Project 1680

AQUATIC RESOURCES
OF
ROCKY MOUNTAIN ARSENAL
ADAMS COUNTY, COLORADO

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THIS REPORT PRESENTS THE RESULTS OF AQUATIC ECOLOGY INVESTIGATIONS CONDUCTED AT RMA FROM FALL 1985 THROUGH SPRING 1988. THE MAJOR OBJECTIVES OF THE INVESTIGATION WERE TO:

1. CHARACTERIZE THE AQUATIC RESOURCES OF RMA, PARTICULARLY THE SOUTH LAKES
2. COMPARE THE WATER QUALITY AND AQUATIC BIOTA OF RMA LAKES WITH AN OFFSITE LAKE.

THE REPORT IS DIVIDED INTO THE FOLLOWING SECTIONS:

1. METHODS - SAMPLING PROCEDURES, TISSUE ANALYSES
2. CHARACTERIZATION OF SOUTH LAKES AQUATIC ENVIRONMENTS - WATER QUALITY, PLANKTON, FISH
3. COMPARISON WITH MCKAY LAKE IN NORTHWESTERN ADAMS COUNTY - WATER QUALITY, AQUATIC SPECIES
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1.0 INTRODUCTION

1.1 PURPOSE

This report presents the results of aquatic ecology investigations conducted at Rocky Mountain Arsenal (RMA) from fall 1985 through spring 1988. The studies were performed by Morrison-Knudsen Engineers (MKE) and their subcontractors on behalf of Shell Oil Company (Shell), through the law firm of Holme Roberts & Owen. The major objectives of the investigations were to characterize the aquatic resources of RMA, particularly the South Lakes, and to compare the water quality and aquatic biota of RMA lakes with an offsite lake.

Much of the information presented in this report has been incorporated into the Biota Remedial Investigation (RI), prepared for the U.S. Army by Hunter/ESE as part of the Remedial Investigation/Feasibility Study (RI/FS) for Rocky Mountain Arsenal (ESE 1989). The purpose of this report is to provide greater detail on the Shell/MKE studies than was appropriate for the Biota RI and to present some data not included in that document.

Results of a literature review on aquatic resources at RMA were provided in a previous report by MKE (1987). The most comprehensive aquatic resource investigation at RMA prior to RI/FS efforts was conducted by the U.S. Fish and Wildlife Service (FWS) in 1984 by Rosenlund et al. (1986).

1.2 REGIONAL AQUATIC ECOLOGY

Rocky Mountain Arsenal covers approximately 27 square miles (70 km^2) of gently rolling terrain in Adams County, Colorado. The Arsenal is located about 16 km (10 miles) northeast of downtown Denver, just north of Stapleton International Airport (Figure 1-1) and within the South Platte River drainage. Prior

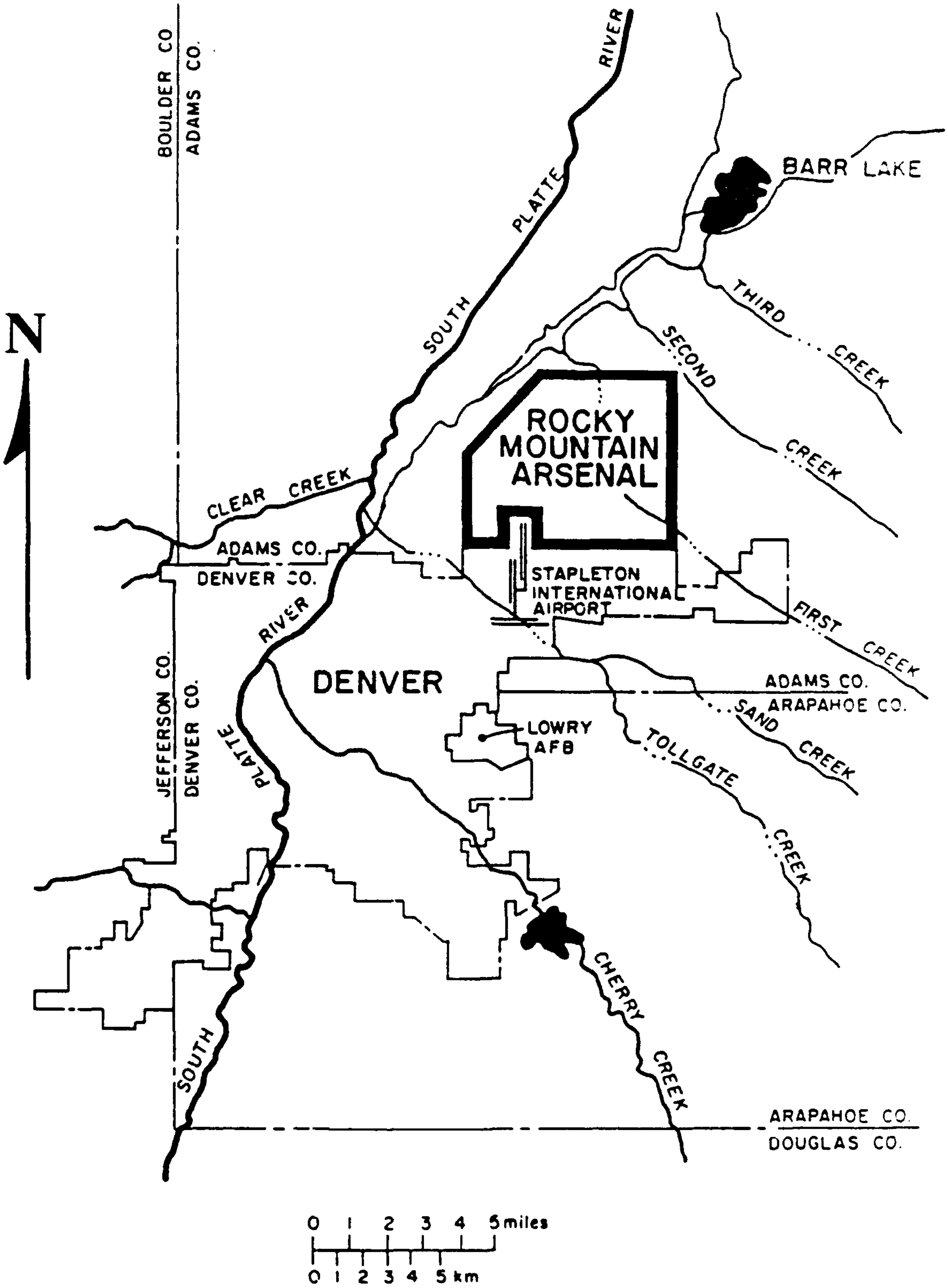

FIGURE 1-1. LOCATION MAP ROCKY MOUNTAIN ARSENAL.

to settlement of the region, aquatic resources were limited to the South Platte River and its tributaries and a small number of natural ponds and lakes. Today, numerous impoundments are the most prominent aquatic resources of the Front Range Urban Corridor. These have been constructed for a variety of purposes, including use for livestock, domestic water supplies, flood control, irrigation storage, and recreation. The following subsections briefly describe the aquatic biota characteristic of flowing or standing bodies of water in the region surrounding RMA.

1.2.1 Rivers and Creeks

Streams with sufficient basin size and runoff for permanent flow generally support an aquatic community. Most of the major streams in the region originate in the mountains to the west where heavier rainfall, extensive snowpack, steep terrain, and rocky soils contribute to the volume and persistence of flow. Many of the minor permanent streams have their headwaters in prairie uplands.

Rivers and creeks originating in the mountains are usually cold, swift, clear, and highly oxygenated when they emerge onto the plains. They typically are also well shaded by riparian trees and have rocky substrates. Primary production in these cold-water and coolwater reaches is generally limited to periphyton (attached algae). Macroinvertebrate communities are usually dominated by crawling forms of insect larvae, such as caddisflies, mayflies, and stoneflies. Densities and diversities of these organisms are high, and they provide an abundant preybase for fish. Cutthroat trout are native to these waters, and three introduced trout--rainbow, brown, and brook--are now widespread. Native nongame fish include the longnose sucker, longnose dace, and johnny darter.

As the streams flow eastward onto the plains, they become slower and wider, the amount of shading decreases, substrates become finer, and turbidity increases. Consequently, temperatures rise and oxygen levels fall. Primary producers in these stretches shift from periphyton to phytoplankton (suspended algae) and macrophytes (aquatic plants). Macroinvertebrate communities also shift, being dominated by burrowing forms (e.g., dipteran larvae and oligochaete worms) and free-swimming aquatic insects (e.g., water striders, water boatmen, and diving beetles). Invertebrate diversities and densities are notably lower than in the upper stream reaches. Fish in the lower reaches are primarily warmwater species. Native fishes include the green sunfish, plains topminnow, plains killifish, fathead minnow, common shiner, and red shiner. Channel catfish are native in larger rivers, especially farther east, and have been stocked extensively.

1.2.2 Lakes and Ponds

Lakes and ponds the size of those at RMA generally support a warmwater aquatic community. Primary production is mostly due to phytoplankton and macrophytes. Zooplankton, particularly copepods and cladocerans (water fleas), are an important component in areas of standing water. Macroinvertebrates include many of the burrowing and free-swimming forms characteristic of warmwater streams. Dragonflies, damselflies, snails, and freshwater mussels are common.

Fishes native to ponds and lakes in the region include the black bullhead, green sunfish, orange-spotted sunfish, and fathead minnow. Many ponds and lakes have been stocked with gamefish for recreational use, mainly panfish such as bluegill or pumpkinseed sunfish and predators such as largemouth bass or northern pike. Green sunfish, black bullhead, and channel catfish are also commonly stocked. Larger ponds and lakes may be stocked with walleye, yellow perch, and black crappie. Rainbow trout and brown trout are frequently added for a put-and-take fishery. Carp are ubiquitous.

Lakes and ponds may support populations of northern leopard frogs and bullfrogs. Marshy areas along pond margins provide breeding habitat for northern chorus frogs, Woodhouse's toads, and Great Plains toads. Another type of toad, the plains spadefoot, is sometimes found near small, shallow ponds. Tiger salamanders also breed in these waters. Aquatic turtles are a minor group in the region; the western painted turtle is the most common species.

For most lakes and ponds in the region--as well as streams--the aquatic community is controlled to a significant extent by management practices and water quality. The semi-arid climate, irregular distribution of runoff events, and use of water for irrigation typically result in widely fluctuating water levels. Salinity, alkalinity, hardness, turbidity, and dissolved oxygen frequently limit the ability of a water body to support a viable fishery.

1.3 AQUATIC RESOURCES OF RMA

Surface waters at RMA include four impoundments collectively known as the South Lakes or Lower Lakes, a number of smaller ponds, and one intermittent-to-perennial stream (Figures 2-1 and 2-2). Field investigations were mostly limited to three of the South Lakes (Lower Derby Lake, Lake Ladora, and Lake Mary) because they are the largest and most complex aquatic ecosystems on the site and receive substantial recreational use as catch-and-release fisheries. Two of these lakes--Lower Derby and Ladora--were used as sources of process cooling water for chemical production at RMA and have a history of contamination. Lake Mary was not part of the process cooling system but received water via overflow or seepage from Lower Derby Lake. A fourth impoundment, Upper Derby Lake, was part of the process cooling system, but it now is mostly dry except following runoff events.

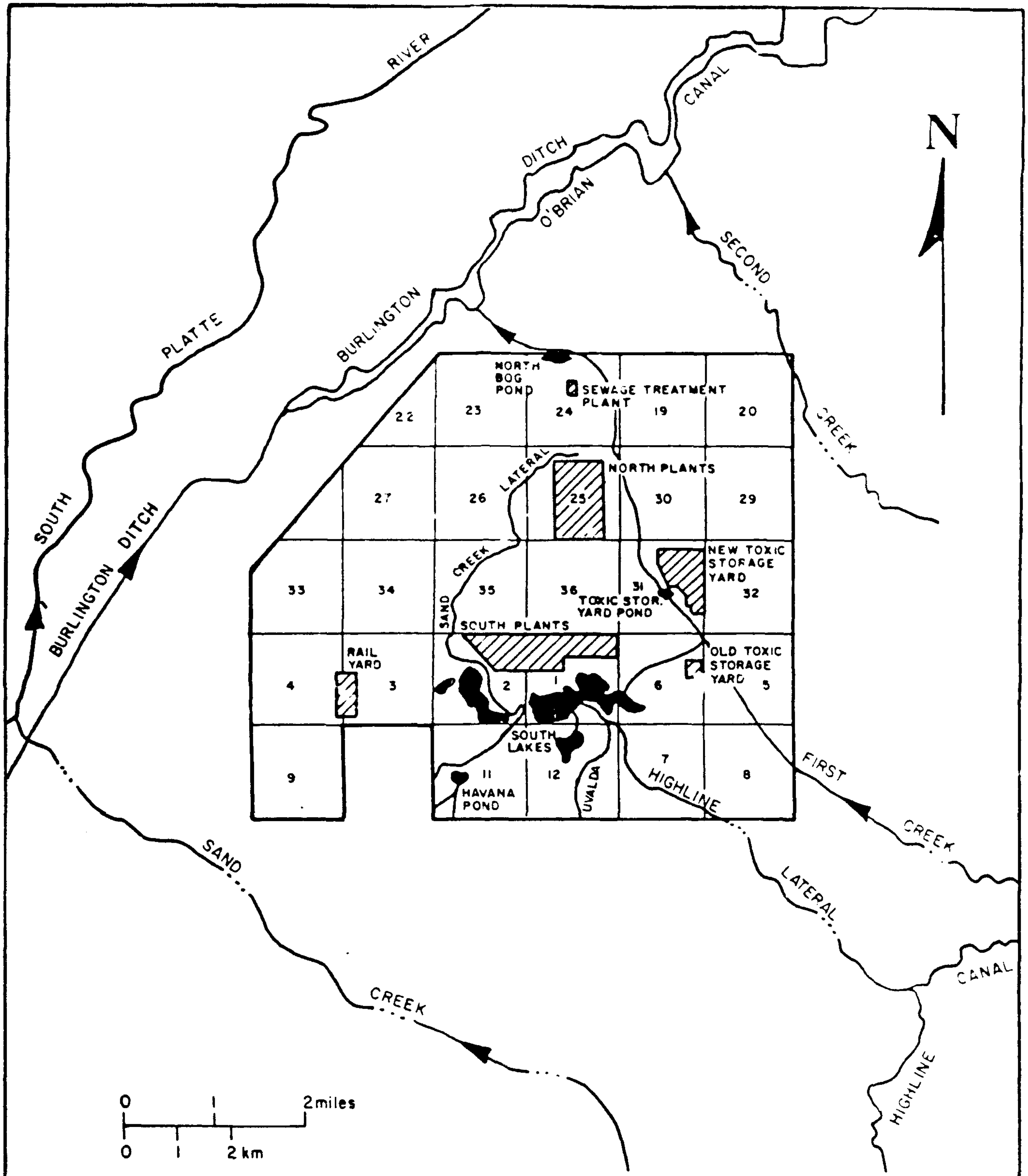

FIGURE 2-1. SURFACE WATERS OF ROCKY MOUNTAIN ARSENAL AND VICINITY.

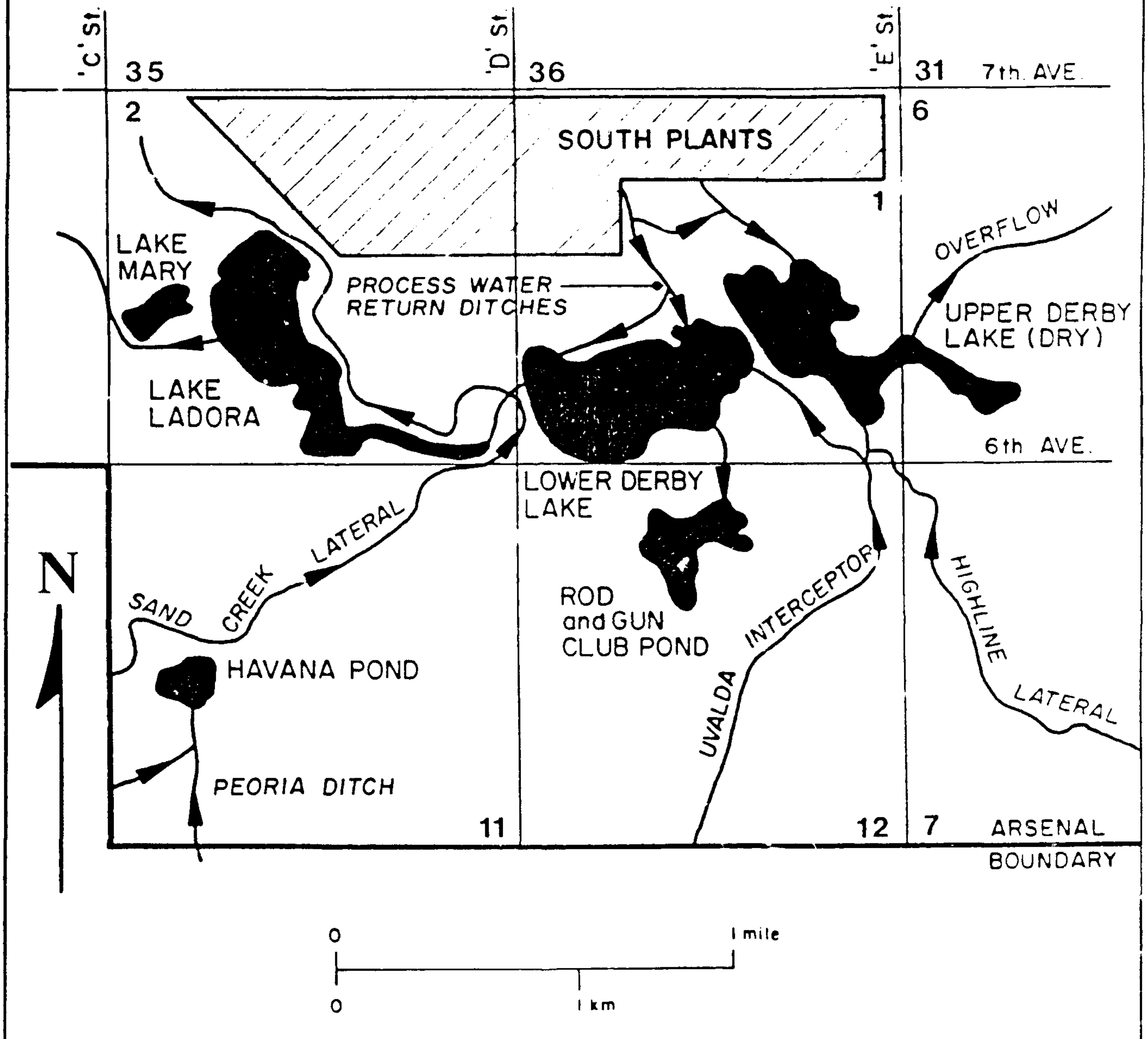

FIGURE 2-2. SOUTH LAKES AND SURROUNDING AREA OF ROCKY MOUNTAIN ARSENAL.

The following subsections briefly describe the surface waters of RMA. For convenience, Lower Derby Lake is sometimes referred to in this report as "Derby Lake", especially on figures and tables. This abbreviation conforms to the name shown on the USGS 7.5 minute topographic quadrangle map.

1.3.1 South Lakes

The largest body of water at RMA is Lower Derby Lake, which has a surface area of about 38 ha and an average depth of 2-3 m. Lower Derby Lake receives inflow from the Irondale Gulch basin (including Upper Derby Lake) and two ditches (Uvalda Interceptor and Highline Lateral), as well as runoff from the South Plants area. Lower Derby Lake existed prior to establishment of the Arsenal, but it was enlarged by the Army for use as process cooling water. The lake substrate is primarily silt with some sand and detritus near the dam.

The second largest lake at RMA is Lake Ladora, which has a surface area of about 25 ha. Its depth averages less than 2 m because of extensive shallows, but the deepest areas exceed 5 m. Lake Ladora is located immediately below (west of) Lower Derby Lake. It also pre-dated the Arsenal but was enlarged by the Army as part of the process cooling system. The shoreline of Lake Ladora is irregular except along the dam, which has been stabilized with discarded concrete. The substrate is composed primarily of silt and sand, with some clay and organic detritus.

Lake Mary is much smaller than Ladora or Lower Derby, with a surface area of only 3.6 ha. Average depth is about 2.7 m, but some areas exceed 4.6 m. The upper portion of Lake Mary is crossed by earthen berms, creating a series of smaller, interconnected ponds. Two small islands occur in the main body of the lake. The substrate of Lake Mary is primarily clay, with some sand, silt, and organic detritus. Lake Mary was constructed by the Army in 1960 for recreational use and was not a source of process cooling water. However, the location of Lake Mary immediately below the dam of Lake Ladora apparently resulted in its receiving contaminated waters from the impoundments upstream.

Upper Derby Lake, the uppermost (easternmost) of the South Lakes, was built by the Army shortly after the Arsenal was established to expand the process cooling water system. The lake currently is used only for flood and overflow storage and thus is dry for much of the year. If the lake were full, it would have a surface area of about 34 ha and an average depth of less than 2 m. The broad, shallow nature of Upper Derby Lake and its intermittent nature make it ideal for breeding by various amphibians, but it does not support fish.

1.3.2 Small Ponds

Three minor water bodies at RMA (North Bog Pond, Rod and Gun Club Pond, and Toxic Storage Yard Pond) occur in areas that were natural marshes before the Arsenal was built. North Bog Pond covers approximately 0.8 ha along the northern boundary, just west of First Creek. The natural seep that fed the marsh is now greatly augmented by excess water from the North Boundary Containment/Treatment System. The pond contained carp and minnows as well as amphibians during field studies.

Rod and Gun Club Pond--actually two separate ponds that coalesce during periods of high water--is located south of Lower Derby Lake. It apparently was excavated in a natural depression between 1965 and 1971. Although an overflow ditch can carry water from Lower Derby Lake into Rod and Gun Club Pond, most of the runoff comes from the surrounding terrain and whatever little additional area is intercepted by the ditch. There is no drainage outlet. The marshy depression covers an area of just under 8 ha, but the main pond (which has not been dry since field studies began in fall 1985) covers only 2 ha and is less than 1 m deep. The pond did not support fish at the time of field studies but was used for breeding by amphibians.

Toxic Storage Yard Pond was originally a series of three small ponds formed by earthen dams constructed across First Creek. The dams have been breached by high runoff, and only one small pond covering less than 0.2 ha remains. A report by Rocky Mountain Fisheries Consultants in 1977 (RMFC 1978) stated that Toxic Storage Yard Pond covered 1 ha and averaged 1 m in depth. The pond apparently supported the same fish species as First Creek, as well as amphibians, and was also stocked with gamefish.

Havana Pond or South Gate Pond is a small impoundment that receives runoff from residential, commercial, and industrial areas south of RMA. Most of the water is carried into the pond by the Havana Street Interceptor and Peoria Ditch. When full, the pond covers less than 8 ha and has an average depth of less than 1 m. Havana Pond supported breeding populations of amphibians during field studies, but it did not contain fish.

1.3.3 First Creek

The only stream on the RMA is First Creek, which drains most of the eastern half of the site (about 24 km^2) and has a length onsite of 9.4 km. First Creek has a maximum discharge capacity of 250 cfs where it enters the southeastern corner of the Arsenal, and 300 cfs where it exits at the northern perimeter (U.S. Army 1983). Its average gradient across the site is 4.9 m/km (26 ft/mi). First Creek is a fairly persistent stream, but in dry years it carries water only during spring and following major storms. The persistence of flow has probably increased as a result of continued residential and commercial development south of RMA. Onsite contribution includes several canals and ditches. First Creek also receives effluent from the sewage treatment plant and overflow water from Upper Derby Lake. The irregular flows and generally poor habitat of First Creek limit its value as an aquatic resource.

The extreme northeastern corner of RMA (about 1 km^2) lies within the Second Creek drainage, although the stream itself does not cross Arsenal property. Basin size of Second Creek is about half that of First Creek, and its flows are less persistent. Second Creek is not currently connected to any onsite water body, but it previously fed a network of irrigation canals on RMA land. Second Creek was not sampled during field studies.

1.3.4 Ditches and Canals

Five canals and ditches enter the Arsenal from the south (Figure 2-2). These are the Highline Lateral and Uvalda Interceptor, which feed into Lower Derby Lake; Havana Street Interceptor and Peoria Ditch, which enter near the South Gate and flow into Havana Pond; and Sand Creek Lateral, which enters west of Havana Pond and terminates north of the North Plants.

The ditches and canals on RMA were not sampled during field studies because they represent extremely limited aquatic habitat and have highly irregular flows. However, most contain a small amount of water during much of the year, and they probably contribute aquatic invertebrates as well as water and sediments to the South Lakes. The Highline Lateral may be a route by which fishes enter Arsenal waters during periods of peak flow.

2.0 METHODS

2.1 GENERAL APPROACH

Aquatic field studies were designed to provide qualitative and quantitative information on the water quality and biotic communities of the South Lakes (Lake Mary, Lake Ladora, and Lower Derby Lake), and an offsite lake (McKay Lake) also located in Adams County. Biotic components investigated included phytoplankton, zooplankton, aquatic macrophytes, benthic macroinvertebrates, fish eggs and larvae, adult and juvenile fish, and amphibians. Sampling was conducted in the spring (April-May), early summer (June), late summer (August), and fall (November) of 1987. Additional samples were collected in April 1988 in conjunction with the collection of fish tissue for contaminant analysis. Data for the additional samples are provided in the Appendices but are not described in the text.

2.2 SAMPLING PROCEDURES

2.2.1 Water Quality

Water samples for laboratory analysis were taken from the upper and lower areas of each lake during all sampling periods. Analytical methods for the water quality parameters are listed in Table 2-1. Each analytical sample was composed of three subsamples, taken 1 m below the surface, at mid-depth, and 1 m above the bottom. Where the water was less than 2 m deep, only a mid-depth sample was collected. Subsamples were collected using a horizontal Van Dorn-style water bottle, composited in a polyethylene carboy, thoroughly mixed, and preserved to stabilize the parameters of interest.

In addition, in-situ measurements of dissolved oxygen, temperature, pH, conductivity, and transparency (Secchi

TABLE 2-1

Methods and Holding Times for Water Quality Analyses

Parameter	Method of Analysis*	Holding Time
Alkalinity	EPA 310.1	14 days
Acidity	EPA 305.1	14 days
Hardness	EPA 130.2	6 months
Total Suspended Solids	EPA 160.2	7 days
Total Dissolved Solids	EPA 160.1	48 hours
Sulfate	EPA 375.3	28 days
Chlorides	EPA 325.3	28 days
True Color	EPA 110.2	48 hours
Turbidity	EPA 180.1	48 hours
Total Phosphate	EPA 365.3	28 days
Dissolved Ortho Phosphate	EPA 365.2	48 hours
Total Kjeldahl Nitrogen	EPA 351.3	28 days
Nitrate+Nitrite Nitrogen	EPA 353.3	28 days
Ammonia Nitrogen	EPA 350.2	28 days
Sodium	EPA 273.1	6 months
Potassium	SM** 322 B	6 months
Magnesium	SM 318 B	6 months

* EPA Guidelines Establishing Test Procedures for the Analysis of Pollutants under the Clean Water Act. 40 CFR Part 136. FR/Vol. 49, No. 209/Friday, October 26, 1984.

** SM = APHA et al. 1985. Standard Methods for the Examination of Water and Wastewater. 16th ed. Washington. 1268p.

visibility) were taken in the upper and lower areas of each lake. In-situ transparency is inversely related to turbidity, which was one of the lab analyses performed. Dissolved oxygen and temperature were measured at depth intervals of 1 m or less throughout the water column. Dissolved oxygen readings were taken within 2 hours of sunset and sunrise to measure the diurnal pulse. Measurements of pH and conductivity were made at the depths where water quality subsamples were collected (i.e., near-surface, mid-depth, and near-bottom).

2.2.2 Phytoplankton

Phytoplankton samples were collected at the same locations and using the same equipment as water quality samples. Samples were taken 1 m below the surface, or at mid-depth in areas less than 2 m deep. Two aliquots were preserved with buffered formalin for analysis of species composition; a third was immediately placed in an ice chest and maintained at 4°C. At the end of the sampling period, each refrigerated aliquot was thoroughly mixed and spiked with saturated magnesium carbonate solution. The aliquots were then passed through glass fiber filters at a vacuum of less than 27 inches of mercury (11 psi) to remove the phytoplankton cells. The filters were folded, placed into glass vials, frozen, and later analyzed for chlorophyll content.

Identification and enumeration of phytoplankton were made using both the Palmer-Maloney method and proportional counting. The Palmer-Maloney method involved settling the phytoplankton in a mild detergent solution for 24 to 48 hours. Excess water was then removed and each sample centrifuged at 2000 rpm for 15 minutes to concentrate the organisms into a small pellet. All but 5 ml of the centrifuged sample was then drawn off, the pellet resuspended, and the contents preserved in buffered formalin. Identification and enumeration were performed by placing 0.1 ml of the sample in a Palmer-Maloney counting chamber, allowing 10 minutes for the organisms to settle, and then scanning at a magnification of 400X. A maximum of twenty fields were examined for each analysis. Identifications were to the lowest taxonomic level practicable.

Proportional counting involved the addition of hydrogen peroxide and potassium dichromate to clear the phytoplankton of organic matter, thereby exposing the diagnostic siliceous valves. Permanent microscope slides were then made using a Hyrax mounting medium. Proportional counts were made by scanning each slide at 1000X and determining the proportion of each taxon within a count of 200 valves.

2.2.3 Zooplankton

The zooplankton communities of the South Lakes included both microzooplankton (rotifers) and macrozooplankton. Samples of microzooplankton were collected in the same manner as for phytoplankton. In areas less than 2 m deep, samples were taken only at mid-depth. In areas greater than 2 m deep, subsamples were taken 1 m below the surface, at mid-depth, and 1 m above bottom.

Macrozooplankton samples were collected using a 0.5-m diameter plankton net with a mesh size of 118 microns (u). The volume of water filtered was measured using two General Oceanic Model 2030 flowmeters mounted on the net. Because of dense growths of submergent aquatic plants, tows were mostly limited to the surface strata. Samples of both macrozooplankton and microzooplankton were preserved with buffered formalin immediately after collection.

Microzooplankton samples were analyzed using a Sedgwick-Rafter Chamber after being washed with tap water in a 64-u sieve to remove the formalin. Samples were thoroughly mixed before portions were placed into the counting chamber. A minimum of 200 organisms (or the number of organisms encountered in five strips) were identified to the lowest practicable level using 100X magnification.

Macrozooplankton samples were identified at 40X magnification using a Ward Counting Wheel. A minimum of 200 organisms were identified to the lowest practicable level.

2.2.4 Benthic Macroinvertebrates

Benthic samples were collected in the upper and lower portions of each lake using a Ponar dredge. A dipnet was used to collect bottom samples where dredge-sampling was not feasible. Samples were washed using a 590-u mesh screen, composited, and preserved with buffered formalin.

Both dredge and dipnet samples were stained in the lab using rose bengal solution. After 24 to 48 hours, the samples were washed through a 590-u screen, and the brightly colored organisms were picked from the detritus and identified to the lowest practicable level.

2.2.5 Fish

Adult and juvenile fish were sampled using a beach seine and boat-mounted electrofishing unit. Fish eggs and larvae were sampled using a towed plankton net and a fry seine. All collections included subsamples from the upper and lower ends of each lake, which were then composited into a single sample.

Beach seines were 7.6 m x 1.8 m and constructed of 3.2-mm netting. Most sampling was done by wading to a depth of about 1 m and hauling the seine to shore. At Lake Mary, a boat was used because of the steep shoreline.

Electrofishing samples were collected using a small boat equipped with a 240-volt, 4000-watt generator coupled to a Coffelt model VVP-15 electrofishing control unit. Two electrodes were positioned about 3 m forward of the boat and two just aft of the working platform. Sampling periods consisted of 30-minute electrofishing runs, usually with two individuals netting fish and one operating the boat.

Fish collected by beach seine or by electrofishing were identified, measured (total length), and weighed. Large catches were randomly subsampled, taking only 25 individuals of each species. Large fish were returned live to the water. Small fish were preserved in buffered formalin. Fry seine samples were taken at the same times and locations as beach seine samples. The fry seine was 3.0 m x 1.8 m and fabricated of 335-u netting. The distance of each haul was 15 m unless precluded by macrophyte beds. All samples were preserved in buffered formalin.

Fish eggs and larvae were sampled using a 5-m plankton net ith a 0.5-m diameter circular mouth and a 335-u mesh size. The distal end of the net was equipped with a quick-couple plankton bucket screened with a 363-u netting. In the lab, the samples were stained with rose bengal solution and washed with tap water across a 120-u sieve. Eggs and larvae were then identified to the lowest practicable level.

Bluegill and largemouth bass were evaluated for "condition" (a measurement that combines weight and length) using Fulton's condition factor K (see Ricker 1971, 1975; Carlander 1977). Fulton's K factor was calculated using the formula:

$$K = \frac{W \times 10^5}{L^3}$$

where W = weight in grams, and
L = length in millimeters.

Condition indices were calculated for fish that were in the same period of growth, or "stanza" (following the recommendation of Carlander 1969, 1977; Ricker 1975). Most fish species have two distinct stanzas: rapid early growth, mainly during the first two years; and subsequent growth, which is slower and tends to decrease with age. These two growth stanzas were treated separately by dividing samples into groups that were <100 mm or $\geq$ 100 mm total length. It was assumed that the smaller size class consisted primarily of the first growth stanza.

2.2.6 Amphibians

Observations of amphibians were incidental to the collection of other aquatic samples. Information recorded included opportunistic sightlings of egg masses, larvae, or adults, and courtship vocalizations ("chorusing") in spring.

2.2.7 Aquatic Plants

Qualitative surveys of aquatic plants were performed during August 1987 to estimate the coverage and community composition of submergent and emergent species. Areal distribution of macrophyte beds was estimated by traversing the lakes in a boat and sketching the extent of the beds on large-scale aerial photographs.

2.3 Tissue Analyses

Samples of macrophytes, plankton, macroinvertebrates, and fish were collected by MKE for analysis of tissue contamination. Chemical analyses were performed by Hunter/ESE. Results of those analyses are presented and discussed in detail in the Biota RI (ESE 1989) and are not included in this report.

3.0 CHARACTERIZATION OF SOUTH LAKES AQUATIC ENVIRONMENTS

3.1 WATER QUALITY

Lower Derby Lake, Lake Ladora, and Lake Mary are man-made reservoirs which have been subjected to a variety of physical and chemical disturbances. These have included draining, sediment removal, lining, and manipulation of water levels, as well as chemical contamination (MKE 1987, ESE 1989). Thus, one would not expect the same degree of equilibrium between water quality and watershed characteristics as is typical of undisturbed lake systems. However, disturbances have been minimal in recent years, and recovery of the South Lakes is evident, both in terms of water quality and aquatic biota.

3.1.1 In-Situ Measurements

In-situ measurements of temperature, dissolved oxygen (DO), pH, conductivity, and transparency (Secchi depth) were taken to provide information useful in comparing conditions among lakes and interpreting conditions within a lake. Data for the three South Lakes are provided in Tables 3-1 through 3-3.

Water temperature in the South Lakes followed a typical seasonal pattern in 1987, with maximum values in August and minimum values in November. Maximum surface water temperatures in August ranged from 21°C to 26°C on the three lakes; minimum values in November were approximately 11°C-12°C. As expected, a pronounced vertical thermal gradient was present in deeper areas during warmer months, but not during cooler months.

Dissolved oxygen levels in surface waters were good (above 80%) through all seasonal samplings, with the majority of DO readings reflecting saturation, and frequently supersaturation. During the warmer months, some pronounced vertical gradients in DO concentration were evident, with very low values in near-bottom samples. Examples of this can be seen in the August data

Table 3-1

In-Situ Water Quality Measurements at Lower Derby Lake, 1987

Date	Water Depth (M)	Sample Depth (M)	Temp. (°C)	DO (mg/l	DO (% Sat.	pH (S.U.)	Conduct. (umhos/cm @25°C)	Secchi Depth (M)
Lower End								
30 Apr	3.5	1.0	16.0	--	--	8.3	617	0.4
		1.5	14.5	--	--	7.7	627	
		2.5	15.5	--	--	8.2	622	
13 May	3.0	1.0	19.5	9.6	105	8.2	615	0.6
		1.5	--	--	--	8.2	620	
		2.0	18.0	5.5	58	--	--	
		3.0	16.5	2.2	23	7.0	596	
9 Jun	3.5	0.5	--	--	--	8.1	--	0.5
		1.0	20.1	8.4	93	--	550	
		2.0	20.1	5.3	58	7.9	550	
		3.0	19.7	0.9	10	7.0	575	
		3.3	18.9	0.2	2	--	--	
11 Aug	3.5	0.5	--	--	--	9.0	425	0.6
		1.0	26.0	11.3	139	--	--	
		2.0	24.0	6.5	77	8.8	425	
		3.0	23.0	4.0	47	8.7	450	
		3.3	23.0	3.0	35	--	--	
3 Nov	3.5	0.5	12.5	--	--	--	510	0.6
		1.0	12.5	12.1	114	8.5	--	
		2.0	12.2	11.4	106	8.4	485	
		3.0	12.0	10.8	100	--	--	
		3.3	11.9	9.7	90	8.4	495	
5 Nov	3.5	1.0	11.5	11.3	104	8.3	480	0.6
		2.0	11.2	10.8	99	8.3	475	
		3.0	11.1	11.2	102	8.2	480	
		3.3	11.0	11.3	102	--	--	
Upper End								
30 Apr	1.3	0.5	16.0	--	--	8.1	610	0.3
13 May	2.0	0.5	19.5	9.1	99	--	--	0.6
		1.0	19.0	8.4	91	8.0	634	
		1.5	18.5	6.3	67	--	--	
		1.8	18.0	4.8	51	--	--	
9 Jun	1.5	0.7	21.0	9.9	111	8.4	550	
11 Aug	2.1	0.5	--	--	--	8.7	--	0.5
		1.0	24.0	11.6	138	8.9	425	
		2.0	23.5	7.4	87	--	450	
3 Nov	1.5	0.5	12.2	11.6	108	8.6	512	0.6
		1.3	12.0	11.5	107	--	--	
5 Nov	1.9	1.0	10.8	11.0	99	8.3	487	0.6
		1.7	10.3	10.7	95	--	--	

Table 3-2

In-Situ Water Quality Measurements at Lake Ladora, 1987

Date	Water Depth (M)	Sample Depth (M)	Temp. (°C)	DO (mg/l	DO (% Sat.	pH (S.U.)	Conduct. (umhos/cm @25°C)	Secchi Depth (M)
Lower End								
29 Apr	5.1	0.5	--	--	--	8.3	617	2.8
		1.0	16.8	9.1	94	--	--	
		1.5	--	--	--	7.7	627	
		2.5	16.8	8.7	90	8.2	622	
		4.5	13.5	7.1	68	--	--	
13 May	4.5	1.0	20.0	10.1	111	--	740	3.0
		2.0	20.0	10.1	111	--	--	
		3.0	17.5	9.2	96	8.0	680	
		4.0	15.5	8.8	88	--	--	
		4.3	14.5	7.8	77	7.8	699	
8 Jun	4.8	1.0	21.0	11.3	127	8.2	640	2.5
		2.0	21.0	11.1	125	8.3	653	
		3.0	20.5	10.6	118	--	--	
		4.0	19.8	7.2	79	8.0	671	
		4.6	18.8	4.2	45	--	--	
10 Jun	5.0	0.5	--	--	--	8.3	550	3.6
		1.0	22.5	9.8	113	--	--	
		2.0	21.2	10.3	116	8.6	550	
		3.0	20.2	9.3	103	7.9	575	
		4.0	20.0	7.0	77	--	--	
		4.8	18.7	0.8	9	--	--	
10 Aug	5.0	0.5	--	--	--	8.9	600	2.6
		1.0	23.0	8.2	96	--	--	
		2.0	23.0	8.2	96	--	--	
		3.0	23.0	5.4	63	8.9	550	
		4.0	22.5	1.2	14	--	--	
		4.8	21.5	0.3	3	8.9	600	
30 Aug	5.0	1.0	22.2	6.7	77	8.6	700	2.6
		2.0	22.0	7.4	85	--	--	
		2.5	22.5	--	--	--	700	
		3.0	22.0	7.1	81	--	--	
		4.0	21.9	4.0	46	8.2	700	
		4.8	21.5	1.7	19	--	--	
2 Nov	4.3	0.5	--	--	--	8.1	700	3.8
		1.0	11.9	11.2	104	--	--	
		2.0	11.5	10.9	100	8.4	750	
		3.0	11.3	11.0	100	8.5	725	
		4.1	11.2	10.5	96	--	--	

Table 3-2
(continued)
In-Situ Water Quality Measurements at Lake Ladora, 1987

Date	Water Depth (M)	Sample Depth (M)	Temp. (^{o}C)	DO (mg/l	DO (% Sat.	pH (S.U.)	Conduct. (umhos/cm @25^{o}C)	Secchi Depth (M)
Upper End								
29 Apr	1.3	0.5	16.8	9.2	95	8.1	610	1.0
		1.1	16.8	9.2	95	--	--	
13 May	1.0	0.5	20.5	10.5	117	8.1	720	0.8
8 Jun	1.3	0.6	21.5	10.7	121	8.0	658	1.0
		1.1	21.0	9.2	103	--	--	
10 Jun	1.3	0.5	21.0	13.3	150	8.0	550	1.2
		1.1	20.2	>15.0	--	--	--	
10 Aug	1.9	0.5	22.5	9.3	107	7.8	800	1.9
13 Aug	1.0	0.5	21.2	10.6	119	7.8	800	0.8
		0.8	21.0	12.7	143	--	--	
2 Nov	1.2	0.5	12.0	10.9	101	7.6	765	1.2
		1.0	12.0	11.7	108	--	--	

Table 3-3

In-Situ Water Quality Measurements at Lake Mary, 1987

Date	Water Depth (M)	Sample Depth (M)	Temp. (°C)	DO (mg/l	DO (% Sat.	pH (S.U.)	Conduct. (umhos/cm @25°C)	Secchi Depth (M)
Lower End								
30 Apr	3.5	0.5	--	--	--	8.3	673	2.6
		1.0	17.5	10.6	111	--	--	
		2.0	17.0	10.7	112	8.3	680	
		3.0	16.5	10.2	104	8.2	669	
		3.3	16.5	10.3	105	--	--	
14 May	3.0	1.0	22.0	12.9	148	8.8	696	2.5
		1.8	--	--	--	8.7	685	
		2.0	19.0	12.5	135	8.8	--	
		2.8	19.0	12.8	138	--	--	
10 Jun	3.0	0.5	--	--	--	9.5	625	2.2
		1.0	21.0	13.9	156	--	--	
		2.0	21.0	12.7	142	9.3	600	
		2.8	20.9	14.3	160	9.0	605	
11 Aug	3.5	0.5	--	--	--	9.2	550	2.5
		1.0	23.6	8.4	99	9.2	--	
		2.0	23.2	4.5	53	--	550	
		3.0	22.5	1.2	14	--	--	
		3.3	22.0	1.2	14	8.9	550	
3 Nov	3.5	0.5	11.9	10.3	95	9.0	700	2.8
		1.5	11.8	10.5	97	8.9	700	
		2.8	11.4	9.1	83	8.8	710	
Upper End								
30 Mar	1.5	0.5	--	--	--	8.5	653	1.2
		1.0	17.5	11.6	121	--	--	
14 May	2.5	1.0	20.0	14.2	156	8.9	671	2.1
		1.8	--	--	--	9.0	680	
		2.0	20.0	>15.0	--	8.9	675	
		2.3	19.0	>15.0	--	--	--	
10 Jun	1.5	0.5	--	--	--	9.3	625	1.5
		1.0	21.0	14.9	167	--	--	
		1.3	20.9	9.6	107	--	--	
11 Aug	2.5	0.5	--	--	--	9.6	600	1.9
		1.0	24.8	9.9	119	--	--	
		1.5	23.5	--	--	9.6	600	
		2.0	22.5	1.5	17	--	--	
		2.3	--	--	--	9.5	600	
3 Nov	1.5	0.5	--	--	--	9.1	750	1.5
		1.0	12.1	10.3	96	--	--	
		1.3	11.5	9.5	87	--	--	

from the deeper portions of the three South Lakes (Tables 3-1 through 3-3). Low DO concentrations in deeper water during the warmer months are typical of naturally productive lakes.

