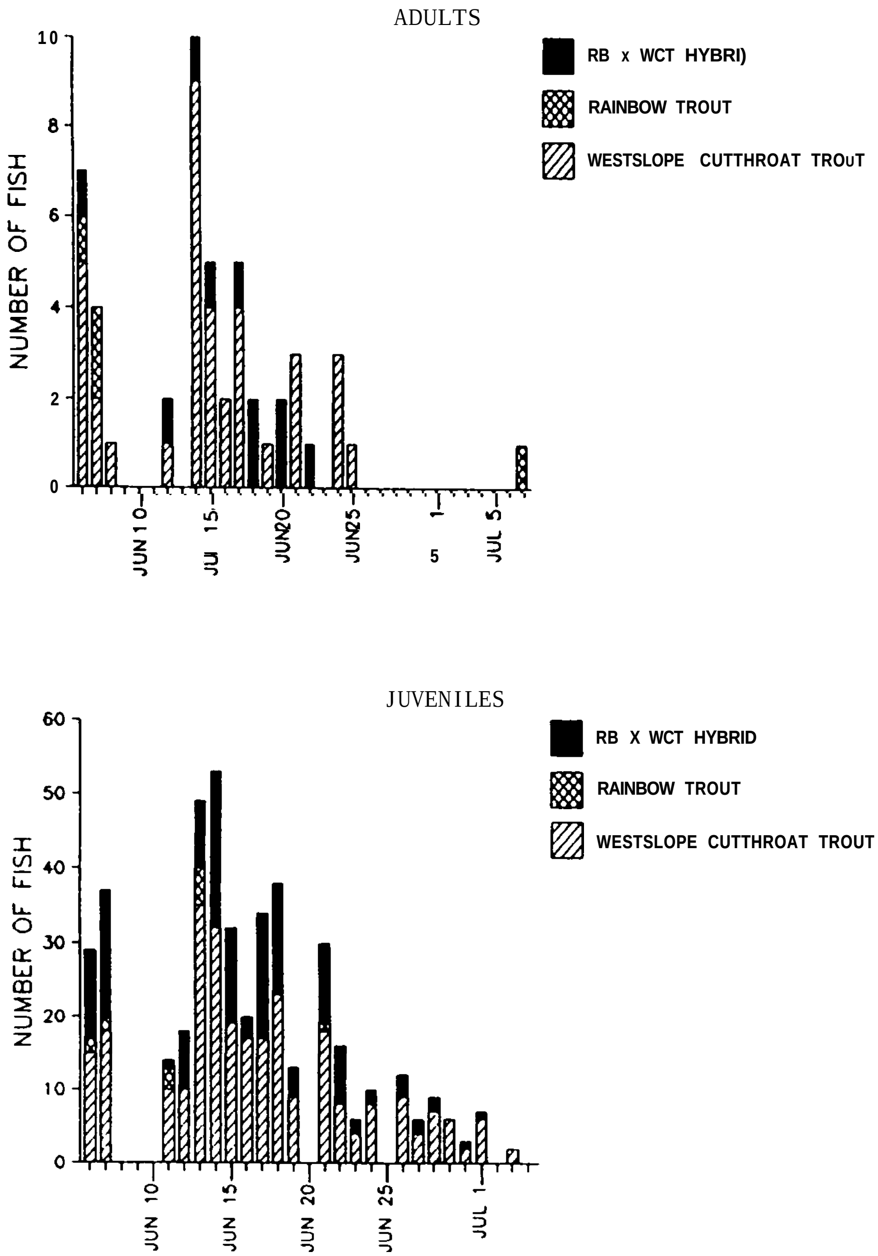


Figure G2. Timing of adult and juvenile trout movement downstream through a trap located in Bristow Creek during 1985.

FIVEMIL CREEK DOWNSTREAM TRAP – 1985

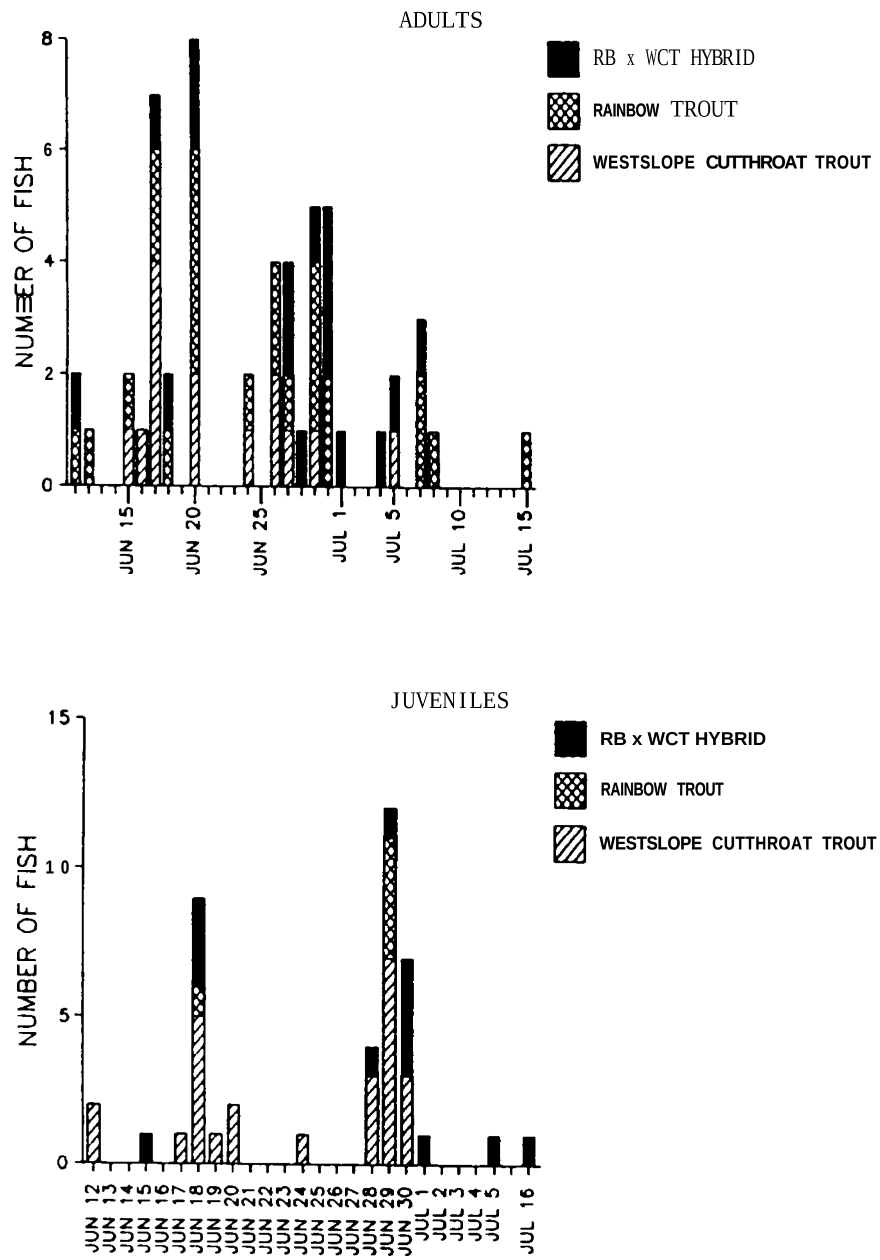


Figure G3. Timing of adult and juvenile trout movement downstream through a trap located in Fivemile Creek during 1985.

