Ed Snucins
Version 2

Chemical and Biological Status of Killarney Park Lakes (1995-1997)

A study of lakes in the early stages of recovery from acidification

Ed Snucins and John Gunn
Ontario Ministry of Natural Resources
Cooperative Freshwater Ecology Unit
Dept. of Biology, Laurentian University
Sudbury, Ontario P3E 2C6

DRAFT

Killarney Lakes Survey 1995-1997

Project Biologist: Ed Snucins
Cooperative Freshwater Ecology Unit
Ontario Ministry of Natural Resources
Biology Department, Laurentian University

Managing Scientist: John Gunn
Cooperative Freshwater Ecology Unit
Ontario Ministry of Natural Resources
Biology Department, Laurentian University

Laboratory Supervisor: Rod Sein
Cooperative Freshwater Ecology Unit
Ontario Ministry of Natural Resources

Survey Crews

1995	1996	1997
Marc Aubin	Matthew Binks	Lisa Benedetti
Carol Chenard	Marc Donato	Christine Brereton
Derek Cole	David Gonder	Eric Chernoff
Carolyn Devries	Lee Haslam	Kyle Hawes
Tom Dwyer	Sarah Hunt	Sara McIlraith
Martin St-Jacques	Jennifer Shaw	Scott Norris
	Michelle Thorkelson	Jennifer Shaw
		Michelle Thorkelson

Project Collaborators: Bill Keller (Cooperative Freshwater Ecology Unit)
Ontario Ministry of Northern Development & Mines
Sudbury, Ontario

Jim Carbone
Ontario Ministry of Environment
Sudbury, Ontario

Species Identification: Yves Alarie (Laurentian University)
Ron Griffiths (Aquatic Ecostudies)
Raymond Hutchinson
George Morgan (Cooperative Freshwater Ecology Unit)
Marty Rouse (Royal Ontario Museum)

Project Contributors: Ontario Ministry of Natural Resources
Ontario Ministry of Environment
Ontario Ministry of Northern Development and Mines
Ontario Parks
Falconbridge Limited
INCO Limited
Laurentian University
Canadian Wildlife Service of Environment Canada
Endangered Species Recovery Fund (World Wildlife Fund, Environment Canada)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF APPENDICES

EXECUTIVE SUMMARY

This study was designed to obtain a current inventory of water quality and biological communities for the lakes and ponds of Killarney Provincial Park. Killarney Park is a 48,000 ha wilderness area containing about 600 waterbodies (0.03 - 810 ha). This report describes the methods, summarizes the data and presents some initial interpretation from inventory work conducted during 1995 - 1997. The inventory project was supported as a partnership between university, government, industry and non-government organizations. It was designed to establish not only the current state of the Park environment, but also as a baseline for future research, monitoring, restoration and educational programs.

Killarney Park is well known as a site of significant environmental damage from acid deposition. Bedrock geology and location relative to pollution sources combined to create this situation. The park is dominated by the La Cloche Mountain Range, a geological formation composed mainly of orthoquartzite, a highly erosion-resistant bedrock that provides little buffering against acid precipitation. Killarney is located 40-60 km southwest of the large sulphide ore smelters in Sudbury, Ontario and within a continental zone of high acid deposition (> 20 kg/ha SO_4) originating from a vast array of long-range industrial sources. Not surprisingly then, the Killarney lakes were some of the first lakes in North America to be acidified by atmospheric pollutants. Most of the Killarney lakes were damaged by the late 1970's, resulting in the loss of thousands of individual populations of fish, plankton, benthic invertebrates, and amphibians.

In recent decades Killarney has again been noteworthy, but this time as a site where substantial recovery from acidification has been observed as a result of major reductions in emissions at local and long-range sources. The evidence of recovery was the principal reason for initiating a park-wide inventory of current conditions.

Water samples were obtained from 154 lakes (87.7% of lakes by surface area) in the 8 major drainage basins, with most sampling occuring in the winter of 1996 and generally a single sample used to characterize the chemistry. The lakes exhibited a broad range in pH (4.3 - 7.6; median 5.2). There was historic evidence that pH had risen by about 0.5 units for a well-studied set of 14 lake trout lakes, but overall it should be noted that a large number of lakes remain acidic (110/154 lakes with pH < 6.0) and vulnerable to acidification (61/154 lakes with tip alkalinity < 0 mg/L).

Metals mobilized from acid deposition on watershed soils (Al, Mn, Zn) were present in high concentrations in low pH lakes. The concentration of nickel (range 0-20 ug/L), a metal presumably deposited as particulates from the area smelters, showed elevations above expected background levels but was low relative to provincial water quality guidelines.

A special feature of the La Cloche Mountain lakes is their exceptional clarity. Relative to other Ontario lakes, an unusually high proportion (43/153) of Killarney's lakes have DOC < 2 mg/L. There was a strong negative correlation between DOC and Secchi depth and the depth of the late summer thermocline. Low DOC, high clarity (Secchi depth up to 30 m) lakes are

generally located on the Lorrain and Bar River Formations. High DOC, brown-coloured waters (Secchi depth as low as 1.1 m) exist primarily in lowland lakes with wetlands.

Biological surveys targeting specific groups or indicator species (rather than attempting complete coverage) were completed on 119 lakes. Some methodological testing of gear and sampling intensity to detect rare specimens was conducted, but most lakes received a rather standard assessment using a broad range of proven sampling techniques for assessing species presence (as opposed to abundance).

A total of 28 species of fish were caught during the survey. The two most common fish species were pumpkinseed and yellow perch. The ten species that were caught in at least 1/3 of the lakes and accounted for 90.6% of the total catch by number were: bluegill, brown bullhead, golden shiner, largemouth bass, northern pike, pumpkinseed, rock bass, smallmouth bass, white sucker, and yellow perch. The most acid-tolerant species, as suggested by their occurence in lakes with pH < 5.0, were bluegill, brown bullhead, brook trout, golden shiner, pumpkinseed, and yellow perch. Fish found only in lakes with pH $\geq$ 6.0 were blackchin shiner, blacknose shiner, finescale dace, johnnie darter, mimic shiner, rainbow smelt and slimy sculpin.

The number of fish species per lake ranged from 0 to 14, with a mean of 4.1 and a median of 3.0. The species richness of lakes with pH > 6.0 was similar to that of unacidified lakes in other parts of Ontario. Among the major drainage basins, the median species richness varied from 0 (Chikanishing River) to 6.5 (Howry Creek). Thirty-six percent (43/119) of the lakes did not have fish. All of the fishless lakes (pH 4.3 - 5.9) have watersheds underlain primarily by the Lorrain and Bar River Formations. The estimated number of fish populations lost from 55 of the biologically surveyed lakes (pH < 6.0, surface area > 3.4 ha) was 262.

The smallest waterbody in the province known to contain a native lake trout population (3.4 ha, Teardrop Lake) was discovered. It's lake trout population is notable for a unique gene assemblage and extremely slow growth rates. This lake is located on top of a ridge in the Bar River Formation and, unlike all other lakes situated on that bedrock type, was protected from acidification by an exposed vein of olivine diabase. The lake supports an undisturbed community of a wide variety of other native species (eg. Hyalella azteca, Stenonema femoratum, slimy sculpin) that may become the source of colonizers for nearby recovering lakes.

Natural recolonization by smallmouth bass and northern pike emmigrating from neighbouring lakes was documented in Johnnie and Freeland Lakes. Evidence was also found in other lakes of successful restoration by recent stocking. The transfer of wild adults re-established a self-sustaining smallmouth bass population in A.Y. Jackson Lake and spawning by introduced hatchery-reared lake trout was documented in three lakes. A largemouth bass population was established in Great Mountain Lake by an unauthorized introduction. In 1997 smallmouth bass were reintroduced to George Lake.

We observed 11 species of amphibians, 24 species of aquatic or fish-eating birds, 6 species of reptiles, and 5 species of aquatic mammals.

Four crayfish species were captured. Cambarus robustus and C. bartoni were found in the most acidic lakes (pH 4.3 - 7.3). Orconectes propinquus and O. virilis were restricted to lakes with more moderate pH (5.2-7.6). The most common crayfish found in the 48 streams that were surveyed were the two Cambarus species. Only three streams, all in the lowlands, contained Orconectes. Natural recolonization by immigration of Orconetes has occured in three recovering acid-damaged lakes.

Acid-sensitive species of mayflies and amphipods were generally resticted to the lowland lakes. Their absence from most high-elevation (ie. > 250 m) lakes was probably due to the acidity of those waters. The amphipod Hyalella azteca was found in 51 lakes (pH range 5.6 -7.6), including some recovering acidified lakes. The most acid-tolerant mayfly species Eurylophella temporalis and Leptophlebia were found in lakes with pH as low as 5.0. Mayflies of the family Baetidae were not found in lakes with pH < 6.2. Moderately acid-sensitive species Stenonema femoratum (pH $\geq$ 5.6) and Stenacron interpunctatum (pH $\geq$ 5.3) were found in some recovering acidified lakes, indicating that natural recolonization is taking place. Invertebrate sampling of the Chikanishing River revealed that mayflies, absent in 1981, have recolonized the lower river in response to improving water quality.

SURVEY SCHEDULE

	1995		1996			1997		
	May-Aug	Sept-Dec	Jan-Apr	May-Aug	Sept-Dec	Jan-Apr	May-Aug	Sept-Dec
Lake surveys (biological/physical)	**********			**********			**********	
Chemical survey (extensive)			****	**			**	
Annual chemical survey (8 lakes)	**			**			**	
Chikanishing River invertebrate recovery survey			******					
Mayfly survey				**			**	
CWS breeding bird survey				** **				
Leech sampling				**********				
Tadpole sampling				**********			********	
Within-lake invertebrate spatial distributions							** ****	
Crayfish visual survey							****	
Synoptic thermal survey							****	
Nordic Standard testing							**	
Lake trout genetics					**			**

SAMPLING EFFORT (number of lakes)

	1995	1996	1997
Biological/physical lake surveys	35	49	35
Chemical survey (extensive)		150	4
Chemical survey QA/QC		30	
Chemical resurvey of Blue Ridge lakes		6	
Annual chemical survey (SES)	8	8	8
Mayfly survey		75	25
Mysis survey	4	6	
Plankton sampling	14	33	30
Tadpole sampling		49	35
Lake trout genetics sampling		2	2
CWS breeding bird survey		115	
Leech sampling		49	
Within-lake invertebrate spatial distribution			2
Synoptic thermal survey			86
Nordic Standard testing			2
Crayfish visual survey			75 + 48 streams

BACKGROUND

Killarney Provincial Park is a 48,110 hectare wilderness area located about 40 km southwest of Sudbury, Ontario (Figure 1). It encompasses most of the eastern half of the 80 km long La Cloche Mountain Range and contains one of the finest scenic landscapes in Ontario. The Killarney landscape has inspired the work of generations of Canadian artists including members of the famed Group of Seven.

The La Cloche Mountain Range is an ancient geological formation unique in Ontario. Its origins are in deposits of oceanic sand that were moulded by heat and pressure to form folds of quartzite rock. The landscape is dominated by the white quartzite, creating the illusion of year-round snow cover on the ridges. Thousands of years ago this rock was quarried by the aboriginal people to make stone tools. Today the quartzite, an extremely high grade silica used by industry, is commercially extracted at an open pit mine on Badgeley Island near the town of Killarney.

Despite its beauty and economic value, the quartzite has been a liability to the many lakes that exist on the ridges and in the valleys of the La Cloche Range. Quartzite is very resistant to mineral erosion and provides little buffering against acid precipitation. Due to this characteristic of the landscape and its location near the giant metal smelter complex at Sudbury, the Killarney lakes were some of the first in North America to be acidified by atmospheric pollutants (Beamish and Harvey 1972). The low pH of the lakes was linked, by the evidence of elevated sulphate and nickel concentrations, to the atmospheric deposition of pollutants from the Sudbury metal smelters (Beamish et al. 1975; Beamish and Van Loon 1977; Neary et al. 1990), but is also greatly affected by a continent-wide distribution of air pollutants.

Paleolimnological evidence suggests that some of the lakes in Killarney Park began to acidify as early as the 1920's (Dixit et al. 1992), but it wasn't until the late 1950's that fish species extirpations were first recorded (Harvey and Lee 1980). Within a matter of decades, by the late 1970's, it was clear that acidification had affected thousands of populations of fish, plankton, benthic invertebrates, amphibians and aquatic birds. The documentation of fish losses from Killarney lakes by Beamish and Harvey (1972) was one of the key findings that alerted North Americans to the threat posed by atmospheric transport of acid-generating pollutants.

During the middle part of this century the Sudbury metal smelters were one of the world's largest sources of acid-generating pollution, emitting over 2.5 million tonnes of sulfur into the atmosphere each year. However, through a combination of legislated control programs and modernization initiatives by industry, sulphur emissions were reduced over 90% by 1994 (Bouillon 1995). In eastern Canada, SO2 emissions from all sources were reduced by 53% between the early 1980's and 1994. The combined effects of these emission reductions at local and long-range sites has led to water quality recovery in many of the acid-stressed lakes near Sudbury (Keller and Pitblado 1986; Gunn and Keller 1990). The Sudbury region, including Killarney Park, is one of the only areas in North America, indeed in the entire world, where natural chemical and biological recovery of acidified lakes is occurring on a broad scale.

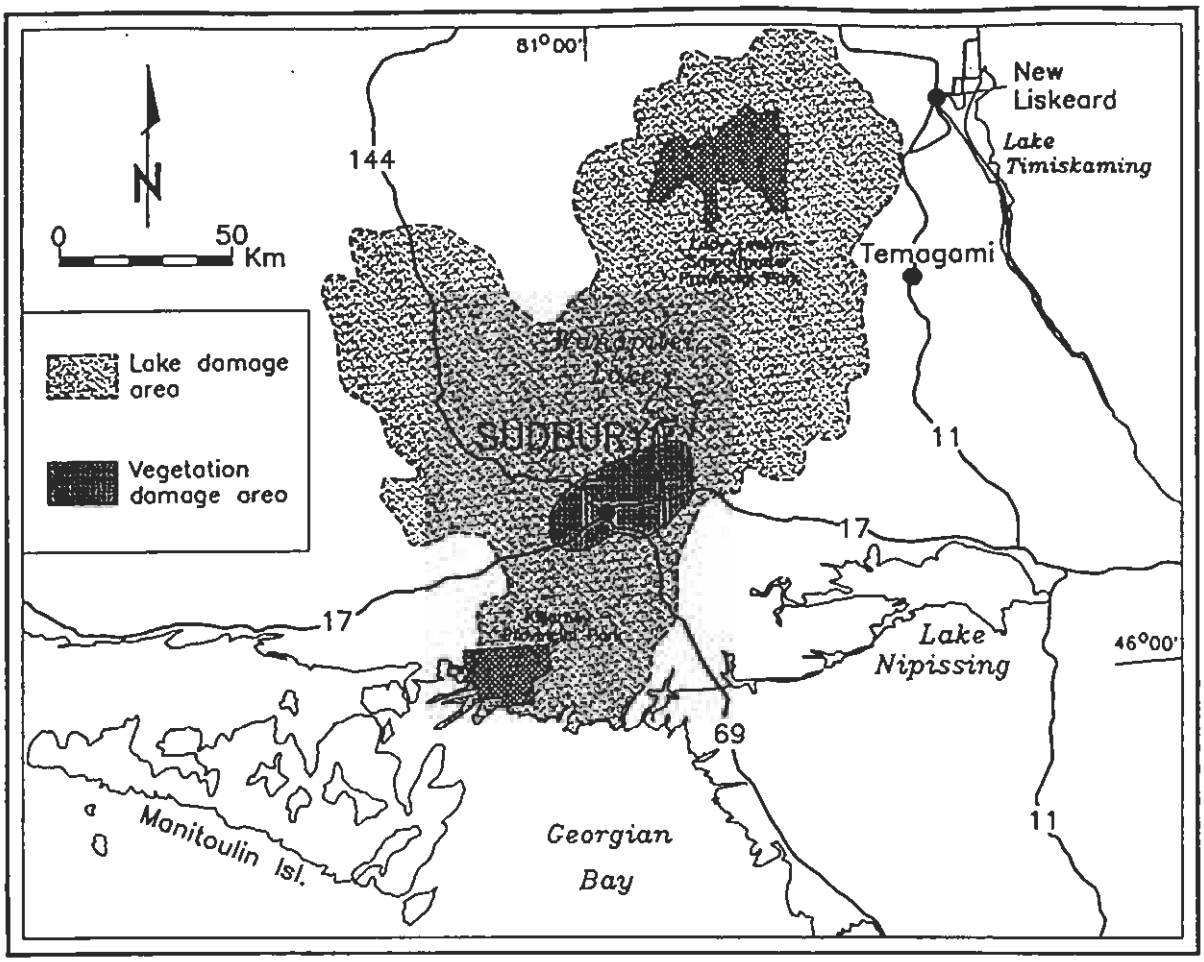


Figure 1. Location of Killarney Provincial Park in relation to Sudbury and the Sudbury sulphur deposition zone as described by Neary et al. (1990).

INTRODUCTION

A state-of-the-ecosystem study was conducted from 1995 to 1997 to obtain an up-to-date inventory of water quality and selected components of aquatic ecosystem diversity in Killarney Park lakes. These data will be used to: (1) design studies to examine the natural chemical and biological recovery of acidified lakes; and (2) plan the possible reintroduction of native species to some of the lakes. The special features of the Killarney lakes (extreme clarity, low productivity) also create the opportunity to use the survey data to serve as a baseline for monitoring the effects of global atmospheric change (eg. UV-B irradiance, climate) on aquatic ecosystems.

The focus of the project evolved slightly during the years. In the initial year the emphasis was on surveying the 94 named lakes within the boundary of Killarney Park for which most of the historical biological and chemical data existed. However, in 1996 the survey was expanded to adopt a watershed approach that required going beyond the park boundary to survey the headwater lakes and many small unnamed lakes within the Park.

The chemical survey was synoptic in nature, done only once on each lake. Some repeat sampling occured as part of an interlaboratory QA/QC study. Most of the water sampling was done during the winter of 1996 to coincide with the tri-annual monitoring of the lake trout lakes that has been done since 1980. The park's named lakes were targeted and unnamed waterbodies, generally > 1 ha surface area, were sampled only as time and funding allowed. The out-of-park headwater lakes that were later added to the study were sampled during the summer of 1996 and 1997. To address the issue of time trends we: (1) used summertime monitoring data collected annually since 1981 on a set of 8 lakes (Ontario Ministry of the Environment); (2) resampled the 6 lakes on Blue Ridge surveyed in 1973 by Beamish et al (1975); and (3) examined the wintertime pH monitoring data collected on 14 lake trout lakes in the park every three years since 1980.

Biological surveys were restricted to lakes that had been water sampled. Each lake was surveyed once, although Freeland Lake was done twice as a training exercise and two lakes were revisited to set gears not used during the first surveys. Species of interest (fish, benthic invertebrates, crayfish, zooplankton) were captured by targeting them with sampling gear or (in the case of amphibians, reptiles, birds, and mammals) by visual observation and capture in sampling gear set for other species. To deal with the problem of asynchronous sampling across lakes for species that have non-aquatic stages in their lifecycles sampling for key indicator species (ie. mayflies) was done within a short time span. In the final year there was some testing of invertebrate and fish sampling methods. Time trends in species diversity were addressed by: (1) comparing fish species lists to those of Harvey and Lee (1980); and (2) by repeating an invertebrate survey of the Chikanishing River (Curry and Powles 1991).

Funding for the project was obtained through a partnership with provincial (Natural Resources, Environment, Northern Development and Mines, Ontario Parks) and federal (Environment Canada) government agencies, industry (INCO, Falconbridge), educational institutions (Laurentian University), and non-government organizations (World Wildlife Fund).

STUDY SITE DESCRIPTION

Lithology

Detailed descriptions of the bedrock geology of Killarney Park (Figure 2) can be found in Cordiner (1974), Debicki (1982), and maps produced by the Ontario Department of Mines and Northern Affairs (Preliminary Map P.668 and P.669 Geological Series).

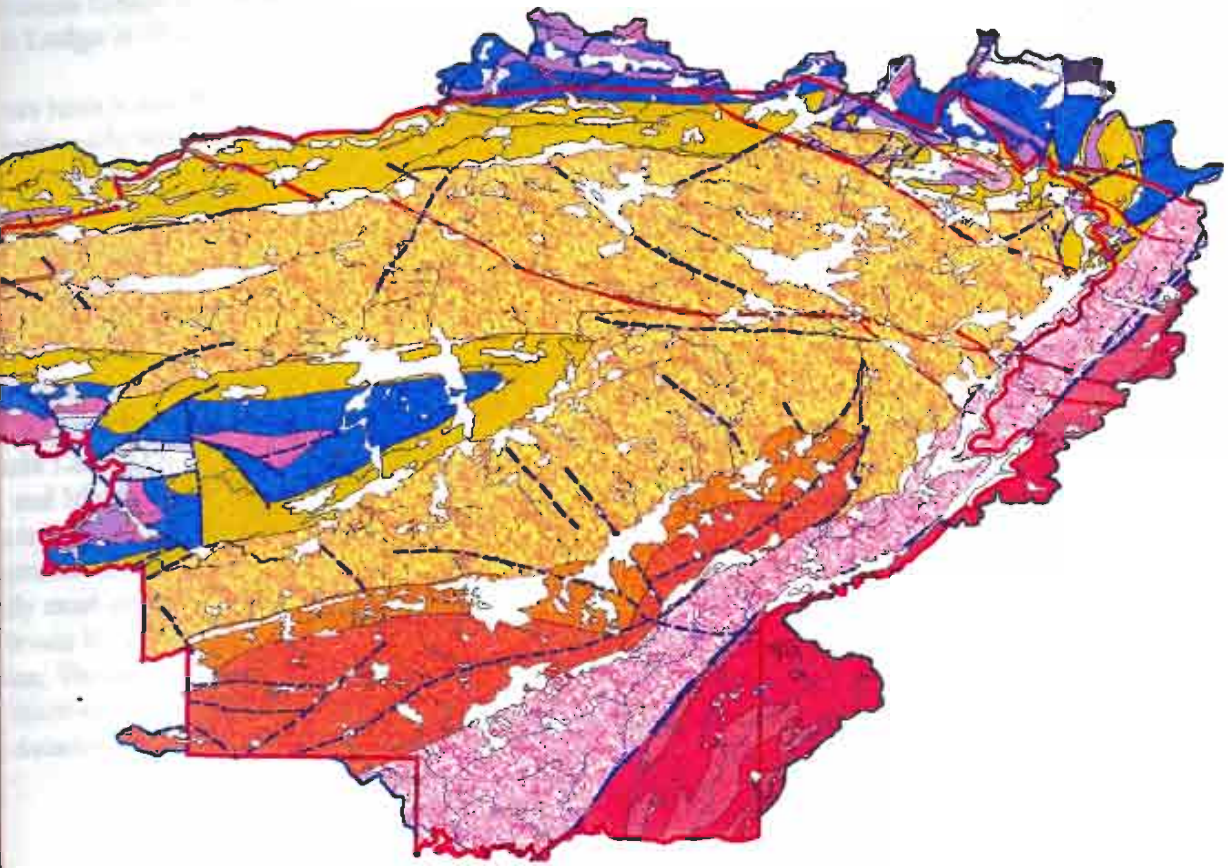
The Killarney Park watershed spans two geologic provinces on the southern fringe of the Canadian Shield. Most of the park consists of the Southern Province which is composed of sedimentary rock, primarily sandstone, that was deposited by a sea that existed 2 1/4 billion years ago. The Grenville Province, occuring as a narrow band in the southeastern part of the watershed, consists of sedimentary and igneous rock that was heated and twisted in the roots of a great mountain range. An important geologic fault called the Grenville Front crosses the southeastern portion of the park in a northeast direction. Between 1.8 and 1 billion years ago the Southern and Grenville Provinces pushed against each other along the fault. The rock of the Southern Province was pushed upwards into mountains thousands of metres in height. The eroded remains of those great mountains form the La Cloche Range. The highest point, Silver Peak (539 m), is currently only 362 m above the level of nearby Lake Huron. To the south and southeast of the mountains along the contact zone between the Grenville and Southern Provinces a large mass of granitic rock (18 in Figure 2) was intruded.

The La Cloche Mountains form an arc of high, erosion-resistant, orthoquartzite ridges (13, 15) that occupy about half (52.3%) the area of the park. Within the valleys between the mountains occur formations that are more prone to weathering. These exist in the lowlands of the McGregor Bay basin (9, 10, 11, 12, 17), in a narrow valley (14) extending from the Norway Lake area to Baie Fine, and a very narrow band between Nellie and Grace Lakes (14). To the north, northeast, and southeast of the La Cloche Mountains there are low, undulating, less erosion-resistant rocklands (8, 9, 10, 11, 12, 17, 22, 23).

Diabase and limestone, rocks with characteristically high weathering rates, exist within the watershed. A series of northwest trending diabase dykes (21) are scattered throughout the watershed, with the greatest number in the northeast portion. Diabase is a basic igneous rock with moderate levels of nutrients that often supports a rich growth of vegetation. Limestone deposits exist in the McGregor Bay basin and portions of the Howry Creek and Mahzenazing watersheds to the north and northeast of the quartzite ridges. Total area of the limestone-bearing Espanola Formation (10) within the watershed is 682.7 ha (1.2% of total watershed area).

Glaciers scratched and polished the bedrock over the entire park area, including the highest hills. Glacial erratics can be found on hilltops. Localized clay, sand and gravel deposits of glacial origin occur throughout the area, but most of the park consists of outcroppings of bedrock which are either bare or only thinly covered by soils. Where thicker soils exist, such as in the lowlands surrounding the ridges, they support a well-developed forest.

Figure 2. Lithology of Killarney Provincial Park



Precambrian

Grenville Province

23 Orthogneiss, felsic intrusions
Amphibolite

22 Paragneiss
Metaconglomerate, para-amphibolite, quartzite, layered pelitic gneiss, migmatite

Proterozoic

Southern Province

21 Late Mafic Intrusions
Diabase, olivine diabase

Intrusive Contacts

18 Grenville Front Felsic Plutonic Rocks
Quartz monzonite, quartz diorite, pegmatite

17 Nipissing Diabase
Hornblende metagabbro, gabbro, diabase

Huronian Supergroup

Cobalt Group

15 Bar River Formation
Orthoquartzite, ferruginous argillite

14 Gordon Lake Formation
Argillite, siltstone, sandstone

13 Lorrain Formation
Feldspathic and kaolinitic sandstone, orthoquartzite

12 Gowganda Formation
Conglomerate, argillite, sandstone

Local Disconformities

Quirke Lake Group

11 Serpent Formation
Sandstone

10 Espanola Formation
Limestone, dolomite, calcareous siltstone, sandstone

9 Bruce Formation
Conglomerate, sandstone

Hough Lake Group

8 Mississagi Formation
Sandstone, argillite

Grenvile Front

Fault

park boundary

watershed

N

0 5Km

Waterbodies

Killarney Park encompasses an area of 48,110 ha (47,970 ha if exclude Baie Fine itself). Within the park there are 514 lakes and ponds ranging in size from 0.03 ha to 810.1 ha (median surface area 1.465 ha). The total area of these lakes is 6,890 ha (14.4% of park area). The park's watershed, subdivided into 8 major drainage basins, extends beyond the park boundary (Figure 3). The entire watershed has an area of 55,980 ha and contains 603 lakes and ponds (surface area range 0.03-810.1 ha; median surface area 1.5 ha; 226 lakes > 3 ha) with a total area of 7516 ha (13.4 % of watershed area).

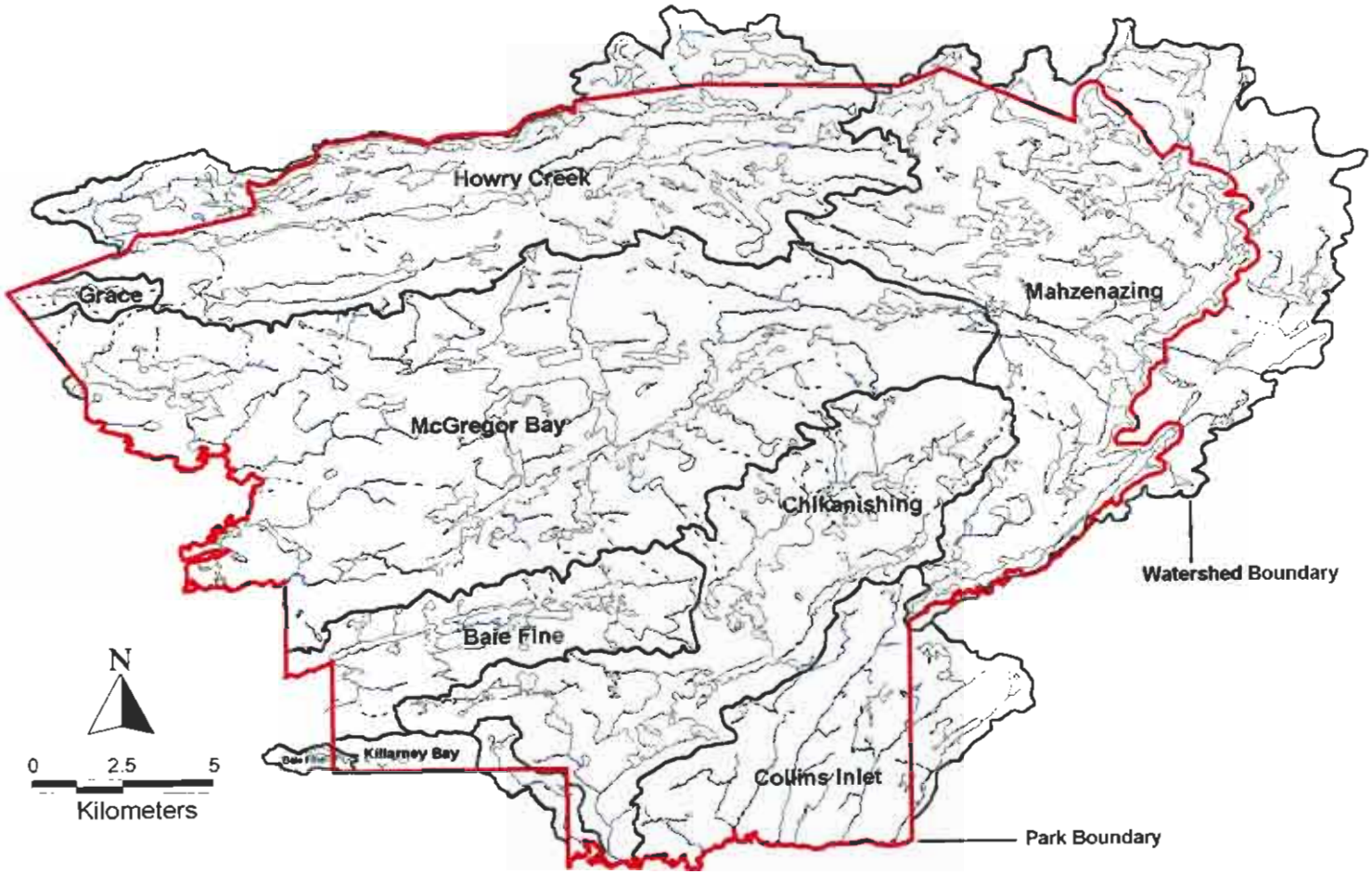
Most of the waterbodies are accessible only by aircraft, boat and portage, or by hiking trail. Some lakes, in particular those located on the ridge heights, have no established access routes and must be reached by off-trail hiking. Only four lakes (Bell, Carlyle, George, Johnnie) can be reached by road.

Most lakes have no seasonal residences (ie. cottages, lodges) within their catchments, but many have primitive campsites that are used by wilderness enthusiasts canoeing or hiking in the park. Permanent buildings exist on 12 of the lakes. Relatively dense cottage development exists on the south shores of Carlyle and Johnnie lakes. The main park campground is at George Lake. Blue Mountain Lodge is located on Bell Lake and an outpost camp belonging to Killarney Mountain Lodge is situated on Johnnie Lake.

Beavers have a significant effect on the size and location of waterbodies throughout the park. They create ponds and lakes and raise water levels by constructing dams on streams and lake outlets. Impoundments created in this manner can and do frequently disappear when beavers abandon an area. For example, Otter Lake, a beaver impoundment, is shown on topographical maps as a lake but now exists only as a stream and meadow. Likewise, the waterline on the shore of Lumsden Lake is about 1 m above the current lake level showing the effect of recent movements by beavers.

A small number of human constructed dams also exist within the park. Dams were built in the park by humans for logging or to create waterways for boats. Pre-1930 maps show logging dams at Johnnie Lake, O.S.A. Lake, Balsam Lake, and on Kirk Creek, Chikanishing River, Howry Creek, and Mahzenazing River (MacDonald 1973). The Chikanishing River logging dam raised the water level of George Lake by as much as 10 feet over the present level. Under those circumstances Little Sheguiandah Lake would have been joined with George Lake. Dams that currently exist on some of the lakes (Threenarrows, Johnnie, Bell, George and Freeland) raise water levels for boating purposes. Freeland Lake is an impoundment of the Chikanishing River. Likewise, Threenarrows Lake was created by a dam on Kirk Creek that flooded a series of small lakes, marshes and streams. A decline in the water level of Threenarrows Lake, possibly related to the deterioration of the dam, has re-isolated one lake (Lake #59).

Figure 3. Major watersheds of Killarney Provincial Park



METHODS

Personnel Training

The survey was conducted by university students hired through the Environmental Youth Corps and Experience programs and the Cooperative Freshwater Ecology Unit. The students received 10 days training prior to the sampling season. Training sessions consisted of hands-on experience paddling canoes, operating motorboats, selecting sampling sites, setting fish sampling gear, sampling invertebrates, measuring dissolved oxygen and temperature profiles, mapping lake features and depth contours, and recording data. A field manual outlining survey procedures was given to each student. The first lake survey was supervised by the project biologist to ensure that practices conformed to methods outlined in the field manual. At the end of each lake survey the records and samples were inspected by the project biologist to ensure that proper techniques were being maintained.

Water Quality

During the winter of 1996 we sampled all of the named lakes in the park and as many of the unnamed waterbodies as time allowed (Appendix A). An interlaboratory QA/QC study of samples from 30 lakes was done as part of the sampling program (Appendix B). Later that year the headwater lakes to the north and east of the park were added to the biodiversity survey and on August 27, 1996 water samples were obtained from those lakes. The same day (August 27, 1996) we also sampled 6 lakes on Blue Ridge that were first sampled on August 20, 1973 (Beamish et al.1975). These lakes were considered by Beamish et al. (1975) to be sensitive monitors of atmospheric inputs because they receive water exclusively from precipitation and have small watersheds underlain by quartzite with very little soil cover. The headwater lakes at the northwest corner of the park were added to the biodiversity survey in 1997 and water samples were obtained from them on August 19, 1997 (Appendix C). Artist Lake was sampled on October 12, 1997.

Fish

Each lake was visited once during the summer (May - September) to determine species presence. An exception was Freeland Lake which was resampled as a training exercise for the 1997 field crews. If all gears were not set during the original surveys lakes were revisited to complete the sampling effort.

Sampling effort was 3 nights on lakes > 20 ha and 1 night on lakes < 20 ha (Table 1). The amount of gear fished each night was the same regardless of lake size. This design resulted in the smaller lakes being sampled more intensively relative to surface area than the larger lakes (Table 2). Gears used included gill nets, trap nets, plexiglass traps (Casselman and Harvey 1973) and baited wire-mesh Gee minnow traps (Appendix D). Most nets and traps were set to fish overnight, checked the following day and moved to a new location on the lake.

Table 1. Summary of fishing effort (number of sets). Each unit of effort represents one night of fishing. "Short" indicates daytime sets of 2-4 hours that were done to avoid killing reintroduced and native lake trout or other gamefish. The wire-mesh minnow traps were set in pairs and each unit of effort is one pair. Crayfish effort indicates the total number of traps. Lakes where species lists were supplemented by the results from recent 2-hour daytime gillnet sets done as part of a lake trout - cisco interaction study are indicated by (#).

Lake	Dates surveyed	Trapnet	Gillnet	Plexiglass	Wire-mesh	Crayfish
Acid	May 30-31 / 95	1	2	1	10	18
Amikogaming	June 6-7 / 96	2	2	2	10	18
Artist	July 2-3 / 97	0	0	2	10	18
A.Y. Jackson	May 23-24 / 95	2	0	1	10	18
Balsam	July 24-27 / 95	6	4 + 2 short	5	30	54
Beaver	July 16-17 / 95	2	2	2	10	18
Bell	July 4-7 / 95	6	2 short (#)	6	30	54
Betty	Aug 17-18 / 96	2	2	2	10	18
Billy	Jul 30-Aug 2 / 96	6	6	6	30	54
Bizhiw	July 6-7 / 96	0	1	0	3	6
Bodina	July 17-20 / 97	6	6	6	30	54
Boundary	June 4-7 / 96	6	4	6	20	54
	June 17-19 / 97	0	0	0	0	108
Bunnyrabbit	July 22-23 / 96	0	1	0	3	6
Burke	May 28-29 / 95	1	1	1	9	18
Canis	July 1-4 / 97	6	6	6	30	54
Carlyle	Jun 19-22, 26 / 95	6	10 short	3	27	54
Casson	June 4-5 / 97	0	1	0	3	6
Cat	July 2-5 / 96	6	2	6	30	54
Cave	July 1-2 / 97	2	2	2	10	18
Chain	July 25-26 / 95	0	2	2	10	18
Clearsilver	August 22-25 / 95	6	6	6	30	54
Cranberry Bog	August 16-17 / 95	0	1	1	10	18
	June 16-17 / 97	0	0	0	10	0
Crater East	July 2-3 / 96	0	1	0	3	6
Crater West	July 3-4 / 96	0	1	0	3	6
Cuckoo	August 14-15 / 96	2	2	2	10	18
David	June 8-11 / 96	6	6	6	30	54

Table 1 (cont.). Summary of fishing effort (number of sets). Each unit of effort represents one night of fishing. "Short" indicates daytime sets of 2-4 hours that were done to avoid killing reintroduced and native lake trout or other gamefish. The wire-mesh minnow traps were set in pairs and each unit of effort is one pair. Crayfish effort indicates the total number of traps. Lakes where species lists were supplemented by the results from recent 2-hour daytime gillnet sets done as part of a lake trout - cisco interaction study are indicated by (#).

Lake	Date surveyed	Trapnet	Gillnet	Plexiglass	Wire-mesh	Crayfish
Deacon	August 1-4 / 95	6	6	3	30	54
de Lamorandiere	May 29-30 / 95	1	2	1	10	18
East Howry	Aug 13-14, 15-16 / 96	4	4	4	20	36
Fish	June 18-21 / 96	6	4	6	30	54
Fox	Aug 1-4 / 95	6	6	3	30	54
Frank	Aug 17-18 / 95	1	2	1	9	18
Freeland	June 12-15 / 95	6	4	2	24	54
	May 9-12 / 97	6	6	6	30	54
Gail	June 7-8 / 96	2	2	2	20	18
Gem	June 21-24 / 96	6	4	6	30	54
George	June 12-15 / 95	6	0 (#)	4	30	54
Goose	June 20-21 / 96	0	0	1	5	6
	May 23-24 / 97	0	1	0	0	0
Goschen	Aug 12-13 / 97	0	1	0	3	6
Grace	Aug 1-4 / 97	6	6	6	30	54
Great Mountain	June 8-11 / 96	6	6	6	30	54
Grey	Jul 30 -Aug1 / 96	6	6	6	30	54
Grow	June 18-19 / 96	2	2	2	10	18
Hanwood	July 18-21 / 96	6	6	3	30	54
Harry	Aug 18-21 / 95	6	6	3	27	54
Heaven	July 18-19 / 96	0	1	0	3	6
Helen	July 10-13 / 95	6	2 + 4 short	6	30	54
	June 21-22 / 97	0	0	0	0	54
Hemlock	July 23-24 / 96	0	1	0	2	6
Howry	June 17-20 / 96	6	6	6	30	54
Ishmael	July 4-7 / 95	6	4 + 2 short	6	30	54
	June 22-23 / 97	0	0	0	0	54

Table 1 (cont.). Summary of fishing effort (number of sets). Each unit of effort represents one night of fishing. "Short" indicates daytime sets of 2-4 hours that were done to avoid killing reintroduced and native lake trout or other gamefish. The wire-mesh minnow traps were set in pairs and each unit of effort is one pair. Crayfish effort indicates the total number of traps. Lakes where species lists were supplemented by the results from recent 2-hour daytime gillnet sets done as part of a lake trout - cisco interaction study are indicated by (#).

Lake	Dates surveyed	Trapnet	Gillnet	Plexiglass	Wire-mesh	Crayfish
Johnnie	July 10-13 / 95	6	6 short (#)	6	30	54
Kakakise	Jun 19-22, 27 / 95	6	2 + 4 short (#)	6	39	54
Kidney	June 13-14 / 96	0	1	0	3	6
Killarney	May 15-18 / 95	6	6	3	30	54
Lake of the Woods	Sept 14-15 / 96	0	1	0	3	6
Leech	June 8-10 / 97	6	6	6	30	54
Little Bell	July 24-25 / 95	0	2	2	10	18
Little Leech	June 8-9 / 97	0	1	0	3	6
Little Mink	July 8-9 / 97	2	2	2	10	18
Little Mountain	June 4-7 / 96	6	6	6	30	36
Little Sheguiandah	May 23-24 / 95	2	2	1	10	42
Little Superior	July 15-16 / 97	0	1	0	6	6
Log Boom	June 28-29 / 95	2	2 short	1	10	18
Low	July 7-10 / 95	6	2 + 4 short	6	30	54
	June 20-21 / 97	0	0	0	0	54
Lumsden	June 1-4 / 95	6	6	6	30	54
Mink	June 3-7 / 97	6	6	6	30	54
Muriel	July 4-7 / 97	6	6	6	30	54
Murray	June 3-6 / 97	6	6	6	30	54
Nellie/Carmichael	June 17-20 / 97	6	6	6	30	54
Norway	June 8-11 / 96	6	6	6	30	54
O.S.A.	May 15-18 / 95	6	5	3	30	54
Partridge	June 4-5 / 96	2	2	2	10	18
Patten	July 8-9 / 96	2	2	2	10	18
Pearl	July 7-8 / 96	0	1	0	3	6
Peter	July 21-27 / 97	6	0 (#)	6	30	54
Pike	Aug 15-16 / 95	2	2	1	9	18

Table 1 (cont.). Summary of fishing effort (number of sets). Each unit of effort represents one night of fishing. "Short" indicates daytime sets of 2-4 hours that were done to avoid killing reintroduced and native lake trout or other gamefish. The wire-mesh minnow traps were set in pairs and each unit of effort is one pair. Crayfish effort indicates the total number of traps. Lakes where species lists were supplemented by the results from recent 2-hour daytime gillnet sets done as part of a lake trout - cisco interaction study are indicated by (#).

Lake	Dates surveyed	Trapnet	Gillnet	Plexiglass	Wire-mesh	Crayfish
Proulx	July 16-17 / 97	0	1	0	6	6
Quartzite	August 2-3 / 97	0	1	0	6	6
Rocky	June 21-26 / 96	6	6	6	30	54
Roque	May 27-28 / 95	1	1	1	10	18
Round Otter	June 21-24 / 96	6	6	6	30	54
RuthRoy	June 26-29 / 95	6	6	6	30	54
Sandy	June 5-6 / 96	2	2	2	10	18
Sealey's	Aug 8-9 / 95	1	1	1	10	18
Shingwak	July 17-18 / 97	0	1	0	6	6
Silver	July 16-17 / 96	0	1	0	3	6
Solomon	May 26-27 / 95	1	2	1	10	18
Spark	July 5-6 / 96	0	1	0	3	6
Teardrop	June 27-28 / 96	0	1 short	0	3	6
Terry	June 7-8 / 95	2	2 short	2	10	18
Threenarrows	July 19-22 / 96	6	6	6	28	54
Topaz	June 8-9 / 96	0	1	0	3	6
TriLakes North	Aug 17-18 / 96	2	2	2	9	18
TriLakes SouthEast	Aug 15-16 / 96	2	2	2	9	18
TriLakes SouthWest	Aug 14-15 / 96	2	2	2	10	18
Turbid	Aug 6-7 / 96	2	2	2	10	18
Turtleback	June 20-21 / 97	2	2	2	10	18
Van	July 22-23 / 96	2	2	1	10	18
Van Winkle	July 6-9 / 96	6	6	6	30	54
Wagon Road	May 29-30 / 95	2	0	1	10	18
	June 17-18 / 97	0	1	0	0	0
Whiskeyjack	July 25-26 / 96	0	1	0	2	6
York	July 1-4 / 96	6	6	6	30	54

Table 1 (cont.). Summary of fishing effort (number of sets). Each unit of effort represents one night of fishing. "Short" indicates daytime sets of 2-4 hours that were done to avoid killing reintroduced and native lake trout or other gamefish. The wire-mesh minnow traps were set in pairs and each unit of effort is one pair. Crayfish effort indicates the total number of traps. Lakes where species lists were supplemented by the results from recent 2-hour daytime gillnet sets done as part of a lake trout - cisco interaction study are indicated by (#).

Lake	Dates surveyed	Trapnet	Gillnet	Plexiglass	Wire-mesh	Crayfish
#6	Aug 15-16 / 97	0	1	0	3	6
#7	Aug 14-15 / 97	0	1	0	3	6
#9	Aug 17-18 / 97	0	1	0	3	6
#24	Aug 3-4 / 97	0	1	0	6	6
#25	Aug 4-5 / 97	0	0	0	6	6
#27	Aug 1-2 / 97	0	1	0	6	6
#28	July 31 - Aug 1 / 97	0	1	0	6	6
#29	July 30-31 / 97	0	1	0	6	6
#30	July 29-30 / 97	0	1	0	6	6
#37A	July 6-7 / 96	2	2	2	10	18
#45	Aug 13-14 / 97	0	1	0	3	6
#59	July 16-19 / 96	6	6	6	30	54
#64	July 19-20 / 97	0	1	0	6	6
#65	July 20-21 / 97	0	1	0	6	6
#66	July 21-22 / 97	0	1	0	6	6
#69	May 25-26 / 95	1	0	1	8	12
#74	July 15-16 / 97	2	2	2	10	18
#76	July 6-7 / 97	0	1	0	6	6

Table 2. Summary of total effort (number of hours) and hours effort per hectare lake surface area.

Lake	Area (ha)	Trapnet		Gillnet		Plexiglass		Wire-mesh	
		total hrs	hrs/ha	total hrs	hrs/ha	total hrs	hrs/ha	total hrs	hrs/ha
Acid	19.6	19.27	0.98	31.48	1.6	17.08	0.87	173.45	8.8
Amikogaming	17.8	32.57	1.82	30.23	1.69	35.92	2.01	169.03	9.44
Artist	26.0	0	0	0	0	43.85	1.69	215.63	8.29
A.Y. Jackson	6.5	38.82	5.97	0	0	16.85	2.59	210.38	32.37
Balsam	266.9	133.48	0.48	116.3	0.42	101.68	0.36	643.27	2.3
Beaver	16.2	43.2	2.67	37.53	2.32	44.63	2.75	214.1	13.22
Bell	347.4	133.2	0.37	5.42	0.02	138.13	0.39	674.83	1.89
Betty	19.1	47.62	2.49	33.17	1.74	47.53	2.49	235.23	12.32
Billy	24.1	127.32	5.28	100.37	4.16	127.6	5.29	649.02	26.93
Bizhiw	2.1	0	0	21.1	10.05	0	0	64.7	30.81
Bodina	35.2	120.90	3.43	59.60	1.69	133.22	3.78	706.12	20.06
Boundary	93.3	134.02	1.42	57.15	0.61	134.52	1.43	636.53	6.74
Bunnyrabbit	12.7	0	0	16	1.26	0	0	46.33	3.65
Burke	8.4	20.78	2.97	19.12	2.73	20.38	2.91	186.4	26.63
Canis	27.4	136.58	4.98	91.23	3.33	131.28	4.79	693.85	25.32
Carlyle	156.7	131.8	0.78	23.63	0.14	68.18	0.4	578.22	3.43
Casson	15.0	0	0	17.53	1.17	0	0	62.57	4.17
Cat	46.4	125.32	2.7	32	0.69	127.62	13.8	640.52	13.8
Cave	12.4	47.63	3.84	36.52	2.95	42.83	3.45	250.67	20.22
Chain	10.9	0	0	45.5	4.17	44.05	4.04	225.81	20.72
Clearsilver	30.9	141.47	4.58	140.15	4.54	140.71	4.55	702.99	22.75
Cranberry Bog 1995	18.5	0	0	23.68	1.28	23.85	1.29	241.78	13.07
1997		0	0	0	0	0	0	184.33	9.96
Crater East	2.2	0	0	23.08	10.49	0	0	70.23	31.92
Crater West	0.8	0	0	21.8	27.25	0	0	65.83	82.29
Cuckoo	24.6	40.08	1.62	34.75	1.4	40.18	1.62	196.42	7.92
David	406.3	130.92	0.31	68.42	0.16	129.38	0.3	645.9	1.52
Deacon	36.9	114.8	3.12	137.38	3.73	63.15	1.72	620.03	16.85
de Lamorandiere	5.9	18.13	3.07	35.42	6	18.43	3.12	186.52	31.61
East Howry	71.7	86.45	1.21	55.42	0.77	86.18	1.2	430.67	6.01
Fish	115.4	137.65	1.18	42.13	0.36	137.33	1.18	690.57	5.93

Table 2 (cont.). Summary of total effort (number of hours) and hours effort per hectare lake surface area.

Lake	Area (ha)	Trapnet		Gillnet		Plexiglass		Wire-mesh	
		total hrs.	hrs/ha	total hrs.	hrs/ha	total hrs	hrs/ha	total hrs	hrs/ha
Fox	42.3	125.22	2.96	119.17	2.82	62.05	1.47	637.38	15.07
Frank	15.6	22.18	1.42	37.03	2.37	16.53	1.06	196.97	12.63
Freeland 1995	47.7	131.48	2.76	104.92	2.2	46.8	0.98	554.55	11.63
1997		138.7	2.91	70.43	1.48	145.32	3.05	734.45	15.4
Gail	20.9	36.58	1.75	33.88	1.62	37.5	1.79	183.05	8.76
Gem	30.7	134.33	4.38	71.5	2.33	147.73	4.81	733.28	23.89
George	188.5	134.3	0.71	0	0	94.08	0.5	689.33	3.66
Goose 1996	10.1	0	0	0	0	29.48	2.92	143.08	14.17
1997		0	0	11.67	1.16	0	0	0	0
Goschen	24.1	0	0	16.85	0.7	0	0	53.78	2.23
Grace	47.2	141.12	2.99	113.75	2.41	143.43	3.04	696.6	14.76
Great Mountain	198.3	134.17	0.68	86.33	0.44	133.55	0.67	687.05	3.46
Grey	31.8	135.87	4.27	89.03	2.8	118.05	3.71	654.08	20.57
Grow	13.1	47.13	3.6	40.23	3.07	48.18	3.68	233	17.79
Hanwood	32	132.2	4.13	77.8	2.43	65.9	2.06	653.32	20.42
Harry	133.6	117.43	0.88	75.5	0.57	55.03	0.41	524.03	3.92
Heaven	1.7	0	0	22.68	13.34	0	0	68.83	40.49
Helen	82.6	128.47	1.56	46.33	0.56	129.5	1.57	655.12	7.93
Hemlock	3.3	0	0	19.42	5.88	0	0	38.83	11.77
Howry	118.1	122.58	1.04	96.18	0.81	125.17	1.06	603.47	5.11
Ishmael	72.8	138.93	1.91	90.38	1.24	135.2	1.86	676.68	9.3
Johnnie	342.3	129.65	0.38	13.02	0.04	137.18	0.4	670.75	1.96
Kakakise	112.6	130.42	1.16	51.88	0.46	127.93	1.14	868	7.71
Kidney	2.9	0	0	16.75	5.78	0	0	50.2	17.31
Killarney	326.5	121.95	0.37	89.88	0.28	56.3	0.17	594.4	1.82
Lake of the Woods	9.7	0	0	23.75	2.45	0	0	70.92	7.31
Leech	92.2	139.12	1.51	75.07	0.81	139.93	1.52	678.23	7.36
Little Bell	21.1	0	0	32.17	1.52	34.38	1.63	173.68	8.23
Little Leech	9.8	0	0	19.53	1.99	0	0	62.2	6.35
Little Mink	18.7	53.57	2.86	32.08	1.72	52.37	2.80	250.58	13.40

Table 2 (cont.). Summary of total effort (number of hours) and hours effort per hectare lake surface area.

Lake	Area (ha)	Trapnet		Gillnet		Plexiglass		Wire-mesh	
		total hrs.	hrs/ha	total hrs.	hrs/ha	total hrs	hrs/ha	total hrs	hrs/ha
Little Mountain	23.6	116.25	4.93	126.55	5.36	111.92	4.74	617.6	26.17
Little Sheguiandah	4.5	49.78	11.06	40.18	8.93	27.92	6.2	259.1	57.58
Little Superior	13.9	0	0	12.00	0.86	0	0	91.57	6.59
Log Boom	6.9	49.05	7.11	4.38	0.63	23.78	3.45	223.22	32.35
Low	33.8	129.55	3.83	44.88	1.33	127.93	3.78	637.67	18.87
Lumsden	23.8	133.2	5.6	87.25	3.67	126.78	5.33	201.53	8.47
Mink	30.5	143.70	4.71	81.88	2.68	132.62	4.35	688.65	22.58
Muriel	31.7	142.87	4.51	69.75	2.20	145.83	4.60	719.37	22.69
Murray	93.0	132.20	1.42	101.02	1.09	131.80	1.42	657.02	7.06
Nellie/Carmichael	260.5	123.58	0.47	99.43	0.38	116.25	0.45	605.45	2.32
Norway	63.3	125.42	1.98	125.37	1.98	125.33	1.98	638.65	10.09
O.S.A.	278.9	125.25	0.45	59.62	0.21	70.65	0.25	609.05	2.18
Partridge	11	28.83	2.62	35.17	3.2	34.5	3.14	162.92	14.81
Patten	11.9	56.02	4.71	43.75	3.68	57.52	4.83	267.45	22.47
Pearl	2.6	0	0	22.75	8.75	0	0	70.08	26.95
Peter	132.4	144.52	1.09	0	0	134.15	1.01	640.13	4.83
Pike	32	40.52	1.26	35.22	1.1	18.43	0.58	177.3	5.54
Proulx	12.0	0	0	15.98	1.33	0	0	135.78	11.32
Quartzite	15.7	0	0	12.82	0.82	0	0	112.68	7.18
Rocky	42.9	110.53	2.58	70.1	1.63	111.33	2.6	549.62	12.81
Roque	2.8	19.6	7	17.82	6.36	20.52	7.32	202.62	72.36
Round Otter	20.4	141.68	6.95	108.48	5.32	144.48	7.08	711.1	34.86
RuthRoy	54.5	133.35	2.45	138.25	2.54	139.68	2.56	667	12.24
Sandy	21.6	38.58	1.79	33.03	1.53	41.02	1.9	200.23	9.27
Sealey's	9.4	22.6	2.4	21.68	2.31	21.7	2.31	217.85	23.18
Shingwak	5.3	0	0	14.42	2.72	0	0	101.93	19.23
Silver	6.2	0	0	19.07	3.08	0	0	57.35	9.25
Solomon	8.3	18.07	2.18	34.91	4.21	19.95	2.4	193.78	23.3
Spark	12	0	0	23.78	1.98	0	0	71.05	5.92
Teardrop	3.4	0	0	4.42	1.3	0	0	45.18	13.29
Terry	11.5	43.97	3.82	5.85	0.51	45.08	3.92	230.3	20.03

Table 2 (cont.). Summary of total effort (number of hours) and hours effort per hectare lake surface area.

Lake	Area (ha)	Trapnet		Gillnet		Plexiglass		Wire-mesh	
		total hrs.	hrs/ha	total hrs.	hrs/ha	total hrs	hrs/ha	total hrs	hrs/ha
Threenarrows	810.1	135.23	0.17	76.15	0.09	128.85	0.16	600.15	0.74
Topaz	4.7	0	0	20.17	4.29	0	0	60.2	12.81
TriLakes N	12.8	45.78	3.58	34.95	2.73	47.6	3.72	179.9	14.05
TriLakes SE	17.5	37.42	2.15	27.97	1.6	37.63	2.15	170.58	9.75
TriLakes SW	10.4	46.42	4.46	23.98	2.31	46.38	4.46	227.68	21.89
Turbid	18.2	35	1.92	35.25	1.94	41.97	2.31	214.35	11.78
Turtleback	5.4	43.60	8.07	37.20	6.89	43.37	8.03	205.07	37.98
Van	14.7	57.75	3.93	40.02	2.72	28.6	1.95	281.45	19.15
Van Winkle	85.2	137.13	1.61	97.45	1.14	142.23	1.67	711.17	8.35
Wagon Road 1995	5.2	37.57	7.23	0	0	24.5	4.71	199.08	38.28
1997		0	0	12.85	2.47	0	0	0	0
Whiskeyjack	12.8	0	0	22.4	1.75	0	0	45	3.52
York	39.1	138.37	3.54	75.33	1.93	137.2	3.51	670.28	17.14
#6	2.4	0	0	18.42	7.68	0	0	55.55	23.15
#7	2.8	0	0	13.90	4.96	0	0	43.62	15.58
#9	1.3	0	0	0	0	0	0	61.68	47.45
#24	3.0	0	0	14.70	4.90	0	0	129.68	43.23
#25	1.2	0	0	0	0	0	0	121.05	100.88
#27	3.1	0	0	17.38	5.61	0	0	132.82	42.85
#28	2.5	0	0	12.87	5.15	0	0	124.75	49.90
#29	2.4	0	0	15.02	6.26	0	0	115.65	48.18
#30	2.5	0	0	16.00	6.40	0	0	100.97	40.39
#37A	17.6	50.88	2.89	50.58	2.87	52.53	2.98	255.75	14.53
#45	4.4	0	0	14.93	3.39	0	0	53.20	12.09
#59	48.5	139.5	2.88	103.95	2.14	144	2.97	705.78	14.55
#64	3.6	0	0	16.52	4.59	0	0	125.73	34.93
#65	2.6	0	0	17.92	6.89	0	0	127.62	49.08
#66	2.0	0	0	17.58	8.79	0	0	134.03	67.02
#69	2.2	19.26	8.75	0	0	19.17	8.71	156.88	71.31
#74	11.8	32.73	2.77	28.67	2.43	49.8	4.22	251.7	21.33
#76	8.7	0	0	14.47	1.66	0	0	109.25	12.56

Sampling effort in lakes accessed by hiking was determined by the amount of gear that could be carried by a 2-person field crew. The gear that fit into 2 backpacks consisted of an inflatable raft, one multi-panel gill net, 6 wire-mesh minnow traps, 1 crayfish trapline (6 traps), a dissolved oxygen meter, a Secchi disk, a graph recording depth sounder, a 12 volt wet-cell battery, a sweepnet, a measuring board, two lifejackets, two paddles, an anchor line, and miscellaneous equipment for sorting and preserving biological samples.