Development of a strong vertical gradient in DO reflects a situation in which oxygen depletion in the lower part of the water column (due to a high oxygen demand associated with biodegradation of detritus) exceeds oxygenation near the surface (due to photosynthesis or atmospheric re-aeration). The magnitude of the gradient observed in the South Lakes suggested considerable loading of organic matter, mostly attributable to primary production of phytoplankton and aquatic macrophytes. The condition of DO supersaturation frequently encountered in the South Lakes (i.e., from photosynthesis) and the extensive development of aquatic macrophytes along the margins of the lakes reinforce this conclusion. The daily variation in DO concentrations (lowest in early morning and highest in afternoon) indicates active and substantial community metabolism (Appendix A, tables A-1 through A-3).

Values of pH recorded during the seasonal samplings were generally between 8.0 and 9.0; the range for all readings was 7.0 to 9.6. At the higher end of the range (i.e., greater than 9.0), pH approached the limits of suitability for aquatic biota. In productive lakes, pH frequently becomes elevated as phytoplankton and aquatic plants extract carbon dioxide for photosynthesis.

Conductivity measurements indicated a substantial dissolved mineral content in all three South Lakes. The ranges of recorded values (in micromhos per centimeter) were as follows: Lower Derby, 425-634; Ladora, 550-800; and Mary, 550-750.

Water transparency in the three lakes, as indicated by Secchi depth measurements, was least in Lower Derby and greatest in Ladora. Maximum Secchi visibility was recorded in November for both Lake Ladora (3.8 m) and Lake Mary (2.8 m). The minimum

Secchi depth for Lake Ladora (0.8 m) was recorded in the shallow upper part of the lake during both May and August, while the minimum visibility for Lake Mary (1.2 m) was recorded in the shallow eastern area during April. Secchi depth values recorded for Lower Derby Lake were fairly uniform across the sampling periods, ranging from 0.3 to 0.6 m. These results indicate a higher burden of suspended particulate matter (i.e., greater turbidity) in Lower Derby Lake than in either Lake Ladora or Lake Mary.

3.1.2 Laboratory Analyses

3.1.2.1 General Water Quality Indicators (Table 3-4)

Alkalinity

Measurements of alkalinity ranged from 99 mg/l for the November sample from Lake Mary to 181 mg/l for the April sample from Lake Mary. These values represent moderate alkalinity and reflect a substantial buffering capacity within the lakes. With the exception that maximum values for all three lakes were recorded in April, there were no consistent spatial or temporal patterns in alkalinity.

Acidity

Acidity was not detected in any samples.

Hardness

Hardness measurements ranged from 98 mg/l to 184 mg/l, indicating relatively hard water. Concentrations were consistently highest for Lake Ladora (mean = 179) and lowest for Lake Mary (mean = 116). Like alkalinity, hardness was highest in April for each lake.

TABLE 3-4

General Water Quality Indicators of the South Lakes, 1987[1]

Parameter	Sample	Lake Derby	Lake Ladora	Lake Mary
Total Alkalinity (mg/l as $CaCO_3$)	Apr	124	147	181
	Jun	104	136	108
	Aug	100	126	114
	Nov	109	106	99
Acidity (mg/l as $CaCO_3$)	Apr	0	0	0
	Jun	0	0	0
	Aug	0	0	0
	Nov	0	0	0
Hardness (mg/l as $CaCO_3$)	Apr	160	184	154
	Jun	148	184	98
	Aug	132	168	108
	Nov	125	180	105
Total Suspended Solids (mg/l)	Apr	24	4	7
	Jun	20	3	2
	Aug	18	3	14
	Nov	15	3	6
Total Dissolved Solids (mg/l)	Apr	378	423	413
	Jun	400	434	360
	Aug	365	440	445
	Nov	290	430	410
True Color (Pt-Co Units)	Apr	--	--	--
	Jun	48	28	24
	Aug	15	15	22
	Nov	25	25	25
Turbidity (NTU)	Apr	11	3.3	1.6
	Jun	12	2.2	1.2
	Aug	11	0.6	4.9
	Nov	6.9	1.7	2.2

1 All data for samples from 1 m or the nearest depth interval (0.5-1.3 m).

Total Dissolved Solids (TDS)

Concentrations of dissolved solids were similar for all three lakes, although Lower Derby Lake averaged slightly lower, with values fairly uniform across the four sampling periods. The TDS values, which ranged from 290 mg/l for Lower Derby in November to 445 mg/l for Lake Mary in August, indicated a substantial content of dissolved minerals. This finding is consistent with conductivity values measured in-situ (see above).

Total Suspended Solids (TSS)

Lake Ladora and Lake Mary both had a very low load of suspended solids, with mean values of 3.2 and 7.2 mg/l, respectively. Lower Derby Lake had a higher TSS, which declined steadily over the four seasons from 24 mg/l in April to 15 mg/l in November. This probably reflects that most runoff into the South Lakes system enters at Lower Derby Lake, and that runoff is greatest during the spring. The extensive mudflat shoreline of Lower Derby undoubtedly contributes to sediment loading when the lake is filled during spring.

Turbidity

Turbidity was consistently low in lakes Ladora and Mary and slightly higher in Lower Derby during the four sampling periods. Values ranged from 0.6 to 3.3 NTU in Ladora, from 1.2 to 4.9 in Mary, and from 6.9 to 12.0 in Lower Derby. Turbidity values were generally consistent with TSS and Secchi depth measurements of total suspended solids and transparency, as would be expected.

True Color

Color measurements revealed a low amount of color in the waters of the three lakes. No spatial or temporal patterns in the recorded values could be discerned.

3.1.2.2 Nutrients (Table 3-5)

Nitrogen (N)

Results of combined nitrogen analyses revealed greater concentrations of the reduced forms of organic-N and ammonia-N than the oxidized forms of nitrate-N and nitrite-N. This suggests that available nitrogen tended to be held in algal and macrophytic biomass and was rapidly recycled following decomposition of organic matter. Concentrations of total combined nitrogen were in the low-to-moderate range and were capable of supporting a healthy community of primary producers.

Nitrate-N plus nitrite-N values were at or below 0.2 mg/l, except for a 2.6 mg/l value from Lake Mary in November. It is unknown whether this high concentration reflected analytical variability or a real increase. No spatial or temporal patterns in nitrite and nitrate concentrations were detected.

Ammonia-N concentrations in the South Lakes were in the low-to-moderate range. Organic-N concentrations (computed by subtracting ammonia-N from total Kjeldahl-N) reflected the large amount of organic matter (algal and macrophytic biomass) within the lakes. No notable patterns were evident in concentration among the lakes, or over time within the lakes, except for the regular increase over the four sampling periods for Lake Mary.

Phosphorus (P)

Concentrations of both total P and dissolved reactive P were low, mostly at or below detection limits. No spatial or temporal patterns in concentration were evident. At the low concentrations recorded, phosphorus might be a limiting factor for phytoplankton within the South Lakes.

TABLE 3-5

Concentrations of Primary Nutrients (N & P) in the South Lakes[1]

Parameter	Sample	Lake Derby	Lake Ladora	Lake Mary
Nitrate+Nitrite N (mg/l)	Apr	0.04	0.06	0.06
	Jun	0.10	0.07	0.07
	Aug	0.20	0.15	0.16
	Nov	0.09	0.11	2.60
Ammonia N (mg/l)	Apr	0.35	0.10	0.07
	Jun	0.45	0.22	0.19
	Aug	0.07	0.25	0.18
	Nov	0.11	0.34	0.50
Total Kjeldahl N (mg/l)	Apr	1.55	0.85	0.40
	Jun	3.65	1.08	0.67
	Aug	1.20	0.81	1.72
	Nov	0.93	1.96	2.60
Organic N (mg/l)	Apr	1.20	0.75	0.33
	Jun	3.20	0.86	0.48
	Aug	1.13	0.56	1.54
	Nov	0.82	1.62	2.10
Total Combined N (mg/l)	Apr	1.59	0.91	0.46
	Jun	3.75	1.15	0.74
	Aug	1.40	0.96	1.88
	Nov	1.02	2.07	5.20
Dissolved Reactive P (mg/l)	Apr	<.07	<.07	<.07
	Jun	<.01	<.01	<.01
	Aug	0.01	<.01	0.03
	Nov	<.01	0.08	<.01
Total P (mg/l)	Apr	0.07	<.07	<.07
	Jun	0.11	<.07	<.07
	Aug	0.10	<.07	0.14
	Nov	0.12	<.07	<.07

1 All data for samples from 1 m or the nearest depth interval (0.5-1.3 m).

3.1.2.3 Principal Anions and Cations (Table 3-6)

Anions

Information on principal anions and cations in the waters of the South Lakes was developed through direct analyses for chloride and sulfate, and computations of carbonate and bicarbonate based on alkalinity data (APHA 1985). A review of this information indicates a relatively even distribution of anions among bicarbonate, chloride, and sulfate, although bicarbonate was present in slightly greater concentrations. The highest concentrations for these three anions were recorded during April from all three lakes. Also, chloride steadily declined over the four sampling periods (Figure 3-1). This might be related to dilution by precipitation and inflow from spring through early fall.

Carbonate was only occasionally detected in samples from Lower Derby and Ladora, and only at very low concentrations. In contrast, Lake Mary samples consistently had low-to-moderate concentrations of carbonate. The presence of carbonate in Lake Mary was responsible for its slightly higher pH.

The relative concentrations of the principal anions within each of the RMA lakes, based on four seasonal samples, may be characterized as follows:

Lower Derby:	bicarbonate > sulfate > chloride > carbonate
Ladora:	bicarbonate > sulfate > chloride > carbonate
Mary:	bicarbonate > chloride > sulfate > carbonate

A preliminary analysis of anion-cation balance suggests the presence of other, unmeasured anions in the lakes, some of which might be present in greater concentrations than carbonates.

TABLE 3-6

Concentrations of Selected Anions and Cations in the South Lakes, 1987[1]

Parameter	Sample	Lake Derby	Lake Ladora	Lake Mary
Bicarbonate (mg/l)	Apr	124	147	167
	Jun	104	136	100
	Aug	94	122	74
	Nov	105	106	81
Carbonate (mg/l)	Apr	0	0	14
	Jun	0	0	8
	Aug	6	4	40
	Nov	4	0	18
Chloride (mg/l)	Apr	85	85	113
	Jun	60	71	96
	Aug	42	67	94
	Nov	25	64	89
Sulfate (mg/l)	Apr	106	126	56
	Jun	66	81	37
	Aug	58	81	51
	Nov	59	95	64
Sodium (mg/l)	Apr	79	89	103
	Jun	80	88	114
	Aug	59	87	96
	Nov	68	80	88
Potassium (mg/l)	Apr	11.0	4.3	5.0
	Jun	5.2	3.2	3.6
	Aug	5.5	3.7	4.9
	Nov	4.0	3.9	3.4
Magnesium (mg/l)	Apr	5.4	6.4	5.3
	Jun	4.4	4.8	4.5
	Aug	13.7	13.1	13.3
	Nov	11.9	17.6	13.1

1 All data for samples from 1 m or the nearest depth interval (0.5-1.3 m).

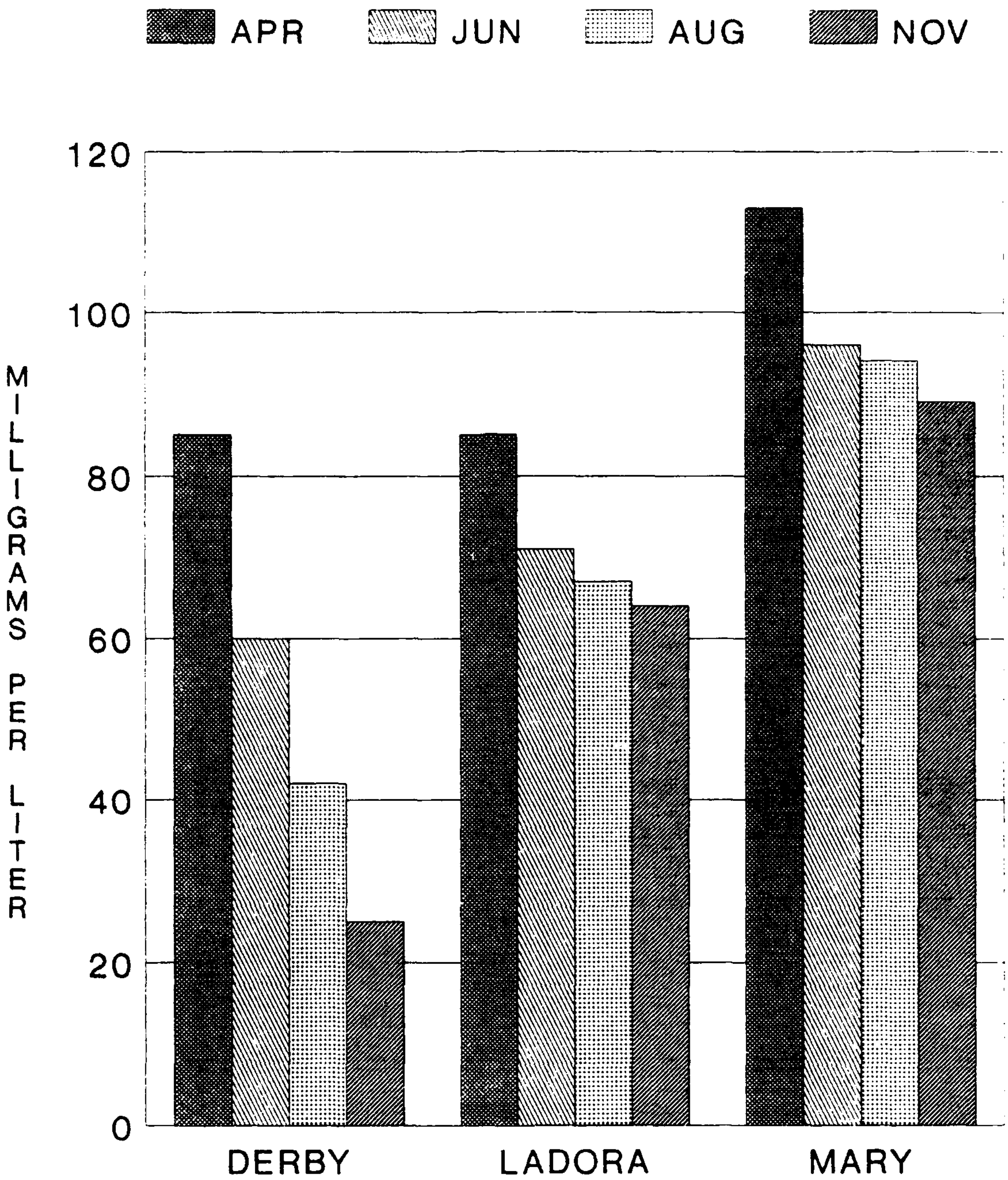

FIGURE 3-1. CHLORIDES IN THE SOUTH LAKES

Cations

Principal cations in the three Arsenal lakes, in decreasing order, were sodium, calcium, magnesium, and potassium. Sodium concentrations were generally lowest in Lower Derby and highest in Mary, while levels of potassium and magnesium were similar among all lakes. Calcium concentrations were calculated from magnesium and hardness values, and therefore little can be said regarding patterns. However, comparison of the magnesium and hardness data suggests that calcium was generally highest in Lake Ladora and lowest in Lake Mary.

3.2 PHYTOPLANKTON

3.2.1 Abundance

Densities of phytoplankton in the South Lakes ranged from very low in April for lakes Ladora and Mary (162 and 129 units/ml, respectively) to very high (24,893 units/ml) in August for Lower Derby Lake (Table 3-7; Figure 3-2). Phytoplankton numbers in Lower Derby were consistently and substantially higher than in Ladora and Mary. This was at least partly responsible for the reduced transparency of Lower Derby.

3.2.2 Community Composition

Although green algae (chlorophytes) were generally prevalent in the phytoplankton of the South Lakes, relative abundance data revealed a considerable flux in community composition over the four sampling periods (Table 3-7). The following discussion treats community composition at the phylum and genus levels; species-level information is provided in Appendix B, tables B-1 through B-3.

Table 3-7

Relative Abundance (%) of Principal Phyla of Phytoplankton at RMA During Each of the Four Seasonal Samplings, 1987

Sample	Total Phytoplankton Density (units/ml)	Chlorophyta	Chrysophyta	Bacillariophyta	Euglenophyta	Cryptophyta	Cyanophyta	Pyrrhophyta
Lake Derby								
Apr	1,357	73.7	0	25.8	0.5	0	0	0
Jun	11,800	84.7	0	14.0	0.9	0	0.4	0
Aug	24,893	87.8	0	3.8	2.4	0	4.2	1.8
Nov	17,368	6.5	3.7	2.8	1.4	29.8	54.9	0.9
Lake Ladora								
Apr	162	12.6	17.0	35.2	0	25.8	9.4	0
Jun	784	71.4	0	27.7	0.5	0	0.5	0
Aug	2,740	81.2	0	15.4	0	0	3.4	0
Nov	1,390	65.4	26.0	22.5	0	12.1	2.3	0
Lake Mary								
Apr	129	92.7	0	0	5.4	0	1.8	0
Jun	251	84.4	0	14.1	0	0	1.6	0
Aug	2,089	87.0	0	4.0	0	0	5.5	3.5
Nov	5,205	3.1	0.9	76.6	1.3	7.0	11.0	0

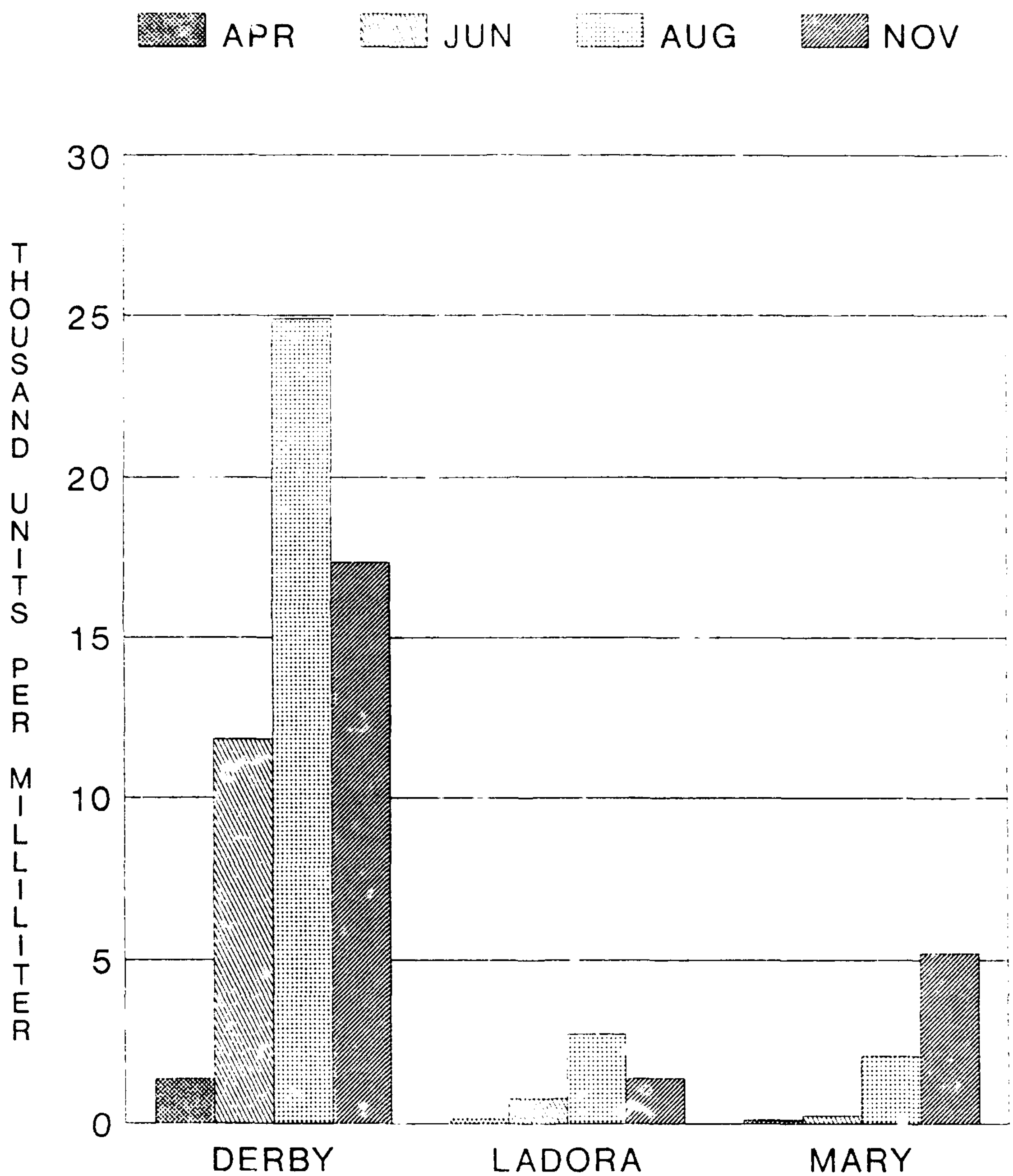

FIGURE 3-2. PHYTOPLANKTON DENSITIES IN THE SOUTH LAKES

Lower Derby Lake

Composition of the phytoplankton community in Lower Derby Lake was similar in April and June, although there was a nearly 9-fold increase in phytoplankton density (Table 3-7). Green algae were dominant during this period, followed in abundance by diatoms (bacillariophytes). The most abundant genera in April were the chlorophytes *Oocystis* and *Selenastrum*. In June, *Oocystis* was followed in abundance by the diatom *Cyclotella*. The chlorophyte *Scenedesmus* had the third highest density during both April and June (Table 3-8).

The August sample from Lower Derby, which had the highest phytoplankton density of any sample collected (24,893 units/ml), was overwhelmingly dominated by the chlorophyte *Chlorella*. Although total density remained high in the November sample, there was a shift in composition to a community dominated by blue-green algae (cyanophytes) and cryptophytes (Table 3-7). The November sample was dominated by the blue-green alga *Microcystis*, and the cryptophytes *Rhodomonas* and *Cryptomonas* (Table 3-8).

Phytoplankton community diversity was generally lower in Lower Derby Lake than in lakes Mary and Ladora because of the small number of taxa observed in relation to total density (Table 3-9). However, the mean number of taxa (28) was intermediate between Lake Mary (16) and Lake Ladora (41).

Lake Ladora

The phytoplankton community of Lake Ladora changed considerably between the April and June samples. The April sample had a very low density, and the most common forms were the cryptophyte *Cryptomonas*, the chrysophyte *Kephyrion*, and the diatom *Fragilaria*. The June sample showed approximately a 5-fold increase in density and a shift in community dominance to chlorophytes, notably *Chlorella* and *Scenedesmus* and diatoms

Table 3-8

Relative Abundance of Genera Representing Over 5% of the Phytoplankton Communities at RMA, 1987

April		June		August		November	
Lower Derby							
Oocystis	(23.4%)	Oocystis	(66.4%)	Chlorella	(84.3%)	Microcystis	(49.8%)
Selenastrum	(21.0%)	Cyclotella	(11.7%)			Rhodomonas	(11.6%)
Scenedesmus	(8.6%)	Scenedesmus	(7.2%)			Cryptomonas	(17.7%)
Navicula	(8.3%)						
Cyclotella	(8.2%)						
Cosmarium	(5.3%)						
Melosira	(5.3%)						
Lake Ladora							
Cryptomonas	(21.4%	Chlorella	(42.2%)	Oocystis	(45.6%)	Oocystis	(22.5%)
Kephyrion	(17.0%)	Scenedesmus	(7.2%)	Chlamydomonas	(16.1%)	Chytridiochloris	(15.0%)
Fragilaria	(16.6%)			Scenedesmus	(6.0%)	Chlorochromonas	(9.8%)
Chroococcus	(6.3%)					Selenastrum	(6.4%)
Lake Mary							
Chlamydomonas	(34.6%)	Trochiscia	(40.6%)	Oocystis	(29.5%)	Fragilaria	(53.8%)
Quadrigula	(21.8%)	Oocystis	(20.3%)	Sphaerocystis	(20.5%)	Oscillatoria	(10.6%)
Oocystis	(20.0%)	Tetraedron	(6.2%)	Dictyosphaerium	(13.0%)	Cyclotella	(9.2%)
Scenedesmus	(7.3%)	Scenedesmus	(6.2%)	Scenedesmus	(8.5%)	Cocconeis	(7.3%)
				Chlamydomonas	(5.5%)		

TABLE 3-9

Phytoplankton Density and Number of Taxa at RMA, 1987

Lake		April	June	August	November	Mean
Derby	no./ml	1,357	11,800	24,893	17,368	13,854
	no. taxa	28	19	29	36	28
Ladora	no./ml	162	784	2,740	1,390	1,269
	no. taxa	44	36	36	48	41
Mary	no./ml	129	251	2,089	5,205	1,918
	no. taxa	9	30	31	24	24

(Table 3-7). The August sample also was dominated by chlorophytes (Oocystis and Chlamydomonas), and density had increased more than 3-fold compared to June.

The November sample reflected about a 50 percent decline in density from August and a resurgence of chrysophytes (Chytridiochloris, Chlorochomonas) and cryptophytes (Rhodomonas) in addition to chlorophytes and diatoms (Table 3-8).

The samples collected from Lake Ladora consistently contained the greatest variety of phytoplankton, with numbers of taxa ranging from 36 to 48 in the four seasonal samples. In conjunction with relatively low total density, this resulted in Lake Ladora having higher community density than the other two lakes (Table 3-9).

Lake Mary

Lake Mary was similar to Lake Ladora in phytoplankton densities, but not in community composition. The number of taxa identified for Lake Mary were considerably lower than for Lake Ladora (Table 3-9). In fact, Lake Mary had the lowest number of taxa at RMA, both for a single sampling period (9 taxa in April) and averaged across the four seasons (24).

April samples from Lake Mary had low densities of phytoplankton, with green algae representing the majority of taxa in the sample (Table 3-7). The most common forms were Chlamydomonas (a green flagellate), Quadrigula, and Oocystis (Table 3-8). The June sample from Lake Mary also had a low density and was dominated by green algae (mostly Trochiscia and Oocystis, Table 3-8).

Phytoplankton concentration increased 8-fold between the June and August samples, although both samples were dominated by green algae (Table 3-7). The phytoplankton concentration more than doubled again by November, and the community shifted to one dominated by diatoms and blue-green algae (Table 3-7). The most common form in the November sample was the diatom Fragilaria, which accounted for over half of the total concentration. The most abundant cyanophyte was Oscillatoria.

3.2.3 Chlorophyll

Concentrations of chlorophyll in plankton samples can indicate phytoplankton biomass, primary productivity (EPA 1985), and composition. Chlorophyll constitutes about 1 to 2 percent of the dry weight of phytoplankton (APHA 1985). It also is possible to use the relative concentrations of the various forms of chlorophyll (a, b, and c) and phaeophytins (chlorophyll degradation products) as a basis for inferring relative abundances of various phyla of algae in the phytoplankton. This was not done in this study because of the availability of actual species information.

Measurements of the various forms of chlorophyll and phaeophytin yielded values ranging from very low to high (Appendix tables B-5 through B-7). The following discussion focuses on chlorophyll-a concentrations since this form is universally present in phytoplankton and thus is most often used as an indicator of algal biomass and productivity.

Chlorophyll-a concentrations in samples of phytoplankton from the South Lakes suggested a generally higher algal biomass in Lower Derby Lake than in lakes Ladora and Mary (Figure 3-3). This general pattern was consistent with phytoplankton density data for the three lakes. However, chlorophyll-a values for individual samples did not always correlate well with phytoplankton densities. An example of this can be seen in the April data for lakes Ladora and Mary, which showed both the lowest phytoplankton densities and the highest chlorophyll-a concentrations. This type of inconsistency is not uncommon, because the relationship between chlorophyll concentration and phytoplankton density is affected by the chlorophyll content of the individual cells. For example, a few large algal cells

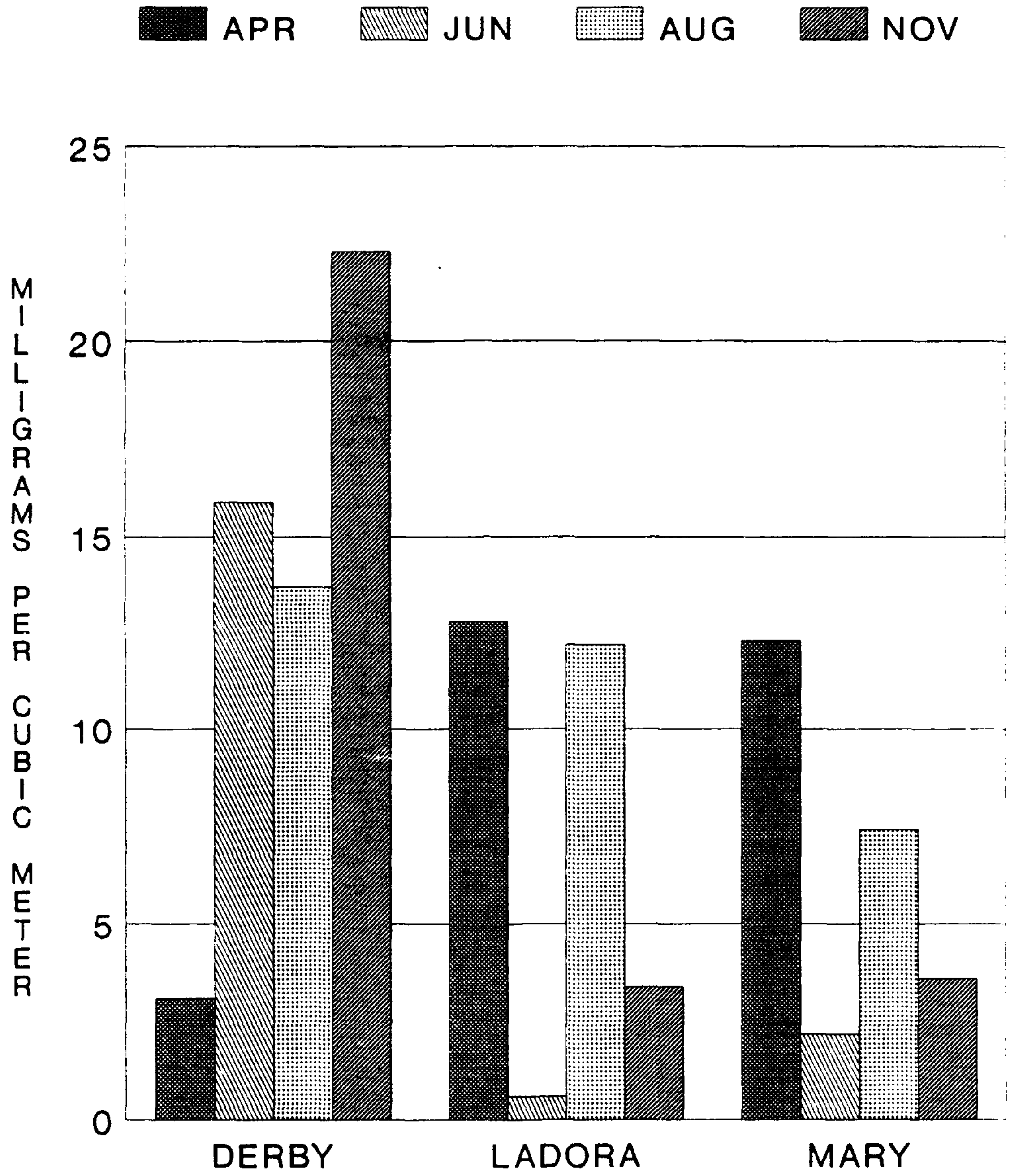

FIGURE 3-3. CHLOROPHYLL a IN THE SOUTH LAKES.

could contain the same chlorophyll content as a much greater number of smaller cells.

The very low concentration of phaeophytin compared to chlorophyll indicates healthy phytoplankton communities.

3.3 ZOOPLANKTON

3.3.1 Microzooplankton Community

The microzooplankton communities of the South Lakes were composed entirely of rotifers (Table 3-10; Appendix C, Tables C-1 through C-3). All taxa recorded are commonly associated with ponds and small lakes (Pennak 1978). The most diverse community was found in Lake Mary, where 17 taxa were identified. A total of 11 taxa were identified from Lake Ladora, and 8 taxa were identified from Lower Derby Lake. The number of taxa per sampling period was always 5 in Lower Derby, 5-7 in Ladora, and (from June through November) 8-11 in Mary. No rotifers (microzooplankton) were found in April samples from Lake Mary.

Averaged over the year, the microzooplankton communities of the South Lakes were dominated by four rotifer taxa: *Branchionus angularis*, *Keratella cochlearis*, *K. stipitata* and *Polyarthra* sp. (Figure 3-4). *Polyarthra* and *Keratella* typically occur in open waters of lakes and ponds, where they can become abundant (Ward and Whipple 1959, Pennak 1978). *Branchionus* are most often found in the littoral (shore) zone, although some forms occur in the limnetic (open water) zone.

The microzooplankton communities of the South Lakes were dynamic, varying seasonally both within and among the lakes. This type of temporal variability is common (see Pennak 1978). Two similarities in seasonal abundance were the prominence of *K. cochlearis* in Lower Derby and Ladora during spring and summer, and the dominance of *K. stipitata* and *Polyarthra* sp. in all three lakes during fall. Notable differences between Lake Mary

Table 3-10

Microzooplankton Collected from the South Lakes, 1987

Taxa	Lake Derby	Lake Ladora	Lake Mary
Rotatoria sp.	X	X	X
Synchaetidae			
Polyarthra sp.	X	X	X
Asplanchnidae			
Asplanchna sp.	X	X	X
Branchionidae			
Branchionus angularis	X		X
B. calyciflorus	X		X
Keratella cochlearis	X	X	X
K. quadrata	X	X	X
K. stipitata	X	X	X
Lecane luna		X	X
Lepadella patella			X
Monostyla bulla		X	X
M. closterocerca			X
M. quadridentata		X	
M. lunaris		X	X
Notholca sp.		X	X
Platyias patulus			X
P. quadricornis			X
Trichoteria tetractis			X
Total Number of Taxa	8	11	17

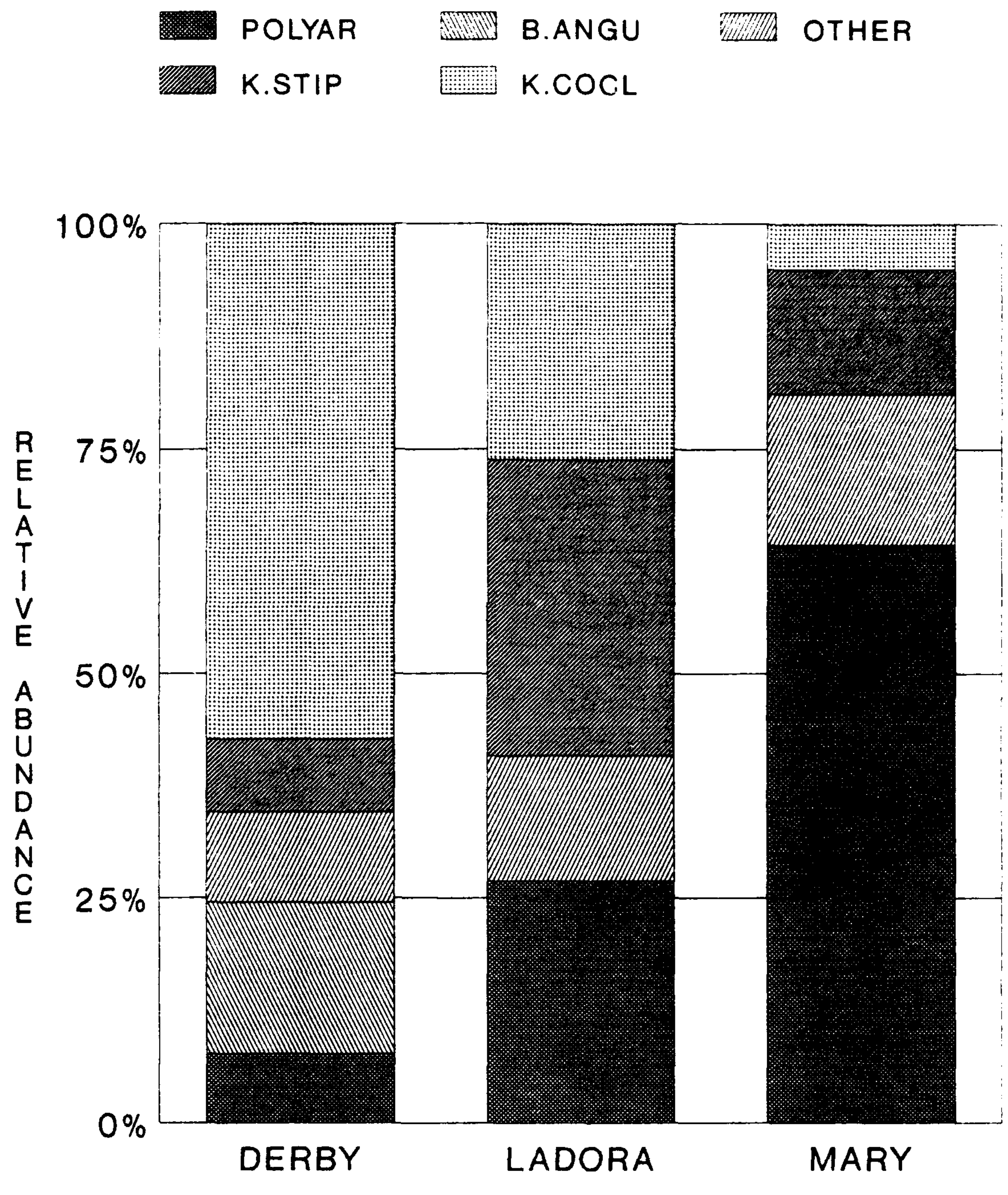

FIGURE 3-4. MICROZOOPLANKTON COMPOSITION IN SOUTH LAKES

and the other two lakes were the absence of rotifers in samples from Lake Mary during spring, the reversed order of dominance of *Polyarthra* sp. and *K. stipitata* in Lake Mary during autumn, and the much greater contribution of *Notholca*, especially during summer (Appendix C, Table C-3).

The abundance of microzooplankton, like community composition, varied among lakes and seasons (Figure 3-5). The average abundance of rotifers in the three lakes over the four sampling periods was highest in Lower Derby (404 organisms/liter), intermediate in Mary (351 organisms/liter), and lowest in Ladora (317 organisms/liter). Pennak (1978) found that most plankton communities averaged between 40 and 500 rotifers per liter, with populations seldom in excess of 1,000 per liter. The highest densities were in Lower Derby during late spring (1,040 organisms/liter), and during autumn in both lakes Ladora (717 organisms/liter) and Mary (1,080 organisms/liter). Lowest abundances occurred during early spring and summer in Lake Mary and during summer in the other two lakes. In general, both the density and diversity data indicate a healthy population.

