Appendix V5-6C

Aquatic Baseline Studies Boston Project
Data Compilation Report 1992 – 2000

TMAC RESOURCES

AQUATIC BASELINE STUDIES
BOSTON PROJECT
DATA COMPILATION REPORT
1992 - 2000

Golder Associates

REPORT ON

AQUATIC BASELINE STUDIES
BOSTON PROJECT AREA DATA COMPILATION REPORT
1992 – 2000

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July 2008 **06-1373-028-1500**

Cover Photo: Koignuk River at Km 18.5, showing the lower part of the 5-m waterfall and a downstream scour pool (photo taken by Tim Antill on 8 July 2007).

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EXECUTIVE SUMMARY

Introduction

The Hope Bay Belt Project area is located in the Canadian Arctic to the east of Bathurst Inlet, approximately 65 km east of the community of Umingmaktok, Nunavut. The project area consists of three main gold deposit zones: Doris, Madrid, and Boston. The Doris and Madrid zones are the northern-most areas and include several lake systems that drain into Roberts Bay. The Boston zone is approximately 50 km south of the Doris and Madrid zones zone and includes several lake and river systems that drain into Hope Bay via Koignuk River.

As part of the mining development plan for the Hope Bay Belt, Miramar Hope Bay Ltd. contracted Golder Associates Ltd. (Golder) to compile and synthesize all aquatic environmental baseline information previously collected within the Boston area. The present synthesis report is based on studies conducted by Rescan Environmental Services Ltd. from 1992 to 2000, as reported in eight separate documents (Rescan 1993, 1994, 1995, 1997, 1998, 1999a, 1999b, 2001). Together with the data from more recent studies conducted in the Boston area in 2007 (Golder 2008), this consolidated report is intended to be used in support of an environmental impact assessment and will form the basis for future monitoring programs.

This report follows a format similar to the one used in the data compilation report for the Doris area (RL&L/Golder 2002). Environmental disciplines are presented as separate chapters in the following order: bathymetry, physical limnology and surface water quality, sediment quality, primary producers, secondary producers, fish populations, and fish habitat assessment.

Bathymetry

Lake bathymetric surveys were carried out on Aimaokatalok and Stickleback lakes in 1993 and 1994. Aimaokatalok Lake is part of a glacially scoured river valley, which is confined by a narrow outlet to form the present lake. The total lake area is approximately 25.5 km^2. Within the area encompassed by the 1994 survey (22.3 km^2 or about 87% of the lake), the estimated water volume was 137×10^6 m^3 and the mean depth was 6.1 m. The maximum depth of 30 m was recorded in a confined depression near the centre of the middle basin of the lake. The south arm of the lake was surveyed in 1993, indicating a shallower basin with a maximum depth of approximately 12 m.

Stickleback Lake is a small, oval shaped lake with the total area of 1.0 km^2. The maximum depth of 3 m was recorded in a small area near the northeast part of the lake. The remainder of the lake featured a consistently flat bottom between 2 and 3 m in depth.

Fickle Duck Lake is a small, oval shaped lake. Its total area is approximately 0.5 km^2. It has a fairly flat bottom and is approximately 2 m deep; however, a systematic bathymetric survey has not been carried out.

Physical Limnology and Surface Water Quality

Physical limnology and surface water quality data were collected in Aimaokatalok, Stickleback, Fickle Duck and Reference lakes. Aimaokatalok Lake is considerably larger and deeper than the other three lakes and its monitoring was more intensive, involving multiple sites and five years of under-ice sampling. In contrast, the other three lakes were sampled at just one site with only a single under-ice sampling event.

The lakes were generally well mixed; thermal stratification was observed only once (in July 1997) in Aimaokatalok Lake. Consistently high and uniform dissolved oxygen concentrations were characteristic of both the under-ice and summer profiles for the three smaller lakes (all about 3 m deep). In the deeper waters of Aimaokatalok Lake, dissolved oxygen concentrations occasionally fell below the 6.5 mg/L Canadian Water Quality Guideline (CWQG) for the protection of aquatic life.

Total suspended solids typically varied between <1 and 5 mg/L in the four lakes. The closely-related turbidity ranged from 0.3 to 30 NTU; however, only 10% of the recorded values exceeded 5 NTU.

The pH of lakes was generally near neutral (pH 7), with the overall pH range of 5.7 to 8.4. On a few occasions, the pH of lakes was slightly less than the lower CWQG limit (pH 6.5) for protection of aquatic life.

Susceptibility to acidification, as determined from total alkalinity values, was low only for Stickleback Lake. Aimaokatalok, Fickle Duck and Reference lakes had moderate to high susceptibility to acidification. Total alkalinity concentrations were similar in summer and winter samples from Aimaokatalok Lake; in contrast, the single winter samples collected from the other three Boston area lakes all had anomalously high total alkalinity concentrations compared with their summer values.

Nutrient levels were typical of oligotrophic to mesotrophic lakes. Total phosphorus levels rarely exceeded the 30 µg/L jurisdictional guideline for Northwest Territories and Nunavut and the exceedences co-occurred with high total suspended solids concentrations (suspended sediments being the likely source of elevated phosphorus).

Metal concentrations sporadically exceeded CWQGs in all four lakes. Median copper concentrations in under-ice water samples from Aimaokatalok Lake were two times higher than the CWQG of 2 µg/L. Total copper concentrations also occasionally exceeded the CWQG in Fickle Duck and Reference lakes. The highest copper concentration (30 µg/L) was measured in an under-ice sample from Reference Lake. Total iron was the only metal to substantially exceed its CWQG (300 µg/L) in all four lakes, on at least one occasion. In general, the total number of parameters which exceeded CWQGs was higher in Aimaokatalok and Stickleback lakes compared to Fickle Duck and Reference lakes.

Flowing waters sampled in this study included Aimaokatalok NE Inflow, Aimaokatalok Outflow, Aimaokatalok River, Stickleback Outflow, Fickle Duck Outflow, Koignuk River, and Reference Outflow. Water quality in general was similar in lakes and associated streams, although there was little correspondence in their guideline exceedences.

The greatest number of CWQG exceedences was recorded in Aimaokatalok NE Inflow, where elevated levels of aluminum, cadmium, chromium, copper, iron, lead and zinc were documented on at least one occasion. Total aluminum and total iron comprised the greatest and most frequent exceedences of CWQGs. Only in Aimaokatalok Outflow, both aluminum and iron concentrations were below the CWQGs, whereas Aimaokatalok River was the only other stream site where aluminum (but not iron) was also below the CWQG. Similar to the lake sites, additional exceedences of CWQGs occurred in the concentrations of cadmium, chromium, copper and lead. In contrast to the lake samples, no exceedences of CWQGs occurred for mercury or selenium.

The marine waters of Hope Bay were unstratified and well oxygenated. All metal concentrations were below their CWQG, except for mercury which was slightly higher than the marine guideline of 0.016 µg/L.

Sediment Quality

Baseline sediment quality data were collected for Aimaokatalok, Stickleback, Fickle Duck and Reference lakes and Stickleback Outflow. Most metal levels in lake sediments were below the Canadian Interim Sediment Quality Guidelines (CISQG). The exceptions were total chromium, arsenic and copper. Of these, total chromium values exceeded the CISQG Probable Effect Level (PEL) in three of the sampled waterbodies.

Total organic carbon levels varied between sediment samples. For sediments with relatively high organic carbon content (Fickle Duck Lake, Stickleback Outflow and Reference Lake), colour and mineralogy indicated that reducing conditions were predominant in the surficial layer, as well as in the underlying sediments. For lake sediments with relatively low to moderate organic carbon concentrations (Aimaokatalok Lake), colour and mineralogy indicated a strong redox gradient between an oxic surficial layer and reducing underlying upper layer. Total organic carbon values from Stickleback Lake were low in 1996 but remarkably higher in 1997.

All of the total metal concentrations in Hope Bay sediments were compliant with the marine sediment quality guidelines.

Phytoplankton in Lakes

Phytoplankton are tiny, free-floating organisms that use energy from sunlight to convert carbon dioxide and water into organic materials to be used in biological tissues. Phytoplankton samples were collected from four lakes within the Boston area (Aimaokatalok, Stickleback, Fickle Duck and Reference lakes). Between three and seventeen sampling sessions were conducted on each lake between 1993 and 1998.

The phytoplankton samples obtained from the Boston lakes contained no uncommon or rare species. The phytoplankton communities (i.e., taxonomic composition) of the four lakes showed little differentiation and were similar in many respects to the communities of other small lakes in the Arctic and sub-Arctic. In general, phytoplankton within the Boston area lakes were numerically dominated by the Cyanophyta species, *Anacystis* spp. and *Lyngbya limnetica*. However, *Crucigenia* spp. (Chlorophyta), *Asterionella formosa*, (Bacillariophyta) and *Dinobryon* spp. (Chrysophyta) also made significant contributions to phytoplankton abundance in some of the lakes. A comparison of mean phytoplankton abundance indicated that Reference Lake was the most productive and that Aimaokatalok and Fickle Duck lakes were the least productive.

Periphyton in Streams

Periphyton is a term used to describe the often complex matrix of algae, bacteria, fungi, other microorganisms and associated materials attached to solid substrata in aquatic ecosystems. Periphyton samples were collected from five streams within the Boston area. Two to five sampling sessions were conducted on each watercourse between 1993 and 1998.

A comparison of mean periphyton abundance among the study streams suggested that Fickle Duck Outflow was the most productive and Reference Outflow was the least productive. Based on chlorophyll *a* concentrations, which is a biomass estimate of live photosynthetic organisms, Reference Outflow was the most productive, whereas Fickle Duck Outflow was the least productive. Similar to the phytoplankton, the numerical dominance by Cyanobacteria (mainly *Gomphosphaeria nagelianum and Lyngbya limnetica*) suggested that this group was able to take advantage of existing low nitrogen conditions and substantially increase its population. In addition, diatoms (mainly *Tabellaria flocculosa)* and to a lesser extent, green algae, also made significant contributions, and typically co-dominated along with Cyanobacteria. The above observations were consistent with those made in other streams of the Arctic and sub-Arctic regions.

Zooplankton in Lakes

Zooplankton are small animals that inhabit the water column of lakes and consume phytoplankton. In turn, zooplankton are utilized by large invertebrates and fish as a food source. Zooplankton samples were collected from four lakes within the Boston area. Three to thirteen sampling sessions were conducted on each lake between 1993 and 1998.

The zooplankton samples obtained from the Boston lakes revealed no uncommon or rare species. The taxonomic composition of the zooplankton among the four waterbodies was similar to the communities of other small lakes in the Arctic and sub-Arctic. In general, zooplankton communities were numerically dominated by the rotifer (wheel animal) *Kellicottia longispina*. The most common cladoceran (water flea) was *Daphnia longiremis*. A comparison of mean zooplankton abundance indicated that Aimaokatalok Lake was the most productive and Reference Lake was the least productive.

Benthic Invertebrates in Lakes

Benthic (bottom-dwelling) invertebrates are an important link in aquatic food webs. Many fish species, including early life history stages of piscivorous species, feed upon benthic invertebrates. Benthic invertebrate samples were collected from four lakes within the Boston area. Three to eighteen sampling sessions were conducted on each lake between 1993 and 1998.

Chironomidae (midges), Pelecypoda (clams), and to a lesser extent Nematoda (round worms) and Oligochaeta (bristle-worms), dominated the benthic communities of the Boston area lakes. A comparison of mean benthic macroinvertebrate abundance suggested that Stickleback Lake was the most productive and the deep areas of Aimaokatalok Lake were the least productive. Although only one Boston area lake had a Chironomidae population that comprised a majority (i.e., more than 50% of total numbers) of the benthic community, Chironomidae was the most numerically abundant taxonomic group within all of the Boston area lakes. The benthic communities of the four study lakes were similar in many respects to the communities of other small lakes in the Canadian Arctic and sub-Arctic.

Drift Organisms in Streams

Benthic macroinvertebrates in streams can actively or passively enter the water column; this behaviour is known as drift. Also included in the drift are pelagic forms of invertebrates (e.g. zooplankton) that can be entrained from lakes, back-eddies, and calm side-channels of flowing waters. Drift organisms are an important part of the food chain, particularly because they are easily observed and available to fish and other potential predators. Drift samples were collected from five streams within the Boston area. Up to four sampling sessions were conducted on each stream between 1997 and 1998.

A comparison of mean total drift abundance suggested that Stickleback Outflow was highly productive, and that Reference Outflow was the least productive. Chironomidae, Simuliidae (black flies), and Ostracoda (seed shrimp) dominated the drift of the Boston area streams. Differences in composition and abundance of drift organisms could largely be ascribed to physical characteristics of the study streams. For example, the very high numbers of drift encountered in Stickleback Outflow may be due to the low flow rates encountered at this site. The high proportion of zooplankton in the drift samples from Stickleback Outflow may be an artifact of positioning the drift nets in close proximity to the lake.

Benthic Invertebrates in Streams

Stream benthic macroinvertebrates are adapted to living in flowing waters; thus, the species encountered in streams are different than those in lake environments. Stream invertebrates are an important part of the food chain; particularly if they are situated within fish rearing and adult feeding locations. Benthic samples were collected from five streams within the Boston area. Two to five sampling sessions were conducted on each stream between 1993 and 1998.

A comparison of mean total benthic invertebrate abundance suggested that Reference Outflow was the most productive and Aimaokatalok River was the least productive. Chironomidae, Ostracoda and ‘other’ invertebrates (Gastropoda and Malacostraca) dominated the benthic communities of the Boston area streams. Trichoptera was very common in Aimaokatalok River (43.2% of total numbers) on one sampling date. All streams sampled featured high proportions (at least 55% of total numbers) of Chironomidae on at least one sampling date.

Benthic Invertebrates in Hope Bay

Similar to freshwater invertebrates, benthic forms of marine invertebrates are an important link in food webs. Benthic marine invertebrate samples were collected from three sites within Hope Bay. A single sampling session was conducted in July 1998.

Polychaeta (lugworms, tube worms, and marine bristle worms), Nematoda and Chironomidae dominated the benthos of Hope Bay. The composition of benthic communities within Hope Bay was typical for the Arctic region. Differences in composition and abundance of the benthos among the three stations could be ascribed to physicochemical (e.g., water depth, salinity) characteristics at the sampling locations. A comparison of mean benthic macroinvertebrate abundance among the three Hope Bay stations indicated that greater faunal densities corresponded with increased water depth.

Fish Communities in Lakes

In total, 300 fish representing four species were captured in gill nets and through angling in three Boston area lakes during fisheries surveys conducted between 1993 and 1997. The captured species included (in the order of abundance in the total catch) lake trout (56%), lake whitefish (38%), cisco (6%), and Arctic grayling (0.3%). Ninespine stickleback were also present in all lakes.

The fish populations in Aimaokatalok Lake included lake trout, lake whitefish, cisco, Arctic grayling and ninespine stickleback. In Fickle Duck Lake, only Arctic grayling and ninespine stickleback were caught, and in Stickleback Lake only ninespine stickleback were caught. Considering that Fickle Duck and Stickleback lakes are similar in size and depth, the absence of Arctic grayling in Stickleback Lake is likely related to the lack of suitable spawning habitat in the outlet stream.

Fish Communities in Streams

Fish surveys during the 1993-2000 period were conducted in watercourses within the Aimaokatalok Lake drainage that included Fickle Duck and Stickleback outflows, Aimaokatalok NW Inflow, as well as several small inflows to Aimaokatalok Lake and one to Fickle Duck Lake. The Koignuk River, Boulder Creek (tributary to the Koignuk River) and three small streams where permanent road crossings were proposed were also sampled.

Streams in the Boston area, excluding the lower sections of the Koignuk River, were inhabited by at least three fish species (lake trout, Arctic grayling and ninespine stickleback). Two additional species (Greenland cod and lake whitefish) were present in the lower section of the Koignuk River. Slimy sculpin were also observed but not captured.

Ninespine stickleback was the most common species (74%) in the total catch of more than 471 fish. This species was also most widely distributed among the sampled streams; it was recorded in 11 of the 13 stream sites. Lake trout was second in abundance (20% of the total catch) and was recorded at six sites. Arctic grayling contributed 6% to the total catch and were recorded at seven sites. Juveniles and adults were present in the catch of both lake trout and Arctic grayling.

Fish Tissues

Fish tissue (dorsal muscle and liver) samples were collected from 70 lake trout, 43 lake whitefish, and five Arctic grayling to provide baseline data on metal concentrations in Aimaokatalok and Fickle Duck lakes. Samples were collected every year from 1993 to 1997; however, most (70%) of the samples were collected in 1995 or 1997.

Analyses of fish tissues indicated generally low levels of metal accumulation; however, exceedences of the federal guidelines for human consumption were noted for mercury. In lake trout, approximately 43% of muscle tissues and 74% of liver tissues exceeded the federal food consumption guideline of 0.5 µg/g for mercury. For lake whitefish, none of the muscle samples, but 43% of liver samples exceeded the guideline. Consistent with bioaccumulation up the food chain, older and larger fish had greater concentrations of mercury in their tissues and these fish were most likely to have mercury concentrations above the federal guideline.

None of the fish samples from Aimaokatalok or Fickle Duck lakes exceeded the federal food consumption guidelines for arsenic and lead (3.5 and 0.5 µg/g, respectively).

Fish Habitat in Streams

Stream habitat assessments were conducted at 21 stream sites between 1996 and 2000. In addition, 21 ephemeral drainages were visually assessed from the air and deemed to contain no fish habitat. A detailed habitat map was elaborated for the lower reaches of the Koignuk River in 1998.

Large streams (Aimaokatalok NE Inflow, Aimaokatalok River and the Koignuk River) supported the highest diversity of fish habitat for rearing, adult feeding, spawning, and migration. Most of the small inflow tributaries that did not feature a lake or pond upstream were found to be either ephemeral, run-off from melt waters, or provided only marginal rearing and feeding habitat near their mouths.

During high water periods, Stickleback Outflow provided good rearing opportunity but poor migration habitat. Fickle Duck Outflow featured mainly riffles and was assessed to provide fair adult feeding and rearing but poor spawning habitat.

ACKNOWLEDGEMENTS

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1 INTRODUCTION

1.1 GENERAL

The Hope Bay Belt area is located in the Canadian Arctic to the east of Bathurst Inlet, approximately 65 km east of the community of Umingmaktok, Nunavut (Figure 1.1). The Hope Bay Mining Ltd. project area consists of three main gold deposit zones: Doris, Madrid, and Boston. The Doris zone is the northern-most area and the surrounding area includes several lake systems that drain into Roberts Bay. The Madrid zone is centered around Patch Lake located approximately 10 km south of the Doris area. The Boston zone is approximately 50 km south of the Doris zone and includes several lake and river systems that drain into Hope Bay via the Koignuk River.

Environmental baseline studies were carried out within the Boston area from 1992 to 1998 and in 2000. As part of the planning to start the permitting process for development of the Boston Project mines, Miramar Hope Bay Ltd. contracted Golder Associates Ltd. (Golder) to compile and synthesize all aquatic environmental baseline information previously collected prior to the current baseline studies within the Boston area. The present synthesis report is based on studies conducted by Rescan Environmental Services Ltd. from 1992 to 2000 as reported in eight separate documents (Rescan 1993, 1994, 1995, 1997, 1998, 1999a, 1999b, 2001). Together with the data from more recent studies conducted in the Boston area in 2006 and 2007 (Golder 2008), this compilation report is intended to be used in support of an environmental impact assessment and will form the basis for future monitoring programs.

1.2 1992-2000 SAMPLING PROGRAM

Aquatic baseline studies conducted in the Boston zone during 1992-2000 included the following major disciplines: bathymetry, physical limnology, water and sediment quality, primary producers (phytoplankton and periphyton), secondary producers (zooplankton, benthos, and drift organisms), fish populations, and fish habitat.

Figure 1.2 provides an overview of waterbodies in the Boston area. Lakes that were sampled as part of the baseline studies within the project area included Aimaokatalok (also known as Spyder and Aimaoktok), Fickle Duck (also known as Trout), and Stickleback lakes. Also sampled were selected inflow and outflow streams within the lake basins, including Koignuk River, and the marine environment of Hope Bay as the main receiving waterbody downstream of the proposed mining development. In addition, sampling was conducted in Reference

LEGEND

- ● Town/Village
- ■ Project Location
- ★ Capital City
- - - - Hope Bay Belt
- Territorial Border
- Waterbodies
- Canada

125 0 125

SCALE 1:4000000 KILOMETRES

MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

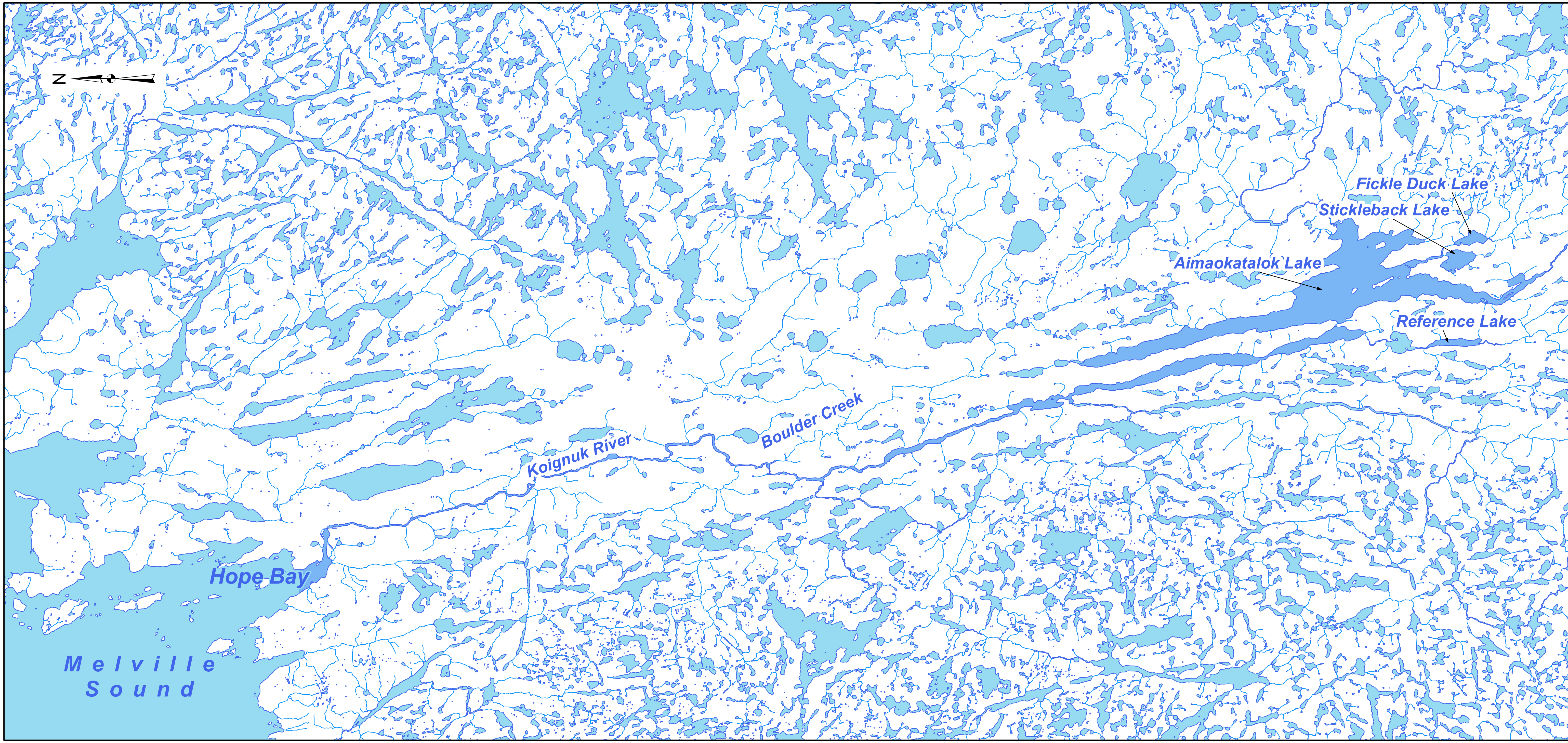
Project Location Map

Golder Associates
Edmonton, Alberta

PROJECT No. 06-1373-028			SCALE AS SHOWN	REV. 0
DESIGN	AH	4 April 2008	**FIGURE 1.1**	
GIS	RC	7 April 2008		
CHECK	AH	11 April 2008		
REVIEW	GA	14 May 2008		

REFERENCE

Sources: Environmental Systems Research Instittute (ESRI)
Projection: Canada Lambert Conformal Conic Datum: NAD 83
This map is for information purposes only. Golder Associates Ltd. does not accept any liability arising from its misuse or misrepresentation.



LEGEND

- Streams
- Study area waterbodies
- Waterbodies

REFERENCE

Sources: Data Obtained from the Government of Canada, Natural Resources Canada, Centre for Topographic Information
Projection: UTM Zone 13N Datum: NAD 83

This map is for information purposes only. Golder Associates Ltd. does not accept any liability arising from its misuse or misrepresentation.

4800 0 4800
SCALE 1:175000 METRES

MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

Studied Waterbodies in the Boston Area, 1992 - 2000

Golder Associates
Edmonton, Alberta

PROJECT No. 06-1373-028			SCALE AS SHOWN	REV. 0
DESIGN	JP	22 April 2008	**FIGURE: 1.2**	
GIS	RC	23 April 2008		
CHECK	JP	12 May 2008		
REVIEW	GA	16 May 2008		

Lake and its outflow. The Reference drainage is located outside of the potential zone of impact from the project. As such, it was considered as a control basin and was sampled to provide reference data for future aquatic effects monitoring programs.

The sampling programs conducted from 1992 to 2000 focused on different disciplines and waterbodies each year (Table 1.1). As such, some of the data sets presented in this report are based on eight years of sampling (e.g., water quality), whereas other discipline data are based on fewer years of sampling. Sampling details and methodology are provided for each discipline in subsequent chapters.

1.3 OVERVIEW OF REPORT

This report follows a format similar to the one used in the data compilation report for the Doris zone (RL&L/Golder 2002). Aquatic environmental disciplines are presented as separate chapters in the following order: bathymetry, physical limnology and surface water quality, sediment quality, primary producers, secondary producers, fish populations, and fish habitat assessment.

All of the relevant original data and analytical results (as presented in the annual data reports) are provided as appendices at the end of the report. In cases where the information in the text of the annual data reports did not agree with the data presented in the corresponding appendices, the appendix values were generally assumed to be correct and were used as bases for all statistical analyses. Where it was obvious that the appendix values were erroneous (e.g., fish lengths that did not agree with the corresponding weights), these data were clearly marked in the appendices (i.e., placed in parenthesis) and were omitted from all statistical analyses.

In the cases of primary and secondary producers, the present report includes only those taxa that were ecologically targeted. For instance, analytical laboratories typically provide results of all specimens encountered. As such, the benthic invertebrate data sets included vertebrates (e.g., fish), non-benthic / non-aquatic invertebrates [e.g., *Thysanoptera* (thrips), *Hymenoptera* (ants and bees)] and terrestrial adult forms of aquatic species. Although these non-targeted data were included in the appendices (marked as shaded rows), they were omitted from all statistical analyses. As it was not always apparent how these non-targeted taxa were treated during previous analyses, summary numbers presented in this report may not match those provided by Rescan in the annual reports.

Table 1.1 Boston Area Aquatic Sampling Program, 1992 to 2000

Waterbody	Bathymetry		Water Quality								Sediments			1° & 2° Producers						Fish Populations					
	'93	'94	'92	'93	'94	'95	'96[b]	'97	'98	'00	'93	'96	'97	'93	'94	'95	'96	'97	'98	'93	'94	'95	'96	'97	'98
Aimaokatalok Lake [a]	8	8	8	6,8	8	7,8	4,8	4,7,8	4,7		8	8	7	8	8	8	8	7,8	7	8	8	7,8	7,8	8	
Stickleback Lake	8			8	8	8		4,7,8	7			8	7	8	8	8	8	7,8	7	8	8	7,8		8	
Fickle Duck Lake					8	8	8	4,7,8	7			8	7			8	8	7,8	7			7,8	8		
Reference Lake								7,8	4,7				7					7,8	7						
Aimaokatalok NE Inflow						8	8	6,7,8	6								8	7,8	6,7			8	7	6,8	
Aimaokatalok River								6,7,8	5,6									8	7,8				8		
Aimaokatalok Outflow									5,6,8																
Stickleback Outflow			8	6,8	8	7	6,8	6,7,8	6							8	8		7,8	8	8	7,8			
Fickle Duck Outflow			8	6,8	8	7	6,8	6,7,8	6		8			8		8		7,8	7,8	8	8	7,8	7	6,8	
Reference Outflow								7,8	6,8[c]									7,8	7,8						
Koignuk River									6,8	6,9												8	8		8
Hope Bay (marine)								8	7				8												

NOTE: Numbers in the table indicate months when sampling was conducted (e.g., 4 = April).

[a] Multiple sites were sampled in Aimaokatalok Lake.

[b] In 1996, samples were collected more than once per month.

[c] In 1998, samples were collected twice in June.

2 BATHYMETRY

2.1 METHODS

In August 1993, cursory bathymetric surveys were conducted in the southern arm of Aimaokatalok Lake and in Stickleback Lake using a Raytheon echosounding chart recorder to record depths and a topographic map for positioning (Rescan 1993). In 1994, a more detailed bathymetric survey was conducted in the mid portion of Aimaokatalok Lake using a differential GPS and a Lowrance depth sounder (Rescan 1994).

2.2 SURVEYED LAKES

2.2.1 Aimaokatalok Lake

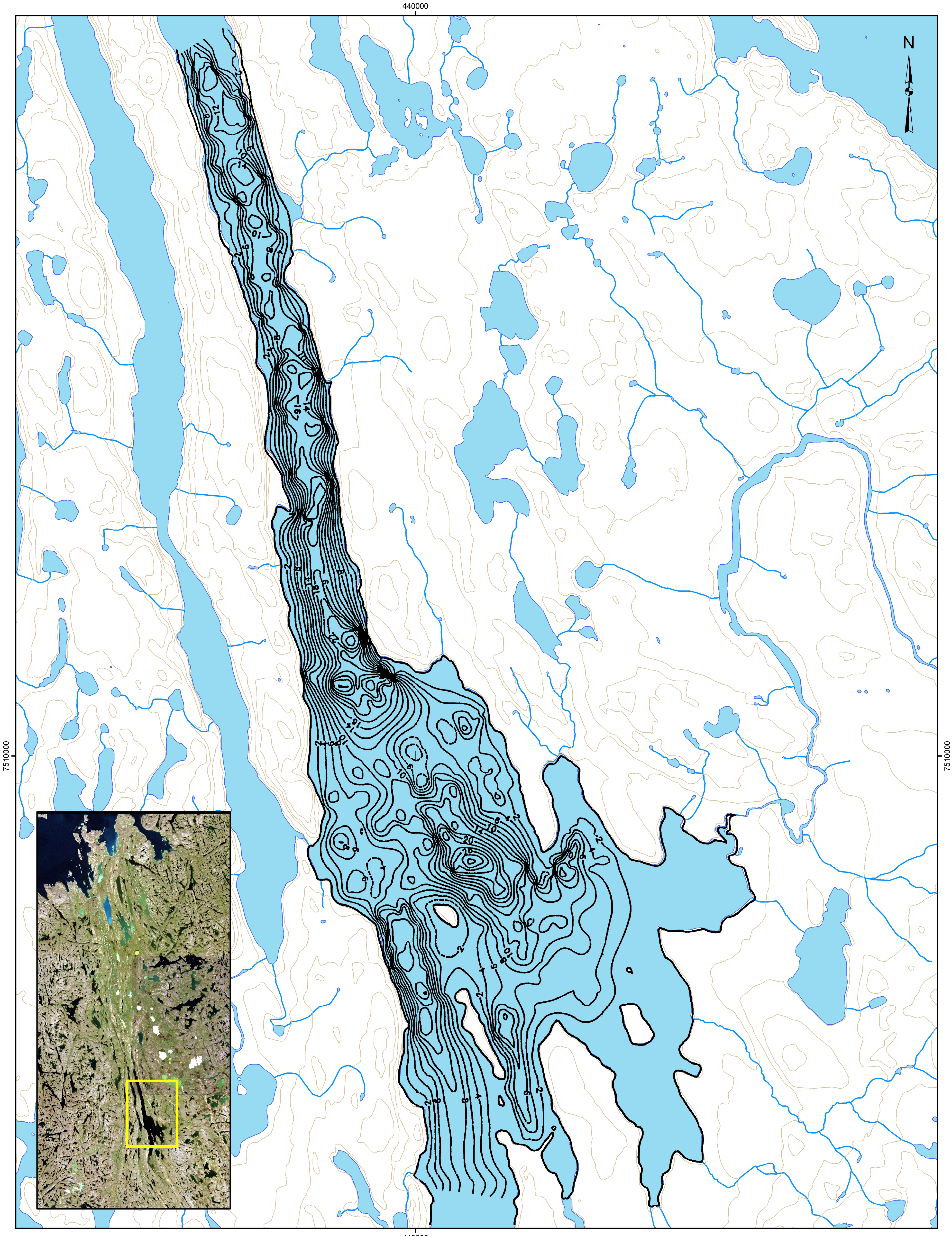
Aimaokatalok Lake lies within an elongated (12 km), narrow (0.5 - 3.0 km), irregularly shaped basin. The lake is part of a glacially scoured river valley, which is confined by a narrow outlet to form the present lake. The total lake area is approximately 25.5 km^2. The 1994 bathymetric survey of the middle sections of the lake indicated a maximum depth of 30 m in a confined depression near the centre of the widened channel (Figure 2.1). Depths up to 24 m were recorded at the base of the narrow north arm of the lake. Within the area encompassed by the 1994 survey (22.3 km^2 or about 87% of the lake), the estimated water volume was 137×10^6 m^3 and the mean depth was 6.1 m. The south arm of the lake (west of Stickleback Lake) was surveyed in 1993, indicating a shallower basin with a maximum depth of approximately 12 m (Figure 2.2).

2.2.2 Stickleback Lake

Stickleback Lake is a small, oval shaped lake, slightly elongated along its north-south axis (1.0 x 1.4 km). The total lake area is approximately 1.0 km^2. The 1993 bathymetric survey indicated a maximum depth of 3 m in a small area near the northeast arm of the lake (Figure 2.2). The remainder of the lake featured a consistently flat bottom between 2 and 3 m in depth and steep slopes along the shoreline, especially on the east side of the lake.

2.2.3 Fickle Duck Lake

Fickle Duck Lake is a small, oval-shaped lake, elongated along its north-south axis (0.5 x 1.5 km). The total lake area is approximately 0.5 km^2. It has a fairly flat bottom, approximately 2 m in depth (Rescan 1994); however, a systematic bathymetric survey of this lake has not been carried out.



LEGEND

- Bathymetry (from Rescan 1994)
- Contours
- Rivers
- Waterbodies

1,500 0 1,500
SCALE 1:40000 METRES

MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

Bathymetry of Aimaokatalok Lake, 1994

REFERENCE

Data obtained from Government of Canada, Natural Resources Canada, Centre for Topographic Information.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 13N
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Golder Associates
Edmonton, Alberta

PROJECT NO. 06-1373-028			SCALE AS SHOWN	REV. 1
DESIGN	JP	15 April 2008	**FIGURE 2.1**	
GIS	RC	17 April 2008		
CHECK	JP	14 May 2008		
REVIEW	GA	16 May 2008		

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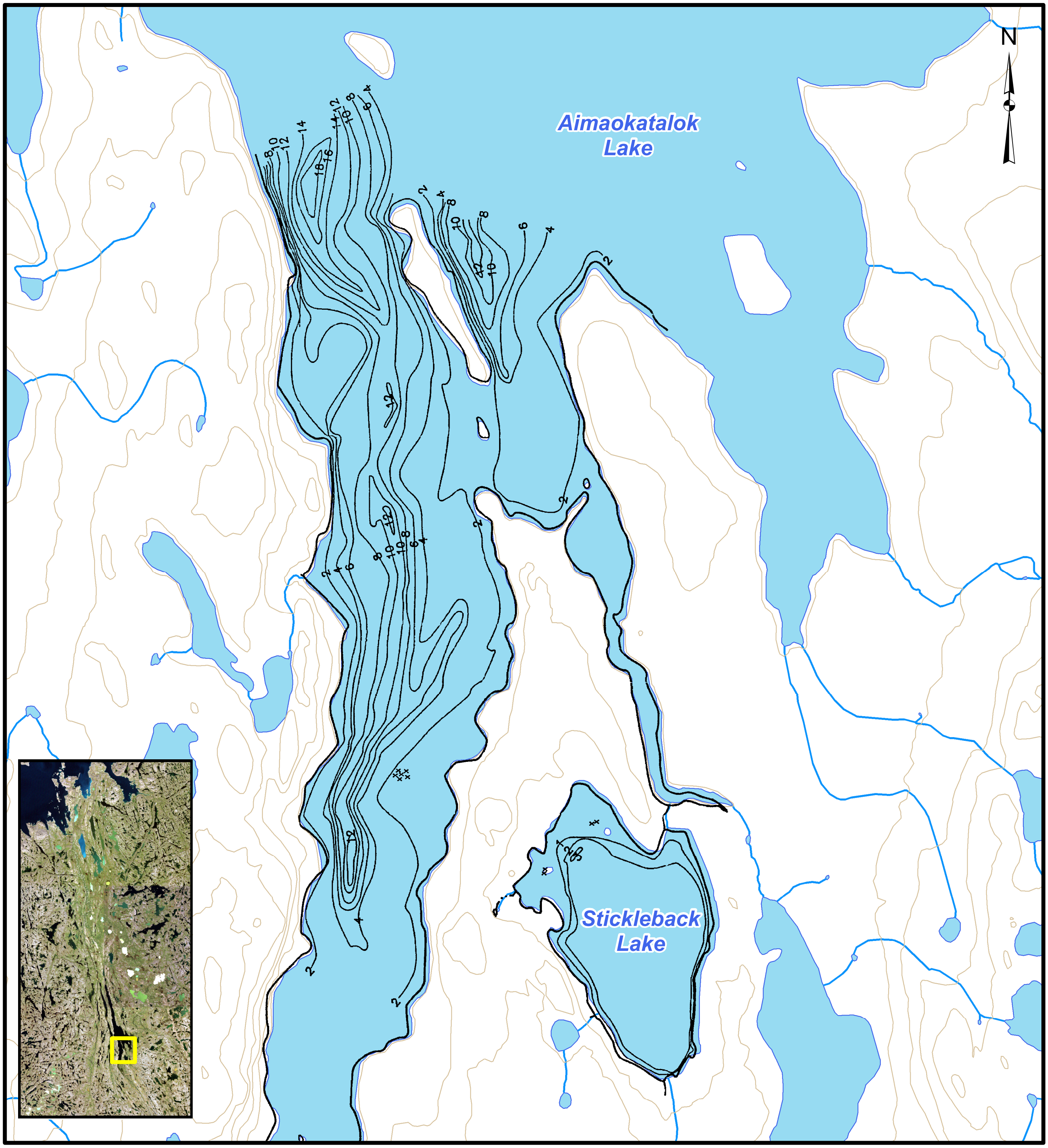

950 0 950
METRES

LEGEND

- Bathymetry (from Rescan 1993)
- Contours
- Rivers
- Waterbodies

MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

REFERENCE

Sources: Government of Canada, Natural Resources Canada, Centre for Topographic Information.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 13N
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TITLE

Bathymetry of Stickleback Lake and South Arm of Aimaokatalok Lake, 1993

Golder Associates
Edmonton, Alberta

PROJECT No. 06-1373-028		
DESIGN	JP	15 April 2008
GIS	RC	17 April 2008
CHECK	JP	14 May 2008
REVIEW	GA	10 May 2008

SCALE AS SHOWN REV. 0

FIGURE 2.2

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3 PHYSICAL LIMNOLOGY AND SURFACE WATER QUALITY

This chapter presents information on baseline water quality conditions in the Boston area of the Hope Bay Belt. Water quality data are presented for four lakes and associated streams, Aimaokatalok River, Koignuk River and marine sites in Hope Bay. The data were compiled from seven annual reports (Rescan 1993, 1994, 1995, 1997, 1998, 1999a, 2001).

3.1 METHODS

3.1.1 Sampling Locations and Timing

Water quality samples and measurements were collected between 1992 and 2000 from lakes, associated streams and the Koignuk River in the Boston area of the Hope Bay Belt (Figure 3.1, Table 1.1). Detailed sampling methods are presented in Rescan reports (Rescan 1993, 1994, 1995, 1997, 1998, 1999a, 2001); a summary of methods used is also presented in Appendix A1.

The initial sampling effort focused on Aimaokatalok (also known as Spyder and Aimaoktok), Fickle Duck Lake (also known as Trout), and Stickleback lakes and their outflow streams. Sampling sites in Reference Lake, Reference Outflow and Aimaokatalok River were added in 1997. Sampling of Aimaokatalok Outflow and Koignuk River started in 1998. Reference Lake was included as a possible reference site for monitoring potential project influences on the Aimaokatalok outflow watershed.

Except for one spring sample collected in June 1993, lake water quality sampling sessions between 1992 and 1995 were carried out under open-water conditions in July and August (Table 3.1). From 1996 to 1998 both open-water (July-August) and under-ice conditions (April) were sampled. The sampling sites were located in the deepest sections of the lakes: one site in each of Fickle Duck, Stickleback and Reference lakes and several sites in Aimaokatalok Lake (Figure 3.1). At each site, water samples were collected for standard water quality parameters including total and dissolved metals and trace elements. On a few dates, field meters were used to measure vertical profiles for temperature and dissolved oxygen (Table 3.1). In addition, field measurements of pH were obtained between 1993 and 1995; pH was measured only in the laboratory in 1996 and 1998. Secchi depth was measured only in 1997 and 1998.

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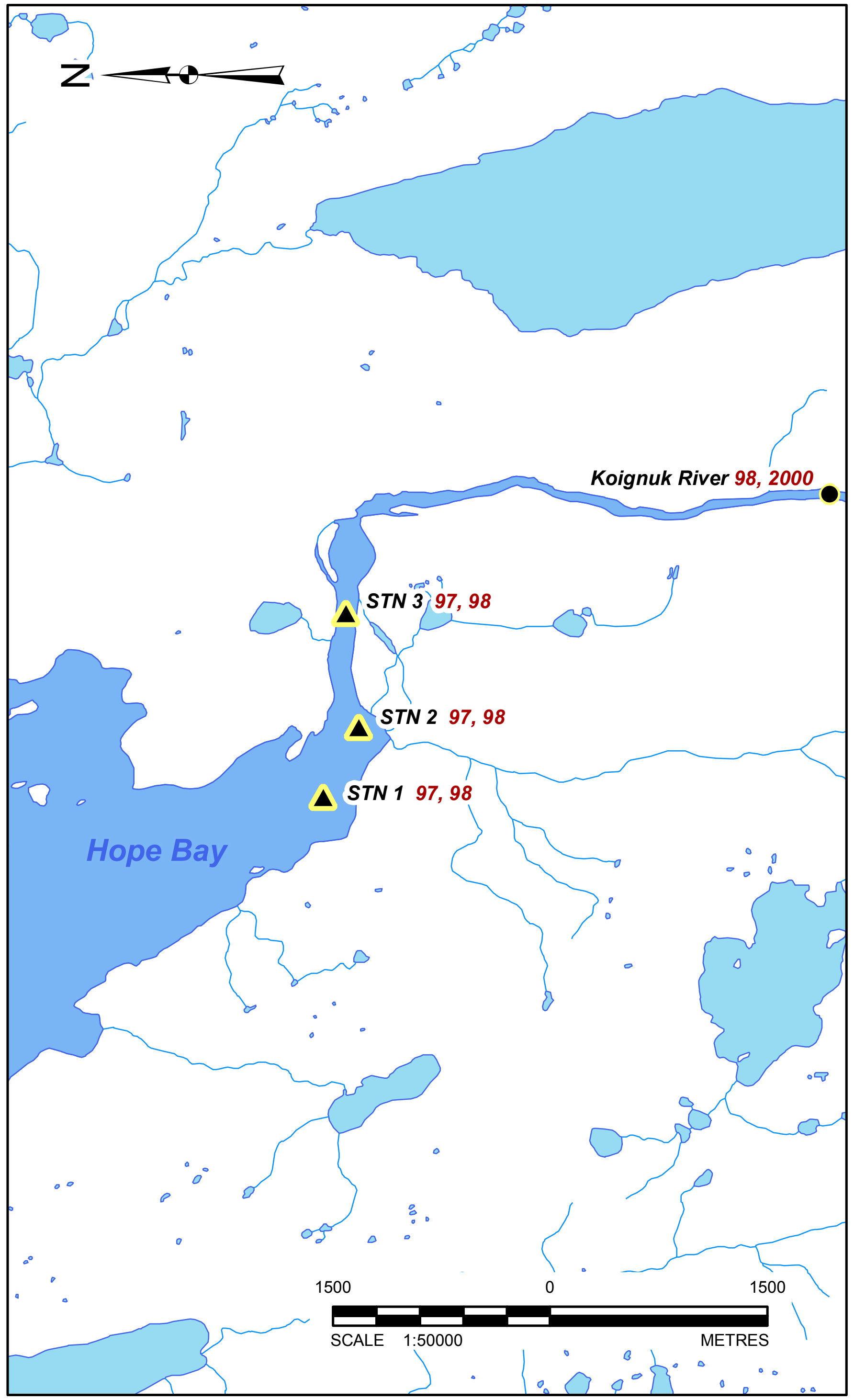

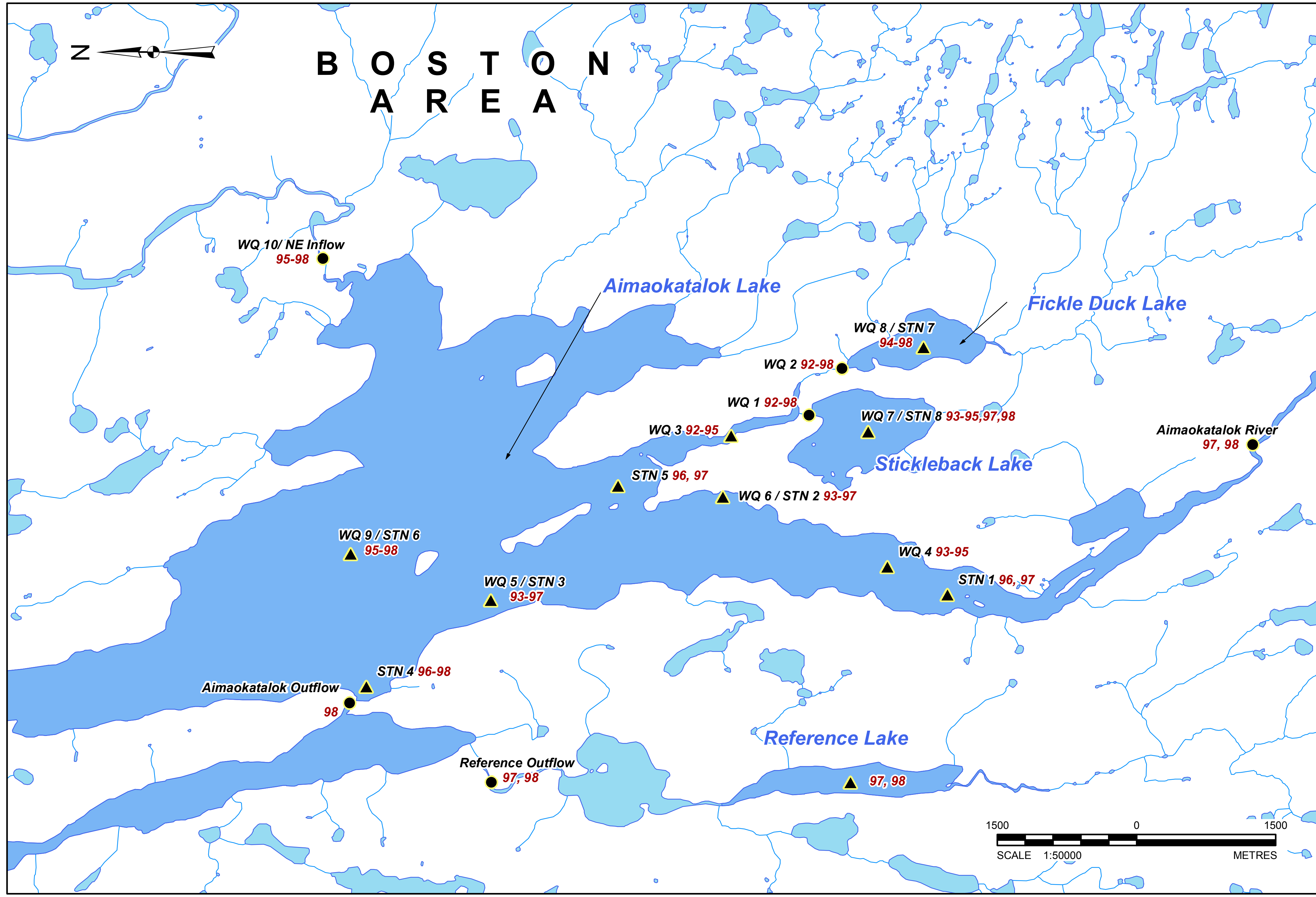

LEGEND

- ▲ Lake/marine sampling locations
- ● Stream sampling locations
- Rivers
- Study area waterbodies
- Waterbodies

WQ X / STN X Sampling station names from Rescan reports

95-97 Consecutive years of sampling at station

REFERENCE

Sources: Data Obtained from the Government of Canada, Natural Resources Canada, Centre for Topographic Information
Projection: UTM Zone 13N Datum: NAD 83

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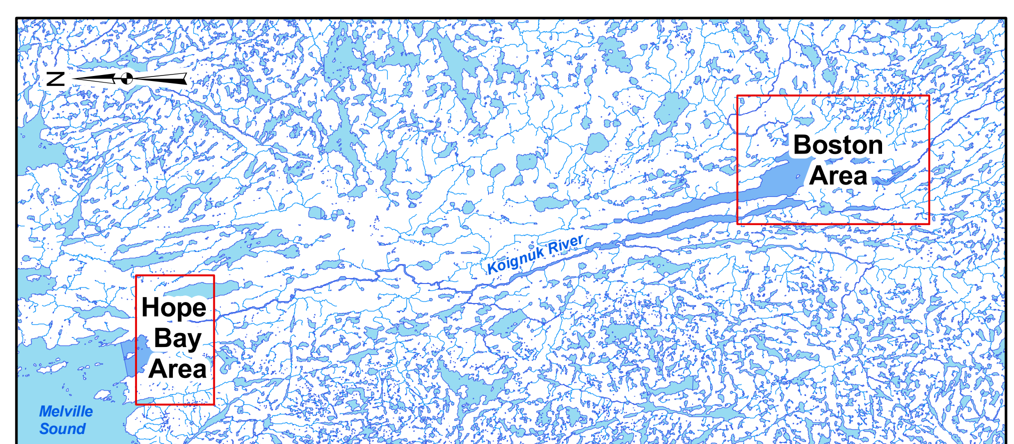

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Boston Project Data Compilation

TITLE

Water Quality Sampling Locations, 1992 - 2000

Golder Associates
Edmonton, Alberta

PROJECT No.06-1373-028			SCALE AS SHOWN	REV. 1
DESIGN	JP	22 April 2008		
GIS	RC	23 April 2008		
CHECK	JP	14 May 2008		
REVIEW	JP	16 May 2008		

FIGURE 3.1

Table 3.1 Summary of Water Sampling (Number of Sampling Sessions) Conducted in Boston Area Lakes and Streams, 1992 - 2000

Lake	1992	1993		1994	1995	1996		1997		1998	
	Ice Free	Ice Cover	Ice Free	Ice Free	Ice Free	Ice Cover	Ice Free	Ice Cover	Ice Free	Ice Cover	Ice Free
Aimaokatalok	1	1	1p[a]	1	1p[a]	1	2	1p	2p[a]	1p[a]	1p[a]
Stickleback			1	1	1p[a]			1p[a]	2p[a]		1p[a]
Fickle Duck			1	1	1p[a]		2	1p[a]	2p[a]		1p[a]
Reference									2p[a]	1p[a]	1p[a]

Stream	1992		1993		1994		1995	
	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
Aimaokatalok NE Inflow		1	1	1		1		2
Fickle Duck Outflow		1	1	1		1		1
Stickleback Outflow		1	1	1		1		1

Stream	1996		1997		1998		2000	
	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
Aimaokatalok NE Inflow		2	1	2	1			
Aimaokatalok Outflow					2	1		
Aimaokatalok River			1	2	2			
Fickle Duck Outflow	1	2	1	2	1			
Koignuk River					1	1	1	1
Reference Outflow				2	2	1		
Stickleback Outflow	1	3	1	2	1			

[a] "p" indicates vertical profiles of temperature and dissolved oxygen were collected with the sample.

In general, stream sampling was conducted during the spring melt conditions (May/June) and during the summer (July to September) between 1992 and 2000 (Table 3.1). At each site, water samples were collected for standard water quality parameters including total and dissolved metals and trace elements. Field meters were used to measure temperature, pH and dissolved oxygen (DO) between 1993 and 1996. In 1997 and 1998, DO and temperature were not measured in the field, whereas pH was measured in the laboratory only.

Baseline marine water quality sampling was conducted in Hope Bay, which is the final receiving waterbody of the Aimaokatalok Lake drainage via the Koignuk River. Water samples were collected in summer of 1997 and 1998 at three sites within Hope Bay (Figure 3.1). Temperature and DO profiles were also measured at these stations in 1998. In general, methods used for the collection of marine samples were similar to those used for lake sampling (Appendix A1).

3.1.2 Laboratory Analytical Methods and QA/QC Procedures

Water samples were analyzed for standard chemical parameters including nutrients, major ions, total metals and dissolved metals (Appendix A2).

Analytical methods and detection limits for the measured parameters varied from year to year, largely because of different laboratories used, including Analytical Service Laboratories (ASL), Elemental Research Inc. (ERI) and University of British Columbia (UBC).

The details of quality control/quality assurance (QA/QC) procedures varied during the 1992-2000 baseline monitoring program. In general, however, field QA/QC procedures included the use of sample replicates, travel blanks and field blanks, whereas laboratory QA/QC procedures involved the use of sample splits and laboratory method blanks (Appendix A3). The analytical results for QA/QC samples are presented in Appendix A4.

3.1.3 Data Interpretation

Concentrations of the various substances were compared against Canadian Water Quality Guidelines (CCME 2007). In cases where the Canadian Water Quality Guidelines (CWQGs) have not yet been developed, the Northwest Territories and Nunavut jurisdictional guidelines (Statistics Canada 2006) or the British Columbia water quality guidelines (BCMOE 2006) were used.

For quick reference, seasonal summaries of water quality data are presented in text. In the seasonal summaries, data are presented as seasonal medians, minimums and maximums for each water body. Excluding replicates and sample splits, these statistics were derived using all available data, including multiple sampling depths, and all sampling stations on each lake. In order to avoid misrepresentation in the determination of the summary statistics, "no analysis" result is shown for specific parameters on dates when detection limits were substantially greater than the reported maximum values in the Boston lakes. Calculation of medians used the following rules: when the median fell between a detection limit (<value) and an actual concentration, the latter was used for the median value; when the median fell between two detection limits the higher resolution detection limit was cited as the median value. When ranking concentrations compared to detection limits, a concentration of less than half the detection limit was considered lower, while concentrations of half or more of the detection limit were considered higher. For example, values of 0.4 mg/L and less were ranked lower than <1 mg/L detection limit, whereas 0.5 mg/L and greater concentrations were ranked higher than the <1 mg/L detection limit.

Total Suspended Solids and Turbidity

CWQGs for total suspended solids (TSS) and turbidity refer to exceedences above natural levels. The data presented in this report were obtained from baseline studies; therefore, TSS and turbidity values presented in this report can be used in the future as guidelines for determining exceedences when mining begins in the areas.

Aluminum

CWQGs for aluminum depend on the pH of water. The 100 µg/L water quality guideline is used for waters with pH ≥6.5, whereas the 5 µg/L CWQG is used for waters with pH <6.5.

Cadmium

CWQGs for total cadmium vary with water hardness. For water hardness between 30 and 90 mg $CaCO_3$/L the following formula is used to derive the guideline for total cadmium:

$$CWQG=10^{\{0.86[\log(hardness)]-3.2\}}$$

where the water quality guideline (CWQG) is in µg/L and hardness is measured as $CaCO_3$ equivalents in mg/L. When water hardness is ≤30 mg/L, the CWQG for total cadmium is 0.01 µg/L. For water with hardness ≥90 mg $CaCO_3$/L, the CWQG for total cadmium is 0.03 µg/L.

Copper

The CWQGs for total copper are dependent on water hardness ($CaCO_3$ concentrations) as follows:

Water Hardness (mg $CaCO_3$/L)	CWQG for Total Copper (µg/L)
<120	2
120–180	3
>180	4

Total Alkalinity

Total alkalinity is a common measure of the acid neutralizing capacity of water. As such, it provides an indication of a waterbody's sensitivity to acid deposition.

According to Saffran and Trew (1996), acid sensitivity ranges of lakes (study was based on lake data only, no similar studies have been conducted on streams) are based on total $CaCO_3$ alkalinity and are defined as follows:

Total Alkalinity (mg $CaCO_3$/L)	***Acid Sensitivity of Lakes***
• <10	high sensitivity
• 11 to 20	moderate sensitivity
• 21 to 40	low sensitivity
• >40	least sensitive

Total Phosphorus

There are no CWQGs for flowing waters presently available for total phosphorus (TP), whereas for still water, the CWQGs are in the form of a series of trigger ranges (CCME 2007). However, a number of Canadian jurisdictions have developed their own TP guidelines for lentic (still) and lotic (flowing) waters (Statistics Canada 2006). In Northwest Territories and Nunavut, a 0.03 mg/L TP guideline is used for both lentic and lotic waters (Statistics Canada 2006). In this report, the TP concentrations from the Boston area water bodies are compared against the 0.03 mg/L Northwest Territories and Nunavut jurisdictional guideline.

Total vs Dissolved Metal Concentrations

In general, toxicity of the particulate fraction of a metal (included in the total concentration of a metal) is lower than that of the dissolved fraction. Although, the CWQGs pertain to the total metal concentrations, most of these guidelines were based on toxicological studies using dissolved metal concentrations. As such, when a dissolved metal concentration exceeds the CWQGs in a natural setting, it is likely to have more serious effects on the aquatic biota than when only the total concentration of a metal exceeds the guideline. *"Of particular concern is the apparent toxicity of some ionic metals to fish due to adsorption of the metal at the gill surface. Particulate bound forms of the same metal have much reduced toxicity. This is important when comparing the laboratory toxicity results with field situations where more metal binding agents are likely to be present, thereby usually reducing the toxicity of the metal. Conversely, fish tested in the laboratory are usually not fed and do not ingest particulate metals."* (CCME 2007).

3.2 LAKE WATER QUALITY

Analytical results for all available water quality data from Boston area lakes are presented in Appendix A5. Seasonal summaries (under ice cover *vs* summer/fall open water conditions) of standard water quality parameters and total metal concentrations are presented for each lake in the following subsections.

3.2.1 Aimaokatalok Lake

Aimaokatalok Lake is, by far, the largest (approximately 20 km long) of the four lakes sampled in the Boston area (Figure 3.1). It also contains the deepest water quality sampling site (28 m deep), whereas the sampling sites at the remaining three lakes are approximately 3 m deep. Aimaokatalok Lake was sampled on 19 dates between June 1993 and July 1998 (Table 3.1).

Temperature profiles in Aimaokatalok Lake, in both ice covered and ice free conditions, indicate a reasonably well mixed water column (Figure 3.2). A defined thermocline was observed between approximately 2 to 8 m depth in July 1997. The bottom waters were warmest in August, ranging from 8.5°C to 12.5°C; in August the lake was typically isothermic. The warmest temperature recorded in surface waters was 19.5°C, measured at Station 5 in July 1998. The under-ice water temperatures ranged from 0°C just below the ice cover to 2.5°C in near-bottom waters.

Dissolved oxygen (DO) profiles for Aimaokatalok Lake show that on all sampling occasions at least the upper 3 m layer of water column was well oxygenated under both ice cover and ice free conditions. A sharp drop in oxygen concentrations, down to near anoxic levels, was recorded twice — once at Station 4 on 22 April 1998, when DO dropped from 10.69 mg/L at 6 m depth to 3.24 mg/L at 8 m depth; and once at Station 6 on 25 Aug 1997, when DO dropped from 11.5 mg/L at 3 m depth to 2.5 mg/L at 5 m depth, continuing to gradually decline to 1.4 mg/L at 18 m. Notably, when oxygen depletion was observed, it was measured at one site only, while elsewhere in the lake oxygen concentrations were high at similar and much greater depths. Indeed, in July 1998 uniformly high DO concentrations (>10 mg/L) were observed all the way to the bottom at the 28 m deep Station 6 (Figure 3.2). DO values in the deeper layers of the water column fell below the 9.5 mg/L CWQG for early life stages of cold-water biota in 8 of the 21 DO profiles measured. In five of these eight profiles, the DO fell below the 6.5 mg/L CWQG for other life stages of coldwater biota.

Aimaokatalok Lake total suspended solids (TSS) values were typical of clear lakes, with a median TSS of <1 mg/L in spring and 2 mg/L in summer (Table 3.2). The spring and summer maximums for TSS were 22 mg/L and 13 mg/L, respectively. The median turbidity values were similarly low (Table 3.2), with a value of 0.8 NTU in the spring and 1.3 NTU in the summer.

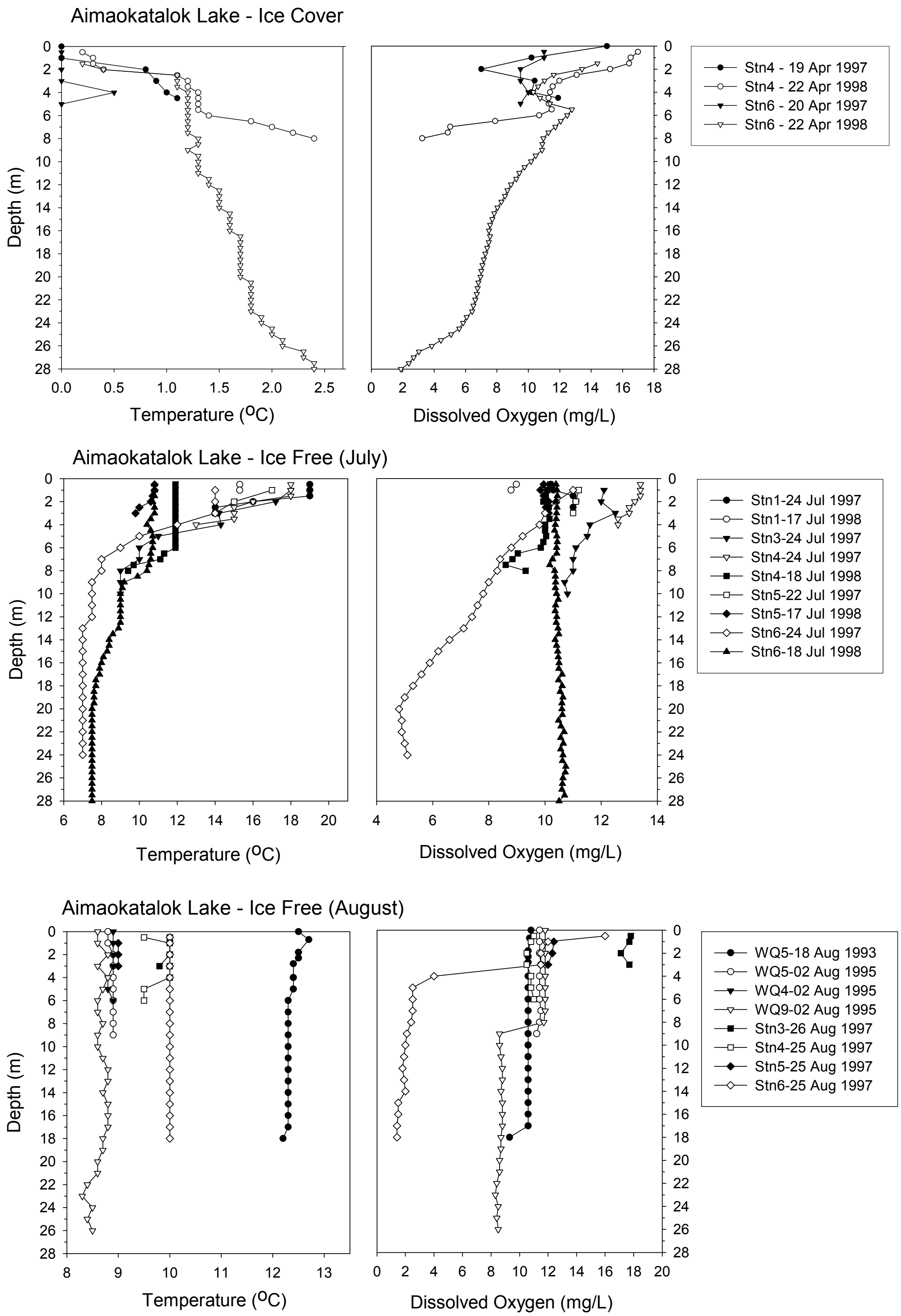


Figure 3.2 Temperature and Dissolved Oxygen Profiles in Aimaokatalok Lake, 1993 to 1998

Table 3.2 Baseline Water Quality in Aimaokatalok Lake, 1993 to 1998

Parameters	Ice Covered (April to June)				Ice free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	56	37	66	17	40	32	320	70	-
pH (units)	6.7	***6.2***	6.9	17	6.7	***5.7***	8.2	68	6.5 – 9.0
TDS (mg/L)	38	20	46	17	29	13	350	69	-
TSS (mg/L)	<1	<1	22	13	2	<1	13	68	short-term increase <25; long-term increase <5
Turbidity (NTU)	0.8	0.3	18.4	17	1.3	0.3	9.0	70	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	13	8	16	17	9	6	110	70	-
Total Alkalinity	9	5	12	16	7	4	21	70	-
Chloride	10	7	12	12	6	5	98	69	-
Fluoride	0.04	0.03	0.07	12	0.04	<0.05	0.08	69	0.12
Sulphate	2.0	1.0	3.2	16	1.0	<0.5	2.0	70	-
Nutrients (mg/L)									
Dissolved phosphorus	0.004	<0.001	0.013	10	0.003	<0.001	0.029	64	-
Total phosphorus	0.007	<0.001	***0.069***	16	0.008	0.002	0.020	64	0.030 (jurisdictional)
Ammonia nitrogen	0.007	<0.005	0.035	14	0.012	<0.005	0.140	64	1.23[a]
Nitrate - nitrogen	0.035	<0.005	0.120	14	<0.005	<0.001	0.016	64	13
Nitrite - nitrogen	<0.001	<0.001	0.006	14	<0.001	<0.001	0.002	64	0.06
Total Metals (µg/L)									
Aluminium	19	10	***118***	13	38	7	***446***	75	5 or 100[b]
Antimony	<0.1	<0.05	0.30	13	<0.1	<0.05	0.20	75	
Arsenic	0.2	0.1	0.4	13	0.2	<0.1	3.0	76	5.0
Barium	2.4	1.7	4.6	7	1.7	1.1	22.1	48	
Beryllium	<5	<0.5	<5	17	<0.5	<0.5	2.7	76	
Bismuth	<0.5	<0.5	<0.5	6	<0.5	<0.03	0.1	47	
Boron	5	4	7	6	3	1	34	47	
Cadmium	<0.2	<0.05	***0.90***	13	<0.2	<0.05	***0.51***	76	0.017[c]
Calcium	2 820	1 500	3 460	17	1 860	1 340	41 900	76	
Chromium	0.6	0.2	***10.0***	13	0.5	<0.1	***1.7***	59	1.0 or 8.9[d]
Cobalt	<1	<0.1	0.1	13	<1	<0.1	0.3	75	
Copper	***4***	1	***14***	16	0.7	<1	***20***	76	2
Iron	50	<10	***629***	17	100	<10	***440***	76	300
Lead	<1	<0.05	***3***	13	<1	<0.05	***10***	76	1
Lithium	<10	<1	1	16	<10	<1	65	54	
Magnesium	1 560	992	2 000	17	1 105	858	8 090	76	
Manganese	3.0	1.5	49.0	17	4.1	0.3	18.0	76	
Mercury	<0.05	<0.01	<0.05	7	<0.05	<0.01	***0.10***	37	0.026[e]
Molybdenum	<1	<0.05	0.14	13	<1	<0.05	0.30	76	73
Nickel	0.8	<1	12.0	13	0.2	<0.1	2.3	75	25
Potassium	830	660	1 130	13	635	490	2 930	70	

Table 3.2 Baseline Water Quality in Aimaokatalok Lake, 1993 to 1998 (continued)

Parameters	Ice Covered (April to June)				Ice free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Selenium	<0.5	<0.5	<0.5	13	<0.5	<0.5	***5***	62	1.0
Silicon	320	160	680	13	240	<50	400	53	
Silver	<0.1	<0.01	<0.1	13	<0.1	<0.01	0.06	75	0.1
Sodium	5 010	2 700	6 150	17	3 370	2 600	11 400	71	
Strontium	13	10	18	17	10	6	362	71	
Thallium	<0.05	<0.05	<0.05	6	<0.05	<0.03	0.05	47	0.8
Tin	<0.1	<0.1	<0.1	6	<0.1	<0.09	0.40	47	
Titanium	<10	<0.01	<10	17	5	<1	19	70	
Tungsten	-	-	-	0	0.1	<0.07	0.2	18	
Uranium	0.02	0.02	0.03	6	0.01	<0.01	0.05	29	
Vanadium	0.3	0.2	1	6	<1	<1	4.0	47	
Zinc	5	<1	16	16	<5	<1	23	76	30
Field WQ									
Temperature (°C)	-	-	-	0	9.5	7.4	14.0	14	-
Dissolved Oxygen (mg/L)	-	-	-	0	12.0	***8.6***	14.2	14	9.5 mg/L early life stages; 6.5 mg/L other life stages
pH (units)	-	-	-	0	7.4	***6.1***	8.2	12	6.5 - 9.0
Secchi (m)	-	-	-	0	-	2.0	3.5	2	-
Chlorophyll *a* (mg/m^3)	-	-	-	0	0.54	0.48	0.72	3	-

Note: italicized, bold values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] The lowest guideline value determined for the particular temperature and pH ranges (temperature up to 20°C and pH 7.5) when ammonia nitrogen was high in Aimaokatalok Lake (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

The maximum values for spring and summer were 18.4 and 9.0 NTU, respectively.

The laboratory measurements of pH in Aimaokatalok Lake water samples were carried out consistently throughout the 1993 to 1998 studies. The median pH value (pH 6.7), measured in the laboratory, was the same for under ice and ice free conditions. Aimaokatalok Lake water samples ranged from pH 5.7 to 8.2 (Table 3.2). The minimum pH levels measured in the laboratory in both under ice (pH 6.2) and ice free (pH 5.7) water samples were below the minimum CWQG of pH 6.5. The field pH measurements were made only during summer sampling events. The field pH measurements ranged from pH 6.1 to 8.2; the median field pH was 7.4.

Total alkalinity in Aimaokatalok Lake was generally low, ranging from 4 to 21 mg/L (Table 3.2). Based on the Saffran and Trew (1996) classification, Aimaokatalok Lake, most of the time, has moderate to high susceptibility to acidification.

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate and nitrite) were well below the CWQGs. Total phosphorus (TP) in Aimaokatalok Lake was typically below the 0.03 mg/L jurisdictional guideline for Northwest Territories and Nunavut; the median TP values were 0.007 mg/L for under-ice samples and 0.008 mg/L for summer samples. The under ice maximum value for TP (0.069 mg/L) represents the only occasion when the TP concentrations exceeded the 0.03 mg/L jurisdictional guideline. Notably, the concurrent TSS concentration (22 mg/L) was also the maximum value recorded for Aimaokatalok Lake, and therefore, this sample was likely contaminated with sediments (Appendix A5).

Median metal concentrations were below the CWQGs with the exception of the under-ice median for total copper (median of 4 µg/L; maximum of 14 µg/L), which exceeded the 2 µg/L CWQG (Table 3.2). High copper concentrations (dissolved copper was also above the CWQG) occurred in water samples collected under-ice in 1996, 1997 and 1998, with the deepest samples containing the least copper (Appendix A5).

The CWQGs were exceeded by both spring and summer maximum values for the following metals (total): aluminum, cadmium, chromium, copper, iron and lead.

In addition, the summer maxima for mercury (0.10 µg/L) and total selenium (5 µg/L) exceeded the CWQGs (Table 3.2).

The CWQG exceedences for total aluminum occurred whenever turbidity was >5 NTU (and on one occasion when turbidity was lower, at 3 NTU). High turbidity, however, did not seem to co-occur with CWQG exceedences for the remaining above-mentioned metals. Additionally, CWQG exceedences for total aluminum (>5 µg/L) also occurred whenever pH fell below the CWQG (pH <6.5).

The summer spikes in metal concentrations in Aimaokatalok Lake appear to be sporadic and, with the exception of aluminum, iron and turbidity at Station 1 on 23 Aug 1996, there was very little consistency between replicate samples and different depths at the same site when CWQG exceedences occurred. The elevated metal concentrations in these "odd" summer samples were likely due to sample contamination or insufficient precision and accuracy of the laboratory analyses. The latter was definitely an issue with regard to cadmium concentration where the CWQG value was lower than the analytical detection limit.

In contrast, the under-ice exceedences of CWQGs were more consistent between replicate samples and different depths at the same site. It is possible that some CWQG exceedences for metal concentrations, especially in under-ice samples, were due to human activity. Aimaokatalok Lake is likely to receive some discharge from the exploration camp site on its shores, and there is a winter road over the lake. Furthermore, Aimaokatalok Lake and its shores were subjected to intensive exploration drilling during the 1992 to 1998 period. Some of these drilling activities may have contributed to the observed spikes in metal concentrations. In the four years of under-ice sampling (1993, 1996, 1997, 1998), water samples from all locations had at least one metal exceeding the CWQG concentrations; only the occasional, deep-water sample had all metal concentrations below the guidelines (Appendix A5).

Specifically, in June 1993 total iron was above the 300 µg/L CWQG and drilling on the lake, upstream of the water quality sampling locations, was conducted between April and the end of May 1993 (file data, provided by Miramar Hope Bay Ltd. – now Hope Bay Mining Ltd.). In 1998, when the under-ice drilling was conducted closer to the main basin of the lake, there were no elevated iron concentrations but there were substantial exceedences of CWQGs for chromium and copper. In 1996, when there was no drilling on the lake (just on the shore), turbidity, copper and aluminum concentrations were above CWQGs, but not those of chromium or iron. In 1997, when drilling was also confined to the shore, small exceedences of CWQGs occurred in total copper and cadmium concentrations, while total iron concentrations were elevated but not above the CWQG. It should be noted, however, that natural exceedances of many of these parameters occur in waterbodies within the Hope Bay Belt, and so the exceedances in Aimaokatalok Lake may not be related to drilling.

3.2.2 Stickleback Lake

Stickleback Lake was sampled on seven dates between August 1993 and July 1998 (Table 3.1). Temperature profiles in Stickleback Lake, during both ice cover and ice free conditions, were isothermic indicating a well mixed water column (Figure 3.3). Summer temperature ranged from 8 to 19°C, whereas under ice temperatures were slightly above 0°C (Figure 3.3). The dissolved oxygen concentration (DO) in all five DO profiles were above the 9.5 mg/L CWQG for protection of all life-stages of fish.

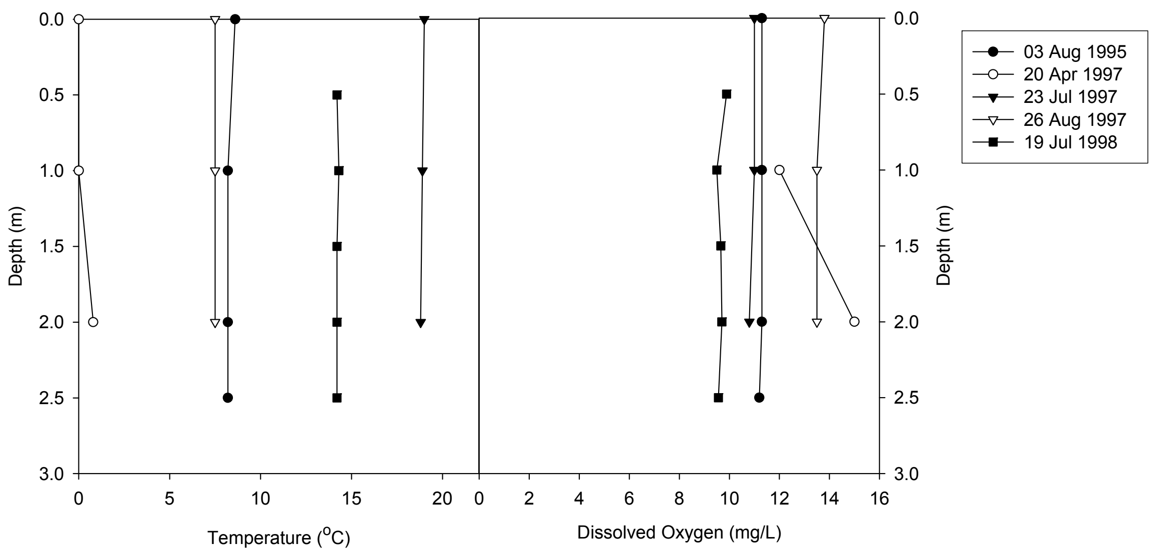


Figure 3.3 Temperature and Dissolved Oxygen Profiles in Stickleback Lake, 1995 to 1998

Stickleback Lake generally had clear water, with median TSS in summer of 3 mg/L and a maximum of 4 mg/L. On the only under-ice sampling occasion, the TSS was 4 mg/L. The turbidity values had a median summer value of 1 NTU and a maximum of 1.4 NTU. The under-ice sample was higher at 7.1 NTU (Table 3.3).

Laboratory readings of pH for Stickleback Lake ranged from pH 6.2 to 8.3. Only the minimum pH (measured in August 1995) was outside the CWQG range of pH 6.5 to 9.0 for the protection of aquatic life. While laboratory readings of pH were available for nine sampling events, the field measurements of pH were taken on three summer sampling occasions. The field pH readings were more alkaline, ranging from pH 7.9 to 8.5 and with a median of pH 8.3 (the laboratory-measured summer median was pH 7.3).

Total alkalinity ranged from 26 to 32 mg/L for the eight summer sampling events. The single under-ice value (20 April 1997 sample) for total hardness was anomalously high (98 mg/L). Using the summer values and based on the Saffran and Trew (1996) classification, Stickleback Lake has low susceptibility to acidification.

Table 3.3 Baseline Water Quality in Stickleback Lake, 1993 to 1998

Parameter	Ice Covered (April)				Ice Free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	458	-	-	1	160	116	203	7	-
pH (units)	7.1	-	-	1	7.4	***6.2***	8.3	7	6.5 – 9.0
TDS (mg/L)	266	-	-	1	110	79	141	7	-
TSS (mg/L)	4	-	-	1	3	<1	4	7	short-term increase <25; long-term increase <5
Turbidity (NTU)	7.1	-	-	1	1	0.6	1.4	7	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	140	-	-	1	48	35	63	7	-
Total Alkalinity	98			1	31	26	32	7	
Chloride	95	-	-	1	36.5	16.9	42.4	7	-
Fluoride	0.08	-	-	1	0.05	0.03	***0.14***	7	0.12
Sulphate	2	-	-	1	<1	0.3	0.3	7	-
Nutrients (mg/L)									
Dissolved Phosphorus	-	-	-	0	0.004	0.001	0.007	6	
Total Phosphorus	0.013	-	-	1	0.009	0.006	0.020	6	0.030 (jurisdictional)
Ammonia Nitrogen	-	-	-	0	0.017	0.007	0.043	6	1.23[a]
Nitrate - nitrogen	-	-	-	0	<0.005	<0.005	0.003	6	13
Nitrite - nitrogen	-	-	-	0	<0.001	<0.001	0.001	6	0.06
Total Metals (µg/L)									
Aluminum	23	-	-	1	9	<5	11	7	5 or 100[b]
Antimony	0.1			1	<0.1	<0.1	0.10	7	
Arsenic	0.8	-	-	1	0.40	<0.1	2	7	5.0
Barium	20	-	-	1	<10	<10	4	7	
Boron	-	-	-	0	-	<1.2	10	2	
Cadmium	<0.2	-	-	1	<0.2	<0.1	***0.12***	7	0.017[c]
Calcium	34 800	-	-	1	11 700	8 200	15 900	7	
Chromium	<1	-	-	1	<1	<0.3	0.50	7	1.0 or 8.9[d]
Cobalt	<1	-	-	1	<1	<0.6	0.29	7	
Copper	2	-	-	1	<1	<0.5	1.21	7	2
Cyanide	-	-	-	0	-	<5	<5	2	5
Iron	***720***	-	-	1	70	40	90	7	300
Lead	<1	-	-	1	<1	<1	***5***	7	1
Magnesium	13 600	-	-	1	4 570	3 550	5 600	7	
Manganese	343	-	-	1	6.39	<5	10	7	
Mercury	<0.01	-	-	1	<0.05	<0.05	***0.03***	6	0.026[e]
Molybdenum	<1	-	-	1	<1	<1	0.10	7	73
Nickel	<1	-	-	1	<1	<1	0.70	7	25
Potassium	4 600	-	-	1	1 670	1 420	1 800	5	
Selenium	<0.5	-	-	1	<1	<0.5	1	7	1.0

Table 3.3 Baseline Water Quality in Stickleback Lake, 1993 to 1998 (continued)

Parameter	Ice Covered (April)				Ice Free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Silicon	1 420	-	-	1	210	190	260	3	
Silver	<0.1	-	-	1	<0.05	<0.01	<0.1	7	0.1
Sodium	29 100	-	-	1	11 200	10 200	12 000	5	
Strontium	170	-	-	1	91	31	110	5	
Thallium	-	-	-	0	-	<0.03	<0.05	2	0.8
Tin	-	-	-	0	-	<0.09	0.2	2	
Titanium	-	-	-	0	-	<0.5	<0.5	2	
Tungsten	-	-	-	0	-	<0.07	<0.1	2	
Vanadium	-	-	-	0	-	<1	<1	2	
Zinc	8	-	-	1	<5	<5	1.23	7	30
Field WQ									
Temperature (°C)	-	-	-	0	12.0	8.6	13.6	3	-
Dissolved Oxygen (mg/L)	-	-	-	0	11.3	10.8	15.7	3	9.5 mg/L early life stages; 6.5 mg/L other life stages
pH (units)	-	-	-	0	8.3	7.9	8.5	3	-
Secchi (m)	-	-	-	0	2.0	-	-	1	-
Chlorophyll *a* (mg/m^3)	-	-	-	0	0.96	-	-	1	-

Note: ***italicized***, ***bold*** values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] The lowest guideline value determined for the particular temperature and pH ranges (temperature up to 20°C and pH 7.5) when ammonia nitrogen was high in Stickleback Lake (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate and nitrite) were below their CWQGs in the 1993 to 1998 samples from Stickleback Lake. TP concentrations were consistently below the 0.03 mg/L jurisdictional guideline and ranged from 0.006 to 0.020 mg/L.

The summer maximum value for fluoride (0.14 mg/L) marginally exceeded the 0.12 mg/L CWQG for protection of aquatic life.

During summer monitoring, the maximum values for total cadmium, lead and mercury exceeded their respective CWQGs. However, it is worth noting that the median values for mercury (<0.05 µg/L) and cadmium (<0.2 µg/L) correspond to method detection limits that are considerably greater than the corresponding CWQGs (0.026 µg/L for mercury; 0.017 µg/L for cadmium).

In the single under-ice sample collected from Stickleback Lake, total metal concentrations were all below the CWQG, with the exception of the total iron concentration, which was 720 µg/L – well above the 300 µg/L CWQG. In the remaining samples (all collected in the summer) iron concentrations ranged from 40 to 110 µg/L.

The under-ice sample may have been contaminated with drainage from waste rock piles or drilling activities as iron compounds (e.g., hematite) are common additives of drilling mud. This water sample also contained at least double the summer maximum concentrations of sodium, chlorine and calcium carbonate (Table 3.3), which are often added to drilling mud (McCosh and Getliff 2003). In addition, in this same under-ice sample, the conductivity, total dissolved solids and the concentrations of total silicon and total magnesium were more than double their summer maximum values. Drilling was carried out on the south-western shores of Stickleback Lake and just north of Stickleback Lake in spring 1997, but it is not known whether drainage from the drilling or rock waste entered the lake.

3.2.3 Fickle Duck Lake

Fickle Duck Lake was sampled on eight dates between August 1994 and July 1998 (Table 3.1). Temperature profiles in Fickle Duck Lake were near isothermic on the four summer sampling dates between 1995 and 1998 (Figure 3.4); the coolest profile (7.5°C) was measured on 26 Aug 1997 and the warmest (20°C) on 23 July 1997. Dissolved oxygen profiles also indicated a well mixed water column. The DO concentrations were above the 9.5 mg/L CWQG for protection of early life stages of fish in 1995 and 1997 and marginally below this guideline during the 1998 survey (Figure 3.4).