Multi-panel gill nets (15.2 m x 1.9 m panels with stretched mesh sizes of 25, 38, 51, 64, and 76 mm) were usually set in the evening and lifted the following morning. Some lakes that contain reintroduced or remnant lake trout populations were not sampled in the hypolimnion with gill nets (eg. George, Bell, Johnnie, Kakakise). Instead, we augmented our species lists by setting gill nets only in the epilimnion or by including the results from non-lethal gill net sampling that was done within the past 4 years to assess the lake trout populations in those lakes. In all other lakes gillnets were set overnight until cumulative sportfish mortality reached 10 fish. Thereafter short-duration (2-4 hour) daytime gillnet sets were used to capture species not susceptible to the other fishing gears.

Gillnets were tied to shore and extended out to deeper water, straddling the thermocline. Water depths with dissolved oxygen < 4 mg/L were avoided. In most lakes two gill nets were set each night, but in the smallest lakes with limited areas of open water only one gill net was used. The nets were alternated with respect to the mesh size set to shore. One was set with 25 mm mesh to shore, the other with 76 mm mesh to shore. If only one gill net was used, it was set with 25 mm mesh to shore.

Two 4-foot small mesh trapnets were set each night in the littoral zone, usually in water depths < 3 m. One or two plexiglass traps were set each night in water < 1m deep. Ten pairs of wire-mesh Gee minnow traps baited with dry dog kibble were set to fish overnight. At each sampling location two traps were set adjacent to each other, one at 0.5 m depth and one at 1.5 m depth. Each pair of traps was a unit of effort. On lakes with more than one night of sampling, 5 pairs of minnow traps remained at the same location each night and the other 5 pairs were moved to different locations each night.

Fish catch processing was as follows. All fish were identified to species and separated by gear type and mesh size. The first 200 fish of each species for each gear type/mesh size were measured for fork length. A representative sample of any species not readily identifiable by field staff was preserved in 70% alcohol. Species identification was done in the laboratory using the keys in Scott and Crossman (1973). Taxonomic identification was confirmed by Marty Rouse, Department of Ichthyology, Royal Ontario Museum, Toronto.

Testing of Nordic Standard

Multi-mesh gillnets (Degerman et al. 1988; Nyberg and Degerman 1988) have been adopted by Scandinavia as the standard for assessing the composition and relative abundance of fish communities. Each gillnet is 30 m long and consists of 12 mesh sizes (5, 6.25, 8, 10, 12.5, 15.5, 19.5, 24, 29, 35, 43, 55 mm), with each mesh 2.5 m long and1.5 m high. The method involves setting the nets overnight (6 pm to 8 am) during summer thermal stratification. Orientation to shore and location on lake are both random, but the effort is stratified by depth and the number of sets is based upon lake size and depth. The effectiveness of the Nordic Standard for assessing the fish species diversity of our waters was tested during late September 1997 in Low Lake (24 sets) and Helen Lake (32 sets).

Zooplankton

Lakes not included in the study by Locke et al. (1994) were sampled for zooplankton during our survey. A sampling technique similar to Locke et al (1994) was used. Vertical net hauls from 1 m above the sediments were used to collect one daytime sample at the deepest point in each lake. Sampling gear was a conical 80 micron mesh zooplankton net with a 29.5 cm diameter mouth and detachable straining bucket. Samples were preserved in 70% alcohol. A taxonomic list for the Teardrop Lake sample was produced by Norm Yan, Ontario Ministry of the Environment, Dorset. All other samples are being stored for future identification.

The same sampling gear was used for Mysis as for zooplankton. One sample was collected at each of 6 deep basin sites during the night. Collections were made in lakes with maximum depth > 15 m and pH > 5.5. The lakes sampled for Mysis were Balsam, Gem, Helen, Howry, Ishmael, Low, Teardrop, Threenarrows, Van Winkle, and York

Macroinvertebrates

Qualitative macroinvertebrate collections were made by sweepnetting nearshore areas and inspecting rocks and wood debris for 6 man-hours in each lake in 1995 and 4 man-hours in each lake in 1996 and 1997. A triangular (9 inch) #30 mesh sweep net was used. Sampling was confined to depths < 1 m. All substrate types present in a lake (eg. detritus, rock, macrophytes, mud) were sampled. Approximately equal periods of time were spent in each habitat type. Specimens were preserved in 70% alcohol. Amphipods were identified using the key in Pennak (1978). Mayflies were identified using the keys in Merritt and Cummins (1996) and Thorp and Covich (1991). The mayfly identifications were confirmed by Ron Griffiths, Aquatic Ecostudies, Dutton. Dysticids were submitted for identification to Yves Alarie (Laurentian University). Odonates identified by Kyle Hawes have been submitted to Raymond Hutchinson for confirmation.

Mayflies

Two mayfly species, Stenonema femoratum and Stenacron interpunctatum, show potential as early indicators of biological recovery (Jim Carbone pers. comm.). These species are relatively acid-sensitive, live in easily sampled shoreline habitats, and are readily identified in the field by survey crews. They commonly occur on clean, wave-swept shorelines of lakes where they cling to rocks and other objects (Edmunds et al. 1976). In May of 1996 and 1997 an effort was made to obtain samples of Stenonema femoratum and Stenacron interpunctatum from 100 lakes (75 in 1996 and 25 in 1997). The sampling was done during May to ensure that sampling occured prior to the emergence period. The field crews paddled along the shoreline of each lake and upon locating rocky substrate conducted a search by turning over the rocks. Other mayfly species encountered in this manner were also collected. The examination of rocks was done for 1/2 hour on each lake and it was assumed that Stenonema and Stenacron were absent if no specimens were found in that time.

The mayflies were preserved in 70% alcohol and later identified using the keys in Merritt and Cummins (1996) and Thorp and Covich (1991). The identifications were confirmed by Ron Griffiths, Aquatic Ecostudies, Dutton.

Chikanishing River Invertebrates

During the winter of 1995-1996 the Chikanishing River was sampled for invertebrates by repeating the sites and methods used in 1985-1986 (Curry and Powles 1991). Surber samples were obtained from three sites: C1 10 m downstream of George Lake; C2 1000 m downstream of George Lake; and C3 1800 m downstream of George Lake. Site C3 is located about 40 m downstream from the highway bridge. Three surber samples were taken at each site on December 7, January 18, February 23, and March 20. Additional sampling with sweepnets was done on December 7 to collect mayfly species not susceptible to the surbers. A sweepnet sample was also obtained upstream of the highway bridge during May 1997. Species identifications were done by Ron Griffiths. Water samples were obtained from all three sites on December 5, 1995 and February 23, 1996.

Crayfish

Crayfish sampling was a slightly modified version of the method outlined by David et al (1994). Sampling was stratified by habitat type. Every night a crayfish trapline was set in each of three habitat types (1-rocky; 2-detritus; 3-macrophyte or silt or sand). If all habitat types were not present in a lake, traplines were placed in available habitats.

Crayfish were collected with a modified wire-mesh minnow trap baited with a perforated (eight 1/4" holes) plastic film canister filled with fish-flavour canned cat food. The funnel entrance was enlarged to 5 cm to allow large crayfish to enter. A trapline consisted of 6 traps fixed to a rope at 3 m intervals. The traplines were set perpendicular to shore, but on very steeply

sloping bottoms they were set diagonal to shore. The traps were numbered consecutively (1-6) from shallow to deep. The line was tied to shore so that the first trap was in water 0.5 m deep. The depth of the trap furthest from shore was recorded.

The substrate at each site was described and recorded as approximate percentages of each substrate type visible from the surface. Thus, in lakes with low water transparency only the nearshore substrate was described. However, at most shallow sampling sites and in lakes with very clear water the substrate surrounding the deepest traps could be seen and included in the description. The percentages for macrophyte cover and submerged logs were estimated separately from substrate type.

Crayfish traps were set to fish overnight and were moved daily. The catch in each trap was counted and identified to species using the keys in Crocker and Barr (1968). A sample of 4 crayfish of each species present in a lake was preserved in 70% alcohol.

By the latter part of 1996 it had become obvious that sampling with baited traps was not an effective method of assessing crayfish species diversity. In five lakes (Carlyle, Fish, Freeland, Harry, Pike) Orconectes had been captured while sweepnetting for macrobenthos, but not in the baited traplines. In addition, we did not capture any crayfish in some lakes that had what appeared to be suitable physical habitat and good water quality (eg. Helen, Low). Therefore, in 1997 the species list was supplemented by visually searching nearshore areas for crayfish. Large rocks in the water adjacent to shore were turned over and the exposed crayfish captured by hand or in a small dipnet. On each lake or stream sampling was done at multiple locations for a total of 1/2 hour. These visual searches were done in 48 streams and 75 lakes, including many that had been surveyed in previous years. On three of the lakes (Helen, Low, Ishmael), sampling with baited traps was repeated concomittant with the visual searches. Additional traps were also set in Boundary Lake in an attempt to locate the route of colonization for Orconectes virilis.

Crayfish captured in fish sampling gear were also identified, but in only one case (Orconectes virilis captured in gillnet at 15 m depth in Low Lake) was a population discovered in this manner and not by any other sampling method (ie. baited trap, dipnetting, visual search).

Leeches

In 1996 leeches were collected using the method of Bendell and McNicol (1991). Funnel traps were made from 1.5 L glass mason jars with plastic funnels (1.1 cm diameter opening) fitted in the mouth of each jar. The jars were baited with 50 g of beef liver, filled with water, and placed on their sides in the littoral zone (depth <= 0.5 m) at 5 separate locations. In lakes with more than one night of sampling the traps were moved to different locations each night. The trapped leeches were narcotized with soda water and preserved in 70% ethanol for future identification.

Within-lake Invertebrate Spatial Distributions

Water quality in George Lake (pH 5.8) is currently adequate for Stenonema femoratum and Stenacron interpunctatum. The presence of both species was confirmed in 1995 by Jim Carbone (pers. comm.). However, neither species was captured during the 1996 mayfly survey. George Lake was subsequently revisited by Ed Snucins in the company of one of the field crew. They succeeded in collecting specimens of both species adjacent to the Little Sheguiandah Lake outlet. These results suggested that the distribution of these mayflies within the lake might be limited, possibly due to recent recolonization.

As a result of this difficulty in finding the mayflies in George Lake, we decided to determine if the distribution of benthic invertebrates within a lake affected our ability to detect their presence. During 1997 we mapped in detail the distribution of four species of acid-sensitive invertebrates, including a crayfish (Orconectes propinquus), two species of mayflies (Stenonema femoratum, Stenacron interpunctatum), and one amphipod species (Hyallela azteca) in two lakes. One was a recovering acidified lake (George Lake; 1980 pH 5.0, 1996 pH 5.8; 189 ha) and the other a circumneutral reference lake that was never acidified (Low Lake; 1996 pH 7.2; 34 ha). We also mapped the distribution of one acid-tolerant crayfish species (Cambarus robustus).

We sampled every area of shoreline that we had classified as containing suitable habitat. All coarse rocky substrate adjacent to shore (water <50-60 cm deep) was searched for crayfish and mayflies. The crayfish were caught by hand or with a small dipnet. Mayflies clinging to rocks were removed with the aid of forceps. The number of coarse substrate sampling sites was 23 in the reference lake (Low Lake) and 113 in the recovery lake (George Lake).

Amphipods we captured by sweepnetting below overhanging shoreline vegetation, in aquatic vegetation and over fine and moderately coarse nearshore substrates. Long continuous patches of habitat were sampled every 50 m for amphipods. Amphipod sampling was done at 37 sites in Low Lake and 68 sites in George Lake.

Amphibians, Reptiles, Birds, Mammals

Field crews noted any aquatic or fish-eating amphibians, reptiles, birds and mammals that were seen on or near the lakes or captured in fish sampling gear. In 1996 Don McNicol of Environment Canada conducted a waterfowl survey by helicopter. Tadpoles that were captured in the fishing gear during 1996 and 1997 were preserved in 70% ethanol for future identification.

Water Temperature, Dissolved Oxygen and Secchi Depth

At the beginning of each survey, the temperature and dissolved oxygen profiles were obtained at the deepest point in the lake using a YSI dissolved oxygen / temperature meter. A Secchi depth (disc diameter 20.5 cm) was also measured in each lake and the water colour was noted. Dissolved oxygen levels under winter ice were obtained during the 1996 water sampling program.

Dissolved oxygen and temperature profiles for 86 of the lakes were obtained during a synoptic thermal survey at the time of maximum thermal stratification from August 25-September 1, 1997. Oxygen and temperature readings were taken at 1 m intervals beginning at the surface except in lakes with maximum depth < 8 m measurements were done every 0.5 m. The thermocline was defined as a change of > 2° C per metre (Dodge et al. 1987). Profiles were obtained using YSI dissolved oxygen / temperature meters. Three meters were used, each with a different length of cable (15m, 30m, 60m). On 13 lakes readings could not be taken over the full depth range because the maximum depth of the lakes exceeded the length of cable. The accuracy of temperature readings by the meters was checked, both before and after the survey, against a standard thermometer with manufacturers calibration certificate traceable to N.B.S.. The meter readings were always within 0.5°C of the standard thermometer.

Lake mapping

If a lake had not been previously surveyed, contour and nearshore habitat maps were produced based upon a shoreline cruise and depth sounding that were done using the standard methods outlined in the Aquatic Habitat Inventory Manual (Dodge et al 1987). Lake outline maps were obtained from digital OBM maps (scale 1:20,000) supplied by the Provincial Mapping Office. Lake surface area and perimeter length were measured from digital maps using MapInfo Professional 4.1 software.

The depth contour map was digitized and the volume calculated using the area of each contour interval. If a lake had previously been surveyed we digitized the existing contour map, fitting it to the OBM lake outline maps. Maps treated in this manner have contour intervals expressed in feet. All values for lake volume and mean depth were then recalculated. The new volume values were on average within 9.2% (range 0.5 - 35.4%) of the values reported in the original lake surveys. Little Sheguiandah Lake was not included in this comparison because the original lake survey value for volume was in error. Field crews also reported that the existing contour maps (ie. available from historical lake surveys) for at least two lakes (Kakakise, O.S.A.) have significant errors. Therefore, it is likely that the volume values for those lakes are also inaccurate.

Data Management

All information collected was recorded on standard data forms. The data forms were specially designed to facilitate recording of information and accurate data entry. At the end of each lake survey all data forms and field book notes were stored in the laboratory. A summary map indicating all sampling sites was prepared for each lake by the field crews.

The data forms were cross-checked by the project biologist against field book notes and any coding errors or inconsistencies were corrected. The fish and crayfish sampling records were then entered into the FISHNET computer database. These data were stored on microcomputer diskettes with backup copies.

Hard copy computer printouts were generated, checked by the project biologist for accuracy and returned to the data entry person for revision. The original and corrected hard copies were returned to the project biologist to verify corrections.

Software used for storage, statistical analysis and mapping of water quality, lake morphometry, and species inventory data included the following: DBase IV; SPSS 6.1 for Windows; and MapInfo Professional 4.1. Paper copies of all data and maps are stored at the Cooperative Freshwater Ecology Unit.

RESULTS

Water Quality

A total of 154 lakes were water sampled (139 during winter 1996; 11 lakes in August 1996; 4 lakes in August 1997; Figure 4). Carmichael Lake, a basin of Nellie Lake, was sampled (data in Appendix A), but not included in the total number. The sampled lakes (median surface area 12.15 ha) represent 25.7% of all waterbodies by number and account for 87.7% of all lakes by surface area (Figure 5). Most of the unsampled waterbodies were small ponds under 1 ha surface area formed by beaver dams on streams. The lakes that were sampled spanned a range in elevation from 181 m to 415 m (Figure 6).

The lakes within the park exhibit a broad range in water quality (Figure 7, Table 3). Most of the 154 sampled lakes were acidic (range 4.3 - 7.6; median pH 5.2), but 43 had pH > 6.0, the threshold above which there is no noticeable effect on even the most acid-sensitive aquatic species. The highest pH's measured were 7.2 (Low Lake winter sample) and 7.6 (Casson Lake summer sample). The highest alkalinities measured were 43.3 mg/L (Lake #76) and 21.9 mg/L (Canis Lake). The lowest pH (4.3) and alkalinity (-2.5 mg/L) values were recorded for Little Superior Lake.

Low pH bogs that were presumably naturally acidic exist in the lowlands (eg. #45. #46), but most acidic lakes are associated with the orthoquartzite ridges (ie. Lorrain and Bar River Formations) (Figure 8). A notable exception is the group of acidic lakes (Billy, Turbid, Grey, Lake of the Woods) south of Bell Lake. Bedrock type cannot explain the low pH of these lakes. They rest on the Grenville Front Felsic Plutonic Rocks and two of them (Grey, Turbid) are in fact transected by acid-neutralizing diabase dykes. The most plausible explanation for the low pH is the presence of organic acids contributed by neighbouring wetlands.

For a few lakes we can reconstruct past chemical conditions using paleolimnological techniques. Sushil Dixit (Queen's University) examined sediment cores and produced the following diatom-inferred pre-industrial (ie. pre-1880) pH values for 8 lakes in the park: Acid Lake 5.64; Bell Lake 6.02; Carlyle Lake 6.21; George Lake 6.01; Johnnie Lake 6.01; Lumsden Lake 5.34; RuthRoy Lake 4.93; Terry Lake 5.64.

Most high pH (>6.0) lakes are located in the lowlands and associated with bedrock that experiences mineral weathering. The lakes with highest alkalinity (Figure 9) and calcium (Figure 10) levels are usually, but not always, adjacent to the limestone deposits of the Espanola Formation. In some cases deposits of glacial debris may be contributing acid-neutralizing minerals. Three distinct areas of high pH/alkalinity lakes exist: (1) to the north and northeast of the ridges (eg. Balsam, East Howry, Van Winkle); (2) in the lowlands of the MacGregor Bay basin (eg. York, Canis, Low); and (3) on the southern edge of the Chikanishing watershed (eg. Kakakise, Little Sheguiandah, Cranberry Bog). Most lakes remain sensitive to acidification (102/154 lakes with alkalinity < 2 mg/L).

Figure 4. Location of water sampled lakes

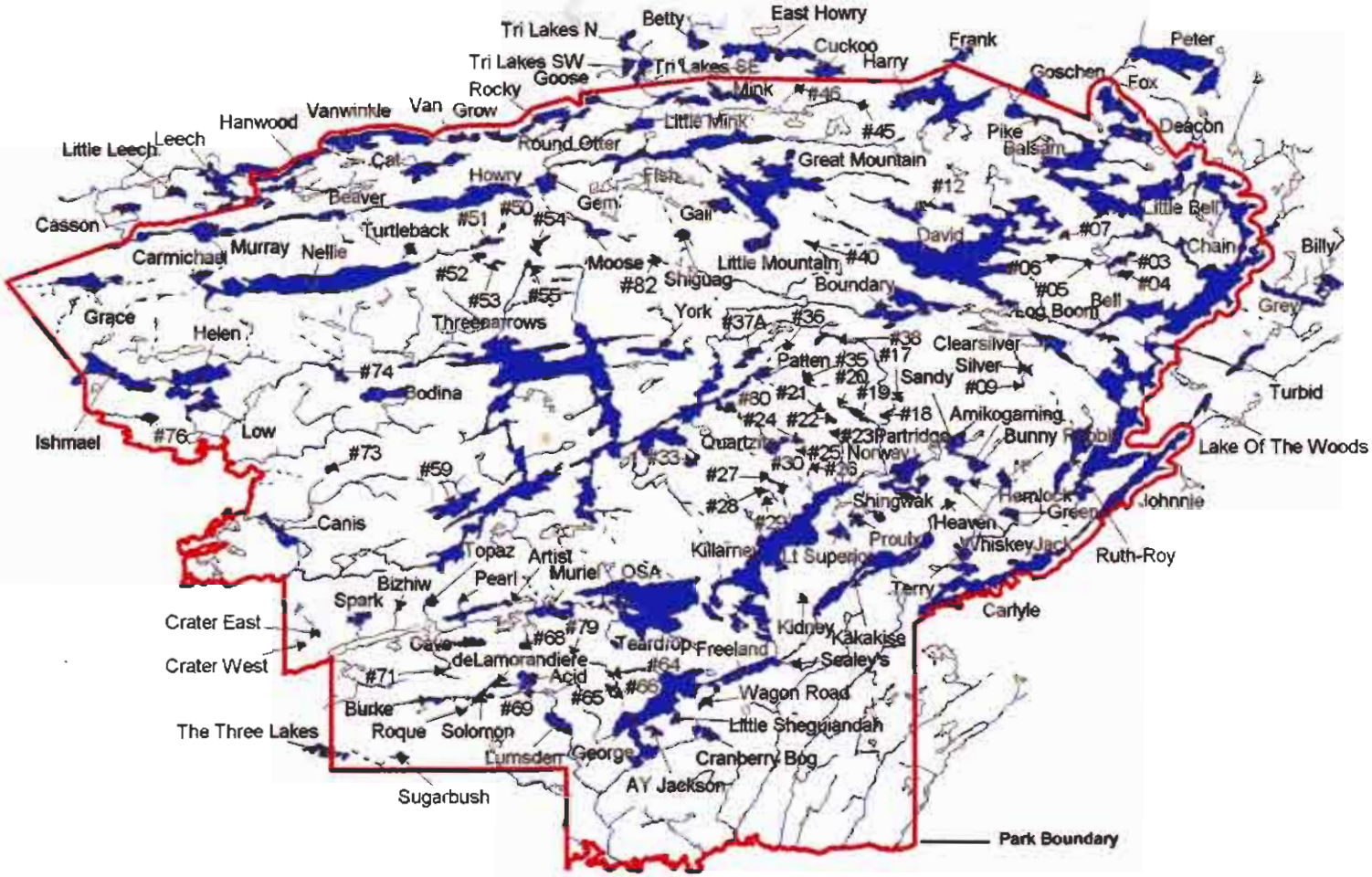


Figure 5. Frequency distribution of surface areas of water sampled lakes

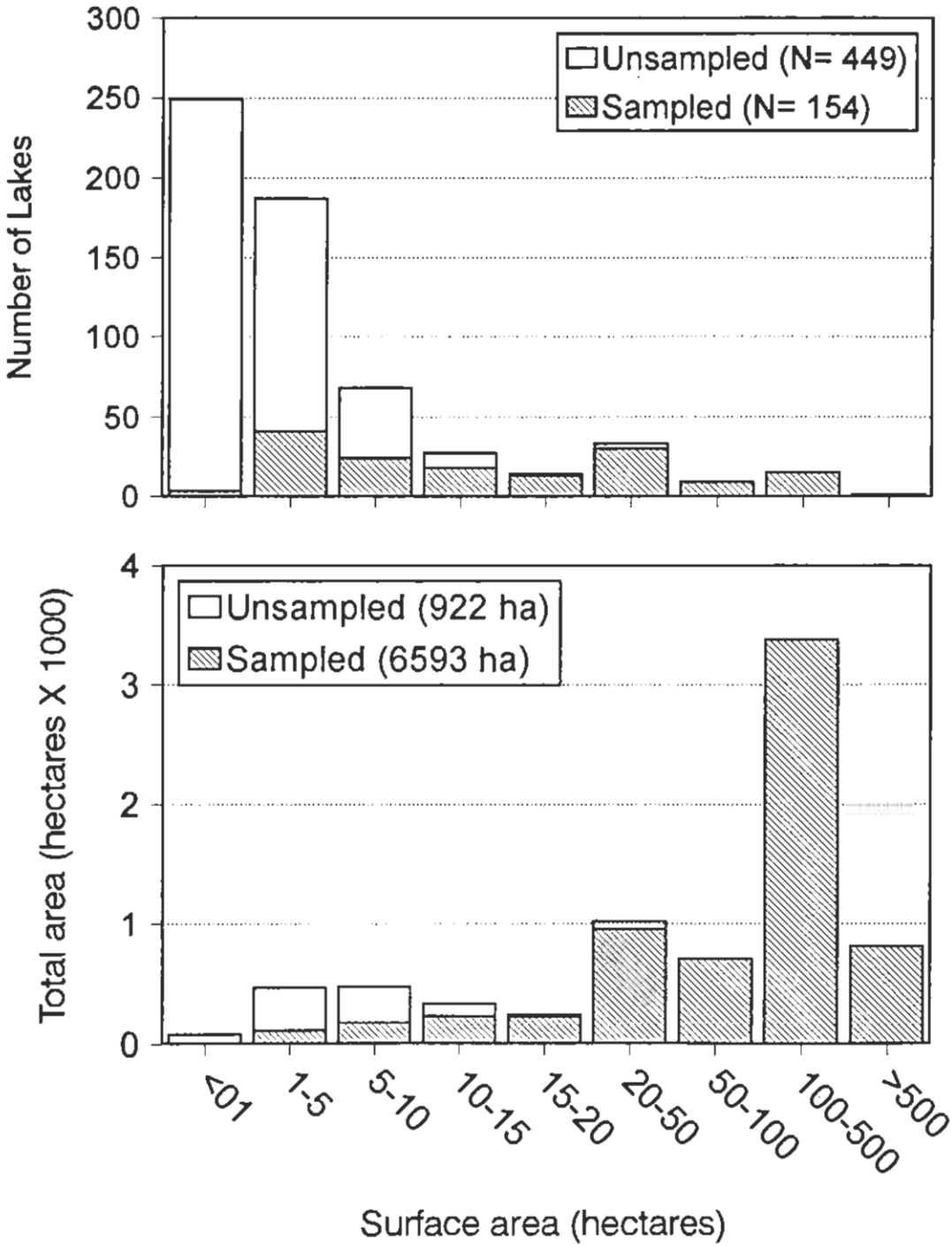


Figure 6. Frequency distribution of elevations of water sampled lakes

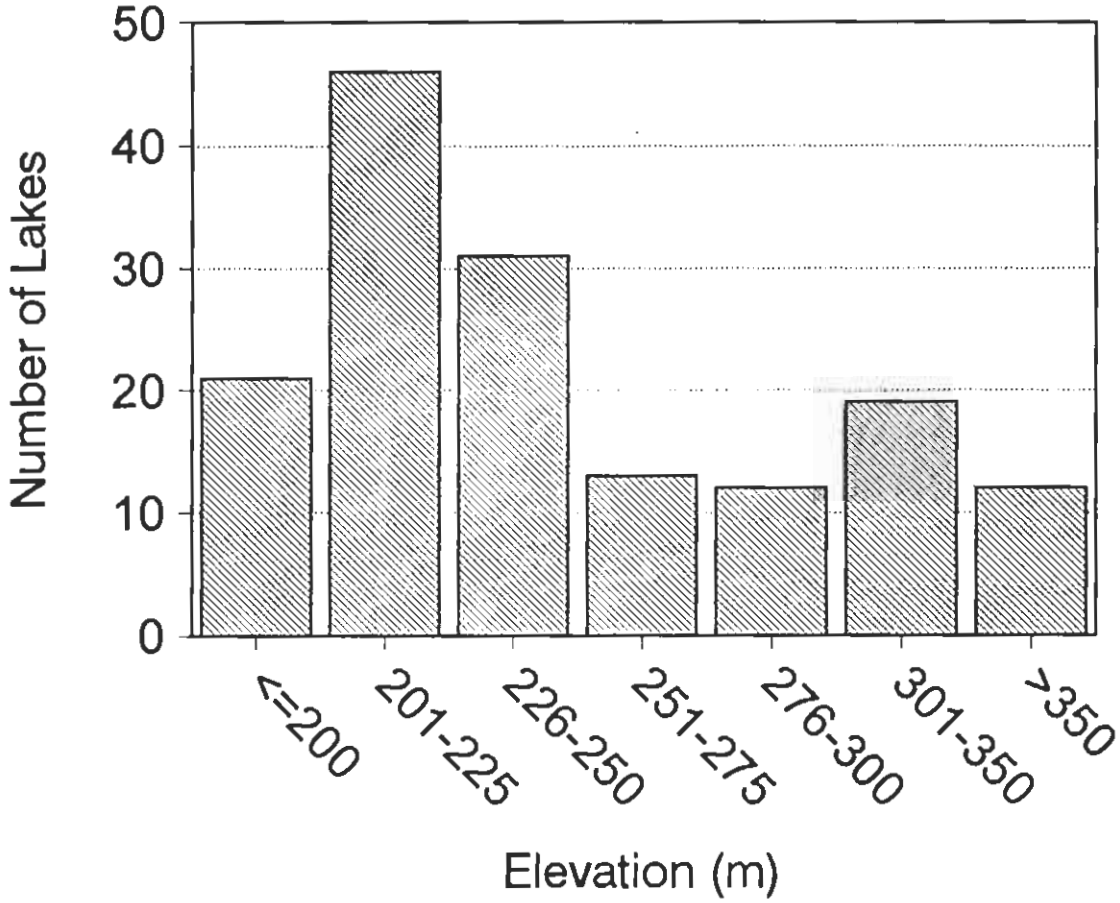


Figure 7. Frequency distributions of water chemistry variables

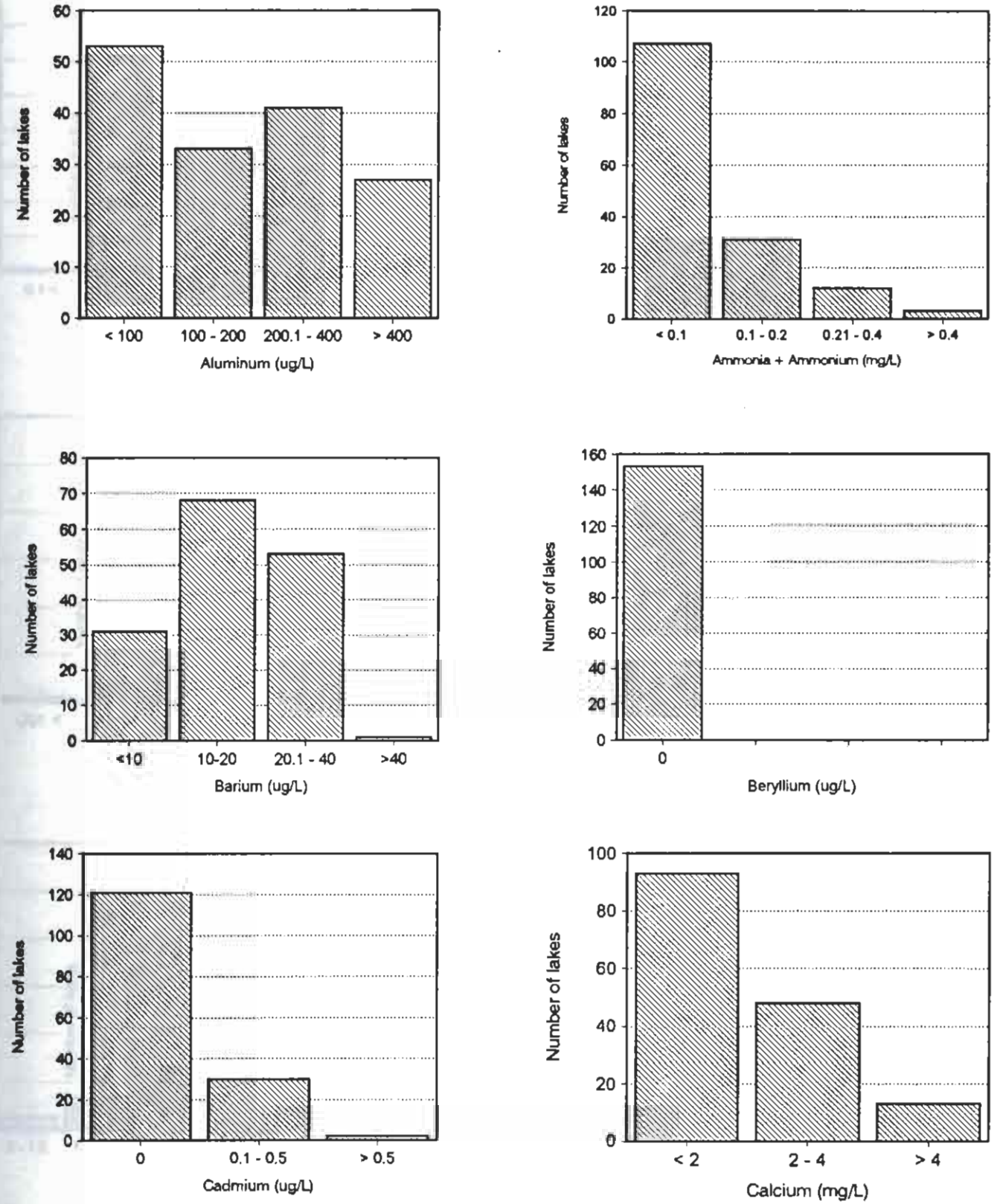
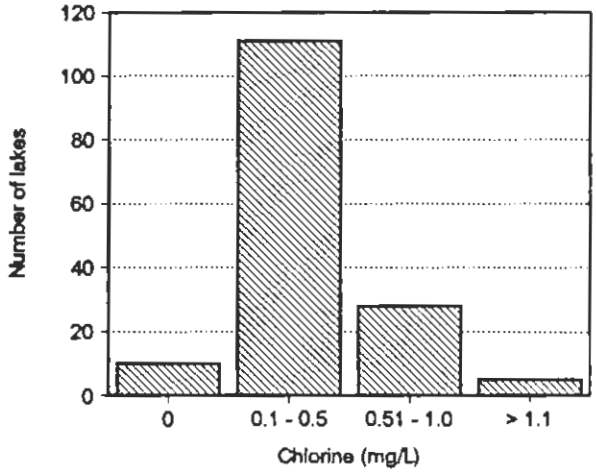
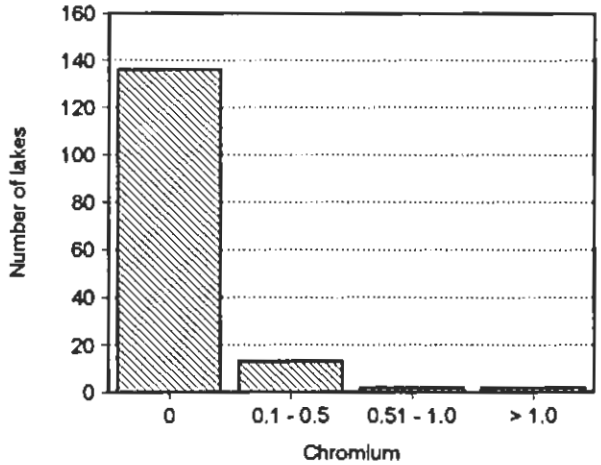
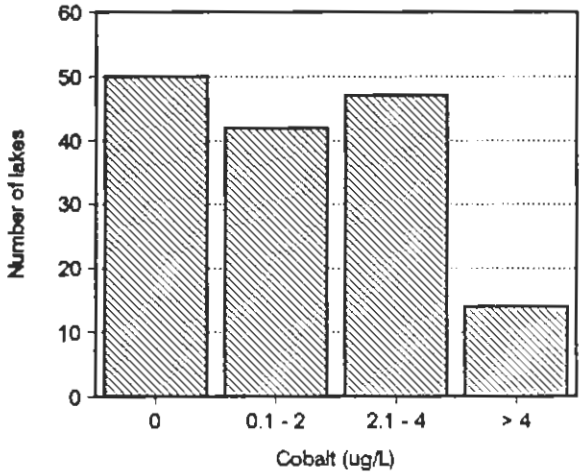
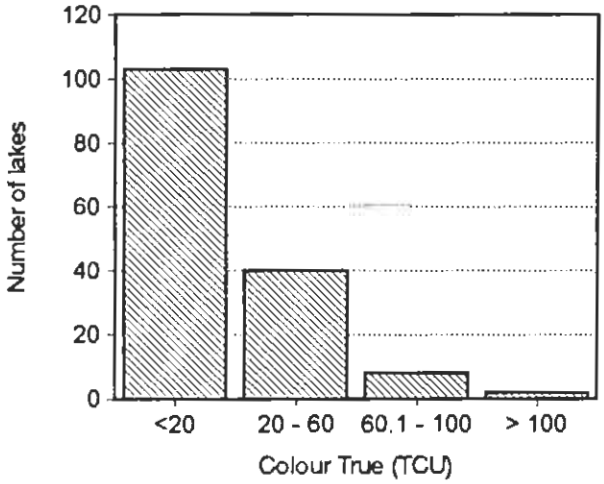


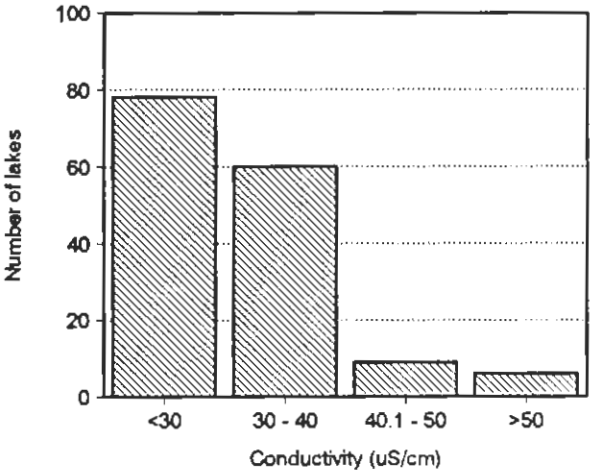
Figure 7 (cont.) Frequency distributions of water chemistry variables











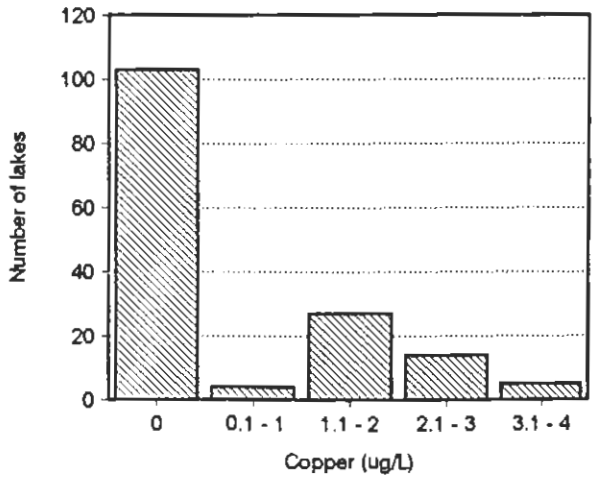


Figure 7 (cont.) Frequency distributions of water chemistry variables

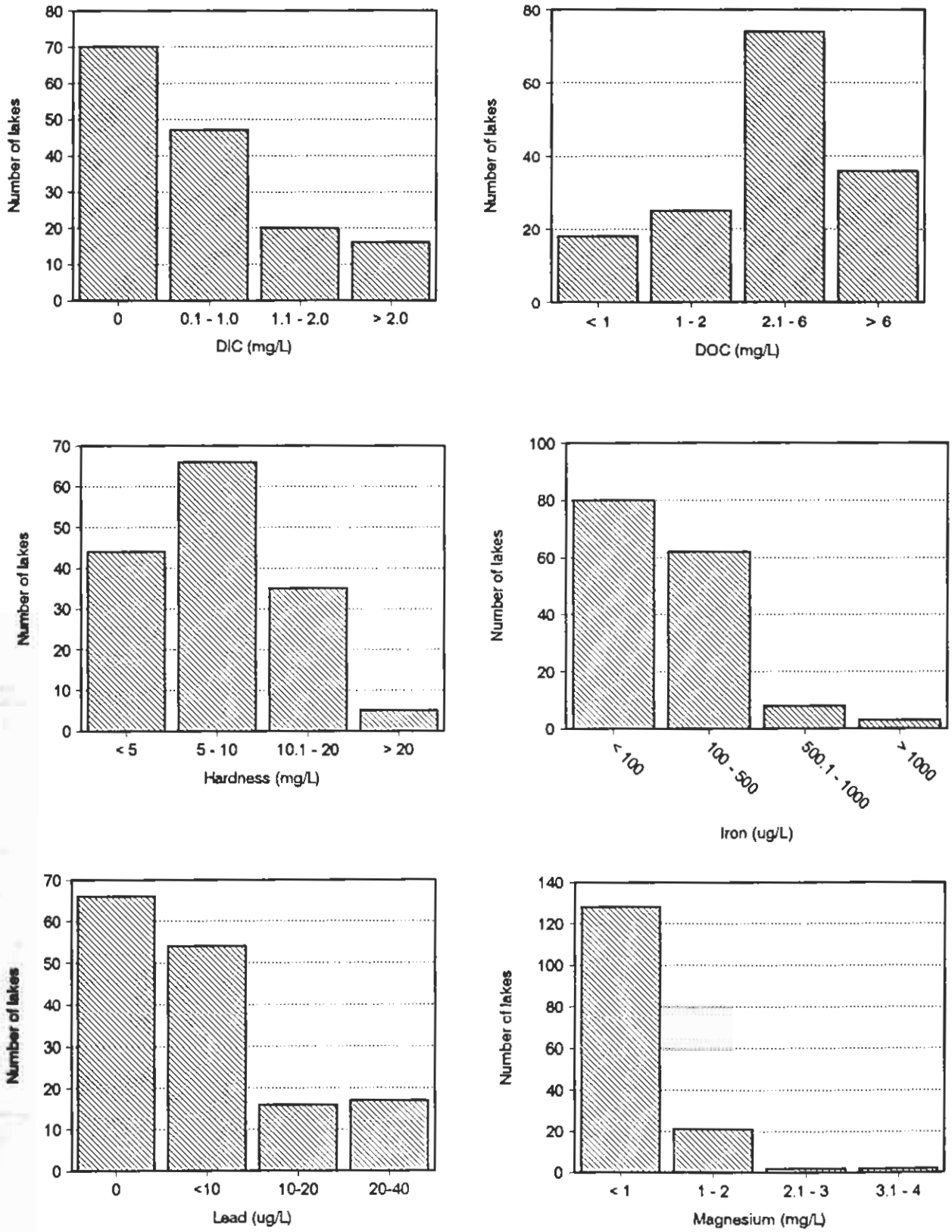
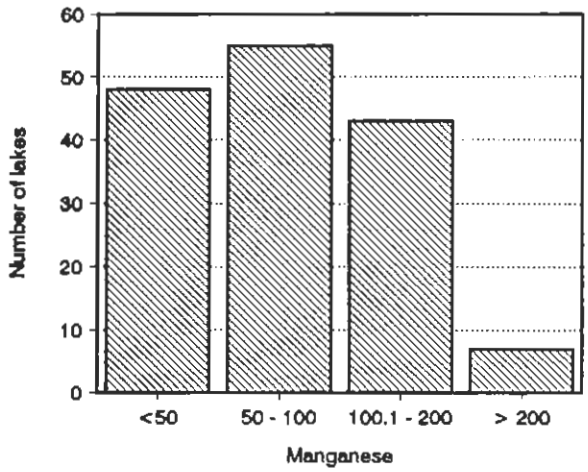
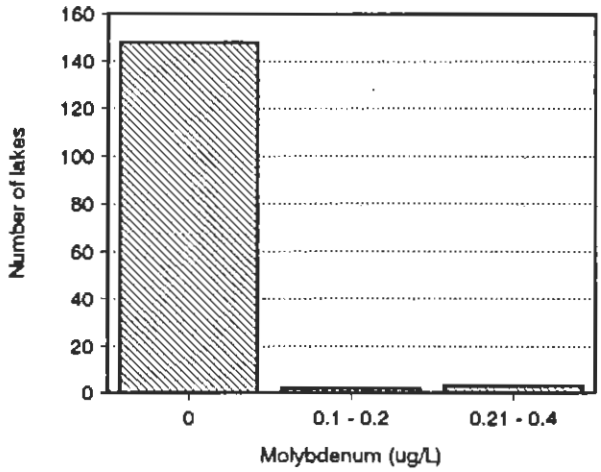
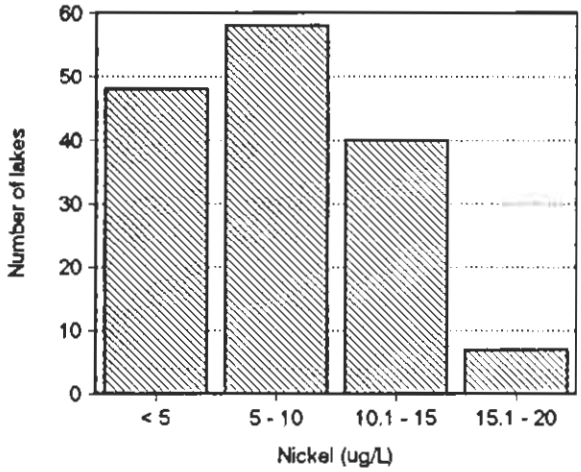
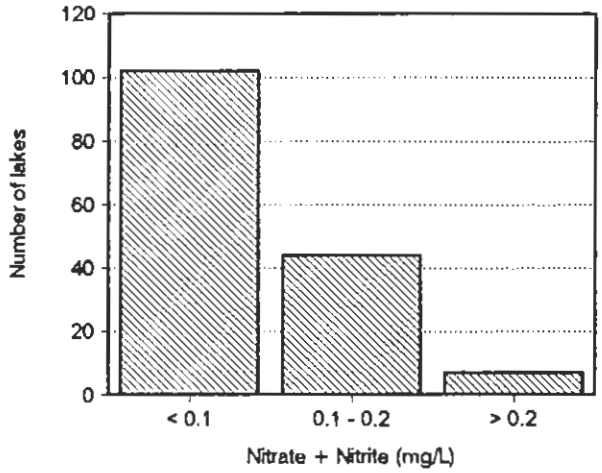


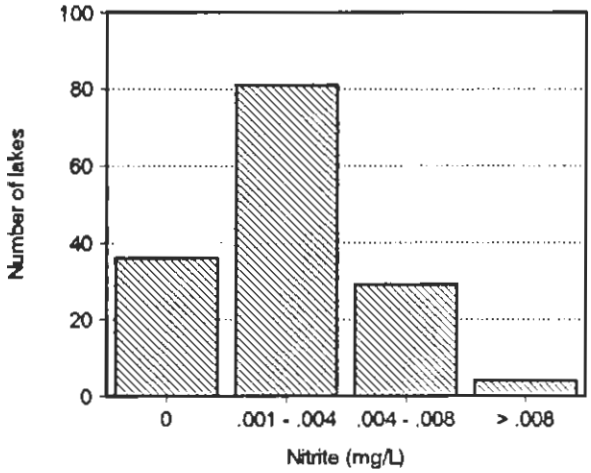
Figure 7 (cont.) Frequency distributions of water chemistry variables











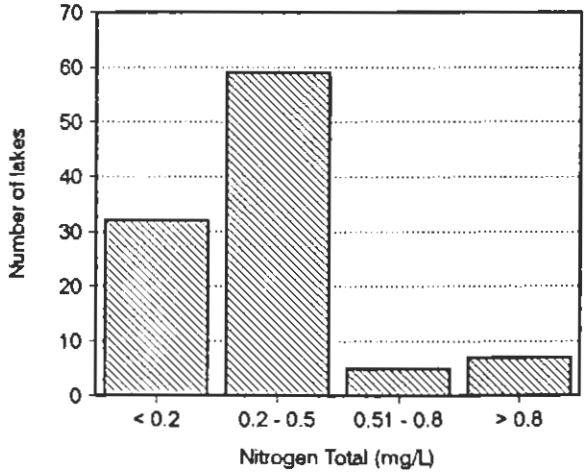


Figure 7 (cont.). Frequency distributions of water chemistry variables

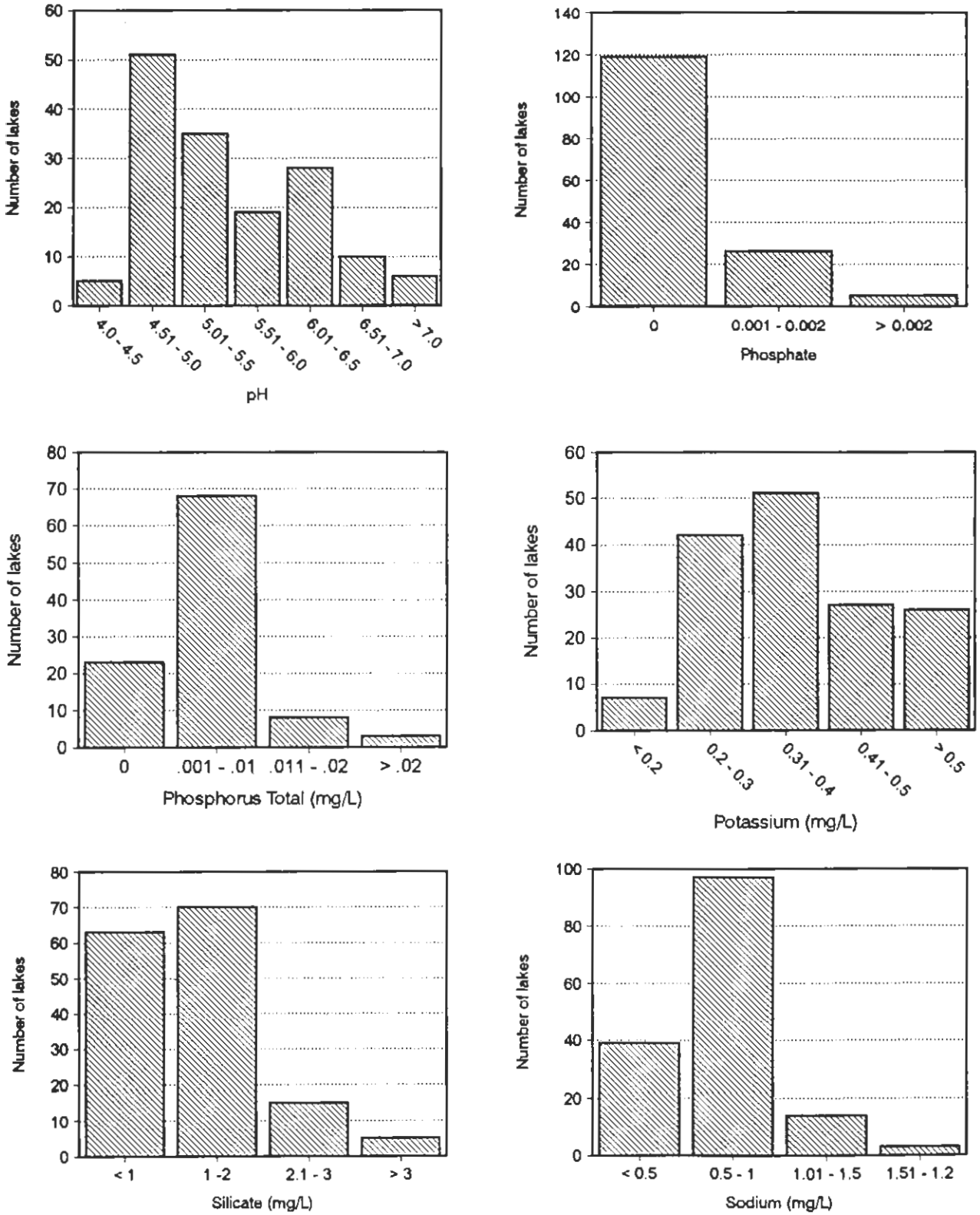


Figure 7 (cont.). Frequency distributions of water chemistry variables

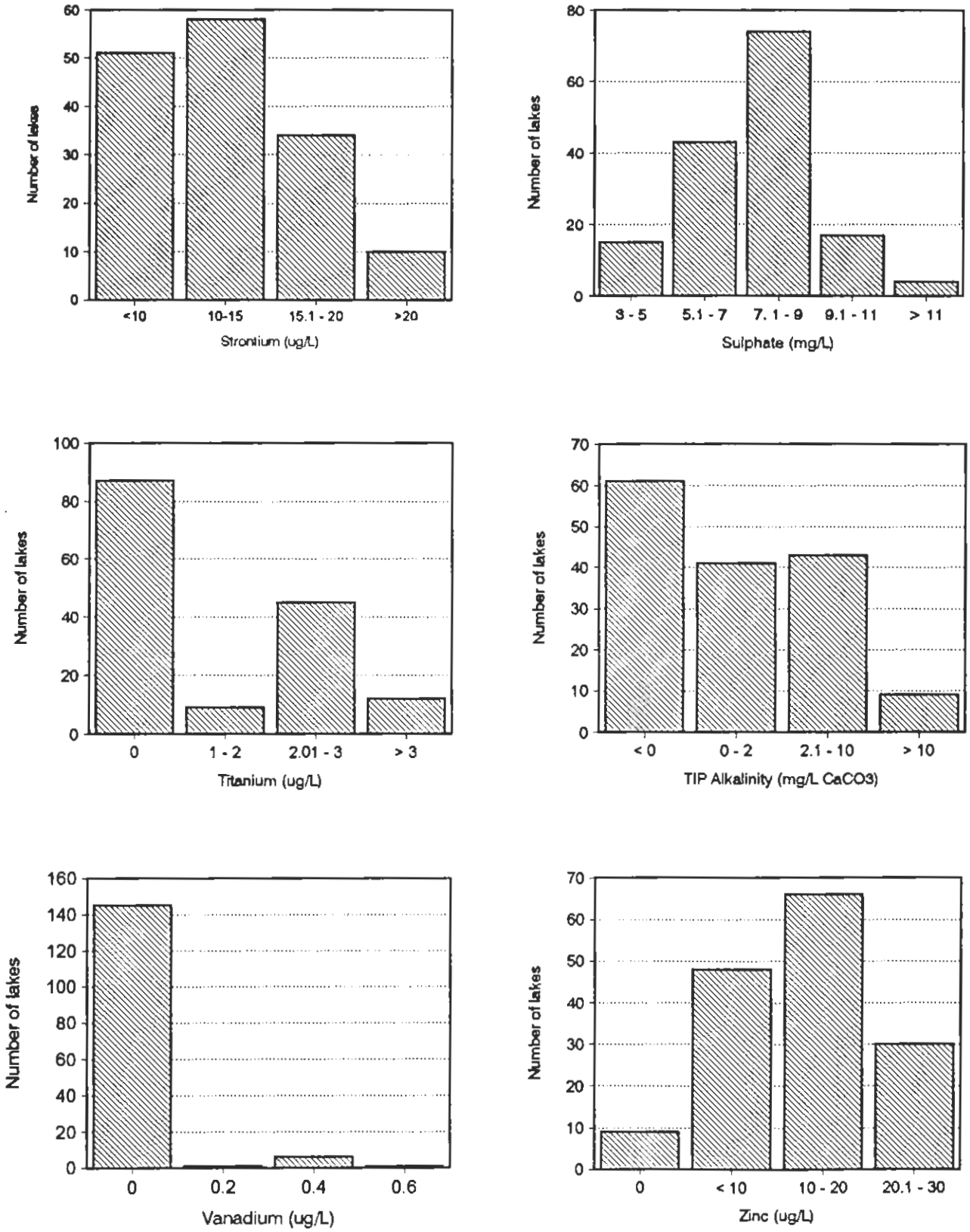


Table 3a. Median, minimum, maximum and number of values zero and <T for water chemistry variables. For explanation of "T" see Appendix A. Total number of lakes 154 (Nellie and Carmichael combined).

Variable	Median	Minimum	Maximum	# lakes with valid samples	# of lakes with zero values	# of lakes with <T code
Aluminum (ug/L)	156	0	757	153	9	15
Ammonia + ammonium (mg/L)	0.052	0	0.698	153	2	4
Barium (ug/L)	16	5	43.4	153	0	0
Beryllium (ug/L)	0	0	0	153	153	0
Cadmium (ug/L)	0	0	3.2	153	121	28
Calcium (mg/L)	1.65	0.55	14.2	153	0	0
Chlorine (mg/L)	0.4	0	1.8	153	11	134
Chromium (ug/L)	0	0	2.2	153	136	15
Cobalt (ug/L)	1.4	0	9.99	153	50	13
Colour True (TCU)	12.6	0	123	153	1	0
Conductivity (uS/cm)	29.8	17.4	108.2	153	0	0
Copper (ug/L)	0	0	4	153	103	1
DIC (mg/L)	0.4	0	10.6	153	70	39
DOC (mg/L)	3.4	0	17.8	153	0	9
Hardness (mg/L)	6.4	2.2	51.2	153	0	0
Iron (ug/L)	85.1	0	2410	153	39	20
Lead (ug/L)	1.35	0	46.4	153	66	0
Magnesium (mg/L)	0.6	1.5	61	153	0	0
Manganese (ug/L)	75	4.02	490	153	0	0
Molybdenum (ug/L)	0	0	0.4	153	148	5
Nickel (ug/L)	7.35	0	20	153	6	7
Nitrate + nitrite (mg/L)	0.08	0	0.265	153	6	14
Nitrite (mg/L)	0.003	0	0.011	153	35	81
Nitrogen Total (mg/L)	0.28	0.04	1.06	153	0	6
pH	5.166	4.32	7.566	154	0	0
Phosphate (mg/L)	0	0	0.011	150	113	30

Table 3a (cont.). Median, minimum, maximum and number of values zero and <T for water chemistry variables. For explanation of "T" see Appendix A. Total number of lakes 154 (Nellie and Carmichael combined).

Variable	Median	Minimum	Maximum	# lakes with valid samples	# of lakes with zero values	# of lakes with <T code
Phosphorus Total (mg/L)	0.006	0	0.026	102	23	61
Potassium (mg/L)	0.37	0.13	1.05	153	0	0
Silicate (mg/L)	1.16	0	3.88	153	1	2
Sodium (mg/L)	0.66	0.32	1.92	153	0	0
Strontium (ug/L)	12	4	28.8	153	0	44
Sulphate (mg/L)	7.5	3	12.5	153	0	0
Titanium (ug/L)	0	0	3.99	153	87	1
TIP alkalinity (mg/L $CaCO_3$)	0.36	-2.52	43.33	154	0	0
Vanadium (ug/L)	0	0	0.6	153	145	8
Zinc (ug/L)	12.6	0	30	153	9	4

Table 3b. Median, minimum and maximum values for size and location of water sampled lakes. Total number of lake is 154.