3.3.2 Macrozooplankton Community

A total of 24 macrozooplankton taxa were identified from the South Lakes over the four sampling periods (Table 3-11). The communities in lakes Ladora and Mary were each represented by 19 taxa, while 16 taxa comprised the community of Lower Derby Lake. All taxa identified are typical of pond and lake environments and are commonly found in the limnetic or littoral zones (Brooks 1957, Ward and Whipple 1959, Pennak 1978). *Daphnia rosea*, bosminids, *Chydorus sphaericus*, *Ceriodaphnia*, and many of the copepods are open water forms seldom found in abundance in vegetated areas. In contrast, *Alona rectangula*, *Leydigia quadrangularis*, *Pleuroxus denticulatus*, *Pseudochydorus globosus*, *Simocephalus vetulus*, and some daphnids and copepods are found in vegetated shallows.

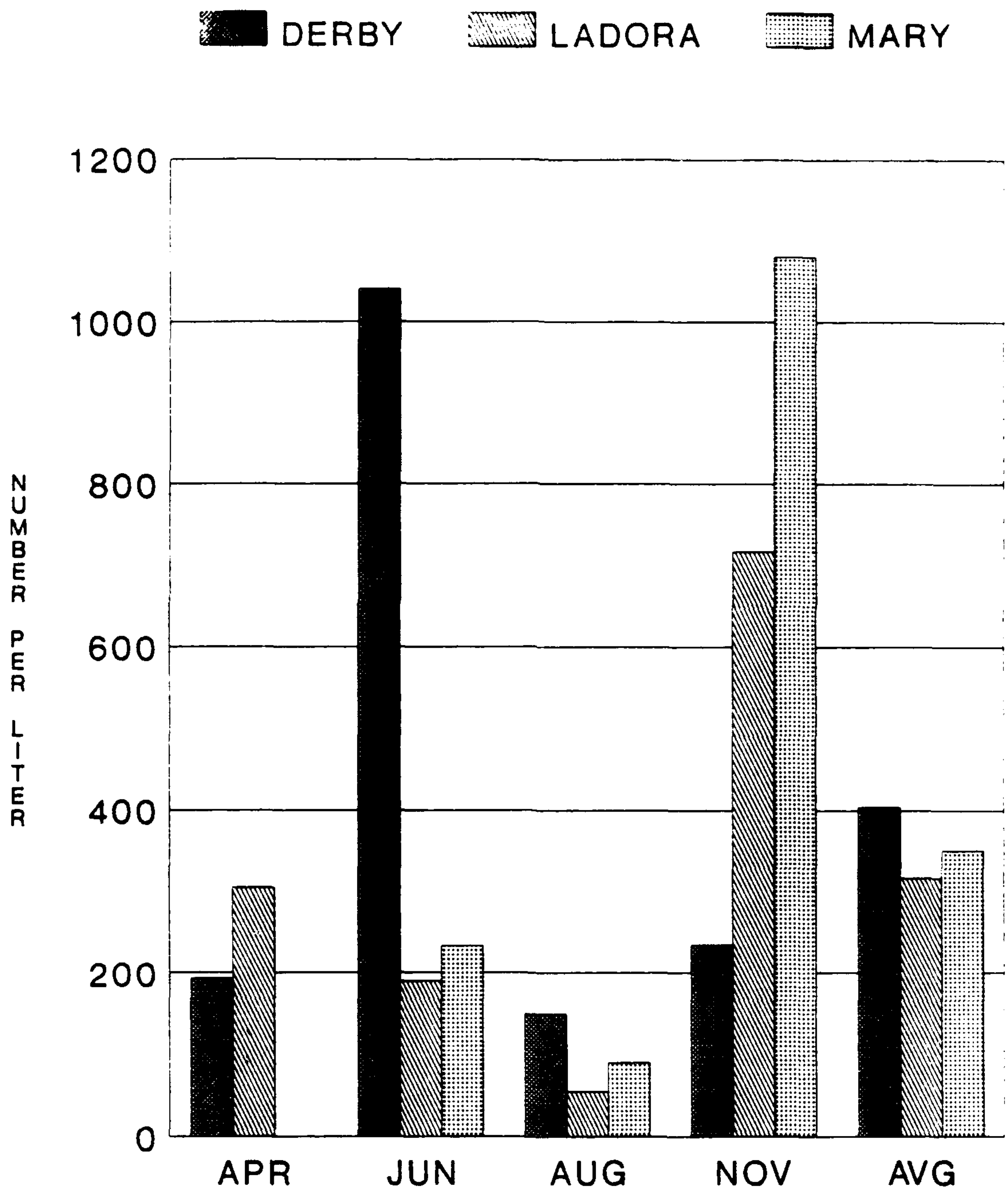

FIGURE 3-5. SEASONAL MICROZOOPLANKTON ABUNDANCE.

Table 3-11

Macrozooplankton Collected from the South Lakes, 1987

Taxa	Lake Derby	Lake Ladora	Lake Mary
Cladocera			
Chydoridae			
Pseudochydorus globosus		X	
Alona rectangula			X
Chydorus sphaericus	X	X	X
Pleuroxus denticulatus			X
Leydigia quadrangularis	X	X	
Bosminidae sp.	X	X	X
Daphnidae			
Ceriodaphnia sp.	X	X	X
Daphnia sp.	X	X	X
D. ambigua	X	X	X
D. laevis	X	X	X
D. parvula		X	X
D. rosea	X	X	X
Simocephalus vetulus			X
Ostracoda sp.		X	
Copepoda			
Copepod nauplii	X	X	X
Calanoida			
Calanoid copepodids	X	X	X
Diaptomidae			
Diaptomus connexus	X		
D. pallidus	X	X	X
D. siciloides	X	X	
Cyclopoida			
Cyclopoid copepodids	X	X	X
Cyclopidae			
Cyclops bicuspidatus thomasi	X	X	X
C. vernalis	X		X
Mesocyclops sp.		X	X
M. edax		X	X
Total Number of Taxa	16	19	19

The macrozooplankton community, averaged over the four sampling periods, was composed mainly of cladocerans and copepods. Bosminids, Ceriodaphnia, and Daphnia were the prevalent cladocerans, while immature nauplii and copepodids were the dominant copepods (Figure 3-6). Ostracods (seed shrimp) were found only in Lake Ladora, and only during May.

Community composition was variable among lakes and seasons. For example, note the density and relative abundance data for three species of Daphnia (D. ambigua, D. laevis, D. rosea) shown in Appendix C, Tables C-5 through C-7. Similarly, note the variability of Chydorus sphaericus.

The average annual abundance of macrozooplankton (Figure 3-7) was highest in Lower Derby Lake (602 organisms/liter), and lower but similar in lakes Ladora (446 organisms/liter) and Mary (408 organisms/liter). All of the density values were within commonly observed ranges. For example, Pennak (1978) found that typical cladoceran populations ranged between 200 and 500 organisms/liter, with copepod populations up to 1,000 organisms/liter.

3.4 BENTHIC MACROINVERTEBRATES

The aquatic macroinvertebrate communities of the South Lakes were dominated by aquatic naidid and tubificid worms, talitrid amphipods (scuds), chironomid (midge) larvae and pupae, culicid (phantom midge) larvae, nematodes (roundworms), and gastropods (snails) (Figure 3-8). Various combinations of these taxa comprised 98 percent of the benthic fauna identified from Lower Derby Lake, 97 percent of the fauna from Lake Ladora, and 87 percent of the fauna from Lake Mary (Appendix D, Tables D-1 through D-3). Taxa identified from the South Lakes are listed in Table 3-12.

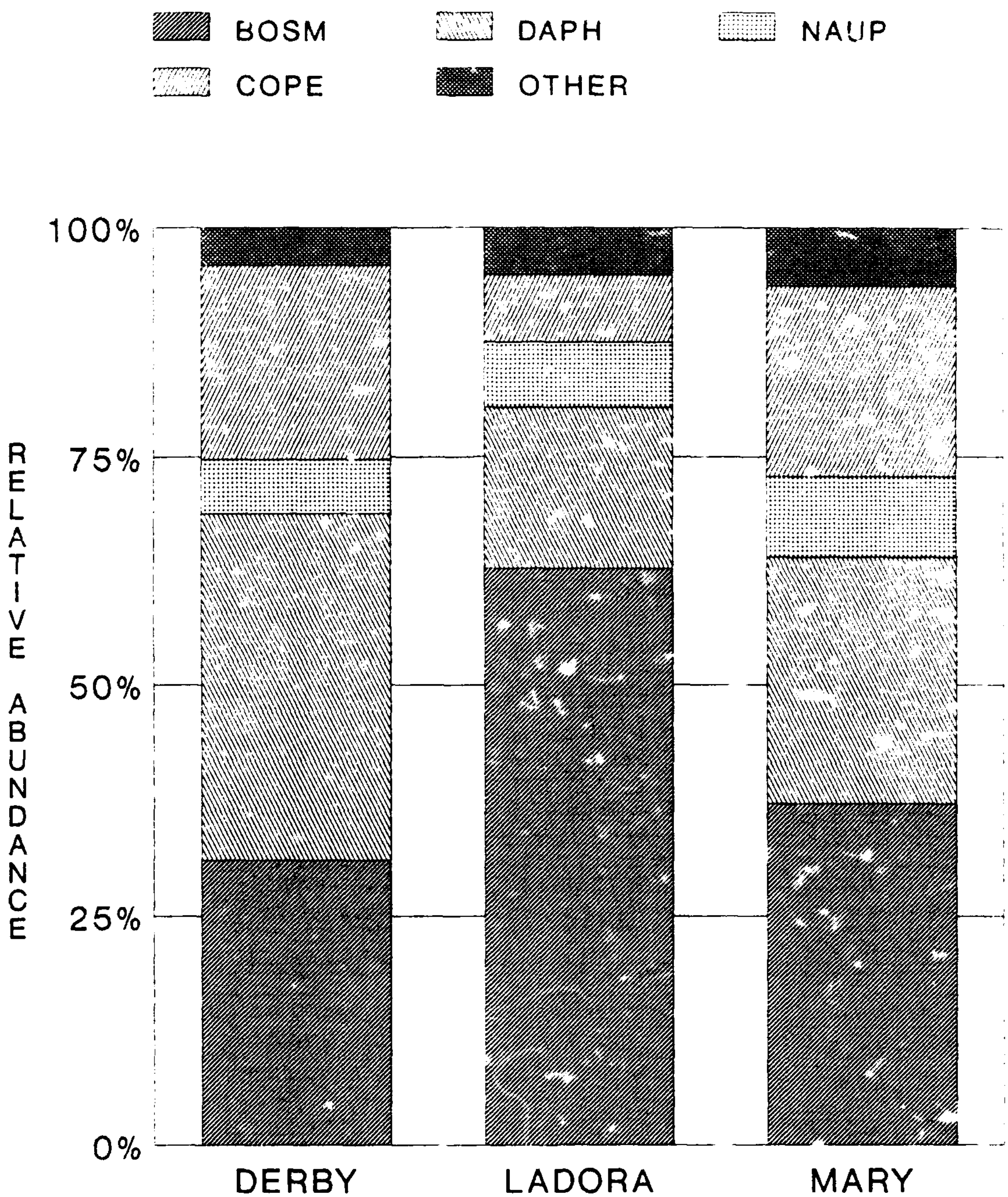

FIGURE 3-6. MACROZOOPLANKTON COMPOSITION IN SOUTH LAKES.

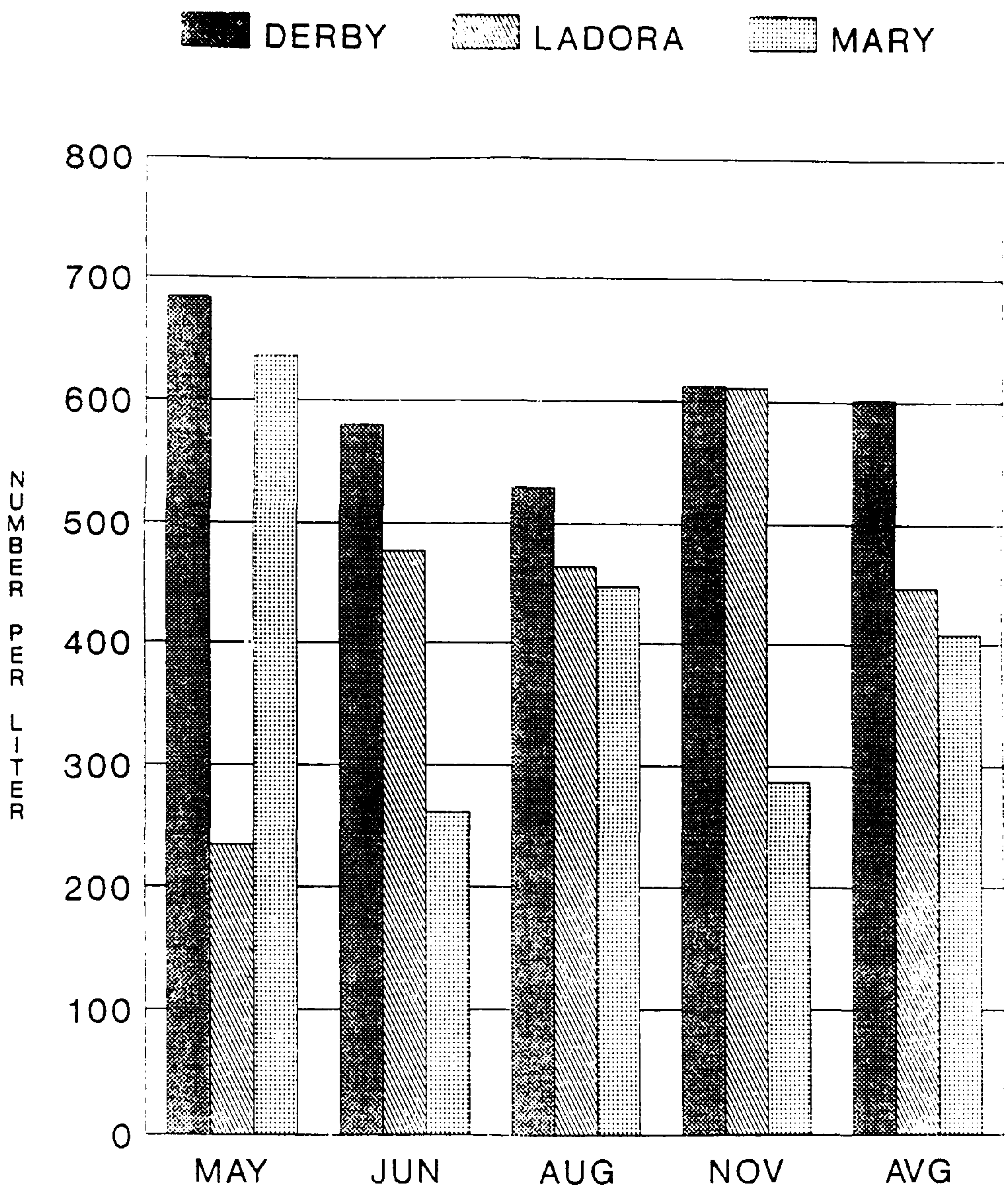

FIGURE 3-7. SEASONAL MACROZOOPLANKTON ABUNDANCE.

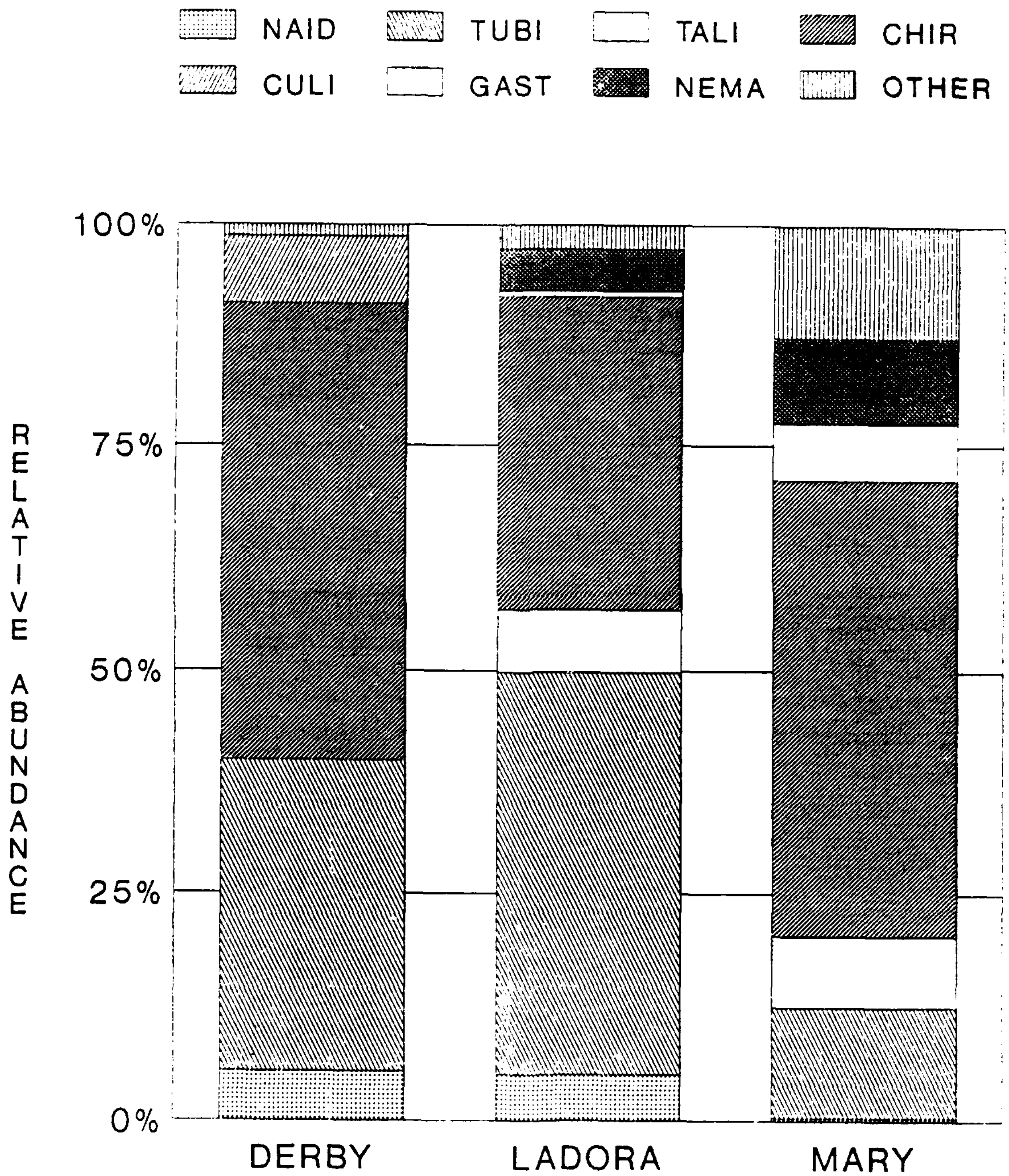

FIGURE 3-8. BENTHIC MACROINVERTEBRATE COMPOSITION.

Table 3-12

Benthic Macroinvertebrates Collected in the South Lakes, 1987

Taxa	Lake Derby	Lake Ladora	Lake Mary
Coelenterata			
Hydridae			
Hydra sp.	D*	D	D
Platyhelminthes			
Turbellaria sp.	D	D,P	D
Nematoda sp.	D,P**	D,P	D,P
Annelida			
Hirundinea			
Eropobdellidae sp.			D,P
Glossiphoniidae			
Helobdella sp.	P	D	D,P
Helobdella stagnalis	D		
Helobdella triserialis		D	
Theromyzon sp.			D
Oligochaeta			
Enchytraeidae sp.		D	D,P
Naididae			
Chaetogaster diaphanus	D	D,P	D
Dero digitata	D,P	D,P	
Dero nivea	D		
Nais pardalis	P		
Nais simplex	D,P	D,P	D
Nais variabilis	D,P	D,P	P
Ophidonais serpentina	D	D,P	
Pristina leidyi	D		D
Stylaria lacustris	D	D	D
Tubificidae			
Immature with capilliformes	D,P	D,P	D,P
Immature without capilliformes	D,P	P	D,P
Aulodrilus pigueti	D,P		
Limnodrilus claparedianus	P		P
Limnodrilus hoffmeisteri	D,P	D,P	P
Limnodrilus udekemianus		P	
Potamothrix bavaricus		P	P
Tubifex tubifex			P
Arthropoda			
Talitridae			
Hyalella azteca	D	D,P	D,P

Table 3-12
(continued)

Benthic Macroinvertebrates Collected in the South Lakes, 1987

Taxa	Lake Derby	Lake Ladora	Lake Mary
Arachnoidea			
Hydrachnellae (Hydracarina) sp.			D
Insecta			
Ephemeroptera			D,P
Baetidae	D	D	D
Baetis sp.		D	D
Callibaetis sp.	D	D	D
Caenidae			
Caenis sp.	D,P	D,P	D,P
Odonata, Anisoptera		D	D,P
Aeshnidae			
Anax sp.		D	D
Corduliidae			
Tetragoneuria sp.		D	D
Libellulidae			
Erythemis sp.		D	D
Libellula sp.			D
Tramea sp.		D	D,P
Odonata, Zygoptera	D	D,P	D,P
Coenagrionidae			
Enallagma sp.	D	D,P	D,P
Hemiptera			
Hemiptera sp.		D	
Corixidae	D		
Corisella sp.	D		
Gerridae			
Gerris sp.		D	D
Hebridae			
Hebrus sp.		D	
Mesoveliidae			
Mesovelia sp.		D	D
Saldidae			
Saldula sp.	D		
Trichoptera			
Hydroptilidae			
Agraylea sp.	D	D	D
Orthotrichia sp.		D,P	
Oxyethira sp.		D,P	D,P
Leptoceridae sp.			
Oecetis sp.	D	D	D,P

Table 3-12
(continued)

Benthic Macroinvertebrates Collected in the South Lakes, 1987

Taxa	Lake Derby	Lake Ladora	Lake Mary
Lepidoptera			
Pyralidae sp.			D,P
Coleoptera			
Dytiscidae			
Laccophilus sp.	D		
Haliplidae			
Haliplus sp.			D
Peltodytes sp.	D		
Hydrophilidae			
Berosus sp.			D,P
Laccobius sp.		D	
Diptera			
Ceratopogonidae			
Culicoides sp.	D	D	
Dasyhelea sp.	D	D	
Palpomyia/Probezzia/Bezzia sp.	D,P	D	D,P
Probezzia/Bezzia sp.	D	D	D
Chironomidae pupae sp.	D,P	D,P	D,P
Chironominae			
Chironomus sp.	D,P	P	P
Crytochironomus sp.	D,P	P	
Cryptotendipes sp.	D,P	D,P	P
Dicrotendipes sp.	D,P	D,P	D,P
Endochironomus sp.	D	P	D
Glyptotendipes sp.	D		D,P
Lenziella sp.	D,P		
Parachironomus sp.	P	D	P
Paratanytarus sp.	D	D,P	D,P
Polypedilum sp.	D,P	D	
Stictochironomus sp.		P	
Tanytarsus sp.	P	D,P	D,P
Orthocladinae A	P		
Orthocladinae B	D		
Orthocladinae C		D	
Orthocladinae D		D	D
Corynoneura sp.			D
Cricotopus sp.	D		D,P
Orthocladius sp.	D	D	D
Psectrocladius sp.	D,P	D	D,P

Table 3-12
(continued)

Benthic Macroinvertebrates Collected in the South Lakes, 1987

Taxa	Lake Derby	Lake Ladora	Lake Mary
Tanypodinae			
Larsia sp.	D,P	D,P	D,P
Procladius sp.	D,P	P	P
Tanypus sp.	P	D,P	P
Culicidae			
Chaoborinae			
Chaoborus sp.	P	P	
Ephyridae sp.	D		
Muscidae sp.	D		
Tabanidae sp.		D	
Mollusca			
Gastropoda sp.		P	D,P
Lymnacidae			
Fossaria sp.	D		D,P
Physidae			
Physa sp.	D	D,P	D,P
Planorbidae			
Gyraulus sp.	D	D,P	D,P
Pelecypoda			
Sphaeriidae			
Musculinum sp.			P
Pisidium sp.		D,P	D,P

* D=Collected by Dip Net
** P=Collected by Ponar Dredge

	Lake Derby	Lake Ladora	Lake Mary
Number of Taxa Collected by Dip Net	54	56	55
Number of Taxa Collected by Dredge	29	35	42
Total Number of Taxa	63	66	66

The most abundant naidid worms in Lower Derby were Dero digita and Nais variabilis, while Dero digita, Nais simplex, and Ophidonais serpentina were the dominant naidids in Lake Ladora. Nais variabilis was the only naidid identified in Lake Mary. Most of the tubificid worms collected were immature and therefore could not be identified to a lower taxonomic level. Of the adult worms, Aulodrilus pigueti and Limnodrilus hoffmeisteri were dominant in Lower Derby; Potamothrix bavaricus and L. hoffmeisteri were dominant in Ladora; and Tubifex tubifex, L. hoffmeisteri, and L. claparedianus were dominant in Lake Mary.

Following Chironomus in abundance among the chironomids were Cryptotendipes in Lower Derby; Tanytarsus and Tanypus in Ladora; and Larsia, Procladius, Tanytarsus, Dicrotendipes, and Paratanytarsus in Mary. The only talitrid amphipod identified was Hyalella azteca, and the only culicid was a Chaoborus species. Gastropods (snails) were principally in the genus Gyraulus, although Physa and Fossaria species were also collected. No snails were collected in Lower Derby Lake, probably owing to the low abundance of aquatic macrophytes.

Although the benthic communities were similar among the lakes in that tubificids and/or chironomids were dominant, they differed somewhat with respect to order of dominance, species composition and subdominant taxa (Appendix D, tables D-1 through D-3).

A total of 66 taxa of benthic macroinvertebrates were identified from both Lake Ladora and Lake Mary, while 63 taxa were identified from Lower Derby Lake. Only 36 of the 97 total taxa (37 percent) were common to all three lakes. Within each lake, diversity was higher in nearshore areas than in offshore areas, although this difference was less pronounced in Lake Mary. Nearshore sampling produced 54 taxa in Lower Derby Lake, 56 taxa in Lake Ladora, and 55 taxa in Lake Mary, while offshore sampling yielded only 29, 35, and 42 taxa, respectively (see Appendix D).

Macroinvertebrate diversities were generally high in April, low in June and August, and moderately high in November (Figure 3-9). Decreases in diversity from spring to summer typically result from the emergence of reproductive adult insects and lower concentrations of dissolved oxygen due to high water temperatures (Merritt and Cummins 1984). Diversity often increases again in autumn because of gradual recolonization following reproduction and better oxygen saturation due to lower water temperatures. Dissolved oxygen is usually less of a factor in near-shore areas because of the shallower depths. Specifics of the seasonal pattern of diversity were somewhat different for each lake (see Appendix D).

The average annual abundance of benthic macroinvertebrates was lowest (1,590 organisms/m^2) in Lower Derby Lake and highest (2,669 organisms/m^2) in Lake Mary (see Appendix D). Densities in Lower Derby and Mary declined progressively each sampling period from April through August but increased again in November (Figure 3-9). Densities in Lake Ladora decreased between the April and June sampling periods but increased in both August and November (Figure 3-9).

Differences in the macroinvertebrate assemblages of the South Lakes were probably due largely to differences in substrate, which is reported to be one of the most important factors influencing community composition (e.g., see EPA 1973, Brinkhurst and Cook 1974, Merritt and Cummins 1984).

The substrate in Lower Derby Lake was composed primarily of muck and detritus. It was sparsely populated with aquatic plants, which occurred only in localized areas along its gradually sloping margins. Because of low and fluctuating water levels, the shoreline was barren and devoid of emergent vegetation. The benthic community in Lower Derby consisted primarily of tubificids, chironomids, naidids, and culicids, all of which

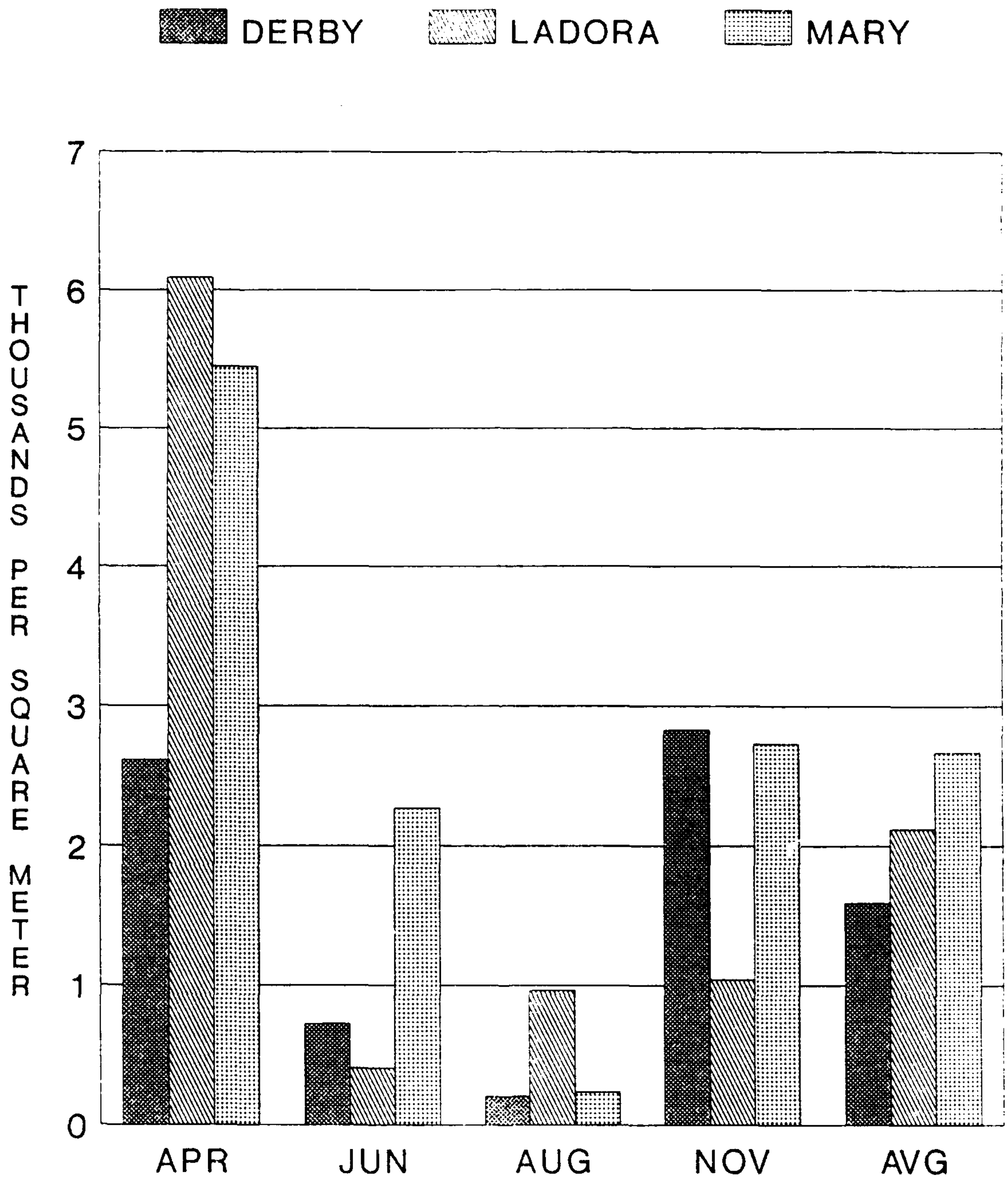

FIGURE 3-9. SEASONAL MACROINVERTEBRATE ABUNDANCE.

either burrow into soft substrates or reside on the substrate during the day and are free-swimming at night (Brigham and Brigham 1982, Merritt and Cummins 1984). Most are tolerant of organic enrichment and can tolerate low dissolved oxygen concentrations for extended periods. Diversity was low (29 taxa) in the open waters where the substrate was uniform and dissolved oxygen concentrations were sometimes low, but considerably higher (54 taxa) in the littoral zone. The increased number of taxa in the nearshore fauna was mostly associated with additional burrowing forms, primarily naidids and dipterans (flies, mosquitoes, and midges).

At the other extreme, Lake Mary had steep banks, a shoreline well vegetated with emergent plants, and dense growths of submergent aquatic plants. As a result of greater habitat complexity, the benthic community of Lake Mary (42 taxa) was considerably more diverse than that of Lower Derby Lake (29 taxa). The benthic fauna of Lake Mary was dominated by nematodes, naidids, tubificids, talitrids, chironomids, and gastropods (Figure 3-8). These include forms that burrow into the substrate (naidids and some chironomids) or vegetation (some chironomids and nematodes), that live upon the vegetation (gastropods), or that seek refuge within the plant cover (talitrids) (Brinkhurst and Cook 1974, Pennak 1978, Merritt and Cummins 1984).

As in Lower Derby, the macroinvertebrate community in the littoral zone was more diverse (55 taxa). The littoral fauna of Lake Mary consisted primarily of ephemeropterans (mayflies), odonates (dragonflies and damselflies), hemipterans (true bugs), coleopterans (beetles), lepidopterans (butterflies and moths), gastropods (snails), and other aquatic invertebrates that inhabit vegetation (Pennak 1978, Merritt and Cummins 1984). Burrowing forms (naidids, tubificids, and chironomids) were present, but these groups were less diverse, less abundant, and/or dominated by different taxa than in Lower Derby.

Lake Ladora was intermediate between Lake Mary and Lower Derby Lake in terms of morphometry and extent of macrophytes. Like Lake Mary, the shoreline of Lake Ladora was well vegetated with emergent plants, and large portions of the lake were chocked with submergent plants. Like Lower Derby, most of the shoreline around Lake Ladora had a gradual slope, and some areas were open and devoid of vegetation. Unlike either of the other two lakes, clay was a major component of the substrate, especially in the lower portions of the lake.

Diversity, as measured by number of taxa in benthic samples, was higher in Lake Ladora (35 taxa) than in Lower Derby (29 taxa), but lower than in Lake Mary (42 taxa). Chironomids and tubificids were abundant, as they were in Mary and Lower Derby. Subdominant taxa consisted of groups mainly associated with aquatic plants (nematodes, talitrids, and gastropods). Naidids comprised about the same percentage of the benthic community in Lake Ladora as in Lower Derby Lake, but a greater percentage than in Lake Mary.

Diversity in the littoral zone of Ladora (56 taxa) was comparable to that in similar environments of Lower Derby (54 taxa) and Mary (55 taxa). Burrowing forms (naidids) were common nearshore in lower pars of Lake Ladora, as they were in Lower Derby Lake. Many of the aquatic insects, talitrids, and gastropods found in the littoral zone of Ladora were common in Lake Mary but uncommon in Lower Derby.

3.5 FISH

3.5.1 Community Composition

Relatively few fish species were present in the South Lakes; Lower Derby and Ladora contained eight species each, while Lake Mary contained five species. Table 3-13 is a list of fish species observed at the South Lakes. Species recorded for McKay Lake are also listed on the table. Most of the species present

Table 3-13

Fish Species Identified from the Study Area Lakes, 1987[1]

Species	Lower Derby	Ladora	Mary	McKay
SALMONIDAE				
Rainbow trout				
Salmo gairdneri	--	--	--	X
CYPRINIDAE				
Fathead minnow				
Pimephales promelas	X	--	--	--
Bluntnose minnow				
P. notatus	X	--	--	--
Common carp				
Cyprinus carpio	X	X	X	X
CATOSTOMIDAE				
White sucker				
Catostomus commersoni	--	--	--	X
ICTALURIDAE				
Black bullhead				
Ictalurus melas	X	X	--	X
Channel catfish				
I. punctatus	--	--	X	X
CENTRARCHIDAE				
Bluegill				
Lepomis macrochirus	X	X	X	X
Green sunfish				
L. cyanellus	X	X	--	--
Pumpkinseed				
L. gibbosus	--	X	--	X
Black crappie				
Pomoxis nigromaculatus	--	--	X	X
White crappie				
P. annularis	--	--	--	X
Largemouth bass				
Micropterus salmoidus	X	X	X	X
PERCIDAE				
Yellow perch				
Perca flavescens	--	X	--	X
ESOCIDAE				
Northern pike				
Esox lucius	X	X	--	--

[1] Samples were obtained by electrofishing.

were stocked for recreation or management purposes (see Section 5). Species present that were not stocked presumably entered the lakes via the canal and ditch system or were released by fishermen (e.g., as bait). As shown by Table 3-13, the only species recorded in all three of the South Lakes were the common carp (Cyprinus carpio), bluegill (Lepomis macrochirus), and largemouth bass (Micropterus salmoides). These species, plus black bullheads (Ictalurus melas) in Lower Derby and Ladora, were the prevalent fish captured (Figure 3-10).

The fish communities of all three lakes appeared out-of-balance. Capture rates during electrofishing indicated that Lower Derby had too many largemouth bass, bullheads, and large carp in relation to forage fish, while lakes Ladora and Mary had too many forage fish compared to the number of predators. The overabundance of bass in Lower Derby may have been caused by drawdown of the lake. Drawdown away from shoreline vegetation exposes forage fish to predation. Conversely, dense growths of aquatic plants, such as in lakes Ladora and Mary, allow forage fish to avoid predation and to overpopulate, which in turn leads to stunting and a decrease in the quality of the prey base. While population die-offs are not anticipated, the South Lakes fisheries could be improved by culling the fish population of Lower Derby Lake and controlling macrophytes in lakes Ladora and Mary.

Capture rates of fish were greatest in Lower Derby Lake (144 fish/hour), intermediate in Lake Ladora (120 fish/hour), and lowest in Lake Mary (115 fish/hour) (Figure 3-11). Catches in each of the three lakes were lowest in April, intermediate in June and August, and highest in November. This pattern is typical of warm-water and cool-water fisheries in the temperate zone, where most fish spawn in spring and early summer. As the year progresses, the young grow in size and become more active, and thus are more susceptible to being captured.

Seasonal catch data varied among the three lakes for the dominant species collected (see Appendix E, Tables E-1 through E-3).

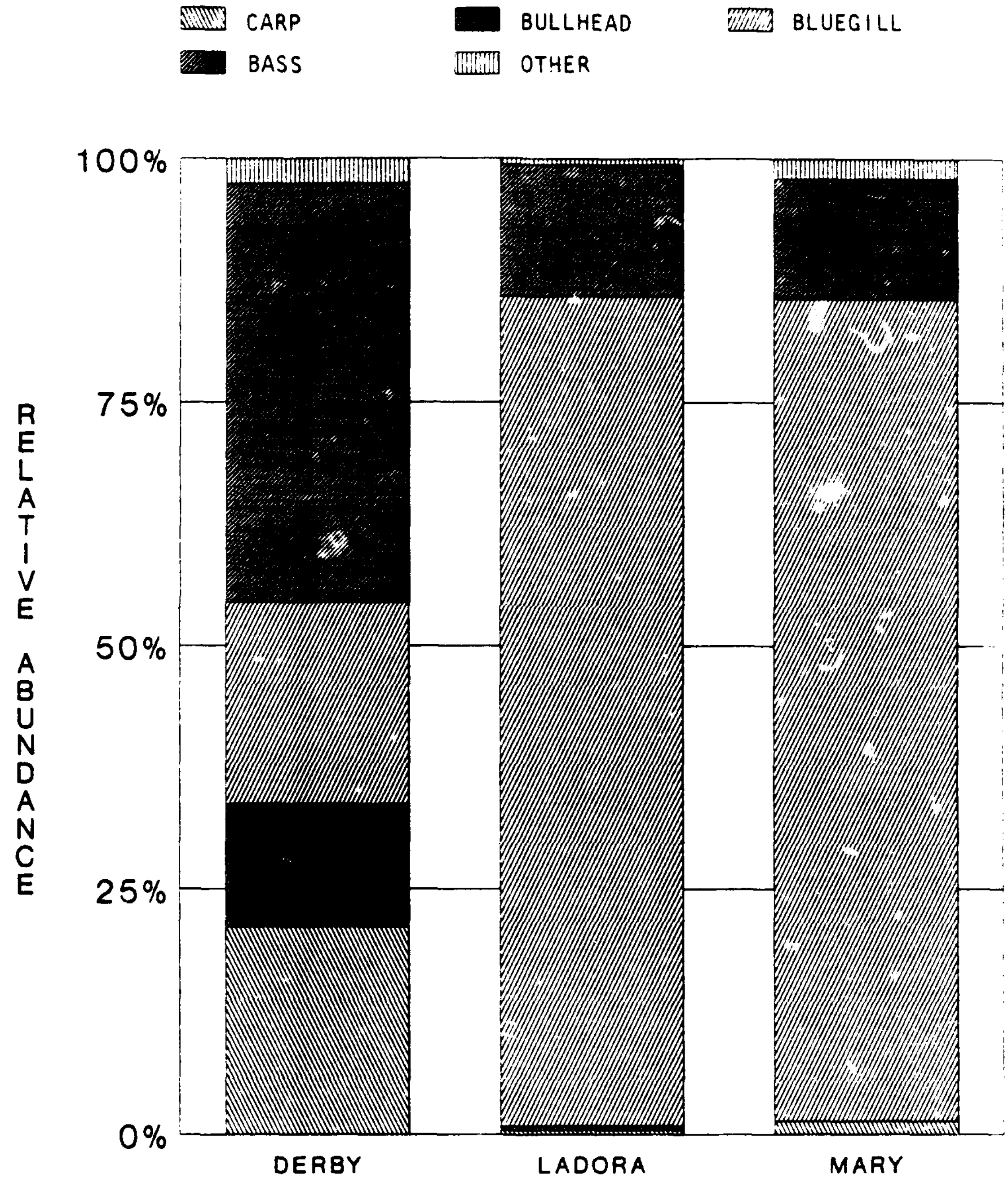

FIGURE 3-10. COMPOSITION OF ELECTROFISHING SAMPLES.