Fickle Duck Lake water clarity varied from very clear to turbid. The median ice-free TSS value was 3 mg/L and the maximum was 20 mg/L. TSS was 12 mg/L when the lake was covered with ice. The median turbidity was 3.9 NTU and the maximum was 30 NTU during the ice-free season, whereas turbidity was 19.2 NTU when the lake was covered with ice (Table 3.4). The high TSS and turbidity under ice may have resulted in accidental disturbance of the lake sediment when drilling the hole through the ice in this shallow lake.

Laboratory readings of pH for Fickle Duck Lake ranged from pH 6.1 to 8.4. The minimum pH, measured during summer, was below (outside) the CWQG range of pH 6.5 to 9.0 for protection of aquatic life. The field pH was measured on two dates only, at pH 8.0 and 8.4 (Table 3.4).

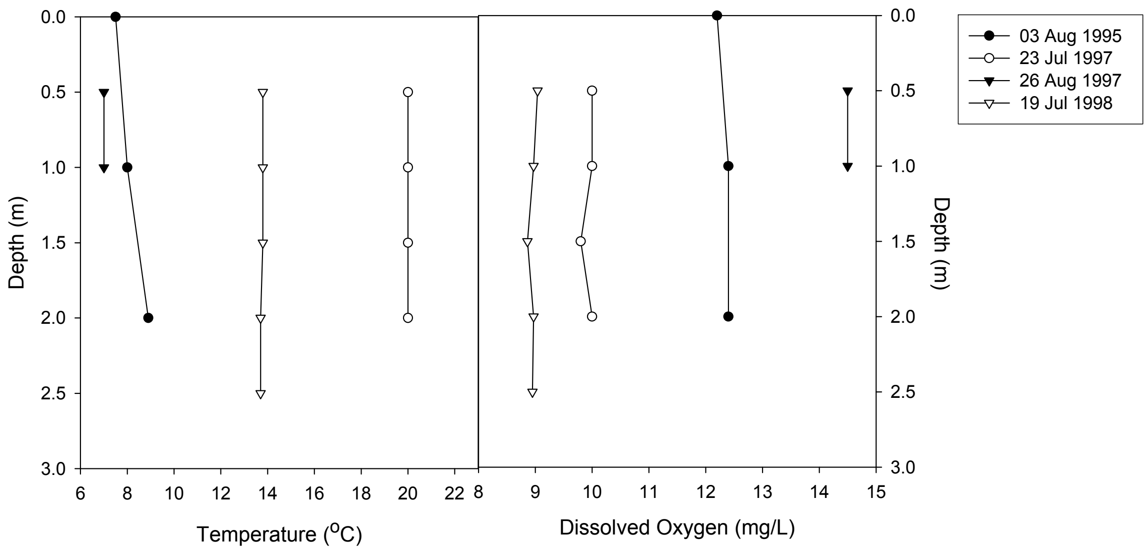


Figure 3.4 Temperature and Dissolved Oxygen Profile in Fickle Duck Lake, 1995 to 1998

Total alkalinity was measured on the eight summer dates and once under-ice. The under-ice value was anomalously high, with 107 mg $CaCO_3$/L, compared to the 18 mg $CaCO_3$/L summer maximum (Table 3.4). Using the summer values, and based on the Saffran and Trew (1996) classification, Fickle Duck Lake has moderate susceptibility to acidification.

All dissolved inorganic forms of nitrogen (ammonia, nitrate and nitrite) were below the CWQGs in Fickle Duck Lake. TP concentrations exceeded the 0.030 mg/L jurisdictional guideline once in August 1996 (0.050 mg/L) and in the single under-ice sample (0.046 mg/L) collected in April 1997.

Summer median concentration of total iron in Fickle Duck Lake was above the CWQG (Table 3.4). This corresponded to total iron exceedences occurring on four of the seven sampling dates. In addition, maximum concentrations of total aluminum, cadmium, chromium, copper, iron and lead in summer exceeded their respective CWQGs. Total lead and aluminum exceedences occurred on three of the seven sampling dates. It is noteworthy that on all summer sampling occasions, the method detection limits for cadmium and mercury were above their respective CWQGs. As such, it is possible that small-scale exceedences of the total cadmium and mercury CWQGs may have occurred undetected.

Table 3.4 Baseline Water Quality in Fickle Duck Lake, 1994 to 1998

Parameter	Ice Covered (April)				Ice Free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	352	-	-	1	63	54	89	7	-
pH (units)	6.8	-	-	1	7.1	***6.1***	8.4	7	6.5 - 9.0
TDS (mg/)	273	-	-	1	51	44	56	7	-
TSS (mg/L)	12	-	-	1	3	1	20	7	short-term increase: <25; long-term increase <5
Turbidity (NTU)	19.2	-	-	1	3.9	1.2	30	7	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($mgCaCO_3/L$)	128	-	-	1	19	8	24	7	-
Total Alkalinity ($mgCaCO_3/L$)	107	-	-	1	14	10	18	7	-
Chloride	43.9	-	-	1	10.5	7.3	17	7	-
Fluoride	0.08	-	-	1	0.05	0.03	0.08	7	0.12
Sulphate	11	-	-	1	1.1	<0.5	2.1	7	-
Nutrients (mg/L)									
Dissolved Phosphorus	-	-	-	0	0.005	0.003	0.012	6	
Total Phosphorus	***0.046***	-	-	1	0.015	0.012	***0.050***	6	0.030 (jurisdictional)
Ammonia Nitrogen	-	-	-	0	0.018	<0.005	0.020	6	0.14[a]
Nitrate - nitrogen	-	-	-	0	<0.005	<0.001	0.009	6	13
Nitrite - nitrogen	-	-	-	0	0.001	<0.001	0.002	6	0.06
Total Metals (µg/L)									
Aluminum	***260***	-	-	1	92	25	***346***	7	5 or 100[b]
Antimony	0.3	-	-	1	<0.1	<0.05	0.1	7	
Arsenic	0.8	-	-	1	0.3	0.2	1.0	7	5.0
Barium	20	-	-	1	3.6	2.0	7.1	4	
Boron	-	-	-	0	4.0	<1	8.6	4	
Cadmium	***0.6***	-	-	1	<0.2	<0.2	***0.11***	7	0.017[c]
Calcium	36 100	-	-	1	5 130	4 640	6 670	7	
Chromium	***2***	-	-	1	<1	<0.3	0.7	6	1.0 or 8.9[d]
Cobalt	<1	-	-	1	<1	<0.6	0.2	7	
Copper	***8***	-	-	1	1.6	1.0	***2.3***	7	2
Iron	***3 410***	-	-	1	***360***	110	***650***	7	300
Lead	1	-	-	1	0.2	<1	***7.0***	7	1
Lithium	-	-	-	0	1.0	<1	1.0	3	
Magnesium	10 000	-	-	1	1 610	1 460	1 970	7	
Manganese	165	-	-	1	0.4	<5	6.3	7	
Mercury	<0.01	-	-	1	<0.05	<0.05	<0.05	4	0.026[e]
Molybdenum	<1	-	-	1	<1	<0.16	0.10	7	73
Nickel	5	-	-	1	1.1	1.0	1.8	7	25
Potassium	2 770	-	-	1	440	320	650	7	
Selenium	<0.5	-	-	1	<0.5	<0.5	1	6	1.0
Silicon	9 020	-	-	1	600	430	2 310	5	
Silver	<0.1	-	-	1	<0.1	<0.01	0.04	7	0.1

Table 3.4 Baseline Water Quality in Fickle Duck Lake, 1994 to 1998 (continued)

Parameter	Ice Covered (April)				Ice Free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Sodium	20 800	-	-	1	5 240	3 380	5 690	7	
Strontium	134	-	-	1	30	16	37	7	
Thallium	-	-	-	0	<0.05	<0.03	0.05	4	0.8
Tin	-	-	-	0	0.2	<0.09	0.3	4	
Titanium	-	-	-	0	0.7	<1	18.0	4	
Tungsten	-	-	-	0		0.07	0.1	2	
Uranium	-	-	-	0		0.04	0.04	2	
Vanadium	-	-	-	0	<1	<1	1	4	
Zinc	22	-	-	1	1	<5	7	7	30
Field WQ									
Temperature (°C)	-	-	-	0	9.3	7.5	11.0	2	-
Dissolved Oxygen (mg/L)	-	-	-	0	12.7	12.2	13.2	2	9.5 mg/L early life stages; 6.5 mg/L other life stages
pH (units)	-	-	-	0	8.0	7.5	8.4	2	6.5-9.0

Note: ***italicized***, **bold** values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] The lowest guideline value determined for the particular temperature and pH ranges (temperature up to 20°C and pH 8.5) observed in Fickle Duck Lake (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

During the single under-ice sampling event (20 April 1997), six metals exceeded their CWQGs; these were total aluminum, cadmium, chromium, copper and iron. CWQG exceedences for iron were especially high for both the total (3410 µg/L) and dissolved (1660 µg/L) components. The under-ice CWQG exceedences for copper also represented the greatest copper concentrations, both total (8 µg/L) and dissolved (6 µg/L), reported for Fickle Duck Lake (Table 3.4, Appendix A5).

Similar to Stickleback Lake, the Fickle Duck Lake under-ice samples from April 1997 appeared to be contaminated with inputs/drainage from a source high in labile sodium, chlorine, calcium carbonate, potassium, magnesium, silicon and strontium (Table 3.4); however, no drilling activities had been reported in or around Fickle Duck Lake in either 1996 or 1997.

3.2.4 Reference Lake

Reference Lake was sampled on four dates between July 1997 and July 1998 (Table 3.1). Temperature profiles in Reference Lake were near isothermic on the three summer sampling dates during 1997 and 1998; the coolest profile (7.5°C) was measured in August 1997 and the warmest (20°C) on 23 July 1997 (Figure 3.5). Dissolved oxygen profiles also indicated a well mixed water column. Only on 22 July 1998, the dissolved oxygen concentrations at all depths were just below the CWQG of 9.5 mg/L for the protection of early life stages of fish. In July 1997, DO declined with depth, but remained above the 9.5 mg/L CWQG (Figure 3.5).

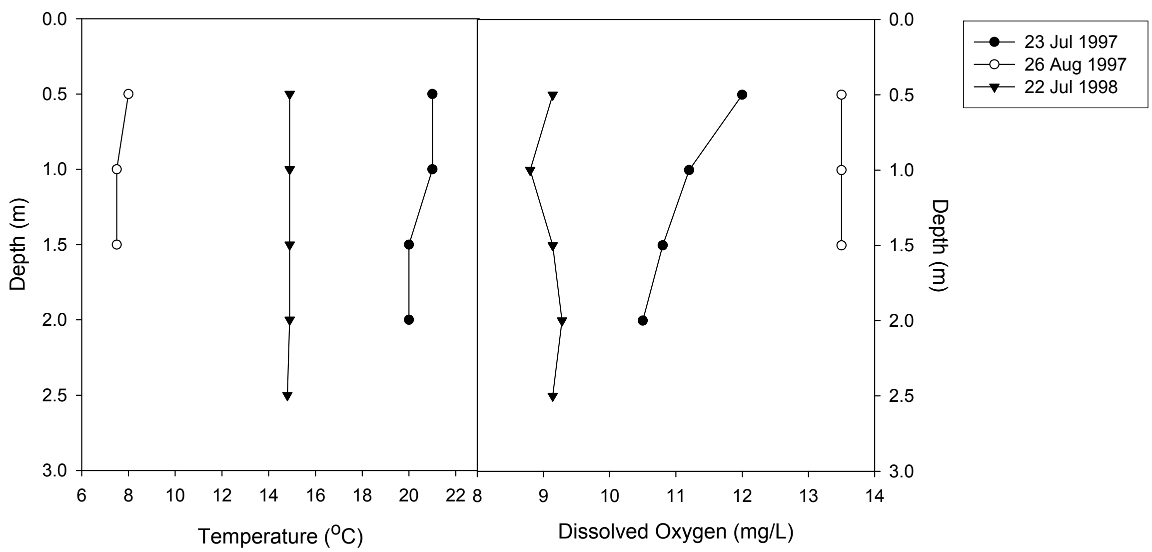


Figure 3.5 Temperature and Dissolved Oxygen Profiles in Reference Lake, 1997 and 1998

The TSS values for Reference Lake were similar in the two years (1997 and 1998) of sampling, with a summer median of 5 mg/L (Table 3.5) and an under-ice value of 4 mg/L (second replicate was contaminated with sediments and resulted in a value of 50 mg/L TSS). Turbidity levels during summer monitoring ranged from 2.0 to 3.9 NTU. Under-ice turbidity was higher, at 7.1 NTU.

Laboratory reading of pH for the single under-ice water sample was pH 7.1. No field measurements of pH were reported for Reference Lake; however, laboratory pH measurements of summer samples ranged from pH 6.6 to pH 6.9 with a median of 6.8 (Table 3.5).

Table 3.5 Baseline Water Quality in Reference Lake, 1997 to 1998

Parameter	Ice Covered (April)				Ice Free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	228	-	-	1	38	32	52	3	-
pH (units)	7.1	-	-	1	6.8	6.6	6.9	3	6.5 - 9.0
TDS (mg/L)	173	-	-	1	34	20	34	3	-
TSS (mg/L)	4	-	-	1	5	4	6	3	short-term increase:<25; long-term increase <5
Turbidity (NTU)	7.1	-	-	1	3.5	2	3.9	3	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	82	-	-	1	11.8	11.6	14.7	3	-
Total Alkalinity ($CaCO_3$)	66	-	-	1	11	9	12	3	-
Chloride	30	-	-	1	4.5	3.5	4.6	3	-
Fluoride	0.12	-	-	1	0.04	0.03	0.06	3	0.12
Sulphate	8	-	-	1	1	1	1	3	-
Nutrients (mg/L)			-						
Dissolved Phosphorus	0.002	-	-		-	0.0012	0.0012	2	
Total Phosphorus	0.018	-	-	1	-	0.008	0.021	2	0.030 (jurisdictional)
Ammonia nitrogen	0.021	-	-	1	-	0.0017	0.0135	2	1.23[a]
Nitrate - nitrogen	0.226	-	-	1	-	0.0020	0.0027	2	13
Nitrite - nitrogen	<0.001	-	-	1	-	<0.001	<0.001	2	0.06
Total Metals (µg/L)									
Aluminum	37	-	-	1	88	44	***109***	3	5 or 100[b]
Antimony	<0.1	-	-	1	<0.1	<0.1	<0.1	3	
Arsenic	0.8	-	-	1	0.2	0.2	0.3	3	5.0
Barium	20	-	-	1	<10	<10	<10	3	
Cadmium	<0.2	-	-	1	<0.2	<0.2	<0.2	3	0.017[c]
Calcium	21 600	-	-	1	3 170	3 110	3 980	3	
Chromium	***3***	-	-	1	<1	<1	<1	3	1.0 or 8.9[d]
Cobalt	<1	-	-	1	<1	<1	<1	3	
Copper	***30***	-	-	1	2	2	2	3	2
Iron	***1 840***	-	-	1	240	230	240	3	300
Lead	<1	-	-	1	<1	<1	***6***	3	1
Magnesium	6 800	-	-	1	1 000	930	1 270	3	
Manganese	150	-	-	1	6	<5	6	3	
Mercury	<0.05	-	-	1		<0.05	<0.05	3	0.026[e]
Molybdenum	<1	-	-	1	<1	<1	<1	3	73
Nickel	4	-	-	1	<1	<1	<1	3	25
Potassium	2 250	-	-	1	440	360	440	3	
Selenium	0.5	-	-	1	<0.5	<0.5	0.5	3	1.0
Silicon	3 380	-	-	1	240	240	290	3	
Silver	<0.1	-	-	1	<0.1	<0.1	<0.1	3	0.1
Sodium	17 000	-	-	1	2 490	2 130	2 650	3	

Table 3.5 Baseline Water Quality in Reference Lake, 1997 to 1998 (continued)

Parameter	Ice Covered (April)				Ice Free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Strontium	59	-	-	1	17	16	19	3	
Zinc	9	-	-	1	<5	<5	<5	3	30

Note: ***italicized***, ***bold*** values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] The lowest guideline value determined for the particular temperature and pH ranges (temperature up to 20°C and pH 7.5) when ammonia nitrogen was high in Reference Lake (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

Total alkalinity was measured on the three summer sampling occasions and once under-ice. The under-ice value obtained for 22 April 1998 was anomalously high, with 66 mg $CaCO_3$/L, compared to the 12 mg $CaCO_3$/L summer maximum (Table 3.5).

Using the summer values and based on the Saffran and Trew (1996) classification, Reference Lake has moderate to high susceptibility to acidification.

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate and nitrite) were below their respective CWQGs on the four sampling dates (Table 3.5). TP concentrations were consistently below the 0.030 mg/L jurisdictional guideline and ranged from 0.008 to 0.021 mg/L.

Fluoride concentrations in one of the two spring replicate samples reached the 0.12 mg/L guideline concentration, while in the second replicate the fluoride concentration was just below the guideline (Appendix A5).

None of the metals or trace elements in Reference Lake samples had summer median values above their CWQGs for protection of aquatic life (Table 3.5). In terms of the summer monitoring, only the maximum values for total lead and total aluminum exceeded their respective CWQGs. Similar to Fickle Duck and Stickleback Lake sample analyses, the method detection limits for cadmium and mercury were above their respective CWQGs. As such, it is possible that small-scale exceedences of the total cadmium and mercury CWQGs may have occurred undetected during the 1997-1998 monitoring period.

During the single under-ice sampling event (22 April 1998), total chromium concentration (3 µg/L) exceeded the 1 µg/L CWQG. In addition, substantial exceedences in CWQGs were found in the under-ice total copper (30 µg/L) and total iron (1840 µg/L) concentrations (Appendix A5).

Similar to the Stickleback and Fickle Duck lakes in April 1997, the April 1998 Reference Lake's under-ice water appeared to be contaminated with inputs/drainage from a source high in labile sodium, chlorine, calcium carbonate, potassium, magnesium, silicon and strontium and which resulted in a three-fold (total strontium) to 11-fold (total silicon) increase of their maximum concentrations (Appendix A5). Drainage from drilling or leaching from waste rock dumps would be expected to produce similar effects; however, no drilling had been reported in or around Reference Lake during that time.

3.2.5 Summary

Water quality data are presented for Aimaokatalok, Fickle Duck, Reference and Stickleback lakes. Aimaokatalok Lake is considerably larger and deeper than the other three lakes and its monitoring was more intensive, involving multiple sites and five years of open-water and under-ice sampling. In contrast, the other three lakes were sampled at just one site with only a single under-ice sampling event.

In summer, the four Boston area lakes were generally well-mixed; however, a defined thermocline was measured in Aimaokatalok Lake in July 1997. Winter under-ice temperatures were available only for Aimaokatalok Lake (four profiles measured on two dates) and Stickleback Lake (one profile). Similar under-ice trends were measured in both lakes. As expected, water temperature was coolest under-ice in the top 1 m of water column (0 to 0.5°C) and increased with depth to 1.5 - 2.5°C near bottom.

Consistently high and uniform dissolved oxygen concentrations were characteristic of both the under-ice and summer DO profiles for the three smaller lakes (all about 3 m deep). The upper 3 m layer of water in Aimaokatalok Lake was similarly well oxygenated on all sampling occasions. Depressed DO concentrations, falling well below the 6.5 mg/L CWQG, were recorded in bottom waters of Aimaokatalok Lake during 1998 under-ice conditions and at the deepest sampling site in July and August 1997.

Total suspended solids (TSS) typically varied between <1 and 5 mg/L in the four lakes, providing some indication of the natural fluctuation of TSS in these lakes. The closely-related turbidity typically ranged from 1 to 30 NTU.

Laboratory measurements of pH were available for nearly all sampling events at all lakes. In contrast, field measurements were not available for any sampling events at Reference Lake, and only for some of the summer sampling dates at the other three lakes. Reference Lake ranged from pH 6.6 to 7.1, not exceeding the CWQG range of pH 6.5 to 9.0. The other three lakes had more variable pH, specifically the laboratory pH ranged from 5.7 to 8.1 in Aimaokatalok Lake, the pH in Stickleback Lake ranged from 6.2 to 8.3 and the pH in Fickle Duck Lake ranged from 6.1 to 8.4 units. The pH of the three latter lakes was occasionally below the lower limit of the CWQG range.

Aimaokatalok Lake and Reference Lake had moderate to high susceptibility to acidification, as determined from Saffran and Trew (1996) classification using total alkalinity values. Total alkalinity concentrations were similar in summer and winter samples from Aimaokatalok Lake; in contrast, the single winter samples collected from the other three Boston area lakes all had anomalously high total alkalinity concentrations compared with their summer maximum values. Considering only the summer total alkalinity values, Fickle Duck Lake had moderate susceptibility to acidification whereas Stickleback Lake had the greatest total alkalinity concentrations (26 to 32 mg $CaCO_3$/L) and, correspondingly, only a low susceptibility to acidification. The anomalously high winter reading of total alkalinity from the three smaller lakes also co-occurred with some CWQG exceedences (see below for further discussion).

None of the inorganic forms of nitrogen (ammonia, nitrate and nitrite) exceeded their respective CWQGs. Total phosphorus did exceed the 30 µg/L jurisdictional guideline for Northwest Territories and Nunavut in one sample from Aimaokatalok Lake and two samples from Fickle Duck Lake. Notably, all three samples had high total suspended solid concentrations (12 to 22 mg/L), and two of these samples were collected under ice (possibly contaminated with sediments).

Metal concentrations sporadically exceeded CWQGs in all four lakes. Copper concentrations in under-ice water samples from Aimaokatalok Lake were the most common guideline exceedance (median total copper concentration was 4 µg/L compared to CWQG of 2 µg/L). No other median values for either summer or under-ice metal concentrations exceeded their respective guidelines. The maximum copper concentration in Aimaokatalok Lake was 20 µg/L. Total copper concentrations also occasionally exceeded the CWQG in Fickle Duck Lake and Reference Lake. The highest copper concentration (30 µg/L) was measured in under-ice samples from Reference Lake.

Total iron was the only metal to substantially exceed its CWQG (300 µg/L) in all four lakes on at least one occasion. The maximum total iron concentration was measured in Reference Lake, in the same sample that contained the maximum copper concentration for Boston area lakes. Total copper maxima also coincided with total iron maxima in Stickleback Lake and Fickle Duck Lake; however, in Aimaokatalok Lake the trends in total copper concentrations appeared to be unrelated to those in total iron.

Total aluminum exceedences of the 100 µg/L CWQG were most common in Aimaokatalok Lake and Fickle Duck Lake, typically occurring in water samples with higher than normal TSS concentrations. However, with the exception of high total iron concentrations in a summer sample from Aimaokatalok Lake, high turbidity did not seem to co-occur with the CWQG exceedences by the remaining, above-mentioned, metals.

Total chromium occasionally exceeded the 1.0 µg/L (Cr VI) CWQG in Aimaokatalok, Fickle Duck and Stickleback lakes. The 8.9 µg/L (Cr III) CWQG was exceeded on only one occasion (under-ice sample) at two sites in Aimaokatalok Lake. Only total and dissolved chromium analyses have been done on water quality samples, whereas the CWQGs are specifically for Cr (VI) and Cr (III). Cr (III) is the principal species found in surface waters, while Cr (VI) dominates in mildly reducing environments, such as wetlands and sediments. It is likely that Cr (III) and Cr (VI) were below the CWQGs. No other exceedences were measured in these water samples.

Total selenium exceeded the 1.0 µg/L CWQG in two water samples (collected on different dates), both from Aimaokatalok Lake. Notably, the other samples collected from Aimaokatalok Lake, on the same dates but from different sites and from the same site but at different depths, had total selenium concentrations below the CWQG.

Mercury and cadmium method detection limits were greater than their respective CWQGs for the majority of water samples collected between 1993 and 1998. Small exceedences of mercury CWQGs were noted on the odd sampling occasion in Aimaokatalok and Stickleback lakes. When lower detection limits were used, total cadmium exceeded the 0.017 µg/L CWQG on several occasions in Aimaokatalok Lake and twice in each of Fickle Duck Lake and Stickleback Lake. It is possible that small-scale exceedences of the total cadmium and mercury CWQGs may have occurred undetected during the 1993-1998 monitoring period.

The total lead 1 µg/L CWQG was sporadically exceeded in all lakes, with the overall maximum (36 µg/L) being reported for Reference Lake.

It is possible that the exceedences of CWQGs by the metal concentrations, especially of total iron in under-ice samples, were due to human activity. Aimaokatalok Lake was likely to receive some discharge from the camp site on its shores and there was also a winter road over the lake. Furthermore, Aimaokatalok, Fickle Duck, and Stickleback lakes and their shores were subjected to exploration drilling during 1992 to 1998. Some of the drilling activities may have contributed to the observed spikes in metal concentrations. In contrast, no drilling has been reported around Reference Lake, yet the 1998 under-ice sample from this lake appeared to be contaminated with inputs/drainage from a source high in sodium, chloride, calcium carbonate, potassium, magnesium, silicon, and strontium, similar to the under-ice results from Stickleback and Fickle Duck lakes in April 1997 (Appendix A5). It would be prudent (and helpful for planning of future monitoring programs) to investigate the cause of these sporadic increases in iron and associated parameters.

In general, the total number of parameters which exceeded CWQGs was about double in Aimaokatalok and Stickleback lakes compared to Fickle Duck and Reference lakes (Table 3.6).

Table 3.6 Summary of Total Metals and Other Water Quality Parameters That Exceeded CWQGs (✓) at Least Once in the Boston Area Lakes, 1993 to 1998

Lake	pH	Fluoride	TP	Al	Cd	Cr	Cu	Fe	Pb	Hg	Se
Aimaokatalok	✓	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stickleback	✓	✓	-	-	✓	-	-	✓	✓	✓	-
Fickle Duck	✓	-	✓	✓	✓	✓	✓	✓	✓	-	-
Reference	-	-	-	✓	-	✓	✓	✓	✓	-	-

3.3 STREAM WATER QUALITY

The following sections present water quality data collected at the various stream sites (lake outflows and inflows) and rivers within the Boston Project area. Analytical results for all water quality samples collected in Aimaokatalok NE Inflow, Aimaokatalok and Koignuk rivers, Aimaokatalok, Stickleback, Fickle Duck, and Reference outflows are presented in Appendix A6. Seasonal summaries of selected water quality data for each stream are presented in individual tables in the following sub-sections. The seasonal summaries were created following the same method as used for the lakes.

3.3.1 Aimaokatalok NE Inflow

Aimaokatalok NE Inflow was sampled on seven dates between August 1995 and June 1998. The field parameters (temperature, dissolved oxygen and field pH) were measured just once in August 1995.

Dissolved oxygen concentration on the one field sampling date was above the 9.5 mg/L CWQG for protection of early life stages of aquatic life.

The TSS summer median was 5 mg/L, with the range being 0 to 15 mg/L. One high TSS value (57 mg/L) collected in spring (15 June 1997) could be a direct result of freshet and the sediment associated with increased surface drainage into the stream. This was also the only occasion when turbidity (26 NTU) was considerably higher than the remaining measurements (0.6 – 6.4 NTU) (Table 3.7; Appendix A6).

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate, and nitrite) were below the CWQGs. Total phosphorus (TP) in Aimaokatalok NE Inflow was typically below the 0.030 mg/L jurisdictional guideline for Northwest Territories and Nunavut; the median summer TP value was 0.008 mg/L. One of the two collected spring samples contained a TP concentration (0.041 mg/L) in excess of the 0.030 mg/L jurisdictional guideline. This maximum value for TP was measured in the same sample that contained the maximum concentration of TSS (22 mg/L), likely originating from sediments brought in by freshet drainage into the stream (Appendix A6).

In spring, both minimum and maximum concentrations for total aluminum and iron exceeded their respective CWQGs (Table 3.7). In summer, the maximum concentrations of total aluminum, cadmium, copper, and iron exceeded their CWQG for the protection of aquatic life. All aluminum and iron exceedences occurred on the same sampling dates, in both spring and summer. The cadmium exceedence occurred on the only date when there were no aluminum or iron exceedences. The only metals for which median concentrations exceeded the CWQG in summer were aluminum and iron. There was no clear association of the metal exceedences of the CWQGs with other measured water quality parameters (Appendix A6).

3.3.2 Aimaokatalok Outflow

Water quality samples were collected from Aimaokatalok Outflow in May, June and August 1998. Field parameters were not measured during sampling.

Table 3.7 Baseline Water Quality in Aimaokatalok NE Inflow, 1992 to 1998

Parameter	Ice Covered (April to June)				Ice free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	-	44	57	2	78	63	105	5	-
pH (units)	-	***6.3***	6.7	2	6.8	***5.7***	7.0	5	6.5 – 9.0
TDS (mg/L)	-	26	43	2	56	50	75	5	-
TSS (mg/L)	-	2	57	2	6	<1	15	5	short-term increase <25; long-term increase <5
Turbidity (NTU)	-	4.7	26.3	2	6.3	0.6	6.4	5	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	-	11	11	2	16	13	20	5	-
Total Alkalinity ($CaCO_3$)	-	7	9	2	12	6	13	5	-
Chloride	-	8	10	2	14.3	8.7	19	5	-
Fluoride	-	0.03	0.05	2	0.06	0.04	0.1	5	0.12
Sulphate	-	<1	1	2	2	1.2	2	5	-
Nutrients (mg/L)									
Dissolved Phosphorus	0.009	-	-	1	0.006	0.001	0.016	5	-
Total Phosphorus	***0.041***	-	-	1	0.024	0.015	0.026	5	0.030 (jurisdictional)
Ammonia Nitrogen	0.035	-	-	1	0.020	<0.005	0.185	5	1.23[a]
Nitrate - nitrogen	0.006	-	-	1	0.006	<0.005	0.010	5	13
Nitrite - nitrogen	0.005	-	-	1	0.001	<0.001	0.011	5	0.06
Total Metals (µg/L)									
Aluminum	-	***177***	***368***	2	***155***	29	***231***	5	5 or 100[b]
Antimony	-	<0.1	<0.1	2	<0.1	<0.05	0.1	5	
Arsenic	-	0.2	0.3	2	0.6	0.4	2.0	5	5.0
Barium	-	<10	<10	2	<10	2.0	5.9	5	
Beryllium	-	<5	<5	2	0.5	<0.5	0.5	5	
Bismuth	-	-	-	0	<0.5	<0.5	0.07	3	
Boron	-	-	-	0	4	<1	8	3	
Cadmium	-	<0.2	<0.2	2	<0.2	<0.05	***0.14***	5	0.017[c]
Calcium	-	2 140	2 260	2	3 300	2 580	3 840	5	
Chromium	-	<1	1	2	0.5	<1	0.7	4	1.0 or 8.9[d]
Cobalt	-	<1	<1	2	0.1	<0.1	0.1	5	
Copper	-	1	1	2	2	0.5	***2.7***	5	2
Iron	-	***430***	***990***	2	***470***	220	***780***	5	300
Lead	-	<1	<1	2	0.1	0.2	0.2	5	1
Lithium	-	-	-	0	-	<1	1	2	
Magnesium	-	1 500	1 620	2	2 010	1 750	2 750	5	
Manganese	-	10	33	2	13	4	33	5	
Mercury	<0.05	-	-	1	-	<0.05	<0.05	2	0.026[e]
Molybdenum	-	<1	<1	2	0.16	0.10	0.16	5	73
Nickel	-	<1	<1	2	0.7	<1	1.8	5	25
Potassium	-	520	910	2	890	670	920	5	

Table 3.7 Baseline Water Quality in Aimaokatalok NE Inflow, 1992 to 1998 (continued)

Parameter	Ice Covered (April to June)				Ice free (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Selenium	-	<0.5	<0.5	2	<0.5	<0.5	<0.5	3	1.0
Silicon	-	560	1 010	2	440	380	2 570	4	
Silver	-	<0.1	<0.1	2	<0.1	<0.01	0.06	5	0.1
Sodium	-	4 050	4 530	2	7 500	4 410	9 840	5	
Strontium	-	14	20	2	20	15	29	5	
Thallium	-	-	-	0	<0.05	<0.05	0.05	3	0.8
Tin	-	-	-	0	0.2	<0.1	0.7	3	
Titanium	-	<10	20	2	2.2	1	9	3	
Tungsten	-	-	-	0	0.1	-	-	1	
Uranium	-	-	-	0	0.04	0.03	0.05	2	
Vanadium	-	-	-	0	1	<1	1	3	
Zinc	-	<5	<5	2	6	<5	***31***	5	30
Field WQ									
Temperature (°C)	-	-	-	0	11.9	-	-	1	-
Dissolved Oxygen (mg/L)	-	-	-	0	11.9	-	-	1	9.5 mg/L early life stages; 6.5 mg/L other life stages
pH (units)	-	-	-	0	7.1	-	-	1	6.5 - 9.0

Note: ***italicized***, ***bold*** values exceed guidelines.

TDS = total dissolved solids.

TSS = total suspended solids.

[a] Guideline value determined for the most ammonia – sensitive conditions likely to occur in Aimaokatalok NE Inflow (temperature 15°C and pH 8.5) (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).Field pH ranged from 5.7 to 7.0 pH units (Table 3.7). Laboratory measurements of pH in the Aimaokatalok NE Inflow water samples were below the pH 6.5 CWQG on two of the seven sampling dates. However, the laboratory pH measurements showed some inconsistencies. For instance, the minimum pH value for Aimaokatalok NE Inflow was measured on 1 August 1995; replicate samples yielded pH 5.7 and 5.9 in the laboratory, whereas the field pH of the same sampling site was pH 7.1. Total alkalinity was typically low, ranging from 5.3 to 20.3 mg/L with the summer median of 12 mg/L and spring median of 8.6 mg/L.

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

The TSS concentrations ranged from 1 to 4 mg/L, and the turbidity measurements similarly indicated clear waters, with values ranging from 1.0 to 2.5 NTU. Laboratory pH values ranged from pH 6.7 to 6.9, which is within the CWQG range of pH 6.5 to 9.0. Total alkalinity was low, ranging from 6 to 9 mg/L $CaCO_3$ (Table 3.8).

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate, and nitrite) were below the CWQGs. Total phosphorus in Aimaokatalok Outflow was measured on one occasion (0.001 mg/L) and it was well below the 0.030 mg/L jurisdictional guideline for Northwest Territories and Nunavut (Table 3.8).

Table 3.8 Baseline Water Quality in Aimaokatalok Outflow, May to August 1998

Parameter	Spring (May and June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)		36	57	2	36	-	-	1	-
pH (units)		6.7	6.9		6.9	-	-	1	6.5 – 9.0
TDS (mg/L)		19	38	2	35	-	-	1	-
TSS (mg/L)		1	4	2	2	-	-	1	short-term increase <25; long-term increase <5
Turbidity (NTU)		1.0	2.5	2	1.1	-	-	1	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)		9.5	13.8	2	10.0	-	-	1	
Total Alkalinity ($CaCO_3$)		6.0	9.0	2	6.0	-	-	1	
Chloride		6.1	8.8	2	5.7	-	-	1	
Fluoride		0.02	0.07	2	0.03	-	-	1	0.12
Sulphate		1	2	2	1	-	-	1	
Nutrients (mg/L)									
Dissolved Phosphorus	0.008			1	-	-	-	-	0.030 (jurisdictional)
Total Phosphorus	0.001			1	-	-	-	-	
Ammonia Nitrogen	0.008			1	-	-	-	-	0.19[a]
Nitrate	0.045			1	-	-	-	-	13
Nitrite	<0.001			1	-	-	-	-	0.06
Total Metals (µg/L)									
Aluminum		12	80	2	26	-	-	1	5 or 100[b]
Antimony		<0.1	<0.1	2	<0.1	-	-	1	
Arsenic		0.1	0.2	2	0.1	-	-	1	5.0
Barium		<10	<10	2	<10	-	-	1	
Cadmium		<0.2	<0.2	2	<0.2	-	-	1	0.017[c]
Calcium		2 180	2 850	2	1 970				
Chromium		<1	<1	2	<1	-	-	1	1.0 or 8.9[d]
Cobalt		<1	<1	2	<1				
Copper		1	***3***	2	<1	-	-	1	2
Iron		30	180	2	70	-	-	1	300
Lead		<1	<1	2	<1	-	-	1	1
Magnesium		1 200	1 700	2	1 200				
Manganese		<5	17	2	7	-	-	1	
Mercury		<0.05	<0.05	2	<0.05	-	-	1	0.026[e]
Molybdenum		<1	<1	2	<1	-	-	1	73
Nickel		<1	<1	2	<1	-	-	1	25
Potassium		630	750	2	590				
Selenium		<0.5	<0.5	2	0.8	-	-	1	1.0
Silicon		300	400	2	210				
Silver		<0.1	<0.1	2	<0.1	-	-	1	0.1
Sodium		3 500	4 430	2	3 120	-	-	1	

Table 3.8 Baseline Water Quality in Aimaokatalok Outflow, May to August 1998 (continued)

Parameter	Spring (May and June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Strontium		14	19	2	20	-	-	1	
Zinc		<5	<5	2	<5	-	-	1	30

Note: ***italicized***, ***bold*** values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] Guideline value determined for the most ammonia – sensitive conditions likely to occur in Aimaokatalok Ouflow (temperature 15°C and pH 8.5) (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

Metal concentrations were below the CWQGs for the protection of aquatic life with the exception of total copper, which exceeded the 2 µg/L guideline with a concentration of 3 µg/L in June 1998. The detection limits for mercury and cadmium were above their CWQGs (Table 3.8); therefore, it is possible that small exceedences of the guidelines may have occurred in mercury and total cadmium concentrations without being detected.

3.3.3 Aimaokatalok River

Aimaokatalok River was sampled on five occasions between June 1997 and June 1998. Field parameters were not measured on any of the sampling dates.

The TSS concentrations typically varied between <1 and 4 mg/L, with the exception of one under-ice sample where the TSS was measured at 19 mg/L. This same sample had a turbidity of 4.1 NTU, whereas on remaining dates the turbidity was much lower (ranged from 0.4 to 1.3 NTU). On two sampling dates, the laboratory pH values (pH 6.1 and 6.3) were below (outside) the CWQG range of pH 6.5 to Ph 9.0. In the remaining Aimaokatalok River samples, the pH ranged from 6.5 to 6.9. Total alkalinity was low, with an overall median concentration of 5 mg/L $CaCO_3$ (Table 3.9).

Table 3.9 Baseline Water Quality in Aimaokatalok River, 1997 to 1998

Parameter	Spring (May and June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	34	19	75	3	-	27	37	2	-
pH (units)	6.7	***6.1***	6.9	3	-	***6.3***	6.5	2	6.5 - 9.0
TDS (mg/L)	23	11	52	3	-	18	20	2	-
TSS (mg/L)	4	<1	19	3	-	<1	2	2	short-term increase <25; long-term increase <5
Turbidity (NTU)	1.3	0.4	4.1	3		0.8	1.0	2	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	7.5	5.7	22.0	3	-	6.7	7.8	2	-
Total Alkalinity ($CaCO_3$)	6	4	14	3	-	5	5	2	-
Chloride	4.6	3.2	10.2	3	-	4.3	4.6	2	-
Fluoride	0.03	0.03	0.09	3	-	0.03	0.05	2	0.12
Sulphate	1	<1	3	3	-	1	1	2	-
Nutrients (mg/L)									
Dissolved Phosphorus	-	0.002	0.004	2	-	0.002	0.002	2	-
Total Phosphorus	-	0.012	0.013	2	-	0.004	0.006	2	0.030 (jurisdictional)
Ammonia Nitrogen	-	0.022	0.023	2	-	0.023	0.041	2	0.57[a]
Nitrate - nitrogen	-	0.020	0.077	2	-	0.015	0.017	2	13
Nitrite - nitrogen	-	0.001	0.004	2	-	0.003	0.010	2	0.06
Total Metals (µg/L)									
Aluminum	32	25	***74***	3	-	14	***17***	2	5 or 100[b]
Antimony	<0.1	<0.1	<0.1	3	-	<0.1	<0.1	2	-
Arsenic	0.2	0.1	0.2	3	-	<0.1	0.1	2	5.0
Barium	<10	<10	<10	3	-	<10	<10	2	-
Cadmium	<0.2	<0.2	<0.2	3	-	<0.2	<0.2	2	0.017[c]
Calcium	1 350	1 100	4 990	3	-	1 290	1 480	2	
Chromium	<1	<1	<1	3	-	<1	<1	2	1.0 or 8.9[d]
Cobalt	<1	<1	<1	3	-	<1	<1	2	
Copper	1	<1	2	3	-	<1	1	2	2
Iron	240	120	***550***	3	-	90	170	2	300
Lead	<1	<1	<1	3	-	<1	<1	2	1
Magnesium	1 010	700	2 300	3	-	870	1 040	2	
Manganese	34	<5	57	3	-	<5	<5	2	-
Mercury	-	<0.05	<0.05	2	<0.05			1	0.026[e]
Molybdenum	<1	<1	<1	3	-	<1	<1	2	73
Nickel	<1	<1	1	3	-	<1	<1	2	25
Potassium	640	370	1 970	3	-	430	510	2	
Selenium	<0.5	<0.5	<0.5	3	-	<0.5	<0.5	2	1.0
Silicon	520	150	550	3	-	100	110	2	

Table 3.9 Baseline Water Quality in Aimaokatalok River, 1997 to 1998 (continued)

Parameter	Spring (May and June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Silver	<0.1	<0.1	<0.1	3	-	<0.1	<0.1	2	0.1
Sodium	2 200	1 520	4 420	3	-	2 260	2 280	2	
Strontium	15	8	17	3	-	13	14	2	
Zinc	<5	<5	<5	3	-	<5	<5	2	30

Note: ***italicized***, ***bold*** values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] Guideline value determined for the most ammonia – sensitive conditions likely to occur in Aimaokatalok River (temperature 15°C and pH 8.0) (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate and nitrite) were below the CWQGs. Similarly, total phosphorus in Aimaokatalok River was below the 0.03 mg/L jurisdictional guideline for Northwest Territories and Nunavut (Table 3.9).

Total metal concentrations were below the CWQGs for the protection of aquatic life, with the exception of aluminum and iron. Total aluminum exceeded the CWQG (5 µg/L when pH<6.5) once in a spring sample (74 µg/L) and once in the summer (17 µg/L) (Table 3.9). Total iron exceeded the 300 µg/L guideline, with a concentration of 550 µg/L in June 1997. The spring samples with total iron and total aluminum concentrations exceeding the CWQGs, also had an unusually high TSS concentration (19 mg/L); therefore, it is possible that the sample was contaminated with sediments.

The detection limits for mercury (0.05 µg/L) and cadmium (0.2 µg/L) were above their respective CWQGs (0.026 µg/L for mercury and 0.017 µg/L for cadmium); therefore, it is possible that small exceedences of the guidelines may have occurred in mercury and cadmium concentrations without being detected.

3.3.4 Stickleback Outflow

Stickleback Outflow was sampled on 12 occasions between August 1992 and June 1998. Field parameters were measured on two sampling dates: 1 August 1994 and 31 July 1995. The outflow's temperatures were measured at 8.0°C in July 1995 and 9.2°C in August 1994. On the July 1995 sampling occasion, dissolved oxygen concentration was 6.3 mg/L, which is just below the 6.5 mg/L CWQG for protection of aquatic life. The stream was well oxygenated (DO was 14.9 mg/L) on the other sampling occasion.

The TSS concentrations ranged from 0 to 6 mg/L, and turbidity was generally low, between 0.6 and 6.3 NTU (Table 3.10).

On two sampling dates, the laboratory measured pH value for Stickleback Outflow was outside the CWQG range of pH 6.5 – 9.0; the measurements were pH 5.8 and 6.4. The laboratory result of pH 5.8 had the corresponding field measurement of pH 6.9 (within the CWQG range). In the remaining Stickleback Outflow samples, the pH ranged from 7.1 to 8.1 (Appendix A6).

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate, and nitrite) were below the CWQGs. Total phosphorus in Stickleback Outflow did not exceed the 0.030 mg/L jurisdictional guideline for Northwest Territories and Nunavut (Table 3.10).

Total aluminum exceeded the 5 µg/L CWQG when pH<6.5 on one sampling date in July 1995. The total concentrations of copper and iron exceeded their respective CWQGs on one summer sampling occasion each (on different dates). The total copper concentration exceedance was 3 µg/L and only slightly above the 2 µg/L CWQGs (Table 3.10). In contrast, the total iron concentration of 1640 µg/L was considerably above the 300 µg/L CWQG. In the same sample, the total calcium and magnesium concentrations were also unusually high (Appendix A6).

The cadmium and mercury detection limits (0.2 µg/L and 0.05 µg/L, respectively) were above their CWQGs (0.017 µg/L for total cadmium and 0.026 µg/L for mercury). Therefore, it is possible that small exceedences of the guidelines may have occurred in mercury and total cadmium concentrations without being detected.

3.3.5 Fickle Duck Outflow

Fickle Duck Outflow was sampled on 12 occasions between August 1992 and June 1998. Field parameters were measured on two sampling dates: 1 August 1994 and 31 July 1995. The outflow’s temperatures were measured at 6.0°C in July 1995 and 8.8°C in August 1994. Dissolved oxygen concentrations did not fall below the 6.5 mg/L CWQG for protection of aquatic life. On one occasion, DO (8.2 mg/L) was measured below the 9.5 mg/L CWQG for protection of early life stages of aquatic life.

Table 3.10 Baseline Water Quality in Stickleback Outflow, 1992 to 1997

Parameter	Spring (June)				Summer (August and September)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	126	92	202	4	175	35	284	8	-
pH (units)	7.1	7.0	7.2	4	7.2	***5.8***	8.1	8	6.5 - 9.0
TDS (mg/L)	92	58	119	4	119	28	130	7	-
TSS (mg/L)	2	<1	4	3	2	<1	6	6	short-term increase: <25; long-term increase <5
Turbidity (NTU)	1.0	0.9	1.3	4	1.5	0.6	6.3	8	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	38	23	59	4	49	9	64	8	-
Total Alkalinity ($CaCO_3$)	30	14	41	4	31	6	53	8	-
Chloride	21	15	37	3	36	17	41	7	-
Fluoride	0.04	0.03	0.05	3	0.05	0.03	0.09	7	0.12
Sulphate	<1	<1	2.3	4	0.3	<0.5	2.0	8	-
Nutrients (mg/L)									
Dissolved Phosphorus	-	0.005	0.008	2	0.002	<0.001	0.008	7	-
Total Phosphorus	0.012	0.008	0.020	3	0.008	0.004	0.022	7	0.030 (jurisdictional)
Ammonia Nitrogen	0.150	<0.005	0.020	3	0.027	<0.005	0.390	7	0.572[a]
Nitrate - nitrogen	<0.005	<0.005	0.010	3	0.013	<0.005	0.025	7	13
Nitrite - nitrogen	<0.001	<0.001	0.006	3	<0.001	<0.001	0.001	7	0.06
Total Metals (µg/L)									
Aluminum	13	6	15	3	25	<1	43	6	5 or 100[b]
Antimony	<0.1	<0.05	<0.1	3	<0.2	<0.05	0.1	6	-
Arsenic	0.2	<2	0.3	3	0.4	<1	3.0	7	5.0
Barium	<10	3	<10	4	5.0	4.3	5.2	7	-
Beryllium	<5	<0.5	<5	4	<5	<0.5	1.7	7	
Bismuth	<0.5	-	-	1	<0.5	<0.03	0.06	4	
Boron	6	-	-	1	17	15	32	4	-
Cadmium	<0.2	***0.09***	<10	4	<0.2	<0.05	***0.12***	7	0.017[c]
Calcium	8 960	5 920	14 300	4	13 400	2 080	20 300	7	-
Chromium	<1	<1	0.60	3	0.5	<1	0.9	5	1.0 or 8.9[d]
Cobalt	<1	0.20	<1	3	0.500	<0.1	0.880	6	
Copper	<1	<1	0.5	3	0.7	0.2	***3.0***	7	2
Iron	78	50	170	4	101	30	***1 640***	7	300
Lead	<1	<0.05	<1	3	0.4	0.1	1.0	7	1
Lithium	<10	2	<15	4	<10	2	63	6	
Magnesium	3 700	2 330	5 460	4	5 050	982	10 300	7	
Manganese	71	13	207	4	10	<5	317	7	-
Mercury	<0.05	-	-	1	<0.05	<0.05	<0.05	3	0.026[e]
Molybdenum	<1	<0.05	<1	3	0.1	<0.05	<1	7	73
Nickel	<1	<1	0.5	3	<1	0.1	2.6	6	25
Potassium	950	830	1 530	3	1 490	1 250	2 140	6	
Selenium	<0.5	<0.5	<0.5	3	<0.5	<0.5	1	5	1.0
Silicon	180	150	510	3	250	90	380	5	
Silver	<0.1	<0.01	<0.1	3	0.030	<0.01	<0.1	6	0.1
Sodium	8 740	5 000	13 700	4	11 200	2 400	18 500	7	-
Strontium	43	23	70	4	59	6	93	7	-
Thallium	<0.05	-	-	1	<0.05	<0.03	<0.05	4	
Tin	<0.1	-	-	1	<0.1	<0.1	0.2	4	

Table 3.10 Baseline Water Quality in Stickleback Outflow, 1992 to 1997 (continued)

Parameter	Spring (June)				Summer (August and September)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Titanium	<10	<1	<10	4	<10	<1	6	7	
Tungsten	-	-	-	0	-	0.08	0.10	2	
Uranium	<0.01	-	-	1	-	<0.01	0.05	2	-
Vanadium	<1	-	-	1	<1	<1	1	4	
Zinc	<5	<5	1	4	<5	<1	7	7	30
Field WQ									
Temperature (°C)	-	-	-	-	-	8	9.2	2	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	***6.3***	14.9	2	9.5 mg/L early life stages; 6.5 mg/L other life stages
pH (units)	-	-	-	-	-	6.9	8.1	2	6.5 - 9.0

Note: italicized, bold values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] Guideline value determined for the most ammonia – sensitive conditions likely to occur in Stickleback Outflow (temperature 15°C and pH 8) (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

The TSS concentrations were variable, ranging from 1 to 74 mg/L. The outflow was more turbid in summer, with both the TSS and turbidity medians being greater than in spring (Table 3.11). The related turbidity measurement ranged from 2 to 40 NTU suggesting that large fluctuations in TSS and turbidity may be common in Fickle Duck Outflow.

On two sampling dates, the laboratory measured pH values for the outflow were pH 5.7 and 6.3 (i.e., outside of the CWQG range of pH 6.5 to 9.0). The laboratory measurement of pH 5.7 corresponded to the field measurement of pH 6.7 (within the CWQG range). In the remaining Fickle Duck Outflow samples, the laboratory measured pH ranged from 6.6 to 7.2.

Table 3.11 Baseline Water Quality in Fickle Duck Outflow, 1992 to 1998

Parameter	Spring (June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	38	34	43	4	68	33	200	8	-
pH (units)	6.9	***6.3***	7.1	4	6.8	***5.7***	7.2	8	6.5 - 9.0
TDS (mg/L)	24	19	32	4	57	27	160	8	-
TSS (mg/L)	1	1	10	3	12	2	74	6	short-term increase: <25; long-term increase <5
Turbidity (NTU)	2.4	2.2	5.9	4	6.5	1.9	40.0	8	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	13	9	14	4	19	9	72	8	-
Total Alkalinity ($CaCO_3$)	10	9	12	4	15	5	79	8	-
Chloride	3	3	4	3	10	8	23	7	-
Fluoride	0.03	0.02	0.04	3	0.05	0.03	0.08	7	0.12
Sulphate	2	<1	3	4	1	1	2	8	-
Nutrients (mg/L)									
Dissolved Phosphorus	-	0.008	0.008	2	0.006	0.001	0.018	7	-
Total Phosphorus	0.016	0.015	0.016	3	0.017	0.010	***0.039***	7	0.030 (jurisdictional)
Ammonia Nitrogen	0.015	0.012	0.030	3	0.100	<0.005	0.397	7	2.6[a]
Nitrate - nitrogen	<0.005	<0.005	0.002	3	<0.005	<0.001	0.006	7	13
Nitrite - nitrogen	<0.001	<0.001	0.007	3	0.002	<0.001	0.010	7	0.06
Total Metals (µg/L)									
Aluminum	72	65	***136***	3	***102***	43	***387***	6	5 or 100[b]
Antimony	<0.1	<0.05	<0.1	3	<0.1	<0.05	0.1	6	-
Arsenic	0.1	<1	0.2	3	0.3	<1	2.0	7	5.0
Barium	<10	<10	2.5	3	4.5	<10	7.7	6	-
Beryllium	<0.5	-	-	1	<0.5	<0.5	0.5	4	-
Bismuth	<0.5	-	-	1	<0.5	<0.03	0.09	4	-
Boron	4	-	-	1	8	<1	11	4	-
Cadmium	<0.2	<0.05	<0.2	3	<0.2	<0.05	***0.140***	7	0.017[c]
Calcium	3 830	2 860	4 020	4	5 540	1 840	28 300	7	-
Chromium	<1	<1	1	3	0.7	<1	1.0	5	1.0 or 8.9[d]
Cobalt	<1	<0.1	<1	3	0.3	<0.1	1.0	6	-
Copper	1	1	1	3	2.0	0.9	***3.5***	7	2
Iron	231	210	***390***	4	***580***	76	***2 320***	7	300
Lead	<1	<1	0.1	3	<1	<0.5	0.3	7	1
Lithium	<10	<1	<10	3	-	<1	1	2	-
Magnesium	974	863	1 000	4	1 830	995	9 560	7	-
Manganese	1	<5	9	4	6	<5	118	7	-
Mercury	<0.05	-	-	1	<0.05	<0.05	<0.05	3	0.026[e]
Molybdenum	<1	<1	0.1	3	<1	<0.16	0.230	7	73
Nickel	<1	<1	0.6	3	1.5	0.8	3.3	6	25
Potassium	290	270	720	3	570	360	3 030	6	-

Table 3.11 Baseline Water Quality in Fickle Duck Outflow, 1992 to 1998 (continued)

Parameter	Spring (June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Selenium	<0.5	<0.5	<0.6	3	<0.5	<0.5	1.0	5	1.0
Silicon	470	340	830	3	500	277	2 590	5	-
Silver	<0.1	<0.01	<0.1	3	0.01	<0.1	0.06	6	0.1
Sodium	2 160	1 740	2 500	4	4 620	2 400	9 430	7	-
Strontium	12	10	23	4	28	6	67	7	-
Thallium	<0.05	-	-	1	<0.05	<0.03	<0.05	4	0.8
Tin	<0.1	-	-	1	0.10	<0.09	<0.1	4	-
Titanium	1	-	-	1	3	1	21	4	-
Tungsten	-	-	-	0	-	0.07	0.10	2	-
Uranium	<0.01	-	-	1	-	<0.01	0.050	2	-
Vanadium	<1	-	-	1	0.5	<1	1.0	4	-
Zinc	<5	<5	2	4	2	<5	5	7	30
Field WQ									
Temperature (°C)	-	-	-	-	-	6.0	8.8	2	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	***8.2***	12.4	2	9.5 mg/L early life stages; 6.5 mg/L other life stages
pH (units)	-	-	-	-	-	6.7	6.8	2	-

Note: ***italicized***, ***bold*** values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] Guideline value determined for the most ammonia – sensitive conditions likely to occur in Fickle Duck Outflow (temperature 10°C and pH 7.5) (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

Total alkalinity was generally low, ranging from 5 to 18 mg $CaCO_3$/L, with the exception of one measurement (79 mg $CaCO_3$/L) made in August 1994.

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate, and nitrite) were below the CWQGs. Total phosphorus exceeded the 0.03 mg/L jurisdictional guideline for Northwest Territories and Nunavut on two sampling dates in August 1996. These two exceedences coincided with high turbidity values, which also exceeded the CWQGs. This may have been due to sediment and TP contributions from surface drainage following rainfall events.

The total concentrations of four metals (aluminum, cadmium, copper, and iron) exceeded their respective CWQGs for the protection of aquatic life. The cadmium and copper exceedences occurred on one sampling date each and were only slightly above the CWQGs (Table 3.11). In contrast, the aluminum and iron exceedences, when present, were more substantial and occurred in four of 12 samples for aluminum and in six of 12 samples for iron. The total cadmium exceedance coincided with the greatest TSS and turbidity values, whereas the total copper and the greatest total iron (2320 µg/L) exceedances occurred in the same August 1994 sample with the unusually high total alkalinity (79 mg/L). All samples with a total aluminum exceedence also had total a iron exceedence, but did not appear to be related to TSS.

The mercury analyses were conducted for only four of the samples and with 0.05 µg/L detection limits (higher than the 0.026 µg/L CWQG). The cadmium detection limits for all but two samples were above the CWQG (0.017 µg/L); therefore, it is possible that small exceedences of the guidelines may have occurred in mercury and total cadmium concentrations without being detected. All metal exceedences in Fickle Duck Outflow were also reported for Fickle Duck Lake (there were two more metal exceedences in the lake).

3.3.6 Koignuk River

Koignuk River was sampled on four occasions between June 1998 and September 2000. Field parameters were not measured on any of the sampling dates.

The TSS concentrations ranged from 2 to 12 mg/L in Koignuk River. The related measure of turbidity yielded measurements from 2 to 36.3 NTUs (Table 3.12). Factors such as colour of water were possibly responsible for the greater increases in turbidity, more so than TSS (CCME 2007).

The laboratory measured pH for the river ranged from 6.9 to 7.4 pH units, remaining within the CWQG range of pH 6.5 to 9.0. Total alkalinity was low, ranging from 8 to 15 mg $CaCO_3$/L (Table 3.12).

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate, and nitrite) were below the CWQGs. Total phosphorus in Koignuk River exceeded the 0.030 mg/L jurisdictional guideline for Northwest Territories and Nunavut in one spring sample, with a TP concentration of 0.051 mg/L (Table 3.12).

The total concentrations of four metals (aluminum, chromium, copper, and iron) exceeded their respective CWQGs for the protection of aquatic life. Both the chromium and copper exceedences occurred once, on the same sampling date, and were only slightly above their respective CWQGs (Table 3.12). In contrast, the aluminum and iron exceedences were substantial, and occurred on three of

Table 3.12 Baseline Water Quality in Koignuk River, 1998 to 2000

Parameter	Spring (June)				Summer (August and September)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	-	61	90	2	-	65	169	2	-
pH (units)	-	6.9	7.2	2	-	6.8	7.4	2	6.5 - 9.0
TDS (mg/L)	-	47	74	2	-	48	101	2	-
TSS (mg/L)	-	10	12	2	-	2	6	2	short-term increase <25; long-term increase <5
Turbidity (NTU)	-	10.4	36.3	2	-	3.2	8.5	2	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness (CaCO3)	-	16.2	22.7	2	-	13.7	36.4	2	-
Total Alkalinity	-	9	11	2	-	8	14	2	-
Chloride	-	9.1	14.9	2	-	14.9	35	2	-
Fluoride	-	0.04	0.09	2	-	0.05	0.06	2	0.12
Sulphate	-	2	4	2	-	2	9	2	-
Nutrients (mg/L)									
Dissolved phosphorus	0.007	-	-	1	-	-	-	1	-
Total phosphorus	***0.051***	-	-	1	0.014	-	-	1	0.030 (jurisdictional)
Ammonia nitrogen	-	0.02	0.031	2	0.011	-	-	1	0.19[a]
Nitrate - nitrogen	-	0.009	0.012	2	<0.005	-	-	1	13
Nitrite - nitrogen	-	0.001	0.001	2	<0.001	-	-	1	0.06
Total Organic Carbon	6.5	-	-	1	5.7	-	-	1	
Total Metals (µg/L)									
Aluminum	-	***429***	***1 400***	2	-	100	***282***	2	5 or 100[b]
Antimony	-	<0.05	<0.1	2	-	<0.1	<0.05	2	-
Arsenic	-	0.20	0.4	2	-	0.30	0.30	2	5.0
Barium	-	6.40	20	2	-	<10	6.23	2	-
Beryllium		<0.5	<5	2		<0.5	<5	2	-
Bismuth	<0.5	-	-	1	<0.5	-	-	1	-
Boron	-	<100	5	2	-	<100	8	2	-
Cadmium	-	<0.05	<0.2	2	-	<0.05	<0.2	2	0.017[c]
Calcium	-	3 450	4 070	2	-	2 610	6 630	2	-
Chromium	-	0.9	***3.0***	2	-	<1	0.7	2	1.0 or 8.9[d]
Cobalt	-	<1	0.3	2	-	<1	0.2	2	-
Copper	-	2	***3***	2	-	1	2	2	2
Iron	-	***560***	***1 200***	2	-	140	***360***	2	300
Lead	-	0.24	<1	2	-	<1	0.23	2	1
Lithium	1	-	-	1	2	-	-	1	-
Magnesium	-	1 900	3 100	2	-	1 700	4 800	2	-
Manganese	-	24	41	2	-	9	12	2	-
Mercury	-	<0.05	<0.05	2	-	<0.05	<0.05	2	0.026[e]

Table 3.12 Baseline Water Quality in Koignuk River, 1998 to 2000 (continued)

Parameter	Spring (June)				Summer (August and September)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Molybdenum	-	<1	0.06	2	-	<1	0.09	2	73
Nickel	-	1.1	2	2	-	<1	0.9	2	25
Potassium	-	<2 000	1 940	2	-	650	1 350	2	-
Selenium	-	<1	0.5	2	-	0.6	<1	2	1.0
Silver	-	<0.1	0.02	2	-	<0.01	<0.1	2	0.1
Sodium	-	5 000	9 000	2	-	6 000	14 900	2	-
Strontium	22	-	-	1	24	-	-	1	-
Titanium	70	-	-	1	<10	-	-	1	-
Uranium	0.05	-	-	1	0.05	-	-	1	-
Vanadium	<1	-	-	1	<1	-	-	1	-
Zinc		<5	2	2	-	<5	2	2	30

Note: italicized, bold values exceed guidelines

TDS = total dissolved solids.

TSS = total suspended solids.

[a] Guideline value determined for the most ammonia – sensitive conditions likely to occur in Koignuk River (temperature 15°C and pH 8.5) (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

the four sampling dates. On the one sampling occasion when the four metals were measured at their highest concentrations, turbidity and TSS were both high (Table 3.12). One possibility is that the sample was contaminated with sediments. In addition, the analytical method detection limits for cadmium and mercury were above their respective CWQGs (Table 3.12); therefore, it is possible that small exceedences of the guidelines may have occurred in mercury and total cadmium concentrations in Koignuk River without being detected.

3.3.7 Reference Outflow

Reference Outflow was sampled on five occasions between July 1997 and August 1998. Field parameters were not measured on any of the sampling dates.

The TSS concentrations ranged from <1 to 4 mg/L. The related measure of turbidity was similarly low (Table 3.13). The laboratory measured pH for the outflow ranged from 6.5 to 6.8 pH units, remaining within the CWQG range of pH 6.5 to 9.0. Total alkalinity was low, ranging from 8 to 13 mg $CaCO_3$/L (Table 3.13).

Table 3.13 Baseline Water Quality in Reference Outflow, 1997 to 1998

Parameter	Spring (June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Physical									
Conductivity (µS/cm)	-	27	37	2	39	38	56	3	-
pH (units)	-	6.6	6.7	2	6.8	6.7	6.8	3	6.5 – 9.0
TDS (mg/L)	-	15	38	2	32	32	34	3	-
TSS (mg/L)	-	<1	4	2	3	3	4	3	short-term increase <25; long-term increase <5
Turbidity (NTU)	-	1.8	3.1	2	2.9	2.4	3.5	3	short-term increase <8; long-term increase <2
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	-	10.4	12.0	2	14.8	12.7	17.4	3	-
Total Alkalinity ($CaCO_3$)	-	8.0	10.0	2	12.0	11.0	13.0	3	-
Chloride	-	3.0	3.4	2	4.1	3.0	4.6	3	-
Fluoride	-	0.02	0.03	2	0.06	0.03	0.07	3	0.12
Sulphate	-	<1	1	2	1	1	2	3	-
Nutrients (mg/L)									
Dissolved Phosphorus	0.007	-	-	1	-	<0.001	0.001	2	-
Total Phosphorus	0.026	-	-	1	-	0.008	0.016	2	0.030 (jurisdictional)
Ammonia Nitrogen	<0.005	-	-	1	-	0.132	0.184	2	1.78[a]
Nitrate - nitrogen	<0.005	-	-	1	-	0.003	0.004	2	13
Nitrite - nitrogen	0.002	-	-	1	-	0.001	0.001	2	0.06
Total Metals (µg/L)									
Aluminum	-	38	85	2	47	42	***133***	3	5 or 100[b]
Antimony	-	<0.1	<0.1	2	<0.1	<0.1	<0.1	3	-
Arsenic	-	0.2	0.4	2	0.4	0.4	0.5	3	5.0
Barium	-	<10	<10	2	<10	<10	<10	3	-
Beryllium	-	<5	<5	2	<5	<5	<5	3	-
Cadmium	-	<0.2	<0.2	2	<0.2	<0.2	<0.2	3	0.017[c]
Calcium	-	2 830	3 160	2	4 010	3 570	4 660	3	
Chromium	-	<1	<1	2	<1	<1	<1	3	1.0 or 8.9[d]
Cobalt	-	<1	<1	2	<1	<1	<1	3	
Copper	-	1	2	2	2	2	2	3	2
Iron	-	140	***410***	2	***320***	280	***420***	3	300
Lead	-	<1	<1	2	<1	<1	<1	3	1
Magnesium	-	800	1 000	2	1 200	990	1 410	3	
Manganese	-	<5	158	2	6	6	13	3	-
Mercury	-	<0.05	<0.05	2	-	<0.05	<0.05	2	0.026[e]
Molybdenum	-	<1	<1	2	<1	<1	<1	3	73
Nickel	-	<1	<1	2	<1	<1	<1	3	25
Potassium	-	320	2450	2	370	350	510	3	
Selenium	-	<0.5	<0.5	2	<0.5	<0.5	0.6	3	1.0

Table 3.13 Baseline Water Quality in Reference Outflow, 1997 to 1998 (continued)

Parameter	Spring (June)				Summer (July and August)				Guidelines for Protection of Aquatic Life
	Median	Min	Max	n	Median	Min	Max	n	
Silicon	-	290	330	2	230	200	520		
Silver	-	<0.1	<0.1	2	<0.1	<0.1	<0.1	3	0.1
Sodium	-	1 610	1 680	2	2 370	2 200	2 620	3	-
Strontium	-	6	15	2	19	16	20	3	
Zinc	-	<5	7	2	<5	<5	<5	3	30

Note: italicized, bold values exceed guidelines.

TDS = total dissolved solids.

TSS = total suspended solids.

[a] Guideline value determined for the most ammonia – sensitive conditions likely to occur in Reference Outflow (temperature 15°C and pH 7.5) (CCME 2007).

[b] 5 µg/L CWQG when pH<6.5; 100 µg/L CWQG when pH≥6.5.

[c] Values compared to guideline corrected for hardness.

[d] 1.0 µg/L CWQG for Cr (VI), 8.9 µg/L interim CWQG for Cr (III).

[e] As CCME (2007) does not provide a guideline for total mercury, this guideline is for inorganic mercury.

All of the dissolved inorganic forms of nitrogen (ammonia, nitrate, and nitrite) were below the CWQGs. Total phosphorus in Reference Outflow was measured on three of the sampling dates, and did not exceed the 0.030 mg/L jurisdictional guideline for Northwest Territories and Nunavut (Table 3.13).

The concentrations of total aluminum and iron exceeded their respective CWQGs for the protection of aquatic life. Total aluminum exceeded its 100 µg/L CWQG on one occasion (August 1997) when its concentration reached 133 µg/L. Total iron concentrations were above the 300 µg/L CWQG on three sampling dates (Table 3.13). In addition, the analytical method detection limits for cadmium (<0.2 µg/L) and mercury (<0.05 µg/L) were above their CWQGs, therefore, it is possible that small exceedences of the guidelines may have occurred in mercury and total cadmium concentrations in Reference Outflow without being detected.

3.3.8 Summary

Water quality data are presented for Aimaokatalok NE Inflow, Aimaokatalok Outflow, Aimaokatalok River, Stickleback Outflow, Fickle Duck Outflow, Koignuk River, and Reference Outflow. The largest water quality datasets (n = 12, collected between 1992 and 1998) are available for Fickle Duck and Stickleback outflows.

Field parameters (DO, pH, and temperature) were measured only in Aimaokatalok NE Inflow (on three dates), Fickle Duck Outflow and Stickleback Outflow (on two dates each) during open-water conditions. The stream temperatures ranged from 6 to 11.9°C, and the streams were well oxygenated, with only one DO concentration in Stickleback Lake falling marginally below the 6.5 mg/L CWQG for protection of coldwater aquatic life.

The clarity of the stream and river sites, as represented by TSS and turbidity, was more variable than that of the lake sites. Overall, the TSS ranged from <1 to 74 mg/L, and the turbidity ranged from 0.4 to 40 NTU.

Field measurements of pH were similar (though not the same) to the laboratory measurements of pH (available for nearly all sampling events). On a few occasions, the pH in Aimaokatalok NE Inflow and River, Stickleback Outflow and Fickle Duck Outflow was below (outside) the CWQG range of pH 6.5 to 9.0; however, most of the samples had a pH close to neutral.

Total alkalinity of the flowing waters was similar to the Boston area lakes. Stickleback Outflow typically had the highest mean values (30 and 31 mg $CaCO_3$/L total alkalinity for spring and summer, respectively). Aimaokatalok River had the lowest values (total alkalinity between 4 and 14 mg $CaCO_3$/L). Anomalously high total alkalinity (and other parameters such as conductivity, hardness, and total iron) were measured in August 1994 water quality samples from Stickleback and Fickle Duck outflows (total alkalinity of 53 and 79 mg $CaCO_3$/L, respectively). Such sporadic and major spikes in these parameters were also observed in the lakes, though on different dates.

None of the inorganic forms of nitrogen (ammonia, nitrate, and nitrite) exceeded their respective CWQGs. TP was generally below the 0.030 mg/L jurisdictional guidelines for Northwest Territories and Nunavut except one sample from each of Aimaokatalok NE Inflow (0.041 mg/L) and Koignuk River (0.051 mg/L) and two samples from Fickle Duck Outflow (0.039 mg/L and 0.036 mg/L). Notably, all of these samples also had the highest turbidity values (all exceeding CWQGs) for the particular site.

In all seven flowing waters sampled in the Boston area, exceedences of CWQG occurred for at least one metal (Table 3.14). Overall, total aluminum and total iron comprised the greatest and most frequent exceedences of CWQGs (up to 1400 µg/L of total aluminum in Koignuk River and up to 2320 µg/L of total iron in Fickle Duck Outflow). Only in Aimaokatalok Outflow were both aluminum and iron concentrations below the CWQGs, whereas Aimaokatalok River was the only other flowing site where aluminum (but not iron) was also below the CWQG. Similar to the lake sites, additional exceedences of CWQGs occurred for cadmium, chromium, copper, and lead. Total zinc also exceeded the 30 µg/L CWQG at Aimaokatalok NE Inflow (but not at any of the lake sites). In contrast to the lake samples, no exceedences of CWQGs occurred for mercury or selenium.

Table 3.14 Summary of Total Metals and Other Water Quality Parameters That Exceeded CWQGs (✓) at Least Once in the Boston Area Streams and River Sites, 1992 to 2000

Site	pH	TP	Al	Cd	Cr	Cu	Fe	Zn
Aimaokatalok NE Inflow	✓	✓	✓	✓	✓	✓	✓	✓
Aimaokatalok Outflow	-	-	-	-	-	✓	-	-
Aimaokatalok River	✓	-	✓	-	-	-	✓	-
Stickleback Outflow	✓	-	✓	✓	-	✓	✓	-
Fickle Duck Outflow	✓	✓	✓	✓	-	✓	✓	-
Koignuk River	-	✓	✓	-	✓	✓	✓	-
Reference Outflow	-	-	✓	-	-	-	✓	-

Mercury and cadmium method detection limits were greater than their respective CWQGs for the majority of water samples collected between 1992 and 2000. Therefore, it is possible that small-scale CWQG exceedences of the total cadmium and mercury may have occurred undetected during the 1992 to 2000 monitoring period.

3.4 MARINE WATER QUALITY

3.4.1 Hope Bay

Marine water quality samples were collected from three sites in Hope Bay on 23 August 1997 and 21 July 1998. Analytical results for individual samples are presented in Appendix A7.

Temperature and dissolved oxygen profiles were measured only in July 1998 at the three sampling stations (Figure 3.6). On 21 July 1998, the upper 3 m of water column were warmest, with temperatures ranging from 7.1 to 11.3°C. At the deepest station, the temperature gradually declined to 0.5°C at 7.5 m. The water column was well oxygenated, with DO ranging from 9.5 mg/L near water surface to 11 mg/L at 7.5 m (the cooler temperatures near the bottom increase the capacity of water to carry dissolved oxygen).

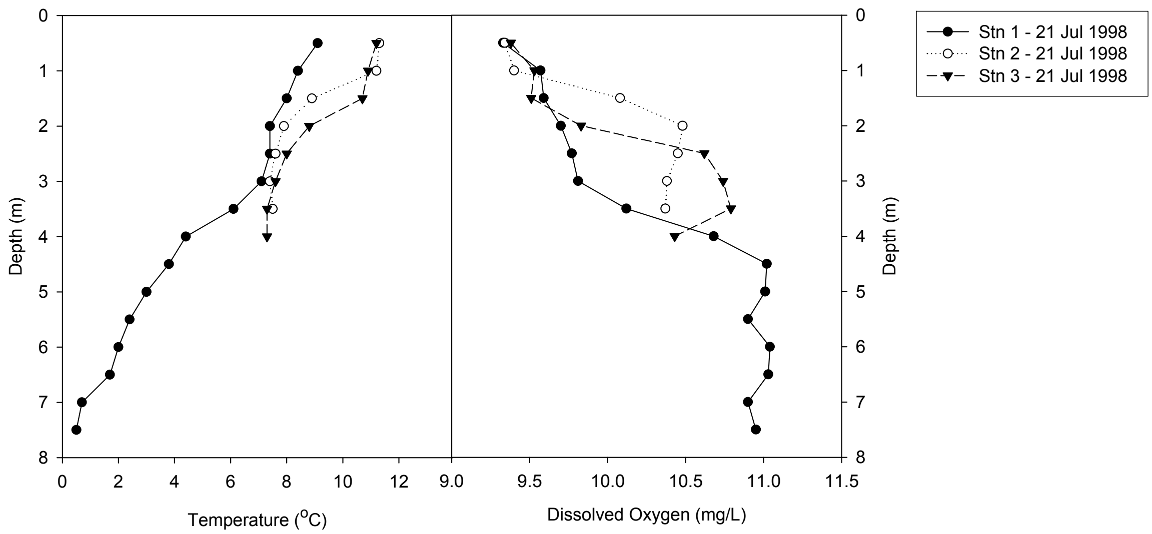


Figure 3.6 Temperature and Dissolved Oxygen Profiles in Hope Bay, 1998

The TSS concentration ranged from 2 to 21 mg/L; the turbidity was less variable, ranging from 0.5 to 2.6 NTU (Table 3.15).

Table 3.15 Baseline Water Quality in Hope Bay, August 1997 and July 1998

Parameter	Ice Free (July and August)				Guidelines for Protection of Marine Aquatic Life[a]
	Median	Min	Max	n	
Physical					
Conductivity (µmhos/cm)	34 100	15 300	48 800	7	-
pH (units)	7.9	7.4	7.9	7	7.0 - 8.7
Total Dissolved Solids (mg/L)	21 700	11 900	25 600	7	-
Total Suspended Solids (mg/L)	10	2	21	7	-
Turbidity (NTU)	1.5	0.5	2.6	7	-
Salinity (‰)	19	10	20	3	
Dissolved Anions (mg/L)					
Hardness ($CaCO_3$)	3 860	2 030	4 430	7	-
Total Alkalinity ($CaCO_3$)	90	60	103	7	-
Chloride	11 600	6 310	14 800	7	-
Fluoride	0.54	0.28	0.70	7	-
Sulphate	1 330	630	1 590	7	-
Nutrients (mg/L)					
Dissolved Phosphorus	0.011	0.005	0.018	4	-
Total Phosphorus	0.021	0.018	0.028	4	-
Ammonia	0.006	0.004	0.010	4	-
Nitrate - nitrogen	0.001	0.001	0.004	4	16[b]

Table 3.15 Baseline Water Quality in Hope Bay, August 1997 and July 1998 (continued)

Parameter	Ice Free (July and August)				Guidelines for Protection of Marine Aquatic Life[a]
	Median	Min	Max	n	
Nitrite - nitrogen	<0.001	<0.001	0.001	4	-
Dissolved Metals (µg/L)					
Antimony	<0.2	<0.1	<0.2	8	-
Arsenic	0.6	0.4	1.0	8	12.5
Cadmium	0.03	0.02	0.04	8	0.12
Calcium	237 000	128 000	287 000	8	
Chromium	<1	<1	<1	8	1.5 or 56[c]
Cobalt	<0.05	<0.05	<0.05	8	
Copper	0.64	0.49	0.81	8	-
Iron	<10	<10	10	8	-
Lead	0.11	<0.05	0.4	8	-
Magnesium	779 000	415 000	903 000	8	
Manganese	1.57	0.95	1.88	8	-
Mercury	0.01	<0.01	***0.02***	8	0.016[d]
Molybdenum	6.5	4.0	9.0	8	-
Nickel	0.57	0.51	0.71	8	-
Selenium	<0.5	<0.5	<0.5	8	2
Silver	<1	<1	<1	8	-
Uranium	1.00	0.59	1.62	8	-
Zinc	0.5	<0.5	2.3	8	-

[a] Marine Guidelines for protection of Aquatic Life (CWQGs) are for total metal concentrations.
[b] Interim guideline for protection from direct toxic effects.
[c] Interim 1.5 µg/L guideline for Cr(VI) and 56 µg/L interim guideline for Cr(III).
[d] Interim guideline may not fully protect high trophic level fish.

Metal analyses in Hope Bay were done only for dissolved metals, for which there are no specific CWQGs; CWQGs exist only for total metal concentrations. Total metal concentrations are either equal to or greater than that of dissolved metals; therefore, if dissolved metal concentrations exceed the CWQGs for total metals, it can be considered an exceedance of the CWQG. Dissolved metal concentrations in Hope Bay were below the CWQG, with the exception of mercury, which was measured at 0.02 µg/L on one occasion. The mercury CWQG for marine waters is 0.016 µg/L. The lower precision of the maximum mercury result for Hope Bay compared to the guideline (two decimal places vs three decimal places) means that it is impossible to determine whether the maximum mercury concentration (0.02 µg/L) was the same as, just above, or just below (e.g., 0.015 µg/L) the CWQG guideline (Table 3.15).

4 SEDIMENT QUALITY

This section presents information on baseline sediment quality conditions for Boston area lakes. The information presented is based on data from annual data reports (Rescan 1994, 1997, and 1998).

Sediment quality data were collected in the summer months of 1993, 1996, and 1997. Due to small sample sizes, summary statistics were not calculated. The results are discussed in the following sections in terms of individual station data.

4.1 METHODS

4.1.1 Sampling Locations and Timing

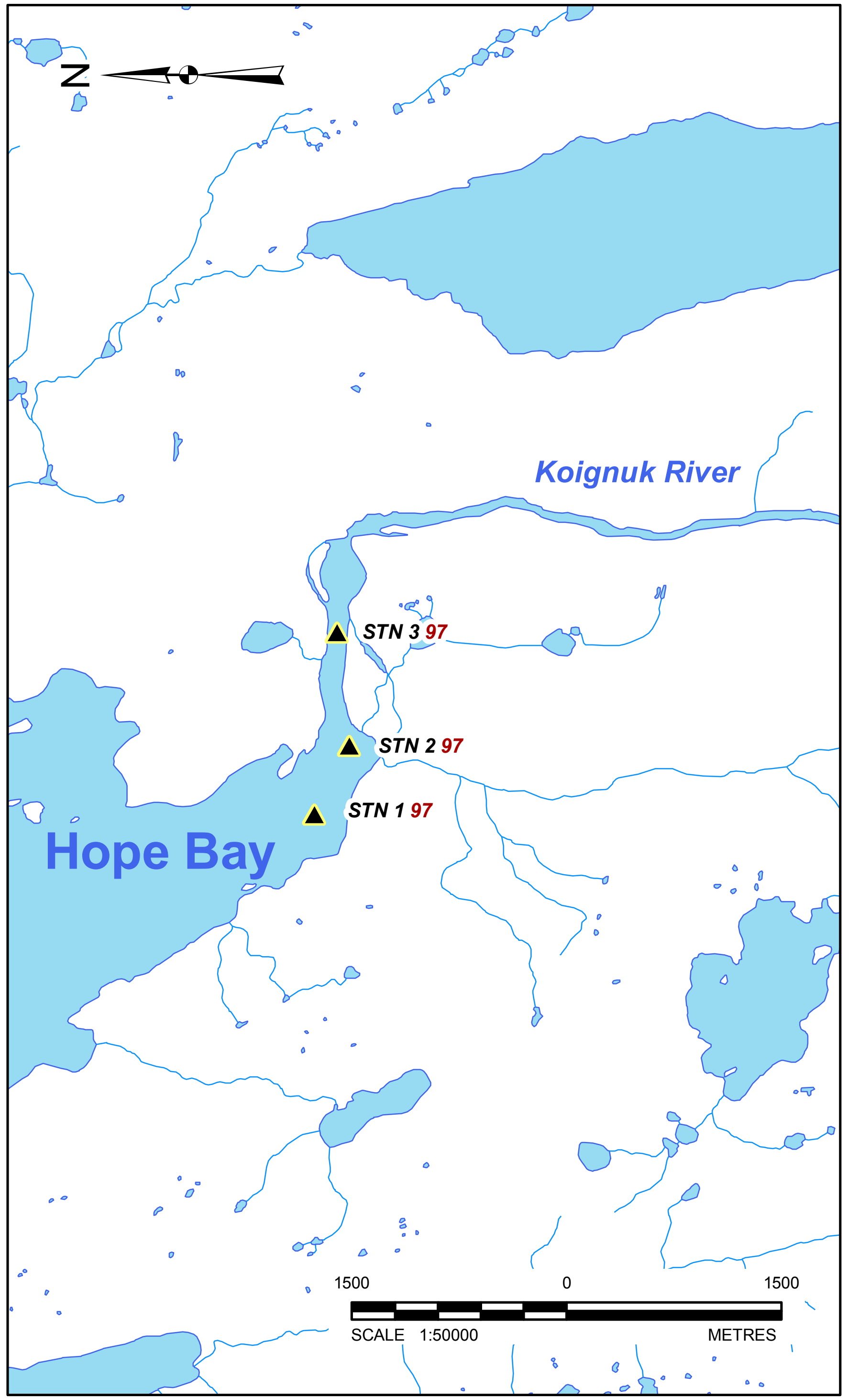
Sediment sampling locations are shown in Figure 4.1 and Table 4.1. Detailed sampling methods are included in the annual reports (Rescan 1994, 1997, and 1998) and summarized in Appendix A1.

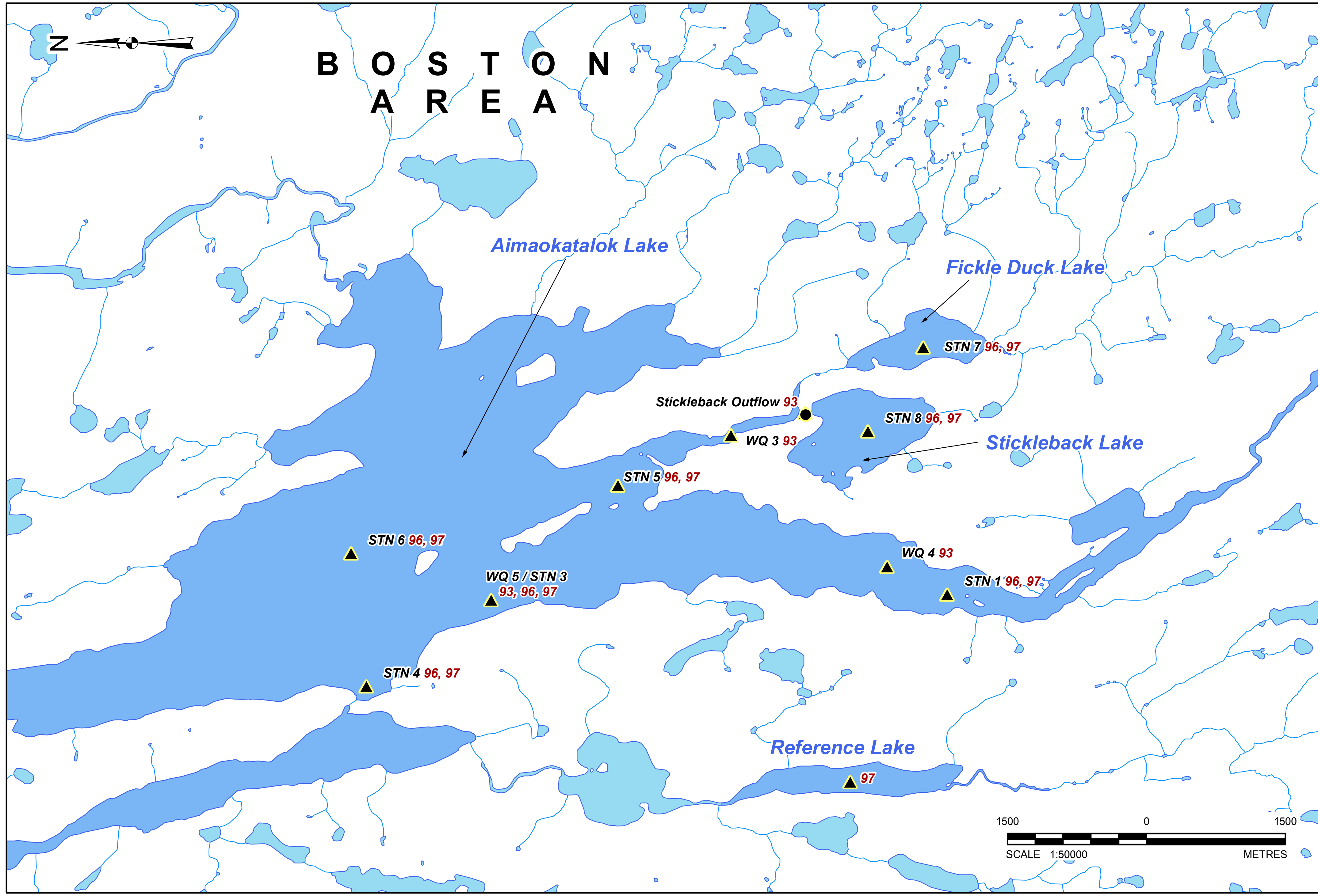
Table 4.1 Years of Sediment Sampling in Boston Area Lakes, Outflows, and Hope Bay, 1993 to 1997

Waterbody	Summer 1993	Summer 1996	Summer 1997
Aimaokatalok Lake	√	√	√
Stickleback Lake		√	√
Fickle Duck Lake		√	√
Fickle Duck Outflow	√		
Reference Lake			√
Hope Bay			√

Sediment samples were collected in the lakes during the summer sampling season (i.e., July and August). Bottom sediment samples were collected using an Ekman grab sampler from the deepest parts of the lakes at the same sites used for water quality sampling. Collected sediment grabs were sub-sampled (top 2 to 3 cm) for analysis of various physical and chemical parameters. In addition, sediment grabs were visually examined in the field in 1996 and 1997 for colour, texture, grain size and presence/absence of biota.