Variable	Median	Minimum	Maximum
Area (ha)	12.15	0.7	810.1
Minimum distance to INCO superstack in Sudbury (km)	47.5	34	62
Elevation (m)	229	181	415
Watershed area (ha)	103.1	3.6	7426
Watershed area including upstream lakes (ha)	123.95	3.6	12952.5

Figure 8. Lake pH in Killarney Provincial Park

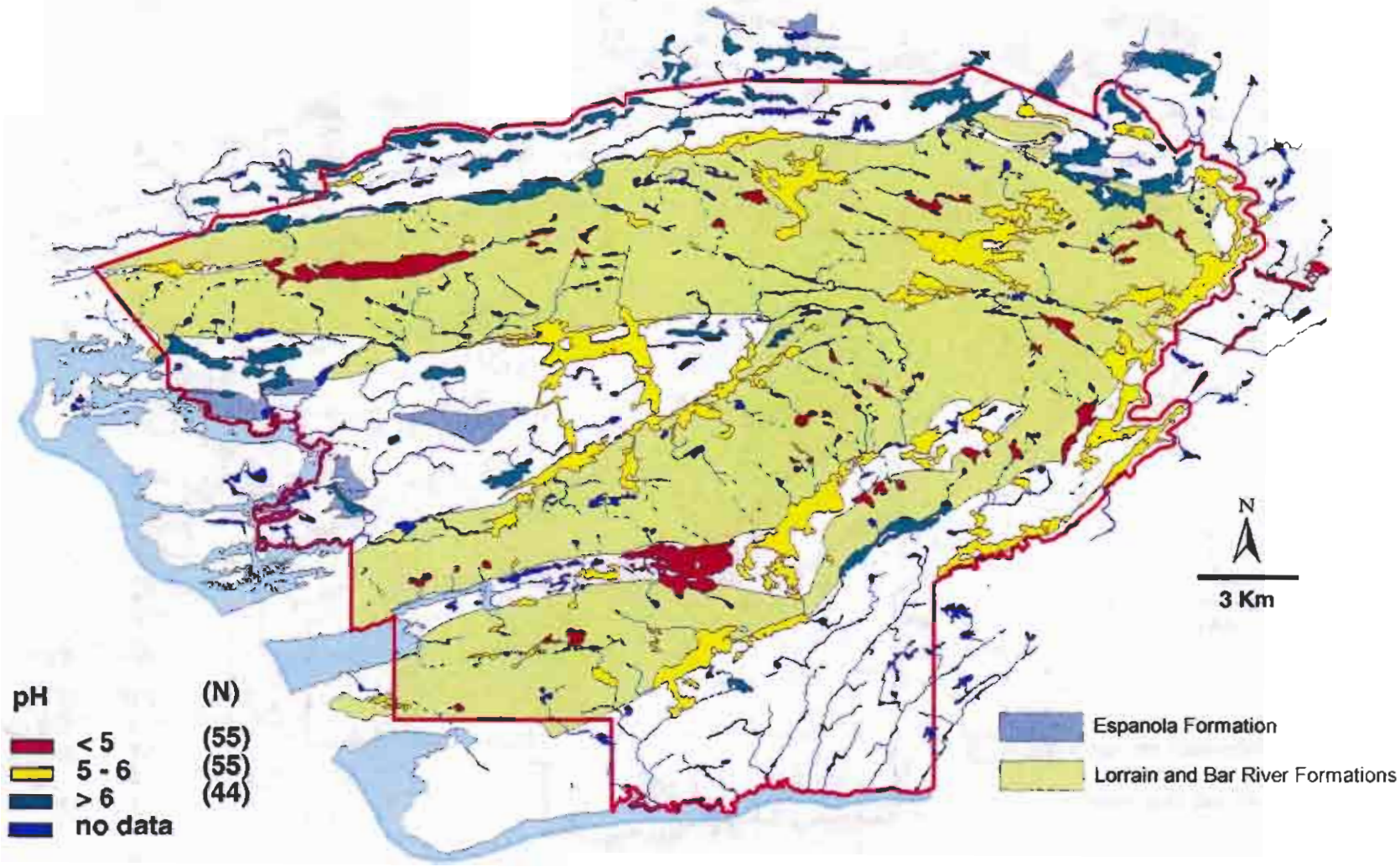


Figure 9. Alkalinity of Killarney Provincial Park lakes

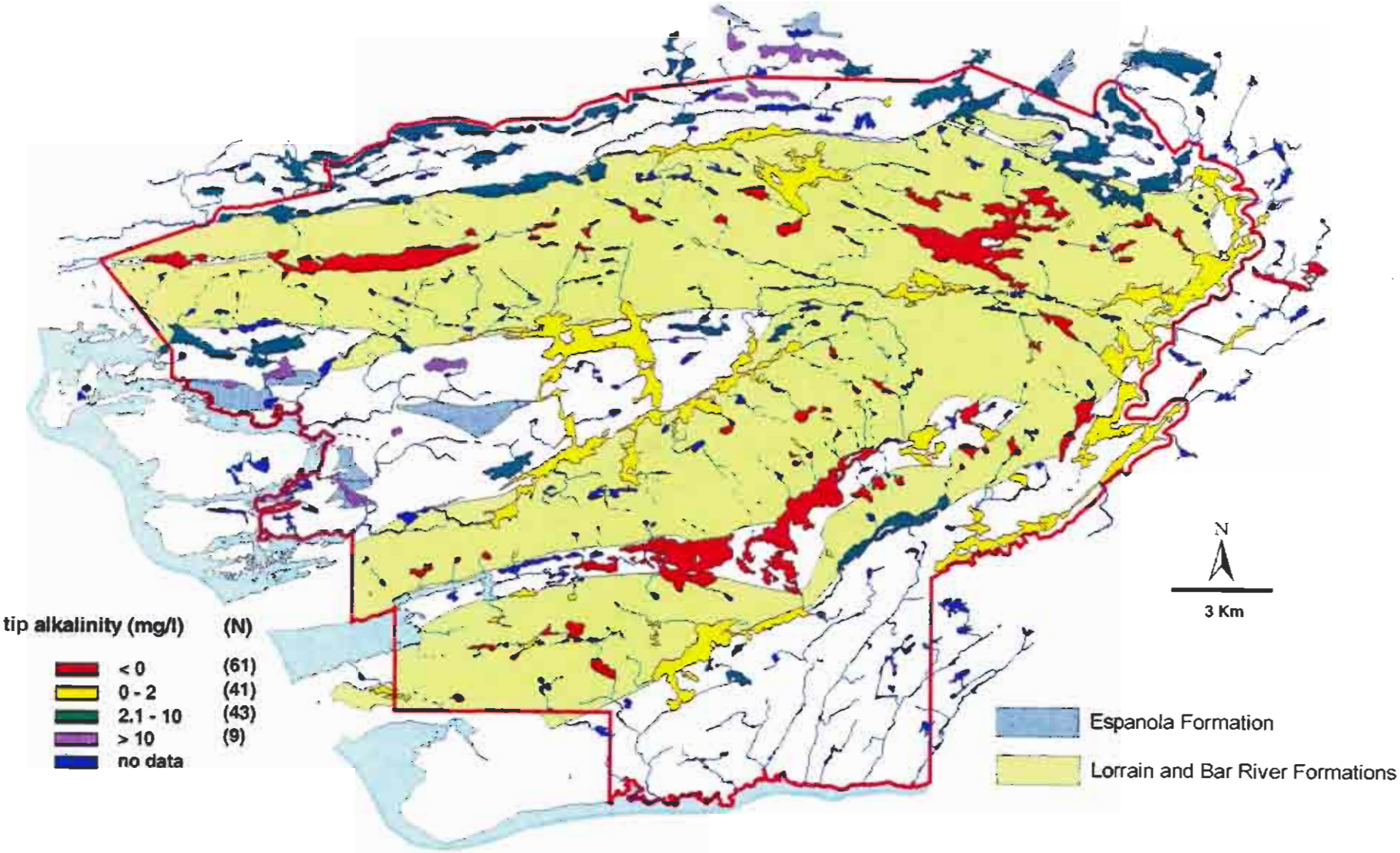
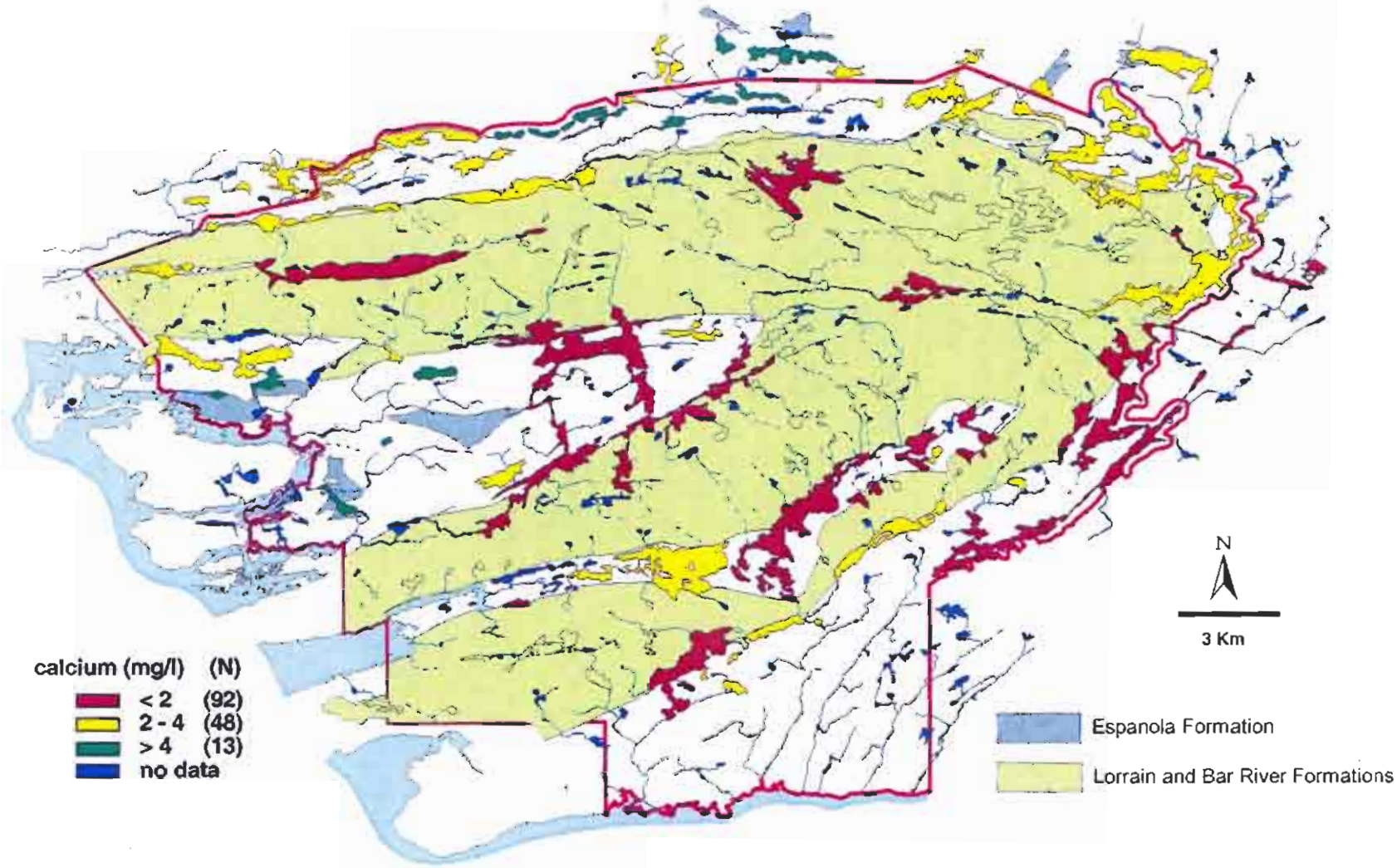


Figure 10. Calcium levels in Killarney Provincial Park lakes



The catchment of only one high pH lake (#37) exists entirely on the Lorrain Formation and only one circumneutral lake (Teardrop) was found on the high ridges of the Bar River Formation. Lake #37 is probably buffered by the mica and feldspar that occurs in the lower portion of the Lorrain Formation (Tim Jones pers. comm. citing Card et al 1977). The pH of Teardrop Lake is maintained by a vein of diabase that borders the north shore (Wilf Meyer, Ontario Geological Survey, pers. comm.). The diabase is crumbling into fragments and precipitation falling on the side of the ridge is neutralized, before it reaches the lake, as it percolates through the loose grains of material. The existence of this diabase dyke was previously undocumented.

Relative to the distribution of DOC in 2587 Ontario lakes (Neary et al 1990), an unusually high proportion of Killarney lakes have DOC levels < 2 mg/L (Figure 11). Lakes with low DOC values exhibited high Secchi disc readings (Spearman correlation coefficient -0.87, $P < 0.05$). Most of the low DOC waters are located on the orthoquartzite ridges (ie. Lorrain and Bar River Formations) (Figure 12). The clearest lakes that we surveyed (Figure 13) were Nellie Lake (Secchi 27 m), Quartzite Lake (Secchi 26 m), and Little Superior Lake (Secchi 23.9 m). A Secchi depth of 30.2 m was recorded in Nellie Lake on September 1, 1997 during the synoptic thermal survey. In 14 lakes the Secchi disc was visible at the maximum depth of the lake.

High DOC, brown-coloured waters exist primarily in lakes associated with wetlands. The highest DOC values were measured in Lake #73 (17.8 mg/L), Lake #45 (17.4 mg/L), and Canis Lake (16.5 mg/L). The lowest Secchi disc measurements were 1.1 m (Lake #45) and 1.2 m (Tri Lakes SW, Canis Lake). The creamy appearance of TriLakes SW, noticed while water sampling on August 26, 1996, suggests that the low clarity in that lake may be due at least in part to the presence of suspended particulates.

Metals that are mobilized from the watersheds by acidification (ie. Al, Mn, Zn) were present at high concentrations in the lowest pH lakes. Most of those lakes are located on the orthoquartzite ridges (Figure 14). The metals nickel and copper are presumably transported through the atmosphere from the Sudbury smelters. Nickel levels in most lakes (105/153 lakes > 5 ug/L; median 7.4 ug/L)) were higher than the average value (< 3 ug/L) recorded in lakes remote from industrial sources (Beamish et al. 1975). Nevertheless, in all of our survey lakes both nickel and copper were at concentrations below provincial water quality guidelines (MOE 1984).

The nutrient status of the lakes that were sampled can be categorized as either oligotrophic, mesotrophic or dystrophic. The vast majority of lakes were oligotrophic, with total phosphorus concentrations of zero or present only at measurable trace amounts (Figure 7, Table 3).

There is overwhelming evidence that water quality recovery is occuring in Killarney's acidified lakes. Annual summertime monitoring of water chemistry in 8 lakes since 1981 has revealed trends towards increasing pH and decreasing sulphate levels (Appendix E). Tri-annual monitoring of under-ice pH in the park's lake trout lakes also shows recovery since 1980 (Figure

Figure 11. Distribution of DOC Levels in Killarney Lakes Relative to Other Ontario Lakes

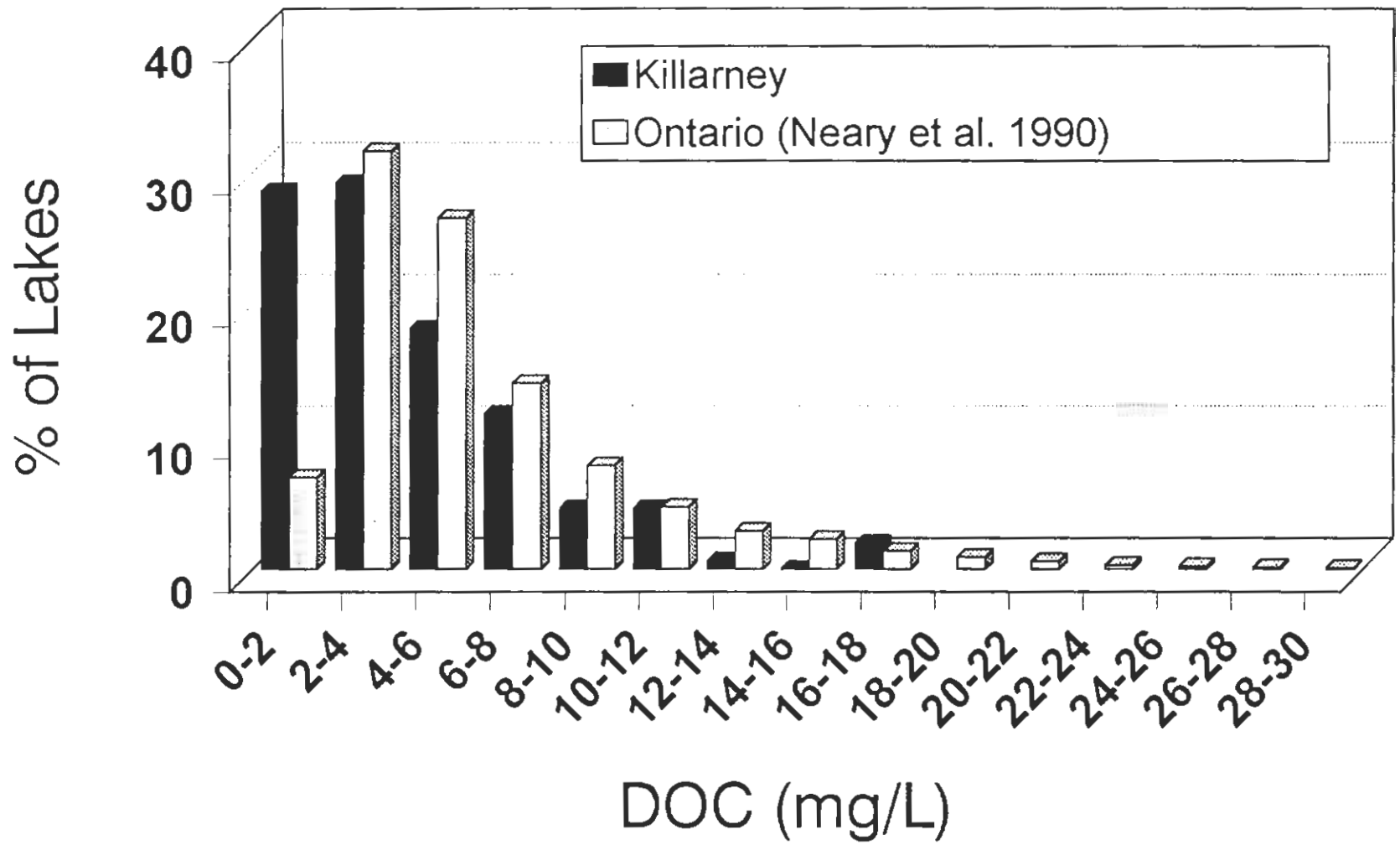


Figure 12. DOC levels in Killarney Provincial Park lakes

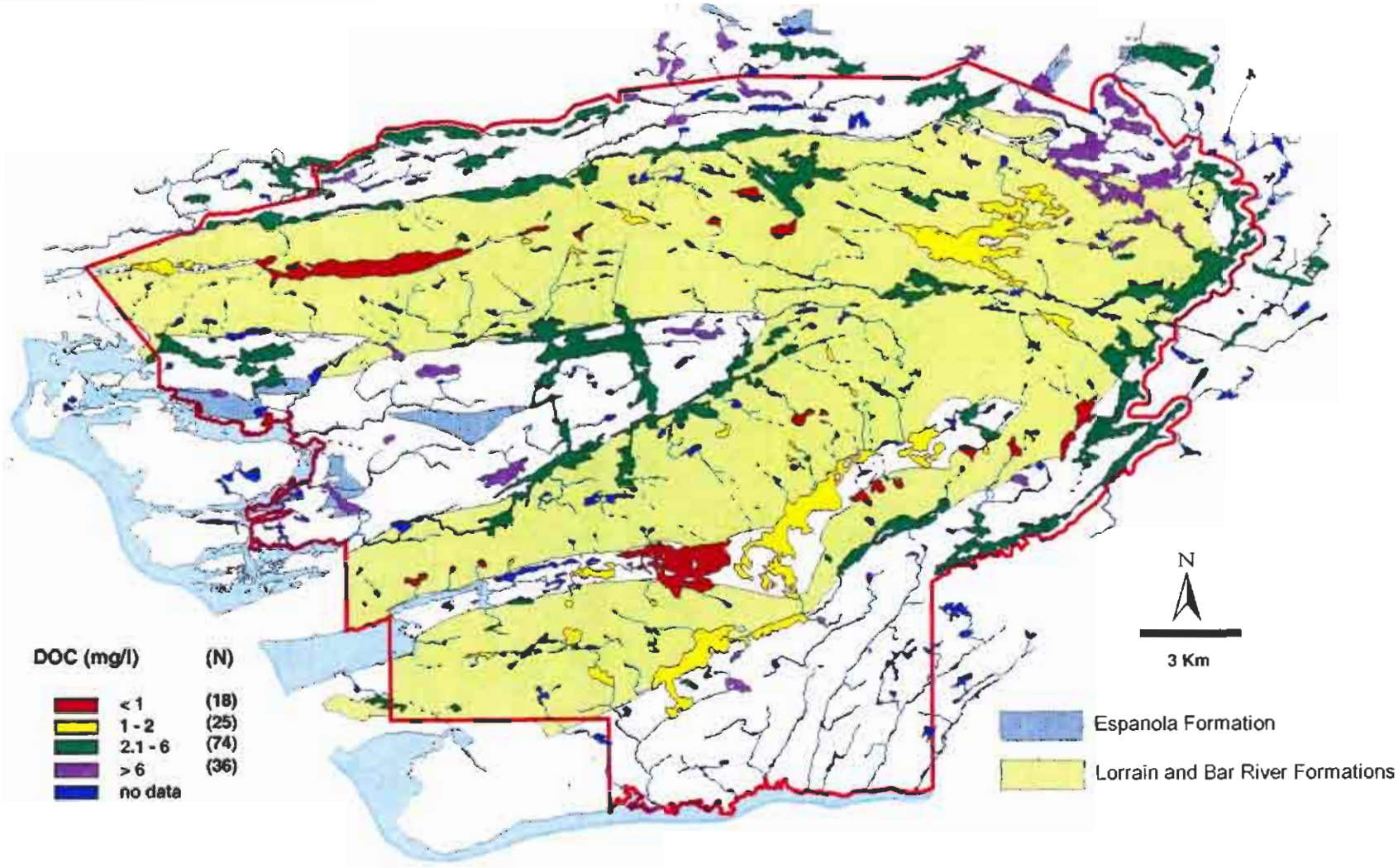


Figure 13. Frequency distribution of Secchi depths

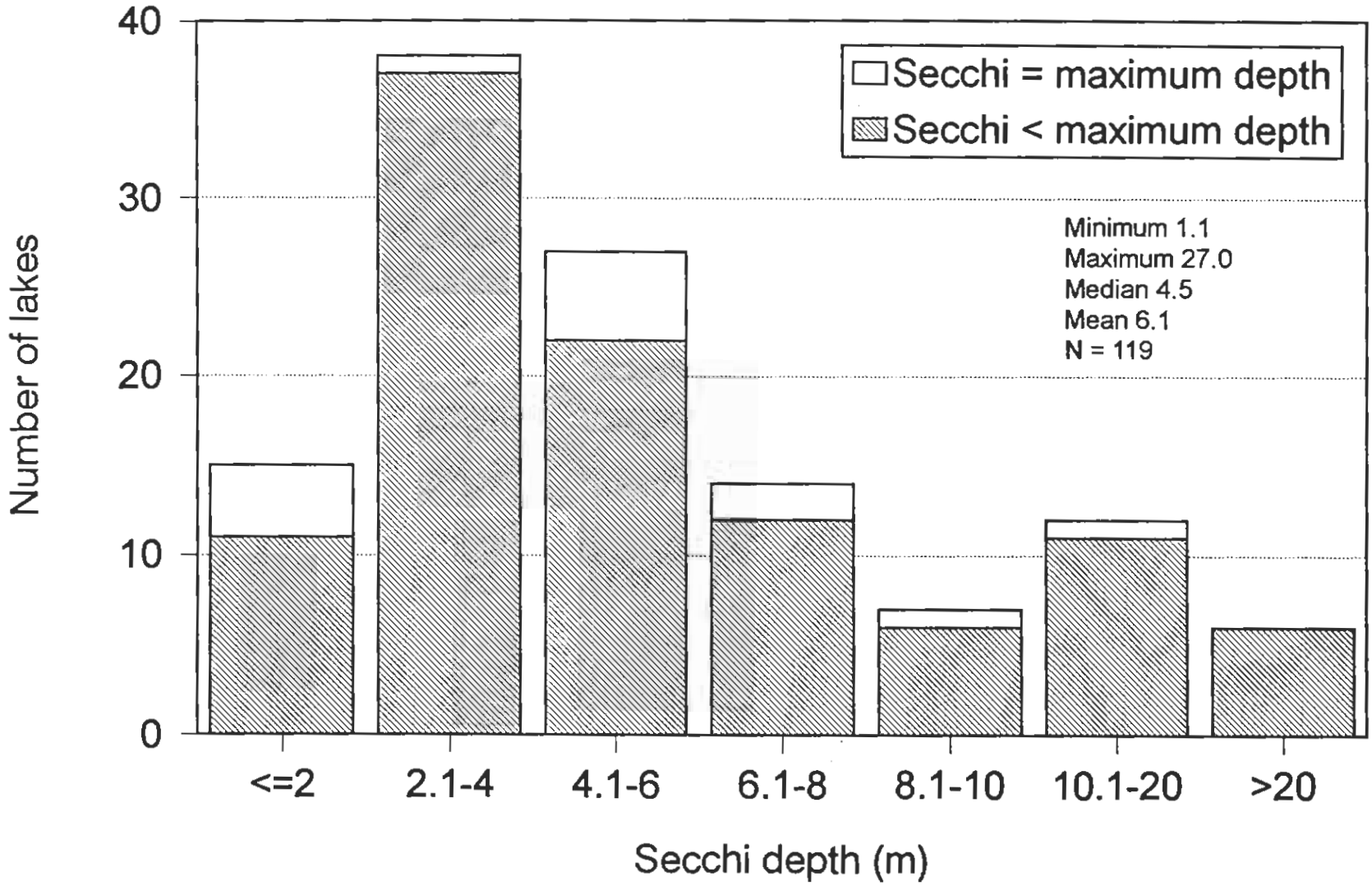


Figure 14. Aluminum levels in Killarney Provincial Park lakes

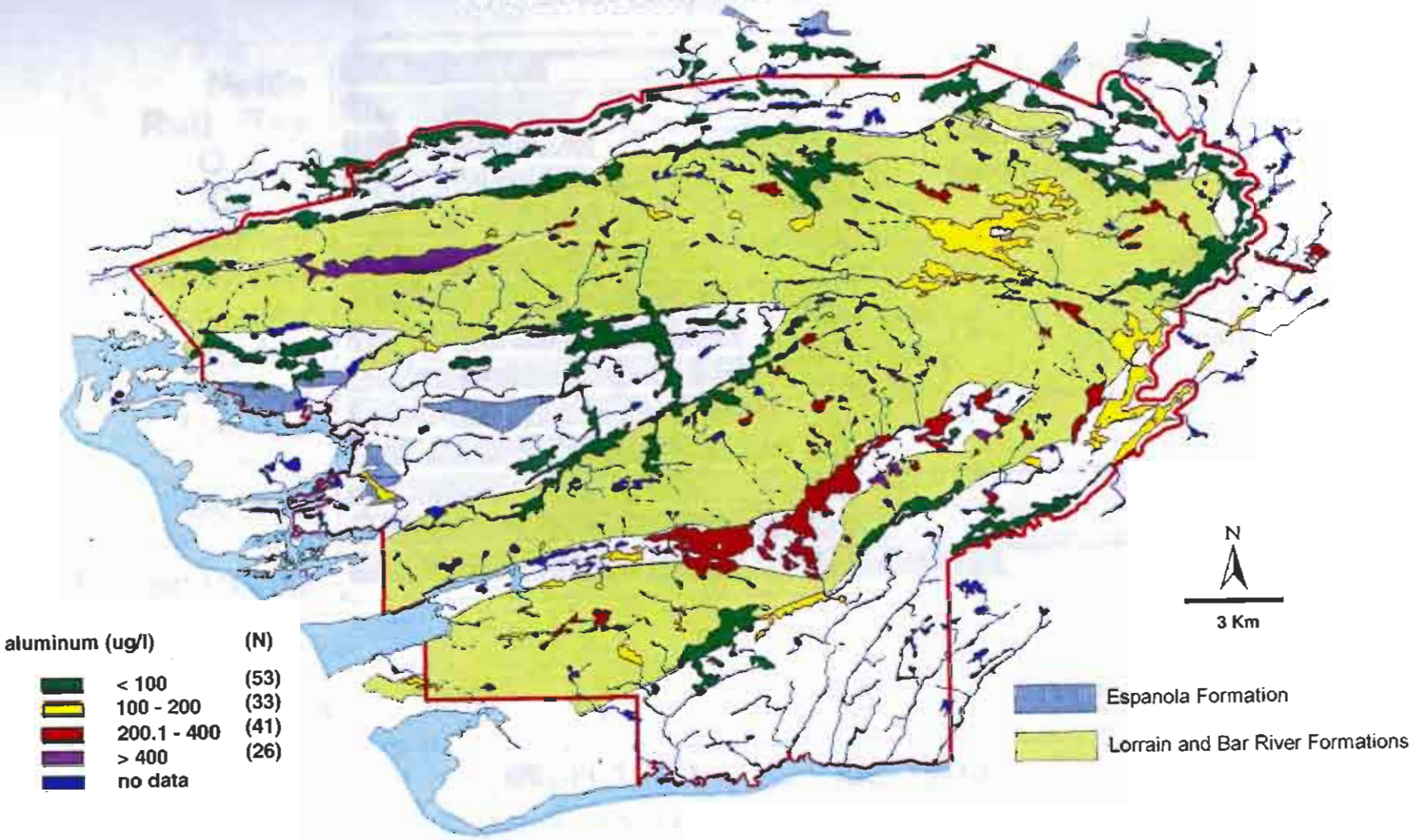
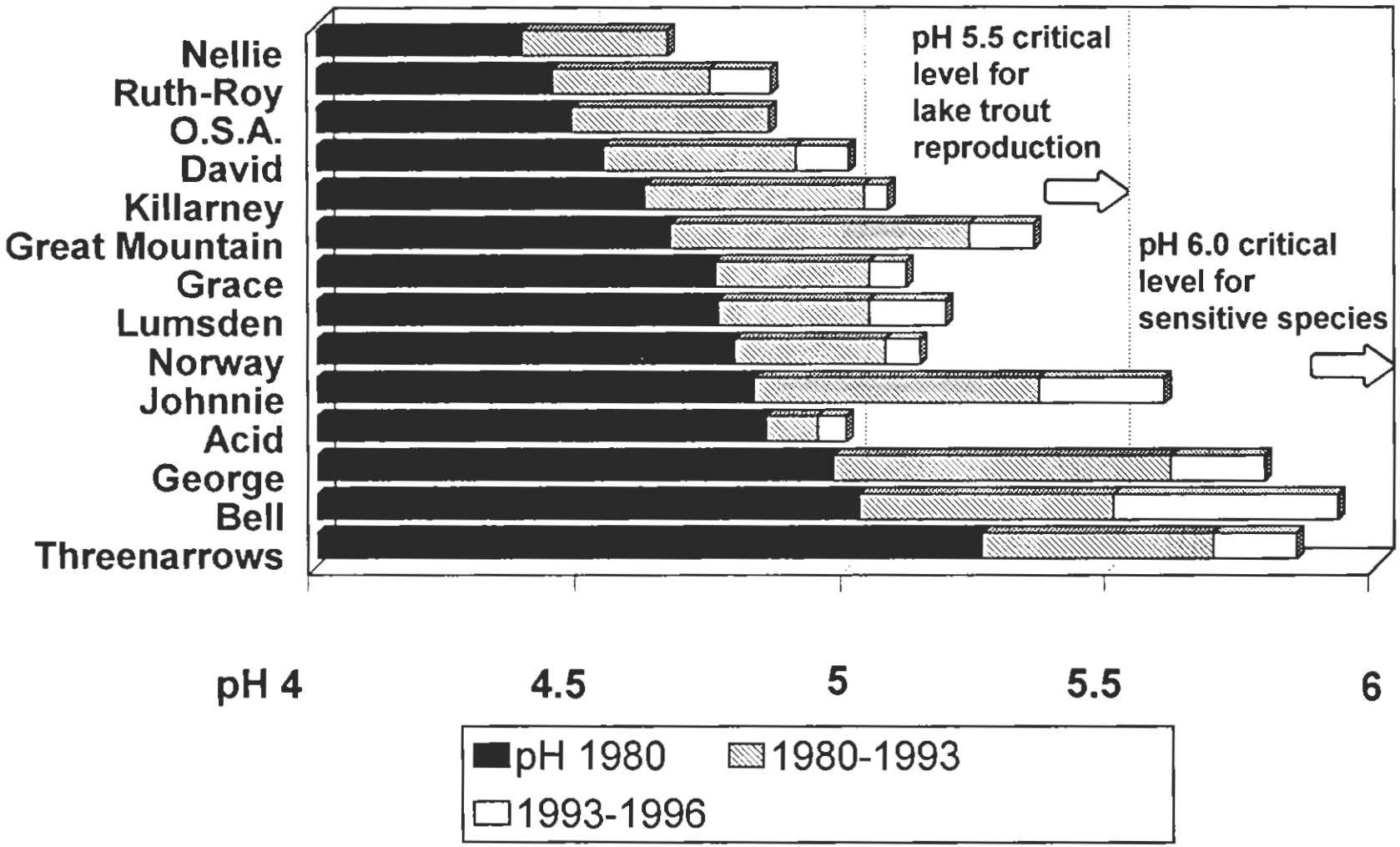


Figure 15. Recovery rates of acid-damaged Killarney Park lake trout lakes



15). The mean pH of these lakes increased about 0.5 units between 1980 and 1986. All lakes are showing some signs of improvement. Even the 6 small lakes on the summit of Blue Ridge considered to be sensitive monitors of atmospheric inputs (Beamish et al. 1975), have experienced improvements in water quality since 1973 (increased pH, decreased metals, ions, sulphate; Table 4).

The chemical recovery of Partridge Lake is notably faster than that of adjacent lakes. Its current pH of 5.7 is 0.5 units higher than it was in 1986-1987 (Snucins and Shuter 1991). In contrast, the pH of Norway Lake (pH 5.04 in 1987, pH 5.1 in 1996) has changed little during the same period. Nearby lakes, Sandy and Amikogaming, also have a current pH of 5.1.

The recovery rate of Partridge Lake could be influenced by a number of factors (eg. surficial geology, bedrock geology, water replacement time, internal alkalinity generation). The lake has a smaller volume than any of the adjacent waterbodies and this might account for some of the difference in recovery rates. There is also a large difference in the type of bedrock underlying these lakes. The catchment of Partridge Lake is almost entirely underlain by the Gordon Lake Formation, a geological unit containing minerals that can contribute to buffering (Tim Jones pers. comm. citing Card et al 1977). The watersheds of the slow-recovery lakes are dominated by the erosion-resistant Lorrain and Bar River Formations. There is no documentation of differences in surficial geology between drainages nor did we measure in Partridge Lake any hypolimnetic hypoxia which might indicate higher internal alkalinity generation.

Dissolved Oxygen and Temperature

At the time of the biological surveys all 119 lakes had summer dissolved oxygen levels that were not limiting for fish (ie. > 5 mg/L) (Table 5). However, 48 lakes had levels below 5 mg/L in at least a portion of the water column and in Cranberry Bog only the top meter of water had levels > 5 mg/L. Dissolved oxygen levels $\leq$ 1 mg/L were measured in a portion of the water column in 33 lakes.

In 48 of the 119 lakes some winter oxygen depletion (dissolved oxygen < 5 mg/L) occured. Extremely low oxygen levels (< 1 mg/L) lethal to most fish species were measured in 10 lakes during the winter, but in only Wagon Road Lake and Sealey's Lake did those levels exist throughout the water column.

The 1997 synoptic thermal survey was done at the time of maximum thermocline development (Table 6). For the 63 lakes with thermoclines (Table 7) Pearson correlation coefficients were calculated between log transformed values of thermocline depth (ie. top of thermocline), lake elevation, lake area, colour, DOC, maximum fetch, mean depth, and maximum depth (Table 8). Significant correlations ($P \leq 0.05$) with thermocline depth existed for DOC, colour, maximum depth, mean depth, lake area and maximum fetch. These variables were entered into a stepwise multiple regression to predict thermocline depth. This produced the following linear regression equation ($r^2 = 0.85$):

Log (thermocline depth) = 1.065187 - 0.661230 (log DOC + 1) + 0.077467 (log area)

The strongest single predictor of thermocline depth was DOC ($r^2 = 0.80$):

Log (thermocline depth) = 1.224420 - 0.716357 (log DOC + 1).

A quadratic function provided a better fit ($r^2 = 0.90$) due to lakes with either very high or very low DOC values having shallower thermocline depths than expected from the linear regression.

An analysis of the 18 thermally stratified lake trout lakes showed that thermocline depth was significantly correlated only with colour and DOC. The best predictor of thermocline depth in these lake trout lakes was DOC (linear regression $r^2 = 0.85$):

Log (thermocline depth) = 1.157808 - 0.508169 (log DOC + 1)

A quadratic function improved the relationship only marginally ($r^2 = 0.87$).

Discriminant analysis was used to determine the factors that distinguish between lakes that had a thermocline and those that did not. Data from 23 lakes without thermoclines and 63 lakes with thermoclines were used. Interestingly, two of the lake trout lakes (Grace, Teardrop) did not have thermoclines. The variables entered into the analysis were those found to be significantly correlated with thermocline depth in stratified lakes (DOC, colour, maximum depth, mean depth, maximum fetch, and lake area). The resulting discriminant function included DOC and maximum depth as factors. Overall correct classification of cases was 83.7%. Lakes with a thermocline were assigned to the correct group 82.6% of the time. Lakes that did not have a thermocline were correctly classified in 84.1% of cases. Low values for DOC (ie. high water clarity) and maximum depth (ie. shallow basins) were associated with lakes that did not have a thermocline.

Physical Characteristics of Biological Survey Lakes

The 119 lakes with biological surveys spanned a wide range in surface area, maximum depth, mean depth, and elevation (Figure 16, Table 9). Biological sampling was done on lakes with a combined total surface area of 6369.3 ha or 84.7% of the total surface area of all lakes. Small (< 5 ha) lakes were undersampled relative to their overall abundance (compare Figure 16 and Figure 5). The water colour was yellow/brown in 63 lakes, blue/green in 51 lakes and colourless in 5 lakes. Contour maps were not produced for 4 lakes that were either too shallow or too vegetated for accurate depth sounding.

Table 4. Water chemistry of six lakes on Blue Ridge sampled August 20, 1973 and August 27, 1996. Parameters that differed significantly (Wilcoxon paired-sample test, $p < 0.05$) between years are indicated by an asterisk. Data for 1973 from Beamish et al. (1975).

Lake name 1973 / 1996	Surface area (ha)		pH *		$[H^+] \times 10^{-5}$ *		SO4 (mg/L) *		Cl (mg/L) *		Ni (ug/L) *		Cu (ug/L)		Zn (ug/L) *	
	1973	1996	1973	1996	1973	1996	1973	1996	1973	1996	1973	1996	1973	1996	1973	1996
1A / #19	4.6	8.6	4.4	4.7	3.981	1.995	11.2	7	1	0.4<T	16	9	3	1.6	22	18
2A / #27	4.6	3.1	4.8	5	1.585	1.0	9	5.5	1	0	11	6.5	3	0.6<T	21	12
3A / #29	2.3	2.4	4.1	4.2	7.943	6.31	11.8	7	1	0.4<=T	16	10	4	2	23	14
4A / #28	2.3	2.5	4.4	4.7	3.981	1.995	9.4	6	0.8	0	12	5.5	2	1.8	15	8
5A / #30	2.3	2.5	4.5	4.7	3.162	1.995	7.8	5.5	1.2	0	11	6.5	2	2.4	14	12
6A / Quartzite	11.6	15.7	4.5	4.7	3.162	1.995	10.6	7	1.2	0	16	10	3	2.6	30	20
MEAN			4.45	4.67	3.969 (pH 4.40)	2.548 (pH 4.59)	9.96	6.33	1.03	0.13	13.7	7.9	2.8	1.8	20.8	14.0

Lake name 1973 / 1996	Fe (ug/L)		Mn (ug/L) *		Na (mg/L) *		K (mg/L) *		Mg (mg/L) *		Ca (mg/L) *		Cond. (umho/cm²) *			
	1973	1996	1973	1996	1973	1996	1973	1996	1973	1996	1973	1996	1973	1996		
1A / #19	64	40<T	250	140	0.53	0.48	0.33	0.31	0.51	0.36	2.19	1.05	56	24		
2A / #27	40	120	170	73	0.56	0.52	0.26	0.2	0.48	0.34	2.15	1	28	18		
3A / #29	91	40	140	64	0.35	0.28	0.3	0.17	0.36	0.2	2.03	0.85	70	27		
4A / #28	32	100	130	62	0.55	0.48	0.32	0.29	0.43	0.28	2.05	1.05	34	20		
5A / #30	19	60<T	220	78	0.53	0.48	0.2	0.16	0.42	0.32	1.08	0.9	30	18		
6A / Quartzite	28	0	340	200	0.49	0.44	0.31	0.21	0.5	0.36	2.25	1.15	35	24		
MEAN	45.7	60.0	208.3	102.8	0.502	0.447	0.287	0.223	0.450	0.310	1.96	1.00	42.2	21.8		

Table 5. Temperature and dissolved oxygen characteristics of lakes determined during biological surveys and winter water sampling. Profiles were done at 1 m intervals beginning at the surface (summer) and at 1 m from the surface (winter). Profiles done with 15m long cable indicated by *. Profiles done with 30 m long cable indicated by **.

Lake	Maximum depth	Summer profile date	Station depth	Thermocline depth	D.O. <5 mg/L depth	D.O. ≤ 1 mg/L depth	Winter profile date	Station depth	D.O. <5 mg/L depth	D.O. ≤ 1 mg/L depth
A.Y. Jackson	9.8	May23/96	9.5	3-5	—	—	February1/96	9.8	—	—
Acid	29	May31/95	26	5-9	—	—	January30/96	26	—	—
Amikogaming	16.7	June7/96	15	2-5	—	—	January23/96	16	14-15	—
Artist	1.5	not done	—	—	—	—	not done	—	—	—
Balsam	16	July27/96	15	2-7	—	—	January23/96	16	12-15	14-15
Beaver	17	July30/96	17	3-6	13-15*	15*	February2/96	16	13-15	—
Bell	26.8	July7/96	17	4-8	—	—	January23/96	26	25	—
Betty	8	August17/96	6.5	3-5	4-6	4-6	not done	—	—	—
Billy	10.3	July31/96	11	2-6	7-10	—	not done	—	—	—
Bizhiw	9.8	July6/96	7+	no thermocline	—	—	February1/96	6	—	—
Bodina	3.9	July 17/97	3.9	no thermocline	3.5	—	February 2/96	3	—	—
Boundary	9.8	June5/96	10	4-7	—	—	February2/96	9.8	—	—
Bunnyrabbit	26	July23/96	24+	5-10	—	—	Janaury23/96	19	—	—
Burke	15.5	May29/95	14.5	5-7	—	—	February2/96	10.5	—	—
Canis	2.8	July 1/97	2.8	0-bottom	2-bottom	bottom	February 2/96	3	2	—
Carlyle	14.6	June20/95	14.5	5-9	—	—	February1/96	9	—	—
Casson	17.9	June 5/97	16.5	2-4	15-16	—	not done	—	—	—
Cat	8.6	July30/96	9	4-7	6-8	8	February2/96	5	—	—
Cave	3.4	July 1/97	3.75	no thermocline	bottom	—	February 1/96	3.5	—	—
Chain	10.5	July25/96	10	2-6	8-9	9	January23/96	10	7-9	8-9
Clearsilver	13.7	August24/96	11.5	3-7	11	—	Janauary23/96	13.7	13	—

Table 5 (cont.). Temperature and dissolved oxygen characteristics of lakes determined during biological surveys and winter water sampling. Profiles were done at 1 m intervals beginning at the surface (summer) and at 1 m from the surface (winter). Profiles done with 15m long cable indicated by *. Profiles done with 30 m long cable indicated by **.

Lake	Maximum depth	Summer profile date	Station depth	Thermocline depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth	Winter profile date	Station depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth
Cranberry Bog	5	August29/95	5	2-4	1-4	3-4	February1/96	5	1-4	3-4
Crater E	4.2	July2/96	4	no thermocline	—	—	February2/96	4	1-3	—
Crater W	7.1	July3/96	7	1-5	4-6	4-6	February9/96	7	1-6	—
Cuckoo	14	August14/96	12.5	3-9	7-12	9-12	not done	—	—	—
David	24.4	June8/96	26	6-8	—*	—*	February2/96	24	—	—
Deacon	7.1	August1/95	8	2-6	3-7	5-7	January23/96	7.1	6-7	—
de Lamorandiere	7.6	May30/95	8.1	2-5	8	—	February2/96	3.5	—	—
East Howry	20	August19/96	19	4-8	9-18	15-18	not done	—	—	—
Fish	8.5	June18/96	8.5	2-7	7-8	8	January 24/96	8	—	—
Fox	10	August 3/96	9.1	2-7	4-9	8-9	Janaury23/96	10	—	—
Frank	8.6	August18/96	9	3-9	4-8	6-8	Janaury23/96	8+	3-8	—
Freeland	3.5	June12/95	3	no thermocline	—	—	February2/96	2.5	2	—
Gail	16.8	June8/96	13	5-7	not measured	not measured	Janaury24/96	10	—	—
Gem	19.2	June25/96	18+	3-6	—	—	February2/96	18	16-17	—
George	36.6	June14/96	37	7-10	—	—	Janaury30/96	37	35-36	—
Goose	2	June20/96	2	no thermocline	—	—	Janaury24/96	2	—	—
Goschen	5.6	August 12/97	5.5	3-5	4-bottom	—	not done	—	—	—
Grace	17.2	August 1/97	16	7-8	—	—	February 2/96	13	—	—
Grt Mountain	37.5	June10/96	36	5-8	—**	—**	January24/96	9	—	—
Grey	11.8	July30/96	12	3-7	8-11	11	not done	—	—	—
Grow	9	June18/96	7.5	2-6	—	—	January24/96	9	—	—

Table 5 (cont.). Temperature and dissolved oxygen characteristics of lakes determined during biological surveys and winter water sampling. Profiles were done at 1 m intervals beginning at the surface (summer) and at 1 m from the surface (winter). Profiles done with 15m long cable indicated by *. Profiles done with 30 m long cable indicated by **.

Lake	Maximum depth	Summer profile date	Station depth	Thermocline depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth	Winter profile date	Station depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth
Hanwood	12	July18/96	11	3-8	not measured	not measured	February2/96	11.5	—	—
Harry	12.5	August19/96	7.5	4-7	5-7	6-7	Janaury23/96	12+	11-12	—
Heaven	17.8	July18/96	18	1-6	7-17	11-17	January23/96	17	11-16	13-16
Helen	41.2	July10/96	19	5-7	—	—	Janauary30/96	25	—	—
Hemlock	4.5	July23/96	5	no thermocline	—	—	January23/96	4	—	—
Howry	27.5	June25/96	18+	3-7	—	—	February2/96	20	—	—
Ishmael	19.8	July6/95	18	4-8	—	—	Janauary30/96	19	18	—
Johnnie	33.6	July13/95	30	5-9	—*	—*	January23/96	33	—	—
Kakakise	30.5	June21/95	25	3-10	24	—	January24/96	26	25	—
Kidney	1.8	June13/96	1.8	no thermocline	—	—	February1/96	1.8	1	—
Killarney	61	not done	—	—	—	—	January30/96	50+	—	—
Lake of the Woods	6	September14/96	6	no thermocline	—	—	not done	—	—	—
Leech	7.9	June 9/97	7.5	2-5	6-7	—	not done	—	—	—
Little Bell	7.2	July26/96	7	2-6	4-6	5-6	January23/96	7.2	6-7	7
Little Leech	6	June 8/97	5	1-3	—	—	not done	—	—	—
Little Mink	7.7	June 8/97	7.3	2-4	—	—	January 24/96	7	6	—
Ltl Mountain	25	June5/96	25	4-5	not measured	not measured	January24/96	10	—	—
Little Sheguiandah	2.7	May24/95	2.3	no thermocline	—	—	February1/96	2.7	2	—
Little Superior	33.6	July 15/97	38(?)	5-6	—	—	January 23/97	38(?)	35-38	—
Log Boom	5.5	June29/95	4.2	2-4	4	4	January23/96	5.5	—	—

Table 5 (cont.). Temperature and dissolved oxygen characteristics of lakes determined during biological surveys and winter water sampling. Profiles were done at 1 m intervals beginning at the surface (summer) and at 1 m from the surface (winter). Profiles done with 15m long cable indicated by *. Profiles done with 30 m long cable indicated by **.

Lake	Maximum depth	Summer profile date	Station depth	Thermocline depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth	Winter profile date	Station depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth
Low	28.4	July10/96	24	5-9	20-23	—	January30/96	27	—	—
Lumsden	21.8	June1/95	12	6-8	—	—	January24/96	16	—	—
Mink	5	June 3/97	4.5	2-3	bottom	—	January 24/96	5	2-4	—
Muriel	12.2	July 4/97	12.5	5-8	—	—	February 1/96	12	—	—
Murray	6.4	June 3/97	6.5	2-4	—	—	February 2/96	4.5	—	—
Nellie (includes Carmichael)	54.9	June 19/97	44.3	no thermocline	—	—	February 2/96	48	—	—
Norway	33.6	June11/96	25	3-6	—	—	January23/96	31	31	—
O.S.A.	39.7	not done	—	—	—	—	January24/96	39	—	—
Partridge	16.9	June11/96	15	2-6	—	—	January23/96	16	15	—
Patten	6.4	July8/96	6.5	3-6	—	—	February2/96	5	—	—
Pearl	6.4	July7/96	7	no thermocline	—	—	February1/96	5.5	—	—
Peter	30.5	July 25/97	30	5-8	—	—	not done	—	—	—
Pike	9.1	August15/95	8.2	2-6	3-8	7-8	January23/96	9	7-8	—
Proulx	28.7	July 15/97	28.4	5-6	—	—	January 23/96	26	—	—
Quartzite	46.2	August 4/97	45	5-7	—	—	February 2/96	45	—	—
Rocky	14.6	June20/96	14	3-7	8-13	11-13	January24/96	12.2	—	—
Roque	10.1	May28/95	8.5	2-5	—	—	February2/96	3	—	—
Round Otter	7	June22/96	8	2-6	4-7	6-7	January24/96	7	5-6	—
RuthRoy	18	June28/96	18.5	4-9	—	—	January23/96	18	17	—
Sandy	15.9	June8/96	10	3-5	—	—	January23/96	10	9	—

Table 5 (cont.). Temperature and dissolved oxygen characteristics of lakes determined during biological surveys and winter water sampling. Profiles were done at 1 m intervals beginning at the surface (summer) and at 1 m from the surface (winter). Profiles done with 15m long cable indicated by *. Profiles done with 30 m long cable indicated by **.

Lake	Maximum depth	Summer profile date	Station depth	Thermocline depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth	Winter profile date	Station depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth
Sealey's	4.1	August9/96	3.5	0-3	2-3	—	February1/96	3.5	1-2	1-2
Shingwak	21.8	July 16/97	20.6	no thermocline	—	—	January 23/96	21	bottom	—
Silver	5	July16/96	5	no thermocline	—	—	January23/96	3	—	—
Solomon	4.9	May27/96	3.5	no thermocline	—	—	February2/96	4	1-3	—
Spark	20.3	July5/96	16	5-9	—	—	February2/96	20.3	—	—
Teardrop	16.6	June27/96	16.5	4-7	—	—	February1/96	15	—	—
Terry	8	June8/95	8.5	2-5	—	—	January30/96	8	—	—
Threenarrows	51.9	July22/96	39	6-10	—	—	January30/96	34	—	—
Topaz	21.4	June8/96	20	3-6	—	—	February1/96	20	—	—
TriLakes N	5	August17/96	6	3-5	3-5	4-5	not done	—	—	—
TriLakes SE	5.5	August15/96	6	2-5	3-5	4-5	not done	—	—	—
TriLakes SW	11.9	August 14/96	12	2-5	3-11	8-11	not done	—	—	—
Turbid	9.1	August7/96	9+	4-8	8-9	9	not done	—	—	—
Turtleback	13.8	June 21/97	13.3	3-6	12-13	12-13	February 2/96	15	11-14	—
Van	4.9	July31/96	5	4-5	4	—	February2/96	4.9	2-4	—
Van Winkle	19..0	July20/96	17	6-10	14-15*	—*	February 2/96	18	16-17	—
Wagon Road	4.2	June9/95	3	no thermocline	—	—	January30/96	4	1-3	1-3
Whiskeyjack	42.7	July25/96	34	5-10	—	—	January23/96	36.5	—	—
York	20.4	July2/96	20	3-7	17-19	19	February2/96	20	19	—
#6	5.8	August 16/97	5.5	2-4	3-bottom	bottom	February 12/96	6	4-5	—

Table 5 (cont.). Temperature and dissolved oxygen characteristics of lakes determined during biological surveys and winter water sampling. Profiles were done at 1 m intervals beginning at the surface (summer) and at 1 m from the surface (winter). Profiles done with 15m long cable indicated by *. Profiles done with 30 m long cable indicated by **.

Lake	Maximum depth	Summer profile date	Station depth	Thermocline depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth	Winter profile date	Station depth	D.O. < 5 mg/L depth	D.O. ≤ 1 mg/L depth
#7	9.5	August 15/97	9	2-4	3-8.75	6-8.75	February 12/96	7.5	2-6	—
#9	2.2	August 17/97	2.2	no thermocline	—	—	February 12/96	1.5	1	1
#24	12.0	August 3/97	11.8	no thermocline	—	—	February 9/96	11	—	—
#25	1.5	August 4/97	1.5	no thermocline	—	—	February 9/96	1.5	1	—
#27	8.1	August 1/97	8	no thermocline	—	—	February 9/96	8	—	—
#28	6.6	August 1/97	5.6	no thermocline	—	—	February 9/96	5	—	—
#29	18.8	July 31/97	18.3	5-6	—	—	February 9/96	18	17	—
#30	5.4	July 30/97	5.2	no thermocline	—	—	February 9/96	2.5	—	—
#37A	16	July6/96	15.5	3-7	10-15	12-15	February9/96	16	—	—
#45	2.7	August 13/97	2.5	no thermocline	—	—	February 13/96	2.8	1-2	—
#59	24.4	June16/96	22	3-8	19-22	21-22	February12/96	23	19-22	—
#64	2.5	July 19/97	2.2	no thermocline	—	—	February 9/96	1.8	—	—
#65	6.4	July 20/97	6	no thermocline	—	—	February 9/96	2.5	—	—
#66	11.7	July 21/97	12	3-7	7-bottom	7-bottom	February 9/96	4	—	—
#69	4.6	not done	—	—	—	—	February9/96	4	—	—
#74	15.1	July 15/97	13.8	1-5	5-13	9-13	February 12/96	14	5-13	12-13
#76	6.5	July 6/97	6.6	2-4	4-bottom	5-bottom	February 12/96	6	2-5	4-5

Table 6. Weekly temperature profiles (August - September 1997) in A.Y. Jackson and George Lakes. Profiles were measured at 1 m intervals. Station depth varied between sampling dates, therefore to allow comparison between dates the temperature at the maximum depth measured on all occasions (10 m in A.Y. Jackson Lake, 37 m in George Lake) was the "bottom temperature". Profiles obtained during synoptic survey indicated by *.

Lake	Date	Surface temperature (°C)	Bottom temperature (°C)	Station depth (m)	Thermocline depth (m)	
					Top	Bottom
A.Y. Jackson	August 20	21.7	11.0	10	6	8
	August 25 *	21.9	10.5	10.6	7	9
	September 12	18.5	10.6	10.2	7	9
	September 16	19.4	12.0	10.3	7	9
George	August 20	20.9	7.2	42	8	9
	August 27 *	19.8	5.6	38	9 (8.5) #	10
	September 11	18.9	7.0	38	9	11
	September 14	18.7	6.8	37	9	11

Number in parentheses is thermocline depth based upon measurements at 0.5 m intervals.

Table 7. Thermocline depths and dissolved oxygen levels measured during thermal survey August 25-September 1, 1997. * indicates 15 m cord was used.

Lake	Date	Surface temperature (°C)	Bottom temperature (°C)	Station depth (m)	Thermocline depth (m)		D.O. < 5 mg/L depth (m)	D.O. ≤ 1 mg/L depth (m)
					Top	Bottom		
Acid	August 26	19.4	4.9	27.2	10	12	27	--
Amikogaming	August 30	20.2	5.9	15	7	9	14 - 15	--
A.Y. Jackson	August 25	21.9	9.9	10.6	7	9	10 - 10.5	--
Balsam	August 28	20.2	6.8	16.3	5	7	8 - 15	12 - 15
Beaver	August 25	21.5	4.8	16	4	6	5 - 15	12 - 15
Bell	August 29	20.6	6.3	25.2	6.5	8	25	--
Billy	August 31	20.6	5.3	10.3	3	6	6 - 10	7 - 10
Boundary	August 27	20.1	15.2	10.1	8	9	--	--
Canis	August 31	21.7	17.5	2.8	1.5	2.5	2 - 2.5	2.5
Carlyle	August 29	19.3	8	13	6	8	13	--
Cat	August 26	19.9	13	8.6	6	7	7 - 8.5	7 - 8.5
Chain	August 29	19.5	8.1	6.2	4	6	5 - 6	6
Clearsilver	August 26	19.4	9.4	13.2	8	11	13	13
Cranberry Bog	August 26	21.2	10.1	5	3	5	3 - 5	5
David	August 26	19.6	7.3	24.4	10	12	--	--
Deacon	August 28	19.8	9.8	7.5	4	7	5 - 7.5	5 - 7.5
Fish	August 27	20.7	14.5	8.2	6.5	8	7.5 - 8	8
Fox	August 28	19.7	9.4	10.6	5	7	6 - 10	6 - 10
Frank	August 29	21.4	8.2	7.3	4.5	6	4 - 7	4.5 - 7
Freeland	August 25	21.2	17.1	3	--	--	--	--
Gail	August 26	20.4	19.7	16.1	--	--	--	--
Gem	August 26	20.2	4.9	19.5	5	7	--	--
George	August 27	19.8	5.6	37.3	8.5	10	--	--
Goose	August 26	20.9	16.5	2	--	--	0.5 - 2	1.5 - 2
Goschen	August 28	20.1	13.4	5.9	3.5	5.5	4.5 - 5.5	4.5 - 5.5
Grace	September 1	20.7	16.1	13.3	--	--	--	--
Great Mountain	August 26	19.7	5.1	36.4	7.5	10.0	36	--
Grey	August 31	20.4	7.2	12.4	5.0	7.0	9 - 12	10 - 12
Grow	August 26	21.2	10.6	8.7	5.5	8.0	6 - 8.5	6.5 - 8.5

Table 7 (cont.). Thermocline depths and dissolved oxygen levels measured during thermal survey August 25-September 1, 1997. * indicates 15 m cord was used.