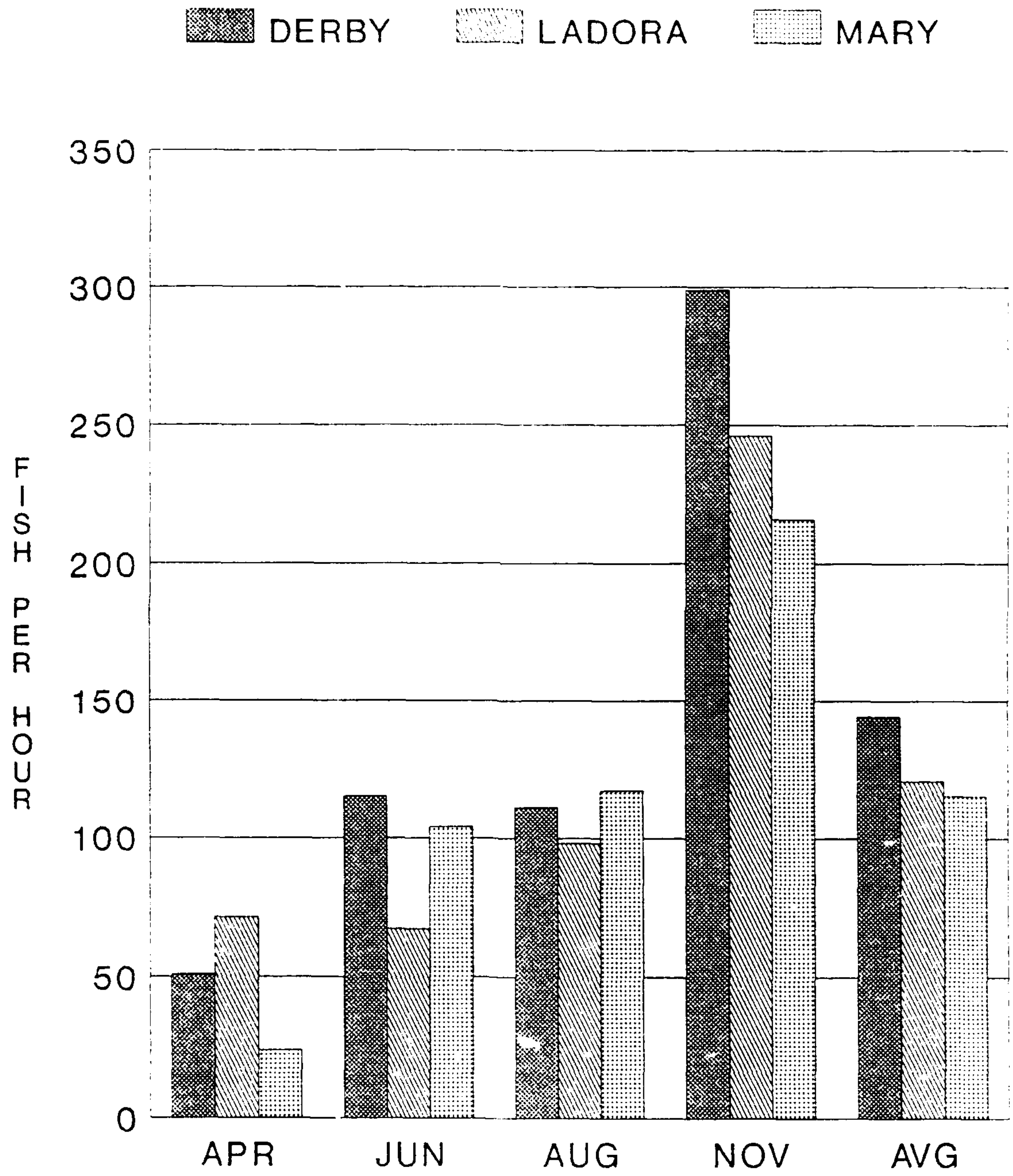

FIGURE 3-11. SEASONAL ELECTROFISHING CATCHES.

3.5.2 Evidence of Reproduction

Reproduction is evidenced by viable fish eggs, larvae, juveniles, and different size (age) classes. As described in Section 2.6, fish eggs and larvae were collected using two techniques (towed plankton net and fry seine) to maximize the chance of obtaining a representative sample. Towed nets were used to collect the eggs of pelagic-spawning species, and larvae that drift or swim into the open waters. Fry seines were used primarily to collect the young of nest-building species such as sunfish, or other larvae that inhabit the shore zone. In addition, juvenile fish were collected by beach seine.

Fry seines were unsuccessful except in Lower Derby. In that lake, two unidentifiable eggs were collected during April, two carp eggs and six fathead minnow (*Pimephales promelas*) larvae were collected in June, and four larvae (two fathead minnows, one bluegill, and one largemouth bass) were collected in August. No eggs or larvae were collected in Lower Derby Lake in November or in lakes Ladora and Mary during any of the four sampling periods.

Conversely, no eggs or larvae were collected in Lower Derby by towed net, but this technique was effective in Ladora and Mary, where dense growths of aquatic plants extended from the shore to depths greater than 1 m. Because fry seines are less effective in weedy habitats, fish eggs and larvae in the shore zone may have been missed, or the fish may have spawned in deeper water. Bluegill and largemouth bass generally are nest builders that prefer to spawn in 15 cm to 5.5 m of water (Scott and Crossman 1973, Heidinger 1976). Bluegill generally spawn over sand, gravel, or mud; bass prefer to spawn near emergent vegetation, rocks, stumps, or slopes.

Larvae of bluegill, other sunfish (*Lepomis* sp.), and yellow perch (*Perca flavescens*) were collected in Lake Ladora; only bluegill larvae were collected in Lake Mary (Appendix E, tables E-9 through E-11). The yellow perch larvae from Lake Ladora were collected only during May, while the unidentified sunfish and bluegill were collected in June and August. Yellow perch usually spawn in April and early May, near rooted vegetation, submerged brush, or fallen trees, and occasionally over sand and gravel. Spawning depths typically range from 50 cm to 3 m (Scott and Crossman 1973, Thorpe 1977).

Beach seines were successful in capturing juvenile fish and occasional subadult and adult fish (Appendix E, tables E-5 through E-7). Catches in Lower Derby and Ladora consisted predominantly of bluegill and largemouth bass, while those in Lake Mary consisted almost entirely of bluegill (Figure 3-12). Average catches in the shore zone were 58 fish per haul in Lower Derby, 24 fish per haul in Lake Ladora, and 18 fish per haul in Lake Mary (Figure 3-13). Catches in Lake Mary may have been influenced somewhat by a lack of suitable sites for beach-seining. Initially, samples in the lower end of the lake were taken from a boat because of the steep shoreline. After June, however, dense growths of aquatic plants precluded use of the boat, and samples in both August and November were therefore collected only from the upper end of the lake.

Results of the sampling program for fish eggs, larvae and junveniles are summarized in Table 3-14. The table includes results for McKay Lake as well as the South Lakes.

3.5.3 Size and Condition Factor

As described in Section 2.2.5, Fulton's condition factor (K) was calculated for two size classes of bluegill and largemouth bass using length and weight data. Results of these calculations are provided in Figure 3-14. Sample sizes for other fish species were too small to permit this type of calculation. Carlander (1969, 1977) provides an excellent overview of the use of condition factors in evaluating the health of a population.

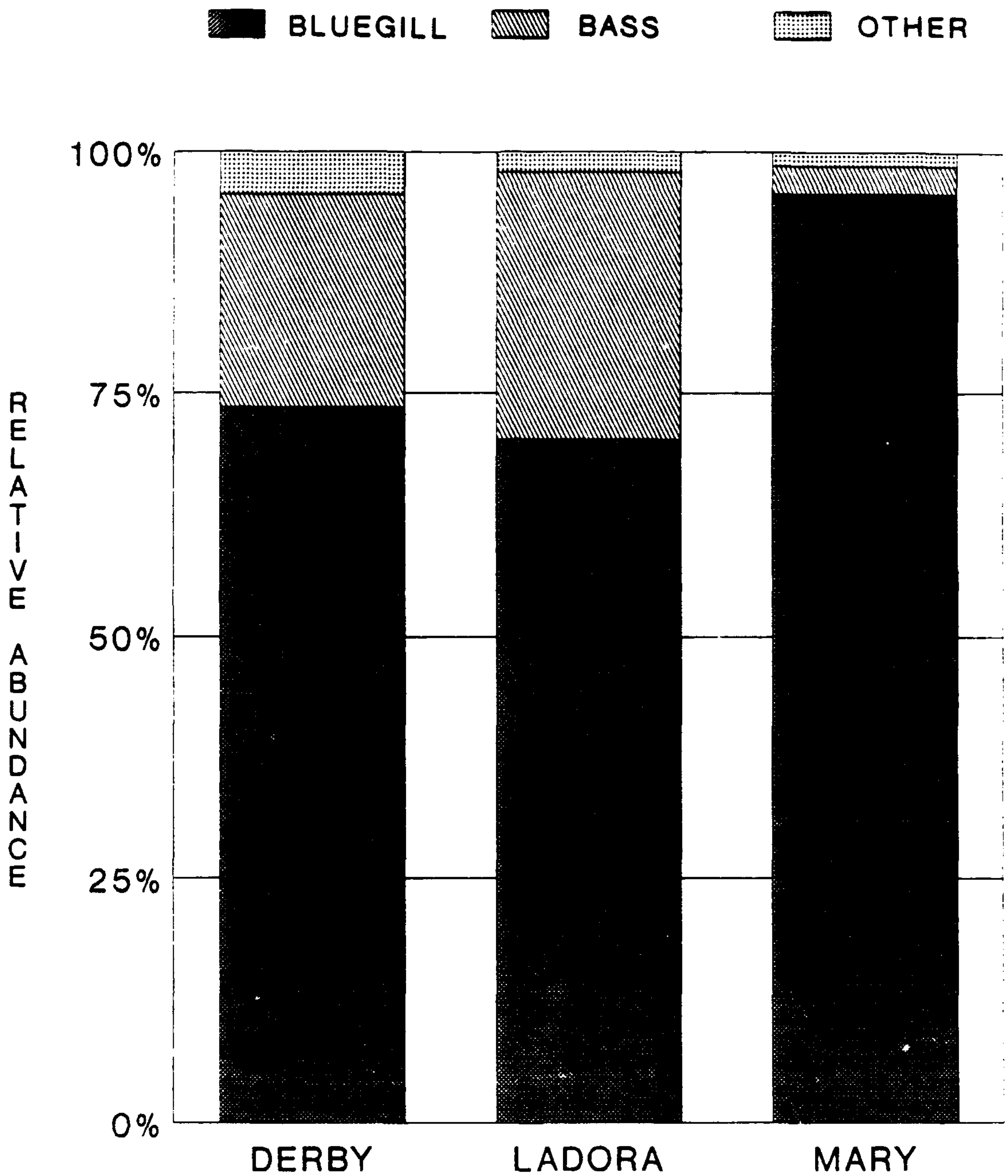

FIGURE 3-12. BEACH SEINE CATCH COMPOSITION.

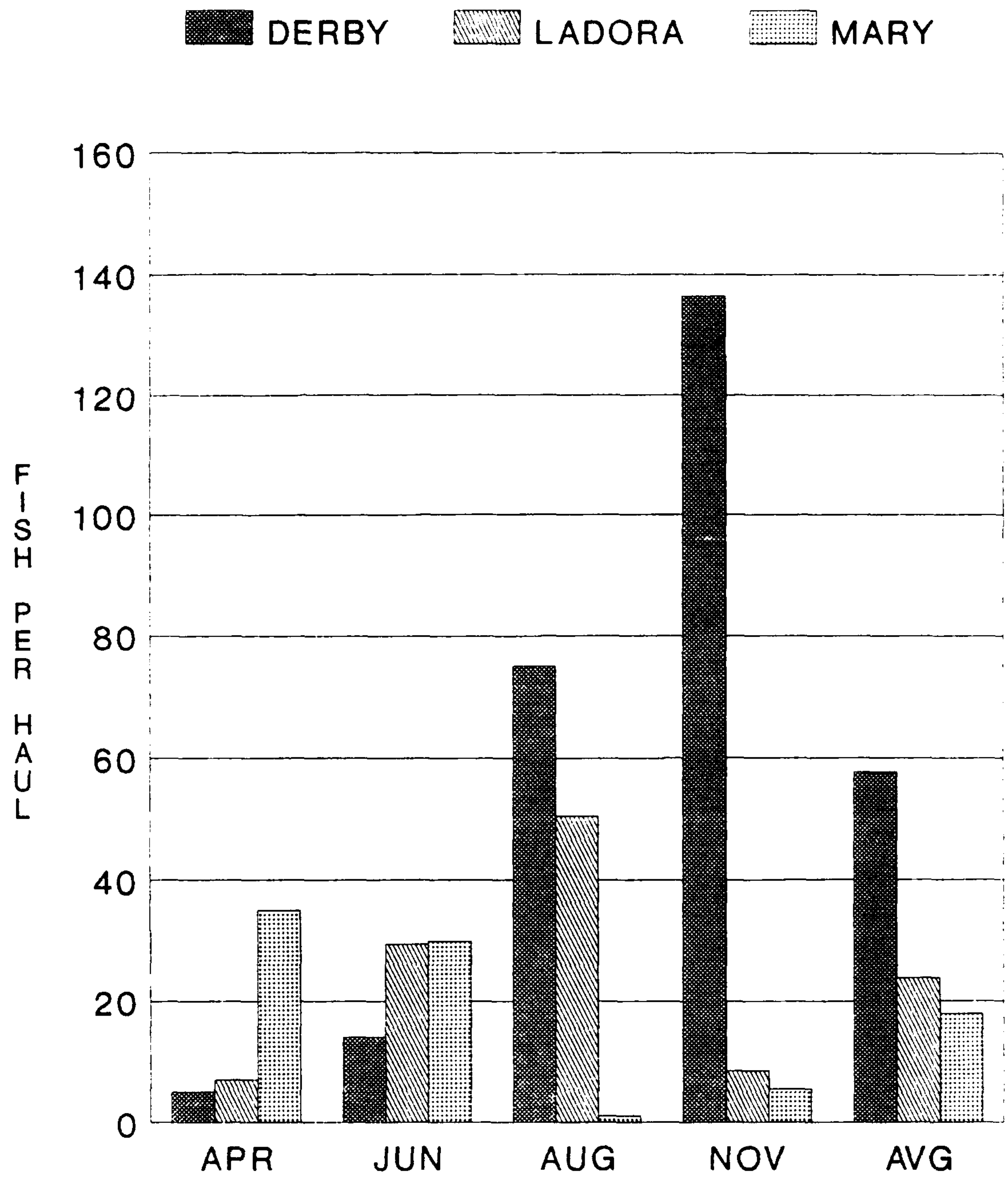

FIGURE 3-13. SEASONAL ABUNDANCES OF BEACH SEINE CATCHES.

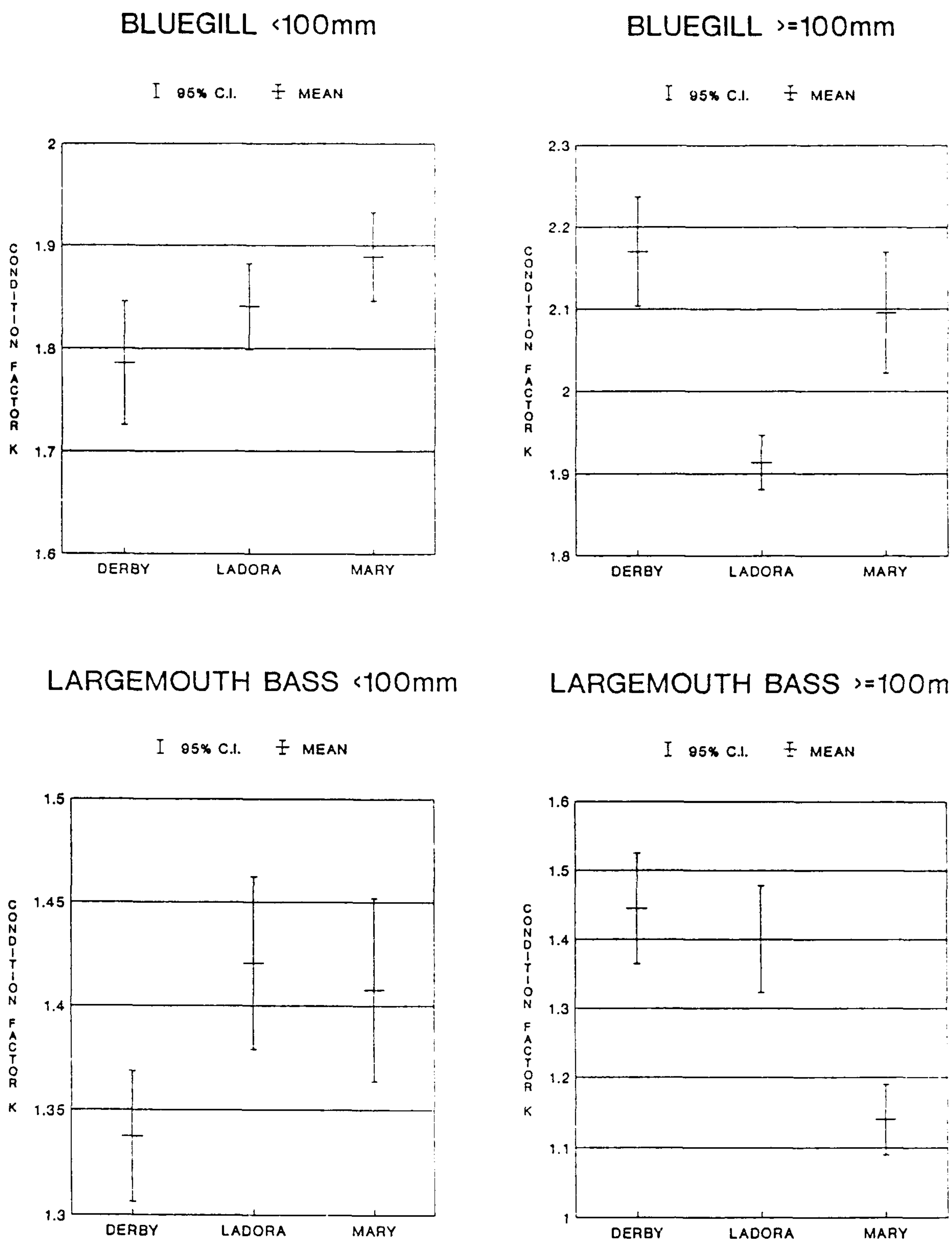

FIGURE 3-14. CONDITION FACTORS FOR BLUEGILL AND BASS.

Table 3-14

Fish Eggs, Larvae, and Juveniles Identified in the Study Area Lakes[1, 2]

Species	Lakes: Derby	Ladora	Mary	McKay
CYPRINIDAE				
Fathead minnow	L,J	--	--	--
Common Carp	E,J	--	--	E,L
CENTRARCHIDAE				
Bluegill	L,J	L,J	L,J	L,J
Green sunfish	J	J	--	--
Pumpkinseed	--	--	--	J
Unidentified sunfish	--	L	--	--
Black crappie	--	--	--	J
White crappie	--	--	--	L
Largemouth bass	L,J	J	--	L,J
PERCIDAE				
Yellow perch	--	L	--	J

1 E=eggs; L=larvae; J=juveniles
2 Samples were obtained by beach seine, fry seine, and towed plankton net

Fulton's condition factor for bluegill was highest in Lake Mary (1.84) and lowest in Lower Derby (1.79) for the small size class (<100 mm). For large bluegill ($\geq$ 100 mm), the K value was highest in Lower Derby (2.17) and lowest in Lake Ladora (1.81) (Figure 3-14). Average K values for small bluegill were similar among lakes (Appendix E, Table E-13).

Average K factors for the small size class of largemouth bass were similar in Lakes Ladora (1.42) and Mary (1.41) and, like bluegill, slightly lower in Lower Derby Lake (1.34) (Figure 3-14). Condition factors of larger bass collected in Lower Derby (1.45) and Ladora (1.40) were not significantly different (at the $p = 0.05$ level), but both K values were significantly higher than for fish in Lake Mary (1.14).

Another method for evaluating condition of fish is to plot a regression curve of the log-transformed weights and lengths (see Calander 1977). As shown by Figure 3-15, these calculations indicated that bass and bluegill in the larger size class were in better condition than those in the smaller size class in all but one case (small bluegill from Lower Derby).

The K factor analyses were consistent with the observations of community structure (see Section 3.5.1). Predators in Lake Mary in particular were relatively slim in relation to their length, indicating that they were expending more energy in pursuit of food than fish in Lake Ladora or Lower Derby Lake. Similarly, the smaller bass in Lower Derby Lake, lacking a large prey base of the appropriate size, were also slim, although as they got larger (and thus able to consume larger food items including small bass) their condition improved. Weight-length regression data are provided in Appendix E, Table E-15.

Lengths, weights, and sample sizes of fish captured by electrofishing at the South Lakes and McKay are presented in Table 3-15.

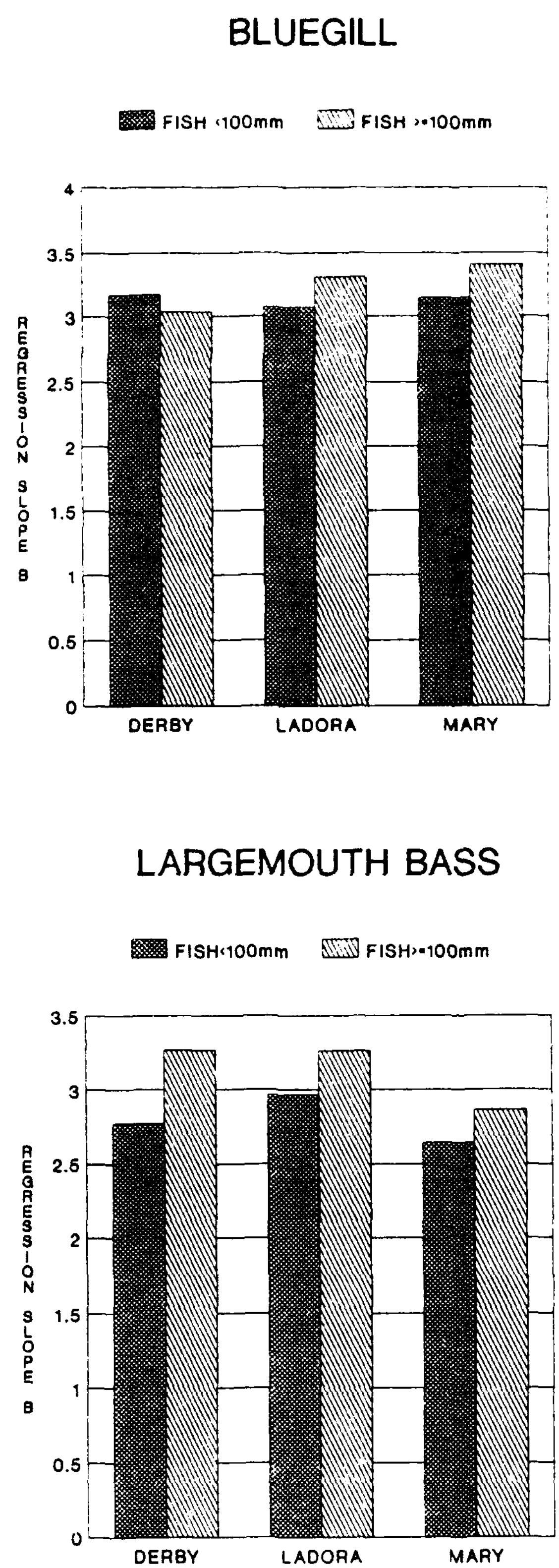

FIGURE 3-15. REGRESSION SLOPES FOR BLUEGILL AND BASS.

3.5.4 Examination for Tumors and Parasitism

As part of the fishery survey, gamefish and large individuals of nongame species were inspected for tumors, scars, external body parasites, and gill parasites. In addition, fish collected for tissue analysis in 1986 were examined for internal parasites.

Visual examinations indicated that fish from the South Lakes were generally free of problems. No tumors or internal parasites were observed on any fish examined. A few external or gill parasites were observed, particularly cyclopoid copepodites. This is common and does not indicate a health problem.

3.6 AMPHIBIANS

Few amphibians were observed on the Arsenal during aquatic investigations. Northern leopard frogs (*Rana pipiens*) and bullfrogs (*R. catesbyiana*) were seen or heard in the nearshore area of lakes Mary and Ladora on several occasions. Also, several amphibian eggs were collected in a fry seine haul in Lake Mary during August. No evidence of amphibians was found near Lower Derby Lake.

A report on the wildlife resources of the RMA prepared separately by MKE (1989) includes a discussion of amphibians observed in the study area, as does the Biota RI (ESE 1989). Amphibians heard chorusing in and near the South Lakes during field studies in the spring of 1988 included the plains spadefoot (*Spea bombifrons*), Woodhouse's toad (*Bufo woodhousei*), Great Plains toad (*B. cognatus*), and northern chorus frog (*Pseudacris triseriata*), in addition to leopard frogs and bullfrogs. Tiger salamanders (*Ambystoma tigrinum*) have been reported for RMA but were not observed during aquatic ecology field studies.

TABLE 3-15

Lengths and Weights of Fish Collected in the Study Area Lakes, 1987

Species	Lake	Sample Size	Length (cm)[1] mean	Length (cm)[1] max	Weight (g)[2] mean	Weight (g)[2] max
Rainbow trout	Derby	--	--	--	--	--
	Ladora	--	--	--	--	--
	Mary	--	--	--	--	--
	McKay	5	34	41	448	760
Fathead minnow	Derby	8	4	6	1	4
	Ladora	--	--	--	--	--
	Mary	--	--	--	--	--
	McKay	--	--	--	--	--
Bluntnose minnow	Derby	2	6	6	2	2
	Ladora	--	--	--	--	--
	Mary	--	--	--	--	--
	McKay	--	--	--	--	--
Common carp	Derby	131	50	66	1,959	4,500
	Ladora	2	66	67	4,100	4,100
	Mary	6	66	69	4,142	5,000
	McKay	64	56	66	2,352	4,100
White sucker	Derby	--	--	--	--	--
	Ladora	--	--	--	--	--
	Mary	--	--	--	--	--
	McKay	1	--	49	--	1,100
Black bullhead	Derby	78	18	21	80	120
	Ladora	2	24	25	193	226
	Mary	--	--	--	--	--
	McKay	--	--	--	--	--
Channel catfish	Derby	--	--	--	--	--
	Ladora	--	--	--	--	--
	Mary	9	51	54	1,164	1,700
	McKay	3	60	65	2,200	2,750
Bluegill	Derby	173	69	172	16	100
	Ladora	298	107	199	31	170
	Mary	306	85	195	24	172
	McKay	267	107	200	46	149
Green sunfish	Derby	7	6	11	6	23
	Ladora	2	9	14	27	54
	Mary	--	--	--	--	--
	McKay	1	--	10	--	18

TABLE 3-15
(Continued)

Species	Lake	Sample Size	Length (cm)[1] mean	Length (cm)[1] max	Weight (g)[2] mean	Weight (g)[2] max
Pumpkinseed	Derby	--	--	--	--	--
	Ladora	2	11	14	44	70
	Mary	--	--	--	--	--
	McKay	32	11	19	40	144
Black crappie	Derby	--	--	--	--	--
	Ladora	--	--	--	--	--
	Mary	4	15	18	78	192
	McKay	159	6	25	7	172
White crappie	Derby	--	--	--	--	--
	Ladora	--	--	--	--	--
	Mary	--	--	--	--	--
	McKay	24	17	26	84	212
Largemouth bass	Derby	149	127	495	192	2,600
	Ladora	102	128	484	168	2,200
	Mary	61	188	355	134	618
	McKay	145	140	568	132	3,550
Yellow perch	Derby	--	--	--	--	--
	Ladora	7	16	18	44	71
	Mary	--	--	--	--	--
	McKay	283	10	20	25	103
Northern pike	Derby	9	58	67	897	1,300
	Ladora	7	75	88	2,850	5,200
	Mary	--	--	--	--	--
	McKay	--	--	--	--	--

[1] 1 inch = 2.5 cm

[2] 1 pound = 454 grams

3.7 AQUATIC MACROPHYTES

The aquatic plant communities of the South Lakes were surveyed during August 1987 to determine the prevalent species and to estimate areal coverage.

Submergent macrophytes identified included two species in Lower Derby Lake, three species in Lake Ladora, and five species in Lake Mary. Sago pondweed (*Potamogeton pectinatus*) was present in each of the three lakes. Two other pondweeds, *P. gramineus* and *P. nodosus*, were observed in Lower Derby and Mary, respectively. American water-milfoil (*Myriophyllum exalbescens*) and coontail (*Ceratophyllum demersum*) were present in lakes Ladora and Mary, but not in Lower Derby. Muskgrass, *Chara* sp. (a macroalga), was present only in Lake Ladora. Narrowleaf cattail (*Typha angustifolia*) and broadleaf cattail (*T. latifolia*) were the dominant emergent species in all three lakes. Both cattail species were abundant around the upper ends of the lakes and in other wet areas scattered across the Arsenal.

Aquatic plants provide cover for aquatic insects, spawning sites for some species of fish, and food sources for a variety of aquatic or amphibious species. On the other hand, species such as American water-milfoil, coontail, and the cattails can become so dense that they displace more desirable species and eventually "choke" an entire water body (Correll and Correll 1972).

Areal estimates of peripheral cattail stands in August 1987 were 3.4 ha at Lower Derby Lake, 7.4 ha at Lake Ladora, and 1.0 ha at Lake Mary. Virtually all of Lake Mary and Lake Ladora were covered by submergent macrophytes in August 1987, probably because the low turbidity (and hence high transparency) of these lakes allowed ample light to penetrate the water. The high turbidity of Lower Derby Lake resulted in less development of submergent macrophytes.

4.0 ONSITE-OFFSITE COMPARISONS

One of the major aspects of the aquatic ecology investigation was to compare the three South Lakes at RMA with an offsite reservoir, namely McKay Lake in northwestern Adams County, about 16 km from RMA (Figure 4-1). McKay Lake was selected as the offsite comparison because it is similar to the South Lakes in size, morphometry, and substrate, and contains the same dominant fish species. It is also similar to the South Lakes in that it receives runoff from adjacent rangeland, agricultural land, and rural residential areas, as well as inflow from a ditch system. McKay Lake has a surface area of about 27 ha and a maximum depth of about 5 m. It has a regular shoreline and a substrate of mud with some sand and detritus.

The following subsections summarize the similarities and differences between the RMA lakes and McKay Lake with regard to water quality and aquatic biota.

4.1 WATER QUALITY

Water quality of the South Lakes was generally similar to that of McKay Lake (Table 4-1) and within normal ranges. Notable findings included the following:

a. Conductivity in McKay Lake ($\bar{x}$ = 344 umhos/cm) was only about 50-65 percent of that in the South Lakes, and laboratory analyses showed that McKay had lower total dissolved solids ($\bar{x}$ = 240 mg/l) than the mean for the South Lakes combined (399 mg/l). Both of these conditions were due primarily to higher concentrations of sodium and chloride ions in the Arsenal lakes.

b. Turbidity values were generally higher for McKay Lake ($\bar{x}$ = 16.5 units) than for the Arsenal lakes ($\bar{x}$ = 4.9 units), probably because the shallower depth of McKay increases the potential for disturbance of bottom sediments by wave action. The most turbid lake on RMA

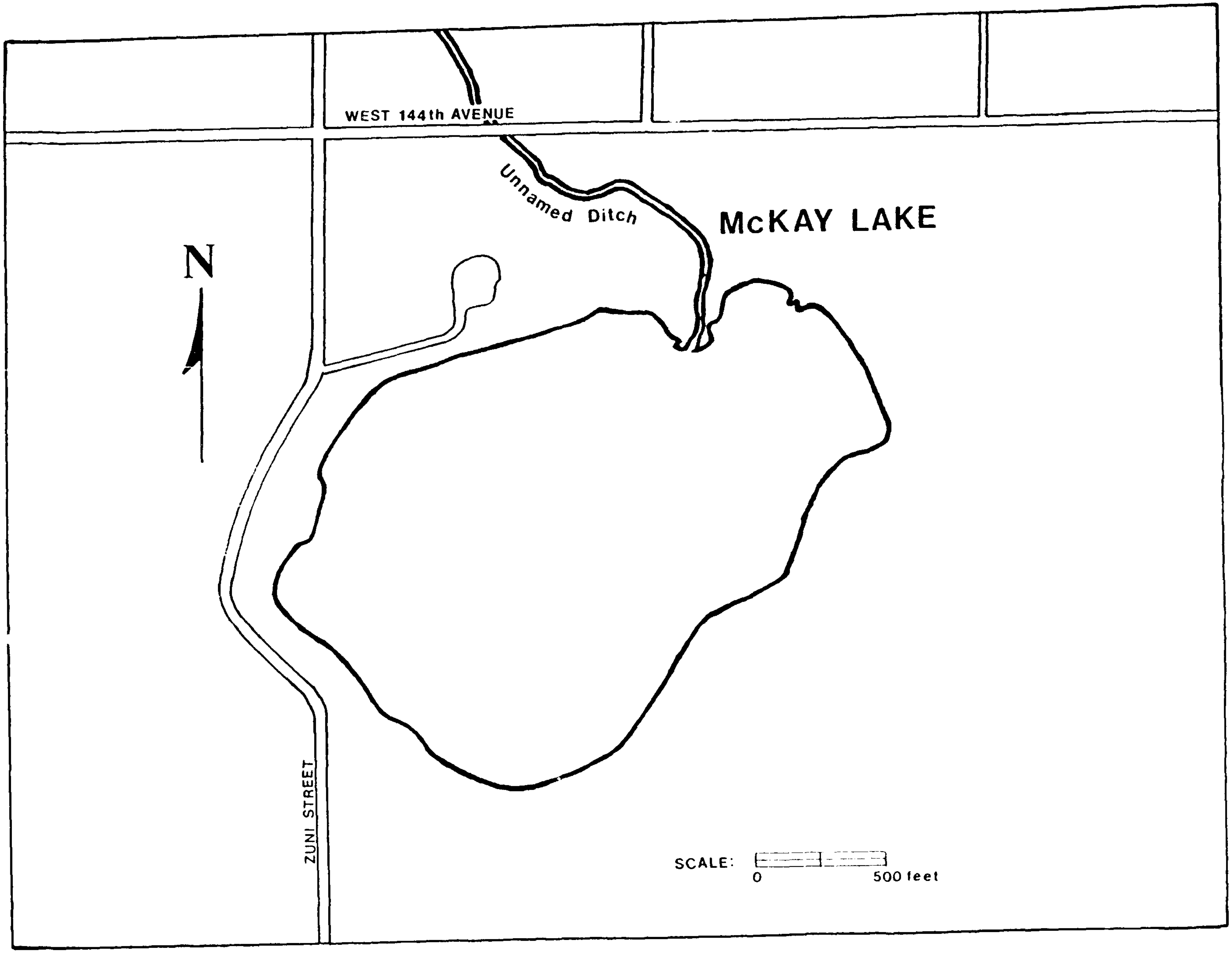

Figure 4-1. Map of McKay Lake, Adams County, Colorado.

TABLE 4-1

Comparison of Mean Water Quality Values Between RMA Lakes and McKay Lake[1, 2]

Parameter[3]	Lower Derby	Ladora	Mary	McKay
Dissolved Oxygen	10.2	10.3	11.7	9.0
pH	8.4	8.1	9.0	7.7
Conductivity (umhos/cm @25°C)	539	675	654	344
Secchi Visibility (m)	0.5	1.7	2.1	0.8
Turbidity (NTU)	10.2	2.0	2.5	16.5
Total Suspend Solids	19.2	3.2	7.2	12.0
Total Dissolved Solids	358	432	407	240
Alkalinity (as $CaCO_3$)	109	129	126	92
Hardness (as $CaCO_3$)	141	179	116	131
Sodium	79	86	100	34
Potassium	6.4	3.8	4.2	3.1
Magnesium	8.8	10.5	9.0	9.0
Bicarbonate	107	128	106	92
Carbonate	2.5	1.0	20.0	0.2
Chloride	53	72	98	16
Sulfate	72	86	100	34
Total Nitrogen (N)	1.9	1.3	2.1	1.8
Nitrate + Nitrite N	0.1	0.1	0.7	0.1
Ammonia N	0.2	0.2	0.2	0.4
Total Phosphorus	0.1	<.07	<.08	<.07

1 All data for samples from 1 m or the nearest depth interval (0.5-1.3 m).

2 Data are arithmetic means for four seasonal samplings in 1987 (April, June, August, November).

3 All values in mg/l unless indicated otherwise.

was Lower Derby ($\bar{x}$ = 10.2 units), which is similar to McKay Lake in being broad and shallow. Total suspended solids (TSS) showed the same pattern as turbidity, with means of 19.5 mg/l for McKay, 19.2 mg/l for Lower Derby, and 9.9 mg/l for the South Lakes which.

c. The low level of dissolved oxygen (DO) in the near-bottom samples from McKay Lake in June (3.2 ug/l) (Table 4-2) was similar to the lowest values for deep areas of the South Lakes. As discussed earlier, low levels of DO are common in deeper portions of productive lakes because of the high biological oxygen demand associated with decomposition of organic detritus. Mean concentrations of dissolved oxygen were higher onsite than at McKay Lake in 1987.

d. The highest pH reading in McKay Lake was 8.0 in June, compared with 8.9 for Lake Ladora, 9.0 for Lower Derby Lake and 9.6 for Lake Mary. Elevated pH during the summer was probably due to photosynthetic activity associated with macrophyte growth, coupled with carbonate alkalinity. This is common for small lakes in the region. The mean pH of McKay Lake (7.7) was notably lower than any of the three South Lakes.

e. Concentrations of ammonia (related to chemical reduction of organic detritus) were highest during November in McKay Lake, as they were in lakes Ladora and Mary. In contrast, the highest value at Lower Derby Lake was recorded in June. The highest ammonia concentration recorded at RMA was 0.50 mg/l in Lake Mary, compared with a high of 0.86 mg/l in McKay Lake during the same sampling period.

Table 4-2

In-Situ Water Quality Measurements at McKay Lake, 1987

Date	Water Depth (M)	Meas. Depth (M)	Temp. (°C)	DO (mg/l	DO (% Sat.)	pH (S.U.)	Conduct. (umhos/cm @25° C)	Secchi Depth (M)
Lower End								
1 May	1.5	0.5	--	--	--	7.8	303	0.5
		1.0	15.5	8.2	82	--	--	
		1.3	15.2	8.3	83	--	--	
14 May	2.0	1.0	18.0	8.9	94	7.8	335	0.7
11 Jun	3.0	0.5	--	--	--	7.5	325	1.5
		1.0	22.5	8.5	98	--	--	
		2.0	21.9	8.6	98	8.0	325	
		2.8	21.0	9.4	105	7.9	330	
12 Aug	1.8	0.5	--	--	--	7.4	345	0.4
		1.0	22.8	7.5	87	--	--	
		1.6	22.5	6.3	73	--	--	
4 Nov	1.3	0.5	11.2	11.7	107	8.0	395	0.4
		1.1	11.2	11.9	108	--	--	
Upper End								
30 Apr	2.5	0.5	--	--	--	7.5	363	0.5
		1.0	15.5	8.1	81	--	--	
		2.0	15.5	8.0	80	--	--	
		2.3	15.2	7.4	74	--	--	
14 May	3.5	1.0	17.8	9.0	95	7.7	320	1.3
		2.0	17.2	9.0	94	7.8	316	
		3.0	16.5	7.3	75	7.2	316	
		3.3	15.2	3.7	37	--	--	
11 Jun	3.7	0.5	--	--	--	7.8	330	1.4
		1.0	19.9	8.2	90	--	--	
		2.0	19.9	9.4	103	7.5	340	
		3.0	19.8	6.7	73	7.8	330	
		3.5	19.2	3.2	35	--	--	
12 Aug	2.1	0.5	--	--	--	7.5	338	0.6
		1.0	23.0	7.4	86	--	--	
		1.9	23.0	6.6	77	--	--	
4 Nov	1.5	0.5	12.0	11.2	104	7.9	390	0.4

4.2 PHYTOPLANKTON

The phytoplankton community of McKay Lake (Appendix B, Table B-4) was generally within the range of the Arsenal lakes in terms of density and diversity (Table 4-3), but somewhat different in terms of composition. Mean density in McKay was 2,623/ml, with a peak of 7,451/ml in November. This pattern most closely resembled that of Lake Mary ($\bar{x}$ = 1,918/ml, with a peak of 5,205/ml in November). McKay was more productive than Ladora ($\bar{x}$ = 1,269/ml), but much less productive than Lower Derby ($\bar{x}$ = 13,854/ml).