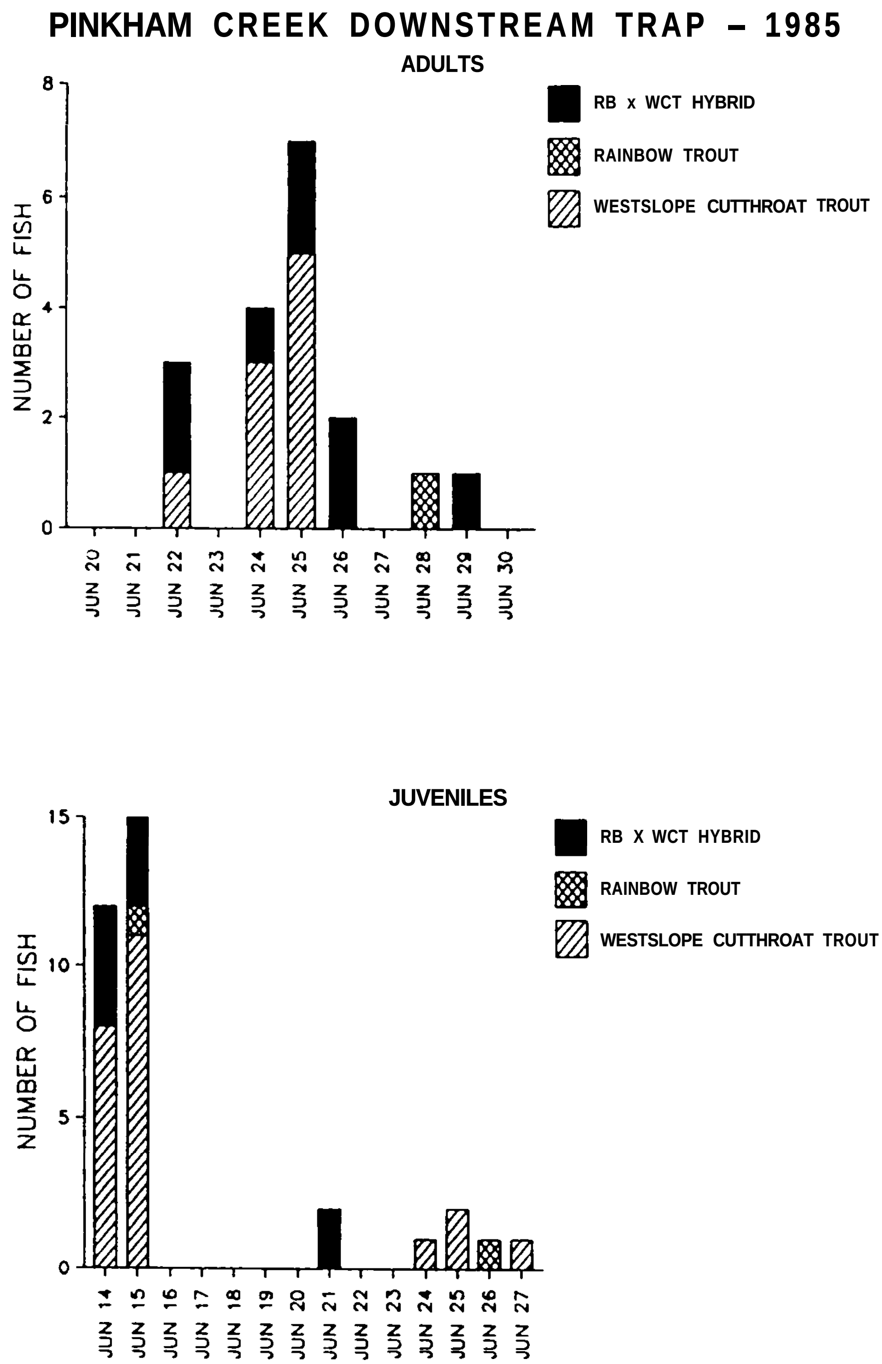


Figure G4. Timing of adult and juvenile trout movement downstream through a trap located in Pinkham Creek during 1985.

SINCLAIR CREEK DOWNSTREAM TRAP – 1985

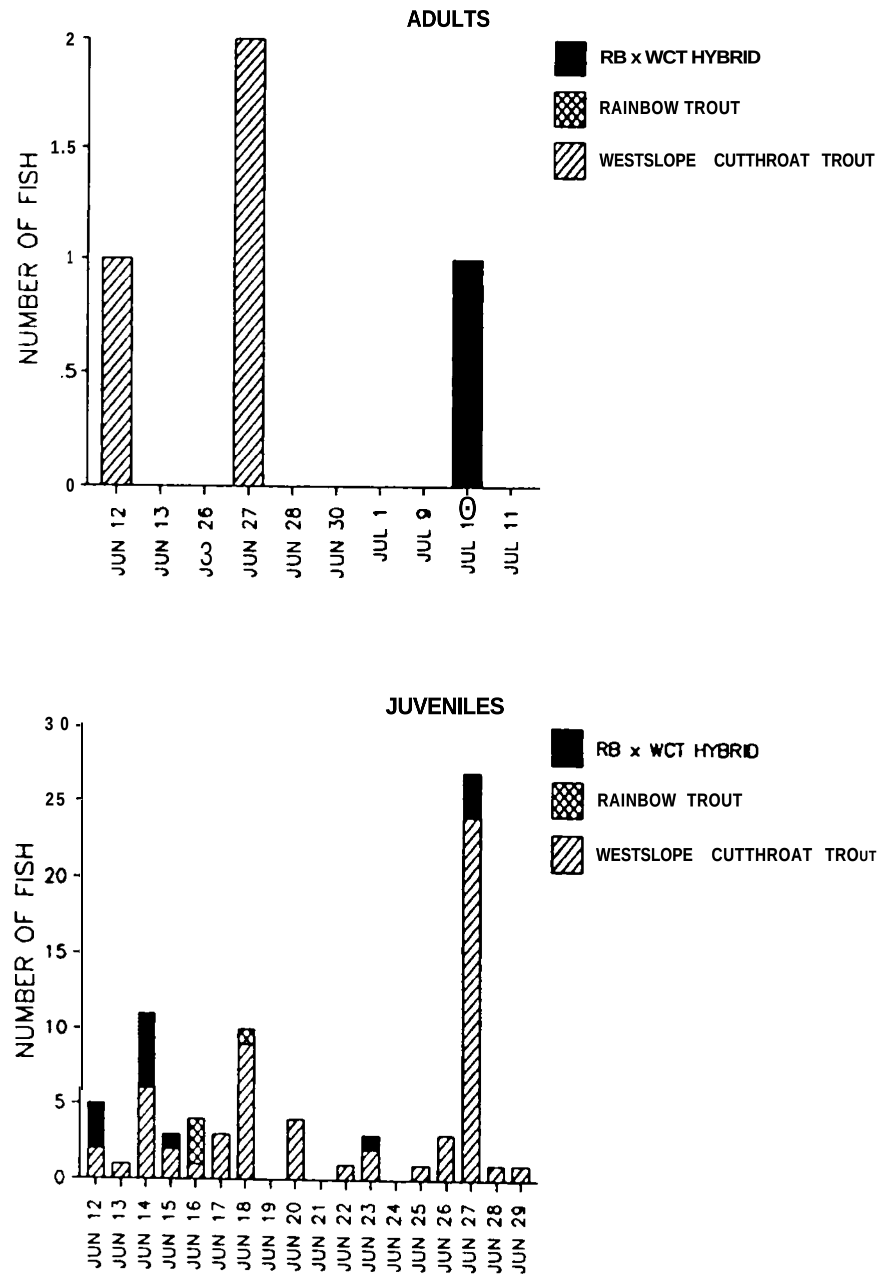
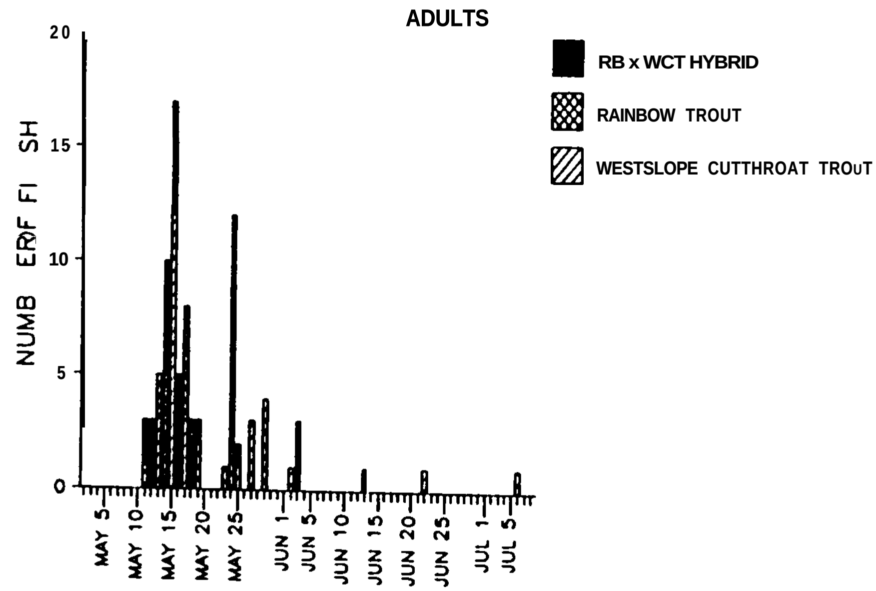


Figure G5. Timing of adult and juvenile trout movement downstream through a trap lxated in Sinclair Creek during 1985.

YOUNG CREEK UPSTREAM TRAP



YOUNG CREEK DOWNSTREAM TRAP – 1985

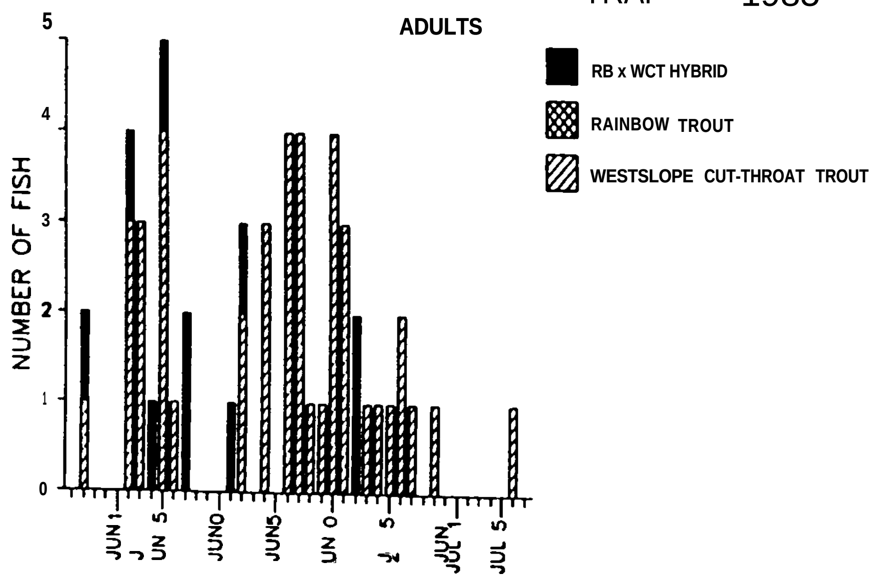


Figure G6. Timing of adult trout movement upstream and downstream through a permanent trap located in Young Creek during 1385.