Lake	Date	Surface temperature (°C)	Bottom temperature (°C)	Station depth (m)	Thermocline depth (m)		D.O. <5 mg/L depth (m)	D.O. ≤1 mg/L depth (m)
					Top	Bottom		
Hanwood	August 26	20.2	8.5	12	6	8	7 - 12	10 - 12
Harry	August 29	21.1	10.4	9.5	6	8	6.5 - 9	7 - 9
Heaven	August 29	20.4	5.1	16.5	4	6	7 - 16	12 - 14
Helen	September 1	20.5	4.4	40	6	9	38 - 40	40
Hemlock	August 30	20.2	19.9	4	5	7	--	--
Howry	August 26	20.1	7	27.5	6	9	--	--
Ishmael	August 31	20.8	6.4	19.2	6	8.5	16 - 19	18 - 19
Johnnie	August 30	20.4	5.4	32.3	7	8.5	32	--
Kakakise	August 30	20	5.2	20.7	7.5	9.5	--	--
Killarney	August 27	19	4.6	60.3	10.5	12	--	--
Leech	August 25	21.9	18.4	7	5	9	7	--
Little Bell	August 29	19.6	15.1	5.6	4	5	4.5 - 5	5
Little Mountain	August 26	18.7	6.7	24	11.5	12.5	24	--
Little Sheg.	August 25	20.8	19.4	2.8	8	12	--	--
Little Superior	September 1	18.9	9.8	33	2	-	--	--
Log Boom	August 29	19.1	16.4	5.5	10	13	5 - 5.5	5.5
Low	September 1	20.2	4.8	27.6	7	9	18 - 27	--
Lumsden	August 26	19.8	7.8	20	11	12	--	--
Murray	August 25	20.9	18.3	6	4	8	--	--
Nellie	September 1	18.7	9.6	>60.0	10.5	12	--	--
Norway	August 29	20.6	4.9	33	9	10	--	--
O.S.A	August 27	19.7	7.9	38.4	13	14	--	--
Patten	September 1	20.2	13.7	7.4	5.5	6.5	6 - 7	6 - 7
Partridge	August 29	21	10.1	16	9	11	--	--
Peter*	August 28	19.5	5.8	30	6	9	--	--
Pike	August 29	21.8	8.7	8.5	4	7	4.5 - 8	4.5 - 8
Proulx	September 1	19.4	10.2	29	10	11	--	--
Quartzite	August 31	18.6	7.9	44	8	9	--	--
Rocky	August 26	20.5	5.7	14.3	5	7	6 - 13	9 - 13

Table 7 (cont.). Thermocline depths and dissolved oxygen levels measured during thermal survey August 25-September 1, 1997. * indicates 15 m cord was used.

Lake	Date	Surface temperature (°C)	Bottom temperature (°C)	Station depth (m)	Thermocline depth (m)		D.O. < 5 mg/L depth (m)	D.O. ≤ 1 mg/L depth (m)
					Top	Bottom		
Round Otter	August 27	20.1	9.2	7	3.5	6	4 - 7	4.5 - 7
Ruth Roy	August 30	19.5	17.2	17.1	6	9	--	--
Sandy	August 30	19.5	17.1	10	--	--	--	--
Sealey's	August 26	22.1	9.6	4	2	4	1.5 - 4	3.5 - 4
Shingwak	September 1	19.2	16.2	20.9	--	--	--	--
Teardrop	August 28	18.5	12.8	16.2	--	--	15 - 16	--
Terry	August 29	19.2	5.4	9	4	6	9	--
Threenarrows*	September 1	20.7	6.4	45	7	10	--	--
Trilakes N	August 26	20.7	16.7	5.1	--	--	4.5 - 5	5
Trilakes SE	August 26	20.4	14.8	5.5	4	5	4.5 - 5.5	4.5 - 5.5
Trilakes SW	August 26	20.7	4.5	11.1	3	6	4 - 11	5 - 11
Turbid	August 30	20.4	7.8	8.8	5.5	8.5	7 - 8.5	8 - 8.5
Van	August 26	20.8	18.4	5.4	--	--	5	--
Van Winkle *	August 26	20.1	6.7	18.5	7	10	14 - 15	15
Wagon Road	August 25	22.2	11.8	4.2	0.5	4	2.5 - 4	--
York	September 1	20.6	5.3	20.1	4	7	--	--
#24	August 31	19.8	19.2	12	--	--	--	--
#27	August 31	19.8	19.4	8.5	--	--	--	--
#28	August 31	19.8	19	6.8	--	--	--	--
#29	August 30	20.8	9	18.5	--	--	18 - 18.5	--
#30	August 30	21.9	19.9	5	--	--	--	--
#45	August 29	21.2	16.5	2.9	1	2.5	2.5	--
#59*	September 1	21.2	5.2	26.7	5	7	--	--
#64	August 27	19.9	19.2	3.2	--	--	3	--
#65	August 27	20	18.7	7	--	--	7	--
#66	August 27	20.8	5.8	11.5	6	8	7 - 11.5	10 - 11.5
#69	August 26	19.9	19.5	4.6	--	--	--	--
#76	August 31	21.5	10.3	6.9	3.5	5.5	4 - 6.5	4.5 - 6.5

Table 8. Pearson correlation matrix for selected variables (log transformed) measured during synoptic thermal survey. Significant correlations based on Bonferroni-adjusted probabilities: $P \leq 0.05$ indicated by *.

(a) All thermally stratified lakes (N=63)

	Elevation	Area	Colour	DOC +1	Fetch	Mean depth	Max. depth
Area	-.3788*						
Colour	-.2100	-.2312					
DOC + 1	-.3548	-.2310	.9093*				
Fetch	-.3862	.9301*	-.1820	-.2029			
Mean depth	.1130	.4143*	-.5968*	-.6974*	.4017*		
Max. depth	.0675	.5612*	-.6602*	-.7338*	.4937*	.8833*	
Thermocline depth (top)	.1049	.4813*	-.8278*	-.8969*	.4706*	.6917*	.7860*

(b) Thermally stratified lake trout lakes (N=18)

	Elevation	Area	Colour	DOC + 1	Fetch	Mean depth	Max. depth
Area	-.1104						
Colour	-.2686	-.1544					
DOC + 1	-.4450	-.1487	.9269*				
Fetch	-.0712	.8784*	-.1875	-.2255			
Mean depth	-.2630	-.0404	-.1311	-.1642	.1654		
Max. depth	.0266	.5483	-.3769	-.4710	.4897	.4539	
Thermocline depth (top)	.4608	.0803	-.8528*	-.9198*	.0507	-.1389	.3009

Figure 16. Frequency Distributions for Physical Characteristics of Biological Survey Lakes

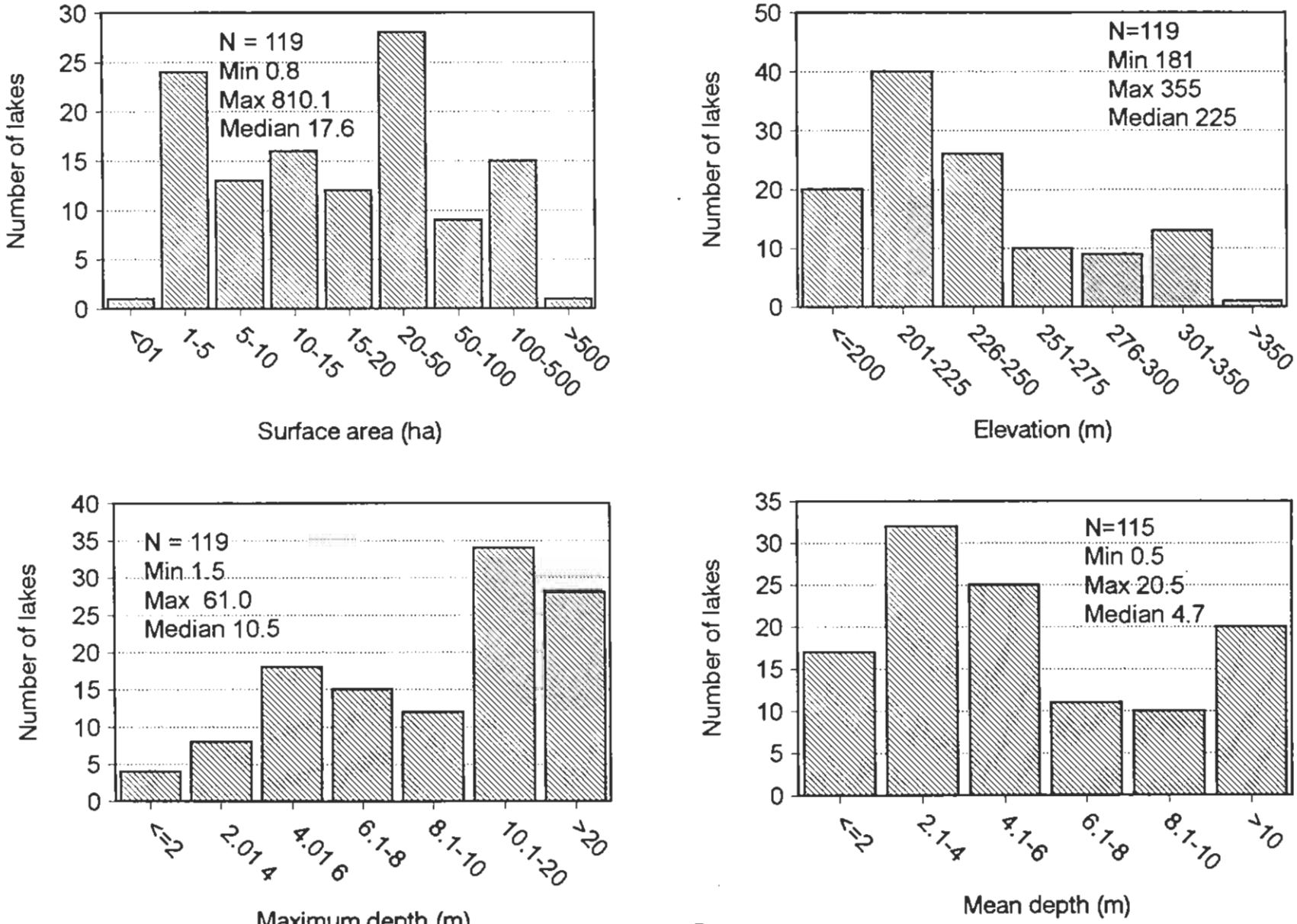


Table 9. Physical characteristics of biological survey lakes. Volumes obtained from old lake survey contour maps that were digitized and fitted to OBM lake outlines are indicated by *. Maximum depths obtained from Ontario Lake Survey Database indicated by *.

Lake	Surface Area (ha)	Volume ($10^6 m^3$)	Perimeter (km)	Shoreline develop. factor	Elevation (m)	Maximum depth (m)	Mean depth (m)	Secchi depth (m)	Water colour	Number of cottages/campsites	Watershed
A.Y. Jackson	6.5	45.70*	1.59	1.76	206	9.8*	7.0	5	blue/green	0 / 1	Chikanishing
Acid	19.6	213.38*	1.96	1.25	275	29.0*	10.9	4.9	blue/green	0 / 1	Chikanishing
Amikogaming	17.8	132.64	2.95	1.97	222	16.7	7.5	7.0	blue/green	0 / 0	Chikanishing
Artist	26.0	no map	4.63	2.54	185	1.5	no map	1.5 (bottom)	yellow/brown	0 / 0	Baie Fine
Balsam	266.9	1173.94	26.35	4.55	224	16.0	4.4	3.7	yellow/brown	0 / 7	Mahzenazing
Beaver	16.2	105.27	3.29	2.31	224	17.0	6.5	3.1	yellow/brown	0 / 0	Howry Creek
Bell	347.4	2827.43*	34.83	5.27	221	26.8*	8.1	3.8	yellow/brown	1 lodge / 12	Mahzenazing
Betty	19.1	62.70	2.01	1.30	235	8.0	3.3	3.5	yellow/brown	0 / out of park	Howry Creek
Billy	24.1	100.97	3.50	2.01	231	10.3	4.2	4.5	yellow/brown	0 / out of park	Mahzenazing
Bizhiw	2.1	10.68	0.60	1.17	285	9.8	5.1	7.0 (bottom)	blue/green	0 / 0	Baie Fine
Bodina	35.2	63.72	3.29	1.56	205	3.9	1.8	1.8	yellow/brown	0 / 2	McGregor Bay
Boundary	93.3	340.97	11.50	3.36	222	9.8	3.7	5.6	blue/green	0 / 2	McGregor Bay
Bunnyrabbit	12.7	141.59	2.02	1.60	246	26.0	11.1	16.0	blue/green	0 / 2	Mahzenazing
Burke	8.4	43.94*	2.02	1.97	304	15.6*	5.2	3.8	blue/green	0 / 0	Chikanishing
Canis	27.4	40.03	3.59	1.94	181	2.8	1.5	1.2	yellow/brown	0 / 0	McGregor Bay
Carlyle	156.7	890.81*	17.10	3.85	206	14.6*	5.7	4.0	yellow/brown	37 / 6	Mahzenazing
Casson	15.0	141.45	2.24	1.63	218	17.9	9.4	7.3	blue/green	0 / out of park	Howry Creek
Cat	46.4	126.40	5.29	2.19	222	8.6	2.7	3.3	blue/green	1 / 1	Howry Creek
Cave	12.4	26.42*	2.00	1.60	185	3.4*	2.1	3.3	yellow/brown	0 / 2	Baie Fine
Chain	10.9	29.49	2.81	2.40	226	10.5	2.7	2.5	yellow/brown	0 / 0	Mahzenazing
Clearsilver	30.9	162.85*	3.92	1.99	227	13.7*	5.3	9.5	blue/green	0 / 1	Mahzenazing

Table 9 (cont.). Physical characteristics of biological survey lakes. Volumes obtained from old lake survey contour maps that were digitized and fitted to OBM lake outlines are indicated by *. Maximum depths obtained from Ontario Lake Survey Database indicated by * .

Lake	Surface Area (ha)	Volume ($10^6 m^3$)	Perimeter (km)	Shoreline develop. factor	Elevation (m)	Maximum depth (m)	Mean depth (m)	Secchi depth (m)	Water colour	Number of cottages/ campsites	Watershed
Cranberry Bog	18.5	19.15	2.47	1.62	205	5	1	2.1	yellow/brown	0 / 0	Chikanishing
Crater East	2.2	5.3	0.62	1.18	205	4.2	2.4	4.1	yellow/brown	0 / 0	McGregor Bay
Crater West	0.8	2.99	0.36	1.14	285	7.1	3.7	2	yellow/brown	0 / 0	McGregor Bay
Cuckoo	24.6	94.71	3.62	2.06	236	14	3.9	4.5	yellow/brown	0 / out of park	Howry Creek
David	406.3	2856.61*	32.52	4.55	238	24.4*	7	10.2	blue/green	2 / 15	Mahzenazing
Deacon	36.9	139.47	3.42	1.59	224	7.1	3.8	3.8	yellow/brown	0 / 2	Mahzenazing
de Lamorandiere	5.9	11.55*	1.69	1.96	286	7.6*	2	5	blue/green	0 / 0	Chikanishing
East Howry	71.7	427.82	7.28	2.43	234	20	6	4	yellow/brown	2 / out of park	Howry Creek
Fish	115.4	437.27*	12.44	3.27	212	8.5*	3.8	4.5	yellow/brown	0 / 2	Howry Creek
Fox	42.3	197.32	3.83	1.66	226	10	4.7	3	yellow/brown	0 / 1	Mahzenazing
Frank	15.6	39.16	3.46	2.47	236	8.6	2.5	2.5	yellow/brown	0 / 0	Mahzenazing
Freeland	47.7	50.5	6.04	2.46	191	3.5	1.1	3	blue/green	0 / 0	Chikanishing
Gail	20.9	89.76*	2.84	1.75	255	16.8*	4.3	10.5	blue/green	0 / 1	Howry Creek
Gem	30.7	250.23*	5.59	2.85	205	19.2*	8.2	4	yellow/brown	0 / 0	Howry Creek
George	188.5	3085.89*	13.46	2.76	189	36.6*	16.4	9	blue/green	0 / 5+campground	Chikanishing
Goose	10.1	no map	2.04	1.81	214	2.0 (best estimate)	no map	2.0 (bottom)	yellow/brown	0 / 0	Howry Creek
Goschen	24.1	69.46	2.6	1.49	235	5.6	2.9	3	yellow/brown	0 / 0	Mahzenazing
Grace	47.2	291.09	5.66	2.32	251	17.2	6.2	11.8	blue/green	0 / 2	Grace
Great Mountain	198.3	1970.29*	15.77	3.16	231	37.5*	9.9	7	blue/green	2 / 3	Howry Creek
Grey	31.8	171.1	6.27	2.8	228	11.8	5.4	5	yellow/brown	0 / out of park	Mahzenazing

Table 9 (cont.). Physical characteristics of biological survey lakes. Volumes obtained from old lake survey contour maps that were digitized and fitted to OBM lake outlines are indicated by *. Maximum depths obtained from Ontario Lake Survey Database indicated by * .

Lake	Surface Area (ha)	Volume ($10^6 m^3$)	Perimeter (km)	Shoreline develop. factor	Elevation (m)	Maximum depth (m)	Mean depth (m)	Secchi depth (m)	Water colour	Number of cottages/campsites	Watershed
Grow	13.1	69.39	2.2	1.72	217	9	5.3	3.7	yellow/brown	0 / 1	Howry Creek
Harwood	32	166.5	5.72	2.85	222	12	5.2	5	yellow/brown	0 / 2	Howry Creek
Harry	133.6	597.11	12.96	3.17	229	12.5	4.5	2.5	yellow/brown	0 / 4	Mahzenazing
Heaven	1.7	9.31	0.55	1.19	305	17.8	5.5	3	yellow/brown	0 / 1	Chikanishing
Helen	82.6	1692.01*	6.3	1.96	187	41.2*	20.5	5.8	yellow/brown	1 / 3	McGregor Bay
Hemlock	3.3	8.48	0.75	1.16	225	4.5	2.6	4.5 (bottom)	blue/green	0 / 0	Chikanishing
Howry	118.1	1417.53*	10.83	2.81	198	27.5*	12.0	4	yellow/brown	1 / 2	Howry Creek
Ishmael	72.8	820.27*	7.78	2.57	185	19.8*	11.3	4.5	yellow/brown	1 / 3	McGregor Bay
Johnnie	342.3	3417.66*	33.81	5.16	206	33.6*	10.0	5.5	yellow/brown	11+1 lodge / 7	Mahzenazing
Kakakise	112.6	1524.40*	10.77	2.86	189	30.5*	13.5	6.5	blue/green	1 / 3	Chikanishing
Kidney	2.9	no map	0.75	1.24	225	1.8	no map	1.8 (bottom)	colourless	0 / 0	Chikanishing
Killarney	326.5	3535.30*	28.88	4.51	200	61.0*	10.8	9.6	blue/green	0 / 11	Chikanishing
Lake of the Woods	9.7	23.77	1.9	1.72	215	6.0	2.5	6.0 (bottom)	yellow/brown	0 / out of park	Mahzenazing
Leech	92.2	223.02	14.42	4.24	221	7.9	2.4	3.5	yellow/brown	0 / 2	Howry Creek
Little Bell	21.1	94.27	3.65	2.24	228	7.2	4.5	2.5	yellow/brown	0 / 1	Mahzenazing
Little Leech	9.8	51.10	1.74	1.57	222	6.0	5.2	3.3	yellow/brown	0 / out of park	Howry Creek
Little Mink	18.7	88.40	2.40	1.57	218	7.7	4.7	5.6	blue/green	0 / 0	Howry Creek
Little Mountain	23.6	269.71*	2.24	1.3	234	25.0*	11.4	9.5	blue/green	0 / 1	Howry Creek
Little Sheguiandah	4.5	7.43*	1.11	1.48	190	2.7*	1.7	2.8	colourless	0 / 1	Chikanishing
Little Superior	13.9	179.28*	1.87	1.42	275	33.6*	12.9	23.9	blue/green	0 / 1	Chikanishing
Log Boom	6.9	23.55*	1.58	1.70	214	5.5*	3.4	4.2	yellow/brown	0 / 0	Mahzenazing

Table 9 (cont.). Physical characteristics of biological survey lakes. Volumes obtained from old lake survey contour maps that were digitized and fitted to OBM lake outlines are indicated by *. Maximum depths obtained from Ontario Lake Survey Database indicated by * .

Lake	Surface Area (ha)	Volume ($10^6 m^3$)	Perimeter (km)	Shoreline develop. factor	Elevation (m)	Maximum depth (m)	Mean depth (m)	Secchi depth (m)	Water colour	Number of cottages/campsites	Watershed
Low	33.8	485.13*	4.01	1.95	182	28.4*	14.4	7.9	yellow/brown	0 / 1	McGregor Bay
Lumsden	23.8	215.17	2.43	1.41	241	21.8	9	7.2	blue/green	0 / 2	Chikanishing
Mink	30.5	52.51	4.55	2.32	222	5	1.7	3.2	yellow/brown	0 / 0	Howry Creek
Muriel	31.7	190.15*	4.28	2.14	189	12.2*	6	10.9	blue/green	0 / 2	Baie Fine
Murray	93	178.09	14.3	4.18	197	6.4	1.9	5	yellow/brown	0 / 3	Howry Creek
Nellie (includes Carmichael)	260.5	4992.27*	16.71	2.92	267	54.9*	19.2	27	blue/green	0 / 3	Howry Creek
Norway	63.3	957.20*	6.47	2.29	205	33.6*	15.1	10.5	blue/green	0 / 3	Chikanishing
O.S.A.	278.9	3340.77*	14	2.37	205	39.7*	12.0	16	blue/green	0 / 5	Baie Fine
Partridge	11	68.12*	1.64	1.4	206	16.9*	6.2	13	blue/green	0 / 0	Chikanishing
Patten	11.9	26.21*	1.88	1.54	196	6.4*	2.2	6.3	blue/green	0 / 0	McGregor Bay
Pearl	2.6	10.21	0.67	1.17	225	6.4	3.9	6.4(bottom)	blue/green	0 / 0	Baie Fine
Peter	132.4	1703.65	9.68	2.37	227	30.5*	12.9	5.0	yellow/brown	1 / out of park	Mahzenazing
Pike	32	83.23	5.05	2.53	226	9.1	2.6	1.8	yellow/brown	0 / 0	Mahzenazing
Proulx	12.0	118.76*	2.05	1.67	258	28.7*	9.9	21.7	blue/green	0 / 1	Chikanishing
Quartzite	15.7	96.08	1.97	1.40	321	46.2	6.1	26.0	blue/green	0 / 0	McGregor Bay
Rocky	42.9	141.1	6.6	2.84	215	14.6	3.3	5.7	yellow/brown	0 / 1	Howry Creek
Roque	2.8	7.54*	0.88	1.48	312	10.1*	2.7	4	colourless	0 / 0	Chikanishing
Round Otter	20.4	80.72	4.15	2.59	208	7	4.0	1.5	yellow/brown	0 / 0	Howry Creek
RuthRoy	54.5	234.81*	6.05	2.31	214	18*	4.3	10.5	blue/green	0 / 2	Mahzenazing
Sandy	21.6	187.26*	2.62	1.59	217	15.9*	8.7	7	blue/green	0 / 1	Chikanishing

Table 9 (cont.). Physical characteristics of biological survey lakes. Volumes obtained from old lake survey contour maps that were digitized and fitted to OBM lake outlines are indicated by *. Maximum depths obtained from Ontario Lake Survey Database indicated by * .

Lake	Surface Area (ha)	Volume ($10^6 m^3$)	Perimeter (km)	Shoreline develop. factor	Elevation (m)	Maximum depth (m)	Mean depth (m)	Secchi depth (m)	Water colour	Number of cottages/campsites	Watershed
Sealey's	9.4	7.55	2.42	2.23	198	4.1	0.8	1.5	yellow/brown	0 / 1	Chikanishing
Shingwak	5.3	50.69	1.11	1.36	290	21.8	9.6	20.6	blue/green	0 / 0	Chikanishing
Silver	6.2	9.85	1.65	1.87	295	5	1.6	3.8	yellow/brown	0 / 2	Mahzenazing
Solomon	8.3	9.48*	2.52	2.47	297	4.9*	1.1	3.5	colourless	0 / 0	Chikanishing
Spark	12.3	58.06	2.19	1.78	275	20.3	4.8	9.5	blue/green	0 / 0	Baie Fine
Teardrop	3.4	32.51	0.79	1.21	325	16.6	9.6	11.5	blue/green	0 / 0	Baie Fine
Terry	11.5	36.03	1.69	1.41	207	8.0*	3.1	2.5	yellow/brown	0 / 1	Mahzenazing
Threenarrows	810.1	11772.17*	88.98	8.82	195	51.9*	14.5	6.5	blue/green	10 / 19	McGregor Bay
Topaz	4.7	57.11*	0.83	1.08	255	21.4*	12.2	19	blue/green	0 / 1	Baie Fine
TriLakes North	12.8	26.21	2.13	1.68	226	5	2	2.3	yellow/brown	0 / out of park	Howry Creek
TriLakes Southeast	17.5	42.29	2.38	1.61	226	5.5	2.4	2.2	yellow/brown	0 / out of park	Howry Creek
TriLakes Southwest	10.4	49.71	1.62	1.42	229	11.9	4.8	1.2	yellow/brown	0 / out of park	Howry Creek
Turbid	20.7	69.43	3.45	2.28	215	9.1	3.8	6.5	yellow/brown	0 / out of park	Mahzenazing
Turtleback	5.4	24.80	1.14		280	13.8	4.6	6.4	blue/green	0 / 0	Howry Creek
Van	14.7	28.96	2.32	1.71	226	4.9	2.0	2.8	yellow/brown	0 / 1	Howry Creek
Van Winkle	85.2	639.01	8.79	2.68	229	19	7.5	7.8	blue/green	0 / 3	Howry Creek
Wagon Road	5.2	8.87	1.24	1.53	206	4.2	1.7	1.5	yellow/brown	0 / 2	Chikanishing
Whiskeyjack	12.8	245.27*	1.71	1.35	275	42.7*	19.2	22	blue/green	0 / 0	Chikanishing
York	39.1	520.22	5.64	2.55	198	20.4	13.3	4.5	yellow/brown	0 / 1	McGregor Bay
#6	2.4	8.57	0.63	1.15	235	5.8	3.6	2.3	yellow/brown	0 / 0	Mahzenazing

Table 9 (cont.). Physical characteristics of biological survey lakes. Volumes obtained from old lake survey contour maps that were digitized and fitted to OBM lake outlines are indicated by *. Maximum depths obtained from Ontario Lake Survey Database indicated by * .

Lake	Surface Area (ha)	Volume ($10^6 m^3$)	Perimeter (km)	Shoreline develop. factor	Elevation (m)	Maximum depth (m)	Mean depth (m)	Secchi depth (m)	Water colour	Number of cottages/campsites	Watershed
#7	2.8	14.59	0.71	1.20	235	9.5	5.2	1.8	yellow/brown	0 / 0	Mahzenazing
#9	1.3	0.70	0.63	1.56	335	2.2	0.5	2.2 (bottom)	yellow/brown	0 / 0	Mahzenazing
#24	3	17.30	0.93	1.52	348	12.0	5.8	11.8 (bottom)	blue/green	0 / 0	McGregor Bay
#25	1.2	no map	0.51	1.31	355	1.5	no map	1.5 (bottom)	colourless	0 / 0	Chikanishing
#27	3.1	11.87	1.09	1.75	328	8.1	3.8	8.1 (bottom)	blue/green	0 / 0	Chikanishing
#28	2.5	6.51	0.8	1.43	340	6.6	2.6	5.6 (bottom)	blue/green	0 / 0	Chikanishing
#29	2.4	18.79	0.57	1.04	337	18.8	7.8	8.3	blue/green	0 / 0	Chikanishing
#30	2.5	5.21	0.67	1.2	309	5.4	2.1	5.2 (bottom)	blue/green	0 / 0	Chikanishing
#37A	17.6	125.18	2.52	1.69	205	16	7.1	5	yellow/brown	0 / 1	McGregor Bay
#45	4.4	4.75	0.87	1.17	235	2.7	1.1	1.1	yellow/brown	0 / 0	Howry Creek
#59	48.5	514.15*	4.89	1.98	195	24.4	10.6	2.5	yellow/brown	0 / 1	McGregor Bay
#64	3.6	2.62	1.52	2.26	285	2.5	0.7	2.2	yellow/brown	0 / 0	Chikanishing
#65	2.6	5.48	0.9	1.57	309	6.4	2.1	4.7	blue/green	0 / 0	Chikanishing
#66	2	6.19	0.88	1.60	315	11.7	3.1	5	blue/green	0 / 0	Chikanishing
#69	2.2	5.51	0.85	1.62	274	4.6	2.5	4.5 (bottom)	blue/green	0 / 1	Chikanishing
#74	11.8	72.88	2.12	1.74	199	15.1	6.2	1.8	yellow/brown	0 / 0	McGregor Bay
#76	8.7	30.63	1.21	1.16	182	6.5	3.5	2.6	yellow/brown	0 / 0	McGregor Bay

Status of Fish Communities

A total of 57,750 fish representing 28 species were caught during the survey (Tables 10 and 11). The number of species caught per lake ranged from 0 to 14, with a mean of 4.1 and a median of 3.0 (Figure 17). Among the major basins, the median species richness varied from 0 for Chikanishing to 6.5 for Howry Creek (Table 12). In the subset of 119 lakes that we surveyed, 43 lakes (pH 4.3-5.9) or 36% of the total are fishless and 23 of these are located within the Chikanishing drainage basin (Figure 18). All of the fishless lakes have watersheds that are underlain primarily by the Lorrain and Bar River Formations.

Two fish species were caught in over 3/4 of the 76 surveyed lakes that supported fish species: pumpkinseed (caught in 81.6% of the lakes) and yellow perch (caught in 78.9% of the lakes). Those two species accounted for 63% of the total catch by number. Ten species were caught in at least 1/3 of the lakes: bluegill, brown bullhead, golden shiner, largemouth bass, northern pike, pumpkinseed, rock bass, smallmouth bass, white sucker and yellow perch. These ten species accounted for 90.6% of the total catch by number.

The most acid-tolerant species, as suggested by their occurrence in lakes with pH<5.0, were bluegill, brook trout, brown bullhead, golden shiner, pumpkinseed, yellow perch. Species found only in lakes above pH 6.0 were slimy sculpin, johnnie darter, and some cyprinids.

Twenty-seven of the lakes have been stocked with fish (Table 13). Most of the stocking was done in the 1950's and 1960's, when many of the lakes were acidifying, suggesting that the action was taken to bolster declining fish stocks. Attempts to introduce non-native species (rainbow trout, pink salmon) were unsuccessful. There is a record of muskellunge being stocked in George Lake, but local residents do not recall the species being native to that lake (B. Burke pers. comm.). The more recent stockings in the 1980's and 1990's took place following water quality improvements and were done in an effort to reintroduce extirpated species.

Brook trout have been stocked in Sudbury District for several decades, since at least 1920 and the natural distribution of the species prior to that time is unknown (Dolson and Liimatainen 1989). During the survey brook trout were captured in both Grey and Turbid Lakes, but the populations in these connnected lakes may have been established by the stocking of Grey Lake in 1957 (Table 13). Both lakes are currently too acidic (pH $\leq$ 5.0) to support reproduction by the species (Beggs and Gunn 1986). However, the toxicity may be somewhat ameliorated by the moderately high DOC levels (3.2-3.4 mg/L) and the olivine diabase dykes that transect both lakes may create refugia of less acidic water. A self-sustaining brook trout population existed in the Chikanishing River until the late 1980's, but its origins are also uncertain.

Stocking of both largemouth bass and smallmouth bass has occured in 18 lakes (Table 13), but both species are native to the area. Smallmouth bass originally colonized during the late Pleistocene glaciation about 10,000 years ago when the water level in the Sudbury region was about 75 - 90 m higher than at present (Robbins and MacCrimmon 1974). Smallmouth bass

Table 10. List of fish species with pH range of lakes and frequency of occurence. pH range and number (%) of lakes was derived from a list of species obtained by all surveys done in these lakes during the 1990's. The total number captured refers only to the 1995-1997 survey.

Species	pH range of lakes	Number of lakes	% occurence in 76 lakes with fish	Total number captured
Blackchin shiner (Notropis heterodon)	6.6	1	1.3	2
Blacknose shiner (Notropis heterolepis)	6.7	1	1.3	1
Bluegill (Lepomis macrochirus)	4.7 - 7.6	32	42.1	6,803
Bluntnose minnow (Pimephales notatus)	5.8 - 7.2	23	30.3	548
Brook stickleback (Culaea inconstans)	5.5 - 6.1	5	6.6	282
Brook trout (Salvelinus fontinalis)	4.9 - 5.0	2	2.6	3
Brown bullhead (Amieurus nebulosus)	4.9 - 7.1	35	46.1	764
Central mudminnow (Umbra limi)	5.0 - 7.0	12	15.8	677
Cisco (Coregonus artedii)	5.4 - 7.2	21	27.6	1,622
Fathead minnow (Pimephales promelas)	5.5 - 6.6	5	6.6	31
Finescale dace (Phoxinus neogaeus)	6.0 - 6.1	2	2.6	included in Northern redbelly dace
Golden shiner (Notemigonus crysoleucas)	4.9 - 7.0	27	35.5	3,582
Iowa darter (Etheostoma exile)	5.6 - 7.2	20	26.3	40
Johnnie darter (Etheostoma nigrum)	6.1 - 7.2	3	3.9	3
Lake trout (Salvelinus namaycush)	5.6 - 7.2	11	14.5	55
Lake whitefish (Coregonus clupeaformis)	5.6 - 5.9	3	3.9	0
Largemouth bass (Micropterus salmoides)	5.4 - 7.2	26	34.2	288
Mimic shiner (Notropis volucellus)	6.4	1	1.3	5
Northern pike (Esox lucius)	5.5 - 7.0	32	42.1	403
Northern redbelly dace (Phoxinus eos)	5.5 - 7.1	8	10.5	2,165
Pumpkinseed (Lepomis gibbosus)	4.7 - 7.6	62	81.6	17,158
Rock bass (Ambloplites rupestris)	5.7 - 7.2	37	48.7	2,738
Rainbow smelt (Osmerus mordax)	7.2	1	1.3	0
Slimy sculpin (Cottus cognatus)	6.5 - 7.2	3	3.9	2
Smallmouth bass (Micropterus dolomieui)	5.6 - 6.6	26	34.2	364
Walleye (Stizostedion vitreum)	5.8 - 6.4	2	2.6	2
White sucker (Catostomus commersoni)	5.5 - 7.1	30	39.5	858
Yellow perch (Perca flavescens)	4.9 - 7.6	60	78.9	19,354
TOTAL	4.7 - 7.6	76	100	57,750

Table 11. List of fish species by lake. An * indicates the species was captured in the 1990's during other studies. Species captured during sweepnetting or in crayfish traps indicated by #. Species captured by angling indicated by "a".

Lake (1996 pH)	#	bcs	bns	blu	bnm	bst	bt	bb	cm	cis	fhm	fsd	gs	id	jd	lt	lw	lmb	ms	np	nrd	pum	rb	rs	ss	smb	wal	ws	yp
A.Y. Jackson (5.8)	4																					X	X			X			X
Acid (5.0)	0																												
Amikogaming (5.1)	0																												
Artist (5.7 - 1997)	6			X				X	X				X								X	X							
Batson (6.1)	11			X	X					X			X					X		X		X	X			X		X	X
Beaver (6.0)	3													X							X	X							
Bell (5.9)	12							X*		X*			X			X*	X*	X*		X		X	X			X		X*	X
Betty (7.0)	6			X									X					X				X						X	X
Billy (4.7)	2			X																		X							
Bizhiw (4.5)	0																												
Bodins (6.6)	7				X								X	X							X	X	X						X
Boundary (5.2)	3												X									X							X
Bunnyrabbit (4.8)	0																												
Burke (5.1)	0																												
Canis (6.4)	7							X	X				X							X		X						X	X
Carlyle (5.9)	9							X		X			X							X		X	X			X		X	X
Casson (7.6 -1997)	3			X																		X							X
Cat (6.4)	9			X	X									X#				X		X		X	X			X			X
Cave (5.6)	7			X				X						X				X				X						X	X
Chain (4.7)	0																												

bcs- blackchin shiner; bns-blacknose shiner; blu=bluegill; bnm bluntnose minnow; bs=brook stickleback; bt=brook trout; bb-brown bullhead; cm central mudminnow; cis-cisco; fhm-fathead minnow; fsd-finescale dace; gs=golden shiner; id iowa darter; jd-johnny darter; lt=lake trout; lw-lake whitefish; lmb=largemouth bass; ms=mimic shiner; np northern pike; nrd=northern redbelly dace; pum=pumpkinseed; rb- rock bass; rs = rainbow smelt; ss slimy sculpin; smb=smallmouth bass; wal-walleye; ws=white sucker; yp yellow perch

Table 11 (cont.). List of fish species by lake. An * indicates the species was captured in the 1990's during other studies. Species captured during sweepnetting or in crayfish traps indicated by #. Species captured by angling indicated by "a".

Lake (1996 pH)	#	bcs	bns	blu	bnm	bst	bt	bb	cm	cis	fhm	fsd	gs	id	jd	lt	lw	lmb	ms	np	nrd	pum	rb	rs	ss	smb	wal	ws	yp
Clearsilver (4.9)	0																												
Cranberry Bog (6.1)	5					X		X					X	X							X								
Crater East (5.9)	0																												
Crater West (5.4)	0																												
Cuckoo(6.6)	6			X				X										X								X		X	X
David (5.0)	1																												X
Deacon (5.9)	10			X	X			X					X					X		X		X	X					X	X
deLamorandiere(5.0)	0																												
East Howry (7.1)	8			X	X			X		X								X				X						X	X
Fish (5.7)	10			X									X	X#				X		X		X	X			X		X	X
Fox (6.2)	7				X				X									X		X		X	X						X
Frank (6.2)	5							X					X									X						X	X
Freeland (5.5)	10					X		X	X		X		X							X	X	X						X	X
Gall (4.6)	0																												
Gem (6.1)	10				X			X		X					X					X		X	X			X		X	X
George (5.8)	11				X	X#		X		X*						X*	X*			X		X	X					X	X
Goose (6.2)	6			X				X						X						X		X							X
Goschen (6.2)	7												X					X		X		X	X					X	X
Grace (5.1)	1																					X							
Great Mountain(5.4)	3									X								X				X							

bcs=blackchin shiner; bns=blacknose shiner; blu=bluegill; bnm=bluntnose minnow; bs=brook stickleback; bt=brook trout; bb=brown bullhead; cm =central mudminnow; cis=cisco; fhm=fathead minnow; fsd=finescale dace; gs=golden shiner; id=iowa darter; jd=johnny darter; lt=lake trout; lw=lake whitefish; lmb=largemouth bass; ms=mimic shiner; np=northern pike; nrd=northern redbelly dace; pum=pumpkinseed; rb=rock bass; rs = rainbow smelt; ss =slimy sculpin; smb=smallmouth bass; wal=walleye; ws=white sucker; yp =yellow perch

Table 11 (cont.). List of fish species by lake. An * indicates the species was captured in the 1990's during other studies. Species captured during sweepnetting or in crayfish traps indicated by #. Species captured by angling indicated by "a".

Lake (1996 pH)	#	bcs	bns	blu	bnm	bst	bt	bb	cm	cis	fhm	fsd	gs	id	jd	lt	lw	lmb	ms	np	nrd	pum	rb	rs	ss	smb	wal	ws	yp
Grey (4.9)	3			X			X															X							
Grow (6.6)	6			X																		X	X			X		X	X
Hanwood (6.4)	3																					X	X			X			
Harry (6.3)	9				X				X				X					X		X		X	X			X			X
Heaven (4.8)	0																												
Helen (6.3)	11			X	X			X*		X				X#		X						X	X		X*	X			X
Hemlock (4.7)	0																												
Howry (6.3)	9			X				X		X										X		X	X			X		X	X
Ishmael (6.5)	10			X	X					X				X		X				X		X	X			X			X
Johnnie (5.6)	11							X		X			X			X	X*			X		X	X			X		X	X
Kakakise (6.3)	12				X				X#	X*	X		X	X		X*				X		X	X			X			X
Kidney (5.3)	0																												
Killarney (5.1)	4							X	X													X							X
Lake of the Woods (4.9)	3			X																		X							X
Leech (6.9 - 1997)	5							X						X								X	X			X			
Little Bell (4.6)	0																												
Little Leech (7.1 -1997)	4			X										seen							X	X							
Little Mink (6.7)	9			X				X					X					X		X		X	X					X	X
Little Mountain(5.1)	0																												

bcs=blackchin shiner; bns=blacknose shiner; blu=bluegill; bnm=bluntnose minnow; bs=brook stickleback; bt=brook trout; bb=brown bullhead; cm=central mudminnow; cis=cisco; fhm=fathead minnow; fsd=finescale dace; gs=golden shiner; id=iowa darter; jd=johnny darter; lt=lake trout; lw=lake whitefish; lmb=largemouth bass; ms=mimic shiner; np=northern pike; nrd=northern redbelly dace; pum=pumpkinseed; rb=rock bass; rs = rainbow smelt; ss=slimy sculpin; smb=smallmouth bass; wal=walleye; ws=white sucker; yp=yellow perch

Table 11 (cont.). List of fish species by lake. An * indicates the species was captured in the 1990's during other studies. Species captured during sweepnetting or in crayfish traps indicated by #. Species captured by angling indicated by "a".

Lake (1996 pH)	#	bcs	bns	blu	bnm	bst	bt	bb	cm	cis	fhm	fsd	gs	id	jd	lt	lw	lmb	ms	np	nrd	pum	rb	rs	ss	smb	wal	ws	yp
Little Shagamah(6.1)	6							X					X									X	X					X	X
Little Superior (4.3)	0																												
Log Boom (5.5)	5												X							X		X						X	X
Low (7.2)	14			X	X					X				X	X	X		X				X	X	X*	X*	X		X	X
Lumsden (5.2)	0																												
Mink (6.3)	9			X	X			X					X	X				X				X						X	X
Muriel (5.1)	3							X														X							X
Murray (6.2)	10			X	X			X					X					X		X		X	X					X	X
Nellie /Carmichael (4.6)	0																												
Norway (5.1)	2								X																				X
O.S.A. (4.8)	0																												
Partridge (5.7)	1																												X
Patten (5.1)	1																												X
Pearl (5.3)	1							X																					
Peter (6.5)	10							X		X				X		X		X		X		X	X			X			X
Pike (5.6)	10				X#			X					X					X		X		X	X			Xa		X	X
Proulx (4.5)	0																												
Quartzite (4.8)	0																												
Rocky (6.6)	10	X		X				X						X						X		X	X			X		X	X

bcs -blackchin shiner; bns=blacknose shiner; blu=bluegill; bnm=bluntnose minnow; bs=brook stickleback; bt=brook trout; bb=brown bullhead; cm=central mudminnow; cis=cisco; fhm=fathead minnow; fsd=finescale dace; gs=golden shiner; id=iowa darter; jd=johnny darter; lt=lake trout; lw=lake whitefish; lmb=largemouth bass; ms=mimic shiner; np=northern pike; nrd=northern redbelly dace; pum=pumpkinseed; rb=rock bass; rs = rainbow smelt; ss=slimy sculpin; smb=smallmouth bass; wal=walleye; ws=white sucker; yp=yellow perch

Table 11 (cont.). List of fish species by lake. An * indicates the species was captured in the 1990's during other studies. Species captured during sweepnetting or in crayfish traps indicated by #. Species captured by angling indicated by "a".

Lake (1996 pH)	#	bcs	bns	blu	bnm	bst	bt	bb	cm	cis	fhm	fsd	gs	id	jd	lt	lw	lmb	ms	np	nrd	pum	rb	rs	ss	smb	wal	ws	yp
Roque (5.0)	0																												
Round Otter (6.2)	10			X	X			X						X				X		X		X	X					X	X
RuthRay (4.9)	0																												
Sandy (5.1)	1																												X
Sealey's (6.1)	5					X			X		X	X									X								
Shingwak (4.7)	0																												
Silver (5.0)	0																												
Solomon (5.6)	0																												
Spark (4.5)	0																												
Teardrop (6.5)	2															X									X				
Terry (5.4)	3							X														X							X
Threearrows (5.8)	10			X	X					X						X				X		X	X			X	X		X
Topaz (4.6)	0																												
TriLakes N (6.7)	7		X					X					X							X		X						X	X
TriLakes SE (6.5)	7			X				X										X		X		X	X						X
TriLakes SW (6.3)	3																	X				X							X
Turbid (5.0)	4			X			X															X							X
Turtleback (5.1)	0																												
Van(6.2)	9				X					X				X				X				X	X			X		X	X
Van Winkle (6.6)	11			X	X					X	X			X				X		X		X	X			X			X
Wagon Road (6.0)	5					X			X		X	X									X								

bcs=blackchin shiner; bns=blacknose shiner; blu=bluegill; bnm=bluntnose minnow; bs=brook stickleback; bt=brook trout; bb=brown bullhead; cm=central mudminnow; cis=cisco; fhm=fathead minnow; fsd=finescale dace; gs=golden shiner; id=iowa darter; jd=johnny darter; lt=lake trout; lw=lake whitefish; lmb=largemouth bass; ms=mimic shiner; np=northern pike; nrd=northern redbelly dace; pum=pumpkinseed; rb=rock bass; rs=rainbow smelt; ss=slimy sculpin; smb=smallmouth bass; wal=walleye; ws=white sucker; yp=yellow perch

Table 11 (cont.). List of fish species by lake. An * indicates the species was captured in the 1990's during other studies. Species captured during sweepnetting or in crayfish traps indicated by #. Species captured by angling indicated by "a".

Lake (1996 pH)	#	bcs	bns	blu	bnm	bst	bt	bb	cm	cis	fhm	fsd	gs	id	jd	lt	lw	lmb	ms	np	nrd	pum	rb	rs	ss	smb	wal	ws	yp
Whiskeyjack (4.6)	0																												
York (6.1)	11			X	X			X		X				X	X					Xa		X	X			X			X
#6 (4.5)	0																												
#7 (5.0)	2							X	X																				
#9 (4.9)	0																												
#24 (4.8)	0																												
#25 (4.8)	0																												
#27 (5.1)	0																												
#28 (4.9)	0																												
#29 (4.3)	0																												
#30 (4.8)	0																												
#37 (6.2)	6			X	X					X								X					X						X
#45 (4.9)	3							X					X																X
#59 (5.7)	14			X	X			X		X			X			X			X	X		X	X			X	X	X	X
#64 (5.3)	0																												
#65 (5.5)	0																												
#66 (5.3)	0																												
#69 (5.0)	0																												
#74 (6.1)	4												X									X	X						X
#76 (7.0)	6								X#				X					Xa		X		X							X

bcs=blackchin shiner; bns=blacknose shiner; blu=bluegill; bnm=bluntnose minnow; bs=brook stickleback; bt=brook trout; bb=brown bullhead; cm=central mudminnow; cis=cisco; fhm=fathead minnow; fsd=finescale dace; gs=golden shiner; id=iowa darter; jd=johnny darter; lt=lake trout; lw=lake whitefish; lmb=largemouth bass; ms=mimic shiner; np=northern pike; nrd=northern redbelly dace; pum=pumpkinseed; rb=rock bass; rs = rainbow smelt; ss=slimy sculpin; smb=smallmouth bass; wal=walleye; ws=white sucker; yp=yellow perch

Figure 17. Frequency distribution of fish species richness

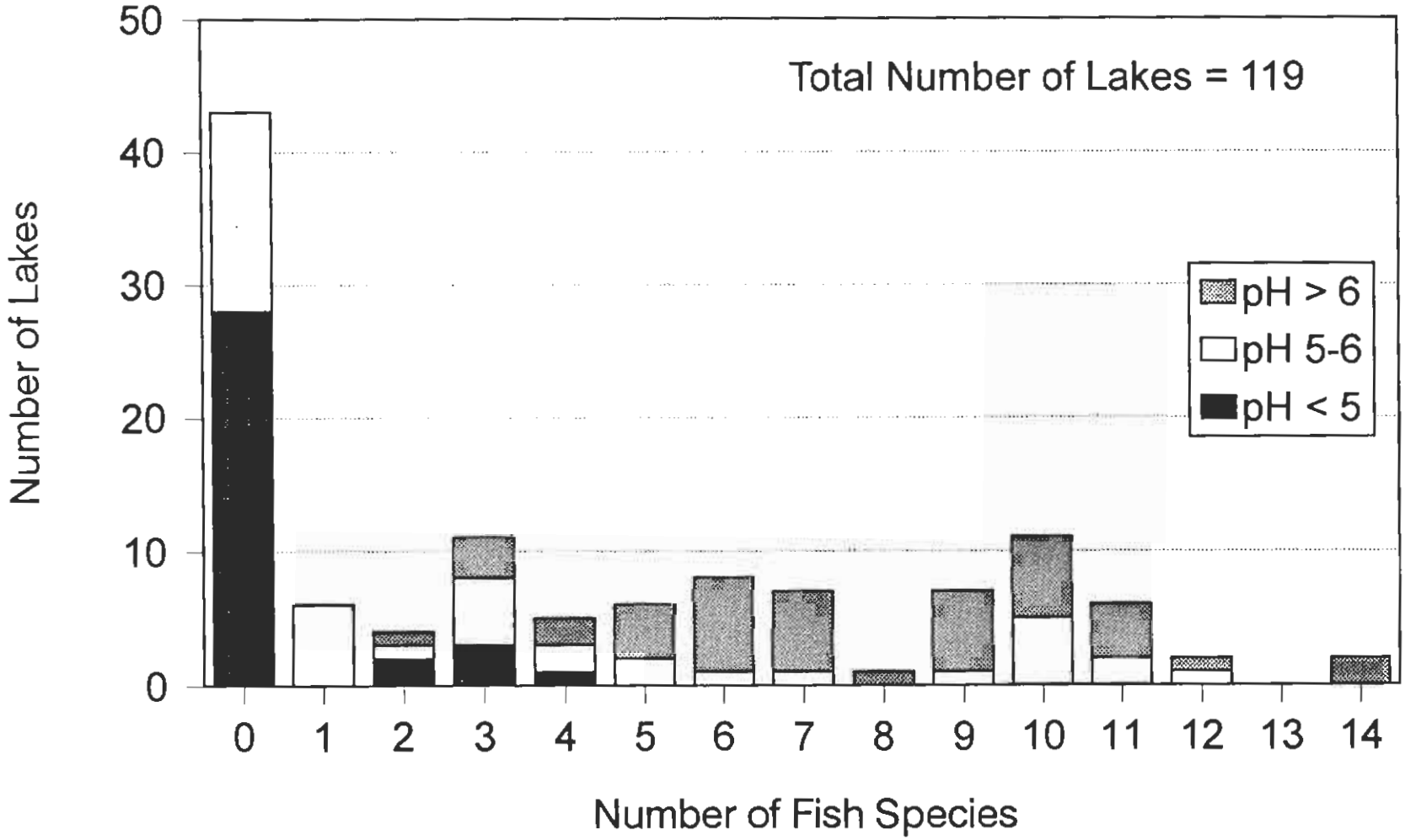


Table 12. Fish species richness of lakes by drainage basin.

Drainage Basin (Number Lakes Sampled)	Total Number Fish Species	Number Fish Species / Lake			Number Fish Species Unique to Drainage
		Range	Mean	Median	
Baie Fine (9)	12	0-7	2.1	1.0	0
Chikanishing (35)	18	0-12	1.9	0.0	2 (brook stickleback, finescale dace)
Grace (1)	1	1	1	-	0
Howry Creek (30)	18	0-11	6.0	6.5	2 (blackchin shiner, blacknose shiner)
Mahzenazing (27)	17	0-12	4.5	3.0	1 (brook trout)
McGregor Bay (17)	23	0-14	6.0	6.0	3 (mimic shiner, rainbow smelt, walleye)
All combined (119)	28	0-14	4.1	3.0	-

Figure 18. Location of fishless lakes

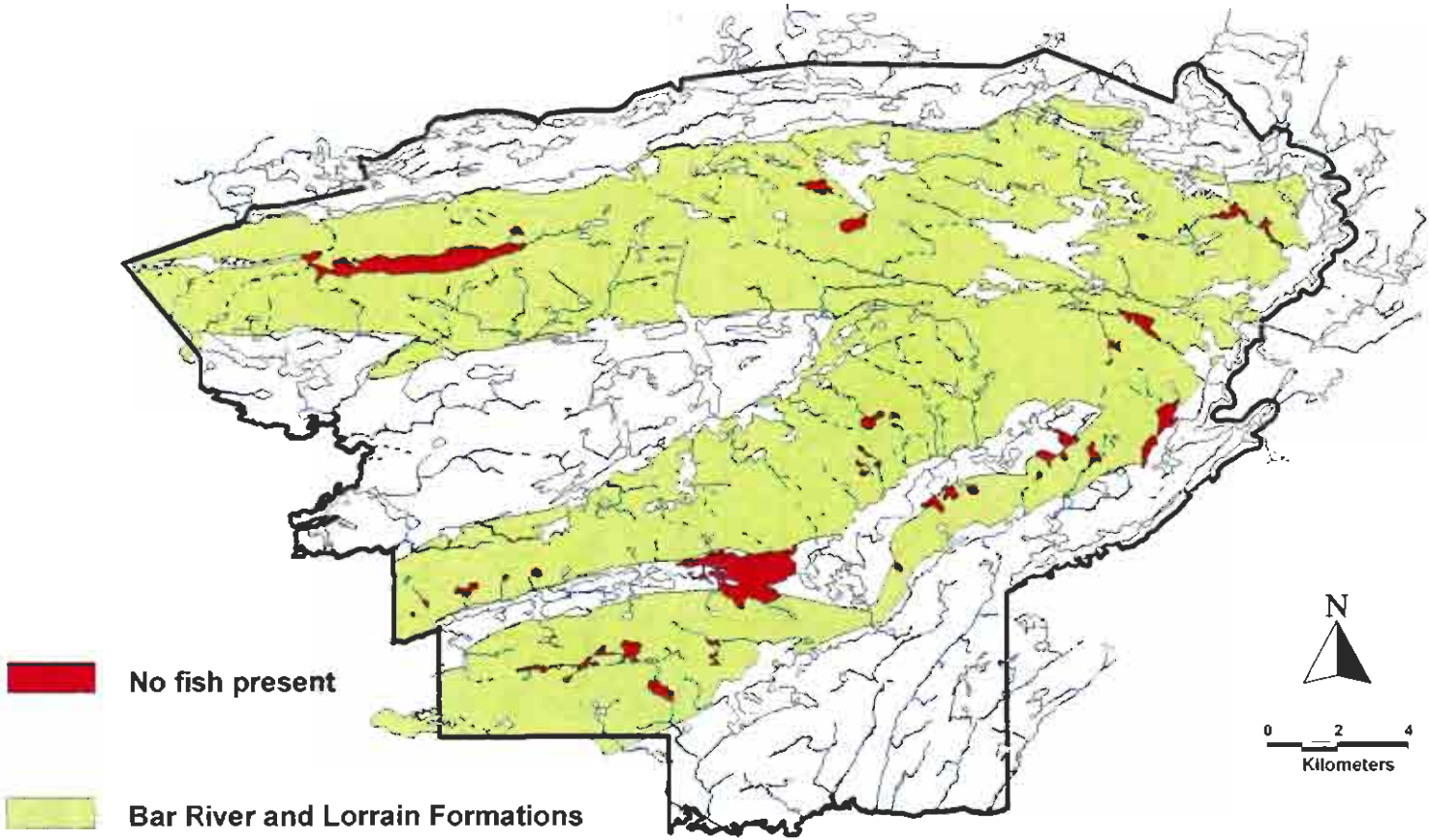


Table 13. Fish stocking in biological survey lakes recorded by Ontario Ministry of Natural Resources.

Lake name	Year stocked	Species stocked
Acid	1986	Smallmouth bass
A.Y. Jackson	1984 1986	Brook trout Smallmouth bass
Balsam	1962, 1966, 1969	Smallmouth bass
Beaver	1965	Rainbow trout
Bell	1962, 1964, 1966, 1969 1984-89, 1992	Smallmouth bass Lake trout
Boundary	1966	Smallmouth bass
Carlyle	1956, 1960, 1962, 1967 1962	Smallmouth bass Walleye
Clearsilver	1965, 1967 1967	Brook trout Smallmouth bass
David	1965	Smallmouth bass
Deacon	1966	Largemouth bass
Fox	1966	Largemouth bass
George	1960-62, 1966-67, 1969-70, 1977, 1984 1962, 1967 1961 1962 1977, 1984-85, 1989-90, 1992	Smallmouth bass Muskellunge Lake whitefish Walleye Lake trout
Grey	1957 1962, 1966	Brook trout Rainbow trout
Harwood	1968, 1971	Rainbow trout
Johnnie	1953, 1956, 1966-68 1953, 1956 1964 1964, 1992	Smallmouth bass Walleye Brook trout Lake trout
Kalalise	1962 1963, 1990 1966, 1969-70	Walleye Lake trout Smallmouth bass
Killarney	1960	Smallmouth bass
Lumsden	1966-67	Pink salmon
Muriel	1964	Brook trout
Norway	1956	Smallmouth bass
O.S.A.	1956, 1960	Smallmouth bass
Partridge	1986	Smallmouth bass
Peter	1984, 1985, 1989, 1990, 1992	Lake trout
Proulx	1970	Rainbow trout
RuthRoy	1961	Brook trout
Terry	1986	Smallmouth bass
Threenarrows (includes #59)	1955	Lake trout

populated the Algoma region at heights 60 m above present-day Lake Huron levels (Robbins and MacCrimmon 1974). Therefore, the smallmouth bass populations in park lakes between 177 m (current Lake Huron water level) and 237 m elevation were probably native. A self-sustaining smallmouth bass population was re-established in A.Y. Jackson Lake following water quality recovery by stocking 22 adults in 1986 (Snucins and Shuter 1991). Smallmouth bass were reintroduced to George Lake in 1997 by transferring 24 fish from Kakakise Lake.

Based on our survey results and historical information, there are 24 lake trout lakes in the Killarney Park watershed. They are the following: Acid, Bell, Burke, David, de Lamorandiere, George, Grace, Great Mountain, Helen, Ishmael, Johnnie, Kakakise, Killarney, Low, Lumsden, Nellie, Norway, O.S.A., Peter, RuthRoy, Solomon, Teardrop, Threenarrows, #59.

A total of 17 lakes within the Killarney watershed lost native lake trout populations (Table 14). The species has been reintroduced into three of those lakes (Bell, George, Johnnie). Deposition of fertilized eggs by the introduced lake trout was confirmed during 1995 in both George and Johnnie lakes. Native lake trout populations currently exist in 7 lakes (Helen, Ishmael, Kakakise, Low, Teardrop, Threenarrows, #59). Only three of those lakes (Threenarrows, #59, Kakakise) have ever been stocked with hatchery-reared lake trout (Table 13).

Teardrop Lake is the smallest waterbody (3.4 ha) in the province known to support a lake trout population. The existence of this population was unknown prior to 1996. Protein electrophoresis of muscle biopsy samples taken from 20 fish on October 30, 1996 was done by Bill Martin (OMNR Peterborough). The results revealed that the population contains a gene assemblage unique in Ontario. It also suggested that the population had experienced a genetic bottleneck at some time in the past, possibly when the lake was first colonized by a small number of individuals. Analysis of otoliths from four lake trout that died during the summer survey indicates that the fish have extremely slow growth rates (John Casselman, OMNR, Glenora).