Project: N:\GIS\Projects\2006\1373\027\MapDocs\4.1_Boston_Hope_Bay_Areas.mxd Plot: N:\GIS\Projects\2006\1373\027\MapDocs\4.1_Boston_Hope_Bay_Areas.pdf



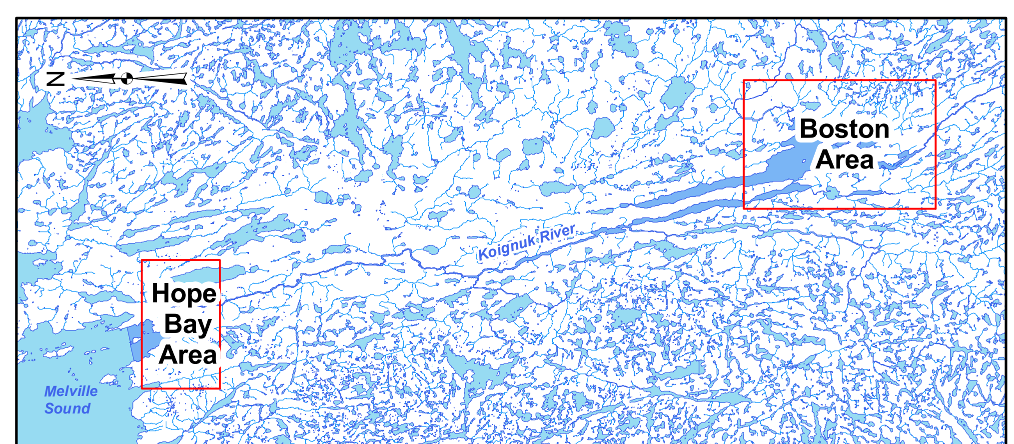


LEGEND

▲	Lake/marine sampling locations	*WQ X / STN X*	Sampling station names from Rescan reports
●	Stream sampling locations	*95-97*	Consecutive years of sampling at station
	Rivers		
	Study area waterbodies		
	Waterbodies		

REFERENCE

Sources: Data Obtained from the Government of Canada, Natural Resources Canada, Centre for Topographic Information
Projection: UTM Zone 13N Datum: NAD 83



MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

Sediment Sampling Locations, 1993 - 1997

Golder Associates
Edmonton, Alberta

PROJECT No.06-1373-028			SCALE AS SHOWN	REV. 0
DESIGN	JP	22 April 2008		
GIS	RC	23 April 2008		
CHECK	JP	14 May 2008		
REVIEW	GA	16 May 2008		

FIGURE: 4.1

Baseline marine sediment quality sampling also was conducted in Hope Bay, which is the final receiving waterbody of drainage from the Aimaokatalok Lake watershed. Samples were collected in August 1997 at three marine stations within Hope Bay. In general, methods used for the collection of marine samples were similar to those used for lake sampling (Appendix A1).

4.1.2 Laboratory Analytical Methods

Sediment quality samples were analysed for moisture content, total organic carbon (TOC), and solid phase metals. Analytical detection limits are presented in Table 4.2.

Table 4.2 Detection Limits for Sediment Quality Analysis, 1993 to 1997

Parameter (units)		1993[a]	1996[b]	1997[c]
Physical Parameters	Moisture (%)	n.s.	n.s.	0.1
Organic Parameters	Total Organic Carbon	n.s.	n.s.	0.05
Total Metals	Aluminum (mg/kg)	n.s.	n.a.	50
	Antimony (mg/kg)	0.05	0.05	n.a.
	Arsenic (mg/kg)	n.s.	n.s.	0.05
	Cadmium (mg/kg)	0.1	0.05	0.1
	Colbalt (mg/kg)	n.s.	n.s.	2.0
	Copper (mg/kg)	n.s.	n.s.	1.0
	Chromium (mg/kg)	n.s.	n.s.	2.0
	Iron (mg/kg)	n.s.	n.s.	50
	Lead (mg/kg)	n.s.	n.s.	2.0
	Manganese (mg/kg)	n.s.	n.s.	1.0
	Mercury (mg/kg)	0.005	0.05	0.005
	Nickel (mg/kg)	n.s.	n.s.	2.0
	Selenium (mg/kg)	0.1	0.5	0.1
	Silver (mg/kg)	0.1	n.s.	0.1
	Zinc (mg/kg)	n.s.	n.s	1.0

[a] Detection limits not reported in Rescan (1994).
[b] Detection limits in Rescan (1997).
[c] Detection limits in Rescan (1998).
n.s. = detection limit not specified; n.a. = parameter not analyzed.

It should be noted that analytical methodologies and detection limits used for some parameters varied from year to year, largely because of different laboratories that were involved in the analyses, including Elemental Research Inc. in 1996 and Analytical Service Laboratories in 1997.

4.2 LAKE SEDIMENT QUALITY

Baseline sediment quality information for the various sampled waterbodies including Aimaokatalok, Stickleback, Fickle Duck and Reference lakes, and

Stickleback Outflow are presented in the following sections (Figure 4.1). Sediment samples collected in the various waterbodies are described based on visual characteristics including colour, texture, and grain size. Metal concentrations in sediments are compared with the Canadian Interim Sediment Quality Guidelines for the Protection of Aquatic Life (CISQG) (CCME 2007) to assess whether background sediment metal concentrations are within recommended ranges. The CISQG recommends using two guidelines in assessing sediment quality. The first, referred to as the Threshold Effect Level (TEL), is the concentration below which adverse effects are rare. The second, referred to as the Probable Effect Level (PEL), is the concentration above which adverse effects are likely to occur. This recommended procedure was followed in this report.

4.2.1 Aimaokatalok Lake

Sediments consisted primarily of clay and fine sand particles. The interfacial layer was dark reddish-brown, whereas the underlying upper layer was greenish grey or brownish yellow (Rescan 1998). The TOC concentration was low compared to most of the other study lakes, ranging from 0.3 to 1.9% dry weight (Table 4.3). The concentration of total arsenic (0.8 to 60 mg/kg) was often above the CISQG PEL and occasionally above the CISQG TEL. Similarly, total chromium (21.7 to 98.5 mg/kg) was often above the CISQG PEL and occasionally above the CISQG TEL (Table 4.3). Profile sub-sampling carried out in 1996 and 1997 indicated that total metal concentrations in the interfacial and near-surface layers were essentially indistinguishable (Table 4.3).

4.2.2 Stickleback Lake

The sediments from Stickleback Lake were soft clays or mud. The TOC concentration in the two 1996 samples (0.6 and 0.8% dry weight) were only slightly higher than TOC values in Aimaokatalok Lake. Metal concentrations in these two samples were below CISQG TEL values. A sample collected in 1997 was considerably different than the samples collected in 1996. In 1997, sediments had a TOC concentration of 18.6%. Additionally, total arsenic (5.9 mg/kg) and copper (41 mg/kg) were slightly above CISQC TEL values, but well below CISQC PEL values (Table 4.3).

Table 4.3 Sediment Chemistry in Boston Area Lakes, 1993 to 1997

Parameter	Aimaokatalok Lake							CISCQ	
Date	**1993**	**1993**	**1993**	**23-Aug-96**		**23-Aug-96**		**TEL**	**PEL**
Site	**WQ3**	**WQ4**	**WQ5**	**Stn 1**		**Stn 3**			
Depth of sample	-	-	-	1 m		12 m			
Sediment layer	-	-	-	0 - 1 cm	1 - 3 cm	0 - 1 cm	1 - 3 cm		
Moisture (%)	-	-	-	48.2	30.3	71.6	64.8		
Total Organic Carbon (%)	0.8	0.5	1.3	0.6	0.5	0.8	0.7		
Total Metals (mg/kg)									
Aluminum	63 400	59 600	75 200	-	-	-	-		
Antimony	0.1	<0.05	0.19	<0.05	<0.05	0.29	0.06		
Arsenic	1	1	11	4	1	15	60	6	17
Barium	690	619	794	-	-	-	-		
Cadmium	<0.10	<0.10	<0.10	<0.05	<0.05	0.28	0.16	0.6	3.5
Calcium	18 700	18 900	13 400	-	-	-	-		
Chromium	62.5	21.7	87.0	26.7	21.8	72.3	85.6	37.3	90
Cobalt	10.1	4.3	72.3	6.4	3.2	31.1	19.4		
Copper	19.4	4.3	26.1	8.4	6.8	26.4	27.2	35.7	197
Iron	25 600	15 600	66 400	35 100	13 100	105 000	96 600		
Lead	6.9	2.9	11.5	3.9	3.2	10.0	10.8	35.0	91.3
Magnesium	10 700	5 800	14 900	-	-	-	-		
Manganese	376	333	6 710	522	129	21 800	3 230		
Mercury	<0.005	<0.005	0.023	<0.05	<0.05	<0.05	<0.05	0.17	0.486
Molybdenum	<1.0	<1.0	14	-	-	-	-		
Nickel	19.7	6.1	33.9	10.0	8.4	35.6	30.5		
Selenium	<0.1	<0.1	0.2	<0.5	<0.5	1.0	1.3		
Silver	<0.10	<0.10	<0.10	<0.01	<0.01	<0.01	0.13		
Vanadium	73.9	39.2	118	-	-	-	-		
Zinc	47	25	118	29	25	98	93	123	315

Table 4.3 Sediment Chemistry in Boston Area Lakes, 1993 to 1997 (continued)

Parameter	Aimaokatalok Lake (continued)							CISCQ	
Date	**24-Aug-96**		**24-Aug-96**		**24-Aug-96**		**24-Jul-97**	**TEL**	**PEL**
Site	**Stn 4**		**Stn 5**		**Stn 6**		**Stn1**		
Depth of sample	21 m		4 m		30 m		2.5m		
Selected Sediment	0 - 1 cm	1 - 3 cm	0 - 1 cm	1 - 3 cm	0 - 1 cm	1 - 3 cm	-		
Moisture (%)	75.0	60.1	45.0	42.3	63.3	56.8	27.9		
Total Organic Carbon (%)	0.9	0.8	0.3	0.3	1.2	1.2	1.4		
Total Metals (mg/kg)									
Aluminum	-	-	-	-	-	-	11 000		
Antimony	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-		
Arsenic	50	20	**6**	**20**	4	4	2	6	17
Barium	-	-	-	-	-	-	-		
Cadmium	0.34	0.20	<0.05	<0.05	0.16	0.10	<0.1	0.6	3.5
Calcium	-	-	-	-	-	-	-		
Chromium	71.6	98.5	**35.1**	**41.6**	**91.1**	**90.6**	27.0	37.3	90.0
Cobalt	33.2	17.9	9.0	7.6	18.2	15.7	5.0		
Copper	28.6	30.4	9.8	10.7	23.8	22.6	10.0	35.7	197
Iron	127 000	75 300	40 400	50 300	53 100	47 700	13 200		
Lead	9.9	12.8	4.1	4.8	10.2	9.4	5.0	35.0	91.3
Magnesium	-	-	-	-	-	-	-		
Manganese	25 400	2 010	1 330	750	762	659	206		
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	0.17	0.486
Molybdenum	-	-	-	-	-	-	-		
Nickel	41.3	34.4	12.5	14.1	34.1	31.8	11.0		
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.1		
Silver	0.22	0.31	0.04	<0.01	0.22	0.15	<0.10		
Vanadium	-	-	-	-	-	-	-		
Zinc	87	116	35	39	103	90	36	123	315

Table 4.3 Sediment Chemistry in Boston Area Lakes, 1993 to 1997 (continued)

Parameter	Aimaokatalok Lake (continued)				Stickleback Lake			CISCQ	
Date	24-Jul-97	24-Jul-97	22-Jul-97	24-Jul-97	25-Aug-96	25-Aug-96	23-Jul-97	TEL	PEL
Site	Stn3	Stn4	Stn5	Stn6	-	-	-		
Depth of sample	11.0m	4.5m	2.5m	24.5m	3 m	3 m	2.5m		
Selected Sediment	-	-	-	-	0 - 1 cm	1 - 2 cm	-		
Moisture (%)	50.4	37.3	34.0	47.7	37.5	29.1	88.6		
Total Organic Carbon (%)	1.9	1.0	0.6	1.5	0.8	0.6	18.6		
Total Metals (mg/kg)									
Aluminum	28 500	19 900	12 000	30 800	-	-	13 700		
Antimony	-	-	-	-	<0.05	<0.05	-		
Arsenic	**26**	**7**	**12**	5.19	2	1	**6**	6	17
Barium	-	-	-	-	-	-	-		
Cadmium	<0.1	<0.1	<0.1	<0.1	0.11	<0.05	0.3	0.6	3.5
Calcium	-	-	-	-	-	-	-		
Chromium	**72.0**	**49.0**	27.0	**83.0**	18.3	14.6	35.0	37.3	90.0
Cobalt	20.0	11.0	5.0	17.0	3.3	3.0	9.0		
Copper	28.0	16.0	8.0	26.0	11.7	7.4	**41.0**	35.7	197.0
Iron	84 700	33 800	30 000	72 000	13 100	12 200	26 200		
Lead	12.0	7.0	5.0	11.0	2.1	1.9	6.0	35.0	91.3
Magnesium	-	-	-	-	-	-	-		
Manganese	4 900	587	360	1 550	105	104	394		
Mercury	0.037	0.012	0.007	0.024	<0.05	<0.05	0.034	0.17	0.486
Molybdenum	-	-	-	-	-	-	-		
Nickel	37.0	22.0	10.0	36.0	7.7	7.5	33.0		
Selenium	0.3	0.2	<0.1	0.2	<0.5	<0.5	0.7		
Silver	<0.1	<0.1	<0.1	0.2	0.3	<0.01	<0.1		
Vanadium	-	-	-	-	-	-	-		
Zinc	108	65	33	109	17	15	54	123	315

Table 4.3 Sediment Chemistry in Boston Area Lakes, 1993 to 1997 (continued)

Parameter	Fickle Duck Lake		Fickle Duck Outflow	Reference Lake	CISCQ	
Date	25-Aug-96	23-Jul-97	1993	23-Jul-97	TEL	PEL
Site	-	-	WQ2	-		
Depth of sample	2 m	2.0m	?	2.5m		
Selected Sediment	surface	-	-	-		
Moisture (%)	68.9	46.2	-	46.0		
Total Organic Carbon (%)	7.1	2.6	5.7	2.13		
Total Metals (mg/kg)						
Aluminum	-	28 600	57 100	23 900		
Antimony	<0.05	-	<0.05	-		
Arsenic	**6**	3	2	6	6	17
Barium	-	-	641	-		
Cadmium	0.41	<0.1	<0.10	<0.1	0.6	3.5
Calcium	-	-	17 600	-		
Chromium	35.7	**72.0**	29.3	**65.0**	37.3	90.0
Cobalt	8.7	11.0	5.2	11.0		
Copper	**96.4**	25.0	10.6	22.0	35.7	197.0
Iron	22 800	34 100	17 300	38 300		
Lead	10.3	9.0	2.8	8.0	35.0	91.3
Magnesium	-	-	5 750	-		
Manganese	146	312	352	351		
Mercury	<0.050	0.014	0.013	0.017	0.17	0.486
Molybdenum	-	-	<1.0	-		
Nickel	42.0	31.0	7.4	28.0		
Selenium	0.5	0.2	<0.1	0.2		
Silver	0.2	<0.1	<0.1	<0.1		
Vanadium	-	-	37	-		
Zinc	93	94	24	87	123	315

Notes: Units are expressed as dry weights. CISQ = Canadian Interim Sediment Quality Guidelines for the Protection of Aquatic Life; TEL= Threshold Effect Level; PEL = Probable Effect Level. Values in bold are equal or greater than the TEL guidelines.

4.2.3 Fickle Duck Lake

The predominantly clay-sized sediment of Fickle Duck Lake was dark grey in colour. The TOC concentrations were high in both 1996 and 1997 (7.1 and 2.6% dry weight, respectively). The concentrations of total arsenic (6 mg/kg) and total copper (96.4 mg/kg) exceeded the CISQG TEL in the 1996 sample. Total chromium (72 mg/kg) exceeded the CISQG TEL in the 1997 sample (Table 4.3).

4.2.4 Fickle Duck Outflow

The sediments of Fickle Duck Outflow were predominantly sand-sized, and colour was not recorded (Rescan 1994). The TOC concentration in 1993 was moderately high (5.7% dry weight), likely due to the aquatic plants and grasses lining this creek area (Rescan 1994). The concentrations of all metals in this sample were below the CISQG TEL values (Table 4.3).

4.2.5 Reference Lake

The sediments of Reference Lake were composed of clay and fine sand-sized material, with the surficial layer being dark grey in colour, whereas the upper layer was yellowish-red (Rescan 1997). The TOC concentration was moderately high (2.1%). The concentration of total chromium (65 mg/kg) exceeded the CISQG TEL (Table 4.3).

4.2.6 Summary

Most lake sediment metal levels fell below the CISQG. The exceptions were total chromium, total arsenic, and total copper. Of these, total chromium values exceeding the guidelines were the most widespread geographically, with concentrations exceeding the CISQG PEL in three of the five waterbodies. Nevertheless, these sediment metal concentrations remained within the range of natural variability for the Slave Structural Province (Puznicki 1996).

Sediment TOC levels varied between lakes. For sediments with relatively elevated TOC (Fickle Duck Lake, Fickle Duck Outflow and Reference Lake), colour and mineralogy indicated that reducing conditions were predominant in the surficial layer as well as the underlying sediments. For lake sediments with relatively low to moderate TOC concentrations, and in which profiling had been carried out (Aimaokatalok Lake), colour and mineralogy indicated a strong redox gradient between an oxic surficial layer and reducing underlying upper layer.

TOC values from Stickleback Lake were low in 1996 but were much higher at the site sampled in 1997.

4.3 MARINE SEDIMENT QUALITY

4.3.1 Hope Bay

Marine sediment samples from Hope Bay were collected during a single sampling event on 23 August 1997 (Figure 4.1). Sediment sampling methods and analysis were similar to those described in Section 4.1. The Hope Bay sediment was primarily clay-sized at the deepest station, and sand-sized at the two shallow stations (Rescan 1998). Concentrations of TOC ranged from 0.08 to 0.77% dry weight, with the deepest station having the highest TOC content (Table 4.4). Moisture content varied between samples, ranging from 17.1% to 29.8%, with the deepest station having the highest moisture content. None of the analyzed metal concentrations exceeded the CISQG TEL guidelines for marine environments.

Table 4.4 Hope Bay Sediment Chemistry, 1997

Parameter[a]	Station 1	Station 2	Station 3	CISQ[b] (Marine)	
Date	23-Aug-97	23-Aug-97	23-Aug-97	TEL	PEL
Depth of Sample	16 m	2 m	4 m		
Selected Sediment Layer	0 – 2 cm	0 – 2 cm	0 – 2 cm		
Moisture (%)	29.8	17.4	17.1		
Total Organic Carbon (%)	0.8	0.1	0.2		
Total Metals (mg/kg)					
Aluminum	15 300	7 870	11 300		
Arsenic	4	2	3	7	42
Cadmium	<0.1	<0.1	<0.1	0.7	4.2
Chromium	40.0	20.0	31.0	52.3	160.0
Cobalt	6.0	5.0	6.0		
Copper	18.0	10.0	15.0	18.7	108
Iron	23 300	12 700	21 300		
Lead	6.0	<2.0	3.0	30.2	112.0
Manganese	224	140	201		
Mercury	0.006	<0.005	<0.005	0.130	0.700
Nickel	17.0	13.0	21.0		
Selenium	0.10	<0.10	<0.10		
Silver	<0.1	<0.1	<0.1		
Zinc	40	21	31	124	271

[a] Total metals are expressed as dry weights.

[b] CISQG = Canadian Interim Sediment Quality Guidelines for the Protection of Aquatic Life; TEL= Threshold Effect Level; PEL = Probable Effect Level.

5 PRIMARY PRODUCERS

5.1 PHYTOPLANKTON IN LAKES

Phytoplankton are tiny, free-floating organisms that use energy from sunlight to convert carbon dioxide and water into organic materials to be used in biological tissues. They live near the water surface where there is sufficient light to support photosynthesis. Phytoplankton form the base of the aquatic food web, providing an essential ecological function for all aquatic life. The data were compiled from six annual reports (Rescan 1993, 1994, 1995, 1997, 1998, and 1999a).

5.1.1 Methods

Phytoplankton samples were collected from four lakes within the Boston area (Figure 5.1). The total number of phytoplankton sampling sessions carried out at each lake between 1993 and 1998 ranged from three in Reference Lake to 17 in Aimaokatalok Lake (Table 5.1).

Table 5.1 Phytoplankton Sampling Dates in Boston Area Lakes, 1993 to 1998

Waterbody	Sampling Station	Date					
		1993	1994	1995	1996	1997	1998
Aimaokatalok Lake	WQ4		Aug				
	WQ5	17 Aug	Aug	Aug			
	Stn 1					24 Jul & 26 Aug	
	Stn 4						18 Jul
	Stn 5				4 & 24 Aug	22 Jul & 26 Aug	
	WQ9 / Stn 6			Aug	4 & 24 Aug	24 Jul & 25 Aug	18 Jul
Stickleback Lake			Aug	Aug	5 & 25 Aug	23 Jul & 26 Aug	19 Jul
Fickle Duck Lake				Aug	5 & 25 Aug	23 Jul & 26 Aug	19 Jul
Reference Lake						23 Jul & 27 Aug	22 Jul

Triplicate phytoplankton samples were collected during each sampling session. Samples were collected from a water depth of either 0.5 or 1 m (depending on the year), transferred into 250-mL bottles and preserved in Lugols's iodine solution. Samples were submitted to Fraser Environmental Services for taxonomic identification and enumeration. Rescan reports identified Cryptophyta and Pyrrophyta as members of the same phylum; however, recent literature (Wehr et al. 2002) makes a distinction between the two taxonomic groups, treating both Cryptophyta and Pyrrophyta as two distinct phyla. For this report, Cryptophyta and Pyrrophyta were analyzed as two separate phyla.

As an indicator of phytoplankton biomass, chlorophyll *a* was measured from single samples collected in 1996 and 1997. Clean 1 L plastic bottles were filled and kept cold and in the dark until returned to camp. Once in camp, samples were gently shaken and filtered through 0.45 µm membrane filters (filter diameter of 47 mm). Filters were carefully folded in half, wrapped in aluminum foil, and frozen until analysis by the fluorometric method described in Parsons et al. (1984).

5.1.2 Aimaokatalok Lake

Seventeen phytoplankton sampling sessions were conducted on Aimaokatalok Lake during the summer: once in 1993, twice in 1994 and 1995, four times in 1996, six times in 1997, and twice in 1998. Mean total algal densities [± 1 standard error (SE)] ranged from 125 ± 17 cells/mL on 24 July 1997 to 3473 ± 1541 cells/mL on 24 July 1996 (Figure 5.2; Appendices B1 and B2).

Phytoplankton communities in Aimaokatalok Lake were typically dominated by Cyanophyta (cyanobacteria or blue-green algae), which contributed between 9.8 and 56.1% towards the mean total number of cells enumerated in each sample. Cyanophyta abundance was unusually low in 1997, but was generally high (>40% of all cells) during other years. The major organisms of this group included *Gomposphaeria* spp., *Lyngbya limnetica,* and *Anacystis* spp. The other major groups in order of abundance were Chlorophyta (generally referred to as green algae; 4.3 to 51.1% of total cell numbers) and Bacillariophyta (diatoms; 2.5 to 37.8% of total cell numbers). The major contributor to Chlorophyta was *Crucigenia* spp. Bacillariophyta was dominated by *Asterionella formosa, Cyclotella* spp. and *Fragilaria* spp., Chrysophytes (golden-brown algae) were typically rare in Aimaokatalok Lake; however, they contributed 63.6% of the total number of cells enumerated at Station 5 in July 1997 (Figure 5.2; Appendix B2).

5.1.3 Stickleback Lake

Seven phytoplankton sampling sessions were conducted on Stickleback Lake during the summer: once in 1994, 1995 and 1998, and twice in 1996 and 1997. Mean total algal cell numbers ranged from 527 ± 114 SE cells/mL on 23 July 1997 to 7962 ± 2016 SE cells/mL on 5 August 1996 (Figure 5.3; Appendices B1 and B2).

Phytoplankton communities in Stickleback Lake were typically dominated by Cyanophyta, which contributed between 5.8 and 77.1% towards the mean total number of cells enumerated per sample. The major contributor of this group was *Anacystis* spp. Additionally, large contributions of Bacillariophyta (diatoms), Chlorophyta, Chrysophyta, and Cryptophyta occurred on some sampling dates (Figure 5.3; Appendices B1 and B2). The major contributors to these four groups were *Asterionella formosa*, *Crucigenia* spp., *Dinobryon bavaricum*, and *Chroomonas acuta*, respectively.

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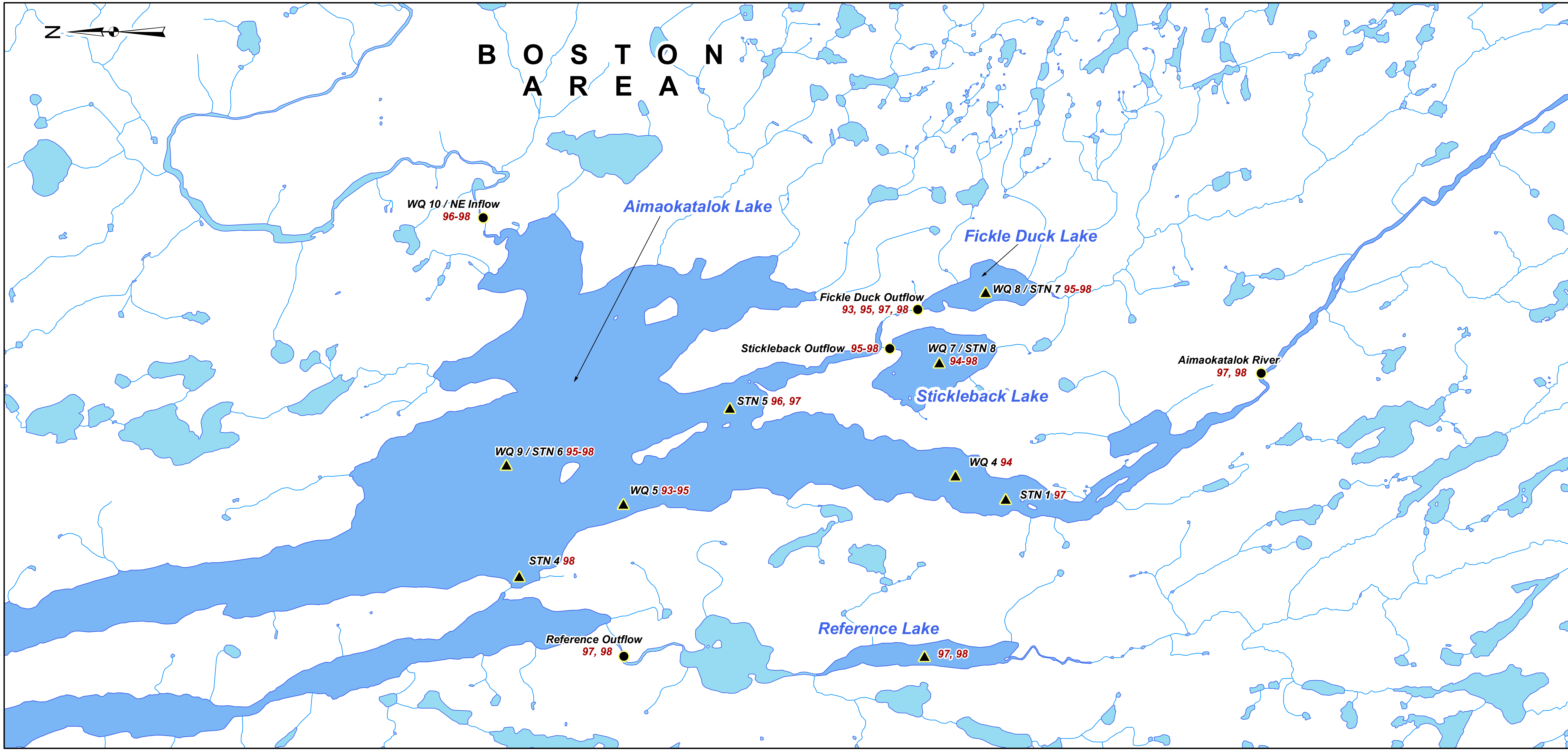


LEGEND

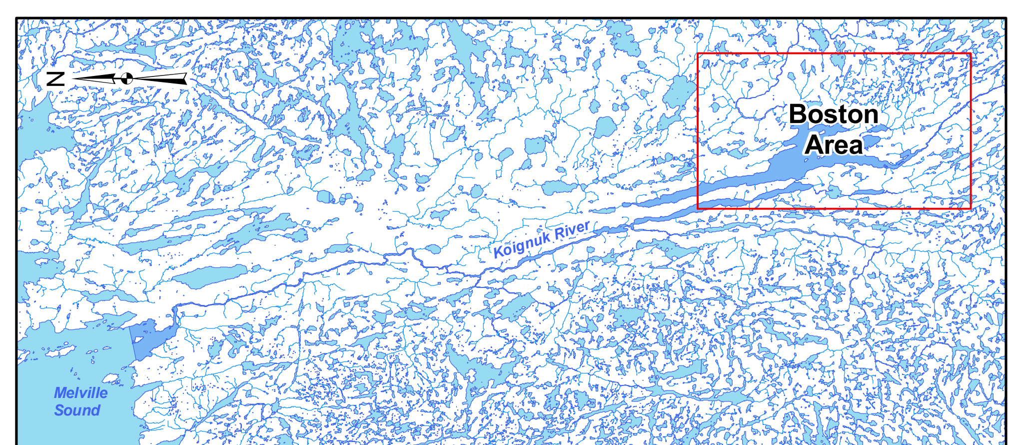
▲	Phytoplankton sampling locations	*WQ X / STN X*	Sampling stations names from Rescan reports
●	Periphyton sampling locations	*95-97*	Consecutive years of sampling at station
	Rivers		
	Study areas		
	Waterbodies		

DRAFT

REFERENCE

Sources: Data Obtained from the Government of Canada, Natural Resources Canada, Centre for Topographic Information
Projection: UTM Zone 13N Datum: NAD 83

This map is for information purposes only. Golder Associates Ltd. does not accept any liability arising from its misuse or misrepresentation.



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SCALE 1:50000 METRES

MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

Phytoplankton and Periphyton Sampling Locations, 1993 - 1998

Golder Associates
Edmonton, Alberta

PROJECT No.06-1373-028			SCALE AS SHOWN	REV. 1
DESIGN	JP	22 April 2008		
GIS	RC	23 April 2008		
CHECK	JP	14 May 2008		
REVIEW	GA	17 May 2008		

FIGURE: 5.1

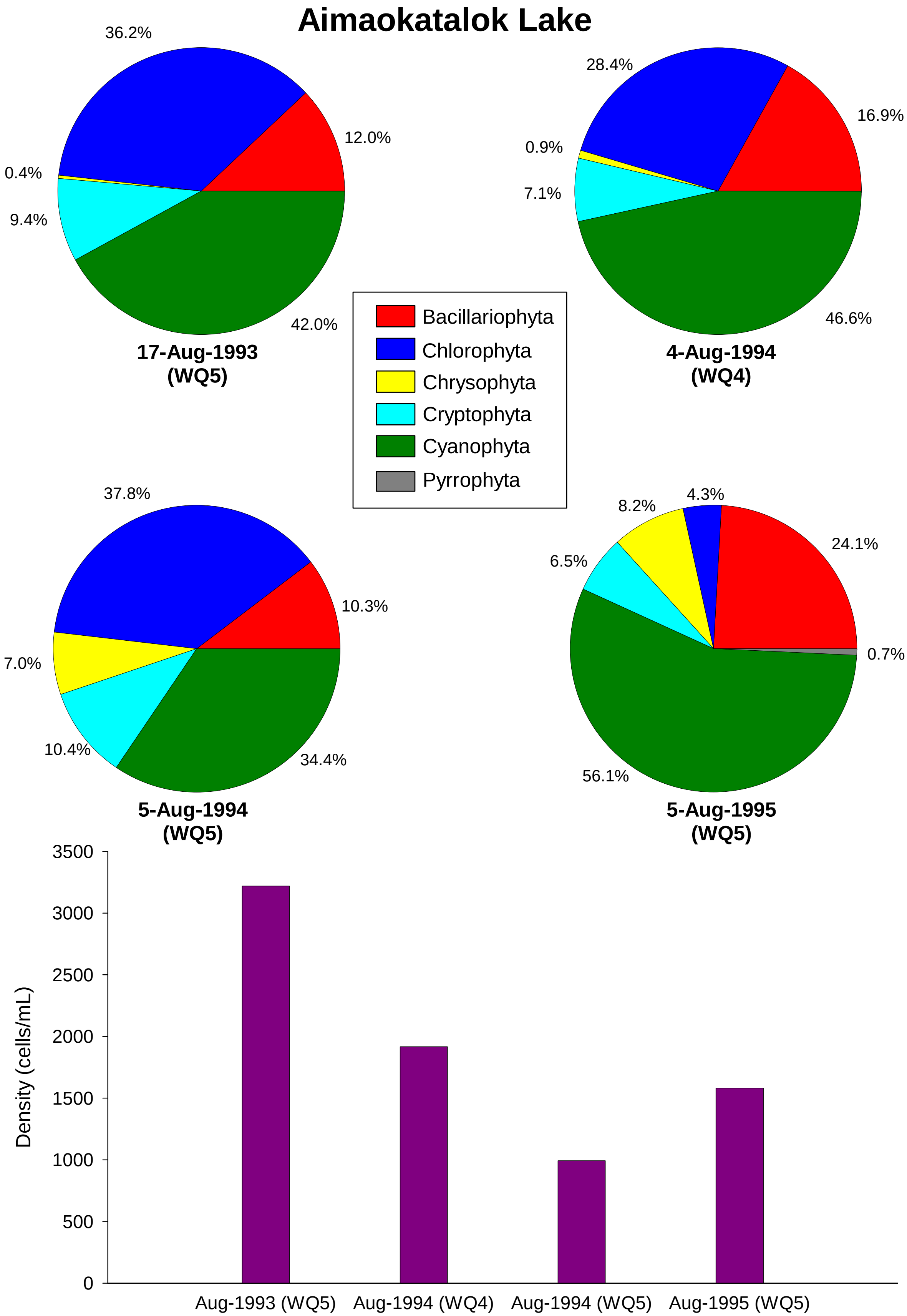


Figure 5.2 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Aimaokatalok Lake, 1993 to 1998.

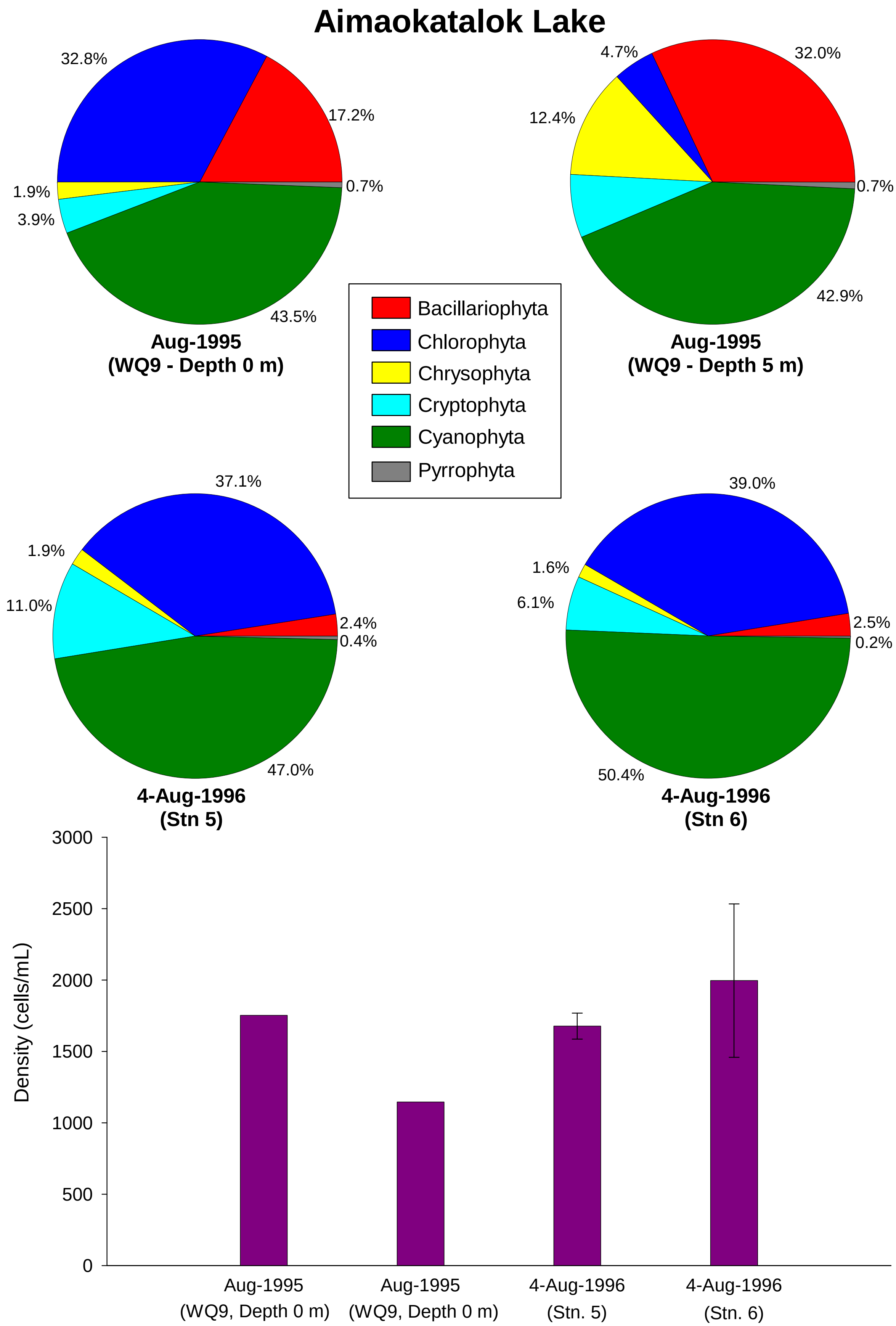


Figure 5.2 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Aimaokatalok Lake, 1993 to 1998.

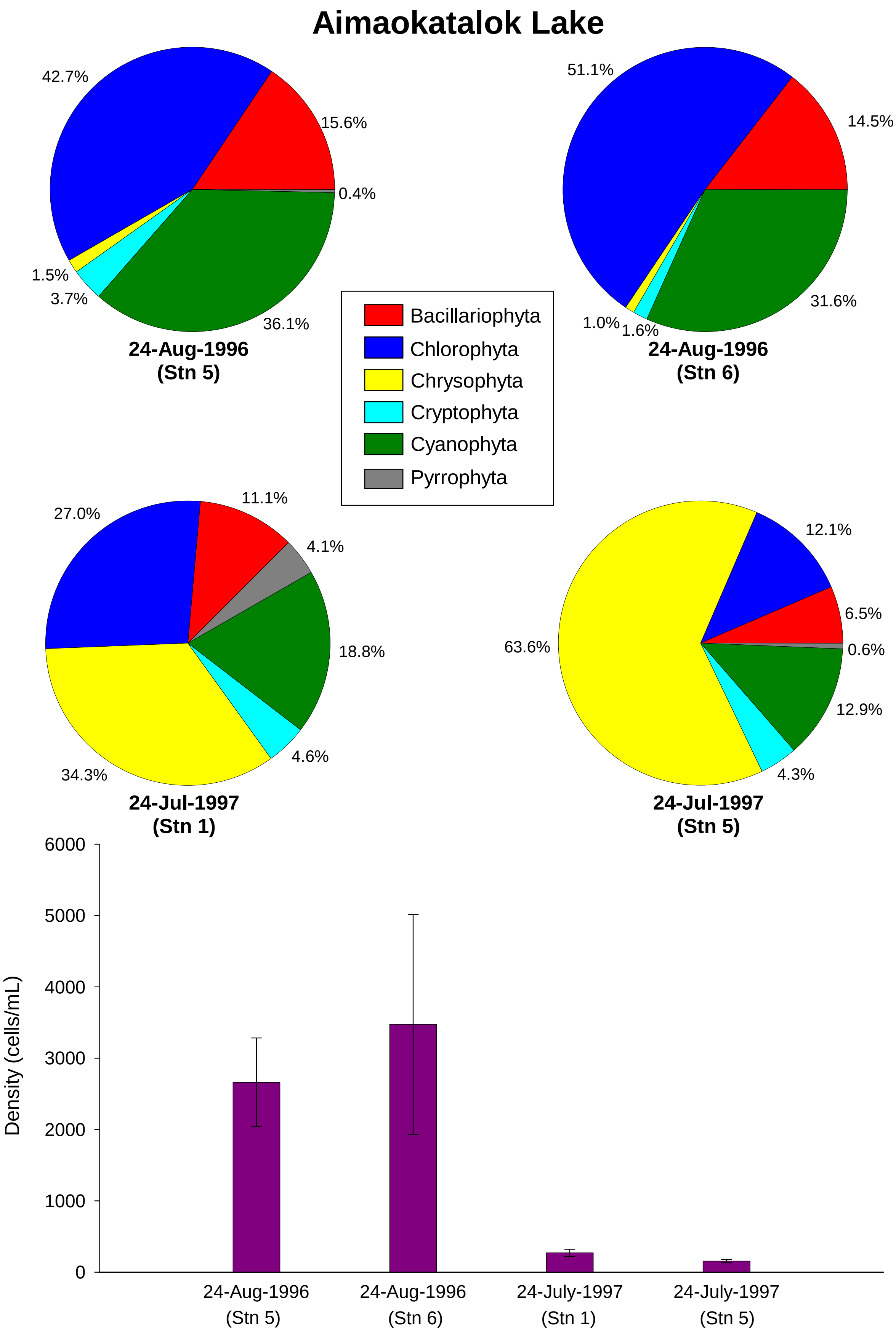


Figure 5.2 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Aimaokatalok Lake, 1993 to 1998.

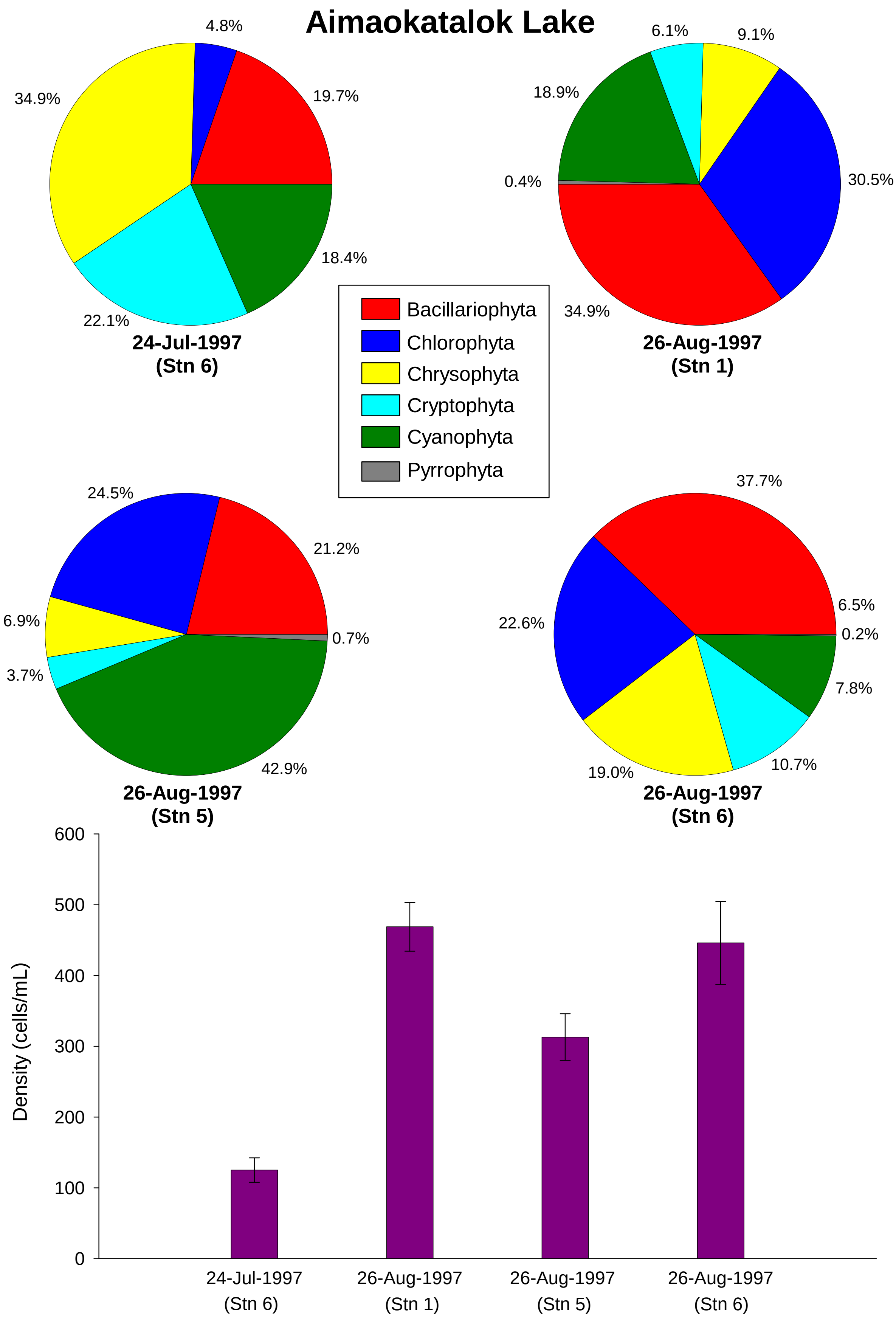
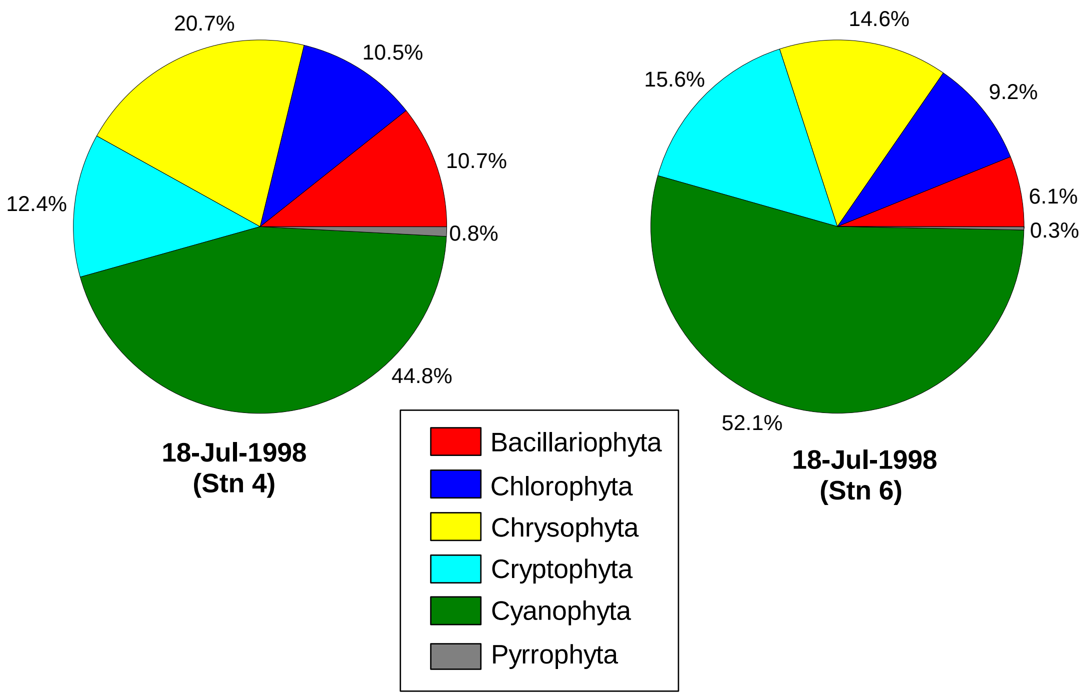


Figure 5.2 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Aimaokatalok Lake, 1993 to 1998.

Aimaokatalok Lake



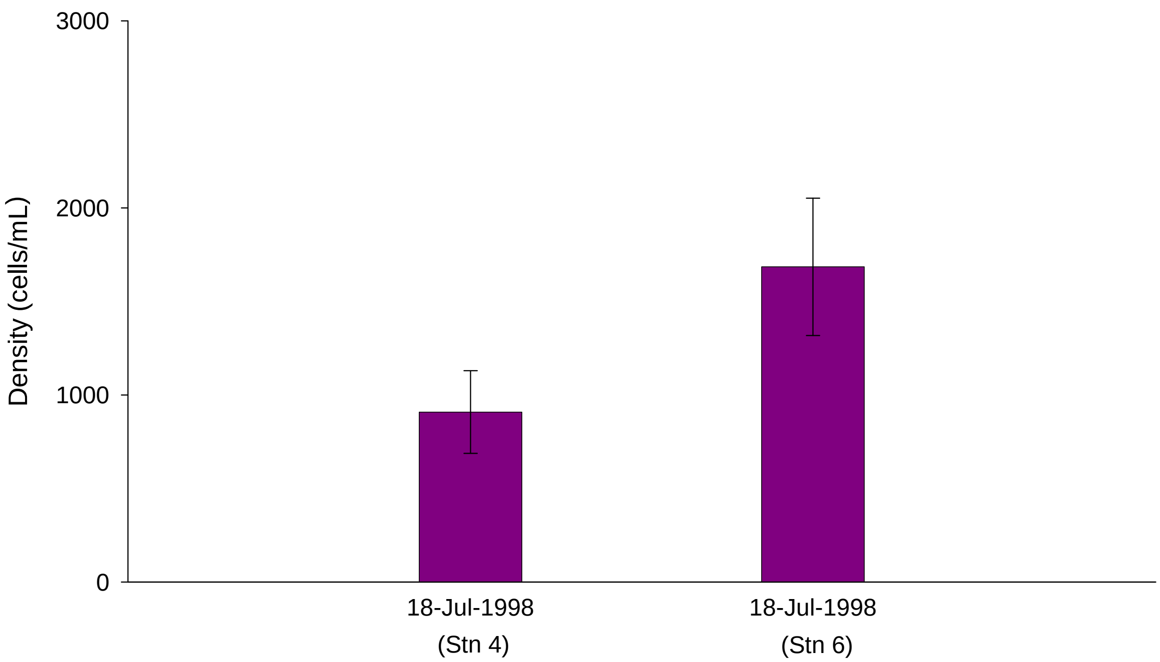


Figure 5.2 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Aimaokatalok Lake, 1993 to 1998.

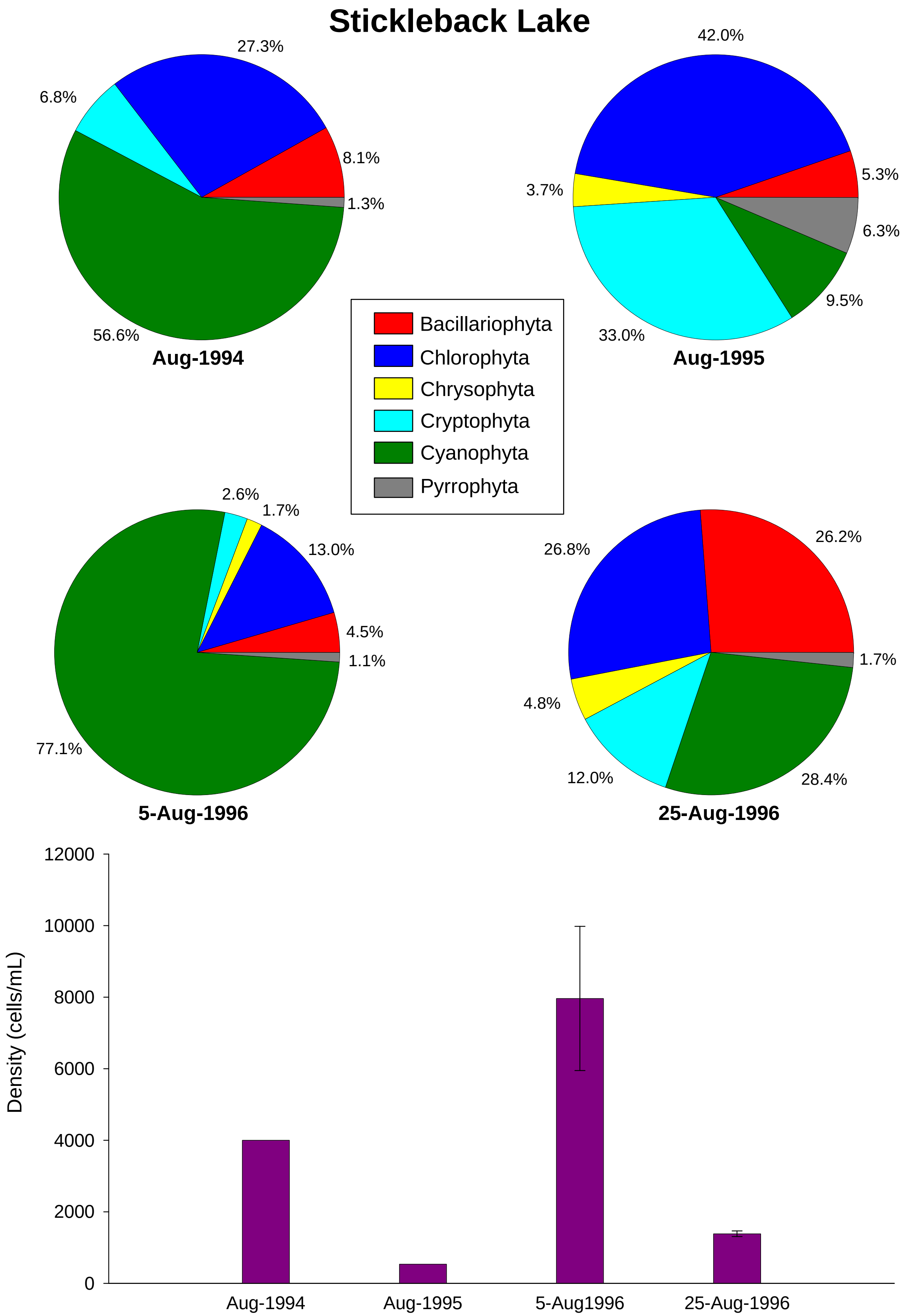


Figure 5.3 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Stickleback Lake, 1994 to 1998.

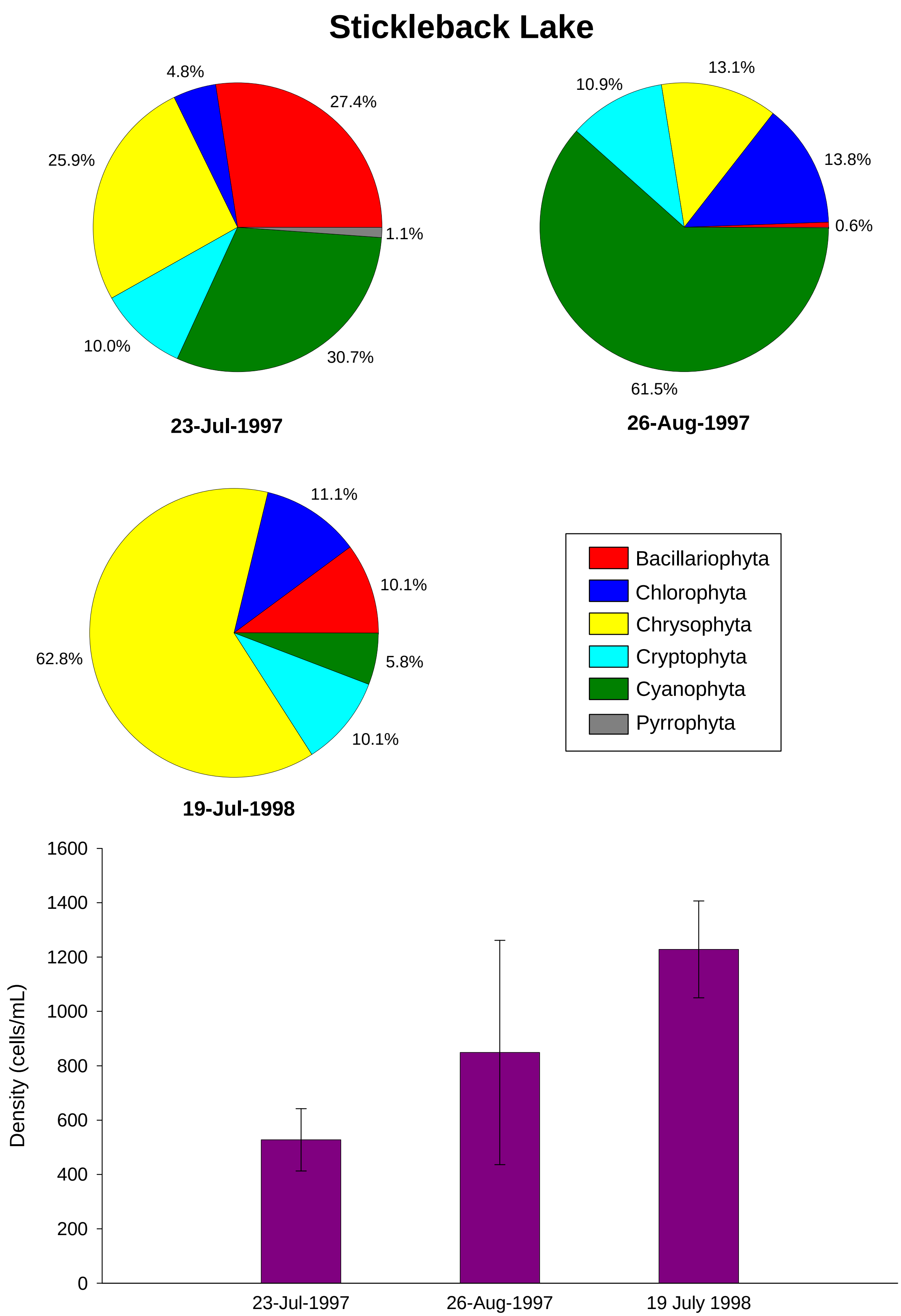


Figure 5.3 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Stickleback Lake, 1994 to 1998.

5.1.4 Fickle Duck Lake

Six phytoplankton sampling sessions were conducted on Fickle Duck Lake during the summer: once in 1995 and 1998 and twice in 1996 and 1997. Mean total algal cell numbers (±1 SE) ranged from 53 ± 19 cells/mL on 23 July 1997 to 3901 ± 829 cells/mL on 5 Aug 1996 (Figure 5.4; Appendix B2).

Phytoplankton communities in Fickle Duck Lake were typically dominated by Cyanophyta, which contributed between 22.5 and 76.8% towards the mean total number of cells enumerated per sample. The major contributor of this group was *Anacystis* spp. Bacillariophyta, Chlorophyta, and Chrysophyta also were abundant on some sampling dates (Figure 5.4; Appendices B1 and B2). The major contributors to these three groups were *Asterionella formosa*, *Crucigenia* spp., and *Dinobryon* spp., respectively.

5.1.5 Reference Lake

Three phytoplankton sampling sessions were conducted on Reference Lake during the summer, including twice in 1997 and once in 1998. Mean total algal cell numbers (±1 SE) ranged from 172 ± 59 cells/mL on 23 July 1997 to 15 883 ± 11 471 cells/mL on 27 Aug 1996 (Figure 5.5; Appendix B2).

Phytoplankton communities in Reference Lake were typically dominated by Cyanophyta, which contributed between 30.4 and 98.6% towards the mean total number of cells enumerated per sampling session. The major contributors of this group included *Aphanizomenon flos-aquae, Anabaena* spp., and *Lyngbya limnetica*. In July 1997, phytoplankton communities also had significant contributions of Chlorophyta (green algae) and Chrysophyta (golden-brown algae). The major components of these groups included *Dinobryon* spp., *Ochromonas* spp., and *Crucigenia* spp., respectively (Figure 5.5; Appendices B1 and B2).

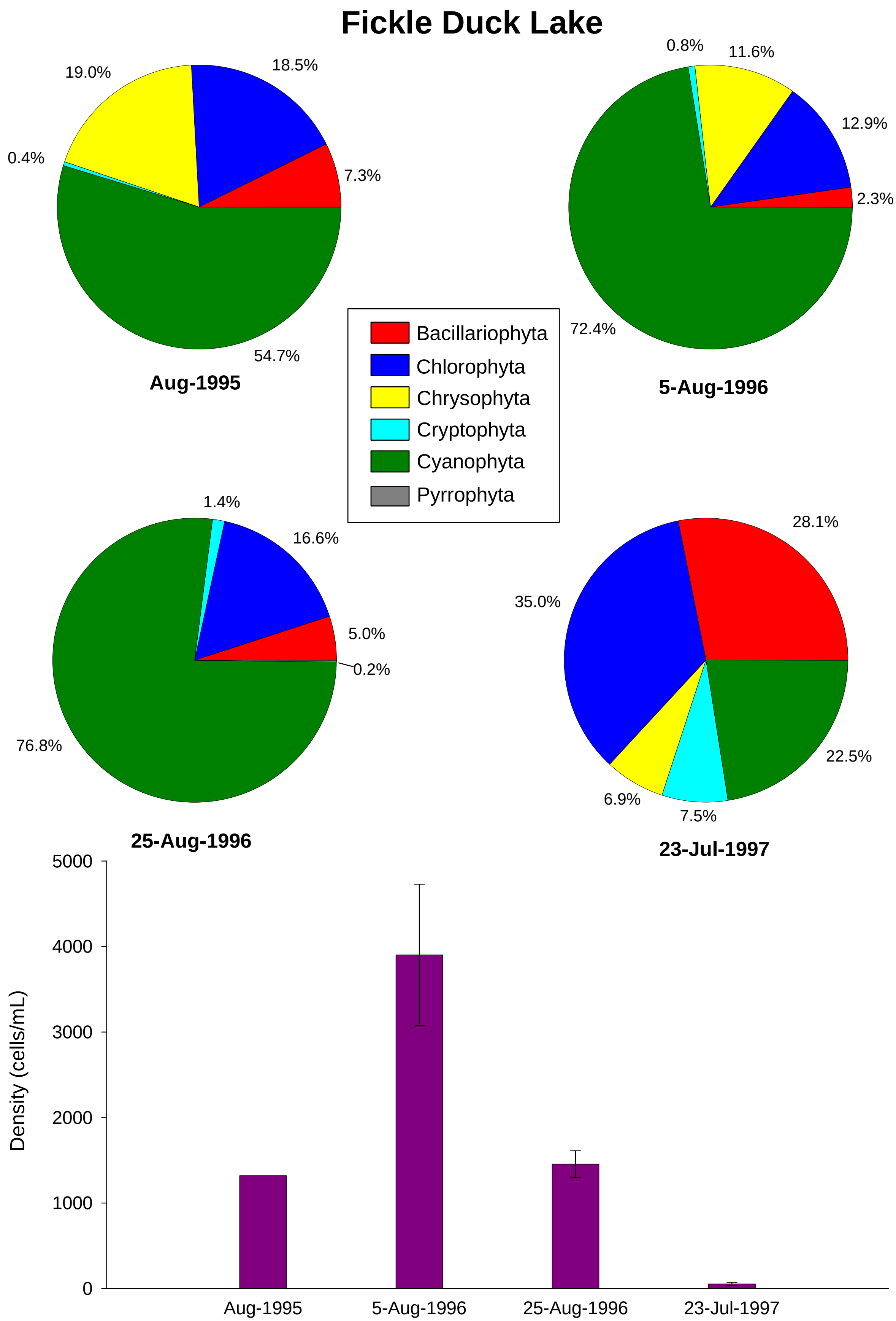


Figure 5.4. Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Fickle Duck Lake, 1995 to 1998.

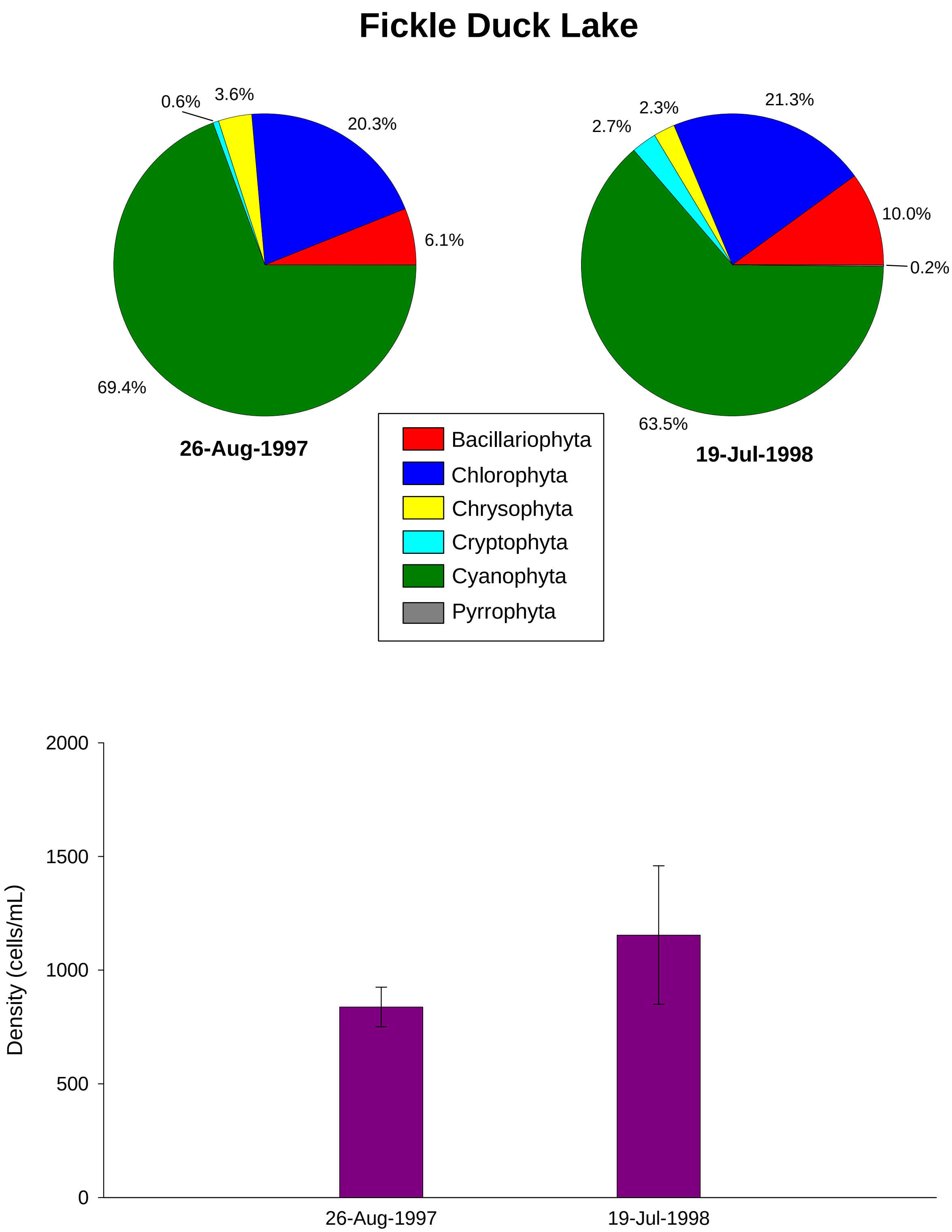


Figure 5.4 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Fickle Duck Lake, 1995 to 1998.

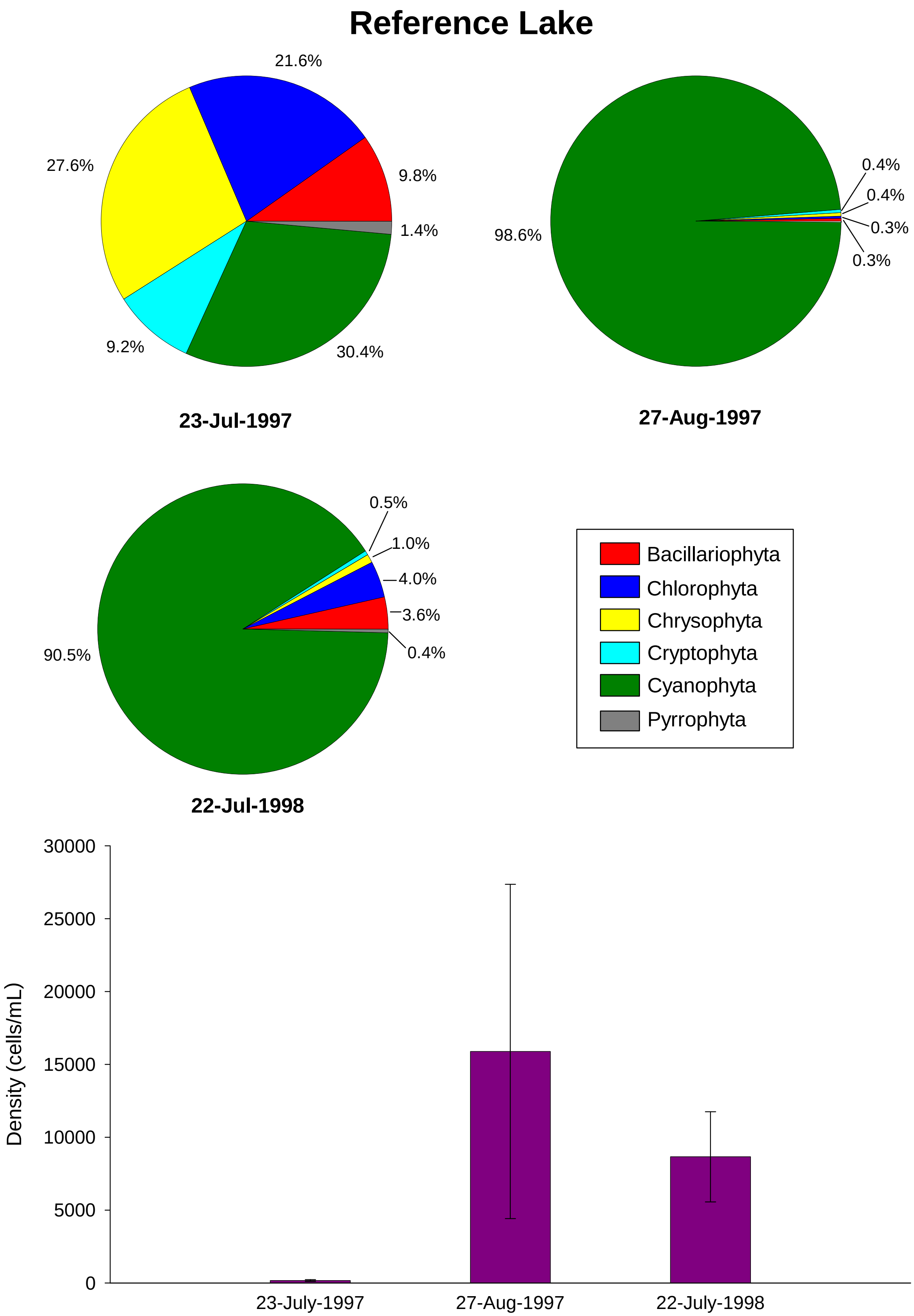


Figure 5.5 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of phytoplankton in Reference Lake, 1997 to 1998.

5.1.6 Summary

The phytoplankton samples obtained from the Boston area lakes did not reveal any uncommon or rare species. The phytoplankton communities (i.e., taxonomic composition) of the four lakes showed little differentiation and were similar in many respects to the communities of many other small lakes in the Arctic and sub-Arctic (Moore 1978a, 1978b; RL&L 1997, 1998, and 1999). In general, phytoplankton within the Boston area lakes were numerically dominated by the Cyanophyta species, *Anacystis* spp. and *Lyngbya limnetica*. However, in several of the lakes *Crucigenia* spp. (Chlorophyta), *Asterionella formosa* (Bacillariophyta), and *Dinobryon* spp. (Chrysophyta) each made significant contributions to phytoplankton abundance.

For the Boston area lakes, a comparison of phytoplankton abundance suggested that Reference Lake was the most productive and Aimaokatalok Lake was the least productive (Table 5.2). The concentration of chlorophyll *a* is typically a better measure of productivity than phytoplankton cell abundance; however, these data were only collected during two sampling sessions from each lake. Based on the chlorophyll *a* data, Reference Lake appears to be nearly twice as productive as the other three lakes, with Fickle Duck Lake being the least productive (Table 5.2).

Table 5.2 Summary of Phytoplankton Abundance in Boston Area Lakes, 1996 to 2000

Waterbody	Number of Sampling Sessions	Mean Abundance (cells/mL)	Mean Chlorophyll *a* (ug/L) in 1997	Mean Chlorophyll *a* (ug/L) in 1998
Aimaokatalok Lake	17	1 354	0.35	1.56
Stickleback Lake	7	2 355	0.76	1.40
Fickle Duck Lake	6	1 454	0.65	1.12
Reference Lake	3	8 237	1.24	3.61

The numerical dominance by Cyanophyta among the four Boston area lakes suggested that this group was able to take advantage of environmental conditions and substantially increase its population. Indeed, many species of Cyanophyta exhibit rapid population increases when conditions are suitable (Hoogenhout and Amez 1964). Cyanophyta can regulate their buoyancy (Reynolds 1975) and thus maintain themselves near the surface where incident light is greatest. Large concentrations of algae near the surface also can effectively shade other algae in the deeper waters (Fogg 1966), thereby inhibiting production of those species that cannot regulate their buoyancy and move toward the surface. Through their ability to fix atmospheric nitrogen, Cyanophyta can flourish during periods when concentrations of available dissolved nitrogen are low (Dugdale and

Dugdale 1962). Water quality results included in this compilation report (see Section 3) indicated that nitrate + nitrite nitrogen levels were low throughout all sampling sessions. The low available nitrogen levels may be a limiting factor for groups other than Cyanophyta.

5.2 PERIPHYTON IN STREAMS

Periphyton is the algae, bacteria, fungi, and associated materials that surround solid surfaces in aquatic systems (Lock et al. 1984). The periphytic algal community is often monitored or assessed because of the following: 1) minimal sampling effort is required, 2) algae are numerically abundant, diverse, and easy to identify, and 3) periphytic algae form part of the lower trophic food chain level (i.e., convert sunlight into biological tissues), upon which other aquatic life forms depend. The information presented is based on data from annual data reports (Rescan 1993, 1994, 1995, 1997, and 1999a).

5.2.1 Methods

Periphyton samples were collected from five streams within the Boston area (Figure 5.1). Two to five sampling sessions were conducted on each waterbody between 1993 and 1998 (Table 5.3). Periphyton samples were not collected in 1994.

Table 5.3 Periphyton Sampling Schedule in Boston Area Lakes, 1993 to 1998

Waterbody	Date					
	1993	1994	1995	1996	1997	1998[a]
Stickleback Outflow			Aug	25 Aug	21 July & 24 Aug	26 June to 30 July
Fickle Duck Outflow	17 Aug		Aug		25 Aug	26 June to 31 July
Aimaokatalok NE Inflow				5 Aug	25 Aug	28 June to 31 July
Aimaokatalok River					24 Aug	27 June to 1 Aug
Reference Outflow					25 Aug	28 June to 1 Aug

[a] In 1998, artificial substrate samplers were used. The date range indicates the period the samplers were in the water.

To collect periphyton samples, an attempt was made to use Plexiglas plate artificial substrate samplers (100 cm^2); however, drastic changes in water levels occasionally resulted in artificial substrate samplers not being recovered. When artificial substrate samplers were not available, instantaneous samples for periphyton were obtained from rocks. Regardless of substrate, periphyton samples were collected either by using a modified syringe-brush or by scraping a known surface area of rock with a plastic spatula and ruler. Surface areas sampled were cleaned with a fine-bristled brush and rinsed using a wash bottle. The samples were transferred in 500-mL jars and preserved in Lugol's iodine solution. Genera and, where possible, species were identified and enumerated by Fraser Environmental Services, in accordance with procedures described in Rescan (1995). Again, Rescan reports identified Cryptophyta and Pyrrophyta as members of the same phylum; however, recent literature (Wehr et al. 2002) makes a distinction between the two taxonomic groups, treating both Cryptophyta and Pyrrophyta as two distinct phyla. For this report, Cryptophyta and Pyrrophyta were analyzed as two separate phyla.

Chlorophyll *a* samples were obtained by gently scraping a known surface area of an artificial substrate into a plastic wide-mouth jar using filtered stream water and a brush. Filtered stream water was added to keep the sample moist and in suspension. Jars were kept cold and in the dark until returned to the field laboratory, where the samples were gently shaken and filtered onto 47 mm diameter membrane filters with a pore size of 0.45 µm. Filters were carefully folded in half, wrapped in aluminum foil, and frozen until analysed by the fluorometric method described in Parsons et al. (1984). Chlorophyll *a* samples were collected only in summer 1998.

5.2.2 Stickleback Outflow

Five periphyton sampling sessions were conducted on Stickleback Outflow during the summer, including once in 1995 and 1996, twice in 1997, and once in 1998. Mean total algal cell numbers (±1 SE) ranged from $133 \times 10^3 \pm 44 \times 10^3$ cells/cm^2 in 1998 to 1196×10^3 cells/cm^2 in a single sample from August 1995 (Figure 5.6; Appendices B3 and B4).

Bacillariophyta (diatoms) contributed between 17.3 and 68.1% towards the total mean number of cells enumerated in each sample (Figure 5.6; Appendix B4). Cyanophyta, also known as cyanobacteria and colloquially referred to as blue-green algae, were also common (contributed betweem 23.7 and 58.9% to total cell numbers). The major components of Bacillariophyta were *Fragilaria* spp., *Navicula* spp., and *Synedra* spp., whereas Cyanophyta were mainly represented by *Lyngbya limnetica* in 1995 and *Anacystis* spp. in 1996 to 1998.

5.2.3 Fickle Duck Outflow

Four periphyton sampling sessions were conducted on Fickle Duck Outflow during the summers of 1993, 1995, 1997, and 1998. Mean total algal cell numbers (±1 SE) ranged from $371 \times 10^3 \pm 127 \times 10^3$ cells/cm^2 in August 1997 to 3933×10^3 cells/cm^2 in a single sample from August 1995 (Figure 5.7; Appendix B4).

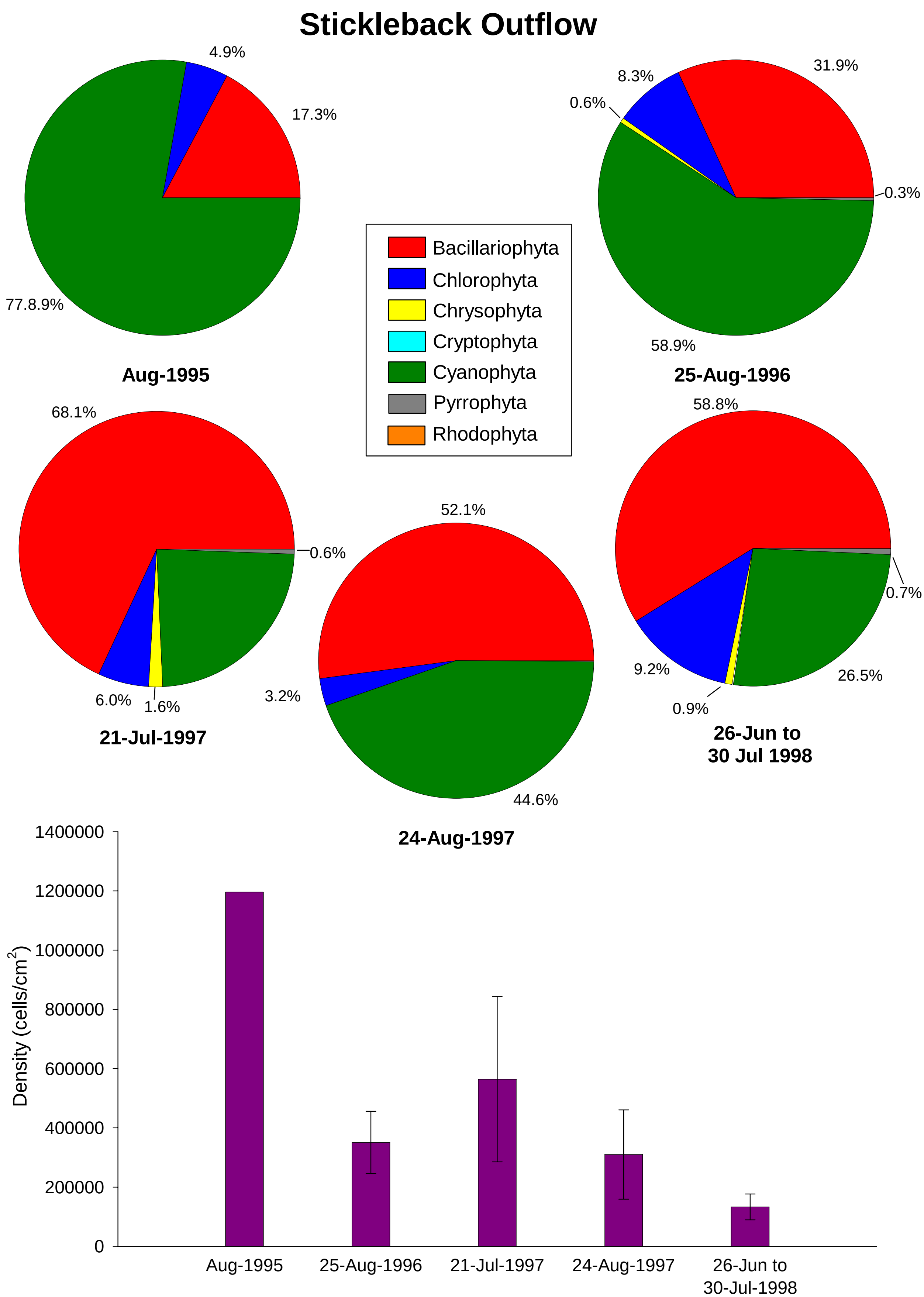


Figure 5.6 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of periphyton in Stickleback Outflow, 1995 to 1998.

