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MEASUREMENT OF LAKE ROOSEVELT BIOTA IN RELATION TO RESERVOIR OPERATIONS

FINAL REPORT 1993

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ABSTRACT

The purpose of this study was to collect biological data from Lake Roosevelt to be used in the design of a computer model that will predict biological responses to reservoir operations as part of the System Operation Review Program. This study worked in conjunction with Lake Roosevelt Monitoring Project which investigated the effectiveness of two kokanee salmon hatcheries. This report summarized the data collected from Lake Roosevelt from 1993 and includes limnological, reservoir operation, zooplankton, benthic macroinvertebrate, experimental trawling, and net-pen rainbow trout tagging data. Major components of the Lake Roosevelt model include quantification of impacts to zooplankton, benthic macroinvertebrates, and fish caused by reservoir drawdowns and low water retention times.

Reservoir operations influence the morphology of a reservoir and habitat for fish and their food. The thermal structure of a reservoir is influenced by the large seasonal inflow and outflow volumes. In Lake Roosevelt, reservoir operation caused the lake elevations to decline continually to 1,255 ft in March, then actively refilling to 1,280 ft on April 25th. Mean yearly reservoir elevation was 1,277 ft. Mean monthly water retention time did not go below thirty days for any month, while daily water retention times ranged from 38 days in December to 87 days in April.

Zooplankton data was collected monthly at nine sites in 1993. Lake Roosevelt experienced two peaks of ***daphnia*** spp. densities. High densities of zooplankton were found in the lower end of the reservoir supporting the hypothesis that flushing of reservoir water increases downstream densities, biomass, and entrainment.

Benthic macroinvertebrate data was collected March through September 1993 and showed high re-colonization rates of benthic macroinvertebrates in dewatered areas. Densities and weights were consistently composed of midges and worms. Emergence data was collected in June and July only, due to trap damage and vandalism. Data supported the hypothesis that benthic macroinvertebrate sampling is not an effective sampling device for Lake Roosevelt and will not continue.

The Idaho Department of Fish and Game in conjunction with the Spokane Tribe of Indians trawled Lake Roosevelt in August, 1993 to determine if trawling was a suitable methodology to estimate kokanee densities in the reservoir. No kokanee were collected in eleven trawls, and no layer of kokanee could be seen with extensive echosounding. Densities of kokanee in Lake Roosevelt appear to be too low for collection by mid-water trawling. Trawling at different times of the year may be a suitable way to estimate kokanee densities in the reservoir. However, warm water temperatures, the lack of stratification, predation, mortality, and low water retention times may result in high entrainment losses and a low population of kokanee in Lake Roosevelt.

A total of 21,255 net-pen rainbow trout were tagged at locations throughout the reservoir. Three hundred, fifty-two tags were returned from angler fishing in Lake Roosevelt or below, and 106 tags were from fish tagged in 1993. Trends in tag returns continue to indicate that entrainment of Lake Roosevelt net-pen fish are influenced by water retention times and release times. Fish released later in the year have an increased chance of remaining in the reservoir. Factors influencing entrainment include a smoltification type process in Lake Roosevelt net-pen fish and low water retention times. Please see the Lake Roosevelt Monitoring Program's 1993 annual report for creel data and pressure estimate changes over the duration of both projects.

ACKNOWLEDGMENTS

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INTRODUCTION

The purpose of this research project is to collect data to model resident fish requirements for Lake Roosevelt as part of the Bonneville Power Administration (BPA), Bureau of Reclamation (BOR), and U.S. Army Corps of Engineer's (ACE) System Operation Review. The System Operation Review (SOR) is a tri-agency team functioning to review the use and partitioning of Columbia Basin waters. User groups of the Columbia have been defined as power, irrigation, flood control, anadromous fish, resident fish, wildlife, recreation, water quality, navigation, and cultural resources.

Once completed the model will predict biological responses to different reservoir operation strategies. The model developed for resident fish is based on a model developed by Montana Department of Fish, Wildlife, and Parks for resident fish requirements within Hungry Horse and Libby Reservoirs. While the Montana model predicts fish growth based on the impacts of reservoir operation and flow conditions on primary and secondary production levels, the Lake Roosevelt model will also factor in the effects of water retention time on zooplankton production levels and fish entrainment. Major components of the Lake Roosevelt model include quantification of impacts to zooplankton and benthic invertebrates caused by reservoir drawdowns and low water retention times and quantification of entrainment levels of fish as related to reservoir operations and water retention times.

In July 1991, BPA entered into a contract with the Spokane Tribe of Indians to initiate the System Operation Review process with continued research through 1995. The SOR project is a modification of the Lake Roosevelt Monitoring Project contract with BPA that studies the effects of kokanee reintroduction into Lake Roosevelt. This report contains the results of the resident fish SOR program for Lake Roosevelt from January through December 1993.

DESCRIPTION OF STUDY AREA

Lake Roosevelt is a mainstem Columbia River impoundment formed by the construction of Grand Coulee Dam in 1939 (Figure 1). Filled in 1941, the reservoir inundates 33,490 hectares at a full pool elevation of 393 m above mean sea level. It has a maximum width of 3.4 km and a maximum depth of 122 m (Stober *et al.* 1981). Grand Coulee Dam is a Bureau of Reclamation storage project operated primarily for power, flood control, and irrigation with secondary operations for recreation, fish, and wildlife.

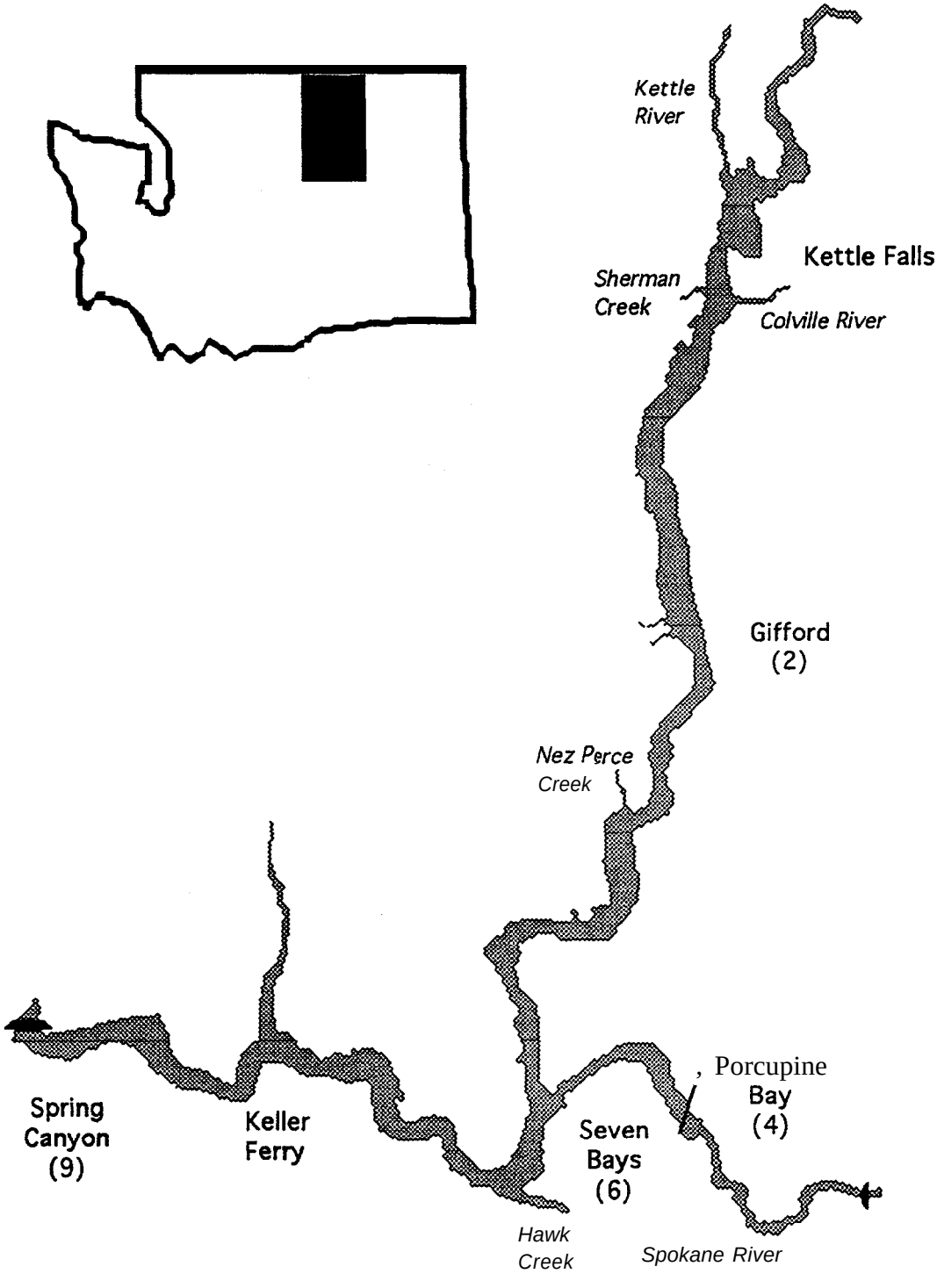


Figure 1. Map of Lake Roosevelt, Washington showing the locations of sampling and tagging stations.

OBJECTIVES - 1993

This study proposes to determine how reservoir operations effect reservoir biology in Lake Roosevelt. The specific study objectives are:

1. Determine reservoir hydrology, downstream flow constraints and how these effect reservoir operations;

2. Determine zooplankton biomass and density at four areas of the reservoir;

3. Determine benthic macroinvertebrate production levels and densities at differing reservoir strata;

4. Determine benthic insect emergence levels at differing reservoir strata;

5. Determine if trawling is a suitable methodology to estimate kokanee (*Oncorhynchus nerka*) densities in Lake Roosevelt.

6. Determine entrainment levels via placement of Floy tags in net-pen rainbow trout (*Salmo gairdneri*).

RESERVOIR HYDROLOGY

Met hods

Water quality measurements of temperature, pH, dissolved oxygen, conductivity, and oxygen reduction potential were collected using a Hydrolab Surveyor II at four sites in the reservoir. Samples were collected mid-channel at Gifford (location 2), Porcupine Bay (location 4), Seven Bays (location 6), and Spring Canyon (location 9) monthly in 1993 (Figure 1). This data collection continues procedures which began in 1991. Consult Appendix D for this data.

Reservoir elevations and water retention times were calculated from daily midnight reservoir elevation (ft) and total outflow (kcfs) summary reports for Grand Coulee Dam prepared monthly in 1993 by the U.S. Army Corps of Engineers, Reservoir Control Center in Portland, OR. Reservoir elevation (ft) was converted to volume of water stored (kcfsd) using a U.S. Army Corps of Engineers (1981) reservoir water storage table. Water retention time was calculated using the formula:

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

Daily values for each category were added and then divided by the number of days in each month to attain mean reservoir elevations and water retention times.

Results and Discussion

Table 1 summarizes mean monthly reservoir operations for Lake Roosevelt in 1993. Appendix A summarizes daily reservoir operations from January through December 1993. Lake Roosevelt was drawn down continually from December 1992, to 1,255 ft in March, then actively refilled to 1,280 on April 25th. The reservoir continued to fill toward fullpool and remained stable through September 27th. A second gradual drawdown occurred from October through December 1993. Mean reservoir elevations ranged from 1,256 feet in March to 1,287 feet in June, 1993. Mean yearly reservoir elevation was 1,277 feet. Mean outflows ranged from 48 kcsf in April to 119 kcfs in May, 1993 with a yearly mean of 84 kcfs.

Mean monthly water retention time did not go below thirty days for any month.

Table 1. Monthly and annual means for reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in 1993.

MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
Jan. 1993	95.0	100.5	1267.5	3731.9	40.2
Feb. 1993	71.6	85.9	1263.5	3594.3	44.0
Mar. 1993	57.1	53.9	1256.0	3329.6	67.1
Apr. 1993	80.4	48.4	1271.8	3887.3	87.1
May 1993	132.0	119.0	1284.7	4375.4	39.4
Jun. 1993	100.8	95.67	1287.5	4487.3	49.55
Jul. 1993	104.1	97.24	1286.4	4444.5	46.9
Aug. 1993	87.7	81.7	1285.9	4422.2	56.8
Sept. 1993	67.9	73.0	1281.3	4242.7	61.0
Oct. 1993	65.0	62.5	1281.2	4266.3	73.5
Nov. 1993	77.1	84.2	1278.8	4150.9	51.4
Dec. 1993	86.5	109.9	1273.0	3930.8	37.5
Mean 1993	85	84	1277	4072	55

Daily water retention times were above 30 days the majority of the year. However, January, February, May, and November all had periods of daily fluctuations in which water retention times were less that thirty days. Mean water retention times ranged from 38 days in December to 87 days in April, with a yearly mean of 55 days.

Table 2 compares inflows, outflows, reservoir elevations, storage capacities, and water retention times of 1992 to 1993. When comparing means for both 1992 and 1993 there are no extreme differences. However daily fluctuations from reservoir operations between the two years are different. The effect these differences have on the biota are unknown. Mean water retention times remained generally constant when comparing months for both years.

Figures 2 and 3 show the changes of monthly reservoir elevations and water retention times from 1991 through 1993. 1991 reservoir operations produced the lowest mean elevations and water retention times when compared to 1992 and 1993. The reduced water retention times in 1991 were thought to be the cause of the significant decreases in zooplankton density and biomass values (Griffith *et al.* 1994).

Reservoir operations influence the morphology of a reservoir and habitat for fish and their food. Changes in surface area, water volume, depth, shoreline development, in lake-filling, and water retention times are varied by the drawdown and refilling cycles of the reservoir. The amount of littoral area varies with reservoir elevation along with volume of water in the euphotic zone, volume of water in preferred temperature ranges for zooplankton and fish growth, an area of reservoir bottom dewatered. The thermal structure of reservoirs is influenced by the large seasonal inflow and outflow volumes (Woods 1982).

Table 2. Monthly and annual means for reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in 1992 and 1993.

MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
Jan. 1993	**95.0**	**100.5**	**1267.5**	**3731.9**	**40.2**
Jan. 1992	107.5	101.5	1287.1	4472.9	45.1
Feb. 1993	**71.6**	**85.9**	**1263.5**	**3594.3**	**44.0**
Feb. 1992	74.8	88.7	1287.8	4501.6	59.0
Mar. 1993	**57.1**	**53.9**	**1256.0**	**3329.6**	**67.1**
Mar. 1992	77.0	92.6	1281.4	4249.4	48.4
Apr. 1993	**80.4**	**48.4**	**1271.8**	**3887.3**	**87.1**
Apr. 1992	75.2	79.3	1267.9	3744.9	51.2
May 1993	**132.0**	**119.0**	**1284.7**	**4375.4**	**39.4**
May 1992	128.6	112.1	1266.4	3688.9	34.4
Jun. 1993	**100.8**	**95.67**	**1287.5**	**4487.3**	**49.55**
Jun. 1992	157.3	131.7	1281.1	4238.2	33.7
Jul. 1993	104.1 90.8	97.24 80.6	1286.4 1286.9	4444.5 4454.2	46.9 62.1
Jul. 1992					
Aug. 1993	87.7	81.7	1285.9	4422.2	56.8
Aug. 1992	87.8	81.7	1285.9	4422.2	56.8
Sept. 1993	67.9	73.0	1281.3	4242.7	61.0
Sept. 1992	67.9	73.0	1281.3	4242.7	61.0
Oct. 1993	65.0	62.5	1281.2	4266.3	73.5
Oct. 1992	76.9	65.9	1284.1	4351.0	69.0
Nov. 1993	77.1	84.2	1278.8	4150.9	51.4
Nov. 1992	77.8	81.9	1284.2	4358.0	56.3
Dec. 1993	86.5	109.9	1273.0	3930.8	37.5
Dec. 1992	97.6	109.9	1273.0	3930.8	37.5
Annual 1993	**85**	**84**			**55**
Annual 1992	**93**	**91**	1287	4072	**51**

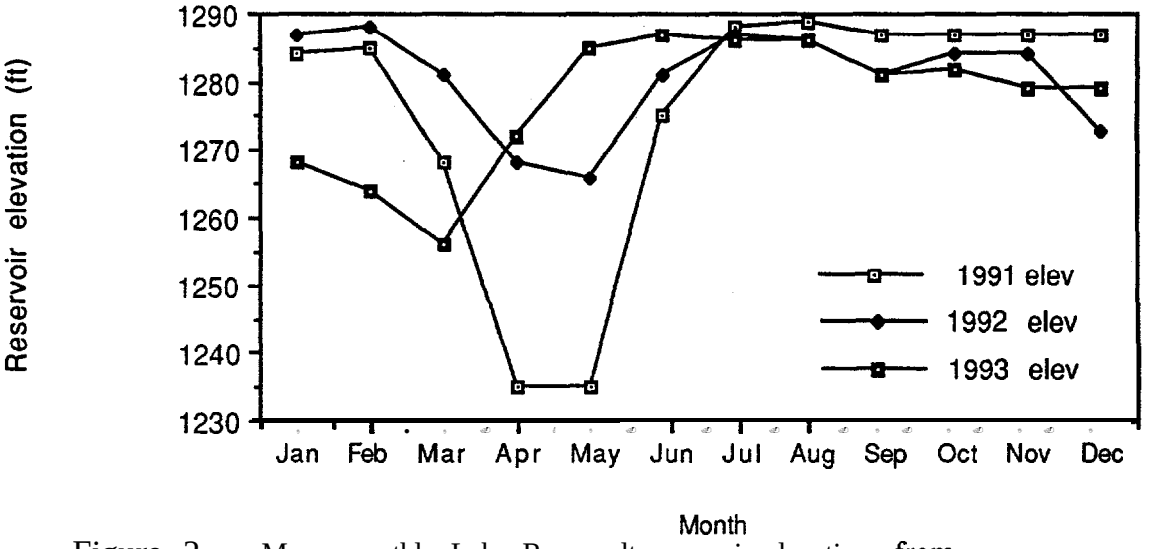


Figure 2. Mean monthly Lake Roosevelt reservoir elevations from 1991 through 1993.

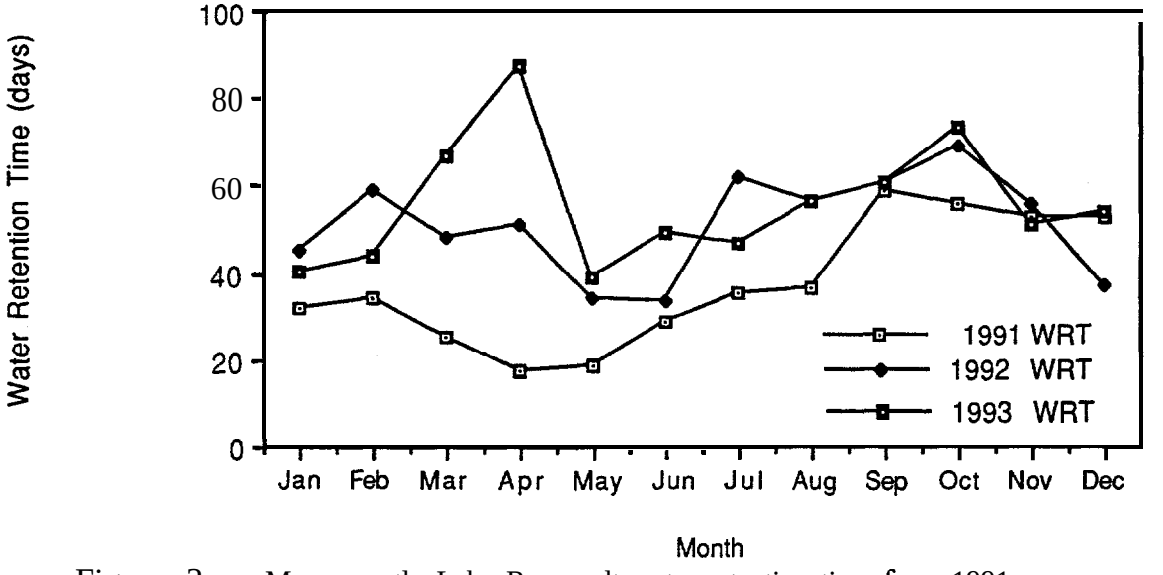


Figure 3. Mean montly Lake Roosevelt water retention time from 1991 through 1993.