Phytoplankton diversity in McKay Lake averaged 25 taxa, compared with 24 for Lake Mary, 28 for Lower Derby Lake, and 41 for Lake Ladora. Chlorophytes (green algae) were dominant in all lakes, but their mean relative abundance was higher in McKay (84 percent) than in Ladora (58 percent), Lower Derby (63 percent), and Mary (67 percent). Notable differences were observed in the abundance patterns of subdominant groups. In McKay Lake, diatoms averaged only 4 percent mean relative abundance. In contrast, they were the principal subdominant in Ladora (25 percent), Mary (24 percent), and Lower Derby (12 percent). Pyrrhophytes were a subdominant in McKay during August, but were virtually absent from the Arsenal lakes. Cyanophytes (blue-green algae) were more abundant than euglenophytes in all three of the South Lakes, and chrysophytes (brown algae) were the second subdominant (behind diatoms) in Lake Ladora. In McKay Lake, no chrysophytes were collected and cyanophytes were present in very low numbers, while euglenophytes were the major subdominant group.

4.3 MICROZOOPLANKTON

Microzooplankton communities of McKay Lake (Appendix C, Table C-4) and the South Lakes consisted entirely of rotifers and were generally similar among the lakes. Although dominance varied somewhat, the three most abundant taxa in all lakes were

Table 4-3

Comparison of Density and Diversity Data for Plankton and Invertebrates in RMA Lakes and McKay Lake[1]

Parameter[2]	Lower Derby	Ladora	Mary	McKay
Phytoplankton				
mean density (no./l)	13,854	1,269	1,918	2,623
mean number of taxa	28	41	24	25
total number of taxa	76	98	69	74
Microzooplankton				
mean density (no./l)	404	317	351	142
mean number of taxa	5.0	6.0	9.7	4.0
total number of taxa	8	11	17	8
Macrozooplankton				
mean density (no./l)	602	446	408	368
mean number of taxa	8.8	10.2	10.0	8.5
total number of taxa	16	19	19	17
Macroinvertebrates				
mean density (no./m^2)	1,590	2,124	2,669	2,004
mean number of taxa	11.8	16.0	19.8	17.0
total number of taxa	29	36	42	29

1 Annual mean calculated from seasonal samples collected in April/May, June, August, and November 1987.

2 Phytoplankton and microzooplankton collected by water bottle; macrozooplankton collected by towed net; macroinvertebrates collected by Ponar dredge.

Keratella stipitata, K. cochlearis, and Polyarthra sp., except for Lower Derby where Brachionus angularis joined these as a codominant. Brachionus angularis was a subdominant in McKay, a minor constituent in Mary, and absent from Ladora samples.

Microzooplankton density was markedly lower in McKay Lake during the four sampling periods, with a mean of 142/liter versus 357/liter for the three South Lakes (Table 4-3). The higher average densities at RMA were due primarily to the very high peaks in Lower Derby in June, and in lakes Ladora and Mary in November. Similar strong pulses were not indicated by the data for McKay Lake, probably because of food supply (see Pennak 1978).

A total of 8 rotifer taxa were identified from McKay Lake, the same number as in Lower Derby. Diversity was somewhat higher in Lake Ladora (11 taxa), and much higher in Lake Mary (17 taxa). The higher number of taxa in Mary and Ladora may have been due to differences in habitat. Most of the species occurring in these lakes are typical of sandy and/or vegetated littoral areas. These conditions predominate in Ladora and Mary, while Lower Derby and McKay are less vegetated and have silt/clay substrates.

4.4 MACROZOOPLANKTON

The mean density of macrozooplankton in McKay (368/liter) (Appendix C, Table C-8) was below the range for the South Lakes (from 408/liter in Mary to 602/liter in Lower Derby) (Table 4-3). As with microzooplankton, the abundance of macrozooplankton is often controlled by food supply (Pennak 1978).

The macrozooplankton communities of the South Lakes contained all of the taxa identified from McKay Lake except for two cladocerans Diaphanosoma sp. and Daphnia galeata mendote. Diaphanosoma commonly occurs in open waters and is seldom found in vegetated areas (Pennak 1978). Daphnia galeata mendote typically prefers large lakes (Brooks 1959). The dominant taxa in all four lakes were cladocerans (including bosminids, Daphnia, and Ceriodaphnia) and copepods (especially nauplii and copepodids). Relative dominance of these groups varied among lakes and seasons. The total number of taxa collected at McKay Lake (17) was similar to that of Lower Derby Lake (16) and lakes Ladora and Mary (19 each).

Trends in seasonal abundance of the prevalent macrozooplankton taxa were similar among the lakes, although overall densities varied. The major difference was the timing and magnitude of the population peaks for the various taxa. Variations of this type are common, even when comparing the same species in adjacent lakes (Pennak 1978).

4.5 BENTHIC MACROINVERTEBRATES

The mean density of benthic macroinvertebrates in McKay Lake (2,004 organisms/m^2) (Appendix D, Table D-4) was within the range of mean densities in the Arsenal lakes (from 1,590/m^2 in Lower Derby to 2,669/m^2 in Lake Mary) (Table 4-3). Overall abundance patterns were similar among the lakes, with highest densities in April/May and November, and lowest densities in June and August.

In general, the community composition of McKay Lake was most similar to that of Lower Derby. Tubificid worms and chironomid flies (midges) composed approximately 92 percent of the community in McKay, 86 percent in Lower Derby, 80 percent in Ladora, and only 63 percent in Mary. Tubificids consisted primarily of immature forms; prevalent adults included Aulodrilus pigueti in Lower Derby, Potamothrix bavaricus in Ladora, and Limnodrilus claparedianus in McKay. Chironomus sp. was the dominant chironomid in each of the four lakes. Subdominant groups, including gastropods (snails), amphipods (sideswimmers), naidid worms, and culicids (phantom midges), were similar among the lakes.

Although chironomids and tubificids were dominant in all four lakes during each sampling period, seasonal trends in dominance between the two groups varied. For example, tubificids were the dominant group during April and June in Lower Derby; April in Ladora; August in Mary; and May, August, and November in McKay.

4.6 FISH

4.6.1 Community Composition and Relative Abundance

Twelve species of fish were identified in McKay Lake, compared to eight species each in Lower Derby Lake and Lake Ladora and five species in Lake Mary. The greater number of species in McKay Lake is due to management practices. Rainbow trout are stocked at McKay in fall and winter, establishing a put-and-take fishery, and other species are occasionally stocked as well. Of the twelve species collected in McKay Lake, the four most abundant were bluegill (43 percent), yellow perch (20 percent), largemouth bass (18 percent), and common carp (9 percent) (Appendix E, Table E-4).

Catches (fish caught per hour) at McKay Lake were highest in April and lowest in August; at the Arsenal they were highest in November and lowest in April. The high spring catches in McKay Lake were largely due to carp concentrating near the shore for spawning; most carp collected were shedding milt or eggs. A number of bluegill also exhibited spawning colors at McKay Lake in April. Few of the fish captured at RMA in April appeared in spawning condition, although a supplemental electrofishing effort in May revealed a number of bluegill with spawning colors. The high catches in all lakes in November were mainly due to presence of young-of-the-year fish.

4.6.2 Evidence of Reproduction

The combination of samples collected by fry seine, towed plankton net, and beach seine, as well as casual observations, indicated successful reproduction by carp, bluegill, white crappie, and largemouth bass in McKay Lake. As described above, spawning apparently occurred earlier in this lake than in the South Lakes. Fry seines produced a total of 921 carp eggs in McKay Lake in April and 108 carp eggs in June. Larvae collected in June included 41 carp, one bluegill, one largemouth bass, and one unidentified species.

A comparison of the fish eggs and larvae collected in McKay Lake and the South Lakes is provided in Appendix E, Tables E-9 through E-12. In general, both McKay Lake and the South Lakes supported reproducing populations of fish. However, management practices at McKay Lake appear to have provided better conditions for reproduction.

4.6.3 Condition Factors

As described in Section 3.5.3, fish length and weight data were used to calculate Fulton's condition factor (K) for two size classes (viz., larger or smaller than 100 mm total length) of bluegill and largemouth bass. Results of the statistical comparisons (rejection levels were 95 percent) are presented in Appendix E, Tables E-13 and E-14, and portrayed graphically in Figure 4-1. Major findings may be summarized as follows:

1. For small bluegill, the mean K value at McKay Lake (1.65) was significantly lower than the values at any of the Arsenal lakes. The highest value was for Lake Mary (1.89).

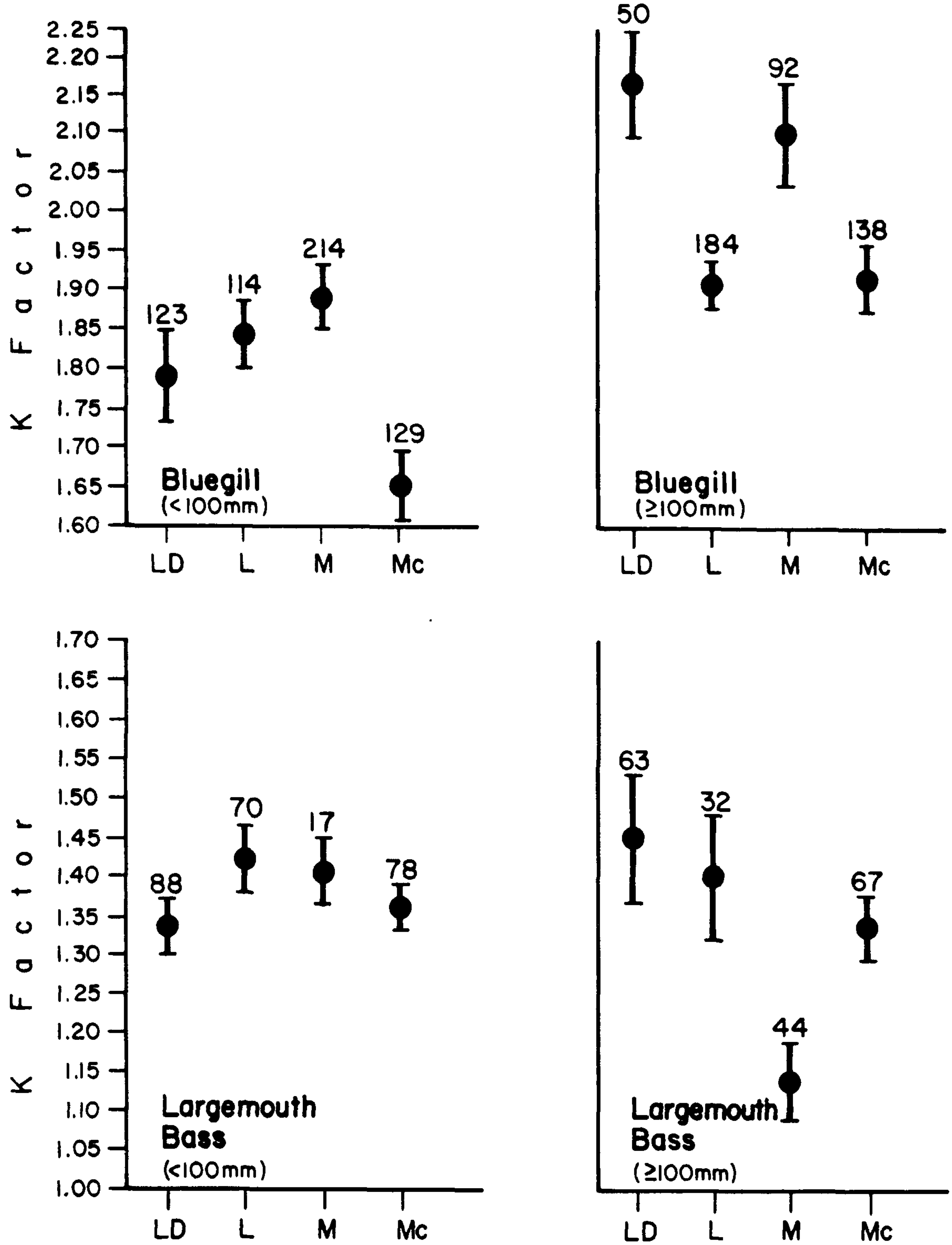

Figure 4-2. Comparison of condition factor (K) for bluegill and largemouth bass from Lower Derby Lake (LD), Lake Ladora (L), Lake Mary (M), and McKay Lake (Mc). Data are means (circles), 95% confidence limits (vertical bars), and samples sizes (numbers above bars).

2. The mean K value for large bluegill in McKay Lake (1.91) was identical to that in Lake Ladora, but significantly lower than the values for Lake Mary (2.10) and Lower Derby Lake (2.17).

3. Condition factors for largemouth bass in the small size class were not significantly different among any of the lakes including McKay. The K value for small bass at McKay (1.36) was within the range for the South Lakes (1.34-1.42).

4. For bass in the large size class, mean condition factor at McKay Lake (1.34) also fell within the range of RMA lakes (1.14-1.45).

These findings indicate that bass and bluegill in the South Lakes were in similar condition to those at McKay Lake. This conclusion is also supported by the slopes of weight-length regressions. For example, the mean regression slope for McKay (3.07) was intermediate between the means for Lower Derby and Ladora (3.27) and Lake Mary (2.86).

4.7 AMPHIBIANS

Observations of amphibians at McKay Lake in 1987 were similar to observations at the South Lakes. Species seen or heard were the northern chorus frog, northern leopard frog, and bullfrog. An unidentified tadpole (*Rana* sp.) was collected by beach seine during the May 1987 sampling.

4.8 AQUATIC MACROPHYTES

The aquatic macrophyte community of McKay Lake contained five of the six taxa identified from the Arsenal lakes. Only muskgrass (*Chara* sp.) was missing in McKay Lake. Areal coverage of submergent species in McKay Lake was about 10 percent. Like Lower Derby, the high turbidity (and thus, low transparency) of

McKay Lake limited the growth of aquatic plants by reducing the penetration of light.

As in the South Lakes, cattails were the predominant emergent plants. Cattails were best developed near the western end of the lake, at the mouth of a small ditch on the north, and along the eastern shore. Areal coverage by cattails around McKay Lake (3.8 ha) was similar to that of Lower Derby (3.4 ha). Coverage by cattails at Lake Ladora and Lake Mary was 7.4 ha and 1.0 ha, respectively.

5.0 HISTORY OF FISHERIES MANAGEMENT AT RMA

This chapter summarizes the history of fisheries management at the RMA. In general, management activities were carried out to establish or maintain a recreational resource. Fisheries management often improves the quality of aquatic ecosystems for terrestrial and semi-aquatic wildlife by providing a better forage base for fish-eating waterfowl, wading birds, and raptors.

Among the most important management tools for fisheries are stocking programs, habitat manipulation, and population control. Fish introductions are sometimes made by fishermen who intentionally release their catches from one lake into another or inadvertently release live bait. Fish introductions and natural colonization via canals have resulted in the present distribution of fish at RMA. Table 5-1 presents documented fish stocking activities on the Arsenal.

5.1 SOUTH LAKES

The South Lakes are the largest impoundments at RMA and have been the focus of fisheries management. It is not clear when fish were first introduced into Ladora and Lower Derby, the two lakes that pre-dated the Arsenal. However, Finley (1959) reported that these lakes were used for fishing patients from Fitzsimmons Army Hospital early in the RMA's history.

The quality of the aquatic resources during that time is unclear, but fish populations reportedly had declined drastically by the late 1940s because of chemical contamination (see MKE 1987). Fish were reportedly absent from the South Lakes in the summer of 1951 (Hyman 1953). Discussions about restocking the lakes were held between the Army and Hyman on several occasions in 1951, but whether fish were re-introduced at that time could not be documented.

Table 5-1

Fish Stocking History of Rocky Mountain Arsenal (1961-1982)[1]

NUMBER AND SIZE (CM) OF EACH SPECIES[2]

Water Body	Year	Rainbow Trout	Northern Pike	Channel Catfish	Bass	Bluegill	Other Sunfish	Black Crappie
Mary	1961	500	--	300	--	--	900(5)	--
	1964	2,000	--	--	--	--	--	--
	1965	4,000	--	--	--	--	--	--
	1967	7,000	--	--	--	--	--	--
	1968	8,176(17)	--	--	--	--	--	--
	1969	8,000(20)	--	--	--	--	--	--
	1970	7,000(17)	--	1,500(17)	--	--	--	--
	1971	8,547(20)	--	--	--	--	--	--
	1972	8,000(20)	--	--	--	--	--	--
	1973	7,400(20)	--	1,500(20)	--	--	--	--
	1974	5,900(20)	--	--	--	--	--	--
	1975	3,500(15)	--	1,500(5)	--	--	--	--
	1976	9,000(22)	--	2,000(5)	--	--	--	--
	1977	476(20)	--	--	--	--	--	--
	1978	896	--	--	--	--	--	--
	1979	250	--	--	--	--	--	--
	1982	--	--	--	--	--	--	3,000(F)
Ladora	1967	--	--	25,000(F)	--	Unknown[3]		--
	1968	--	500,000(F)	5,000(6)	--	--	--	--
	1969	--	--	--	16,000(5)	4,000(5)	--	--
	1970	--	39(10)	--	--	--	--	--
	1976	--	3,000(7)	--	--	--	--	--
	1978	--	300(12)	--	--	--	--	--
	1979	--	4,250(2)	--	--	--	--	--
Lower Derby	1976	--	3,000(5)	--	--	--	--	--
	1978	--	200(12)	--	--	--	--	--
	1979	--	4,250(F)	--	--	--	--	--
Upper Derby	1979	--	1,000(F)	--	--	--	--	--
Rod & Gun Club	1976	--	1,600(5)	--	--	--	--	--
	1979	--	500(F)	--	--	--	--	--
Toxic Storage Yard	1976	--	600(5)	--	--	--	--	--
North Bog	1976	--	600(5)	--	--	--	--	--

[1]Data sources: Bartschi (1968,1969); Mullan (1971, 1974, 1975b); Rosenlund (1978, 1981, 1982); FWS (undated a, b).

[2]Some conflicting data were reported in the documents. Numbers reported here were from the most contemporaneous source. Size (cm) shown is parentheses; 1 cm = 0.4 inches. F = fry (length unreported).

[3]Undocumented number of bluegill transferred from Lake Mary.

Lake Mary was constructed in 1960 for recreational use, and the U.S. Fish and Wildlife Service (FWS) became involved at that time in actively managing the aquatic resources of RMA (Rosenlund 1981). In 1964 and 1965, the South Lakes (except Lake Mary) were drained and sediments were removed in an effort to clean the lakes. The following discussions summarize the management of the South Lakes and other aquatic ecosystems at RMA, since 1965.

5.1.1 Upper and Lower Derby Lakes

The Derby Lakes reportedly did not support a fish population in 1968, when channel catfish fingerlings were planted on an experimental basis (Bartschi 1968). Fish apparently had been established in the Derby Lakes by 1975, because crayfish were released that year as a forage base for largemouth bass. Furthermore, bass, bluegill, and catfish were observed along the shore of Lower Derby Lake in May 1973 (U.S. Army 1973).

In September 1975, the FWS sampled the Derby Lakes with gill nets set overnight (Mullan 1975c). This effort yielded a large number of black bullheads in both lakes, and the FWS's 1975 Annual Fisheries Report stated that the "reservoirs are on the verge of being overrun with black bullheads." To help control this overpopulation of bullheads, northern pike were introduced into Lower Derby in May 1976 (FWS undated b).

Sampling of Arsenal waters by an Army consultant in 1977 (RMFC 1978) indicated that Lower Derby Lake was the most productive and well balanced fishery on RMA and generally contained larger fish than the other lakes. Black bullhead were still the most abundant species, and they apparently had not been stunted by overpopulation. Spawning success was high for largemouth bass, but relatively low for bluegill and green sunfish. Yellow perch were present in low numbers, and northern pike--probably from the 1976 stocking--were also captured. The pike were 25-30 cm in length, which represents considerable growth during their two summers in Lower Derby Lake. Moderate populations of carp and white sucker were also noted, but survival of native minnows was low.

In further attempts at establishing a reproducing population of northern pike, pike 12.5 cm in length were stocked in Lower Derby in 1978 (Rosenlund 1978), and pike fry were released in 1978 (Rosenlund 1981). Upper Derby Lake was stocked with pike fry in 1979. Pike captured in Lower Derby 1981 ranged from 43 to 69 cm and were thought to be feeding on white suckers and bluegill (Rosenlund 1981). Sampling in 1982 produced at least six year classes of pike, indicating that natural reproduction had occurred. The pike were reported to be feeding primarily on bullheads (Rosenlund 1982).

Between 1978 and 1981, the largemouth bass population was apparently low, with individuals ranging from 15 to 38 cm (Rosenlund 1981). Sampling indicated that the bass were feeding on bluegill and growing an average of 7.5 cm per year. By 1982, the bass population had stabilized, and they were utilizing crayfish as their forage base (Rosenlund 1982). This shift in diet apparently resulted from a decline in bluegill, which were thought to have disappeared from Lower Derby Lake by 1982.

Bullheads continued to dominate the Derby Lakes in 1981, but by 1982 their numbers had dropped due to low water levels or predation by bass and pike (Rosenlund 1982). Decreases in populations of yellow perch and white suckers during this period were also attributed to predation by bass and pike. By 1984, northern pike and common carp were abundant, largemouth bass were moderately abundant, and bluegill and black bullhead populations were low (Rosenlund et al. 1986).

5.1.2 Lake Ladora

In 1967, Lake Ladora was stocked by the FWS with 25,000 channel catfish fry and an unknown number of stunted bluegill seined from Lake Mary (Bartschi 1968). The next year, the lake was stocked with 500,000 northern pike fry (Mullan 1975c). Sampling in August 1968 suggested that these stocking efforts were unsuccessful. Channel catfish fingerlings were stocked again in October 1968 (Bartschi 1968). In June 1969, large numbers of small bluegill and largemouth bass were released into Lake Ladora (Bartschi 1969).

In May 1970, a small number of 10-cm northern pike were released (Mullan 1975b). Observations and seining at that time indicated that fathead minnows were abundant and that survival and growth of the bluegills and bass stocked in 1969 was good (Mullan 1971). Fish captured in May 1970 included 43 bluegill (10 to 18 cm), eighty largemouth bass (15 to 28 cm), one green sunfish, and one white sucker.

In 1972, fewer bass were captured than in 1970 (48 vs. 80), but they were larger (25 to 33 cm). More than three times as many bluegill were captured than in 1970 (131 vs. 43), and lengths ranged from 7.5 to 25 cm. Twenty-three green sunfish and a small number of black bullheads were also captured (Mullan 1975b).

The Army opened Lake Ladora to catch-and-release fishing in 1974. Largemouth bass weighing up to 2.7 kilograms (kg) and northern pike up to 10.9 kg were reported by anglers. A few 46-cm northern pike were observed by FWS (Mullan 1974). Sampling in September 1975 suggested an increase in black bullheads. Yellow perch were captured for the first time in 1975; the researchers conjectured that the perch had entered the lakes through the Highline Lateral. Scale analysis of the perch indicated an age of at least one year, and overpopulation was thought possible. The number of bluegill captured in 1975 was almost identical to 1972, but their growth appeared to be declining. Largemouth bass numbers decreased compared to 1972, but their growth was reasonably good. Only one green sunfish was captured in 1975. As previously mentioned, the FWS introduced crayfish into Arsenal waters in 1975 in hopes that they would establish breeding populations and contribute to the forage base. No northern pike were netted in the 1975 survey (Mullan 1975a); 3,000 snall pike were released in 1976.

In 1977, bluegill were the dominant species in Lake Ladora, and overpopulation had resulted in stunted growth (RMFC 1978). Dense aquatic vegetation was thought to have provided too much cover and protection from predatory species. [The removal of aquatic vegetation have benefitted from the Lake Ladora fishery, particularly for bass.] The pike population was of moderate size, but there was no evidence of reproduction. Populations of green sunfish and yellow perch were low, which was attributed mainly to competition with the bluegill for food and habitat. The white sucker population was also low in 1978.

Gill-netting by the FWS in 1978 resulted in captures of 106 bullheads (23-25 cm), three northern pike (35-74 cm), two yellow perch (20 cm), one bluegill (15 cm), and one largemouth bass (37 cm) (Rosenlund 1978). Northern pike were planted in Lake Ladora in 1978 and 1979 in a continuing effort to establish a breeding population.

Black bullhead abundance remained high in Lake Ladora from 1979 through 1981. During that period, their mean size increased from approximately 20 cm to 25 cm (Rosenlund 1981). Bullhead captures dropped to about 20 per net in 1982, which Rosenlund (1982) attributed to an increasing northern pike population. Largemouth bass numbers remained low in 1981; their size ranged from 15 to 37 cm, and they were growing an average of 7.5 cm per year (the same as in Lower Derby Lake). The bass were found to be feeding primarily on bluegill in both 1981 and 1982 (Rosenlund 1981, 1982). The pike caught in Lake Ladora were the largest in Arsenal waters. In 1982 they ranged from 40 cm to 94 cm, representing six age classes. The pike reportedly were utilizing white suckers and bluegills as forage (Rosenlund 1982). As in Lower Derby Lake, both yellow perch and white suckers had decreased by 1982, which FWS attributed to predation by pike. A previously uncaptured species, the golden shiner, was caught in Lake Ladora in 1982 (Rosenlund 1982).

Lake Ladora was again sampled with gill nets in 1984 (Rosenlund et al. 1986). Northern pike, largemouth bass, and bluegill were abundant, and bullheads were common.

5.1.3 Lake Mary

Lake Mary was constructed in 1960 for recreational purposes (Azevedo 1961). It was filled with water from Lake Ladora, located immediately upstream. Carp were seen in the lake in 1960. Lake Mary was initially stocked in 1961 by the Colorado Division of Wildlife (CDOW) with channel catfish, redear sunfish, largemouth bass, and rainbow trout (Mullan 1975b). Annual restockings of catchable-size rainbow trout were made to maintain a put-and-take fishery; that is, fish were stocked to be caught and taken home by anglers. Bluegill were first noted in the lake in 1962.

Rainbow trout (weighing up to 2.2 kg) comprised the largest percentage of fish taken by anglers during the early 1960s. Large redear sunfish (to 0.5 kg), and channel catfish (to 2.0 kg) also were reported by the anglers, but not in great numbers (Mullan 1975b). Fishing pressure rose during the following years (1964-1969 because of the cleanup in the other lakes), and the number of trout stocked by the FWS was doubled. Harvest rates for warmwater species also increased. Redear sunfish disappeared from the catch and were replaced by bluegill (Mullan 1975b). The catch per effort for trout and largemouth bass declined sharply during the late 1960s, and Lake Mary became overpopulated with small bluegill. In 1967, Arsenal personnel attempted to alleviate the problem by seining numerous small bluegill, but this was not successful (Mullan 1975b).

Low oxygen concentrations and excessive growths of algae and macrophytes prompted the Army personnel to apply a herbicide and an algacide to the lake and to bubble air through a hose placed on the bottom (Bartschi 1969). Because of continuing problems with bluegill overpopulation, Lake Mary was drawn down in 1970, and the lake was treated with Rotenone. Dead fish observed included numerous small bluegill, a few largemouth bass, approximately 200 rainbow trout, and a large number of black bullheads. The bullheads probably invaded the lake through the spillway from Lake Ladora (Mullan 1971).

Later in 1970, Lake Mary was refilled with water from Lake Ladora, and channel catfish and rainbow trout were restocked. The fishery was satisfactory for the next two years, but by 1973 it had declined due to an overpopulation of green sunfish. The sunfish apparently entered the lake when it was refilled. Aquatic weeds also had become a problem again (Mullan 1975b).

Lake Mary was treated with Rotenone in 1974 to remove the green sunfish, and in 1975 it was deepened and enlarged from 2.4 to 3.2 ha (Mullan 1975b). It was then filled with groundwater seepage instead of water from Lake Ladora to avoid introducing undesirable fish. At the same time, a new canal was dug around the eastern and southern sides of Lake Mary to prevent Lake Ladora overflows from entering. The lake was stocked with trout and channel catfish, and management for a put-and-take fishery was resumed (Mullan 1975b). Crayfish were introduced to Lake Mary in 1975 to augment the forage base and to help control the weed problem (Mullan 1975b).

Lake Mary was stocked again in 1976 and 1977 (Robinson 1977), but aquatic weeds were reportedly interfering with the development of a healthy, productive fishery (RMFC 1978). Most rainbow trout sampled were in poor condition. The forage base consisted primarily of red shiners, and appeared to be adequate. Bass and bullheads were present, apparently having been released by fishermen or invading naturally via overflow from Lake Ladora. The channel catfish stocked in 1975 had been depleted, either by fishing pressure or natural mortality. More catfish were released in 1976.

From 1978 through 1981, largemouth bass replaced trout as the dominant game fish in Lake Mary (Rosenlund 1981). Bass sampled during this period ranged from 15 cm to 38 cm. By 1980, the increase in the bass population was offset by a decrease in condition and length, with few individuals larger than about 20 cm (Rosenlund 1981). This was attributed to a poor forage base, consisting almost entirely of aquatic invertebrates. The FWS suggested introducing black crappie into Lake Mary to provide prey for the bass, to improve angling opportunities, and to help prevent the bass from becoming overpopulated (adult crappie eat small bass). This recommendation was followed, and 3,000 black crappie fry were planted in Lake Mary in June 1982 (Thorne 1980, Rosenlund 1982).

In 1984, Lake Mary "was dominated by a declining population of stunted old bass" (Rosenlund et al. 1986). Only a few bluegill, black crappie, and channel catfish were collected.

5.2 OTHER RMA WATER BODIES

5.2.1 First Creek

The only documented sampling of First Creek was by electrofishing in 1977 as part of the Arsenal-wide biological inventory (RMFC 1978). The plains killifish, a native topminnow, was the most abundant fish in the stream. Small populations of green sunfish and fathead minnows were observed. Crayfish were also collected, and the population was estimated to be the largest crayfish population on the Arsenal.

5.2.2 Toxic Storage Yard Pond

Northern pike approximately 5 cm long were stocked in Toxic Storage Yard Pond in 1976 (FWS undated b). Sampling in 1977 (RMFC 1978) showed black bullhead to be the most abundant species, followed by largemouth bass. Northern pike and bluegill were also collected. Sizes of pike captured were not reported. Since only pike were stocked in this pond, the other species presumably invaded naturally or were introduced by fishermen.

5.2.3 Rod and Gun Club Pond

FWS personnel stocked Rod and Gun Club Pond with 1,600 pike (5 cm in size) in 1976 (FWS undated b). No other information on stocking of this pond was found. In 1977, Rod and Gun Club Pond contained only a small amount of water (RMFC 1978). Sampling at that time yielded 154 black bullheads, 51 bluegills, ten bass, nine green sunfish, and one northern pike. All of the fish were small. This was believed to be due to overpopulation by black bullheads and bluegill, which were able to avoid predation because of the extensive aquatic weeds. The low number of green sunfish was attributed to competition with bluegill. Pike fry were released in the pond in 1979.

5.2.4 North Bog Pond

North Bog Pond has received little management attention. The FWS stocked 600 northern pike (5 cm in size) in North Bog Pond in 1976 (FWS undated b). It was sampled in 1977, but no fish were captured (RMFC 1978).

5.2.5 Havana (South Gate) Pond

This pond has never been managed and was not included in the 1977 fisheries survey of RMA (RMFC 1978).

6.0 SUMMARY AND RECOMMENDATIONS

Aquatic ecology investigations conducted at the RMA South Lakes and a similar offsite lake revealed no discernible effects of previous contamination at RMA. Phytoplankton, zooplankton, macroinvertebrates, and macrophyte communities in the South Lakes were generally comparable to the offsite lake and within expected ranges. Fish communities were healthy, reproducing, and included many large individuals. Water quality in the South Lakes was also normal and generally comparable to the offsite lake, except for a higher pH and somewhat elevated levels of sodium and chloride.

The aquatic resource represented by the South Lakes appeared to be most limited by extremes of macrophyte growth. At one extreme, lakes Mary and Ladora were very clear, and aquatic macrophytes flourished. This reduced the ability of predatory fish (bass and pike) to catch prey, resulting in an overabundance of forage fish. The macrophytes also interfered with angling. At the other extreme, the higher turbidity of Lower Derby Lake resulted in very little macrophyte growth and thus poor cover for prey species. As a result, forage fish were less abundant than desirable for the predator population. This was exacerbated by fluctuating water levels in Lower Derby, which sometimes led to peripheral emergent vegetation being unavailable for forage fish for food, cover, or reproduction.

All of the South Lakes would benefit from renewed management. In Lake Mary and Lake Ladora, macrophytes should be controlled through the use of aquatic herbicides, mechanical harvesting, or the introduction of grass carp. In Lower Derby Lake, fluctuations in water level should be controlled to reduce turbidity and keep the limited shoreline vegetation accessible to aquatic organisms. Selective stocking programs would also be beneficial.

Some fish tissues analyzed by the Army (ESE 1989) and U.S. Fish and Wildlife Service (Rosenlund et al. 1986) were found to contain pesticides and mercury in concentrations that may be considered unsafe for regular consumption by humans or fish-eating birds such as the bald eagle. If the South Lakes are remediated, a staged approach could be followed so that the entire resource is not affected at once. Long-term management of the aquatic resources at RMA could include enhancement of currently unproductive areas such as Rod and Gun Club Pond, Havana Pond, and Toxic Storage Yard Pond. This would increase recreational opportunities and improve the overall habitat quality of the Arsenal.

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APPENDIX A

Tables A-1 through A-4
Dissolved Oxygen Data

Table A-1
The Early Morning and Evening Dissolved Oxygen in Lower Derby

UPPER END

	APRIL 30, 1987 TIME			JUNE 9, 1987 TIME			AUGUST 11, 1987 TIME			NOVEMBER 3, 1987 TIME			APRIL 13, 1988 TIME		
DEPTH (m)	0717	2006	Delta	0735	2015	Delta	0654	2005	Delta	0650	1700	Delta	0730	1750	Delta
0.50	8.4	9.8	+ 1.4												
1.00				7.3	10.8	+ 3.5	9.3	11.2	+ 1.9	10.3	11.6	+ 1.3	14.0	12.8	- 1.2
0.15 off bottom				7.4	8.2	+ 0.8	7.8	7.7	- 0.1	9.9	10.2	+ 0.3	13.3	12.8	- 0.5
TOTAL DEPTH (m)	1.0	1.3		1.5	1.5		2.0	2.0		1.9	2.0		1.5	1.3	

LOWER END

	APRIL 30, 1987 TIME			JUNE 9, 1987 TIME			AUGUST 11,1987 TIME			NOVEMBER 3, 1987 TIME			APRIL 13. 1988 TIME		
DEPTH (m)	0725	1955	Delta	0745	2021	Delta	0700	2015	Delta	0655	1705	Delta	0745	1800	Delta
0.50	8.8	8.7	- 0.1												
1.00	8.6	7.2	- 1.4	8.4	8.7	+ 0.3	9.2	8.4	- 0.8	11.1	11.4	+ 0.3	14.4	14.6	+ 0.2
1.50	7.5	6.6	- 0.9												
2.00	6.5	4.8	- 1.7	5.3	5.5	+ 0.2	6.9	5.9	- 1.0	11.1	9.0	- 2.1	12.8	12.2	- 0.6
2.50	1.7	1.6	-0.1												
3.00				0.9	0.3	- 0.6	4.5	3.6	- 0.9						
0.15 off bottom	0.4			0.2	0.2	0.0	3.9	1.3	- 2.6	11.0	8.8	- 2.2	2.1	8.4	+ 6.3
TOTAL DEPTH (m)	2.5	2.5		3.5	3.5		3.5	3.5		3.5	3.5		3.0	3.0	

Table A-2
The Early Morning and Evening Dissolved Oxygen in Lake Ladora

UPPER END

DEPTH (m)	APRIL 30, 1987 TIME 0645	1934	Delta	JUNE 9, 1987 TIME 0655	1941	Delta	AUGUST 11, 1987 TIME 0622	1935	Delta	NOVEMBER 2, 1987 TIME 0720	1820	Delta	APRIL 13, 1988 TIME 0700	1850	Delta
0.50	8.9			8.9	9.6	+ 0.7	12.0	13.8	+ 1.8	11.2	12.6	+ 1.4	11.6	12.2	+ 0.4
1.00	8.6	8.3	- 0.3												
0.15 off bottom				8.2			12.6	>15.0	> 2.4	10.5	13.8	+ 3.3	11.8	12.2	+ 0.4
TOTAL DEPTH (m)	1.3	1.5		1.3	1.0		1.25	1.25		0.9	1.0		1.0	1.0	

LOWER END

DEPTH (m)	APRIL 30, 1987 TIME 0630	1918	Delta	JUNE 9, 1987 TIME 0659	1948	Delta	AUGUST 11, 1987 TIME 0630	1945	Delta	NOVEMBER 2, 1987 TIME 0725	1825	Delta	APRIL 13, 1988 TIME 0715	1900	Delta
1.00	8.5	9.8	+ 1.3	10.4	10.7	+ 0.3	8.4	8.5	+ 0.1	12.5	12.4	- 0.1	11.8	11.6	- 0.2
2.00	8.3	9.0	+ 0.7	10.4	10.1	- 0.3	8.1	7.6	- 0.5	12.7	12.2	- 0.5	11.4	11.5	+ 0.1
3.00	8.1	8.1	0.0	10.2	7.5	- 2.7	2.9			11.4	12.3	+ 0.9	12.1	11.6	0.5
4.00	6.9			6.5	7.0	+ 0.5									
0.15 off bottom	3.9			3.1	1.4	- 1.7	1.4			11.1	11.0	+ 0.1	10.9	11.3	+ 0.4
TOTAL DEPTH (m)	5.0	3.0		5.0	5.2		4.0	4.0		4.8	3.9		4.5	4.0	

Table A-3
The Early Morning and Evening Dissolved Oxygen in Lake Mary

UPPER END

DEPTH (m)	MAY 1, 1987 TIME 0634	MAY 1, 1987 TIME 2016	MAY 1, 1987 Delta	JUNE 9, 1987 TIME 0626	JUNE 9, 1987 TIME 1903	JUNE 9, 1987 Delta	AUGUST 11, 1987 TIME 0556	AUGUST 11, 1987 TIME 1850	AUGUST 11, 1987 Delta	NOVEMBER 3, 1987 TIME 0745	NOVEMBER 3, 1987 TIME 1840	NOVEMBER 3, 1987 Delta	APRIL 13, 1988 TIME 0630	APRIL 13, 1988 TIME 1910	APRIL 13, 1988 Delta
1.00	9.8	10.2	+ 0.4	11.6	14.6	+ 3.0	9.4	9.9	+ 0.5	9.4	11.1	+ 1.7	11.1	10.8	- 0.3
2.00							2.1	1.5	- 0.6						
0.15 off bottom	9.8	9.9	+ 0.1	1.8	3.7	+ 1.9	1.4			9.4	10.0	+ 0.6	8.7	10.7	+ 2.0
TOTAL DEPTH (m)	1.5	1.7		1.5	2.0		2.5	2.5		1.5	1.5		2.5	2.0	

LOWER END

DEPTH (m)	MAY 1, 1987 TIME 0640	MAY 1, 1987 TIME 2021	MAY 1, 1987 Delta	JUNE 9, 1987 TIME 0635	JUNE 9, 1987 TIME 1910	JUNE 9, 1987 Delta	AUGUST 11, 1987 TIME 0603	AUGUST 11, 1987 TIME 1900	AUGUST 11, 1987 Delta	NOVEMBER 3, 1987 TIME 0750	NOVEMBER 3, 1987 TIME 1845	NOVEMBER 3, 1987 Delta	APRIL 13, 1988 TIME 0645	APRIL 13, 1988 TIME 1915	APRIL 13, 1988 Delta
1.00	9.7	10.1	+ 0.4	13.1	13.7	+ 0.6	8.2	8.4	+ 0.2	11.2	11.4	+ 0.2	11.2	10.9	0.3
2.00	9.6	9.8	+ 0.2	12.9	13.4	+ 0.5	6.3	4.5	- 1.8	11.3	11.3	0.0	10.3	10.3	0.0
0.15 off bottom	8.6	9.5	+ 0.9	12.6	11.2	+ 1.4	1.7	1.2	- 0.5	11.1	12.8	+ 1.7	[illegible]	9.4	[illegible]
TOTAL DEPTH (m)	3.5	3.0		3.0	3.3		3.0	3.5		2.5	3.0		3.0	3.0	

Table A-4
The Early Morning and Evening Dissolved Oxygen in Mckay Lake

UPPER END

DEPTH (m)	MAY 1, 1987 TIME 0856	1909	Delta	JUNE 11, 1987 TIME 0650	1900	Delta	AUGUST 12, 1987 TIME 0715	1900	Delta	NOVEMBER 4, 1987 TIME 0720	1630	Delta	APRIL 14, 1980 TIME 0720	1750	Delta
1.00	8.1	8.2	+ 0.1	8.2	8.2	0.0	6.7	7.2	+ 0.5	11.1	11.7	+ 0.6	10.8	11.6	+ 0.8
2.00	8.0	8.2	+ 0.2	9.4	9.0	- 0.4	6.7	7.2	+ 0.5						
3.00				6.7	6.4	-0.3									
0.15 off bottom	7.4	8.0	+ 0.6	3.2			6.3	6.6	+ 0.3	11.0	11.6	+ 0.6	9.7	10.8	+ 1.1
TOTAL DEPTH (m)	2.5	3.2		3.5	3.5		3.0	2.9		1.5	1.5		1.5	1.5	

LOWER END

DEPTH (m)	MAY 1, 1987 TIME 0900	1916	Delta	JUNE 11, 1987 TIME 0655	0720	Delta	AUGUST 12, 1987 TIME 0720	1915	Delta	NOVEMBER 4, 1987 TIME 0725	1640	Delta	April 14, 1988 TIME 0730	1757	Delta
0.50													10.7	11.7	+ 1.0
1.00	8.2	8.8	+ 0.6	8.1	8.5	+ 0.4	6.7	6.6	+ 0.1	11.0	11.4	+ 0.4			
2.00				8.0	8.6	+ 0.6									
0.15 off bottom	8.3	8.8	+ 0.5	7.8	9.4	+ 1.6	6.6	6.6	0.0	10.9	11.3	+ 0.4			
TOTAL DEPTH (m)	1.5	2.0		2.3	3.0		1.1	2.0		1.5	1.5		1.0	1.0	