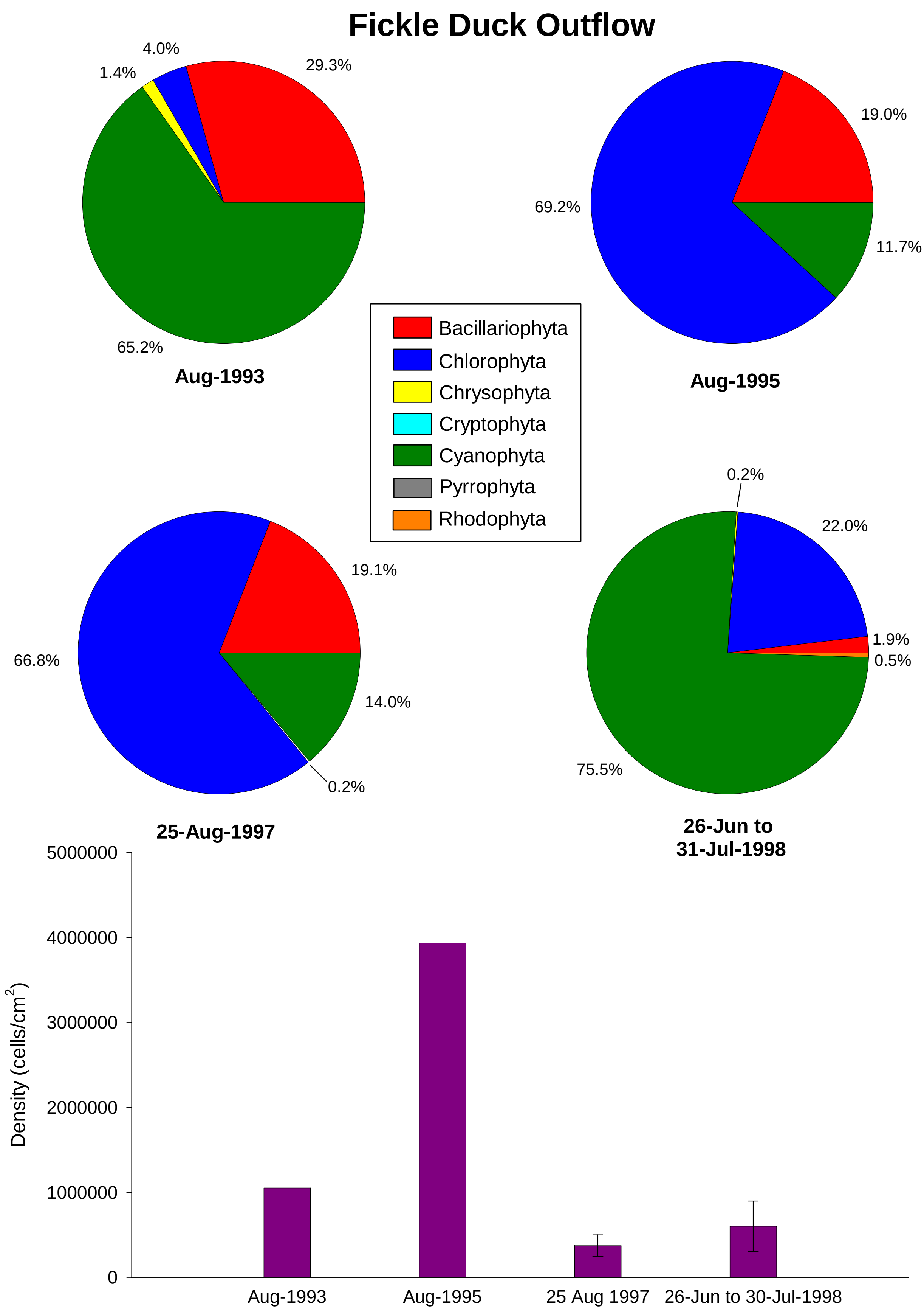


Figure 5.7 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of periphyton in Fickle Duck Outflow, 1993 to 1998.

In 1993 and 1998, the periphyton algal community of Fickle Duck Outflow was dominated by Cyanophyta (65.2 and 75.5%, respectively), whereas in 1995 and 1997 Chlorophyta (green algae) were dominant (69.2 and 66.8%, respectively). In years when Cyanophyta dominated, Chlorphyta formed a relatively small portion of the community and *vice versa*. Bacillariophyta also made significant contributions towards the total mean cell count in the sample, ranging from 1.9 to 29.3% (Figure 5.7; Appendices B3 and B4). Major contributors to Chlorophyta were *Stigeoclonium* spp. in 1995 and *Tetraspora* spp. in 1997 and 1998. Cyanophyta were comprised largely of *Agmenellum* spp. in 1993 and an unidentified species in 1998. The major component of the Bacillariophyta was *Tabellaria flocculosa*.

5.2.4 Aimaokatalok NE Inflow

Three periphyton sampling sessions were conducted on Aimaokatalok NE Inflow, one each during the summers of 1996, 1997 and 1998. Mean total algal cell numbers (±1 SE) ranged from 121 x 10^3 cells/cm^2 in 1997 to 987 x 10^3 ± 150 x 10^3 cells/cm^2 in 1998 (Figure 5.8; Appendix B4).

The periphyton algal community of Aimaokatalok NE Inflow was dominated by Cyanophyta (57.5 to 74.3% of total cell numbers) (Figure 5.8; Appendices B3 and B4); this group was comprised largely of *Gomphosphaeria nagelianum*.

5.2.5 Aimaokatalok River

Two periphyton sampling sessions were conducted on the Aimaokatalok River, including once during the summers of 1997 and 1998. Mean total algal cell numbers (± 1 SE) ranged from 26 x 10^3 ± 2 x 10^3 cells/cm^2 in 1997 to 582 x 10^3 ± 82 x 10^3 cells/cm^2 in 1998 (Figure 5.9; Appendices B3 and B4).

The periphyton community in the Aimaokatalok River was dominated by three taxonomic groups: Bacillariophyta (29.4 and 48.7% of total cell numbers), Chlorophyta (24.4 and 39.5%) and Cyanophyta (11.8 and 45.7%) (Figure 5.9; Appendices B3 and B4). The major contributor to the Bacillariophyta was *Tabellaria flocculosa*. Chlorophyta were comprised largely of *Ankistrodesmus falcatus* and an unidentified unicellular species. Cyanophyta were mainly represented by *Gomphosphaeria nagelianum*.

5.2.6 Reference Outflow

Two periphyton sampling sessions were conducted on Reference Outflow during the summers of 1997 and 1998. Total algal cell numbers (±1 SE) ranged from

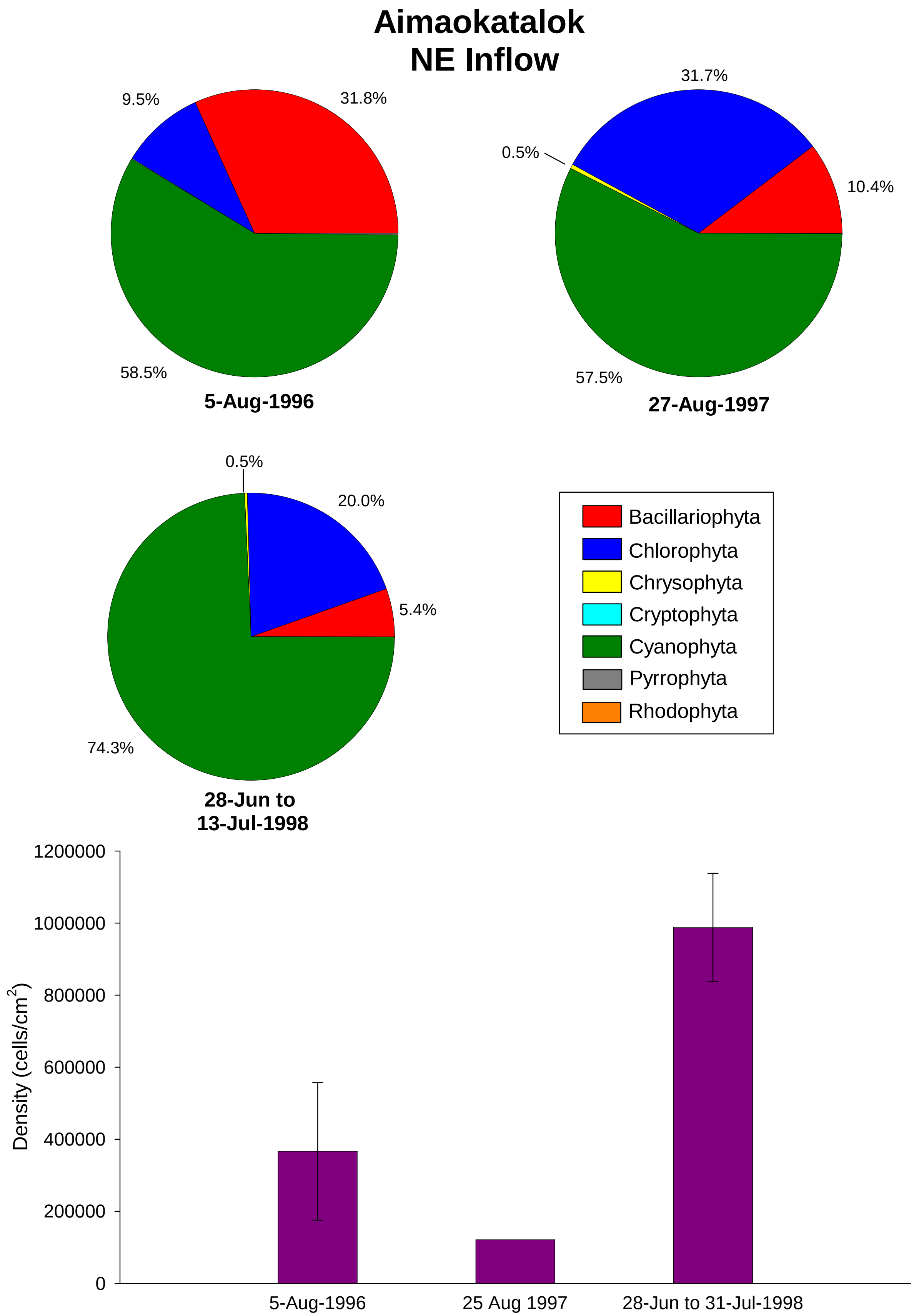
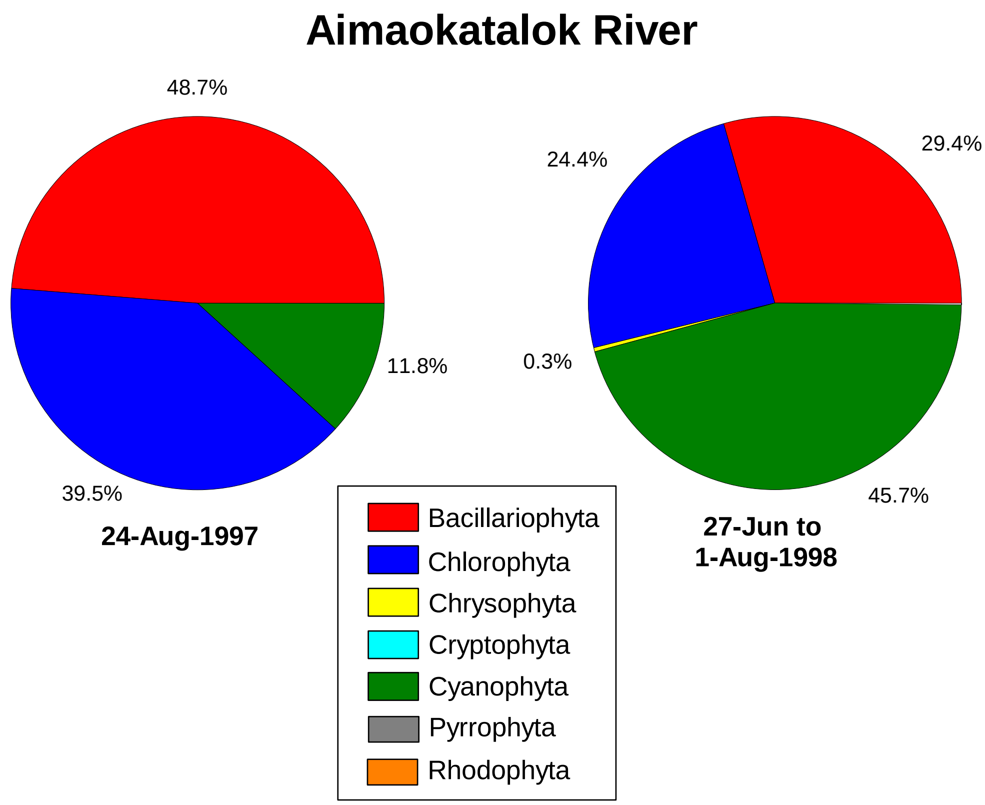


Figure 5.8 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of periphyton in Aimaokatalok NE Inflow 1996 to 1998.



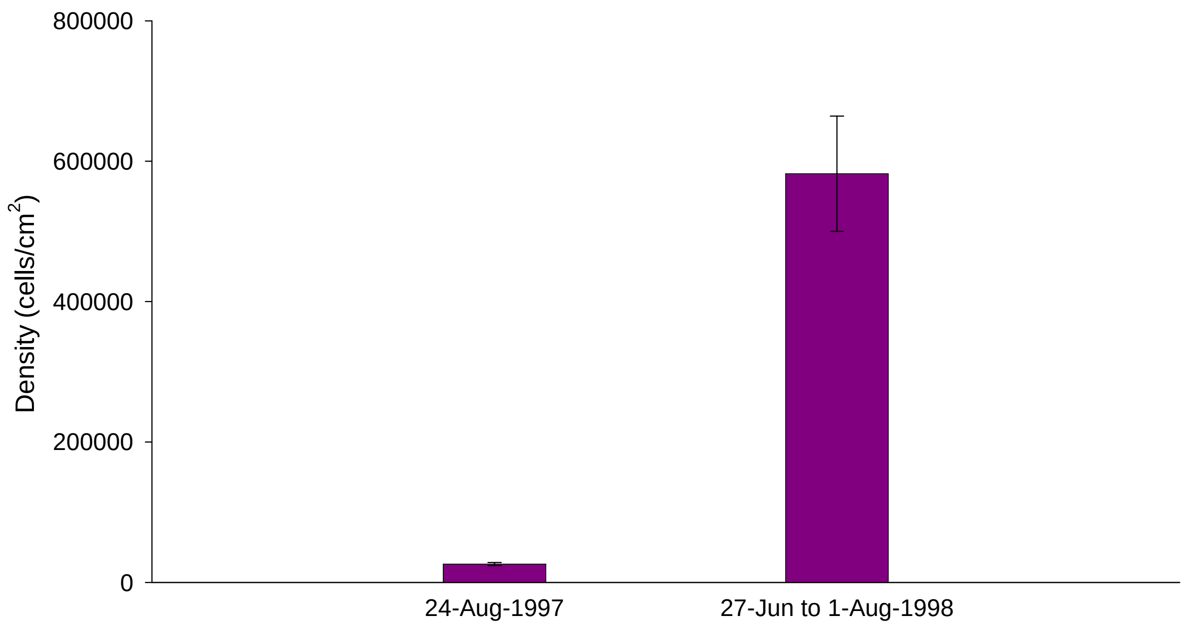


Figure 5.9 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of periphyton in Aimaokatalok River, 1997 to 1998.

175 ± 66 x 10^3 cells/cm^2 in 1998 to 247 ± 82 x 10^3 cells/cm^2 in 1997 (Figure 5.10; Appendices B3 and B4).

The periphyton community in Reference Outflow was equally dominated by three taxonomic groups: Bacillariophyta (18.9 and 42.0% of total cell numbers), Chlorophyta (20.5 and 23.6%) and Cyanophyta (36.6 and 56.7%) (Figure 5.10; Appendices B3 and B4). The major contributor to the Bacillariophyta was *Diatoma elongatum*. Chlorophyta were comprised largely of *Tetraspora* spp. and *Oedogonium* sp. Cyanophyta were mainly represented by *Clastidium setiferum* and *Gomphosphaeria nagelianum.*

5.2.7 Summary

For the Boston area streams, a comparison of mean periphyton abundance suggested that Fickle Duck Outflow was the most productive and Reference Outflow was the least productive stream (Table 5.4). Based on chlorophyll *a* concentrations, which is a biomass estimate of live algae, Reference Outflow was the most productive, whereas Fickle Duck Outflow was the least productive. The discrepancy between the results based on cell abundance and chlorophyll *a* concentrations was likely related to the relatively small cell size of Cyanophyta, which could greatly contribute to high numerical abundance (cells/cm^2) without an associated increase in algal biomass.

Table 5.4 Summary of Periphyton Abundance in Boston Area Streams, 1993 to 1998

Waterbody	Number of Sampling Events	Mean Abundance (cells/cm^2)	June 1998 Chlorophyll *a* (µg/cm^2)	July/Aug 1998 Chlorophyll *a* (µg/cm^2)
Stickleback Outflow	5	510 784	-	49.76
Fickle Duck Outflow	4	1 489 118	124.08	88.74
Aimaokatalok NE Inflow	3	491 534	51.94	370.88
Aimaokatalok River	2	304 172	199.54	49.38
Reference Outflow	2	210 974	371.65	95.02

Similar to the phytoplankton (see Section 5.1), the numerical dominance by Cyanophyta (mainly *Gomphosphaeria nagelianum and Lyngbya limnetica*) among the five Boston area streams suggested that this group was able to take advantage of environmental conditions and substantially increase its population. In contrast to the phytoplankton, Bacillariophyta (mainly *Tabellaria flocculosa)* and Chlorophyta made significant contributions to periphyton communities, and typically co-dominated along with Cyanophyta. The co-dominance of several taxonomic groups makes the assessment of water quality difficult. As Cyanophyta can fix atmospheric nitrogen, the incomplete dominance of this

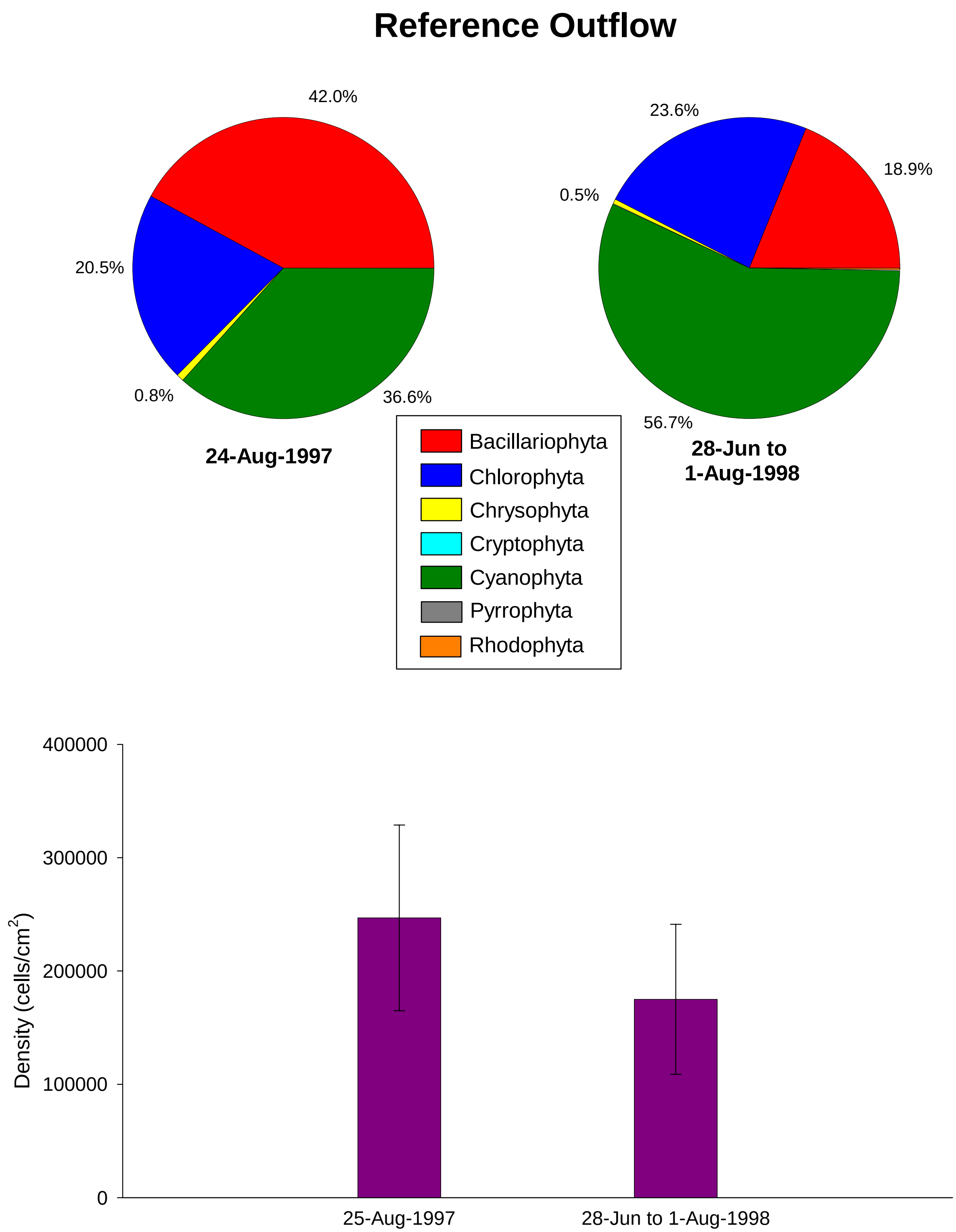


Figure 5.10 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of periphyton in Reference Outflow, 1997 to 1998.

group generally suggested that nitrogen levels were not the single limiting factor. The dominant periphyton taxa were those that form filaments or gelatinous bags and are able to attach to substrata in flowing waters. The above observations were consistent with those made in other streams of the Arctic and sub-Arctic (RL&L 1997, 1998, and 1999).

6 SECONDARY PRODUCERS

6.1 ZOOPLANKTON IN LAKES

In general, zooplankton are small animals that inhabit the water column of lakes. Zooplankton consume phytoplankton and other organic matter. Zooplankton are an important food source for large invertebrates and fish. The information presented is based on data from annual data reports (Rescan 1993, 1994, 1995, 1997, 1998, and 1999a).

6.1.1 Methods

Zooplankton samples were collected from four lakes within the Boston area between 1993 and 1998 (Figure 6.1) (Rescan 1993, 1994, 1995, 1997, 1998, and 1999a). Three to 13 sampling sessions were conducted on each lake. Zooplankton samples were not collected in 1994 (Table 6.1).

Table 6.1 Zooplankton Sampling Schedule in Boston Area Lakes, 1993 to 1998

Waterbody	Sampling Station	Date					
		1993	1994	1995	1996	1997	1998
Aimaokatalok Lake	WQ5	Aug		2 Aug			
	Stn 1					24 Jul	
	Stn 4						18 July
	Stn 5				4 & 24 Aug	24 Jul & 25 Aug	
	WQ9/Stn 6				4 & 24 Aug	24 Jul & 25 Aug	18 July
Stickleback Lake		Aug		3 Aug	4 & 25 Aug	23 Jul & 25 Aug	19 July
Fickle Duck Lake				3 Aug	5 & 25 Aug	23 Jul & 26 Aug	19 July
Reference Lake						23 Jul & 27 Aug	22 July

Zooplankton samples were collected with a 118 µm mesh net with an opening diameter of 30 cm. Triplicate zooplankton samples were collected during each sampling session, except for 1993 when only single samples were collected. At each site, samples were collected from the entire water column beginning at a depth 2 m above the bottom sediments. At each site, a single haul was collected by vertically raising the net at a constant speed of 0.5 m/s. Each sample was transferred to a clean 500-mL plastic bottle, preserved with 10% formalin, and labeled. All samples were submitted to Applied Technical Services, Victoria, BC, for taxonomic identification and enumeration.

Although all zooplankton abundance data had been reported by Rescan in terms of number of animals per cubic metre (i.e., standardized to account for depth differences, between vertical hauls and net diameter), data from 1995 and 1996 (Rescan 1996, 1997) appeared to be in an unconverted form (i.e., number of animals per sample), as confirmed with Applied Technical Services, who performed the original analysis. To allow comparisons of zooplankton abundance, the zooplankton data from 1995 and 1996 were converted into animals/m^3 by applying the same conversion factors that were used in 1997 (Rescan 1998). Additionally, all 1993 data were excluded from the summary calculations of zooplankton abundance for Aimaokatalok and Stickleback lakes. Due to the large number of rotifers collected in 1993 compared to other years, and the lack of identification further than the phylum Rotifera, we were not confident that these samples were processed properly.

6.1.2 Aimaokatalok Lake

Thirteen zooplankton sampling events were conducted on Aimaokatalok Lake during summer, including one each in 1993 and 1995, four in 1996, five in 1997 and two in 1998. Mean total numbers (±1 SE) ranged from 1816 ± 115 animals/m^3 on 24 July 1997 to 72 596 ± 7735 animals/m^3 on 6 August 1996 (Figure 6.2; Appendices C1 and C2).

At most sites and times cyclopoid copepods (Cyclopoida) dominated the zooplankton community of Aimaokatalok Lake, contributing between 23.3 and 86.9% towards the total number of animals recorded per sample. The major contributors to Cyclopoida were juvenile *Lichomolgidae* nauplii, which are parasites. The second most abundant group were Rotifera (wheel-animals), contributing between 9.5 and 66.3%, largely dominated by *Kellicottia longispina* and *Trichocerca* sp. In August 1996, large numbers (up to 26 453 animals/m^3) of Cladocera (water fleas, mostly *Daphnia longiremis*) were found at several sites (Figure 6.2; Appendices C1 and C2).

6.1.3 Stickleback Lake

Seven zooplankton sampling sessions were conducted on Stickleback Lake, including once during 1993 and 1995, twice in 1996 and 1997, and once in 1998. Mean total numbers (±1 SE) ranged from 1127 ± 124 animals/m^3 on 25 August 1996 to 911 697 animals/m^3 in a single sample from August 1993 (Figure 6.3; Appendices C1 and C2).

Cyclopoid copepods contributed the most (between 21.3 and 98.5%) towards total numbers in most years (except for the 1993 sample, which was composed

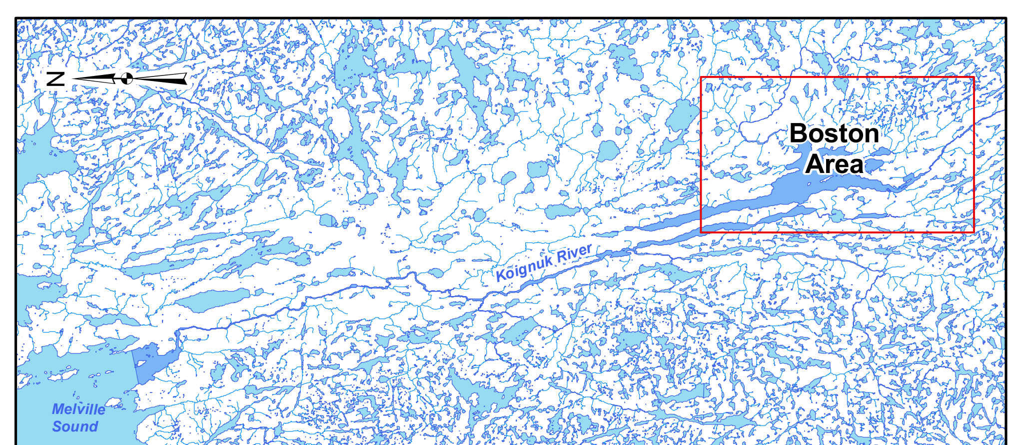
LEGEND

▲	Zooplankton sampling locations	*WQ X / STN X*	Sampling station names from Rescan Reports
●	Drift sampling locations	*95-97*	Consequtive years of sampling at station
	Rivers		
	Study area waterbodies		
	Waterbodies		

REFERENCE

Sources: Data Obtained from the Government of Canada, Natural Resources Canada, Centre for Topographic Information
Projection: UTM Zone 13N Datum: NAD 83

This map is for information purposes only. Golder Associates Ltd. does not accept any liability arising from its misuse or misrepresentation.



1500 0 1500
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MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

Zooplankton and Macroinvertebrate Drift Sampling Locations, 1993 - 1998

Golder Associates
Edmonton, Alberta

PROJECT No.06-1373-028			SCALE AS SHOWN	REV. 0
DESIGN	JP	22 April 2008		
GIS	RC	22 April 2008		
CHECK	JP	14 May 2008		
REVIEW	GA	16 May 2008		

FIGURE: 6.1

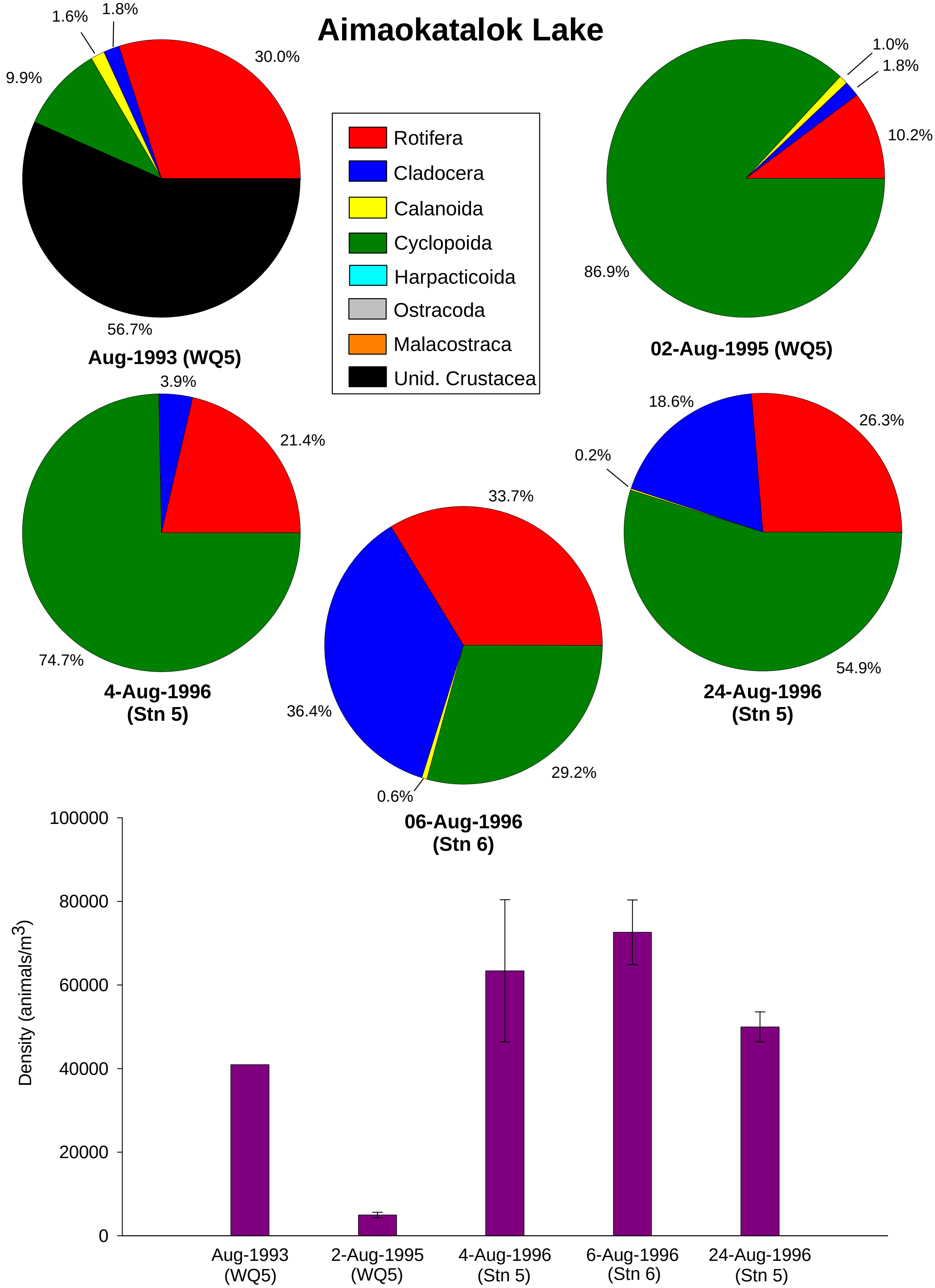


Figure 6.2 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Aimaokatalok Lake, 1993 to 1998.

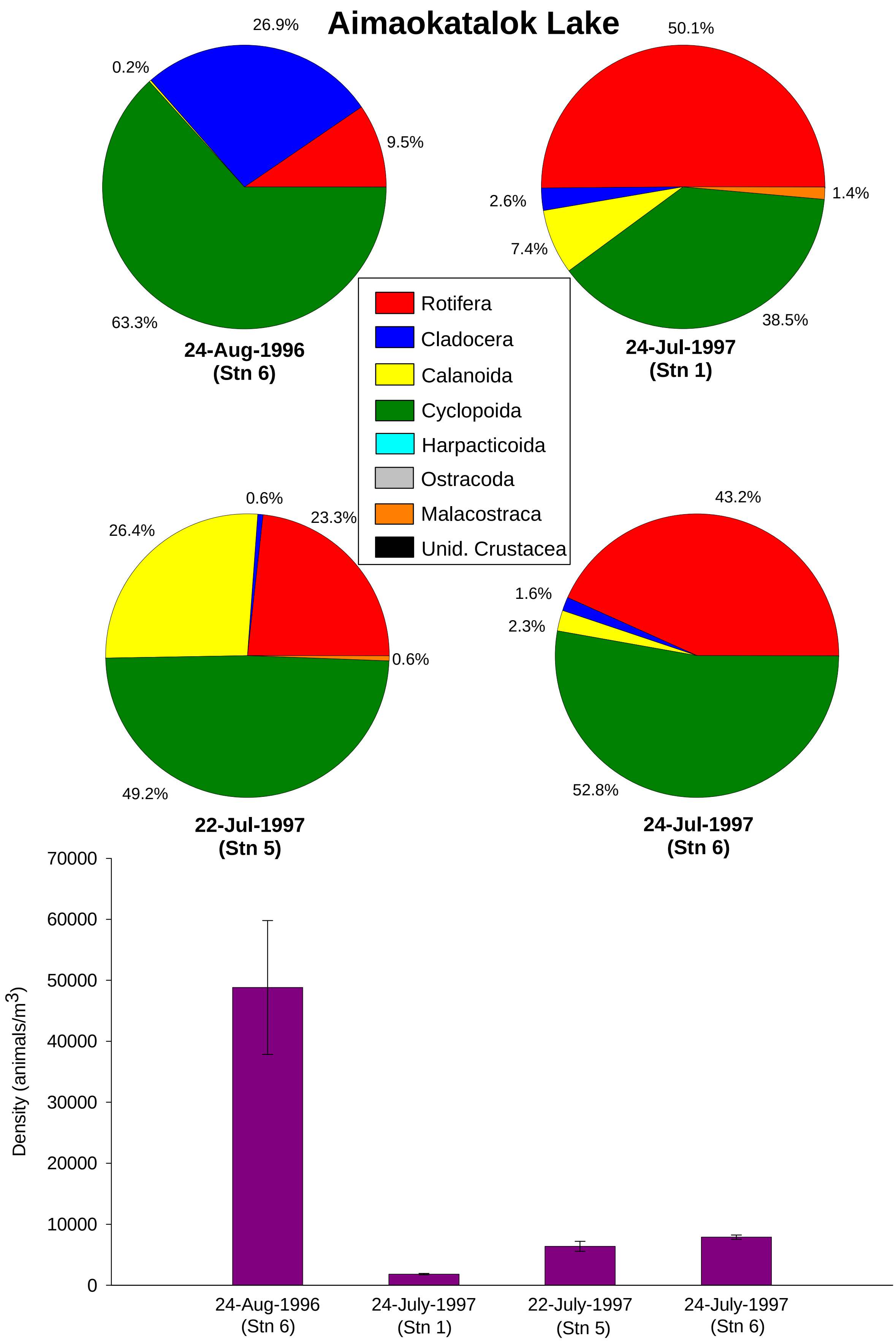


Figure 6.2 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Aimaokatalok Lake, 1993 to 1998.

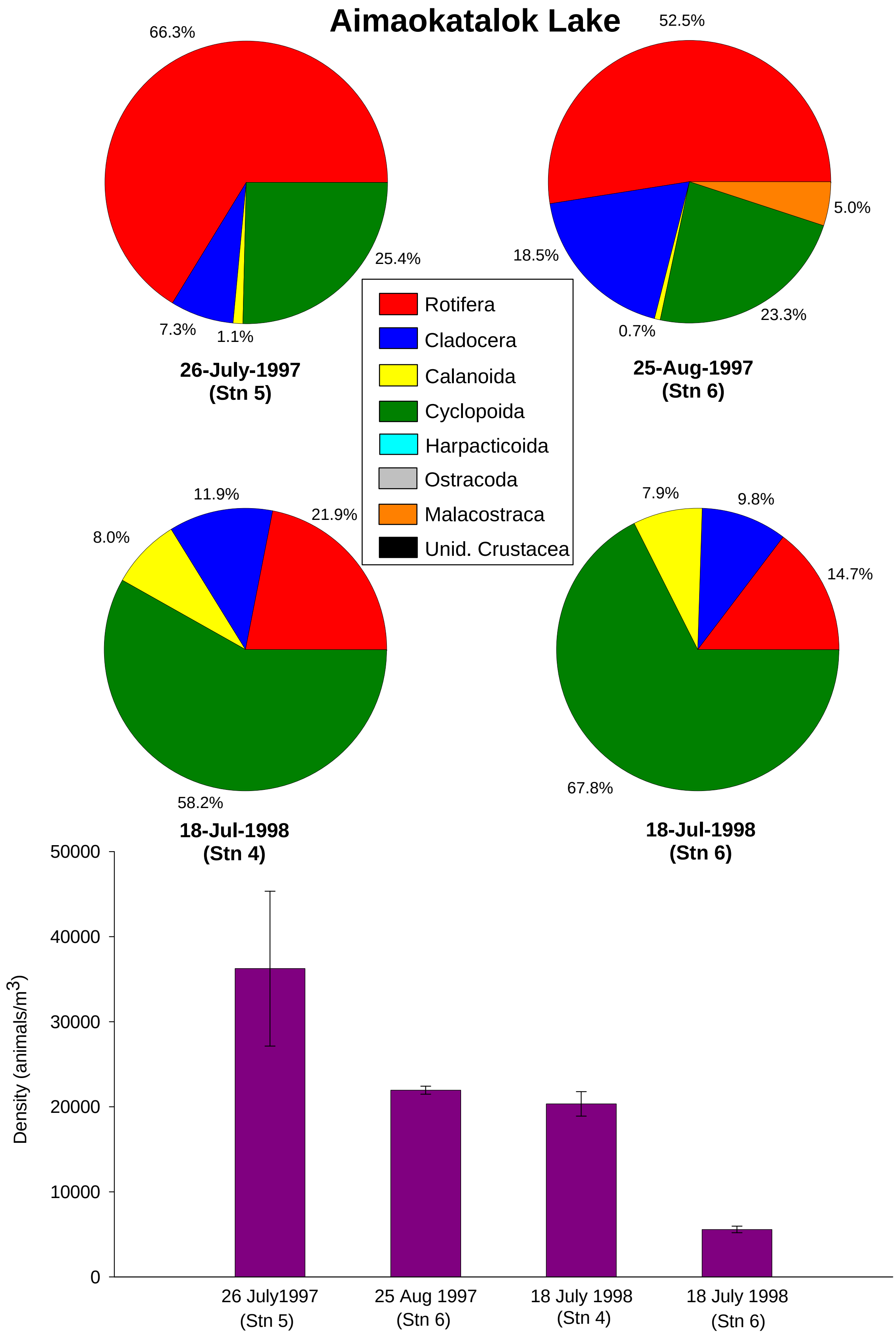


Figure 6.2 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Aimaokatalok Lake, 1993 to 1998.

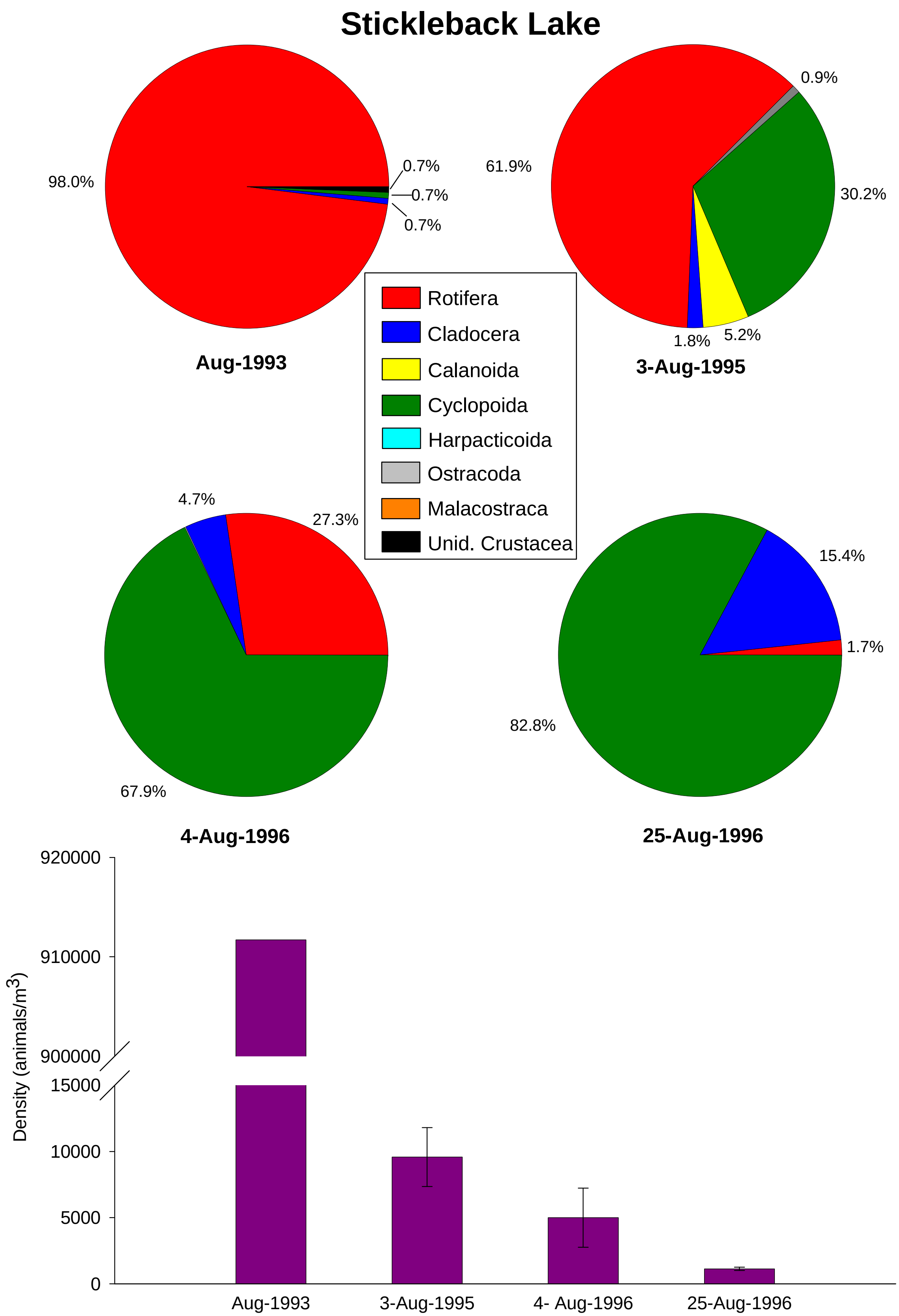


Figure 6.3 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Stickleback Lake, 1993 to 1998.

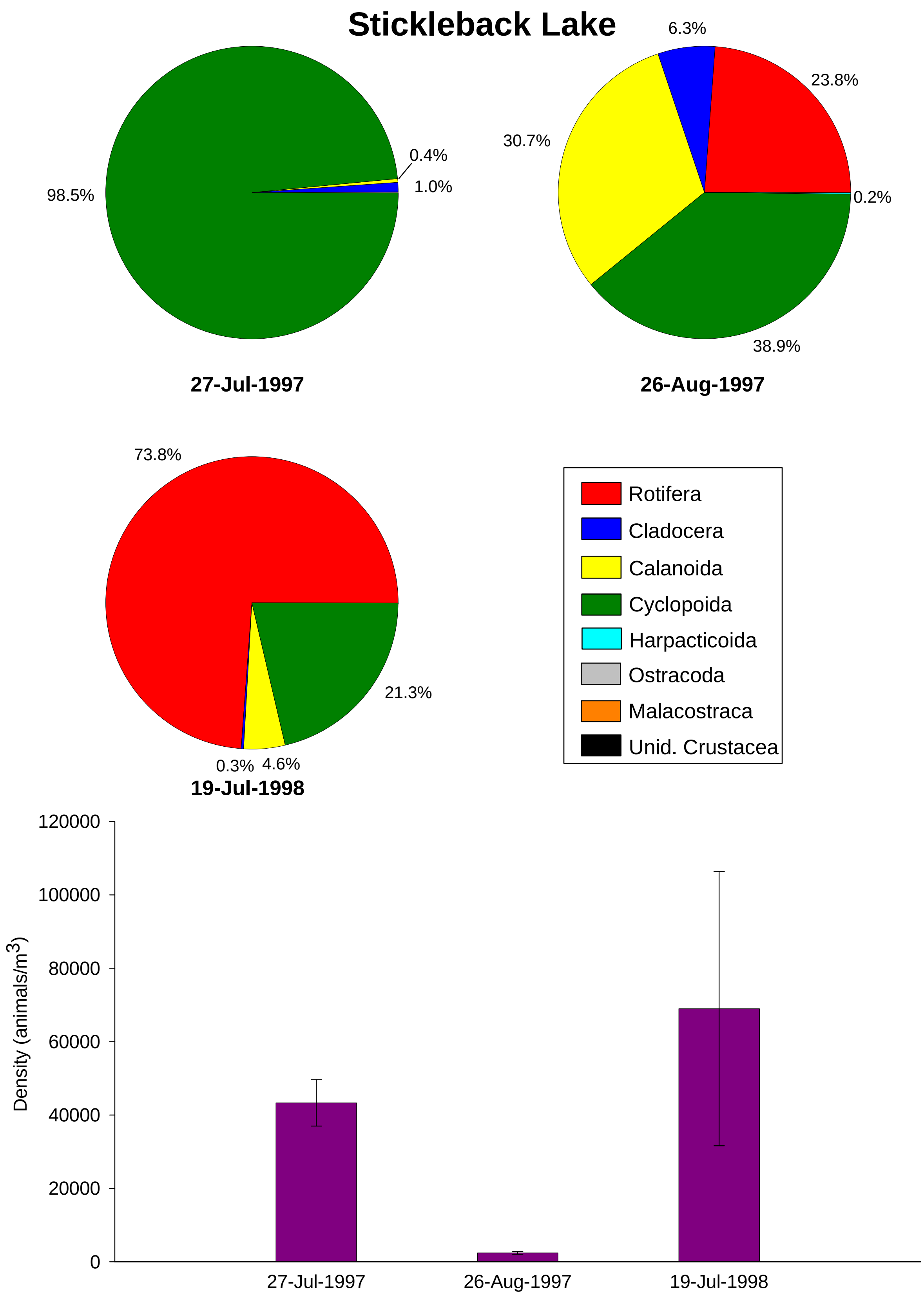


Figure 6.3 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Stickleback Lake, 1993 to 1998.

almost exlusively by Rotifera). Rotifers varied greatly in abundance, from 19 animals/m^3 in August 1996 to 893 584 animals/m^3 in August 1993. The major contributors to the cyclopoids were immature copepodites (the most abundant species of adult size was *Cyclops scutifer*), whereas *Kellicottia longispina* dominated the rotifers (Figure 6.3; Appendices C1 and C2).

6.1.4 Fickle Duck Lake

Six zooplankton sampling sessions were conducted on Fickle Duck Lake, including once during 1995, twice in 1996 and 1997, and once in 1998. Mean total abundance (±1 SE) ranged from 16 124 ± 2234 to 153 408 ± 17 981 animals/m^3 (Figure 6.4; Appendices C1 and C2).

Rotifera dominated the zooplankton community in Fickle Duck Lake, contributing between 30.8 and 91.8% towards the total mean animal count per sample (Figure 6.4; Appendices C1 and C2). The major contributors in this group were *Kellicottia longispina* and *Asplanchna* spp. In 1995, immature calanoid copepodites (Calanoida) of *Diaptomus* spp. and *Epischura nevadensis* contributed 46.9% of the zooplankton community, but were much less common in other years.

6.1.5 Reference Lake

Three zooplankton sampling sessions were conducted on Reference Lake, including twice in 1997 and once in 1998. Mean total numbers (±1 SE) ranged between 2001 ± 455 animals/m^3 in July 1997 and 16 589 ± 7293 animals/m^3 in August 1997 (Figure 6.5; Appendices C1 and C2).

In July 1997, the zooplankton of Reference Lake was dominated by calanoid copepods, which contributed 53.1% of the total mean animal count in the sample (Figure 6.5; Appendices C1 and C2); the major contributors within this major taxonomic group were adults and copopodites of *Leptodiaptomus pribilofensis*. In August of 1997 and July of 1998, Rotifera contributed 88.8 and 66.9%, respectively, to the total animal count, dominating the zooplankton community of Reference Lake. This major taxonomic group was represented primarily by *Kellicottia longispina*.

6.1.6 Summary

The zooplankton samples obtained from the Boston area lakes did not reveal any uncommon or rare species. The zooplankton communities (i.e., taxonomic composition) among the four waterbodies showed little differentiation and were

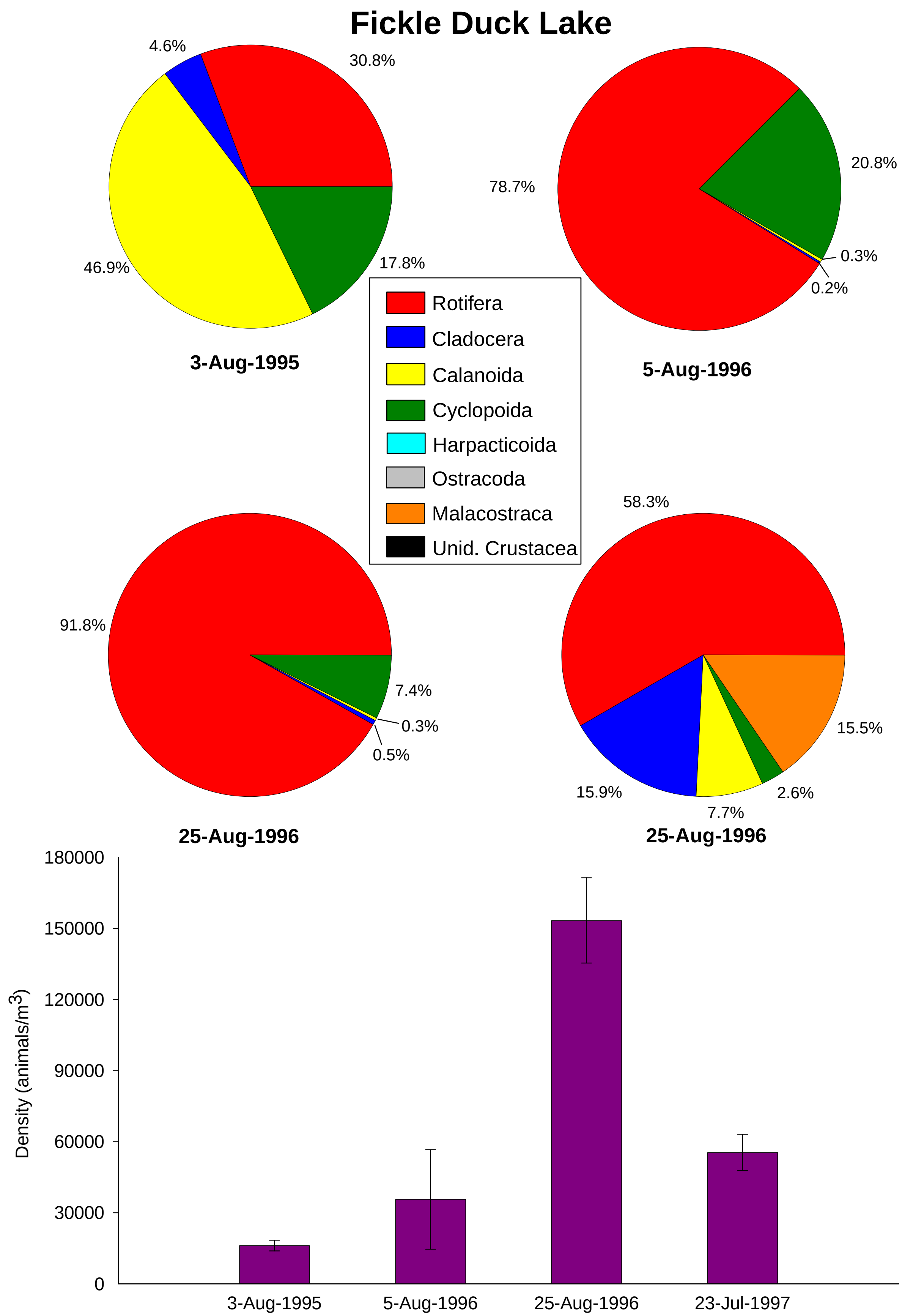


Figure 6.4 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Fickle Duck Lake, 1995 to 1998.

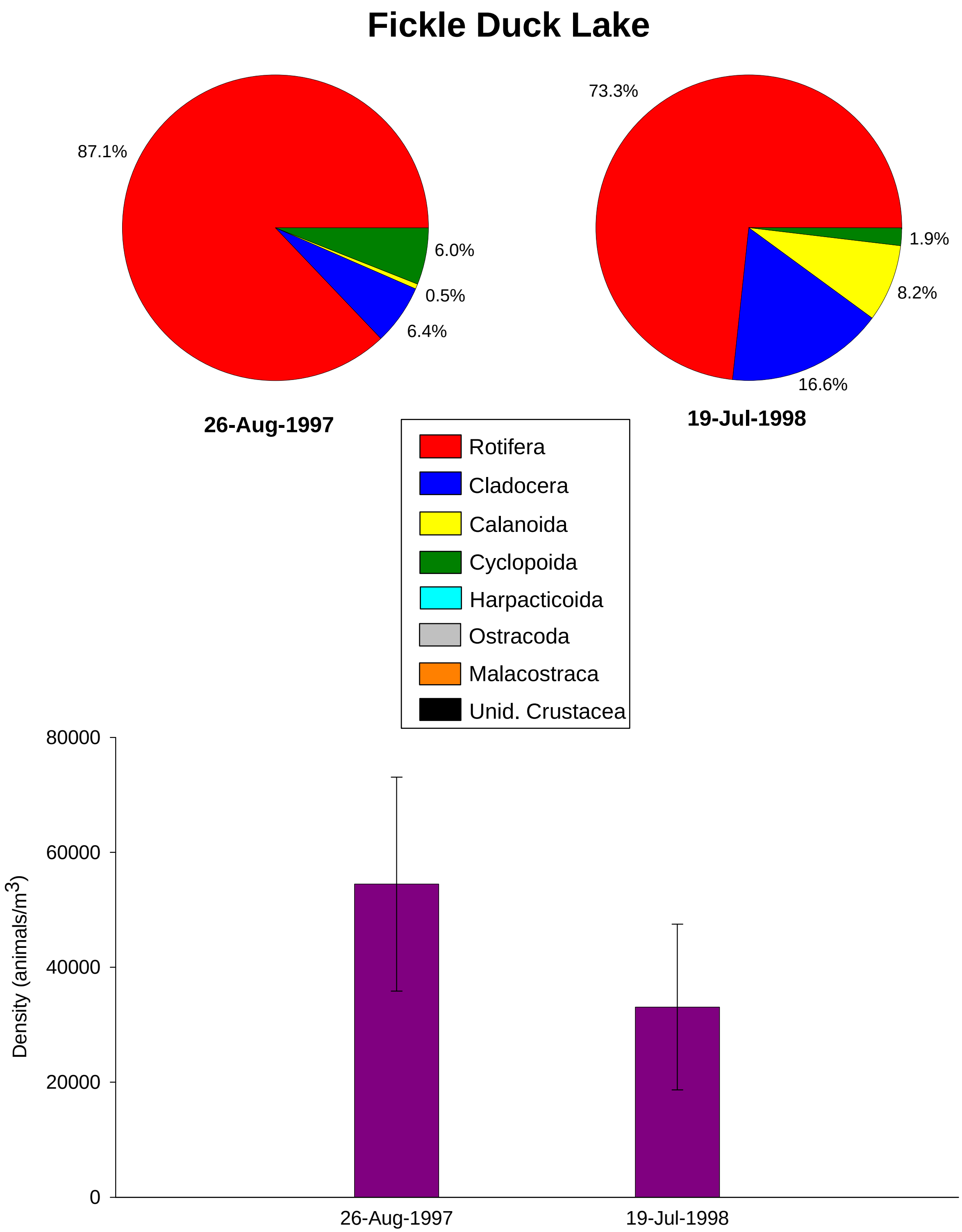


Figure 6.4 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Fickle Duck Lake, 1995 to 1998.

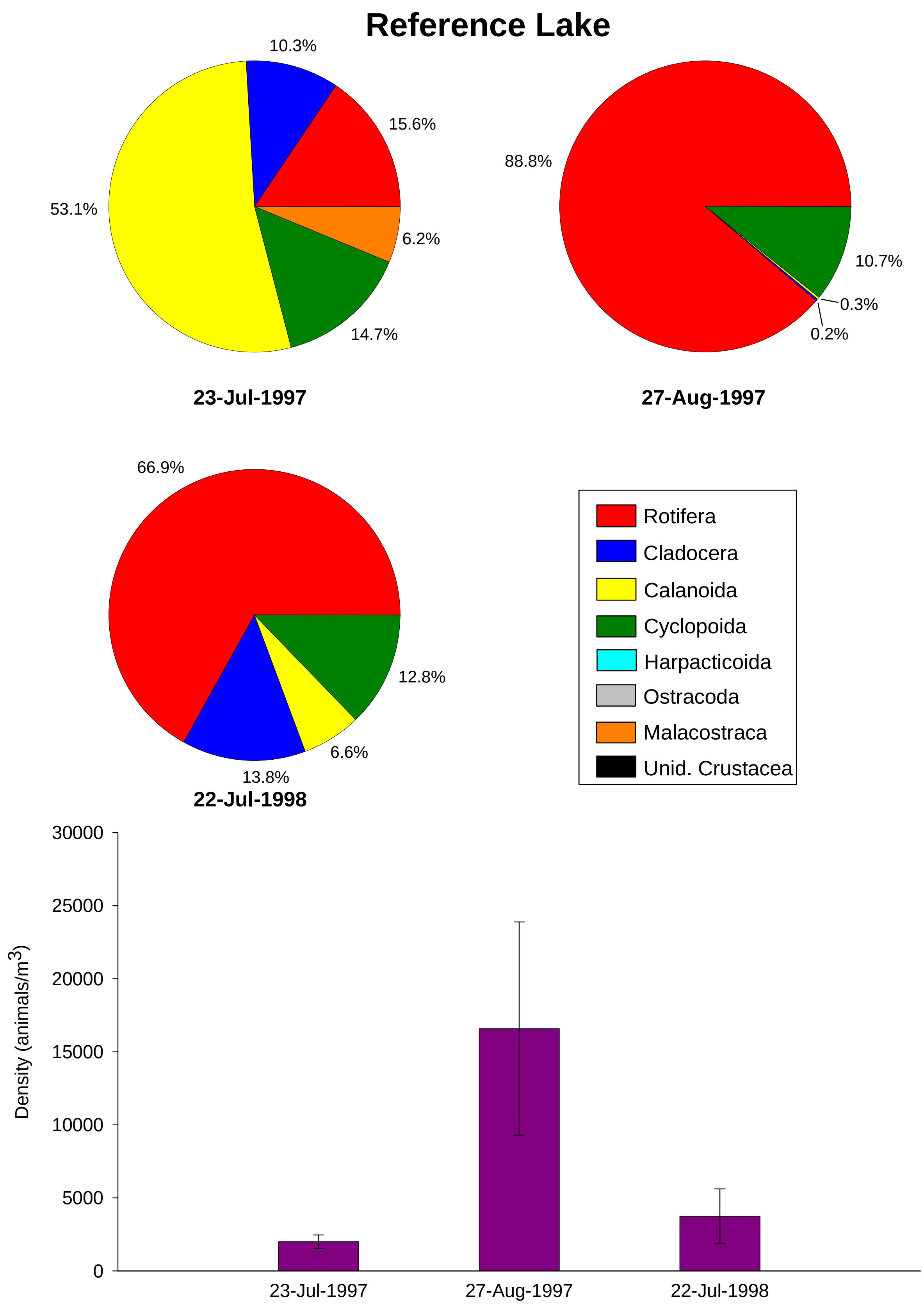


Figure 6.5 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of zooplankton in Reference Lake, 1997 to 1998.

similar in many respects to the communities of many other small lakes in the Arctic and sub-Arctic (Moore 1978a, and 1978b; RL&L 1997, 1998, and 1999).

In general, zooplankton communities within the Boston area lakes were numerically dominated by the rotifer *Kellicottia longispina*. It should be pointed out, however, that the numbers of rotifers reported were likely underestimated, because the mesh size of the zooplankton net was 118 µm (i.e., smaller rotifers could pass through the mesh). Among Copepoda, cyclopoid nauplii, copopodids and adult *Cyclops scutifer* were the most abundant. *Daphnia longiremis* was the most numerous cladoceran, but as a group, Cladocera were not abundant.

A comparison of mean zooplankton abundance indicated that Fickle Duck Lake was the most productive and Reference Lake was the least productive; mean total numbers among all sampling sessions in these two lakes were 58 018 animals/m^3 in Fickle Duck Lake and 7442 animals/m^3 in Reference Lake (Table 6.2). This observation may be somewhat misleading because biomass data, often reported as wet weight/m^3, were not reported by Rescan. In terms of biomass, large zooplankton species can dominate zooplankton communities, while remaining numerically subdominant. For example, Cladocera invariably dominated the biomass of eight study lakes near Rankin Inlet, Nunavut, and six lakes near Lupin, Nunavut, despite being overwhelmingly outnumbered by small-sized Rotifera (RL&L 1997, 1998, and 1999). Among zooplankton communities, Rotifera have small sized species relative to other groups, Copepoda have moderately sized species, and Cladocera have species that are large in size (particularly *Daphnia* spp.).

Table 6.2 Summary of Zooplankton Abundance in Boston Area Lakes, 1993 to 1998

Lake	Number of Sampling Events	Mean Total Density (animals/m^3)	Mean Number of Rotifera (animals/m^3)	Mean Number of Cyclopoida (animals/m^3)	Mean Number of Cladocera (animals/m^3)	Ratio of Rotifera to Cladocera	Ratio of Rotifera to Cyclopoida
Aimaokatalok[a]	13	28 323	8 579	14 094	5 110	1.68	0.61
Stickleback[a]	7	21 734	9 808	10 920	762	12.87	0.90
Fickle Duck	6	58 018	46 311	4 483	2 570	18.20	10.33
Reference	3	7 442	5 847	850	235	24.88	6.88

[a] 1993 data were not included due to potentially inaccurate identification and enumeration.

In the presence of sufficient food and the absence of zooplankton-feeding predators, zooplankton communities tend to be dominated by large-sized species (Lynch et al. 1977a; Vanni 1986a, and 1986b), although the species of certain genera such as *Daphnia* (large) and *Kellicottia* (small) may coexist in the absence of predators by partitioning an adequately diverse food source (Kerfoot and DeMott 1980). Many investigators have shown that a shift from large to small species is related to the presence of abundant fish or large invertebrate predators (Brooks and Dodson 1965; Hrbacek and Novotna-Dvorakova 1965; Anderson and Raasveldt 1974; Anderson 1980). Conversely, the decline or removal of fish may promote a return to large zooplankton species (Shapiro and Wright 1984). However, other studies have shown that the type and concentration of food available or a combination of a number of environmental factors in addition to food and/or predators may determine the size structure of zooplankton communities (Lynch 1977b, and 1980; Vanni 1986a, and 1986b). Based on the above, the presence of large numbers of moderately-sized zooplankton (i.e., Copepoda) relative to small-sized zooplankton (i.e., Rotifera), suggested that Aimaokatalok Lake may have lower predation pressure than Stickleback, Fickle Duck, and Reference lakes (Table 6.2).

Although the presence of large numbers of zooplankton-feeding predators (particularly cisco and whitefish species) is the most obvious explanation for the apparent shift from large to small body size in the zooplankton, other causes are possible. Large year-to-year fluctuations do occur in many small lake zooplankton communities, and it would be necessary to collect fish, zooplankton, and other limnological data consistently over a period of several years to be able to determine the causes of community structure changes and to ascertain the permanent or cyclical nature of these changes. For example, high flushing rates in small waterbodies are known to have an impact on community structure and abundance (Soballe and Kimmel 1987). In the Boston area lakes, flushing may reduce overall abundance without affecting zooplankton species composition. The strong winds reported in the Boston area (Klohn-Crippen 1995; Rescan 1997) and the morphology of the studied waterbodies (i.e., elongated and narrow basins) suggested that winds likely influenced the distribution of zooplankton, with some species likely affected more than others (Teraguchi et al. 1983). This wind factor may explain the considerable differences in abundance of certain species between different stations in the same waterbody or between years.

6.2 BENTHIC INVERTEBRATES IN LAKES

Benthic (bottom-dwelling) invertebrates (also termed macroinvertebrates because of their large size; some species can reach a few centimetres in length) are an important link in aquatic food webs. Most benthic invertebrates are herbivores, detritivores or filter feeders and derive much of their energy from aquatic plants and organic materials. Some benthic macroinvertebrates are predacious, generally feeding upon other invertebrates. Many fish species, including early life history stages of piscivorous species, feed upon benthic macroinvertebrates. The information presented is based on data from annual data reports (Rescan 1993, 1994, 1995, 1997, 1998, and 1999a).

6.2.1 Methods

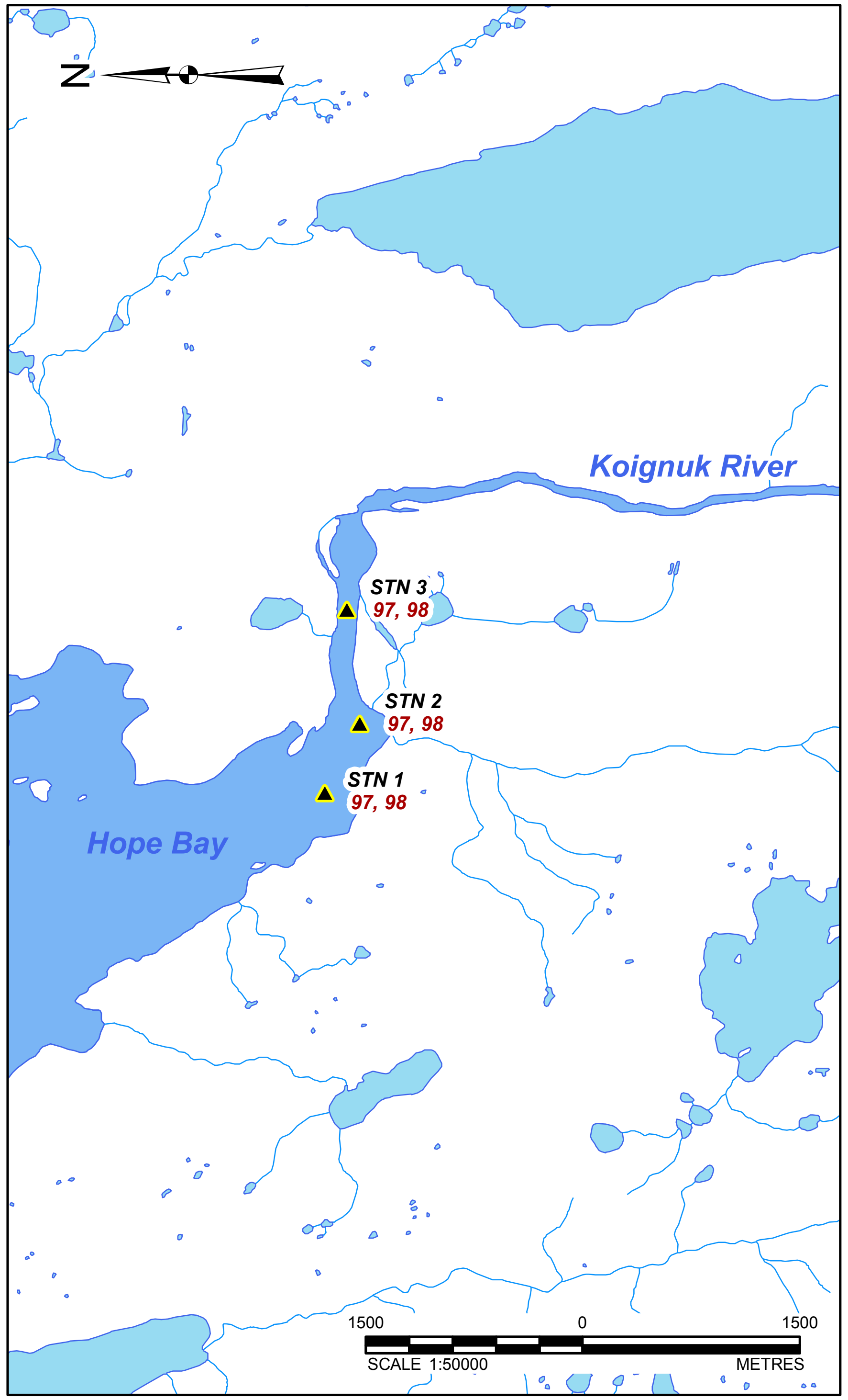
Benthic macroinvertebrates samples were collected from four lakes within the Boston area (Figure 6.6) (Rescan 1993, 1994, 1995, 1997, 1998, 1999a). Three to 18 sampling events were conducted on each lake between 1993 and 1998 (Table 6.3).

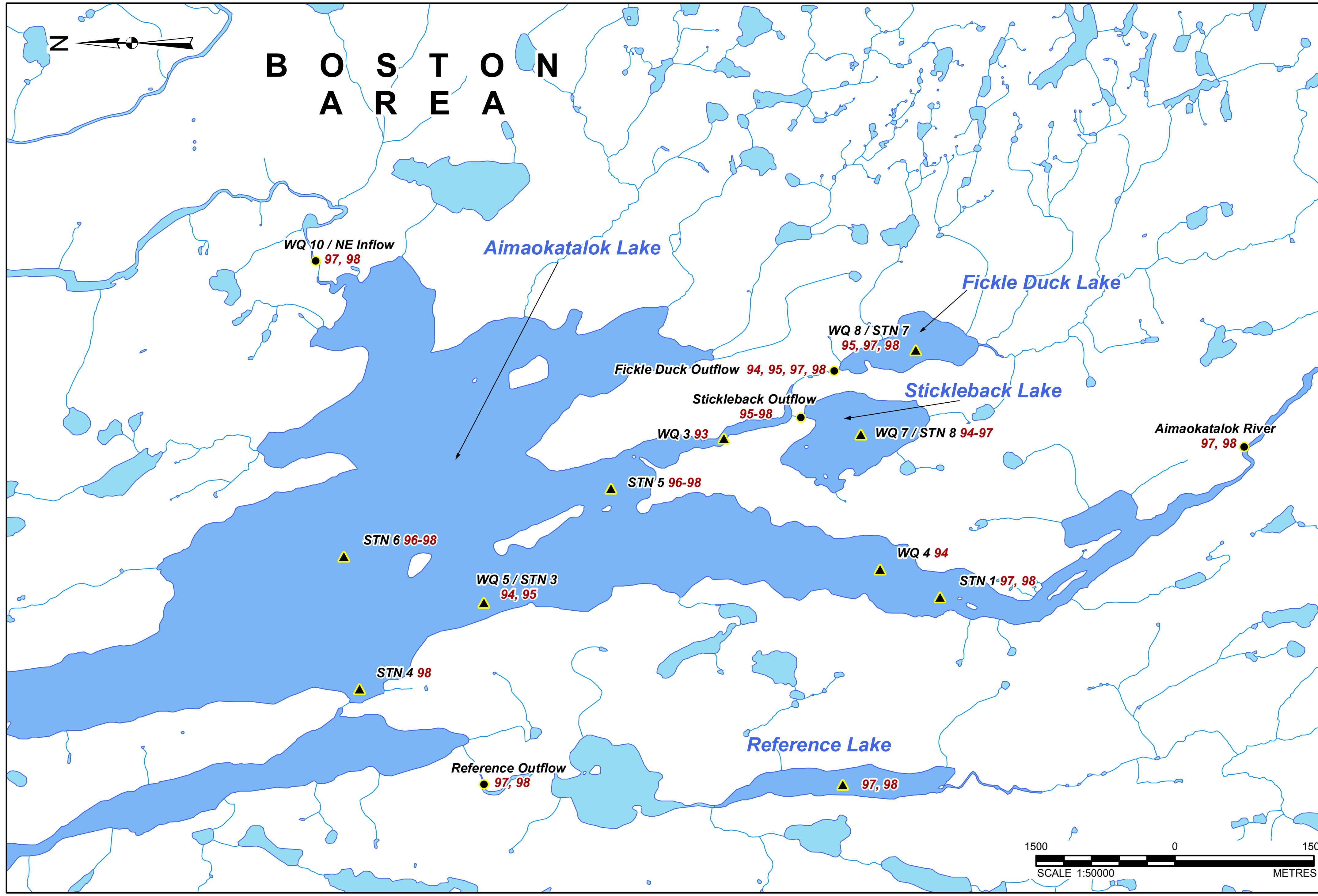
Table 6.3 Benthic Invertebrate Sampling Schedule in Boston Area Lakes, 1993 to 1998

Waterbody	Sampling Station	Date					
		1993	1994	1995	1996	1997	1998
Aimaokatalok Lake	WQ3	Aug					
	WQ4		Aug				
	WQ5		Aug	2 Aug			
	Stn 1					24 Jul & 26 Aug	17 Jul
	Stn 4						17 Jul
	Stn 5				4 & 24 Aug	24 Jul & 26 Aug	17 Jul
	Stn 6				4 & 24 Aug	24 Jul & 26 Aug	17 Jul
Stickleback Lake			Aug	3 Aug	5 & 25 Aug	23 Jul & 26 Aug	19 Jul
Fickle Duck Lake				3 Aug		23 Jul & 26 Aug	19 Jul
Reference Lake						23 Jul & 27 Aug	22 Jul

Benthic macroinvertebrate samples were collected using an Ekman grab with a sampling area of 0.0225 m^2. Except for 1993 and 1994 when only single samples were collected, triplicate samples were collected during each sampling event from 1995 to 1998. For Stickleback, Fickle Duck, and Reference lakes, sample collections were taken from shallow (littoral zone) locations that were generally less than 3.0 m in depth. Sample locations in Aimaokatalok Lake were taken from both shallow (up to 6.5 m in depth) and deep (10 to 29 m in depth) locations. Deep sampling locations included WQ5 and Station 6. Shallow sampling locations included WQ3, WQ4, Station 1, Station 4, and Station 5. Each replicate sample was sieved over 0.493 mm mesh, transferred to a clean 500-mL plastic bottle, preserved with 10% formalin, and labeled. All samples were submitted to Applied Technical Services in Victoria, BC for taxonomic identification and enumeration. Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) are taxa of interest due to their sensitivity to pollution and their use as a biomonitoring index (Rosenberg and Resh 1993). However, because of their low abundance in Boston area lakes, they were treated as one taxonomic group and were not evaluated separately when calculating relative abundances.

Benthic macroinvertebrate results from 1995 sampling appear to have been reported as the number of individuals/sample, even though the appendix indicates





LEGEND

▲	Lake/marine sampling locations	*WQ X / STN X*	Sampling station names from Rescan Reports
●	Stream sampling locations	*95-97*	Consequtive years of sampling at station
	Rivers		
	Study area waterbodies		
	Waterbodies		

REFERENCE

Sources: Data Obtained from the Government of Canada, Natural Resources Canada, Centre for Topographic Information
Projection: UTM Zone 13N Datum: NAD 83

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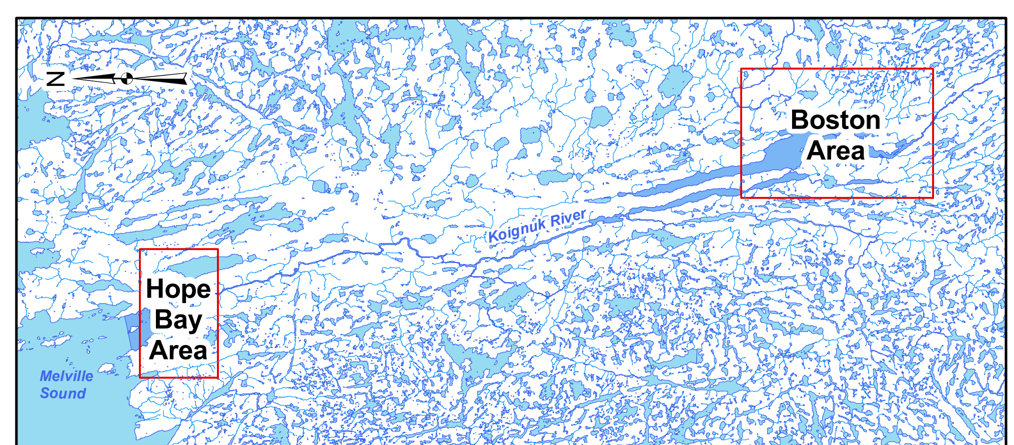


MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

Benthic Invertebrate Sampling Locations, 1993 - 2000

PROJECT No.06-1373-028			SCALE AS SHOWN / REV. 1
DESIGN	JP	22 April 2008	
GIS	RC	22 April 2008	
CHECK	JP	14 May 2008	
REVIEW	GA	21 May 2008	

Golder Associates
Edmonton, Alberta

FIGURE 6.6

that the data are individuals/m^2. To allow comparisons between years, results from 1995 were divided by 0.0225 m^2 to account for the area sampled by the Ekman grab.

6.2.2 Aimaokatalok Lake

Eighteen benthic macroinvertebrate summer sampling events were conducted on Aimaokatalok Lake; these included one in 1993 and 1995, two in 1994, four in 1996, six in 1997, and four in 1998. Mean total numbers (±1 SE) from the shallow locations ranged from 193 ± 104 animals/m^2 on 26 August 1997 to 19 378 animals/m^2 in a single sample from 1993. Mean total number of benthic macroinvertebrates from the deep locations ranged from 104 ± 15 animals/m^2 in July 1998 to 3437 animals/m^2 (no SE was not calculated because only one sample was collected) in August 1994 (Figure 6.7; Appendices C3 and C4).

Shallow Locations

Three taxa dominated the benthos at shallow depths in Aimaokatalok Lake. Chironomidae (midges) were well represented during most sampling sessions; this taxon contributed between 10.2 and 92.3% to total numbers. Several species contributed to the abundance of Chironomidae, none being clearly dominant across years and sites. Pelecypoda (clams), represented by Sphaeriidae (*Pisidium* spp. and *Sphaerium* spp.), were generally low in abundance from Station 1 and WQ 3 in the southern arm of Aimaokatalok Lake (0.0 to 13.6%), but typically more abundant at other shallow stations (11.4 to 57.1%). Nematoda (round worms) had high contributions to total number (up to 45.9%) in most years, except for 1997 (0.0 to 7.7%) (Figure 6.7; Appendices C3 and C4). Nematodes are typically not identified to lower taxonomic levels.

Deep Locations

Chironomidae dominated the benthos of Aimaokatalok Lake at depths greater than 10 m (Figure 6.7; Appendices C3 and C4). This taxon contributed between 10.2 and 71.5% to total mean number of animals among the sample dates and locations. Several species contributed to the abundance of Chironomidae, none being clearly dominant. With the exception of being absent from Station 6 on 18 July 1998, Pelecypoda had large contributions to the benthic community of Aimaokatalok Lake (21.6 to 60.0%). The exclusive contributors to Pelecypoda were *Pisidium* spp. and *Sphaerium* spp.

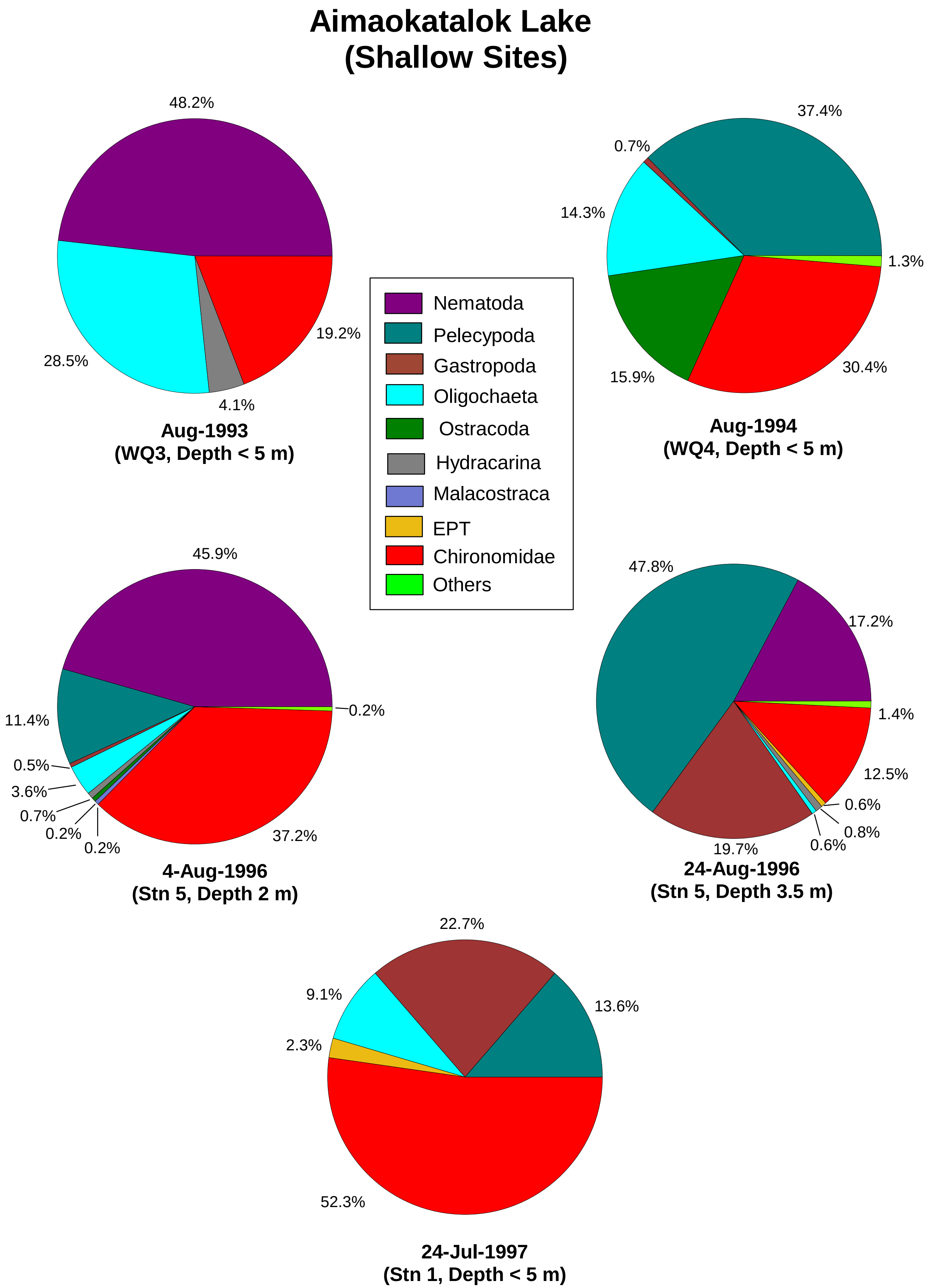


Figure 6.7. Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Aimaokatalok Lake, 1993 to 1998.

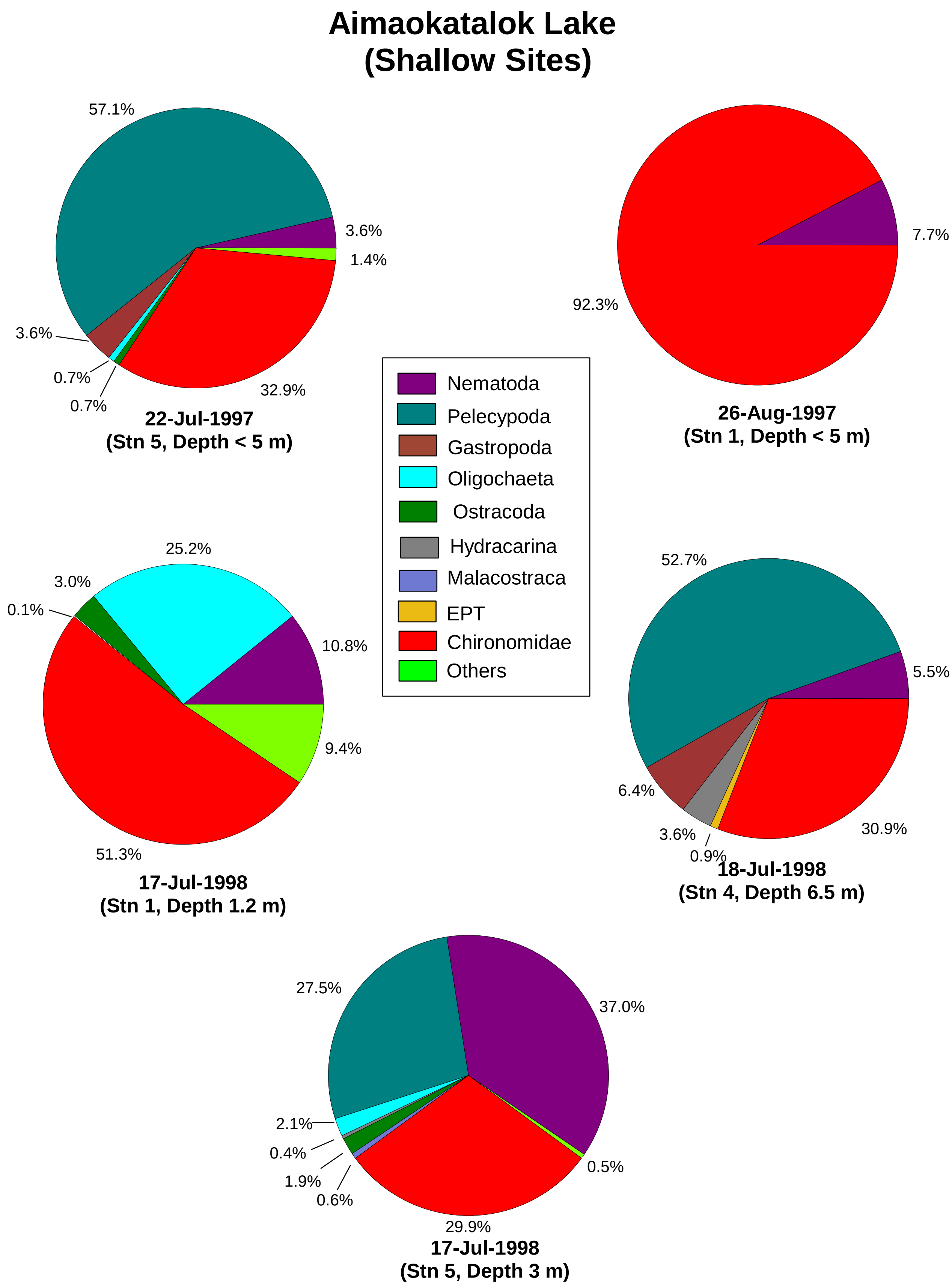


Figure 6.7 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Aimaokatalok Lake, 1993 to 1998.