ZOOPLANKTON

Met hods

Zooplankton samples were collected mid-channel at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon monthly in 1993. Samples were taken using a Wisconsin vertical tow plankton net with an 80 µm silk net and bucket. Duplicate tows were made from 33 m to the surface at each location. Organisms were washed into a 253 ml bottle containing 10 ml of 37% formaldehyde and 0.5 g sugar (Rigler 1978). Organisms were stained with 1.0 ml of five percent Lugol's solution and 1.0 ml of saturated eosin-y ethanol stain.

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

Density (# organisms/m^3) was calculated using the following sets of equations. Volume of the sample collected by the Wisconsin plankton sampler was calculated with the following formula:

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

where:

V = volume of the sample;
Π = pi (3.14);
r = radius of sampler, and
h = depth of sample.

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

$$D = DF*1000$$

where:

D	=	density (# organisms/m^3);
Sn	=	number of sub-samples;
s v	=	sample volume;
s s v	=	sub-sample volume;
V	=	volume of entire sample;
DF	=	dilution factor; and
Tc	=	total number counted of each species of organisms.

Predominant cladocerans were randomly chosen and measured from the top of the head to the base of the carapace, excluding the spine. Cladocera biomass was determined using length-weight regression equations summarized by Downing and Rigler (1984).

Results and Discussion

Zooplankton Densities

A total of 38 species of zooplankton were identified in Lake Roosevelt during 1993 (Table 3). Phylum Rotifera were not enumerated. Fifteen species were identified from Order Plioma, the most diverse group, followed by Order Cladocera with 14 species, and 6 species were identified from Order Eucopepoda.

Monthly mean densities (#/m^3) of microcrustacean zooplankton collected at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon are shown in Tables 4 through 7. Mean density/species for each location are located in Appendix B.

Mean total zooplankton densities at Gifford ranged from 8.04/m^3 in April to 6,942.59/m^3 in September with an annual mean of 907.86m^3. Mean total zooplankton densities at Porcupine Bay ranged from 24.13/m^3 in April to 6912.79/m^3 in February with an annual mean of 1217.6/m^3. Mean total zooplankton densities at Seven Bays ranged from 28.16/m^3 in December to 9594.47/m^3 in August with an annual mean of 2031.33/m^3. Mean total zooplankton densities at Spring Canyon ranged from 50.94/m^3 in October to 5750.72/m^3 in June with an annual mean of 1184.93/m^3.

Table 3. Synoptic list of zooplankton **taxa** identified in Lake Roosevelt during the 1993 study period.

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

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

Table 4. , Mean monthly density values (#/m^3) and standard deviations of different categories of zooplankton at Gifford (Index Station 2) in 1993.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Daphnia spp.													
#/m^3	-	0.0	1.34	0.0	24.14	24.14	130.06	343.26	6763.80	488.07	20.11	-	779.49
± S.D.	-	-	± 1.90	-	± 26.55	± 3.79	± 70.16	-		± 60.68	± 1.90	-	27.50
Leptodora													
#/m^3		0.0	0.0	0.0	0.0	1.34	0.0	0.0	29.80	0.0	0.0	-	3.11
± S.D.		-	-			± 1.90	-						1.90
Cladocera													
#/m^3		0.0	1.34	2.68	24.14	40.23	132.74	343.26	6793.60	492.09	20.11	-	785.02
± S.D.		-	± 1.90	± 3.79	± 26.55	± 3.79	± 70.16	-		± 62.58	± 1.90	-	24.38
Adult Copepoda													
#/m^3		59.00	14.75	1.34	17.43	8.05	10.73	13.41	89.39	25.48	8.05	-	24.76
± S.D.		±1.13	± 5.69	±90	± 1.90	± 0.0	± 7.58	-		±1.90	± 3.79	-	7.11
Nauplii													
#/m^3		851.43	40.23	4.02	4.02	1.34	18.77	0.0	29.80	0.0	0.0	-	94.96
± S.D.	-	±3.61	± 3.79	±90	± 1.90	± 1.90	± 3.79	-	-				9.48
Total Zooplankton													
#/m^3	-	910.43	56.32	8.04	45.59	50.96	162.24	356.67	6942.59	517.57	28.16	-	907.86
± S.D.	-	±77.74	±11.38	±7.59	±22.75	±7.59	±81.53	-		±64.48	±1.90	-	35.79

- represents no samples were collected).

Table 5. Mean monthly density values (#/m^3) and standard deviations of different categories of zooplankton at Porcupine Bay (Index Station 4) in 1993.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Daphnia spp.													
#/m^3		148.98	9.39	5.36	20.11	96.54	870.21	231.97	1382.41	244.03	450.52	1133.01	417.50
± S.D.		± 0.0	± 13.27	± 7.58	± 5.69	± 26.55	± 347.01	± 218.07	± 301.50			± 142.22	± 117.99
Leptodora													
#/m^3		0.0	0.0	0.0	0.0	6.70	6.70	1.34	6.70	0.0	0.0	0.0	1.95
± S.D.			-	-		± 5.69	± 5.69	± 1.90	± 5.69				± 4.43
Cladocera													
#/m^3		193.68	13.41	5.36	88.50	117.99	876.91	233.31	1395.82	244.03	450.52	1133.11	432.05
± S.D.	-	± 21.07	± 11.38	± 7.58	37.92	± 22.75	± 352.70	± 219.96	± 297.71			± 142.22	± 123.70
Adult Copepoda													
#/m^3	-	1325.94	172.97	17.43	104.59	100.56	335.21	104.59	155.54	40.23	83.13	107.27	231.59
± S.D.	-	± 105.35	± 43.61	± 9.48	± 49.30	± 54.99	± 121.36	± 83.43	± 7.58			± 18.96	± 54.90
Nauplii													
#/m^3		5393.16	442.48	1.34	59.00	24.14	41.57	77.77	24.14	8.05	0.0	0.0	551.97
± S.D.	-	± 294.97	± 30.34	± 1.90	± 56.89	± 11.38	± 17.07	± 18.96	± 0.0				± 53.94
Total Zooplankton													
#/m^3	-	6912.79	628.85	24.13	252.09	249.39	1260.39	417.01	1582.20	292.31	533.65	1240.28	1217.6
± S.D.	-	±421.39	±85.33	±18.96	±144.11	±94.81	±496.82	±324.25	±310.98	±0.0	±0.0	±161.18	±228.7

- represents no samples were collected).

Table 6. Mean monthly density values (#/m^3) and standard deviations of different categories of zooplankton at Seven Bays (Index Station 6) in 1993.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Daphnia spp.													
#/m^3		25.48	5.36	9.39	607.40	1104.85	2957.00	8194.03		1182.62	-	16.09	1566.91
± S.D.	-	± 5.69	± 3.79	± 13.27	± 36.03	± 60.68	± 2771.03	± 1390.57		-		± 7.58	± 536.08
Leptodora													
#/m^3	-	0.0	0.0	0.0	0.0	42.91	0.0	74.49		0.0		0.0	13.04 ±
S.D.	-	-		-		± 11.38		± 21.07	-		-		± 16.23
Cladocera													
#/m^3		25.48	5.36	9.39	611.42	1153.12	2988.14	8268.53		1185.30		16.09	1584.76
± S.D.	-	± 5.69	± 3.79	± 13.27	± 41.72	± 72.06	±2811.28	± 1369.50				± 7.58	± 540.61
Adult Copepoda													
#/m^3		122.02	87.15	20.11	305.71	281.58	174.66	387.35	-	337.89	-	12.07	192.04
± S.D.		± 17.07	± 5.69	± 1.90	± 3.79	± 94.81	±174.66	± 84.28			-	± 5.69	± 48.49
Nauplii													
#/m^3	-	540.36	533.66	61.68	79.11	32.18	62.27	864.10		0.0	-	0.0	241.48
± S.D.	-	± 32.24	± 41.72	± 22.75	± 36.03	± 30.34	± 80.48	± 210.69			-		± 64.89
Total Looplankton													
#/m^3	-	687.86	626.17	91.18	996.25	1509.79	3224.87	9594.47	-	1523.19	-	28.16	2031.33
± S.D.	-	±55.00	±51.20	±37.92	±81.54	±208.59	±3066.42	±1685.54		-		±13.27	±649.94

- represents no samples were collected).

Table 7. , Mean monthly density values (#/m^3) and standard deviations of different categories of zooplankton at Spring Canyon (Index Station 9) in 1993.

Taxon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean
Daphnia spp.													
#/m^3	-	5.36	4.02	6.70	13.41	1906.98	494.77	1358.27	1296.59	18.77	41.57	201.13	486.14
± S.D.	-	± 7.58	±69	±90	± 3.79	± 42.14	±263.58	± 290.12	± 168.77	± 15.17	± 13.27	± 30.34	± 76.58
Leptodora													
#/m^3	-	0.0	1.34	0.0	0.0	89.39	0.0	0.0	0.0	0.0	0.0	0.0	8.25
± S.D.		-	± 1.90			± 42.14							± 22.02
Cladocera													
#/m^3	-	5.36	5.36	6.70	13.41	1996.36	494.77	1358.27	1297.94	22.79	41.57	201.13	494.88
± S.D.	-	± 7.58	± 7.58	±90	± . 7 9	± 84.28	±263.58	± 290.12	± 170.66	± 9.48	± 13.27	± 30.34	± 80.23
Adult Copepoda													
#/m^3	-	164.92	300.35	42.91	162.24	2562.50	305.71	256.10	266.83	21.45	29.50	41.57	377.64
± S.D.	-	± 32.24	± 72.06	18.96	± 28.44	± 42.14	±257.89	± 130.84	± 127.05	± 3.79	± 11.38	± 13.27	± 67.10
Nauplii													
#/m^3		1318.05	788.42	40.23	63.02	1102.47	4.02	13.41	9.39	6.70	0.0	0.0	304.16
± S.D.		± 77.75	64.47	± 15.17	± 17.07	± 294.97	±1.90	± 7.58	± 13.27	± 1.90			± 54.90
Total Zooplankton													
#/m^3	-	1488.33	095.47	89.84	238.67	5750.72	804.51	1627.78	1574.15	50.94	71.06	242.69	1184.93
± S.D.	-	±117.57	±146.01	±36.03	±49.30	:463.53	±519.6	:428.54	±310.98	±15.17	±24.65	±43.61	±196.25

- represents no samples were collected).

The reservoir experienced two peaks of *daphnia* spp. densities. The first peak occurred between January and March due to nutrients and stable water retention times. The second peak occurred between May and October as the reservoir was filling which provided a large quantity of nutrients for phytoplankton which increased the forage base for zooplankton. There was a considerable difference in densities of zooplankton among the areas (Figures 4 and 5). Highest recorded *daphnia* spp. was 8,194/m^3 at Seven Bays in August. Seven Bays also had the highest total zooplankton density in August at 9564/m^3. The higher density values at the lower end of the reservoir may be explained by the flushing of water through the reservoir.

Figures 6 and 7 show water retention times and densities for the past three years at Porcupine Bay and Seven Bays. At Porcupine Bay, in 1991 densities in spring peaked dramatically while the water retention times remained low.

Declining pool elevation and large releases from the dam may cause extreme downstream loss of zooplankton. When zooplankton are circulated deep into the water column, deep drawdowns in the winter should increase the downstream loss of this valuable fish food resource.

Zooplankton Biomass

Monthly mean biomass (mg/m^3) values of microcrustacean zooplankton collected at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon are shown in Tables 8 through 11. Mean biomass/species for each location can be found in Appendix B. Total zooplankton biomass at Gifford averaged 7.14 mg/m^3 for the year, Total zooplankton biomass at Porcupine Bay averaged 8.18 mg/m^3 for the year. Total zooplankton biomass at Seven Bays averaged 50.09 mg/m^3 for the year. Total zooplankton biomass at Spring Canyon averaged 16.01 mg/m^3 for the year.

Zooplankton Lengths

Monthly mean lengths (mm) of microcrustacean zooplankton collected at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon are shown in Tables 12 through 15. Length ranges and mean lengths/species for each location are located in Appendix B.

Yearly mean lengths of cladocera at Gifford are: Daphnia *galeata mendbtae* - 1.09 *mm; Daphnia retrocurva* - 1.29 *mm; Daphnia schødleri* - 1.06 *mm; Daphnia thorata* - 1.26

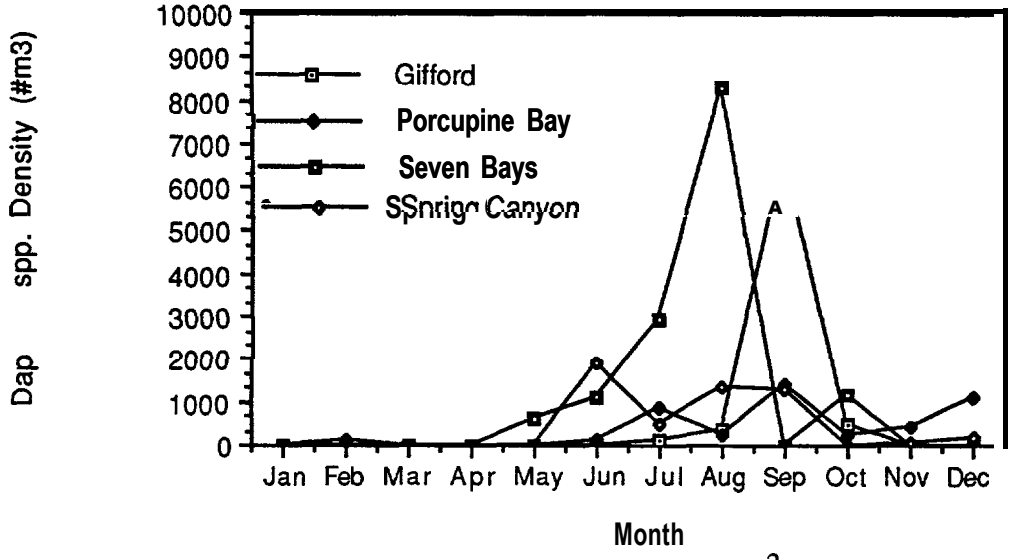


Figure 4. Mean monthly *Daphnia* spp. density (#m^3) at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon in 1993.

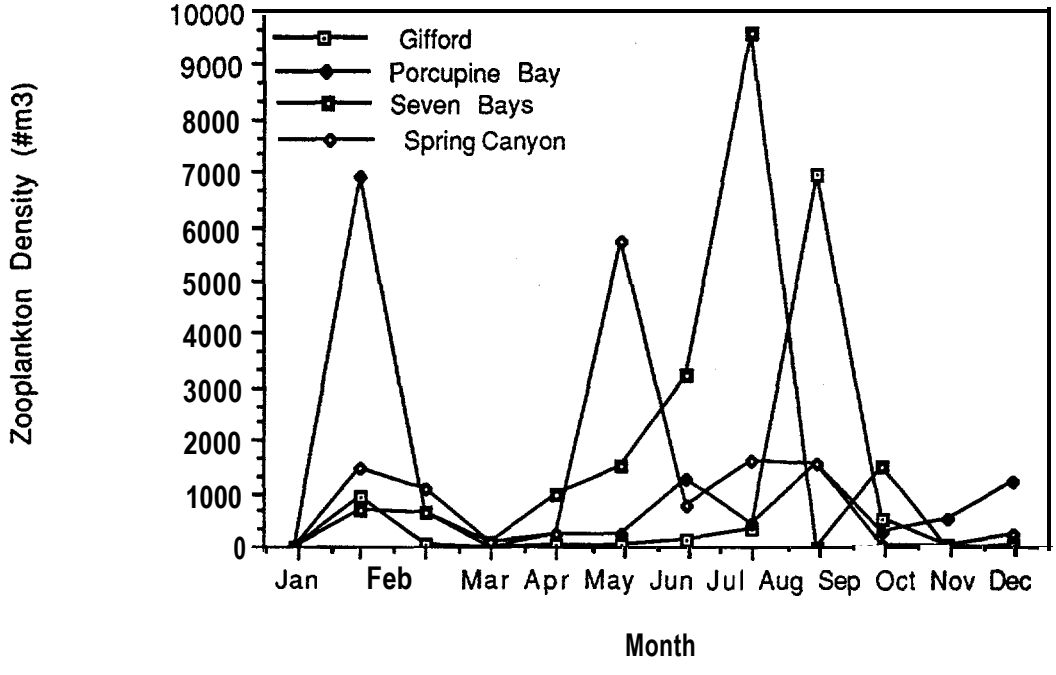


Figure 5. Mean monthly zooplankton density (#m^3) at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon in 1993.

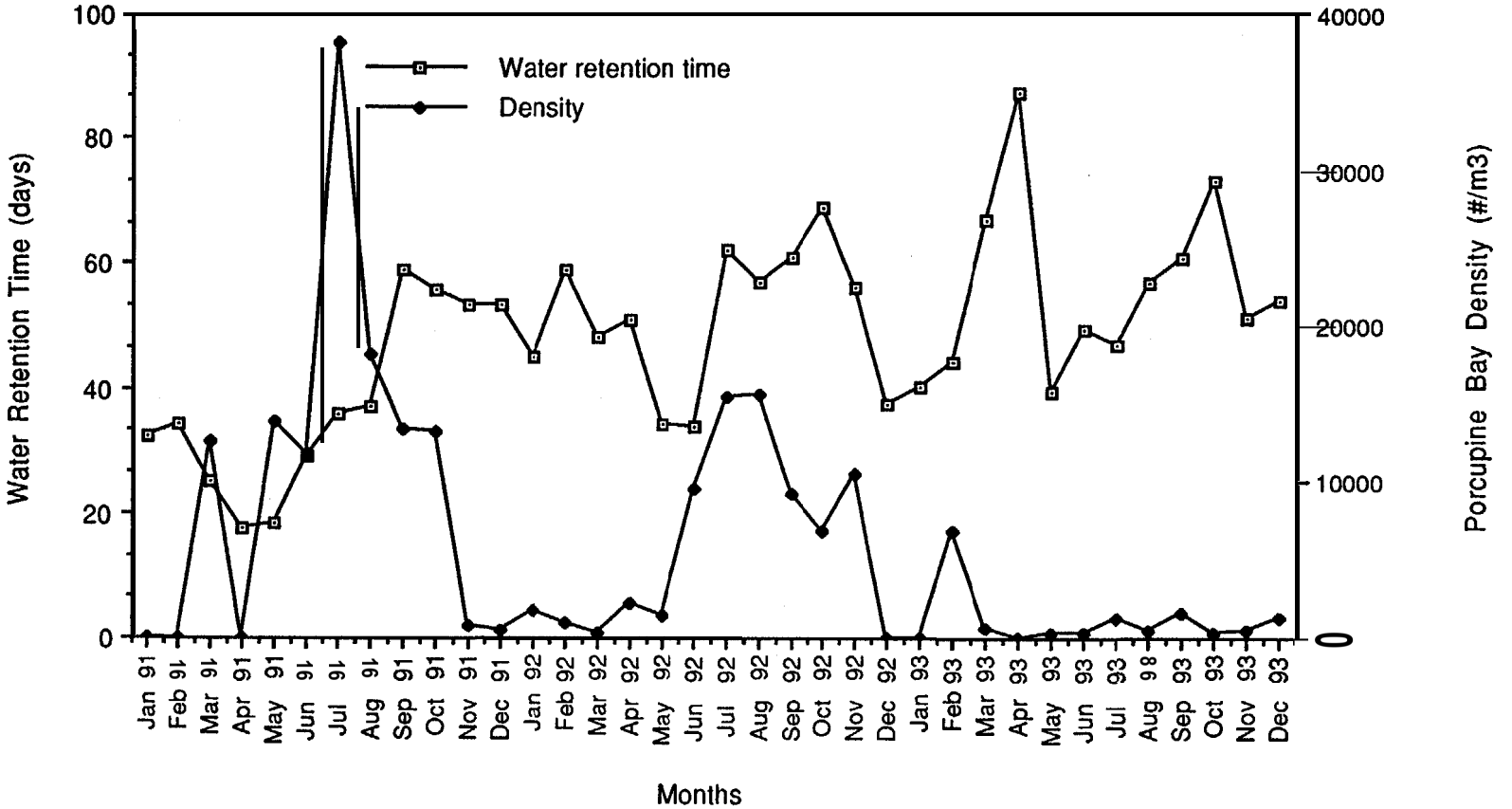


Figure 6. Density and water retention times at Porcupine Bay from 1991 through 1993.