Natural recolonization by fish is occurring in some lakes. Smallmouth bass have returned to Johnnie Lake; a single specimen (fork length 271 mm) was captured at the north end of the lake during a netting survey in 1984 (OMNR unpublished data) and in 1995 two young-of-the-year fish were captured in a plexiglass trap set by the mouth of the channel connecting with Carlyle Lake. The lake trout population in Johnnie Lake was re-established in 1992-1993 by emigration of stocked fish from Bell Lake. A northern pike was captured in Freeland Lake during 1997, the first record of that species in the lake since 1971 (Harvey and Lee 1980). The pike probably emmigrated from Kakakise Lake.

Great Mountain Lake contains largemouth bass as the a result of an unauthorized introduction that likely occured after the last netting assessment in 1985. The species is not native to the lake (D. MacHarg, D. Brown, pers. comm.).

Table 14. Known and probable fish losses from Killarney Park lakes. Native species captured in 1979 and not captured in 1995-1997 are indicated by *. These species are extirpated or may still be present but missed by our sampling.

Lake	Known and probable losses reported by Harvey and Lee (1980)	Native species not captured in 1995-1997	Comments
A.Y. Jackson	brook trout, largemouth bass, northern pike	Northern pike	Brook trout population was probably introduced and not native. Scarcity of typical largemouth bass habitat in the lake suggests that native species was smallmouth bass. Smallmouth bass were reintroduced in 1986.
Acid	cisco, lake trout	cisco, lake trout	
Amikogaming	smallmouth bass	smallmouth bass	
Bell	cisco, lake trout, largemouth bass		Lake trout reintroduced during 1980's. Cisco and largemouth bass either missed in 1979 survey or have recolonized from Balsam Lake.
Bodina		brook stickleback*	
Boundary	largemouth bass, smallmouth bass	largemouth bass, smallmouth bass	
Burke	lake trout	lake trout	
Carlyle	cisco, white sucker		Cisco and white sucker either missed in 1979 survey or have recolonized from Johnnie Lake.
Cave	iowa darter, northern redbelly dace	northern redbelly dace	
David		lake trout, lake whitefish*	Harvey and Lee (1980) did not capture lake trout in their survey and appeared to be unaware that the species was historically present. Polkinghorne and Gunn (1981) documented the historical occurrence of lake trout in the lake.
de Lamorandiere	lake trout	lake trout	
Fish		brown bullhead*	
Freeland	northern pike		Northern pike may have immigrated from Kakakise Lake.
Gem		bluegill*, iowa darter*	

Table 14 (cont.). Known and probable fish losses from Killarney Park lakes. Native species captured in 1979 and not captured in 1995-1997 are indicated by *. These species are extirpated or may still be present but missed by our sampling.

Lake	Known and probable losses reported by Harvey and Lee (1980)	Native species not captured in 1995-1997	Comments
George	burbot, muskellunge, smallmouth bass, trout perch, walleye	burbot, trout perch, walleye	Muskellunge not native (B Burke, pers. comm.), but were stocked in the 1960's. The two brook trout captured in 1979 were probably immigrants from the stocking of A.Y. Jackson Lake mentioned by Harvey and Lee (1980). The completed field summary forms in Appendix IV of Harvey and Lee (1980) do not indicate that any bluegills were captured in George Lake, suggesting that the listing (of bluegill occurrence in George Lake) in their table 11 was erroneous. Smallmouth bass reintroduced in 1997 after our survey.
Grace		cisco*, lake trout, lake whitefish*, white sucker*	Espanola District OMNR files contain record of lake trout.
Great Mountain	smallmouth bass	lake trout*, rock bass*, smallmouth bass, white sucker*	
Helen	northern pike	johnny darter*, northern pike	
Howry		banded killifish*, iowa darter*, rainbow darter*	
Ishmael	northern pike	brown bullhead*, johnny darter*, sculpin spp.*	
Johnnie	central mudminnow, cisco, lake trout, smallmouth bass	central mudminnow	Lake trout were reintroduced in 1992. Smallmouth bass are reinvading from Carlyle Lake. Cisco have reinvaded from either Carlyle Lake or Bell Lake, or were always present, but in low abundance and not captured during 1979 (Harvey and Lee 1980) or 1984 (Sudbury Basin Study) gill netting.
Kakakise	bluntnose minnow, central mudminnow, iowa darter, johnny darter, northern redbelly dace, walleye	brown bullhead*, johnny darter, northern redbelly dace, walleye, white sucker*	
Killarney	burbot, lake trout, smallmouth bass, walleye, white sucker	burbot, cisco*, lake trout, rock bass*, smallmouth bass, walleye, white sucker	
Little Sheguiandah	smallmouth bass, walleye	northern pike*, smallmouth bass, walleye	
Log Boom		brown bullhead*	

Table 14 (cont.). Known and probable fish losses from Killarney Park lakes. Native species captured in 1979 and not captured in 1995-1997 are indicated by *. These species are extirpated or may still be present but missed by our sampling.

Lake	Known and probable losses reported by Harvey and Lee (1980)	Native species not captured in 1995-1997	Comments
Low		golden shiner*, rainbow darter*	
Lumsden	burbot, cisco, lake chub, lake trout, slimy sculpin, trout perch, white sucker, yellow perch	burbot, cisco, lake chub, lake trout, slimy sculpin, trout perch, white sucker, yellow perch	Two lake chub were captured during 1983 CLS survey, but none during the two surveys done since then (1989 CLS survey, 1995 survey).
Muriel	brook trout, central mudminnow, cisco, golden shiner, lake whitefish, smallmouth bass, white sucker	central mudminnow, cisco, golden shiner, lake whitefish, rock bass*, smallmouth bass, white sucker	The brook trout were stocked, not native.
Nellie	lake trout	lake trout	
Norway	lake trout, smallmouth bass	lake trout, smallmouth bass	
O.S.A.	brown bullhead, cisco, lake trout, rock bass, smallmouth bass, yellow perch	brown bullhead, cisco, lake trout, rock bass, smallmouth bass, yellow perch	
Partridge	smallmouth bass	smallmouth bass	
Peter			Native lake trout extirpated. Current population consists of stocked fish.
Sandy	smallmouth bass	smallmouth bass	
Solomon	lake trout	lake trout	
Terry	rock bass	brown bullhead*, rock bass	
Threenarrows		brown bullhead*	
Topaz	pumpkinseed, yellow perch	pumpkinseed, yellow perch	
Turbid	largemouth bass	largemouth bass	
Whiskeyjack	smallmouth bass	smallmouth bass	

Fish Species Losses

Fish species currently known to be missing total 87 populations from 36 lakes (Table 14). The overall number of fish populations lost was estimated to be 262 for the 55 lakes that were biologically sampled, currently have pH < 6.0 and surface area > 3.4 ha (Table 15). This estimate of species losses assumes that the natural pH of the lakes was above 6.0, an assumption that could be challenged for some lakes. The estimated fish diversity for lakes 3.4 ha to 266.9 ha was based upon a regression derived from the 44 surveyed Killarney lakes with pH $\geq$ 6.0 and presumably unaffected by acidification (Number of species = 0.99 + 4.59 Log_{10}Area; $r^2 = 0.46$). Hanwood Lake was considered an outlier (> 2 SD; Figure 19) and not included in the regression equation. The estimated fish diversity for lakes > 266.9 ha was based upon the Matuszek et al (1990) regression (Log_{10}Number of species = 0.59 + 0.2 Log_{10}Area) for Ontario lakes 10-1585 ha in size with pH > 6.0. We sampled 20 acidified lakes that are < 3.4 ha surface area, but did not estimate species losses for those waterbodies because biological sampling was not done on any unacidified lakes in that size range.

The number of fish species that we observed in the 39 lakes with pH > 6.0 and surface area > 10 ha generally agreed with the output of the Matuszek et al (1990) regression equation (Figure 19). An exception was Hanwood Lake. Interestingly, three of the four other lakes with relatively low species diversity (ie. Leech, Beaver, Casson, TriLakes SW) are also near Hanwood Lake. Lake #59 had one of the more diverse fish communities and this may be related to the fact that it was once a part of Threenarrows Lake. The relatively high number of species captured in Low Lake is due at least in part to the additional species sampled during testing of the Nordic Standard nets.

Fishing Gear Effectiveness

There were 366 fish populations in the 54 lakes that were sampled with all gear types. The gear that sampled the greatest number of populations was the gillnet (Tables 16 and 17; Appendices F,G,H,I). The least effective gear was the 4 foot trap net. If trap nets had not been used, only 2 populations would have been undocumented. Gill nets and wire-mesh minnow traps, together sampled 331 populations (90% of the total).

The number of species captured differed between gear types: both the wire-mesh minnow traps and the plexiglass traps captured 20 species each; the gillnets caught 14 species; and the trapnets sampled 12 species. Hypolimnetic species (eg. cisco, lake trout) and some other species (eg. brown bullhead, white sucker) were sampled most effectively by the gillnets (Table 17). Small nearshore species (eg. cyprinids) were captured best by the wire-mesh minnow traps and plexiglass traps. The trap nets appeared to work as well or better than the other gears for only two species (largemouth bass, smallmouth bass).

The repeat sampling of Freeland Lake captured a greater number of species than the first visit

Table 15. Estimated number of fish species missing from lakes that were biologically sampled, currently have pH < 6.0 and area > 3.4 ha. Estimated fish diversity for lakes 3.4 to 266.9 ha in size based upon regression derived from 44 surveyed Killarney lakes with pH>6.0 (Number of Species = 0.99 + 4.59 Log_{10}Area). Estimated fish diversity for lakes > 266.9 ha based upon Matuszek et al. (1990) regression (Log_{10}Number of species = 0.59 + 0.2 Log_{10}Area) for Ontario lakes 10-1585 ha in size with pH > 6.0.

Lake name	Area (ha)	Observed Number Species	Estimated Number Species	Difference (Est. - Obs.)
#45	4.4	3	3.94	0.94
#64	3.6	0	3.54	3.54
Acid	19.6	0	6.92	6.92
Amikogaming	17.8	0	6.73	6.73
Artist	26.0	6	7.48	1.48
A.Y. Jackson	6.5	4	4.72	0.72
Bell	347.4	12	12.54	0.54
Billy	24.1	2	7.33	5.33
Boundary	93.3	3	10.03	7.03
Bunnyrabbit	12.7	0	6.06	6.06
Burke	8.4	0	5.23	5.23
Carlyle	156.7	9	11.07	2.07
Cave	12.4	7	6.01	-0.99
Chain	10.9	0	5.75	5.75
Clearsilver	30.9	0	7.83	7.83
David	406.3	1	12.94	11.94
Deacon	36.9	10	8.18	-1.82
de Lamorandiere	5.9	0	4.53	4.53
Fish	115.4	10	10.46	0.46
Freeland	47.7	10	8.69	-1.31
Gail	20.9	0	7.05	7.05
George	188.5	11	11.43	0.43
Grace	47.2	1	8.67	7.67

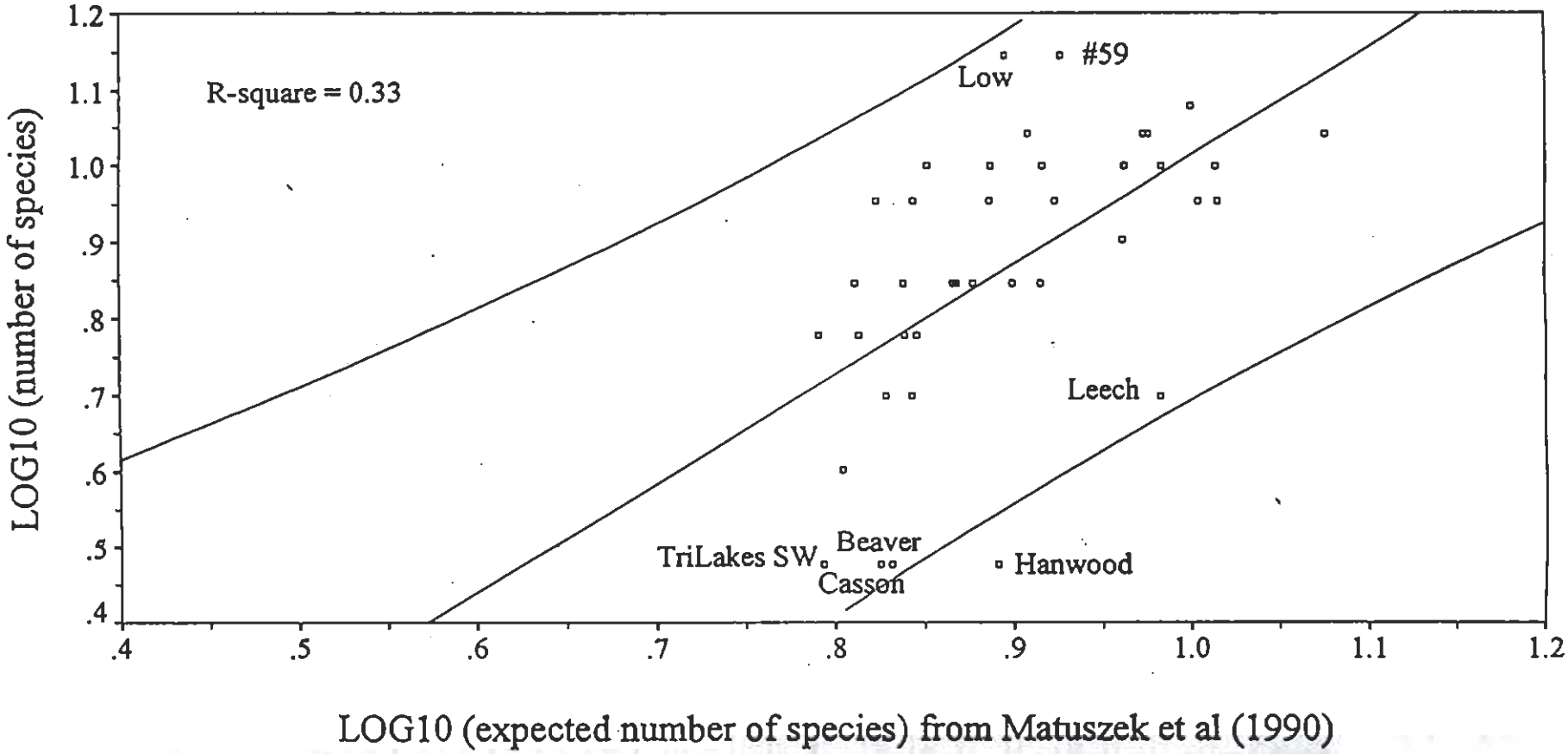
Table 15 (cont.). Estimated number of fish species missing from lakes that were biologically sampled, currently have pH < 6.0 and area > 3.4 ha. Estimated fish diversity for lakes 3.4 to 266.9 ha in size based upon regression derived from 44 surveyed Killarney lakes with pH>6.0 (Number of Species = 0.99 + 4.59 Log_{10}Area). Estimated fish diversity for lakes > 266.9 ha based upon Matuszek et al. (1990) regression (Log_{10}Number of species = 0.59 + 0.2 Log_{10}Area) for Ontario lakes 10-1585 ha in size with pH > 6.0.

Lake name	Area (ha)	Observed Number Species	Estimated Number Species	Difference (Est. - Obs.)
Great Mountain	198.3	3	11.53	8.53
Grey	31.8	3	7.89	4.89
Johnnie	342.8	11	12.50	1.50
Killarney	326.5	4	12.53	8.53
Lake of the Woods	9.7	3	5.52	2.52
Little Bell	21.1	0	7.07	7.07
Little Mountain	23.6	0	7.29	7.29
Little Superior	13.9	0	6.24	6.24
Log Boom	6.9	5	4.84	-0.16
Lumsden	23.8	0	7.31	7.31
Muriel	31.7	3	7.88	4.88
Nellie	260.5	0	12.08	12.08
Norway	63.3	2	9.26	7.26
O.S.A.	278.9	0	12.00	12.00
Partridge	11.0	1	5.77	4.77
Patten	11.9	1	5.93	4.93
Pike	32.0	10	7.9	-2.10
Proulx	12.0	0	5.94	5.94
Quartzite	15.7	0	6.48	6.48
RuthRoy	54.5	0	8.96	8.96
Sandy	21.6	1	7.12	6.12
Shingwak	5.3	0	4.31	4.31
Silver	6.2	0	4.63	4.63

Table 15 (cont.). Estimated number of fish species missing from lakes that were biologically sampled, currently have pH < 6.0 and area > 3.4 ha. Estimated fish diversity for lakes 3.4 to 266.9 ha in size based upon regression derived from 44 surveyed Killarney lakes with pH>6.0 (Number of Species = 0.99 + 4.59 Log_{10}Area). Estimated fish diversity for lakes > 266.9 ha based upon Matuszek et al. (1990) regression (Log_{10}Number of species = 0.59 + 0.2 Log_{10}Area) for Ontario lakes 10-1585 ha in size with pH > 6.0.

Lake name	Area (ha)	Observed Number Species	Estimated Number Species	Difference (Est. - Obs.)
Solomon	8.3	0	5.21	5.21
Spark	12.3	0	5.99	5.99
Terry	11.5	3	5.86	2.86
ThreeNarrows	810.1	10	14.85	4.85
Topaz	4.7	0	4.07	4.07
Turbid	20.7	4	7.03	7.03
Turtleback	5.4	0	4.35	4.35
Whiskeyjack	12.8	0	6.07	6.07
#64	3.6	0	3.5	3.5
TOTAL		153	415	262

Figure 19. Number of fish species sampled in Killarney lakes (pH >=6) versus number expected based upon lake area



Regression line and 95% confidence intervals shown

Table 16. Total number of fish populations captured by each gear type in the 54 lakes that were sampled with all gears. Total number of populations (ie. a species in a lake) in this set of lakes is 366.

Gear	Number of populations (% of total) sampled by gear	Number of populations (% of total) sampled exclusively by gear	
		including trapnet catch	excluding trapnet catch
Gill net	228 (62%)	58 (16%)	92 (25%)
Wire-mesh minnow trap	225 (61%)	25 (7%)	28 (8%)
Plexiglass trap	199 (54%)	12 (3%)	18 (5%)
4 foot Trap net	178 (49%)	2 (0.5%)	excluded
Other (angling, invertebrate gear, Nordic gill nets)	not summarized	15 (4%)	15 (4%)

Table 17. Number of populations, by species, captured by each gear in the 54 lakes fished with all gears. "Other" refers to species caught angling, in Nordic nets (N) or by invertebrate gear.

Species	Total number of populations in the 54 lakes	Number of populations captured by each gear				
		Gill net	Trap net	Plexiglas	Wire-mesh	Other
Blackchin shiner	1			1		
Blacknose shiner	1			1		
Bluegill	26	9	16	24	24	
Bluntnose minnow	21		2	14	20	1
Brook stickleback	2			1	2	
Brook trout	2	2				
Brown bullhead	24	21	13	6	5	1(N)
Central mudminnow	8			3	5	3
Cisco	15	15				
Fathead minnow	4			2	2	
Finescale dace	1			1	1	
Golden shiner	19	10	8	9	13	1
Iowa darter	15			4	9	4
Johnnie darter	3			1	2	
Lake trout	6	6				
Lake whitefish	0					
Largemouth bass	21	14	16	13	16	
Mimic shiner	1			1	1	
Northern pike	22	21	8	1	3	1
N. redbelly dace	4			4	2	
Pumpkinseed	46	28	36	45	42	
Rock bass	29	21	22	24	28	
Rainbow smelt	1					1(N)
Slimy sculpin	2					2(N)
Smallmouth bass	20	17	15	9	8	1
Walleye	2	2				
White sucker	24	24	17		1	
Yellow perch	46	38	25	35	41	
TOTAL	366	228	178	199	225	15

to the lake. Differences in amount of aquatic vegetation between surveys may account for the improved catch. The first survey was done in mid-June after dense growths of aquatic vegetation were well established, but the second occured in May while the lake was free of obstruction by plants.

The Nordic Standard gillnets appear to be a good method for assessing fish species diversity. In Low Lake the Nordic Standard gillnets captured as many species as our entire suite of survey gears (Figure 20). The Nordic gear failed to catch two species, johnnie darter and lake trout, but it added two others, rainbow smelt and slimy sculpin, to the species list. The failure to capture lake trout in Low Lake was due to the species' very low abundance; a parallel study over a period of 10 days with gillnets (sixty 2-hour daytime sets) yeilded only one lake trout. In Helen Lake the Nordic gear captured two species, brown bullhead and slimy sculpin, that were not captured by our survey gear. The smaller mesh sizes and finer material used to make the Nordic nets appear to make it more effective than our standard gear for catching the smaller hypolimnetic species. These results suggest that the distribution of slimy sculpin was probably underestimated by our biological survey.

Plankton

The plankton sample from Teardrop Lake contained the following species: Cyclops scutifer, Diaptomus minutus, Cyclops b. thomasi, Epischura lacustris copepodid, Daphnia dubia, Daphnia galeata mendotae, Daphnia catawba, Polyphemus pediculus, Sida crystallina, Daphnia longiremis, Daphnia ambigua. These species are typical of unacidified lakes in the area. No Mysis were captured in any of the lakes that were sampled.

Crayfish

Four species of crayfish were captured (Table 18). Cambarus robustus was the most common, occuring in 41 lakes (pH 4.7 - 7.2), but was not captured in any of the lakes we surveyed in the Howry Creek watershed (Figure 21). Cambarus bartoni, found in only 23 lakes (pH 4.3 - 6.6), was the least common species. Cambarids were found in lakes at elevations up to 348 m. In contrast, Orconectids were restricted to low-elevation lakes (ie. $\leq$ 236 m). Orconectes virilis was found in 35 lakes (pH 5.2 - 7.6) and Orconectes propinquus was found in 32 lakes (pH 5.6 - 7.6). No crayfish were captured in 25 of the surveyed lakes.

The most common stream species were C. robustus (13 locations) and C. bartoni (12 locations). Orconectids were found in only three streams, all in the park's northern lowlands (Figure 22). No crayfish were captured in 22 of the surveyed streams .

The lakes that we have surveyed to date in the Chikanishing Creek watershed are populated almost exclusively by C. robustus. Notable exceptions are Kakakise Lake (pH 6.3) and Little Sheguiandah Lake which probably did not acidify to the same degree as other lakes in the watershed and thus were refugia for acid-sensitive Orconectes.

Figure 20. Comparison of catches: Killarney Inventory (K) versus Nordic Standard (N)

Parentheses indicate species captured by only one of the methods

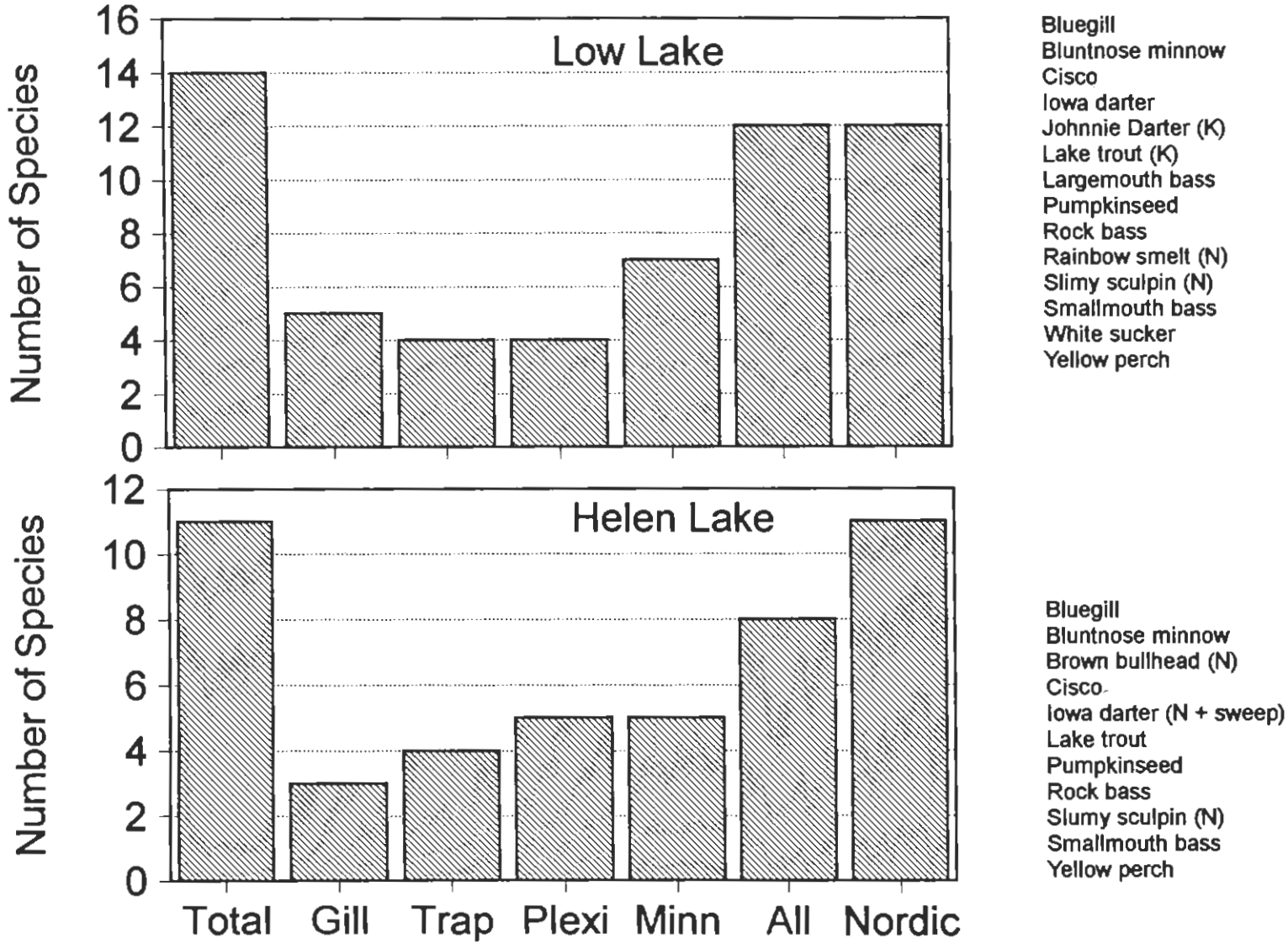


Table 18. Crayfish species captured in each lake and method of capture (T = crayfish trap; V = visual search; S = sweepnetting). If a species was caught in the traps, the catch-per-unit-effort (number per trap per night) is indicated. (Cr = Cambarus robustus; Cb = Cambarus bartoni; Ov = Orconectes virilis; Op = Orconectes propinquus).

Lake (pH)	Search methods	Cambarus robustus		Cambarus bartoni		Orconectes virilis		Orconectes propinquus		Comments
		Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	
Acid (5.0)	TS	T	0.11		0		0		0	
Amikogaming (5.1)	TS	T	0.44		0		0		0	
Artist (5.7)	TSV	T	0.89		0		0		0	(V) Cr in outlet
A.Y. Jackson (5.8)	TSV	TV	0.27		0		0		0	
Balsam (6.1)	TS	T	0.02		0		0	T	0.07	
Beaver (6.0)	TS		0		0	T	8.17	T	0.5	
Bell (5.9)	TSV	T	0.09		0	T	0.02	V	0	(V) Cr in David Creek
Betty (7.0)	TS		0		0	T	0.61		0	
Billy (4.7)	TS	T	0.61		0		0		0	(V) Cr in outlet
Bizhiw (4.5)	TS		0		0		0		0	(V) none in outlet
Bodina (6.6)	TSV		0		0		0	T	0.19	
Boundary (5.2)	(1996) TS	T	0.26		0	T	0.04		0	
	(1997) TSV	T	0.03	T	0.01	T	0.14		0	(V) Cr and Cb in outlet, Cr in David Creek inlet, Cb in a small inlet stream
Bunnyrabbit (4.8)	TS		0	T	0.5		0		0	
Burke (5.1)	TSV	TV	0.11		0		0		0	
Canis (6.4)	TSV		0		0	T	1.5		0	
Carlyle (5.9)	TS	T	0.09		0		0	S	0	
Carson (7.6)	TSV		0		0	TV	7.33	TV	8.33	
Cat (6.4)	TSV		0		0	T	0.56	V	0	(V) Ov in outlet
Cave (5.6)	TSV		0		0	TV	0.89		0	(V) Cr in outlet
Chain (4.7)	TSV		0		0		0		0	(V) none in outlet or inlet
Clearsilver (4.9)	TSV		0		0		0		0	(V) none in inlet - dried up
Cranberry Bog (6.1)	TS		0		0		0		0	
Crater East (5.9)	TS		0		0		0		0	
Crater West (5.4)	TS		0		0		0		0	
Cuckoo (6.6)	TS		0		0	T	0.17		0	
David (5.0)	TS	T	0.61		0		0		0	
Deacon (5.9)	TSV	TV	0.04		0		0	V	0	

Table 18 (cont.). Crayfish species captured in each lake and method of capture (T = crayfish trap; V = visual search; S = sweepnetting). If a species was caught in the traps, the catch-per-unit-effort (number per trap per night) is indicated. (Cr = Cambarus robustus; Cb = Cambarus bartoni; Ov = Orconectes virilis; Op = Orconectes propinquus).

Lake (pH)	Search methods	Cambarus robustus		Cambarus bartoni		Orconectes virilis		Orconectes propinquus		Comments
		Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	
de Lamorandiere (5.0)	TSV	V	0		0		0		0	
East Howry (7.1)	TS		0		0	T	0.25		0	
Fish (5.7)	TSV		0		0	TV	0.06	SV	0	(V) none in outlet or inlet on north shore
Fox (6.2)	TSV	TV	0.04		0		0	V	0	(V) Cr and Op in outlet
Frank (6.2)	TS	T	0.11		0		0	T	0.06	
Freeland (5.5)	(1995) TS	T	0.07		0	S	0		0	
	(1997) TS	T	0.07		0	T	0.13		0	(V) Cr in inlet from Killarney Lk none in inlet from Kakakise Lk
Gail (4.6)	TSV		0		0		0		0	(V) none in outlet
Gem (6.1)	TSV		0		0	TV	0.04	V	0	
George (5.8)	TSV	TV	0.06		0		0	V	0	(V) Cr in inlet from Freeland and in outlet (Chikanishing River)
Goose (6.2)	TSV		0		0	T	0.17		0	(V) none in outlet or inlet
Goschen (6.2)	TSV		0		0		0	T	0.06	
Grace (5.1)	TSV		0	TV	0.33		0		0	(V) Cb in outlet
Great Mountain (5.4)	TS		0	T	0.33		0		0	(V) Cb in outlet
Grey (4.9)	TS	T	1.96		0		0		0	
Grew (6.6)	TSV		0	V	0	V	0		0	
Hanwood (6.4)	TSV		0		0		0	V	0	
Harry (6.3)	TSV	TV	0.06		0		0	SV	0	
Heaven (4.8)	TSV		0		0		0		0	(V) none in outlet
Helen (6.3)	(1995) TS		0		0		0		0	
	(1997) TV	V	0		0		0	V	0	
Hemlock (4.7)	TS		0		0		0		0	
Howry (6.3)	TSV		0	V	0	V	0	V	0	
Ishmael (6.5)	(1995) TS		0		0		0	T	0.04	
	(1995) TV	TV	0.06		0		0	TV	0.09	
Johnnie (5.6)	TSV	TV	0.13		0		0	T	0.02	
Kakakise (6.3)	TS	T	0.06		0	T	0.04	T	0.02	

Table 18 (cont.). Crayfish species captured in each lake and method of capture (T = crayfish trap; V = visual search; S = sweepnetting). If a species was caught in the traps, the catch-per-unit-effort (number per trap per night) is indicated. (Cr = Cambarus robustus; Cb = Cambarus bartoni; Ov = Orconectes virilis; Op = Orconectes propinquus).

Lake (pH)	Search methods	Cambarus robustus		Cambarus bartoni		Orconectes virilis		Orconectes propinquus		Comments
		Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	
Kidney (5.3)	TSV		0		0		0		0	
Killarney (5.1)	TS	T	1.07		0		0		0	(V) Cb in small tributary by Threenarrows portage.
Lake of the Woods (4.9)	TSV		0		0		0		0	
Leech (6.9)	TSV		0		0	V	0		0	
Little Bell (4.6)	TSV		0		0		0		0	(V) none in outlet or inlet
Little Leech (7.1)	TSV		0		0	TV	6.17		0	
Little Mink (6.7)	TSV		0		0	TV	0.06	V	0	(V) Ov in outlet
Little Mountain (5.1)	TS		0	T	0.41		0		0	
Little Sheguiandah (6.1)	TSV	T	0.1		0		0	V	0	
Little Superior (4.3)	TSV		0	V	0		0		0	
Log Boom (5.5)	TS	T	0.27		0	T	0.06		0	
Low (7.2)	(1995) TS		0		0		0		0	
	(1997) TV	V	0		0	gillnet	0	TV	0.02	
Lumsden (5.2)	TS	T	0.3		0		0		0	
Mink (6.3)	TSV		0		0	TV	0.19		0	(V) none in inlet
Muriel (5.1)	TS	T	0.07		0		0		0	(V) Cr in outlet, none in inlet.
Murray (6.2)	TSV		0		0	TSV	0.22	TV	0.02	(V) Cb in Notch Creek
Nellie/Carmichael (4.6)	TS		0	T	1.44		0		0	(V) Cb in outlet (Notch Creek)
Norway (5.1)	TS	T	1.81		0		0		0	
O.S.A. (4.8)	TSV	T	0.93	V	0		0		0	(V) Cb in Teardrop Lake outlet stream and in adjacent area of O.S.A.
Partridge (5.7)	TS	T	1.0		0		0		0	
Patten (5.1)	TSV		0		0		0		0	(V) Cb in outlet.
Pearl (5.3)	TS		0	T	0.17		0		0	
Peter (6.5)	TSV	V	0		0		0	V	0	
Pike (5.6)	TSV	V	0		0		0	SV	0	
Proulx (4.5)	TSV		0	TV	0		0		0	
Quartzite (4.8)	TSV		0	TV	1.83		0		0	
Rocky (6.6)	TSV		0		0	TV	0.26		0	

Table 18 (cont.). Crayfish species captured in each lake and method of capture (T = crayfish trap; V = visual search; S = sweepnetting). If a species was caught in the traps, the catch-per-unit-effort (number per trap per night) is indicated. (Cr = Cambarus robustus; Cb = Cambarus bartoni; Ov = Orconectes virilis; Op = Orconectes propinquus).

Lake (pH)	Search methods	Cambarus robustus		Cambarus bartoni		Orconectes virilis		Orconectes propinquus		Comments
		Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	
Roque (5.0)	TSV		0		0		0		0	
Round Otter (6.2)	TSV		0		0	T	0.02	V	0	
RuthRoy (4.9)	TS	T	0.37		0		0		0	
Sandy (5.1)	TS	T	2.11		0		0		0	
Sealey's (6.1)	TS		0		0		0		0	
Shingwak (4.7)	TSV		0	TV	0.17		0		0	
Silver (5.0)	TSV		0		0		0		0	
Solomon (5.6)	TSV		0		0		0		0	(V) Cr and Cb in inlet stream from Roque Lake.
Spark (4.5)	TS		0	T	3.33		0		0	(V) none in outlet
Teardrop (6.5)	TSV		0	TV	6.5		0		0	
Terry (5.4)	TS	T	0.17		0		0		0	
Threearrows (5.8)	TSV	TV	0.02		0	T	0.04		0	(V) none in inlet from Lake #80, but Cb in a nearby tributary.
Topaz (4.6)	TS		0	T	1.83		0		0	(V) none in outlet.
TriLakes N (6.7)	TSV		0		0	TV	2.39		0	
TriLakes SE (6.5)	TSV		0		0	TV	0.17		0	
TriLakes SW (6.3)	TSV		0		0	TV	0.06		0	
Turbid (5.0)	TS	T	0.17		0		0		0	(V) Cr in inlet.
Turtleback (5.1)	TSV		0	plexiglas V	0		0		0	
Van (6.2)	TSV		0		0	TV	0.06		0	(V) saw one ? sp.in outlet
Van Winkle (6.6)	TSV		0		0	TV	0.17		0	
Wagon Road (6.0)	TS		0		0		0		0	
Whiskeyjack (4.6)	TSV		0		0		0		0	
York (6.1)	TS		0		0	T	0.02	T	0.04	
#6 (4.5)	TSV		0		0		0		0	
#7 (5.0)	TSV		0		0		0		0	
#9 (4.9)	TSV		0		0		0		0	(V) none in outlet stream.

Table 18 (cont.). Crayfish species captured in each lake and method of capture (T = crayfish trap; V = visual search; S – sweepnetting). If a species was caught in the traps, the catch-per-unit-effort (number per trap per night) is indicated. (Cr = Cambarus robustus; Cb = Cambarus bartoni; Ov = Orconectes virilis; Op = Orconectes propinquus).

Lake (pH)	Search methods	Cambarus robustus		Cambarus bartoni		Orconectes virilis		Orconectes propinquus		Comments
		Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	Capture Method	Trap CUE	
#24 (4.8)	TSV		0	TV	7.83		0		0	
#25 (4.8)	TSV		0		0		0		0	(V) none in outlet
#27 (5.1)	TSV		0	TV	2		0		0	
#28 (4.9)	TSV		0		0		0		0	
#29 (4.3)	TSV		0		0		0		0	
#30 (4.8)	TSV		0	T	0.33		0		0	
#33 (5.1)	V		–	V	–		–		–	(V) Cb in inlet.
#37 (6.2)	TS		0		0		0	T	0.06	
#45 (4.9)	TSV		0		0		0		0	
#59 (5.7)	TS	T	0.07		0	T	0.39	T	0.02	
#64 (5.3)	TSV		0	S	0		0		0	(V) Cb in outlet stream below waterfalls, but not above it.
#65 (5.5)	TSV		0		0		0		0	
#66 (5.3)	TSV		0		0		0		0	(V) none in outlet.
#69 (5.0)	TSV	V	0		0		0		0	
#74 (6.1)	TSV		0		0		0	T	0.06	
#76 (7.0)	TSV		0		0	T	2		0	

Figure 21. Crayfish distributions in Killarney Provincial Park lakes

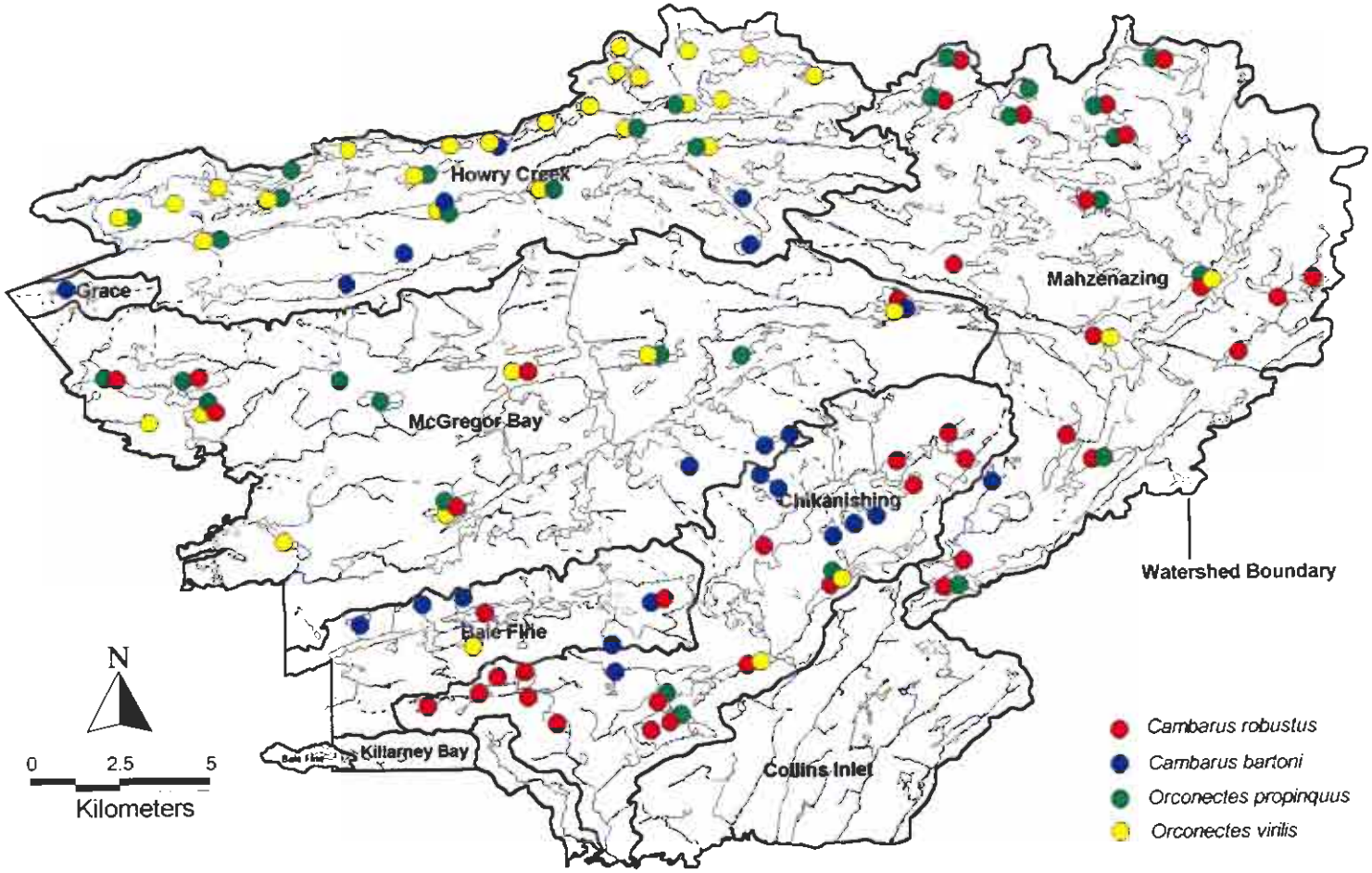
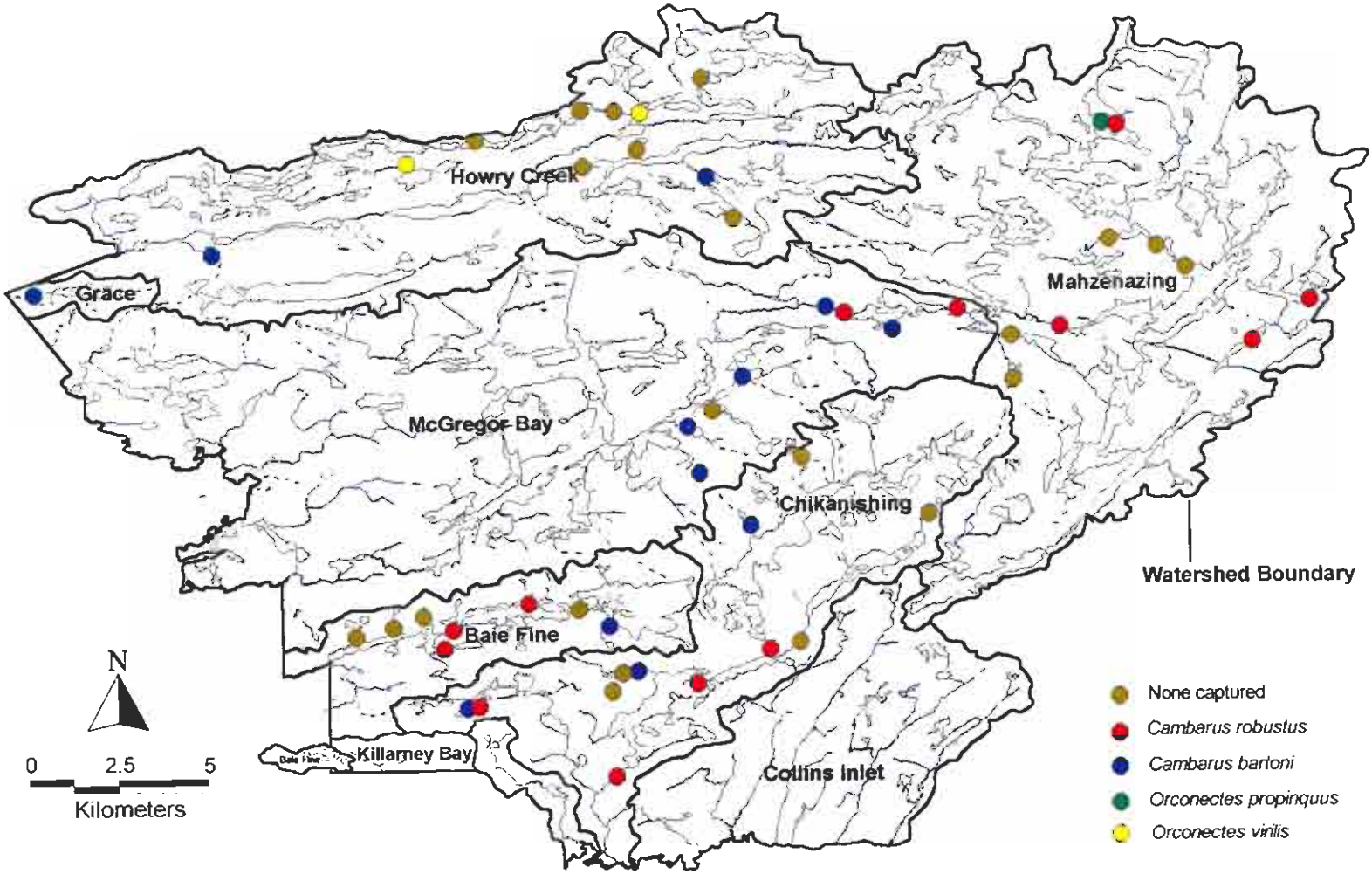


Figure 22. Crayfish distributions in Killarney Provincial Park streams



The species O. virilis experiences reproductive failure below pH 5.6 (Davies 1989). Its presence in Freeland Lake (pH 5.5) and in Boundary Lake (pH 5.2), may be due to recent colonization. Continued monitoring is needed to determine if the populations in Freeland Lake and Boundary Lake will persist in the long term. Either Bell Lake or Threenarrows Lake could conceivably have been the source of colonizers for Boundary Lake. A search of the Boundary Lake outlet and tributaries in 1997 did not capture O. virilis.

The sampling in 1997 of Helen, Low, and Ishmael Lakes with baited traps in parallel with visual searches of shoreline rocks confirmed that visual searching was the better means of determining species presence.

Macrobenthos

The pH range of lakes in which mayflies were found differed between taxa (Table 19). The most acid-tolerant species, Eurylophella temporalis and Leptophlebia, were found in lakes with pH as low as 5.0. Caenis was found in Lake #45 (pH 4.9) and at first glance it appears to also be very acid-tolerant. However, the very high DOC concentration (17.4 mg/L) in Lake #45 may be ameliorating toxicity of the acidic water. Excluding Lake #45, Caenis were found only in lakes with pH $\geq$ 5.5. Baetidae, apparently the most acid-sensitive taxon, were not found in lakes with pH < 6.2. Moderately acid-sensitive species included Stenonema femoratum (pH $\geq$ 5.6) (Figure 23) and Stenacron interpunctatum (pH $\geq$ 5.3).

Mayflies were present throughout the lowland areas of the park, but were found in only two lakes (Burke, Teardrop) with elevations > 250 m. Burke Lake (pH 5.0; elevation 304 m) contained only Leptophlebia, an acid-tolerant taxon. Teardrop Lake (pH 6.5; elevation 325 m) supported a variety of taxa, including the acid-sensitive species Stenonema femoratum. These observations suggest that the absence of mayflies from most high-elevation lakes (ie. > 250 m) is due to the low pH of those waters, rather than an inability to colonize those sites.

The acid-sensitive amphipod Hyalella azteca (Stephenson and Mackie 1986) was present in 51 lakes (pH 5.6-7.6) (Table 20). It too was generally restricted to the lower elevation lakes (Figure 24).

Leeches were captured in 4 (Beaver, Boundary, Hanwood, Sandy) of the 32 lakes in which leech traps were set during 1996. Leeches were also captured in sweepnets or fish traps in Teardrop, Rocky, and Cuckoo lakes. The specimens are preserved for future identification. Leech sampling was discontinued in 1997 because of the low catches.

Table 19. List of mayfly species captured by lake. Number of mayflies collected during May (1996 & 1997) by turning over rocks is given. Species found by turning over rocks during July 1995 indicated by #. Number of mayflies collected by summertime sweepnetting indicated by *.

Lake name	pH	Clean rock substrate found during May (1996 or 1997) survey	Sweepnetting date	Baetidae		Caenidae	Ephemerellidae	Leptophlebiidae		Heptageniidae			Siphlonuridae
				Procloeon	Callibaetis	Caenis	Eurylophella temporalis	Chloroterpes basalis	Leptophlebia	Stenonema femoratum	Stenonema modestum	Stenacron interpunctatum	Siphlonurus
Acid	5	Yes	May31, June22 / 95										
Amikogaming	5.1	Yes	June 8 / 96										
Artist	5.7	Not surveyed	July2 / 97			18*	1*						
A Y. Jackson	5.8	Yes	May24, July26 / 95				14*		5, 6*	#		15	
Baie Fine	7.8	Yes	Not surveyed				6			14			
Balsam	6.1	Yes	July27 / 95						2	4, 14*		15, 2*	
Beaver	6	Yes	July17 / 95						4	17		11	
Bell	5.9	Yes	July7 / 95				1*					23,#	
Betty	7	Yes	August17 / 96	2*		2*				29, 10*		14, 1*	
Billy	4.7	Not surveyed	July31 / 96										
Bizhiw	4.5	Not surveyed	July6,7 / 96										
Bodina	6.6	Yes	July15 / 97	3* Baetidae (genus unknown)			4*			22,13*		9	
Boundary	5.2	Yes	June5,8 / 96				1*		10				
Bunnyrabbit	4.8	Not surveyed	July25 / 96										
Burke	5.1	Yes	May29 / 95						11				
Canis	6.4	No	July 2,4 / 97			4*	2			20,4*			
Carlyle	5.9	Yes	June22, July19 / 95				20*		4			16	
Casson	7.6	Yes	June 6 / 97				34*,1		6	2		12	
Cat	6.4	Yes	July9 / 96	1*			12*			17		1	
Cave	5.6	Yes	July 1 / 97			46*	1*			23		10	

Table 19 (cont.). List of mayfly species captured by lake. Number of mayflies collected during May (1996 & 1997) by turning over rocks is given. Species found by turning over rocks during July 1995 indicated by #. Number of mayflies collected by summertime sweepnetting indicated by *.

Lake name	pH	Clean rock substrate found during May (1996 or 1997) survey	Sweepnetting date	Baetidae		Caenidae	Ephemerellidae	Leptophlebiidae		Heptageniidae			Siphlonuridae
				Procloeon	Cetilbaetis	Caenis	Euryiophella temporalis	Chloroterpes basalis	Leptophlebia	Stenonema femoratum	Stenonema modestum	Stenacron interpunctatum	Siphlonurus
Chain	4.7	Not surveyed	July26 / 95										
Clearsilver	4.9	Not surveyed	August24 / 95										
Cranberry Bog	6.1	No	August17 / 95										
Crater East	5.9	Yes	June2,3 / 96										
Crater West	5.4	No	June3 / 96										
Cuckoo	6.6	Yes	August14 / 96						4	23, 4*		1*, 4	
David	5	Yes	June10 / 96				2*		21				
Deacon	5.9	Yes	August4 / 95						2	4*		21, 2*	
de Lamorandiere	5	No, lots of detritus around rock	May30 / 95										
East Howry	7.1	Yes	August19 / 96					1*	3	17		9	
Fish	5.7	Yes	June18,20 / 96				3*			4, 4*		16, 15*	
Fox	6.2	Yes	August2 / 95			1*			2	2, 6*		18	
Frank	6.2	No. Swampy, few rocks.	August18 / 95									5	
Freeland	5.5	No. Silty, swampy.	June14 / 95				1*						
Freeland outlet stream	not measured	Yes	Not surveyed										
Gail	4.6	Yes	June8 / 96										
Gem	6.1	Yes	June25 / 96				11*		9	17, 1*		8, 1*	
George	5.8	Yes	June14 / 95				3, 121*		4	5,#		17,#	

Table 19 (cont.). List of mayfly species captured by lake. Number of mayflies collected during May (1996 & 1997) by turning over rocks is given. Species found by turning over rocks during July 1995 indicated by #. Number of mayflies collected by summertime sweepnetting indicated by *.

Lake name	pH	Clean rock substrate found during May (1996 or 1997) survey	Sweepnetting date	Baetidae		Caenidae	Ephemerellidae	Leptophlebiidae		Heptageniidae			Siphlonuridae
				Procloeon	Callibaetis	Caenis	Eurylophella temporalis	Chloroterpes basalis	Leptophlebia	Stenonema femoratum	Stenonema modestum	Stenacron interpunctatum	Siphlonurus
Goose	6.2	Yes	June20 / 96			8*	1, 1*		3	1			
Goschen	6.2	Yes, but very little	Aug12 / 97	1* Baetidae	genus unknown				2	2*		21	
Grace	5.1	No. Detritus bottom	Aug 1 / 97										
Great Mountain	5.3	Yes	June11 / 96						2, 2*			14	
Grey	4.9	Not surveyed	July3 / 96										
Grow	6.6	Yes	June19 / 96				31*					21	
Hamwood	6.4	Yes	July21 / 96		30*	2*	1*			9		8	
Harry	6.3	Yes	August20 / 95	1*						13, 2*		2	
Heaven	4.8	Not surveyed	July18 / 96										
Helen	6.3	Yes	July6 / 95							13		5	
Hemlock	4.7	Marginal, few rocks.	July24 / 96										
Howry	6.3	Yes	June25 / 96				1, 7*			20, 1*		2	
Howry Creek	---	Yes	Not surveyed								6	1	
Ishmael	6.5	Yes	July6 / 95			3*	1*			7		14	
Johnnie	5.6	Yes	July4,13 / 95				1*					19, #	
Kakakise	6.3	Yes	June21 / 95				1*		3	6, 4*		13, 4*	
Kidney	5.3	No. Few rocks, algae.	June14 / 96										
Killarney	5.1	Yes	May16 / 95										
Lake of the Woods	4.9	Not surveyed	September14 / 96										

Table 19 (cont.). List of mayfly species captured by lake. Number of mayflies collected during May (1996 & 1997) by turning over rocks is given. Species found by turning over rocks during July 1995 indicated by #. Number of mayflies collected by summertime sweepnetting indicated by *.

Lake name	pH	Clean rock substrate found during May (1996 or 1997) survey	Sweepnetting date	Baetidae		Caenidae	Ephemerellidae	Leptophlebiidae		Heptageniidae			Siphlonuridae
				Procloeon	Callibaetis	Caenis	Eurylophella temporalis	Chloroterpes basalis	Leptophlebia	Stenonema femoratum	Stenonema modestum	Stenacron interpunctatum	Siphlonurus
Leech	6.9	Yes	June7 / 97			15*	23*		23			1	
Little Bell	4.6	Not surveyed	July25 / 95										
Little Leech	7.1	Yes	June9 / 97			1*	9*		12	8		8	
Little Mink	6.7	Yes	June9 / 97			2*			1	1*,24		28	
Little Mountain	5.1	Yes	June5 / 96										
Little Mountain outlet stream	not measured	Yes	Not surveyed										
Little Sheguiandah	6.1	Yes	May25 / 95			9*	37*		1*	20, #		1,#	
Little Superior	4.3	Not surveyed	July 15 / 97										
Log Boom	5.5	Yes	June28 / 95				3, 11*		5			10	
			June 20 / 97			13*	36*		1*				
Low	7.2	Yes	July11 / 95				1*			10		5	
Lumsden	5.2	Yes	June2 / 95										
Mink	6.3	Yes	June3-7 / 97				1*,1			4		1*, 26	
Muriel	5.1	Yes	July 6 / 97										
Murray	6.2	Yes	June 7 / 97			9*	4*			5		9	
Nellie +Carmicheal	4.6	Yes	June 18 / 97										
Norway	5.1	Yes	June10,11 / 96										
Notch Creek	not measured	Yes	Not surveyed										
O.S.A.	4.8	Yes	May15 / 95										
Partridge	5.7	Yes	June11 / 96										

Table 19 (cont.). List of mayfly species captured by lake. Number of mayflies collected during May (1996 & 1997) by turning over rocks is given. Species found by turning over rocks during July 1995 indicated by #. Number of mayflies collected by summertime sweepnetting indicated by *.

Lake name	pH	Clean rock substrate found during May (1996 1997) survey	Sweepnetting date	Baetidae		Caenidae	Ephemerellidae	Leptophlebiidae		Heptageniidae			Siphlonuridae
				Procloeon	Callibaetis	Caenis	Euryiophella temporalis	Chloroterpes basalis	Leptophlebia	Stenonema femoratum	Stenonema modestum	Stenacron interpunctatum	Siphlonurus
Patten	5.1	No. Silt, swampy.	July9 / 96										
Pearl	5.3	Yes	July8 / 96										
Pearl outlet stream	not measured	Yes	Not surveyed										
Peter	6.5	Yes	July21-27 / 97			1	1		1	1		29	
Pike	5.6	Yes	August19 / 95						5	2		5	
Proulx	4.5	Not surveyed	July16 / 97										
Quartzite	4.8	Not surveyed	Aug 3 / 97										
Rocky	6.6	Yes	June22 / 96			6*	11*			26			
Roque	5	Yes	May28 / 95										
Round Otter	6.2	Yes	June23 / 96			1*	16*			18		3	
RuthRoy	4.9	Marginal. Silty	June29 / 95										
Sandy	5.1	Marginal. Silty	June6 / 96										
Sealey's	6.1	No. Swampy	August8 / 95										
Shingwak	4.7	Not surveyed	July17 / 97										
Silver	5	Not surveyed	July16 / 96										
Solomon	5.6	Yes	May27 / 95										
Spark	4.5	Yes	July6 / 96										
Teardrop	6.5	Yes	June27,28 / 96				15*		3*	50, 1*		6	
Teardrop outlet at OSA	not measured	Not surveyed	Oct. 11 / 97				4						
Terry	5.4	Yes	June8 / 95				45*		18			1*	

Table 19 (cont.). List of mayfly species captured by lake. Number of mayflies collected during May (1996 & 1997) by turning over rocks is given. Species found by turning over rocks during July 1995 indicated by #. Number of mayflies collected by summertime sweepnetting indicated by *.