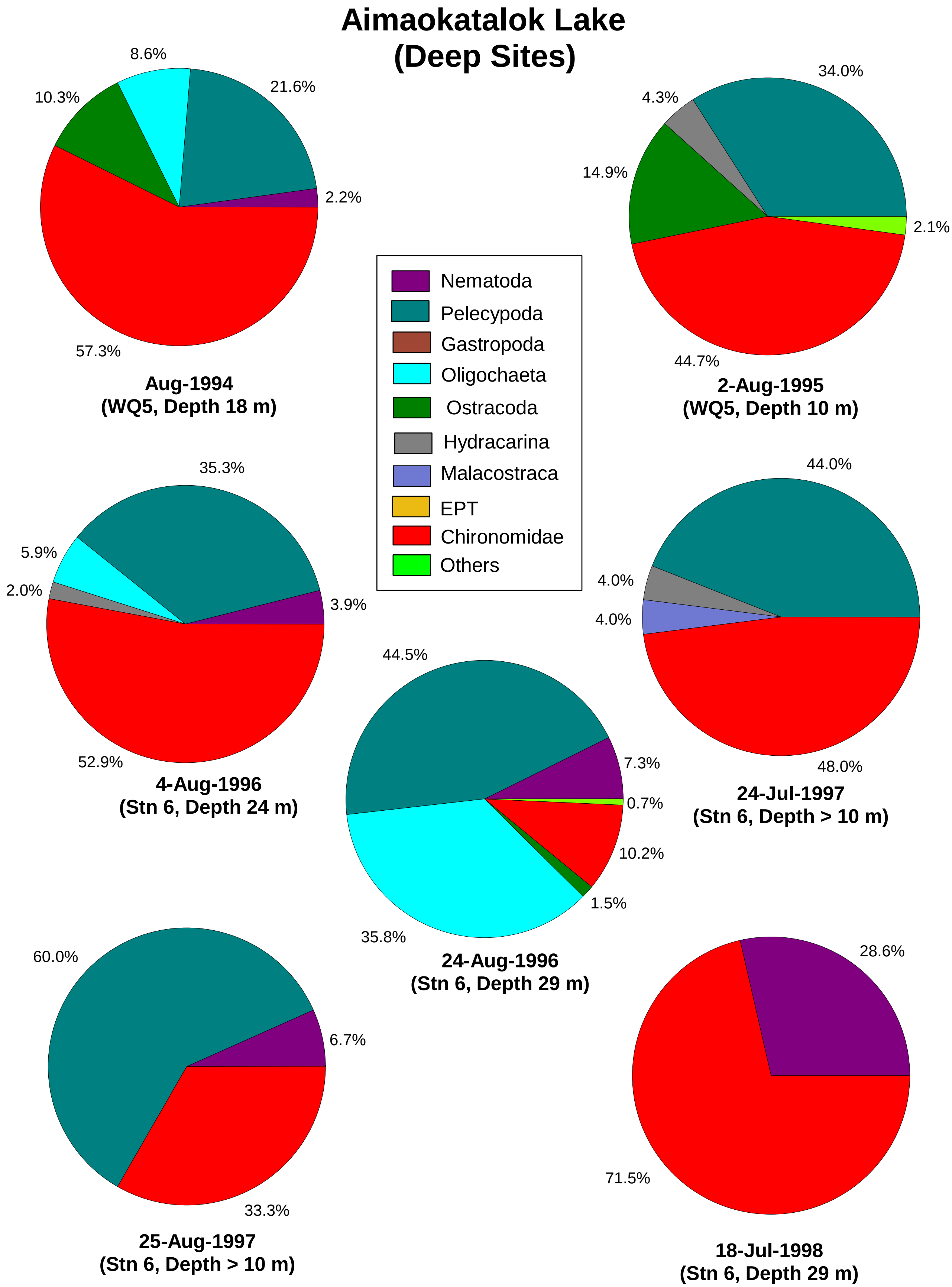


Figure 6.7 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Aimaokatalok Lake, 1993 to 1998.

Aimaokatalok Lake

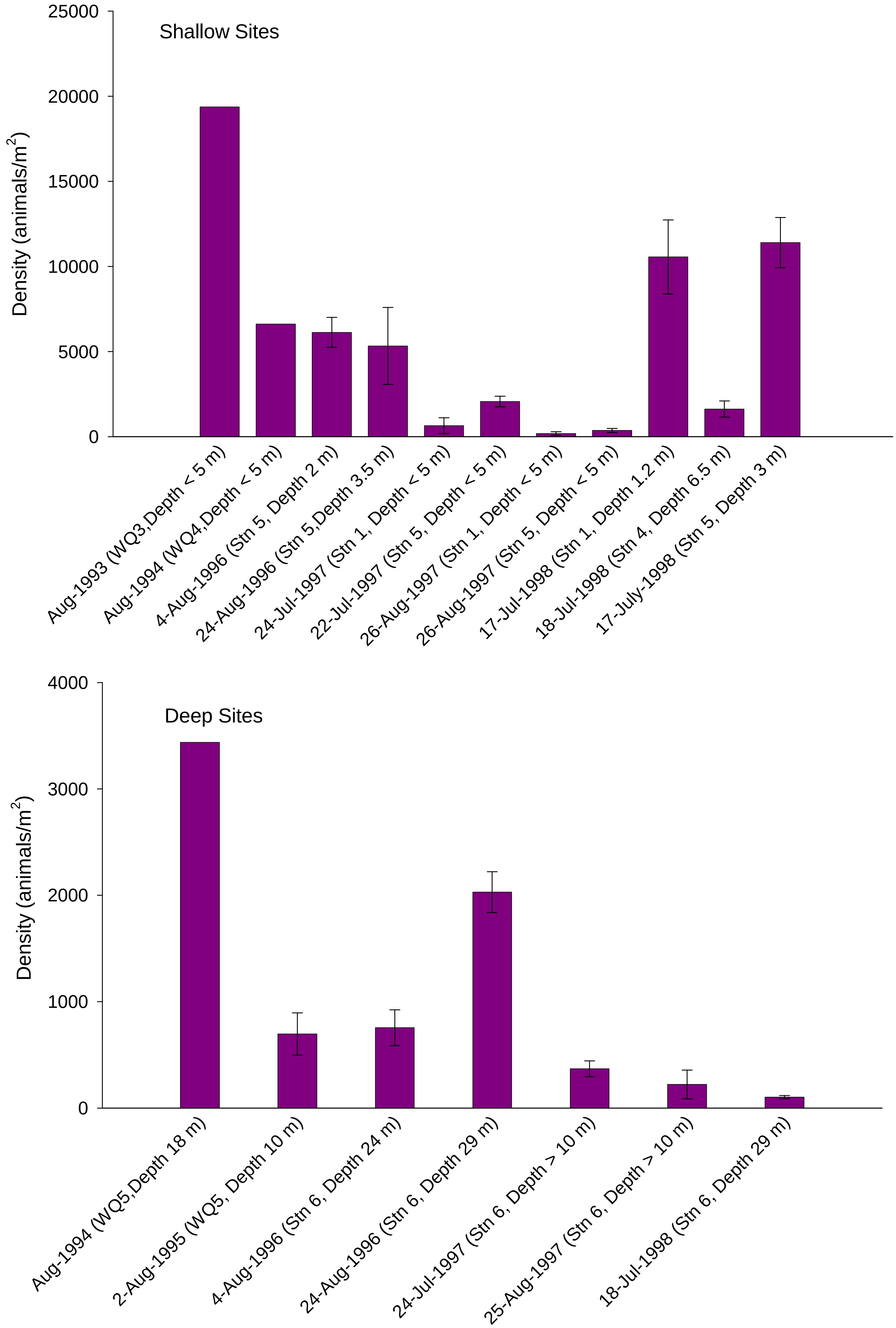


Figure 6.7 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Aimaokatalok Lake, 1993 to 1998.

6.2.3 Stickleback Lake

Seven benthic macroinvertebrate sampling sessions were conducted on Stickleback Lake in the summer; these included one session in 1994 and 1995, two in 1996 and 1997, and one in 1998. Samples were collected from shallow locations (water depths were 2.6 m or less). Mean total numbers (± 1 SE) ranged from 3185 ± 1095 animals/m^2 in late August 1997 to 41 226 ± 5241 animals/m^2 in early August 1996 (Figure 6.8; Appendices C3 and C4).

Overall, Chironomidae contributed the most (12.8 to 47.9%) to total mean numbers of benthic invertebrates within Stickleback Lake. Nematoda were well represented in the samples (0.5 to 64.0%), particularly during 1996. Ostracoda (seed shrimp) displayed contrasting results to Nematoda, having high abundances in most years (10.2 to 39.1%), except 1996 (1.9 and 3.3%).

6.2.4 Fickle Duck Lake

Benthic invertebrate sampling sessions on Fickle Duck Lake were conducted once in 1995, twice in 1997 and once in 1998. During all sessions, samples were collected from shallow waters (less than 3.0 m). Mean total numbers (±1 SE) were between 2637 ± 928 animals/m^2 in August 1997 and 5896 ± 1129 animals/m^2 in August 1995 (Figure 6.9; Appendices C3 and C4).

Chironomidae dominated the benthos of Fickle Duck Lake (contributed between 57.4 and 80.7% to the total mean animal count). Pelecypoda were second in abundance at 0.8 to 37.1% of total numbers (Figure 6.9; Appendices C3 and C4). The major contributors for the Chironomidae were *Zalutschia* spp., *Procladius* spp., and *Tanytarsus* spp. Pelecypoda were composed almost exclusively of *Sphaerium* spp.

6.2.5 Reference Lake

The benthic community of Reference Lake was sampled twice in 1997 and once in 1998, in water 2.5 m deep. Mean total numbers (±1 SE) were between 4237 ± 948 in July 1997 and 6163 ± 347 animals/m^2 in July 1998 (Figure 6.10; Appendices C3 and C4).

Chironomidae, which contributed between 28.3 and 82.4% to the total mean animal count, dominated the benthos of Reference Lake. Pelecypods were second

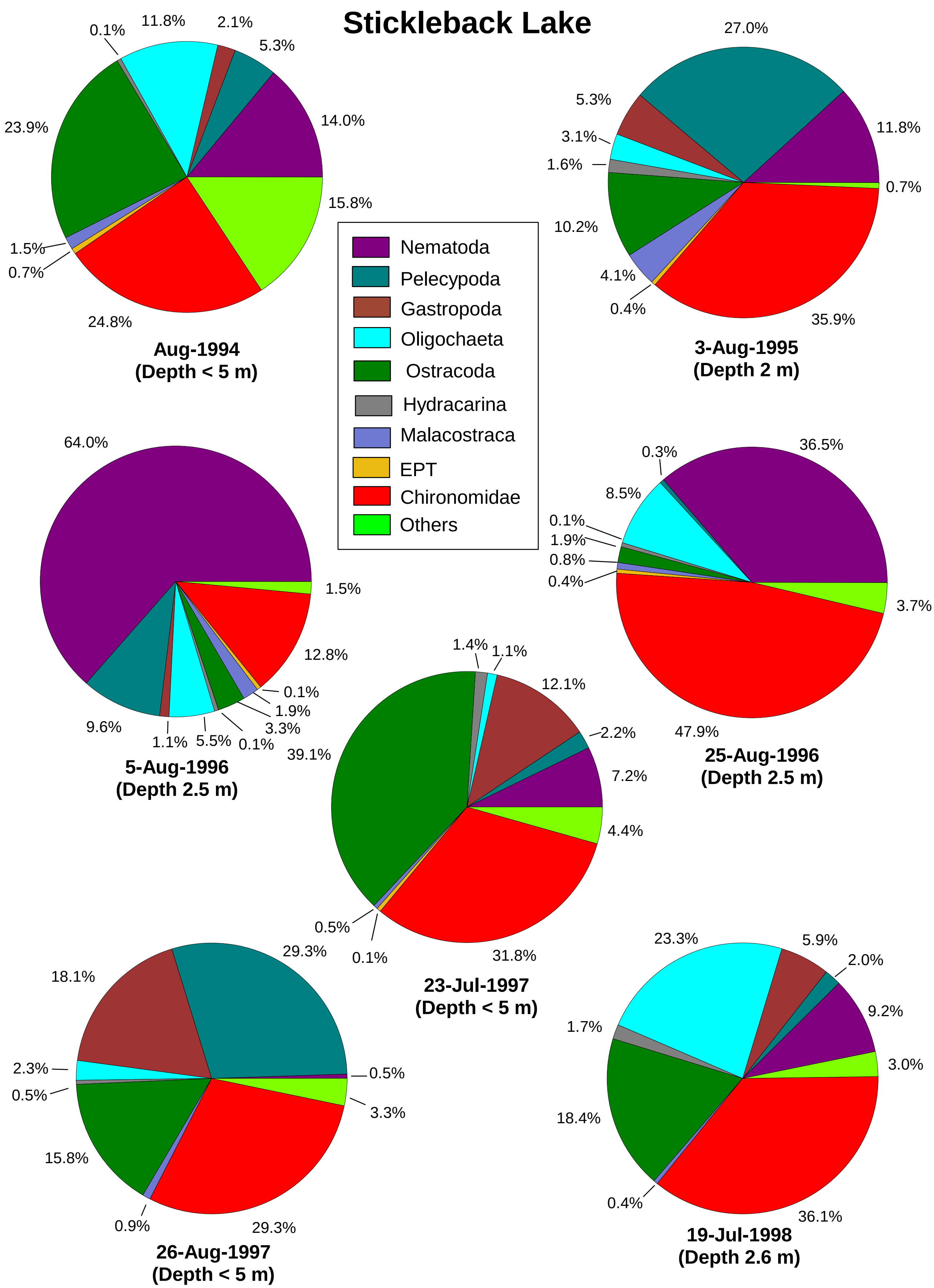


Figure 6.8 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Stickleback Lake, 1994 to 1998.

Stickleback Lake

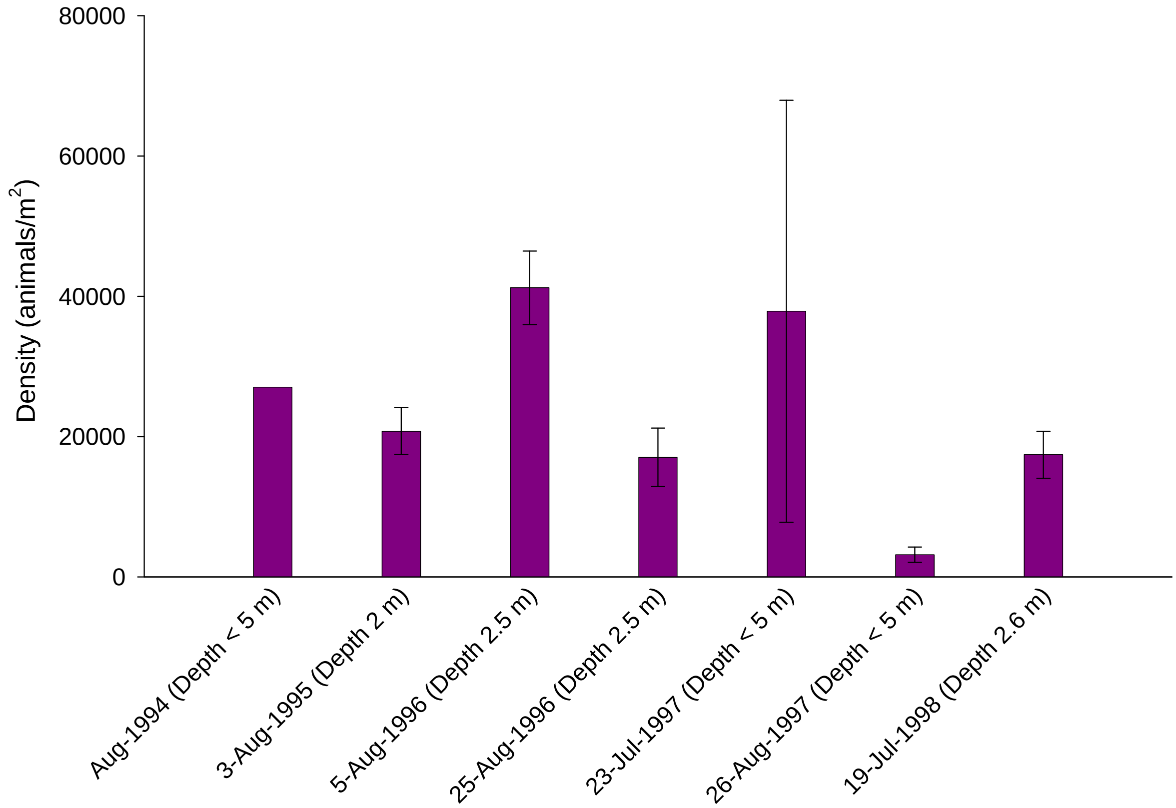


Figure 6.8 (continued). Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Stickleback Lake, 1994 to 1998.

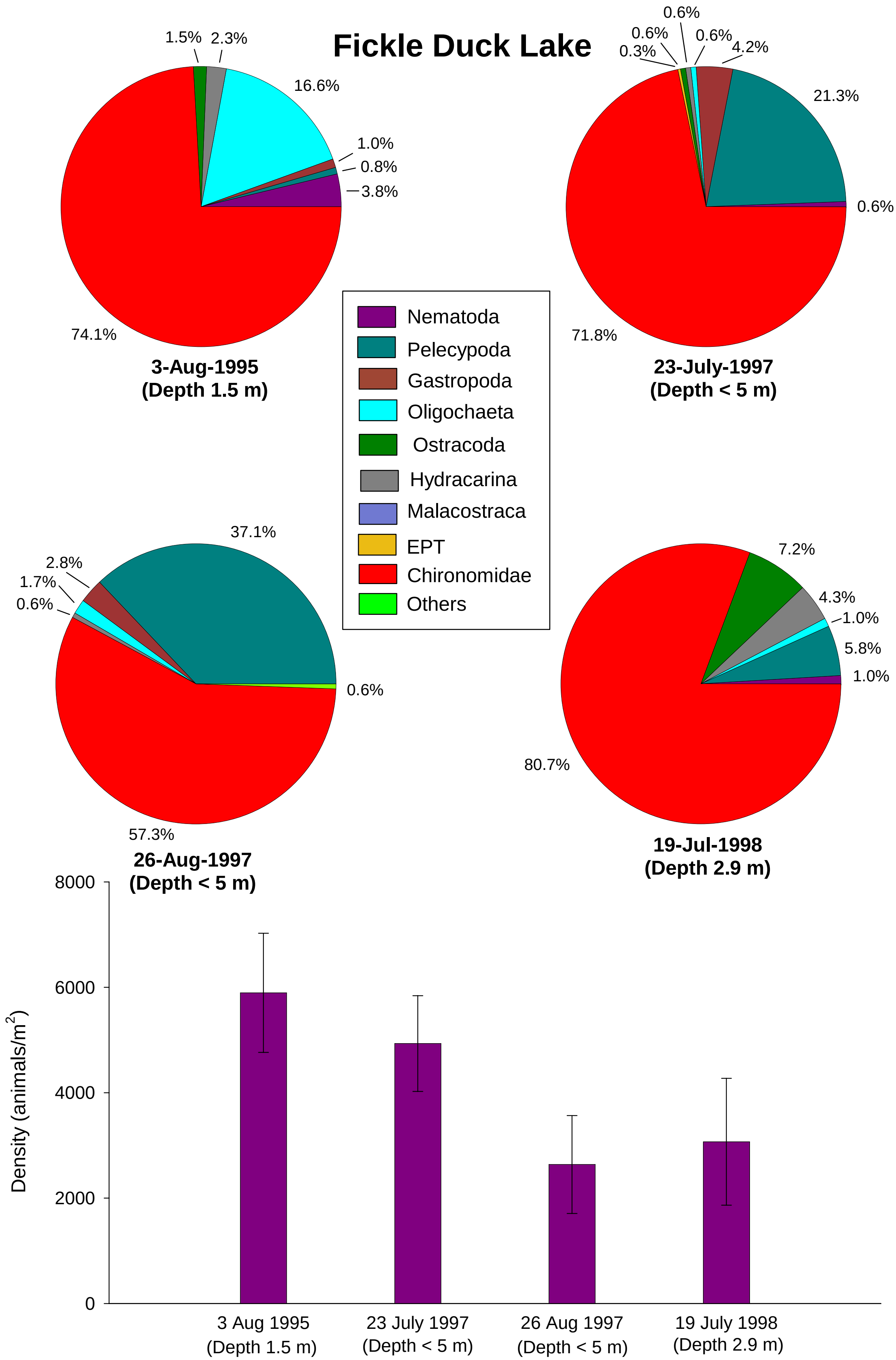


Figure 6.9 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Fickle Duck Lake, 1995 to 1998.

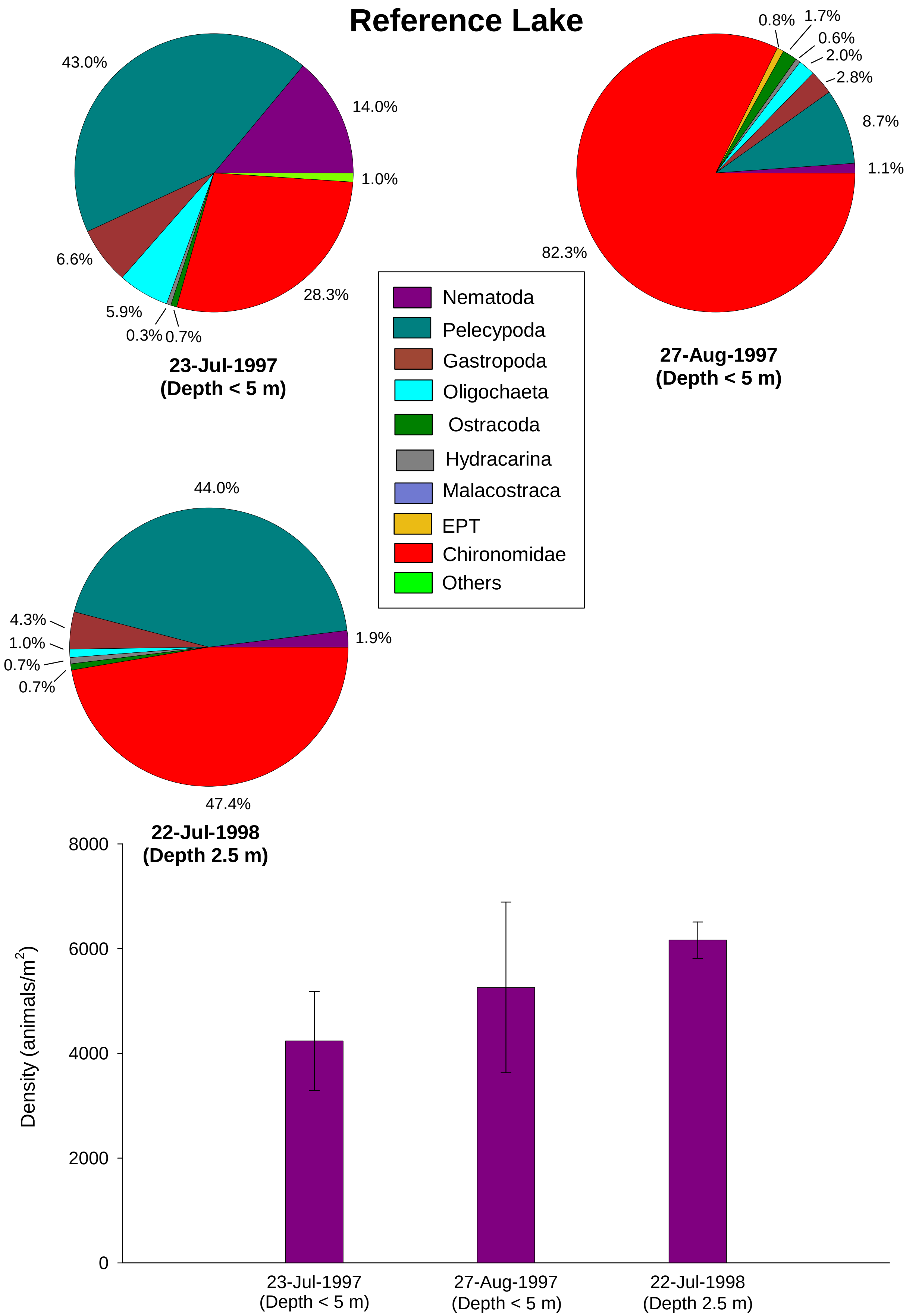


Figure 6.10 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Reference Lake, 1997 to 1998.

in abundance at 8.7 to 44.0% of total numbers (Figure 6.10; Appendices C3 and C4). The major contributors for the Chironomidae were *Psectrocladius* spp. and *Procladius* spp. Pelecypoda were comprised exclusively of *Sphaerium* spp.

6.2.6 Summary

Chironomidae and Pelecypoda, and to a lesser extent Nematoda and Oligochaeta, dominated the benthos of the Boston area lakes. Differences in composition and abundance of the benthos could largely be ascribed to physical characteristics among the sampling locations. The benthic invertebrate communities of the four lakes were similar in many respects to the communities of many other small lakes in the Canadian Arctic and sub-Arctic (RL&L 1997, 1998, and 1999).

A comparison of mean benthic macroinvertebrate abundance suggests that Stickleback Lake was the most productive and that the deep areas of Aimaokatalok Lake were the least productive (Table 6.4). Deep-water habitats in Aimaokatalok Lake had reduced abundances of benthic invertebrates, but the proportion of Chironomidae remained similar to shallow habitats. Deep-water habitats can become oxygen depleted and primarily support taxa that can tolerate low oxygen levels (e.g., certain Chironomidae and Oligochaeta). Anoxia of the profundal zone was not recorded in the study lakes (see Section 3.0) and probably was not a factor in benthic macroinvertebrate production. Oxic conditions are common to Arctic and sub-Artic lakes and likely reflect the short open water season (resulting in low productivity), low nutrient loading, and windy conditions that tend to keep the lakes from stratifying (RL&L 1999).

Table 6.4 Summary of Benthic Invertebrate Abundance in the Boston Area Lakes, 1993 to 1998

Lake	Sample Depth (m)	Number of Sampling Events	Mean Total Density (animals/m^2)	Mean Number of Chironomidae (animals/m^2)	Contribution of Chironomidae to Total (%)
Aimaokatalok (shallow)	≤ 6 and 5	11	5 851	1 752	36.8
Aimaokatalok (deep)	> 10	7	1 088	459	45.4
Stickleback	≤ 2.6	7	23 596	6 722	31.2
Fickle Duck	≤ 3.0	4	4 134	2 975	71.0
Reference	≤ 2.5	3	5 220	2 815	52.6

Although Chironomidae contributed a majority (i.e., more than 50% of total numbers) of the benthic community only in Fickle Duck and Reference lakes, they were the most numerically abundant taxonomic group in all Boston area lakes (Table 6.4). The family Chironomidae is an ecologically important group of aquatic insects, often occurring in high densities and diversity. Indeed, the number of chironomid species present, and their densities, often account for at least half of the total macroinvertebrate species diversity and abundance in most systems. The actual number of chironomid species present in a system is the result of the complex of physical, chemical, biological, and biogeographic conditions (Coffman and Ferrington 1996).

6.3 DRIFT ORGANISMS IN STREAMS

Benthic macroinvertebrates can actively or passively enter the water column. This behaviour is known as drift (Resh and Rosenberg 1984). Also included in the drift can be pelagic forms or invertebrates (e.g., zooplankton) that are entrained from lakes, back-eddies, and calm side-channels of flowing waters. Drift organisms are an important part of the food chain, particularly because they are easily observed and available to fish and other potential predators. The information presented is based on data from annual data reports (Rescan 1998 and 1999a).

6.3.1 Methods

Drift samples were collected from five streams within the Boston area (Figure 6.6) (Rescan 1998 and 1999a). Up to four sampling sessions were conducted on each stream between 1997 and 1998 (Table 6.5).

Table 6.5 Drift Sampling Schedule in Boston Area Streams, 1997 to 1998

Stream	Date Sampled	
	1997	1998
Aimaokatalok NE Inflow	22 July & 24 August	27 June & 31 July
Aimaokatalok River		27 June & 31 July
Stickleback Outflow	21 July	26 June & 30 July
Fickle Duck Outflow	21 July & 25 August	26 June & 30 July
Reference Outflow	21 July & 25 August	27 June & 01 August

Two replicate drift samples were collected with a cone-shaped net (0.5 mm mesh size) that featured an opening aperture frame of 0.14 m^2. Soak time for the samplers was approximately 24 h. Water flow rates were measured in the streams during sampling, and the average flow rate was used to standardize data to volume (animals/1000 m^3). Each sample was transferred to a clean 500-mL plastic bottle, preserved with 10% formalin, and labeled. All samples were submitted to Applied Technical Services, Victoria, BC, for taxonomic identification and enumeration. Drift samples were also collected in 1996 for Stickleback Outflow and Fickle Duck Outflow; however, these data could not be standardized for volume because flow data were not provided. Therefore, these were not used for further analysis.

As mentioned in the lake section, percentage contribution of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT) was also calculated because these taxonomic groups are a common biomonitoring index (Rosenberg and Resh 1993). Presence of these taxa may indicate that these are healthy waterbodies.

6.3.2 Aimaokatalok NE Inflow

Four drift sampling sessions were conducted on Aimaokatalok NE Inflow, including two in both 1997 and 1998. Mean total drift numbers (±1 SE) ranged from 196 ± 102 animals/1000 m^3 on 22 July 1997 to 16 175 ± 2076 animals/1000 m^3 on 28 June 1998 (Figure 6.11; Appendices C5 and C6).

Chironomidae (midges) dominated the drift samples in all sampling sessions, contributing 40.6 to 51.7% to the total mean number of animals enumerated. The July 1997 samples had a considerable proportion (37.0%) of Simulidae (black flies), whereas the August 1997 samples had large proportions of Ostracoda (seed shrimp; 25.3%), Hydracarina (water mites; 16.7%) and Copepoda (copepods; 12.7%). EPT taxa contributed 9.3 and 7.5% to the total mean number of individuals in the June and July 1998 samples, respectively (Figure 6.11; Appendices C5 and C6). The Chironomidae were primarily represented by Orthocladiinae species, whereas the Copepoda were well represented by Cyclopoida species and the Simulidae were represented by *Simulium* spp.

6.3.3 Aimaokatalok River

Two drift sampling sessions were conducted on Aimaokatalok River in 1998. Mean total numbers (±1 SE) of drifting benthic invertebrates were 12 447 ± 3072 animals/1000 m^3 in June and 13 896 ± 394 animals/1000 m^3 in July (Figure 6.12; Appendices C5 and C6).

In June and July 1998, Chironomidae dominated the drift of the Aimaokatalok River, contributing 39.0 and 53.0% to total mean numbers, respectively. Cladocera (water fleas) also made up a significant proportion (11.0%) of the June drift, but was absent from the July sample. EPT taxa contributed 11.4% to total mean numbers in June 1998 and 8.4% in July 1998 (Figure 6.12;

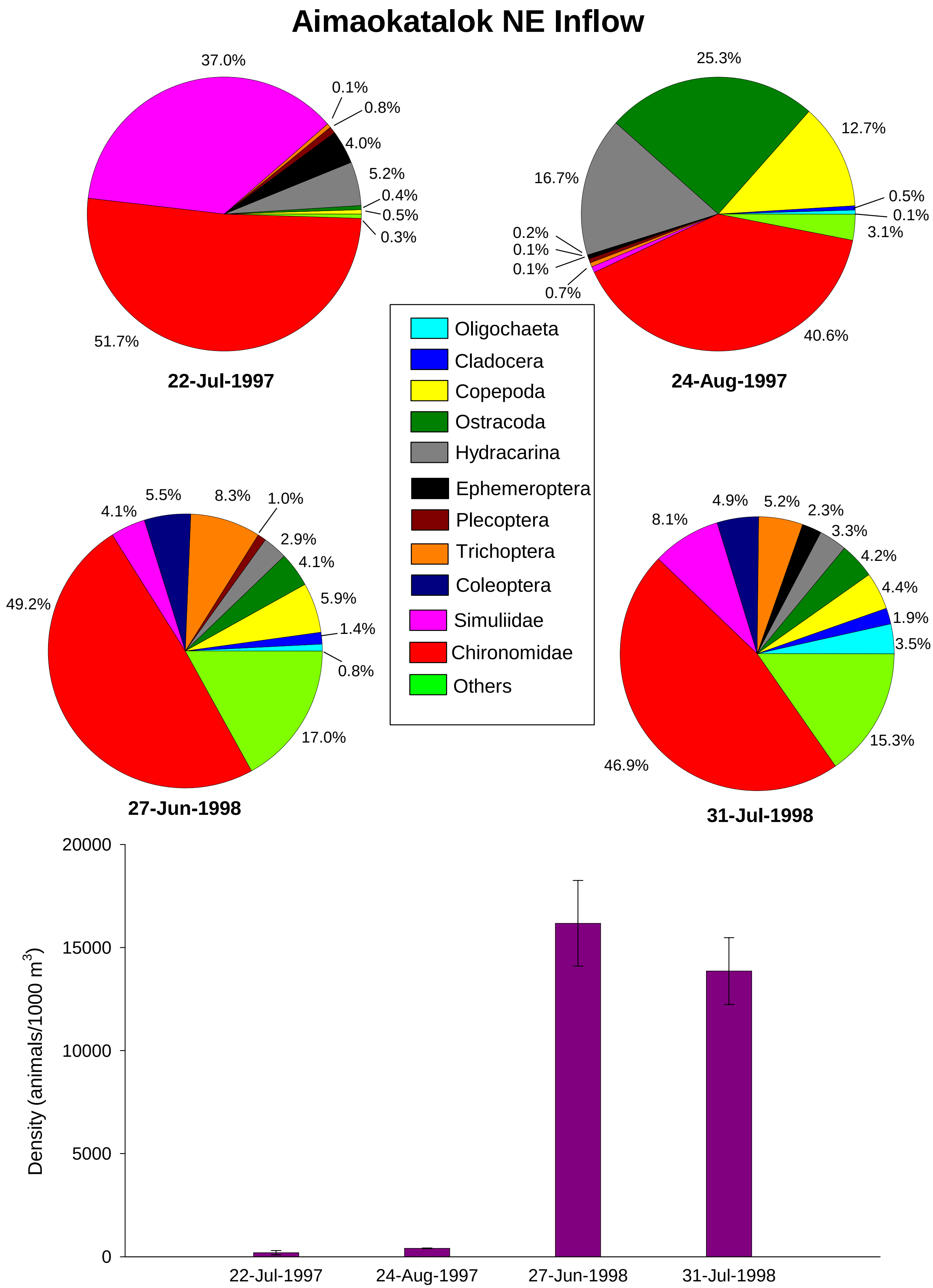


Figure 6.11 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of drifting invertebrates in Aimaokatalok NE Inflow, 1997 and 1998.

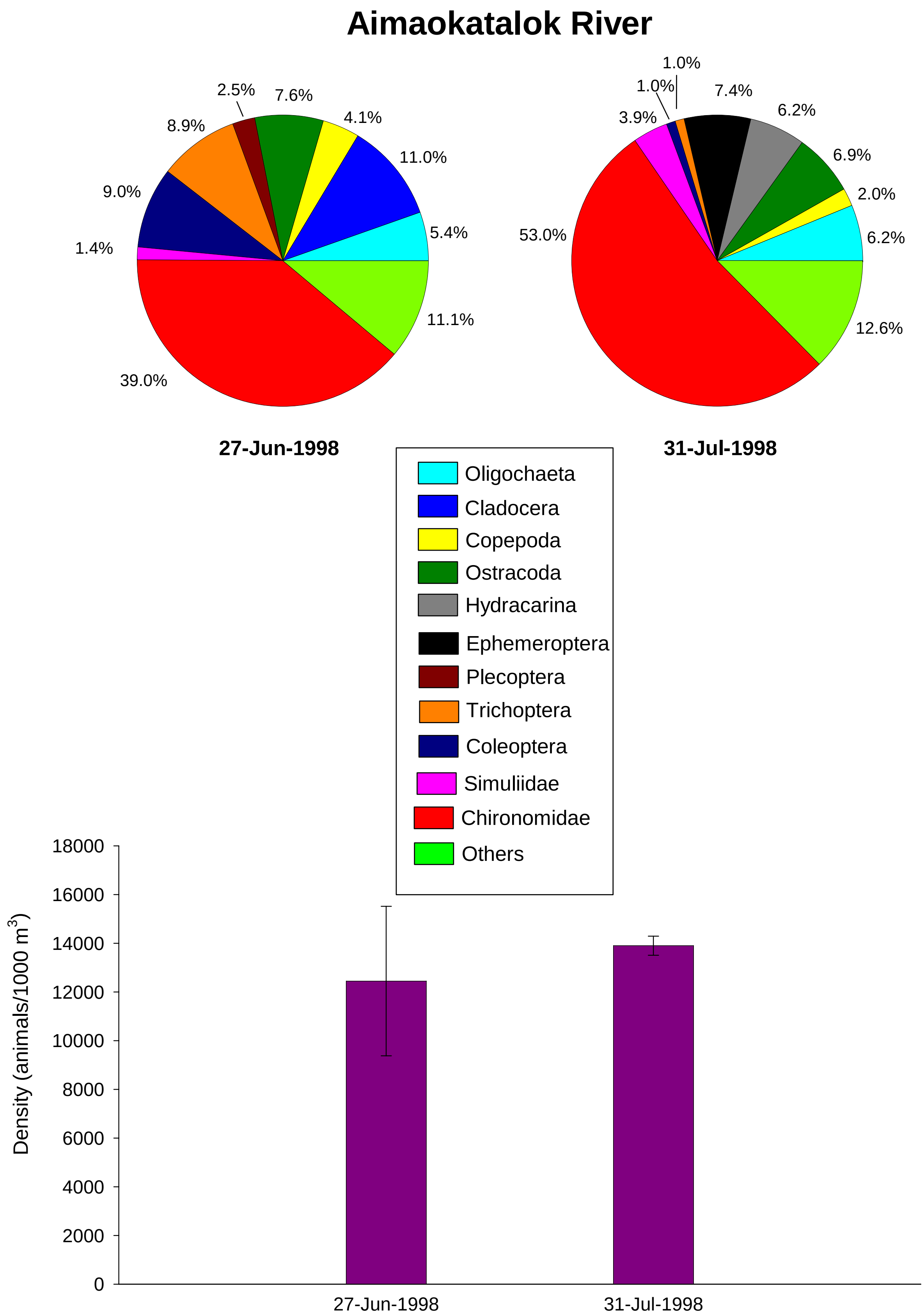


Figure 6.12 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of drifting invertebrates in Aimaokatalok River, 1998.

Appendices C5 and C6). The major contributors of the Chironomidae were members of the Orthocladiinae sub-family.

6.3.4 Stickleback Outflow

Three sampling sessions were conducted in Stickleback Outflow, including one in July 1997 and two in 1998 during June and July. There was no flow in the stream in August 1997, preventing sampling. Mean total numbers (±1 SE) ranged from 9733 ± 3196 animals/1000 m^3 in June 1998 to 160 784 ± 70 693 animals/1000 m^3 in July 1997 (Figure 6.13; Appendices C5 and C6).

In July 1997, Ostracoda and Hydracarina dominated the drift of Stickleback Outflow; these groups contributed 51.8 and 44.8% to total mean numbers, respectively. In 1998, the June drift community was dominated by Chironomidae (46.5% of total mean numbers), whereas the July drift was dominated by both Chironomidae and Ostracoda (37.1 and 35.6% of total mean numbers, respectively). EPT taxa contributed less than one percent to total mean abundances in July 1997, 9.0% in June 1998, and 3.7% in July 1998 (Figure 6.13; Appendices C5 and C6). Ostracoda was primarily represented by *Cypria* spp., and Chironomidae were mainly represented by members of the Tanytarsini and Orthocladiinae subfamilies.

6.3.5 Fickle Duck Outflow

Drift net sampling in Fickle Duck Outflow was conducted only in July and August in 1997 and in June and July in 1998. Mean total number (± 1 SE) of organisms collected ranged from 833 ± 375 animals/1000 m^3 in July 1997 to 13 996 ± 4459 animals/1000 m^3 in July 1998 (Figure 6.14; Appendices C5 and C6).

Chironomidae dominated the drift community during both July and August sampling sessions in 1997 and during the June sampling session in 1998, contributing 41.8, 51.6 and 48.8% to the total mean count in the samples, respectively (Figure 6.14; Appendices C5 and C6). Simuliidae and Ostracoda also contributed a substantial portion of the drift in July 1997 (22.3 and 16.9% of the total mean count, respectively). Hydracarina contributed 29.7% of the total mean count of the drift in August 1997. In the July 1998 sampling session, Chironomidae and Ostracoda contributed a large portion of the drift (23.0 and 23.2% of total mean count, respectively). EPT taxa contributed only 2.6% towards total mean abundance in July 1997, 0.7% in August 1997, 9.5% in June 1998, and 22.6% in July 1998. Chironomidae were largely represented by

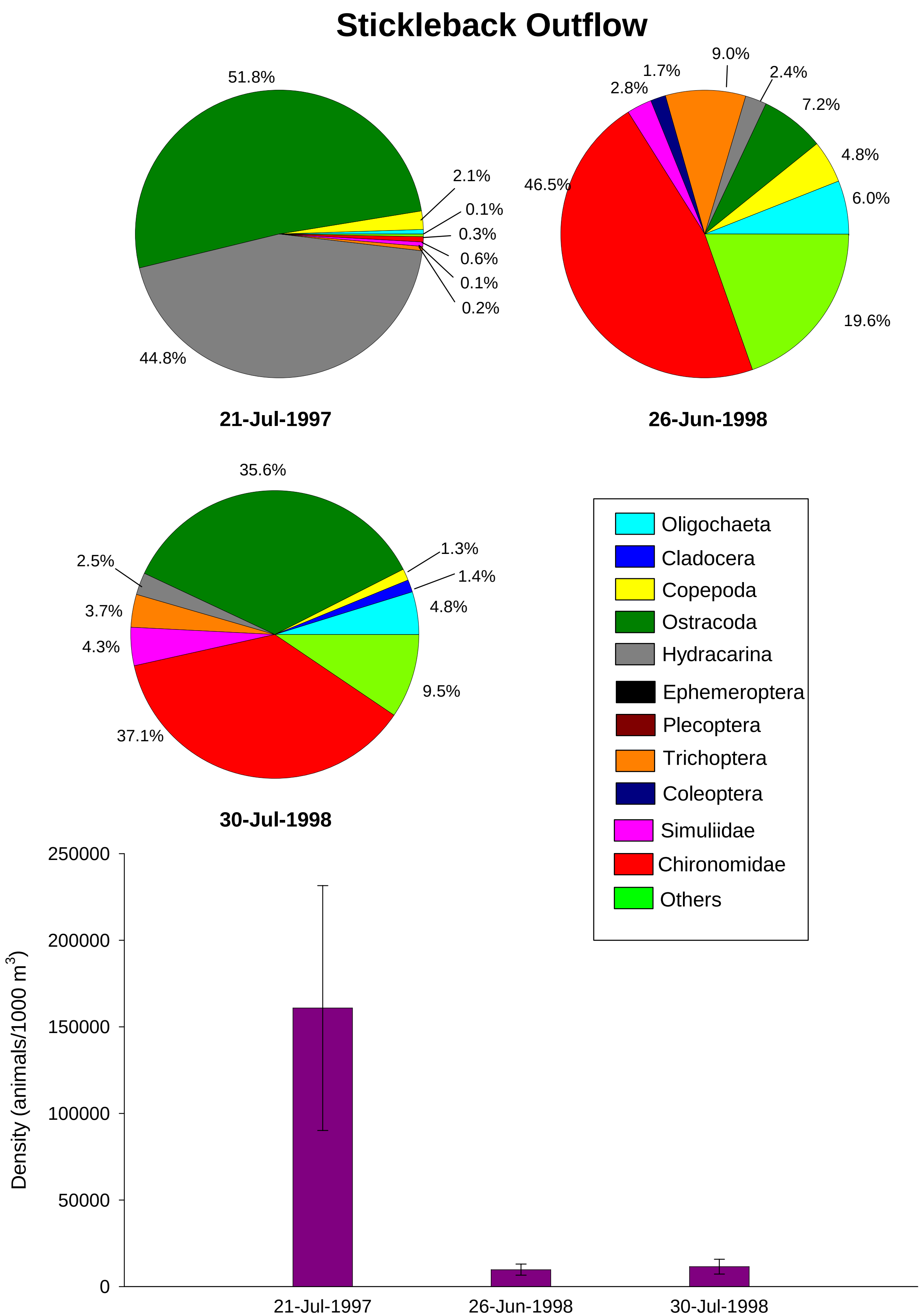


Figure 6.13 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of drifting invertebrates in Stickleback Outflow, 1997 to 1998.

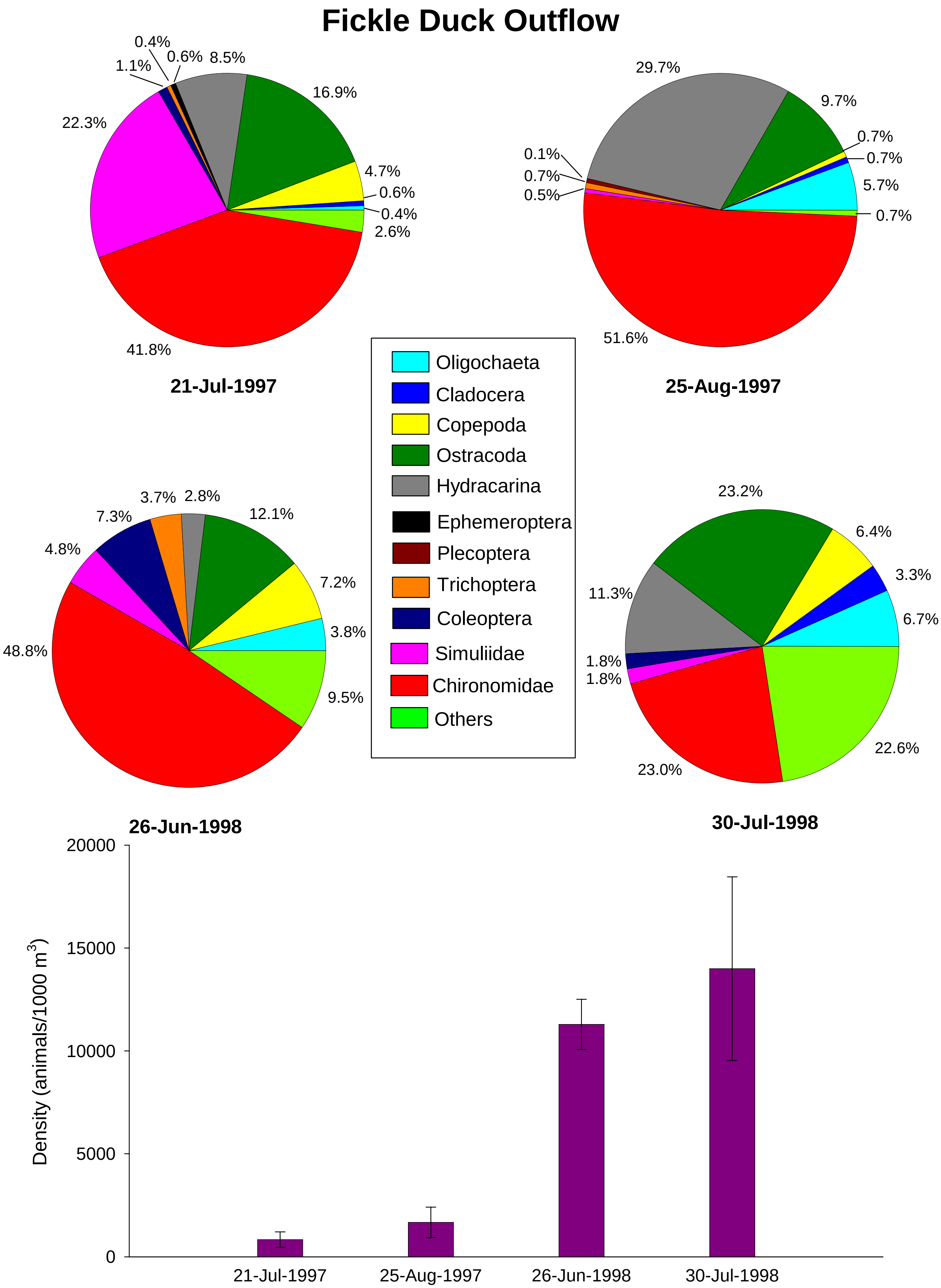


Figure 6.14 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of drifting invertebrates in Fickle Duck Outflow, 1997 to 1998.

species of the Orthocladiinae and Tarytarsini subfamilies. Simuliidae were represented by *Simulium* spp. and Ostracoda were mainly represented by *Cadona, Cypria,* and *Cypris* spp.

6.3.6 Reference Outflow

Drift net drift sampling in Reference Outflow was conducted in July 1997, August 1997, June 1998 and August 1998. Mean total numbers (±1 SE) ranged from 381 ± 224 in August 1997 to 13 533 ± 2317 animals/1000 m^3 in August 1998 (Figure 6.15; Appendices C5 and C6).

Chironomidae dominated the drift of Reference Outflow in all sampling sessions, contributing 41.2 to 83.5% towards total mean numbers (August 1997 and August 1998, respectively) (Figure 6.15; Appendices C5 and C6). In July 1997, Simulidae also made up a large portion of the drift (24.7% of total numbers). In June and August 1998, Cladocera also contributed a significant amount to the drift (13.8 and 10.1%, respectively). EPT taxa contributed less than one percent towards total mean abundances in all four sampling events. The Chironomidae were represented by Orthocladinae, Tanytarsini, and unidentified species. Simulidae were mainly represented by unidentified species and the Cladocera were represented by a variety of species.

6.3.7 Summary

For the Boston area streams, a comparison of mean total drift abundance suggests that Stickleback Outflow was highly productive, and that Reference Outflow was the least productive (Table 6.6). Chironomidae (midges), Simuliidae (black flies), and Ostracoda (seed shrimp) dominated the drift of the Boston area streams. EPT taxa were present in low abundances in most streams. The presence of these taxa is not currently indicative of the health of the streams; however, if the EPT taxa were absent in future sampling events this may indicate worsening health of the ecosystems.

Table 6.6 Summary of Drift Abundance in Boston Streams, 1997 to 2000

Stream	Number of Sampling Events	Mean Drift Numbers[a] (animals/1000 m^3)
Aimaokatalok NE Inflow	4	7 659
Aimaokatalok River	2	13 171
Stickleback Outflow	3	60 675
Fickle Duck Outflow	4	6 947
Reference Outflow	4	5 890

[a] All sampling events combined.

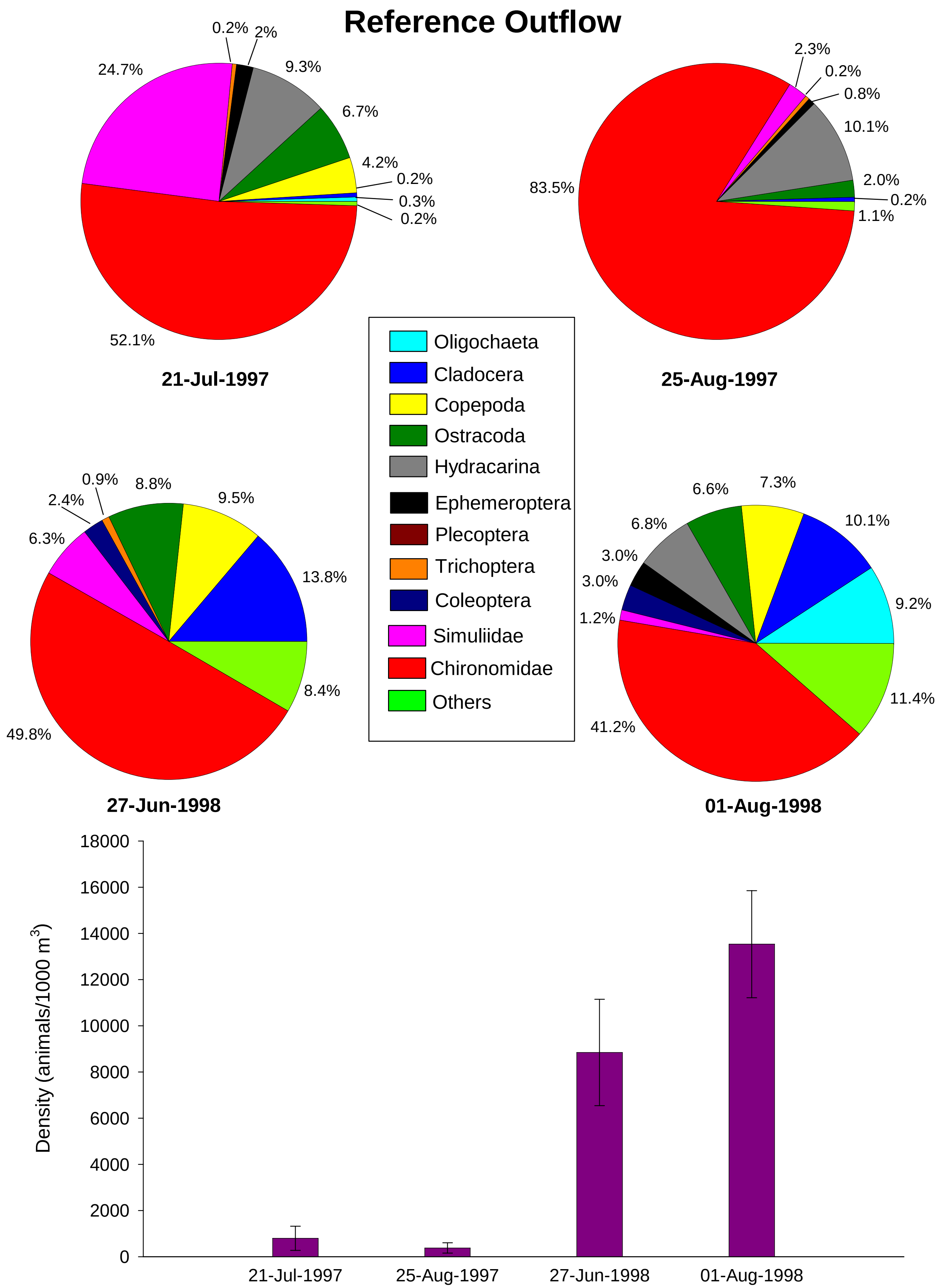


Figure 6.15 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of drifting invertebrates in Reference Outflow, 1997 to 1998.

Differences in composition and abundance of drift organisms could largely be ascribed to physical and energetic characteristics among the study streams. For example, the very high numbers of drift encountered in Stickleback Outflow in July 1997 may be due to the low flow rates encountered at this site (Rescan 1998). Zooplankton were abundant in most of the Boston Area streams, which may be an artifact of positioning the drift nets in close proximity to the lake and/or high flushing rates of the lake. Abundant zooplankton present within the drift of streams suggests that they may be an important prey item for stream resident predators.

6.4 BENTHIC INVERTEBRATES IN STREAMS

Stream benthic macroinvertebrates are adapted to living in flowing waters. Thus, the species encountered in streams are typically different than those from lake environments (see Section 6.2). Stream invertebrates are an important part of the food chain, particularly if they are located within fish feeding and rearing habitats. The information presented is based on data from annual data reports (Rescan 1994, 1995, 1997, 1998, and 1999a).

6.4.1 Methods

Benthic samples were collected from five streams within the Boston area (Figure 6.6) (Rescan 1994, 1995, 1997, 1998, and 1999a). Two to five sampling sessions were conducted on each stream between 1995 and 1998 (Table 6.7).

Artificial substrate samplers (Hester and Dendy 1962) were used to collect stream invertebrates. The artificial substrate samplers consisted of eight 0.064 m^2 plates stacked 0.5 cm apart. Five samplers were set in each stream sampling site to facilitate the collection of a minimum of three replicate samplers at the time of retrieval. Among the study sites, the artificial substrate samplers were placed, exposed, and collected in conditions as nearly identical as possible to reduce site-to-site variability. Invertebrates were allowed to colonize the artificial substrates for approximately 33 to 35 days; however, deployment dates for the 1998 survey were the only ones reported by Rescan (1998). For the sample from Fickle Duck Outflow in 1994, a Hess sampler with a sampling area of 0.09616 m^2 was used to collect benthic invertebrates (Rescan 1995).

Once again, percentage contribution of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT) was also calculated because these taxonomic groups are a common biomonitoring index (Rosenberg and Resh 1993). Presence of these taxa may indicate that these are healthy waterbodies.

Table 6.7 Benthic Invertebrate Sampling Schedule in Boston Area Streams, 1995 to 1998

Stream	Date Sampled				
	1994	1995	1996	1997	1998
Aimaokatalok NE Inflow				25 August	28 June to 31 July
Aimaokatalok River				24 August	27June to 1 August
Stickleback Outflow		1 August	5 August	21 July + 25 August	26 June to 30 July
Fickle Duck Outflow	August	1 August		25 August	26 June to 31 July
Reference Outflow				25 August	28 June to 1 August

Prior to sampler removal, a sieve (mesh size not reported) was placed on the downstream side of the sampler to prevent possible loss of organisms. Organisms were then gently brushed from the sampler onto a sieve, transferred to a clean 500-mL plastic bottle, preserved with 10% formalin, and labeled. The 1995, 1996 and 1997 samples were submitted to Biologica (Victoria, BC), whereas the 1998 samples were submitted to Applied Technical Services (Victoria, BC) for taxonomic identification and enumeration.

6.4.2 Aimaokatalok NE Inflow

Two benthic invertebrate sampling sessions were conducted on the Aimaokatalok NE Inflow, including one in August 1997 and one in July 1998. Mean total numbers (±1 SE) were 301 ± 202 animals/m^2 in August 1997 and 2522 ± 500 animals/m^2 in 1998 (Figure 6.16; Appendices C7 and C8).

Chironomidae dominated the benthic invertebrate community of Aimaokatalok NE Inflow in 1997, contributing 70.7% to the total mean number of animals enumerated (Figure 6.16; Appendices C7 and C8). The second most abundant group was EPT taxa at 17.4%. The 1998 sampling session was co-dominated by ‘other’ benthic invertebrates, Ostracoda, and Chironomidae, each contributing 40.0, 35.5, and 21.9%, respectively. No particular taxa were identified as the major contributor to Chironomidae, whereas *Candona* sp. was the dominant Ostracoda. EPT taxa contributed less than 1% towards total mean abundance in 1998. The ‘other’ benthic invertebrates were comprised of *Valvata sincera sincera* (Gastropoda) and *Physa* spp. (Pelecypoda).

6.4.3 Aimaokatalok River

Two benthic invertebrate sampling sessions were conducted on the Aimaokatalok River, including one in August 1997 and one in July 1998. Mean total numbers

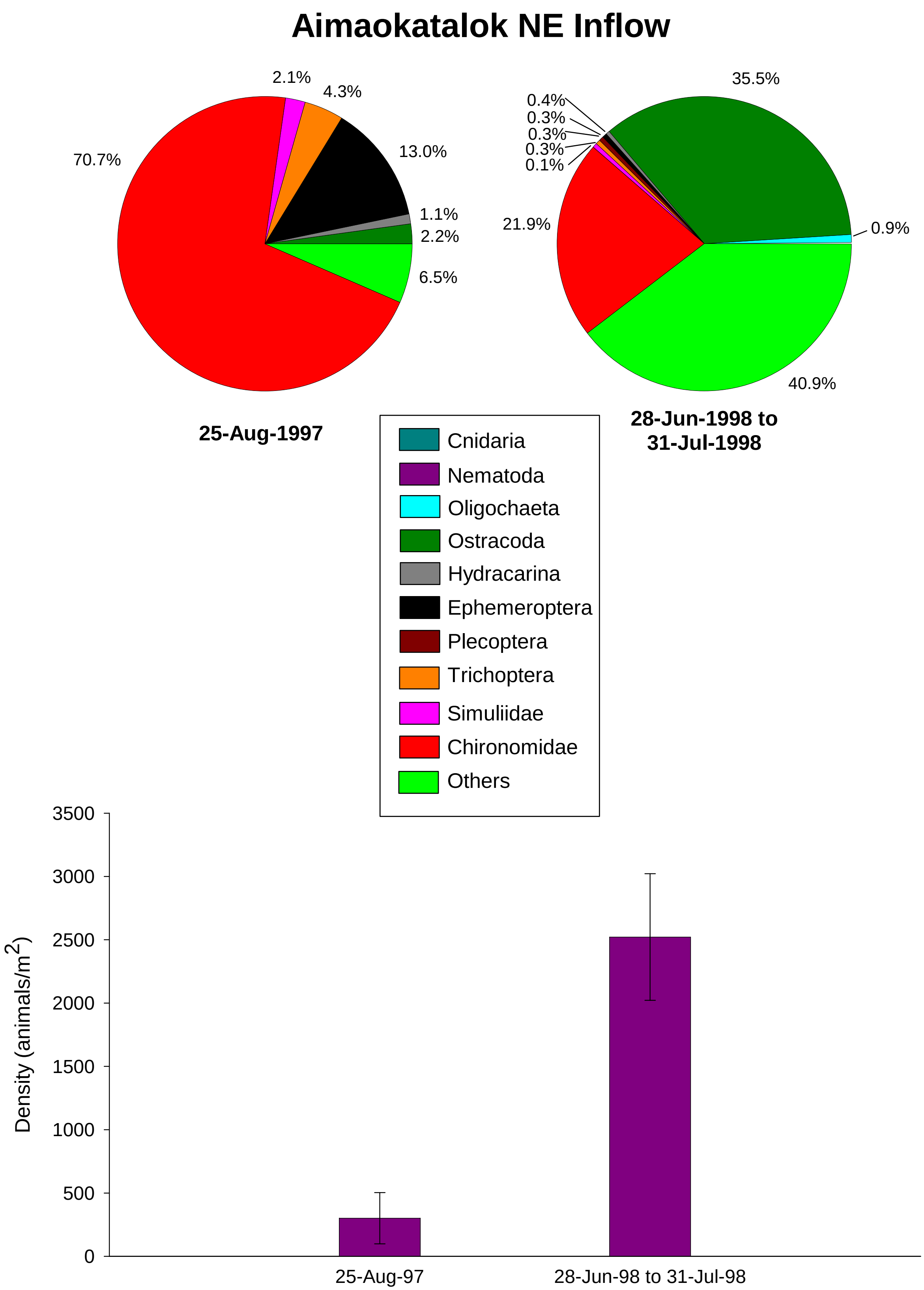


Figure 6.16 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Aimaokatalok NE Inflow, 1997 to 1998.

(±1 SE) were 529 ± 152 animals/m^2 in August 1997 and 870 ± 57 animals/m^2 in 1998 (Figure 6.17; Appendices C7 and C8).

Dominant taxa differed between sampling years. In August 1997, EPT taxa contributed 49.4% towards mean abundance (with Trichoptera at 43.2%) while Ostracoda contributed 39.5%. In 1998, however, Chironomidae was dominant with 67.6% of total mean abundance. EPT taxa contributed less than 1% towards total mean abundance (Figure 6.17; Appendices C7 and C8). The ostracods were dominated by *Candona* spp., whereas the chironomids were comprised of numerous taxa.

6.4.4 Stickleback Outflow

Five benthic invertebrate sampling sessions were conducted on the Stickleback Outflow, including one in each of 1995 and 1996, two in 1997, and one in 1998. Mean total invertebrate numbers (±1 SE) ranged from 258 ± 20 animals/m^2 in August 1997 to 10 003 ± 3717 animals/m^2 in 1998 (Figure 6.18; Appendices C7 and C8).

The benthic invertebrate community of Stickleback Outflow varied considerably among sampling events. For example Ostracoda dominated the benthic invertebrate samples in 1995 and 1998, contributing 78.9 and 83.3%, respectively, towards the total mean number of animals enumerated (Figure 6.18; Appendices C7 and C8). However, Ostracoda only contributed between 0.2 and 17.3% in samples from other years. Chironomidae dominated the sample in 1996, contributing 73.2% to total numbers. In the two samples in 1997, 'other' benthic invertebrates were the most numerous, contributing 22.0 and 27.8% to total numbers. The Ostracoda were represented by a number of different genera such as *Cypridopsis* spp. and *Cypris* spp., *Cyprois marginata*. Chironomidae were represented primarily by *Tanytarsus* spp. In the 1996 samples the 'other' benthic invertebrates comprised of large numbers of the *Grensia praeterita* (Trichoptera), and *Gammarus lacustris* (Malacostraca). EPT were present in greatest abundance in 1997 and 1998, contributing 10.4 and 13.9% to total mean abundance, respectively.

6.4.5 Fickle Duck Outflow

Four invertebrate sampling sessions were conducted on the Fickle Duck Outflow, including one in August of 1994, 1995, and 1997, and one in July 1998. Mean total numbers (±1 SE) on these dates ranged from 1088 ± 262 animals/m^2 in August 1997 to 13 457 ± 5655 animals/m^2 in 1998 (Figure 6.19; Appendices C7 and C8).

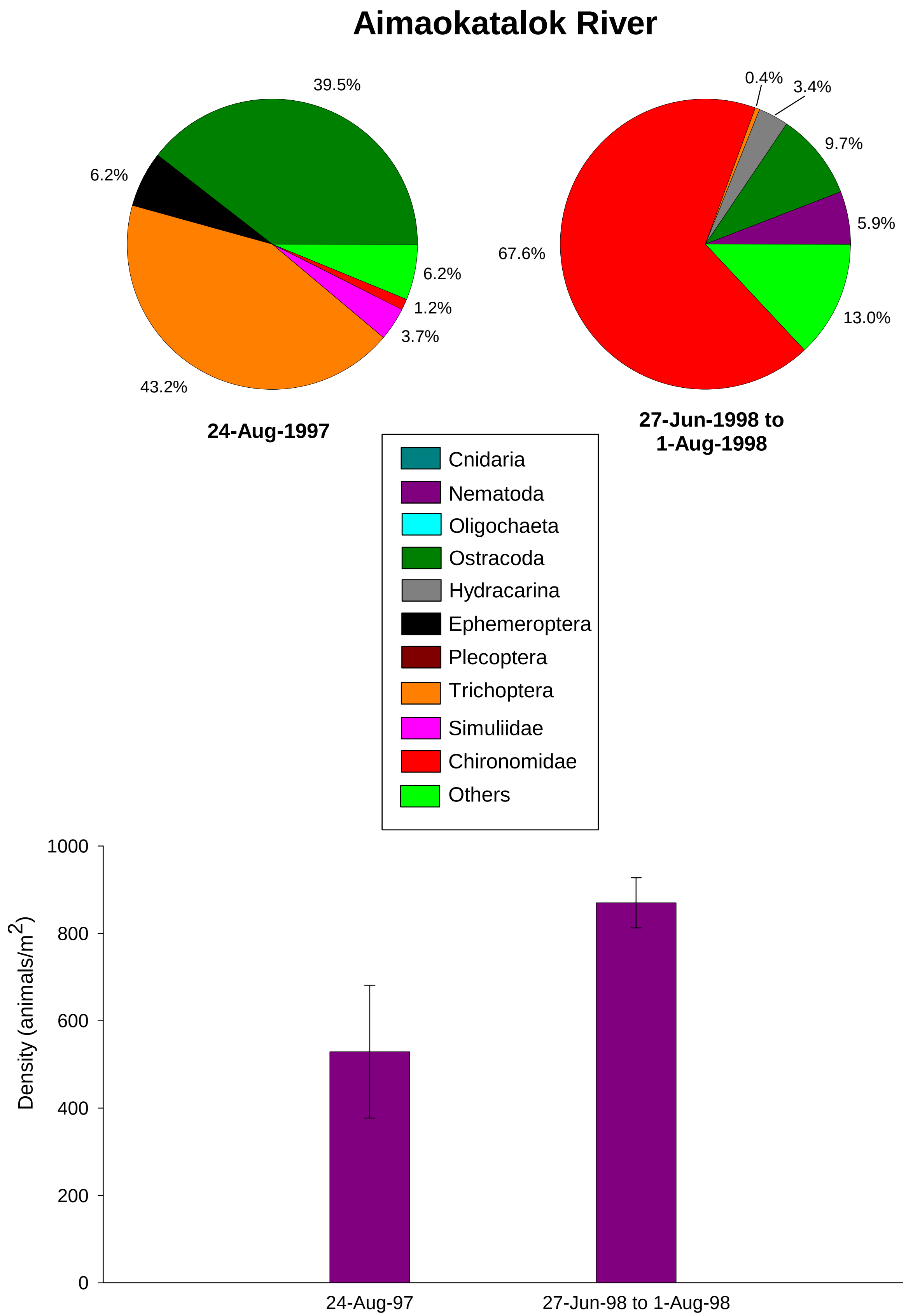


Figure 6.17 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Aimaokatalok River, 1997 to 1998.

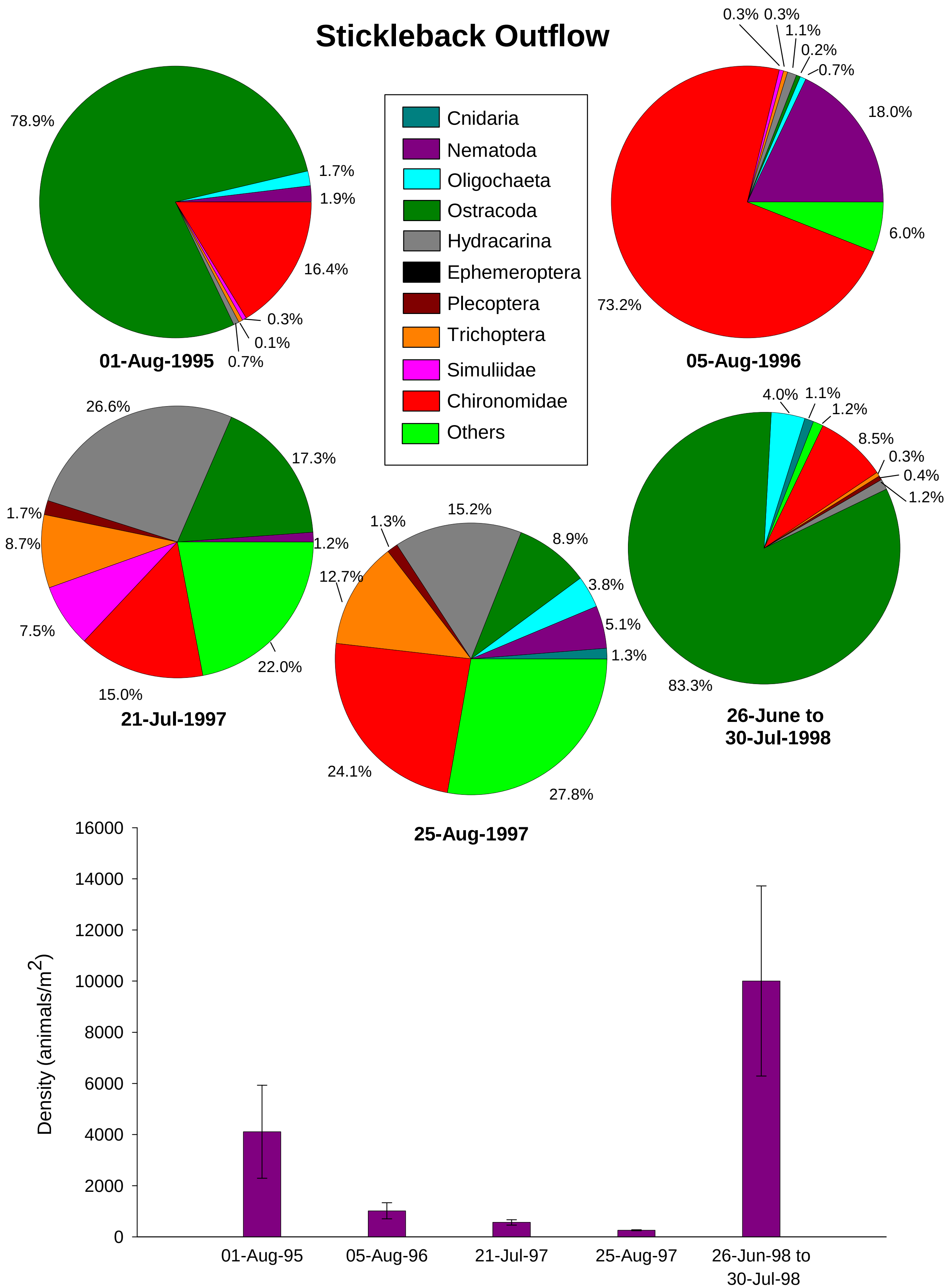


Figure 6.18 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Stickleback Outflow, 1995 to 1998.

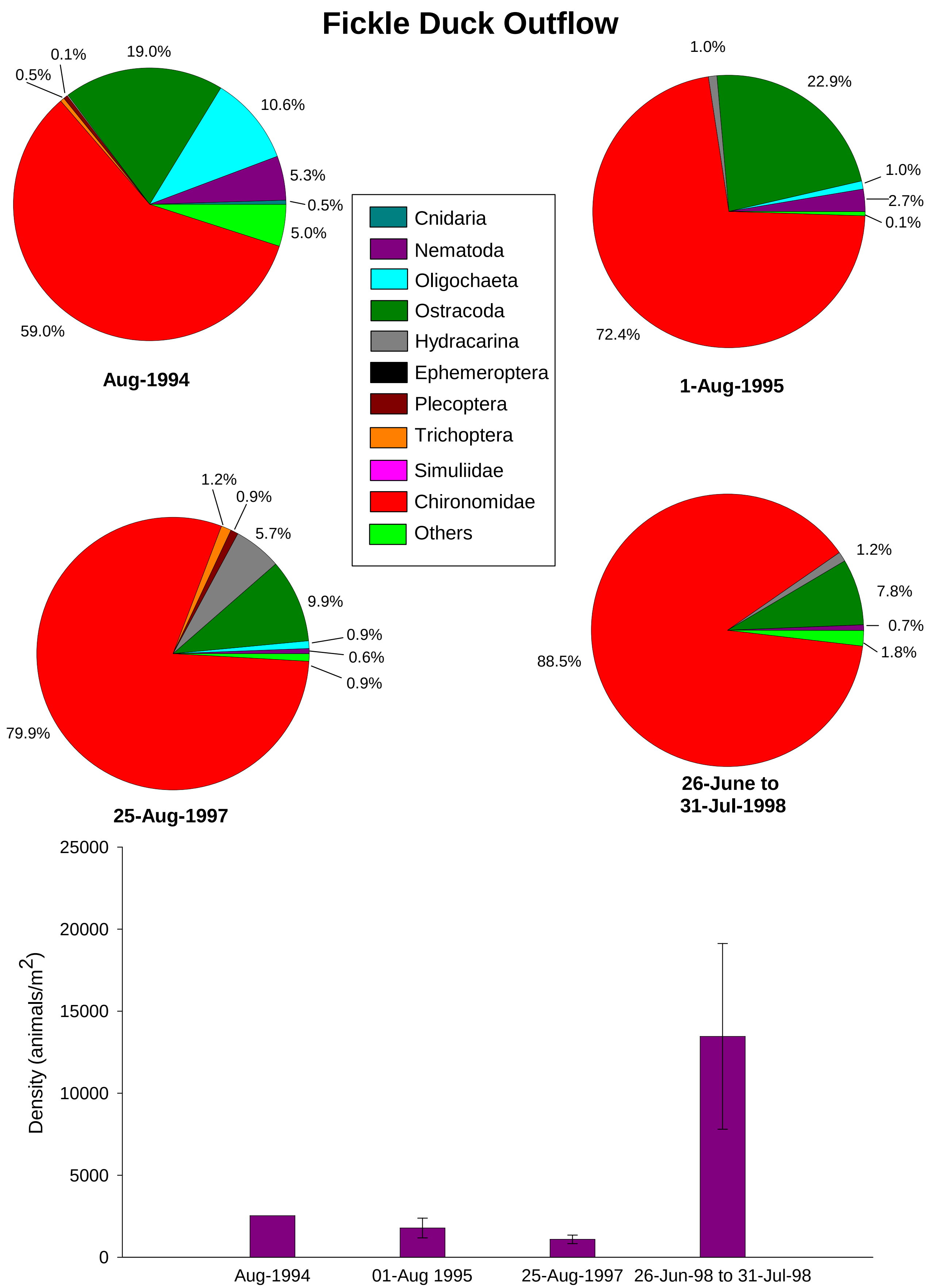


Figure 6.19 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of bethic invertebrates in Fickle Duck Outflow, 1994 to 1998.

The benthic invertebrate community of Fickle Duck Outflow was dominated by Chironomidae, which contributed between 59.0 and 88.5% to total mean numbers (Figure 6.19; Appendices C7 and C8). In 1995, Ostracoda, represented largely by *Cypridopsis* spp., formed a considerable part (22.9%) of the benthic community. Unidentified chironomids, unidentified Tanytarsini, *Corynoneura* spp., and *Stempellinella* spp. were the main contributors to Chironomidae. EPT taxa contributed small percentages towards total mean abundances in 1994 (0.6%) and 1997 (2.1%), and were absent from the outflow in 1995 and 1998 (Appendices C7 and C8).

6.4.6 Reference Outflow

Retrieval of the artificial substrates from Reference Outflow was conducted on 25 August 1997 and 1 August 1998. Mean total numbers (±1 SE) on these dates were 565 ± 105 animals/m^2 and 38 880 ± 20 748 animals/m^2, respectively (Figure 6.20; Appendices C7 and C8).

The benthic invertebrate community of Reference Outflow was comprised largely of Chironomidae, which contributed 50.3 and 88.6% to total mean numbers in 1997 and 1998, respectively (Figure 6.20; Appendices C7 and C8). EPT taxa contributed small percentages towards total mean abundance in both years: 6.4% in 1997 and 0% in 1998. In 1997, ‘other’ benthic invertebrates (largely the gastropod *Valvata sincera sincera*) represented a considerable proportion (38.7%) of the benthic community. The major contributors to the chironomids were unidentified Diamesinae, unidentified Tanytarsini, *Cricotopus* spp. and *Rheotanytarsus* spp. (Appendices C7 and C8).

6.4.7 Summary

For the Boston area streams, a comparison of mean total benthic abundance suggested that Reference Outflow was the most productive, and Aimaokatalok River was the least productive (Table 6.8). Chironomidae, Ostracoda, and ‘other’ invertebrates (e.g., Gastropoda) dominated the benthic communities of the Boston area streams. EPT were common in a few streams, contributing towards almost half of the total mean abundance of invertebrates on one sampling occasion. Once again, as discussed in the drift invertebrates portion, absence of these taxa from future sampling events may indicate worsening health of the ecosystems.

Differences in composition and abundance of benthic organisms could largely be ascribed to physical and energetic characteristics among the study streams, as well as seasonality. For example, the low numbers of benthos encountered

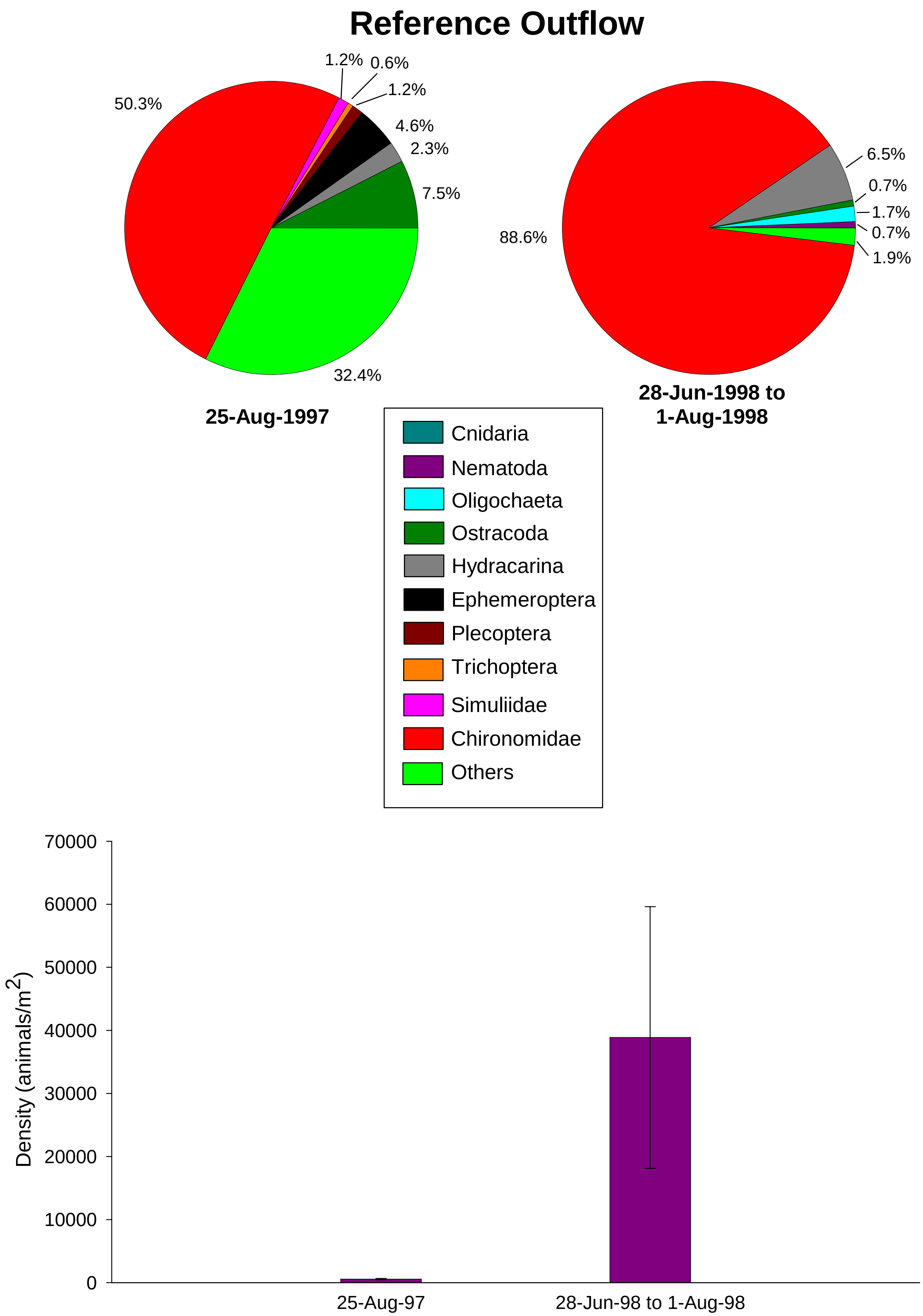


Figure 6.20 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Reference Outflow, 1997 to 1998.

in Aimaokatalok River may be due to the higher velocities encountered in that system. Similarly, higher abundances of benthos in the outflow systems might be attributed to the effect of a lake located immediately upstream. All streams sampled featured high proportions (at least 68% of total numbers) of Chironomidae on at least one sampling date. The dominance of chironomids among all of the Boston area streams suggested that this group was able to take advantage of existing conditions and maintain the high population densities.

Table 6.8 Summary of Benthic Invertebrate Abundance in Boston Area Streams, 1995 to 1998

Stream	Number of Sampling Events	Mean Number of organisms (per m^2)
Aimaokatalok NE Inflow	2	1 411
Aimaokatalok River	2	700
Stickleback Outflow	5	3 190
Fickle Duck Outflow	4	4 712
Reference Outflow	2	19 722

6.5 MARINE BENTHIC INVERTEBRATES

As with freshwater invertebrates, benthic forms of marine invertebrates are an important link in food webs. Most marine invertebrates are herbivores, detritivores or filter feeders and derive much of their energy from aquatic plants and organic materials. Some benthic macroinvertebrates are predacious, generally feeding upon other invertebrates. Many fish and mammal species feed upon marine invertebrates. The watersheds of the Boston area empty into Hope Bay via the Koignuk River.

6.5.1 Methods

Benthic marine invertebrate samples were collected from three sites within Hope Bay (Figure 6.6). A single sampling session was conducted at each site on 21 July 1998. Triplicate benthic invertebrate samples were collected at each study location and during each sampling session with an Ekman grab sampler (0.0232 m^2). Two different water depths were sampled; Station 1 was approximately 8 m, and Station 2 and Station 3 were approximately 3.6 m deep. Each replicate sample was sieved over 493 µm mesh, transferred to a clean 500-mL plastic bottle, preserved with 10% formalin, and labeled. All samples were submitted to Applied Technical Services, Victoria, BC, for taxonomic identification and enumeration.

6.5.2 Hope Bay

Mean total numbers (±1 SE) of benthic marine invertebrates inhabiting Hope Bay ranged from 1652 ± 456 animals/m^2 to 3417 ± 427 animals/m^2. The site with the greatest depth also had the largest benthic invertebrate density (Figures 6.21; Appendices C9 and C10).