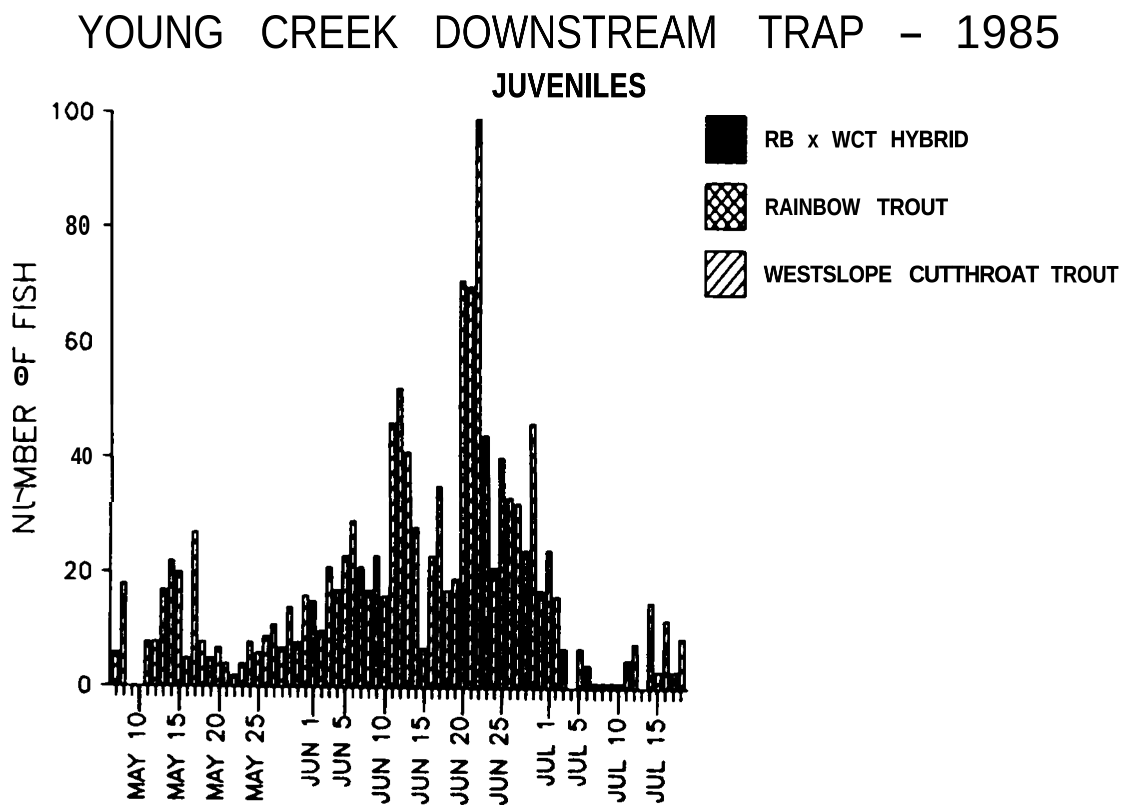


Figure G7. Timing of juvenile trout movement downstream through a trap located in Young Creek during 1985.

APPENDIX H

Tag return information for fish tagged in Libby Reservoir and its tributaries from 1983 through 1985. Return information is separated by capture method.

Table H1. Tag return information for floy tagged adult fish in Libby Reservoir and its tributaries from 1983 through 1985. Species abbreviations are explained in the "Methods" section. Lengths and weights of returned fish were estimated by anglers unless otherwise noted.

	Tagging Information						Return Information			
Location	Tag Color	Tag Number	Date	Sp	L	Wt	Date	L	Wt	Location
Fish Trap										
Big Creek:	Red dangler	218	07-14-83	HB	416	534	12-03-83	—	—	Koocanusa (Lk)
	Red	4310	07-06-84	WCT	406	520	07-07-84	406	520	Peck Gulch (Lk)
	Red	4299	07-21-84	HB	450	550+	07-22-84	432	—	Westside Forebay (Lk)
	Red	4342	07-19-84	WCT	362	444	09-08-84	356	—	Eastside Forebay (Lk)
	Yellow	5527	06-28-84	WCT	390	586	09-09-84	381	454	McGuire Creek area (Lk)
	Red	4346	07-19-84	HB	352	550+	09-23-84	—	—	Mouth of Barron Creek (Lk)
	Red	4344	07-19-84	HB	432	550+	09-03-84	—	—	Old Bridge - Tobacco River
	Yellow	5831	06-04-85	HB	346	405	06-11-85	356	907	Peck Gulch (Lk)
	Yellow	6213	06-24-85	HB	372	359	06-26-85	356	680	Big Creek
	Yellow	6212	06-24-85	HB	387	412	06-28-85	—	—	Big Creek
	Yellow	6303	06-30-85	WCT	336	300	07-06-85	330	425	Gold Creek B.C. (Lk)
	Yellow	6318	07-03-85	HB	375	387	07-06-85	381	499	Gold Creek B.C. (Lk)
	Yellow	6372	07-08-85	HB	342	260	07-13-85	—	—	Big Creek
	Yellow	6304	06-30-85	HB	337	285	07-26-85	328	—	Cripple Horse (Lk)
	Yellow	6281	06-26-85	HB	328	272	08-03-85	330	—	McGillivray (Lk)
	Yellow	6325	07-10-85	WCT	345	282	08-13-85	330	—	Just north of Dam (Lk)
	Yellow	6305	06-30-85	WCT	374	355	08-18-85	356	—	Just north of Dam (Lk)
Bristow Creek:	Red dangler	400	07-08-83	HB	277	207	09-04-83	302	227	Forebay (Lk)
	Lt. Blue dangler	773	06-19-83	WCT	390	480	09-20-83	386	572	S. Pt 10 mile a/ (Lk)
	Lt. Blue dangler	779	06-20-83	WCT	410	550+	10-12-83	381	—	Kokomun Area B.C. (Lk)
	Green dangler	443	06-27-83	HB	372	412	05-18-84	405	—	Parsnip Creek area (Lk)
	Red dangler	511	07-14-83	RB	445	585	06-14-84	445	626	Big Bend a/ (Lk)
	Yellow	5500	06-19-84	WCT	380	500	07-03-84	368	—	Mouth of Canyon Creek (Lk)
	Yellow	6395	06-06-85	WCT	344	372	07-??-85	—	—	Peck Gulch (Lk)
	Yellow	6186	06-19-85	WCT	339	—	07-??-85	—	—	No location
Five Mile Creek:	Yellow	5560	07-12-84	HB	401	415	07-11-84	432	—	Forebay (Lk)
	Yellow	5544	07-05-84	RB	404	488	07-12-84	—	—	Forebay (Lk)
	Yellow	5489	06-19-84	WCT	377	455	07-13-84	—	—	Souse Gulch (Lk)
	Yellow	5524	06-24-84	RB	405	430	07-19-84	381	—	Peck Gulch (Lk)
	Yellow	5539	07-02-84	RB	359	339	07-19-84	318	—	Kootenai River below dam
	Yellow	3488	06-19-84	WCT	395	424	07-26-84	—	—	No location
	Yellow	5546	07-06-84	WCT	357	351	11-16-84	305	—	Boulder Creek area (Lk)
	Yellow	6193	06-20-85	HB	282	190	07-05-85	—	—	Five Mile Creek area (Lk)
	Yellow	6182	06-18-85	RB	335	282	07-??-85	—	—	Peck Gulch (Lk)
	Yellow	6329	07-15-85	RB	358	288	07-28-85	356	—	Five Mile Creek
	Yellow	6177	06-17-85	WCT	365	396	08-18-85	368	—	Bailey Bridge B.C. (Lk)
	Yellow	6279	06-26-85	WCT	243	148	09-01-85	203	202	Five Mile Creek Bay (Lk)
Pinkham Creek:	Red	4226	07-18-84	WCT	378	402	08-04-84	279	—	Mouth of Pinkham Creek (Lk)
	Red	4224	07-18-84	RB	365	410	08-04-84	279	—	Mouth of Pinkham Creek (Lk)
	Red	4216	11-30-84	WCT	352	413	11-30-84	406	—	Kootenai River below dam
	Yellow	5988	06-22-85	HB	252	145	07-06-85	254	—	Elk River area B.C. (Lk)
	Yellow	5901	06-25-85	WCT	327	310	07-10-85	330	397	Pinkham Creek
	Yellow	5999	06-25-85	WCT	344	332	07-20-85	381	510	Rexford boat ramp (Lk)
Young Creek:	Yellow	2598	06-10-83	WCT	397	544	07-03-83	356	—	Mouth Elk River B.C. (Lk)
	Yellow	2493	06-15-83	WCT	398	526	07-04-83	—	—	Big Creek
	Yellow	3438	06-25-83	WCT	380	536	08-10-83	445	964	S. Pt. - Tobacco Bay (Lk)
	Yellow	2790	06-18-83	WCT	375	517	08-11-83	—	—	Lower Elk River B.C.
	Yellow	2554	06-06-83	WCT	372	456	08-26-83	333	526	Mouth of Tobacco River (Lk)
	Yellow	2780	06-17-83	WCT	370	817	09-23-83	394	567	Westbank Tenmile (Lk)
	Yellow	2569	06-07-83	WCT	425	—	09-24-83	406	454	Mouth of Barron Creek (Lk)

Table H1 Continued.