APPENDIX B

Tables B-1 through B-8
Phytoplankton Data

Table B-1

The Phytoplankton Community of Lake Derby

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
Chlorophyta	999.7519	73.68	9992.8012	84.68	21846.9079	87.76	1130.9690	6.51	8492.6075	61.30	1123.1239	10.03
Volvocales												
Carteria (LPIL)							80.7835	0.47	20.1959	0.15		
Chlamydomonas (LPIL)	45.4433	3.35	251.0754	2.13					74.1297	0.54	231.2314	2.06
Tetrasporales												
Gloeocystis vesiculosa			301.2905	2.55					75.3226	0.54		
Sphaerocystis schroeteri							80.7835	0.47	20.1959	0.15		
Chlorococcales												
Chlorella pyrenoidosa					20976.5133	84.27			5244.1283	37.85		
Dictyosphaerium pulchellum	6.4919	0.48	200.8603	1.70					51.8381	0.37		
Trochiscia reticularis			301.2905	2.55					75.3226	0.54		
Coelastrum microporum	25.9676	1.91							6.4919	0.05		
Pediastrum duplex	6.4919	0.48							1.6230	0.01		
Pediastrum simplex	32.4595	2.39			174.0789	0.70			51.6346	0.37	66.0661	0.59
Oocystis gloeocystiformis			4720.2176	40.00					1180.0544	8.52		
Oocystis lacustris	207.7406	15.31	1104.7318	9.36					328.1181	2.37	99.0992	0.88
Oocystis parva							242.3505	1.40	60.5876	0.44		
Oocystis solitaria	110.3622	8.13	1104.7318	9.36	174.0789	0.70			347.2932	2.51	66.0661	0.59
Oocystis (LPIL)			903.8715	7.66	174.0789	0.70			269.4876	1.95		
Ankistrodesmus falcatus	32.4595	2.39					161.5670	0.93	48.5066	0.35	198.1983	1.77
Lagerheimia ciliata	12.9838	0.96							3.2460	0.02		
Lagerheimia quadriseta			150.6452	1.28					37.6613	0.27		
Quadrigula lacustris	6.4919	0.48							1.6230	0.01		
Selenastrum minutum	285.6434	21.05					161.5670	0.93	111.8026	0.81	66.0661	0.59
Closteriopsis longissima							323.1340	1.86	80.7835	0.58	198.1983	1.77
Scenedesmus abundans	6.4919	0.48							1.6230	0.01		
Scenedesmus arcuatus	6.4919	0.48							1.6230	0.01		

Table B-1

The Phytoplankton Community of Lake Derby

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
Scenedesmus bijuga	19.4757	1.44	853.6564	7.23	87.0395	0.35			240.0429	1.73	33.0331	0.29
Scenedesmus dimorphus	6.4919	0.48							1.6230	0.01		
Scenedesmus quadicauda	116.8541	8.61							29.2135	0.21	99.0992	0.88
Crucigenia quadricauta							80.7835	0.47	20.1959	0.15		
Tetrastrum glabrum			100.4302	0.85					25.1076	0.18		
Zygnematales												
Cosmarium (LPIL)	71.4108	5.26			87.0395	0.35			39.6126	0.29	66.0661	0.59
Closterium parvulum					174.0789	0.70			43.5197	0.31		
Chrysophyta							646.2681	3.72	161.5670	1.17	66.0661	0.59
Chrysomonadales												
Mallomonas (LPIL)							646.2681	3.72	161.5670	1.17	66.0661	0.59
Bacillariophyta	350.5622	25.84	1657.0979	14.04	957.4340	3.85	484.7010	2.79	862.4488	6.22	5483.4865	48.97
Centrales												
Melosira granulata	71.4108	5.26	200.8603	1.70	46.8674	0.19	13.1712	0.08	83.0774	0.60	514.9768	4.60
Melosira granulata var. angustissima					40.1721	0.16	67.6123	0.39	26.9461	0.19	112.6512	1.01
Cyclotella meneghiniana	111.0114	8.18	21.4115	0.18	48.6556	0.20	55.4633	0.32	59.1355	0.43	63.7066	0.57
Cyclotella ocellata	12.3346	0.91	1384.6108	11.73	473.5812	1.90	106.1037	0.61	494.1576	3.57	530.8884	4.74
Pennales												
Asterionella formosa							12.7553	0.07	3.1888	0.02	41.3715	0.37
Fragilaria capucina var. mesolepta											20.6857	0.18
Fragilaria crotonesis					43.5197	0.17	8.5035	0.05	13.0058	0.09		
Fragilaria pinnata					8.7039	0.03			2.1760	0.02	351.6577	3.14
Synedra delicatissima											82.7430	0.74
Cocconeis placentula							8.5035	0.05	2.1259	0.02	20.6857	0.18
Achnanthes haukiana							17.0071	0.10	4.2518	0.03		
Achnanthes haukiana var. rostrata					8.7039	0.03			2.1760	0.02		

Table B-1

The Phytoplankton Community of Lake Derby

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
Achnanthes lanceolata											82.7430	0.74
Gyrosigma acuminatus											82.7430	0.74
Gyrosigma (LPIL)							8.5035	0.05	2.1259	0.02		
Diploneis (LPIL)	6.2322	0.46							1.5581	0.01		
Navicula anglica			3.5868	0.03					0.8967	0.01		
Navicula capitata	18.6967	1.38					12.7553	0.07	7.8630	0.06	165.4860	1.48
Navicula capitata var. hungarica					17.4079	0.07			4.3520	0.03		
Navicula cryptocephala					52.2237	0.21			13.0559	0.09	455.0864	4.06
Navicula cuspidata											20.6857	0.18
Navicula decussis							8.5035	0.05	2.1259	0.02		
Navicula exiguiformis	112.1799	8.27	17.9340	0.15	52.2237	0.21	12.7553	0.07	48.7732	0.35	124.1145	1.11
Navicula pupula var. rectangularis	6.2322	0.46			87.0395	0.35	42.5176	0.24	33.9473	0.25	496.4579	4.43
Navicula pygmaea							25.5106	0.15	6.3777	0.05	41.3715	0.37
Navicula rhynchocephala											62.0572	0.55
Navicula salinarum											372.3434	3.33
Navicula tenera											41.3715	0.37
Navicula (LPIL)			28.6943	0.24					7.1736	0.05		
Cymbella minuta											455.0864	4.06
Cymbella prostrata							4.2518	0.02	1.0630	0.01		
Amphora perpusilla							34.0141	0.20	8.5035	0.06		
Amphora ovalis					17.4079	0.07			4.3520	0.03		
Nitzschia amphibia	3.1161	0.23							0.7790	0.01	41.3715	0.37
Nitzschia angustata	3.1161	0.23							0.7790	0.01	20.6857	0.18
Nitzschia apiculata							4.2518	0.02	1.0630	0.01		
Nitzschia hungarica					26.1118	0.10	8.5035	0.05	8.6538	0.06	62.0572	0.55
Nitzschia linearis											20.6857	0.18
Nitzschia palea					17.4079	0.07	34.0141	0.20	12.8555	0.09	1137.7161	10.16
Nitzschia (LPIL)					8.7039	0.03			2.1760	0.02		

Table B-1

The Phytoplankton Community of Lake Derby

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
Cymatopluera solea	6.2322	0.46			8.7039	0.03			3.7340	0.03	62.0572	0.55
Euglenophyta	6.4919	0.48	100.4302	0.85	609.2763	2.45	242.3505	1.40	239.6372	1.73	66.0662	0.59
Euglenales												
Euglena acus											33.0331	0.29
Trachelomonas hispida					261.1184	1.05			65.2796	0.47		
Trachelomonas volvocina	6.4919	0.48	100.4302	0.85	348.1579	1.40	161.5670	0.93	154.1618	1.11		
Trachelomonas (LPIL)							80.7835	0.47	20.1959	0.15	33.0331	0.29
Pyrrhophyta					435.1974	1.75	161.5670	0.93	149.1911	1.08	99.0992	0.88
Peridinales												
Glenodinim gymnodinium					348.1579	1.40			87.0395	0.63		
Peridinium inconspicuum							161.5670	0.93	40.3918	0.29	99.0992	0.88
Ceratium hirundinella					87.0395	0.35			21.7599	0.16		
Cryptophyta							5170.1448	29.77	1292.5362	9.33	3600.6029	32.15
Cryptomonadales												
Cryptomonas marsonnii											528.5289	4.72
Rhodomonas minuta							2019.5878	11.63	504.8970	3.64	3072.0740	27.43
Cryptomonas erosa							80.7835	0.47	20.1959	0.15		
Cryptomonas ovata							3069.7735	17.67	767.4434	5.54		
Cyanophyta			50.2151	0.43	1044.4736	4.20	9532.4544	54.88	2656.7858	19.18	759.7602	6.78
Chroococcales												
Chroococcus (LPIL)							80.7835	0.47	20.1959	0.15		
Microcystis incerta							8643.8358	49.77	2160.9590	15.60		
Microcystis (LPIL)											627.6780	5.60
Hormogonales												

Table B-1

The Phytoplankton Community of Lake Derby

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
Aphanizomenon flos-aquae					870.3947	3.50			217.5987	1.57		
Oscillatoria tenuis			50.2151	0.43			807.8351	4.65	214.5126	1.55		
Oscillatoria (LPIL)					174.0789	0.70			43.5197	0.31	132.1322	1.18
TOTAL (UNITS/MILLILITER)	1356.8060		11800.5442		24893.2892		17368.4548		13854.7736		11198.2051	
NUMBER OF TAXA	28		19		29		36		76		45	
MEAN TAXA/MONTH									28			

Table B-2

The Phytoplankton Community of Lake Ladora

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Chlorophyta	20.3671	12.58	559.4488	71.36	2225.0229	81.21	514.2022	36.99	829.7603	65.39	114.2395	4.45
Volovocales												
Chlamydomonas (LPIL)	4.0734	2.52	22.8346	2.91	441.3269	16.11	8.0344	0.58	119.0673	9.38	7.6160	0.30
Oedogoniales												
Oedogonium (LPIL)					128.7203	4.70			32.1801	2.54	15.2319	0.59
Ulotricales												
Radiofilum (LPIL)							8.0344	0.58	2.0086	0.16		
Tetrasporales												
Gloeocystis vesiculosa			53.2808	6.80					13.3202	1.05		
Sphaerocystis schroeteri							8.0344	0.58	2.0086	0.16		
Chlorococcales												
Chlorella (LPIL)			331.1024	42.23					82.7756	6.52		
Torchiscia (LPIL)	5.0918	3.14			18.3886	0.67			5.8701	0.46		
Coelastrum microporum			3.8058	0.49	36.7772	1.34			10.1458	0.80		
Pediastrum simplex					18.3886	0.67			4.5972	0.36		
Pediastrum tetras			3.8058	0.49					0.9515	0.07		
Oocystis lacustris			19.0289	2.43					4.7572	0.37		
Oocystis solitaria	3.0551	1.89			1250.4262	45.64	313.3421	22.54	391.7059	30.87	53.3117	2.08
Quadrigula lacustris							16.0688	1.16	4.0172	0.32		
Ankistrodesmus falcatus											7.6160	0.30
Selenastrum minutum	4.0734	2.52					88.3785	6.36	23.1130	1.82		
Tetraedron minumum			22.8346	2.91	18.3886	0.67			10.3058	0.81		
Tetraedron muticum					36.7772	1.34	8.0344	0.58	11.2029	0.88		
Scenedesmus arcuatus							24.1032	1.73	6.0258	0.47		
Scenedesmus bijuga	2.0367	1.26			165.4976	6.04			41.8836	3.30	7.6160	0.30
Scenedesmus quadicauda	2.0367	1.26			18.3886	0.67	16.0688	1.16	9.1235	0.72		
Scenedesmus (LPIL)			49.4751	6.31					12.3688	0.97		
Crucigenia apiculata var. *truncata*			15.2231	1.94					3.8058	0.30		

Table B-2

The Phytoplankton Community of Lake Ladora

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Zygnematales												
Spirogyra (LPIL)					55.1659	2.01	16.0688	1.16	17.8087	1.40		
Mougeotia (LPIL)			38.0577	4.85					9.5144	0.75	7.6160	0.30
Cosmarium (LPIL)							8.0344	0.58	2.0086	0.16	15.2319	0.59
Staurastrum (LPIL)					36.7772	1.34			9.1943	0.72		
Chrysophyta	27.4958	16.98					361.5485	26.01	97.2611	7.66	1104.3133	43.03
Chrysomonadales												
Chrysococcus rufescens											152.3191	5.93
Dinobryon divergens											540.7327	21.07
Diplosiga socialis											159.9350	6.23
Kephyrion (LPIL)	27.4958	16.98					16.0688	1.16	10.8912	0.86		
Uroglenopsis americana											251.3265	9.79
Heterochloridales												
Chlorochromonas (LPIL)							136.5850	9.83	34.1463	2.69		
Heterococcales												
Chytridiochloris acus							208.8947	15.03	52.2237	4.12		
Bacillariophyta	57.0273	35.22	216.9293	27.67	422.9385	15.44	313.3419	22.54	252.5593	19.90	967.2266	37.69
Centrales												
Melosira granulata			3.8058	0.49	18.3886	0.67			5.5486	0.44		
Cyclotella meneghiniana	1.0184	0.63	22.8346	2.91	73.5545	2.68	21.6929	1.56	29.7751	2.35		
Cyclotella ocellata							2.4103	0.17	0.6026	0.05		
Pennales												
Diatoma tenue	0.2800	0.17							0.0700	0.01	6.4268	0.25
Fragilaria capucina var. mesolepta	3.6406	2.25			30.6477	1.12	2.9364	0.21	9.3062	0.73	19.2803	0.75
Fragilaria construens											6.4268	0.25
Fragilaria construens var. binodis	1.6803	1.04							0.4201	0.03		
Fragilaria construens var. subsalina							49.9194	3.59	12.4799	0.98		

Table B-2

The Phytoplankton Community of Lake Ladora

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Fragilaria crotonensis	23.8042	14.70							5.9511	0.47	578.4077	22.54
Fragilaria vaucheria	3.0805	1.90	27.3797	3.49	95.0079	3.47	77.8155	5.60	50.8209	4.00		
Synedra capitata	3.9207	2.42	2.7380	0.35	6.1295	0.22			3.1971	0.25	41.7739	1.63
Synedra delicatissima							2.9364	0.21	0.7341	0.06		
Synedra fasciculata	0.2800	0.17			12.2591	0.45			3.1348	0.25		
Synedra rumpens					1.5324	0.06			0.3831	0.03		
Synedra ulna			24.6417	3.14					6.1604	0.49	12.8535	0.50
Cocconeis placentula	2.8005	1.73	21.9037	2.79	3.0648	0.11	30.8326	2.22	14.6504	1.15	22.4936	0.88
Cocconeis pediculus					3.0648	0.11	4.4047	0.32	1.8674	0.15		
Achnanthes hauckiana											6.4268	0.25
Achnanthes lanceolata											3.2134	0.13
Achnanthes minutissima							2.9364	0.21	0.7341	0.06	22.4936	0.88
Rhoicosphenia curvata	0.8401	0.52							0.2100	0.02		
Amphipleura pellucida											3.2134	0.13
Anomoeoneis sphaerophora			1.3690	0.17			1.4682	0.11	0.7093	0.06	3.2134	0.13
Mastogloia elliptica var. danseii							1.4682	0.11	0.3671	0.03		
Navicula anglica var. subsalsa	0.2800	0.17							0.0700	<0.01		
Navicula capitata			6.8449	0.87			5.8729	0.42	3.1795	0.25	25.7070	1.00
Navicula cuspidata			5.4759	0.70	1.5324	0.06	4.4047	0.32	2.8533	0.22		
Navicula exiguiformis			8.2139	1.05					2.0535	0.16		
Navicula pupula var. rectangularis	1.9603	1.21	1.3690	0.17					0.8323	0.07	35.3471	1.38
Navicula rhynchocephala	0.2800	0.17							0.0700	<0.01		
Navicula radiosa	0.2800	0.17	1.3690	0.17					0.4123	0.03	19.2803	0.75
Navicula secura	0.2800	0.17			7.6619	0.28			1.9855	0.16		
Calonies amphisbaena							2.9364	0.21	0.7341	0.06		
Pinnularia borealis	0.5601	0.35	2.7380	0.35					0.8245	0.06		
Pinnularia (LPIL)					1.5324	0.06	4.4047	0.32	1.4843	0.12	3.2134	0.13
Gomphonema affine			5.4759	0.70					1.3690	0.11		
Gomphonema affine var. insigne					7.6619	0.28			1.9155	0.15		

Table B-2

The Phytoplankton Community of Lake Ladora

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Gomphonema truncatum var. capitatum	0.2800	0.17	23.2727	2.97	3.0648	0.11	2.9364	0.21	7.3885	0.58		
Gomphonema parvulum	0.5601	0.35							0.1400	0.01		
Gomphonema (LPIL)							5.8729	0.42	1.4682	0.12		
Cymbella affinis	1.1202	0.69							0.2801	0.02		
Cymbella angustata											9.6401	0.38
Cympbella cistula											3.2134	0.13
Cymbella mexicana var. mexicana							2.9364	0.21	0.7341	0.06	3.2134	0.13
Cymbella minuta			1.3690	0.17	3.0648	0.11			1.1085	0.09		
Cymbella muelleri	0.2800	0.17							0.0700	<0.01		
Cymbella prostrata	0.8401	0.52	1.3690	0.17					0.5523	0.04	3.2134	0.13
Epithemia adnata											6.4268	0.25
Epithemia sorex	3.9207	2.42	27.3797	3.49	85.8136	3.13			29.2785	2.31	19.2803	0.75
Epithemia turgida					39.8420	1.45			9.9605	0.78	19.2803	0.75
Amphora ovalis	0.8401	0.52	8.2139	1.05	3.0648	0.11			3.0297	0.24	3.2134	0.13
Amphora perpusilla							2.9364	0.21	0.7341	0.06		
Rhopalodia gibba	1.9603	1.21	4.1070	0.52			14.6822	1.06	5.1874	0.41	22.4936	0.88
Rhopalodia gibba var. ventricosa					9.1943	0.34			2.2986	0.18		
Nitzschia amphibia	0.2800	0.17	2.7380	0.35	15.3239	0.56	11.7457	0.85	7.5219	0.59	22.4936	0.88
Nitzschia angustata	0.2800	0.17							0.0700	<0.01		
Nitzschia hungarica	0.2800	0.17					17.6186	1.27	4.4747	0.35	25.7070	1.00
Nitzschia kutzingiana							1.4682	0.11	0.3671	0.03		
Nitzschia recta											3.2134	0.13
Nitzschia sigma											3.2134	0.13
Nitzschia tryblionella	0.2800	0.17	6.8449	0.87			8.8093	0.63	3.9836	0.31		
Nitzschia (LPIL)	0.2800	0.17					19.0868	1.37	4.8417	0.38	12.8535	0.50
Hantzschia elongata			1.3690	0.17					0.3423	0.03		
Cymatopluera solea	0.2800	0.17	4.1070	0.52	1.5324	0.06	5.8729	0.42	2.9481	0.23		
Surirella ovata	0.5601	0.35							0.1400	0.01		
Surirella robusta							2.9364	0.21	0.7341	0.06		

Table B-2

The Phytoplankton Community of Lake Ladora

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Euglenophyta			3.8058	0.49					0.9515	0.07		
Euglenales												
Phacus pseudoswirenkoi			3.8058	0.49					0.9515	0.07		
Cryptophyta	41.7529	25.79					168.7226	12.14	52.6189	4.15	365.5659	14.24
Cryptomonadales												
Rhodomonas minuta							136.585	9.83	34.1463	2.69	251.3265	9.79
Chroomonas minuta	6.1102	3.77							1.5276	0.12		
Cryptomonas erosa	3.0551	1.89							0.7638	0.06		
Cryptomonas marssonii	31.5692	19.50					16.0688	1.16	11.9095	0.94	106.6234	4.15
Cryptomonas ovata							16.0688	1.16	4.0172	0.32	7.6160	0.30
Cryptomonas (LPIL)	1.0184	0.63							0.2546	0.02		
Cyanophyta	15.2754	9.43	3.8058	0.49	91.9431	3.36	32.1376	2.31	35.7905	2.82	15.2320	0.59
Chroococcales												
Chroococcus (LPIL)	10.1836	6.29					8.0344	0.58	4.5545	0.36		
Gomphosphaeria lacustris							8.0344	0.58	2.0086	0.16	7.6160	0.30
Hormogonales												
Anabaena (LPIL)					18.3886	0.67			4.5972	0.36		
Oscillatoria limnetica	5.0918	3.14			18.3886	0.67	8.0344	0.58	7.8787	0.62	7.6160	0.30
Oscillatoria (LPIL)					55.1659	2.01			13.7915	1.09		
Lyngbya (LPIL)			3.8058	0.49			8.0344	0.58	2.9601	0.23		
TOTAL (UNITS/MILLILITER)	161.9185		783.9897		2739.9045		1389.9528		1268.9414		2566.5773	
NUMBER OF TAXA	44		36		36		48		98		46	
MEAN TAXA/MONTH									41			
		199.98		199.98		200		200.04		199.97793		200.07

Table B-3

The Phytoplankton Community of Lake Mary

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1897 MEAN DENSITY	1897 MEAN RELATIVE ABUNDANCE (%)	APRIL 15, 1988 DENSITY	APRIL 15, 1988 RELATIVE ABUNDANCE (%)
Chlorophyta	119.8534	92.73	211.5061	84.38	1817.3841	87.00	160.4924	3.08	577.3090	30.09	114.8921	2.14
Volovocales												
Carteria (LPIL)											43.0845	0.80
Chlamydomonas (LPIL)	44.6513	34.55			114.8921	5.50			39.8859	2.08	28.7230	0.54
Ulotricales												
Geminella interrupta			3.9168	1.56					0.9792	0.05		
Radiofilum (LPIL)					41.7789	2.00	22.9275	0.44	16.1766	0.84		
Ulothrix subtillissima			7.8336	3.13					1.9584	0.10		
Ulothrix (LPIL)					31.3342	1.50			7.8336	0.41		
Tetrasporales												
Gloeocystis vesiculosa	4.7001	3.64							1.1750	0.06		
Sphaerocystis schroeteri					428.2342	20.50	22.9275	0.44	112.7904	5.88		
Chlorococcales												
Dictyosphaerium Ehrenbergianum			3.9168	1.56	271.5632	13.00			68.8700	3.59		
Dictyosphaerium pulchellum							22.9275	0.44	5.7319	0.30		
Trochiscia reticularis			101.8362	40.63					25.4591	1.33		
Coelastrum microporum					10.4447	0.50			2.6112	0.14		
Oocystis lacustris			3.9168	1.56					0.9792	0.05		
Oocystis solitaria	25.8507	20.00			616.2395	29.50			160.5226	8.37		
Oocystis (LPIL)			50.9181	20.31					12.7295	0.66		
Ankistrodesmus falcatus	7.0502	5.45							1.7626	0.09		
Quadrigula lacustris	28.2008	21.82			10.4447	0.50			9.6614	0.50	14.3615	0.27
Selenastrum minutum					31.3342	1.50			7.8336	0.41		
Tetraedron minimum			15.6671	6.25					3.9168	0.20		
Scenedesmus arcuatus					10.4447	0.50	22.9275	0.44	8.3431	0.43		
Scenedesmus bijuga					10.4447	0.50			2.6112	0.14		
Scenedesmus quadicauda	9.4003	7.27			156.6711	7.50	22.9275	0.44	47.2497	2.46	28.7230	0.54

Table B-3

The Phytoplankton Community of Lake Mary

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1897 MEAN DENSITY	1897 MEAN RELATIVE ABUNDANCE (%)	APRIL 15, 1988 DENSITY	APRIL 15, 1988 RELATIVE ABUNDANCE (%)
Scenedesmus (LPIL)			15.6671	6.25					3.9168	0.20		
Crucigenia rectangularis					10.4447	0.50			2.6112	0.14		
Zygnematales												
Cosmarium impressulum var. suborthogona			3.9168	1.56					0.9792	0.05		
Cosmarium (LPIL)					20.8895	1.00	45.8549	0.88	16.6861	0.87		
Staurastrum (LPIL)					20.8895	1.00			5.2224	0.27		
Closterium parvulum			3.9168	1.56					0.9792	0.05		
Closterium (LPIL)					31.3342	1.50			7.8336	0.41		
Chrysophyta							45.8549	0.88	11.4637	0.60	2096.7809	39.14
Chrysomonadales												
Chrysococcus rufescens											789.8832	14.75
Dinobryon divergens							45.8549	0.88	11.4637	0.60	114.8921	2.14
Kephyrion (LPIL)											1192.0056	22.25
Bacillariophyta			35.2508	14.06	83.5578	4.00	3989.3800	76.65	1027.0472	53.54	2269.1191	42.36
Centrales												
Melosira granulata			3.9168	1.56					0.9792	1.05		
Cyclotella meneghiniana					7.5962	0.36	481.4769	9.25	122.2683	6.37	15.3063	0.29
Cyclotella ocellata			3.9168	1.56	2.8486	0.14			1.6914	0.09		
Cyclotella stelligera											5.1021	0.10
Stephanodiscus astrea											238.0988	4.44
Pennales												
Diatoma tenue			4.9966	1.99	0.3711	0.02			1.3419	0.07	95.4404	1.78
Fragilaria capucina var. mesolepta					6.6804	0.32			1.6701	0.09	95.4404	1.78
Fragilaria construens var. binodis			0.8968	0.36					0.2242	0.01		
Fragilaria crotonesis											1196.1868	22.33
Fragilaria pinnata											19.0881	0.36

Table B-3

The Phytoplankton Community of Lake Mary

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1897 MEAN DENSITY	1897 MEAN RELATIVE ABUNDANCE (%)	APRIL 15, 1988 DENSITY	APRIL 15, 1988 RELATIVE ABUNDANCE (%)
Fragilaria vaucheria			5.7653	2.30			2798.1328	53.76	700.9745	36.54		
Synedra cyclopum											12.7254	0.24
Synedra delicatissima							13.6494	0.26	3.4124	0.18	114.5285	2.14
Synedra fasciculata			0.1281	0.05					0.0320	<0.01	12.7254	0.24
Synedra ulna											19.0881	0.36
Cocconeis placentula			4.3560	1.74	14.1030	0.68	382.1840	7.34	100.1608	5.22	89.0777	1.66
Achnanthes lanceolata			0.5125	0.20					0.1281	<0.01		
Achnanthes minutissima											69.9897	1.31
Rhoicosphenia curvata			0.8968	0.36					0.2242	0.01		
Pleurosigma (LPIL)					0.3711	0.02			0.0928	<0.01		
Navicula cryptocephala			0.3844	0.15					0.0961	<0.01		
Navicula radiosa											6.3627	0.12
Navicula rhynchocephala			0.3844	0.15					0.0961	<0.01		
Navicula (LPIL)			1.5374	0.61					0.3844	0.02		
Gomphonema truncatum var. capitatum			0.1281	0.05					0.0320	<0.01		
Gomphonema (LPIL)											6.3627	0.12
Epithemia adnata					24.8659	1.19	27.2989	0.52	13.0412	0.68		
Epithemia sorex			4.2279	1.69	22.6391	1.08	68.2471	1.31	23.7785	1.24	19.0881	0.36
Epithemia turgida			1.5374	0.61			40.9483	0.79	10.6214	0.55		
Amphora ovalis			0.1281	0.05					0.0320	<0.01		
Rhopalodia gibba			1.2812	0.51	3.7113	0.18			1.2481	0.07		
Rhopalodia gibba var. ventricosa							40.9483	0.79	10.2371	0.53		
Nitzschia acicularis											25.4508	0.48
Nitzschia amphibia							40.9483	0.79	10.2371	0.53	12.7254	0.24
Nitzschia angustata			0.1281	0.05					0.0320	<0.01	12.7254	0.24
Nitzschia palea											6.3627	0.12
Nitzschia (LPIL)					0.3711	0.02	95.5460	1.84	23.9793	1.25	197.2436	3.68
Surirella ovata			0.1281	0.05					0.0320	<0.01		

Table B-3

The Phytoplankton Community of Lake Mary

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1897 MEAN DENSITY	1897 MEAN RELATIVE ABUNDANCE (%)	APRIL 15, 1988 DENSITY	APRIL 15, 1988 RELATIVE ABUNDANCE (%)
Euglenophyta	7.0502	5.45					68.7824	1.32	18.9582	0.99	43.0845	0.80
Euglenales												
Lepocinclis (LPIL)							22.9275	0.44	5.7319	0.30		
Trachelomonas hispida							45.8549	0.88	11.4637	0.60		
Trachelomonas scabra	4.7001	3.64							1.1750	0.06		
Trachelomonas volvocina	2.3501	1.82							0.5875	0.03		
Trachelomonas (LPIL)											43.0845	0.80
Pyrrhophyta					73.1132	3.50			18.2783	0.95	28.7230	0.54
Peridinales												
Ceratium hirundinella					73.1132	3.50			18.2783	0.95		
Peridinium inconspicuum											28.7230	0.54
Cryptophyta							366.8396	7.05	91.7099	4.78	804.2447	15.01
Cryptomonadales												
Rhodomonas minuta							91.7099	1.76	22.9275	1.20	761.1602	14.21
Cryptomonas erosa							114.6374	2.20	28.6594	1.49		
Cryptomonas marssonii							160.4923	3.08	40.1231	2.09	43.0845	0.80
Cyanophyta	2.3501	1.82	3.9168	1.56	114.8920	5.50	573.1868	11.01	173.5864	9.05		
Chroococcales												
Gomphosphaeria lacustris					41.7789	2.00	22.9275	0.44	16.1766	0.84		
Hormogonales												
Anabaena (LPIL)					31.3342	1.50			7.8336	0.41		
Nodularia spumigena			3.9168	1.56					0.9792	0.05		
Oscillatoria limnetica					10.4447	0.50	550.2593	10.57	140.1760	7.31		
Oscillatoria (LPIL)	2.3501	1.82			31.3342	1.50			8.4211	0.44		

Table B-3

The Phytoplankton Community of Lake Mary

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1897 MEAN DENSITY	1897 MEAN RELATIVE ABUNDANCE (%)	APRIL 15, 1988 DENSITY	APRIL 15, 1988 RELATIVE ABUNDANCE (%)
TOTAL (UNITS/MILLILITER)	129.2537		250.6737		2088.9471		5204.5361		1918.3527		5356.8443	
NUMBER OF TAXA	9		30		31		24		69		32	
MEAN TAXA/MONTH									23.5			

Table B-4

The Phytoplankton Community of Lake McKay

TAXA	MAY 1, 1987 DENSITY	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 1:, 1987 DENSITY	JUNE 1:, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
Chlorophyta	205.6308	84.00	1538.0510	80.10	17.1788	1.96	7096.2770	95.24	2214.2844	84.42	5727.19.	21.41
Volovocales												
Chlamydomonas globosa			28.6593	1.49					7.1648	0.27		
Chlamydomonas (LPIL)	146.8791	60.00					32.2558	0.43	44.7837	1.71		
Chlorococcales												
Chlorococcales (LPIL)			19.1062	1.00					4.7766	0.18		
Chlorella (LPIL)							1193.4648	16.02	298.3662	11.37		
Oocystis lacustris			831.1208	43.28					207.7802	7.92		
Oocystis solitaria			582.7399	30.35			32.2558	0.43	153.7489	5.86		
Oocystis (LPIL)							838.6509	11.26	209.6627	7.99		
Ankistrodesmus falcatus	39.1678	16.00			17.1788	1.96	870.9067	11.69	231.8133	8.84	3763.586	14.07
Schroederia setigera							32.2558	0.43	8.0640	0.31		
Selenastrum minutum							2419.1854	32.47	604.7964	23.06	899.9882	3.36
Closteriopsis longissima							161.2790	2.16	40.3198	1.54		
Scenedesmus arcuatus							64.5116	0.87	16.1279	0.61		
Scenedesmus arcuatus var. platydiscia			9.5531	0.50					2.3883	0.09		
Scenedesmus bijuga							129.0232	1.73	32.2558	1.23	163.6342	0.61
Scenedesmus quadicauda							96.7674	1.30	24.1919	0.92	81.8171	0.31
Crucigenia apiculata var. truncata			28.6593	1.49					7.1648	0.27		
Crucigenia quadrata							645.1161	8.66	161.2790	6.15	818.1711	3.06
Crucigenia tetrapedia			28.6593	1.49			451.5813	6.06	120.0602	4.58		
Zygnematales												
Cosmarium (LPIL)							129.0232	1.73	32.2558	1.23		
Staurastrum (LPIL)	19.5839	8.00	9.5531	0.50					7.2843	0.28		
Chrysophyta											4581.757	17.13
Chrysomonadales												
Chrysococcus rufescens											4499.940	16.82
Kephyrion (LPIL)											81.8171	0.31

Table B-4

The Phytoplankton Community of Lake McKay

TAXA	MAY 1, 1987 DENSITY	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
Bacillariophyta			57.3185	2.99	188.9674	21.57	193.5349	2.60	109.9552	4.19	13827.09	51.68
Centrales												
Melosira granulata			28.6593	1.49	9.0415	1.03			9.4252	0.36	327.2684	1.22
Melosira granulata var. angustissima					6.3290	0.72	32.2558	0.43	9.6462	0.37		
Melosira varians					1.8083	0.21			0.4521	<0.01		
Cyclotella comta			9.5531	0.50					2.3883	0.09		
Cyclotella meneghiniana					116.4940	13.30			29.1235	1.11		
Cyclotella ocellata					3.7579	0.43	129.0232	1.73	33.1953	1.27	67.8667	0.25
Stephanodiscus astrea											7295.672	27.27
Pennales												
Fragilaria construens			1.0918	0.06					0.2730	<0.01		
Fragilaria crotonensis					1.3047	0.15			0.3262	<0.01		
Fragilaria vaucheria			11.4637	0.60	1.3047	0.15			3.1921	0.12		
Synedra ulna			0.1365	0.01					0.0341	<0.01		
Cocconeis placentula			0.4094	0.02	6.8498	0.78	2.5200	0.03	2.4448	0.09		
Achnanthes minutissima					0.6524	0.07			0.1631	<0.01		
Achnanthes peragalli			0.2729	0.01					0.0682	<0.01		
Gyrosigma acuminatum					10.1116	1.15	8.5679	0.11	4.6699	0.18	2045.427	7.65
Gyrosigma (LPIL)			0.4094	0.02					0.1024	<0.01		
Diploneis (LPIL)					0.6524	0.07			0.1631	<0.01		
Navicula capitata			0.1365	0.01			1.5120	0.02	0.4121	<0.01		
Navicula cryptocephala			0.2729	0.01					0.0682	<0.01		
Navicula cryptocephala var. veneta							1.0080	0.01	0.2520	<0.01		
Navicula cuspidata					0.3262	0.04			0.0816	<0.01		
Navicula exiguiformis			2.0471	0.11	5.8713	0.67	2.0160	0.03	2.4836	0.09		
Navicula minima							4.5360	0.06	1.1340	0.04		
Navicula mutica			0.4094	0.02					0.1024	<0.01		
Navicula pupula							2.0160	0.03	0.5040	0.02		

Table B-4

The Phytoplankton Community of Lake McKay

TAXA	MAY 1, 1987 DENSITY	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
Navicula pupula var. rectangularis			0.1355	0.01	4.2403	0.48			1.0942	0.04		
Caloneis bacillium			0.5459	0.03					0.1365	<0.01		
Cymbella prostrata			0.1365	0.01					0.0341	<0.01		
Cymbella prostrata var. auerseváldii					0.6524	0.07			0.1631	<0.01		
Epithemia adnata					3.9142	0.45			0.9786	0.04		
Epithemia sorex			0.1365	0.01	6.8498	0.78			1.7466	0.07		
Epithemia turgida					2.9356	0.34			0.7339	0.03		
Amphora ovalis			0.9553	0.05			2.0160	0.03	0.7428	0.03		
Rhopalodia gibba					0.6524	0.07			0.1631	<0.01		
Rhopalodia gibberula					1.6309	0.19			0.4077	<0.01		
Nitzschia acuta											681.8092	2.55
Nitzschia acicularis											681.8092	2.55
Nitzschia amphibia					0.9785	0.11			0.2446	<0.01		
Nitzschia angustata			0.2729	0.01	0.3262	0.04	1.0080	0.01	0.4018	<0.01		
Nitzschia dissipata											681.8092	2.55
Nitzschia hungarica			0.2729	0.01	1.6309	0.19			0.4760	0.02		
Nitzschia palea											1363.618	5.10
Nitzschia sigmoidea							1.5120	0.02	0.3780	<0.01		
Nitzschia tryblionella							0.5040	0.01	0.1260	<0.01		
Nitzschia (LPIL)							4.5360	0.06	1.1340	0.04	681.8092	2.55
Cymatopluera elliptica					0.3262	0.04			0.0816	<0.01		
Cymatopluera solea					0.3262	0.04	0.5040	0.01	0.2076	<0.01		
Euglenophyta	39.1678	16.00	286.5933	14.93	463.8288	52.94	64.5116	0.87	213.5254	8.14	245.4513	0.92
Euglenales												
Euglena acus	39.1678	16.00							9.7920	0.37	163.6342	0.61
Euglena gracilis			85.9780	4.48					21.4945	0.82		
Euglena texta			9.5531	0.50					2.3883	0.09		
Trachelomonas intermedia			114.6374	5.97					28.6594	1.09		

Table B-4

The Phytoplankton Community of Lake McKay

TAXA	MAY 1, 1987 DENSITY	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
Trachelomonas scabra			19.1062	1.00					4.7766	0.18		
Trachelomonas volvocina			28.6593	1.49	463.8288	52.94	64.5116	0.87	139.2499	5.31	81.8171	0.31
Trachelomonas (LPIL)			28.6593	1.49					7.1648	0.27		
Pyrrhophyta					188.9673	21.57			47.2418	2.05	572.7197	2.14
Peridinales												
Peridinium cinctum					154.6096	17.65			38.6524	1.47		
Peridinium inconspicuum											572.7197	2.14
Ceratium hirundinella					34.3577	3.92			8.5894	0.33		
Cryptophyta											899.9882	3.36
Cryptomonadales												
Rhodomonas minuta											572.7197	2.14
Cryptomonas marssonii											327.2684	1.22
Cyanophyta			38.2125	1.99	17.1788	1.96	96.7674	1.30	38.0397	1.45	899.9882	3.36
Chroococcales												
Chroococcus (LPIL)							96.7674	1.30	24.1919	0.92		
Microcystis (LPIL)											899.9882	3.36
Hormogonales												
Oscillatoria limnetica					17.1788	1.96			4.2947	0.16		
Anabaena spiroides			38.2125	1.99					9.5531	0.36		
TOTAL (UNITS/MILLILITER)	244.7986		1920.1753		876.1211		7451.0909		2623.0465		26754.19	
NUMBER OF TAXA	4		34		30		31		74		22	
MEAN TAXA/MONTH									24.75			

Table B-5

The Phytoplankton Chlorophyll of Lake Derby

Chlorophyll	Units	APRIL 30, 1987	JUNE 9, 1987	AUGUST 11, 1987	NOVEMBER 3, 1987	1987 Mean*	APRIL [illegible], 1988
Chlorophyll a	mg/m3	3.10	15.92	13.66	22.34	14.11	15.52
Chlorophyll b	mg/m3	< 0.03	8.00	8.09	10.50	6.47	5.74
Chlorophyll c	mg/m3	< 0.03	2.53	4.13	6.11	4.72	10.82
Phaeophytin	mg/m3	< 0.03	3.83	1.60	4.10	4.17	11.30

* Less than values were considered as zeros for mean calculation

Table B-6

The Phytoplankton Chlorophyll of Lake Ladora

Chlorophyll	Units	APRIL 30, 1987	JUNE 9, 1987	AUGUST 11, 1987	NOVEMBER 3, 1987	1987 Mean*	APRIL 12, 1988
Chlorophyll a	mg/m3	12.83	0.63	12.18	3.46	6.75	4.66
Chlorophyll b	mg/m3	2.39	1.14	7.80	2.52	3.09	1.60
Chlorophyll c	mg/m3	< 0.03	< 0.03	7.17	0.62	1.56	<0.03
Phaeophytin	mg/m3	3.65	7.31	0.62	< 0.03	2.36	0.23

* Less than values were considered as zeros for mean calculation

Table B-7

The Phytoplankton Chlorophyll of Lake Mary

Chlorophyll	Units	MAY 1, 1987	JUNE 9, 1987	AUGUST 11, 1987	NOVEMBER 3, 1987	1987 Mean*	APRIL 12, 1988
Chlorophyll a	mg/m3	12.14	2.22	7.41	3.59	5.50	2.15
Chlorophyll b	mg/m3	9.38	3.73	0.50	1.48	3.09	0.35
Chlorophyll c	mg/m3	< 0.03	< 0.03	< 0.03	< 0.03	1.33	6.64
Phaeophytin	mg/m3	3.65	4.37	< 0.03	3.21	2.69	2.21