Station 1 – Moderate Depth

Polychaeta (lugworms, tube worms, and marine bristle worms) and Chironomidae (midges) dominated the moderate depth (i.e., 8 m deep) benthic community of Hope Bay, contributing 59.2 and 19.5% towards total numbers, respectively (Figure 6.21; Appendices C9 and C10). The polychaetes were represented mainly by *Nephthys cornuta* and *Pholoe minuta*, whereas the chironomids were comprised of a dozen taxa approximately equivalent in abundance.

Station 2 – Shallow

Nematoda (nematodes), Polychaetea, and Chironomidae dominated the benthic community at Station 2 in Hope Bay (Figure 6.21; Appendices C9 and C10). Nematoda contributed 44.4% to total mean number of animals and typically are not identified to lower taxonomic levels. The proportions of polychaetes within the benthos was 25.1%, and this group was composed largely of *Laonice cirrata*. Chironomids contributed 22.4% of the total mean benthos numbers, but were found almost exclusively within a single replicate; *Rheotanytarsus* spp., *Cricotopus* spp., and *Eukiefferiella* spp. were the species commonly encountered.

Station 3 – Shallow

Nematoda and Polychaetea dominated the benthic community at Station 3 in Hope Bay (Figure 6.21; Appendices C9 and C10). Nematodes contributed 51.7% to the total mean number of benthic invertebrates. Polychaetes contributed 35.4% to total mean number of benthic invertebrates. The main contributors to this major taxonomic group were *Mediomastus* spp. and *Laonice cirrata*.

6.5.3 Summary

Benthic marine invertebrate samples were collected from three sites (two at shallow depths, one at a moderate depth) within Hope Bay. A single sampling session was conducted at each site on 21 July 1998.

Polychaeta (lugworms, tube worms, and marine bristle worms), Nematoda and Chironomidae dominated the benthos of Hope Bay. The composition of benthic

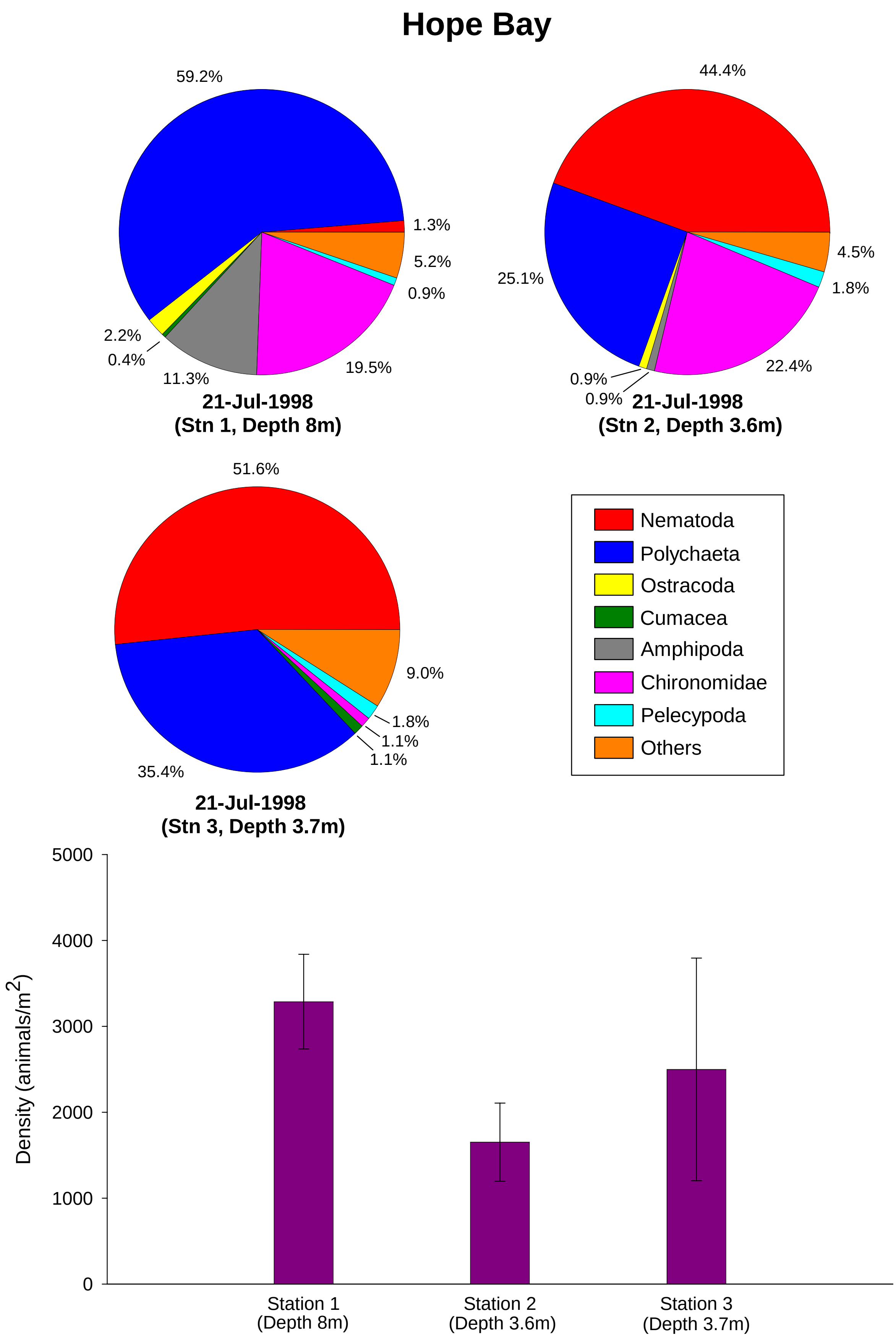


Figure 6.21 Relative abundance of major taxonomic groups and mean total density (± 1 SE) of benthic invertebrates in Hope Bay, 1998.

communities within Hope Bay were typical for the Arctic and Antarctic regions of the world (Hickman 1973; Johannesson et al. 2000). Differences in composition and abundance of the benthos among the three stations could be ascribed to physicochemical (e.g., water depth, salinity) characteristics at the sampling locations.

A comparison of mean benthic macroinvertebrate abundance among the three Hope Bay stations indicated that greater faunal densities correspond with increased water depth (Table 6.9). Increased invertebrate abundances at greater depths were also observed in nearby Roberts Bay samples (RL&L/Golder 2002). Additionally, substantial differences in the abundances of several taxonomic groups were observed between the two depths. For example, Amphipoda were located almost exclusively at the deeper location (Table 6.9). Additionally, a greater diversity and abundance of Polychaeta existed at greater depths.

Table 6.9 Summary of Benthic Invertebrate Abundance in Hope Bay, 1998

Location	Sample Depth (m)	Number of Sampling Events	Mean Total Density (animals/m^2)	Mean Number of Amphipoda (animals/m^2)	Mean Number of Polychaeta Taxa	Mean Number of Polychaeta (animals/m^2)
Station 1	8	1	3417	385	10	2025
Station 2	3.6	1	1652	15	3	415
Station 3	3.7	1	2628	0	4	930

The taxonomic Class Polychaeta (within the phylum Annelida) is an ecologically important group of primarily marine worms. More than 10 000 species of these worms exist in nature, displaying an enormous size range (less than 1 mm to 3 m). There are two general forms of polychaetes: those that are free living (Errantia) and those that are sedentary tube dwellers (Sedentaria). The actual number and type of polychaete species present in a system is the result of the complex of physical, chemical, biological and biogeographic conditions (Hickman 1973).

7 FISH POPULATIONS

7.1 LAKE COMMUNITIES

7.1.1 Methods

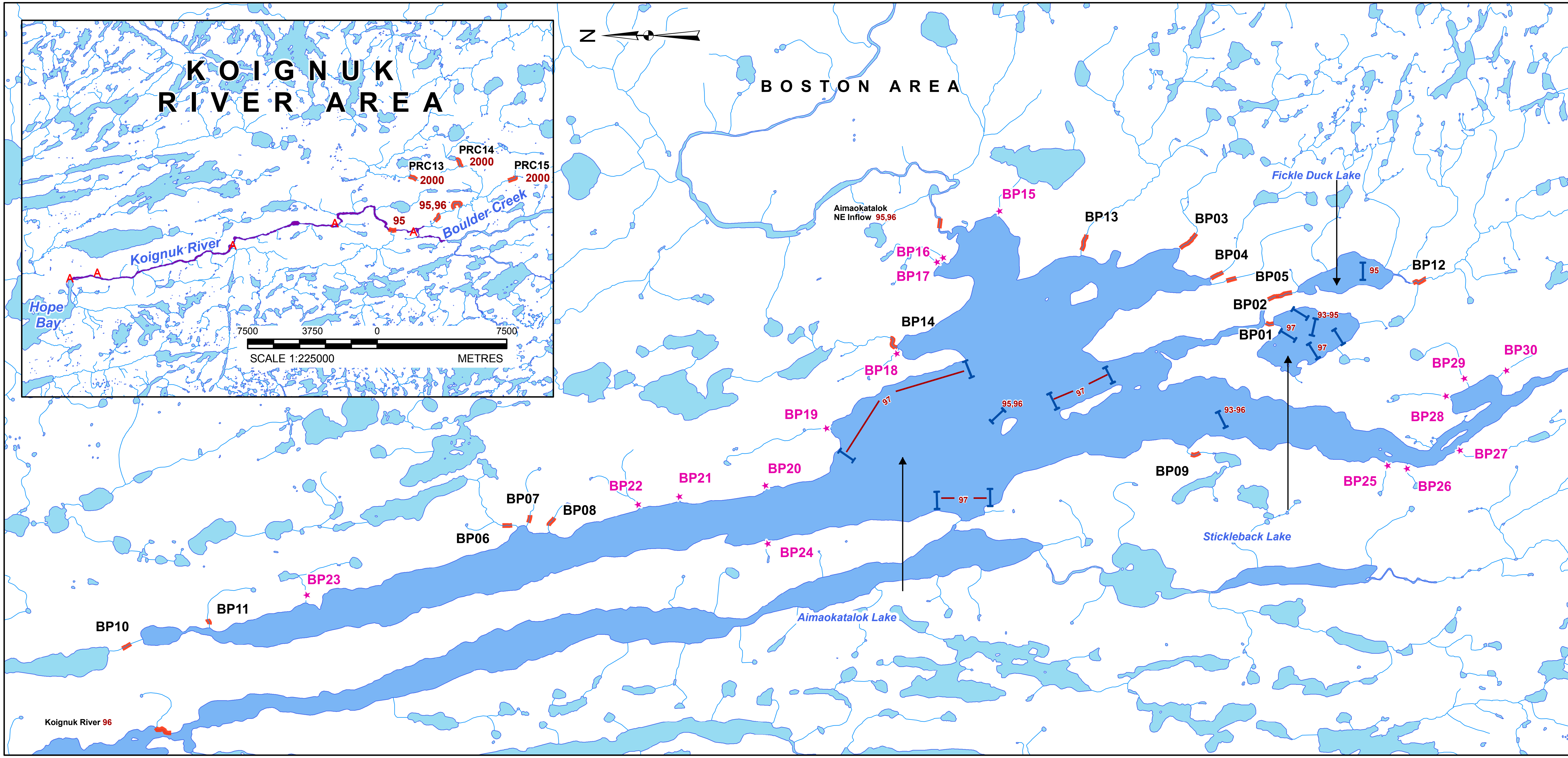
Field Methods

Fish sampling techniques used in the Boston area lakes between 1993 and 1997 included gill nets, minnow traps, and angling. The primary fish capture method was gill netting (all years), with considerably lesser amounts of angling (1995 and 1997), and minnow trapping (1995). All surveys were conducted during August. The waterbodies sampled during the 1993 to 1997 period included Aimaokatalok (Spyder), Fickle Duck (Trout), and Stickleback lakes (Figure 7.1). Fickle Duck Lake was sampled only twice during this period (1995 and 1996), whereas Stickleback Lake was sampled four times (1993, 1994, 1995 and 1997), and Aimaokatalok Lake was sampled each year. Detailed descriptions of fish capture methods are provided below.

Fish surveys conducted in the Boston area lakes in 1993, 1994 and 1995 used gill nets with a variety of mesh sizes, and the nets were deployed at the surface and on the bottom. In 1993, gill net set duration was 7.5 hours; however, information on mesh and net size was not provided in Rescan (1993). In 1994, both a sinking gill net gang (15.2 m long by 1.8 m deep, with a mesh size of 89 mm) and a floating gang (three 15.2 m long by 1.8 m deep panels comprised of 38, 64, and 89 mm mesh sizes) were used. Each net was set for 16 hours. In 1995, gill nets consisted of three panels, each 15.2 m long by 2.4 m deep, with 38, 64, and 89 mm mesh sizes. These nets were deployed near the surface in all but one site, which was on Aimaokatalok Lake.

Surveys conducted in 1996 involved setting two gill nets at each sampling site. The nets were positioned perpendicular to shore and parallel to each other. One net consisted of three panels with 19, 25, and 38 mm mesh sizes and a total length of 45.7 m. The other net consisted of four panels with 51, 64, 89, and 127 mm mesh sizes and a total length of 61.0 m. Gill net depths were not specified. Fish mortality was minimized by setting gill nets for a maximum of eight hours and checking each net hourly.

In 1997, both standard gill net gangs and index gill nets were used. The standard gill net gangs consisted of seven panels with 19, 25, 38, 51, 64, 76 and 89 mm mesh sizes. Each panel was 15.0 m long by 2.44 m deep. The total net area of each gang was 256 m^2. Index gill nets consisted of three panels of 38 mm mesh.



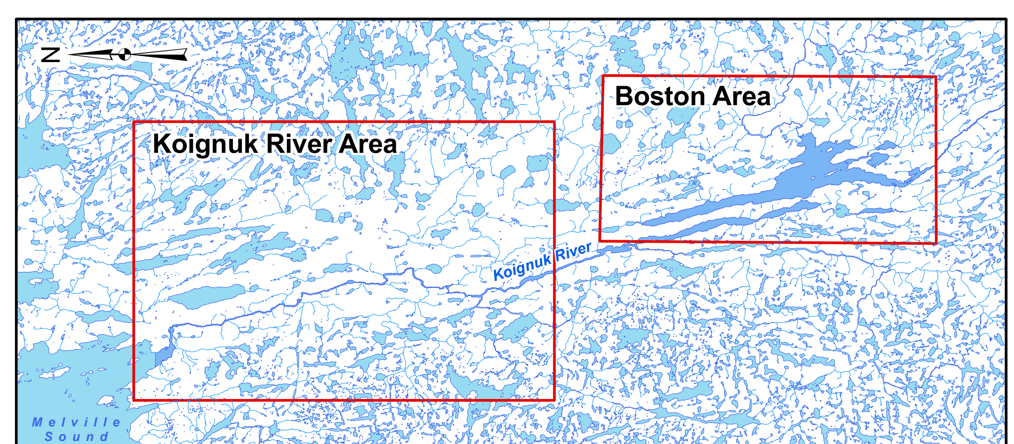
LEGEND

- Electrofishing and Habitat Survey
- Habitat Assessment Only (1997)
- Gill Net Locations
- Koignuk River Habitat Survey (1998)
- Angling
- Streams
- Study Area Waterbodies
- Waterbodies

93-96 Years of Sampling at Station
Note: All BPxx sites were sampled in 1997

REFERENCE

Sources: Data Obtained from the Government of Canada, Natural Resources Canada, Centre for Topographic Information
Projection: UTM Zone 13N Datum: NAD 83
This map is for information purposes only. Golder Associates Ltd. does not accept any liability arising from its misuse or misrepresentation.



2000 0 2000
SCALE 1:550000 METRES

MIRAMAR HOPE BAY LTD.

Boston Project Data Compilation

TITLE

Fish and Habitat Sampling Locations, 1993 - 2000

Golder Associates
Edmonton, Alberta

PROJECT No.06-1373-028		
DESIGN	JP	30 Apr. 2008
GIS	RC	05 May 2008
CHECK	JP	14 May 2008
REVIEW	GA	20 May 2008

SCALE AS SHOWN REV. 0

FIGURE: 7.1

Each panel was 15.0 m long by 2.44 m deep. The total net area was 110 m^2 per gang. Index gangs were deployed in what was termed as "rounds." In a round, three to four index nets were set in succession for approximately one-hour sessions. They were then retrieved in the order of setting and re-deployed upon completion of fish sampling.

Minnow traps were used only in 1995. They were made of galvanized metal with a wire mesh of 6.5 mm (diagonal measure). The traps were baited with salmon eggs and left submerged for 22 or 23 hours at each deployment site.

Fish life history information was collected from all fish captured. From 1993 to 1995, fish were identified to species, measured (fork length and/or total length in mm), weighed (g), and sampled for ageing structures; sex was determined through internal examination. In 1996, live fish were identified to species and measured (fork length in mm). In 1997, live fish were identified to species, measured (fork length in mm), weighed (g), sampled for ageing structures (left pectoral fin clips) and released. Fish larger than 300 mm in fork length were marked in 1997 with a uniquely numbered Floy™ anchor tag to assess their movements through subsequent recaptures. Additional data were collected from accidental and euthanized mortalities. These included sex and maturity, reproductive status, stomach contents, collection of otoliths (for ageing), and muscle, liver and/or kidney tissues for metal analysis.

Data Analysis

Data analysis and presentation varied considerably between the five annual data reports. As a result, all raw data have been consolidated into one table (Appendix D7) and submitted to a thorough QA/QC procedure. In cases where fish length did not correspond to its weight (i.e., Fulton's condition factor less than 0.5 or greater than 2.0), both length and weight data were eliminated from life history analyses (these data are reported in quotation marks in Appendix D7). As fish length data in 1994 were recorded only as total length (instead of fork length), they were converted to fork length using linear regression of species specific total length and fork length data collected in 1995. Subsequent to filtering out data errors, the raw data were used to calculate life history statistics that included:

- length-frequency distributions;
- length-weight relationships;
- mean, standard deviation, and range of length, weight, age and condition factor data;
- age-specific mean length and weight;
- size characteristics for separate sex and maturity categories; and

- diet analyses.

The multi-year data collected from each lake were combined during analyses to increase the sample size for each species.

As an index of relative abundance, catch-per-unit-effort (CPUE) values were presented only for 1997 surveys because of the consistent sampling methods (index gill nets) used during this year. Inconsistent mesh sizes used during 1993 to 1996, as well as the lack of detailed catch and effort information in the early data reports, did not allow for proper CPUE comparisons. The CPUE values for 1997 gill netting data are reported as number of fish captured per 100 m^2 of net set for 24 hours.

7.1.2 Aimaokatalok Lake

The catch rates, length-frequency distributions, size and age statistics, age-specific lengths and weights, diet, and sex/maturity data for fish species sampled in Aimaokatalok Lake during 1993 to 1997 are summarized in Appendices D1 to D6; data from individual fish are presented in Appendix D7. Gill netting was the main capture method used in Aimaokatalok Lake; however, angling and minnow traps were also used occasionally to capture fish.

7.1.2.1 Species Composition and Relative Abundance

In total, 260 fish were caught in Aimaokatalok Lake using gill nets during 1993 to 1997 (Table 7.1). They included lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), cisco (*Coregonus* sp.), and Arctic grayling (*Thymallus arcticus*). Lake trout was the predominant species in the overall catch (51.2%), followed by lake whitefish (41.9%) and cisco (6.5%). Arctic grayling was represented by only one individual captured in 1994. In 1993 and 1994, fish sampling occurred at only one location near the south end of the lake. In 1995 and 1996, fish sampling was conducted at two sites (in the south arm and the middle basin). In 1997, three new sampling locations were assessed (all within the middle basin of the lake).

Although lake trout dominated the catch in 1995 and 1996, lake whitefish outnumbered lake trout in 1994 and 1997. Cisco were captured only in 1997, likely as a result of the increased sampling effort in 1997 relative to the other years. This more intensive sampling effort, combined with the change in capture methods (use of index gangs), contributed to the large increase in the total number of fish caught in 1997 (62% of the total five-year catch). The CPUE values for lake trout, lake whitefish, and cisco caught in the index nets in 1997 were 35, 61, and

10 fish/100 m^2/24 h, respectively (Appendix D2). The overall CPUE values for the small and large mesh standard gangs (55 and 72 fish/100m^2/24 h, respectively) were lower than the overall CPUE value for index nets (106 fish/100m^2/24 h).

Table 7.1 Number and Percent Composition of Fish Captured by Gill Nets in Aimaokatalok Lake, 1993 to 1997

Species	1993		1994		1995		1996		1997		1993-1997	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Lake trout	*7*	53.8	*20*	45.5	*23*	82.1	*13*	92.9	*70*	43.5	***133***	**51.2**
Lake whitefish	*6*	46.2	*23*	52.3	*5*	17.9	*1*	7.1	*74*	46.0	***109***	**41.9**
Cisco	*0*	0.0	*0*	0.0	*0*	0.0	*0*	0.0	*17*	10.5	***17***	**6.5**
Arctic grayling	*0*	0.0	*1*	2.3	*0*	0.0	*0*	0.0	*0*	0.0	***1***	**0.4**
Total	***13***	**100**	***44***	**100**	***28***	**100**	***14***	**100**	***161***	**100**	***260***	**100**

Fish marked with Floy tags during the 1997 survey included 60 lake trout and 30 lake whitefish. None of the marked fish were subsequently recaptured.

Angling in Aimaokatalok Lake resulted in the capture of two lake trout in 1995 and 30 lake trout in 1997 (Appendix D1). Ninespine stickleback (*Pungitius pungitius*) (n = 75) were also captured in Aimaokatalok Lake using minnow traps in 1995 (total sampling effort of 46 h).

7.1.2.2 Life History Data

Lake Trout

Size Distribution

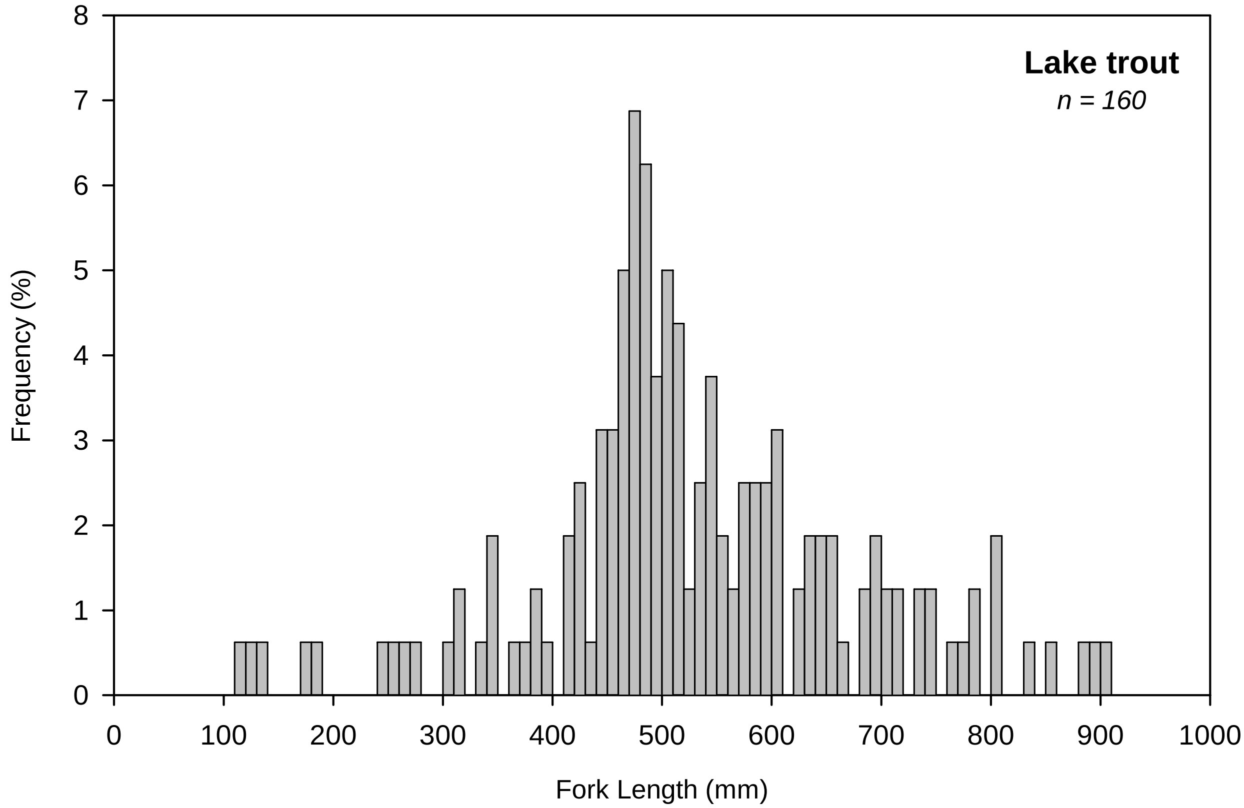
The length-frequency distribution of the measured lake trout catch in Aimaokatalok Lake (n = 160) was widespread, ranging from 113 to 905 mm in fork length (Figure 7.2; Appendix D4). The mean fork length was 527 mm (Appendix D3). Although the overall length distribution of the catch was widespread, most lake trout (59%) were within the 440 to 610 mm size-class.

Length-Weight Relationship

The length-weight regression equation for lake trout from Aimaokatalok Lake (all sampling years and methods combined) was as follows:

log Weight (g) = -4.890 + 2.969 log Fork Length (mm) (n=153; r^2=0.973)

The mean condition factor was 1.08; condition factors for individual fish ranged from 0.67 to 1.97 (Appendix D3).



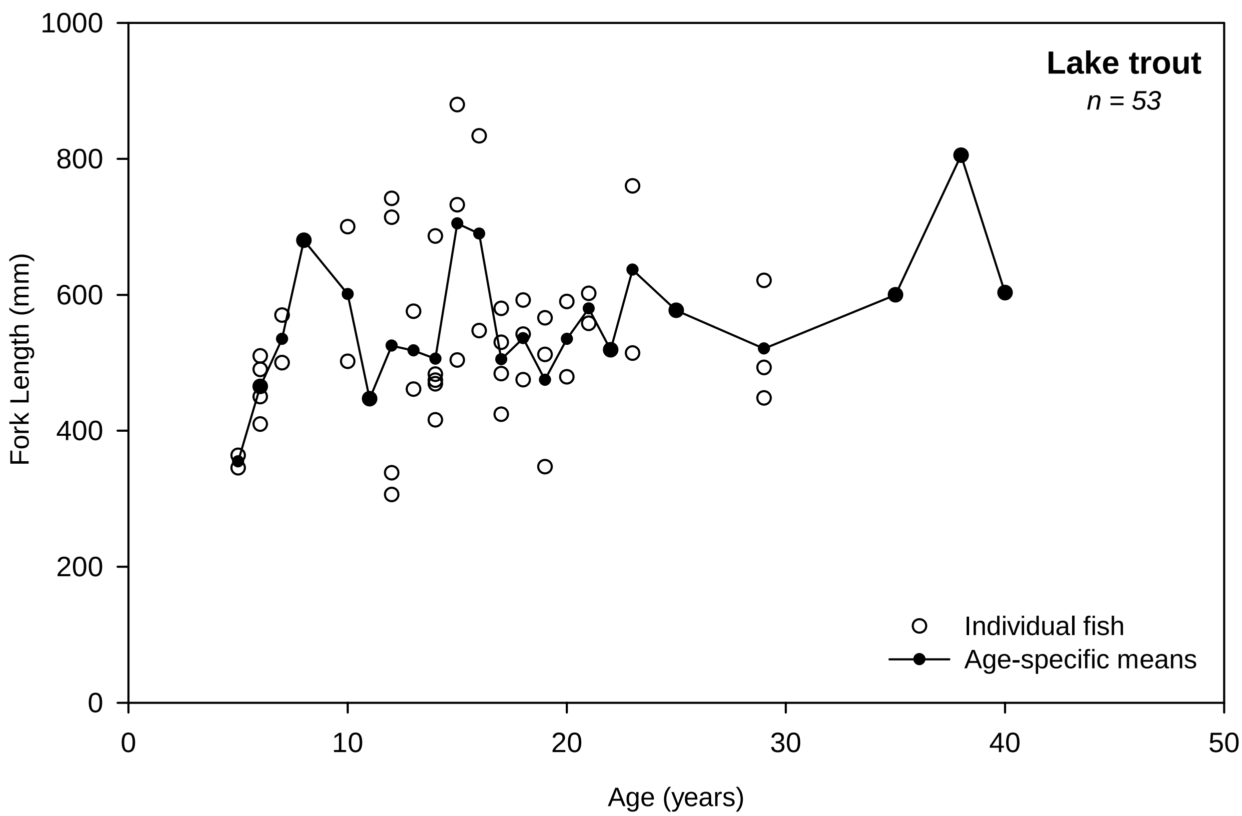


Figure 7.2 Length frequency distribution and age-length relationship for lake trout captured in Aimaokatalok Lake, 1993 to 1997.

Age and Growth

The age-length relationship for lake trout sampled in 1993-1997 is illustrated in Figure 7.2. Age-classes between 5 and 40 years were represented in the sample of 53 fish; the mean age was 16.4 years (Appendices D3 and D5). Mean length-at-age data were highly variable, likely because of the small sample size of aged fish (i.e., most age-specific means were based on one or two fish).

Sex and Maturity

Sex and maturity characteristics were determined for 42 lake trout from Aimaokatalok Lake (Appendix D6). Of these, 25 were females (15 mature and 10 immature) and 17 were males (eight mature and nine immature).

The largest immature female was 461 mm in fork length and the smallest mature female was 469 mm, suggesting that females reach maturity at an approximate length of 460-470 mm. Within the sample of males, the largest immature fish was 602 mm in fork length and the smallest mature individual was 448 mm in fork length. This large discrepancy in the size-at-maturity of males may indicate that some males remain immature despite their large size.

Diet

Nineteen lake trout captured in Aimaokatalok Lake during August 1997 were examined for stomach contents (Appendix D7). Of these, 11 (58%) had empty stomachs. Within the stomachs of eight fish that contained food items, unidentified fish remains were recorded in six of the stomachs and dipteran larvae were recorded in two stomachs. On the average, the non-empty stomachs were 30% full, ranging from 5 to 75% in stomach capacity of individual fish.

In addition to the above, qualitative data on lake trout diet in Aimaokatalok Lake were reported in Rescan (1994). The list of stomach contents included blackflies (*Simulium* sp.), mosquitoes (Culicidae), shrimp (*Mysis relicta*), amphipods (*Hyalella azteca*), isopods (*Lireus* sp.), nematodes, orb snail (*Valvata sincera heliocoidea*), lake whitefish (*Coregonus clupeaformis*), and stickleback (Gasteroidae).

Lake Whitefish

Size Distribution

Lake whitefish caught in Aimaokatalok Lake between 1993 and 1997 (n = 107) ranged from 172 to 538 mm in fork length (mean of 430 mm) (Figure 7.3). Most (72%) of the catch was composed of fish larger than 400 mm in fork length, with 18% of the catch exceeding 500 mm in fork length. Fish smaller than 240 mm in fork length contributed only 3% of the catch.

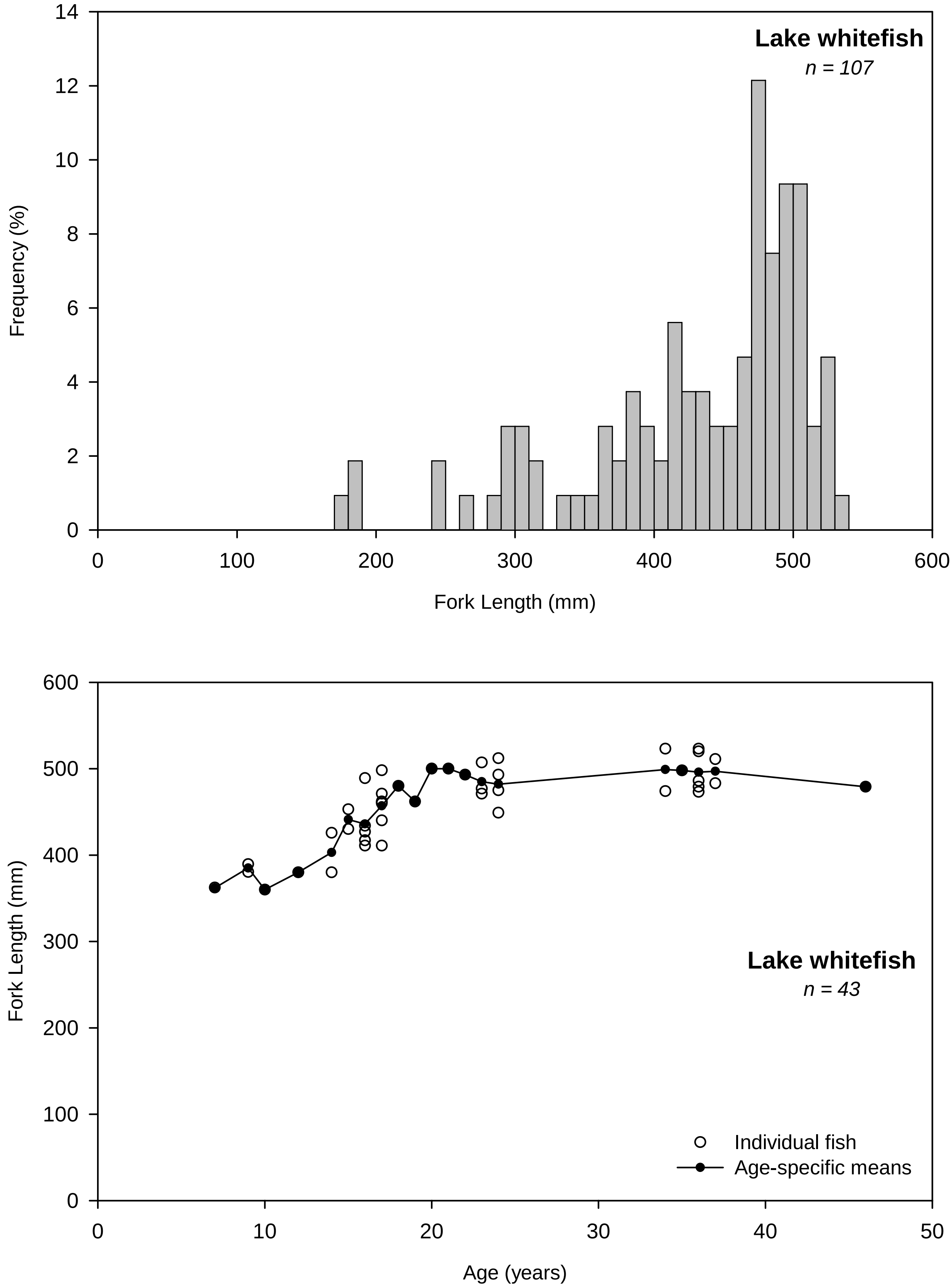


Figure 7.3 Length frequency distribution and age-length relationship for lake whitefish captured in Aimaokatalok Lake, 1993 to 1997.

Length-Weight Relationship

The length-weight regression equation for lake whitefish caught in Aimaokatalok Lake (all sampling years combined) was as follows:

log Weight (g) = -5.702 + 3.313 log Fork Length (mm) (n = 105; r^2 = 0.96)

The mean condition factor was 1.33; condition factors for individual fish ranged from 0.74 to 1.94 (Appendix D3).

Age and Growth

The age-length relationship for lake whitefish sampled in 1993-1997 is illustrated in Figure 7.3. Within the aged sample of 43 fish, age-classes from 7 to 46 years were represented, and the mean age was 22.2 years (Appendices D3 and D5). Although data were limited for younger age-classes, fish between ages 7 and 18 exhibited steady annual growth of approximately 11 mm in fork length. Older age-classes did not appear to grow as fast and reached an asymptotic size of about 500 mm in fork length.

Sex and Maturity

Sex and maturity characteristics were determined for 44 lake whitefish from Aimaokatalok Lake (Appendix D6). Of these, 23 were females (18 mature and five immature) and 21 were males (13 mature and eight immature).

The largest immature female was 379 mm in fork length and the smallest mature female was 411 mm in fork length. Within the sample of males, the largest immature fish was 437 mm in fork length and the smallest mature individual was 413 mm in fork length. The youngest ages recorded for mature fish were 15 years for females and 16 years for males. These data suggest that both sexes reach sexual maturity around age 15 at an approximate fork length of 410 to 430 mm.

Diet

Only qualitative data were available for lake whitefish diet (Rescan 1994). Listed food items included orb snails (*Valvata sincera helicoidea*), fingernail clams (*Pisidium casertanum*), fingernail clams (*Sphaerium nitidum*), freshwater shrimp (*Mysis relicta*), aquatic mites (*Lebertia sp*.), caddisflies (Trichoptera), mayflies (Ephemeroptera), and unidentified fish eggs.

Cisco

Size Distribution

Cisco were captured in Aimaokatalok Lake only in August 1997 (n = 17). They ranged from 92 to 348 mm in fork length (Figure 7.4), with a mean of 207 mm. Most (53%) of the catch was comprised of fish within a relatively narrow size-class of 170 to 209 mm in fork length.

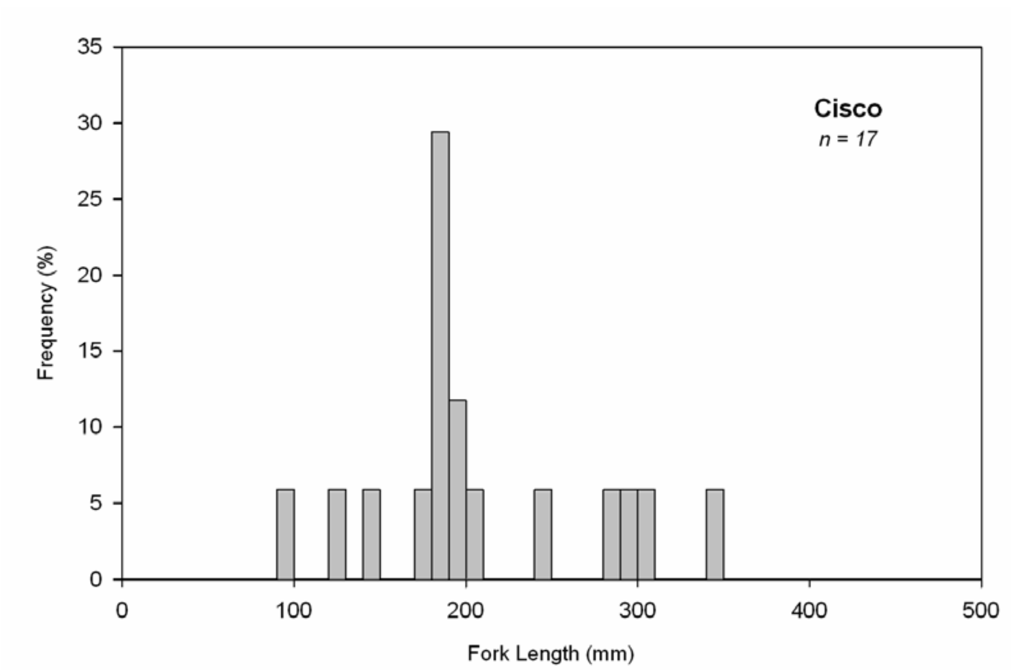


Figure 7.4 Length-Frequency Distribution of Cisco Captured in Aimaokatalok Lake, 1997

Length-Weight Relationship

The length-weight regression equation for cisco caught in Aimaokatalok Lake was as follows:

log Weight (g) = -5.389 + 3.166 log Fork Length (mm) (n = 17; r^2 = 0.994)

The mean condition factor was 0.99; condition factors for individual fish ranged from 0.85 to 1.26 (Appendix D3).

Sex and Maturity

Sex and maturity characteristics were determined for 11 cisco captured in Aimaokatalok Lake (Appendix D6). Of these, three were females (two mature and one immature) and eight were males (two mature and six immature).

The largest immature female was 305 mm in fork length and the smallest mature female was 198 mm in fork length. This large discrepancy in size-at-maturity data and the small size of two females reported in ripe spawning condition (198 and 205 mm in fork length) suggested that one part of the cisco catch in Aimaokatalok Lake may have been comprised of least cisco (*Coregonus sardinella*) that were misidentified as cisco (*Coregonus artedi*).

Within the sample of males, the largest immature fish was 287 mm in fork length and the smallest mature individual was 293 mm in fork length. These data suggested that cisco males reach sexual maturity at an approximate size of 290 mm in fork length.

Arctic Grayling

Only one Arctic grayling was caught in Aimaokatalok Lake. This fish was a six-year old male with a total length of 340 mm and a weight of 400 g (Appendix D7).

7.1.3 Stickleback Lake

Gill nets were set in Stickleback Lake during 1993, 1994, 1995, and 1997; however, no fish were captured despite the large amount of effort exerted. Minnow traps deployed for 22 h in 1995 captured 19 ninespine stickleback, indicating that it is likely the only fish species that inhabits this lake. Ninespine stickleback were also reported as observed in Stickleback Lake during 1993, 1994, and 1997 (Appendix D1).

7.1.4 Fickle Duck Lake

The catch rates, length-frequency distributions, size and age statistics, age-specific lengths and weights, diet, and sex/maturity data for fish species sampled in Fickle Duck Lake during 1995 and 1996 are summarized in Appendices D1 to D6; data from individual fish are presented in Appendix D7.

7.1.4.1 Species Composition and Relative Abundance

Arctic grayling was the only fish species captured in gill nets in Fickle Duck Lake during the 1995 to 1996 period (Appendix D1). Unlike Aimaokatalok Lake, Fickle Duck Lake did not appear to support lake trout, lake whitefish or cisco populations. Based on minnow trap catches, ninespine stickleback also inhabits this waterbody (three individuals were caught in July 1995).

Although Rescan (1997) presented tissue results for lake trout captured in Fickle Duck Lake in 1996, the same report stated that only Arctic grayling were captured in this lake. As such, it remains unclear which part of the report is in error; however, subsequent sampling in Fickle Duck Lake by Golder Associates Ltd. has confirmed that lake trout and present in the lake (Golder 2008).

In total, eight Arctic grayling were captured in gill nets; four were caught in 1995 and four were caught in 1996.

7.1.4.2 Life History Data

Arctic Grayling

Size Distribution

The sample of Arctic grayling from Fickle Duck Lake (n = 8) ranged between 224 and 407 mm in fork length, with a mean of 323 mm (Appendix D3). Only four fish were weighed; they ranged from 600 to 900 g, with a mean weight of 750 g.

Length-Weight Relationship

The length-weight regression equation for the sampled Arctic grayling was as follows:

log Weight (g) = -5.340 + 3.216 log Fork Length (mm) ($n = 4$; $r^2 = 0.998$)

The mean condition factor was 1.63; condition factors for individual fish ranged from 1.60 to 1.65 (Appendix D3).

Age and Growth

Age was determined for only two Arctic grayling from Fickle Duck Lake. One was an eight-year old female with a fork length of 335 mm. The other was a 12-year old male with a fork length of 380 mm.

7.1.5 Summary

In total, 300 fish representing four species were captured in gill nets or angled in three Boston area lakes during fisheries surveys conducted between 1993 and 1997 (Table 7.2). The captured species included lake trout (56% of the total catch), lake whitefish (38%), cisco (6%), and Arctic grayling (0.3%). Ninespine stickleback were also present in all lakes, as recorded from observations and minnow trap catches; however, numeric counts of these catches were not always reported.

Table 7.2 Summary of Fish Species Composition in Gill Net Catches of Boston Area Lakes, 1993 to 1997

Lake	Total Catch	Dominant Species (% of total catch)		Co-dominant Species (% of total catch)		Other Species (% of total catch)	
Aimaokatalok	292	Lake Trout	(56.2)	Lake whitefish	(37.6)	Cisco Arctic grayling	(5.9) (0.3)
Fickle Duck	8	Arctic grayling	(100.0)				
Stickleback	0						
Total	**300**						

The fish populations in Aimaokatalok Lake included lake trout, lake whitefish, cisco, Arctic grayling and ninespine stickleback. In Fickle Duck Lake, only Arctic grayling and ninespine stickleback were caught, and in Stickleback Lake only ninespine stickleback were caught. Considering that Fickle Duck and Stickleback lakes are similar in size and depth, the presence of Arctic grayling in Fickle Duck Lake is suspect. The presence of lake trout in Fickle Duck Lake has been confirmed in 2006 (Golder 2006), which suggests that lake trout may have been reported as Arctic grayling in error.

7.2 STREAM COMMUNITIES

7.2.1 Methods

Field Methods

Fish sampling techniques used in streams within the Boston area (including the Koignuk River) included backpack electrofishing, angling, minnow trapping, and gill netting (only in the Koignuk River). The primary fish capture method was backpack electrofishing. Stream surveys were conducted from June to August during the 1993-2000 period. Sampled watercourses included Fickle Duck and Stickleback outflows, Aimaokatalok NW Inflow, as well as several small inflows to Aimaokatalok Lake and one to Fickle Duck Lake (Figure 7.1; Appendix D8). The Koignuk River, Boulder Creek (tributary to the Koignuk River) and three small streams where permanent road crossings were proposed (PRC13, PRC14, and PRC15) were also sampled. Detailed descriptions of fish capture methods are provided below.

Backpack electrofishing was conducted by a two-person crew using either a gas-powered Smith-Root™ model 15A POW (Programmable Output Waveforms) or model 15C backpack electrofisher. Working in an upstream direction, both single and double pass electrofishing were used on accessible portions of selected streams (Rescan 1993, 1994, 1995, 1997, 1998, and 2001).

Surveyed sections varied between years. Data recorded during backpack electrofishing events included location, effort, amperage, voltage, water temperature, and habitat conditions; however, this data set was not complete for all sites. After the electrofishing survey, a habitat assessment of the surveyed stream section was also conducted (see Section 8). All stream site reference numbers (e.g., BP01, BP02, etc.; Figure 7.1) are based on Rescan (1998) designations, with the exception of the PRC sites, which were reported in Rescan (2001).

Fish life history data were collected from the captured fish. Live fish were identified to species, measured (fork length or total length in mm), weighed (g), and released. Due to large catches of ninespine stickleback in some years, the numbers of captured fish were only estimated and life history data (e.g., length) were not recorded. Additional data were collected from accidental and euthanized mortalities; these included sex and maturity, reproductive status, and collection of otoliths (for ageing).

Data Analysis

The presentation of fish population data for Boston area streams varied considerably between the six annual data reports in which they were discussed. To facilitate data presentation in this report, all data were consolidated into one table (Appendix D10) and analyzed for life history characteristics based on multi-year catches combined. Where data were available, mean fork length, weight, condition factor, and age (with corresponding standard deviations and ranges) were calculated for each stream and each species on a yearly basis (Appendix D9). The multi-year data collected from each stream were also combined to maximize the sample sizes.

As an index of relative abundance, catch-per-unit-effort (CPUE) values are presented in Appendix D8 as fish captured or observed per minute of active sampling (fish/min). Although some previous data reports had recorded CPUE differently (e.g., as fish/300 m/hour; Rescan 1997), data on distance sampled were not consistently reported in all years. To allow use of a common unit for comparisons, some of the CPUE data presented in Appendix D9 were calculated or changed to fish caught per minute of sampling, without considering the distance sampled.

7.2.2 Aimaokatalok NE Inflow

The Aimaokatalok NE Inflow originates from a chain of lakes east of Aimaokatalok Lake and drains into the northeast part of the middle basin of Aimaokatalok Lake. It is the second largest inflow into Aimaokatalok Lake after the Aimaokatalok River. Sampling of this inflow occurred during August 1995 and July 1996. High flows and turbid water conditions did not allow assessment in 1997. Where reported, the electrofished stream sections ranged from 150 to 300 m in length and both one-pass and two-pass (1996 only) electrofishing methods were used.

In total, 39 fish were captured in Aimaokatalok NE Inflow during backpack electrofishing surveys in August 1995 and August 1996 (Appendix D8). They included 34 lake trout and five Arctic grayling. Ninespine stickleback were also caught in this stream in 1996; however, they were not enumerated because of time constraints and the large numbers caught (Rescan 1997). In 1995, only Arctic grayling were reported from minnow trapping and electrofishing effort, whereas in 1996 only lake trout were caught by electrofishing. The electrofishing CPUE value was 0.5 fish/min in 1995 and 3.3 fish/min in 1996.

The Arctic grayling caught in 1995 (*n* = 5) were all juveniles and were not measured. The lake trout catch in 1996 (*n* = 34) ranged from 52 to 82 mm fork length, with a mean of 64 mm (Appendix D9). The entire catch consisted of juvenile fish, suggesting that Aimaokatalok NE Inflow is used during summer for Arctic grayling and lake trout rearing.

7.2.3 Stickleback Outflow (BP01)

The Stickleback Outflow drains out of Stickleback Lake and into the southern portion of Aimaokatalok Lake. This stream has no observable spawning, overwintering, or adult holding habitat and there are no barriers to fish migration. Sampling was conducted by backpack electrofishing during August 1993 and June 1997 (Figure 7.1). Minnow traps were used in August 1994 and August 1995. The electrofished stream section was only 12 m in length in 1993; it was 175 m long in 1997.

Only two fish species were captured in Stickleback Outflow. The catch was dominated by ninespine stickleback, whereas lake trout were represented by a single fish (fry) caught in a minnow trap in 1994 (Appendix D8). Not all ninespine stickleback were counted in 1994 due to large catches.

In total, over 140 ninespine stickleback and one lake trout fry were captured in Stickleback Outflow. Electrofishing catches of ninespine stickleback were much higher in August 1993 (*n* = 31 or 12.4 fish/min) than in June 1997 (*n* = 2 or 0.3 fish/min), suggesting a seasonal difference in use by ninespine stickleback. Only two ninespine stickleback were measured; they were caught near the inflow to Aimaokatalok Lake in 1997 and were 59 and 61 mm in total length (Appendix D8); the size of the single lake trout fry was not reported.

7.2.4 Fickle Duck Outflow (BP02)

The Fickle Duck Outflow drains into the southern portion of Aimaokatalok Lake. This stream has no observable spawning, overwintering, or adult holding habitat, and there are no barriers to fish migration. Sampling was conducted using backpack electrofishing in August 1993, July 1995, and June 1997. Minnow traps were used in August 1994 and August 1995. The length of the electrofished stream section was 20 m in 1993 and 80 m in 1997.

Similar to Stickleback Outflow, only two fish species were captured in Fickle Duck Outflow. The catch was dominated by ninespine stickleback, and lake trout were represented by a single fish caught in a minnow trap in 1994 (Appendix D8). Not all ninespine stickleback were counted in 1994 due to large catches.

In total, over 166 ninespine stickleback and one lake trout fry were captured in Fickle Duck Outflow. The electrofishing catch of ninespine stickleback was much higher in July 1995 (n = 40 or 33 fish/min) than in August 1993 (n = 2 or 0.3 fish/min) and June 1997 (n = 2 or 0.4 fish/min). Only two ninespine stickleback were measured (61 and 69 mm in total length; Appendix D8); the size of the single lake trout fry was not reported.

7.2.5 Small Tributaries to Aimaokatalok Lake (B03 to B30)

In total, 12 small tributaries to Aimaokatalok Lake were sampled by backpack electrofishing in June 1997 (BP03 to BP14; Figure 7.1). An additional 16 streams (BP15-BP30) were assessed as not having fish habitat, or as having barriers preventing fish movement from Aimaokatalok Lake. Details on the streams where fish sampling occurred are reported below.

Stream BP03

Stream BP03 flows into the southeast basin of Aimaokatalok Lake. A 350 m stream section was electrofished on 15 June 1997. The total catch consisted of five ninespine stickleback and one Arctic grayling adult. The Arctic grayling was captured in a small pool immediately downstream of the marshy area and the ninespine stickleback were caught at the mouth of the creek. The ninespine stickleback ranged from 43 to 50 mm in total length, with a mean length of 47 mm (Appendix D9). The Arctic grayling was a mature male, 358 mm in fork length and 460 g in weight. The overall CPUE value was 0.6 fish/min (Appendix D8).

Stream BP04

Stream BP03 drains a series of small ponds and flows into the southeast basin of Aimaokatalok Lake. This stream was sampled by backpack electrofishing on 16 June 1997. No fish were captured during sampling. The surveyed section of the stream was in flood, flowing over terrestrial grasses and organic matter. Potential spawning, rearing, adult feeding, or overwintering habitat was not present within the stream. A low-laying marshy area likely acted as a barrier to large-bodied fish accessing the upstream ponds (Rescan 1998).

Stream BP05

Stream BP05 is located immediately southwest of Stream BP04 and flows into the southeast basin of Aimaokatalok Lake. An 80 m stream section was electrofished on 16 June 1997. Two ninespine stickleback and one Arctic grayling were captured (CPUE of 0.6 fish/min; Appendix D8). The ninespine stickleback were 49 and 54 mm in total length, whereas the Arctic grayling was an immature male, 224 mm in fork length and 102 g in weight (Appendix D9).

The surveyed section of the stream was in flood, flowing for the most part over terrestrial grasses and organic matter, and it is likely that this stream is ephemeral. There was no observable spawning, rearing, overwintering, or adult feeding habitat present. The fish were caught near the mouth of the stream.

Stream BP06

Stream BP06 drains a series of small ponds into the northern arm of Aimaokatalok Lake. It was sampled by backpack electrofishing on 16 June 1997, resulting in no fish captures. The surveyed section of the stream flowed through series of rock shelves, pools, and riffles. The substrate was composed largely of organic matter as the stream flowed through terrestrial grasses and shrubs. The stream provided potential rearing habitat, but not spawning, overwintering, or adult feeding habitat. A rock shelf at the mouth of the stream probably acts as a fish barrier, preventing movement into BP06 or the upstream ponds.

Stream BP07

Stream BP07 is located immediately south of Stream BP06 and drains a marshy area into the northern arm of Aimaokatalok Lake. It was sampled by backpack electrofishing on 16 June 1997, resulting in no fish captures. The stream flowed over terrestrial grasses and organic matter. There was no observable spawning, overwintering, or adult feeding habitat present, and there was no potential rearing habitat within the channel.

Stream BP08

Stream BP08 is located immediately south of Stream BP07 and drains into the northern arm of Aimaokatalok Lake. It was sampled by backpack electrofishing on 16 June 1997, resulting in no fish captures. The stream flowed over terrestrial grasses and organic matter. There was no spawning, overwintering, rearing, or adult feeding habitat within the channel.

Stream BP09

Stream BP09 is located on the west side of Aimaokatalok Lake, and drains a series of small ponds into the southern arm of Aimaokatalok Lake. It was sampled by backpack electrofishing on 16 June 1997, resulting in no fish captures. As the stream was in flood stage, much of the stream was flowing through terrestrial grasses; however, the central channel had a substrate consisting of fines, cobble and boulders. Of all the streams assessed, this stream had the best potential as spawning and rearing habitat for Arctic grayling; however, a rock shelf at the mouth of the stream likely acted as a migration barrier for fish movements, especially during low water levels.

Stream BP10

Stream BP10 drains a small lake into the northern tip of Aimaokatalok Lake. A 150 m section was electrofished on 17 June 1997, when the stream was in flood. The stream was composed of a series of deep pools connected by "riffles over terrestrial grasses" (Rescan 1998). The stream then changed to a marshy area of indistinct channels 200 m upstream, which most likely acted as a migration barrier. In total, one mature Arctic grayling, one mature lake trout and one ninespine stickleback were caught (overall CPUE of 1.2 fish/min; Appendix D8). The Arctic grayling was 415 mm in fork length and weighed 826 g. The lake trout was 733 mm in fork length and weighed 4050 g. The ninespine stickleback had a total length of 54 mm.

Stream BP11

Stream BP11 flows into the northern arm of Aimaokatalok Lake. A 160 m stream section was electrofished on 17 June 1997. Seven ninespine stickleback were captured (CPUE of 2 fish/min; Appendix D8). They ranged from 47 to 55 mm in total length (Appendix D9). The surveyed section of the stream was in flood, flowing for the most part over terrestrial grasses and organic matter. There was no observable spawning, rearing, overwintering, or adult feeding habitat present.

The fish were caught near the mouth of the stream, suggesting they originated in Aimaokatalok Lake.

Stream BP12 (Fickle Duck Inflow)

Although Rescan (1998) designated Stream BP12 as Stickleback Inflow, the location of this site on the accompanying map clearly shows that it flows into Fickle Duck Lake. It was assumed that the map was correct and the site has been renamed to Fickle Duck Inflow in this report.

Stream B12 drains a series of small lakes and marshy areas southeast of Fickle Duck Lake. It was sampled on 17 June 1997. The surveyed section of stream consisted of a series of pools connected by riffles and runs. Run sections were lined by undercut banks. Although the stream was in flood stage, the central channel was underlain by fines, cobble, and boulders. Two ninespine stickleback were captured (CPUE of 0.4 fish/min; Appendix D8). They were 57 and 71 mm in total length (Appendix D9).

Stream BP13

Stream BP13 drains a series of small lakes into the east part of the middle basin of Aimaokatalok Lake. It was sampled by backpack electrofishing on 17 June 1997, resulting in no fish captures. The stream was a series of small pools connected by riffles flowing over terrestrial grasses and organic matter. There was no spawning, overwintering, rearing, or adult feeding habitat in the channel.

Stream BP14

Stream BP14 drains a series of small lakes into the northeast part of the middle basin of Aimaokatalok Lake. It was sampled by backpack electrofishing on 17 June 1997, resulting in no fish captures; however, one juvenile Artic grayling was observed. The surveyed section of the stream was steep in gradient and flowed over terrestrial grasses and a set of rapids. Poor spawning, rearing, and adult feeding habitat was located with the channel. There was no overwintering habitat.

Streams BP15 to BP30

Based on helicopter reconnaissance surveys, streams BP15 to BP30 were determined to have no suitable fish habitat and were not sampled for fish. All of these streams were ephemeral in nature, draining melt water into Aimaokatalok Lake.

7.2.6 Koignuk River

The Koignuk River extends from a chain of lakes west of Aimaokatalok Lake, then converges with the outflow of Aimaokatalok Lake and flows north into Hope Bay. The Koignuk River features mainly rock/cobble substrate with numerous gravel bars. Sampling took place in 1995, 1996, and 1998 and included backpack electrofishing (1995 and 1996), angling (1995 and 1998), and gill netting (1998). Backpack electrofishing was done downstream of the Boulder Creek confluence in 1995 and in the upstream reach in 1996. In 1998, angling was conducted at five locations along the lowermost 25-km section of the river (Figure 7.1).

In total, 46 fish were caught using all three capture methods. Eighteen fish were caught by electrofishing, 27 were caught by angling, and one was caught in a gill net (Appendix D8). The catch was comprised of 30 lake trout, 10 Arctic grayling, four ninespine stickleback, one lake whitefish (caught in the gill net) and one Greenland cod (*Gadus ogac*). Observations of slimy sculpin were also reported in 1998 (Rescan 1999).

Within the sample of 26 lake trout that were measured, fork lengths ranged from 46 to 795 mm (Appendix D9). Lake trout captured by backpack electrofishing on 8 August 1996 (n = 14) ranged between 46 and 72 mm in fork length (likely young-of-the-year or yearlings). Lake trout captured by angling ($n = 12$) ranged from 322 to 795 mm in fork length; the largest fish weighed 5850 g. Ages were determined for nine of these fish and ranged from 10 to 25 years.

Arctic grayling ($n = 7$) ranged from 293 to 383 mm in fork length (mean of 347 mm). They ranged from four to 10 years in age. All Arctic grayling were caught by angling. The heaviest fish weighted 570 g.

One lake whitefish was caught using a gill net drifted through a scour pool located about 1.25-km upstream from the Koignuk River mouth in August 1998. This fish was 173 mm in fork length and weighed 51 g. One Greenland cod (467 mm in length and 1180 g in weight) was also angled at this site, indicating that this marine species can occasionally use freshwater habitats.

7.2.7 Tributaries to Koignuk River

Boulder Creek

Boulder Creek is approximately 13-km long and drains a series of lakes into the Koignuk River (Figure 7.1). Near its confluence with the Koignuk River, Boulder Creek features suitable spawning habitat for Arctic grayling and possibly for lake trout. Backpack electrofishing in this stream was conducted on 3 August 1995. During 440 s of electrofishing, seven juvenile Arctic grayling were caught (CPUE = 1.0 fish/min; Appendix D8). The sizes of these fish were not reported. Water depth in the sampled area ranged from <0.3 to 1.0 m.

Backpack electrofishing was also conducted in this stream on 10 August 1996. Lake trout were the only fish species caught during this survey (n = 26). They were all juveniles within two distinct size-classes; 21 fish were between 48 and 62 mm in fork length (likely young-of-the-year fish) and three ranged from 102 to 116 mm in fork length (likely yearlings).

Stream PRC13

Stream PRC13 (a tributary to Boulder Creek) was sampled at a proposed crossing for an all-weather road. Backpack electrofishing was conducted on 29 August 2000, when a 100 m long section was sampled. Only three ninespine stickleback were captured. They ranged from 24 to 33 mm in total length.

Stream PRC14

Stream PRC14 (a tributary to Boulder Creek) was sampled at a proposed crossing for an all-weather road. Backpack electrofishing was conducted on 25 June 2000 along a 300 m long section. Sixteen ninespine stickleback were captured. They ranged from 26 to 69 mm in total length.

Stream PRC15

Stream PRC15 (a tributary to Boulder Creek) was sampled at a proposed crossing for an all-weather road. Backpack electrofishing was conducted on 29 August 2000 along a 175 m long stream section. Three ninespine stickleback and one Arctic grayling were captured. The ninespine stickleback ranged from 28 to 33 mm in total length. The Arctic grayling was 55 mm in fork length (likely a y-o-y fish).

7.2.8 Summary

Streams in the Boston area, excluding the lower sections of the Koignuk River, were inhabited by at least three fish species (lake trout, Arctic grayling, and ninespine stickleback). Two additional species (Greenland cod and lake whitefish) were present in the lower section of the Koignuk River. Slimy sculpin were also observed but not captured.

Ninespine stickleback was the most common species (74%) in the total catch of more than 471 fish. This species was also most widely distributed among the sampled streams; it was recorded in 11 of the 13 stream sites sampled for fish. Lake trout was second in abundance (20% of the total catch) and was recorded at six sites. Arctic grayling contributed 6% to the total catch and were recorded at seven sites. Juveniles and adults were present in the catch of both lake trout and Arctic grayling.

7.3 FISH TISSUES

To provide baseline data on metal concentrations in fish tissues, dorsal muscle and liver samples were collected from lake trout, lake whitefish, and Arctic grayling from Aimaokatalok and Fickle Duck lakes (Figure 7.1). In total, 236 tissue samples were collected and analyzed. Table 7.3 shows the distribution of the samples in terms of species, tissue types, lakes, and sampling years. Preliminary analyses of small numbers of fish tissue samples were carried out in 1993, 1994, and 1996 (Rescan 1993, 1994, and 1997); however, most (70%) of the samples were collected in 1995 and 1997 (Rescan 1995 and 1998). The data for all individual samples are included in Appendix D11.

Table 7.3 Number of Fish Tissue Samples Analyzed for Metal Concentrations, Boston Area Lakes, 1993 to 1997

Lake	Species	1993		1994		1995		1996		1997	
		Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle
Aimaokatalok	Lake trout	3	3	11	11	25	25	3	3	25	25
	Lake whitefish	3	3	11	11	5	5	-	-	24	24
	Arctic grayling	-	-	1	1	-	-	-	-		
Fickle Duck	Lake trout[a]	-	-	-	-	-	-	3	3	-	-
	Arctic grayling	-	-	-	-	4	4	-	-	-	-

[a] The tissue results for lake trout from Fickle Duck Lake were presented in Rescan (1997); however, the same report stated that only Arctic grayling were captured in this lake.

Because most of the analyzed metal constituents are not potential contaminants associated with the Boston Project, they are not included in the detailed analyses, but are presented in Appendices D11 to D13. Metal constituents that were deemed to be suitable indicators included aluminum, arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc. These metals were included because they are of potential concern in gold mining developments and from a human consumption perspective. The following sections briefly outline the significance of these constituents to aquatic environments and human health.

Aluminum

The availability of aluminum to aquatic organisms has been correlated with the pH of the aquatic environment (Holtze and Hutchinson 1989); however, it is unclear at what pH threshold or concentration aluminum becomes toxic to fish. Aluminum can be acutely toxic at high exposure levels, but it does not bioaccumulate in aquatic organisms (Neville 1985).

Arsenic

Arsenic is more common in the earth's crust than is mercury or cadmium, and is more toxic to plants than to animals (Demayo et al. 1979). It does not appear to biomagnify through different trophic levels. Demersal (bottom dwelling) fish species are more likely to accumulate arsenic than pelagic (open-water) species (Demayo et al. 1979). Arsenic concentrates mainly in the liver and is a cumulative toxin (Falk et al. 1973). Background concentrations of arsenic in most aquatic organisms generally are less than 1 µg/g wet weight (Eisler 1988) or less than 5 µg/g dry weight (assuming 80% moisture content). The Canadian Food Inspection Agency guideline indicates that arsenic levels in fish tissues should not exceed 3.5 µg/g wet weight (http://www.inspection.gc.ca/english/anima/fispoi/manman/samnem/app3e.shtml).

Cadmium

Cadmium is a relatively rare element and is most often associated with copper, lead, and zinc. In sufficient concentrations, cadmium is toxic to plants and animals (Health Canada 1992). The rate of cadmium uptake in aquatic organisms is generally faster in hard waters, although cadmium toxicity decreases in hard water (Reeder et al. 1979). Cadmium does not bioaccumulate in the food web (Reeder et al. 1979). Cadmium concentrations exceeding 3 µg/L in water lead to high mortality of aquatic organisms, reduced growth, and inhibited reproduction (Eisler 1985a). The main sources of cadmium pollution are industrial and municipal wastes. Other anthropogenic sources of cadmium include smelter dusts and fumes, and fossil fuel incineration products (Health Canada 1992).

Copper

In contrast to the non-essential trace metals (e.g., arsenic, cadmium, mercury, and lead), copper is an essential element with important biochemical functions; however, excessive amounts of copper are toxic to freshwater fish (Forstner and Wittman 1979). The toxicity of copper varies not only with the species of fish, but also with ambient water characteristics such as pH and alkalinity. Copper is not considered to be a cumulative systematic poison as most of it is excreted from the body (Falk et al. 1973). The main areas of the body where it concentrates are liver, muscle, and brain tissues (Demayo and Taylor 1981).

Lead

Lead is the most common of the heavy metals and is toxic to all forms of life. Lead does not appear to bioaccumulate. In aquatic ecosystems, lead concentrations are generally higher in benthic organisms and lower in organisms at higher trophic levels. Lead tends to deposit in bone (hard tissue) as a cumulative toxin (Falk et al. 1973). It is more toxic in soft water than in hard water (Demayo et al. 1980). Solid and liquid wastes account for a large percentage of the lead discharged into the Canadian environment, usually into landfills, but lead has been dispersed more widely in the general environment though atmospheric emissions (Health Canada 1992). The federal guidelines state that lead levels should not exceed 0.5 µg/g wet weight in fish tissues (http://www.inspection.gc.ca/english/anima/fispoi/manman/samnem/app3e.shtml).

Mercury

Mercury is a toxic element, which, in fish tissue, is most commonly present in the form of methyl mercury. Under anaerobic conditions in sediments, inorganic mercury can be processed by microorganisms into organic mercury compounds (most commonly in the form of methyl mercury). Methyl mercury can readily associate with suspended and organic matter and be taken up by aquatic organisms. It has a high affinity for lipids and is distributed to the fatty tissues of living organisms (Health Canada 1992). As such, methyl mercury bioaccumulates in the food chain and tissues of the top predators may contain mercury levels that are unacceptable for human consumption (Health Canada 1992). The average proportion of methyl mercury to total mercury increases from 10% in the water column to 15% in phytoplankton, 30% in zooplankton, and 90% or more in fish (Huckabee et al. 1979; Morel et al. 1998). High levels of mercury are common in reservoirs as flooded terrestrial vegetation, which is rich in organic material, decomposes and stimulates the production of methyl mercury. Environmental conditions can influence the rate of methylation; these environmental conditions include water temperature, pH, dissolved oxygen, and sediment chemistry (Rudd and Turner 1983). Mercury may enter the water column from three principal sources: 1) by direct deposition from the atmosphere, 2) in runoff from the drainage basin, or 3) by solubilization or suspension from the benthic sediments. Erosion of mercury-bearing rocks is the ultimate geological source of mercury, and also contributes to mercury loads in rivers. Long-term daily ingestion of mercury has been found to cause the onset of neurological symptoms (Health Canada 1992). The maximum allowable level of mercury in muscle tissue of fish sold in Canada for human consumption is 0.5 µg/g wet weight (http://www.inspection.gc.ca/english/anima/fispoi/manman/samnem/app3e.shtml).

Nickel

The toxicity of nickel increases with decreasing water hardness and increasing acidity (CCREM 1996). Nickel toxicity also increases when it is present with copper, likely as a result of synergism (Taylor et al. 1979). Nickel does not biomagnify in the food web (Taylor et al. 1979). Hutchinson et al. (1975) reported that nickel concentrations were highest in plants and lowest in top predators. Bowen (1966) considered 1 µg/g (dry weight) of nickel in fish tissue to be in the range of natural background levels. Nickel concentrations tend to be highest in the vicinity of nickel smelters, sewage outfalls, coal ash disposal basins, and heavily populated areas (Eisler 1998). In fish, signs of nickel poisoning include rapid opercular and mouth movements, and surfacing. Loss of equilibrium and convulsions occur prior to death (Khangarot and Ray 1990).

Selenium

Selenium is an essential nutrient in low concentrations (Eisler 1985b); however, it is also a toxicant for humans and animals at concentrations slightly higher than those required (Chen 2000). Selenium is a naturally occurring trace element found commonly in rocks and soil, particularly in deposits of coal and other fossil fuels (Lemly and Smith 1987). Selenium is usually present in water as selenate or selenite; however, the elemental form may be carried in suspension (Health Canada 1992). Anthropogenic sources of selenium include irrigation waters from seleniferous soils, municipal and industrial wastewaters, fuel (coal and oil) combustion, mining, smelting, and refining (Nagpal and Howell 2001; Health Canada 1992). Selenium has been found to bioaccumulate within the food chain (Nagpal and Howell 2001; Lemly and Smith 1987). In aquatic environments, organisms accumulate selenium from both water and food. Most selenium (90%) that enters an aquatic ecosystem is taken up by organisms or bound to particulate matter, which results in its deposition and accumulation in the top layer of sediments and detritus. Toxic effects of selenium include mortality of juvenile and adult fish and reproductive effects (Lemly and Smith 1987). Selenite tends to be more toxic at early life history stages (i.e., eggs and juveniles) and these effects are more pronounced when water temperature is elevated. Selenium concentrations greater than 0.005 mg/L in water can be bioconcentrated in food chains and cause toxicity and reproductive failure in fish (Lemly and Smith 1987). Juvenile and adult fish usually require higher concentrations of selenium in water before mortality occurs. Signs of selenium toxicity include losses of equilibrium, lethargy, muscle spasms, liver degeneration, reduction in erythrocytes and blood haemoglobin, and an increase in white blood cells (Eisler 1985b). Lemly and Smith (1987) provided selenium levels of concern for fish and wildlife. They suggested that concentrations in water should not exceed 2 to 5 µg/L to protect fish and waterfowl. For food ingested by fish, they suggested that concentrations of 5 µg/g (dry weight) could cause toxic effects. Reproductive failure was found to occur in fish when concentrations exceeded 12 µg/g (dry weight) in whole body residue, 16 µg/g in visceral residue, and 8 µg/g in skeletal muscle residue.

Zinc

Zinc primarily affects gill epithelial tissues. In excessive amounts, it can cause outright mortality or induce stress that leads to death (Falk et al. 1973). Zinc, however, is essential for plant and animal health. Zinc toxicity increases with increasing pH and decreasing water hardness. Zinc concentrations are usually greater in omnivorous than in piscivorous species, and greater in benthic invertebrates than in fish (CCME 2007).

7.3.1 Methods

Field Methods

Tissue samples were collected opportunistically from fish mortalities encountered during the gill netting surveys of the Boston area lakes. Most fish were captured during the lake survey programs in 1995 and 1997. All fish selected for tissue analyses were identified to species; most were measured for fork length (mm), weighed (g), examined for sex, maturity, and reproductive status, and dissected for ageing structures (otoliths) and tissues. Length, weight and age data were not reported for fish sampled in 1996.

A minimum of 100 g of muscle tissue was collected from each fish, as well as the complete liver (without the bile gland). Samples were individually stored in plastic Whirl-Pac bags and frozen until analysis.

Laboratory

Analyses for fish collected in 1997 were conducted by Analytical Services Laboratories Ltd. in Vancouver, BC. The 1995 samples were analyzed by Elemental Research Inc. laboratory in North Vancouver, BC. The laboratories used for analyses of the 1993, 1994, and 1996 samples were not specified. The detection limits and methods used for metal analyses are listed for each sampling year in Table 7.4.

All results are reported as micrograms per gram on a ‘wet weight’ basis. The results from 1996 were reported in Rescan (1997) as ‘µg/g dry weight’; however, the magnesium concentrations in muscle tissues indicated that they were likely based on wet weight. As such, this report assumes the 1996 values to be based on wet weight (same as reported in all other years).

Table 7.4 Detection Limits (µg/g wet weight) and Methods Used to Analyze Fish Tissues for Metals Concentrations, Boston Area Lakes, 1993 to 1997

	1993	1994	1995		1996	1997	
	Det. Limit	Det. Limit	Det. Limit	Method	Det. Limit	Det. Limit	Method
Aluminum						5	ICP
Arsenic		0.01	0.05	ICPMS	0.05	0.05	HVAAS
Barium						0.5	ICP
Beryllium						0.2	ICP
Cadmium	0.006	0.0008 - 0.0021	0.005	ICPMS	0.02	0.02	ICP
Calcium						10	ICP
Chromium						0.5	ICP
Cobalt						0.5	ICP
Copper			0.01	ICPMS	0.1	0.5	ICP
Iron						1	ICP
Lead	0.04		0.002	ICPMS	0.05	0.05	GFAAS
Magnesium					1	0.05	ICP
Manganese					0.1	0.2	ICP
Mercury		0.008 - 0.013	0.005	ICPMS	0.005	0.005	CVAAS
Molybdenum						1	ICP
Nickel	0.2		0.05	ICPMS	0.2	1	ICP
Selenium					0.2	0.1 - 0.3	HVAAS
Silver	0.01	0.0014 -0.0038	0.005		0.01	0.1	ICP
Tellurium		0.002 - 0.0038	0.005 -0.009		0.2		
Zinc			0.01	ICPMS	0.1	0.3	ICP

Notes:

CVAAS = Cold Vapor Atomic Absorption Spectrophotometry.

GVAAS = Graphite Furnace Atomic Absorption Spectrophotometry.

HVAAS = Hydride Vapor Atomic Absorption Spectrophotometry.

ICP = Inducively Coupled Argon Plasma / Atomic Emission Spectrophotometry.

ICPMS = Inducively Coupled Argon Plasma / Mass Spectrometer.

Detection limits for 1993 and 1994 were inferred from the data, as laboratory detection limits were not reported.

Data Analyses

To allow statistical analyses of all sample data, metal constituent values that were below analytical detection limits were replaced with values that equaled one half the detection limit (Helsel and Hirsch 1992). As concentration of mercury in fish tissues tends to increase with increasing fish size and age (Bodaly et al. 1984), mercury concentrations were described in relation to fork length and age of fish. Mercury concentrations were presented on the dependent axis (Y) and the fork length and age of the fish on the independent axis (X). Because growth of fish (irrespective of age, weight, or length) is curvilinear, it would be inappropriate to apply linear regression techniques against non-linear data without first transforming the data. As such, length, age, and mercury data were transformed into logarithmic values prior to calculating the regression equations and the associated r^2 values.

7.3.2 Aimaokatalok Lake

The following discussion is based on muscle and liver tissues collected from 67 lake trout, 43 lake whitefish, and one Arctic grayling in Aimaokatalok Lake. Lake trout captured for tissue analyses in Aimaokatalok Lake ranged from 170 to 880 mm in fork length and from five to 40 years in age (Table 7.5). Lake whitefish ranged from 172 to 523 mm in fork length and from 10 to 46 years in age. The single Arctic grayling had a total length of 340 mm and weighed 400 g; its age was not determined.

Table 7.5 Fork Length, Weight and Age of Lake Trout and Lake Whitefish Sampled for Metal Concentrations in Aimaokatalok Lake, 1993-1997

Species	n	Fork Length (mm)			Weight (g)			Age (years)		
		Mean	SD[a]	Range	Mean	SD[a]	Range	Mean	SD[a]	Range
Lake trout	67[b]	550	129	170-880	1976	1329	35-7100	17	8	5-40
Lake whitefish	43[c]	450	64	172-523	1260	441	45-2100	26	10	10-46
Arctic grayling	1	340[d]	-	-	400	-	-	-	-	-

[a] Standard deviation.
[b] Length/weight reported for 64 fish; age determined for 43 fish.
[c] Age determined for 29 fish.
[d] Total length; fork length not reported.

The concentrations of 20 different elements in individual tissue samples are presented in Appendix D11. Mean metal concentrations (including standard deviation, range, and number of samples below analytical detection limits) are provided for each species, sampling year and tissue type in Appendix D12. The average concentrations of some of the potentially toxic trace metals in Aimaokatalok Lake (i.e., aluminum, arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc) are summarized in Table 7.6.

Aluminum

All lake trout and lake whitefish muscle and liver tissue samples contained aluminum levels below the detection limit (<5 µg/g). The single Arctic grayling was not sampled for aluminum (Table 7.6).

Table 7.6 Metal Concentrations in Lake Trout, Lake Whitefish and Arctic Grayling Tissues from Aimaokatalok Lake, 1993-1997

Species	Tissue	Parameter	Metal Concentrations (µg/g wet weight)								
			Al[c]	As	Cd	Cu	Pb	Hg	Ni[d]	Se	Zn
Lake trout	Muscle *n=67*	*n < D.L.*[a]	*25*	*50*	*56*	*25*	*31*	*1*	*17*	*3*	*0*
		Mean	2.50	0.03	0.01	0.33	0.04	0.51	0.10	0.19	3.63
		SD[b]	0.00	0.02	0.004	0.17	0.05	0.28	0.15	0.05	1.32
		Minimum	2.50	0.01	0.001	0.18	0.002	0.01	0.01	0.04	2.20
		Maximum	2.50	0.13	0.02	1.44	0.37	1.44	0.91	0.36	8.10
	Liver *n=67*	*n < D.L*	*25*	*49*	*25*	*4*	*31*	*0*	*24*	*14*	*0*
		Mean	2.50	0.04	0.04	9.58	0.03	1.01	0.05	0.64	20.64
		SD	0.00	0.05	0.04	8.44	0.02	0.71	0.05	0.64	14.64
		Minimum	2.50	0.01	0.01	0.25	0.004	0.05	0.02	0.05	1.70
		Maximum	2.50	0.31	0.16	34.1	0.08	3.48	0.32	2.77	46.20
Lake whitefish	Muscle *n=43*	*n < D.L*	*24*	*23*	*40*	*24*	*27*	*0*	*4*	*0*	*0*
		Mean	2.50	0.04	0.01	0.31	0.02	0.19	0.07	0.23	3.38
		SD	0.00	0.02	0.004	0.29	0.01	0.11	0.05	0.06	1.08
		Minimum	2.50	0.01	0.001	0.12	0.003	0.03	0.01	0.14	2.28
		Maximum	2.50	0.10	0.01	2.09	0.05	0.48	0.18	0.34	8.86
	Liver *n=43*	*n < D.L*	*24*	*28*	*19*	*7*	*27*	*0*	*4*	*4*	*0*
		Mean	2.50	0.07	0.06	2.93	0.02	0.80	0.08	0.57	16.42
		SD	0.00	0.08	0.07	3.18	0.01	0.96	0.04	0.63	18.92
		Minimum	2.50	0.03	0.01	0.25	0.01	0.13	0.02	0.05	1.90
		Maximum	2.50	0.43	0.30	11.80	0.05	5.72	0.15	2.35	93.20
Arctic Grayling	Muscle *n=1*	*n < D.L.*	n/a	*1*	*1*	*0*	*0*	*1*	*0*	*0*	*0*
		Mean	n/a	0.01	0.001	0.29	0.01	0.004	0.01	0.10	3.28
	Liver *n=1*	*n < D.L*	n/a	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
		Mean	n/a	0.01	0.04	3.30	0.01	0.12	0.07	0.42	21.10

[a] Number of samples below detection limit.
[b] Standard deviation.
[c] Aluminum was analyzed only in 1997; therefore *n*=25 for lake trout, 24 for lake whitefish and 0 for Arctic grayling.
[d] Nickel values were calculated for only 1993 to 1996 data (42 lake trout and 19 lake whitefish) because of very high detection limits used in 1997 (1 µg/g).

Arsenic

The maximum arsenic levels in lake trout from Aimaokatalok Lake (0.13 µg/g in muscle and 0.31 µg/g in liver tissues) were recorded from a single fish caught in 1994 (410 mm in fork length). Mean concentrations were similar in muscle and liver tissues (0.03 and 0.04 µg/g). The percentages of samples below the detection limit were 74% for muscle and 73% for liver.

In lake whitefish, the mean concentrations of arsenic were greater in liver than in muscle tissues (0.07 and 0.04 µg/g, respectively). The highest arsenic level (0.43 µg/g) was recorded in a lake whitefish liver sample. More than half of lake whitefish samples (53% muscle and 65% liver samples) were below the detection limit.

Arsenic concentrations were below detection limits in both muscle and liver tissues of the single Arctic grayling sampled.

Cadmium

Mean cadmium concentrations were higher in liver tissues than in muscle of both lake trout (0.04 and 0.01 µg/g, respectively) and lake whitefish (0.06 and 0.01 µg/g, respectively). The maximum cadmium concentration (0.30 µg/g) was recorded in a lake whitefish liver sample; the maximum concentration recorded in the muscle tissues (0.02 µg/g in a lake trout) was considerably lower.

Cadmium concentrations in the single Arctic grayling were 0.001 and 0.04 µg/g in its muscle and liver tissues, respectively.

Copper

Mean copper concentrations were higher in liver than in muscle tissues of both lake trout (9.58 and 0.33 µg/g, respectively) and lake whitefish (2.93 and 0.31 µg/g, respectively). The maximum copper concentration (34.1 µg/g) was recorded in a lake trout liver sample; the maximum concentration recorded in the muscle tissues (2.09 µg/g in a lake whitefish) was considerably lower.

Copper concentrations in the single Arctic grayling were of 0.29 and 3.30 µg/g in its muscle and liver tissues, respectively.

Lead

Almost half (46%) of both muscle and liver tissue samples collected from lake trout in Aimaokatalok Lake had lead concentrations below the detection limit. Mean lead concentrations were similar in both tissues (0.04 µg/g in muscle and 0.03 µg/g in liver). The maximum lead concentration (0.37 µg/g recorded in a lake trout muscle sample) was below the federal guideline for human consumption (0.5 µg/g).

Mean lead concentrations in lake whitefish tissue samples (0.02 µg/g for both muscle and liver) were lower than in lake trout tissues. The maximum recorded concentration (0.05 µg/g) was about 10 times lower than the federal guideline for human consumption.

The single Arctic grayling contained 0.01 µg/g of lead in both muscle and liver tissues.

Mercury

Total mercury concentrations in lake trout muscle tissues ranged from 0.01 to 1.44 µg/g. The mean concentration was 0.51 µg/g. Almost half (45%) of the tested lake trout (*n* = 67) muscle tissues exceeded the federal guideline for human consumption (0.5 µg/g).

Mercury levels in lake trout liver tissues were higher than in muscle tissues and ranged from 0.05 to 3.48 µg/g.; the mean concentration was 1.01 µg/g. Most (76%) of the tested lake trout liver tissues exceeded the federal guideline for human consumption.

Lake whitefish mercury concentrations were lower than in lake trout, with mean concentrations of 0.19 and 0.80 µg/g in muscle and liver samples, respectively. Whereas none of the lake whitefish muscle samples exceeded the federal guidelines for human consumption, almost half (47%) of liver samples exceeded the guideline. The maximum mercury level recorded in lake whitefish from Aimaokatalok Lake was 5.72 µg/g in a liver sample.

Because mercury is known to bioaccumulate in fish, mercury concentrations in muscle and liver tissues were regressed against age and fork length to determine the strength of these relationships and to allow comparisons with future monitoring studies (Figure 7.5). The correlation coefficients for lake trout (r^2 between 0.32 and 0.68) were generally lower than those determined for lake whitefish (between 0.35 and 0.82). Mercury concentrations in lake trout tissues appeared to be better correlated with fork length than with age, an opposite relationship was recorded for lake whitefish (i.e., age was a better indicator of mercury levels than fork length).

The single Arctic grayling had a mercury concentration of <0.008 and 0.12 µg/g in muscle and liver tissues, respectively.

Nickel

Mean nickel concentrations are presented here only for the 1993 to 1996 data (42 lake trout and 19 lake whitefish) because of the very high detection limit (1 µg/g) used for nickel analyses in 1997. The 1997 samples were excluded from the calculations because assigning 0.5 µg/g as the value of half detection limit would skew the “real” values, which were generally less than 0.1 µg/g.