	Tagging Information						Return Information			
Location	Tag Color	Tag Number	Date	Sp	L	Wt	Date	L	Wt	Location
Fish Trap										
Yellow Creek: (continued)	Yellow	3460	06-29-83	WCT	395	526	09-30-83	395	680	Koocanusa Bridge (Lk)
	Yellow	2795	06-16-83	WCT	395	535	09-??-83	406	567	Peck Gulch (Lk)
	Yellow	3807	07-02-83	WCT	380	425	10-22-83	381	680	Sutton Creek Bay (Lk)
	Yellow	2499	06-15-83	WCT	401	526	10-??-83	---	---	No location
	Yellow	2494	06-15-83	WCT	407	544	11-05-83	381	680	Black Lake Bay (Lk)
	Yellow	3448	06-28-83	WCT	305	250	11-16-83	---	---	Warland (Lk)
	Yellow	2584	06-08-83	HB	417	549	04-29-84	445	907	Mouth of Young Creek (Lk)
	Yellow	2593	06-09-83	WCT	380	472	04-29-84	---	---	No location
	Yellow	3450	06-29-83	WCT	405	522	04-29-84	356	---	No location
	Yellow	3815	07-14-83	WCT	356	404	05-01-84	356	---	Tobacco Bay (Lk)
	Yellow	3434	06-23-83	WCT	391	581	05-22-84	391	473	South Pt. of Bristow [a] (Lk)
	Red	4043	06-07-84	WCT	410	581	06-08-84	406	907	No location (Lk)
	Red	4066	06-09-84	WCT	407	576	06-13-84	356	454	Mouth of Pinkham (Lk)
	Red	4067	06-09-84	WCT	402	544	06-13-84	457	---	Rexford area (Lk)
	Red	4068	06-09-84	WCT	402	621	06-16-84	387	567	Peck Gulch (Lk)
	Red	4058	06-08-84	WCT	381	544	06-16-84	406	---	North of Sutton Creek (Lk)
	Red	4021	06-05-84	WCT	407	671	06-17-84	406	---	East side Forebay (Lk)
	Red	4094	06-14-84	WCT	392	531	06-18-84	381	---	No location
	Red	4127	06-15-84	WCT	396	635	06-20-84	406	---	Murray Springs Bay (Lk)
	Yellow	2783	06-16-83	WCT	406	522	06-22-84	406	794	Fivemile Creek
	Red	4185	07-02-84	HB	382	517	07-06-84	---	567	Mouth of Young Creek (Lk)
	Yellow	2575	06-07-83	WCT	398	550+	07-11-84	381	---	Fivemile Creek
	Yellow	5861	07-08-84	WCT	313	284	07-20-84	318	227	Mouth of Young Creek (Lk)
	Yellow	5867	07-16-84	WCT	359	366	07-22-84	356	366	Mouth of Young Creek (Lk)
	Yellow	3426	06-21-83	WCT	376	481	08-09-84	445	---	Forebay (Lk)
	Yellow	5868	07-10-84	WCT	386	540	08-11-84	381	453	Mouth of Sullivan (Lk)
	Yellow	3398	06-16-84	WCT	410	599	08-13-84	406	794	Forebay (Lk)
	Red	4038	06-06-84	WCT	383	563	08-25-84	457	624	Sutton Creek area (Lk)
	Yellow	2586	06-09-83	WCT	433	644	09-01-84	381	---	Forebay (Lk)
	Yellow	5856	07-05-85	WCT	380	490	09-07-84	406	907	Koocanusa Bridge (Lk)
	Red	4182	07-18-84	WCT	382	544	09-08-84	356	---	Eastside Forebay (Lk)
	Yellow	2561	06-06-83	HB	390	---	09-29-84	381	453	Souse Gulch (Lk)
	Yellow	2594	06-09-83	WCT	387	513	09-??-84	---	---	No location
	Red	4012	06-04-84	WCT	371	572	09-??-84	---	---	No location
	Red	4042	06-06-84	HB	371	567	04-07-85	381	---	Pine Bay (Lk)
	Red	4167	06-26-84	WCT	382	535	04-09-85	383	486	North Pt. Tobacco [a] (Lk)
	Red	4195	07-05-84	WCT	384	494	05-13-85	---	454	Rexford area (Lk)
	Red	4024	06-05-84	WCT	397	640	06-02-85	420	544	Mouth of Young (Lk)
	Red	4071	06-10-84	WCT	387	590	06-08-85	406	---	Cripple Horse (Lk)
	Red	4149	06-23-84	WCT	390	544	07-01-85	381	---	Cripple Horse (Lk)
	Red	4164	06-26-84	WCT	384	544	07-15-85	395	503	Mouth of Young Creek (Lk)
	Red	4116	06-14-84	WCT	390	526	07-26-85	343	---	Bailey Bridge B.C. (Lk)
	Yellow	2600	06-10-84	WCT	392	540	09-22-85	413	544	Rocky Gorge (Lk)
Purse Seine										
Tenmile Area										
Souse Gulch	Yellow	2601	11-28-83	WCT	308	278	12-01-83	---	---	Warland Creek
Cripple Horse	Yellow	5642	05-31-85	HB	264	---	06-15-85	330	227	Bristow Creek area (Lk)
McGillivray	Yellow	5591	10-18-84	RB	350	408	05-26-85	330	453	Mouth of Tobacco (Lk)
Sutton Creek area	Yellow	5461	05-04-84	RB	302	315	08-??-84	426	---	Koocanusa B.C. (Lk)
Rexford										
Sullivan Creek area	Yellow	5228	04-12-84	WCT	398	671	05-22-84	409	649	S. Pt. Tenmile [a] (Lk)
	Yellow	5232	04-12-84	RB	416	762	06-15-84	413	717	N. Pt. Fivemile [a] (Lk)
	Yellow	5019	03-27-84	MWF	337	358	08-14-84	331	351	Tobacco Bay (Lk)
	Yellow	5021	03-27-84	RB	430	703	08-??-84	426	---	Koocanusa B.C. (Lk)
	Yellow	5227	04-12-84	WCT	280	245	09-13-84	330	---	Souse Gulch (Lk)
	Yellow	5022	03-27-84	RB	335	404	11-07-84	318	---	Koocanusa, USA (Lk)
Tobacco Bay area	Yellow	5188	04-09-84	HB	337	432	??-??-??	368	---	Bailey Bridge, B.C. (Lk)
	Yellow	5051	03-28-84	WCT	387	608	04-15-84	406	---	Koocanusa Bridge (Lk)
	Yellow	5071	03-28-84	RB	399	653	04-24-84	397	653	N. Pt. Fivemile [a] (Lk)
	Yellow	5186	04-09-84	WCT	338	431	05-02-84	330	227	Tenmile Creek area (Lk)

Table H1 Continued.