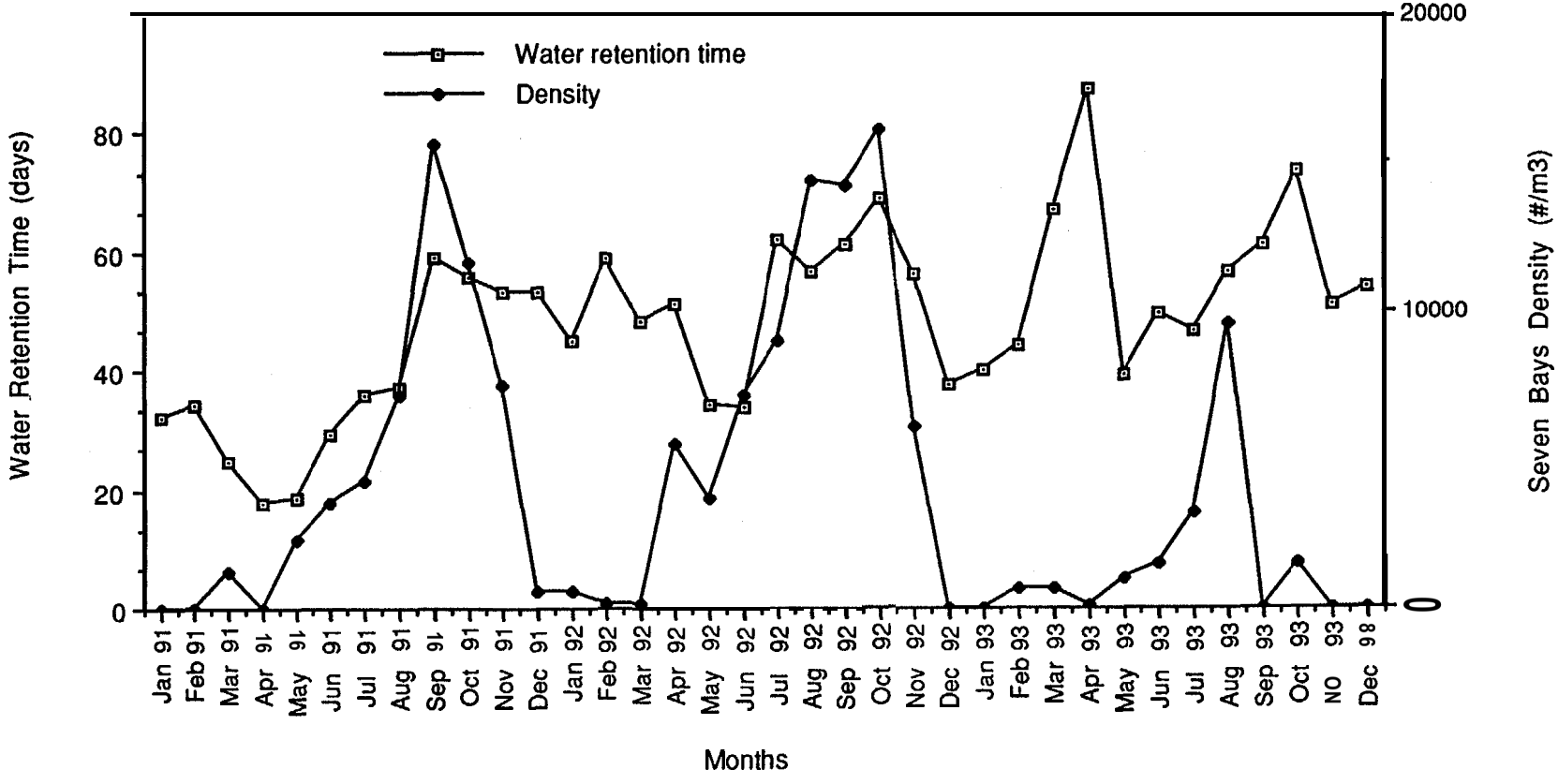


Figure 7. Density and water retention times at Seven Bays from 1991 through 1993.

Table 8. Mean monthly biomass values **(mg/m^3)** of different Cladocera at Gifford (Index Station 2) in 1993.

	Daphnia spp. µg/m^3	*Leptodora kindti* µg/m^3	Total Cladocera µg/m^3
Jan.	-	-	-
Feb.	-	-	-
Mar.	0.004	0.0	0.004
Apr.	-	-	-
May	0.092	0.0	0.092
Jun.	0.257	0.355	0.613
Jul.	1.054	0.0	1.054
Aug.	1.570	0.0	1.570
Sep.	56.368	0.963	57.331
Oct.	10.244	0.0	10.244
Nov.	0.536	0.0	0.536
Dec.	-	-	-
Yearly Mean	**7.013**	**0.132**	**7.144**

Table 9. Mean monthly biomass values **(mg/m^3)** of different Cladocera at Porcupine Bay (Index Station **4**) in 1993.

	Daphnia spp. µg/m^3	*Leptodora kindti* µg/m^3	Total Cladocera µg/m^3
Jan.	-	-	-
Feb.	1.198	0.0	1.198
Mar.	0.084	0.0	0.084
Apr.	0.039	0.0	0.039
May	0.135	0.0	0.135
Jun.	0.721	0.184	0.904
Jul.	13.471	0.532	14.002
Aug.	1.869	0.011	1.880
Sep.	15.379	0.228	15.607
Oct.	13.146	0.0	13.146
Nov.	19.040	0.0	19.040
Dec.	23.971	0.0	23.971
Yearly Mean	**8.096**	**0.087**	**8.182**

(- represents no samples were collected).

Table 10. Mean monthly biomass values **(mg/m^3)** of different Cladocera at Seven Bays (Index Station 6) in 1993.

	Daphnia spp. µg/m^3	*Leptodora kindti* µg/m^3	Total Cladocera µg/m^3
Jan.	-	-	-
Feb.	0.319	0.0	0.319
Mar.	0.139	0.0	0.139
Apr.	0.027	0.0	0.027
May	10.132	0.0	10.132
Jun.	18.112	1.307	19.419
Jul.	31.059	0.0	31.059
Aug.	294.987	3.361	298.348
Sep.	-	-	-
Oct.	41.472	0.0	41.475
Nov.	-	-	-
Dec.	0.149	0.0	0.149
Yearly Mean	**49.51**	**0.58**	**50.09**

Table 11. Mean monthly biomass values **(mg/m^3)** of different Cladocera at Spring Canyon (Index Station 9) in 1993.

	Daphnia spp. µg/m^3	*Leptodora kindti* µg/m^3	Total Cladocera µg/m^3
Jan.	-	-	-
Feb.	0.038	0.0	0.038
Mar.	0.018	0.0	0.018
Apr.	0.103	0.0	0.103
May	0.262	0.0	0.262
Jun.	83.965	16.026	99.991
Jul.	6.695	0.0	6.695
Aug.	26.066	0.0	26.066
Sep.	36.077	0.0	36.077
Oct.	0.426	0.0	0.426
Nov.	1.143	0.0	0.143
Dec.	5.334	0.0	5.334
Yearly Mean	**14.56**	**1.46**	**16.01**

(- represents no samples were collected).

Table 12. Mean monthly size values (mm) (± S.D.) of different Cladocera species at Gifford (Index Station 2) in 1993.

	D. galeata mendotae (mm)	*Daphnia retrocurva* (mm)	*Daphnia schødleri* (mm)	*Daphnia thorata* (mm)	*Leptodora kindti* (mm)
Jan.	-	-	-	-	-
± S.D.	-	-	-	-	-
Feb.	-	-		-	-
± S.D.	-	-	-	-	-
Mar.	1.40	-	-	-	-
± S.D.	-	-	-	-	-
Apr.	-	-	-	-	-
± S.D.	-	-		-	-
May	-	-	0.73	-	-
± S.D.	-	-	0.17	-	-
Jun.	0.95	0.98	1.06	0.90	11.00
± S.D.	± 0.21	-	± 0.29	0.0	-
Jul.	0.93	1.14	0.94	1.41	-
± S.D.	± 0.05	± 0.23	± 0.21	± 0.27	-
Aug.	0.71	-	0.79	-	-
± S.D.	± 0.08	-	± 0.17	-	-
Sep.	0.99	1.64	1.07	1.35	5.00
± S.D.	± 0.16	± 0.17	± 0.22	± 0.31	-
Oct.	1.40	1.46	1.42	1.38	-
± S.D.	± 0.25	± 0.0	± 0.19	± 0.27	-
Nov.	1.27	-	1.42	-	-
± S.D.	± 0.47	-	± 0.44	-	-
Dec.	-	-	-	-	-
± S.D.	-	-	-	-	-
Yearly Mean	**1.09**	**1.29**	**1.06**	**1.26**	**8.0**

(- indicates no data were obtained due to lack of sample or organisms in sample.)

Table 13. Mean monthly size values (mm) (± S.D.) of different Cladocera species at Porcupine Bay (Index Station 4) in 1993.

	D. galeata mendotae (mm)	*Daphnia retrocurva* (mm)	*Daphnia schødleri* (mm)	*Daphnia thorata* (mm)	*Leptodora kindti* (mm)
Jan. ± S.D.					
Feb. ± S.D.			0.93 ± 0.14		
Mar. ± S.D.	1.18 ± 0.13	-	0.82 ± 0.0	1.20 ± 0.0	
Apr. ± S.D.			0.90 ± 0.12		
May ± S.D.	1.08 ± 0.24	1.04 ± 0.12	0.95 ± 0.10	1.22 ± 0.0	
Jun. ± S.D.	1.05 ± 0.14	1.11 ± 0.29	1.06 ± 0.18	1.16 ± 0.0	4.70 ± 2.20
Jul. ± S.D.	1.60 ± 0.42	1.37 ± 0.38	1.33 ± 0.35	1.33 ± 0.36	7.00 ± 2.83
Aug. ± S.D.	0.82 ± 0.11	1.29 ± 0.31	0.92 ± 0.13	1.00 ± 0.0	3.00 ± 0.0
Sep. ± S.D.	1.10 ± 0.45	1.70	1.01 ± 0.32	1.63 ± 0.18	5.10 ± 1.88
Oct. ± S.D.			1.72 ± 0.45	1.15 ± 0.14	
Nov. ± S.D.	1.60 ± 0.20		1.60 ± 0.38	1.59 ± 0.46	
Dec. ± S.D.		1.09 ± 0.19	1.26 ± 0.40	1.28 ± 0.28	
Yearly Mean	1.20	1.27	1.14	1.28	4.95

(- indicates no data were obtained due to lack of sample or organisms in sample.)

Table 14. Mean monthly size values (mm) (± S.D.) of different **Cladocera** species at Seven Bays (Index Station 6) in **1993.**

	D. galeata mendotae (mm)	*Daphnia retrocurva* (mm)	*Daphnia schødleri* (mm)	*Daphnia thorata* (mm)	*Leptodora kindti* (mm)
Jan. ± S.D.	- -	- -	- -	- -	- -
Feb. ± S.D.	- -	- -	1.08 ± 0.22	- -	- -
Mar. ± S.D.	- -	- -	1.36 ± 0.14	- -	- -
Apr. ± S.D.	0.78 0.05	- -	0.75 ± 0.13	- -	- -
May ± S.D.	0.88 ± 0.11	- -	1.18 ± 0.35	- -	- -
Jun. ± S.D.	1.03 ± 0.17	0.82 ± 0.05	1.18 ± 0.46	- -	4.89 ± 2.31
Jul. ± S.D.	1.11 ± 0.24	1.31 ± 0.42	1.02 ± 0.37	1.50 ± 0.10	- -
Aug. ± S.D.	1.30 ± 0.13	- -	1.52 ± 0.50	1.64 ± 0.53	5.67 ± 0.71
Sep. ± S.D.	0.90 ± 0.10	- -	1.20 ± 40	0.90 ± 0.20	- -
Oct. ± S.D.	1.10 ± 0.20	- -	1.40 ± 0.30	- -	- -
Nov. ± S.D.					
Dec. ± S.D.	1.10 ± 0.32	1.33 ± 0.32	1.47 ± 0.41	1.64 ± 0.54	
Yearly Mean	1.03	1.15	1.22	1.42	5.28

(- indicates no data were obtained due to lack of sample or organisms in sample.)

Table 15. Mean monthly size values (mm) (± S.D.) of different Cladocera species at Spring Canyon (Index Station 9) in 1993.

	D. galeata mendotae (mm)	*Daphnia retrocurva* (mm)	*Daphnia schødleri* (mm)	*Daphnia thorata* (mm)	*Leptodora kindti* (mm)
Jan.	-	-	-	-	-
± S.D.	-	-	-	-	-
Feb.	-	-	0.90	-	-
± S.D.	-	-	± 0.27	-	-
Mar.	-	-	0.77	-	-
± S.D.	-	-	±0.06	-	-
Apr.	-	-	1.15	-	-
± S.D.	-	-	±0.25	-	-
May	-	-	1.24	-	-
± S.D.	-	-	± 0.21	-	-
Jun.	-	-	1.62	1.24	9.50
± S.D.	-	-	± 0.38	-	± 3.66
Jul.	1.12	1.14	1.11	-	-
± S.D.	-	± 0.23	± 0.33	-	-
Aug.	1.02	-	1.24	1.48	-
± S.D.	± 0.14	-	± 0.38	± 0.38	-
Sep.	1.24	-	1.40	1.20	-
± S.D.	± 0.46	-	± 0.38	-	-
Oct.	1.63	1.09	0.89	2.24	-
± S.D.	± 0.29	± 0.13	± 0.20	-	-
Nov.	-	1.45	1.40	-	-
± S.D.	-	± 0.30	± 0.37	-	-
Dec.	-	-	1.37	-	-
± S.D.	-	-	± 0.37	-	-
Yearly Mean	**1.25**	**1.23**	**1.19**	**1.54**	**9.50**

(- indicates no data were obtained due to lack of sample or organisms in sample.)

mm, and; Leptodora kindti - 8.00 mm. Yearly mean lengths of cladocera at Porcupine Bay are: Daphnia galeata *mendotae* - 1.20 mm; *Daphnia retrocurva* - 1.27 mm; *Daphnia schødleri* - 1.14 *mm; Daphnia thorata* - 1.28 mm, and; *Leptodora kindti* - *4.95 mm.* Yearly mean lengths of cladocera at Seven Bays are: Daphnia *galeata mendotae* - 1.03 mm; *Daphnia retrocurva* - 1.15 *mm; Daphnia schødleri* - 1.22 *mm; Daphnia thorata* - 1.42 *mm, an&, Leptodora kindti* - 5.28. mm. Yearly mean lengths of cladocera at Spring Canyon are: Daphnia *galeata mendotae* - 1.25 mm; *Daphnii retrocurva* - 1.23 mm; *Daphnia schødleri* - 1.19 mm; *Daphnia thorata* - 1.54 mm, and; *Leptodora kindti* - *9.50.* mm.

MACROINVERTEBRATES

Methods

Quantitative samples of benthic macroinvertebrates were collected using a Ponar dredge with a 0.053 m opening. Benthos were collected from March through September at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon. Three replicate samples were taken from each of the following reservoir elevations at each station: area 1 - below elevation 1,210 ft; area 2 - 1,240 to 1,211 ft; and area 3 - 1,290 ft (full pool) to 1,241 ft.

Benthic samples were sub-sampled. Grab mixtures were stirred, allowed to settle, and top water poured off through a series of U.S. Standard sieves that measured 4 mm, 2 mm, and 0.5 mm. Material that remained on the final screen was retained and preserved in 10% formalin solution, labeled "top water" and later transferred to 70% alcohol. The remaining grab was weighed. If weight of the remaining sample was less than 1 kg the entire sample was filtered through the sieves and preserved. If the sample was greater than 1 kg three sub-samples of 10% by weight were taken. Each sub-sample was filtered through the series of sieves, labeled accordingly and preserved in the same manner.

Organisms were sorted and identified to family using the taxonomic keys of Brooks (1957), Ward and Whipple (1966), Borror *et al.* (1976), Ruttner-Kolisko (1974), Edmonds *et al.* (1976), Wiggins (1977), Pennak (1978;1989), and Merritt and Cummins (1984).

The average weight of a single organism for each species was determined on a yearly basis to obtain wet weight values. Yearly figures were used instead of monthly due to the lack of variance in data between 1992 and 1993. Excess moisture was removed from each organism and the organism was weighed to the nearest 0.0001 g using a Sartorius Model H51 analytical balance (Weber 1973, APHA 1976). Monthly values were used in weight calculations.

Number and weight values obtained were converted to densities and expressed in number/m2 and grams/m2. Number and weight density values were averaged for each season to obtain seasonal means and seasonal percent occurrence. Mean seasonal data were averaged to obtain unbiased annual means.

Emerging benthic macroinvertebrates were sampled with a square meter emergence

trap constructed of 1/4 inch thick fiberglass (Figure 8). Styrofoam strips were attached to the bottom of the trap for flotation and the trap was anchored to a five gallon bucket filled with concrete. Holes were cut in each side of the trap and the top of the catch basin to reduce condensation problems and allow for evaporation on the inside of the trap. Holes were covered with cloth. This trap is a modification of emergence traps used by May *et. al* (1988) on Hungry Horse Reservoir. Traps were set from June to October at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon. At each location, one trap was placed in near shore areas at water depths less than 15 m at full pool. These areas were dewatered annually during the study. A second trap was placed at each location in offshore areas at water depths greater than 15 to 26 m below full pool. A third trap was placed in offshore areas at water depths greater than 26 m below full pool. Traps were filled with anti-freeze to preserve insects and checked twice each month. All insects were sorted, identified to order and counted.

Number values obtained were converted to density and expressed as number/m^2. Number density values were averaged for each season to obtain seasonal means and seasonal percent occurrence. Mean seasonal data were averaged to obtain unbiased annual means.

Resuits and Discussion

Ben thos

A total of 10 benthic macroinvertebrate families from 7 orders were found in the substrate samples from Lake Roosevelt. Tables 16 through 19 show the mean benthic macroinvertebrate number and weight densities from Gifford, Porcupine Bay, Seven Bays, and Spring Canyon from March to October 1993.

At depths of 26 m or greater at full pool (area 1), mean benthic macroinvertebrate densities and weights at Gifford were consistently composed of midges and worms in all sampling. In areas 2 (15 - 26 m) and area 3 (less that 15 m) caddis flies and other were observed while midges and worms represented the majority. At Porcupine Bay, areas 1, 2, and 3 were primarily comprised of midges and worms. As at Gifford, the closer to shore, more diverse organisms were found. Seven Bays and Spring Canyon both have highest densities of worms and midges in the deeper waters, while more caddis flies and scuds were collected in the deeper areas at Seven Bays as compared to Spring Canyon where scuds were more prevalent than caddisflies or other. Snails were only found in the deepest areas of Spring Canyon and Porcupine Bay.

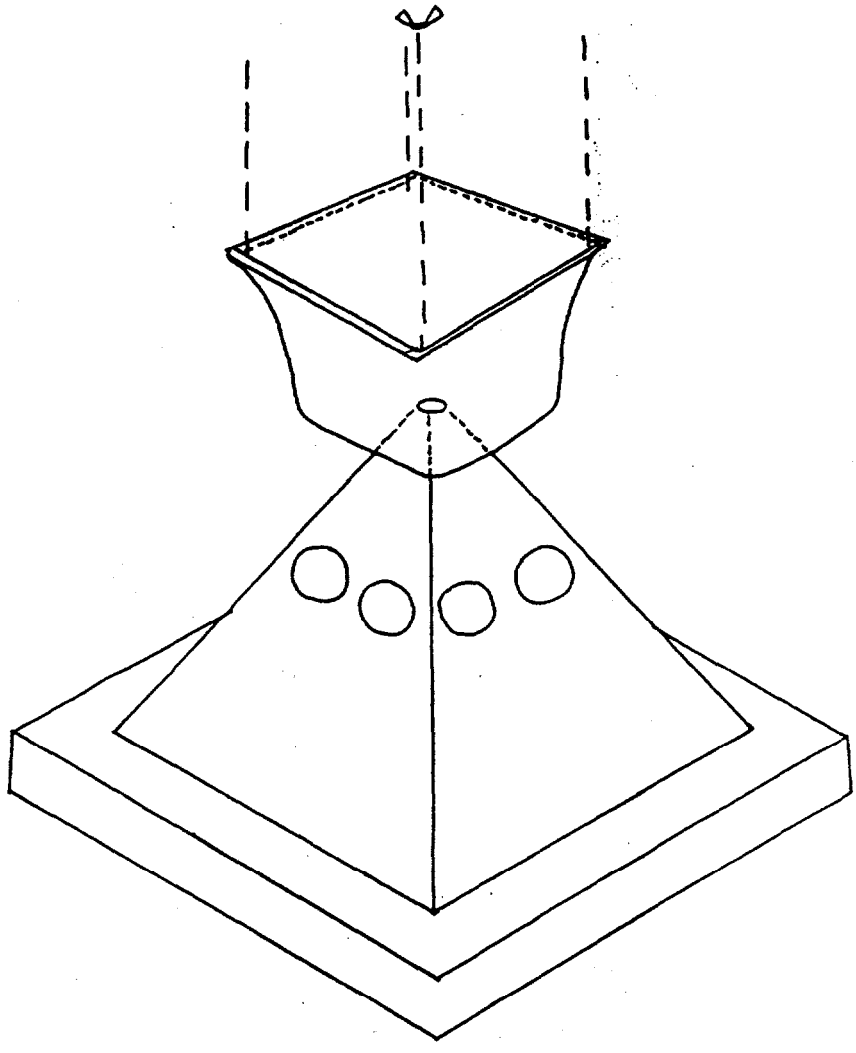


Figure 8. Benthic macroinvertebrate emergence trap used on Lake Roosevelt.