* Less than values were considered as zeros for mean calculation

Table B-8

The Phytoplankton Chlorophyll of McKay Lake

Chlorophyll	Units	MAY 1, 1987	JUNE 11, 1987	AUGUST 12, 1987	NOVEMBER 4, 1987	1987 Mean*	APRIL 14, 1988
Chlorophyll a	mg/m3	7.76	5.12	7.77	7.05	8.68	15.71
Chlorophyll b	mg/m3	< 0.03	4.41	3.70	4.12	4.39	9.73
Chlorophyll c	mg/m3	< 0.03	1.33	6.78	< 0.03	2.92	6.47
Phaeophytin	mg/m3	< 0.03	< 0.03	< 0.03	0.36	8.71	43.21

* Less than values were considered as zeros for mean calculation

APPENDIX C

Tables C-1 through C-8
Zooplankton Data

Table C-1

The Microzooplankton Community of Lake Derby

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE
Rotatoria	193.00	100.00	1040.00	100.00	149.00	100.00	234.44	100.00	404.11	100.00	686.67	100.00
Rotatoria (LPIL)	1.00	0.52	30.00	2.88	5.00	3.36	1.11	0.47	9.28	10.59	206.67	30.10
Synchaetidae												
Polyarthra (LPIL)	6.00	3.11	10.00	0.96	29.00	19.46	80.00	34.12	31.25	5.86	10.00	1.46
Asplanchnidae												
Asplanchna (LPIL)					1.00	0.67	21.11	9.00	5.53	0.96		
Brachionidae	0.00											
Brachionus angularis			265.00	25.48	6.00	4.03			67.75	11.77		
Brachionus calyciflorus	39.00	20.21							9.75	16.60	343.33	50.00
Keratella cochlearis	124.00	64.25	695.00	66.83	108.00	72.48			231.75	41.41	26.67	3.88
Keratella quadrata	23.00	11.92	40.00	3.85			1.11	0.47	16.03	2.78		
Keratella stipitata							131.11	55.92	32.78	9.75	93.33	13.59
Notholca (LPIL)											6.67	0.97
TOTAL (NUMBER/LITER)	193.00		1040.00		149.00		234.44		404.11		686.67	
NUMBER OF TAXA	5		5		5		5		8		6	
MEAN TAXA/MONTH									5			

Table C-2

The Microzooplankton Community of Lake Ladora

TAXA	APRIL 29,1987 DENSITY	APRIL 29,1987 RELATIVE ABUNDANCE (%)	JUNE 10,1987 DENSITY	JUNE 10,1987 RELATIVE ABUNDANCE (%)	AUGUST 10,1987 DENSITY	AUGUST 10,1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12,1988 DENSITY	APRIL 12,1988 RELATIVE ABUNDANCE
Rotatoria	305.00	100.00	190.00	100.00	55.00	100.00	716.66	100.00	316.67	100.00	346.66	100.00
Rotatoria (LPIL)			1.00	0.53	3.00	5.45	93.33	13.02	24.33	6.55	8.33	2.40
Testudinellidae												
Filinia (LPIL)											8.33	2.40
Synchaetidae												
Polyarthra (LPIL)	63.00	20.66	80.00	42.11	14.00	25.45	183.33	25.58	85.08	23.89	45.00	12.98
Asplanchnidae												
Asplanchna (LPIL)			11.00	5.79	6.00	10.91	10.00	1.40	6.75	3.74	33.33	9.61
Brachionidae												
Brachionus calyciflorus											1.67	0.48
Keratella cochlearis	229.00	75.08	75.00	39.47	14.00	25.45	13.33	1.86	82.83	23.02	40.00	11.54
Keratella quadrata	9.00	2.95	22.00	11.58	4.00	7.27			8.75	2.17		
Keratella stipitata	1.00	0.33					416.67	58.14	104.42	36.43	170.00	49.04
Lecane luna					13.00	23.64			3.25	0.81		
Monostyla bulla					1.00	1.82			0.25	0.06		
Monostyla lunaris	1.00	0.33							0.25	0.16	1.67	0.48
Monostyla quadridentata			1.00	0.53					0.25	0.06		
Notholca (LPIL)	2.00	0.66							0.50	2.50	38.33	11.06
TOTAL (NUMBER/LITER)	305.00		190.00		55.00		716.66		316.67		346.66	
NUMBER OF TAXA	6		6		7		5		11		9	
MEAN TAXA/MONTH									6			

Table C-3

The Microzooplankton Community of Lake Mary

TAXA	APRIL 30, 1987 DENSITY	RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	RELATIVE ABUNDANCE
Rotatoria			233.00	100.00	90.00	100.00	1080.00	100.00	350.75	100.00	733.32	100.00
Rotatoria (LPIL)			6.00	2.58	25.00	27.78	16.67	1.54	11.92	9.41	153.33	20.91
Synchaetidae												
Polyarthra (LPIL)			74.00	31.76			826.67	76.54	225.17	53.24	236.67	32.27
Asplanchnidae												
Asplanchna (LPIL)					34.00	37.78	6.67	0.62	10.17	2.06	3.33	0.45
Brachionidae												
Brachionus angularis			2.00	0.86					0.50	0.09		
Brachionus calyciflorus					1.00	1.11			0.25	0.05		
Keratella cochlearis			56.00	24.03	2.00	2.22	13.33	1.23	17.83	4.90	33.33	4.55
Keratella quadrata			8.00	3.43	3.00	3.33	10.00	0.93	5.25	7.54	140.00	19.09
Keratella stipitata			1.00	0.43			193.33	17.90	48.58	16.27	153.33	20.91
Lecane luna			12.00	5.15	2.00	2.22			3.50	0.66		
Lepadella patella							3.33	0.31	0.83	0.16		
Monostyla bulla			3.00	1.29	1.00	1.11			1.00	0.19		
Monostyla closterocerca			10.00	4.29	2.00	2.22			3.00	0.56		
Monostyla lunaris							10.00	0.93	2.50	0.47		
Notholca (LPIL)			60.00	25.75					15.00	3.28	10.00	1.36
Platyias patulus					19.00	21.11			4.75	0.89		
Platyias quadricornis					1.00	1.11			0.25	0.05		
Trichotria tetractis			1.00	0.43					0.25	0.20	3.33	0.45
TOTAL (NUMBER/LITER)	NO CATCH		233.00		90.00		1080.00		350.75		733.32	
NUMBER OF TAXA	0		11		10		8		17		8	
MEAN TAXA/MONTH									7.25			

Table C-4

The Microzooplankton Community of McKay Lake

TAXA	MAY 1, 1987 DENSITY	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE
Rotatoria	3.00	100.00	135.00	100.00	92.00	100.00	336.68	100.00	141.67	100.00	10.66	100.00
Rotatoria (LPIL)			3.00	2.22			1.67	0.50	1.17	1.67	5.00	46.90
Synchaetidae												
Polyarthra (LPIL)			55.00	40.74	56.00	60.87	11.67	3.47	30.67	21.24		
Asplanchnidae												
Asplanchna (LPIL)			17.00	12.59			6.67	1.98	5.92	4.10		
Brachionidae												
Brachionus angularis					19.00	20.65			4.75	3.29		
Brachionus (LPIL)											1.00	9.38
Keratella cochlearis	3.00	100.00	57.00	42.22	12.00	13.04			18.00	12.53	0.33	3.10
Keratella quadrata			3.00	2.22	1.00	1.09	1.67	0.50	1.42	0.98		
Keratella stipitata							315.00	93.56	78.75	55.31	4.33	40.62
Platyias patulus					4.00	4.35			1.00	0.69		
TOTAL (NUMBER/LITER)	3.00		135.00		92.00		336.68		141.67		10.66	
NUMBER OF TAXA	1		5		5		5		8		4	
MEAN TAXA/MONTH									4			

Table C-5

The Macrozooplankton Community of Lake Derby

TAXA	MAY 13, 1987 DENSITY	MAY 13, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 5, 1987 DENSITY	NOVEMBER 5, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE(%)
Cladocera	508.27	74.36	337.23	58.06	415.44	78.37	402.18	65.68	415.78	56.85	184.83	21.91
Chydoridae												
Chydorus sphaericus			4.68	0.81					1.17	0.14		
Leydigia quadrangularis			2.34	0.40					0.59	0.07		
Bosminidae												
Bosminidae(LPIL)	170.26	24.91	175.64	30.24	89.21	16.83	311.37	50.85	186.62	23.70	23.85	2.83
Bosmina longirostris											23.85	2.83
Daphnidae												
Ceriodaphnia (LPIL)					313.49	59.13			78.37	9.64		
Daphnia immature(LPIL)							2.59	0.42	0.65	3.47	110.30	13.07
Daphnia ambigua	15.02	2.20	32.79	5.65					11.95	1.47		
Daphnia laevis			86.65	14.92	12.74	2.40	77.84	12.71	44.31	5.45		
Daphnia rosea	322.99	47.25	35.13	6.05			10.38	1.69	92.13	12.90	50.68	6.01
Copepoda	175.26	25.64	243.56	41.94	114.69	21.63	210.17	34.32	185.92	43.15	658.83	78.09
Copepod nauplii(LPIL)	47.57	6.96	44.50	7.66	10.19	1.92	41.52	6.78	35.95	9.28	158.00	18.73
Calanoida												
Calanoid copepodids	7.51	1.10	60.89	10.48	5.10	0.96			18.38	2.26		
Diaptomidae												
Diaptomus connexus							18.16	2.97	4.54	0.56		
Diaptomus pallidus	2.50	0.37							0.63	0.08		
Diaptomus siciloides	20.03	2.93					2.59	0.42	5.66	0.79	2.98	0.35
Cyclopoida												
Cyclopoid copepodids	85.13	12.45	133.49	22.98	89.21	16.83	127.14	20.76	108.74	28.24	482.94	57.24
Cyclopidae												
Cyclops bicusp. thomasi	12.52	1.83	4.68	0.81			20.76	3.39	9.49	1.63	14.91	1.77
Cyclops vernalis					10.19	1.92			2.55	0.31		
TOTAL (NUMBER/LITER)	683.53		580.80		530.14		612.35		601.71		843.66	
NUMBER OF TAXA	9		10		7		9		16		7	
MEAN TAXA/MONTH									8.75			

Table C-6

The Macrozooplankton Community of Lake Ladora

TAXA	MAY 13, 1987 DENSITY	MAY 13, 1987 RELATIVE ABUNDANCE (%)	JUNE 5, 1987 DENSITY	JUNE 5, 1987 RELATIVE ABUNDANCE (%)	AUGUST 13, 1987 DENSITY	AUGUST 13, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Cladocera	150.59	64.27	369.94	77.64	400.65	86.31	570.99	93.42	373.04	83.49	282.53	83.26
Chydoridae												
Chydorus sphaericus	5.00	2.13	32.93	6.91					9.48	1.79		
Leydigia quadrangularis			1.94	0.41					0.49	0.09		
Pseudochydorus globosus							15.09	2.47	3.77	0.71		
Bosminidae												
Bosminidae (LPIL)	96.23	41.07	207.24	43.50	282.40	60.84	535.77	87.65	280.41	65.43	269.08	79.30
Daphnidae												
Ceriodapnia (LPIL)	1.87	0.80	48.42	10.16	114.72	24.71	10.06	1.65	43.77	8.24		
Daphnia immature (LPIL)			3.87	0.81					0.97	0.46	5.98	1.76
Daphnia ambigua	27.49	11.73	36.80	7.72					16.07	3.03		
Daphnia laevis			1.94	0.41	3.53	0.76	2.52	0.41	2.00	0.38		
Daphnia parvula							2.52	0.41	0.63	0.12		
Daphnia rosea	20.00	8.53	36.80	7.72			5.03	0.82	15.46	3.26	7.47	2.20
Ostracoda	0.62	0.27							0.16	0.03		
Ostracoda (LPIL)	0.62	0.27							0.16	0.03		
Copepoda	83.11	35.47	106.53	22.36	63.54	13.69	40.25	6.58	73.36	16.48	56.81	16.74
Copepod nauplii (LPIL)	22.49	9.60	32.93	6.91	44.12	9.51	27.67	4.53	31.80	7.53	32.89	9.69
Calanoida												
Calanoid copepodids	1.25	0.53	7.75	1.63	7.06	1.52			4.02	0.76		
Diaptomidae												
Diaptomus pallidus	0.62	0.27	1.94	0.41					0.64	0.12		
Diaptomus siciloides					3.53	0.76			0.88	0.17		
Cyclopoida												
Cyclopoid copepodids	56.24	24.00	52.29	10.98	5.29	1.14			28.46	6.48	23.92	7.05

Table C-6

The Macrozooplankton Community of Lake Ladora

TAXA	MAY 13, 1987 DENSITY	MAY 13, 1987 RELATIVE ABUNDANCE (%)	JUNE 5, 1987 DENSITY	JUNE 5, 1987 RELATIVE ABUNDANCE (%)	AUGUST 13, 1987 DENSITY	AUGUST 13, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Cyclopidae												
Cyclops bicusp. thomasi	2.50	1.07	3.87	0.81			12.58	2.06	4.74	0.89		
Mesocyclops (LPIL)					3.53	0.76			0.88	0.17		
Mesocyclops edax			7.75	1.63					1.94	0.36		
TOTAL (NUMBER/LITER)	234.32		476.46		464.19		611.23		446.55		339.34	
NUMBER OF TAXA	11		14		8		8		19		5	
MEAN TAXA/MONTH									10.25			

Table C-7

The Macrozooplankton Community of Lake Mary

TAXA	MAY 14, 1987 DENSITY	MAY 14, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE(%)
Cladocera	379.07	59.58	158.42	60.67	426.62	95.38	145.59	50.75	277.43	65.81	69.77	43.43
Chydoridae												
Alona rectangula							3.21	1.12	0.80	0.25	1.17	0.73
Chydorus sphaericus	2.22	0.35	57.90	22.18					15.03	3.35		
Chydorus (LPIL)											25.80	16.06
Pleuroxus denticulatus	2.22	0.35							0.56	0.12		
Bosminidae												
Bosminidae (LPIL)	206.16	32.40	49.16	18.83	227.41	50.84	123.11	42.91	151.46	35.51	30.49	18.98
Daphnidae												
Ceriodapnia (LPIL)			8.74	3.35	199.22	44.54	4.28	1.49	53.06	11.84		
Daphnia immature (LPIL)	8.87	1.39					4.28	1.49	3.29	1.19	8.21	5.11
Daphnia ambigua	97.54	15.33	24.04	9.21					30.40	6.78		
Daphnia laevis			1.09	0.42					0.27	0.06		
Daphnia parvula							10.71	3.73	2.68	0.83	4.10	2.55
Daphnia rosea	62.07	9.76	9.83	3.77					17.98	4.01		
Simocephalus vetulus			7.65	2.93					1.91	0.43		
Copepoda	257.15	40.42	102.70	39.33	20.67	4.62	141.31	49.25	130.46	34.19	90.88	56.57
Copepod nauplii (LPIL)	31.04	4.88	34.96	13.39	7.52	1.68	71.73	25.00	36.31	9.45	24.04	14.96
Calanoida												
Calanoid copepodids	4.43	0.70	3.28	1.26	7.52	1.68	3.21	1.12	4.61	1.03		
Diaptomidae												
Diaptomus pallidus	4.4[illegible]	0.70					2.14	0.75	1.64	0.37		
Cyclopoida												
Cyclopoid copepodids	215.03	33.80	50.26	19.25	3.76	0.84	51.39	17.91	80.11	21.22	59.80	37.22
Cyclopidae												
Cyclops biscusp. thomasi	2.22	0.35	2.19	0.84			12.85	4.48	4.32	1.36	7.04	4.38
Cyclops vernalis			4.37	1.67					1.09	0.24		

Table C-7

The Macrozooplankton Community of Lake Mary

TAXA	MAY 14, 1987 DENSITY	MAY 14, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEM[illegible], 1987 DENSITY	NOVEM[illegible], 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE(%)
Mesocyclops (LPIL)					1.88	0.42			0.47	0.11		
Mesocyclops edax			7.65	2.93					1.91	0.43		
TOTAL (NUMBER/LITER)	636.22		261.11		447.30		286.91		407.89		160.65	
NUMBER OF TAXA	11		13		6		10		19		8	
MEAN TAXA/MONTH									10			

Table C-8

The Macrozooplankton Community of McKay Lake

TAXA	MAY 14, 1987 DENSITY	MAY 14, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE(%)
Cladocera	91.95	75.47	54.01	57.92	836.07	94.14	288.33	78.50	317.59	79.11	20.34	12.63
Sididae												
Diaphanosoma (LPIL)					13.88	1.56			3.47	0.85		
Chydoridae												
Alona rectangula											0.58	0.36
Pleuroxus denticulatus			0.36	0.39					0.09	0.02		
Bosminidae												
Bosminidae (LPIL)	2.30	1.89	5.04	5.41	395.49	44.53	142.45	38.79	136.32	33.99	9.30	5.78
Bosmina longirostria											9.30	5.78
Daphnidae												
Ceriodaphnia (LPIL)					426.71	48.05			106.68	26.15		
Daphnia immature (LPIL)							65.22	17.76	16.31	4.53	8.72	5.42
Daphnia ambigua	33.33	27.36							8.33	2.04		
Daphnia galeata mendotae	35.06	28.77							8.77	2.15		
Daphnia laevis			39.25	42.08			5.15	1.40	11.10	2.72		
Daphnia parvula							54.92	14.95	13.73	3.47	1.74	1.08
Daphnia rosea	21.26	17.45	9.36	10.04			20.59	5.61	12.80	3.14		
Copepoda	29.88	24.53	39.25	42.08	52.04	5.86	78.95	21.50	50.03	20.89	140.65	87.37
Copepod nauplii (LPIL)	5.75	4.72	11.52	12.36	17.35	1.95	8.58	2.34	10.80	5.25	42.43	26.36
Calanoida												
Calanoid copepodids	2.30	1.89	10.08	10.81	13.88	1.56	18.88	5.14	11.29	2.77		
Diaptomidae												
Diaptomus pallidus			1.80	1.93					0.45	0.11		
Diaptomus siciloides			1.08	1.16					0.27	0.07		
Cyclopoida												
Cyclopoid copepodids	20.11	16.51	9.36	10.04	20.82	2.34	37.76	10.28	22.01	10.88	89.50	55.59
Cyclopidae												
Cyclops bicusp. thomasi	1.72	1.42	0.36	0.39			13.73	3.74	3.95	1.47	8.14	5.06
Mesocyclops edax			5.04	5.41					1.26	0.34	0.58	0.36

Table C-8

The Macrozooplankton Community of McKay Lake

TAXA	MAY 14, 1987 DENSITY	MAY 14, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE(%)
TOTAL (NUMBER/LITER)	121.83		93.26		888.11		367.27		367.62		160.99	
NUMBER OF TAXA	8		11		6		9		17		8	
MEAN TAXA/MONTH									8.5			

APPENDIX D

Tables D-1 through D-8
Macroinvertebrate Data

Table D-1

The Benthic Macroinvertebrates of Lake Derby Sampled by Ponar Dredge

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE(%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
Nematoda	38.46	1.47	9.62	1.33					12.02	0.52		
Nematoda (LPIL)	38.46	1.47	9.62	1.33					12.02	0.52		
Annelida	1615.38	61.88	307.69	42.67	76.93	38.09	548.08	19.39	637.02	34.17	593.22	20.95
Hirudinea					9.62	4.76			2.41	0.10		
Glossiphoniidae					9.62	4.76			2.41	0.10		
Helobdella (LPIL)					9.62	4.76			2.41	0.10		
Oligochaeta	1615.38	61.88	307.69	42.67	67.31	33.33	548.08	19.39	634.62	34.07	593.22	20.95
Naididae	134.62	5.16					201.92	7.14	84.14	3.66		
Dero digitata							201.92	7.14	50.48	2.20		
Nais pardalis	19.23	0.74							4.81	0.21		
Nais simplex	4.81	0.18							1.20	0.05		
Nais variabilis	110.58	4.24							27.65	1.20		
Tubificidae	1480.76	56.72	307.69	42.67	67.31	33.33	346.16	12.24	550.48	30.41	593.22	20.95
Immature with capilliformes	120.19	4.60							30.05	1.52	19.14	0.68
Immature without capilliformes	639.42	24.49	250.00	34.67	67.31	33.33	269.23	9.52	306.49	17.81	411.42	14.53
Aulodrilus pigueti	576.92	22.10							144.23	6.28		
Limnodrilus claparedianus	19.23	0.74					67.31	2.38	21.64	1.67	66.98	2.37
Limnodrilus hoffmeisteri	125.00	4.79	57.69	8.00			9.62	0.34	48.08	3.13	95.68	3.38
Arthropoda	956.76	36.65	403.85	56.00	125.00	61.90	2278.85	80.61	941.12	65.20	2229.34	78.72
Insecta	956.76	36.65	403.85	56.00	125.00	61.90	2278.85	80.61	941.12	65.20	2229.34	78.72
Ephemeroptera	14.42	0.55							3.61	0.16		
Caenidae	14.42	0.55							3.61	0.16		
Caenis (LPIL)	14.42	0.55							3.61	0.16		
Diptera	942.34	36.10	403.85	56.00	125.00	61.90	2278.85	80.61	937.51	65.05	2229.34	78.72
Ceratopogonidae							9.62	0.34	2.41	0.31	19.14	0.68
Palpomyia/ Probezzia/Bezzia (LPIL)							9.62	0.34	2.41	0.31	19.14	0.68
Chironomidae	807.72	30.93	240.40	33.34	125.00	61.90	2076.93	73.47	812.51	57.21	2009.27	70.95
Chironomidae pupae (LPIL)	14.42	0.55							3.61	1.20	95.68	3.38

Table D-2

The Benthic Macroinvertebrates of Lake Ladora Sampled by Ponar Dredge

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 8, 1987 DENSITY	JUNE 8, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Platyhelminthes	14.42	0.24					12.82	1.23	6.81	0.28		
Turbellaria	14.42	0.24					12.82	1.23	6.81	0.28		
Turbellaria (LPIL)	14.42	0.24					12.82	1.23	6.81	0.28		
Nematoda	413.46	6.79							103.37	4.20		
Nematoda (LPIL)	413.46	6.79							103.37	4.20		
Annelida	3923.07	64.40	44.87	11.11	179.49	18.67	108.97	10.49	1064.10	46.33	299.79	22.38
Oligochaeta	3923.07	64.40	44.87	11.11	179.49	18.67	108.97	10.49	1064.10	46.33	299.79	22.38
Naididae	307.68	5.04			12.82	1.33	108.97	10.49	107.37	5.08	70.16	5.72
Chaetogaster diaphanus	38.46	0.63							9.62	0.46	6.38	0.48
Dero digitata	115.38	1.89					6.41	0.62	30.45	1.24		
Nais simplex	115.38	1.89							28.85	1.24	6.38	0.48
Nais variabilis	38.46	0.63							9.62	0.46	6.38	0.48
Ophidonais serpentina					12.82	1.33	102.56	9.88	28.85	1.43	25.51	1.90
Stylaria lacustris											25.51	1.90
Tubificidae	3615.39	59.35	44.87	11.11	166.66	17.33			956.73	41.25	229.63	17.14
Immature with capilliformes	1961.54	32.20	6.41	1.59	115.38	12.00			520.83	22.87	165.84	12.38
Immature without capilliformes	461.54	7.58	38.46	9.52	51.28	5.33			137.82	5.80	19.14	1.43
Limnodrilus hoffmeisteri	230.77	3.79							57.69	2.48	12.76	0.95
Limnodrilus udekemianus	38.46	0.63							9.62	0.39		
Potamothrix bavaricus	923.08	15.15							230.77	9.71	31.89	2.38
Arthropoda	1725.96	28.33	352.56	87.29	782.05	81.33	878.20	84.57	934.69	48.07	988.69	73.81
Crustacea	240.38	3.95	12.82	3.17			352.56	33.95	151.44	7.78	159.47	11.91
Amphipoda	240.38	3.95	12.82	3.17			352.56	33.95	151.44	7.78	159.47	11.91
Talitridae	240.38	3.95	12.82	3.17			352.56	33.95	151.44	7.78	159.47	11.91
Hyalella azteca	240.38	3.95	12.82	3.17			352.56	33.95	151.44	7.78	159.47	11.91
Insecta	1485.58	24.39	339.74	84.13	782.05	81.33	525.64	50.62	783.25	40.29	829.22	61.90
Ephemeroptera	52.88	0.87			6.41	0.67			14.82	0.67	6.38	0.48

Table D-2

The Benthic Macroinvertebrates of Lake Ladora Sampled by Ponar Dredge

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 8, 1987 DENSITY	JUNE 8, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Baetidae											6.38	0.48
Callibaetis (LPIL)											6.38	0.48
Caenidae	52.88	0.87			6.41	0.67			14.82	0.60		
Caenis (LPIL)	52.88	0.87			6.41	0.67			14.82	0.60		
Odonata,Zygoptera	38.46	0.63					6.41	0.62	11.22	0.46		
Odonata, Zygoptera (LPIL)	24.04	0.39							6.01	0.24		
Coenagrionidae							6.41	0.62	1.60	0.07		
Coenagrion/Enallagma (LPIL)	14.42	0.24					6.41	0.62	5.21	0.21		
Trichoptera	38.47	0.63							9.62	0.39		
Hydroptilidae	38.47	0.63							9.62	0.39		
Orthotrichia (LPIL)	9.62	0.16							2.41	0.10		
Oxyethira (LPIL)	28.85	0.47							7.21	0.29		
Diptera	1355.77	22.26	339.74	84.13	775.64	80.67	519.23	50.00	747.60	38.77	822.84	61.43
Chironomidae	1350.97	22.18	339.74	84.13	775.64	80.67	519.23	50.00	746.40	38.72	822.84	61.43
Chironomidae pupae (LPIL)	28.85	0.47	12.82	3.17	19.23	2.00			15.23	0.88	25.51	1.90
Chironominae												
Chironomini A (LPIL)												
Chironomus (LPIL)	225.96	3.71	269.23	66.67	416.67	43.33	429.49	41.36	335.34	19.02	529.42	39.52
Cryptochironomus (LPIL)	9.62	0.16	6.41	1.59					4.01	0.16		
Cryptotendipes (LPIL)	67.31	1.10			6.41	0.67	19.23	1.85	23.24	0.95		
Dicrotendipes (LPIL)	28.85	0.47					19.23	1.85	12.02	0.62	12.76	0.95
Endochironomus (LPIL)							6.41	0.62	1.60	0.07		
Paratanytarsus (LPIL)	14.42	0.24					19.23	1.85	8.41	0.34		
Stictochironomus (LPIL)							6.41	0.62	1.60	0.07		
Tanytarsus (LPIL)	644.23	10.58							161.06	6.55		
Tanypodinae												
Larsia (LPIL)	100.96	1.66	6.41	1.59			6.41	0.62	28.45	1.81	63.79	4.76
Procladius (LPIL)	48.08	0.79	6.41	1.59	12.82	1.33			16.83	1.07	38.27	2.86

Table D-2

The Benthic Macroinvertebrates of Lake Ladora Sampled by Ponar Dredge

TAXA	APRIL 29, 1987 DENSITY	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 8, 1987 DENSITY	JUNE 8, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 DENSITY	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Tanypus (LPIL)	182.69	3.00	38.46	9.52	320.51	33.33	12.82	1.23	138.62	7.19	153.09	11.43
Culicidae	4.81	0.08							1.20	0.05		
Chaoborinae	4.81	0.08							1.20	0.05		
Chaoborus (LPIL)	4.81	0.08							1.20	0.05		
Mollusca	14.43	0.24	6.41	1.59			38.46	3.70	14.83	1.12	51.03	3.81
Gastropoda	14.43	0.24					38.46	3.70	13.22	1.06	51.03	3.81
Gasrtopoda (LPIL)	9.62	0.16							2.41	0.10		
Physidae							12.82	1.23	3.21	0.13		
Physa (LPIL)							12.82	1.23	3.21	0.13		
Planorbidae	4.81	0.08					25.64	2.47	7.61	0.83	51.03	3.81
Gyraulus (LPIL)	4.81	0.08					25.64	2.47	7.61	0.83	51.03	3.81
Pelecypoda			6.41	1.59					1.60	0.07		
Sphaeriidae			6.41	1.59					1.60	0.07		
Pisidium (LPIL)			6.41	1.59					1.60	0.07		
TOTAL NUMBER/SQUARE METER	6091.33		403.85		961.54		1038.46		2123.80		1339.51	
TOTAL NUMBER OF TAXA	30		10		9		15		35		18	
MEAN TAXA/MONTH									16			

Table D-3

The Benthic Macroinvertebrates of Lake Mary Sampled by Ponar Dredge

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 198 DENSITY	NOVEMBER 3, 198 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Nematoda	855.77	15.71	115.38	5.08	48.08	20.83			254.81	6.62	28.70	0.56
Nematoda (LPIL)	855.77	15.71	115.38	5.08	48.08	20.83			254.81	6.62	28.70	0.56
Coelenterata (Cnidaria)											86.11	1.67
Hydroida											86.11	1.67
Hydra (LPIL)											86.11	1.67
Annelida	687.49	12.62	586.54	25.85	96.15	41.67	57.69	2.11	356.97	10.89	296.61	5.75
Hirudinea	43.27	0.79							10.82	0.27		
Erpobdellidae	28.85	0.53							7.21	0.18		
Eropobdellidae (LPIL)	28.85	0.53							7.21	0.18		
Glossiphoniidae	14.42	0.26							3.61	0.09		
Helobdella (LPIL)	14.42	0.26							3.61	0.09		
Oligochaeta	644.22	11.83	586.54	25.85	96.15	41.67	57.69	2.11	346.15	10.62	296.61	5.75
Enchytraeidae (LPIL)	52.88	0.97							13.22	0.33		
Naididae			38.46	1.69					9.62	0.36	19.14	0.37
Dero nivea											19.14	0.37
Nais variabilis			38.46	1.69					9.62	0.24		
Tubificidae	591.34	10.86	548.07	24.15	96.15	41.67	57.69	2.11	323.31	9.92	277.47	5.38
Immature with capilliformes	240.38	4.41	182.69	8.05	19.23	8.33			110.58	3.70	143.52	2.78
Immature without capilliformes	168.27	3.09	346.15	15.25	76.92	33.33	57.69	2.11	162.26	4.28	28.70	0.56
Limnodrilus claparedianus	38.46	0.71	19.23	0.85					14.42	0.73	57.41	1.11
Limnodrilus hoffmeisteri	52.88	0.97							13.22	0.33		
Potamothrix bavaricus	4.81	0.09							1.20	0.33	47.84	0.93
Tubifex tubifex	86.54	1.59							21.64	0.55		
Arthropoda	3062.53	56.22	1490.39	65.68	86.54	37.50	2576.92	94.37	1804.10	65.45	3147.83	61.04
Crustacea	653.85	12.00	96.15	4.24			86.54	3.17	209.14	6.91	258.33	5.01
Amphipoda	653.85	12.00	96.15	4.24			86.54	3.17	209.14	6.91	258.33	5.01
Talitridae	653.85	12.00	96.15	4.24			86.54	3.17	209.14	6.91	258.33	5.01
Hyalella azteca	653.85	12.00	96.15	4.24			86.54	3.17	209.14	6.91	258.33	5.01
Insecta	2408.68	44.22	1394.24	61.44	86.54	37.50	2490.38	91.19	1594.96	58.54	2889.50	56.03

Table D-3

The Benthic Macroinvertebrates of Lake Mary Sampled by Ponar Dredge

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 198 DENSITY	NOVEMBER 3, 198 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Ephemeroptera	163.46	3.00	192.31	8.47					88.94	2.61	57.41	1.11
Ephemeroptera (LPIL)	4.81	0.09	9.62	0.42					3.61	0.09		
Caenidae	158.65	2.91	182.69	8.05					85.34	2.16		
Caenis (LPIL)	158.65	2.91	182.69	8.05					85.34	2.52	57.41	1.11
Odonata, Anisoptera	9.62	0.18							2.41	0.06		
Odonata, Anisoptera (LPIL)	4.81	0.09							1.20	0.03		
Libellulidae	4.81	0.09							1.20	0.03		
Tramea (LPIL)	4.81	0.09							1.20	0.03		
Odonata, Zygoptera	365.39	6.71	19.23	0.84	9.62	4.17	19.23	0.70	103.37	2.85	38.27	0.74
Odonata, Zygoptera (LPIL)	293.27	5.38	9.62	0.42	9.62	4.17	19.23	0.70	82.94	2.10		
Coenagrionidae	72.12	1.32	9.62	0.42					20.44	0.52		
Coenagrion/Enallagma (LPIL)	72.12	1.32	9.62	0.42					20.44	0.76	38.27	0.74
Trichoptera	38.46	0.71							9.62	0.24		
Hydroptilidae	4.81	0.09							1.20	0.03		
Oxyethira (LPIL)	4.81	0.09							1.20	0.03		
Leptoceridae	33.65	0.62							8.41	0.21		
Oecetis (LPIL)	33.65	0.62							8.41	0.21		
Lepidoptera	19.23	0.35							4.81	0.12		
Pyralidae	19.23	0.35							4.81	0.12		
Pyralidae (LPIL)	19.23	0.35							4.81	0.12		
Coleoptera	52.88	0.97							13.22	0.33		
Hydrophilidae	52.88	0.97							13.22	0.33		
Berosus (LPIL)	52.88	0.97							13.22	0.33		
Diptera	1759.64	32.30	1182.70	52.12	76.92	33.33	2471.17	90.49	1372.61	52.32	2793.83	54.17
Ceratopogonidae	48.08	0.88							12.02	0.30		
Palpomyia/ Probezzia/Bezzia (LPIL)	48.08	0.88							12.02	0.30		
Chironomidae	1711.56	31.42	1182.70	52.12	76.92	33.33	2471.17	90.49	1360.59	52.01	2793.83	54.17
Chironomidae pupae (LPIL)	9.62	0.18	144.23	6.36					38.46	2.00	162.65	3.15
Chironominae												

Table D-3

The Benthic Macroinvertebrates of Lake Mary Sampled by Ponar Dredge

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 198 DENSITY	NOVEMBER 3, 198 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Chironomus (LPIL)	326.92	6.00	96.15	4.24	19.23	8.33	2278.85	83.45	680.29	22.44	832.41	16.14
Cryptotendipes (LPIL)	9.62	0.18	105.77	4.66					28.85	0.91	28.70	0.56
Dicrotendipes (LPIL)	211.54	3.88	86.54	3.81			57.69	2.11	88.94	3.94	267.90	5.19
Glyptotendipes (LPIL)	28.85	0.53							7.21	1.09	143.52	2.78
Parachironomus (LPIL)	9.62	0.18	28.85	1.27					9.62	0.30	9.57	0.19
Paratanytarsus (LPIL)	211.54	3.88	48.08	2.12			9.62	0.35	67.31	1.70		
Tanytarsus (LPIL)	365.38	6.71	38.46	1.69					100.96	2.55		
Orthocladinae											9.57	0.19
Orthocladinae A (LPIL)											9.57	0.19
Cricotopus (LPIL)			9.62	0.42					2.41	0.06		
Psectrocladius (LPIL)			48.08	2.12			9.62	0.35	14.43	5.14	755.87	14.66
Tanypodinae												
Larsia (LPIL)	336.54	6.18	163.46	7.20	57.69	25.00	67.31	2.46	156.25	7.45	554.94	10.76
Procladius (LPIL)	192.31	3.53	375.00	16.53			48.08	1.76	153.85	4.07	28.70	0.56
Tanypus (LPIL)	9.62	0.18	38.46	1.69					12.02	0.30		
Mollusca	841.34	15.45	76.93	3.39			96.15	3.52	253.61	16.50	1597.84	30.98
Gastropoda	490.38	9.00	76.93	3.39			96.15	3.52	165.87	14.28	1597.84	30.98
Gastropoda (LPIL)	9.62	0.18							2.41	0.06		
Lymnacidae	4.81	0.09							1.20	0.03		
Fossaria (LPIL)	4.81	0.09							1.20	0.03		
Physidae	43.27	0.79	9.62	0.42					13.22	0.52	28.70	0.56
Physa (LPIL)	43.27	0.79	9.62	0.42					13.22	0.52	28.70	0.56
Planorbidae	432.69	7.94	67.31	2.97			96.15	3.52	149.04	13.67	1569.14	30.43
Gyraulus (LPIL)	432.69	7.94	67.31	2.97			96.15	3.52	149.04	13.67	1569.14	30.43
Pelecypoda	350.96	6.44							87.74	2.22		
Sphaeriidae	350.96	6.44							87.74	2.22		
Musculium (LPIL)	4.81	0.09							1.20	0.03		
Pisidium (LPIL)	346.15	6.35							86.54	2.19		

Table D-3

The Benthic Macroinvertebrates of Lake Mary Sampled by Ponar Dredge

TAXA	APRIL 30, 1987 DENSITY	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 198 DENSITY	NOVEMBER 3, 198 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
TOTAL NUMBER/SQUARE METER	5447.14		2269.23		230.77		2730.77		2669.48		5157.10	
TOTAL NUMBER OF TAXA	39		24		6		10		42		22	
MEAN TAXA/MONTH									19.75			

Table D-4

The Benthic Macroinvertebrates of McKay Lake Sampled by Ponar Dredge

TAXA	MAY 1, 1987 DENSITY	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
Nematoda	14.42	0.48	19.23	2.47					8.41	0.50	19.14	0.74
Nematoda (LPIL)	14.42	0.48	19.23	2.47					8.41	0.50	19.14	0.74
Annelida	2115.38	69.73	326.92	41.98	1028.85	58.47	2192.31	89.76	1415.87	71.37	1913.59	73.53
Oligochaeta	2115.38	69.73	326.94	41.98	1028.85	58.47	2192.31	89.76	1415.87	71.37	1913.59	73.53
Naididae	153.85	5.07	9.62	1.24					40.87	1.72	19.14	0.74
Dero digitata											19.14	0.74
Nais variabilis	19.23	0.63	9.62	1.23					7.21	0.27		
Ophidonais serpentina	134.62	4.44							33.66	1.27		
Tubificidae	1961.53	64.66	317.32	40.74	1028.85	58.47	2192.31	89.76	1375.00	69.65	1894.45	72.68
Immature with capilliformes	519.23	17.12	38.46	4.94	86.54	4.92	1394.23	57.09	509.62	21.90	287.04	11.03
Immature without capilliformes	576.92	19.02	134.62	17.28	605.77	34.43	471.15	19.29	447.12	30.54	1454.32	55.88
Aulodrilus pigueti	38.46	1.27			192.31	10.93	144.23	5.91	93.75	4.79	133.95	5.15
Limnodrilus claparedianus	653.85	21.55	134.62	17.28	144.23	8.20	38.46	1.57	242.79	9.33	19.14	0.74
Limnodrilus hoffmeisteri	115.38	3.80	9.62	1.23			9.62	0.39	33.66	1.27		
Tubifex tubifex	57.69	1.90					134.62	5.51	48.08	1.81		
Arthropoda	903.86	29.80	432.69	55.56	730.77	41.53	250.00	10.24	579.33	28.14	669.77	25.74
Arachnoidea												
Hydrachnellae (Hydracarina) (LPIL)					9.62	0.55			2.41	0.09		
Insecta	903.86	29.80	432.69	55.56	715.15	40.98	250.00	10.24	575.43	27.99	669.77	25.74
Ephemeroptera												
Caenidae	9.62	0.32							2.41	0.09		
Caenis (LPIL)	9.62	0.32							2.41	0.09		
Odonata, Zygoptera	4.81	0.16							1.20	0.05		
Coenagrionidae	4.81	0.16							1.20	0.05		
Coenagrion/Enallagma (LPIL)	4.81	0.16							1.20	0.05		
Trichoptera	9.62	0.32							2.41	0.09		
Leptoceridae	9.62	0.32							2.41	0.09		
Oecetis (LPIL)	9.62	0.32							2.41	0.09		

Table D-4

The Benthic Macroinvertebrates of McKay Lake Sampled by Ponar Dredge

TAXA	MAY 1, 1987 DENSITY	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
Diptera	879.81	29.00	432.69	55.56	721.15	40.98	250.00	10.24	570.91	27.82	669.77	25.74
Ceratopogonidae	52.88	1.74	86.54	11.11	19.23	1.09			39.66	1.58	9.57	0.37
Palpomyia/ Probezzia/Bezzia (LPIL)	52.88	1.74	86.54	11.11	19.23	1.09			39.66	1.58	9.57	0.37
Chironomidae	802.91	26.47	326.94	41.98	701.94	39.89	153.85	6.30	496.41	23.66	526.25	20.19
Chironomidae pupae (LPIL)	4.81	0.16	19.23	2.47	9.62	0.55			8.42	0.50	19.14	0.74
Chironominae												
Chironomini A (LPIL)	9.62	0.32			19.23	1.09			7.21	0.27		
Chironomus (LPIL)	91.35	3.01	105.77	13.58	346.15	19.67	105.77	4.33	162.26	8.37	239.20	9.19
Cryptochironomus (LPIL)	235.58	7.77	19.23	2.47	9.62	0.55	38.46	1.57	75.72	3.30	47.84	1.84
Cryptotendipes (LPIL)	307.69	10.14	19.23	2.47	28.85	1.64	9.62	0.39	91.35	3.53	9.57	0.37
Dicrotendipes (LPIL)	33.65	1.11							8.41	0.32		
Lenziella (LPIL)	28.85	0.95							7.21	0.27		
Parachironomus (LPIL)					9.62	0.55			2.41	0.09		
Polypedilum (LPIL)	4.81	0.16	48.08	6.17					13.22	0.50		
Tanytarsus (LPIL)	24.04	0.79	28.85	3.70					13.22	1.13	66.98	2.57
Orthocladinae												
Orthocladinae A (LPIL)	4.81	0.16							1.20	0.05		
Tanypodinae												
Larsia (LPIL)			9.62	1.23	9.62	0.55			4.81	0.18		
Procladius (LPIL)	52.88	1.74	67.31	8.64	67.31	3.83			46.88	2.94	124.38	4.78
Tanypus (LPIL)	4.81	0.16	9.62	1.23	201.92	11.48			54.09	2.22	19.14	0.74
Culicidae	24.04	0.79	19.23	2.46			96.15	3.94	34.86	1.31		
Chaoborinae	24.04	0.79	19.23	2.46			96.15	3.94	34.86	1.31		
Chaoborus (LPIL)	24.04	0.79	19.23	2.46			96.15	3.94	34.86	2.57	133.95	5.15
TOTAL DENSITY/ CUBIC METER	3033.65		778.85		1759.62		2442.31		2003.61		2602.50	
TOTAL NUMBER OF TAXA	26		17		15		10		29		15	
MEAN TAXA/MONTH									17			