Lake name	pH	Clean rock substrate found during May (1996 or 1997) survey	Sweepnetting date	Baetidae		Caenidae	Ephemerellidae	Leptophlebiidae		Heptageniidae			Siphlonuridae
				Procloeon	Callibaetis	Caenis	Euryiophella temporalis	Chloroterpes basalis	Leptophlebia	Stenonema femoratum	Stenonema modestum	Stenacron interpunctatum	Siphlonurus
Threenarrows	5.8	Yes	July23 / 96				1*			5		22	
Topaz	4.6	Yes	June9 / 96										
TriLakes North	6.7	Yes	August17 / 96				1		7	3		17	
TriLakes Southeast	6.5	Yes	August16 / 96				1		6	2, 1*		36	
TriLakes Southwest	6.3	Yes	July16 / 96						9			23	
Turbid	5	Not surveyed	August7 / 96										
Turtleback	5.1	Not surveyed	June20 / 97										
Van	6.2	Yes	July23 / 96							5		2	
Van Winkle	6.6	Yes	July9 / 96			1*			1	12		5	
Wagon Road	6	Marginal Silt	May29 / 95			5*							
Whiskeyjack	4.6	Not surveyed	July25 / 96										
York	6.1	Yes	July5 / 96				3*			12, 4*		12, 15*	
#6	4.5	Not surveyed	Aug 16 / 97										
#7	5	Not surveyed	Aug 15 / 97										
#9	4.9	Not surveyed	Aug 17 / 97										
#24	4.8	Not surveyed	Aug 4 / 97										
#25	4.8	Not surveyed	Aug 5 / 97										
#27	5.1	Not surveyed	Aug 2 / 97										
#28	4.9	Not surveyed	July31 / 97										
#29	4.3	Not surveyed	July31 / 97										

Table 19 (cont.). List of mayfly species captured by lake. Number of mayflies collected during May (1996 & 1997) by turning over rocks is given. Species found by turning over rocks during July 1995 indicated by #. Number of mayflies collected by summertime sweepnetting indicated by *.

Lake name	pH	Clean rock substrate found during May (1996 or 1997) survey	Sweepnetting date	Baetidae		Caenidae	Ephemerellidae	Leptophlebiidae		Heptageniidae			Siphlonuridae
				Procloeon	Callibaetis	Caenis	Eurylophella temporalis	Chloroterpes basalis	Leptophlebia	Stenonema femoratum	Stenonema modestum	Stenacron interpunctatum	Siphlonurus
#30	4.8	Not surveyed	July 30 / 97										
#33	5.1	No. swampy.	Not surveyed										
#36	5.9	No. All muck - beaver pond	Not done										9
#37A	6.2	Yes	July6 / 96			2*	26*			6		10, 7*	
#45	4.9	Not surveyed	Aug 13 / 97			4*							
#46	6.3	No. muck/detritus bottom	Not done										
#59	6.4	Yes	July16 / 96				1			17		16, 1*	
#64	5.3	Marginal. Dirty	Sept 9 / 95, July19 / 97										
#65	5.5	Yes	Sept16 / 95, July20 / 97										
#66	5.3	Yes	Sept 17 / 95, July22 / 97										
#68	5.4	Yes	Not done						2				
#69	5	Yes	May 26, June 22 / 95										
#74	6.1	Yes	July15 / 97			1*				10		13	
#76	7	Yes	July6 / 97		8*	12*			3	22		2	
pH Range (number of sites)				**6.2 - 7.0 (7)**		**4.9 - 7.1 (23)**	**5.0 - 7.8 (43)**	**7.1 (1)**	**5.0 - 7.6 (34)**	**5.6 - 7.6 (46)**	**? (1)**	**5.3 - 7.6 (55)**	**5.9 (1)**

Figure 23. Location of lakes with Stenonema femoratum

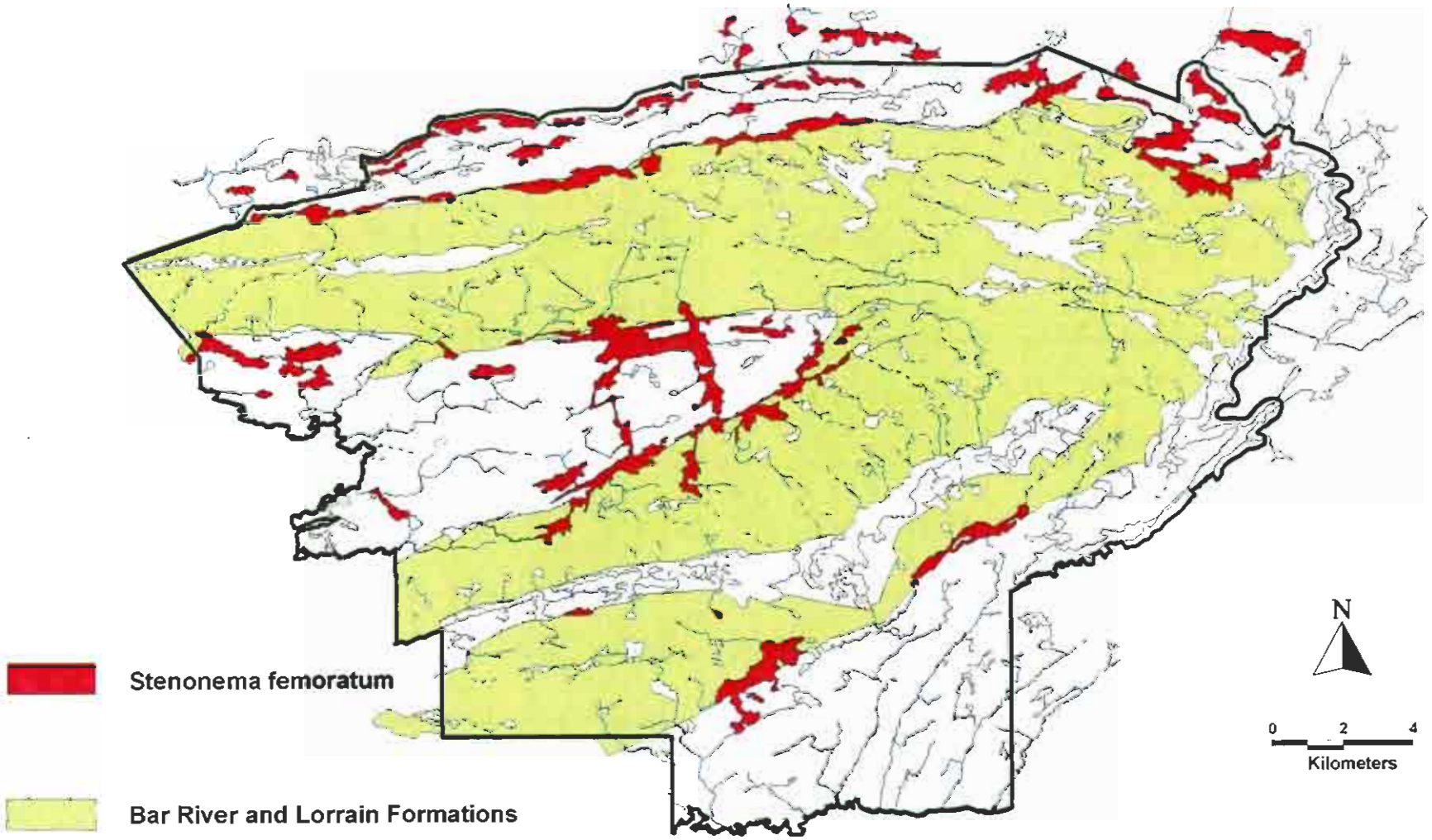
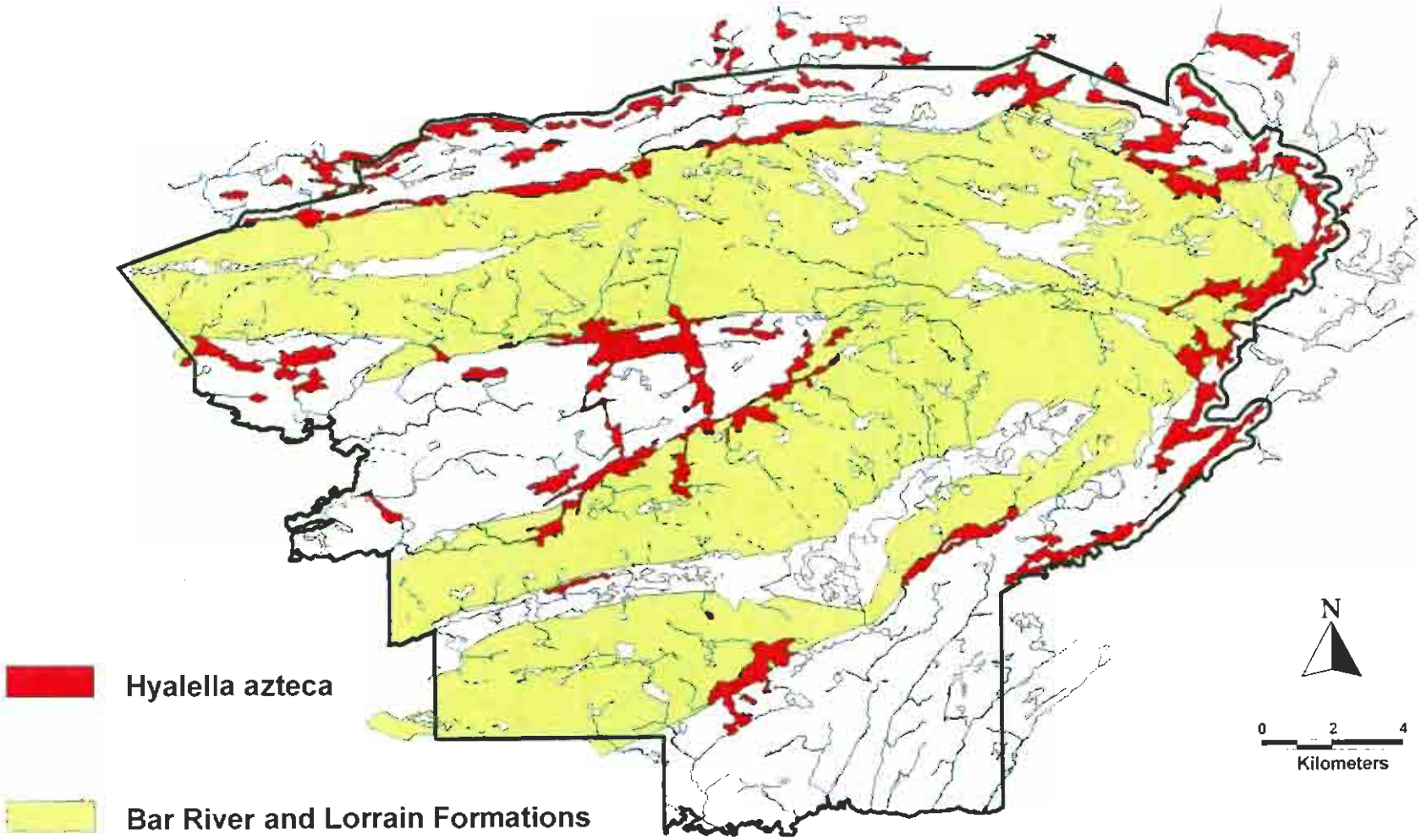


Table 20. List of amphipods captured by lake.

Lake	pH	Hyalella azteca	Gammaridae	Lake	pH	Hyalella azteca	Gammaridae
Artist	5.7	1	0	Leech	6.9	24	0
A.Y. Jackson	5.8	20	1	Little Leech	7.1	30	0
Balsam	6.1	30	1	Little Mink	6.7	27	0
Beaver	6	73	0	Little Sheguiandah	6.1	23	1
Bell	5.9	84	1	Low (1995)	7.2	21	0
Bodina	6.6	141	0	(1997 intensive)		312	2
Boundary	5.2	0	4	Mink	6.3	27	0
Canis	6.4	18	0	Murray	6.2	34	0
Carlyle	5.9	16	0	O.S.A.	4.8	0	2
Casson	7.6	16	0	Peter	6.5	31	0
Cat	6.4	71	0	Pike	5.6	23	0
Cuckoo	6.6	4	0	Rocky	6.6	38	0
Deacon	5.9	11	0	Round Otter	6.2	33	0
East Howry	7.1	3	0	Sandy	5.1	0	2
Fish	5.7	11	0	Teardrop	6.5	1	2
Fox	6.2	10	0	Teardrop outlet at O.S.A	not measured	0	19
Frank	6.2	2	0	Terry	5.4	0	2
Gem	6.1	46	0	Threenarrows	5.8	37	0
George (1997 intensive)	5.8	5	7	TriLakes N	6.7	12	0
Goose	6.2	31	0	TriLakes SE	6.5	12	0
Goschen	6.2	27	0	TriLakes SW	6.3	56	0
Great Mountain	5.4	0	11	Van	6.2	32	1
Grow	6.6	37	0	Van Winkle	6.6	53	1
Hanwood	6.4	7	0	York	6.1	12	0
Harry	6.3	23	0	#37A	6.2	13	0
Helen	6.3	5	0	#59	6.4	9	0
Howry	6.3	45	0	#65	5.5	0	8
Ishmael	6.5	27	0	#66	5.3	0	4
Johnnie (1995)	5.6	2	0	#74	6.1	14	0
(1997)		20	0	#76	7	18	0
Kakakise	6.3	16	0				

Figure 24. Location of lakes with Hyalella azteca



Within-lake Invertebrate Spatial Distributions

In the circumneutral reference lake (Low Lake) the mayfly (Figures 25 and 26) and amphipod (Figure 27) species were collected at all (100%) of the sampling sites. Catches were patchy for the crayfish, Orconectes propinquus (35% of the sites) (Figure 28).

The distributions of acid-sensitive species within the lake exhibiting chemical recovery (George Lake) were more limited, reflecting recent recolonization (Orconectes propinquus at 1.8% of sites; Stenacron interpunctatum at 23% of sites; Stenonema femoratum <1% of sites; Hyallela azteca <6% of sites). The one location in George Lake that contained all four acid-sensitive species was adjacent to Little Sheguiandah Lake, which is a less acidic refuge site that is serving as a source of colonizers.

The acid-tolerant crayfish Cambarus robustus was captured at only 39.8% of the sampling sites in George Lake and at 87% of the sites in Low Lake (Figure 29). The apparent absence of crayfish from many sites in both George and Low Lakes may simply reflect the difficulty in sampling these very mobile animals.

The results of this study indicate that sampling a small number of random sites in a lake may not be sufficient to detect benthic invertebrate colonization in its earliest stages. Monitoring programs should: (1) concentrate sampling near the expected point of immigration, if the source of colonizers and route of migration is known; and (2) sample all suitable habitat within a lake, if the source and route of migration are unpredictable or if the species is particularly mobile.

Chikanishing River Invertebrates

In the past the Chikanishing River has experienced low-pH episodes during spring snowmelt. During the late 1970's depressions to pH 4.8 were recorded at C3 (MOE unpublished data), but since then there has been a trend to increasing pH and decreasing severity of the episodic pH depressions. By 1986-1988 the lowest springtime pH measured at C3 had risen to 5.2 (Curry et al 1991). In general, C3 had better water quality than the two upstream sites (Curry and Powles 1991). This difference in pH between sites was also apparent in 1995-1996 (mean pH's: 5.7 at C1; 5.8 at C2; 5.9 at C3). In addition to the higher pH, the toxicity of water at C3 may also be reduced by DOC inputs from Lumsden Creek which enters the Chikanishing River between C2 and C3 (Hulsman et al.1983).

The presence of acid-sensitive mayflies suggests that the water quality at C3 has improved since the early 1980's. Mayflies were not present in 1981 adjacent to the highway bridge (Ron Griffiths, pers. comm.), about 40 m upstream of C3, but they are now common at that location (Table 21). The sweepnet sample about 20 m upstream of the bridge in May 1997 captured 7 mayflies (1 Eurylophella, 2 Leptophlebia, 4 Stenacron interpunctatum). In 1985-1986 only two mayflies were captured in the 12 surber samples at C3 (Al Curry unpublished data), but ten years later the total number captured increased to 48 and all 12 surber samples at that site contained

mayflies. The most abundant mayfly in the surbers was Stenacron interpunctatum (24 captured), a moderately acid-sensitive species found during our survey only in lakes with pH $\geq$ 5.3.

At C2 only four mayflies from two taxa (Ephemerella and Tricorythodes) were collected in 1986 and two from one taxon (Eurylophella) in 1996. None were collected at C1 in either year. The absence of Stenacron interpunctatum at C2 and total absence of mayflies at C1 may indicate that recolonization has not yet occurred at those sites. Alternatively, episodic pH depressions that are lethal to mayflies may still be occurring in the upper part of the river.

Differences in species captured during the 1986 and 1996 sampling are apparent, but a more detailed comparison of our results with those of Curry and Powles (1991) will require much more thought and may be problematic due to: (1) the absence of a circumneutral reference site; and (2) the unavailability of samples from the first study to confirm species identifications.

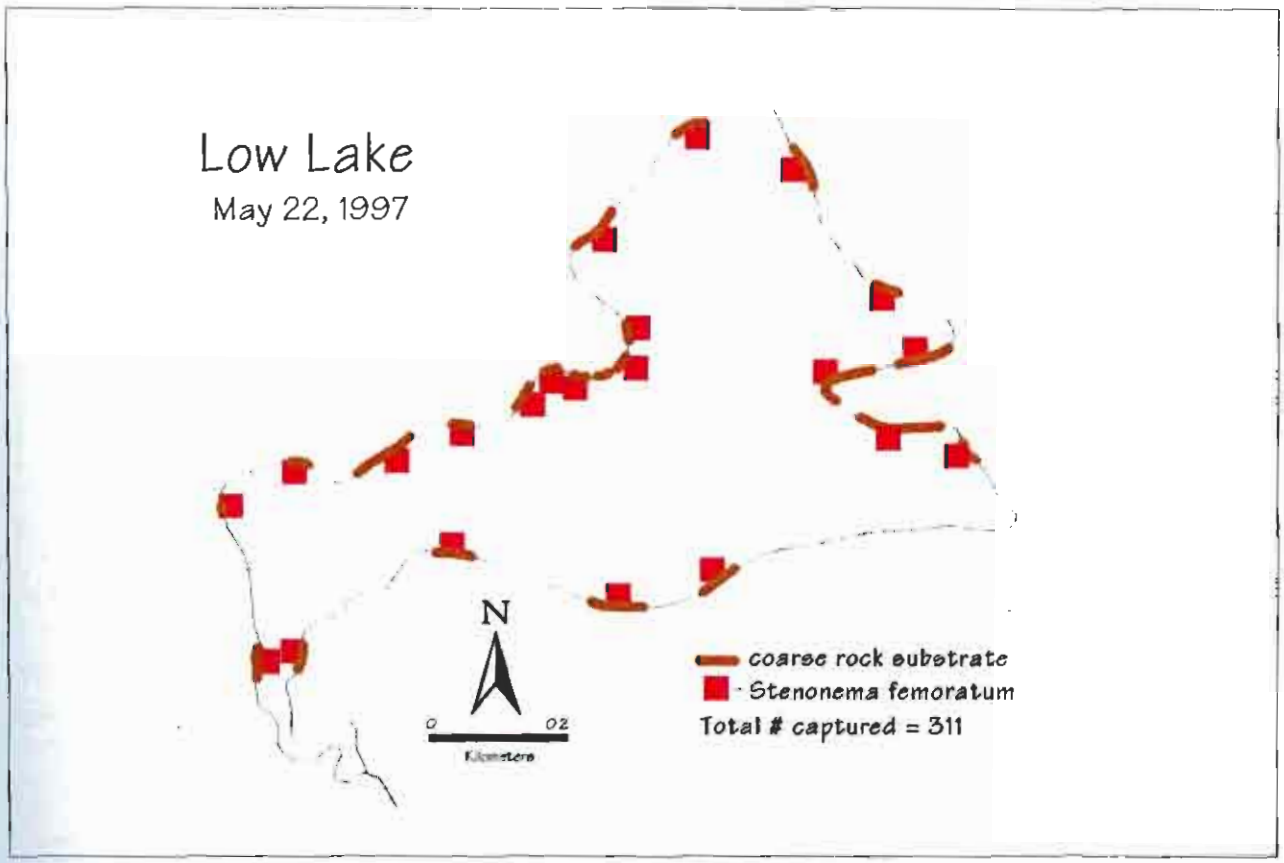
Amphibians, Reptiles, Birds, Mammals

We observed 11 species of amphibians including 7 frog species, 15 species of aquatic or fish-eating birds, 5 species of aquatic mammals, and 6 species of reptiles (Table 22). The most common frog species observed as adults was the green frog (24 lakes). Mudpuppies were captured in 10 lowland lakes. The most common turtle species was the snapping turtle (26 lakes). The most common fish-eating birds were loons (65 lakes) and great blue heron (42 lakes). Fish-eating mammals such as mink and otter were observed infrequently.

The 1973 park species list (MacDonald 1973) contained 5 amphibians (red-backed salamander, American toad, mink frog, northern leopard frog, green frog), 3 reptiles (bandings turtle, eastern garter snake, northern water snake), and 104 birds. Bird species that we observed, but were not included in the 1973 list are: double-crested cormorant, hooded merganser, sandhill crane, and wood duck. Cormorant populations on Lake Huron have increased in abundance over the past decade and this is reflected in the increased occurence of that species on the inland lakes.

The 1996 CWS helicopter survey of breeding birds (Appendix J) documented the following 14 bird species that were not identified by the lake survey crews and 4 of these (indicated by *) were not on the 1973 list: spotted sandpiper, greenwing teal *, killdeer, redtailed hawk, ringnecked duck, turkey vulture, black duck, broadwinged hawk *, caspian tern, common snipe *, bufflehead, eastern kingbird, solitary sandpiper *, unknown yellowlegs.

Figure 25. Capture locations for Stenonema femoratum in Low and George Lakes



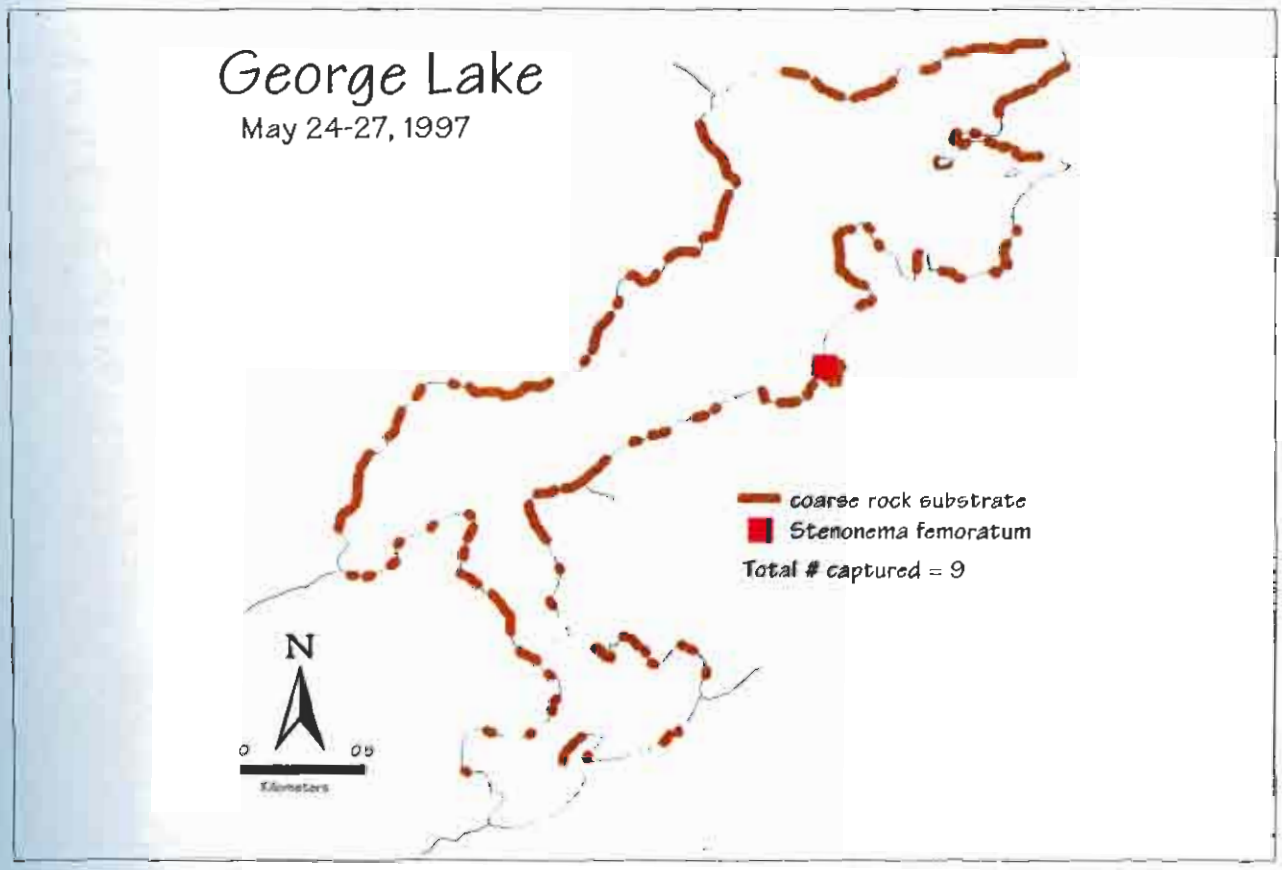
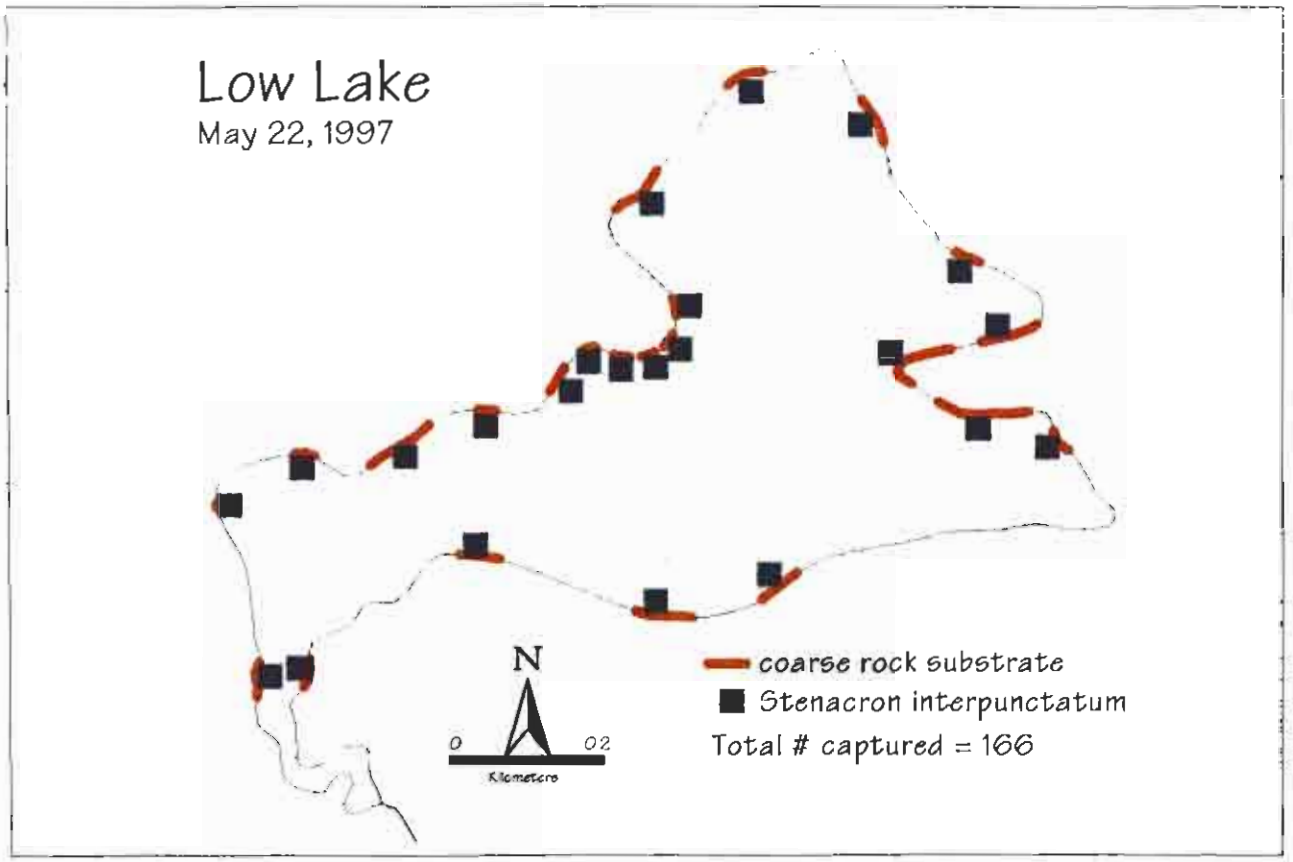


Figure 26. Capture locations for Stenacron interpunctatum in Low and George Lakes



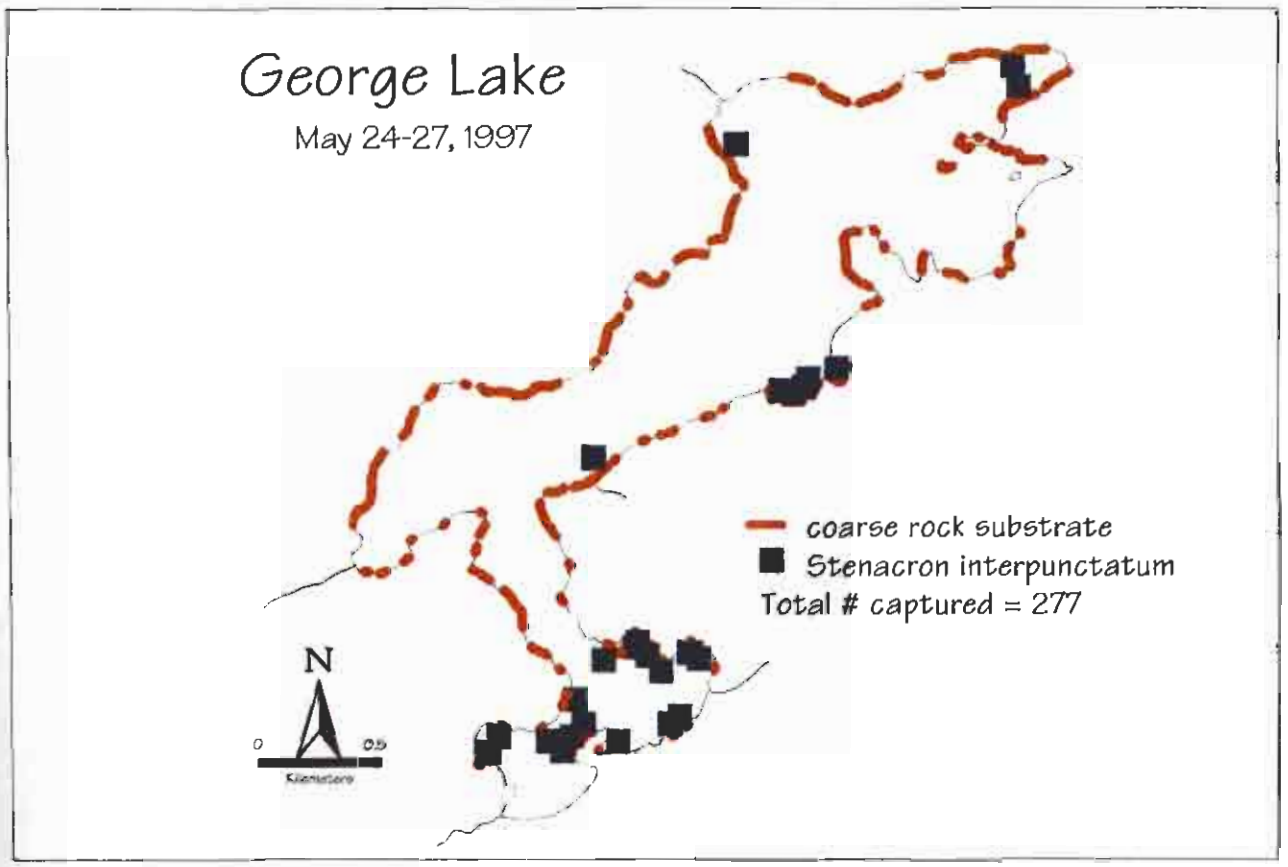
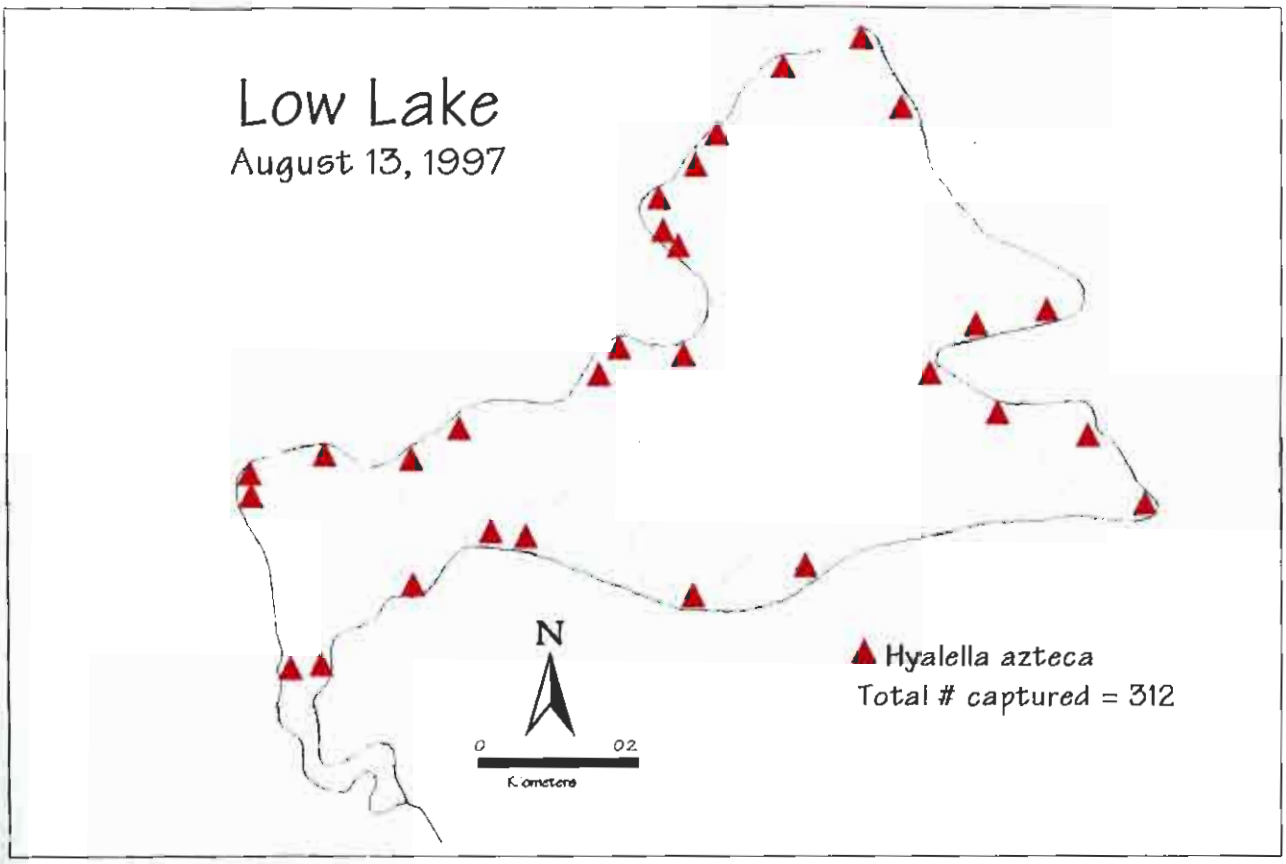


Figure 27. Capture locations for Hyalella azteca in Low and George Lakes



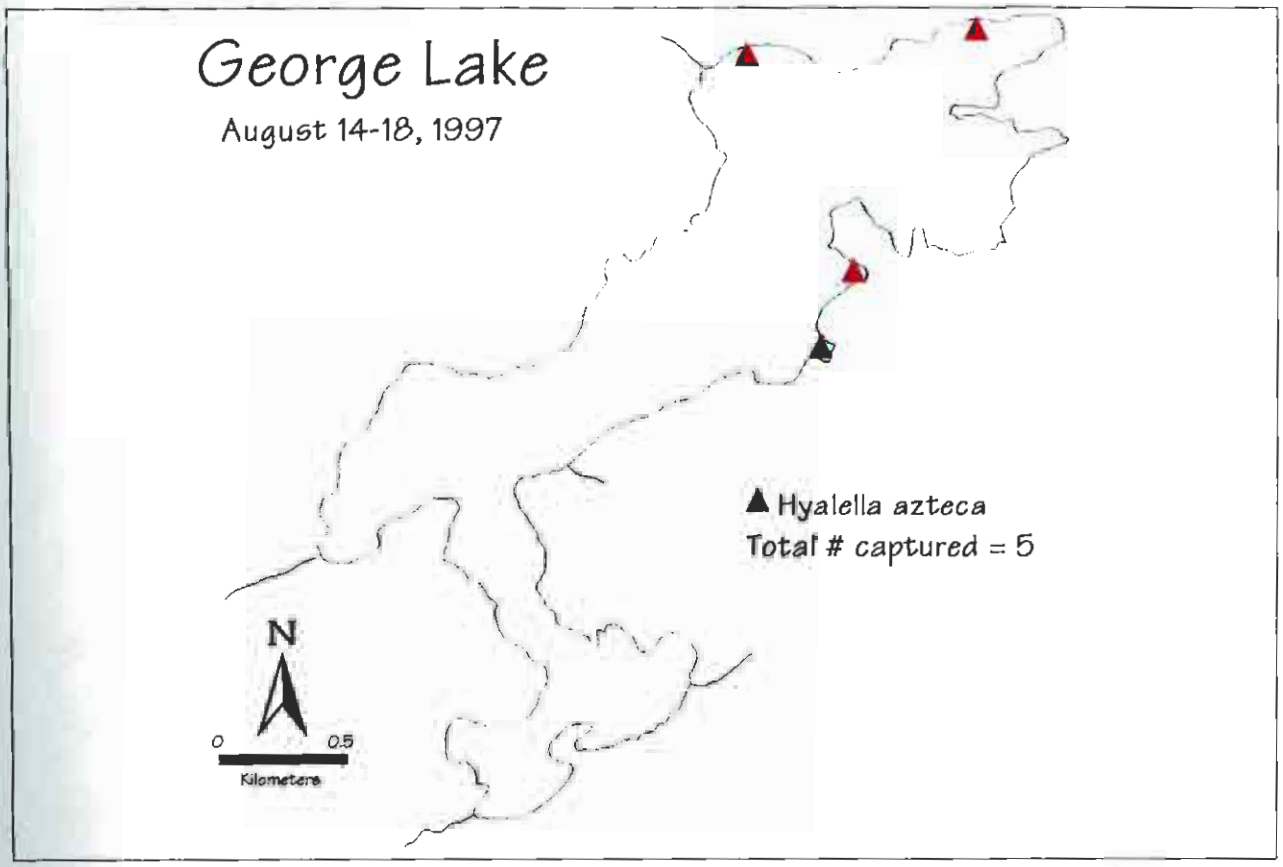
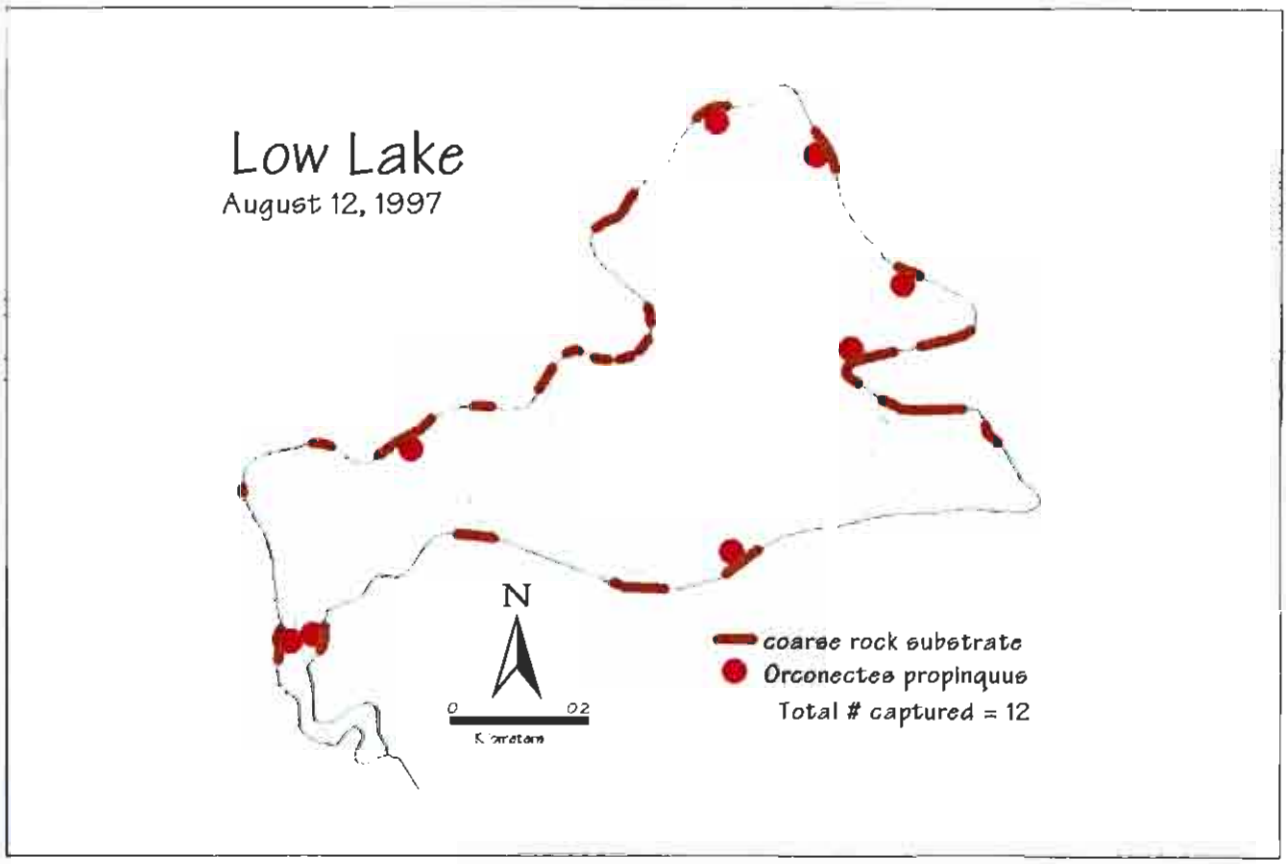


Figure 28. Capture locations for Orconectes propinquus in Low and George Lakes



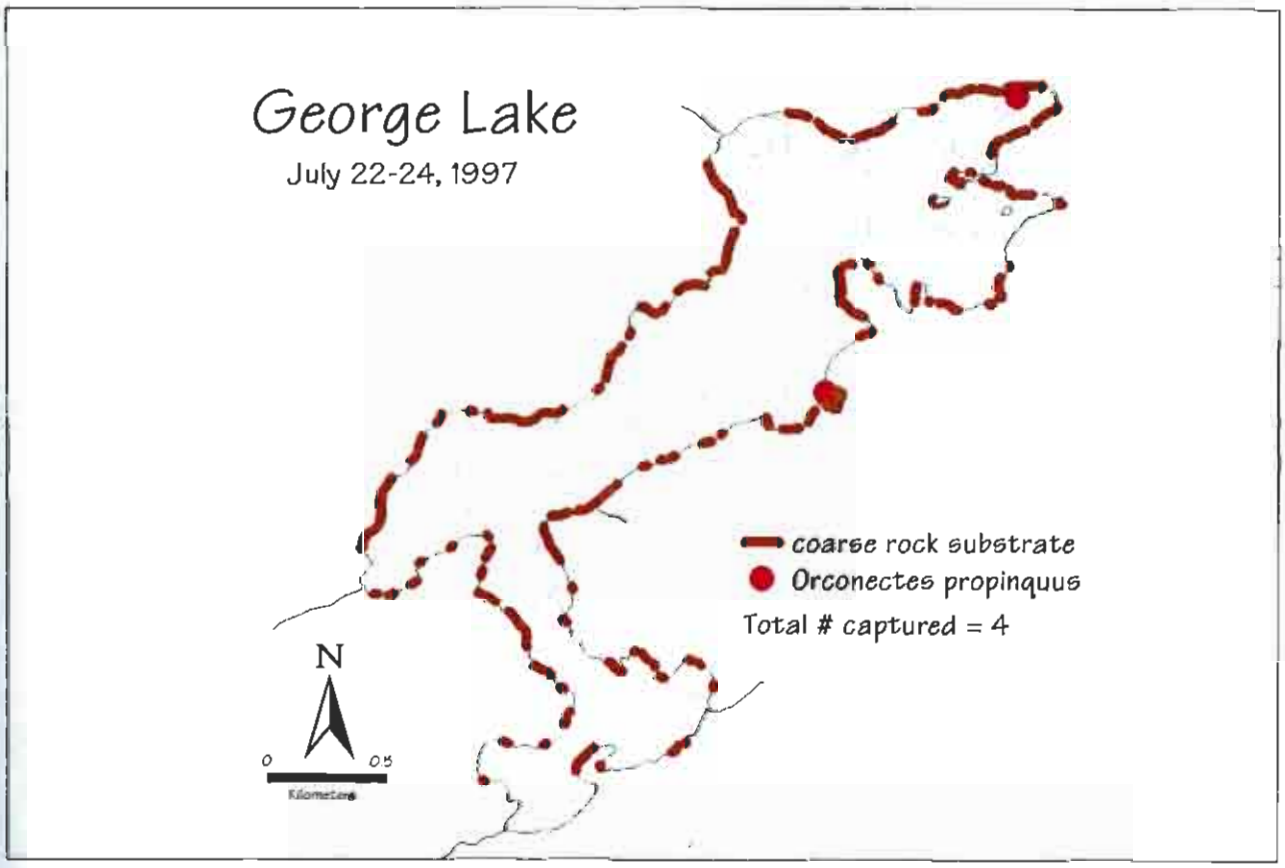
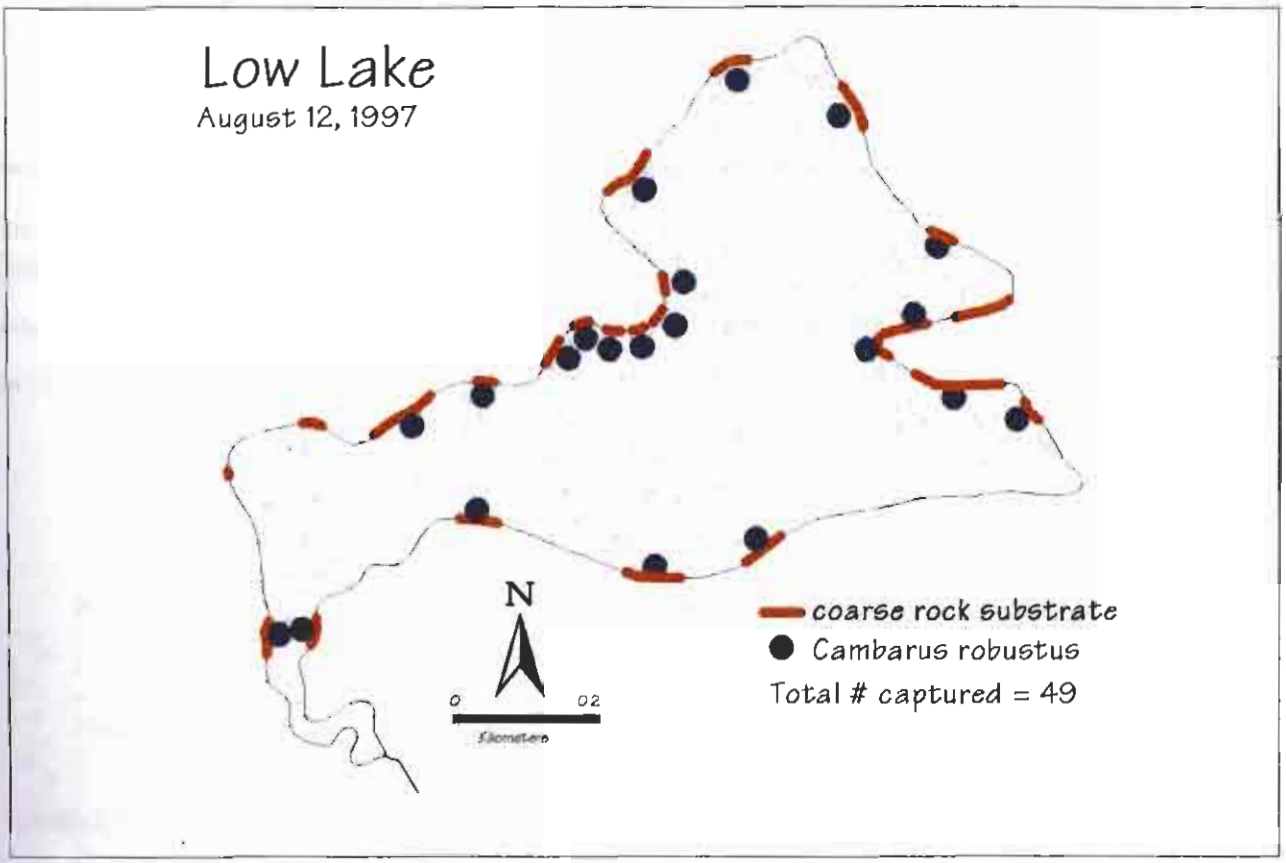


Figure 29. Capture locations for Cambarus robustus in Low and George Lakes



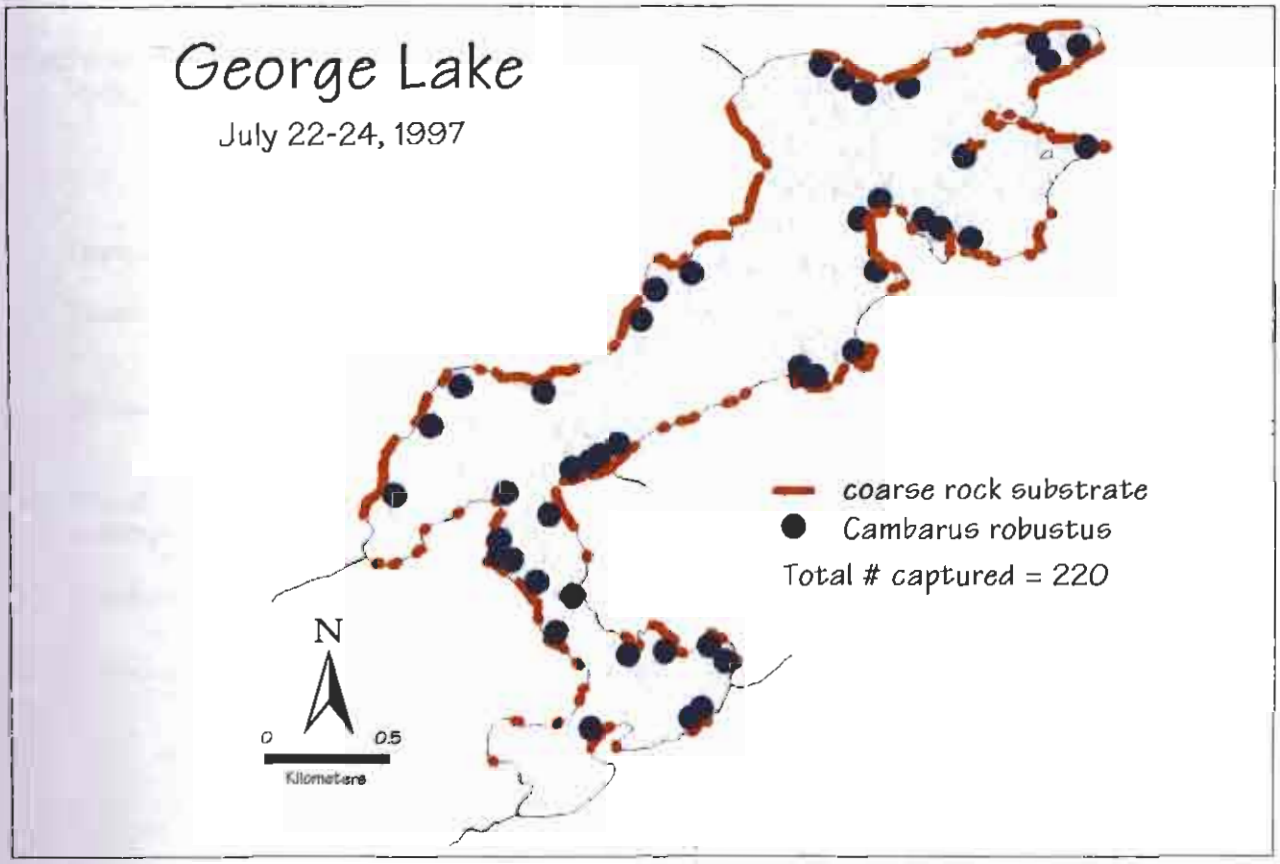


Table 21. Invertebrates collected in Chikanishing River during winter of 1995 - 1996 at three sites downstream of George Lake. (#) = Mayfly species captured in sweepnet, but not in surber.

Sampling Site (Distance from George Lake)	C1 (10 m)	C2 (1000 m)	C3 (1800 m)
MAYFLIES			
Baetidae			
Centroptilum			X (#)
Ephemerellidae			
Eurylophella		X	X
Ephemeridae			
Ephemera simulans			X
Heptageniidae			
Stenacron interpunctatum			X
Leptophlebiidae			
Leptophlebia		X (#)	X
Metretopodidae			
Siphlopecton basale		X (#)	X (#)
STONEFLIES			
Nemouridae			
Shipsa rotunda	X	X	X
CADDISFLIES			
Hydropsychidae			
Cheumatopsyche	X	X	X
Hydropsyche betteni	X	X	
Hydropsyche sparna	X	X	
Hydropsyche spp.	X		
Limnephilidae			
Pycnopsyche		X	X
Polycentropodidae			
Neureclipsis	X		
Polycentropus		X	X
Sericostomatidae			
Agarodes	X		
DRAGONFLIES			
Cordulegastridae			
Cordulegaster obliquus		X	
Gomphidae		X	X

Table 21 (cont.). Invertebrates collected in Chikanishing River 1995-96 at three sites downstream of George Lake.

Sampling Site (Distance from George Lake)	C1 (10 m)	C2 (1000 m)	C3 (1800 m)
TRUE FLIES			
Ceratopogonidae	X		
Chironomidae			
Cricotopus	X	X	X
Eukiefferiella	X		X
Glyptotendipes	X		
Micropsectra	X		
Microtendipes	X		
Paralauterborniella			X
Rheotanytarsus		X	X
Stempellina	X		
Thienemannimyia-gp	X	X	X
Simuliidae	X	X	X
Tipulidae			
Dicranota	X	X	X
Pilaria	X		
Tipula	X	X	
AMPHIPODS			
Gammaridae			
Crangonyx	X		X
ISOPODS			
Asellidae			
Caecidotea	X		
SNAILS			
Viviparacea			
Campeloma decisum			X
WORMS			
Lumbriculidae	X	X	X
Tubificidae-immature			X
FLATWORMS			
Tricladida	X		

Table 22. Animals observed during biological surveys.

Lake	Amphibians												Birds															Mammals					Reptiles					
	Tad	AT	BF	GF	LF	MF	SF	TF	WF	Mud	RSN	Sal	CG	CM	Cor	GBH	GE	Gul	HM	Kin	Loo	ML	Osp	SC	Ter	TL	WD	Bea	Min	Moo	Mus	Ott	BT	EMS	GS	PT	ST	WS
A.Y. Jackson										X				X							X		X															
Acid	X																	X			X																	
Amikoganing	X																				X							X									X	
Artist																X					X						X											
Balsam																																						
Beaver					X											X		X			X		X															
Bell	X			X						X				X							X																	
Betty																		X			X																	
Billy	X													X		X			X		X																	
Bizhiw																																						
Bodina	X															X		X			X																X	X
Boundary	X															X					X							X						X			X	
Bunnyrabbit																					X																	
Burke																																						
Canis																X		X			X				X							X					X	
Carlyle	X									X				X	X	X					X				X											X	X	
Casson	X			X	X											X					X							X										X
Cat				X										X				X			X														X	X	X	
Cave														X		X		X																				
Chain	X																																					

AMPHIBIANS: Tad=tadpole; AT=American Toad, BF=Bullfrog, GF=Green Frog, LF=Leopard Frog, MF=Mink Frog, SF=Spring Peeper Frog, TF=Tree Frog, WF=Wood Frog, Mud=Mudpuppy; RSN=Red Spotted Newt; Sal=Salamander, unknown sp BIRDS: CG=Canada Goose, CM=Common Merganser, Cor=Doublecrested Cormorant, HM=Hooded Merganser, GBH=Great Blue Heron, GE=Golden Eye; Gul=Gull, Kin=Kingfisher; Loo=Loon; ML=Mallard, Osp=Osprey; SC=Sandhill Crane, Ter=Tern, TL=Teal, WD=Wood duck MAMMALS: Bea=Beaver, Min=Mink; Moo=Moose, Mus=Muskrat, Ott=Otter REPTILES: BT=Bandings Turtle, EMS=Eastern Milk Snake, GS=Garter Snake; PT=Painted Turtle, ST=Snapping Turtle, WS=Water Snake

Table 22 (cont.). Animals observed during biological surveys.

Lake	Amphibians												Birds															Mammals					Reptiles					
	Tad	AT	BF	GF	LF	MF	SF	TF	WF	Mud	RSN	Sal	CG	CM	Cor	GBH	GE	Gul	HM	Kin	Loo	ML	Osp	SC	Ter	TL	WD	Bea	Min	Moo	Mus	Ott	BT	EMS	GS	PT	ST	WS
Clearsilver																					X																	
Cran. Bag-1995															X						X																	
Cran. Bag-1997																X					X							X										
Crater East	X											X																								X		
Crater West	X																																					
Cuckoo																					X																	
David	X			X										X		X					X									X							X	
Deacon	X									X						X					X																	
de Lamorand.														X																								
East Howry															X	X		X			X																	
Fish	X													X		X		X			X			X				X			X						X	
Fox	X																																					
Frank	X																																					
Freeland -1995		X	X	X	X										X	X		X	X		X		X									X				X	X	
Freeland - 1997	X			X	X					X				X	X	X	X	X			X	X	X					X								X	X	
Gull																					X							X										
Gem	X																	X			X				X											X	X	
George				X	X											X					X								X									
Goose-1996	X				X																																	
Goose-1997																																						
Goschen	X																	X			X																	

AMPHIBIANS: Tad=tadpole, AT=American Toad; BF=Bullfrog, GF=Green Frog, LF=Leopard Frog, MF=Mink Frog, SF=Spring Peeper Frog, TF=Tree Frog, WF=Wood Frog, Mud=Mudpuppy, RSN=Red Spotted Newt, Sal=Salamander, unknown sp BIRDS: CG=Canada Goose; CM=Common Merganser; Cor=Doublecrested Cormorant; HM=Hooded Merganser; GBH=Great Blue Heron, GE=Golden Eye, Gul=Gull, Kin=Kingfisher, Loo=Loon; ML=Mallard, Osp=Osprey, SC=Sandhill Crane; Ter=Tern, TL=Teal, WD=Wood duck MAMMALS: Bea=Beaver; Min=Mink; Moo=Moose; Mus=Muskrat; Ott=Otter REPTILES: BT=Bandings Turtle, EMS=Eastern Milk Snake, GS=Garter Snake; PT=Painted Turtle, ST=Snapping Turtle, WS=Water Snake

Table 22 (cont.). Animals observed during biological surveys.