Table 16. Mean number (#/m^2) and weight (g/m^2) density values for groups of benthic organisms at Gifford sampling locations on Lake Roosevelt,- WA in 1993.

	SNAILS		CLAMS		MIDGES		CADDISFLIES		WORMS		SCULPINS		OTHER	
	No.	wt.	No.	wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	wt.	No.	Wt.
Prea 1														
May	0.00	0.000	0.00	0.000	273.58	0.827	18.9	0.052	141.51	0.057	0.00	0.000	22.01	0.002
July	0.00	0.000	0.00	0.000	110.06	0.298	0.00	0.000	267.30	0.118	0.00	0.000	0.00	0.000
August	0.00	0.000	0.00	0.000	251.57	0.679	0.00	0.000	119.50	0.028	0.00	0.000	0.00	0.000
September No samples									-		-			
Area 2														
May	0.00	0.000	0.00	0.000	886.79	2.247	34.59	0.014	0.00	0.000	0.00	0.000	761.01	0.037
July	0.00	0.000	0.00	0.000	132.08	1.169	0.00	0.000	204.40	0.720	0.00	0.000	0.00	0.000
August	0.00	0.000	0.00	0.000	179.25	1.302	0.00	0.000	163.52	0.065	0.00	0.000	12.58	0.001
September	0.00	0.000	0.00	0.000	377.36	1.019	44.03	0.085	31.45	0.013	0.00	0.000	0.00	0.000
Area 3														
May	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
July	0.00	0.000	0.00	0.000	179.25	0.492	0.00	0.000	182.39	0.063	9.43	0.026	28.30	0.028
August	0.00	0.000	0.00	0.000	498.95	1.531	8.39	0.001	69.18	0.028	0.00	0.000	6.29	0.001
September	0.00	0.000	0.00	0.000	798.74	2.157	9.43	0.004	72.33	0.029	22.01	0.059	0.00	0.000

Table 17. , Mean number (#/m^2) and weight (g/m^2) density values for groups of benthic organisms at Porcupine Bay sampling locations on Lake Roosevelt, WA in 1993.

	SNAILS		CLAMS		MIDGES		ADDISFLIES		WORMS		SCUDS		OTHER	
	No.	wt.	No.	wt.	No.	wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Area 1														
May	0.00	0.000	0.00	0.000	40.88	0.110	0.00	0.000	9.43	0.004	0.00	0.000	0.00	0.000
July	0.00	0.000	0.00	0.000	254.72	0.688	0.00	0.000	235.85	0.109	0.00	0.000	0.00	0.000
August	0.00	0.000	0.00	0.000	358.49	0.974	0.00	0.000	125.79	0.048	28.30	0.076	0.00	0.000
September	12.58	0.026	0.00	0.000	317.61	0.858	0.00	0.000	3.14	0.001	654.09	1.970	0.00	0.000
Area 2														
May	0.00	0.000	0.00	0.000	37.74	0.106	9.43	0.009	18.87	0.008	0.00	0.000	0.00	0.000
July	0.00	0.000	0.00	0.000	31.00	0.469	0.00	0.000	59.75	0.024	56.60	0.088	0.00	0.000
August	0.00	0.000	0.00	0.000	664.65	1.741	0.00	0.000	18.87	0.008	40.88	0.110	0.00	0.000
September	0.00	0.000	0.00	0.000	279.87	0.756	0.00	0.000	40.88	0.016	0.00	0.000	0.00	0.000
Area 3														
May	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
July	0.00	0.000	0.00	0.000	327.04	1.271	0.00	0.000	22.01	0.009	12.58	0.034	0.00	0.000
August	0.00	0.000	0.00	0.000	47.17	0.127	0.00	0.000	9.43	0.004	0.00	0.000	6.29	0.001
September	0.00	0.000	0.00	0.000	37.74	0.102	0.00	0.000	25.16	0.010	0.00	0.000	0.00	0.000

Table 18. Mean number (#/m^2) and weight (g/m^2) density values for groups of benthic organisms at Seven Bays sampling locations on Lake Roosevelt, WA in 1993.

	SNAILS		CLAMS		MIDGES		CADDISFLIES		WORMS		SCUDS		OTHER	
	No.	wt.	No.	wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	wt.	No.	Wt.
4rea 1														
May	0.00	0.000	0.00	0.000	78.62	0.217	9.43	0.009	22.01	0.009	28.30	0.076	0.00	0.000
July	0.00	0.000	0.00	0.000	383.65	1.041	0.00	0.000	69.18	0.028	88.05	0.238	0.00	0.000
August	0.00	0.000	0.00	0.000	402.52	1.087	22.01	0.023	323.90	0.130	719.68	1.936	0.00	0.000
September	0.00	0.000	0.00	0.000	27.25	0.074	6.29	1.209	0.00	0.000	56.60	0.153	0.00	0.000
Area 2														
May	0.00	0.000	0.00	0.000	364.78	0.990	9.43	0.009	276.73	0.112	160.38	0.433	0.00	0.000
July	0.00	0.000	0.00	0.000	795.60	2.101	0.00	0.000	3.14	0.001	358.49	0.968	0.00	0.000
August	0.00	0.000	0.00	0.000	160.38	0.437	9.43	0.009	0.00	0.000	254.72	0.688	0.00	0.000
September	0.00	0.000	0.00	0.000	14.68	0.040	0.00	0.000	0.00	0.000	115.30	0.311	0.00	0.000
Area 3														
May	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
July	0.00	0.000	0.00	0.000	248.43	0.675	0.00	0.000	12.58	0.005	28.30	0.076	0.00	0.000
August	0.00	0.000	0.00	0.000	69.18	0.187	9.43	0.009	9.43	0.004	3.14	0.009	0.00	0.000
September	0.00	0.000	0.00	0.000	18.87	0.051	0.00	0.006	0.00	0.000	18.87	0.051	0.00	0.000

Table 19. Mean number (#/m^2) and weight (g/m^2) density values for groups of benthic organisms at Spring Canyon sampling locations on Lake Roosevelt, WA in 1993.

	SNAILS		CLAMS		MIDGES		CADDI	FLIES	WORMS		SC'	DS	OTHER	
	No.	wt.	No.	wt.	No.	wt.	No.	Wt.	No.	wt.	No.	wt.	No.	Wt.
Area 1														
May	9.43	0.020	0.00	0.000	286.16	0.773	0.00	0.000	194.97	0.078	150.94	0.408	0.00	0.000
July	0.00	0.000	0.00	0.000	100.63	0.273	0.00	0.000	44.03	0.018	0.00	0.000	0.00	0.000
August	0.00	0.000	0.00	0.000	58.70	0.159	6.29	0.006	58.70	0.024	69.18	0.187	0.00	0.000
September	0.00	0.000	0.00	0.000	270.44	0.730	8.39	0.008	23.06	0.002	0.00	0.000	0.00	0.000
Area 2														
May	0.00	0.000	0.00	0.000	28.30	0.076	0.00	0.000	37.74	0.015	0.00	0.000	0.00	0.000
July	0.00	0.000	0.00	0.000	94.34	0.262	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
August	0.00	0.000	0.00	0.000	106.92	0.291	0.00	0.000	117.40	0.047	20.96	0.057	2.10	<0.001
September	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	26.03	0.002	6.29	0.017	0.00	0.000
Area 3														
May	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
July	0.00	0.000	0.00	0.000	48.22	0.335	0.00	0.000	40.88	0.016	50.31	0.013	0.00	0.000
August	0.00	0.000	0.00	0.000	48.22	0.141	0.00	0.000	14.68	0.005	31.45	0.056	0.00	0.000
September	0.00	0.000	0.00	0.000	62.80	0.170	6.29	0.006	12.58	0.001	18.87	0.051	0.00	0.000

Emergence

A total of 2 benthic macroinvertebrate orders were found in emergence traps located at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon in June and July. Table 20 shows the number and annual mean of benthic macroinvertebrates collected in emergence traps.

Twelve emergence traps were set in June throughout the reservoir at sites designated. However six traps were substantially damaged and pulled from the reservoir or lost within the reservoir by the end of July. On several occasions traps were damaged or vandalized, and all antifreeze and any emerged benthics were lost. June and July were the only months that any emergence were found in these traps and vandalism did not occur. Seven Bays is the only site which all three traps were functioning in June and July. Diptera were collected in all three areas in both months, and had an emergence number of $69/m^2$. At ail other locations, diptera were observed. Order Odonata was collected from area 2 (depths between 15 and 26 m) at Seven Bays. Only one organism was collected out of the six traps. Warmer temperature in the shallow zones relative to the deeper zones may account for the high rates of emergence there. Oliver (197 1) stated that larvae mature faster in warmer water. As in Libby Reservoir, the potential for a continued supply of dipterans throughout the warmer months is high. However due to water level fluctuations, the full potential of the shallow zone will never be realized because of the reduction in wetted substrate (Chisholm, et al. 1983-87).

Table 20. Mean number (#/m^2) density values for groups of benthic organisms captured in emergence traps located at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon, Lake Roosevelt, WA in 1993.

	June	July
Location Gifford		
Area 1		
Diptera (midges)	17	0
Odonata (dragonflies)	0	0
Annual mean for all benthics ± s.d.	1 7 f 0	-
Location Porcupine Bay		
Area 1		
Diptera (midges)	0	4
Odonata (dragonflies)	0	0
Annual mean for all benthics ± s.d.		4.0 ± 0
Location Seven Bays		
Area 1		
Diptera (midges)	22	9
Odonata (dragonflies)	0	0
Location Seven Bays		
Area 2		
Diptera (midges)	116	18
Odonata (dragonflies)	1	0
Location Seven Bays		
Area 3		
Diptera (midges)	0	28
Odonata (dragonflies)	0	0
Annual mean for all benthics ± s.d.	46.3 ± 61.2	18.3 ± 9.5
Location Spring Canyon		
Area 1		
Diptera (midges)	31	0
Odonata (dragonflies)	0	0
Annual mean for all benthics ± s.d.	31.0 ± 0	

EXPERIMENTAL TRAWLING

Methods

The Idaho Department of Fish and Game in conjunction with the Spokane Tribe of Indians trawled Lake Roosevelt in August to determine if trawling was a suitable methodology to estimate kokanee (*Oncorhynchus nerka*) densities in the reservoir (Maiolie and Elam, 1993). Oblique tows of a Hauser types mid-water trawl were used to obtain density estimates and representative samples of fish. An 8.5 m, 140 horsepower diesel engine boat towed a 13.7 m long trawl net with a 3 m by 3 m mouth. Mesh sizes (stretch measure) graduated from 32 mm to 25 mm to 19 mm to 13 mm in the body of the net and terminated in a 6 mm mesh cod end. Rieman (1992) presented a detailed description of the methodology.

Trawling was conducted after dark during the new moon phase to optimize capture efficiency (Bowler et al. 1979). Net towing speed was standardized at 1.5 m/s. Depth of the net was determined for each 15.2 m distance of tow cable and checked annually. Kokanee distribution is determined using a Raytheon Model V860 depth sounder with a 20 degree transducer. Step-wise oblique net tows were made from depths of 34.4 m to a minimum depth of 3.4 m. The trawl net was pulled for 3 minutes in each "step", sampling 2,832 m^3 of water over a distance of 315 m, at boat speed of 1.5 m/s. The net was then raised 3 m and sampling continued for another 3 min. The time it took to readjust the net between steps and the time the net was sampling while initially setting the net was also entered into density estimates (approximately 30 seconds between sublayers while raising and lowering the net).

Eight trawls from the buoys in front of Grand Coulee Dam upstream for a distance of 18 km to river mile 608 were completed. Two more trawls were conducted in the Spokane Arm about 5 km and 8 km from the mouth. The last trawl was conducted in the main reservoir beginning at a point just north of the mouth of the Spokane Arm and continued in a southerly direction for 3 km.

Results and Discussion

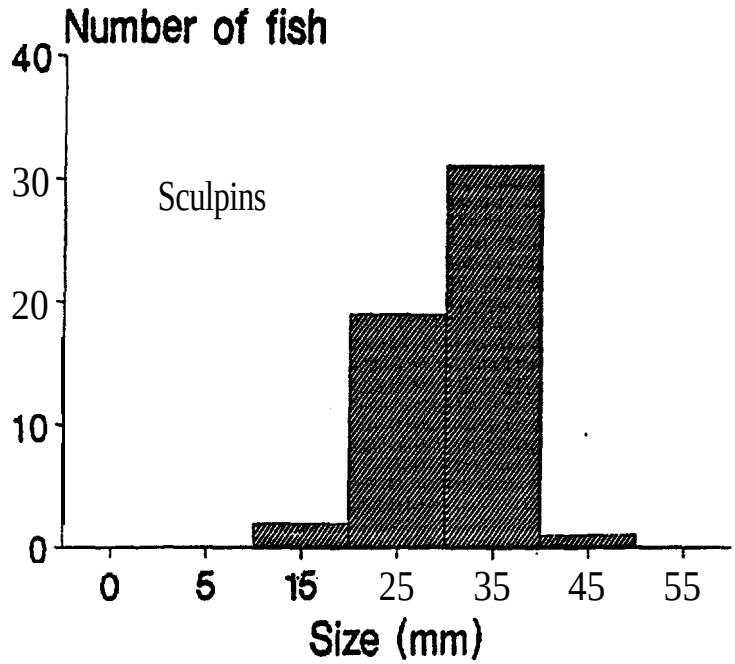
No kokanee were collected in the eleven trawls performed by Idaho Department of Fish and Game. In the main reservoir, few fish were seen on the echosounder in the

pelagic zone. No layer of kokanee could be seen even with extensive echosounding. In the Spokane Arm a layer of fish was seen on the echosounder near the bottom in 27 m to 35 m of water inside the old river channel. Subsequent trawls in this area collected three whitefish up to 596 mm in length. Density estimate of whitefish in the Spokane Arm was 15 whitefish/ha.

Nearly every trawl collected numerous small sculpins (genus *Cottus*) from 17 mm to 37 mm Densities of sculpins in trawl samples were 66 sculpins/ha in the lower end of the reservoir 56 sculpins/ha in the Spokane Arm, and 101 sculpins/ha in the Seven Bays area (Figure 9) (Maiolie and Elam 1993). The experimental trawling conducted by Idaho Department of Fish and Game, indicated that midwater trawling for kokanee as a sampling devise, was not effective during August in Lake Roosevelt. Few fish were seen on the echosounder and no kokanee were caught in eleven trawls. We believe the kokanee population is too small for collection by this manner. It is possible however, that trawling may be effective at other locations, or other times of the year.

This finding presents an additional question as to why kokanee densities would be so low. Kokanee have been stocked into Lake Roosevelt since 1986 and the Spokane Tribe maintains and operates two kokanee hatcheries on the reservoir. Yet, not even small kokanee were collected. Temperature profiles collected during August documented water temperatures greater than 16 degrees C above 33 m (the maximum depth sampled). Kokanee are thought to seek 11 degree C water at night to aid in food digestion. Possibly kokanee were in areas of cooler water, although it is unknown where that may be. No kokanee layer was seen on the echosounder even at depths to 100 m. If kokanee densities are as low as anticipated, it may indicate very high entrainment losses through Grand Coulee Dam. Entrainment losses may be exacerbated by the somewhat warm temperatures of the reservoir.

Density of kokanee in Lake Roosevelt appear to be too low for their collection by mid-water trawling. Possibly kokanee were missed because they were too deep, of they were in other areas of the reservoir. Trawling at different times of the year may be a suitable way to estimate kokanee densities in the reservoir. It is however likely that their densities are very low and we question whether warm water temperatures, the lack of stratification, predation, natural mortality, and the low water retention time, could result in high entrainment losses and a low population (Maiolie and Elam 1993).



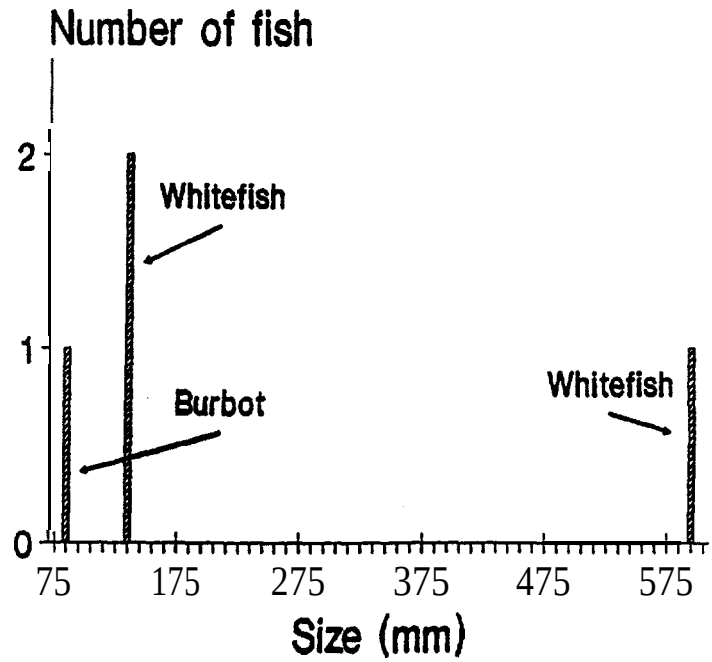


Figure 9. Lengths of sculpins, burbot, and lake whitefish caught trawling in Lake Roosevelt, August 1993.

TAGGING STUDIES

Met hods

Tagging studies were conducted with net-pen rainbow trout. Individually numbered Floy tags were inserted into the musculature at the posterior base of the dorsal fin of one year old fish. Rainbow trout were marked, measured, and released at Kettle Falls, Gifford, Hunters, Seven Bays, and Keller Ferry net-pens in 1993. Two thousand fish were tagged and released bi-monthly from each net-pen site in March, April, and May. In June, approximately 300 additional fish were tagged and released from Seven Bays.

Posters were distributed at locations frequented by anglers in the area surrounding Lake Roosevelt. Posters contained information about the Lake Roosevelt Monitoring Program and requested that anglers return tags with recapture date and location, and length and weight of fish. Any angler that returned tag information was sent a letter informing him or her of the release date, location, and length of fish at time of release. The angler was also provided with a brief summary of the tagging program.

Tag return data was compiled and analyzed to determine movement within and through Lake Roosevelt. Movement was analyzed by noting recapture location and plotting it against release location and date.

Results and Discussion

Tables 21 through 26 summarize fish tag recoveries from each net-pen tagging effort on Lake Roosevelt from 1988 through 1993. In 1993 a total of 21,255 fish were tagged at Hall Creek, Hunters, Seven Bays, and Keller Ferry net-pens in March, April, and May. In 1993, 352 tags were returned from anglers fishing in Lake Roosevelt or below. Of these returns, 106 tags were from fish tagged in 1993. 29% of these fish were tagged at Hunters, 51% were tagged at Seven Bays, and 20% were tagged at Keller Ferry. No tags were recovered from Hall Creek. Three tags were recovered below Lake Roosevelt at Rock Island Dam, from the 1993 tag returns.