AIMAOKATALOK LAKE

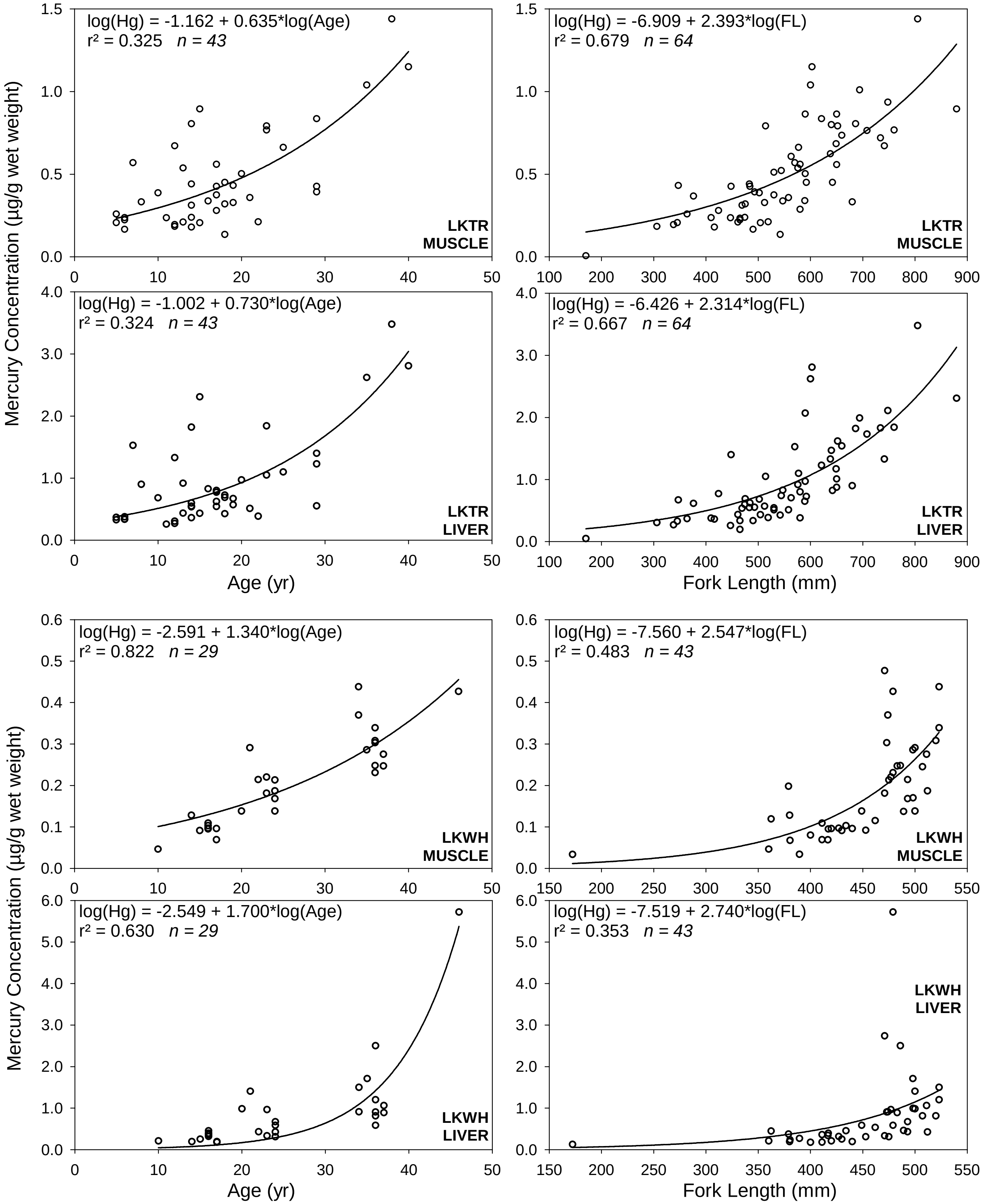


Figure 7.5 Mercury concentrations in lake trout (LKTR) and lake whitefish (LKWH) muscle and liver tissues from Aimaokatalok Lake, 1993 to 1997.

The maximum nickel concentrations recorded in lake trout from Aimaokatalok Lake were 0.91 µg/g in muscle and 0.32 µg/g in liver tissues. Mean nickel concentration in lake trout muscle tissue (0.10 µg/g) was twice as high as in the liver (0.05 µg/g).

In lake whitefish, the maximum nickel concentrations were 0.18 µg/g in muscle and 0.15 µg/g in liver tissues. The mean concentrations were similar in both muscle and liver tissues (0.07 and 0.08 µg/g, respectively).

The single Arctic grayling had a nickel concentration of 0.01 and 0.07 µg/g in muscle and liver tissues, respectively.

Selenium

Selenium levels in lake trout muscle tissues ranged from 0.04 to 0.36 µg/g; the mean concentration was 0.19 µg/g. In lake trout liver tissues, mean selenium concentration (0.64 µg/g) and the maximum recorded level (2.77 µg/g) were much higher than in muscle tissues.

Lake whitefish selenium concentrations were similar to those recorded in lake trout, with mean concentrations of 0.23 and 0.57 µg/g (muscle and liver samples, respectively). The highest selenium concentration in lake whitefish was 2.35 µg/g (in liver).

The single Arctic grayling had a selenium concentration of 0.10 and 0.42 µg/g in muscle and liver tissues, respectively.

Zinc

Zinc concentrations in lake trout muscle tissues ranged from 2.20 to 8.10 µg/g. The mean concentration in muscle tissues (3.63 µg/g) was approximately six times lower than in liver tissues (20.64 µg/g). Zinc concentrations ranged from 1.70 to 46.20 µg/g in lake trout liver tissues.

Lake whitefish zinc concentrations were similar to those recorded in lake trout, with mean levels of 3.38 and 16.42 µg/g (muscle and liver samples, respectively).

The highest zinc levels recorded in lake whitefish were 93.20 µg/g in liver and 8.86 µg/g in muscle tissues; these maximum values were reported for the same fish (172 mm in fork length) captured in 1994.

The single Arctic grayling had a zinc concentration of 3.28 and 21.10 µg/g in muscle and liver tissues, respectively.

7.3.3 Fickle Duck Lake

Tissue samples from Fickle Duck Lake were collected in 1995 and 1996. The 1995 samples were limited to muscle and liver tissues from four Arctic grayling, whereas muscle and liver tissues were collected from three lake trout in 1996 (Appendices D11 and D12). The tissue results for lake trout from Fickle Duck Lake were presented in Rescan (1997); however, the same report stated that only Arctic grayling were captured in this lake. As it was not possible to ascertain which part of the report (Rescan 1997) was correct, the lake trout results are presented here at face value (i.e., as lake trout from Fickle Duck Lake).

The Arctic grayling ranged from 335 to 380 mm in fork length and from 8 to 12 years in age. Fish sizes and ages were not reported for the lake trout sample (Table 7.7).

Table 7.7 Fork Length, Weight and Age of Fish Sampled for Metal Concentrations in Fickle Duck Lake, 1995 to 1996

Species	n	Fork Length (mm)			Weight (g)			Age (years)		
		Mean	SD[a]	Range	Mean	SD[a]	Range	Mean	SD[a]	Range
Arctic Grayling	4	358	19	335-380	750	129	600-900	10	3	8-12
Lake Trout	3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

[a] Standard deviation.

The concentrations of metal elements in individual tissue samples are presented in Appendix D11. Mean metal concentrations (including standard deviation, range, and number of samples below analytical detection limits) are provided for each tissue type in Appendix D13. The average concentrations of some of the potentially toxic trace metals (i.e., arsenic, cadmium, copper, lead, mercury, nickel, and zinc) are summarized in Table 7.8. The tissue samples collected from Fickle Duck Lake were not analyzed for aluminum.

Arsenic

Arsenic levels in lake trout tissues ranged from 0.06 to 0.91 µg/g. Mean concentrations were higher in liver tissues (0.66 µg/g) than in muscle tissues (0.08 µg/g). Arsenic levels were considerably lower in Artic grayling tissues, with seven out of the eight samples (muscle and liver) below the detection limit. The only sample above the detection limit was a liver sample with an arsenic concentration of 0.19 µg/g.

Table 7.8 Metal Concentrations in Lake Trout and Arctic Grayling Tissues from Fickle Duck Lake, 1995 to 1996

Species	Tissue	Parameter	Metal Concentrations (µg/g wet weight)							
			As	Cd	Cu	Pb	Hg	Ni	Se	Zn
Lake Trout	Muscle *n=3*	*n < D.L.*[a]	*0*	*3*	*0*	*3*	*0*	*3*	*0*	*0*
		Mean	0.08	0.01	0.27	0.03	0.03	0.10	0.47	3.20
		SD[b]	0.03	0.00	0.05	0.00	0.02	0.00	0.06	0.17
		Minimum	0.06	0.01	0.22	0.03	0.01	0.10	0.40	3.00
		Maximum	0.11	0.01	0.30	0.03	0.04	0.10	0.50	3.30
	Liver *n=3*	*n < D.L*	*0*	*0*	*0*	*2*	*0*	*3*	*0*	*0*
		Mean	0.66	0.05	36.47	0.04	0.24	0.10	2.73	46.23
		SD	0.21	0.03	7.79	0.02	0.32	0.00	0.61	4.18
		Minimum	0.52	0.02	27.70	0.03	0.02	0.10	2.20	41.50
		Maximum	0.91	0.08	42.60	0.06	0.61	0.10	3.40	49.40
Arctic Grayling	Muscle *n=4*	*n < D.L.*	*4*	*2*	*0*	*0*	*0*	*3*	*0*	*0*
		Mean	0.03	0.004	0.63	0.03	0.06	0.03	0.32	5.13
		SD	0.00	0.00	0.39	0.02	0.03	0.02	0.05	1.00
		Minimum	0.03	0.003	0.39	0.01	0.03	0.03	0.25	3.80
		Maximum	0.03	0.01	1.21	0.05	0.10	0.06	0.36	6.00
	Liver *n=4*	*n < D.L*	*3*	*0*	*0*	*0*	*3*	*4*	*0*	*0*
		Mean	0.07	0.02	1.81	0.02	0.02	0.03	1.05	19.95
		SD	0.08	0.01	0.30	0.00	0.03	0.00	0.05	1.14
		Minimum	0.03	0.01	1.52	0.01	0.003	0.03	0.99	18.90
		Maximum	0.19	0.03	2.09	0.02	0.06	0.03	1.11	21.40

[a] Number of samples below detection limit.
[b] Standard deviation.

Cadmium

Although all lake trout muscle tissue samples contained cadmium levels below the detection limit, all liver samples had detectable levels. Mean cadmium concentration in the liver was 0.05 µg/g, and the highest level was 0.08 µg/g.

Two of the four Arctic grayling muscle tissue samples contained cadmium levels below the detection limit, whereas all liver samples were above detectable levels. The mean cadmium concentration in liver tissues was 0.02 µg/g, and the maximum was 0.03 µg/g.

Copper

Copper concentrations in lake trout ranged from 0.22 to 42.60 µg/g. Mean concentrations were considerably higher in liver tissues (36.47 µg/g) than in muscle tissues (0.27 µg/g). All copper concentrations were above the detection limit.

For Arctic grayling, the mean copper concentration in liver tissue (1.81 µg/g) was considerably lower than in lake trout liver tissue. Mean copper concentration in Arctic grayling muscle tissue was 0.63 µg/g.

Lead

Most (88%) of lake trout tissue samples were below the detection limit (>0.05 µg/g) used for lead in 1996. With much lower detection limits used in 1995, lead concentrations in Arctic grayling tissues were all above detection limit and ranged from 0.01 to 0.05 µg/g.

Mercury

Total mercury concentrations in lake trout muscle tissues ranged from 0.01 to 0.04 µg/g (mean of 0.03 µg/g). The maximum mercury concentration recorded was well below the federal guideline for human consumption (0.5 µg/g).

Mercury concentrations in lake trout liver tissues ranged from 0.02 to 0.61 µg/g; mean of 0.24 µg/g). The maximum mercury concentration found in liver tissues was slightly higher than the federal guideline for human consumption (0.5 µg/g).

The maximum mercury concentration recorded in Arctic grayling (0.10 µg/g, in muscle) was considerably lower than the federal guideline (0.5 µg/g).

Nickel

All lake trout tissue samples collected from Fickle Duck Lake were below the detection limit (0.2 µg/g) used for nickel in 1996. The maximum nickel concentration in Arctic grayling (0.06 µg/g) was recorded in a muscle sample in 1995, when lower detection limits were used.

Selenium

Selenium concentrations in lake trout muscle samples ranged from 0.40 to 0.50 µg/g (mean of 0.47 µg/g). Lake trout liver samples had considerably higher selenium concentrations, ranging from 2.20 to 3.40 µg/g (mean of 2.73 µg/g).

Arctic grayling muscle tissue had selenium concentrations ranging from 0.25 to 0.36 µg/g (mean of 0.32 µg/g). Selenium concentrations were greater in liver tissues, ranging from 0.99 to 1.11 µg/g (mean of 1.05 µg/g).

Zinc

All tissue samples collected from Fickle Duck Lake had detectable zinc concentrations. Mean concentrations of zinc in lake trout tissues were considerably higher in liver tissue (46.23 µg/g) than in the muscle tissue (3.20 µg/g). The maximum zinc concentration was 49.40 µg/g in liver tissue.

Mean zinc concentrations in Arctic grayling were also higher in liver tissue (19.95 µg/g) than in the muscle tissue (5.13 µg/g). The maximum zinc concentration was 21.40 µg/g (in liver).

7.3.4 Summary

Fish tissue (dorsal muscle and liver) samples were collected from 70 lake trout, 43 lake whitefish and five Arctic grayling to provide baseline data on metal concentrations in Aimaokatalok and Fickle Duck lakes. Samples were collected every year from 1993 to 1997; however, most (70%) of the samples were collected in 1995 or 1997.

Analyses of fish tissues indicated generally low levels of metal accumulation; however, exceedences of the federal guidelines for human consumption were noted for mercury. In lake trout, approximately 43% of muscle tissues and 74% of liver tissues exceeded the federal food consumption guideline of 0.5 µg/g for mercury. For lake whitefish, none of the muscle samples, but 43% of liver samples exceeded the guideline. Consistent with bioaccumulation up the food chain, older and larger fish had greater concentrations of mercury in their tissues, and these fish were most likely to have mercury concentrations above the federal guideline.

None of the fish samples from Aimaokatalok or Fickle Duck lakes exceeded the federal food consumption guidelines for arsenic and lead (3.5 and 0.5 µg/g, respectively).

8 FISH HABITAT ASSESSMENT

8.1 LAKES

Fish habitat information for Boston area lakes is limited to bathymetric surveys of Aimaokatalok and Stickleback lakes conducted in 1993 and 1994 (already presented in Section 2). Data on lake substrates and characteristics of the litoral zones were not included in the previous reports.

8.2 STREAMS

8.2.1 Methods

Stream habitat surveys were conducted in the Boston area in 1996, 1997, and 2000 (Rescan 1997, 1998, 1999a and 1999b). This involved aerial assessments and detailed ground surveys carried out in conjunction with fish surveys. The classification system used in collecting Arctic stream habitat data, including substrate assessment, is provided in Appendix E1. This system allowed the observer to visually quantify habitat units and quality using such key variables as water depth, velocity, and substrate type.

Most streams were sampled during freshet (June-July), others were sampled during lower flows (August), and a few were sampled during both periods. Where streams were sampled in more than one year, it is unknown whether the assessments were done at the same locations from year to year, as site coordinates were provided only for the 1996 survey. The site numbers assigned to streams in 1997 were used in this report to reference streams assessed by air and ground between 1996 and 2000 (streams not sampled in 1997 were assigned their original designations).

Aerial surveys in 1996 and 1997 were conducted to determine the overall importance of lake inflow and outflow streams as fish habitat and to add streams not delineated on the topographical maps. Streams were labelled as either ephemeral or permanent, and reference photographs were taken of streams exhibiting very poor habitat. All other streams were given an identification number, photographed, and measured for approximate length using GPS waypoints. Some streams were assessed from the air in both 1996 and 1997, and some were ground surveyed in 1997 after an initial aerial assessment was done in 1996.

In 2000, aerial surveys were conducted to determine potential fish habitat at proposed permanent road stream crossings initially identified on 1:50,000 topographic maps. After the assessments, streams identified as potentially containing suitable fish habitat were surveyed.

In 1996, habitat was characterized during ground surveys using several criteria, including average water velocity, percent of runs/riffles/pools, bank vegetation, stream bank and substrate composition, and mean wetted width. Habitat was classified in three 100 m sections for each stream. Velocity was measured using the timed float method. The average of five wetted width measurements was calculated to determine the mean stream width. The remaining habitat parameters were visually estimated.

Methodology used for stream habitat surveys conducted in 1997 and 2000 were similar. Within each segment surveyed, instream habitat units (i.e., pools, runs, flats, riffles, cascades, and rapids) were quantified as a percentage of each surveyed segment. A series of habitat measurements was then collected for each habitat unit and averaged for the entire survey section. These parameters included the following:

- survey length;
- gradient;
- mean channel width;
- mean depth, maximum pool depth, and maximum riffle depth;
- streambed material composition (percent organic matter, silt, sand, small gravel, large gravel, cobble, boulder, and bedrock);
- total cover for fish, and percent from pools, boulders, cutbanks, macrophytes, and overhanging vegetation;
- streambed compaction and embeddedness;
- water temperature, colour, and stream stage; and
- bank height, stability, substrate composition, and vegetative cover.

Stream habitat suitability for spawning, rearing, adult feeding, overwintering, and migration was qualitatively classified using a numerical scale of 0 to 4. Within this system, 0 = no fish habitat present, 1 = poor, 2 = fair, 3 = good, and 4 = excellent (Appendix E1).

Since the assessment methodology and habitat descriptions were similar and most detailed in 1997 and 2000, where possible discussion of stream habitat is primarily based on the survey data and descriptions from these two years

(Rescan 1998 and 2001). Stream habitat data were collected for five streams in 1996, and at a less detailed level than in the other years surveyed. Three of these streams were only sampled in 1996.

8.2.2 Aimaokatalok NE Inflow

The Aimaokatalok NE Inflow is a long stream relative to most of the other streams sampled. It extends from a chain of lakes to the east, and drains into the northeast portion of Aimaokatalok Lake (Figure 7.1). It is the second largest inflow into Aimaokatalok Lake after the Aimaokatalok River. Habitat sampling of this stream was conducted in 1996 and 2000. High, turbid water conditions did not allow assessment in 1997.

Fish habitat was assessed over three 100 m sections on 7 July 1996 and one 750 m section on 26 June 2000 (Appendix E2). Average velocity was measured at 0.61 m/s during the 1996 survey, and the surveyed section had an average channel width of 12.4 m. The surveyed section in 2000 had a gradient of 2%, and the channel had an average width 20 m. Instream habitat was characterized by a series of rapids, runs, and pools, with rapids and best quality runs (depth greater than 0.75 m) dominating the surveyed section. Some riffle, chute and flat habitats were also noted in the 2000 survey.

Cobble, boulder, and bedrock were the predominant substrates within the stream sections surveyed. Boulders provided most (85%) of the instream cover. Overall spawning, rearing, adult feeding, and migration habitat was considered excellent, whereas overwintering habitat was generally poor (Appendix E2). Electrofishing surveys resulted in the capture of lake trout, Arctic grayling, and ninespine stickleback (Appendix D8).

8.2.3 Aimaokatalok River

The Aimaokatalok River is the largest inflow to Aimaokatalok Lake and flows into the southern end of the lake (Figure 7.1). Habitat sampling was conducted at three 100 m sections at this site on 9 August 1996 (Appendix E2). The wetted channel width ranged from 9.6 to 30.7 m, with an average of 15.7 m. The average velocity was 0.58 m/s. The instream habitat consisted mainly of runs and pools, with riffles also present. Boulder and cobble were the main substrate within the surveyed section. Bank vegetation consisted of grass and willow (Appendix E2). Fish sampling was not conducted at this site.

8.2.4 Stickleback Outflow

The Stickleback Outflow drains into the southern portion of Aimaokatalok Lake. This stream was surveyed 15 June 1997 and was found to be in flood and covered by sheets of ice (Plate 1 in Appendix E). The stream was flowing over terrestrial grasses and organic matter. The 175 m stream section that was surveyed had an average width of 4.5 m and average depth of 0.35 m (Appendix E2). The instream habitat was composed of riffles (90%) and pools (10%). The substrate was composed of organic matter (95%) and sand (5%). Instream cover was provided by aquatic vegetation (90%) and pools (10%). There was no observable spawning, overwintering, or adult rearing habitat. Of the habitat present, the rearing habitat was rated as good, while the migration habitat was rated as poor. There were no barriers to fish migration present. The electrofishing survey in 1997 resulted in the capture of two ninespine stickleback. Minnow traps set in 1994 and 1995 resulted in the catch of many ninespine stickleback and one juvenile lake trout (Appendix D8).

8.2.5 Fickle Duck Outflow

The Fickle Duck Outflow drains into the southern portion of Aimaokatalok Lake. Habitat sampling of this stream was conducted on 7 July 1996 and 15 June 1997. Fish habitat was assessed over three 100 m sections in 1996 and only one 80 m section in 1997 (Appendix E2). Average velocity was 0.65 m/s during the 1996 survey. The surveyed sections of stream channel were 0.7 m to 4.8 m wide, averaging 2.3 m in 1996 and 6.5 m in 1997. Average water depth was 0.55 m in 1997. In 1997, the stream was in flood, flowing over terrestrial grasses and organic matter (90%), with a narrow strip of cobble substrate (10%) in the centre of the channel (Plate 2 in Appendix E). Instream habitat was characterized entirely by riffles (Appendix E2). Instream cover was provided entirely by aquatic vegetation. There was no observable overwintering habitat due to shallow depths. Spawning habitat was rated as poor, whereas rearing and adult feeding habitats were rated as fair, and migration habitat was considered good (Appendix E2). Similar to Stickleback Outflow, only two fish species were captured in Fickle Duck Outflow. The catch was dominated by ninespine stickleback, with lake trout represented by a single juvenile caught in a minnow trap (Appendix D8).

8.2.6 Fickle Duck Inflow (Site BP12)

This inflow stream drains a series of small lakes and marshy areas into Fickle Duck Lake. A 210 m stream section was assessed for fish habitat in June 1997. The stream was found to be in flood, overflowing the banks and flowing through terrestrial grasses (Plate 3 in Appendix E). The surveyed section was composed of a series of good quality pools (20%) connected by riffles (55%) and runs (20%). The run sections were lined with cutbanks. Rapids were also present (5%). Average stream width of the surveyed section was 6.2 m and average depth was 0.65 m. The substrate in the areas where the stream was flowing over terrestrial vegetation were composed of organic matter (60%), whereas the central channel was underlain with silt (15%), cobble (10%), boulder (10%), and sand (5%). Instream cover was provided by aquatic vegetation (40%), cutbanks (25%), pools (25%) and boulders (10%). This stream was persistent into late summer. Whereas rearing habitat was rated as good, both adult feeding and migration habitat were rated as fair. Spawning and overwintering habitat were rated as poor. An electrofishing survey resulted in the capture of two ninespine stickleback (Appendix D9).

8.2.7 Small Tributaries to Aimaokatalok Lake (B03 to B30)

Eleven small tributary inflows to Aimaokatalok Lake were assessed for fish habitat on 15 to 17 June 1997. Streams BP03, BP04, BP05, and BP13 flowed into the east side of the lake (Figure 7.1). Streams BP06, BP07, BP08, BP10, and BP11 flowed into the northern arm of the lake. Stream BP09 was the only inflow that flowed into the west side of the lake. Stream BP14 flowed into a small inlet on the north side of Aimaokatalok Lake, west of the Aimaokatalok NE Inflow .

Stream BP03

Stream BP03, which enters Aimaokatalok Lake from the southeast, was surveyed over a distance of 350 m. It drains a series of small ponds through a low, marshy area before entering Aimaokatalok Lake. The stream was in flood at the time of the survey, flowing over terrestrial grasses and organic matter (Plate 4 in Appendix E). The average wetted width was 3.3 m, and the average depth was 0.4 m (Appendix E2). Instream habitat was dominated by riffle habitat (80%), but also contained good quality pools (10%) and poor quality runs (10%). The substrate was 90% organic matter, 5% sand, and 5% boulder. Instream cover was provided by aquatic vegetation (65%), pools (20%), cutbanks (10%), and boulders (5%). There was no observable spawning, overwintering, or migration habitat. Rearing habitat was rated as good and adult feeding was rated as poor (Appendix E2). The total electrofishing catch consisted of five ninespine stickleback and one Arctic grayling (Appendix D8).

Stream BP04

This stream, which enters Aimaokatalok Lake from the southeast, was surveyed over a distance of 95 m. The stream was in flood at the time of the survey, draining a series of small ponds through a low marshy area before entering Aimaokatalok Lake. The stream flowed, for the most part, over terrestrial grasses and organic matter. The average wetted width was 8.5 m, and the average depth was 0.35 m (Appendix E2). Instream habitat was dominated by riffles (95%) and the substrate was composed entirely of organic matter. Instream cover was provided by aquatic vegetation. There was no observable spawning, adult feeding, overwintering, or migration habitat, and rearing suitability was rated as fair at the time of the survey (Appendix E2). The low marshy area provided a barrier to Arctic grayling migration. No fish were captured during an electrofishing survey.

Stream BP05

This inlet stream flows into Aimaokatalok lake from the southeast, just west of Stream BP04. An 80 m section of this stream was sampled. It was in flood, draining a low marshy area into Aimaokatalok Lake. The stream flowed for the most part over terrestrial grasses and organic matter. Average stream width was 7.5 m and average depth was 0.25 m. The stream was dominated by riffles (95%) and the substrate was composed entirely of organic matter. With no persistent source of water, this stream is most likely ephemeral. Instream cover was provided by aquatic vegetation. There was no observable spawning, adult feeding, overwintering, or migration habitat. Rearing suitability was rated as fair at the time of the survey (Appendix E2). An electrofishing survey resulted in the capture two ninespine stickleback and one Arctic grayling near the mouth of the stream (Appendix D8).

Stream BP06

Stream BP06 drains a series of small lakes into the northern arm of Aimaokatalok Lake. When surveyed, the stream was found to be in flood and the 150 m stream section that was surveyed flowed through a stepped series of rock shelves, pools, and riffles. A rock shelf present at the mouth of the stream likely provided a barrier to fish migration (Plate 5 in Appendix E). The substrate of the surveyed section was composed of fines (5% sand, 5% silt) and bedrock (10%), but mostly (80%) organic matter (where the stream overflowed its banks). Average stream width was 8.3 m and average depth was 0.35 m. The stream was dominated by riffles (75%), but also contained good quality pool (15%) and poor quality run (10%) habitat. Instream cover was provided mainly by aquatic vegetation (55%) and pools (35%), whereas boulders (5%) and cutbanks (5%) provided the remainder. There was no observable spawning, adult feeding, overwintering, or migration habitat. Rearing suitability was rated as fair at the time of the survey (Appendix E2). An electrofishing survey resulted in no fish captures.

Stream BP07

This stream drains a marshy area into the northern arm of Aimaokatalok Lake. The stream was in flood, flowing over terrestrial grasses and organic matter. Within the 50 m surveyed section, the average stream width was 0.6 m and average depth was 0.15 m. The stream was dominated by riffles (95%) and the substrate was composed entirely of organic matter. Instream cover was provided by aquatic vegetation. There was no observable spawning, rearing, adult feeding, overwintering, or migration habitat within the channel (Appendix E2). An electrofishing survey resulted in no fish captures.

Stream BP08

This stream was in flood, draining melt water from a snow deposit into the northern arm of Aimaokatalok Lake. The 110 m surveyed stream section flowed over terrestrial grasses and organic matter. Average stream width was 5.3 m and average depth was 0.25 m. The stream was dominated by riffles (90%) and also contained poor quality pools (10%). The substrate was mostly organic matter. Instream cover was provided by aquatic vegetation (80%) and pools (20%). There were no observable adult feeding, overwintering, or migration habitat within the channel. Spawning and rearing habitat were rated as poor. An electrofishing survey resulted in no fish captures.

Stream BP09

This stream was in flood, draining a series of small lakes into the northern arm of Aimaokatalok Lake. The 95 m surveyed stream section flowed over terrestrial grasses and organic matter (80%); however the central channel was composed of small gravel (7.5%), cobble (5%), sand (5%), and boulders (2.5%) (Appendix E2). Average stream width was 4.2 m and average depth was 0.30 m. The stream was dominated by riffles (75%) and also contained intermediate and poor quality pool habitat (7.5 and 2.5%, respectively). Instream cover was provided by aquatic vegetation (80%), cutbanks (10%), pools (7.5%), and boulders (2.5%). This stream featured good spawning and rearing habitat; however, a migration barrier was present where the stream flowed over a rock shelf before entering Aimaokatalok Lake (Plate 6 in Appendix E). An electrofishing survey resulted in no fish captures.

Stream BP10

This stream was found to be in flood, draining a small lake into the northern tip of Aimaokatalok Lake. The 150 m surveyed section of stream was composed of a series of deep pools connected by riffles over terrestrial grasses (Plate 7 in Appendix E). This habitat disappeared 200 m upstream in a marshy area of indistinct channels. In the surveyed section average stream width was 3.2 m and average depth was 0.35 m (Appendix E2). The stream section was dominated by riffles (70%) and also contained intermediate and good quality pools (10 and 15%, respectively). The substrate in the riffle sections was composed of organic matter, whereas the pools were underlain with silt. Instream cover was mostly provided by aquatic vegetation (70%), whereas pools provided some additional cover (30%). There was no observable spawning or overwintering habitat, and the marshy area most likely provided a migration barrier. Both rearing and adult feeding habitat were present at the time of the survey (rated as fair and good, respectively; Appendix E2). An electrofishing survey resulted in the capture of one mature Arctic grayling, one mature lake trout and one ninespine stickleback (Appendix D8).

Stream BP11

This stream was in flood, draining melt water from a snow deposit into the northern tip of Aimaokatalok Lake. The 160 m surveyed stream section flowed, for the most part, over terrestrial grasses and organic matter. Average stream width of the surveyed section was 0.7 m and average depth was 0.35 m Appendix E2). This stream section was dominated by riffles (85%), but also consisted of poor quality run (10%) and poor quality pool habitat (5%). The substrate was composed entirely of organic matter. Instream cover was provided by flooded vegetation. There was no observable spawning, rearing, adult feeding, overwintering, or migration habitat within the channel (Appendix E2). It was suspected that the stream flowed subsurface in the summer. An electrofishing survey resulted in the capture of seven ninespine stickleback (Appendix D8). The fish were caught near the mouth of the creek, suggesting they originated in Aimaokatalok Lake.

Stream BP13

This stream was in flood, draining a series of small pools through a marshy area into the eastern side of Aimaokatalok Lake. The 225 m section of surveyed stream was comprised of a series of good quality pools (20%) connected by riffles (80%) flowing over terrestrial grasses and willows (Appendix E2). Average stream width in the surveyed section was 3.2 m and average depth was 0.65 m. The substrate was composed mainly of organic matter (75%), but also consisted of silt (15%), cobble (5%), and boulder (5%). Instream cover was largely provided by aquatic vegetation (70%), whereas pools and boulders also provided some additional cover (25% and 5%, respectively). There was no observable overwintering or migration habitat within the channel. Rearing, adult feeding, and spawning habitat were ranked as good, fair, and poor, respectively (Appendix E2). An electrofishing survey resulted in no fish captures.

Stream BP14

This stream was in flood, draining a series of small ponds and lakes from the north into the central part of Aimaokatalok Lake. The 310 m section of surveyed stream had a steep gradient and flowed for the most part over terrestrial grasses and willows (Plate 8 in Appendix E). The stream consisted of pools (30%) connected by riffles over terrestrial grasses (40%) (Appendix E2). Also present were rapids (20%) and some poor quality run habitats (10%). Average stream width of the surveyed section was 3.1 m. Instream cover was largely provided by aquatic vegetation (65%), whereas pools (15%), boulders (10%), and overhanging vegetation (10%) provided addition cover. There was no observable migration or overwintering habitat within the channel. Spawning and adult feeding were ranked as poor, whereas rearing habitat was rated as fair (Appendix E2). An electrofishing survey resulted in no fish captures; however, one juvenile Arctic grayling was observed.

Streams BP14 to BP30

Streams that were aerially assessed in 1996 and 1997, and found to be either ephemeral, draining melt water, or considered to be poor fish habitat are indicated as BP15 to BP30 in Figure 7.1. In June 1997, 16 streams were assessed as not possessing fish habitat or having barriers to fish migration for fish colonization from Aimaokatalok Lake. Helicopter surveys showed that all of these streams were ephemeral, draining melt water into Aimaokatalok Lake. Stream BP15 drained a small lake into Aimaokatalok Lake; however, it had no distinct channel and provided no fish habitat. Streams BP16 to BP23 carried melt water and had no distinct channels or fish habitat. Streams BP24 to BP26 had low flows and steep gradients, but did not persist beyond the spring freshet. Streams BP27 to BP30 had no distinct channels and no fish habitat present.

Additional sites assessed in 1996 included three small inflows into Fickle Duck Lake and two inflows into Stickleback Lake. All of these sites were assessed as melt-water channels that did not contain fish habitat.

8.2.8 Koignuk River

The Koignuk River extends from a chain of lakes west of Aimaokatalok Lake, before converging with the Aimaokatalok Outflow and running north into Hope Bay. In the upper portion of the river, a habitat survey of this stream was conducted on 9 August 1996. Fish habitat was assessed over two 100 m sections at a site located approximately 12-km downstream of Aimaokatalok Outflow (Figure 8.1). Average velocity was measured at 1.16 m/s and the stream channel was 21.8 to 33.2 m wide, averaging 25.5 m (Appendix E2). Channel depth was not recorded. Instream habitat was characterized by rapids, runs, and pools, with rapids and best quality runs (depth greater than 0.75 m) being most prominent in the surveys. Cobble and boulder were the predominant substrates within the sections surveyed and the bank vegetation consisted of both willows and grasses (Appendix E2). At the time of the habitat sampling, electrofishing surveys resulted in the capture of 14 lake trout and an uncounted number of ninespine stickleback.

Habitat assessments also took place in the lower 25.5 km of the Koignuk River on 13 to 20 August 1998. The resulting habitat mapping data are presented in Figure 8.1. The surveyed section was divided into four reaches. The lowest reach had a low gradient (0.08%) channel of riffle/run flowing over marine sediments, sand, gravel, and boulders and was 11.5-km in length. There were also a few constrictions where the river flowed over bedrock. The second reach was 12-km in length, flowing through a low gradient channel (0.17%) of riffle/run habitat with fines, gravel, boulders, and bedrock substrate. The third reach had a total length of only 1.4-km and had a high gradient (1.56%) series of rapids, waterfalls, and runs underlain by fines, gravel, boulders, and bedrock. Within this section was a 10 m high waterfall, which provided a definite barrier to fish migration. An aerial survey of the fourth reach (14.3-km in length) revealed that it had a low gradient channel (0.13%) characterized by deep runs, pools, flats, and occasional bedrock outcrops.

Angling surveys in the lower 25-km section of the river in 1998 resulted in the capture of 13 lake trout, seven Arctic grayling and one Greenland cod. Gill net sets in 1998 resulted in the capture of one lake whitefish (Appendix D8).

8.2.9 Tributaries to Koignuk River

Boulder Creek

Boulder Creek is a long (approximately 13-km), wide stream, which drains a series of lakes into the Koignuk River (Figure 7.1**)**. Three 100 m sections of Boulder Creek were surveyed on 10 August 1996. The headwaters of Boulder Creek were slow moving with mud/cobble substrate, but the creek became faster and had a rocky substrate near the confluence with the Koignuk River. This rock/gravel section provided suitable spawning habitat for Arctic grayling and lake trout. The surveyed sections had an average velocity of 0.45 m/s and an average width of 10.2 m. These sections were composed of cobble/boulder substrate with run, rapid, and pool habitat (Appendix E2). An electrofishing survey at the time of the habitat survey resulted in the capture of 26 juvenile lake trout. An electrofishing survey of this stream in 1995 resulted in the capture of seven Arctic grayling.

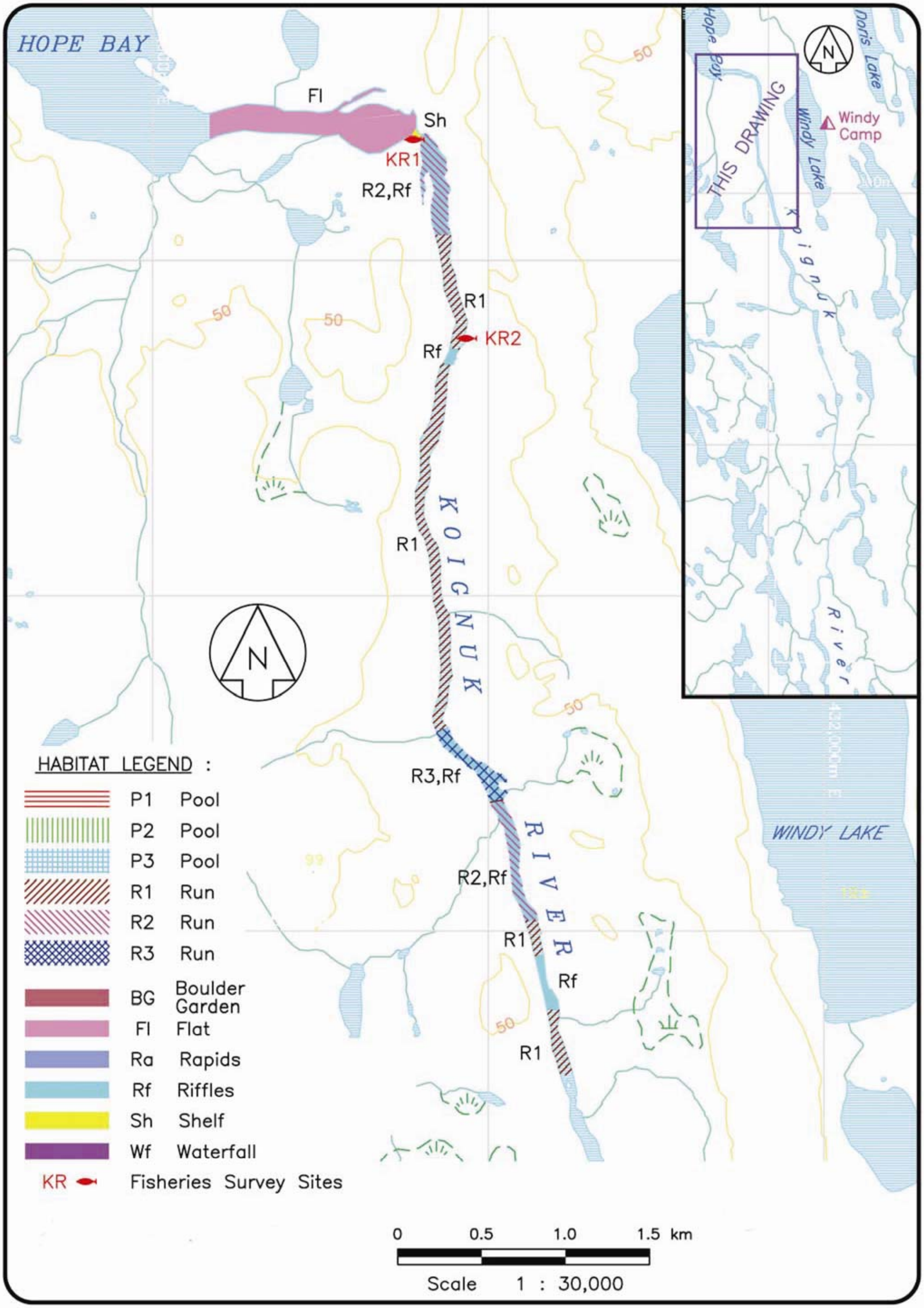


Figure 8.1 Habitat Map of Koignuk River (from Rescan 1999a)

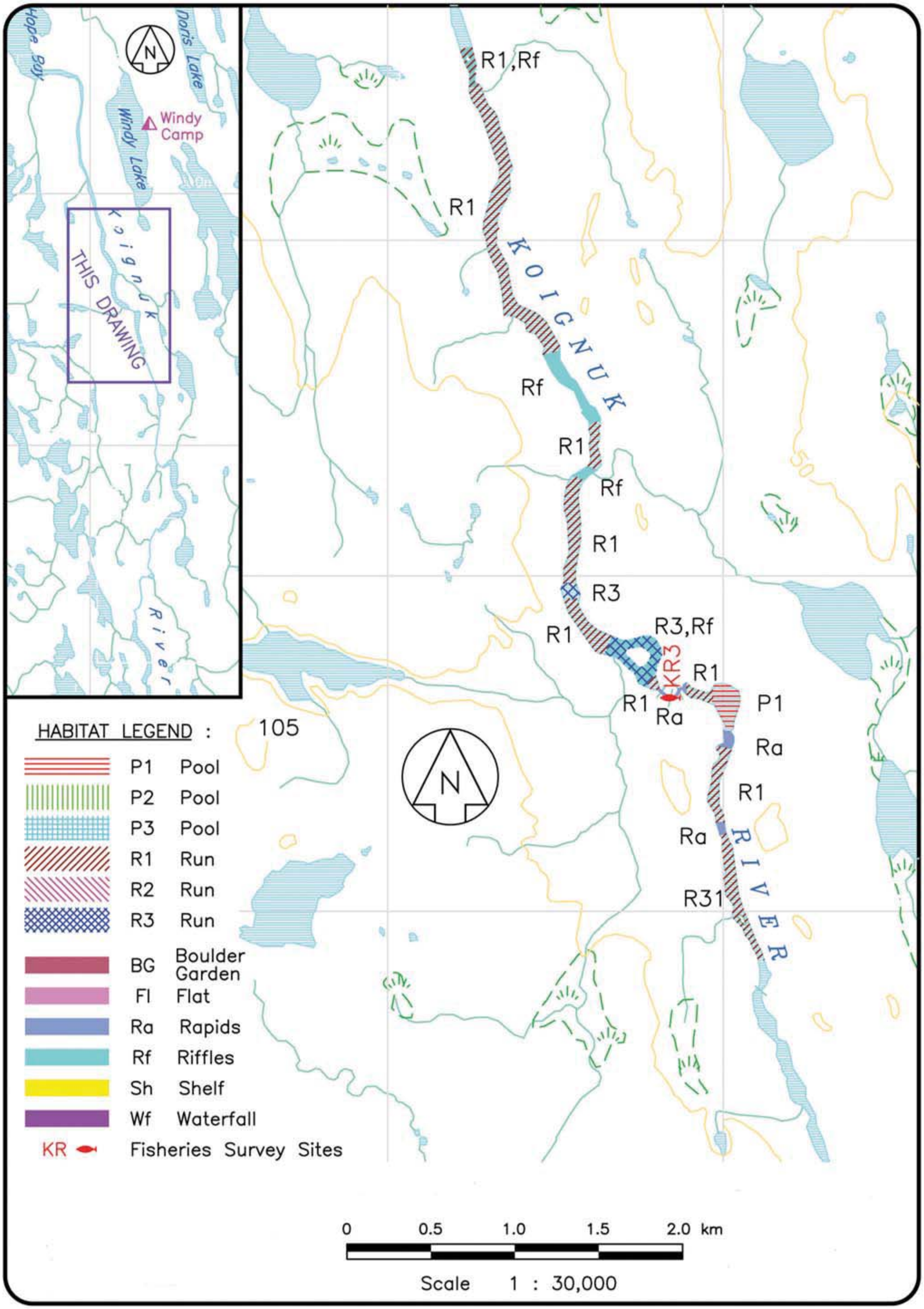


Figure 8.1 (continued) Habitat Map of Koignuk River (from Rescan 1999a)

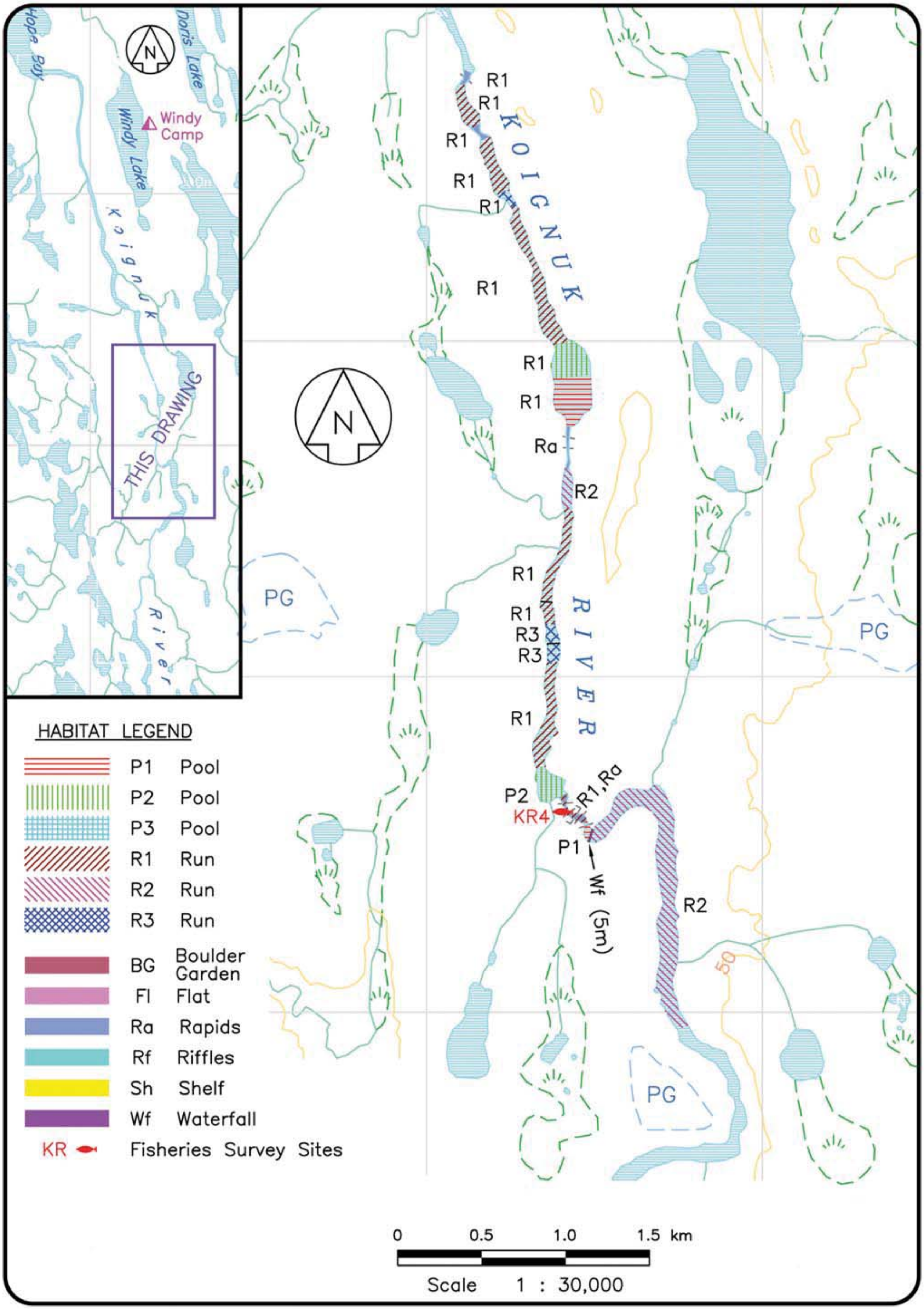


Figure 8.1 (continued) Habitat Map of Koignuk River (from Rescan 1999a)

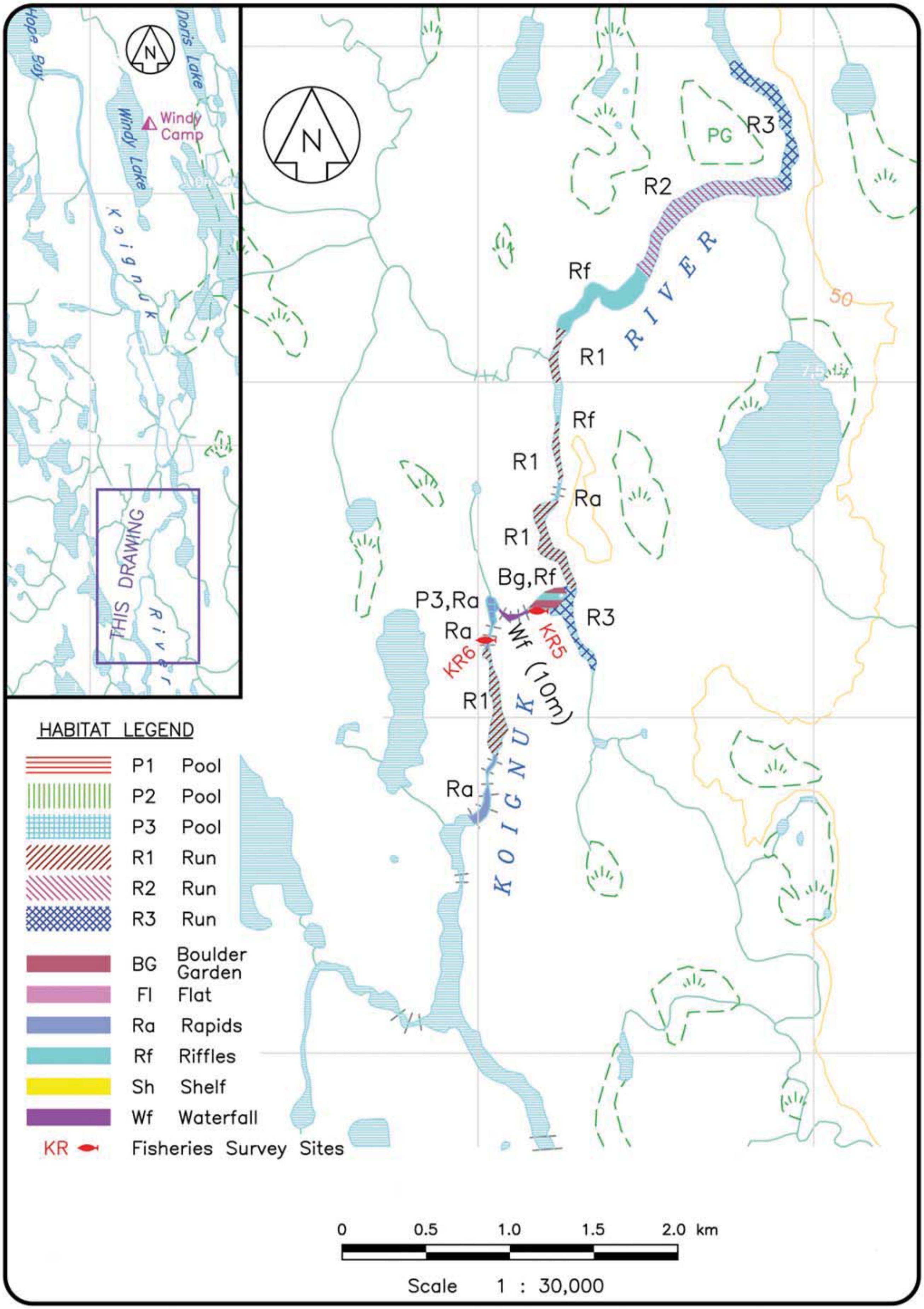


Figure 8.1 (continued) Habitat Map of Koignuk River (from Rescan 1999a)

Stream PRC13

A 500 m section of Stream PRC13 was assessed on 25 June 2000. The water level was high. In the surveyed section, the average channel width was 8 m, average depth was 1.2 m, and the stream gradient was less than 1%. The habitat consisted primarily of good and intermediate quality run habitat (65% and 20% of the area, respectively) with the remainder composed of best and intermediate quality pools (5% each) and riffles (5%). The channel substrate was dominated by silt (75%), with organic matter (10%), sand (12.5%), and boulders (2.5%) also present. The banks were 1.5 m in height; they were covered with vegetation and were stable. There was no overwintering habitat present in the surveyed section. Adult feeding areas and spawning habitat were classified as poor, whereas rearing habitat was rated as fair. Migration habitat was rated as excellent due to the width and depth of the channel (Appendix E2).

This stream was sampled again on 29 August 2000 during a low flow period. This time only a single 100 m section of the channel was surveyed. The channel had an average width of 2 m and an average depth of 0.5 m (Appendix E2). Pools and runs were the most prominent habitat features, each representing 45% of the total area. The run habitat quality decreased from June, with the majority being poor, but there was a large increase in high quality pools, which composed 40% of the total area. Substrate was predominantly silt (65%) with organic matter (10%), small gravel (10%), boulder (10%), and cobble (5%) contributing the remainder. Instream cover was provided by macrophytes (40%), pools (40%), boulders (10%), and cutbanks (5%). There was no observable spawning, adult feeding, or overwintering habitat in the surveyed section. The migration habitat was classified as poor, due to the low water level. Rearing habitat was classified as fair (Appendix E2). Backpack electrofishing conducted on 29 August 2000 resulted in the capture of three ninespine stickleback.

Stream PRC14

A 300 m section of Stream PRC14 was assessed on 25 June 2000. The water level was high. In the surveyed section, the average channel width was 2.2 m, average depth was 0.35 m, and the gradient was 2% (Appendix E2). The habitat consisted primarily of riffles and poor quality runs (35% each) with the remainder composed of fair and poor quality pools (5 and 15%, respectively) and fair quality runs (10%). The channel substrate was dominated by organic matter (80%). Instream cover was provided by pools (85%), cutbanks (10%), and overhanging vegetation (5%). The banks were partly covered with vegetation, but were unstable. They were 0.25 m and 0.50 m in height (left and right bank, respectively). There was no observable spawning, adult feeding, or overwintering habitat present in the surveyed section. Rearing habitat was ranked as poor and migration habitat was ranked as good (Appendix E2).

This stream was surveyed again on 29 August 2000 during low flow period. A 350 m section of the channel was surveyed. This section had an average width of 2.5 m and an average depth of 0.45 m. Poor, intermediate and good quality pools dominated this section (40%, 30%, and 20%, respectively). The rest of the habitat was composed of riffles (10%). Substrate was predominantly organic matter and silt (each contributing 45% of the total), with some boulders also present. The instream cover was provided by pools (80%), macrophytes (10%), overhanging vegetation (5%), and cutbanks (5%). There was no observable spawning, adult feeding, overwintering or migration habitat present in the surveyed section. Rearing habitat was classified as poor (Appendix E2).

Backpack electrofishing conducted on 25 June 2000 resulted in the capture of 16 ninespine stickleback.

Stream PRC15

During the June 2000 survey, the length of surveyed section was not recorded; however, the channel had an average width of 3 m and a gradient of less than 1% (Appendix E2). The instream habitat consisted of a series of pools connected by runs and deep riffles. Intermediate and good quality runs contributed the majority of the habitat (40% and 15%, respectively), whereas riffles (25%) and good quality pool habitat (20%) made up the remainder. The majority of the substrate was composed of organic matter (85%), but also contained silt (5%), sand (5%), and boulders (5%). Instream cover was provided by pools (80%) and cutbanks (20%). The banks were completely covered with vegetation, 0.50 m in height and stable. There was no observable overwintering habitat in the surveyed section. Spawning and adult feeding habitat were classified as poor. Rearing habitat was classified as fair and migration habitat was rated excellent, as the channel was deeply cut into the permafrost and thus provided an excellent migrating channel for adult fish (Appendix E2).

In August 2000, a 175 m section of stream was surveyed. The average stream width was 1.0 m and the average depth was 0.8 m (Appendix E2). The surveyed section was comprised of good and intermediate quality pools (20 and 15%, respectively), intermediate and poor quality runs (10 and 5%, respectively), riffles (5%), and best and intermediate quality flats (25 and 20%, respectively). Deep pools were connected by deep and narrow channels cut in the tundra and the flow was barely perceptible. Organic matter was again the most abundant substrate (65%), with silt (25%), sand (5%), and large gravel (5%) making up the rest. Instream cover was provided by macrophytes and/or submerged vegetation (50%), pools (35%), cutbanks (10%) and overhanging vegetation (5%). The banks were 0.75 m high, well vegetated and stable. There was no overwintering, spawning or adult feeding habitat in the surveyed section. Rearing habitat was ranked as poor and migration habitat was ranked as good, due to sufficient water depth in the surveyed section (Appendix E2).

Backpack electrofishing conducted in August 2000 resulted in the capture of three ninespine stickleback and one immature Arctic grayling.

8.2.10 Summary

Stream habitat assessments were conducted at 21 stream sites between 1996 and 2000. An additional 21 stream sites were visually assessed from the air and deemed to contain no fish habitat. A detailed habitat map was prepared for the lower reaches of the Koignuk River in 1998.

Large streams supported the highest diversity of fish habitat for rearing, adult feeding, spawning, and migration (Aimaokatalok NE Inflow, Aimaokatalok River, and the Koignuk River). The associated lakes likely provided overwintering habitat, which was typically lacking within streams due to shallow depths. Most of the small inflow tributaries that did not feature a lake or pond upstream were found to be either ephemeral, consisting of run-off from melt waters, or provided only marginal rearing and feeding habitat near their mouths.

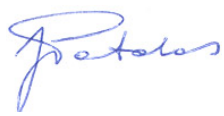
During high water, Stickleback Outflow had an instream habitat consisting of mainly riffles. This stream provided good rearing but poor migration habitat. During the same high water period, Fickle Duck Outflow had an instream habitat consisting entirely of riffles and provided good migration habitat, fair adult feeding and rearing, and poor spawning habitat.

9 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

GOLDER ASSOCIATES LTD.

Report prepared by:



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APPENDIX A

SURFACE WATER QUALITY

Appendix A1. Summary of water quality and sediment sampling methods used in the Boston area, 1992-2000.

Parameter		Sampling Year							
		1992[a]	**1993[a]**	**1994[b]**	**1995[c]**	**1996[d]**	**1997[e]**	**1998[f]**	**2000[g]**
Lakes	**Limnology Methods**	Unknown	Unknown	Unknown	YSI 51 B dissolved oxygen meter with 30 m probe	Unknown	Precalibrated YSI 58 DO meter with 50 m probe; measured at the deepest part of the lake.		NA
	Water Quality Methods	Unknown	Grab samples at surface; samples from discrete depths		Acid-washed Go-Flo bottle for surface and depth sampling	2 L acid-washed Go-Flo bottle for surface and depth sampling, bottles triple rinsed	5 L Go-Flo bottle for 1 m and depth samples; nutrient samples field-filtered and stored frozen; other samples kept cool and dark		NA
	Number of Sample Days	Aimaokatalok - 1	Aimaokatalok - 4, Stickleback - 1	Aimaokatalok - 2, Stickleback - 1, Fickle Duck - 1	Aimaokatalok - 2, Stickleback - 1, Fickle Duck - 1	Aimaokatalok - 3, Fickle Duck - 1	Aimaokatalok - 3, Stickleback - 3, Fickle Duck - 3, Reference - 2	Aimaokatalok - 2, Stickleback - 1, Fickle Duck - 1, Reference - 2	NA
	No. Sites on Aimaokatalok	NA	4	4	5	6	6	2	NA
	Depth Sampling in Lakes[h]	NA	Yes	Yes	Yes	Yes	Yes	Yes	NA
	Sediment Quality Methods	NA	Unknown	NA	NA	Ekman grab sampler, samples divided into 0-1 cm and 1-3 cm fractions	Ekman grab sampler, sample examined for texture and colour, top 2 cm transferred to Ziploc bags and frozen		NA
Streams	**Water Quality Methods**	Unknown	Grab samples at surface		Grab samples just below surface	Grab samples just below surface, sample bottles triple-rinsed			Depth-integrated samples
	Number of Sample Days	Stickleback OF - 1, Fickle Duck OF - 1	Stickleback OF - 2, Fickle Duck OF - 2	Stickleback OF - 1, Fickle Duck OF - 1	Stickleback OF - 1, Fickle Duck OF - 1, Aimaokatalok NE IF - 1	Stickleback OF - 3, Fickle Duck OF - 3, Aimaokatalok NE IF - 2	Stickleback OF - 3, Fickle Duck OF - 3, Aimaokatalok NE IF - 3, Aimaokatalok River - 3, Reference OF - 2	Stickleback OF - 1, Fickle Duck OF - 1, Aimaokatalok NE IF - 1, Aimaokatalok River - 2, Aimaokatalok OF - 3, Reference OF - 3, Koignuk River -2	Koignuk River -2
Marine	**Water Quality Methods**	NA	NA	NA	NA	NA	5 L Go-Flo bottle for 1 m and depth samples; Nutrient samples field-filtered and stored frozen; Other samples kept cool and dark		NA
	Sediment Quality Methods	NA	NA	NA	NA	NA	Ekman grab sampler, sample examined for texture and colour, top 2cm bagged and frozen	Ekman grab sampler, sample examined for texture and colour, no chemical analyses	NA
QA/QC	**Split Samples[i]**	Unknown	No	No	No	No	Yes	Yes	No
	Replicates[i]	Unknown	Yes	No	Yes	Yes	Yes	Yes	Yes
	Travel/Field Blanks	Unknown	No	Yes	Yes	No	Yes	Yes	Yes
	Inter Lab Sample	Unknown	No	No	No	No	No	No	No
	Analytical Laboratory(ies)[j]	Unknown	Unknown	"independent accredited laboratories in Vancouver, B.C."	ERI	Water - ASL or ERI Sediment - ERI	Dissolved nutrients (water) - UBC Routine, dissolved ions and metals (water) - ASL Sediment - ASL		ASL

Notes: NA = not applicable (not sampled during that year); UK = unknown (methods not described in report); OF = outflow

[a] For a complete description of methods, see Rescan (1993)

[b] For a complete description of methods, see Rescan (1994)

[c] For a complete description of methods, see Rescan (1995)

[d] For a complete description of methods, see Rescan (1997)

[e] For a complete description of methods, see Rescan (1998)

[f] For a complete description of methods, see Rescan (1999)

[g] For a complete description of methods, see Rescan (2001)

[h] See Appendices A4, A5 and A6 for raw data

[i] See Appendix A3 for QA/QC data

[j] ASL= Analytical Service Laboratories, Vancouver; ERI = Elemental Research Inc., Vancouver; UBC = University of British Columbia, Vancouve

Appendix A2. Detection limits for freshwater parameters analyzed water quality analysis in Boston area, 1992-2000.

Parameter	1992	Jun 1993	Aug 1993	1994	1995	1996	1997	1998	2000
Physical									
Conductivity (µmhos/cm)					2	2	2	2	1
pH						0.01	0.01	0.01	0.1
Hardness ($CaCO_3$) (mg/L)				1	1	0.05	0.05	0.05	0.1
Total Dissolved Solids (mg/L)					1	1	10	1	
Total Suspended Solids (mg/L)			1	1	1	1	1	1	3
Turbidity (NTU)					0.1	0.1	0.1	0.1	0.1
Dissolved Anions (mg/L)									
Acidity to pH 8.3					1		1	1	1
Alkalinity to pH 4.5				1	1		1	1	1
Bicarbonate Alkalinity							1	1	
Carbonate Alkalinity						1.0	1	1	1
Chloride				0.5	0.5	0.5	0.5	0.5	0.1
Fluoride				0.05	0.05	0.05	0.02	0.02	0.01
Sulphate	1	1		0.5	0.5	1	1	1	1
Nutrients (mg/L)									
Free Ammonia		0.005		0.005	0.02	0.005	0.001	0.005	0.005
Nitrate		0.005	0.005	0.005	0.01	0.005	0.001	0.005	0.005
Nitrite		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Dissolved P				0.002	0.002	0.001	0.001	0.001	0.001
Total P				0.002	0.002	0.002	0.001	0.002	0.001
Ortho P				0.002	0.002	0.001	0.001	0.001	0.001
Total Metals (µg/L)									
Aluminium	200	200			1	1	5	5	0.001
Antimony	200	200	0.1	0.2	0.1	0.05	0.1	0.1	0.05
Arsenic	0.1	200	0.1	1	1	0.01a	0.1	0.1	0.1
Barium	10	10	10	0.03	0.6	0.05	10	10	0.05
Beryllium	5	5	5	0.5	0.5	0.5	5	5	0.5
Bismuth	100	100		0.03	0.05	0.5	100	10	0.5
Boron	100		100	1.2	1	1	100	100	1
Cadmium	0.2	10	0.1	0.07	0.2	0.05	0.2	0.2	0.05
Calcium				10	10	50	50	50	10
Chromium	15	15	1	0.3	0.5	0.1	1	1	0.5
Cobalt	15	15	1	0.06	0.08	0.1	1	1	0.1
Copper		10	0.5		0.5	0.1	1	1	0.1
Iron			30	10	10	10	10	10	30
Lead	1	50	1	0.06	0.1	0.05	1	1	0.05
Lithium	15	15		5	1	1	10	10	1
Magnesium					10	5	50	50	100
Manganese	5	5	5	0.1	0.2	0.05	5	5	0.05
Mercury			0.01	0.05	0.05		0.05	0.05	0.05
Molybdenum	1	30	1	0.16	0.1	0.05	1	1	0.05
Nickel	20	20	1		0.5	0.1	1	1	0.1
Phosphorus	300	300		20	20		300	300	
Potassium	2000	2000		50	50		10		200
Selenium	200	200	0.5	1	1	0.5	0.5	0.5	1
Silicon						50	50		50
Silver	15	15	0.05	0.01	0.01	0.01	0.1	0.1	0.01
Sodium					10		10		200
Strontium				0.06	0.1	0.1	1	1	
Thallium	100	100		0.03	0.05	0.05	100	200	
Tin	300	300		0.09	0.1	0.1	30	30	
Titanium	10	10		0.5	0.5	1	10	10	
Tungsten	100	100		0.07	0.1				
Uranium						0.01		0.005	0.01
Vanadium	30	30	5	1	1	0.1	30	30	1
Zinc	5	5	5	1	1	1	5	5	1
Cyanide									
Cyanate (mg/L)			0.5						
Thiocyanate (mg/L)			0.5						
Total Cyanide (mg/L)			0.005						
WAD Cyanide (mg/L)			0.005						

a = the detection limit was 0.05 µg/L for April 1996 samples; however, it was 0.01 µg/L for the remaining samples in 1996.

Appendix A3. Summary of water quality QA/QC program in Boston area waterbodies, 1992-2000.

Waterbody	**Number of Sample Days**	**Number of Duplicates/ Splits/ Triplicates**	**Depth Composites**	**Site Composites**	**Inter Lab Comparisons**	**North/ South Comparisons**
Aimaokatalok Lake	13	13	Yes	No	No	Yes
Stickleback Lake	7	1	Yes	No	No	No
Fickle Duck Lake	8	1	No	No	No	No
Reference Lake	4	3	No	No	No	No
Aimaokatalok NE Inflow	7	1	No	No	No	No
Aimaokatalok River	5	1	No	No	No	No
Aimaokatalok Outflow	3	1	No	No	No	No
Stickleback Outflow	12	2	No	No	No	No
Fickle Duck Outflow	12	1	No	No	Yes	No
Reference Outflow	5	1	No	No	No	No
Koignuk River	4	3	No	No	No	No
Hope Bay (marine)	2	4	Yes	No	No	Yes

Appendix A4. Analytical results for water quality QA/QC samples from Boston area, 1994-1998.

Parameter	Aimaokatalok Lake										
	Station 4 (3 m)		Station 6 (3 m)			Station 6 (10 m)		Station 6 (20 m)		Station 6 (25 m)	
	22-Apr-98		22-Apr-98			22-Apr-98		22-Apr-98		22-Apr-98	
	Rep 1	Rep 2	Rep 1a	Rep 1b	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Physical											
Conductivity (µS/cm)	64	62	56	57	56	57	58	64	57	57	58
pH	6.85	6.80	6.73	6.74	6.72	6.76	6.77	6.86	6.74	6.45	6.59
Total Diss. Solids (mg/L)	46	50	41	45	40	49	38	35	39	41	42
Total Susp. Solids (mg/L)	2	<1	2	2	<1	<1	<1	<1	<1	<1	<1
Turbidity (NTU)	0.7	0.5	1.4	1.1	0.9	0.9	0.8	0.6	0.5	0.8	0.6
Dissolved Anions (mg/L)											
Hardness ($CaCO_3$)	16.1	16.9	14.2	14.0	14.4	14.3	14.1	14.3	14.2	14.3	14.0
Total Alkalinity	10	7	9	10	8	9	9	9	9	9	9
Chloride	11.5	11.7	9.8	10.2	9.8	9.8	9.8	9.8	9.9	10.0	10.1
Fluoride	0.07	0.04	0.05	0.06	0.04	0.05	0.04	0.03	0.03	0.03	0.03
Sulphate	3	2	2	2	2	2	2	2	2	2	2
Nutrients (mg/L)											
Dissolved Phosphate	0.047	0.034	0.052	0.053	0.051	0.066	0.061	0.103	0.091	0.110	0.120
Total Phosphorus	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ammonia Nitrogen	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	0.003	0.003	0.006
Nitrate - nitrogen	0.007	0.001	0.008	0.002	0.002	0.001	<0.001	0.004	0.005	0.003	0.007
Nitrite - nitrogen	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)											
Aluminum	19	19	24	-	28	22	18	24	22	26	27
Antimony	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.2	0.2	0.2	-	0.2	0.2	0.2	0.1	0.1	0.2	0.1
Barium	-	20	<10	-	-	<10	-	<10	-	<10	-
Beryllium	<5	<5	<5	-	<5	<5	<5	<5	<5	<5	<5
Bismuth	-	<100	<100	-	-	<100	-	<100	-	<100	-
Boron	-	<100	<100	-	-	<100	-	<100	-	<100	-
Cadmium	<0.2	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	3230	3320	2860	-	2900	2910	3080	2920	2900	2860	2820
Chromium	***4***	***4***	***9***	-	***10***	***6***	***3***	<1	<1	<1	<1
Cobalt	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
Copper	***14***	***18***	***11***	-	***13***	***7***	***4***	2	2	***3***	1
Iron	50	60	90	-	90	80	50	40	40	100	40
Lead	<1	<1	***3***	-	***3***	1	<1	<1	<1	<1	<1
Lithium	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10
Magnesium	2000	2100	1800	-	1800	1800	1800	1800	1800	1800	1800
Manganese	<5	<5	<5	-	<5	<5	<5	8	7.0	13	13.0
Mercury	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1
Nickel	8	6	11	-	12	8	4	<1	1	12	1
Potassium	940	940	840	-	880	830	820	840	830	820	800
Selenium	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	270	330	290	-	280	300.00	320	590	540	650	680
Silver	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	6000	6000	5000	-	6000	5000	6000	6000	5000	6000	6000
Strontium	17.0	17	15	-	15.0	15	15.0	15	15.0	15	15.0
Thallium	-	<200	<200	-	-	<200	-	<200	-	<200	-
Tin	-	<30	<30	-	-	<30	-	<30	-	<30	-
Titanium	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	<30	<30	-	-	<30	-	<30	-	<30	-
Zinc	16.0	***39***	10	-	14.0	7	7.0	<5	<5	<5	<5
Dissolved Metals (µg/L)											
Aluminum	-	-	15	14	15	14	12	14	13	15	15
Antimony	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	-	-	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Barium	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Beryllium	-	-	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bismuth	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100
Boron	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100
Cadmium	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	-	-	2810	2830	2860	2830	2800	2840	2830	2810	2750
Chromium	-	-	***6***	***6***	***6***	***5***	***2***	<1	<1	***7***	<1
Cobalt	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	-	-	***10***	***9***	***10***	***6***	***4***	1	1	2	1
Iron	-	-	60	60	60	40	30	20	20	60	20
Lead	-	-	2	2	2	1	<1	<1	<1	<1	<1
Lithium	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Magnesium	-	-	1800	1800	1800	1800	1700	1800	1700	1800	1700
Manganese	-	-	<5	<5	<5	<5	<5	8	7	13	13
Mercury	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	-	-	11	10	11	8	4	<1	<1	13	1
Potassium	-	-	840	840	860	830	820	800	800	800	780
Selenium	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	-	-	260	260	250	280	290	550	510	610	610
Silver	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	-	-	5000	5000	5000	5000	5000	5000	5000	5000	5000
Strontium	-	-	14	15	14	15	14	15	15	14	14
Thallium	-	-	<200	<200	<200	<200	<200	<200	<200	<200	<200
Tin	-	-	<30	<30	<30	<30	<30	<30	<30	<30	<30
Titanium	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	<30	<30	<30	<30	<30	<30	<30	<30	<30
Zinc	-	-	10	10	10	6	<5	<5	<5	<5	<5

Appendix A4. Analytical results for water quality QA/QC samples from Boston area, 1994-1998.

Parameter	Aimaokatalok Lake											
	Station 1 (2 m)		**Station 4 (8 m)**		**Station 5 (2 m)**		**Station 6 (5 m)**		**Station 6 (15 m)**		**Station 6 (25 m)**	
	23-Aug-96		24-Aug-96		24-Aug-96		18-Jul-98		18-Jul-98		18-Jul-98	
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Physical												
Conductivity (µS/cm)	78	83.0	-	-	-	-	35	-	35	-	37	38
pH	6.90	7.18	-	-	-	-	6.38	-	6.43	-	6.50	6.57
Total Diss. Solids (mg/L)	37	35	-	-	-	-	34	-	24	-	30	26
Total Susp. Solids (mg/L)	10	11	-	-	-	-	4	-	2	-	2	3
Turbidity (NTU)	9.0	14.0	-	-	-	-	2.8	-	2.6	-	2.4	2.3
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	12.0	12.6	-	-	-	-	9.8	-	9.7	-	9.7	9.7
Total Alkalinity	10	8	-	-	-	-	7	-	6	-	7	6
Chloride	6.44	6.39	-	-	-	-	5.7	-	5.8	-	6.2	6.1
Fluoride	0.04	0.04	-	-	-	-	0.02	-	0.03	-	0.03	0.02
Sulphate	2.0	2.0	-	-	-	-	1	-	1	-	1	1
Nutrients (mg/L)												
Dissolved Phosphate	<0.005	<0.005	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	<0.001	<0.001	-	-	-	-	-	-	-	-	-	-
Ammonia Nitrogen	0.029	0.028	-	-	-	-	-	-	-	-	-	-
Nitrate - nitrogen	0.002	0.002	-	-	-	-	-	-	-	-	-	-
Nitrite - nitrogen	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)												
Aluminum	***446***	***508***	40	33	88	***112***	45	45	48	-	40	-
Antimony	0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.1	<0.1	<0.1	-	<0.1	-
Arsenic	1.0	<1	2	<1	2.0	3.0	0.1	0.1	0.2	-	0.1	-
Barium	5.45	5.11	1.37	1.53	1.81	2.15	<10	-	-	-	-	-
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5	-	<5	-
Bismuth	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<100	-	-	-	-	-
Boron	4	3.0	2	5	2.0	3	<100	-	-	-	-	-
Cadmium	***0.28***	***0.23***	***0.15***	***0.45***	***0.19***	***0.19***	<0.2	<0.2	<0.2	-	<0.2	-
Calcium	2600	2700	1600	1500	1790	2110	1940	1950	2110	-	1960	-
Chromium	-	-	-	-	-	-	<1	<1	<1	-	<1	-
Cobalt	0.2	0.2	<0.1	<0.1	<0.1	<0.1	<1	<1	<1	-	<1	-
Copper	1.6	1.5	0.7	0.9	1.1	0.8	<1	<1	1	-	<1	-
Iron	***440***	***380***	30	40	70	100	130	110	120	-	120	-
Lead	0.28	0.30	0.16	0.11	0.18	0.13	<1	<1	<1	-	<1	-
Lithium	-	-	-	-	-	-	<10	<10	<10	-	<10	-
Magnesium	1540	1520	1050	1160	1110	1220	1200	1200	1200	-	1200	-
Manganese	9.4	8.31	3.0	3.39	3.42	4.1	9	10.0	12.0	-	12.0	-
Mercury	-	-	-	-	-	-	<0.05	<0.05	<0.05	-	<0.05	-
Molybdenum	<0.05	0.10	<0.05	0.07	<0.05	<0.05	<1	<1	<1	-	<1	-
Nickel	1.30	1.00	0.3	0.2	0.20	<0.1	<1	<1	<1	-	<1	-
Potassium	790	840	670	720	700	810	660	660	760	-	700	-
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	-	<0.5	-
Silicon	60	450	60	340	<50	<50	280	290	290	-	290	-
Silver	0.06	0.06	<0.01	0.04	0.04	0.03	<0.1	<0.1	<0.1	-	<0.1	-
Sodium	3750	3580	3480	3690	3730	3770	2980	2910	3450	-	3110	-
Strontium	12.4	13.1	7.4	8.1	8.1	7.9	20	19.0	20.0	-	19.0	-
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-
Tin	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	-	-	-	-	-	-
Titanium	19	18	9	26	3.0	3.0	<10	<10	<10	-	<10	-
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.03	0.06	<0.01	0.01	<0.01	0.03	-	-	-	-	-	-
Vanadium	<1	<1	<1	<1	<1	<1	<30	-	-	-	-	-
Zinc	7.0	8	5.0	9	22.0	9.0	<5	<5	<5	-	<5	-
Dissolved Metals (µg/L)												
Aluminum	40	40	3	3	7	5	11	-	13	12	13	-
Antimony	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	-	<0.1	<0.1	<0.1	-
Arsenic	<1	<1	<1	<1	<1	<1	0.1	-	0.1	0.1	0.1	-
Barium	2.11	2.39	1.35	0.85	1.03	1.15	<10	-	<10	<10	<10	-
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	-	<5	<5	<5	-
Bismuth	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<100	-	-	<100	-	-
Boron	2.0	3.0	2.0	3.0	2.0	2.0	<100	-	-	<100	-	-
Cadmium	0.05	0.20	<0.05	0.12	0.15	<0.05	<0.2	-	<0.2	<0.2	<0.2	-
Calcium	2580	2570	1520	1450	1520	1520	1950	-	1950	1970	1940	-
Chromium	-	-	-	-	-	-	<1	-	<1	<1	<1	-
Cobalt	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	-	<1	<1	<1	-
Copper	1	1	0	0	0	1	1	-	1	<1	<1	-
Iron	40.0	50.0	<10	<10	<10	<10	30	-	30	30	30	-
Lead	0.08	0.08	<0.05	<0.05	0.06	<0.05	<1	-	<1	<1	<1	-
Lithium	-	-	-	-	-	-	<10	-	<10	<10	<10	-
Magnesium	1350.0	1490.0	1050.0	1040.0	1060.0	1020.0	1200	-	1200	1200	1200	-
Manganese	0.48	0.64	<0.05	<0.05	<0.05	<0.05	<5	-	<5	<5	<5	-
Mercury	-	-	-	-	-	-	<0.05	-	<0.05	<0.05	<0.05	-
Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<1	-	<1	<1	<1	-
Nickel	0.80	0.80	0.10	0.10	<0.1	<0.1	<1	-	<1	<1	<1	-
Potassium	640	730	670	650	700	630	630	-	670	650	670	-
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	-
Silicon	80.0	180.0	<50	<50	<50	<50	210	-	230	240	240	-
Silver	0.02	0.02	<0.01	-<0.02	<0.01	<0.01	<0.1	-	<0.1	<0.1	<0.1	-
Sodium	3320	3290	3140	3140	3390	3280	2880	-	3030	3010	3120	-
Strontium	10.6	11.8	7.3	8.1	7.4	7.1	20	-	20	19	19	-
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<200	-	-	<200	-	-
Tin	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<30	-	-	<30	-	-
Titanium	<1	<1	<1	<1	<1	<1	<10	-	<10	<10	<10	-
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.0	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-
Vanadium	0.30	0.30	0.1	0.1	0.1	0.1	<30	-	-	<30	-	-
Zinc	1.0	2.0	1.0	2.0	<1	<1	<5	-	<5	<5	<5	-

Appendix A4. Analytical results for water quality QA/QC samples from Boston area, 1994-1998.

Parameter	Stickleback Lake		Fickle Duck Lake		Reference Lake					
	(1 m)		WQ8 (1 m)		(1 m)		(2.5 m)		(1 m)	
	23-Jul-97		03-Aug-95		27-Aug-97		22-Apr-98		22-Jul-98	
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Physical										
Conductivity (µS/cm)	187	189	61	60	52	51	235	228	32	32
pH	6.98	7.07	***6.1***	***6.1***		6.83	7.07	7.09	6.72	6.79
Total Diss. Solids (mg/L)	124	132	42	44	34	29	223	173	23	20
Total Susp. Solids (mg/L)	3	3	1	1	5	5	50[a]	4	4	6
Turbidity (NTU)	0.7	1.4	3.5	3.9	3.5	3.1	7.2	7.1	3.8	3.9
Dissolved Anions (mg/L)										
Hardness ($CaCO_3$)	54.2	54.8	17	8	14.7	14.6	82.9	81.9	12	11.8
Total Alkalinity	32	32	10	10	12	12	67	66	9	9
Chloride	37.4	36.8	10.6	10.5	4.6	4.7	30.0	30.0	3.5	3.5
Fluoride	0.04	0.05	0.04	0.04	0.06	0.09	0.11	0.12	0.03	0.04
Sulphate	<1	<1	1	1.1	1	1	8	8	1	1
Nutrients (mg/L)										
Dissolved Phosphate	0.001	0.005	0.004	0.006	0.001	-	0.002	0.002	-	-
Total Phosphorus	0.008	0.007	0.02	0.014	0.021	0.015	0.016	0.018	-	-
Ammonia Nitrogen	0.006	0.007	0.04	0.020	0.014	-	0.019	0.021	-	-
Nitrate - nitrogen	0.002	0.003	0.005	0.006	0.002	-	0.226	0.226	-	-
Nitrite - nitrogen	<0.001	<0.001	0.001	0.001	<0.001	-	0.002	<0.001	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)										
Aluminum	6	<5	***109***	***141***	***109***	79	36	37	80	88
Antimony	<0.1	<0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.3	0.4	1	1	0.3	0.3	0.7	0.8	0.2	0.2
Barium	<10	<10	4.24	3.97	<10	<10	30	20	<10	<10
Beryllium	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-
Boron	<100	-	5	3	-	-	-	-	-	-
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	14400	14000	4640	4760	3980	3840	21800	21600	3120	3110
Chromium	<1	<1	***1.6***	0.5	<1	<1	***3***	***3***	<1	<1
Cobalt	<1	<1	0.17	0.16	<1	<1	<1	<1	<1	<1
Copper	<1	<1	***2.9***	1	2	2	***30***	***30***	1	2
Iron	110	90	***430***	***450***	230	210	***1840***	***1840***	240	240
Lead	<1	<1	***4.3***	0.4	<1	***36***[b]	<1	<1	<1	<1
Lithium	-	-	1	1	-	-	-	-	-	-
Magnesium	4990	4870	1620	1610	1270	1240	6900	6800	1000	1000
Manganese	11	10	2.6	2.4	<5	<5	152	150	6	6
Mercury	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	<1	<1	0.3	0.1	<1	<1	<1	<1	<1	<1
Nickel	<1	<1	2.3	1.4	<1	<1	4	4	<1	<1
Potassium	1440	1490	400	320	440	430	2220	2250	440	440
Selenium	<0.5	<0.5	1	1	<0.5	<0.5	<0.5	0.5	<0.5	0.5
Silicon	220	210	-	-	240	240	3420	3380	260	240
Silver	<0.1	<0.1	0.05	0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	11400	11200	5450	5450	2650	2670	17000	17000	2260	2130
Strontium	94	92	22.3	23.1	19	18	59	59	18	17
Thallium	<100	-	0.05	0.05	-	-	-	-	-	-
Tin	<30	-	0.4	0.2	-	-	-	-	-	-
Titanium	<10	-	4.1	0.5	-	-	-	-	-	-
Tungsten	-	-	0.1	0.1	-	-	-	-	-	-
Uranium										
Vanadium	<30	-	1	1	-	-	-	-	-	-
Zinc	<5	<5	2	7	<5	<5	14	9	<5	<5
Dissolved Metals (µg/L)										
Aluminum	<5	<5	48	53	17	17	-	-	-	-
Antimony	<0.1	<0.1	0.1	0.1	<0.1	<0.1	-	-	-	-
Arsenic	0.3	0.3	1	1	0.2	0.3	-	-	-	-
Barium	<10	<10	3.54	3.56	<10	<10	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-
Boron	<100	<100	3	1	-	-	-	-	-	-
Cadmium	<0.2	<0.2	0.2	0.2	<0.2	<0.2	-	-	-	-
Calcium	13800	13900	4530	4270	3870	3850	-	-	-	-
Chromium	<1	<1	0.6	0.5	<1	<1	-	-	-	-
Cobalt	<1	<1	0.08	0.08	<1	<1	-	-	-	-
Copper	<1	<1	0.8	0.9	1	1	-	-	-	-
Iron	<10	<10	150	150	70	70	-	-	-	-
Lead	<1	<1	0.1	0.1	<1	16[b]	-	-	-	-
Lithium	-	-	1	1	-	-	-	-	-	-
Magnesium	4820	4880	1520	1450	1220	1210	-	-	-	-
Manganese	<5	<5	0.2	0.2	<5	<5	-	-	-	-
Mercury	-	-	<0.05	<0.05	<0.05	<0.05	-	-	-	-
Molybdenum	<1	<1	0.1	0.1	<1	<1	-	-	-	-
Nickel	<1	<1	1.1	1	<1	<1	-	-	-	-
Potassium	1450	1480	320	280	410	410	-	-	-	-
Selenium	<0.5	<0.5	1	1	<0.5	<0.5	-	-	-	-
Silicon	200.00	210	-	-	130	130	-	-	-	-
Silver	<0.1	<0.1	0.01	0.01	<0.1	<0.1	-	-	-	-
Sodium	11000.0	11000.0	5060	4880	2630	2630	-	-	-	-
Strontium	90.000	90.000	22.2	21.5	19	18	-	-	-	-
Thallium	<100	<100	0.05	0.05	-	-	-	-	-	-
Tin	<30	<30	0.1	0.1	-	-	-	-	-	-
Titanium	<10	<10	0.9	0.5	-	-	-	-	-	-
Tungsten	-	-	0.1	0.1	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-
Vanadium	<30	<30	1	1	-	-	-	-	-	-
Zinc	<5	<5	1	1	<5	<5	-	-	-	-

[a] Rep 1 sample appears to have been contaminated with sediments (50 mg/L of TSS compared to 4 mg/L in Rep 2)
[b] Rep 2 sample was likely contaminated (36 mg/L of Lead compared to <1 mg/L in Rep 1)

Appendix A4. Analytical results for water quality QA/QC samples from Boston area, 1994-1998.