Location	Tag Color	Tag Number	Date	Sp	L	Wt	Date	L	Wt	Location
	Tagging Information						Return Information			
Purse Seine (Cont.)										
Rexford (Cont.)										
Tobacco Bay	Yellow	5218	04-12-84	HB	447	839	05-06-84	432	---	Koocanusa (Lk)
area	Yellow	5055	03-28-84	WCT	403	667	05-15-84	432	---	Forebay (Lk)
(continued)	Yellow	5180	03-30-84	WCT	418	721	05-25-84	470	---	Bristow Creek
	Yellow	5438	05-02-84	WCT	319	353	05-22-84	---	680	Murray Springs (Lk)
	Yellow	5003	03-26-84	WCT	398	690	05-27-84	394	---	Tobacco River
	Yellow	5177	03-30-84	WCT	304	290	05-27-84	305	---	Rexford area (Lk)
	Yellow	5262	04-13-84	WCT	334	336	06-11-84	330	454	Forebay (Lk)
	Yellow	5440	05-02-84	HB	352	490	06-14-84	---	---	N. Cripple Horse (Lk)
	Yellow	5441	05-01-84	RB	332	386	06-14-84	---	---	N. Cripple Horse (Lk)
	Yellow	5001	03-26-84	RB	353	463	06-20-84	330	---	Boulder Creek area (Lk)
	Yellow	5210	04-12-84	WCT	302	318	06-22-84	318	---	Forebay (Lk)
	Yellow	5078	03-28-84	RB	420	826	06-23-84	343	340	Mouth of Pinkham Creek (Lk)
	Yellow	5209	04-12-84	HB	333	449	06-28-84	355	---	Tobacco River
	Yellow	5254	04-12-84	RB	323	367	06-??-84	330	312	Pinkham Creek area (Lk)
	Yellow	5004	03-26-89	HB	401	735	07-01-84	406	794	Mouth of Parsnip (Lk)
	Yellow	5045	03-28-84	RB	417	712	08-09-84	406	---	Forebay (Lk)
	Yellow	5174	03-30-84	WCT	387	608	08-11-84	394	1134	Kokomun Area B.C. (Lk)
	Yellow	5065	03-28-84	WCT	316	363	08-27-84	432	680	Koocanusa (Lk)
	Yellow	5061	03-28-84	WCT	296	250	10-01-84	---	---	Mouth of Wigwam B.C. (Lk)
	Yellow	5188	04-09-84	HB	337	432	??-??-84	368	---	N. Bailey Bridge B.C. (Lk)
	Yellow	5284	04-13-84	HB	440	875	??-??-??	456	567	Tobacco Bay (Lk)
	Yellow	5192	04-09-84	RB	367	502	03-06-85	406	680	Muray Springs (Lk)
	Yellow	5091	03-28-84	RB	406	717	05-18-85	355	680	Tobacco River
	Yellow	2695	04-24-85	HB	296	---	06-02-85	296	---	Forebay (Lk)
	Yellow	3822	10-11-84	DV	440	550+	06-05-85	451	1225	Kokomun area B.C. (Lk)
	Yellow	5000	03-26-84	RB	286	259	06-12-85	---	---	McGuire Creek area (Lk)
	Yellow	5053	03-28-84	HB	304	286	06-13-85	342	---	Mouth of Big Creek (Lk)
	Yellow	5912	05-01-84	RB	431	771	07-02-85	381	454	Elk River B.C.
Young Creek	Yellow	5159	03-29-84	WCT	405	744	06-03-84	406	---	Koocanusa Bridge (Lk)
area	Yellow	5155	03-29-84	RB	308	313	06-05-84	311	340	Koocanusa (Lk)
	Yellow	5160	03-29-84	WCT	358	481	06-10-84	356	340	Canyon Creek
	Yellow	5161	05-29-84	HB	313	349	06-11-84	406	---	Tobacco Bay (Lk)
	Yellow	5146	03-29-84	WCT	402	616	06-15-84	394	---	Sinclair Creek
	Yellow	5112	03-29-84	WCT	310	311	06-16-84	330	---	Souse Gulch (Lk)
	Yellow	5132	03-29-84	RB	432	694	07-04-84	---	---	Gold Creek B.C.
	Yellow	5163	03-29-84	HB	357	481	07-06-84	279	---	Elk River B.C.
	Yellow	5123	03-29-84	WCT	282	249	07-06-84	355	---	Elk River area B.C. (Lk)
	Yellow	5116	03-29-84	WCT	382	626	07-12-84	---	---	Forebay (Lk)
	Yellow	5120	03-29-84	RB	348	440	09-??-84	---	---	No location
Murray Springs	Yellow	5089	03-28-84	RB	386	608	04-20-84	368	567	Tobacco Bay (Lk)
area	Yellow	5197	04-10-84	RB	340	417	04-28-84	343	227	Koocanusa Bridge (Lk)
	Yellow	5075	03-28-84	RB	319	362	04-13-85	355	453	Peck Gulch (Lk)
	Yellow	5068	03-28-84	MWF	300	508	08-29-85	---	---	Elk River B.C.
Canada										
Kokomun Creek	Yellow	3832	10-16-84	HB	272	181	06-26-85	305	---	Bull River B.C.
area	Yellow	3833	10-16-84	HB	252	182	07-06-85	305	---	Elk River B.C.
Electrofish:										
Canada										
Gold Creek	Yellow	6115	04-18-85	HB	299	285	??-??-85	---	454	Mouth of Sutton (Lk)
area	Yellow	6015	04-16-85	RB	352	430	05-01-85	---	---	Bailey Bridge B.C. (Lk)
	Yellow	3846	10-18-84	HB	297	262	05-26-85	310	454	Rexford Area (Lk)
	Yellow	5587	07-19-84	RB	395	544	05-26-85	395	---	Peck Gulch (Lk)
	Yellow	6065	04-18-85	RB	316	310	08-13-85	343	---	Wigwam River B.C.
	Yellow	6107	04-18-85	HB	387	470	08-19-85	---	---	Koocanusa, USA (Lk)
	Yellow	6122	04-18-85	RB	359	440	08-21-85	356	---	Bailey Bridge B.C. (Lk)
Elk River	Yellow	5368	04-19-84	WCT	338	367	08-10-84	305	---	Elk River B.C.
area	Yellow	5365	04-19-84	DV	541	1415	08-30-84	559	1588	Wigwam River B.C.
	Yellow	5363	04-19-84	WCT	310	313	08-31-84	375	680	Wigwam Creek B.C.
	Yellow	5660	04-16-85	RB	312	268	06-25-85	324	---	Elk River B.C.
	Yellow	5713	04-16-85	RB	368	---	06-30-85	353	---	Rexford area (Lk)

Table H1 Continued.

Location	Tagging Information: Tag Color	Tag Number	Date	Sp	L	Wt	Return Information: Date	L	Wt	Location
Electrofish:										
Canada										
Elk River area (Cont.)	Yellow	5608	04-17-85	HB	351	—	07-05-85	315	—	Rexford area (Lk)
	Yellow	5744	04-16-85	HB	365	—	07-24-85	406	771	Mouth of Bull River B.C.
	Yellow	5735	04-16-85	RB	375	—	07-27-85	—	—	No location
	Yellow	2734	04-18-85	RB	282	—	09-08-85	406	—	Wigwam River B.C.
Kikomun area	Yellow	5351	04-18-84	RB	250	191	09-??-84	—	—	Mouth of Kikomun B.C. (Lk)
	Yellow	5338	04-18-84	WCT	326	372	06-03-84	—	—	Mouth of Kikomun B.C. (Lk)
	Yellow	5327	04-17-84	RB	443	817	06-04-84	356	—	Koocanusa Bridge (Lk)
	Yellow	5352	04-18-84	RB	411	603	07-01-84	381	567	Koocanusa Bridge (Lk)
	Yellow	5332	04-17-84	RB	376	563	07-24-84	368	340	Peck Gulch (Lk)
	Yellow	5326	04-17-84	Ling	501	160	03-01-85	—	—	Kootenai River B.C.
	Yellow	5620	04-17-85	DV	429	—	04-25-85	—	1134	Bull River B.C.
	Yellow	6036	04-17-85	RB	370	480	04-30-85	356	454	Rocky Creek B.C.
	Yellow	6193	04-17-85	DV	413	—	06-19-85	457	680	Mouth of Elk B.C. (Lk)
	Yellow	2688	04-16-85	RB	403	—	06-30-85	406	680	Elk River B.C.
	Yellow	5696	04-15-85	RB	385	—	07-05-85	381	—	Mouth of Elk B.C. (Lk)
	Yellow	5616	04-17-85	RB	379	—	08-26-85	356	454	Elk River area (Lk)
	Yellow	5321	04-17-84	WCT	277	236	09-02-85	—	—	Bailey Bridge B.C. (Lk)
Gillnet:										
Rexford										
Murray Springs	Yellow	5643	06-07-85	RB	371	—	08-15-85	371	590	Forebay (Lk)

Table H2. Tag return information for dangler tagged juvenile fish in Libby Reservoir tributaries from 1983 through 1985. Species abbreviations are explained in the "Methods" section. Lengths and weights of returned fish were estimated by anglers unless otherwise noted.