Table D-5

Estimated Abundance of Benthic Macroinvertebrates in Lake Derby Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE**	JUNE 9, 1987 ESTIMATED ABUNDANCE	AUGUST 11, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 13, 1988 ESTIMATED ABUNDANCE
Coelenterata					
Hydroida					
Hydridae					
Hydra (LPIL)				R	
Platyhelminthes					
Turbellaria					
Turbellaria (LPIL)				FC	
Nematoda					
Nematoda (LPIL)	U	U	R		
Annelida					
Hirudinea					
Glossiphoniidae					
Helobdella stagnalis				R	
Oligochaeta					
Naididae					
Chaetogaster diaphanus			R	FC	
Dero digitata	R				FC
Dero nivea				R	
Nais simplex				R	
Nais variabilis	A	C	A	FC	FC
Ophidonais serpentina			R		R
Pristina leidyi				U	
Stylaria lacustris				R	
Tubificidae					
Immature with capilliformes		R		R	
Immature without capilliformes	U			R	R
Aulodrilus pigueti	FC	R			

Table D-5

Estimated Abundance of Benthic Macroinvertebrates in Lake Derby Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE**	JUNE 9, 1987 ESTIMATED ABUNDANCE	AUGUST 11, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 13, 1988 ESTIMATED ABUNDANCE
Limnodrilus hoffmeisteri	R				U
Tubifex tubifex					R
Arthropoda					
Crustacea					
Amphipoda					
Talitridae					
Hyalella azteca	U	R	U	A	C
Insecta					
Ephemeroptera					
Baetidae					
Baetidae (LPIL)			R		R
Callibaetis (LPIL)	R			U	R
Caenidae					
Caenis (LPIL)	C	R	R	R	
Libellulidae					
Libellula (LPIL)					R
Odonata, Zygoptera					
Odonata, Zygoptera (LPIL)			FC	R	
Coenagrionidae					
Coenagrion/Enallagma (LPIL)			U	R	R
Hemiptera					
Corixidae (LPIL)	R		U	R	R
Corisella (LPIL)	R	R		U	FC
Gerridae					
Gerris (LPIL)					R
Saldidae					
Saldula (LPIL)		R			
Trichoptera					

Table D-5

Estimated Abundance of Benthic Macroinvertebrates in Lake Derby Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE**	JUNE 9, 1987 ESTIMATED ABUNDANCE	AUGUST 11, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 13, 1988 ESTIMATED ABUNDANCE
Hydroptilidae					
Agraylea (LPIL)				R	
Leptoceridae					
Oecetis (LPIL)			R		
Coleoptera					
Dytiscidae					
Laccophilus (LPIL)			R		
Haliplidae					
Peltodytes (LPIL)				R	
Hydrophilidae					
Berosus (LPIL)					R
Diptera					
Ceratopogonidae					
Culicoides (LPIL)		U			
Dasyhelea (LPIL)		R			
Palpomyia/ Probezzia/Bezzia (LPIL)		FC	R		R
Probezzia/Bezzia (LPIL)		R	R		
Chironomidae					
Chironomidae pupae (LPIL)	R	R	R	R	U
Chironominae					
Chironomus (LPIL)	R				
Cryptochironomus (LPIL)	C		R		U
Cryptotendipes (LPIL)	U				
Dicrotendipes (LPIL)	R	R	R	U	C
Endochironomus (LPIL)			U	C	R
Glyptotendipes (LPIL)			R	R	U
Lenziella (LPIL)	U				U
Paratanytarsus (LPIL)			U	FC	

Table D-5

Estimated Abundance of Benthic Macroinvertebrates in Lake Derby Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE**	JUNE 9, 1987 ESTIMATED ABUNDANCE	AUGUST 11, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 13, 1988 ESTIMATED ABUNDANCE
Polypedilum (LPIL)	R		R		
Pseudochironomus (LPIL)					R
Orthocladinae					
Orthocladinae B (LPIL)		U			R
Cricotopus (LPIL)			R	R	
Cricotopus/Orthocladius (LPIL)		U	U		
Psectrocladius (LPIL)			R		
Tanypodinae					
Larsia (LPIL)			R		
Procladius (LPIL)	U				U
Ephyridae					
Ephyridae A (LPIL)		U			
Muscidae					
Muscidae (LPIL)		R			
Mollusca					
Gastropoda					
Lymnacidae					
Fossaria (LPIL)				R	R
Physidae					
Physa (LPIL)			R	U	
Planorbidae					
Gyraulus (LPIL)			R	U	R
TOTAL NUMBER OF TAXA	19	18	27	29	27

* KEY

R=Rare(1-5 organisms);U=Uncommon(6-25);FC=Fairly Common(26-50);C=Common(51-100);A=Abundant(101-500);VA=Very Abundant(500+)

Table D-6

Estimated Abundance of Benthic Macroinvertebrates in Lake Ladora Sampled by Dip Net

TAXA	APRIL 29, 1987 ESTIMATED *ABUNDANCE***	JUNE 8, 1987 ESTIMATED *ABUNDANCE*	AUGUST 10, 1987 ESTIMATED *ABUNDANCE*	NOVEMBER 2, 1987 ESTIMATED *ABUNDANCE*	APRIL 12, 1988 ESTIMATED *ABUNDANCE*
Coelenterata					
Hydroida					
Hydridae					
Hydra (LPIL)	R	FC	R		
Platyhelminthes					
Turbellaria					
Turbellaria (LPIL)	R	FC	C	U	U
Nematoda					
Nematoda (LPIL)		R			
Annelida					
Hirudinea					
Glossiphoniidae					
Helobdella (LPIL)	R				
Helobdella triserialis			R		
Helobdella stagnalis					R
Oligochaeta					
Enchytraeidae (LPIL)		R			
Naididae					
Chaetogaster diaphanus	U	A		FC	R
Dero digitata				R	R
Nais simplex	FC	U		U	U
Nais variabilis	FC	C	R	C	U
Ophidonais serpentina		U			C
Stylaria lacustris	R	R	R		
Tubificidae					
Immature with capilliformes		R	R		
Limnodrilus hoffmeisteri	R				

Table D-6

Estimated Abundance of Benthic Macroinvertebrates in Lake Ladora Sampled by Dip Net

TAXA	APRIL 29, 1987 ESTIMATED ABUNDANCE**	JUNE 8, 1987 ESTIMATED ABUNDANCE	AUGUST 10, 1987 ESTIMATED ABUNDANCE	NOVEMBER 2, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Tubifex tubifex					R
Arthropoda					
Crustacea					
Amphipoda					
Talitridae					
Hyalella azteca	FC	A	FC	A	C
Insecta					
Ephemeroptera					
Baetidae					
Baetidae (LPIL)			R		R
Baetis (LPIL)		R			
Callibaetis (LPIL)			R	U	R
Caenidae					
Caenis (LPIL)	R	R	R		R
Odonata,Anisoptera					
Odonata, Anisoptera (LPIL)		R	R		
Aeshnidae					
Anax (LPIL)	R				
Corduliidae					
Tetragoneuria (LPIL)		R			
Libellulidae					
Erythemis (LPIL)	R				
Tramea (LPIL)				R	
Odonata,Zygoptera					
Odonata, Zygoptera (LPIL)	FC	FC	FC	FC	U
Coenagrionidae					
Coenagrion/Enallagma (LPIL)	U	U	U	FC	U
Hemiptera					

Table D-6

Estimated Abundance of Benthic Macroinvertebrates in Lake Ladora Sampled by Dip Net

TAXA	APRIL 29, 1987 ESTIMATED ABUNDANCE**	JUNE 8, 1987 ESTIMATED ABUNDANCE	AUGUST 10, 1987 ESTIMATED ABUNDANCE	NOVEMBER 2, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Hemiptera (LPIL)			R		
Gerridae					
Gerris (LPIL)	R				
Hebridae					
Hebrus (LPIL)		R			
Mesoveliidae					
Mesovelia (LPIL)		U	R		
Trichoptera					
Hydroptilidae					
Agraylea (LPIL)		R			
Orthotrichia (LPIL)		R	R		
Oxyethira (LPIL)	R	R	R		
Leptoceridae (LPIL)					
Oecetis(LPIL)			R		
Coleoptera					
Hydrophilidae					
Laccobius (LPIL)		R			
Diptera					
Ceratopogonidae					
Culicoides (LPIL)			U		
Dasyhelea (LPIL)			R		
Palpomyia/ Probezzia/Bezzia (LPIL)		U			
Probezzia/Bezzia (LPIL)		VA	U		
Chironomidae					
Chironomidae pupae (LPIL)	U	R	R		U
Chironominae					
Chironomus (LPIL)					R
Cryptotendipes (LPIL)		R			

Table D-6

Estimated Abundance of Benthic Macroinvertebrates in Lake Ladora Sampled by Dip Net

TAXA	APRIL 29, 1987 ESTIMATED ABUNDANCE**	JUNE 8, 1987 ESTIMATED ABUNDANCE	AUGUST 10, 1987 ESTIMATED ABUNDANCE	NOVEMBER 2, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Dicrotendipes (LPIL)	*R*	*U*	*R*		FC
Microspectra/Tanytarsus (LPIL)					FC
Parachironomus (LPIL)	R				
Paratanytarsus (LPIL)	R	A	FC	U	R
Polypedilum (LPIL)	R				
Tanytarsus (LPIL)	U	A	FC	R	U
Orthocladinae					
Orthocladinae B					R
Orthocladinae C		R			
Orthocladinae D		U			
Cricotopus/Orthocladius (LPIL)			U		R
Nanocladius (LPIL)					R
Procladius (LPIL)					R
Psectrocladius (LPIL)		*U*	*U*		
Tanypodinae					
Larsia (LPIL)		U	FC	R	R
Tanypus (LPIL)		U			
Tabanidae					
Tabanidae (LPIL)		R			
Muscidae					
Muscidae (LPIL)					R
Stratiomyiidae					
Caloparyphus (LPIL)					R
Mollusca					
Gastropoda					
Gastropoda (LPIL)					R
Lymnacidae					
Fossaria (LPIL)					R

Table D-6

Estimated Abundance of Benthic Macroinvertebrates in Lake Ladora Sampled by Dip Net

TAXA	APRIL 29, 1987 ESTIMATED ABUNDANCE**	JUNE 8, 1987 ESTIMATED ABUNDANCE	AUGUST 10, 1987 ESTIMATED ABUNDANCE	NOVEMBER 2, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Physidae					
Physa (LPIL)	U	A	U	FC	U
Planorbidae					
Gyraulus(LPIL)	U	A	U	U	R
Pelecypoda					
Sphaeriidae					
Pisidium (*LPIL*)		R	R		R
TOTAL NUMBER OF TAXA	24	39	31	15	32

* Key

R=Rare(1-5 Organisms);U=Uncommon(6-25);FC=Fairly Common(26-50);C=Common(51-100);A=Abundant(101-500);VA=Very Abundant(500+)

Table D-7

Estimated Abundance of Benthic Macroinvertebrates in Lake Mary Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE*	JUNE 10, 1987 ESTIMATED ABUNDANCE	AUGUST 13, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Coelenterata					
Hydroida					
Hydridae					
Hydra (LPIL)	FC	R		R	U
Platyhelminthes					
Turbellaria					
Turbellaria (LPIL)	R				
Nematoda					
Nematoda (LPIL)	U	U			
Annelida					
Hirudinea					
Erpobdellidae					
Eropobdellidae (LPIL)	R				
Glossiphoniidae					
Helobdella (LPIL)			R		
Theromyzon (LPIL)	R				
Oligochaeta					
Enchytraeidae (LPIL)	U				
Naididae					
Chaetogaster diaphanus	U	C	U		R
Nais simplex	U	U		U	R
Nais variblils					R
Pristina leidyi				U	
Stylaria lacustris				U	
Tubificidae					
Immature with capilliformes		U			
Immature without capilliformes	R	U			
Arthropoda					

Table D-7

Estimated Abundance of Benthic Macroinvertebrates in Lake Mary Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE*	JUNE 10, 1987 ESTIMATED ABUNDANCE	AUGUST 13, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Crustacea					
Amphipoda					
Talitridae					
Hyalella azteca	A	C	FC	U	R
Arachnoidea					
Hydrachnellae (Hydracarina) (LPIL)	R				
Insecta					
Ephemeroptera					
Ephemeroptera (LPIL)	R				
Baetidae					
Baetidae (LPIL)			U		R
Baetis(LPIL)	R	U			
Callibaetis (LPIL)			U	C	
Caenidae					
Caenis (LPIL)	C	FC	R	U	
Odonata,Anisoptera					
Odonata, Anisoptera (LPIL)	R				
Aeshnidae					
Anax (LPIL)			FC		
Corduliidae					
Tetragoneuria (LPIL)	R				
Libellulidae					
Erythemis (LPIL)			FC		
Libellula (LPIL)	R		U		
Tramea (LPIL)		R	U		
Odonata,Zygoptera	A	FC	A	FC	
Odonata,Zygoptera (LPIL)					U
Coenagrionidae					

Table D-7

Estimated Abundance of Benthic Macroinvertebrates in Lake Mary Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE*	JUNE 10, 1987 ESTIMATED ABUNDANCE	AUGUST 13, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Coenagrion/Enallagma (LPIL)	C	U	FC	U	R
Hemiptera					
Gerridae					
Gerris (LPIL)			U		
Mesoveliidae					
Mesovelia (LPIL)		R	FC		
Trichoptera					
Hydroptilidae					
Agraylea (LPIL)		U			
Oxyethira (LPIL)	U				
Leptoceridae (LPIL)					
Oecetis (LPIL)	U	R	U	R	
Lepidoptera					
Pyralidae					
Pyralidae (LPIL)		R	U		
Coleoptera					
Haliplidae					
Haliplus (LPIL)			R		R
Hydrophilidae					
Berosus (LPIL)	U	U	U		
Diptera					
Ceratopogonidae					
Palpomyia/ Probezzia/Bezzia (LPIL)	R		R		
Probezzia/Bezzia (LPIL)	R	FC	R		
Chironomidae					
Chironomidae pupae (LPIL)	U	U	U	R	U
. .ironominae					
Dicrotendipes (LPIL)	FC				

Table D-7

Estimated Abundance of Benthic Macroinvertebrates in Lake Mary Sampled by Dip Net

TAXA	APRIL 30, 1987 ESTIMATED ABUNDANCE*	JUNE 10, 1987 ESTIMATED ABUNDANCE	AUGUST 13, 1987 ESTIMATED ABUNDANCE	NOVEMBER 3, 1987 ESTIMATED ABUNDANCE	APRIL 12, 1988 ESTIMATED ABUNDANCE
Endochironomus (LPIL)	R	R	R		R
Glyptotendipes(LPIL)	U				C
Paratanytarsus (LPIL)	A	A	U	FC	R
Tanytarsus (LPIL)	A	A	FC	R	R
Orthocladinae					
Orthocladinae (LPIL)					R
Orthocladinae D (LPIL)		R			
Corynoneura (LPIL)				R	
Cricotopus (LPIL)	R	U	R	R	
Psectrocladius (LPIL)	U	FC		FC	R
Tanypodinae					
Larsia (LPIL)	U	U	R	R	
Mollusca					
Gastropoda					
Gasrtopoda (LPIL)	R				
Lymnacidae					
Fossaria (LPIL)	R	R			
Physidae					
Physa (LPIL)	U	U	U	R	
Planorbidae					
Gyraulus (LPIL)	A		U	C	A
Pelecypoda					
Sphaeriidae					
Pisidium (LPIL)	R				
TOTAL NUMBER OF TAXA	38	28	28	19	17

* Key

R=Rare(1-5 organisms);U=Uncommon(6-25);FC=Fairly Common(26-50);C=Common(51-100);A=Abundant(101-500);VA=Very Abundant(500+)

Table D-8

Estimated Abundance of Benthic Macroinvertebrates in McKay Lake Sampled by Dip Net

TAXA	MAY 1, 1987 ESTIMATED ABUNDANCE*	JUNE 11, 1987 ESTIMATED ABUNDANCE	AUGUST 12, 1987 ESTIMATED ABUNDANCE	NOVEMBER 4, 1987 ESTIMATED ABUNDANCE	APRIL 14, 1988 ESTIMATED ABUNDANCE
Platyhelminthes					
Turbellaria					
Turbellaria (LPIL)				R	
Nematoda					
Nematoda (LPIL)		U		R	U
Annelida					
Oligochaeta					
Enchytraeidae (LPIL)	U	FC			
Lumbriculidae (LPIL)		R			
Naididae					
Chaetogaster diaphanus		C	U		
Dero digitata			U	U	
Dero nivea					R
Nais variabilis	R	VA		R	R
Ophidonais serpentina		C	C	R	
Stylaria lacustris			U		
Tubificidae					
Immature with capilliformes				R	R
Immature without capilliformes	U			FC	R
Tubifex tubifex					U
Arthropoda					
Crustacea					
Isopoda					
Asellidae					
Licerus (LPIL)		R			
Amphipoda					
Talitridae					
Hyalella azteca			FC	C	U

Table D-8

Estimated Abundance of Benthic Macroinvertebrates in McKey Lake Sampled by Dip Net

TAXA	MAY 1, 1987 ESTIMATED ABUNDANCE*	JUNE 11, 1987 ESTIMATED ABUNDANCE	AUGUST 12, 1987 ESTIMATED ABUNDANCE	NOVEMBER 4, 1987 ESTIMATED ABUNDANCE	APRIL 14, 1988 ESTIMATED ABUNDANCE
Decapoda					
Astacidae					
Astacidae A (LPIL)		U			
Orconectes nais/virilis				R	
Insecta					
Collembola					
Isotomidae (LPIL)	U				
Ephemeroptera					
Baetidae					
Baetidae (LPIL)		R			
Callibaetis (LPIL)		R	U		
Caenidae					
Caenis (LPIL)	R	R	FC	U	R
Odonata,Anisoptera					
Odonata, Anisoptera (LPIL)		R			
Aeshnidae					
Anax (LPIL)			U		
Odonata,Zygoptera	R	R	U		
Coenagrionidae					
Coenagrion/Enallagma (LPIL)	R	R	FC	R	
Plecoptera					
Plecoptera (LPIL)		R			
Hemiptera					
Corixidae					
Corixidae (LPIL)	R				R
Corisella (LPIL)	R	R		U	
Gerridae					
Gerris (LPIL)			U		
Trichoptera					

Table D-8

Estimated Abundance of Benthic Macroinvertebrates in McKay Lake Sampled by Dip Net

TAXA	MAY 1, 1987 ESTIMATED ABUNDANCE*	JUNE 11, 1987 ESTIMATED ABUNDANCE	AUGUST 12, 1987 ESTIMATED ABUNDANCE	NOVEMBER 4, 1987 ESTIMATED ABUNDANCE	APRIL 14, 1988 ESTIMATED ABUNDANCE
Hydroptilidae					
Oxyethira (LPIL)			R		
Coleoptera					
Dytiscidae		R			
Hygrotus (LPIL)			R		
Haliplidae					
Peltodytes (LPIL)		R			
Hydrophilidae					
Berosus (LPIL)		FC	U		
Tropisternus (LPIL)			R		
Diptera					
Ceratopogonidae					
Palpomyia/ Probezzia/Bezzia (LPIL)		U	U		R
Probezzia/Bezzia (LPIL)		U	U		
Chironomidae					
Chironomidae pupae (LPIL)		U	U		R
Chironominae					
Chironomus (LPIL)				R	
Cryptochironomus (LPIL)				R	R
Dicrotendipes (LPIL)		U			R
Endochironomus (LPIL)	R		R		
Lenziella (LPIL)					FC
Microtendipes (LPIL)			R		
Parachironomus (LPIL)		R	R		
Paratanytarsus (LPIL)	R	VA	U	R	
Polypedilum (LPIL)	R				
Tanytarsus (LPIL)	R	U		R	
Orthocladinae					
Orthocladinae B (LPIL)	R				

Table D-8

Estimated Abundance of Benthic Macroinvertebrates in McKay Lake Sampled by Dip Net

TAXA	MAY 1, 1987 ESTIMATED ABUNDANCE*	JUNE 11, 1987 ESTIMATED ABUNDANCE	AUGUST 12, 1987 ESTIMATED ABUNDANCE	NOVEMBER 4, 1987 ESTIMATED ABUNDANCE	APRIL 14, 1988 ESTIMATED ABUNDANCE
Orthocladinae D (LPIL)		U			
Corynoneura (LPIL)		U			
Cricotopus (LPIL)	R	C			
Cricotopus/Orthocladius (LPIL)	R				
Psectrocladius (LPIL)		U			
Tanypodinae					
Larsia (LPIL)		U	U		
Procladius (LPIL)				R	
Sciomyzidae					
Sepedon (LPIL)			R		
Tipulidae					
Tipulidae (LPIL)	R				
Mollusca					
Gastropoda					
Gastropoda (LPIL)				R	
Lymnacidae					
Fossaria (LPIL)		R	U		
Physidae					
Physa (LPIL)		U	VA	R	
Planorbidae					
Gyraulus (LPIL)	R	R	VA	R	
Pelecypoda					
Unionidae					
Alasmidonta (LPIL)				R	
TOTAL NUMBER OF TAXA	18	34	27	21	14

* Key

R=Rare(1-5 organisms);U=Uncommon(6-25);FC=Fairly Common(26-50);C=Common(51-100);A=Abundant(101-500);VA=Very Abundant(500+)

APPENDIX E

Tables E-1 through E-14
Fish Data

Table E-1

The Fish Community of Lake Derby Sampled by Electrofishing

COMMON NAME	APRIL 30, 1987 CATCH/EFFORT	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 CATCH/EFFORT	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 CATCH/EFFORT	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 CATCH/EFFORT	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN CATCH/EFFORT	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 CATCH/EFFORT	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
PIKES												
Northern pike	2.00	3.92	5.00	4.35	1.00	0.90	1.00	0.33	2.25	1.56	2.00	1.52
CARPS AND MINNOWS												
Common carp	17.00	33.33	19.00	16.52	23.00	20.72	63.00	21.07	30.50	21.18	89.00	67.42
Fathead minnow	2.00	3.92					3.00	1.00	1.25	0.87	3.00	2.27
BULLHEAD CATFISHES												
Black bullhead			56.00	48.70	10.00	9.01	6.00	2.01	18.00	12.50	2.00	1.52
SUNFISHES												
Green sunfish							1.00	0.33	0.25	0.17	1.00	0.76
Bluegill	19.00	37.25	23.00	20.00	8.00	7.21	70.00	23.41	30.00	20.83	22.00	16.67
Largemouth bass	11.00	21.57	12.00	10.43	69.00	62.16	155.00	51.84	61.75	42.88	13.00	9.85
CATCH/EFFORT (NUMBER/HOUR)	51.00		115.00		111.00		299.00		144.00		132.00	
NUMBER OF SPECIES	5		5		5		6		7		7	
MEAN SPECIES/MONTH									5.25			

Table E-2

The Fish Community of Lake Ladora Sampled by Electrofishing

COMMON NAME	APRIL 29, 1987 CATCH/EFFORT	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 8, 1987 CATCH/EFFORT	JUNE 8, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 CATCH/EFFORT	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 CATCH/EFFORT	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN CATCH/EFFORT	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 11, 1988 CATCH/EFFORT	APRIL 11, 1988 RELATIVE ABUNDANCE (%)
PIKES												
Northern pike							3.00	1.22	0.75	0.62	4.00	0.79
CARPS AND MINNOWS												
Common carp	1.00	1.41	1.00	1.49					0.50	0.41		
BULLHEAD CATFISHES												
Black bullhead			2.00	2.99					0.50	0.41	3.00	0.59
SUNFISHES												
Green Sunfish											2.00	0.39
Bluegill	63.00	88.73	60.00	89.55	60.00	61.22	223.00	90.65	101.50	84.23	457.00	89.96
Largemouth bass	6.00	8.45	3.00	4.48	37.00	37.76	19.00	7.72	16.25	13.49	20.00	3.94
PERCHES												
Yellow perch	1.00	1.41	1.00	1.49	1.00	1.02	1.00	0.41	1.00	0.83	22.00	4.33
CATCH/EFFORT (NUMBER/HOUR)	71.00		67.00		98.00		246.00		120.5		508.00	
NUMBER OF SPECIES	4		5		3		4		6		6	
MEAN SPECIES/MONTH									4			

Table E-3

The Fish Community of Lake Mary Sampled by Electrofishing

COMMON NAME	APRIL 30, 1987		JUNE 10, 1987		AUGUST 11, 1987		NOVEMBER 3, 1987		1987 MEAN		APRIL 12, 1988	
	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)
CARPS AND MINNOWS												
Common carp					4.00	3.42	2.00	0.93	1.50	1.30		
BULLHEAD CATFISHES												
Channel catfish	1.33	5.54	1.00	0.96	2.00	1.71	2.00	0.93	1.58	1.37	3.00	0.91
SUNFISHES												
Bluegill	21.33	88.91	83.00	79.81	103.00	88.03	181.00	83.80	97.08	84.20	309.00	94.21
Largemouth bass			20.00	19.23	8.00	6.84	29.00	13.43	14.25	12.36	16.00	4.88
Black crappie	1.33	5.54					2.00	0.93	0.84	0.73		
CATCH/EFFORT (NUMBER/HOUR)	23.99		104.00		117.00		216.00		115.25		328.00	
NUMBER OF SPECIES	3		3		4		5		5		3	
MEAN SPECIES/MONTH									3.75			

Table E-4

The Fish Community of McKay Lake Sampled by Electrofishing

COMMON NAME	MAY 1, 1987 CATCH/EFFORT	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 CATCH/EFFORT	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 CATCH/EFFORT	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 CATCH/EFFORT	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN CATCH/EFFORT	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 CATCH/EFFORT	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
TROUTS												
Rainbow trout					2.00	1.11	2.00	0.91	1.00	0.54		
CARPS AND MINNOWS												
Common carp	43.00	17.41	14.00	14.89	7.00	3.89			16.00	8.64		
SUCKERS												
White sucker			1.00	1.06					0.25	0.13		
BULLHEAD CATFISHES												
Channel catfish	2.00	0.81			1.00	0.56			0.75	0.40	1.00	0.30
SUNFISHES												
Green sunfish							1.00	0.45	0.25	0.13		
Pumpkinseed	10.00	4.05	10.00	10.64	1.00	0.56	9.00	4.09	7.50	4.05	2.00	0.60
Bluegill	129.00	52.23	39.00	41.49	47.00	26.11	103.00	46.82	79.50	42.91	65.00	19.40
Bluegill x Redear sunfish	2.00	0.81							0.50	0.27		
Largemouth bass	11.00	4.45	11.00	11.70	77.00	42.78	35.00	15.91	33.50	18.08	23.00	6.87
White crappie	10.00	4.05	3.00	3.19	4.00	2.22	3.00	1.36	5.00	2.70	2.00	0.60
Black crappie			4.00	4.26	5.00	2.78	10.00	4.55	4.75	2.56	1.00	0.30
PERCHES												
Yellow perch	40.00	16.19	12.00	12.77	36.00	20.00	57.00	25.91	36.25	19.57	241.00	71.94
CATCH/EFFORT (NUMBER/HOUR)	247.00		94.00		180.00		220.00		185.25		335.00	
NUMBER OF SPECIES	8		8		9		8		12		7	
MEAN SPECIES/MONTH									8.25			

Table E-5

The Fish Community of Lake Derby Sampled by Beach Seine

COMMON NAME	APRIL 30, 1987 CATCH/EFFORT	APRIL 30, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 CATCH/EFFORT	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 CATCH/EFFORT	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 5, 1987 CATCH/EFFORT	NOVEMBER 5, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN CATCH/EFFORT	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 CATCH/EFFORT	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
CARPS AND MINNOWS												
Common carp					1.00	1.33			0.25	0.43		
Fathead minnow					3.00	4.00			0.75	1.30	3.00	21.43
BULLHEAD CATFISHES												
Black bullhead			2.50	17.86	0.50	0.67			0.75	1.30		
SUNFISHES												
Green sunfish			0.50	3.57	0.50	0.67	2.00	1.47	0.75	1.30	1.00	7.14
Bluegill	4.50	90.00	11.00	78.57	39.00	52.00	115.00	84.25	42.38	73.54	9.00	64.29
Largemouth bass	0.50	10.00			31.00	41.33	19.50	14.29	12.75	22.12	1.00	7.14
CATCH/EFFORT (NUMBER/HAUL)	5.00		14.00		75.00		136.50		57.63		14.00	
NUMBER OF SPECIES	2		3		6		3		6		4	
MEAN SPECIES/MONTH									3.5			

Table E-6

The Fish Community of Lake Ladora Sampled by Beach Seine

COMMON NAME	APRIL 29, 1987 CATCH/EFFORT	APRIL 29, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 CATCH/EFFORT	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 10, 1987 CATCH/EFFORT	AUGUST 10, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 CATCH/EFFORT	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN CATCH/EFFORT	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 11, 1988 CATCH/EFFORT	APRIL 11, 1988 RELATIVE ABUNDANCE (%)
PIKES												
Northern pike							0.50	5.88	0.13	0.54		
SUNFISHES												
Green sunfish							1.00	11.76	0.25	1.05	1.00	15.38
Bluegill	6.50	92.86	28.00	94.92	28.00	55.45	4.50	52.94	16.75	70.14	4.00	61.54
Largemouth bass	0.50	7.14	1.50	5.08	22.50	44.55	2.00	23.53	6.62	27.72	1.50	23.08
PERCHES												
Yellow perch							0.50	5.88	0.13	0.54		
CATCH/EFFORT (NUMBER/HAUL)	7.00		29.50		50.50		8.50		23.88		6.50	
NUMBER OF SPECIES	2		2		2		5		5		3	
MEAN SPECIES/MONTH									2.75			

Table E-7

The Fish Community of Lake Mary Sampled by Beach Seine

COMMON NAME	APRIL 30, 1987		JUNE 10, 1987		AUGUST 13, 1987		NOVEMBER 3, 1987		1987 MEAN		APRIL 12, 1988	
	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)	CATCH/EFFORT	RELATIVE ABUNDANCE (%)
BULLHEAD CATFISHES												
Channel catfish	1.00	2.86							0.25	1.40		
SUNFISHES												
Bluegill	34.00	97.14	30.00	100.00	1.00	100.00	3.50	63.64	17.13	95.81	2.5	100.00
Largemouth bass							2.00	36.36	0.50	2.80		
CATCH/EFFORT (NUMBER/HAUL)	35.00		30.00		1.00		5.50		17.88		2.5	
NUMBER OF SPECIES	2		1		1		2		3		1	
MEAN SPECIES/MONTH									1.5			

Table E-8

The Fish Community of Lake McKay Sampled by Beach Seine

COMMON NAME	MAY 1, 1987 CATCH/EFFORT	MAY 1, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 CATCH/EFFORT	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 CATCH/EFFORT	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 CATCH/EFFORT	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN CATCH/EFFORT	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 CATCH/EFFORT	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
TROUTS												
Rainbow trout							0.50	0.32	0.13	0.11	0.50	2.70
SUNFISHES												
Pumpkinseed	0.50	5.00	0.50	16.67			5.00	3.25	1.50	1.28		
Bluegill	2.00	20.00			181.50	60.50	86.00	55.84	67.37	57.70		
Largemouth bass			0.50	16.67	37.00	12.33	9.50	6.17	11.75	10.06	2.00	10.81
White crappie	2.00	20.00							0.5[illegible]	0.43		
Black crappie	0.50	5.00			41.50	13.83	28.00	18.18	17.50	14.99		
PERCHES												
Yellow perch	5.00	50.00	2.00	66.67	40.00	13.33	25.00	16.23	18.00	15.42	16.00	86.49
CATCH/EFFORT (NUMBER/HAUL)	10.00		3.00		300.00		154.00		116.75		18.50	
NUMBER OF SPECIES	5		3		4		6		7		3	
MEAN SPECIES/MONTH									4.5			

Table E-9

The Fish Eggs and Larvae Collected in Lake Derby by Net Tow

TAXA	MAY 13, 1987 DENSITY	MAY 13, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 5, 1987 DENSITY	NOVEMBER 5, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 13, 1988 DENSITY	APRIL 13, 1988 RELATIVE ABUNDANCE (%)
TOTAL(NUMBER/CUBIC METER)	NO CATCH		NO CATCH		NO CATCH		NO CATCH		NO CATCH		NO CATCH	
NUMBER OF SPECIES	0		0		0		0		0		0	
MEAN SPECIES/MONTH									0			

Table E-10

The Fish Eggs and Larvae Collected in Lake Ladora by Net Tow

TAXA	MAY 13, 1987 DENSITY	MAY 13, 1987 RELATIVE ABUNDANCE (%)	JUNE 10, 1987 DENSITY	JUNE 10, 1987 RELATIVE ABUNDANCE (%)	AUGUST 13, 1987 DENSITY	AUGUST 13, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 2, 1987 DENSITY	NOVEMBER 2, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Sunfish												
Bluegill, Larvae			2.16	97.30	0.07	100.00			0.56	81.16		
Sunfish sp., Larvae			0.06	2.70					0.01	1.45		
Perches												
Yellow perch, Larvae	0.47	100.00							0.12	17.39		
TOTAL(NUMBER/CUBIC METER)	0.47		2.22		0.07		NO CATCH		0.69		NO CATCH	
NUMBER OF SPECIES	1		2		1		0		3		0	
MEAN SPECIES/MONTH									1			

Table E-11

The Fish Eggs and Larvae Collected in Lake Mary by Net Tow

TAXA	MAY 14, 1987 DENSITY	MAY 14, 1987 RELATIVE ABUNDANCE (%)	JUNE 9, 1987 DENSITY	JUNE 9, 1987 RELATIVE ABUNDANCE (%)	AUGUST 11, 1987 DENSITY	AUGUST 11, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 3, 1987 DENSITY	NOVEMBER 3, 1987 RELATIVE ABUNDANCE (%)	MEAN DENSITY	MEAN RELATIVE ABUNDANCE (%)	APRIL 12, 1988 DENSITY	APRIL 12, 1988 RELATIVE ABUNDANCE (%)
Sunfish												
Bluegill, Larvae			0.15	100.00	0.03	100.00			0.05	100.00		
TOTAL(NUMBER/CUBIC METER)	NO CATCH		0.15		0.03		NO CATCH		0.05		NO CATCH	
NUMBER OF SPECIES	0		1		1		0		1		0	
MEAN SPECIES/MONTH									0.5			

Table E-12

The Fish Eggs and Larvae Collected in McKay Lake by Net Tow

TAXA	MAY 14, 1987 DENSITY	MAY 14, 1987 RELATIVE ABUNDANCE (%)	JUNE 11, 1987 DENSITY	JUNE 11, 1987 RELATIVE ABUNDANCE (%)	AUGUST 12, 1987 DENSITY	AUGUST 12, 1987 RELATIVE ABUNDANCE (%)	NOVEMBER 4, 1987 DENSITY	NOVEMBER 4, 1987 RELATIVE ABUNDANCE (%)	1987 MEAN DENSITY	1987 MEAN RELATIVE ABUNDANCE (%)	APRIL 14, 1988 DENSITY	APRIL 14, 1988 RELATIVE ABUNDANCE (%)
Sunfish												
Bluegill, Larvae			0.05	35.71					0.01	33.33		
White crappie, Larvae			0.09	64.29					0.02	66.67		
TOTAL(NUMBER/CUBIC METER)	NO CATCH		0.14		NO CATCH		NO CATCH		0.03		NO CATCH	
NUMBER OF SPECIES	0		2		0		0		2		0	
MEAN SPECIES/MONTH									0.1			

Table E-13

Descriptive Statistics for Bluegill <100 mm Total Length

	Lake Derby			Lake Ladora			Lake Mary			Lake McKay		
Statistic	Length	Weight	K Factor	Length	Weight	K Factor	Length	Weight	K Factor	Length	Weight	K Factor
Minimum	19	0.14	1.2328	24	0.22	1.1719	22	0.12	0.9481	22	0.2	0.4719
Maximum	99	22	3.3185	99	20	2.8299	99	20	3.3185	99	19	2.2779
Range	80	21.86	2.0857	75	19.78	1.6580	77	19.88	2.3704	77	18.80	1.8060
Mean	46.43	4.09	1.7857	71.16	8.51	1.8410	62.29	6.52	1.8895	47.99	3.52	1.6489
Median	34	0.65	1.7260	79	9.05	1.8498	64	4.80	1.8583	40	1	1.6401
Mode	24	0.3	*	*	12	1.9238	67	18	*	*	*	*
STD. Dev.	25.48	6.01	0.3376	22.30	5.64	0.2259	21.70	5.78	0.3212	22.00	5.35	0.2350
95% C.I.	±4.52	±1.07	±0.0599	±4.11	±0.84	±0.0417	±2.9091	±0.7746	±0.0432	±3.81	±0.93	±0.0407
No. of Fish		123			114			214			129	

* = Multi modal

Descriptive Statistics for Bluegill ≥100 mm Total Length

	Lake Derby			Lake Ladora			Lake Mary			Lake McKay		
Statistic	Length	Weight	K Factor	Length	Weight	K Factor	Length	Weight	K Factor	Length	Weight	K Factor
Minimum	101	20	1.6529	100	14	1.3435	100	18	1.3736	101	18	0.8193
Maximum	172	100	2.7177	199	170	2.5800	195	172	4.0965	200	149	2.4168
Range	71	80	1.0648	99	156	1.2365	95	154	2.7229	99	131	1.5975
Mean	124.98	45.49	2.1698	129.21	45.39	1.9134	138.58	64.73	2.0957	161.83	84.77	1.9087
Median	119.50	39.20	2.1344	125	39.50	1.9159	132	50	2.0751	165.50	91	1.9219
Mode	*	42	1.9558	*	30	*	130	20	2 1353	181	98	*
STD. Dev.	19.34	22.02	0.2374	20.23	25.52	0.2290	26.51	43.33	.3578	23.69	31.25	0.2364
95% C.I.	±5.42	±6.17	±0.0665	±2.93	±3.7	±0.0332	±5.44	±8.9	±0.0735	±3.96	±5.23	±0.0396
No. of Fish		50			184			92			138	

* = Multi modal

Table E-14

Descriptive Statistics for Largemouth Bass <100 mm Total Length

Statistic	Lake Derby Length	Lake Derby Weight	Lake Derby K Factor	Lake Ladora Length	Lake Ladora Weight	Lake Ladora K Factor	Lake Mary Length	Lake Mary Weight	Lake Mary K Factor	Lake McKay Length	Lake McKay Weight	Lake McKay K Factor
Minimum	39	0.77	1.1477	31	0.49	1.0712	54	2.40	1.2074	40	0.85	1.1379
Maximum	97	12.1	2.2950	99	13	2.4678	87	9	1.5420	93	10.5	1.6512
Range	58	11.33	1.1473	68	12.51	1.3966	33	6.60	0.3346	53	9.65	0.5133
Mean	68.85	4.89	1.3374	59.33	3.44	1.4206	66.12	4.18	1.4078	54.35	2.51	1.3570
Median	69	4.35	1.3072	59	2.80	1.4120	65	3.80	1.3964	51	1.85	1.3491
Mode	*	*	*	*	*	*	*	*	1.5094	48	1.70	1.3336
STD. Dev.	15.89	2.89	0.1475	13.85	2.55	0.1773	7.6071	1.47	0.0904	11.60	20.3	0.1163
95% C.I.	±3.34	±0.61	±0.031	±3.27	±0.6	±0.0418	±3.73	±0.72	±0.0443	±2.59	±0.45	±0.0259
No. of Fish		88			70			17			78	

* = Multi modal

Descriptive Statistics for Largemouth Bass ≥100 mm Total Length

Statistic	Lake Derby Length	Lake Derby Weight	Lake Derby K Factor	Lake Ladora Length	Lake Ladora Weight	Lake Ladora K Factor	Lake Mary Length	Lake Mary Weight	Lake Mary K Factor	Lake McKay Length	Lake McKay Weight	Lake McKay K Factor
Minimum	100	12.6	0.9317	109	14.7	0.9143	112	20	0.7368	100	10	1.0000
Maximum	495	2600	2.3421	484	2200	1.9404	355	618	1.4457	568	3550	1.9372
Range	395	2587.40	1.4104	375	2185.3	1.0261	243	598	0.7089	468	3540	0.9372
Mean	207.98	452.38	1.4455	277.38	528.58	1.4008	234.70	156.02	1.1403	240.45	282.99	1.3361
Median	130	28	1.3706	277	283	1.3740	237.50	148	1.1362	262	230	1.3425
Mode	105	20	1.5549	136	*	1.1926	*	*	*	274	20	*
STD. Dev.	138.71	786.53	0.3220	118.93	582.85	0.2206	31.61	81.91	0.1541	86.75	470.18	0.1614
95% C.I.	±34.53	±195.78	±0.0801	±41.86	±205.18	±0.0777	±9.45	±24.49	±0.0497	±20.93	±113.43	±0.0389
No. of Fish		63			32			44			67	

* = Multi modal