Trends in tag returns continue to indicate that entrainment of Lake Roosevelt net-pen fish are influenced by water retention times and release times. Percent of fish

Table 21. Summary of release dates, numbers, and subsequent capture locations of net-pen rainbow trout tagged and released from Kettle Falls.

Release Date	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coulee		
						Number Recovered in Rufus Woods	Number Recovered at Rock Is. or McNary	Percent Recovered Below FDR
Sep. 89	584	15	3%	14	93%	1	0	7%
Mar. 90	508	2	c1%	2	100%	0	0	0%
Apr. 90	498	23	5%	17	74%	5	1	26%
Apr. 91	1,000	57	6%	44	77%	11	2	21%
Mar. 92	1,000	13	1%	13	100%	0	0	0%
Apr. 92	1,000	42	4%	42	98%	1	0	2%
May 92	1,000	41	4%	41	100%	0	0	0%

No fish were tagged in 1993 at the Kettle Falls net-pens.

Table 22. Summary of release dates, numbers, and subsequent capture locations of net-pen rainbow trout tagged and released from Gifford.

Release Date	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coule		
						Number Recovered in Rufus woods	Number Recovered at Rock Is. or McNary	Percent Recovered Below FDR
Mar. 92	1,000	15	2%	15	100%	0	0	0%
Apr. 92	1,000	35	4%	35	100%	0	0	0%
May 92	1,000	40	4%	40	100%	0	0	0%
Jun. 92	1,000	67	7%	67	100%	0	0	0%
Mar. 93	2,000	6	1%	6	100%	0	0	0%
Apr. 93	1,998	9	1%	9	100%	0	0	0%
May	1,000	19	2%	19	100%	0	0	0%

Table 23. Summary of release dates, numbers, and subsequent capture locations of net-pen rainbow trout tagged and released from Hunters.

Release Date	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coulee		
						Number Recovered in Rufus woods	Number Recovered at Rock Is. or McNary	Percent Recovered Below FDR
Mar. 89	768	8	1%	3	38%	0	5	63%
Oct. 89	447	10	2%	10	100%	0	0	0%
Mar. 90	490	3	1%	1	33%	0	2	67%
Apr. 90	498	9	2%	7	78%	2	0	22%
May 90	492	7	1%	6	86%	1	0	14%
Oct. 90	366	5	1%	3	60%	1	1	40%
Mar. 92	1,000	14	1%	13	93%	1	0	7%
Apr. 92	1,000	32	3%	32	100%	0	0	0%
May 92	1,000	47	5%	46	97%	1	0	2%
Mar. 93	1,994	1	<1%	1	100%	0	0	0%
Apr. 93	1,999	21	1%	21	100%	0	0	0%
May. 93	999	9	1%	9	100%	0	0	0%

Table 24. **Summary of release dates, numbers, and subsequent capture locations of net-pen rainbow trout tagged and released from Hunters.**

Release Date	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coulee		
						Number Recovered in Rufus Woods	Number Recovered at Rock Is. or McNary	Percent Recovered Below FDR
Mar. 89	768	8	1%	3	38%	0	5	63%
Oct. 89	447	10	2%	10	100%	0	0	0%
Mar. 90	490	3	1%	1	33%	0	2	67%
Apr. 90	498	9	2%	7	78%	2	0	22%
May 90	492	7	1%	6	86%	1	0	14%
Oct. 90	366	5	1%	3	60%	1	1	40%
Mar. 92	1,000	14	1%	13	93%	1	0	7%
Apr. 92	1,000	32	3%	32	100%	0	0	0%
May 92	1,000	47	5%	46	97%	1	0	2%
Mar. 93	1,994	1	<1%	1	100%	0	0	0%
Apr. 93	1,999	21	1%	21	100%	0	0	0%
May. 93	999	9	1%	9	100%	0	0	0%

Table 25. Summary of release dates, numbers, and subsequent capture locations of net-pen rainbow trout tagged and released from Lincoln.

Release Date	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coulee		
						Number Recovered in Rufus Woods	Number Recovered at Rock Is. or McNary	Percent Recovered Below FDR
Mar. 92	1,000	10	1%	10	100%	0	0	0%
Apr. 92	1,000	32	3%	32	100%	0	0	0%
May 92	1,000	58	4%	55	95%	4	0	5%
Jun. 92	1,000	37	4%	35	95%		0	5%

Net-pens were not in operations in 1993 at Linclon.

Table 26. Summary of release dates, numbers, and subsequent capture locations of net-pen rainbow trout tagged and released from Keller Ferry.

Release Date	Total # Tagged	Total # Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coulee		
						Number Recovered in Rufus Woods	Number Recovered at Rock Is. or McNary	Percent Recovered Below FDR
May 90	459	17	4%	14	82%	2	1	18%
Mar. 92	998	16	2%	16	100%	0	0	0%
Apr. 92	998	31	3%	29	94%	2	0	6%
May 92	1,000	50	5%	48	96%	2	0	4%
Mar. 93	1,994	5	<1%	4	80%	1	0	20%
Apr. 93	2,000	1	<1%	1	100%	0	0	0%
May 93	2,000	15	1%	13	87%	2	0	13%

recovered below Grand Coulee Dam has ranged from 0 to 63% over the past five years when releases were grouped monthly (Table 27). This data supports the theory that fish released later in the year have an increased chance of remaining in the reservoir. When early releases axe paired with high water retention times, decreased entrainment levels are observed in both 1992 and 1993. A smoltification type process in Lake Roosevelt net-pen fish and low water retention times are thought to be major factors influencing entrainment (Peone, et *al.* 1990).

Recovery rates for 1993 released fish in March, April, May, and June, were 93, 100, 97, and 100% respectively in Lake Roosevelt. In 1993, recovery rates for fish caught in Lake Roosevelt were 98,94, and 99% for releases of fish in March, April, and May of that year.

Higher water retention times, and release time are important factors of keeping the fish within the reservoir. Clearly the longer fish remain in net-pens, the higher probability that the fish will remain in the reservoir. The Lake Roosevelt Monitoring Program's 1993 annual report contains creel data and pressure estimate changes over the duration of both project. That data is not incorporated into this report.

Table 27. **Summary of rainbow trout release times, water retention times and subsequent recapture numbers and percentages.**

Release Date	Water Retention Time	Total No. Tagged	Total No. Recovered	Percent Recovered	Number Recovered in FDR	Percent Recovered in FDR	Recoveries Below Grand Coulee: Number Recovered in Rufus Woods	Recoveries Below Grand Coulee: Number Recovered at Rock Is. or McNary	Recoveries Below Grand Coulee: Percent Recovered Below FDR
Mar. 89	32	768	8	1%	3	38%	0	5	63%
Mar. 90	48	5,9991,441	1077	0%	4	57%	0	3	43%
Mar. 92				2%	105	98%	2	0	2%
Mar. 93		7,974	15	<1%	14	93%	1	0	0
Apr. 89	33 31	1,470985	20	2%	11	55%	3	6	45%
Apr. 90	18		52	4%	38	73%	10	4	27%
Apr. 91	51	2,300	20878	3%	52	67%	13	13	33%
Apr. 92		5,998		3%	204	98%	4	0	2%
Apr. 93		7,992,	48	1%	48	100%	0	0	0
May 88	40	1,171	99	9%	99	100%	0	0	0%
May 90	29	1,450	54	4%	44	81%	8	2	19%
May 92	34	6,000	295					0	1%
May 93		4,999	66	1%	64	97%	12	0	0
Jun. 91	29	296	32	11%	27	99%	5	0	1%
Jun. 92	34	3,000	139	5%	139	100%	0	0	0%
Jun. 93		296	11	4%	11	100%	0	0	0
Jul. 91	62	1,749	155	9%	148	97%	7	0	3%

RECOMMENDATIONS

1. The effects of reservoir drawdowns should be thoroughly studied to determine the impact upon the reservoir's biota.

2. Continue to collect zooplankton and water quality data to build into a model.

3. Continue tagging during a period of stable elevation, at sites producing the most returns.
4. Coordinate with the Lake Roosevelt Monitoring Program to develop biological rule curves for Lake Roosevelt.

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APPENDIX A
HYDROLOGY

Table A.1 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in January, 1993. Data from CORPs daily summary reports.

JANUARY					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	97.80	96.00	1,272.80	3,922.40	40.86
2	94.10	116.20	1,272.20	3,900.30	33.57
3	90.90	112.90	1,271.60	3,878.30	34.35
4	95.00	138.80	1,270.40	3,834.50	27.63
5	98.70	140.40	1,269.30	3,794.60	27.03
6	114.00	148.20	1,268.30	3,758.50	25.36
7	125.90	152.80	1,267.60	3,733.40	24.43
8	127.90	126.10	1,267.60	3,733.40	29.61
9	123.80	113.10	1,267.90	3,744.20	33.11
10	119.80	123.10	1,267.80	3,740.60	30.39
11	112.00	133.50	1,267.20	3,719.10	27.86
12	109.70	134.80	1,266.50	3,694.10	27.40
13	97.80	126.20	1,265.70	3,701.20	29.33
14	100.10	103.60	1,267.60	3,737.00	36.07
15	94.30	96.00	1,265.60	3,664.60	38.17
16	93.80	86.70	1,265.80	3,669.20	42.32
17	91.10	78.77	1,266.10	3,679.80	46.72
18	92.10	106.30	1,265.70	3,664.60	34.47
19	93.20	98.60	1,265.55	3,658.50	37.10
20	79.10	63.10	1,266.00	3,676.30	58.26
21	94.60	94.60	1,266.00	3,676.30	38.86
22	80.80	87.90	1,265.80	3,669.20	41.74
23	84.60	95.20	1,265.50	3,658.50	38.43
24	84.70	63.40	1,266.10	3,679.80	58.04
25	86.00	68.20	1,266.60	3,697.60	54.22
26	88.60	72.60	1,267.05	3,711.90	51.13
27	83.10	77.70	1,267.20	3,719.10	47.86
28	83.90	73.00	1,267.50	3,729.80	51.09
29	71.30	73.10	1,267.40	3,726.20	50.97
30	70.70	58.10	1,267.80	3,740.60	64.38
31	66.10	57.10	1,268.00	3,776.50	66.14
Totals	95.0	100.5	1,267.S	3,731.9	40.2

Table A.2 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in February, **1993.**- Data from CORPs daily summary reports.

FEBRUARY					
DAY OF MOTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1					
2	75.40 74.80	95.10 85.50	1,267.201,267.50	3,719.103,729.80	43.50 39.22
3	77.80	95.70	1,266.70	3,701.20	38.68
4	74.60	76.40	1,266.60	3,697.60	48.40
5	76.70	71.40	1,266.80	3,704.80	51.89
6	80.30	55.30	1,267.50	3,729.80	67.45
7	72.20	63.30	1,267.70	3,737.00	59.04
8					
9	71.00 65.40	70.80 83.50	1,267.201,267.40	3,726.203,719.10	44.63 52.53
10	69.80	71.60	1,267.20	3,719.10	51.94
11					
12	70.70 66.50	70.10 83.30	1,266.801,266.70	3,704.803,701.20	44.48 52.80
13	61.60	56.20	1,266.90	3,708.40	65.99
15	63.60	69.00	1,266.70	3,701.20	53.64
16	62.10 60.30	120.40 97.70	1,265.701,264.00	3,664.603,605.60	29.95 37.51
17	69.70	111.60	1,262.80	3,563.50	31.93
18	84.70	116.10	1,261.90	3,532.90	30.43
19	84.00	108.20	1,261.20	3,507.80	32.42
20					
21	74.00 66.40	76.80 84.40	1,260.601,260.90	3,497.403,487.00	41.44 45.40
22					
23	73.60 74.60	109.60 100.50	1,259.901,258.80	3,562.903,425.20	35.45 31.25
24					
25	72.40 68.10	104.60 95.30	1,257.101,258.00	3,397.903,367.40	35.65 32.19
26					
27	77.40 75.00	105.90 66.60	1,256.201,256.45	3,337.103,343.80	31.51 50.21
28	62.10	60.40	1,256.50	3,347.20	55.42
Totals	71.6	85.9	1,263.S	3,594.3	44.1

Table A.3 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in March, 1993. Data from CORPs daily summary reports.

MARCH					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION (TIMD)
1	63.40	97.00	1,255.50	3,313.60	34.16
2	56.20	74.60	1,255.00	3,296.90	44.19
3	58.90	63.90	1,254.80	3,290.30	51.49
4	58.70	67.00	1,254.60	3,283.60	49.01
5	53.20	54.90	1,254.50	3,280.30	59.75
6	52.50	44.20	1,254.80	3,290.30	74.44
7	46.60	38.30	1,255.00	3,296.90	86.08
8	59.20	57.50	1,255.10	3,300.30	57.40
9	54.10	62.40	1,254.80	3,290.30	52.73
10	56.60	54.90	1,254.90	3,296.60	60.05
11	60.10	51.80	1,255.10	3,300.30	63.71
12	58.30	53.30	1,255.30	3,306.90	62.04
13	50.90	42.60	1,255.50	3,313.60	77.78
14	50.00	36.60	1,255.90	3,327.00	90.90
15	53.70	67.10	1,255.50	3,313.60	49.38
16	57.60	69.40	1,255.20	3,303.60	47.60
17	53.10	51.40	1,255.20	3,303.60	64.27
18	54.90	43.20	1,255.60	3,317.00	76.78
19	60.20	45.20	1,256.00	3,330.40	73.68
20	45.10	38.40	1,256.20	3,337.10	86.90
21	49.10	37.40	1,256.60	3,350.50	89.59
22	45.70	67.50	1,255.90	3,327.00	49.29
23	49.20	59.20	1,255.60	3,317.00	56.03
24	61.00	61.00	1,255.60	3,317.00	54.38
25	58.20	49.90	1,255.90	3,327.00	66.67
26	63.80	40.30	1,256.60	3,350.50	83.14
27	68.30	29.50	1,257.70	3,387.70	114.84
28	69.60	25.30	1,259.00	3,432.00	135.65
29	68.40	70.10	1,259.00	3,432.00	48.96
30	71.70	68.10	1,259.10	3,435.40	50.45
31	63.10	49.40	1,259.50	3,449.10	69.82
Totals	57.1	53.9	1256.0	3329.6	67.1

Table A.4 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention **time for Lake** Roosevelt in April, 1993. Data **from** CORPs daily summary reports.

APRIL					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER ZETENTION TIME (D)
1	72.30	48.10	1,260.20	3,473.20	72.21
2	67.00	49.50	1,260.70	3,490.50	70.52
3	68.60	32.30	1,261.60	3,521.70	109.03
4	73.40	23.00	1,263.00	3,570.50	155.24
5	73.70	41.30	1,263.90	3,602.00	87.22
6	75.30	56.00	1,264.40	3,619.70	64.64
7	66.30	41.60	1,265.10	3,644.40	87.61
8	84.40	59.60	1,265.80	3,669.20	61.56
9	67.80	56.70	1,266.10	3,679.80	64.90
10	82.10	39.80	1,267.10	3,715.50	93.35
11	76.40	32.00	1,268.15	3,751.30	117.23
12	83.70	53.90	1,268.90	3,780.20	70.13
13	81.30	59.80	1,269.45	3,798.20	63.52
14	80.10	47.70	1,270.30	3,830.90	80.3 1
15	82.00	47.70	1,27 1.20	3,863.70	81.00
16	77.80	47.30	1,272.00	3,892.90	82.30
17	79.40	37.60	1,272.90	3,892.90	103.53
18	80.40	34.70	1,274.00	3,966.70	114.31
19	76.00	51.70	1,,274.50	3,985.30	77.09
20	80.50	49.30	1,275.30	4,015.10	81.44
21	76.40	47.00	1,275.95	4,037.50	85.90
22	75.10	56.00	1,276.40	4,056.30	72.43
23	78.70	54.50	1,277.00	4,078.90	74.84
24	91.90	27.90	1,278.70	4,143.20	148.50
25	93.30	26.90	1,280.35	4,204.30	156.29
26	92.50	62.00	1,281.10	4,235.20	68.3 1
27	98.90	66.60	1,281.80	4,262.30	64.00
28	88.00	80.00	1,281.80	4,262.30	53.28
29	93.20	78.10	1,282.00	4,270.10	54.67
30	93.90	44.30	1,282.90	4,305.20	97.18
Totals	80.4	48.4	1,27 1.8	3,887.3	87.1

Table A.5 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention **time** for Lake . Roosevelt in May, 1993. Data from CORPs daily summary reports.

MAY					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1	86.40	65.00	1,283.10	4,313.10	66.36
2	86.70	57.40	1,283.50	4,328.80	75.41
3	92.20	102.80	1,283.00	4,309.10	41.92
4	91.60	75.60	1,283.30	4,320.90	57.15
5	98.10	88.70	1,283.40	4,324.80	48.76
6	97.80	90.00	1,283.40	4,324.80	48.05
7	107.30	94.80	1,283.60	4,332.70	45.70
8	108.50	90.60	1,283.80	4,340.60	47.91
9	103.80	110.60	1,283.50	4,328.80	39.14
10	104.20	115.00	1,283.10	4,313.10	37.5 1
11	111.80	122.50	1,282.70	4,297.40	35.08
12	125.20	124.20	1,282.60	4,293.50	34.57
13	139.70	99.50	1,283.50	4,328.80	43.5 1
14	150.50	79.70	1,285.20	4,396.20	55.16
15	146.60	130.30	1,285.30	4,400.20	33.77
16	149.70	123.40	1,285.70	4,416.20	35.79
17	145.10	141.00	1,285.60	4,412.20	31.29
18	155.30	150.80	1,285.50	4,408.20	29.23
19	156.30	151.90	1,285.40	4,404.20	28.99
20	158.10	143.70	1,285.60	4,412.20	30.70
21	166.10	147.20	1,285.80	4,420.20	30.03
22	168.80	162.60	1,285.65	4,412.20	27.14
23	165.00	151.10	1,285.70	4,416.20	29.23
24	156.60	157.50	1,285.50	4,408.20	27.99
25	147.20	160.60	1,285.00	4,388.20	27.32
26	154.50	145.10	1,285.10	4,392.20	30.27
27	147.40	130.60	1,285.40	4,404.20	33.72
28	144.20	115.00	1,286.00	4,428.30	38.51
29	145.70	135.20	1,286.10	4,432.30	32.78
30	148.20	111.40	1,286.80	4,460.50	40.04
31	133.00	114.30	1,287.00	4,468.60	39.10
Totals	132.0	119.0	1284.7	4375.4	39.4

Table A.6 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in June, 1993. Data from CORPs daily summary reports.

JUNE					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	135.60	116.50	1,287.40	4,484.80	38.50
2	141.20	136.00	1,287.40	4,484.80	32.98
3	131.80	132.60	1,287.30	4,480.80	33.79
4	125.60	126.00	1,287.20	4,476.70	35.53
5	124.00	105.10	1,287.30	4,480.80	42.63
6	114.20	80.90	1,288.15	4,513.40	55.79
7	112.30	101.30	1,288.30	4,521.50	44.63
8	111.10	98.10	1,288.30	4,521.50	46.09
9	98.60	116.30	1,288.00	4,509.30	38.77
10	100.00	125.70	1,287.20	4,476.70	35.61
11	93.00	121.00	1,286.40	4,444.40	36.73
12	94.10	67.50	1,286.80	4,460.50	66.08
13	91.70	59.10	1,287.30	4,480.80	75.82
14	95.40	75.60	1,287.60	4,493.00	59.43
15	93.40	74.50	1,287.90	4,505.20	60.47
16	92.40	83.70	1,288.00	4,509.30	53.87
17	89.40	80.60	1,288.00	4,509.30	55.95
18	84.40	85.10	1,287.80	4,501.10	52.89
19	86.50	68.10	1,288.00	4,509.30	66.22
20	86.20	59.50	1,288.30	4,521.50	75.99
21	89.80	94.10	1,288.00	4,509.30	47.92
22	90.10	91.60	1,287.80	4,501.10	49.14
23	92.20	103.90	1,287.40	4,484.80	43.16
24	91.10	90.60	1,287.20	4,476.70	49.41
25	95.50	80.10	1,287.40	4,484.80	55.99
26	89.80	87.70	1,287.20	4,476.70	51.05
27	94.20	71.80	1,287.40	4,484.80	62.46
28	87.50	101.80	1,286.90	4,464.60	43.86
29	98.20	109.80	1,286.40	4,444.40	40.48
30	94.60	125.50	1,285.50	4,408.20	35.13
Totals	100.80	95.67	1,287.46	4,487.34	49.55

Table A.7 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in July, 1993. Data from CORPs daily summary reports.