Location	Tagging Information						Return Information			
	Tag Color	Tag Number	Date	Sp	L	Wt	Date	L	Wt	Location
Fish Trap										
Big Creek:	Lt. Blue	482	06-21-83	WCT	204	74	07-22-83	—	—	Big Creek
	Lt. Green	880	07-01-83	WCT	156	33	07-22-83	—	—	Steep Creek
	Lt. Green	852	06-30-83	HB	184	54	07-30-83	—	—	Big Creek
	Lt. Green	480	06-27-83	HB	150	32	08-02-83	178	—	Big Creek
	Lt. Blue	890	06-18-83	WCT	160	38	08-14-83	203	—	Kootenai River below dam
	Lt. Blue	471	06-19-83	HB	180	54	08-21-83	265	—	North of Peck Gulch (Lk)
	Lt. Blue	889	06-18-83	HB	169	39	05-??-84	279	—	Mouth of Young Creek (Lk)
	Red	960	07-09-84	WCT	151	30	07-??-84	—	—	Big Creek
	White	2602	07-06-84	WCT	141	22	08-21-84	189	54	Tenmile USGS Buoy a/ (Lk)
	White	3199	07-09-84	WCT	164	37	09-??-84	—	—	No locatio
	White	2770	07-07-84	WCT	145	26	02-26-85	229	454	Murray Springs (Lk)
	White	3231	07-09-84	WCT	166	38	04-26-85	—	—	Peck Gulch (Lk)
	White	2794	07-07-84	HB	174	50	05-19-85	254	—	Forebay (Lk)
	White	3009	07-07-84	WCT	173	50	05-24-85	305	—	Canyon Creek
	White	3225	07-09-84	WCT	146	30	05-27-85	276	—	Barron Boat Ramp (Lk)
	Red	994	07-09-84	WCT	165	43	05-??-85	228	—	
	White	2317	07-05-84	WCT	140	22	06-01-85	261	—	Forebay (Lk)
	White	3360	07-11-84	WCT	137	24	06-01-85	305	—	Koocanusa (Lk)
	White	2736	07-07-84	WCT	175	47	06-12-85	330	227	Koocanusa (Lk)
	White	3209	07-09-84	WCT	160	38	06-24-85	194	60	Big Creek fish trap
	White	1878	07-14-84	WCT	142	25	07-01-85	279	—	Cripple Horse (Lk)
	White	1931	07-14-84	WCT	165	43	07-06-85	190	50	Big Creek fish trap
	White	2749	07-07-84	WCT	141	24	07-16-85	229	—	Peck Gulch (Lk)
	White	2711	07-06-84	HB	143	26	08-31-85	330	—	Linkletter Cr. B.C.
	White	3268	07-10-84	WCT	142	24	09-03-85	279	—	Rexford area (Lk)
Bristow Creek:	Red	842	06-19-84	WCT	143	26	04-14-85	381	396	Koocanusa Bridge (Lk)
	White	4426	06-15-85	WCT	134	20	07-05-85	—	—	Rexford area (Lk)
	White	4215	06-14-85	HB	153	35	07-24-85	221	—	Cripple Horse (Lk)
	White	4392	06-12-85	WCT	155	40	09-07-85	203	—	Rexford area (Lk)
	White	4550	06-21-85	WCT	128	18	09-15-85	165	—	Rexford area (Lk)
Fortine Creek:	White	3439	07-24-84	WCT	217	89	04-??-85	266	—	No location
	White	3572	07-20-84	WCT	212	83	06-13-85	191	—	Rexford area (Lk)
Young Creek:	Dk. Blue	5455	06-08-83	HB	168	47	10-09-83	305	—	South Elk River B.C. (Lk)
	Lt. Blue	356	06-21-83	WCT	195	70	10-??-83	241	—	Warland area (Lk)
	White	2532	07-11-84	WCT	156	40	07-11-84	152	—	Rexford area (Lk)
	Red	561	06-21-84	WCT	142	29	08-??-84	—	—	B.C. Canada (Lk)
	White	2082	06-30-84	WCT	213	109	09-08-84	241	—	Souse Gulch (Lk)
	White	3553	07-19-84	WCT	192	76	09-27-84	254	150	Kokomun B.C. (Lk)
	White	2663	07-06-84	WCT	130	20	05-01-85	292	—	Rexford area (Lk)
	Red	259	06-05-84	WCT	128	21	05-12-85	305	227	Rexford area (Lk)
	Red	579	06-24-84	HB	136	23	05-18-85	305	—	Barron boat ramp (Lk)
	White	2505	07-09-84	WCT	156	36	05-27-85	259	—	Forebay (Lk)
	White	3537	07-17-84	WCT	171	49	06-06-85	—	—	Fisher River below dam
	White	3625	07-17-84	WCT	166	21	06-06-85	—	—	Mouth of Fisher River - below dam
	White	4121	05-27-85	WCT	210	92	06-21-85	222		Just north of dam (Lk)
	Red	564	06-??-84	WCT	—	—	07-06-85	280	185	Mouth of Young Creek (Lk)
	White	3630	11-14-84	WCT	201	—	07-13-85	278	—	McGillvary (Lk)
	White	4111	05-25-85	WCT	182	55	08-??-85	254	—	Rexford (Lk)
	White	5161	06-29-85	WCT	161	37	09-07-85	—	—	Cripple Horse (Lk)
	White	5105	06-27-85	WCT	180	58	10-18-85	267	—	Barron Creek
	White	1113	06-22-84	WCT	175	41	10-24-85	335	343	So. Pt. Tobacco Bay a/ (Lk)

a/ Recaptured in our sampling gear.

APPENDIX I

Food habits information for gamefish collected during October 1983 from Libby Reservoir.

Appendix I. Index of relative abundance for gamefish collected in Libby Reservoir during the fall of 1983.

Date	Species	Length Class	n	Daphnia	Epischura	Leptodora	Other	Terrestrial Insects	Diptera larvae	Diptera pupae	Diptera adult	Arachnids	Misc. Other	Fish KOK	Fish Trout	Fish Other	Insect Parts	Debris	Algae
10/83	Rb	≤330	22	82.8	4.5	<.l	1.5	lB.E	---	—	12.5	1.6	4.6	----	--	3.5	20.7	7.1	2.3
10/83	Rb	>330	29	51.8	—	---	- -	21.4	6.6	2.3	7.0	11.6	7.0	---	--	5.9	33.9	41.4	--
10/83	WCT	≤330	15	14.4	—	- -	- -	21.6	- -	- -	23.6	16.2	11.3	----	---	2.2	26.9	3.5	---
10/83	WCT	>330	18	61.6	- -	-	- -	26.0	2.1	—	21.0	12.5	13.6	--	--	3.5	36.1	36.2	--
10/83	HB	≤330	18	68.5	- -	—	2.0	39.7	- -	2.0	17.7	16.4	15.5	---	---		23.1	8.0	--
10/83	HB	>330	27	13.7	1.2	—	—	30.6	2.5	—	16.5	10.4	10.4	—	--		21.4	26.7	--
10/83	DV	—	6	----	---	- -	- -	- -	---	- -	---	—	---	41.3	--	52.6	———	---	--
10/83	MWF	—	23	81.9	8.6	—	- -	1.4	7.0	4.4	1.4	--	17.2	—	---	—	----	9.1	--
10/83	KOK	—	3	100.0	11.0	- -	—	0.0	0.0	- -			----	---	--	—	----	--	---

APPENDIX J

Average estimated densities and compostion (%) of zooplankton by genera in three areas of Libby Reservoir, 1984-85.

Table J1. Mean zooplankton densities (No./1) and percentages (in parentheses) estimated from 0-30 m vertical tows during 1984 in the Tenmile area of Libby Reservoir.

Date	Daphnia	Bosmina	Cyclops	Diaptomus	Epischura	Total
07/31/84	1.93 (18)	1.78 (16)	5.78 (53)	1.42 (13)	0.08 (T)	10.99
08/09/84	1.46 (14)	3.90 (38)	4.13 (41)	0.71 (07)	0.03 (T)	10.23
08/27/84	2.81 (25)	0.50 (04)	6.81 (60)	1.22 (11)	0.05 (T)	11.39
09/10/84	1.69 (14)	0.71 (06)	8.49 (70)	1.24 (10)	<0.01 (T)	12.04
10/01/84	2.34 (13)	4.32 (24)	10.20 (56)	1.30 (07)	0.02 (T)	18.18
10/29/84	2.63 (25)	1.96 (19)	4.62 (44)	1.33 (13)	0.00 (00)	10.54
11/27/84	1.47 (20)	0.84 (11)	4.00 (53)	1.18 (16)	0.02 (T)	7.51
12/13/84	0.47 (13)	0.16 (05)	2.39 (67)	0.53 (15)	0.01 (T)	3.56

Table J2. Mean zooplankton densities (No./l)and percentages (in parentheses) estimated from 0-30 m vertical tows during 1985 in the Tenmile area of Libby Reservoir.

Date	Daphnia	Bosmina	Cyclops	Diaptomus	Epischura	Total
01/2l/85	0.89 (12)	0.15 (02)	5.69 (74)	0.91 (12)	0.00 (00)	7.64
04/08/85	0.67 (07)	0.14 (02)	7.04 (77)	1.28 (14)	0.00 (00)	9.13
05/02/85	0.65 (05)	0.12 (01)	12.31 (90)	0.61 (04)	0.00 (00)	13.69
05/08/85	0.84 (10)	0.13 (02)	6.61 (79)	0.73 (09)	0.00 (00)	8.31
05/21/85	1.43 (08)	0.36 (02)	15.57 (84)	1.11 (06)	0.00 (00)	18.47
06/11/85	4.59 (15)	3.47 (11)	21.17 (67)	1.83 (06)	0.25 (01)	31.31
06/26/85	4.28 (31)	4.72 (34)	4.39 (31)	0.61 (04)	0.00 (00)	14.00
07/09/85	2.50 (15)	6.22 (37)	7.19 (43)	0.83 (05)	0.02 (T)	16.76
07/29/85	1.79 (25)	0.23 (03)	3.35 (48)	1.52 (22)	0.11 (02)	7.00

Talbe J3. Mean zooplankton densities (No./l)and percentages (in parentheses) estimated from 0-30 m vertical tows during 1984 in the Rexford area of Libby Reservoir.

Date	Daphnia	Bosmina	Cyclops	Diaptomus	Epischura	Total
08/01/84	1.93 (17)	1.08 (09)	6.97 (61)	1.35 (12)	0.07 (01)	11.40
08/13/84	0.92 (20)	0.29 (07)	2.20 (48)	1.14 (25)	0.00 (00)	4.55
08/28/84	2.17 (26)	0.62	4.18 (08)	1.34 (50)	0.02 (T)	8.33
09/11/84	0.31 (05)	1.87 (32)	2.80 (49)	0.69 (12)	0.11 (02)	5.78
10/03/84	0.48 (11)	0.94 (21)	1.82 (42)	1.04 (24)	0.07 (02)	4.35
10/25/84	3.30 (24)	3.09 (23)	4.99 (36)	2.27 (17)	0.03 (T)	13.68
11/19/84	0.50 (14)	0.11 (03)	2.13 (62)	0.68 (20)	0.02 (01)	3.44
12/12/84	0.52 (17)	0.04 (01)	2.05 (65)	0.53 (17)	0.01 (T)	3.15

Table J4. Mean zooplankton densities (No./l)and percentages (in parentheses) estimated from O-30 m vertical tows during 1985 in the Rexford area of Libby Reservoir.