Lake	Amphibians												Birds															Mammals					Reptiles					
	Tad	AT	BF	GF	LF	MF	SF	TF	WF	Mud	RSN	Sal	CG	CM	Cor	GBH	GE	Gul	HM	Kin	Loo	ML	Osp	SC	Ter	TL	WD	Bea	Min	Moo	Mus	Ott	BT	EMS	GS	PT	ST	WS
Grace	X			X														X			X																	
Grew				X	X											X					X														X			
Grt. Mountain	X																	X			X																	
Grey	X			X												X					X																	
Hanwood	X														X			X			X																	
Harry	X		X	X	X											X					X				X											X	X	
Heaven				X																																		
Helen															X	X		X			X																	
Hemlock																																						
Howry																X					X																	
Ishmael			X	X	X									X				X			X				X													
Johnnie														X	X	X					X																	
Kakakise	X									X						X			X						X												X	
Kidney	X												X																									
Killarney							X							X					X		X																	X
Lake of Woods	X																																					
Leech	X															X		X			X		X		X			X		X							X	X
Little Bell	X																																					
Little Leech	X															X		X			X																X	
Little Mink	X																				X									X						X	X	X

AMPHIBIANS: Tad- tadpole; AT=American Toad, BF=Bullfrog, GF=Green Frog, LF=Leopard Frog; MF=Mink Frog, SF=Spring Peeper Frog, TF=Tree Frog; WF=Wood Frog; Mud=Mudpuppy, RSN=Red Spotted Newt; Sal=Salamander, unknown sp BIRDS: CG=Canada Goose; CM=Common Merganser; Cor=Doublecrested Cormorant; HM=Hooded Merganser; GBH=Great Blue Heron; GE=Golden Eye; Gul=Gull, Kin=Kingfisher; Loo=Loon; ML=Mallard, Osp=Osprey; SC=Sandhill Crane; Ter=Tern; TL=Teal, WD=Wood duck MAMMALS: Bea=Beaver; Min=Mink, Moo=Moose, Mus=Muskrat, Ott=Otter REPTILES: BT=Bandings Turtle; EMS=Eastern Milk Snake; GS=Garter Snake; PT=Painted Turtle; ST=Snapping Turtle; WS=Water Snake

Table 22 (cont.). Animals observed during biological surveys.

Lake	Amphibians												Birds															Mammals					Reptiles					
	Tad	AT	BF	GF	LF	MF	SF	TF	WF	Mud	RSN	Sal	CG	CM	Cor	GBH	GE	Gul	HM	Kin	Loo	ML	Osp	SC	Ter	TL	WD	Bea	Min	Moo	Mus	Ott	BT	EMS	GS	PT	ST	WS
Little Mountain									X				X								X																	
Lt. Shegulandah	X									X				X						X																		
Little Superior																					X																	
Log Boom										X						X																						
Low			X		X											X		X		X																		X
Lumsden					X	X		X													X		X									X						X
Mink	X	X														X					X		X	X	X			X		X							X	
Muriel	X																				X														X		X	
Murray	X				X					X			X	X		X					X							X							X	X	X	
Nellie\Carmichael	X			X			X											X			X							X							X			
Norway	X												X								X																	
O.S.A.							X							X	X						X																	
Partridge	X																				X																	
Patten	X															X																						
Pearl	X																																					
Peter	X									X					X	X		X			X				X												X	
Pike	X			X	X											X					X																	
Proulx																																						
Quartzite																					X																	
Rocky																X		X													X		X			X	X	

AMPHIBIANS: Tad=tadpole; AT=American Toad, BF=Bullfrog, GF=Green Frog; LF=Leopard Frog; MF=Mink Frog; SF=Spring Peeper Frog, TF=Tree Frog, WF=Wood Frog, Mud=Mudpuppy, RSN=Red Spotted Newt; Sal=Salamander, unknown sp.BIRDS: CG=Canada Goose; CM=Common Merganser; Cor=Doublecrested Cormorant; HM=Hooded Merganser; GBH=Great Blue Heron, GE=Golden Eye; Gul=Gull, Kin=Kingfisher, Loo=Loon; ML=Mallard, Osp=Osprey, SC=Sandhill Crane; Ter=Tern; TL=Teal, WD=Wood duck MAMMALS. Bea=Beaver; Min=Mink; Moo=Moose; Mus=Muskrat; Ott=Otter.REPTILES. BT=Bandings Turtle, EMS=Eastern Milk Snake, GS=Garter Snake; PT=Painted Turtle; ST=Snapping Turtle; WS=Water Snake

Table 22 (cont.). Animals observed during biological surveys.

Lake	Amphibians												Birds															Mammals					Reptiles					
	Tad	AT	BF	GF	LF	MF	SF	TF	WF	Mud	RSN	Sal	CG	CM	Cor	GBH	GE	Gul	HM	Kin	Loo	ML	Osp	SC	Ter	TL	WD	Bea	Min	Moo	Mus	Ott	BT	EMS	GS	PT	ST	WS
Roque	X										X																											
Round Otter	X															X		X			X									X						X	X	
RuthRoy																X																						
Sandy	X																																					
Sealey's																																						
Shingwak	X			X																	X																	
Silver																																						
Solomon		X				X																														X	X	
Spark																																						
Teardrop				X																																		
Terry	X															X					X																	
Threenarrows	X														X			X			X			X														
Topaz																																						
TriLakes N				X																	X								X									
TriLakes SE	X			X	X																X																	
TriLakes SW				X												X					X																	
Turbid	X			X																	X																	
Turtleback	X																																					
Van				X												X					X																X	
Van Winkle	X													X		X		X			X					X												

AMPHIBIANS Tad=tadpole, AT=American Toad, BF=Bullfrog, GF=Green Frog, LF=Leopard Frog, MF=Mink Frog, SF=Spring Peeper Frog, TF=Tree Frog, WF=Wood Frog, Mud=Mudpuppy; RSN=Red Spotted Newt; Sal=Salamander, unknown sp.BIRDS: CG=Canada Goose, CM=Common Merganser; Cor=Doublecrested Cormorant; HM=Hooded Merganser; GBH=Great Blue Heron, GE=Golden Eye, Gul=Gull, Kin=Kingfisher, Loo=Loon, ML=Mallard, Osp=Osprey; SC=Sandhill Crane, Ter=Tern; TL=Teal, WD=Wood duck MAMMALS. Bea=Beaver; Min=Mink, Moo=Moose; Mus=Muskrat, Ott=Otter REPTILES. BT=Bandings Turtle, EMS=Eastern Milk Snake; GS=Garter Snake; PT=Painted Turtle; ST=Snapping Turtle, WS=Water Snake

Table 22 (cont.). Animals observed during biological surveys.

Lake	Amphibians												Birds														Mammals					Reptiles					
	Tad	AT	BF	GF	LF	MF	SF	TF	WF	Mud	RSN	Sal	CG	CM	Cor	GBH	GE	Gul	HM	Kin	Loo	ML	Osp	SC	Ter	TL	WD	Bea	Min	Moo	Mus	Ott	BT	EMS	GS	PT	ST	WS
Wagon Road																X				X	X		X															
Whiskeyjack																					X																	
York	X															X					X																	
#6	X																																					
#7																																						
#9																																						
#24																																						
#25																																						
#27	X																																					
#28	X			X																						X		X										
#29																																						
#30	X		X	X																																		
#37																X				X	X							X										
#45	X														X						X																	
#59	X																				X				X												X	
#64	X																																					
#65	X																																					
#66	X																																					
#69																																				X		
#74	X																				X																	
#76																					X							X									X	

AMPHIBIANS Tad=tadpole, AT=American Toad; BF=Bullfrog, GF=Green Frog, LF=Leopard Frog, MF=Mink Frog, SF=Spring Peeper Frog, TF=Tree Frog, WF=Wood Frog, Mud=Mudpuppy; RSN=Red Spotted Newt, Sal=Salamander, unknown sp BIRDS. CG=Canada Goose, CM=Common Merganser, Cor=Doublecrested Cormorant, HM=Hooded Merganser; GBH=Great Blue Heron, GE=Golden Eye, Gul=Gull, Kin=Kingfisher, Loo=Loon; ML=Mallard, Osp=Osprey; SC=Sandhill Crane, Ter=Tern; TL=Teal, WD=Wood duck MAMMALS Bea=Beaver; Min=Mink, Moo=Moose, Mus=Muskrat, Ott=Otter REPTILES: BT=Bandings Turtle; EMS=Eastern Milk Snake, GS =Garter Snake, PT=Painted Turtle, ST=Snapping Turtle, WS=Water Snake

REFERENCES

Beamish, R.J., and H.H. Harvey. 1972. Acidification of the La Cloche Mountain Lakes, Ontario, and resulting fish mortalities. J. Fish. Res. Bd. Canada 29: 1131-1143.

Beamish, R.J., G.A. McFarlane, J.C. VanLoon, and J. Lichwa. 1975. an examination of the possible effects of Sudbury nickel mining and smelting operations on fishes and the water Environment Canada Fisheries and Marine Service Technical Report 579.

Beamish, R.J., and J.C. VanLoon. 1977. Precipitation loading of acid and heavy metals to a small acid lake near Sudbury, Ontario. J. Fish. Res. Board Can. 34: 649-658.

Beggs, G.L., and J.M. Gunn. 1986. Response of lake trout (Salvelinus namaycush) and brook trout (S. fontinalis) to surface water acidification in Ontario. Wat. Air Soil Pollut. 30: 711-718.

Bendell, B.E., and D.K. McNicol. 1991. An assessment of leeches (Hirudinea) as indicators of lake acidification. Can. J. Zool. 69: 130-133.

Bouillon, D.F. 1995. Developments in emission control technologies/strategies: A case study. In J.M. Gunn [ed.] Restoration and Recovery of an Industrial Region. Springer-Verlag. New York.

Card, K.D., D.G. Innes, and R.L. Debicki. 1977. Stratigraphy, sedimentology and petrology of the Huronian Supergroup in the Sudbury-Espanola area. Ontario Division of Mines, Geoscience Report GS16.

Casselman, J.M., and H.H. Harvey. 1973. Fish traps of clear plastic. Prog. Fish. Cult. 35: 218-220.

Cordiner, G.S. 1973. Brief geology and geomorphology of Killarney Provincial Park Northeastern region, Ontario. Ont. Min. Nat. Res., Environmental Planning Series Earth Science Report. Revised Edition. Vol. V

Crocker, D.W. and D.W. Barr. 1968. Handbook of the crayfishes of Ontario. University of Toronto Press, Toronto.

Curry, R.A., and P.M. Powles. 1991. The insect community in an outlet stream of an acidified lake. Naturaliste can. (Rev. Ecol. Syst.) 118: 27-34.

Curry, R.A., P.M. Powles, V.A. Liimatainen, and J.M. Gunn. 1991. Emergence chronology of brook charr (Salvelinus fontinalis) alevins in an acidic stream. Envir. Biol. Fish. 31: 25-31.

David, S.M., K.M. Somers, and R.A. Reid. 1994. Long-term trends in the relative abundance of crayfish from acid sensitive, softwater lakes in south central Ontario: a data summary for the first 5 years, 1988-1992. Ontario Ministry of Environment and Energy, Toronto.

Davies, I.J. 1989. Population collapse of the crayfish Orconectes virilis in response to experimental whole-lake acidification. Can. J. Fish. Aquat. Sci. 46: 910-922.

Debicki, R.L. 1982. Geology and scenery, Killarney Provincial Park area. Ontario Geological Survey Guidebook No. 6.

Degerman, E., P. Nyberg, and M. Appelburg. 1988. Estimating the number of species and relative abundance of fish in oligotrophic Swedish lakes using multi-mesh gillnets. Nordic J. Freshw. Res. 64: 91-100.

Dixit, A.S., S.S. Dixit, and J.P. Smol. 1992. Long-term trends in lake water pH and metal concentrations inferred from diatoms and chrysophytes in three lakes near Sudbury, Ontario. Can. J. Fish. Aquat. Sci. 49 (Suppl. 1): 17-24.

Dodge, D.P., G.A. Goodchild, J.C. Tilt, D.G. Waldriff, and I. MacRitchie. 1987. Manual of instructions aquatic habitat inventory surveys. Ontario Ministry of Natural Resources, Toronto.

Dolson, N, and V. Liimatainen. 1989. Sudbury District Brook Trout Atlas. Ontario Ministry of Natural Resources, Sudbury.

Edmunds, G.F., Jr., S.L. Jensen, and L. Berner. 1976. The mayflies of North and Central America. Univ. Minnesota Press, Minneapolis.

Gunn, J.M. and W. Keller. 1990. Biological recovery of an acid lake following reductions in industrial emissions of sulphur. Nature 345: 431-433.

Harvey, H.H. and C. Lee. 1980. Report to Ontario Ministry of Natural Resources on the fishes of the La Cloche Mountain lakes of Ontario 1965-1980. Unpublished report.

Hulsman, P.F., P.M. Powles, and J.M. Gunn. 1983. Mortality of walleye eggs and rainbow trout yolk-sac larvae in low-pH waters of the La Cloche Mountain area, Ontario. Trans. Am. Fish. Soc. 112: 680-688.

Keller, W. and J.R. Pitblado. 1986. Water quality changes in Sudbury area lakes: a comparison of synoptic surveys in 1974-1976 and 1981-1983. Water Air Soil Pollut. 29: 285-296.

Locke, A., W.G. Sprules, W. Keller, and J. R. Pitblado. 1994. Zooplankton communities and water chemistry of Sudbury area lakes: changes related to pH recovery. Can. J. Fish. Aquat. Sci. 51: 151-160.

MacDonald, I.D. 1973. A preliminary ecological inventory of Killarney Provincial Park. Ont. Min. Nat. Res. Environmental Planning Series; Life Science Report Vol. IV, No. 12.

Matuszek, J.E., J. Goodier, and D.L. Wales. 1990. The occurrence of cyprinidae and other small fish species in relation to pH in Ontario lakes. Trans. Am. Fish. Soc. 119: 850-861.

Merrit, R.W. and K.W. Cummins. 1996. An introduction to the aquatic insects of North America. 3rd edition. Kendal/Hunt Publishing Company. Dubuque, Iowa.

Ministry of Environment (MOE). 1984. Water management - goals, policies, objectives and implementation procedures of the Ministry of the Environment. Technical Report. Toronto.

Neary, B.P., P.J. Dillon, J.R. Munro, and B.J. Clark. 1990. The acidification of lakes: an assessment of their sensitivity and current status with respect to biological damage. Ont. Min. Environ. Rep., Toronto.

Nyberg, P. and E. Degerman. 1988. Standardized test fishing with survey nets. Inform. Inst. Freshw. Res. Drottningholm (7). (Swedish with English summary).

Pennak, R.W. 1978. Fresh-water invertebrates of the United States. 2nd edition. John Wiley and Sons, New York.

Polkinghorne, D. and J. Gunn. 1981. Sudbury District Lake Trout Lakes ... a description of the lakes and the changes produced by man. Ontario Ministry of Natural Resources, Sudbury, Unpublished report.

Robbins, W.H., and H.R. MacCrimmon. 1974. The blackbasses of America and overseas. Biomanagement and Research Enterprises, Sault Ste. Marie, Ontario.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bulletin 184.

Snucins, E.J. and B.J. Shuter. 1991. Survival of introduced smallmouth bass in low-pH lakes. Trans. Am. Fish. Soc. 120: 209-216.

Stephenson, M., and G.L. Mackie. 1986. Lake acidification as a limiting factor in the distribution of the freshwater amphipod Hyallela azteca. Can. J. Fish. Aquat. Sci. 43: 288-192.

Thorp, J.H. and A.P. Covich (eds.). 1991. Ecology and classification of North American freshwater invertebrates. Academic Press Ltd., London.

APPENDIX A

1996 Water Sampling Methods and Results

Ed Snucins, Cooperative Freshwater Ecology Unit, Sudbury

Geographic Locations, Surface Areas and Watershed Areas

Digital OBM maps (scale 1:20,000 ; geodetic datum NAD83) were supplied by the Provinical Mapping Office. Geographic location, lake surface area and watershed area for each sampled lake were obtained from the maps using MAPINFO software.

Sampling Techniques

Access: helicopter

Winter: 5 m tube composite
Summer: surface grab

Tube composite method description:

Tube composite water samples were collected from the lakes through a hole drilled in the ice. A length of 2.5 cm diameter Tygon tubing was lowered to a depth of 5 m (or to 1 m off bottom in shallower lakes), clamped at water level, then raised to the surface. The tube contents were emptied into a 10 L plastic jug. This procedure was repeated until sufficient water was collected in the jug to completely fill eight 500 ml polystyrene bottles. All containers were rinsed at least twice with the sample. Samples were stored in the dark and kept refrigerated. Samples for analysis of dissolved metals were acidified with 1 ml nitric acid.

Surface grab method description:

Surface grab samples were obtained at mid-lake. All sample containers (500 ml polystyrene bottles) were rinsed at least twice with lake water prior to final filling with the sample. Final filling was done by submerging the capped bottle to a depth of 10-15 cm, then removing the lid to allow water to completely fill the container. The lid was screwed in place prior to removing the bottle from the water. Samples were stored in the dark and kept refrigerated. Samples for analysis of dissolved metals were acidified with 1 ml nitric acid.

Error Detection and Data Qualifiers

pH, alkalinity, conductivity

Total inflection point alkalinity (TIP), pH and conductivity were measured at the Coop Unit laboratory in Sudbury. Split samples were analysed by the Ministry of Environment and Energy (MOEE) laboratories in Dorset and Toronto. Regression equations ($r^2 = 0.99$) developed in a QA/QC study conducted as part of the wintertime water sampling program were used to estimate Coop Unit values from the Dorset and Toronto results. These estimates provided a check on the quality of Coop Unit results.

If a Coop Unit alkalinity value disagreed by more than 100% with the regression estimates from both the Toronto and Dorset laboratories, the Coop Unit value was assumed to be in error and a regression-estimated value was substituted. This occurred for only three alkalinity measurements. More often, the estimates were used when alkalinity or conductivity analyses had not been done at the Coop Unit. The data derived from regression estimates are indicated (T = Toronto data used to estimate Coop Unit value; D = Dorset data used to estimate Coop Unit value). One Coop Unit pH measurement was inaccurate and replaced with a regression estimate.

Trace Metals

All metal analyses were done at the MOEE laboratory in Toronto. However, two different techniques were used, depending on when the samples were submitted. Some samples were analysed by ICP-AES. Most were analysed by the more sensitive ICP-MS.

Data qualifiers differed between the two techniques. For ICP-AES results, W and T values were given. The code <W indicates that no measurable response was observed under the test conditions (ie.not distinguishable from zero). The reported value indicates the minimum amount of analyte that could have been measured under routine conditions. W is usually less than the standard deviation of duplicates near zero. The <T code is used to represent a measurable amount of the analyte which under the test conditions was not verifiable. The MOEE laboratory recommends that results reported as <T should be considered tentative and used only for large batches of similar data to evaluate background levels or contaminant trends in the environment.

The ICP-MS results included uncertainty calculations based on performance data for that method and error of the individual sample. If the uncertainty limits included zero, the parameter was not detected within the precision of measurement (ie. it was not distinguishable from a concentration of zero) and this is indicated in the table by ND.

Ions, DOC, DIC, Colour, Nutrients, Hardness, Silicate

Data qualifiers for these parameters are W and T, as explained above for trace metals. T is five times W. An ion balance has not been calculated.

W and T values

Parameter	W	T
Total Aluminum	10 ug/L	100 ug/L
Barium	0.4 ug/L	5 ug/L
Beryllium	0.1 ug/L	1 ug/L
Cadmium	0.1 ug/L	0.5 ug/L
Chromium	0.2 ug/L	1 ug/L
Cobalt	0.2 ug/L	1 ug/L
Copper	0.2 ug/L	1 ug/L
Iron	20 ug/L	100 ug/L
Lead	5 ug/L	25 ug/L
Manganese	0.5 ug/L	2 ug/L
Molybdenum	0.2 ug/L	2 ug/L
Nickel	0.5 ug/L	5 ug/L
Strontium	2 ug/L	20 ug/L
Titanium	1 ug/L	10 ug/L
Vanadium	0.2 ug/L	2 ug/L
Zinc	0.5 ug/L	5 ug/L
Chloride	0.2 mg/L	1 mg/L
Sulphate	0.5 mg/L	2.5 mg/L
Calcium	0.05 mg/L	0.25 mg/L
Magnesium	0.02 mg/L	0.10 mg/L
Sodium	0.02 mg/L	0.10 mg/L
Potassium	0.01 mg/L	0.05 mg/L
Hardness	0.2 mg/L as CaCO3	1 mg/L as CaCO3
Colour, True	0.2 TCU	1 TCU
Conductivity	1 uS/cm	5 uS/cm
Nitrogen, Ammonia + ammonium	0.002 mg/L as N	0.01 mg/L as N
Nitrogen, Nitrate + nitrite	0.005 mg/L as N	0.025 mg/L as N
Nitrogen, Nitrite	0.001 mg/L as N	0.005 mg/L as N
Phosphorus, reative ortho-phosphate	0.0005 mg/L as P	0.0025 mg/L as P
Nitrogen, total Kjeldahl	0.02 mg/L as N	0.1 mg/L as N
Phosphorus, total	0.002 mg/L as P	0.01 mg/L as P
Dissolved inorganic carbon	0.2 mg/L as C	1.0 mg/L as C
Dissolved organic carbon	0.1 mg/L as C	0.5 mg/L as C
Silicon, reactive silicates	0.02 mg/L as Si	0.10 mg/L as Si

ICP-MS

Parameter	Range of individual sample uncertainties
Total Aluminum	± 10 - 48 ug/L
Barium	± 0.58 - 2.75 ug/L
Beryllium	± 1.00 ug/L
Cadmium	± 0.5 ug/L
Chromium	± 5.00 ug/L
Cobalt	±1.00 ug/L
Copper	± 5.00 ug/L
Iron	± 50 - 192.8 ug/L
Lead	± 0.50 - 3.99 ug/L
Manganese	± 1.00 - 18.48 ug/L
Molybdenum	± 1.00 ug/L
Nickel	± 1.00 - 1.21 ug/L
Strontium	± 1.00 - 2.22 ug/L
Titanium	± 2.00 ug/L
Vanadium	± 1.00 ug/L
Zinc	± 2.00 - 2.40 ug/L

Table 1. Geographic locations (geodetic datum NAD83), surface areas and watershed areas of sampled lakes. Watershed area includes lake surface area.

Number	Lake name	Latitude (deg, min, sec)	Longitude (deg, min, sec)	Surface area (ha)	Watershed area (ha) exclusive to lake	Watershed area (ha) including upstream lakes	Upstream lakes by number
1	Acid	46, 02, 01	81, 26, 38	19.6	145.0	463.8	13, 27, 78, 86
2	Amikogaming	46, 05, 16	81, 17, 06	17.8	211.6	275.6	47, 102
3	A.Y. Jackson	46, 01, 17	81, 23, 57	6.5	29.5	29.5	none
4	Balsam	46, 09, 55	81, 14, 34	266.9	1,193.0	3,360.7	26, 30, 31, 37, 44, 73, 74
5	Beaver	46, 09, 24	81, 32, 31	16.2	263.4	263.4	none
6	Bell	46, 08, 23	81, 11, 22	347.4	2,643.0	8,596.3	4, 19, 25, 26, 30, 31, 37, 44, 55, 73, 74, 104, 105, 106, 107, 108, 110
7	Betty	46, 11, 31	81, 23, 04	19.1	169.5	169.5	none
8	Billy	46, 07, 55	81, 09, 29	24.1	315.3	315.3	none
9	Bizhiw	46, 03, 06	81, 29, 24	2.1	9.2	9.2	none
10	Bodina	46, 06, 15	81, 29, 45	35.2	111.9	111.9	none
11	Boundary	46, 07, 35	81, 19, 04	93.3	873.9	873.9	none
12	Bunnyrabbit	46, 05, 01	81, 16, 26	12.7	96.4	96.4	none
13	Burke	46, 01, 43	81, 28, 28	8.4	107.6	107.6	none
14	Canis	46, 04, 13	81, 32, 00	27.4	699.6	805.0	146
15	Carlyle	46, 05, 03	81, 14, 45	156.7	515.9	1,058.6	12, 40, 90
16	Carmichael	46, 07, 58	81, 33, 43	13.0	125.4	1465.0	67, 98, 133, 134, 135, 136
17	Cat	46, 09, 37	81, 28, 04	46.4	262.6	262.6	none
18	Cave	46, 02, 36	81, 27, 52	12.4	113.9	113.9	none
19	Chain	46, 08, 25	81, 12, 36	10.9	94.0	677.1	55, 104, 105, 106, 107
20	Clearsilver	46, 07, 00	81, 15, 27	30.9	228.2	342.2	85, 109
21	Cranberry Bog	46, 01, 16	81, 22, 48	18.5	110.7	110.7	none
22	Crater East	46, 02, 43	81, 31, 26	2.2	22.4	22.4	none
23	Crater West	46, 02, 33	81, 31, 26	0.8	3.6	3.6	none
24	Cuckoo	46, 11, 07	81, 20, 17	24.6	123.1	123.1	none
25	David	46, 08, 24	81, 17, 11	406.3	1,557.0	1,915.5	108, 110
26	Deacon	46, 10, 09	81, 13, 44	36.9	212.5	1,023.9	30, 73
27	de Lamorandiere	46, 02, 00	81, 27, 14	5.9	35.9	318.8	13, 78, 86
28	East Howry	46, 11, 22	81, 21, 31	71.7	318.2	441.3	24
29	Fish	46, 09, 53	81, 23, 21	115.4	1,262.0	2,338.7	33, 39, 57
30	Fox	46, 10, 35	81, 14, 01	42.3	336.3	811.4	73

Table 1 (cont.). Geographic locations (geodetic datum NAD83), surface areas and watershed areas of sampled lakes. Watershed area includes lake surface area.

Number	Lake name	Latitude (deg, min, sec)	Longitude (deg, min, sec)	Surface area (ha)	Watershed area (ha) exclusive to lake	Watershed area (ha) including upstream lakes	Upstream lakes by number
31	Frank	46, 11, 19	81, 17, 25	15.6	78.8	78.8	none
32	Freeland	46, 02, 09	81, 22, 01	47.7	377.4	4,582.6	2, 45, 47, 51, 52, 53, 59, 68, 70, 75, 80, 82, 84, 101, 102, 111, 112, 113, 114, 117, 120, 121, 122, 123, 124
33	Gail	46, 09, 05	81, 22, 36	20.9	103.3	103.3	none
34	Gem	46, 09, 30	81, 26, 15	30.7	413.4	4,320.3	24, 28, 29, 33, 36, 39, 42, 56, 57, 63, 64, 77,92, 93, 94, 99, 100, 131, 132
35	George	46, 01, 28	81, 24, 19	188.5	841.4	5,716.7	2, 3, 21, 32, 45, 47, 51, 52, 53, 58, 59, 68, 70, 75, 80, 82, 84, 101, 102, 111, 112, 113, 114, 117, 120, 121, 122, 123, 124, 140, 141, 142, 149
36	Goose	46, 10, 37	81, 25, 10	10.1	67.7	616.9	42, 77, 99, 100
37	Goschen	46, 10, 50	81, 15, 45	24.1	144.3	144.3	none
38	Grace	46, 07, 53	81, 36, 06	47.2	263.1	263.1	none
39	Great Mountain	46, 09, 19	81, 21, 27	198.3	812.2	1,076.7	33, 57
40	Green	46, 04, 30	81, 16, 20	13.0	49.1	49.1	none
41	Grey	46, 07, 46	81, 10, 14	31.8	297.9	613.2	8
42	Grow	46, 10, 05	81, 27, 17	13.1	48.0	314.0	99, 100
43	Hanwood	46, 09, 39	81, 31, 35	32.0	144.1	614.6	5, 100
44	Harry	46, 10, 40	81, 18, 30	133.6	669.0	747.8	31
45	Heaven	46, 04, 42	81, 17, 38	1.7	14.1	14.1	none
46	Helen	46, 06, 25	81, 33, 45	82.6	883.4	883.5	none
47	Hemlock	46, 05, 00	81, 17, 06	3.3	20.2	64.0	102
48	Howry	46, 09, 10	81, 28, 27	118.1	642.8	5,376.5	24, 28, 29, 33, 34, 36, 39, 42, 56, 57, 63, 64, 77, 92, 93, 94, 99, 100, 131, 132
49	Ishmael	46, 06, 33	81, 35, 33	72.8	359.2	1242.6	46
50	Johnnie	46, 05, 03	81, 14, 45	342.3	1873.0	12952.5	4, 6, 8, 12, 15, 19, 20, 25, 26, 30, 31, 37, 40, 41, 54, 55, 60, 73, 74, 80, 85, 90, 97, 104, 105, 106, 107, 108, 109, 110
51	Kakakise	46, 03, 32	81, 19, 37	112.6	697.8	749.4	45, 52
52	Kidney	46, 03, 17	81, 20, 44	2.9	37.5	37.5	none

Table 1 (cont.). Geographic locations (geodetic datum NAD83), surface areas and watershed areas of sampled lakes. Watershed area includes lake surface area.

Number	Lake name	Latitude (deg, min, sec)	Longitude (deg, min, sec)	Surface area (ha)	Watershed area (ha) exclusive to lake	Watershed area (ha) including upstream lakes	Upstream lakes by number
53	Killarney	46, 03, 48	81, 21, 14	326.5	1,761.0	3,227.5	2, 47, 59, 68, 70, 75, 81, 84, 102, 111, 112, 113, 114, 117, 120, 121, 122, 123, 124
54	Lake of the Woods	46, 06, 09	81, 12, 10	9.7	67.0	67.0	none
55	Little Bell	46, 08, 42	81, 13, 25	21.1	234.5	583.1	104, 105, 106, 107
56	Little Mink	46, 05, 16	81, 23, 10	18.7	51.0	51.0	none
57	Little Mountain	46, 08, 33	81, 21, 45	23.6	161.2	161.2	none
58	Little Sheguiandah	46, 01, 28	81, 23, 31	4.5	21.5	21.5	none
59	Little Superior	46, 04, 14	81, 19, 59	13.9	35.4	35.4	none
60	Log Boom	46, 07, 07	81, 14, 14	6.9	52.0	8,648.3	4, 6, 19, 25, 26, 30, 31, 37, 44, 55, 73, 74, 104, 105, 106, 107, 108, 110
61	Low	46, 06, 06	81, 33, 38	33.8	117.0	1000.4	46
62	Lumsden	46, 01, 23	81, 25, 59	23.8	298.8	707.9	1, 13, 27, 86, 144
63	Mink	46, 10, 45	81, 22, 40	30.5	260.6	701.9	24, 28
64	Moose	46, 08, 44	81, 25, 23	16.6	157.2	157.2	none
65	Muriel	46, 03, 04	81, 26, 11	31.7	354.9	1,278.8	69, 89, 143
66	Murray	46, 08, 44	81, 33, 36	93.0	945.4	7,786.9	16, 24, 28, 29, 33, 34, 36, 39, 42, 48, 56, 57, 63, 64, 67, 77, 92, 93, 94, 98, 99, 100, 131, 132, 133, 134, 135, 136
67	Nellie	46, 07, 54	81, 31, 20	247.5	1055.0	1339.6	98, 133, 134, 135, 136
68	Norway	46, 05, 04	81, 18, 36	63.3	377.0	1,046.4	2, 47, 70, 81, 102
69	O.S.A.	46, 03, 07	81, 24, 18	278.9	866.2	879.0	89
70	Partridge	46, 04, 58	81, 18, 12	11.0	46.9	46.9	none
71	Patten	46, 06, 36	81, 21, 37	11.9	280.5	411.7	115, 116, 126, 127
72	Pearl	46, 03, 13	81, 28, 04	2.6	19.2	19.2	none
73	Peter	46, 11, 07	81, 12, 50	132.4	475.1	475.1	none
74	Pike	46, 10, 23	81, 15, 41	32.0	251.7	1,143.8	31, 37, 44
75	Proulx	46, 04, 26	81, 19, 36	12.0	42.0	42.0	none
76	Quartzite	46, 05, 31	81, 21, 19	15.7	59.1	98.3	118
77	Rocky	46, 10, 19	81, 26, 26	42.9	235.2	549.2	42, 99, 100
78	Roque	46, 01, 35	81, 28, 01	2.8	69.9	69.9	none

Table 1 (cont.). Geographic locations (geodetic datum NAD83), surface areas and watershed areas of sampled lakes. Watershed area includes lake surface area.

Number	Lake name	Latitude (deg, min, sec)	Longitude (deg, min, sec)	Surface area (ha)	Watershed area (ha) exclusive to lake	Watershed area (ha) including upstream lakes	Upstream lakes by number
79	Round Otter	46, 10, 15	81, 24, 26	20.4	670.4	2,494.8	24, 28, 36, 42, 56, 63, 77, 92, 93, 94, 99, 100, 131, 132
80	RuthRoy	46, 05, 20	81, 14, 58	54.5	496.8	496.8	none
81	Sandy	46, 05, 34	81, 17, 31	21.6	346.9	622.5	2, 47, 102
82	Sealey's	46, 03, 03	81, 24, 24	9.4	51.0	51.0	none
83	Shigaug	46,08,39	81,23,23	7.7	22.0	22.0	none
84	Shungwak	46, 04, 28	81, 19, 06	5.3	24.9	24.9	none
85	Silver	46, 06, 40	81, 15, 59	6.2	101.1	114.0	109
86	Solomon	46, 01, 48	81, 27, 31	8.3	105.4	282.9	13, 78
87	Spark	46, 02, 55	81, 30, 15	12.3	44.9	44.9	none
88	Sugarbush	46, 00, 53	81, 29, 20	5.1	92.0	92.0	none
89	Teardrop	46, 02, 33	81, 24, 48	3.4	12.8	12.8	none
90	Terry	46, 03, 56	81, 17, 19	11.5	397.2	542.8	12, 40
91	The Three Lakes	46, 00, 56	81, 30, 56	19.7	137.6	137.6	none
92	The Tri Lakes (North)	46, 11, 31	81, 24, 36	12.8	50	50	none
93	The Tri Lakes (Southeast)	46, 11, 02	81, 24, 19	17.5	148.4	312.9	94, 96
94	The Tri Lakes (Southwest)	46, 11, 08	81, 24, 32	10.4	114.5	114.5	none
95	Threenarrows	46, 05, 28	81, 27, 02	810.1	7,426.0	10,319.8	11, 71, 76, 83, 103, 115, 116, 118, 125, 126, 127, 128, 129, 130, 137, 138, 139, 150, 151
96	Topaz	46, 03, 11	81, 28, 43	4.7	24.4	24.4	none
97	Turbid	46, 06, 49	81, 11, 23	20.7	523.2	1,136.4	8, 41
98	Turtleback	46, 08, 24	81, 29, 12	5.4	57.7	57.7	none
99	Van	46, 10, 03	81, 28, 04	14.7	58.9	266.0	100
100	Van Winkle	46, 10, 00	81, 30, 36	85.2	207.1	207.1	none
101	Wagon Road	46, 01, 43	81, 22, 51	5.2	27.4	27.4	none
102	Whiskeyjack	46, 04, 57	81, 17, 29	12.8	43.8	43.8	none
103	York	46, 06, 58	81, 23, 50	39.1	399.3	399.3	none
104	#3	46, 08, 17	81, 13, 57	11.9	102.9	348.6	105, 106, 107

Table 1 (cont.). Geographic locations (geodetic datum NAD83), surface areas and watershed areas of sampled lakes. Watershed area includes lake surface area.

Number	Lake name	Latitude (deg, min, sec)	Longitude (deg, min, sec)	Surface area (ha)	Watershed area (ha) exclusive to lake	Watershed area (ha) including upstream lakes	Upstream lakes by number
105	#4	46, 08, 05	81, 13, 52	6.6	64.1	64.1	none
106	#5	46, 08, 16	81, 14, 34	3.5	112.2	181.6	107
107	#6	46, 08, 20	81, 15, 22	2.4	69.4	69.4	none
108	#7	46, 08, 39	81, 15, 11	2.8	50.7	50.7	none
109	#9	46, 06, 26	81, 16, 05	1.3	12.9	12.9	none
110	#12	46, 09, 01	81, 18, 16	38.1	307.8	307.8	none
111	#17	46, 06, 14	81, 19, 02	2.9	29.5	29.5	none
112	#18	46, 05, 58	81, 19, 02	1.5	26.7	56.2	111
113	#19	46, 05, 58	81, 19, 35	8.6	100.3	107.7	114
114	#20	46, 06, 08	81, 19, 58	0.9	7.4	7.4	none
115	#21	46, 06, 03	81, 20, 20	1.1	11.8	33.7	116
116	#22	46, 05, 55	81, 20, 07	2.8	21.9	21.9	none
117	#23	46, 05, 43	81, 20, 07	1.9	30. 7	30. 7	none
118	#24	46, 05, 36	81, 20, 50	3	39.2	39.2	none
119	#25	46, 05, 27	81, 20, 50	1.2	9.6	9.6	none
120	#26	46, 05, 12	81, 20, 33	1.6	36.5	46.1	119
121	#27	46, 05, 03	81, 21, 31	3.1	36.4	36.4	none
122	#28	46, 04, 52	81, 21, 37	2.5	19.0	19.0	none
123	#29	46, 04, 44	81, 21, 31	2.4	7.7	7.7	none
124	#30	46, 04, 52	81, 21, 12	2.5	23.6	60.0	121
125	#33	46, 05, 18	81, 23, 09	9.3	114.9	114.9	none
126	#35	46, 06, 32	81, 20, 41	5.5	78.0	78.0	none
127	#36	46, 06, 59	81, 21, 07	3.0	19. 5	19 5	none
128	#37A	46, 06, 50	81, 21, 56	17.6	96.3	96.3	none
129	#38	46, 07, 06	81, 19, 57	1.5	263.4	263.4	none
130	#40	46, 08, 31	81, 20, 35	3.3	22.2	22.2	none
131	#45	46, 10, 36	81, 19, 30	4.4	90.0	90.0	none
132	#46	46, 10, 50	81, 20, 54	2.5	51.7	51.7	none
133	#50	46, 08, 44	81, 27, 14	1.8	28.3	28.3	none
134	#51	46, 08, 30	81, 27, 33	9.7	138.5	226.9	133, 135, 136

Table 1 (cont.). Geographic locations (geodetic datum NAD83), surface areas and watershed areas of sampled lakes. Watershed area includes lake surface area.

Number	Lake name	Latitude (deg, min, sec)	Longitude (deg, min, sec)	Surface area (ha)	Watershed area (ha) exclusive to lake	Watershed area (ha) including upstream lakes	Upstream lakes by number
135	#52	46, 08, 20	81, 27, 43	4.1	33.8	60.1	136
136	#53	46, 08, 13	81, 27, 24	2.8	26.3	26.3	none
137	#54	46, 08, 28	81, 26, 32	7.1	34.9	34.9	none
138	#55	46, 08, 08	81, 26, 34	6.7	68.2	103.1	137
139	#59	46, 04, 38	81, 28, 15	48.4	251.2	251.2	none
140	#64	46, 02, 08	81, 24, 49	3.6	97.2	131.3	141, 142, 149
141	#65	46, 01, 57	81, 24, 52	2.6	11.7	24.0	142
142	#66	46, 01, 49	81, 24, 46	2.0	12.3	12.3	none
143	#68	46, 02, 32	81, 26, 43	3.8	44.9	44.9	none
144	#69	46, 01, 51	81, 26, 34	2.2	15.2	479.0	1, 13, 27, 78, 86
145	#71	46, 02, 10	81, 28, 28	3.6	96.9	96.9	none
146	#73	46, 05, 09	81, 30, 53	6	105.4	105.4	none
147	#74	46, 06, 34	81, 30, 46	11.8	257.9	257.9	none
148	#76	46, 05, 53	81, 34, 46	8.7	124.8	124.8	none
149	#79	46, 02, 26	81, 25, 59	0.7	10.1	10.1	none
150	#80	46, 00, 56	81, 22, 21	5.1	136.7	235.0	76, 118
151	#82	46, 08, 18	81, 23, 57	3.4	100.8	100.8	none

Table 2. If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
1	Acid	Jan. 30	4.995	-0.27	23.6	7	1.6	0.2<=W
2	Amikogaming	Jan. 23	5.119	0.20 (D)	30.3	5.6	2.5	0.2<=W
3	A.Y. Jackson	Feb. 1	5.815	1.23	26	6.8	2.7	0.4<T
4	Balsam	Jan. 23	6.091	4.03 (D)	33.2	30.4	6	1
5	Beaver	Feb. 2	5.976	5.435	28.7	64	8	1.2
6	Bell	Jan. 23	5.925	1.63	29.2	21	4.9	0.4<T
7	Betty	Aug. 27	7.035	14.35 (T)	55.5 (T)	31.8	8.5	3
8	Billy	Aug. 27	4.678	-0.28 (D)	26.6 (T)	20	5	0.2<=W
9	Bizhiw	Feb. 1	4.518	-1.4	30.2	5	0.8	0.2<=W
10	Bodina	Feb. 2	6.585	11.39	51	50.4	10.5	2.4
11	Boundary	Feb. 2	5.207	0.1	23.4	7.6	2.3	0.2<=W
12	Bunnyrabbit	Jan. 23	4.767	-0.61 (D)	27.1	1.6	0.8	0.2<=W
13	Burke	Feb. 2	5.094	-0.17	25.4	9.4	1.8	0.2<=W
14	Canis	Feb. 2	6.387	21.89	76.2	111	16.5	6
15	Carlyle	Feb. 1	5.85	1.147	27.7	14.6	3.7	0.2<=W
16	Carmichael	Feb. 2	4.625	-1.1	39	4.8	0.3<T	0.2<=W
17	Cat	Feb. 2	6.383	6.558	37	13.6	4.1	1.6
18	Cave	Feb. 1	5.602	1.828	30.5	13	4.2	0.8<T
19	Chain	Jan. 23 Jan. 30	4.650 4.599	-0.81(D) -1.1	30.4 30.7	40.4 42.0	5.7 6.5	0.4<T 2.2

Table 2 (cont.). If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
20	Clearsilver	Jan 23	4.932	-0.32 (D)	23.8	4.4	1.8	0.2<=W
21	Cranberry Bog	Feb 1	6.147	9.511	33.5	56.4	7.7	3.2
22	Crater East	Feb. 2	5.852	3.449	36.3	17.4	3.0	1.2
23	Crater West	Feb. 9	5.421	1.624	17.4	34.8	6.2	0.8<T
24	Cuckoo	Aug. 27	6.647	4.40 (T)	27.6 (T)	9.0	4.2	0.6<T
25	David	Feb. 2	5.000	-0.49	25.1	4.2	1.6	0.2<=W
26	Deacon	Jan 23	5.914	2.56 (D)	36.3	32.4	6.3	0.6<T
27	de Lamorandiere	Feb. 2 Feb 9	4.974 4.984	0.04 (D) -0.06	27.3 20.5	17.8 11.8	2.9 2.9	0.2<=W 0.2<=W
28	East Howry	Aug 27	7.129	11.43 (T)	45.5 (T)	14.4	5.7	2.2
29	Fish	Jan 24 Feb 12	5.744 5.940	0.70 (T) 1.904	25.3 27.7	11.6 16.8	2.8 3.8	0.4<T 0.4<T
30	Fox	Jan 23	6.210	3.81 (D)	38.2	33.0	6.3	0.8<T
31	Frank	Jan 23	6.248	6.26 (D)	35.0	32.4	6.6	1.4
32	Freeland	Feb. 2	5.520	0.5819	29.8	6.6	1.1	0.2<=W
33	Gail	Jan 24 Feb. 12	4.633 4.587	N/A -1.1	28.3 28.0	2.2 0.4 < T	0.6 0.8	0.2<=W 0.2<=W
34	Gem	Feb. 2	6.104	3.860	33.7	22.0	4.8	1.0
35	George	Jan. 30	5.787	1.009	28.7	6.2	1.7	0.8<T
36	Goose	Jan. 24	6.209	7.28 (D)	37.9	40.0	6.5	2.6
37	Goschen	Aug 27	6.234	3.82 (T)	31.6 (T)	37.6	8.0	0.4<T

Table 2 (cont.). If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
38	Grace	Feb. 2	5.110	-0.14	25.7	5.8	1.5	0.2<=W
39	Great Mountain	Jan. 24 Feb. 12	5.351 5.283	0.27 (D) 0.1880	26.1 26.0	8.0 5.4	2.2 2.0	0.2<=W 0.2<=W
40	Green	Jan. 23	5.329	1.39 (D)	31.4	56.0	8.1	0.6<T
41	Grey	Aug. 27	4.904	-0.09 (T)	27.6 (T)	9.2	3.4	0.2<=W
42	Grow	Jan. 24	6.571	8.47 (D)	36.7	12.4	4.1	2.8
43	Harwood	Feb. 2	6.378	7.490	33.7	23.4	4.8	1.6
44	Harry	Jan. 23 Feb. 13	6.345 6.197	3.93 (D) 3.626	28.8 29.3	18.2 15.0	5.1 5.1	0.8<T 0.6<T
45	Heaven	Jan. 23	4.767	-0.58 (D)	22.5	38.0	4.0	0.2<=W
46	Helen	Jan. 30	6.292	4.508	32.5	15.0	3.7	1.4
47	Hemlock	Jan. 23	4.737	-0.61 (D)	37.8	2.6	1.2	0.2<=W
48	Howry	Feb. 2	6.314	4.294	32.9	17.8	4.5	1.0
49	Ishmael	Jan. 30	6.508	5.010	33.7	10.4	3.5	1.2
50	Johnnie	Jan. 23	5.598	0.6442	26.7	11.0	3.4	0.2<=W
51	Kakakise	Jan. 30	6.286	2.668	30.4	8.0	2.7	1.0
52	Kidney	Feb. 1	5.323	0.9472	29.6	12.8	3.5	0.8<T
53	Killarney	Jan. 30	5.075	-0.09	29.2	4.0	1.0	0.2<=W
54	Lake of the Woods	Aug. 27	4.885	-0.08 (T)	25.6 (T)	7.8	3.3	0.2<=W
55	Little Bell	Jan. 23 Jan. 30	4.578 4.583	-1.21 (D) -1.1	32.0 31.7	58.0 55.0	7.4 7.1	0.6<T 0.2<=W

Table 2 (cont.). If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
56	Little Mink	Jan. 24	6.685	12.28 (D)	43.4	9.8	3.6	3.4
57	Little Mountain	Jan. 24	5.065	-0.04 (D)	28.4	2.8	0.8	0.2<=W
58	Little Sheguiandah	Feb. 1	6.122	5.297	35.0	14.8	4.7	2.0
59	Little Superior	Jan. 23	4.320	-2.52 (D)	49.1	1.0	0.2<T	0.2<=W
60	Log Boom	Jan. 23	5.482	1.22 (D)	25.1	11.4	2.4	0.6<T
61	Low	Jan. 30	7.239	20.93	73.9	7.4	3.0	5.2
62	Lumsden	Jan. 30	5.185	-0.01	21.9	6.4	1.5	0.2<=W
63	Mink	Jan. 24	6.298	11.17 (D)	48.8	39.2	7.4	3.0
64	Moose	Feb. 2	5.135	-0.06	26.0	0.2<=W	1.5	0.2<=W
65	Muriel	Feb. 1	5.146	-0.16	32.3	5.6	1.2	0.2<=W
66	Murray	Feb. 2	6.205	4.007	32.2	23.8	4.3	0.8<T
67	Nellie	Feb. 2	4.580	-1.2	40.0	3.0	0.2<T	0.2<=W
68	Norway	Jan. 23	5.136	0.15 (D)	29.2	3.8	1.7	0.2<=W
69	O.S.A.	Jan. 30 Feb. 13	4.840 4.808	-0.73 -0.76	35.3 35.9	3.0 0.2<=W	0.3<T 0.4<T	0.2<=W 0.2<=W
70	Partridge	Jan. 23	5.683	0.69 (D)	30.2	2.4	1.8	0.2<=W
71	Patten	Feb. 2	5.053	0.2534	31.3	14.4	3.5	0.4<T
72	Pearl	Feb. 1	5.311	0.3353	31.6	4.4	1.1	0.4<T
73	Peter	Feb. 12	6.504	4.368	41.3	7.2	3.3	0.6<T
74	Pike	Jan. 23	5.593	5.34 (D)	32.6	49.0	7.6	1.6
75	Proulx	Jan. 23	4.499	-1.21 (D)	43.8	0.4	0.3<T	0.2

Table 2 (cont.). If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
76	Quartzite	Feb. 2 Aug. 27	4.804 4.680	-0.66 -0.47 (T)	28.9 23.6 (T)	5.0 0.2<=W	0.1<=W 0.2<T	0.2<=W 0.2<=W
77	Rocky	Jan. 24	6.587	9.39 (D)	38.1	17.2	4.9	3.0
78	Roque	Feb. 2	5.005	-0.01	28.6	16.0	3.4	0.2<=W
79	Round Otter	Jan. 24	6.199	8.05 (D)	42.9	51.6	7.6	2.8
80	Ruth-Roy	Jan. 23	4.853	-0.59	28.3	2.8	0.5	0.2<=W
81	Sandy	Jan. 23	5.147	-0.25 (D)	28.9	4.6	2.0	0.2<=W
82	Sealey's	Feb. 1	6.064	9.427	38.7	71.2	10.7	3.6
83	Shigaug	Feb.2	4.830	-0.60	25.4	4.8	0.9	0.2<=W
84	Shingwak	Jan. 23	4.714	-0.61 (D)	31.6	1.2	0.3<T	0.2<=W
85	Silver	Jan. 23	4.976	-0.02 (D)	26.2	8.8	2.3	0.4<T
86	Solomon	Feb. 2	5.556	1.55 (D)	29.7	45.4	3.8	0.8<T
87	Spark	Feb. 2	4.463	-1.7	36.7	7.4	0.5	0.2<=W
88	Sugarbush	Feb. 2	4.770	-0.61	32.4	9.2	2.2	0.2<=W
89	Teardrop	Feb.1 Feb. 9	6.500 6.505	2.638 2.748	26.6 26.8	4.6 0.2<=W	1.0 1.1	0.6<T 0.4<T
90	Terry	Jan. 30	5.371	0.8031	27.7	33.8	5.5	1.4
91	The Three Lakes	Feb. 2 Feb. 9	5.052 5.079	0.2584 0.3774	23.4 23.2	29.6 26.4	4.9 5.4	0.4<T 0.4<T
92	The Tri Lakes (North)	Aug. 27	6.664	8.11 (T)	37.5 (T)	24.2	7.3	1.6
93	The Tri Lakes (Southeast)	Aug. 27	6.513	7.91 (T)	37.5 (T)	31.6	7.0	1.6
94	The Tri Lakes (Southwest)	Aug. 27	6.3 (T)	4.01 (T)	25.6 (T)	27.2	8.3	0.4<T
95	Threenarrows	Jan. 30	5.847	1.156	29.3	9.8	3.2	0.2<=W
96	Topaz	Feb. 1	4.608	-1.1	35.7	3.8	0.3<T	0.2<=W

Table 2 (cont.). If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
97	Turbid	Aug. 27	4.960	0.11 (T)	24.6 (T)	8.6	3.2	0.2<=W
98	Turtleback	Feb. 2	5.077	-0.02	28.7	1.4	2.1	0.2<=W
99	Van	Feb. 2	6.163	6.640	32.6	16.0	4.4	1.6
100	Van Winkle	Feb. 2	6.562	4.284	30.5	5.6	3.0	0.8<T
101	Wagon Road	Jan. 30	5.995	7.841	32.7	63.2	8.5	4.6
102	Whiskeyjack	Jan. 23	4.610	-1.11 (D)	38.7	1.0	0.4<T	0.2<=W
103	York	Feb. 2	6.081	3.696	36.6	33.2	6.2	0.4<T
104	#3	Feb. 12	4.564	-1.2	33.0	35.2	6.2	0.2<=W
105	#4	Feb. 12	4.728	-0.58	37.0	15.4	4.8	0.2<=W
106	#5	Feb. 12	4.363	-2.0	30.6	100.0	11.9	0.2<=W
107	#6	Feb. 12	4.524	-1.2	27.2	85.8	10.5	0.4<T
108	#7	Feb. 12	4.973	0.3842	19.5	83.4	9.8	0.6<T
109	#9	Feb. 12	4.895	0.06 (D)	28.0	41.6	5.8	1.0
110	#12	Feb. 12	4.920	-0.17	22.9	13.8	3.3	0.2<=W
111	#17	Feb. 9	4.620	-0.75	30.6	16.0	4.5	0.2<=W
112	#18	Feb. 9	5.351	2.115	27.1	37.8	5.3	0.2<=W
113	#19	Feb. 9 Aug. 27	4.818 4.709	-0.32 -0.47 (T)	28.9 23.6 (T)	8.8 2.8	2.7 1.7	0.2<=W 0.2<=W

Table 2 (cont.). If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
114	#20	Feb. 9	4.849	0.1870	27.7	22.0	4.5	0.4<T
115	#21	Feb. 9	4.966	0.0253	29.8	8.8	2.1	0.2<=W
116	#22	Feb. 9	4.926	-0.22	26.7	6.0	1.5	0.2<=W
117	#23	Feb. 9	4.937	0.2821	25.6	18.0	3.9	0.2<=W
118	#24	Feb. 9	4.843	-0.31	23.9	4.4	0.9	0.2<=W
119	#25	Feb. 9	4.810	0.2412	24.2	43.0	6.1	1.0
120	#26	Feb. 9	4.699	-0.70	23.6	10.6	2.7	0.2<=W
121	#27	Feb. 9 Aug. 27	5.113 4.978	0.0792 0.11 (T)	22.7 17.6 (T)	5.2 3.8	1.6 1.1	0.2<=W 0.2<=W
122	#28	Feb. 9 Aug. 27	4.899 4.723	-0.29 -0.28 (T)	24.3 19.6 (T)	4.8 5.4	1.8 2.3	0.2<=W 0.2<=W
123	#29	Feb. 9 Aug. 27	4.337 4.163	-2.4 N/A	35.3 26.6 (T)	2.2 0.2<=W	0.2<T 0.2<T	0.2<=W 0.2<=W
124	#30	Feb. 9 Aug. 27	4.764 4.745	-0.66 -0.28 (T)	27.2 17.6 (T)	8.2 2.8	2.1 1.5	0.2<=W 0.2<=W
125	#33	Feb. 12	5.082	-0.08	27.9	1.4	1.5	0.2<=W
126	#35	Feb. 9	4.853	-0.35	26.2	3.2	1.4	0.2<=W
127	#36	Feb. 9	5.917	4.517	43.8	31.8	7.1	1.0
128	#37A	Feb. 9	6.158	3.693	33.6	13.2	4.6	0.6<T
129	#38	Feb. 9	4.937	0.1334	30.9	24.8	5.1	0.2<=W
130	#40	Feb. 13	5.035	-0.11	26.4	1.6	1.9	0.2<=W

Table 2 (cont.). If Coop Unit values not available for conductivity, pH or alkalinity, regression equations were used to estimate Coop Unit values from Toronto (T) or Dorset (D) results.