JULY					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	90.80	127.90	1,284.50	4,368.30	34.15
2	96.60	117.30	1,283.90	4,344.60	37.04
3	99.40	112.80	1,283.20	4,317.00	38.27
4	108.30	72.50	1,283.80	4,340.60	59.87
5	117.10	112.90	1,283.60	4,332.70	38.38
6	106.30	112.40	1,283.30	4,320.90	38.44
7	119.10	94.80	1,283.70	4,336.70	45.75
8	116.60	102.20	1,283.90	4,344.60	42.5 1
9	115.10	107.70	1,283.90	4,344.60	40.34
10	121.00	80.90	1,284.70	4,376.30	54.10
11	125.30	97.10	1,285.10	4,392.20	45.23
12	133.80	94.20	1,285.90	4,424.20	46.97
13	137.40	96.20	1,286.80	4,460.50	46.37
14	123.80	107.80	1,287.00	4,468.60	41.45
15	117.00	109.10	1,287.10	4,472.70	41.00
16	121.70	113.70	1,287.20	4,476.70	39.37
17	133.00	87.60	1,288.10	4,513.40	51.52
18	130.20	103.00	1,288.60	4,533.80	44.02
19	119.20	92.70	1,289.10	4,554.40	49.13
20	105.70	96.60	1,289.20	4,558.50	47.19
21	103.10	97.30	1,289.20	4,558.50	46.85
22	96.40	94.60	1,289.20	4,558.50	48.19
23	82.30	100.50	1,288.70	4,537.90	45.15
24	84.00	75.20	1,288.70	4,537.90	60.34
25	77.70	64.80	1,288.70	4,537.90	70.03
26	82.80	89.10	1,288.50	4,529.70	50.84
27	78.90	94.20	1,288.00	4,509.30	47.87
28	65.70	105.60	1,286.90	4,464.60	42.28
29	69.10	93.90	1,286.20	4,436.30	47.24
30	76.90	92.60	1,285.70	4,416.20	47.69
31	71.20	67.20	1,285.60	4,412.20	65.66
Totals	104.0s	97.24	1,286.39	4,444.53	46.88

Table A.8 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in August, 1993. Data from CORPs daily summary reports.

August					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1					
2	91.30 81.60	76.60 60.70	1,287.30	4,480.80	58.34 73.82
3	80.90	98.30	1,286.70	4,456.50	45.34
4	78.70	81.80	1,286.50	4,448.40	54.38
5	81.20	82.30	1,286.30	4,440.30	53.95
6	78.40	81.50	1,286.10	4,432.30	54.38
8	81.90	76.40	1,286.10	4,432.30	58.01
9	73.90 98.20	55.30 57.30	1,286.30	4,440.30	78.06 80.29
			1,287.10	4,472.70	
10	99.40	109.20	1,286.70	4,456.50	40.81
11	95.40	98.40	1,286.50	4448.40	45.21
12					
13	96.60 91.60	92.70 87.60	1,286.40	4,444.40	50.83 47.94
14	89.40	101.70	1,286.00	4,428.30	43.54
15					
17	92.30 80.10	82.20 83.80	1,285.70	4,416.20	53.87 52.70
18	81.90 85.00	112.30 109.10	1,284.80	4,380.30	39.86 39.01
			1,284.00	4,348.50	
19					
21	91.50 89.80	98.40 84.60	1,283.70	4,336.70	44.07 51.26
22	89.70 84.90	74.60 58.40	1,283.90	4,344.60	74.66 58.24
23			1,284.30	4,360.40	
24	99.20 89.40	49.00 74.20	1,285.10	4,392.20	59.41 89.64
			1,285.50	4,408.20	
26	91.60	74.60	1,285.80	4,420.20	59.25
27	100.70 92.00	91.10 87.70	1,286.00	4,428.30	48.56 50.49
28			1,285.90	4,424.20	
29	93.00 93.60	79.80 56.50	1,286.10	4,432.30	79.02 55.54
			1,286.90	4,464.60	
30					
31	67.00 83.50	97.10 60.40	1,286.40	4,444.40	74.19 45.77
Totals	87.86	81.73	1,285.89	4,424.16	56.79

Table A.9 Daily midnight reservoir **inflow,** outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in September, 1993, Data from CORPs daily summary reports.

September					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1					
2	46.50 57.90	75.50 75.70	1,285.10	4,392.20	58.44 58.02
3	49.20	77.70	1,284.30	4,360.40	56.12
4	54.90	79.00	1,283.60	4,332.70	54.84
5					
6	41.00 63.10	46.00 56.20	1,283.601,283.30	4,320.90	77.09 93.93
7	49.10	61.90	1,282.80	4,301.30	69.49
8					
9	45.00 50.10	74.70 87.70	1,280.90	4,227.40	48.51 56.59
10	53.70	65.20	1,280.60	4,215.90	64.66
11					
12	67.50 71.10	67.50 69.70	1,280.10	4,196.70	62.29 60.21
13	89.80	53.80	1,280.90	4,227.40	78.58
14	91.30	103.70	1,280.50	4,215.90	40.65
15	95.00	83.80	1,280.70	4,219.70	50.35
16	87.70	74.50	1,281.00	4,231.30	56.80
17	79.70	71.50	1,28 1.20	4,239.00	59.29
18	80.10	71.30	1,28 1.30	4,242.90	59.51
20	78.30	48.30	1,281.80	4,262.30	88.25
21	74.90 74.50	44.80 99.00	1,282.40 1.70	4,285.60	43.01 95.66
22			1,28	4,258.40	
23	68.10 61.00	99.50 90.20	1,280.80	4,223.60	46.48 42.45
			1,280.00	4,192.80	
24					
25	58.00 54.30	67.40 83.10	1,278.90	4,150.80	50.13 61.58
26	67.30	60.20	1,278.90	4,150.80	68.95
27					
28	78.40 83.20	54.20 84.50	1,279.30	4,166.10	76.94 49.30
29					
30	85.80 80.10	82.30 82.40	1,279.20	4,162.30	50.5 50.62 1
Totals	67.89	73.04	**1,281.28**	**4,242.74**	60.98

Table A.10 Daily midnight reservoir inflow, outflow, elevation, storage capacity, and water retention time for Lake Roosevelt in October, 1993. -Data from CORPs daily summary reports.

October					
DAY OF MONTH	**INFLOW (KCFS)**	**OUTFLOW (KCFS)**	**RESERVOIR ELEVATION (FT)**	**STORAGE CAPACITY (KCFSD)**	**WATER RETENTION TIME (D)**
1					
2	56.80 58.90	70.70 39.00	1,282.30	4,281.70 1.70	109.79 60.56
			1,282.55	4,28	
3	60.70	36.80	1,283.00	4,309.10	117.10
4					
5	61.70 61.00	72.40 68.30	1,282.15	4,277.80	59.25 62.63
6					
8	60.60 57.10	63.90 56.60	1,281.901,28 1.80	4,262.30	75.3 66.76 1
9	58.10 59.90	44.00 55.20	1,281.70	4,258.40	96.87 77.14
			1,281.80	4,262.30	
10	60.40	42.30	1,282.00	4,270.10	100.95
11	61.60	68.30	1,281.70	4,258.40	62.35
12	62.40	72.50	1,281.30	4,242.90	58.52
13	72.80	61.60	1281.50	4250.60	69.00
14	71.10	59.90	1,28 1.70	4,258.40	71.09
15	67.00	63.60	1,28 1.70	4,258.40	66.96
16	67.80	41.70	1,282.40	4,285.60	102.77
17	65.80	36.50	1,283.10	4,313.10	118.17
18	67.90	65.90	1,283.20	4,317.00	65.51
20	64.90	70.80	1,283.00	4,309.10	60.86
21	67.70 68.00	74.30 85.20	1,282.60	4,293.50	57.68 50.39
			1,282.40	4,285.60	
22	91.30	76.90	1,282.00	4,270.10	55.53
23					
24	56.60 60.40	47.10 43.00	1,282.50	4,289.50	90.82 99.76
25	68.20	92.40	1,281.90	4,266.20	46.17
26	63.10	92.20	1,281.10	4,235.20	45.93
27					
28	66.90 67.80	75.50 82.30	1,280.50	4,212.00	51.27 55.79
29	65.80	77.20	1,280.20	4,200.50	54.41
30					
31	68.00 75.90	45.30 56.00	1,2850 1.20	4,239.00	75.21 93.58
Totals	65.04	62.50	**1,281.91**	**4,266.25**	73.49

Table A.11 Daily midnight reservoir inflow, outflow elevation, storage capacity, and water retention time for Lake Roosevelt in November, 1993. Data from CORPs daily summary reports.

November					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	78.90	87.20	1,280.90	4,227.40	48.48
2	74.90	86.50	1,280.60	4,215.90	48.74
3	77.50	79.50	1,280.60	4,215.90	53.03
4	74.40	76.30	1,280.50	4,212.00	55.20
5	71.60	83.20	1,280.20	4,200.50	50.49
6	70.70	64.90	1,280.40	4,208.20	64.84
7	70.30	56.90	1,280.70	4,210.70	74.00
8	72.60	91.90	1,280.20	4,200.50	45.71
9	71.40	86.70	1,279.80	4,185.40	48.27
10	72.90	84.30	1,279.50	4,173.70	49.51
11	63.70	86.50	1,278.90	4,189.00	48.43
12	72.30	72.30	1,278.90	4,189.00	57.94
13	67.60	63.80	1,279.00	4,154.60	65.12
14	71.00	63.30	1,279.20	4,162.30	65.76
15	77.10	86.70	1,279.00	4,154.60	47.92
16	72.60	80.20	1,278.75	4,147.00	51.71
17	76.50	84.10	1,278.55	4,139.40	49.22
18	81.10	71.60	1,278.80	4,147.00	57.92
19	83.70	72.30	1,279.10	4,158.50	57.52
20	80.70	63.50	1,279.55	4,177.50	65.79
21	81.90	66.60	1,280.00	4,129.80	62.01
22	87.30	112.10	1,279.30	4,166.10	37.16
23	96.40	120.80	1,278.70	4,143.20	34.30
24	86.90	139.80	1,277.30	4,090.20	29.26
25	72.20	96.70	1,276.60	4,063.80	42.02
26	78.40	108.40	1,275.80	4,033.80	37.21
27	84.50	88.30	1,275.70	4,030.10	45.64
28	77.30	68.00	1,276.00	4,141.30	60.90
29	84.40	88.10	1,275.90	4,037.50	45.83
30	81.50	94.60	1,275.50	4,022.60	42.52
Totals	77.08	84.17	1,278.80	4,150.92	51.41

Table A.12 Daily midnight reservoir inflow, outflow elevation, storage capacity, and water retention time for Lake Roosevelt in December, 1993. Data from CORPs daily summary reports.

December					
DAY OF MONTH	INFLOW (KCFS)	OUTFLOW (KCFS)	RESERVOIR ELEVATION (FT)	STORAGE CAPACITY (KCFSD)	WATER RETENTION TIME (D)
1	83.20	77.60	1,275.70	4,030.10	51.93
2	86.20	78.70	1,275.90	4,037.50	51.30
3	94.20	66.00	1,276.60	4,063.80	61.57
4	88.70	58.60	1,277.40	4,094.00	69.86
5	86.10	69.10	1,277.90	4,112.90	59.52
6	82.40	88.10	1,277.70	4,105.30	46.60
7	89.00	85.20	1,277.80	4,109.10	48.23
8	91.00	85.30	1,278.00	4,116.70	48.26
9	99.10	74.40	1,278.60	4,139.40	55.64
10	85.00	60.30	1,279.30	4,166.10	69.09
11	88.40	56.00	1,280.10	4,196.70	74.94
12	86.10	61.00	1,280.80	4,223.60	69.24
13	93.90	97.80	1,280.70	4,219.70	43.15
14	80.10	82.10	1,280.60	4,215.90	51.35
15	87.30	83.40	1,280.70	4,219.70	50.60
16	88.30	99.90	1,280.40	4,208.20	42.12
17	93.90	115.00	1,279.70	4,181.40	36.36
18	74.90	78.70	1,279.80	4,185.40	53.18
19	75.80	81.60	1,279.60	4,177.50	51.19
20	83.30	102.40	1,279.10	4,158.50	40.61
21	89.10	108.10	1,278.60	4,139.40	38.29
22	87.30	112.00	1,278.00	4,116.70	36.76
23	88.30	92.10	1,277.90	4,112.90	44.66
24	88.60	63.90	1,278.50	4,135.60	64.72
25	84.40	54.00	1,279.30	4,166.10	77.15
26	79.50	71.90	1,279.50	4,173.70	58.05
27	82.70	80.80	1,279.60	4,177.50	51.70
28	81.70	79.80	1,279.60	4,177.50	52.35
29	87.30	87.30	1,279.60	4,177.50	47.85
30	90.00	83.30	1,279.80	4,185.40	50.24
31	85.00	50.50	1,280.70	4,219.70	83.55
Totals	86.48	80.16	1.278.95	4,153.02	54.20

Table A.13 Elevation-Area data points for Lake Roosevelt. Data from U.S. Bureau of Reclamation 1977.

Elevation (feet)	Area (acres)	Elevation (feet)	Area (acres)
930.5	511	1120	12980
940	819	1130	22205
950	1219	1140	24748
960	1700	1150	27429
970	2260	1160	30248
980	2900	1170	33205
990	3520	1180	36674
1000	4200	1190	39307
1010	5106	1200	43059
1020	6100	1210	46232
1030	6815	1220	50163
1040	7571	1230	55028
1050	8365	1240	59811
1060	9200	1250	63959
1070	10688	1260	98304
1080	12287	1270	71989
1090	13998	1280	75949
1100	15821	1290	82270
1110	17755	1291	82916

Table A.14 Elevation-Gross storage data points for Lake Roosevelt from Reservoir storage tables for Grand Coulee Reservoir. U.S. Bureau of Reclamation-and U.S. Geological Survey. October 1977.

Elevation (feet)	Gross Storage (MAF)	Elevation (feet)	Gross Storage (MAF)
1205	3786.7	1248	6087.2
1206	3831.5	1249	6150.5
1207	3876.6	1250	6214.2
1208	3921.9	1251	6278.4
1209	3967.8	1252	6343.0
1210	4013.9	1253	6408.0
1211	4060.3	1254	6473.5
1212	4107.1	1255	6539.4
1213	4154.3	1256	6605.7
1214	4201.9	1257	6672.5
1215	4249.9	1258	6739.7
1216	4298.2	1259	6807.3
1217	4347.0	1260	6875.4
1218	4396.2	1261	6943.9
1219	4445.7	1262	7012.8
1220	4495.7	1263	7082.0
1221	4546.1	1264	7151.6
1222	4597.0	1265	7221.5
1223	4648.3	1266	7291.8
1224	4700.2	1267	7362.5
1225	4752.5	1268	7433.6
1226	4805.3	1269	7505.0
1227	4558.6	1270	7576.8
1228	4912.4	1271	7649.0
1229	4966.7	1272	7721.6
1230	5021.5	1273	7794.6
1231	5076.7	1274	7867.9
1232	5132.5	1275	7941.7
1233	5188.7	1276	8015.8
1234	5245.4	1277	8090.4
1235	5302.5	1278	8165.3
1236	5360.1	1279	8240.7
1237	5418.3	1280	8316.4
1238	5476.9	1281	8392.7
1239	5535.9	1282	8469.6
1240	5595.5	1283	8547.1
1241	5655.5	1284	8625.2
1242	5715.9	1285	8704.0
1243	5776.8	1286	8783.4
1244	5838.0	1287	8863.4
1245	5899.7	1288	8944.1
1246	5961.8	1289	9025.4
1247	6024.3	1290	9107.4

APPENDIX B
ZOOPLANKTON

No samples were colleceted in January 1993 due to inclimate weather conditions

Table **B.1** Mean density (#/m^3) values calculated for zooplankton collected in February 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae				
Daphnia retrocurva				
Daphnia schødleri		149.98	25.48	5.36
Daphnia thorata				
Daphnia pulex				
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris		*44.69*		
Leptodora kindti				
Eucopepoda				
Leptodiaptomus ashlandi	44.25	610.83	80.45	130.06
Skistodiaptomus oregonensis				
Epischura nevadensis				
Diacyclops bicuspidatus thomasi	14.75	715.12	41.57	34.86
Mesocyclop edax				
Bryocamptus spp.				
nauplii	851.43	5393.16	540.66	1318.05
Total *Daphnia* spp.	0.00	149.98	25.48	5.36
Total Cladocera	0.00	193.68	25.48	5.36
Total Copepoda	59.00	1325.94	122.02	164.92
Total Nauplii	851.43	5393.16	540.36	1318.05
Grand Total	910.43	6912.79	687.85	1488.33

Table B.2 Mean density (#/m^3) values calculated for zooplankton collected in March 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae		6.70		
Daphnia retrocurva				
Daphnia schødleri	1.34	1.34	5.36	4.02
Daphnia thorata		1.34		
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris		4.02		1.34
Leptodora kindti				
Eucopepoda				
Leptodiaptomus ashlandi	14.75	37.54	49.61	205.15
Skistodiaptomus oregonensis				
Epischura nevadensis				
Diacyclops bicuspidatus thomasi		135.43	37.54	91.18
Mesocyclop edax				4.02
Bryocamptus spp. nauplii	40.23	442.48	533.66	788.42
Total *Daphnia* spp.	1.34	9.39	5.36	4.02
Total Cladocera	1.34	13.14	5.36	5.36
Total Copepoda	14.75	172.97	87.15	300.35
Total Nauplii	40.23	442.48	533.66	788.42
Grand Total	56.32	628.85	626.17	1094.13

Table B.3 Mean density (#/m^3) values calculated for zooplankton collected in April 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae			6.70	
Daphnia retrocurva				
Daphnia schødleri		5.36	2.68	6.70
Daphnia thorata				
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangularis				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum	2.68			
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris				
Leptodora kindti				
Eucopepoda				
Leptodiaptomus ashlandi	1.34	5.36	9.39	29.50
Skistodiaptomus oregonensis				
Epischura nevadensis			1.34	
Diacyclops bicuspidatus thomasi		12.07	8.05	12.07
Mesocyclop edax			1.34	1.34
Bryocamptus spp. nauplii	4.02	1.34	61.68	40.23
Total *Daphnia* spp.	0.00	5.36	9.39	6.70
Total Cladocera	2.68	5.36	9.39	6.70
Total Copepoda	1.34	17.43	20.11	42.91
Total Nauplii	4.02	1.34	61.68	40.23
Grand Total	8.05	24.14	91.18	89.84

Table B.4 Mean density (#/m^3) values calculated for zooplankton collected in May 1993 at four sampling locations on **Lake Roosevelt, WA**

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae		6.70	4.02	
Daphnia retrocurva		9.39		
Daphnia schødleri	24.14	2.68	603.38	13.41
Daphnia thorata		1.34		
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangularis				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris		68.38	4.02	
Leptodora kindti				
Ehcopepoda				
Leptodiaptomus ashlandi			111.29	54.97
Skistodiaptomus oregonensis				
Epischura nevadensis	1.34		16.09	
Diacyclops bicuspidatus thomasi	16.09	41.57	174.31	107.27
Mesocyclop edax		63.02	4.02	
Bryocamptus spp. nauplii	4.02	59.00	79.11	63.02
Total *Daphnia* spp.	24.14	20.11	607.40	**13.41**
Total Cladocera	24.14	880.50	**611.42**	**13.41**
Total Copepoda	17.43	104.59	305.71	162.24
Total Nauplii	4.02	59.00	**79.11**	63.02
Grand Total	45.59	252.08	996.25	238.67