Date	Daphnia	Bosmina	Cyclops	Diaptomus	Epischura	Total
02/19/85	0.91 (07)	0.11 (01)	6.08 (50)	5.09 (42)	0.00 (00)	12.19
04/08/85	0.38 (04)	0.14 (02)	6.65 (81)	1.06 (13)	0.00 (00)	8.23
04/25/85	0.41 (04)	0.19 (02)	8.15 (89)	0.45 (05)	0.00 (00)	9.20
05/07/85	0.42 (04)	0.15 (02)	9.48 (91)	0.34 (03)	0.00 (00)	10.39
05/22/85	0.38 (03)	0.37 (03)	13.51 (94)	0.10 (01)	0.01 (T)	14.37
06/12/85	3.74 (28)	2.80 (21)	5.87 (45)	0.69 (05)	0.12 (01)	13.22
06/26/85	6.59 (32)	7.58 (36)	5.52 (27)	1.03 (05)	0.00 (00)	20.72
07/10/85	6.16 (33)	0.22 (01)	9.83 (53)	2.40 (13)	0.01 (T)	18.62
07/3l/85	1.78 (29)	0.10 (02)	2.74 (45)	1.45 (23)	0.06 (01)	6.13

Table J5. Mean zooplankton densities (No./l)and percentages (in parentheses) estimated from O-30 m vertical tows during 1984 in the Canada area of Libby Reservoir.

Date	Daphnia	Bosmina	Cyclops	Diaptomus	Epischura	Total
08/02/84	5.00 (56)	0.07 (01)	2.83 (31)	1.11 (121	0.01 (T)	9.02
08/16/84	2.52 (45)	0.24 (05)	1.96 (35)	0.83 (15)	0.02 (T)	5.57
08/29/84	3.75 (41)	0.59 (06)	3.63 (40)	1.07 (12)	0.13 (01)	9.17
09/12/84	0.87 (18)	1.10 (23)	2.20 (45)	0.61 (13)	0.06 (01)	4.84
10/04/84	4.94 (26)	4.38 (23)	7.14 (38)	2.37 (13)	0.00 (00)	18.83
10/18/84	8.48 (29)	8.85 (30)	8.78 (30)	3.39 (11)	0.02 (T)	29.52
11/2l/84	2.77 (22)	1.80 (15)	5.65 (46)	2.14 (17)	0.01 (T)	12.37

Table J6. Mean zooplankton densities (No./l)and percentages (in parentheses) estimated from O-30 m vertical tows during 1985 in the Canada area of Libby Reservoir.

Date	Daphnia	Bosmina	Cyclops	Diaptomus	Epischura	Total
06/13/85	0.01 (17)	0.02 (33)	0.02 (33)	0.01 (17)	0.00 (00)	0.06
06/27/85	8.99 (52)	0.36 (02)	7.49 (43)	0.51 (03)	0.00 (00)	17.35
07/11/85	4.11 (70)	T (T)	1.14 (19)	0.66 (11)	0.01 (T)	5.92
08/01/85	3.43 (35)	0.01 (T)	4.60 (47)	1.70 (17)	0.06 (01)	9.80

APPENDIX K

Sampling efficiency (percent) of Wisconsin net compared to a Schindler plankton trap for 30 m vertical tows in three areas of Libby Reservoir during 1984 and 1985.

Appendix K. Sampling efficiency (percent) of Wisconsin net compared to a Schindler plankton trap for 30 m vertical tows in three areas of Libby Reservoir during 1984 and 1985. The Schindler plankton trap was assumed to be 100 percent efficient.

Month, Year	Daphnia			Bosmina			Cyclops			Diaptomus		
	Tenmile	Rexford	Canada	Tenmile	Rexford	Canada	Tenmile	Rexford	Canada	Tenmile	Rexford	Canada
August, 1984	78	35	---	32	55	---	85	65	- -	96	73	- -
September, 1984	64	110	75	127	58	89	75	88	107	48	136	133
October, 1984	- -	82	74	- -	85	165	- -	125	117	- -	166	79
November, 1984	92	143	200	84	33	233	141	146	253	141	148	275
December, 1984	130	300	---	114	200	---	165	131	---	179	140	---
January, 1985	43	---	---	37	---	---	46	---	---	70	---	---
April, 1985	---	80	---	---	115	---	---	83	---	---	60	---
June, 1985	93	55	54	77	89	00	57	46	83	55	37	93
July, 1985	98	113	120	15	125	00	65	62	118	71	49	115

July 1985 Rexford efficiency slanted toward VP due to loss of Schindler samples.

APPENDIX L

Estimated densities (number per m2) and biomass (grams per3) of Diptera and Oligochaeta within the reservoir bed of Libby Reservoir in frequently dewatered, occasionally dewatered, and permanently wetted substrated (by area) during November 1984, and from April 1985 through July 1985.

Appendix L. Estimated densities (number per m2) and biomass (grams per m2) of Diptera and Oligochaeta within the reservoir bed of Libby Reservoir in frequently dewatered, occaisonally dewatered and permanently wetted substrates (by area) during November 1984, and from April 1985 through July 1985.

	Frequently dewatered		Occassionally dewatered		Permanently wetted		**Frequently dewatered**
	Tenmile	Rexford	Tenmile	Rexford	Tenmile	Rexford	Canada
Number/m2							
Diptera							
November 1984	247	183	1,007	269	197	670	645
April 1985	*	*	556	462	369	563	*
June 1985	39	--	645	226	720	355	*
May 1985	39	--	90	79	323	*	14
July 1985	265	4	280	32	229	43	18
Average	110	37	516	214	459	408	226
Oligochaeta							
November 1984	–	–	151	–	–	326	507
April 1985	*	*	197	294	176	932	*
May 1985	*	*	244	298	50	135	*
June 1985	4	7	183	301	172	*	22
July 1985	68	–	61	129	502	1,269	208
Average	24	2	167	204	180	666	246
Grams/m^2							
Diptera							
November 1984	0.615	0.161	2.555	0.428	0.653	1.589	1.385
April 1985	*	*	0.717	0.449	0.678	1.154	*
May 1985	*	*	0.547	0.367	0.370	1.161	*
June 1985	0.052	–	0.330	0.064	0.650	*	0.008
July 1985	0.089	0.004	0.120	0.029	1.048	0.023	0.004
Average	0.252	0.057	0.854	0.267	0.680	0.981	0.466
01igochaeta							
November 1984	––	–	0.061	–	–	0.108	0.306
April 1985	*	*	0.059	0.050	0.035	0.225	*
May 1985	0.001	*	0.044	0.047	0.005	0.015	*
June 1985		0.008	0.041	0.354	0.038	*	0.004
July 1985	0.006	–	0.008	0.019	0.100	0.241	0.170
Average	0.002	0.003	0.043	0.094	0.036	0.147	0.160

* No samples taken

APPENDIX M

Seasonal average densities and biomass
of terrestrial and aquatic mxroinvertebrates
captured on the surface of three areas of Libby
Reservoir during October 1984 through September 1985.

Appendix M. Seasonal average densities (number per hectare) and biomass (grams per hectare) of terrestrial and aquatic macroinvertebrates captured on the surface of three areas of Libby Reservoir during October 1984 through September 1985.

Season/Year	Tenmile			Rexford			Canada		
	N.S.	L.	Avg.	N.S.	L.	Avg.	N.S.	L.	Avg.
Number per hectare									
Fall/1984	(4 tows)			(3 tows)			(8 tows)		
Terrestrial	1904	1050	1477	585	1444	1015	157	132	145
Aquatic	125	83	104	50	61	56	25	10	18
Total	2029	1133	1581	635	1505	1071	182	142	162
Winter/1985	(no tows)			(no tows)			(no tows)		
Spring/1985	(18 tows)			(18 tows)			(tows)		
Terrestrial	4105	2518	3312	310	239	275	150	107	129
Aquatic	186	13	100	63	23	43	48	56	52
Total	4291	2531	3412	373	262	318	198	163	181
Grams per hectare									
Fall/1984	(4 tows)			(3 tows)			(8 tows)		
Terrestrial	6.324	4.103	5.214	2.071	0.955	1.513	0.929	0.109	0.519
Aquatic	0.356	0.115	0.236	0.176	0.193	0.185	0.159	0.012	0.086
Total	6.680	4.218	5.450	2.247	1.148	1.698	1.088	0.121	0.605
Winter/1985	(no tows)			(no tows)			(no tows)		
Spring/1985	(15 tows)			(tows)			(6 tows)		
Terrestrial	11.958	7.012	9.485	2.661	1.334	1.998	1.400	0.612	1.006
Aquatic	0.632	0.379	0.506	1.889	1.066	1.478	1.419	0.043	0.731
Total	12.590	7.391	9.991	4.550	2.400	3.476	2.819	0.655	1.737
Summer/1985	(18 tows)			(18 tows)			(tows)		
Terrestrial	7.585	5.721	6.653	0.922	0.589	0.756	0.542	0.202	0.372
Aquatic	0.306	0.018	0.162	0.595	0.023	0.309	0.047	0.086	0.067
Total	7.891	5.739	6.815	1.517	0.612	1.065	0.589	0.288	0.439

APPENDIX N

Surface macroinvertebrate densities and biomass by Order, from fall 1984 through summer 1985.