Number	Lake name	Sampling Date	pH	TIP alkalinity	Conductivity (uS/cm)	True Colour (TCU)	DOC (mg/L)	DIC (mg/L)
131	#45	Feb. 13	4.922	0.7731	33.5	31.0	17.4	0.6<T
132	#46	Feb. 13	5.5	2.448	29.1	19.2	11.7	0.4<T
133	#50	Feb. 12	4.592	-1.0	34.8	14.6	4.6	0.4<T
134	#51	Feb. 12	4.669	-0.92	32.3	5.2	2.4	0.4<T
135	#52	Feb. 12	4.660	-1.0	26.5	4.0	1.3	0.2<=W
136	#53	Feb. 12	4.808	-0.26	25.3	12.6	2.4	0.4<T
137	#54	Feb. 12	4.711	-0.82	29.8	1.0	0.5	0.2<=W
138	#55	Feb. 12	4.934	-0.38	22.7	3.2	1.1	0.2<=W
139	#59	Feb. 12	6.395	5.652	40.9	18.4	6.3	1.2
140	#64	Feb. 9	5.278	0.8279	25.7	16.0	3.4	0.4<T
141	#65	Feb. 9	5.508	1.578	28.6	12.4	2.6	0.6<T
142	#66	Feb. 9	5.259	0.4643	18.8	8.6	2.8	0.2<=W
143	#68	Feb. 9	5.409	0.1844	24.0	3.2	1.5	0.2<=W
144	#69	Feb. 9	5.036	-0.05	25.0	10.6	2.2	0.2<=W
145	#71	Feb. 9	5.123	0.7807	28.7	28.0	5.2	0.6<T
146	#73	Feb. 12	6.263	18.95	74.0	123.0	17.8	4.8
147	#74	Feb. 12	6.052	6.012	36.6	70.0	10.7	1.8
148	#76	Feb. 12	7.028	43.33	108.2	36.2	10.1	10.6
149	#79	Feb. 9	5.089	2.089	23.6	95.0	12.5	1.8
150	#80	Feb. 9	5.053	0.2275	28.3	7.8	2.1	0.2<=W
151	#82	Feb. 13	5.046	0.5002	31.9	6.0	2.7	0.4<T

Table 3. Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Potassium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
1	Acid	Jan. 30	0.2<=W	1.10	0.44	0.44	0.23	4.4	6.5	0.042	0.001<=W	0.075	0.0005<=W	0.002<=W	0.16	1.16
2	Amikogam	Jan. 23	0.4<T	1.85	0.64	0.72	0.36	7.2	9.5	0.026	0.003<T	0.070	0.0005<=W	0.004<T	0.20	1.84
3	A.Y. Jackson	Feb. 1	0.4<T	1.70	0.70	0.74	0.37	7.2	7.5	0.062	0.001<=W	0.055	0.0005<=W	0.004<T	0.26	0.32
4	Balsam	Jan. 23	0.6<T	2.90	0.88	0.92	0.57	11.0	7.5	0.018	0.002<T	0.035	0.0005<=W	0.006<T	0.36	0.84
5	Beaver	Feb. 2	0.4<T	2.65	0.80	0.84	0.44	10.0	4.5	0.004<T	0.005	0.125	0.0005<=W	0.010	0.46	1.84
6	Bell	Jan. 23	0.4<T	2.25	0.78	0.84	0.46	8.8	8.0	0.032	0.002<T	0.080	0.0005<=W	0.006<T	0.32	0.98
7	Betty	Aug. 27	0.4<T	7.30	1.06	0.90	0.76	22.6	8.0	0.018	0.006	0.015<T	0.002<T	0.006<T	0.40	0.52
8	Billy	Aug. 27	0.2<=W	1.55	0.64	0.72	0.24	6.6	8.0	0.012	0.004<T	0.010<T	0.0005<=W	0.006<T	0.26	0.22
9	Bizhiw	Feb. 1	0.4<T	0.70	0.24	0.32	0.17	2.8	7.0	0.062	0.001<=W	0.135	0.0005<=W	0.004<T	0.12	0.32
10	Bodina	Feb. 2	0.6<T	4.50	1.68	1.44	0.61	18.2	8.5	0.328	0.007	0.085	0.0005<=W	0.010	0.96	0.96
11	Boundary	Feb. 2	0.4<T	1.35	0.50	0.52	0.35	5.4	6.5	0.080	0.003<T	0.085	0.0005<=W	0.004<T	0.26	0.70
12	Bunnyrabbit	Jan. 23	0.4<T	1.10	0.36	0.40	0.20	4.2	7.5	0.064	0.001<=W	0.140	0.0005<=W	0.002<=W	0.12	0.62
13	Burke	Feb. 2	0.4<T	1.40	0.48	0.52	0.26	5.4	7.5	0.068	0.002<T	0.085	0.0005<=W	0.004<T	0.26	1.38
14	Canis	Feb. 2	1.2	7.60	3.32	1.92	1.05	32.6	10.0	0.058	0.011	0.150	0.0045	0.026	0.90	3.88
15	Carlyle	Feb. 1	0.4<T	1.90	0.72	0.88	0.34	7.6	7.5	0.040	0.001	0.050	0.0005<=W	0.004<T	0.24	1.02
16	Carmichael	Feb. 2	0.4<T	1.55	0.46	0.52	0.23	5.8	10.5	0.048	0.001<=W	0.195	0.0005<=W	0.002<=W	0.12	0.54
17	Cat	Feb. 2	0.4<T	2.70	1.08	0.92	0.48	11.2	6.0	0.002<=W	0.002<T	0.165	0.0005<=W	0.008<T	0.30	0.56
18	Cave	Feb. 1	0.4<T	1.95	0.88	0.70	0.44	8.4	8.5	0.138	0.001<=W	0.050	0.0005<=W	0.008<T	0.42	1.22
19	Chain	Jan. 23	0.4<T	1.30	0.44	0.56	0.37	5.0	7.5	0.098	0.003<T	0.060	0.0005<=W	0.006<T	0.40	1.36
		Jan. 30	0.4<T	1.20	0.44	0.60	0.39	4.8	7.0	0.092	0.001<=W	0.065	0.0005<=W	0.006<T	0.40	1.62
20	Clearsilver	Jan. 23	0.4<T	1.10	0.38	0.48	0.27	4.4	7.0	0.020	0.001<=W	0.045	0.0005<=W	0.004<T	0.14	1.06
21	Cranberry B.	Feb. 1	0.4<T	2.45	1.08	1.00	0.64	10.6	4.0	0.324	0.006	0.040	0.0005<=W	0.016	0.82	1.60

Table 3 (cont.). Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Potassium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
22	Crater (East)	Feb. 2	1.2	2.60	0.96	0.82	0.40	10.4	9.0	0.274	0.003<T	0.035	0.0005<=W	0.004<T	0.54	1.12
23	Crater (West)	Feb. 9	0.4<T	0.65	0.20	0.48	0.67	2.6	3.0	0.516	0.007	0.055	0.0005<=W	—	—	0.86
24	Cuckoo	Aug. 27	0.2<=W	2.40	0.68	0.76	0.38	8.8	6.0	0.010	0.004<T	0.010<T	0.0015<T	0.006<T	0.32	0.16
25	David	Feb. 2	0.8<T	1.40	0.44	0.56	0.26	5.2	7.5	0.056	0.002<T	0.065	0.0005<=W	0.002<=W	0.16	0.52
26	Deacon	Jan. 23	0.6<T	3.15	0.88	0.94	0.54	11.4	9.5	0.056	0.003<T	0.125	0.0005<=W	0.008<T	0.40	0.68
27	de Lamor	Feb. 2	0.4<T	1.35	0.50	0.52	0.30	5.4	7.5	0.140	0.004<T	0.095	0.0005<=W	0.004<T	0.36	1.72
		Feb. 9	0.4<T	1.50	0.52	0.60	0.31	6.0	8.0	0.090	0.003<T	0.145	0.0005<=W	—	—	2.02
28	East Howry	Aug. 27	0.4<T	5.25	0.96	0.86	0.63	17.2	7.5	0.014	0.004<T	0.005<=W	0.0015<T	0.006<T	0.34	0.12
29	Fish	Jan. 24	0.4<T	1.75	0.62	0.72	0.34	7.0	7.5	0.050	0.003<T	0.070	0.0005<=W	0.002<=W	0.12	0.78
		Feb. 12	0.4<T	2.00	0.70	0.80	0.39	8.0	7.5	0.066	0.001<=W	0.095	0.0015<T	—	—	0.92
30	Fox	Jan. 23	0.6<T	3.65	0.98	1.06	0.61	13.2	9.5	0.028	0.003<T	0.070	0.0005<=W	0.006<T	0.38	1.06
31	Frank	Jan. 23	1.8	2.55	1.00	1.64	0.52	10.4	5.0	0.058	0.004<T	0.100	0.0005<=W	0.008<T	0.56	0.72
32	Freeland	Feb. 2	0.4<T	2.00	0.68	0.72	0.34	7.8	9.0	0.058	0.003<T	0.125	0.0005<=W	0.002<=W	0.20	1.30
33	Gail	Jan. 24	0.4<T	1.25	0.36	0.48	0.18	4.6	7.0	0.060	0.001<=W	0.080	0.0005<=W	0.004<T	0.12	0.34
		Feb. 12	0.4<T	0.80	0.24	0.32	0.16	2.8	7.0	0.060	0.001<=W	0.065	0.0010<T	—	—	0.34
34	Gem	Feb. 2	0.6<T	2.85	0.80	0.84	0.48	10.4	8.0	0.082	0.006	0.135	0.0005<=W	0.008<T	0.40	1.68
35	George	Jan. 30	0.4<T	1.95	0.72	0.76	0.38	7.8	8.5	0.044	0.002<T	0.090	0.0005<=W	0.002<=W	0.16	1.24
36	Goose	Jan. 24	0.4<T	3.65	0.96	0.88	0.54	13.2	7.0	0.046	0.003<T	0.155	0.0005<=W	0.014	0.50	1.74
37	Goschen	Aug. 27	0.4<T	2.55	0.90	1.02	0.48	10.2	7.0	0.018	0.008	0.015<T	0.0015<T	0.010	0.42	0.34
38	Grace	Feb. 2	0.4<T	2.05	0.54	0.54	0.23	7.4	7.5	0.052	0.002<T	0.055	0.0005<=W	0.004<T	0.18	0.40
39	Great Mountain	Jan. 24	0.4<T	1.60	0.58	0.68	0.31	6.4	8.0	0.036	0.002<T	0.035	0.0005<=W	—	1.06	0.48
		Feb. 12	0.4<T	1.60	0.58	0.64	0.32	6.4	8.0	0.050	0.001<=W	0.020<T	0.0010<T	—	—	0.44

Table 3 (cont.). Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Poussium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
40	Green	Jan. 23	0.6<T	2.30	0.80	0.92	0.39	9.0	8.0	0.140	0.005	0.160	0.0005<=W	0.010	0.60	1.16
41	Grey	Aug. 27	0.4<T	1.55	0.64	0.76	0.37	6.4	8.5	0.038	0.003<T	0.055	0.0005<=W	0.006<T	0.24	1.20
42	Grow	Jan. 24	0.4<T	4.05	0.76	0.76	0.36	13.2	6.5	0.016	0.004<T	0.115	0.0005<=W	0.006<T	0.32	0.30
43	Hanwood	Feb. 2	0.4<T	3.20	0.92	0.86	0.42	11.8	5.5	0.044	0.004<T	0.110	0.0005<=W	0.006<T	0.34	0.98
44	Harry	Jan. 23	0.4<T	2.30	0.80	0.80	0.47	9.0	6.5	0.036	0.004<T	0.070	0.0005<=W	0.006<T	0.34	0.62
		Feb. 13	0.4<T	2.30	0.80	0.60	0.46	9.0	6.5	0.038	0.004<T	0.090	0.0015<T	—	—	0.66
45	Heaven	Jan. 23	0.4<T	0.70	0.28	0.32	0.22	2.8	5.0	0.142	0.004<T	0.080	0.0005<=W	0.006<T	0.38	1.00
46	Helen	Jan. 30	0.4<T	2.65	1.00	0.86	0.45	10.8	7.5	0.028	0.001<=W	0.110	0.0005<=W	0.004<T	0.24	1.66
47	Hemlock	Jan. 23	0.4<T	1.65	0.52	0.56	0.34	6.4	11.0	0.072	0.001<=W	0.160	0.0005<=W	0.002<=W	0.18	0.68
48	Howry	Feb. 2	0.4<T	2.85	0.84	0.88	0.46	10.6	7.5	0.030	0.004<T	0.105	0.0005<=W	0.006	0.36	1.24
49	Ishmael	Jan. 30	0.4<T	2.75	1.04	0.88	0.42	11.2	8.0	0.026	0.002<T	0.080	0.0005<=W	0.004<T	0.22	1.02
50	Johnnie	Jan. 23	0.4<T	1.90	0.64	0.72	0.37	7.4	7.5	0.044	0.003<T	0.095	0.0005<=W	0.004<T	0.24	1.00
51	Kakakise	Jan. 30	0.6<T	2.30	0.86	0.84	0.40	9.2	8.0	0.018	0.001<=W	0.055	0.0005<=W	0.004<T	0.22	0.88
52	Kidney	Feb. 1	0.4<T	2.00	0.70	0.64	0.32	7.8	8.0	0.062	0.001<=W	0.135	0.0005<=W	0.006<T	0.28	2.64
53	Killarney	Jan. 30	0.4<T	1.60	0.56	0.66	0.32	6.4	9.0	0.042	0.001<=W	0.135	0.0005<=W	0.004<T	0.14	1.34
54	Lake of the Woods	Aug. 27	0.2<=W	1.45	0.64	0.68	0.30	6.2	8.0	0.016	0.003<T	0.005<=W	0.0010<T	0.008<T	0.28	0.02<=W
55	Little Bell	Jan. 23	0.6<T	1.30	0.44	0.58	0.38	5.2	7.0	0.102	0.003<T	0.100	0.0005<=W	0.006<T	0.46	1.70
		Jan. 30	0.4<T	1.30	0.44	0.60	0.40	5.0	7.5	0.080	0.002<T	0.065	0.0005<=W	0.006<T	0.40	1.80
56	Little Mink	Jan. 24	0.4<T	4.80	1.08	1.04	0.62	16.4	6.0	0.112	0.009	0.095	0.0005<=W	0.012	0.42	0.56
57	Little Mountain	Jan. 24	0.4<T	1.65	0.48	0.60	0.28	6.0	9.0	0.028	0.001<=W	0.055	0.0005<=W	0.004<T	0.18	1.34
58	Little Shegindah	Feb. 1	0.4<T	2.40	1.16	1.10	0.75	10.8	7.5	0.074	0.002<T	0.100	0.0005<=W	0.006<T	0.34	1.40
59	Little Superior	Jan. 23	0.4<T	1.10	0.34	0.36	0.22	4.2	11.5	0.026	0.001<=W	0.160	0.0005<=W	0.002<=W	0.06<T	0.20
60	Log Boom	Jan. 23	0.4<T	1.65	0.56	0.64	0.34	6.4	7.5	0.126	0.003<T	0.075	0.0005<=W	0.006<T	0.30	0.98

Table 3 (cont.). Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Potassium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
61	Low	Jan. 30	1.6	8.40	2.12	1.44	0.62	29.8	10.5	0.008<T	0.001<=W	0.040	0.0005<=W	0.004<T	0.18	0.78
62	Lumsden	Jan. 30	0.4<T	1.15	0.44	0.44	0.22	4.6	6.5	0.038	0.001<=W	0.080	0.0005<=W	0.002<=W	0.16	1.26
63	Mink	Jan. 24	0.8<T	5.50	1.18	1.00	0.77	18.6	8.0	0.002<=W	0.004<T	0.225	0.0005<=W	0.004<T	0.24	1.48
64	Moose	Feb. 2	0.4<T	1.55	0.56	0.60	0.27	6.0	8.0	0.046	0.002<T	0.040	0.0005<=W	0.002<=W	0.18	1.22
65	Muriel	Feb. 1	0.4<T	2.30	0.68	0.68	0.29	8.4	10.0	0.032	0.002<T	0.155	0.0005<=W	0.002<=W	0.10	0.78
66	Murray	Feb. 2	0.4<T	2.80	0.80	0.88	0.46	10.2	7.5	0.034	0.003<T	0.090	0.0005<=W	0.004<T	0.30	1.28
67	Nellie	Feb. 2	0.4<T	1.65	0.48	0.56	0.25	6.0	11.5	0.048	0.001<=W	0.205	0.0005<=W	0.002<=W	0.12	0.42
68	Norway	Jan. 23	0.4<T	1.75	0.60	0.64	0.31	6.8	8.5	0.028	0.001<=W	0.115	0.0005<=W	0.002<=W	0.16	1.60
69	O.S.A.	Jan. 30	0.4<T	2.05	0.62	0.64	0.29	7.6	10.0	0.020	0.001<=W	0.240	0.0005<=W	0.002<=W	0.08<T	0.32
		Feb. 13	0.4<T	2.10	0.60	0.68	0.30	7.6	10.5	0.038	0.001<=W	0.265	0.0010<T	—	—	0.34
70	Partridge	Jan. 23	0.4<T	2.40	0.72	0.72	0.32	9.0	10.0	0.042	0.001<=W	0.030	0.0005<=W	0.002<=W	0.20	0.44
71	Patten	Feb. 2	0.4<T	1.65	0.68	0.86	0.55	7.0	9.0	0.114	0.003<T	0.080	0.0005<=W	0.004<T	0.32	2.24
72	Pearl	Feb. 1	0.4<T	2.05	0.78	0.60	0.38	8.4	10.5	0.052	0.001<=W	0.060	0.0005<=W	0.004<T	0.14	1.14
73	Peter	Feb. 12	0.4<T	3.85	1.00	0.98	0.56	13.6	11.0	0.016	0.001<=W	0.065	0.0005<=W	—	—	0.60
74	Pike	Jan. 23	0.8<T	2.85	0.88	0.88	0.67	10.8	6.0	0.052	0.005	0.095	0.0005<=W	0.006<T	0.46	1.24
75	Proulx	Jan. 23	0.4<T	1.70	0.52	0.54	0.25	6.4	12.5	0.034	0.001<=W	0.180	0.0005<=W	0.002<=W	0.06<T	0.20
76	Quartzite	Feb. 2	0.2<=W	1.30	0.38	0.46	0.22	4.8	8.0	0.022	0.002<T	0.150	0.0005<=W	0.004<T	0.14	0.48
		Aug. 27	0.2<=W	1.15	0.36	0.44	0.21	4.4	7.0	0.020	0.004<T	0.140	0.0005<=W	0.002<=W	0.06<T	0.42
77	Rocky	Jan. 24	0.4<T	4.70	0.94	0.92	0.42	15.6	6.0	0.014	0.003<T	0.105	0.0005<=W	0.008<T	0.44	0.50
78	Roque	Feb. 2	0.4<T	1.45	0.52	0.60	0.33	5.8	8.0	0.110	0.004<T	0.075	0.0005<=W	0.004<T	0.32	2.24
79	Round Otter	Jan. 24	0.6<T	4.40	1.10	1.02	0.65	15.6	8.5	0.040	0.008	0.195	0.0005<=W	0.008<T	0.40	1.90
80	Ruth-Roy	Jan. 23	0.4<T	1.20	0.40	0.50	0.20	4.6	8.0	0.050	0.001<=W	0.080	0.0005<=W	0.002<=W	0.10	0.82

Table 3 (cont.). Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Potassium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
81	Sandy	Jan. 23	0.4<T	1.75	0.60	0.68	0.32	7.0	8.5	0.038	0.002<T	0.105	0.0005<=W	0.004<T	0.18	1.66
82	Sealey's	Feb. 1	1.2	2.75	1.24	1.44	0.69	12.0	5.0	0.336	0.004<T	0.020<T	0.0005<=W	0.022	0.96	1.64
83	Shigaug	Feb. 2	0.4<T	1.20	0.32	0.52	0.31	4.4	7.0	0.048	0.002<T	0.035	0.0005<=W	0.004<T	0.18	0.92
84	Shingwak	Jan. 23	0.4<T	1.40	0.40	0.44	0.23	5.2	8.5	0.040	0.001<=W	0.150	0.0005<=W	0.002<=W	0.08<T	0.44
85	Silver	Jan. 23	0.4<T	1.25	0.36	0.46	0.29	4.6	7.0	0.156	0.001< W	0.115	0.0005<=W	0.006<T	0.34	1.38
86	Solomon	Feb. 2	0.8<T	1.55	0.52	0.60	0.57	6.0	7.5	0.130	0.004<T	0.045	0.0005<=W	0.012	0.52	2.10
87	Spark	Feb. 2	0.4<T	0.85	0.30	0.36	0.16	3.4	9.0	0.036	0.002<T	0.145	0.0005<=W	0.004<T	0.12	0.30
88	Sugarbush	Feb. 2	0.4<T	1.20	0.54	0.48	0.26	5.2	9.5	0.026	0.004<T	0.045	0.0005<=W	0.002<=W	0.18	1.94
89	Teardrop	Feb. 1	0.4<T	1.85	0.90	0.58	0.35	8.2	7.0	0.024	0.001<=W	0.020<T	0.0005<=W	0.006<T	0.12	0.60
		Feb. 9	0.4<T	1.85	0.90	0.58	0.34	8.2	7.5	0.032	0.002<T	0.025	0.0005<=W	—	—	0.60
90	Terry	Jan 30	0.4<T	1.85	0.68	0.82	0.44	7.4	7.5	0.052	0.002<T	0.070	0.0005<=W	0.006<T	0.32	2.06
91	The Three Lakes	Feb. 2	0.4<T	1.3	0.48	0.48	0.28	5.2	6	0.168	0.003<T	0.055	0.0005<=W	0.006<T	0.54	1.06
		Feb. 9	0.4<T	1.35	0.52	0.48	0.31	5.6	6	0.194	0.006	0.055	0.0005<=W	—	—	1.14
92	The Tri Lakes (North)	Aug. 27	0.4<T	3.75	1.02	0.9	0.38	13.6	6.5	0.018	0.006	0.010<T	0.0035	0.012	0.48	0.18
93	The Tri Lakes (Southeast)	Aug. 27	0.4<T	3.65	1	0.88	0.36	13.2	6	0.012	0.007	0.005<=W	0.0005<=W	0.016	0.48	0.34
94	The Tri Lakes (Southwest)	Aug. 27	0.4<T	2.35	0.7	0.82	0.44	8.8	5	0.004<T	0.002<T	0.005<=W	0.0015<T	0.016	0.96	0.2
95	Threenarrows	Jan. 30	0.4<T	1.95	0.84	0.84	0.39	8.2	8.5	0.010	0.001<=W	0.095	0.0005<=W	0.002<=W	0.20	1.76
96	Topaz	Feb. 1	0.4<T	1.40	0.44	0.48	0.31	5.4	9.5	0.020	0.001<=W	0.110	0.0005<=W	0.002<=W	0.04<T	0.56
97	Turbid	Aug. 27	0.2<=W	1.50	0.60	0.76	0.29	6.2	8.0	0.006<T	0.002<T	0.005<=W	0.0005<=W	0.006<T	0.20	0.06<T
98	Turtleback	Feb. 2	0.4<T	1.70	0.52	0.74	0.31	6.4	8.5	0.050	0.003<T	0.045	0.0005<=W	0.002<=W	0.22	1.06
99	Van	Feb. 2	0.4<T	4.00	0.76	0.76	0.36	13.2	7.0	0.026	0.001<=W	0.265	0.0005<=W	0.008<T	0.32	0.78
100	Van Winkle	Feb. 2	0.4<T	2.95	0.72	0.74	0.34	10.4	7.5	0.040	0.003<T	0.040	0.0005<=W	0.006<T	0.28	0.14

Table 3 (cont.). Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Potassium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
101	Wagon Road	Jan. 30	0.6<T	2.15	1.00	1.08	0.68	9.6	5.0	0.264	0.005	0.015<T	0.0015<T	0.024	0.84	1.90
102	Whiskeyjack	Jan. 23	0.4<T	1.35	0.44	0.46	0.23	5.2	11.5	0.034	0.002<T	0.160	0.0005<=W	0.002<=W	0.08<T	0.22
103	York	Feb. 2	0.6<T	2.85	1.24	1.08	0.46	12.2	9.0	0.014	0.004<T	0.090	0.0005<=W	0.006<T	0.32	0.80
104	#3	Feb. 12	0.4<T	1.20	0.42	0.60	0.45	4.8	7.5	0.116	0.002<T	0.080	0.0010<T	—	—	1.38
105	#4	Feb. 12	0.4<T	1.80	0.62	0.74	0.35	7.0	10.0	0.112	0.001<=W	0.060	0.0010<T	—	—	1.66
106	#5	Feb. 12	0.6<T	0.90	0.28	0.40	0.46	3.4	4.5	0.110	0.007	0.040	0.002<T	—	—	1.88
107	#6	Feb. 12	0.6<T	1.00	0.30	0.40	0.44	3.8	4.5	0.154	0.004<T	0.020<T	0.0015<T	—	—	2.16
108	#7	Feb. 12	0.6<T	0.90	0.36	0.44	0.34	3.8	3.5	0.222	0.006	0.035	0.002<T	—	—	1.80
109	#9	Feb. 12	0.8<T	0.85	0.36	0.44	0.46	3.6	6.5	0.314	0.004<T	0.040	0.001<T	—	—	2.42
110	#12	Feb. 12	0.4<T	1.05	0.38	0.48	0.29	4.2	6.0	0.082	0.002<T	0.025	0.001<T	—	—	1.22
111	#17	Feb. 9	0.4<T	0.65	0.28	0.44	0.36	2.8	7.5	0.104	0.005	0.075	0.0005<=W	—	—	1.72
112	#18	Feb. 9	0.8<T	0.80	0.30	0.44	0.51	3.2	7.0	0.216	0.005	0.050	0.0005<=W	—	—	1.72
113	#19	Feb. 9	0.4<T	1.20	0.40	0.52	0.37	4.6	7.5	0.108	0.002<T	0.105	0.0005<=W	—	—	1.86
		Aug. 27	0.4<T	1.05	0.36	0.48	0.31	4.2	7.0	0.032	0.002<T	0.055	0.0005<=W	0.002<=W	0.18	1.04
114	#20	Feb. 9	0.6<T	0.90	0.24	0.48	0.42	3.2	7.0	0.148	0.007	0.015<T	0.0005<=W	—	—	1.88
115	#21	Feb. 9	0.4<T	1.65	0.52	0.64	0.40	6.2	8.5	0.152	0.005	0.140	0.0005<=W	—	—	1.62
116	#22	Feb. 9	0.4<T	1.25	0.44	0.50	0.28	5.0	7.5	0.078	0.002	0.075	0.0005<=W	—	—	0.88
117	#23	Feb. 9	0.6<T	1.00	0.28	0.52	0.43	3.6	6.5	0.258	0.006	0.105	0.0005<=W	—	—	2.16
118	#24	Feb. 9	0.4<T	0.75	0.26	0.38	0.20	3.0	6.5	0.052	0.004<T	0.080	0.0005<=W	—	—	1.26
119	#25	Feb. 9	0.6<T	0.60	0.20	0.44	0.46	2.4	5.5	0.272	0.008	0.015<T	0.0005<=W	—	—	2.10
120	#26	Feb. 9	0.4<T	0.55	0.20	0.44	0.28	2.2	5.5	0.068	0.004<T	0.025	0.0005<=W	—	—	1.44
121	#27	Feb.9	0.2<=W	1.20	0.36	0.52	0.27	4.4	6.5	0.164	0.006	0.095	0.0005<=W	—	—	1.40
		Aug. 27	0.2<=W	1.00	0.34	0.52	0.20	4.0	5.5	0.030	0.003<T	0.025	0.0005<=W	0.006<T	0.20	0.82

Table 3 (cont.). Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Potassium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
122	#28	Feb. 9	0.2<=W	1.10	0.30	0.50	0.29	4.0	6.5	0.108	0.003<T	0.070	0.0005<=W	—	—	0.70
		Aug. 27	0.2<=W	1.05	0.28	0.48	0.29	3.8	6.0	0.118	0.002<T	0.025	0.0005<=W	0.008<T	0.38	0.30
123	#29	Feb. 9	0.2<=W	0.90	0.20	0.32	0.20	3.2	7.5	0.104	0.003<T	0.085	0.0005<=W	—	—	0.14
		Aug. 27	0.4<T	0.85	0.20	0.28	0.17	2.8	7.0	0.020	0.001<=W	0.055	0.001<T	0.004<T	0.10	0.04<T
124	#30	Feb. 9	0.4<T	1.15	0.36	0.52	0.26	4.2	7.0	0.076	0.004<T	0.245	0.0005<=W	—	—	1.54
		Aug. 27	0.2<=W	0.90	0.32	0.48	0.16	3.6	5.5	0.014	0.002<T	0.005<=W	0.0005<=W	0.006<T	0.14	0.06
125	#33	Feb. 12	0.4<T	1.60	0.46	0.60	0.28	5.8	8.5	0.062	0.001<=W	0.090	0.0015<T	—	—	2.38
126	#35	Feb. 9	0.4<T	0.75	0.30	0.40	0.22	3.2	7.5	0.038	0.002<T	0.045	0.0005<=W	—	—	2.06
127	#36	Feb. 9	0.4<T	2.65	1.30	1.04	0.50	12.0	11.0	0.698	0.007	0.075	0.0005<=W	—	—	2.26
128	#37A	Feb. 9	0.4<T	2.50	1.08	0.98	0.39	10.8	8.5	0.050	0.005	0.090	0.0005<=W	—	—	0.60
129	#38	Feb. 9	0.4<T	1.60	0.60	0.72	0.35	6.4	8.5	0.120	0.005	0.060	0.0005<=W	—	—	3.62
130	#40	Feb. 13	0.2<T	1.45	0.44	0.52	0.26	5.4	8.0	0.054	0.001<=W	0.040	0.001<T	—	—	0.98
131	#45	Feb. 13	0.8<T	2.45	0.84	0.94	0.39	9.6	7.0	0.134	0.009	0.060	0.0110	—	—	3.04
132	#46	Feb. 13	0.4<T	2.55	0.76	0.72	0.41	9.4	6.0	0.102	0.006	0.150	0.0050	—	—	2.16
133	#50	Feb. 12	0.4<T	0.95	0.40	0.48	0.32	4.0	9.0	0.116	0.002<T	0.050	0.0010<T	—	—	1.62
134	#51	Feb. 12	0.4<T	1.20	0.40	0.46	0.26	4.6	8.5	0.078	0.002<T	0.060	0.0015<T	—	—	1.20
135	#52	Feb. 12	0.2<=W	0.75	0.20	0.36	0.13	2.8	7.0	0.050	0.002<T	0.050	0.0015<T	—	—	0.98
136	#53	Feb. 12	0.4<T	0.70	0.20	0.36	0.30	2.6	6.0	0.182	0.003<T	0.045	0.0010<T	—	—	1.48
137	#54	Feb. 12	0.2<=W	1.25	0.32	0.40	0.16	4.4	8.0	0.074	0.003<T	0.145	0.0015<T	—	—	0.52
138	#55	Feb. 12	0.2<=W	1.15	0.32	0.40	0.18	4.0	6.0	0.070	0.001<=W	0.070	0.0015<T	—	—	0.86
139	#59	Feb. 12	0.4<T	2.95	1.64	1.20	0.68	14.2	9.5	0.010	0.001<=W	0.135	0.0015<T	—	—	1.00
140	#64	Feb. 9	0.4<T	1.45	0.58	0.84	0.38	6.0	7.0	0.168	0.004<T	0.165	0.0005<=W	—	—	2.24

Table 3 (cont.). Concentrations in mg/L.

Number	Lake name	Date	Chloride	Calcium	Magnesium	Sodium	Potassium	Hardness	Sulphate	ammonia + ammonium	Nitrite	Nitrate + nitrite	Phosphate	Total Phosphorus	Total Nitrogen	Silicate
141	#65	Feb. 9	0.4<T	1.00	0.40	0.40	0.22	4.2	5.0	0.330	0.003<T	0.070	0.0005<=W	---	---	1.04
142	#66	Feb. 9	0.4<T	0.90	0.36	0.36	0.19	3.8	5.0	0.168	0.004<T	0.050	0.0005<=W	---	---	0.70
143	#68	Feb. 9	0.4<T	1.55	0.52	0.52	0.23	6.0	7.5	0.012	0.003<T	0.015<T	0.0005<=W	---	---	1.80
144	#69	Feb. 9	0.4<T	1.35	0.48	0.52	0.27	5.2	7.0	0.092	0.004<T	0.115	0.0005<=W	---	---	1.50
145	#71	Feb. 9	0.6<T	1.65	0.68	0.54	0.35	7.0	8.0	0.220	0.006	0.030	0.0005<=W	---	---	2.34
146	#73	Feb. 12	0.8<T	8.45	2.66	1.68	1.05	32.0	10.5	0.046	0.007	0.245	0.0110	---	---	3.58
147	#74	Feb. 12	0.8<T	3.15	1.32	1.08	0.45	13.2	6.5	0.012	0.004<T	0.180	0.0025	---	---	1.88
148	#76	Feb. 12	0.4<T	14.2	3.84	1.40	0.82	51.2	7.5	0.124	0.006	0.225	0.0025	---	---	1.54
149	#79	Feb. 9	0.8<T	0.80	0.20	0.44	0.37	2.8	4.5	0.416	0.010	0.015<T	0.0005<=W	---	---	1.96
150	#80	Feb. 9	0.4<T	1.70	0.48	0.68	0.40	6.2	8.0	0.142	0.005	0.150	0.0005<=W	---	---	1.52
151	#82	Feb. 13	0.4<T	1.15	0.48	0.60	0.37	4.8	9.0	0.066	0.001< W	0.110	0.0010<T	---	---	3.36

Table 4. Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS.

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
1	Acid	Jan. 30		205	18.7	ND	ND	ND	2.51	ND	78.3	3.17	165	ND	5.72	7.87	ND	ND	16.8
2	Amikogam.	Jan. 23	**	250	21	0.1<=W	0.3<T	0.4<T	2.2	1.6	60<T	5<=W	150	0.2<=W	11	16<T	1<=W	0.2<=W	16
3	A.Y.Jack.	Feb. 1		42	14.8	ND	ND	ND	ND	ND	ND	1.44	21.4	ND	3.43	12.4	ND	ND	8.38
4	Balsam	Jan. 23	**	50<T	9	0.1<=W	0.2<T	0.4<T	0.4<T	2.6	180	5<=W	26	0.2<=W	6.5	14<T	1<=W	0.2<=W	3.5
5	Beaver	Feb. 2		11.4	8.38	ND	ND	ND	ND	ND	295	ND	38	ND	3.2	13.4	2.21	ND	2.54
6	Bell	Jan. 23	**	80<T	12	0.1<=W	0.3<T	0.4<T	0.4<T	2.6	140	5<=W	54	0.2<=W	8.5	14<T	1<=W	0.2<=W	6.5
7	Betty	Aug. 27	**	20<T	6	0.1<=W	0.2<T	0.2<=W	0.2<=W	2	20<=W	5<=W	8.5	0.2<=W	3.5	16<T	1<=W	0.2<=W	1.0<T
8	Billy	Aug. 27	**	210	24	0.1<=W	0.3<T	0.2<=W	1	3	140	5<=W	110	0.2<=W	20	16<T	1<=W	0.4<T	20
9	Bizhiw	Feb. 1		434	11.3	ND	ND	ND	2	ND	ND	1.22	60.3	ND	8.53	5.03	ND	ND	16.2
10	Bodina	Feb. 2		40.9	12.3	ND	ND	ND	ND	ND	112	4.86	37.7	ND	3.29	19.9	ND	ND	4.91
11	Boundary	Feb. 2		128	15.6	ND	ND	ND	ND	ND	66.3	ND	36.5	ND	8.16	9.81	ND	ND	13.3
12	Bunnyrab.	Jan. 23	**	370	16	0.1<=W	0.3<T	0.2<=W	3.2	1.8	60<T	5<=W	100	0.2<=W	13	10<T	1<=W	0.2<=W	16
13	Burke	Feb. 2		185	20.1	ND	ND	ND	2.08	ND	141	14.1	141	ND	5.28	8.77	ND	ND	16.9
14	Canis	Feb. 2		113	11	ND	ND	ND	ND	ND	446	6.2	49.5	ND	2.64	27.7	3.29	ND	5.27
15	Carlyle	Feb. 1		74	15.2	ND	ND	ND	ND	ND	93.6	6.91	51	ND	5.38	19.1	2.56	ND	10.4
16	Carmichael	Feb. 2		493	27.9	ND	ND	ND	5.4	ND	ND	3.72	210	ND	10.9	11.3	ND	ND	23.5
17	Cat	Feb. 2		ND	9.48	ND	ND	ND	ND	ND	73.5	30.4	32.4	ND	2.07	15.7	ND	ND	3.4
18	Cave	Feb. 1		129	22.2	ND	ND	ND	1.43	ND	121	1.15	118	ND	4.68	13.3	2.45	ND	15.7
19	Chain	Jan. 23	**	260	16	0.1<=W	0.2<T	0.6<T	2.6	2.2	280	5<=W	76	0.2<=W	14	10<T	1<=W	0.4<T	12
		Jan. 30		270	18.6	ND	ND	ND	2.26	ND	310	2.1	85.9	ND	14.8	11.1	2.53	ND	13.1
20	Clearsilver	Jan. 23	**	230	14	0.1<=W	0.3<T	0.2<=W	4.4	1.4	40<T	5<=W	120	0.2<=W	12	8<T	1<=W	0.2<=W	13
21	Cranberry	Feb. 1		87.8	12.7	ND	ND	ND	ND	ND	809	7.76	141	ND	2	18.2	2.99	ND	3.49
22	Crater E.	Feb. 2		104	22.7	ND	ND	ND	1.08	ND	148	4.74	62.1	ND	2.92	15.7	ND	ND	6.64

Table 4 (cont.). Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
23	Crater W.	Feb. 9		108	9.42	ND	ND	ND	ND	ND	381	ND	47.3	ND	2.48	4.97	2.43	ND	6.32
24	Cuckoo	Aug. 27	**	10<=W	5	0.1<=W	0.2<T	0.2<=W	0.2<=W	2.4	20<=W	5<=W	8	0.2<=W	2.5<T	12<T	1<=W	0.2<=W	10
25	David	Feb. 2		115	14	ND	ND	ND	1.33	ND	ND	0.944	108	ND	11.5	10.8	ND	ND	11.6
26	Deacon	Jan. 23	**	80<T	11	0.1<=W	0.1<=W	0.4<T	0.4<T	4.0	80<T	5<=W	38	0.2<=W	8.0	16<T	1<=W	0.2<=W	6.5
27	de Lamor	Feb. 2		281	20.7	ND	ND	ND	3.43	ND	214	21.9	158	ND	6.29	8.44	ND	ND	22.1
		Feb. 9		308	24.2	ND	ND	ND	3.24	ND	206	67.9	168	ND	5.76	9.95	2.25	ND	25.5
28	East How.	Aug. 27	**	20<T	6	0.1<=W	0.2<T	0.2<=W	0.2<=W	2.6	20<=W	5<=W	8.5	0.2<=W	3.0<T	14<T	1<=W	0.2<=W	0.5<=W
29	Fish	Jan. 24	**	60<T	12	0.1<=W	0.1<=W	0.2<=W	0.4<T	3.8	100	5<=W	59	0.2<=W	5.0	12<T	1<=W	0.2<=W	7.0
		Feb. 12		54	12.9	ND	ND	ND	ND	ND	86.5	ND	36.3	ND	4.28	14.3	2.37	ND	5.68
30	Fox	Jan. 23	**	60<T	9	0.1<=W	0.2<T	0.6<T	0.4<T	3.6	60<T	5<=W	14	0.4<T	6.0	16<T	1<=W	0.2<=W	3.5
31	Frank	Jan. 23	**	40<T	8	0.1<=W	3.2	1.2	0.6<T	2.6	200	5<=W	48	0.2<=W	5.5	12<T	1<=W	0.2<=W	12
32	Freeland	Feb. 2		169	24.3	ND	ND	ND	2.17	ND	ND	14.3	161	ND	8.26	17.1	ND	ND	16.9
33	Gail	Jan. 24	**	380	14	0.1<=W	0.2<T	0.2<=W	2.4	2.4	40<T	5<=W	87	0.4<T	14	6<T	1<=W	0.2<=W	20
		Feb. 12		320	16.4	ND	ND	ND	2.39	ND	ND	ND	81.4	ND	14.7	6.07	ND	ND	21.2
34	Gem	Feb. 2		82.5	14	ND	ND	ND	1.12	ND	159	ND	57.7	ND	5.67	14.5	3.03	ND	8.12
35	George	Jan. 30		94	23.6	ND	ND	ND	1.09	ND	ND	5.92	160	ND	6.42	18.5	ND	ND	12.5
36	Goose	Jan. 24	**	90<T	8	0.1<=W	0.1<=W	0.4<T	0.2<=W	2.2	120	5<=W	26	0.2<=W	3.0<T	14<T	1<=W	0.2<=W	3.0
37	Goschen	Aug. 27	**	60<T	8	0.1<=W	0.2<T	0.2<=W	0.2<=W	3.2	100	5<=W	20	0.2<=W	7.5	16<T	1<=W	0.2<=W	3.0
38	Grace	Feb. 2		58.4	19.3	ND	ND	ND	1.69	ND	ND	9.58	88.3	ND	6.33	9.93	ND	ND	12.6
39	Great M.	Jan. 24	**	80<T	14	0.1<=W	0.1<=W	0.2<=W	0.4<T	2.6	140	5<=W	110	0.2<=W	7.0	12<T	1<=W	0.2<=W	8.0
		Feb. 12		71.6	16.5	ND	ND	ND	ND	ND	114	ND	104	ND	7.69	11.9	ND	ND	8.64
40	Green	Jan. 23	**	140	11	0.1<=W	0.2<T	0.4<T	1.2	2.8	180	5<=W	53	0.2<=W	7.5	20	1<=W	0.4<T	12
41	Grey	Aug. 27	**	200	23	0.1<=W	0.4<T	0.2<=W	2.2	2.6	160	5<=W	140	0.2<=W	17	16<T	1<=W	0.2<=W	16

Table 4 (cont.). Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
42	Grow	Jan. 24	**	20<T	7	0.1<=W	0.1<=W	0.4<T	0.2<=W	1.6	40<T	5<=W	19	0.2<=W	1.5<T	12<T	1<=W	0.4<T	1.5<T
43	Hanwood	Feb. 2		ND	7.34	ND	ND	ND	ND	ND	83	0.543	16.2	ND	1.16	13.4	ND	ND	ND
44	Harry	Jan. 23	**	20<T	7	0.1<=W	0.3<T	0.2<=W	0.2<=W	3.0	40<T	5<=W	6.5	0.4<T	4.5<T	12<T	1<=W	0.2<=W	3.0
		Feb. 12		28.1	8.74	ND	ND	ND	ND	ND	ND	1.08	7.87	ND	4	11.5	ND	ND	4.68
45	Heaven	Jan. 23	**	340	9	0.1<=W	0.2<T	0.2<=W	1.4	1.4	1100	5<=W	99	0.2<=W	9.0	4<T	1<=W	0.2<=W	11
46	Helen	Jan. 30		64	13.2	ND	ND	ND	1.11	ND	147	5.22	85.4	ND	3.16	15.8	3.01	ND	5.59
47	Hemlock	Jan. 23	**	500	23	0.1<=W	0.2<T	0.2<=W	3.4	2.6	40<T	5<=W	350	0.2<=W	14	16	1<=W	0.2<=W	18
48	Howry	Feb. 2		36.4	12.1	ND	ND	ND	ND	ND	78.6	ND	27.6	ND	4.37	15.6	ND	ND	4.91
49	Ishmael	Jan. 30		17.9	11.1	ND	ND	ND	ND	ND	ND	1.45	27.3	ND	2.09	16.1	2.01	ND	3.49
50	Johnnie	Jan. 23	**	120	14	0.1<=W	0.2<T	0.2<=W	1.4	2.2	120	5<=W	75	0.4<T	9.5	14	1<=W	0.2<=W	8
51	Kakakise	Jan. 30		23.3	21.5	ND	ND	ND	ND	ND	ND	4.34	37	ND	2.37	27.2	2.56	ND	6.38
52	Kidney	Feb. 1		314	29.8	ND	ND	ND	1.52	ND	150	14.1	60.2	ND	7.31	10.9	3.14	ND	27.6
53	Killarney	Jan. 30		238	23.6	ND	ND	ND	2.48	ND	64.2	1.69	148	ND	9.89	14	ND	ND	18.5
54	Lake of the	Aug. 27	**	120	19	0.1<=W	0.4<T	0.2<=W	0.6<T	2.0	140	5<=W	98	0.2<=W	11	14	1<=W	0.2<=W	12
55	Little Bell	Jan. 23	**	270	17	0.1<=W	0.1<=W	0.6<T	2.6	2.8	380	5<=W	82	0.2<=W	14	10<T	1<=W	0.2<=W	12
		Jan. 30		271	19.1	ND	ND	ND	2.46	ND	394	5.29	91	ND	15.1	12	2.87	ND	13.8
56	Little Mink	Jan. 24	**	10<=W	7	0.1<=W	0.1<=W	0.2<=W	0.2<=W	1.6	40<T	5<=W	16	0.2<=W	2.0<T	20	1<=W	0.2<=W	5<=W
57	Little Mo.	Jan. 24	**	190	24	0.1<=W	0.1<=W	0.4<T	2.0	1.0	60<T	5<=W	280	0.2<=W	11	12<T	1<=W	0.2<=W	12
58	Little Sh.	Feb. 1		77.5	15.6	ND	ND	ND	1.16	ND	ND	14.4	23.8	ND	2.88	21.7	2.29	ND	10.5
59	Little Sup	Jan. 23	**	730	18	0.1<=W	0.4<T	0.2<=W	2.0	3.8	80<T	5<=W	160	0.2<=W	16	6<T	1<=W	0.4<T	28
60	Log Boom	Jan. 23	**	110	14	0.1<=W	0.1<=W	0.4<T	1.8	2.0	240	5<=W	190	0.2<=W	12	12	1<=W	0.2<=W	10
61	Low	Jan. 30		ND	7.29	ND	ND	ND	ND	ND	ND	7.22	4.99	ND	ND	27.3	ND	ND	2.19
62	Lumsden	Jan. 30		175	19	ND	ND	ND	1.84	ND	67	5.77	145	ND	5.74	8.24	2.34	ND	17.6

Table 4 (cont.). Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
63	Mink	Jan. 24	**	50<T	7	0.1<=W	0.1<=W	0.2<=W	0.4<T	1.6	160	5<=W	44	0.2<=W	3.5	14<T	1<=W	0.2<=W	1.5
64	Moose	Feb. 2		156	21.4	ND	ND	ND	2.97	ND	ND	4.26	123	ND	9.25	11	ND	ND	14.7
65	Muriel	Feb. 1		151	23.3	ND	ND	ND	ND	ND	ND	1.35	92	ND	6.79	14.8	ND	ND	19.6
66	Murray	Feb. 2		36.4	12.5	ND	ND	ND	ND	ND	85.1	33.5	28.2	ND	4.01	14.4	ND	ND	4.83
67	Nellie	Feb. 2		513	29.2	ND	ND	ND	5.15	ND	ND	15.9	231	ND	11.8	12.5	ND	ND	25
68	Norway	Jan. 23	**	260	22	0.1<=W	0.2<T	0.2<=W	2.2	1.2	40<T	5<=W	92	0.2<=W	10	14<T	1<=W	0.2<=W	15
69	O.S.A.	Jan. 30		194	22.4	ND	ND	ND	ND	ND	ND	12.3	155	ND	8.2	14	ND	ND	19.3
		Feb. 13		218	23.3	ND	ND	ND	ND	ND	ND	ND	139	ND	7.38	12	ND	ND	21.2
70	Partridge	Jan. 23	**	70<T	17	0.1<=W	0.1<=W	0.4<T	0.8<T	1.2	20<=W	5<=W	54	0.2<=W	8	12<T	1<=W	0.2<=W	11
71	Patten	Feb. 2		297	22.9	ND	ND	ND	4.27	ND	150	2.2	141	ND	10.5	13	2.72	ND	19.5
72	Pearl	Feb. 1		183	27.4	ND	ND	ND	2.44	ND	ND	3.45	95.3	ND	7.13	14.5	ND	ND	15.6
73	Peter	Feb. 12		4.67	13.6	ND	ND	ND	ND	ND	ND	ND	19.3	ND	3.42	18	ND	ND	1.9
74	Pike	Jan. 23	**	70<T	8	0.1<=W	0.1<=W	0.2<=W	0.6<T	2.6	280	5<=W	61	0.2<=W	6	12<T	1<=W	0.4<T	3.5
75	Proulx	Jan. 23	**	640	34	0.1<=W	0.4<T	0.2<=W	3.2	3.2	40<T	5<=W	140	0.2<=W	15	12<T	1<=W	0.2<=W	26
76	Quartzite	Feb. 2		308	26	ND	ND	ND	3.54	ND	ND	1.72	194	ND	11	8.72	ND	ND	20.3
		Aug. 27	**	310	26	0.1<=W	0.3<T	0.2<=W	3	2.6	20<=W	5<=W	200	0.2<=W	10	10<T	1<=W	0.2<=W	20
77	Rocky	Jan. 24	**	30<T	6	0.1<=W	0.1<=W	0.2<=W	0.2<=W	1.8	40<T	5<=W	6	0.2<=W	2.0<T	14<T	1<=W	0.2<=W	0.5<=W
78	Roque	Feb. 2		358	21.1	ND	ND	ND	4.35	ND	139	46.4	202	ND	6.58	10	2.32	ND	26.2
79	RoundOt.	Jan. 24	**	80<T	8	0.1<=W	0.1<=W	0.6<T	0.4<T	1.8	280	5<=W	56	0.2<=W	4.0<T	16<T	2<T	0.4<T	3.0
80	Ruth-Roy	Jan. 23	**	340	13	0.1<=W	0.5	0.2<=W	2.8	2	40<T	5<=W	86	0.4<T	14	8<T	1<=W	0.2<=W	18
81	Sandy	Jan. 23	**	250	23	0.1<=W	0.2<T	0.2<=W	1.8	2	40<T	5<=W	92	0.2<=W	11	16<T	1<=W	0.2<=W	16
82	Sealey's	Feb. 1		139	16.3	ND	ND	ND	ND	ND	653	20.9	120	ND	3.12	20.8	2.2	ND	4.12
83	Shigaug	Feb. 2		198	18.1	ND	ND	ND	2.39	ND	135	1.35	150	ND	10.8	7.98	ND	ND	14.9

Table 4 (cont.). Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
84	Shingwak	Jan. 23	**	340	20	0.1<=W	0.3<T	0.2<=W	2.2	2	40<T	5<=W	130	0.2<=W	10	8<T	1<=W	0.2<=W	20
85	Silver	Jan. 23	**	380	14	0.1<=W	0.4<T	0.2<=W	3.4	1.8	160	5<=W	81	0.2<=W	14	10<T	1<=W	0.2<=W	17
86	Solomon	Feb. 2		284	22.1	ND	ND	ND	4.27	ND	1750	34.3	169	ND	6.48	10.1	2.26	ND	21.1
87	Spark	Feb. 2		600	28.2	ND	ND	ND	2.93	ND	ND	38.6	94.9	ND	10.1	7.53	ND	ND	26.9
88	Sugarbush	Feb. 2		445	24.3	ND	ND	ND	5.58	ND	52.1	29.8	198	ND	8.16	8.08	2.01	ND	30
89	Teardrop	Feb. 1		ND	13.5	ND	ND	ND	ND	ND	ND	ND	11.7	ND	ND	10.8	ND	ND	ND
		Feb. 9		ND	14.6	ND	ND	ND	ND	ND	ND	5.91	11.8	ND	ND	10.5	ND	ND	ND
90	Terry	Jan. 30		215	16.3	ND	ND	ND	1.52	ND	348	.945	85.5	ND	8.58	18.3	2.94	ND	13.9
91	The Three Lakes	Feb. 2		184	12.5	ND	ND	ND	1.51	ND	297	49.9	64	ND	4.69	6.82	ND	ND	10.1
		Feb. 9		193	13.3	ND	ND	ND	1.7	ND	311	12.2	67.8	ND	4.31	7.53	2.37	ND	10
92	The Tri N	Aug. 27	**	20	6	0.1<=W	0.2<T	0.2<=W	0.2<=W	0.8<T	40<T	5<=W	14	0.2<=W	2.5	16	1<=W	0.2<=W	0.5<=W
93	The Tri Se	Aug. 27	**	20	7	0.1<=W	0.1<=W	0.4<T	0.2<=W	1.0	80	5<=W	20	0.2<=W	3	16	1<=W	0.2<=W	1.0<T
94	The Tri Sw	Aug. 27	**	40	6	0.1<=W	0.5	0.2<=W	0.2<=W	1.6	80	5<=W	6.5	0.2<=W	4	12	1<=W	0.2<=W	1.5<T
95	Threenarr.	Jan. 30		72.8	18.4	ND	ND	ND	ND	ND	62.3	3.81	88	ND	6.26	15.9	2.13	ND	10.2
96	Topaz	Feb. 1		435	28	ND	ND	ND	2.65	ND	ND	5.18	153	ND	10.2	10.1	2.31	ND	25.4
97	Turbid	Aug. 27	**	150	21	0.1<=W	0.2<T	0.2<=W	0.8<T	2.0	200	5<=W	110	0.2<=W	14	16<T	1<=W	0.2<=W	13
98	Turtleback	Feb. 2		136	31.1	ND	ND	ND	3.59	ND	ND	12.9	71.2	ND	6.79	16	ND	ND	9.67
99	Van	Feb. 2		ND	9.47	ND	ND	ND	ND	ND	ND	41.4	23.6	ND	2.28	13	ND	ND	3.61
100	Van Wink.	Feb. 2		ND	8.53	ND	ND	ND	ND	ND	ND	ND	7.06	ND	1.61	11.7	ND	ND	ND
101	Wagon R.	Jan. 30		138	14.7	ND	ND	ND	1.19	ND	964	6.33	152	ND	3.08	18.3	2.89	ND	5.06
102	Whiskeyj.	Jan. 23	**	560	19	0.1<=W	1.8	2.2	3.6	2.8	40<T	5<=W	490	0.2<=W	16	12<T	1<=W	0.6<T	20
103	York	Feb. 2		63.4	11.2	ND	ND	ND	ND	ND	96.5	2.54	10.5	ND	5.14	19.1	ND	ND	5.52
104	#3	Feb. 12		350	22.8	ND	ND	ND	3.04	ND	262	1.25	79.2	ND	15.9	11.5	2.56	ND	18

Table 4 (cont.). Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
105	#4	Feb. 12		394	34.4	ND	ND	ND	2.88	ND	205	10.8	82.2	ND	18.4	16	2.71	ND	24.4
106	#5	Feb. 12		139	10.6	ND	ND	ND	1.38	ND	235	ND	47.2	ND	10.3	8.44	2.62	ND	9.81
107	#6	Feb. 12		156	13.9	ND	ND	ND	1.64	ND	260	ND	63.4	ND	10.8	9.88	3.03	ND	9.93
108	#7	Feb. 12		127	8.47	ND	ND	ND	ND	ND	357	ND	51.6	ND	9.42	7.08	2.55	ND	5.44
109	#9	Feb. 12		556	17.6	ND	ND	ND	3.28	ND	942	1.69	54.1	ND	14.2	7.49	3.32	ND	17.3
110	#12	Feb. 12		234	14.9	ND	ND	ND	2.12	ND	204	18.2	106	ND	10.9	8.35	2.48	ND	10.4
111	#17	Feb. 9		754	16.4	ND	ND	ND	3.03	ND	283	22	63.9	ND	11.4	5.56	2.52	ND	29.2
112	#18	Feb. 9		559	20.6	ND	ND	ND	3.65	ND	2410	ND	59.3	ND	10.4	7.2	2.1	ND	21.7
113	#19	Feb. 9		402	43.4	ND	ND	ND	6.61	ND	187	17.9	162	ND	9.17	9.72	2.14	ND	21.1
		Aug. 27	**	230	27	0.1<=W	0.2<T	0.2<=W	4.8	1.6	40<T	5<=W	140	0.2<=W	9	8<T	1<=W	0.2<=W	18
114	#20	Feb. 9		548	30.8	ND	ND	ND	2.56	ND	734	15.4	73.4	ND	10.9	7.33	2.36	ND	22.7
115	#21	Feb. 9		328	37.7	ND	ND	ND	4.87	ND	105	4.32	87.7	ND	11	12.2	2.41	ND	27.9
116	#22	Feb. 9		288	26.4	ND	ND	ND	3.59	ND	ND	5.09	75.5	ND	9.69	8.69	2.01	ND	15
117	#23	Feb. 9		572	21.3	ND	ND	ND	5.92	ND	422	2.51	123	ND	11.2	7.38	2.9	ND	25.8
118	#24	Feb. 9		407	21.9	ND	ND	ND	2.95	ND	ND	32.5	62.2	ND	8.2	6.12	ND	ND	16.8
119	#25	Feb. 9		494	13.2	ND	ND	ND	1.63	ND	808	4.2	48.2	ND	9.37	5.15	3.1	ND	18.8
120	#26	Feb. 9		461	13.6	ND	ND	ND	2.11	ND	144	13.4	65.2	ND	8.09	4.74	ND	ND	17.4
121	#27	Feb. 9		216	23.6	ND	ND	ND	2.61	ND	ND	2.8	84.2	ND	7.22	9	2.25	ND	15.7
		Aug. 27	**	90<T	12	0.1<=W	0.2<T	0.2<=W	1.2	0.6<T	120	5<=W	73	0.4<T	6.5	10<T	1<=W	0.2<=W	12
122	#28	Feb. 9		243	17.4	ND	ND	ND	1.34	ND	ND	22.1	67.1	ND	6.37	8	ND	ND	13.4
		Aug. 27	**	140	18	0.1<=W	0.3<T	0.2<=W	0.8<T	1.8	100	5<=W	62	0.2<=W	5.5	8<T	1<=W	0.4<T	8
123	#29	Feb. 9		214	15.1	ND	ND	ND	1.28	ND	52.3	9.06	67	ND	11.1	5.64	ND	ND	13.7
		Aug. 27	**	220	11	0.1<=W	0.4<T	0.2<=W	0.8<T	2	40<T	5<=W	64	0.2<=W	10	6<T	1<=W	0.4<T	14

Table 4 (cont.). Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
124	#30	Feb. 9		351	22.8	ND	ND	ND	2.97	ND	67.9	29.6	78.8	ND	8.74	8.72	2.31	ND	21
		Aug. 27	**	90<T	9	0.1<=W	0.2<T	0.2<=W	2.4	2.4	60<T	5<=W	78	0.2<=W	6.5	8<T	1<=W	0.2<=W	12
125	#33	Feb. 12		212	32.6	ND	ND	ND	2.25	ND	ND	1.85	108	ND	8.79	14.2	2.84	ND	18.8
126	#35	Feb.9		541	18.9	ND	ND	ND	5.03	ND	ND	ND	116	ND	11.7	6.05	2.71	ND	25.4
127	#36	Feb.9		120	20.6	ND	ND	ND	ND	ND	125	ND	112	ND	5.75	22.5	3.14	ND	12.9
128	#37A	Feb. 9		35.6	13.9	ND	ND	ND	ND	ND	ND	ND	7.14	ND	2.86	20.2	ND	ND	5.22
129	#38	Feb. 9		477	24.6	ND	ND	ND	7.61	ND	484	0.902	166	ND	11.1	12.2	3.79	ND	28.3
130	#40	Feb. 13		223	25.1	ND	ND	ND	1.95	ND	ND	3.39	103	ND	10.3	9.84	ND	ND	15.9
131	#45	Feb. 13		171	10.5	ND	ND	ND	ND	ND	429	27	32.7	ND	9.58	14.4	3.99	ND	10.5
132	#46	Feb. 13		135	9.39	ND	ND	ND	ND	ND	270	4.17	27.3	ND	8.82	11.5	2.56	ND	7.46
133	#50	Feb. 12		757	21.3	ND	ND	ND	3.27	ND	297	13.7	61.2	ND	11.6	7.29	2.49	ND	24.4
134	#51	Feb. 12		529	25.3	ND	ND	ND	5.25	ND	100	12.1	109	ND	11.2	7.98	2.63	ND	23.1
135	#52	Feb. 12		574	16.1	ND	ND	ND	2.55	ND	83.7	14.9	60	ND	10.5	4.83	2.64	ND	19.7
136	#53	Feb. 12		467	16.3	ND	ND	ND	2.07	ND	440	3.59	76.2	ND	10	5.17	ND	ND	17.2
137	#54	Feb. 12		452	18.6	ND	ND	ND	3.92	ND	ND	14.8	130	ND	10.3	6.98	ND	ND	24.6
138	#55	Feb. 12		234	16.3	ND	ND	ND	3.22	ND	ND	ND	91.3	ND	8.61	6.75	ND	ND	18.5
139	#59	Feb. 12		28.7	11.4	ND	ND	ND	ND	ND	ND	11.3	4.78	ND	2.14	20.8	ND	ND	3.92
140	#64	Feb. 9		246	20.8	ND	ND	ND	3.21	ND	351	ND	134	ND	5.17	11.2	2.37	ND	24.5
141	#65	Feb. 9		163	15.1	ND	ND	ND	1.4	ND	302	3.69	81.7	ND	4.21	8.48	ND	ND	11.4
142	#66	Feb. 9		129	14.6	ND	ND	ND	1.1	ND	158	22.9	65.6	ND	4.58	8.34	ND	ND	11.9
143	#68	Feb. 9		128	22.3	ND	ND	ND	ND	ND	ND	5.9	66.6	ND	5.44	11.1	ND	ND	16
144	#69	Feb. 9		244	21.6	ND	ND	ND	2.9	ND	113	9.65	159	ND	5.17	8.58	2.09	ND	21.1
145	#71	Feb. 9		328	29.9	ND	ND	ND	5.76	ND	743	ND	207	ND	6.96	9.06	3.43	ND	20.9

Table 4 (cont.). Concentrations in ug/L. Method: ** = ICP-AES ; blank = ICP-MS

Number	Name	Date	Method	Al	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Sr	Ti	V	Zn
146	#73	Feb. 12		97.7	12.7	ND	ND	ND	ND	ND	353	4.92	53.5	ND	2.46	25.8	3.6	ND	6.46
147	#74	Feb. 12		112	10.4	ND	ND	ND	ND	ND	235	ND	59.4	ND	3.26	16.1	2.36	ND	6.34
148	#76	Feb. 12		ND	14.6	ND	ND	ND	ND	ND	ND	7.32	45.9	ND	ND	28.8	2.31	ND	ND
149	#79	Feb. 9		357	11.6	ND	ND	ND	ND	ND	901	3.18	45.6	ND	5.43	5.74	2.95	ND	13.3
150	#80	Feb. 9		271	30.8	ND	ND	ND	2.65	ND	128	25.7	136	ND	8.62	11.1	2.28	ND	17.8
151	#82	Feb. 13		526	23.3	ND	ND	ND	9.99	ND	485	ND	225	ND	12	7.85	2.75	ND	28.9