Table B.5 Mean density (#/m^3) values calculated for zooplankton collected in June 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae	2.68	4.02	10.73	
Daphnia retrocurva	1.34	67.04	5.36	
Daphnia schødleri	18.77	24.14	1086.08	1877.18
Daphnia thorata	1.34	1.34	1.34	14.90
Daphnia p0ulicaria			1.34	14.90
Daphnia thorata				
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangularis				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	14.75	14.75	5.36	
Leptodora kindti	1.34	6.70	42.9 1	89.39
Sucopepoda				
Leptodiaptomus ashlandi	1.34	14.75	126.04	1772.89
Skistodiaptomus oregonensis				
Epischura nevadensis		10.73	13.41	29.80
Diacyclops bicuspidatus thomasi	6.70	59.00	134.08	685.32
Mesocyclop edax		*16.09*	8.05	74.49
Bryocamptus spp. nauplii	1.34	24.14	32.18	1102.47
Total *Daphnia* spp.	24.14	96.54	1104.85	1906.98
Total Cladocera	40.23	117.99	1153.12	1996.36
Total Copepoda	8.05	100.56	281.58	2562.50
Total Nauplii	1.34	24.14	32.18	1102.47
hand Total	49.61	242.69	1466.88	5661.33

Table B.6 Mean density (#/m^3) values calculated for zooplankton collected in July 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae	13.41	54.97	52.74	1.34
Daphnia retrocurva	8.05	557.79	31.14	4.02
Daphnia schødleri	105.93	225.26	2869.10	489.41
Daphnia thorata	2.68	32.18	4.02	
Meggfenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina			31.14	
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris	2.68			
Leptodora kindti		6.70		
hcopepoda				
Leptodiaptomus ashlandi	6.70	124.70	52.74	277.55
Skistodiaptomus oregonensis				
Epischura nevadensis				13.41
Diacyclops bicuspidatus thomasi	4.02	100.56	120.38	12.07
Mesocyclop edax		100.56	1.34	2.68
Bryocamptus spp. nauplii	18.77	41.57	62.27	4.02
Total *Daphnia* spp.	130.06	870.21	2957.00	494.77
Total Cladocera	132.74	876.91	2988.14	494.77
Total Copepoda	10.73	335.21	174.46	305.71
Total Nauplii	18.77	41.57	62.27	4.02
Grand Total	162.24	1253.69	3224.87	804.51

Table B.7 Mean density (#/m^3) values calculated for zooplankton collected in August 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae	18.77	6.70	104.29	17.43
Daphnia retrocurva		64.36		
Daphnia schødleri	324.48	159.56	8015.26	1328.77
Daphnia thorata		1.34	74.49	12.07
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris				
Leptodora kindti		1.34	74.49	
Eucopepoda				
Leptodiaptomus ashlandi	8.05	45.59	193.68	172.97
Skistodiaptomus oregonensis				
Epischura nevadensis	2.68		59.59	33.52
Diacyclops bicuspidatus thomasi	2.68	32.18	134.08	29.50
Mesocyclop edax		26.82		
Bryocamptus spp. nauplii		77.77	864.10	13.41
Total *Daphnia* spp.	343.26	231.97	8194.03	1358.27
Total Cladocera	343.26	233.31	8268.53	1358.27
Total Copepoda	13.41	104.59	387.35	256.10
Total Nauplii	0.00	77.77	864.10	13.41
Grand Total	356.66	415.66	9519.98	1627.78

Table B.8 Mean density (#/m^3) values calculated for zooplankton collected in September 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula			*NO*	
Daphnia galeata mendotae	3933.14	22.79	DATA	1.90
Daphnia retrocurva	148.98	1.34	COLLECTED	
Daphnia schødleri	2502.91	1346.21		1267.10
Daphnia thorata	178.78	12.07		1.34
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangular-is				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum		6.70		
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris				1.34
Leptodora kindti	29.80	6.70		
Sucopepoda				
Leptodiaptomus ashlandi		30.84		190.40
Skistodiaptomus oregonensis				
Epischura nevadensis				42.91
Diacyclops bicuspidatus thomasi	*89.39*	105.93		13.41
Mesocyclop edax				20.11
Bryocamptus spp.		18.77		
nauplii	29.80	24.14		9.39
Total *Daphnia* spp.	6763.80	1382.41		1296.59
Total Cladocera	6793.60	1395.82		1297.94
Total Copepoda	89.39	155.54		266.83
Total Nauplii	29.80	24.14		9.39
Grand Total	6912.79	1575.49		1574.15

Table B.9 Mean density (#/m^3) values calculated for zooplankton collected in October 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula				
Daphnia galeata mendotae	230.62		10.73	10.73
Daphnia retrocurva	1.34		8.05	2.68
Daphnia schødleri	158.22	244.03	970.77	4.02
Daphnia thorata	97.88		193.08	1.34
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangularis				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum	2.68			2.68
Diapharwsoma birgei				
Sida crystallina	1.34		2.68	
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris				
Leptodora kindti				
Sucopepoda				
Leptodiaptomus ashlandi	10.73	24.14	284.26	14.75
Skistodiaptomus oregonensis				
Epischura nevadensis				
Diacyclops bicuspidatus thomasi	9.39	13.41	13.41	5.36
Mesocyclop edax	5.36	2.68	40.23	1.34
Bryocamptus spp. nauplii		8.05		6.70
Total *Daphnia* spp.	488.07	244.03	1182.62	18.77
Total Cladocera	492.09	244.03	1185.30	22.79
Total Copepoda	25.48	40.23	337.89	21.45
Total Nauplii	0.00	8.05	0.00	6.70
Grand Total	517.57	292.30	1523.20	50.95

Table B.10 Mean density (#/m^3) values calculated for zoopiankton collected in November 1993 at four sampling locations' on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula			NO	
Daphnia galeata mendotae	2.68	*10.73*	DATA	
Daphnia retrocurva			COLLECTED	*2.68*
Daphnia schødleri	17.43	364.7 1		38.88
Daphnia thorata		75.09		
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangularis				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris				
Leptodora kindti				
Sucopepoda				
Leptodiaptomus ashlandi	8.05	72.41		26.82
Skistodiaptomus oregonensis				
Epischura nevadensis				
Diacyclops bicuspidatus thomasi		10.73		2.68
Mesocyclop edax				
Bryocamptus spp.				
nauplii				
Total *Daphnia* spp.	20.11	450.52		41.57
Total Cladocera	20.11	450.52		41.57
Total Copepoda	8.05	83.13		29.50
Total Nauplii	0.00	0.00		0.00
hand Total	28.16	533.66		71.06

Table **B.11** Mean density (#/m^3) values calculated for zooplankton collected in December 1993 at four sampling locations on Lake Roosevelt, WA

	Gifford Mean Density (#/m^3)	Porcupine Bay Mean Density (#/m^3)	Seven Bays Mean Density (#/m^3)	Spring Canyon Mean Density (#/m^3)
Cladocera				
Ceriodaphnia quadranqula	NO			
Daphnia galeata mendotae	DATA			
Daphnia retrocurva	COLLECTED	10.73		
Daphnia schødleri		962.72	16.09	201.13
Daphnia thorata		159.56		
Megafenestra aurita				
Simocephalus serrulatus				
Alona guttata				
Alona quadrangularis				
Chydorus sphaericus				
Eurycerus lamellatus				
Pleuroxus denticulatus				
Diaphanosoma brachyurum				
Diaphanosoma birgei				
Sida crystallina				
Macrothrix laticornis				
Streblocerus serricaudatus				
Bosmina longirostris				
Leptodora kindti				
Ehcopepoda				
Leptodiaptomus ashlandi		84.47	12.07	40.23
Skistodiaptomus oregonensis				
Epischura nevadensis				
Diacyclops bicuspidatus thomasi		16.09		1.34
Bryocamptus spp.				
nauplii				
Total *Daphnia* spp.		1133.01	16.09	201.13
Total Cladocera		1133.01	16.09	201.13
Total Copepoda		107.27	12.07	41.57
Total Nauplii		0.00	0.00	0.00
Grand Total		1240.28	28.16	242.69

No samples were colleceted in January 1993 due to inclimate weather conditions

Table B.12 Size ranges (mm), mean lengths (mm) and biomass calculations (μg/m^3) for zooplankton collected at four sampling locations in February 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m^3)
Location 2			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri			
Daphnia thorata			
Leptodora kindti			
Total **Biomass**			
ocation 4			
Daphnia galeata memiotae			
Daphnia retrocwva			
Daphnia schødleri	0.78- 1.22	0.93	1197.93
Daphnia thorata			
Leptodora kindti			
Total Biomass			1197.93
ocation 6			
Daphnia galeata mendotae			
Daphnia retrocwva			
Daphnia schødleri	0.76- 1.62	1.07	318.74
Daphnia thorata			
Leptodora kindti			
Total Biomass			318.74
ocation 9			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	0.64- 1.28	0.90	37.91
Daphnia thorata			
Leptodora kindti			
Total Biomass			37.91

Table B.13 Size ranges (mm), mean lengths. (mm) and biomass calculations ($\mu g/m^3$) for zooplankton collected at four sampling locations in March 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri		1.40	3.68
Daphnia thorata			
Leptodora kindti			
Total Biomass			3.68
Location 4			
Daphnia galeata mendotae	0.98- 1.32	1.18	46.73
Daphnia retrocurva			
Daphnia schødleri		0.82	7.22
Daphnia thorata		1.20	29.84
Leptodora kindti			
Total Biomass			83.79
Location 6			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	1.18-1.50	1.36	138.68
Daphnia thorata			
Leptodora kindti			
Total Biomass			138.68
Location 9			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	0.70-0.80	0.77	17.59
Daphnia thorata			
Leptodora kindti			
Total Biomass			17.59

Table B.14 Size ranges (mm), mean lengths (mm) and biomass calculations (μg/m^3) for zooplankton collected at four sampling locations in April 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m^3)
Location 2			
Daphnia galeata mendotae			
Daphnia retrocwva			
Daphnia schødleri			
Daphnia thorata			
Leptodora kindti			
Total Biomass			
Location 4			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	0.78-1.04	0.90	38.57
Daphnia thorata			
Leptodora kindti			
Total Biomass			38.57
Location 6			
Daphnia galeata mendotae	0.70-0.84	0.78	15.85
Daphnia retrocurva			
Daphnia schødleri	0.66-0.84	0.75	10.96
Daphnia thorata			
Leptodora kindti			
Total Biomass			26.81
Location 9			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	0.76-1.40	1.15	102.51
Daphnia thorata			
Leptodora kindti			
Total Biomass			102.51

Table B.15 Size ranges (mm), mean lengths (mm) and biomass calculations (μg/m^3) for zooplankton collected at four sampling locations in May 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m^3)
Location 2			
Daphnia galeata menabtae			
Daphnia retrocurva			
Daphnia schødleri	0.52-1.14	0.73	92.06
Daphnia thorata			
Leptodora kindti			
Total Biomass			92.06
Location 4			
Daphnia galeata menabtae	0.86-1.44	1.06	36.93
Daphnia retrocurva	0.84- 1.22	1.04	44.08
Daphnia schødleri	0.88- 1.02	0.95	22.80
Daphnia thorata	1.22	1.22	31.12
Leptodora kindti			
Total Biomass			134.93
Location 6			
Daphnia galeata menabtae	0.80-1.00	0.88	13.12
Daphnia retrocurva			
Daphnia schødleri	0.42-1.90	1.19	10119.33
Daphnia thorata			
Leptodora kindti			
Total Biomass			10132.45
Location 9			
Daphnia galeata menabtae			
Daphnia retrocurva			
Daphnia schødleri	0.84-1.42	1.24	261.87
Daphnia thorata			
Leptodora kindti			
Total Biomass			261.87

Table B.16 Size ranges (mm), mean lengths (mm) and biomass calculations (μg/m^3) for zooplankton collected at four sampling locations in June 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m^3)
Location 2			
Daphniagaleata mendotae	0.80-1.10	0.95	10.64
Daphnia retrocwva	0.98	0.98	5.27
Daphnia schødleri	0.70-1.96	1.06	227.10
Daphnia thorata	0.90	0.90	14.37
Leptodora kindti	11.00	11.00	355.33
Total Biomass			612.71
Location 4			
Daphnia galeata mendotae	0.96- 1.22	1.05	20.79
Daphnia retrocurva	0.60- 1.82	1.11	385.89
Daphnia schødleri	0.80-1.62	1.06	286.57
Daphnia thorata	1.16	1.16	27.38
Leptodora kindti	3.00-8.50	4.70	183.48
Total Biomass			904.11
Location 6			
Daphnia galeata mendotae	0.76-1.24	1.03	52.39
Daphnia pulicaria	1.78	1.78	79.85
Daphnia retrocwva	0.78-0.88	0.82	12.06
Daphnia schødleri	0.60-2.08	1.18	17858.97
Daphnia thorata			
Leptodora kindti	2.50- 11 .OO	4.89	109.21
Total Biomass			19419.17
Location 9			
Daphnia galeata mendotae			
Daphnia pulicaria	1.16	1.16	235.44
Daphnia retrocurva			
Daphnia schødleri	0.88-2.28	1.62	83369.02
Daphnia thorata	1.24	1.24	360.59
Leptodora kindti	3.50- 13.50	9.50	16025.84
Total Biomass			99990.90

Table B.17 Size ranges (mm), mean lengths (mm) and biomass calculations ($\mu g/m^3$) for zooplankton collected at four sampling locations in July 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2			
Daphnia galeata mendotae	0.88-0.98	0.93	50.4 1
Daphnia retrocurva	0.76- 1.40	1.14	50.33
Daphnia schødleri	0.46- 1.54	0.94	863.55
Daphnia thorata	1.22-1.60	1.41	89.89
Leptodora kindti			
Total Biomass'			1054.18
Location 4			
Daphnia galeata mendotae	0.82-2.22	1.60	826.17
Daphnia retrocurva	0.60-2.00	1.37	6277.01
Daphnia schødleri	0.50-2.08	1.32	5442.03
Daphnia thorata	0.78-2.0	1.28	925.64
Leptodora kindti	5.00- 12.00	7.00	531.49
Total Biomass			14002.34
Location 6			
Daphnia galeata mendotae	0.66- 1.42	1.11	***309.46***
Daphnia retrocwva	0.84-1.64	1.31	301.16
Daphnia schødleri	0.60-2.00	1.02	30290.20
Daphnia thorata	1.40- 1.60	1.50	157.77
Leptodora kindti			
Total Biomass			31058.60
Location 9			
Daphnia galeata mendotae	1.12	1.12	8.11
Daphnia retrocurva	0.98-1.30	1.14	25.37
Daphnia schødleri	0.56- 1.90	1.11	6661.66
Daphnia thorata			
Leptodora kindti			
Total Biomass			6659.13

Table B.18 Size ranges (mm), mean lengths (mm) and biomass calculations (μg/m³) for zooplankton collected at four sampling locations in August 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m³)
Location 2			
Daphnia galeata mendotae	0.60-0.82	0.65	35.91
Daphnia retrocurva			
Daphnia schødleri	0.44-1.08	0.79	1534.18
Daphnia thorata			
Leptodora kindti			
Total Biomass			1570.08
Location 4			
Daphnia galeata mendotae	0.72-1.00	0.82	18348
Daphnia retrocurva	0.76-1.84	1.29	604394
Daphnia schødleri	0.64-1.24	0.92	1226.74
Daphnia thorata	1.00	1.00	18.78
Leptodora kindti	3.00	3.00	11.07
Total Biomass			1880.00
Location 6			
Daphnia galeata mendotae	1.04-1.44	1.30	928.16
Daphnia retrocurva			
Daphnia schødleri	0.84-2.60	1.52	290377.16
Daphnia thorata	0.82-2.40	1.64	3681.45
Leptodora kindti	5.00-7.00	5.67	3361.19
Total Biomass			298347.95
Location 9			
Daphnia galeata mendotae	0.88-1.38	1.02	83.42
Daphnia retrocurva			
Daphnia schødleri	0.68-2.20	1.24	25521.95
Daphnia thorata	*1.08-2.20*	1.48	460.46
Leptodora kindti			
Total Biomass			26065.83

Table B.19 Size ranges (mm), mean lengths (mm) and biomass calculations ($\mu g/m^3$) for zooplankton collected at four sampling locations in September 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2			
Daphnia galeata mendotae	0.64-1.60	0.95	17217.73
Daphnia retrocurva	1.40-1.80	1.64	2911.07
Daphnia schødleri	0.82-1.60	1.07	30879.47
Daphnia thorata	0.78-1.80	1.13	5359.95
Leptodora kindti	5.00	5.00	962.67
Total Biomass			57330.90
Location 4			
Daphnia galeata mendotae	0.60-1.80	1.10	131.67
Daphnia retrocwva	1.70	1.70	29.52
Daphnia schødleri	0.60-2.00	1.01	14636.5 1
Daphnia thorata	1.30-1.84	1.63	581.16
Leptodora kindti	3.50-8.00	5.10	228.19
Total Biomass			15607.05
Location 6			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri			
Daphnia thorata			
Leptodora kindti			
Total Biomass			
Location 9			
Daphnia galeata mendotae	0.54-1.90	1.24	222.06
Daphnia retrocurva			
Daphnia schødleri	0.80-2.60	1.40	35825.47
Daphnia thorata	1.20	1.20	22.27
Leptodora kindti			
Total Biomass			36077.36

Table B.20 Size ranges (mm), mean lengths (mm) and biomass calculations ($\mu g/m^3$) for zooplankton collected at four sampling locations in October-1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass ($\mu g/m^3$)
Location 2			
Daphnia galeata mendotae	0.88-1.82	1.40	2468.15
Daphnia retrocurva	1.46	1.46	18.34
Daphnia schødleri	0.98-1.80	1.42	4669.39
Daphnia thorata	0.88-1.80	1.37	3087.81
Leptodora kindti			
Total Biomass			10243.69
Location 4			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	0.78-2.44	1.72	13146.34
Daphnia thorata			
Leptodora kindti			
Total Biomass			**13146.34**
Location 6			
Daphnia galeata mendotae	0.72-1.40	1.10	61.28
Daphnia retrocurva	1.04- 1.68	1.33	82.93
Daphnia schødleri	0.74-2.36	1.47	31763.40
Daphnia thorata	0.74-2.56	1.64	9564.57
Leptodora kindti			
Total Biomass			41472.18
Location 9			
Daphnia galeata mendotae	1.26-2.10	1.63	169.00
Daphnia retrocurva	1.00-1.18	1.09	14.70
Daphnia schødleri	0.74-1.12	0.89	96.31
Daphnia thorata	2.24	2.24	145.64
Leptodora kindti			
Total Biomass			425.64

Table B.21 Size ranges (mm), mean lengths (mm) and biomass calculations (μg/m^3) for zooplankton collected at four sampling locations in November 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m^3)
Location 2			
Daphnia galeata mendotae	0.94- 1.60	1.27	22.37
Daphnia retrocurva			
Daphnia schødleri	0.86-2.20	1.42	513.82
Daphnia thorata			
Leptodora kindti			
Total Biomass			**536.19**
Location 4			
Daphnia galeata mendotae	1.34-1.82	1.60	161.78
Daphnia retrocurva			
Daphnia schødleri	0.96-2.36	1.60	15466.18
Daphnia thorata	*0.98-2.48*	1.59	3411.73
Leptodora kindti			
Total Biomass			19039.69
Location 6			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri			
Daphnia thorata			
Leptodora kindti			
Total Biomass			
Location 9			
Daphniagaleata mendotae			
Daphnia retrocurva	1.24- 1.66	1.45	35.90
Daphnia schødleri	0.82-2.24	1.40	1107.26
Daphnia thorata			
Leptodora kindti			
Total Biomass			1143.16

Table B.22 Size ranges (mm), mean lengths (mm) and biomass calculations (μg/m^3) for zooplankton collected at four sampling locations in December 1993 on Lake Roosevelt, WA

	Size range (mm)	Mean length (mm)	Biomass (μg/m^3)
Location 2			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri			
Daphnia thorata	0.78-2.42	1.28	414.17
Leptodora kindti			
Total **Biomass**			
Location 4			
Daphnia galeata mendotae			
Daphnia retrocurva	0.78- 1.44	1.09	58.42
Daphnia schødleri	0.72-2.20	1.26	19705.80
Daphnia thorata	0.78-2.42	1.28	4206.56
Leptodora kindti			
Total Biomass			23970.78
Location 6			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	0.74-1.40	0.98	149.16
Daphnia thorata			
Leptodora kindti			
Total Biomass			149.16
Location 9			
Daphnia galeata mendotae			
Daphnia retrocurva			
Daphnia schødleri	0.76-2.04	1.37	5335.44
Daphnia thorata			
Leptodora kindti			
Total Biomass			5335.44

APPENDIX C
BENTHIC MACROINVERTEBRATES

Table C.l Number of benthic macroinvertebrate samples collected each month at each location on Lake Roosevelt in 1993.