Table N1. Surface macroinvertebrate densities and biomass, by Order, during fall 1984.

n	TENMILE N.S.	TENMILE L	TENMILE Combined	REXFORD N.S.	REXFORD L	REXFORD Combined	CANADA N.S.	CANADA L	CANADA Combined
	(# tows = 8)			(# tows = 6)			(# tows = 16)		
Number/ha									
Terrestrial:									
Coleoptera	117	54	86	28	11	20	13	4	9
Hemiptera	258	229	244	28	6	17	19	10	15
Homoptera	1058	617	838	506	1383	944	75	108	92
Hymenoptera	400	125	263	17	44	31	42	8	25
Lepidoptera	38	4	21	6	-	3	4	-	2
Neuroptera	-	-	-	-	-	-	-	-	-
Orthoptera	-	-	-	-	-	-	-	-	-
Pscoptera	-	-	-	-	-	-	-	-	
Arachnidia	33	21	27	-	-	-	4	2	3
Other	-	-	-				-	-	-
TOTAL TERRESTRIAL	1904	1050	1477	585	1444	1015	157	132	146
Aquatic:									
Diptera	100	58	79	39	61	50	23	6	15
Ephemeroptera	17	21	19				-	-	-
Trichoptera	8	0	4	11	-	6	2	4	3
Other	-	4	2	-	-	-	-	-	-
TOTAL AQUATIC	125	83	104	50	61	56	25	10	18
GRAND TOTAL	2029	1133	1581	635	1505	1071	182	142	164
Grams/ha									
Terrestrial:									
Coleoptera	1.082	0.432	0.757	0.376	0.012	0.194	0.579	0.035	0.307
Hemiptera	1.104	2.267	1.686	1.297	0.010	0.654	0.065	0.024	0.045
Homoptera	2.299	0.847	1.573	0.362	0.921	0.642	0.034	0.038	0.036
Hymenoptera	1.282	0.127	0.705	0.027	0.012	0.020	0.205	0.007	0.106
Lepidoptera	0.344	0.003	0.174	0.009	——	0.005	0.026	——	0.013
Neuroptera	——	——	——	——	——	——	——	——	——
Orthoptera	——	——	——	——	——	——	——	——	——
Pscoptera	——	——	——	——	——	——	——	——	——
Arachnidia	0.213	0.427	0.320	——	——	——	——	——	——
Other	——	——	——	——	——	——	——	——	——
TOTAL TERRESTRIAL	6.324	4.103	5.215	2.071	.0955	1.515	0.929	0.109	0.520
Aquatic:									
Diptera	0.269	0.077	0.173	0.116	0.193	0.155	0.156	0.004	0.080
Ephemeroptera	0.052	0.035	0.044	——	——	——	——	——	——
Trichoptera	0.035	——	0.018	0.060		0.030	0.003	0.008	0.006
Other	——	0.003	0.002	——	——	——	——	——	——
TOTAL AQUATIC Parts	0.356	0.115	0.237	0.176	0.193	0.185	0.159	0.012	0.086
GRAND TOTAL	6.680	4.218	5.452	2.247	1.148	1.700	1.088	0.121	0.606

Table N2. Surface macroinvertebrate densities and biomass, by Order, during the spring, 1985.

n	TENMILE N.S.	TENMILE L	TENMILE Combined	REXFORD N.S.	REXFORD L	REXFORD Combined	CANADA N.S.	CANADA L	CANADA Combined
	(# tows = 30)			(# tows = 31)			(# Tows = 12)		
Number/ha									
Terrestrial:									
Coleoptera	153	92	123	76	56	66	42	17	30
Hemiptera	17	9	13	19	1	10	47	22	35
Homoptea	74	76	75	20	27	24	4	10	7
Hymenoptera	84	102	93	30	17	24	8	-	4
Lepidoptera	2	0	1	-	-	-	-	-	-
Neuroptera	-	-	-	-	-	-	-	-	-
Orthoptera	-	-	-	-	-	-	-	-	-
Pscoptera	-	-	-	-	-	-	-	-	-
Arachnidia	51	22	37	19	10	15	2	2	2
Other	-	-	-	3	-	2	-	-	-
TOTAL TERRESTRIAL	381	301	342	167	111	141	103	51	78
Aquatic:									
Diptera	184	205	195	477	331	404	17	8	13
Ephemeroptera	16	1	9	0	2	1	83	8	46
Trichoptera	11	3	7	2	2	2	-	-	-
Other	2	3	3	20	3	12	2	11	7
TOTAL AQUATIC	213	212	213	499	338	419	102	27	66
GRAND TOTAL	594	513	555	666	449	560	205	78	144
Grams/ha									
Terrestrial:									
Coleoptera	3.478	1.388	2.433	1.210	1.070	1.140	0.935	0.294	0.615
Hemiptera	0.059	0.180	0.120	0.167	0.012	0.090	0.254	0.220	0.237
Homoptera	0.040	0.060	0.050	0.549	0.017	0.283	0.003	0.078	0.041
Hymenoptera	1.982	1.700	1.841	0.426	0.157	0.292	0.161	——	0.081
Lepidoptera	0.023	——	0.012	——	——	——	——	——	——
Neuroptera	——	——	——	——	——	——	——	——	——
Orthoptera	——	——	——	——	——	——	——	——	——
Pscoptera	——	——	——	——	——	——	——	——	——
Arachnidia	0.397	0.178	0.288	0.293	0.078	0.186	0.047	0.020	0.034
Other	5.979	3.506	4.744	0.016	——	0.008	——	——	
TOTAL TERRESTRIAL	11.958	7.012	9.488	2.661	1.334	1.999	1.400	0.612	1.008
Aquatic:									
Diptera	0.444	0.243	0.344	1.750	1.032	1.391	0.113	0.009	0.061
Ephemeroptera	0.041	0.032	0.037	——	0.005	0.003	1.301	0.015	0.558
Trichoptera	0.101	0.064	0.083	0.027	0.027	0.027	——	——	——
Other	0.046	0.040	0.043	0.112	0.001	0.057	0.005	0.019	0.012
TOTAL AQUATIC Parts	0.632	0.379	0.507	1.889	1.066	1.478	1.419	0.043	0.731
GRAND TOTAL	12.590	7.391	9.995	4.550	2.400	3.477	2.819	0.655	1.739

Table N3. Surface macroinvertebrate densities and biomass, by Order, during the summer, 1985.

n	TENMILE N.S.	TENMILE L	TENMILE Combined	REXFORD N.S.	REXFORD L	REXFORD Combined	CANADA N.S.	CANADA L	CANADA Combined
	(# tows = 36)			(# tows = 36)			(# tows = 35)		
Number/ha									
Terrestrial:									
Coleoptera	22	11	17	13	8	11	9	6	8
Hemiptera	51	18	35	50	41	46	12	12	12
Homoptera	128	32	80	171	113	142	104	82	93
Hymenoptera	3891	2454	3173	75	69	72	22	7	15
Lepidoptera	2	1	2	-	2	1	-	-	-
Neuroptera	1	-	1	-	1	1	-	-	-
Orthoptera	-	-	-	-	-	-	-	-	-
Pscoptera	-	-	-	-	-	-	-	-	-
Arachnidia	9	2	6	1	5	3	3	0	2
Other	1	0	1	-	-	-	-	-	-
TOTAL TERRESTRIAL	4105	2518	3315	310	239	276	150	107	130
Aquatic:									
Diptera	181	13	97	60	18	39	47	54	51
Ephemeroptera	4	-	2	3	-	2	1	1	1
Trichoptera	-	-	-	0	5	3	0	1	1
Other	1	-	1	-	-	-	-	-	-
TOTAL AQUATIC	186	13	100	63	23	44	48	56	54
GRAND TOTAL	4291	2531	3415	373	262	320	198	163	184
Grams/ha									
Terrestrial:									
Coleoptera	0.208	0.579	0.394	0.247	0.071	0.159	0.100	0.079	0.090
Hemiptera	0.359	0.103	0.231	0.089	0.129	0.109	0.183	0.051	0.117
Homoptera	0.538	0.051	0.320	0.214	0.085	0.150	0.173	0.045	0.109
Hymenoptera	6.426	4.973	5.700	0.365	0.220	0.293	0.071	0.027	0.049
Lepidoptera	0.003	0.001	0.002	-----	0.033	0.017	-----	-----	-----
Neuroptera	0.001	-----	0.001	-----	0.004	0.002	-----	-----	-----
Orthoptera	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pscoptera	-----	-----	-----	-----	-----	-----	-----	-----	-----
Arachnidia	0.045	0.014	0.030	0.007	0.047	0.027	0.015	-----	0.008
Other	0.005	-----	0.003	-----	-----	-----	-----	-----	-----
TOTAL TERRESTRIAL	7.585	5.721	6.681	0.922	0.589	0.757	0.542	0.202	0.373
Aquatic:									
Diptera	0.213	0.018	0.116	0.590	0.017	0.304	0.045	0.046	0.046
Ephemeroptera	0.022	-----	0.011	0.005	-----	0.003	0.002	0.005	0.004
Tricoptera	-----	-----	-----	-----	0.006	0.003	-----	0.035	0.018
Other	0.071	-----	0.036	-----	-----	-----	-----	-----	-----
TOTAL AQUATIC Parts	0.306	0.018	0.163	0.595	0.023	0.310	0.047	0.086	0.068
GRAND TOTAL	7.891	5.739	6.844	1.517	0.612	1.067	0.589	0.288	0.441