Month	Res. Elevation	Res. Location	Area Number	Number of Samples	Mean Sample Depth (m)
May	1285	2	2	2	24
			3	0	15
			1	2	
		4	2	2	24
					15
			3	0	
			1	2	
		6	2	2	24
					15
			3	0	
				2	
		9	2	2	24
			3	0	15
			1	2	
July	1286	2	2	2	24
					15
			3	2	6
			1	2	
		4	2	2	24
					15
			3	2	6
		6	1	2	24
			2	2	
			3	2	15 6
			1	2	
		9	2	2	24
					15
			3	2	6

Table C.l Continued.

Month	Res. Elevation	Res. Location	Area Number	Number of Samples	Mean Sample Depth (m)
August	1286	2	1	3	24
			2	3	15
			3	3	6
		4	1	2	24
			2	2	15
			3	2	6
		6	1	2	24
			2	2	15
			3	2	6
		9	1	3	24
			2	3	15
			3	3	6
September	1281	2	1	0	-
			2	1	15
			3	2	6
		4	1	2	24
			2	2	15
			3	1	6
		6	1	1	24
			2	1	15
			3	1	6
		9	1	1	24
			2	1	15
			3	1	6

Table C.2 Number of acres within each benthic macroinvertebrate sampling area and calculations.

Samp ing Areas and **Descriptions:**
Area 1 11210 at full pool
Area 2 From 1211 to 1240 at full pool
Area3 From 1290 to 1241

Benthic Sampling Area	Elev. used for calculations	Acres at elevation	# of Acres in Sampling Area
1	1210 930.5	46,232 511	45,721
2	1240 1210	59811 46232	13,579
3	1240 1290	59811 82270	22,459

Acres converted to m^2.

Sampling Area	Acres/Area (x 4046.8564)	m^2/Area
1	45,721	185,026,321
2	13,579	54,952,263
3	22,459	90,888,348

Table C.3 Orders and families of benthic macroinvertebrates found in the substrate of Lake Roosevelt.

Order	Amphipoda (scuds)	
	Family:	Gammerus
Order	Basommatophora (snails)	
	Family	Lynmaeidae
		Planoribidae
		Physidae
Order	Diptera (midges)	
	Family	Chironomidae
Order	Hydrachnellae (aquatic spiders)	
	Family	Hydracarina
Order	Oligocheata (worms)	
	Family	Lumbriculidae
Order	Pelecypoda (clams)	
	Family	Sphaeridae
Order	Trichoptera (caddisflies)	
	Family	Leptoceridae
		Limnephilidae

Table C.4 Mean monthly weight values (#/m^2) ± standard deviation of individual benthic macroinvertebrates used to calculate weight frequency.

Weights (g)	Yearly Mean X ± S.D.
Amphipoda	
Gammarus	0.0027 ± 0.0021
Basommatophora	
Lymnaeidae	0.1922 ± 0.0001
Planorbidae	0.0021 ± 0.0001
Physidae	
Diptera	
Chironomidae pupae	0.0031 ± 0.0021
Chironomidae larvae	0.0027 ± 0.0079
Simuliidae	
Hydrachnellae	
Hydracarina	0.0001 ± 0.0001
Oligochaeta	
Lumbriculidae	0.0004 ± 0.0002
Pelecypoda	
Sphaeridae	0.0001 ± 0.0001
Trichoptera	
Leptoceridae	0.0001 ± 0.0001
Limnephilidae	0.0009 ± 0.0003
Brachycentridae	0.0004 ± 0.0001
Odonata	0.0001 ± 0.0001

APPENDIX D
WATER QUALITY

No samples could be collected due to inclimate weather conditions at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon in January. February, March, April, and May, and June samples were not collected due to equipment problems.

Table D.l Water quality measurements taken with Hydrolab Surveyor II at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon in July 1993.

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	17.56	8.31	7.96	.124	.273
3	17.02	8.28	7.80	.124	.273
6	16.11	8.19	7.73	.124	.277
9	15.96	8.14	7.75	.124	.277
12	15.87	8.13	7.85	.123	.278
15	15.48	8.12	7.82	.122	.279
18	15.36	8.11	7.79	.122	.280
21	15.31	8.09	7.73	.122	.281
24	15.25	8.07	7.68	.124	.282
27	15.23	8.06	7.74	.124	.287
30	15.23	8.02	7.65	.119	.287
33	15.21	8.05	7.59	.125	.288
41	15.22	8.03	7.38	.123	.290

PORCUPINE

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	19.70	8.40	6.99	.127	.272
3	19.13	8.31	6.93	.129	.270
6	18.83	8.28	6.87	.129	.272
9	18.36	8.11	6.56	.133	.278
12	17.82	7.96	6.14	.132	.283
15	17.37	7.86	5.88	.121	.285
18	17.17	7.79	5.65	.109	.287
21	16.56	7.72	5.55	.096	.289
24	16.29	7.64	5.50	.090	.293
27	15.53	7.57	5.35	.088	.296
30	14.96	7.51	5.06	.082	.299
33	13.62	7.39	4.75	.079	.304

Table D.l Continued;

SEVEN BAYS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mm ho/cm	ORP (V)
0	18.40	8.15	8.57	.123	.281
3	17.94	8.30	8.40	.123	.280
6	17.86	8.30	7.86	.126	.283
9	17.76	8.28	7.64	.125	.284
12	17.42	8.23	7.62	.125	.286
15	17.30	8.19	7.56	.124	.287
18	17.01	8.13	7.50	.125	.289
21	16.93	8.10	7.42	.125	.290
24	16.69	8.05	7.36	.128	.291
27	16.63	8.03	7.36	.128	.293
30	16.27	7.96	7.25	.126	.295
33	16.11	7.93	7.22	.126	.296
39	15.97	7.85	6.96	.126	.299

SPRING CANYON

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	19.93	8.06	7.32	.121	.277
3	19.67	8.11	6.7	.121	.277
6	19.05	8.15	6.78	.121	.279
9	18.95	8.15	6.85	.120	.280
12	18.88	8.13	6.85	.120	.281
15	18.50	8.06	6.74	.121	.284
18	17.81	8.03	6.82	.122	.286
21	17.25	8.01	9.28	.123	.288
24	16.93	7.97	9.31	.124	.289
27	16.61	7.94	9.13	.125	.290
30	16.36	7.92	6.76 8.95	.123.120	.278.292

Table D.2 Water quality measurements taken with Hydrolab Surveyor II at Gifford, Porcupine **Bay,** Seven Bays, and Spring Canyon in August 1993.

GIFFORD

Depth (m)	**Temp. (°C)**	**pH**	**D.O. (mg/L)**	**Conduct. mmho/cm**	**ORP (V)**
0	19.53	7.46	7.59	.126	.254
3	19.31	7.46	8.25	.128	.254
6	19.26	7.45	8.33	.126	.255
9	18.81	7.35	8.26	.125	.259
12	18.73	7.31	8.23	.125	.260
15	18.46	7.27	8.24	.124	.261
18	18.32	7.22	8.15	.124	.263
21	18.26	7.15	8.19	.126	.264
24	18.20	7.16	7.58	.126	.270
27	18.06	7.14	7.94	.124	.272
30	17.80	7.13	8.05	.124	.272
33	17.66	7.12	7.98	.126	.273

PORCUPINE

Depth **(m)**	Temp. **(°C)**	**pH**	D.O. **(mg/L)**	Conduct. **mmho/cm**	ORP **(V)**
0	21.22	7.80	7.64	.138	.235
3	21.11	7.79	8.09	.138	.235
6	20.97	7.79	8.72	.138	.235
9	20.02	7.61	9.32	.136	.245
12	19.22	7.42	9.23	.134	.250
15	18.93	7.19	8.85	.133	.255
18	18.50	7.10	8.77	.134	.258
21	18.01	6.99	8.75	.134	.261
24	17.25	6.94	8.06	.129	.264
27	16.09	6.91	6.99	.100	.266
30	15.54	6.76	3.41	.091	.279
33					

Table D.2 Continued;

SEVEN BAYS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	20.27	7.32	8.29	.129	.277
3	20.26	7.32	8.31	.129	.277
6	20.26	7.34	8.35	.129	.277
9	20.21	7.35	8.39	.130	.277
12	19.56	7.29	8.37	.127	.280
15	19.24	7.22	8.37	.129	.281
18	18.70	7.19	8.42	.128	.282
21	18.47	7.17	8.43	.129	.283
24	17.78	7.14	8.49	.126	.285
27	17.32	7.11	8.47	.127	.286
30	17.20	7.06	8.43	.125	.287
33	16.95	7.02	8.27	.123	.289

, SPRING CANYON

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mm ho/cm	ORP (V)
0	21.61	7.46	7.98	.125	.260
3	21.61	7.46	8.11	.124	.261
6	21.56	7.48	8.17	.125	.261
9	21.54	7.47	8.25	.126	.261
12	20.86	7.41	8.07	.124	.264
15	19.84	7.30	8.10	.125	.267
18	19.54	7.20	7.98	.126	.270
21	18.61	7.15	7.95	.124	.272
24	17.71	7.08	7.94	.128	.274
27	17.17	7.04	7.96	.124	.276
30	16.08	6.98	8.06	.126	.277
33	16.57	6.94	8.03	.127	.279

Table D.3 Water quality measurements taken with Hydrolab **Surveyor** II at Gifford and Porcupine Bay in September **1993.**

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mm ho/cm	ORP (V)
0	16.25	8.28	12.85	134.9	243
3	16.28	7.83	9.94	134.7	243
6	16.28	7.68	9.65	134.8	242
9	16.26	7.62	9.46	134.3	243
12	16.16	7.59	9.40	135.8	244
15	16.15	7.58	9.37	135.7	245
18	16.15	7.57	9.33	136.5	245
21	16.15	7.57	9.31	137.2	245
24	16.13	7.56	9.29	137.8	246
27	16.05	7.55	9.27	139.4	247
30	15.98	7.52	9.25	137.9	248
33	15.96	7.51	9.26	139.2	249

PORCUPINE

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	17.27	7.94	14.38	155	241
3	17.29	7.41	8.41	150	241
6	17.29	7.36	8.28	151	242
9	17.29	7.34	8.21	155	242
12	17.26	7.32	8.11	154	243
15	17.24	7.31	8.03	156	244
18	17.12	7.25	7.96	165	246
21	16.82	7.23	7.60	172	247
24	16.35	7.19	7.52	163	249
27	16.23	7.15	7.10	165	251
30					
33					

Data was not collected at Gifford, Seven Bays, and **Spring** Canyon on September.

Table D.4 Water quality measurements taken with Hydrolab Surveyor II at Seven Bays-and Spring Canyon in October 1993.

SEVEN BAYS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.73	7.81	13.03	139.1	396
3	3.73	7.84	13.05	139.3	396
6	3.71	7.85	13.03	139.8	396
9	3.73	7.85	12.98	140.7	398
12	3.73	7.85	12.96	140.8	398
15	3.73	7.86	12.90	141.9	399
18	3.73	7.86	12.88	139.3	399
21	3.73	7.86	12.83	138.6	400
24	3.73	7.87	12.79	144.6	401
27	3.74	7.86	12.78	138.6	402
30	3.74	7.86	12.76	139.4	403
33	3.74	7.86	12.72	140.8	403

, SPRING CANYON

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	5.34	7.79	12.36	135.6	423
3	5.27	7.81	12.06	134.9	431
6	5.22	7.83	11.91	135.3	435
9	5.19	7.84	11.76	135.9	437
12	5.14	7.84	11.40	135	441
15	5.09	7.85	11.41	136.8	441
18	5.09	7.85	11.64	133.6	442
21	5.10	7.85	11.66	136.6	443
24	5.09	7.85	11.66	137.5	444
27	5.09	7.85	11.68	135.7	444
30	5.09	7.85	11.66	138.8	445
33	5.05	7.85	11.59	134.8	445

Data was not collected at Gifford and Porcupine Bay in October.

Table **D.5** Water quality measurements taken with Hydrolab Surveyor II at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon in November 1993.

. SPRING CANYON

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	13.26	7.36	11.24	139.3	335
3	13.28	7.45	10.66	139.2	331
6	13.29	7.60	10.0	139.4	327
9	13.29	7.64	9.95	139.2	326
12	13.29	7.65	9.98	131.1	325
15	13.29	7.67	9.81	139.7	325
18	13.29	7.68	9.77	141.6	325
21	13.29	7.69	9.74	139.6	324
24	13.29	7.71	9.72	141.0	323
27	13.29	7.71	9.68	143.1	324
30	13.29	7.71	9.69	143.1	323
33	13.29	7.73	9.71	138.4	323

Table **D.5** Water quality measurements taken with Hydrolab Surveyor II at Gifford, Porcupine Bay, Seven Bays, and Spring Canyon in December 1993.

GIFFORD

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.89	7.75	1Q06	145.3	323
3	3.94	7.75	14.75	145.1	318
6	3.98	7.76	14.40	145.6	316
9	3.96	7.78	14.29	145.6	315
12	3.98	7.79	14.18	146.5	315
15	3.99	7.81	14.08	144.3	314
18	3.98	7.82	13.97	145.7	314
21	3.98	7.82	13.88	144.0	314
24	3.99	7.83	13.77	147.1	313
27	3.99	7.84	13.73	141.9	313
30	3.99	7.84	13.64	144.5	313
33	3.98	7.85	13.55	143.9	313

PORCUPINE

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	4.69	7.69	17.11	172	311
3	4.76	7.66	13..61	181	310
6	4.76	7.67	12.39	169	311
9	4.74	7.69	11.99	168	312
12	4.76	7.71	11.84	170	314
15	4.74	7.73	11.73	159	315
18	4.69	7.76	11.63	169	316
21	4.67	7.77	11.56	183	317
24	4.64	7.77	11.39	188	319
27					
30					
33					

Table D.6 Continued;

SEVEN BAYS

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	3.61	7.82	17.28	145.9	284
3	3.71	7.83	15.18	145.7	283
6	3.71	7.82	14.26	145.8	281
9	3.73	7.82	13.94	146.4	280
12	3.74	7.83	13.68	147.5	280
15	3.74	7.83	13.44	147.3	280
18	3.76	7.83	13.35	143.4	280
21	3.76	7.83	13.21	147.4	280
24	3.80	7.84	13.17	144.0	280
27	3.83	7.85	13.10	146.9	280
30	3.83	7.85	13.04	147.4	280
33	3.83	7.86	12.99	144.9	280

SPRING CANYON

Depth (m)	Temp. (°C)	pH	D.O. (mg/L)	Conduct. mmho/cm	ORP (V)
0	6.67	7.84	15.50	142.3	292
3	6.72	7.80	13.07	142.4	289
6	6.71	7.81	12.54	143.4	286
9	6.72	7.82	12.22	143.1	285
12	6.71	7.84	12.01	141.4	284
15	6.74	7.85	11.90	141.5	284
18	6.74	7.86	11.85	142.2	283
21	6.59	7.86	11.80	143.1	283
24	6.54	7.87	11.77	140.0	283
27	6.36	7.87	11.77	140.0	283
30	6.11	7.88	11.87	144.4	284
33	6.09	7.88	11.88	143.0	283

Table E.l Record of tagging releases from all net-pen tagging efforts on Lake Roosevelt from 1986 to present.

DATE	LOC CODE	NUMBER TAGGED	SPECIES	TAG COLOR	NUMBER SERIES
4/13/89	0-NP	495	R	Y	22101-22601
5/12/87	l-NP	25	R	0	26-50
9/27/89				O	
9/27/89	1 1 -NP -NP	390 194	R R	O	15101-15299 15601-16000
9/27/89	1-NP	584			
3/27/90			R	O	
3/27/90	11-NP -NP	502 6	R	O	33500-33500 33978-33983
3/27/90	1-NP	508			
4/19/90	1-NP	498	R	O	38001-38500
4/17/91	1-NP	1000	R	O	44001-45000
3/22/92	1-NP	1000	R	P	0001-1000
4/26/92	1-NP	1000		P	1001-2000
5/24/92	1-NP	1000	R	P	12001-13000
3/22/92	HC-NP	1000	R	0	65001-66000
4/26/92	HC-NP	1000	R	P	2001-2000
5/24/92	HC-NP	1000	R	P	11001-12000
6/11/92	HC-NP	1000	R	P	13001-14000
4/20/93	HC-NP	999	R	O	32001-33000
5/27/93	HC-NP	1000	R	0	37001-38000
3/10/89	3-NP	768	R	O	24151-25000
10/7/89	3-NP	447	R	O	17001-17500
3/29/90	3-NP	490	R	0	34001-34500
4/19/90	3-NP	498	R	O	37001-37500
5/19/90	3-NP	492	R	O	38501-39000
				O	
10/24/90	3-NP	124	R	O	46001-46129
10/24/90	3-NP	59	R		46267-46325
10/24/90	3-NP	183			

Table E.l Continued

DATE	LOC CODE	NUMBER TAGGED	SPECIES	TAG COLOR	NUMBER SERIES
3/21/92	3-NP	1000	R	O	61001-62000
4/25/92	3-NP	1000	R	P	5001-6000
5/23/92	3-NP	1000	R	P	10001-11000
9/24/92	3-NP	1000	R	P	16001-17000
4/20/93	3-NP	999	R	P	31001-32000
5/20/93	3-NP	999	R	P	34001-35000
3/17/92	5-HR	971	R	Y	50001-51000
3/17/92	5-HR	961	R	Y	51001-52000
3/17/92	5-HR	1932			
5/15/90	5-TNP	426	R	Y	18576-19000
5/4/88	6-NP	175	R	O	10751-l 1000
5/4/88	6-NP	996	R	O	11001-12000
5/4/88	6-NP	1171	R		
4/12/89	6-NP	985	R	0	26001-27000
12/21/89	6-NP	496	KAM	B	21001-21500
3/22/90	6-NP	443	R	O	25201-25700
4/17/90	6-NP	474	R	O	33501-33977
5/26/90	6-NP	499	R	O	39001-39500
5/26/90	6-NP	925	KAM	B	55001-55975
7/13/90	6-NP	50	R	0	37501-3755
4/17/91	6-NP	300	R	O	47001-47300
4/17/91	6-NP	1000	R	O	45001-46000
4/17/91	6-NP	1300	R		
4/17/91	6-NP	200	KAM	0	47301-47500
6/6/91	6-NP	50	R	O	46201-46250
6/6/91	6-NP	246	R	O	46326-467 10
6/6/91	6-NP	296	R		
6/6/91	6-NP	575	KAM	B	46126-47000
7/13/91	6-NP	190	R	O	467 1 l-46900
7/13/91	6-NP	495	R	O	47501-48000
7/13/91	6-NP	75	R	0	17726- 17800

Table E.l Continued

DATE	LOC CODE	NUMBER TAGGED	SPECIES	TAG COLOR	NUMBER SERIES
7/13/91	6-NP	989	R	Ø	48001-49000
7/13/9 1	6-NP	1749	R		
			R		
3/20/92	6-NP	999	R	Ø	62ØØ1-63ØØØ
4/25/92	6-NP	1000	R	P	4001-5000
5/23/92	6-NP	1000	R	P	9001-10000
6/16/92	6-NP	1000	R	P	14001-15000
4/ 19/93	6-NP	997	R	P	30001-31000
5/26/93	6-NP	1000			35001-36000
6/7/93	6-NP	296	R	P	
3/21/92	L-NP	1000	R	0	60001-61000
5/22/92	L-NP	1000	R	P	6001-7000
6/18/92	L-NP L-NP	1000 6ØØ	R R	P	15ØØ1-157ØØ 8001-9000
			R		
5/1 2/90	7-NP	101	R	Y	39501-39650
5/12/90	7-NP	358		Y	40001-40400
3/20/92	7-NP	459	R	O	
4/19/93	7-NP 7-NP	1000 998	R	O	29001-30000 64ØØ1-65ØØØ
5/4/93	7-NP	1000	R	O	36001-37000
5/20/93	7-NP	1000	R	O	33001-34000

Location Code:

0-NP	Northport
l-NP	Kettle Falls
HC-NP/2-NP	Hall Creek
3-NP	Hunters
5-HR	Spokane Tribal Hatchery Release
5-TNP	Tribal Net-Pen
6-NP	Seven Bays
L-NP/6.5-NP	Lincoln
7-NP	Keller Ferry

Tag Color Code

Y-Yellow
O-Orange
P-Pink
B-Brown