Parameter	Aimaokatalok NE Inflow		Aimaokatalok Outflow		Aimaokatalok River		Stickleback Outflow			
	1-Aug-95		31-May-98		24-Aug-97		21-Jul-97		25-Aug-96	
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Physical										
Conductivity (µS/cm)	63	63	57	55	37	38	187	186	405	284
pH	***5.70***	***5.90***	6.88	6.77	6.53	***6.49***	7.05	7.10	7.60	7.50
Total Diss. Solids (mg/L)	52	37	38	36	20	21	130	130	125	123
Total Susp. Solids (mg/L)	5	12	4	2	2	2	2	2	3	1
Turbidity (NTU)	0.6	5.0	1.0	1.4	1.0	0.6	0.7	0.6	2.0	2.0
Dissolved Anions (mg/L)										
Hardness ($CaCO_3$)	14	13.0	13.6	13.8	7.76	7.86	55.2	53.2	47.6	50.2
Total Alkalinity	6	6	9	9	5	5	33	32	28	30
Chloride	12.8	12.8	8.8	8.8	4.6	4.6	36.5	37.0	41.3	41.2
Fluoride	0.05	0.05	0.07	0.05	0.05	0.05	0.04	0.04	0.05	0.05
Sulphate	1.2	1	2	2	1	1	<1	2	0.4	0.4
Nutrients (mg/L)										
Dissolved Phosphate	0.006	0.006	0.008	0.006	0.002	0.002	<0.001	0.002	0.004	0.002
Total Phosphorus	0.024	0.028	0.001	0.002	0.006	0.005	0.008	0.006	0.016	0.019
Ammonia Nitrogen	0.020	0.020	0.008	0.021	0.023	0.019	0.461	0.382	<0.005	<0.005
Nitrate - nitrogen	0.008	0.006	0.045	0.042	0.015	0.014	0.002	0.005	<0.005	<0.005
Nitrite - nitrogen	0.001	0.001	<0.001	<0.001	0.010	<0.001	0.0012	0.0012	<0.001	<0.001
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)										
Aluminum	***183***	***207***	12	13	14	14	6	<5	38	43
Antimony	0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.05	0.06
Arsenic	1	1	0.1	0.2	<0.1	0.1	0.3	0.4	<1	1
Barium	3.34	3.91	<10	<10	<10	<10	<10	<10	4.8	4.9
Beryllium	0.5	0.5	-	-	-	-	<5	<5	<0.5	<0.5
Bismuth	0.07	0.07	-	-	-	-	<100		<0.5	<0.5
Boron	4	6	-	-	-	-	<100		14	17
Cadmium	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	***0.19***	<0.05
Calcium	2580	2530	2850	2750	1480	1470	14200	14000	11500	12000
Chromium	0.5	0.5	<1	<1	<1	<1	<1	<1		
Cobalt	0.08	0.20	<1	<1	<1	<1	<1	<1	<0.1	0.10
Copper	0.5	1.9	1	1	<1	1	<1	<1	0.5	0.7
Iron	***470***	***500***	30	30	90	90	110	90	140	120
Lead	0.1	0.4	<1	<1	<1	<1	<1	<1	0.1	0.1
Lithium	1	2	-	-			<10	<10	-	-
Magnesium	1750	1890	1700	1700	1040	1020	4930	4880	5220	5050
Manganese	13	23	<5	<5	<5	<5	12	10	10	9
Mercury	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-
Molybdenum	0.1	0.3	<1	<1	<1	<1	<1	<1	<0.05	<0.05
Nickel	0.7	1.1	<1	<1	<1	<1	<1	<1	<0.1	0.1
Potassium	920	880	750	750	510	480	1460	1530	1530	1450
Selenium	1	1	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	-	-	300	300	110	100.00	220	210	120	90
Silver	0.01	0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.06	0.04
Sodium	7060	7480	4430	4420	2260	2260	11300	11200	11000	11400
Strontium	15	15	14	13	14	14	92	90	58	59
Thallium	0.05	0.05	-	-	-	-	-	-	0.08	<0.05
Tin	0.2	0.1	-	-	-	-	<30	-	<0.1	<0.1
Titanium	2.2	6.4	-	-	-	-	<10	<10	7	6
Tungsten	0.1	0.1	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	0.03	0.05
Vanadium	1	1	-	-	-	-	<30	-	<1	<1
Zinc	7	5	<5	<5	<5	<5	<5	<5	30	5
Dissolved Metals (µg/L)										
Aluminum	37	31	8	-	<5	<5	<5	7	<1	<1
Antimony	0.1	0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.05	<0.05
Arsenic	1	1	0.1	-	0.1	0.1	0.4	0.4	<1	<1
Barium	2.2	3.9	<10	-	<10	<10	<10	<10	4.0	4.0
Beryllium	0.5	0.5	<5	-	-	-	<5	<5	<0.5	<0.5
Bismuth	0.07	0.05	-	-	-	-	<100	<100	<0.5	<0.5
Boron	4	6	-	-	-	-	<100	<100	13	15
Cadmium	***0.2***	***0.2***	<0.2	-	<0.2	<0.2	<0.2	<0.2	<0.05	<0.05
Calcium	2520	2380	2740	-	1450	1470	14100	13500	11000	11800
Chromium	0.5	0.5	<1	-	<1	<1	<1	<1	-	-
Cobalt	0.08	0.09	<1	-	<1	<1	<1	<1	<0.1	<0.1
Copper	0.5	1.7	1	-	<1	<1	<1	1	<0.1	0.2
Iron	120	90	20	-	10	20	<10	<10	<1	<1
Lead	0.1	0.1	1	-	<1	<1	<1	<1	0.06	<0.05
Lithium	1	1	<10	-	-	-	<10	<10	-	-
Magnesium	1750	1720	1700	-	1010	1020	4880	4730	4900	5030
Manganese	0.2	0.5	<5	-	<5	<5	<5	<5	<0.05	<0.05
Mercury	0.05	0.05	<0.05	-	<0.05	<0.05	-	-	-	-
Molybdenum	0.1	0.1	<1	-	<1	<1	<1	<1	<0.05	<0.05
Nickel	0.7	1	<1	-	<1	<1	<1	<1	<0.1	0.1
Potassium	850	590	740	-	470	470	1490	1470	1370	1420
Selenium	1	1	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	-	-	290	-	90	90	210	200	70	70
Silver	0.01	0.01	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01
Sodium	7010	7100	4450	-	2240	2240	11300	11200	10500	10600
Strontium	14.8	14.7	14	-	14	14	91	87	55	56
Thallium	0.05	0.05	-	-	-	-	-	-	<0.05	<0.05
Tin	0.2	0.1	-	-	-	-	<30	<30	<0.1	<0.1
Titanium	2.0	0.5	-	-	-	-	<10	<10	<1	<1
Tungsten	0.1	0.1	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	<0.01	0.02
Vanadium	1	1	-	-	-	-	<30	<30	0.6	0.4
Zinc	2	1	<5	-	<5	<5	<5	<5	2.0	<1

Appendix A4. Analytical results for water quality QA/QC samples from Boston area, 1994-1998.

Parameter	Fickle Duck Outflow			Koignuk River						Reference Outflow		
	Jun-93			03-Jun-98		20-Jun-00		15-Sep-00		28-Jun-98		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 3
Physical												
Conductivity (µS/cm)	39	39	40	90	90	61	61	169	168	27	27	27
pH	6.80	6.72	6.95	6.88	6.79	7.21	7.21	7.39	7.45	***6.47***	6.69	***6.47***
Total Diss. Solids (mg/L)	31	31	32	74	74	47	46	101	101	15	15	15
Total Susp. Solids (mg/L)	-	-	-	12	14	10	14	6	5	<1	<1	<1
Turbidity (NTU)	2.3	2.4	2.4	36.3	35.5	10.4	11.5	8.5	9.8	1.9	1.8	1.9
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	13.3	13.0	13.3	22.7	22.3	16.2	26.4	36.4	36.6	10.4	10.4	10.4
Total Alkalinity	10	9	9	11	11	9	9	14	13	8	8	8
Chloride	-	-	-	14.9	15.2	9.1	9.1	35.0	33.9	3.0	3.0	3.0
Fluoride	-	-	-	0.09	0.08	0.04	0.03	0.06	0.03	0.03	0.03	0.03
Sulphate	2	3	3	4	4	2	2	9	9	<1	<1	<1
Nutrients (mg/L)												
Dissolved Phosphate	-	-	-	0.007	0.006	-	-	-	-	-	-	-
Total Phosphorus	0.013	0.016	0.016	***0.051***	***0.057***	-	-	0.014	0.014	-	-	-
Ammonia Nitrogen	0.009	0.009	0.015	0.020	0.022	0.031	0.031	0.011	0.009	-	-	-
Nitrate - nitrogen	<0.005	<0.005	<0.005	0.012	0.013	0.009	0.008	<0.005	<0.005	-	-	-
Nitrite - nitrogen	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	-	-	-
Total Organic Carbon	-	-	-	-	-	6.5	6.5	5.7	5.3	-	-	-
Total Metals (µg/L)												
Aluminum	-	-	-	***1400***	***1400***	***429***	***424***	***282***	***283***	85	78	85
Antimony	-	-	-	<0.1	<0.1	<0.05	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1
Arsenic	-	-	-	0.4	0.4	0.20	1.20	0.30	0.30	0.2	0.2	0.2
Barium	-	-	-	20	20	6.40	6.28	6.23	6.07	<10	<10	<10
Beryllium	-	-	-	<5	<5	<0.5	<0.5	<0.5	<0.5	<5	<5	<5
Bismuth	-	-	-	-	<100	<0.5	<0.5	<0.5	<0.5	-	-	-
Boron	-	-	-	-	<100	5	5	8	9	-	-	-
Cadmium	-	-	-	<0.2	<0.2	<0.05	0.06	<0.05	<0.05	<0.2	<0.2	<0.2
Calcium	3720	3630	3740	4070	4010	3450	7410	6630	6640	2830	2830	2830
Chromium	-	-	-	***3***	***3***	0.9	0.9	0.7	0.6	<1	<1	<1
Cobalt	-	-	-	<1	<1	0.3	0.4	0.2	0.2	<1	<1	<1
Copper	-	-	-	***3***	***20***	2	1.8	2	2	2	1	2
Iron	205	230	222	***1200***	***1180***	***560***	***570***	***360***	***360***	140	140	140
Lead	-	-	-	<1	<1	0.24	0.64	0.23	0.22	2	<1	2
Lithium	-	-	-	-	<10	1	1	2	2	-	-	-
Magnesium	967	956	967	3100	3000	1900	1900	4800	4900	800	800	800
Manganese	<5	<5	<5	41	41	24	25	12	11	<5	<5	<5
Mercury	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	-	-	-	<1	<1	0.06	0.09	0.09	0.11	<1	<1	<1
Nickel	-	-	-	2	2	1.1	1.3	0.9	0.8	<1	<1	<1
Potassium	-	-	-	1940	1990	-	<2000	1350	1330	340	320	340
Selenium	-	-	-	0.5	<0.5	<1	<1	<1	<1	<0.5	<0.5	<0.5
Silicon	-	-	-	3790	3850	-	-	-	-	290	290	290
Silver	-	-	-	<0.1	<0.1	0.02	0.07	<0.01	<0.01	<0.1	<0.1	<0.1
Sodium	2700	2500	2500	9000	8000	5000	6000	14900	14700	1610	1610	1610
Strontium	10	10	10	22	22	-	-	-	-	15	15	15
Thallium	-	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	<10	<10	-	70	70	-	-	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	0.05	0.06	0.05	0.05	-	-	-
Vanadium	-	-	-	-	<30	<1	<1	<1	<1	-	-	-
Zinc	<5	<5	<5	<5	<5	2	5	2	1	<5	<5	<5
Dissolved Metals (µg/L)												
Aluminum	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	-	-	-	-	-	-	-	-	-	-	-	-
Barium	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-	-	-
Boron	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-
Lithium	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	-	-	-	-	-	-	-	-	-	-	-	-
Silicon	-	-	-	-	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	-	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	-	-	-	-	-	-	-	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A4. Analytical results for water quality QA/QC samples from Boston area, 1994-1998.

Parameter	Field Blank					Travel Blank						Internal Lab QC
	Aug 94	2-Aug-95	22-Apr-98	25-Apr-98	21-Jul-98	2-Aug-95	22-Apr-98	25-Apr-98	3-Jun-98	21-Jul-98	3-Aug-98	26-Jun-98
Physical												
Conductivity (µS/cm)	1.4	1.5	-	-	<2	1.5	-	-	-	<2	<2	34
pH	-	4.4	-	-	4.74	4.4	-	-	-	5.89	5.00	6.92
Total Diss. Solids (mg/L)	4	1	-	-	<10	1	-	-	-	<10	<10	36
Total Susp. Solids (mg/L)	<1	1	-	-	2	1	-	-	-	<1	2	<1
Turbidity (NTU)	0.14	0.2	-	-	0.1	0.3	-	-	-	<0.1	<0.1	2.1
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	<1	1	-	-	<0.05	1	-	-	-	-	<0.05	13.8
Total Alkalinity	<1	1	-	-	<1	1	-	-	-	<1	<1	10
Chloride	<0.5	0.03	-	-	<0.5	0.01	-	-	-	<0.5	<0.5	3.3
Fluoride	<0.05	0.02	-	-	<0.02	0.02	-	-	-	<0.02	<0.02	0.02
Sulphate	<0.5	0.1	-	-	<1	0.1	-	-	-	<1	<1	<1
Nutrients (mg/L)												
Dissolved Phosphate	<0.002	0.002	-	-	-	0.002	-	-	-	-	-	-
Total Phosphorus	<0.002	0.002	-	-	-	0.002	-	-	-	-	-	-
Ammonia Nitrogen	<0.005	0.02	-	-	-	0.02	-	-	-	-	-	-
Nitrate - nitrogen	<0.005	0.010	-	-	-	0.005	-	-	-	-	-	-
Nitrite - nitrogen	<0.001	0.001	-	-	-	0.001	-	-	-	-	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)												
Aluminum	4	4	7	110	<5	3	10	<5	<6	-	<5	72
Antimony	<0.2	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1
Arsenic	1	1	<0.1	<0.1	<0.1	1	<0.1	<0.1	<0.1	-	<0.1	<0.1
Barium	<0.03	60	<10	<10	<10	0.1	<10	<10	<10	-	<10	<10
Beryllium	<0.5	0.5	<5	<5	<5	0.5	<5	<5	<5	-	<5	<5
Bismuth	<0.03	0.05	<100	<100	<100	0.05	<100	<100	<100	-	<100	<100
Boron	11.2	1	<100	<100	<100	1	<100	<100	<100	-	<100	<100
Cadmium	0.07	0.2	<0.2	<0.3	<0.2	0.2	<0.2	<0.3	<0.2	-	<0.2	<0.2
Calcium	<10	20	1070	550	<50	30	750	<50	<50	-	<50	3940
Chromium	0.53	0.5	<1	<1	<1	0.5	<1	<1	<1	-	<1	<1
Cobalt	0.08	0.08	<1	<1	<1	0.08	<1	<1	<1	-	<1	<1
Copper	0.98	2.9	<1	<1	<1	0.5	<1	<1	<1	-	<1	1
Iron	<10	30	<10	<10	<10	30	<10	<10	<10	-	<10	240
Lead	<0.06	0.2	<1	<1	<1	0.1	<1	<1	<1	-	<1	<1
Lithium	21.8	1	<10	<10	<10	1	<10	<10	<10	-	<10	<10
Magnesium	2.2	1.1	<100	<100	<100	1.2	<100	<100	<100	-	<100	1000
Manganese	<0.10	0.2	<5	<5	<5	0.2	<5	<5	<5	-	<5	<5
Mercury	<0.05	0.05	<0.05	<0.06	<0.05	0.05	<0.05	<0.06	<0.05	-	<0.05	<0.05
Molybdenum	<0.16	0.1	<1	<1	<1	0.1	<1	<1	<1	-	<1	<1
Nickel	0.3	1	<1	<1	<1	1	<1	<1	<1	-	<1	<1
Potassium	<50	50	<10	40	<10	100	20	<1	20	-	10	270
Selenium	<1	1	1	<0.5	<0.6	1	<0.5	<0.5	<0.6	-	<0.5	<0.5
Silicon	-	-	<50	<51	<52	-	<50	<50	<51	-	<50	470
Silver	<0.01	0.01	<0.1	<0.1	<0.1	0.01	<0.1	<0.1	<0.2	-	<0.1	<0.1
Sodium	50	30	30	200	<10	20	60	20	<10	-	<10	1730
Strontium	<0.06	0.2000	<5	<5	<5	0.1000	<5	<5	<5	-	<5	23
Thallium	<0.03	0.05	<200	<200	<200	0.05	<200	<200	<200	-	<200	<200
Tin	<0.09	0.1	<30	<30	<30	0.2	<30	<30	<30	-	<30	<30
Titanium	<0.5	0.5	<10	<10	<10	0.5	<10	<10	<10	-	<10	<10
Tungsten	<0.07	0.1	-	-	-	0.1	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<1	1	<30	<30	<30	1	<30	<30	<30	-	<30	<30
Zinc	<1.00	3	<5	<5	<5	5	<5	<5	<5	-	<5	<5
Dissolved Metals (µg/L)												
Aluminum	<1	4	-	-	-	1	-	-	-	-	-	-
Antimony	<0.2	0.1	-	-	-	0.1	-	-	-	-	-	-
Arsenic	<1	1	-	-	-	1	-	-	-	-	-	-
Barium	<0.03	0.1	-	-	-	0.1	-	-	-	-	-	-
Beryllium	<0.5	0.5	-	-	-	0.5	-	-	-	-	-	-
Bismuth	<0.03	0.05	-	-	-	0.05	-	-	-	-	-	-
Boron	<1.2	1	-	-	-	1	-	-	-	-	-	-
Cadmium	<0.07	0.2	-	-	-	0.2	-	-	-	-	-	-
Calcium	<10	10	-	-	-	10	-	-	-	-	-	-
Chromium	<0.3	0.5	-	-	-	0.5	-	-	-	-	-	-
Cobalt	<0.06	0.08	-	-	-	0.08	-	-	-	-	-	-
Copper	<0.4	0.5	-	-	-	0.5	-	-	-	-	-	-
Iron	<10	10	-	-	-	30	-	-	-	-	-	-
Lead	<0.06	0.05	-	-	-	0.05	-	-	-	-	-	-
Lithium	<5	1	-	-	-	1	-	-	-	-	-	-
Magnesium	<0.37	1.1	-	-	-	1	-	-	-	-	-	-
Manganese	<0.1	0.2	-	-	-	0.2	-	-	-	-	-	-
Mercury	<0.05	0.05	-	-	-	0.05	-	-	-	-	-	-
Molybdenum	<0.16	0.1	-	-	-	0.1	-	-	-	-	-	-
Nickel	<.3	0.5	-	-	-	0.5	-	-	-	-	-	-
Potassium	<50	50	-	-	-	50	-	-	-	-	-	-
Selenium	<1	1	-	-	-	1	-	-	-	-	-	-
Silicon	-	-	-	-	-	-	-	-	-	-	-	-
Silver	<0.01	0.01	-	-	-	0.01	-	-	-	-	-	-
Sodium	<10	10	-	-	-	10	-	-	-	-	-	-
Strontium	<0.06	0.2	-	-	-	0.1	-	-	-	-	-	-
Thallium	<0.03	0.05	-	-	-	0.05	-	-	-	-	-	-
Tin	<0.09	0.1	-	-	-	0.1	-	-	-	-	-	-
Titanium	<0.5	0.5	-	-	-	0.5	-	-	-	-	-	-
Tungsten	<0.07	0.1	-	-	-	0.1	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<1	1	-	-	-	1	-	-	-	-	-	-
Zinc	<1	1	-	-	-	1	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake											
	WQ3 Jun-93 surface	WQ4 Jun 93 surface	WQ5 Jun 93 surface	WQ6 Jun 93 surface	Station 3 23-Apr-96 3 m	Station 4 23-Apr-96 2 m	Station 4 23-Apr-96 8 m	Station 4 23-Apr-96 14 m	Station 4 23-Apr-96 21 m	Station 5 23-Apr-96 2.5 m	Station 4 19-Apr-97 1 m	Station 6 20-Apr-97 1 m
Physical												
Conductivity (µS/cm)	38	37	44	41	66	53	49	47	44	57	63	65
pH	6.65	6.90	6.68	6.60	***6.47***	***6.36***	***6.17***	***6.43***	***6.20***	6.52	6.91	6.86
Total Diss. Solids (mg/L)	31	29	35	32	38	41	29	24	20	26	42	42
Total Susp. Solids (mg/L)	-	-	-	-	<1	<1	<1	<1	<1	22	<1	<1
Turbidity (NTU)	2.5	3.2	4.0	5.2	0.5	0.6	0.3	0.3	0.3	18.4	3.1	0.9
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	12.7	8.5	10.6	9.9	15.2	12.2	11.0	10.5	9.9	12.5	15.2	14.8
Total Alkalinity	8.6	4.7	6.2	5.0	-	9.1	8.4	7.9	7.3	9.2	11.0	12.0
Chloride	-	-	-	-	-	8.8	8.0	7.8	7.2	9.7	10.5	11.1
Fluoride	-	-	-	-	-	0.04	0.04	0.03	0.03	0.04	0.03	0.04
Sulphate	3.2	1.3	1.3	1.0	-	1.9	1.5	1.9	1.5	1.4	3.0	3.0
Nutrients (mg/L)												
Dissolved Phosphorus	-	-	-	-	-	0.004	<0.001	0.004	0.005	0.013	-	-
Total Phosphorus	0.016	0.015	0.018	0.023	-	0.013	0.005	0.007	0.007	***0.069***	0.007	0.010
Ammonia Nitrogen	0.007	0.011	0.024	0.016	-	0.007	<0.005	0.019	0.015	0.035	-	-
Nitrate - nitrogen	<0.005	0.028	0.028	0.030	-	0.013	0.019	0.031	0.082	0.038	-	-
Nitrite - nitrogen	<0.001	<0.001	<0.001	<0.001	-	0.001	0.001	0.001	0.001	0.006	-	-
Total Metals (µg/L)												
Aluminium	-	-	-	-	13	15	11	10	13	118	48	31
Antimony	-	-	-	-	<0.05	0.06	<0.05	<0.05	<0.05	0.30	<0.1	0.10
Arsenic	-	-	-	-	0.4	0.4	0.3	0.3	0.2	0.4	0.1	0.2
Barium	<10	-	-	-	2.94	2.94	1.87	1.81	1.66	4.59	-	-
Beryllium	<5	<5	<5	<5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5	<5
Bismuth	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-
Boron	-	-	-	-	7.0	5.0	5.0	5.0	4.0	6.0	-	-
Cadmium	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	***0.40***	***0.90***
Calcium	3460	1500	1990	1770	3210	2520	2220	2080	2080	2620	2950	3010
Chromium	-	-	-	-	0.6	0.6	0.6	0.4	0.2	0.7	<1	<1
Cobalt	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.10	<1	<1
Copper	-	<10	<10	<10	***2.3***	***7.5***	***2.1***	1.6	1.3	***4.7***	***3.0***	2.0
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-
Iron	249	***399***	***629***	***601***	30	20	10	<10	10	150	70	50
Lead	-	-	-	-	0.20	***1.33***	0.73	0.08	<0.05	0.34	<1	<1
Lithium	-	<15	<15	<15	1	<1	<1	<1	<1	<1	<10	<10
Magnesium	992	1150	1370	1330	1830	1470	1320	1260	1190	1560	1810	1850
Manganese	7.0	28.0	49.0	39.0	3.0	1.6	1.5	1.5	3.2	10.1	<5	<5
Mercury	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Molybdenum	-	-	-	-	0.08	0.14	0.08	<0.05	<0.05	0.08	<1	<1
Nickel	-	-	-	-	0.8	0.8	0.6	0.6	0.5	2.1	<1	<1
Potassium	-	-	-	-	1040	830	750	700	660	910	1080	1130
Selenium	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	-	-	-	-	240	160	160	220	420	400	350	320
Silver	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1
Sodium	2700	3500	4200	3900	6150	5010	3720	3570	3400	5160	5480	5620
Strontium	10.0	10.0	10.0	10.0	16.1	12.9	11.8	11.0	10.6	13.4	16.0	18.0
Thallium	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-
Tin	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-
Titanium	<10	<10	<10	<10	<1	<0.01	<0.01	<0.01	<0.01	<1	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	0.03	0.02	0.02	0.02	0.02	0.03	-	-
Vanadium	-	-	-	-	0.3	0.3	0.3	0.3	0.2	0.6	-	-
Zinc	<5	<5	<5	<5	2.0	14.0	5.0	<1	<1	5.0	11.0	9.0
Dissolved Metals (µg/L)												
Aluminium	-	-	-	-	8	8	7	6	9	14	14	15
Antimony	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.1
Arsenic	-	-	-	-	0.4	0.3	0.3	0.3	0.4	0.4	0.1	0.1
Barium	-	-	-	-	2.84	2.43	1.78	1.56	1.68	3.17	<10	<10
Beryllium	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<5	<5
Bismuth	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<100	<100
Boron	-	-	-	-	7.0	6.0	5.0	5.0	4.0	6.0	<100	<100
Cadmium	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	***0.50***	***0.80***
Calcium	-	-	-	-	3110	2480	2220	2080	1980	2520	3040	2950
Chromium	-	-	-	-	0.4	0.8	0.6	0.3	0.5	0.4	<1	<1
Cobalt	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<1
Copper	-	-	-	-	***2.3***	***8.0***	***3.0***	***2.1***	***2.5***	***4.2***	2.0	2.0
Iron	-	-	-	-	<0.01	<10	<10	<10	<10	40	20	20
Lead	-	-	-	-	0.07	0.83	0.18	0.08	0.07	0.07	<1	<1
Lithium	-	-	-	-	1	<1	<1	<1	<1	<1	<10	<10
Magnesium	-	-	-	-	1800	1450	1330	1290	1190	1520	1850	1810
Manganese	-	-	-	-	0.8	0.8	0.5	0.6	2.2	5.5	<5	<5
Mercury	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
Molybdenum	-	-	-	-	0.08	0.15	0.15	0.09	0.10	0.17	<1	<1
Nickel	-	-	-	-	0.8	1.2	1.0	0.9	1.0	1.0	<1	<1
Potassium	-	-	-	-	1030	840	750	720	670	870	1050	1060
Selenium	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5	<0.5
Silicon	-	-	-	-	230	150	150	180	370	180	320	290
Silver	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1
Sodium	-	-	-	-	5940	4140	3650	3560	3380	5040	5620	5630
Strontium	-	-	-	-	16.1	13.1	11.9	11.3	10.6	13.4	17.0	16.0
Thallium	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<100	<100
Tin	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<30	<30
Titanium	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	-	-
Vanadium	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<30	<30
Zinc	-	-	-	-	2.0	13.0	5.0	<1	1.0	2.0	12.0	10.0
Field WQ												
Temperature (°C)	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake											
	Station 4 22-Apr-98 3 m	**Station 6** 22-Apr-98 3 m	**Station 6** 22-Apr-98 10 m	**Station 6** 22-Apr-98 20 m	**Station 6** 22-Apr-98 25 m	**WQ3** Aug-92 surface	**WQ3** Aug-93 surface	**WQ4** Aug-93 surface	**WQ5** Aug-93 surface	**WQ5** Aug-93 8 m	**WQ5** Aug-93 16 m	**WQ6** Aug-93 surface
Physical												
Conductivity (µS/cm)	64	56	58	57	58	33	79	35	35	36	36	35
pH	6.85	6.72	6.77	6.74	6.59	6.64	7.14	7.27	7.36	7.31	7.54	7.58
Total Diss. Solids (mg/L)	46	40	38	39	42	26	50	24	25	23	24	23
Total Susp. Solids (mg/L)	2	<1	<1	<1	<1	-	-	1	1	<1	<1	7
Turbidity (NTU)	0.7	0.9	0.8	0.5	0.6	1.2	5.4	1.9	1.1	1.0	1.1	5.4
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	16.1	14.4	14.1	14.2	14.0	9.5	27.7	8.7	8.8	8.6	8.6	8.9
Total Alkalinity	10.0	8.0	9.0	9.0	9.0	5.3	21.3	6.4	6.2	6.4	6.2	6.3
Chloride	11.5	9.8	9.8	9.9	10.1	-	10.2	5.5	5.6	5.5	5.7	5.4
Fluoride	0.07	0.04	0.04	0.03	0.03	-	0.03	0.02	0.02	0.02	0.02	0.02
Sulphate	3.0	2.0	2.0	2.0	2.0	<1	<1	1.3	1.4	2.0	1.6	1.1
Nutrients (mg/L)												
Dissolved Phosphorus	<0.001	0.001	<0.001	0.003	0.006	-	0.009	0.006	0.005	0.005	0.006	0.011
Total Phosphorus	0.007	0.002	<0.001	0.005	0.007	-	0.014	0.007	0.007	0.007	0.008	0.014
Ammonia Nitrogen	<0.005	<0.005	<0.005	0.006	<0.005	-	0.026	0.012	0.007	0.009	0.008	0.017
Nitrate - nitrogen	0.047	0.051	0.061	0.091	0.120	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrite - nitrogen	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Total Metals (µg/L)												
Aluminium	19	28	18	22	27	-	-	38	29	33	31	***184***
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.2	0.2	0.2	0.1	0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1
Barium	-	-	-	-	-	<10	-	-	-	-	-	-
Beryllium	<5	<5	<5	<5	<5	<5	-	<5	<5	<5	<5	<5
Bismuth	-	-	-	-	-	-	-	-	-	-	-	-
Boron	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	***0.40***	-	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium	3230	2900	3080	2900	2820	2110	-	1750	1780	1760	1750	1850
Chromium	***4.0***	***10.0***	***3.0***	<1	<1	-	-	<1	<1	<1	<1	<1
Cobalt	<1	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1
Copper	***14***	***13***	***4***	2	1	***8***	-	***20***	1.0	0.5	0.5	0.5
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-
Iron	50	90	50	40	40	116	-	93	71	71	74	***361***
Lead	<1	***3.00***	<1	<1	<1	***2.00***	-	<1	<1	<1	<1	<1
Lithium	<10	<10	<10	<10	<10	-	-	-	-	-	-	-
Magnesium	2000	1800	1800	1800	1800	1030	-	1050	1050	1040	1050	1100
Manganese	<5	<5	<5	7.0	13.0	7.0	-	<5	<5	6.0	<5	18.0
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	0.02	<0.01	<0.01	0.01	***0.03***
Molybdenum	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1
Nickel	8.0	12.0	4.0	1.0	1.0	-	-	<1	<1	<1	<1	<1
Potassium	940	880	820	830	800	-	-	-	-	-	-	-
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	270	280	320	540	680	288	-	-	-	-	-	-
Silver	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium	6000	6000	6000	5000	6000	4800	-	-	-	-	-	-
Strontium	17.0	15.0	15.0	15.0	15.0	6.0	-	-	-	-	-	-
Thallium	-	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	<10	<10	<10	<10	<10	-	-	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	16.0	14.0	7.0	<5	<5	18.0	-	<5	<5	<5	8.0	<5
Dissolved Metals (µg/L)												
Aluminium	-	15	12	13	15	-	-	12	13	13	12	12
Antimony	-	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	-	0.1	0.1	0.1	0.1	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Barium	-	<10	<10	<10	<10	-	-	<10	<10	<10	<10	<10
Beryllium	-	<5	<5	<5	<5	-	-	<5	<5	<5	<5	<5
Bismuth	-	<100	<100	<100	<100	-	-	-	-	-	-	-
Boron	-	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100
Cadmium	-	<0.2	<0.2	<0.2	<0.2	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium	-	2860	2800	2830	2750	-	-	1740	1780	1740	1730	1840
Chromium	-	***6.0***	***2.0***	<1	<1	-	-	<1	<1	<1	<1	<1
Cobalt	-	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1
Copper	-	***10.0***	***4.0***	1.0	1.0	-	-	<0.5	1.0	<0.5	<0.5	<0.5
Iron	-	60	30	20	20	-	-	<30	<30	<30	<30	<30
Lead	-	***2.00***	<1	<1	<1	-	-	<1	<1	<1	<1	<1
Lithium	-	<10	<10	<10	<10	-	-	-	-	-	-	-
Magnesium	-	1800	1700	1700	1700	-	-	1040	1050	1030	1030	1050
Manganese	-	<5	<5	7.0	13.0	-	-	<5	<5	<5	<5	<5
Mercury	-	<0.05	<0.05	<0.05	<0.05	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	-	<1	<1	<1	<1	-	-	<1	<1	<1	<1	<1
Nickel	-	11.0	4.0	<1	1.0	-	-	<1	<1	<1	<1	<1
Potassium	-	860	820	800	780	-	-	-	-	-	-	-
Selenium	-	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	-	250	290	510	610	-	-	-	-	-	-	-
Silver	-	<0.1	<0.1	<0.1	<0.1	-	-	<0.05	<0.05	<0.05	<0.05	-
Sodium	-	5000	5000	5000	5000	-	-	-	-	-	-	-
Strontium	-	14.0	14.0	15.0	14.0	-	-	-	-	-	-	-
Thallium	-	<200	<200	<200	<200	-	-	-	-	-	-	-
Tin	-	<30	<30	<30	<30	-	-	-	-	-	-	-
Titanium	-	<10	<10	<10	<10	-	-	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	<30	<30	<30	<30	-	-	<5	<5	<5	<5	<5
Zinc	-	10.0	<5	<5	<5	-	-	<5	<5	<5	6.0	<5
Field WQ												
Temperature (°C)	-	-	-	-	-	-	-	12.4	12.5	-	-	14.0
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	10.9	10.8	-	-	11.4
pH	-	-	-	-	-	-	-	7.4	7.4	-	-	7.6
Secchi (m)	-	-	-	-	-	-	-	2.0	3.5	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake											
	WQ3 Aug-94 surface	**WQ4** Aug 94 surface	**WQ5** Aug 94 surface	**WQ5** Aug 94 5 m	**WQ5** Aug 94 11 m	**WQ6** Aug 94 surface	**WQ3** 31-Jul-95 ? m	**WQ6** 31-Jul-95 surface	**WQ4** 2-Aug-95 surface	**WQ4** 2-Aug-95 5 m	**WQ5** 2-Aug-95 surface	**WQ5** 2-Aug-95 5 m
Physical												
Conductivity (µS/cm)	320	36	36	35	35	34	130	33	33	32	33	33
pH	8.20	6.60	***6.10***	-	-	8.10	***6.00***	***5.70***	***5.90***	***5.90***	***5.70***	***5.70***
Total Diss. Solids (mg/L)	350	35	40	22	33	29	91	65	34	29	43	34
Total Susp. Solids (mg/L)	4	4	1	9	4	13	5	1	1	1	1	3
Turbidity (NTU)	2.5	3.0	2.7	2.6	3.0	3.3	2.3	2.4	1.3	1.3	1.1	1.1
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	110.0	7.0	9.0	10.0	8.0	9.0	35.0	8.0	8.0	8.0	8.0	8.0
Total Alkalinity	10.0	7.0	6.0	7.0	7.0	8.0	18.0	4.0	4.0	4.0	4.0	4.0
Chloride	98.0	9.5	10.0	9.5	9.5	9.5	27.5	5.6	5.5	5.5	5.7	5.8
Fluoride	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04
Sulphate	1.8	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	0.9	0.9	0.9	0.9	0.9
Nutrients (mg/L)												
Dissolved Phosphorus	0.004	0.008	0.008	0.006	0.004	0.004	0.002	0.002	0.002	0.004	0.002	0.002
Total Phosphorus	0.016	0.020	0.018	0.018	0.018	0.020	0.018	0.006	0.010	0.010	0.008	0.006
Ammonia Nitrogen	0.013	0.009	0.012	0.009	0.011	0.013	0.120	0.020	0.120	0.140	0.080	0.140
Nitrate - nitrogen	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.005	0.005	0.005	0.005	0.005
Nitrite - nitrogen	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001	0.001
Total Metals (µg/L)												
Aluminium	71	44	51	62	42	88	93	55	39	36	36	31
Antimony	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.10	0.10	0.10	0.10	0.10	0.10
Arsenic	<1	<1	<1	<1	2.0	<1	1.0	1.0	1.0	1.0	1.0	1.0
Barium	22.10	1.18	1.27	1.16	1.08	1.97	4.03	2.32	1.54	1.57	1.69	1.56
Beryllium	<0.5	0.92	0.95	<0.5	<0.5	2.72	0.50	<0.5	<0.5	<0.5	<0.5	<0.5
Bismuth	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.10	0.05	0.07	0.05	0.05	0.05
Boron	34.3	<1.2	4.3	7.5	<1.2	28.2	11.0	1.0	4.0	3.0	1.0	1.0
Cadmium	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.2	***0.20***	***0.20***	***0.20***	***0.20***	***0.20***
Calcium	41900	2110	2540	2170	1980	2980	10200	1590	1760	1720	1720	1930
Chromium	0.6	0.7	0.6	0.5	0.6	***1.7***	***1.7***	0.5	0.5	0.5	0.5	***1.3***
Cobalt	0.31	0.24	0.18	0.09	0.11	0.25	0.27	0.08	0.11	0.08	0.11	0.08
Copper	1.7	1.1	2.0	2.0	1.1	***10.7***	1.8	0.5	0.5	0.5	0.5	0.7
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-
Iron	80	80	80	80	70	227	***340***	140	110	110	100	100
Lead	0.12	0.19	0.32	0.35	0.15	0.39	0.10	0.60	0.70	***10.20***	0.90	***3.70***
Lithium	8	<5	<5	<5	<5	65	1	1	1	1	1	1
Magnesium	8090	1490	1570	1570	1380	2100	3910	997	1060	1090	1020	1060
Manganese	5.3	3.0	3.4	2.6	3.3	5.7	1.7	4.9	4.1	4.2	4.2	4.5
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	<0.16	<0.16	<0.16	<0.16	<0.16	0.27	0.20	0.10	0.10	0.10	0.10	0.30
Nickel	1.3	0.8	1.3	1.6	0.4	0.5	2.3	1.2	1.1	1.0	1.0	1.3
Potassium	2930	1080	1160	1160	975	1590	1300	500	600	640	600	700
Selenium	<1	<1	<1	<1	<1	***5.0***	1.0	1.0	1.0	1.0	1.0	1.0
Silicon	-	-	-	-	-	-	-	-	-	-	-	-
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sodium	11400	4710	4760	4730	4120	6710	10800	3090	3190	3160	3170	3250
Strontium	362.0	7.4	7.2	6.8	6.3	10.1	43.6	8.3	9.1	8.9	8.9	8.7
Thallium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	<0.09	0.17	<0.09	<0.09	<0.09	<0.09	0.20	0.10	0.10	0.10	0.10	0.10
Titanium	5.24	5.14	2.41	2.90	1.28	5.08	2.80	0.50	0.50	0.50	0.50	1.00
Tungsten	0.11	0.09	<0.07	0.16	0.20	0.15	0.10	0.10	0.10	0.10	0.10	0.10
Uranium	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<1	<1	<1	<1	<1	<1	1.0	1.0	1.0	1.0	1.0	1.0
Zinc	1.9	1.3	18.6	<1	2.2	5.4	3.0	1.0	1.0	2.0	2.0	6.0
Dissolved Metals (µg/L)												
Aluminium	<1	3	3	4	3	4	7	30	11	10	8	10
Antimony	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.10	0.10	0.10	0.10	0.10	0.10
Arsenic	<1	<1	<1	<1	<1	<1	1.0	1.0	1.0	1.0	1.0	1.0
Barium	21.00	0.91	1.05	1.15	0.96	0.93	2.90	1.33	1.37	1.57	1.58	1.56
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.50	0.50	0.50	0.50	0.50
Bismuth	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	0.05	0.05	0.05	0.05	0.05
Boron	1.3	<1.2	<1.2	<1.2	<1.2	<1.2	3.0	1.0	2.0	1.0	1.0	1.0
Cadmium	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	***0.20***	***0.20***	***0.20***	***0.20***	***0.20***	***0.20***
Calcium	34500	1490	1760	1940	1630	1820	8820	1460	1680	1590	1680	1620
Chromium	0.4	<0.3	<0.3	<0.3	<0.3	<0.3	***1.1***	0.5	0.5	0.5	0.5	0.5
Cobalt	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.08	0.08	0.08	0.08	0.10	0.08
Copper	0.6	<0.4	0.6	0.5	<0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Iron	<10	<10	10	10	<10	10	40	20	30	30	30	30
Lead	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.10	0.10	0.10	0.10	0.10	0.10
Lithium	8	<5	<5	<5	<5	<5	1	1	1	1	1	1
Magnesium	6030	912	1080	1180	993	1120	3260	990	993	968	991	955
Manganese	0.7	0.2	0.3	0.5	0.3	0.2	0.2	1.8	0.2	0.2	0.2	0.2
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***
Molybdenum	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	0.10	0.10	0.10	0.10	0.10	0.10
Nickel	0.3	0.5	0.3	1.0	0.4	<0.3	0.8	0.8	0.5	1.0	0.8	0.9
Potassium	2260	636	793	893	714	838	830	460	600	540	600	550
Selenium	<1	<1	<1	<1	<1	<1	1.0	1.0	1.0	1.0	1.0	1.0
Silicon	-	-	-	-	-	-	-	-	-	-	-	-
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sodium	7940	2460	3050	3430	2810	3260	9130	2810	2980	2890	3050	2950
Strontium	359.0	6.1	7.1	6.8	6.2	7.8	39.5	8.2	9.0	8.6	8.8	8.7
Thallium	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	0.05	0.05	0.05	0.05	0.05
Tin	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	0.1	0.1	0.1	0.1	0.1	0.1
Titanium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1	0.5	0.5	0.5	0.5	0.5
Tungsten	0.08	<0.07	<0.07	<0.07	<0.07	0.08	0.10	0.10	0.10	0.10	0.10	0.10
Uranium	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<1	<1	<1	<1	<1	<1	1.0	1.0	1.0	1.0	1.0	1.0
Zinc	<1	<1	1.9	<1	1.1	<1	1.0	1.0	1.0	1.0	1.0	1.0
Field WQ												
Temperature (°C)	11.0	10.0	8.3	8.2	8.2	10.0	7.4	8.5	8.9	-	8.8	-
Dissolved Oxygen (mg/L)	14.2	13.0	13.0	13.0	13.0	12.8	9.0	12.2	11.8	-	11.4	-
pH	8.2	6.6	6.1	-	-	8.1	7.5	6.4	7.3	-	6.9	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	0.72	0.54	-	-	0.48	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake											
	WQ5 2-Aug-95 9 m	WQ9 2-Aug-95 surface	WQ9 2-Aug-95 5 m	WQ9 2-Aug-95 10 m	WQ9 2-Aug-95 15 m	WQ9 2-Aug-95 20 m	Station 2 05-Aug-96 surface	Station 3 05-Aug-96 surface	Station 4 04-Aug-96 surface	Station 4 04-Aug-96 4 m	Station 4 04-Aug-96 8 m	Station 5 05-Aug-96 0.5 m
Physical												
Conductivity (µS/cm)	34	35	33	34	34	36	40	38	40	40	40	40
pH	***5.70***	***5.90***	***5.90***	***5.90***	***5.70***	***5.70***	6.80	6.80	6.90	6.90	6.80	6.90
Total Diss. Solids (mg/L)	33	15	18	21	47	27	47	51	40	45	88	127
Total Susp. Solids (mg/L)	2	1	1	1	2	1	2	4	3	<1	5	1
Turbidity (NTU)	1.6	1.3	1.3	1.3	1.2	1.2	0.4	0.8	0.6	1.0	0.6	1.0
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	8.0	8.0	8.0	8.0	9.0	9.0	8.0	8.0	7.0	7.0	8.0	7.0
Total Alkalinity	4.0	4.0	4.0	4.0	4.0	4.0	9.0	8.0	8.0	7.0	7.0	8.0
Chloride	5.8	5.9	5.9	5.9	5.9	7.0	5.9	5.8	5.8	5.8	5.8	5.8
Fluoride	0.04	0.04	0.04	0.04	0.04	0.04	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sulphate	0.9	0.9	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Nutrients (mg/L)												
Dissolved Phosphorus	0.002	0.002	0.002	0.002	0.004	0.002	0.002	0.001	0.003	0.003	0.003	0.007
Total Phosphorus	0.012	0.008	0.008	0.006	0.010	0.010	0.005	0.007	0.006	0.004	0.006	0.002
Ammonia Nitrogen	0.060	0.020	0.020	0.020	0.020	0.020	<0.02	<0.02	<0.02	0.040	<0.02	0.040
Nitrate - nitrogen	0.005	0.011	0.005	0.005	0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrite - nitrogen	0.001	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Metals (µg/L)												
Aluminium	32	36	35	32	38	42	15	10	7	9	10	11
Antimony	0.10	0.10	0.10	0.10	0.10	0.20	0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic	1.0	1.0	1.0	1.0	1.0	1.0	1.0	<1	<1	1.0	2.0	2.0
Barium	1.70	1.63	1.62	1.58	1.79	1.85	1.80	1.90	2.16	2.26	2.18	1.75
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bismuth	0.05	0.06	0.05	0.05	0.05	0.05	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	1.0	4.0	1.0	4.0	5.0	2.0	4.0	3.0	3.0	4.0	4.0	4.0
Cadmium	***0.20***	***0.20***	***0.20***	***0.20***	***0.20***	***0.20***	<0.05	<0.05	***0.07***	***0.05***	<0.05	***0.10***
Calcium	1600	1650	1720	1700	1840	1780	1820	1960	1490	1340	1460	1880
Chromium	0.6	0.5	0.5	0.8	0.5	0.9	0.8	<0.1	0.6	0.7	0.6	0.8
Cobalt	0.19	0.08	0.08	0.08	0.08	0.18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	0.5	0.5	0.5	0.7	0.5	1.3	0.5	0.4	1.6	0.5	0.6	0.4
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-
Iron	100	100	110	110	110	120	<10	<10	<10	<10	<10	<10
Lead	0.70	0.40	***1.70***	1.00	0.10	0.10	0.06	0.06	0.18	0.14	<0.05	<0.05
Lithium	1	1	1	1	1	3	<1	<1	<1	<1	<1	<1
Magnesium	993	1010	1060	1030	1220	1120	988	998	886	869	969	1010
Manganese	4.1	4.1	4.9	4.9	4.4	5.0	0.5	0.4	0.3	0.6	0.3	0.5
Mercury	<0.05	<0.05	***0.10***	<0.05	<0.05	<0.05	-	-	-	-	-	-
Molybdenum	0.20	0.20	0.10	0.10	0.10	0.10	<0.05	<0.05	0.06	<0.05	<0.05	<0.05
Nickel	1.0	1.6	0.8	1.0	1.9	1.3	0.2	0.4	1.2	0.4	0.5	0.3
Potassium	580	510	760	780	790	870	550	600	660	540	510	530
Selenium	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-
Silicon	-	-	-	-	-	-	290	240	200	240	230	280
Silver	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01
Sodium	3110	3290	3280	3270	3440	3790	3220	3260	2860	2720	3190	3190
Strontium	8.3	8.8	8.9	8.9	9.3	9.1	9.7	9.6	9.7	9.5	9.7	9.6
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	0.10	0.20	0.10	0.10	0.10	0.10	0.30	<0.1	0.10	<0.1	0.10	0.40
Titanium	0.60	0.50	0.70	1.10	0.50	1.60	<1	<1	<1	<1	<1	<1
Tungsten	0.10	0.10	0.10	0.10	0.10	0.20	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	0.01	0.01	0.01	<0.01	<0.01	<0.01
Vanadium	1.0	1.0	1.0	1.0	1.0	1.0	<1	<1	<1	<1	<1	<1
Zinc	1.0	1.0	1.0	3.0	23.0	3.0	<1	11.0	3.0	1.0	<1	7.0
Dissolved Metals (µg/L)												
Aluminium	9	13	15	10	9	9	1	9	<1	1	2	1
Antimony	0.10	0.10	0.10	0.10	0.10	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic	1.0	1.0	1.0	1.0	1.0	1.0	<1	<1	<1	<1	<1	<1
Barium	1.36	1.57	1.50	1.57	1.69	1.57	1.67	1.56	1.52	2.26	2.12	1.70
Beryllium	0.50	0.50	0.50	0.50	0.50	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bismuth	0.05	0.05	0.05	0.05	0.05	0.05	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	1.0	4.0	1.0	4.0	5.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Cadmium	***0.20***	***0.20***	***0.20***	***0.20***	***0.20***	***0.20***	<0.05	<0.05	<0.05	<0.05	<0.05	***0.06***
Calcium	1490	1650	1510	1700	1810	1770	1740	1650	1340	1250	1430	1390
Chromium	0.5	0.5	0.5	0.5	0.5	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	0.08	0.08	0.08	0.08	0.08	0.16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	0.5	0.5	0.5	0.6	0.5	1.0	0.5	0.4	0.3	0.4	0.5	0.4
Iron	20	50	50	60	70	70	<10	<1	<10	<10	<10	<1
Lead	0.10	0.10	0.10	0.10	0.10	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium	1	1	1	1	1	3	<1	<1	<1	<1	<1	<1
Magnesium	944	1010	975	1020	1120	1040	909	914	867	843	873	899
Manganese	0.2	0.2	0.2	0.2	0.2	0.3	0.5	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	-	-	-	-	-	-
Molybdenum	0.10	0.10	0.10	0.10	0.10	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	0.5	1.6	0.7	0.8	1.8	1.1	0.1	0.3	0.2	0.4	0.3	0.1
Potassium	470	500	720	740	790	810	540	490	510	490	510	510
Selenium	1.0	1.0	1.0	1.0	1.0	1.0			-	-	-	
Silicon	-	-	-	-	-	-	180	230	190	220	230	210
Silver	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	2910	3210	3090	3200	3180	3460	2840	2830	2720	2610	2720	2700
Strontium	8.3	8.6	8.2	8.8	9.0	8.6	9.7	9.5	9.7	9.4	9.5	9.5
Thallium	0.05	0.05	0.05	0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	0.1	0.1	0.1	0.1	0.1	0.1	0.3	<0.1	0.1	<0.1	0.1	0.4
Titanium	0.5	0.5	0.7	0.5	0.5	1.0	<1	<1	<1	<1	<1	<1
Tungsten	0.10	0.10	0.10	0.10	0.10	0.10	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	1.0	1.0	1.0	1.0	1.0	1.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	1.0	1.0	1.0	3.0	4.0	2.0	<1	<1	3.0	<1	<1	5.0
Field WQ												
Temperature (°C)	-	11.8	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	8.6	-	-	-	-	-	-	-	-	-	-
pH	-	7.1	-	-	-	-	-	-	-	-	-	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake											
	Station 5 05-Aug-96 1 m	**Station 5** 05-Aug-96 2 m	**Station 6** 05-Aug-96 surface	**Station 6** 05-Aug-96 5 m	**Station 6** 05-Aug-96 10 m	**Station 6** 05-Aug-96 15 m	**Station 6** 05-Aug-96 20 m	**Station 1** 23-Aug-96 2 m	**Station 2** 23-Aug-96 surface	**Station 3** 23-Aug-96 1 m	**Station 3** 23-Aug-96 6 m	**Station 3** 23-Aug-96 12 m
Physical												
Conductivity (µS/cm)	39	40	40	40	39	40	-	78	80	95	94	93
pH	6.90	6.80	6.80	6.80	6.80	6.80	-	6.90	7.20	7.20	7.30	7.30
Total Diss. Solids (mg/L)	52	80	59	81	56	42	-	37	23	28	13	27
Total Susp. Solids (mg/L)	2	1	2	1	1	<1	-	10	6	2	1	2
Turbidity (NTU)	0.8	0.8	0.8	0.3	0.3	0.8	-	9.0	7.0	2.6	3.2	2.8
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	7.0	8.0	7.0	8.0	7.0	6.0	-	12.0	9.0	8.0	8.0	8.0
Total Alkalinity	8.0	7.0	7.0	7.0	8.0	8.0	-	10.0	8.0	8.0	8.0	8.0
Chloride	5.9	5.8	5.8	5.8	5.8	5.8	-	6.4	7.2	6.3	6.3	6.3
Fluoride	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	0.04	0.04	0.04	0.04	0.04
Sulphate	0.9	0.9	0.9	0.9	0.9	0.9	-	2.0	1.5	1.0	1.0	1.0
Nutrients (mg/L)												
Dissolved Phosphorus	0.001	0.002	<0.001	0.004	0.003	0.001	-	0.029	0.002	0.002	0.002	0.002
Total Phosphorus	0.004	0.007	0.007	0.005	0.007	0.006	-	0.002	0.018	0.008	0.008	0.012
Ammonia Nitrogen	<0.02	<0.02	0.040	<0.02	<0.02	<0.02	-	<0.01	0.043	0.041	0.047	0.040
Nitrate - nitrogen	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005
Nitrite - nitrogen	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001
Total Metals (µg/L)												
Aluminium	10	9	10	14	8	9	12	***446***	***256***	40	83	66
Antimony	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05
Arsenic	2.0	<1	<1	<1	<1	1.0	<1	1.0	1.0	<1	<1	<1
Barium	2.75	2.18	3.54	2.26	2.29	2.72	2.26	5.45	2.47	1.47	1.74	1.25
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bismuth	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	3.0	3.0	3.0	1.0
Cadmium	<0.05	***0.09***	<0.05	***0.07***	<0.05	***0.08***	***0.05***	***0.28***	***0.30***	***0.30***	***0.06***	***0.08***
Calcium	1670	1860	1380	1620	1370	1720	1600	2600	2100	1570	1660	1570
Chromium	0.7	0.9	0.7	***1.1***	0.8	***1.1***	0.8	-	-	-	-	-
Cobalt	<0.1	<0.1	0.20	<0.1	<0.1	0.20	<0.1	0.20	<0.1	<0.1	<0.1	<0.1
Copper	0.5	0.6	0.6	1.5	0.8	0.6	0.5	1.6	0.9	0.5	0.8	0.9
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-
Iron	<10	<10	20	<10	<10	<10	<10	***440***	180	30	90	50
Lead	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.28	0.13	0.09	0.08	<0.05
Lithium	1	<1	<1	<1	<1	1	<1	-	-	-	-	-
Magnesium	979	988	945	979	858	998	936	1540	1340	1040	1130	1080
Manganese	0.4	0.5	0.5	0.8	0.3	0.5	0.6	9.4	5.4	2.3	4.0	3.1
Mercury	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	0.09	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05
Nickel	0.3	0.5	0.4	0.5	1.0	0.2	0.4	1.3	0.2	0.3	1.5	<0.1
Potassium	540	550	540	530	600	530	530	790	790	670	700	630
Selenium	-	-	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	250	250	250	280	230	250	240	60	200	<50	190	<50
Silver	0.01	0.01	0.01	0.02	<0.01	0.01	0.02	0.06	0.02	<0.01	0.01	0.02
Sodium	2750	3320	3100	3240	2720	3310	3050	3750	3630	3270	3600	3190
Strontium	9.5	10.0	9.6	9.5	10.0	9.9	9.9	12.4	11.4	7.6	9.0	8.3
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	<0.1	<0.1	<0.1	0.40	0.30	0.30	0.10	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	<1	<1	<1	<1	<1	<1	<1	19.00	9.00	5.00	9.00	5.00
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.04	0.02	0.02	<0.01	0.03	<0.01	<0.01	0.03	<0.01	0.05	0.04	<0.01
Vanadium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	4.0	<1
Zinc	3.0	10.0	8.0	3.0	13.0	6.0	1.0	7.0	5.0	4.0	5.0	5.0
Dissolved Metals (µg/L)												
Aluminium	1	1	2	1	1	3	1	40	10	7	8	7
Antimony	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Barium	2.66	2.15	1.93	2.24	2.20	2.37	2.14	2.11	1.61	1.23	0.92	1.17
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bismuth	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	1.0	2.0	2.0	<1
Cadmium	<0.05	<0.05	<0.05	***0.07***	<0.05	***0.05***	<0.05	***0.05***	<0.05	***0.30***	***0.15***	<0.05
Calcium	1530	1600	1290	1620	1360	1270	1540	2580	1840	1460	1570	1550
Chromium	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	-	-	-	-	-
Cobalt	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	0.5	0.6	0.5	0.5	0.5	0.4	0.5	1.0	0.6	0.5	0.4	0.5
Iron	<10	<10	<10	<10	<10	<10	<10	40	<10	<1	<1	<1
Lead	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05
Lithium	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-
Magnesium	868	908	895	879	840	784	899	1350	1190	1030	1100	1050
Manganese	0.1	0.1	<0.05	0.1	<0.05	<0.05	<0.05	0.5	<0.05	<0.05	<0.05	<0.05
Mercury	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.8	0.2	<0.1	<0.1	<0.1
Potassium	500	540	520	520	490	450	530	640	650	640	700	620
Selenium			-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	190	240	220	240	210	230	240	80	<50	<50	<50	<50
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Sodium	2690	2870	2790	2760	2630	2430	2860	3320	3210	3070	3150	3150
Strontium	9.4	9.6	9.1	9.5	9.1	9.2	9.5	10.6	9.9	7.6	8.9	7.7
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	<0.1	<0.1	<0.1	0.4	<0.1	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.03	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	0.2	0.1	0.1	0.1
Zinc	1.0	<1	7.0	<1	<1	<1	1.0	1.0	2.0	2.0	2.0	<1
Field WQ												
Temperature (°C)	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake											
	Station 4 24-Aug-96 1 m	Station 4 24-Aug-96 8 m	Station 4 24-Aug-96 1 5m	Station 5 24-Aug-96 1 m	Station 5 24-Aug-96 2 m	Station 5 24-Aug-96 3 m	Station 6 24-Aug-96 1 m	Station 6 24-Aug-96 7 m	Station 6 25-Aug-96 14 m	Station 6 25-Aug-96 20 m	Station 6 25-Aug-96 28 m	Station 1 24-Jul-97 1 m
Physical												
Conductivity (µS/cm)	-	-	-	118	-	-	84	78	113	74	121	34
pH	-	-	-	7.40	-	-	7.40	7.40	7.30	7.40	7.40	***6.16***
Total Diss. Solids (mg/L)	-	-	-	29	-	-	25	49	20	34	52	26
Total Susp. Solids (mg/L)	-	-	-	1	-	-	2	3	1	4	5	2
Turbidity (NTU)	-	-	-	3.2	-	-	0.7	1.8	2.0	2.2	1.0	1.0
Dissolved Anions (mg/L)												
Hardness ($CaCO_3$)	-	-	-	8.0	-	-	7.0	8.0	8.0	8.0	8.0	7.8
Total Alkalinity	-	-	-	8.0	-	-	6.0	8.0	8.0	8.0	8.0	6.0
Chloride	-	-	-	6.4	-	-	6.3	6.3	6.3	6.3	6.3	5.1
Fluoride	-	-	-	0.06	-	-	0.06	0.06	0.06	0.06	0.06	0.03
Sulphate	-	-	-	1.0	-	-	1.0	1.0	1.0	1.0	1.0	1.0
Nutrients (mg/L)												
Dissolved Phosphorus	-	-	-	0.002	-	-	0.002	0.006	0.006	0.010	0.004	0.003
Total Phosphorus	-	-	-	0.010	-	-	0.008	0.006	0.007	0.010	0.011	0.006
Ammonia Nitrogen	-	-	-	0.044	-	-	0.055	0.043	0.049	<0.005	<0.005	0.006
Nitrate - nitrogen	-	-	-	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	0.001
Nitrite - nitrogen	-	-	-	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Total Metals (µg/L)												
Aluminium	37	40	33	***108***	***112***	***109***	28	42	52	80	47	27
Antimony	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	0.07	0.05	0.10
Arsenic	1.0	2.0	<1	<1	3.0	<1	<1	<1	<1	<1	<1	0.2
Barium	1.58	1.37	1.10	1.70	2.15	2.17	1.29	1.42	1.55	1.60	1.57	-
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5
Bismuth	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-
Boron	4.0	2.0	2.0	2.0	3.0	2.0	2.0	3.0	2.0	1.0	4.0	-
Cadmium	***0.45***	***0.15***	***0.14***	***0.19***	***0.19***	***0.17***	***0.22***	***0.27***	***0.31***	***0.22***	***0.51***	<0.2
Calcium	1660	1600	1530	1710	2110	1640	1710	1890	1670	1670	1860	1590
Chromium	-	-	-	-	-	-	-	-	-	-	-	<1
Cobalt	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1
Copper	0.8	0.7	0.7	0.8	0.8	0.8	1.2	0.8	0.7	0.8	0.9	1.0
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-
Iron	60	30	20	70	100	80	20	40	40	60	70	200
Lead	0.12	0.16	<0.05	0.07	0.13	0.07	0.07	<0.05	0.11	<0.05	0.13	<1
Lithium	-	-	-	-	-	-	-	-	-	-	-	<10
Magnesium	1220	1050	1020	1070	1220	1120	1090	1110	1100	1100	1360	1010
Manganese	3.2	3.0	2.5	3.9	4.1	3.0	2.0	2.8	3.0	3.8	3.2	10.0
Mercury	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	0.06	0.10	<1
Nickel	0.6	0.3	<0.1	<0.1	<0.1	0.2	<0.1	0.2	<0.1	<0.1	0.5	<1
Potassium	830	670	640	700	810	730	700	750	700	740	950	490
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	***1.2***	<0.5
Silicon	<50	60	220	100	<50	<50	<50	<50	<50	<50	<50	150
Silver	0.03	<0.01	0.01	<0.01	0.03	0.02	0.04	0.04	0.03	0.02	0.04	<0.1
Sodium	3870	3480	3630	3740	3770	3700	3580	3530	3590	3500	3400	2600
Strontium	8.6	7.4	7.7	8.0	7.9	8.7	8.0	8.2	7.9	8.7	8.6	15.0
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Tin	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Titanium	6.00	9.00	15.00	8.00	3.00	3.00	1.00	2.00	2.00	<1	<1	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.02	<0.01	0.05	<0.01	0.03	0.03	<0.01	<0.01	<0.01	<0.01	0.03	-
Vanadium	<1	<1	3.0	<1	<1	<1	<1	<1	<1	<1	<1	-
Zinc	6.0	5.0	7.0	10.0	9.0	8.0	8.0	12.0	6.0	4.0	8.0	<5
Dissolved Metals (µg/L)												
Aluminium	3	3	2	7	5	8	3	5	5	5	12	9
Antimony	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1
Arsenic	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.2
Barium	1.49	1.35	1.10	1.36	1.15	1.44	1.15	1.07	1.37	1.05	1.13	<10
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<5
Bismuth	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<100
Boron	2.0	2.0	2.0	2.0	2.0	<1	1.0	2.0	2.0	<1	3.0	<100
Cadmium	<0.05	<0.05	***0.08***	<0.05	<0.05	***0.14***	***0.12***	***0.13***	***0.18***	***0.22***	***0.22***	<0.2
Calcium	1530	1520	1420	1460	1520	1430	1440	1430	1550	1560	1470	1530
Chromium	-	-	-	-	-	-	-	-	-	-	-	<1
Cobalt	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1
Copper	0.5	0.4	0.3	0.5	0.5	0.5	0.3	0.4	0.4	0.4	0.5	<1
Iron	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	80
Lead	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<1
Lithium	-	-	-	-	-	-	-	-	-	-	-	<10
Magnesium	1030	1050	981	1010	1020	1020	929	973	1090	1100	1090	970
Manganese	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	0.1	0.1	<5
Mercury	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<1
Nickel	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1
Potassium	770	670	610	700	630	600	560	670	680	680	670	470
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5
Silicon	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	120
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	0.03	<0.01	0.02	<0.1
Sodium	3170	3140	3380	3060	3280	3130	3070	3000	3200	3150	3230	2580
Strontium	7.9	7.3	7.4	7.7	7.1	8.2	7.2	7.4	7.9	8.1	8.2	15.0
Thallium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<100
Tin	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<30
Titanium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	-
Vanadium	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<30
Zinc	2.0	1.0	1.0	<1	<1	<1	<1	1.0	2.0	2.0	2.0	<5
Field WQ												
Temperature (°C)	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake										
	Station 2 22-Jul-97 1 m	**Station 3** 24-Jul-97 1 m	**Station 3** 24-Jul-97 9 m	**Station 4** 24-Jul-97 1 m	**Station 5** 22-Jul-97 1 m	**Station 6** 24-Jul-97 1 m	**Station 6** 24-Jul-97 12 m	**Station 6** 24-Jul-97 23 m	**Station 1** 26-Aug-97 1 m	**Station 2** 26-Aug-97 1 m	**Station 3** 25-Aug-97 1 m
Physical											
Conductivity (µS/cm)	41	41	40	41	42	42	40	41	49	50	105
pH	***6.14***	***6.24***	***6.23***	***6.29***	***6.29***	***6.31***	***6.28***	***6.25***	6.78	6.62	6.84
Total Diss. Solids (mg/L)	24	28	24	30	26	27	27	30	28	24	62
Total Susp. Solids (mg/L)	2	3	<1	<1	<1	<1	1	2	3	2	2	2
Turbidity (NTU)	1.2	1.1	1.1	1.2	1.2	1.4	1.3	2.0	1.3	1.4	1.5
Dissolved Anions (mg/L)											
Hardness ($CaCO_3$)	9.5	9.2	9.4	9.6	9.5	9.7	9.2	9.2	9.9	10.1	10.2
Total Alkalinity	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.0
Chloride	7.0	7.0	6.8	6.9	6.8	7.2	6.9	7.1	6.7	7.0	6.7
Fluoride	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.07	0.08	0.06
Sulphate	1.0	2.0	2.0	2.0	2.0	1.0	2.0	2.0	1.0	1.0	1.0
Nutrients (mg/L)											
Dissolved Phosphorus	0.003	0.003	0.003	0.007	0.003	0.003	0.010	<0.001	0.003	0.007	0.007
Total Phosphorus	0.007	0.006	0.008	0.007	0.006	0.013	0.007	0.007	0.008	0.008	0.008
Ammonia Nitrogen	0.005	0.004	0.015	0.005	0.009	0.007	0.015	0.016	0.005	0.004	0.003
Nitrate - nitrogen	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	0.011	0.016	<0.001	<0.004	<0.001
Nitrite - nitrogen	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.002
Total Metals (µg/L)											
Aluminium	31	29	36	27	32	37	37	38	43	38	35
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	0.10	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Barium	-	-	-	-	-	-	-	-	-	-	-
Beryllium	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bismuth	-	-	-	-	-	-	-	-	-	-	-
Boron	-	-	-	-	-	-	-	-	-	-	-
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	1950	1910	1880	2010	1980	1990	1960	1970	2040	2140	2070
Chromium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cobalt	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	<1	1.0	<1	<1	1.0	<1	<1	<1	<1	1.0	<1
Cyanide	-	-	-	-	-	-	-	-	-	-	-
Iron	190	180	180	180	180	180	190	190	100	100	100
Lead	<1	<1	<1	<1	***2.00***	<1	<1	<1	<1	<1	<1
Lithium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Magnesium	1190	1160	1170	1230	1150	1190	1160	1180	1200	1250	1220
Manganese	12.0	12.0	14.0	14.0	12.0	12.0	16.0	17.0	6.0	<5	6.0
Mercury	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Molybdenum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Potassium	570	570	580	580	580	580	600	580	600	620	600
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	290	280	340	300	310	320	360	400	220	240	240
Silver	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	3490	3510	3530	3730	3610	3730	3660	3850	3280	3370	3300
Strontium	16.0	15.0	15.0	16.0	15.0	16.0	16.0	16.0	16.0	17.0	17.0
Thallium	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-
Titanium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-	-	-
Zinc	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	6.0
Dissolved Metals (µg/L)											
Aluminium	12	11	13	11	14	15	15	15	11	46	11
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Barium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Beryllium	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bismuth	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Boron	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	1880	1850	1860	1910	1940	1970	1850	1860	2030	2080	2080
Chromium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cobalt	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	<1	1.0	2.0	<1	1.0	<1	<1	<1	<1	1.0	<1
Iron	70	60	70	60	70	90	80	80	40	40	40
Lead	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lithium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Magnesium	1160	1120	1150	1170	1130	1160	1120	1120	1180	1200	1200
Manganese	<5	<5	<5	<5	<5	<5	<5	7.0	<5	<5	<5
Mercury	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Molybdenum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Potassium	560	550	550	550	550	570	570	580	580	620	600
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	260	240	290	250	260	260	320	350	170	170	190
Silver	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	3370	3470	3430	3540	3540	3700	3610	3780	3230	3350	3080
Strontium	15.0	15.0	15.0	15.0	15.0	16.0	16.0	16.0	16.0	16.0	17.0
Thallium	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Tin	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Titanium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Zinc	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Field WQ											
Temperature (°C)	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Aimaokatalok Lake										
	Station 4 25-Aug-97 1 m	**Station 5** 26-Aug-97 1 m	**Station 6** 25-Aug-97 1 m	**Station 6** 25-Aug-97 9 m	**Station 6** 25-Aug-97 18 m	**Station 4** 18-Jul-98 1 m	**Station 4** 18-Jul-98 5 m	**Station 6** 18-Jul-98 1 m	**Station 6** 18-Jul-98 5 m	**Station 6** 18-Jul-98 15 m	**Station 6** 18-Jul-98 25 m
Physical											
Conductivity (µS/cm)	49	50	48	48	50	35	37	34	-	35	37
pH	6.97	6.64	6.59	6.59	6.61	6.56	6.64	***6.10***	-	***6.43***	6.50
Total Diss. Solids (mg/L)	30	29	30	29	28	28	<10	29	-	24	30
Total Susp. Solids (mg/L)	3	4	3	3	2	2	1	3	-	2	2
Turbidity (NTU)	2.0	1.9	1.7	1.4	1.1	3.4	2.9	2.7	-	2.6	2.4
Dissolved Anions (mg/L)											
Hardness ($CaCO_3$)	10.4	10.5	10.4	10.2	10.3	9.7	9.6	9.4	-	9.7	9.7
Total Alkalinity	7.0	6.0	7.0	7.0	7.0	6.0	6.0	7.0	-	6.0	7.0
Chloride	6.8	6.9	6.6	6.8	6.8	5.8	5.8	5.8	-	5.8	6.2
Fluoride	0.08	0.06	0.06	0.07	0.06	0.03	0.06	0.03	-	0.03	0.03
Sulphate	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	1.0	1.0
Nutrients (mg/L)											
Dissolved Phosphorus	0.007	0.003	0.003	0.003	0.009	-	-	-	-	-	-
Total Phosphorus	0.013	0.008	0.008	0.008	0.008	-	-	-	-	-	-
Ammonia Nitrogen	0.006	0.003	0.006	0.006	0.006	-	-	-	-	-	-
Nitrate - nitrogen	0.002	0.001	0.002	0.003	0.002	-	-	-	-	-	-
Nitrite - nitrogen	0.001	<0.001	0.002	<0.001	0.001	-	-	-	-	-	-
Total Metals (µg/L)											
Aluminium	58	46	47	30	38	51	53	51	45	48	40
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Barium	-	-	-	-	-	-	-	-	-	-	-
Beryllium	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bismuth	-	-	-	-	-	-	-	-	-	-	-
Boron	-	-	-	-	-	-	-	-	-	-	-
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	2180	2170	2070	2040	2070	1980	1930	1900	1950	2110	1960
Chromium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cobalt	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	1.0	<1	1.0	<1	<1	<1	<1	<1	<1	1.0	<1
Cyanide	-	-	-	-	-	-	-	-	-	-	-
Iron	170	110	100	90	90	120	130	120	110	120	120
Lead	<1	***2.00***	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lithium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Magnesium	1340	1270	1270	1260	1280	1200	1200	1100	1200	1200	1200
Manganese	13.0	7.0	<5	<5	5.0	10.0	10.0	9.0	10.0	12.0	12.0
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Potassium	630	600	610	600	610	660	650	650	660	760	700
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	0.8	<0.5	0.7	<0.5	<0.5
Silicon	280	250	250	240	240	290	280	250	290	290	290
Silver	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	3330	3450	3340	3310	3460	2850	2900	2890	2910	3450	3110
Strontium	18.0	17.0	17.0	17.0	17.0	19.0	19.0	20.0	19.0	20.0	19.0
Thallium	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-
Titanium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-	-	-
Zinc	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dissolved Metals (µg/L)											
Aluminium	11	12	11	11	11	-	-	11	-	13	13
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	-	<0.1	<0.1
Arsenic	0.2	0.2	0.4	0.2	0.1	-	-	0.1	-	0.1	0.1
Barium	<10	<10	<10	<10	<10	-	-	<10	-	<10	<10
Beryllium	<5	<5	<5	<5	<5	-	-	<5	-	<5	<5
Bismuth	<100	<100	<100	<100	<100	-	-	-	-	-	-
Boron	<100	<100	<100	<100	<100	-	-	-	-	-	-
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	<0.2	-	<0.2	<0.2
Calcium	2090	2170	2060	2020	2040	-	-	1900	-	1950	1940
Chromium	<1	<1	<1	<1	<1	-	-	<1	-	<1	<1
Cobalt	<1	<1	<1	<1	<1	-	-	<1	-	<1	<1
Copper	<1	<1	<1	<1	<1	-	-	1.0	-	1.0	<1
Iron	40	40	40	40	40	-	-	30	-	30	30
Lead	<1	<1	<1	<1	<1	-	-	<1	-	<1	<1
Lithium	<10	<10	<10	<10	<10	-	-	<10	-	<10	<10
Magnesium	1270	1250	1270	1250	1260	-	-	1100	-	1200	1200
Manganese	<5	<5	<5	<5	<5	-	-	<5	-	<5	<5
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	<0.05	-	<0.05	<0.05
Molybdenum	<1	<1	<1	<1	<1	-	-	<1	-	<1	<1
Nickel	<1	<1	<1	<1	<1	-	-	<1	-	<1	<1
Potassium	610	600	590	590	590	-	-	650	-	670	670
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	<0.5	-	<0.5	<0.5
Silicon	210	200	200	200	190	-	-	200	-	230	240
Silver	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	-	<0.1	<0.1
Sodium	3300	3370	3290	3290	3410	-	-	2890	-	3030	3120
Strontium	16.0	17.0	17.0	17.0	17.0	-	-	20.0	-	20.0	19.0
Thallium	<100	<100	<100	<100	<100	-	-	-	-	-	-
Tin	<30	<30	<30	<30	<30	-	-	-	-	-	-
Titanium	<10	<10	<10	<10	<10	-	-	<10	-	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<30	<30	<30	<30	<30	-	-	-	-	-	-
Zinc	<5	<5	<5	<5	<5	-	-	<5	-	<5	<5
Field WQ											
Temperature (°C)	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Stickleback Lake								Fickle Duck Lake	
	20-Apr-97 1 m	Aug 93 surface	Aug 93 2 m	Aug 94 surface	3-Aug-95 1 m	23-Jul-97 1 m	26-Aug-97 1 m	19-Jul-98 1 m	20-Apr-97 1 m	Aug 94 surface
Physical										
Conductivity (µS/cm)	458	119	116	130	160	189	203	196	352	61
pH	7.12	7.55	7.59	8.30	***6.20***	7.07	7.38	7.26	6.77	8.40
Total Diss. Solids (mg/L)	266	80	79	110	110	132	118	141	273	51
Total Susp. Solids (mg/L)	4	<1	<1	4	4	3	3	4	12	7
Turbidity (NTU)	7.1	0.7	0.6	1.1	0.7	1.4	1.0	1.4	19.2	5.2
Dissolved Anions (mg/L)										
Hardness ($CaCO_3$)	140.0	35.0	35.0	36.0	48.0	54.8	55.9	62.7	128.0	15.0
Total Alkalinity	98.0	32.1	32.0	31.0	26.0	32.0	27.0	26.0	107.0	13.0
Chloride	95.0	16.9	16.9	35.0	36.5	36.8	41.1	42.4	43.9	17.0
Fluoride	0.08	0.03	0.03	0.10	0.05	0.05	***0.14***	0.07	0.08	0.05
Sulphate	2.0	<1	<1	<0.5	0.3	<1	<1	<1	11.0	<0.5
Nutrients (mg/L)										
Dissolved Phosphorus	-	0.007	0.007	0.004	0.002	0.005	0.001	-	-	0.004
Total Phosphorus	0.013	0.009	0.009	0.020	0.006	0.007	0.008	-	***0.046***	0.030
Ammonia Nitrogen	-	0.043	0.037	0.011	0.020	0.007	0.014	-	-	0.018
Nitrate - nitrogen	-	<0.005	<0.005	<0.005	<0.005	0.003	0.003	-	-	<0.005
Nitrite - nitrogen	-	0.001	<0.001	<0.001	0.001	<0.001	<0.001	-	-	<0.001
Total Metals (µg/L)										
Aluminium	23	9	11	6	9	<5	8	11	***260***	62
Antimony	0.10	<0.1	<0.1	<0.2	0.10	<0.1	0.10	<0.1	0.30	<0.2
Arsenic	0.8	<0.1	<0.1	2.0	1.0	0.4	0.4	0.3	0.8	<1
Barium	20.00	<10	<10	2.23	4.00	<10	<10	<10	20.00	2.00
Beryllium	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-
Boron	-	-	-	<1.2	10.0	-	-	-	-	8.6
Cadmium	<0.2	<0.1	<0.1	***0.12***	<0.2	<0.2	<0.2	<0.2	***0.60***	***0.11***
Calcium	34800	8260	8200	10000	11700	14000	14300	15900	36100	4640
Chromium	<1	<1	<1	<0.3	0.5	<1	<1	<1	***2.0***	<0.3
Cobalt	<1	<1	<1	<0.06	0.29	<1	<1	<1	<1	<0.06
Copper	2.0	1.0	<0.5	1.2	0.5	<1	<1	<1	***8.0***	1.1
Cyanide	-	<5	<5	-	-	-	-	-	-	-
Iron	***720***	84	81	40	70	90	70	60	***3410***	137
Lead	<1	<1	<1	***1.97***	0.50	<1	***5.00***	<1	1.00	0.08
Lithium	-	-	-	-	-	-	-	-	-	<5
Magnesium	13600	3550	3550	4540	4570	4870	5020	5600	10000	1860
Manganese	343.0	<5	9.0	6.8	3.2	10.0	6.0	6.0	165.0	2.6
Mercury	<0.01	0.02	***0.03***	<0.05	<0.05	-	<0.05	<0.05	<0.01	<0.05
Molybdenum	<1	<1	<1	<0.16	0.10	<1	<1	<1	<1	<0.16
Nickel	<1	<1	<1	0.5	0.7	<1	<1	<1	5.0	1.3
Potassium	4600	-	-	1670	1670	1490	1420	1800	2770	650
Selenium	<0.5	<0.5	<0.5	<1	1.0	<0.5	<0.5	<0.5	<0.5	<1
Silicon	1420	-	-	-	-	210	260	190	9020	-
Silver	<0.1	<0.05	<0.05	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	0.02
Sodium	29100	-	-	10200	11900	11200	10700	12000	20800	5690
Strontium	170.0	-	-	30.8	62.1	92.0	91.0	110.0	134.0	15.7
Thallium	<100	-	-	<0.03	<0.05	-	-	-	-	<0.03
Tin	<30	-	-	<0.09	<0.2	-	-	-	-	<0.09
Titanium	<10	-	-	<0.5	<0.5	-	-	-	-	0.94
Tungsten	-	-	-	<0.07	<0.1	-	-	-	-	<0.07
Uranium	-	-	-	-	-	-	-	-	-	-
Vanadium	<30	-	-	<1	<1	-	-	-		<1
Zinc	8.0	<5	<5	1.2	1.0	<5	<5	<5	22.0	1.7
Dissolved Metals (µg/L)										
Aluminium	<5	5	7	1	1	<5	<5	-	51	2
Antimony	<0.1	<0.1	<0.1	<0.2	0.10	<0.1	<0.1	-	0.10	<0.2
Arsenic	0.7	<0.1	<0.1	<1	1.0	0.3	0.3	-	0.7	<1
Barium	20.00	<10	<10	2.10	3.94	<10	<10	-	20.00	1.56
Beryllium	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-
Boron	<100	<100	<100	<1.2	9.0	<100	<100	-	<100	<1.2
Cadmium	<0.2	<0.1	<0.1	<0.07	***0.20***	<0.2	<0.2	-	***0.30***	<0.07
Calcium	33900	8210	8200	8630	11600	13900	14200	-	35100	3930
Chromium	<1	<1	<1	<0.3	0.5	<1	<1	-	1.0	<0.3
Cobalt	<1	<1	<1	<0.06	0.08	<1	<1	-	<1	<0.06
Copper	2.0	<0.5	<0.5	<0.4	0.5	<1	<1	-	***6.0***	0.6
Iron	90	<30	<30	<10	10	<10	<10	-	***1660***	<10
Lead	<1	<1	<1	<0.06	0.10	<1	<1	-	<1	<0.06
Lithium	-	-	-	-	-	-	-	-	<10	<5
Magnesium	13300	3510	3530	3540	4500	4880	4970	-	9840	1360
Manganese	295.0	<5	<5	<0.1	0.2	<5	<5	-	152.0	<0.1
Mercury	<0.01	<0.01	0.01	<0.05	***0.05***	-	<0.05	-	<0.01	<0.05
Molybdenum	<1	<1	<1	<0.16	0.10	<1	<1	-	<1	<0.16
Nickel	<1	<1	<1	0.4	0.6	<1	<1	-	4.0	0.9
Potassium	4620	-	-	1330	1540	1480	1400	-	2690	438
Selenium	<0.5	<0.5	<0.5	<1	1.0	<0.5	<0.5	-	<0.5	<1
Silicon	1360	-	-	-	-	210	250	-	8620	-
Silver	<0.1	<0.05	<0.05	<0.01	0.01	<0.1	<0.1	-	<0.1	<0.01
Sodium	28900	-	-	7840	11500	11000	10700	-	20100	4010
Strontium	167.0	-	-	29.2	61.2	90.0	89.0	-	123.0	15.5
Thallium	<100	-	-	<0.03	0.05	<100	<100	-	-	<0.03
Tin	<30	-	-	<0.09	0.1	<30	<30	-	-	<0.09
Titanium	<10	-	-	<0.5	0.5	<10	<10	-	-	<0.5
Tungsten	-	-	-	<0.07	0.10	-	-	-	-	<0.07
Uranium	-	-	-	-	-	-	-	-	-	-
Vanadium	<30	<5	<5	<1	1.0	<30	<30	-		<1
Zinc	8.0	<5	<5	<1	1.0	<5	<5	-	9.0	<1
Field WQ										
Temperature (°C)	-	13.6	-	12.0	8.6	-	-	-	-	11.0
Dissolved Oxygen (mg/L)	-	10.8	-	15.7	11.3	-	-	-	-	13.2
pH	-	8.5	-	8.3	7.9	-	-	-	-	8.4
Secchi (m)	-	2.0	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	0.96	-	-	-	-	-	-

Appendix A5. Analytical results for water quality samples from Boston area lakes, 1992-1998.

Parameter	Fickle Duck Lake						Reference Lake			
	03-Aug-95 1 m	05-Aug-96 ? m	25-Aug-96 ? m	23-Jul-97 1 m	26-Aug-97 1 m	19-Jul-98 1 m	22-Apr-98 2.5 m	23-Jul-97 1 m	27-Aug-97 1 m	22-Jul-98 1 m
Physical										
Conductivity (µS/cm)	60	73	79	89	63	54	228	38	52	32
pH	***6.10***	7.10	7.20	7.02	6.61	7.10	7.09	6.94	6.55	6.79
Total Diss. Solids (mg/L)	44	56	54	56	50	48	173	34	34	20
Total Susp. Solids (mg/L)	1	1	20	3	4	3	4	4	5	6
Turbidity (NTU)	3.9	1.2	30.0	3.6	2.7	5.0	7.1	2.0	3.5	3.9
Dissolved Anions (mg/L)										
Hardness ($CaCO_3$)	8.0	17.0	22.0	24.1	20.7	19.1	81.9	11.6	14.7	11.8
Total Alkalinity	10.0	14.0	18.0	16.0	17.0	13.0	66.0	11.0	12.0	9.0
Chloride	10.5	11.7	10.2	12.4	8.5	7.3	30.0	4.5	4.6	3.5
Fluoride	0.04	0.05	0.05	0.08	0.03	0.06	0.12	0.03	0.06	0.04
Sulphate	1.1	0.8	2.1	1.0	2.0	1.0	8.0	1.0	1.0	1.0
Nutrients (mg/L)										
Dissolved Phosphorus	0.006	0.005	0.012	0.003	0.003	-	0.002	0.001	0.001	-
Total Phosphorus	0.014	0.012	***0.050***	0.016	0.013	-	0.018	0.008	0.021	-
Ammonia Nitrogen	0.020	<0.02	<0.005	0.003	0.009	-	0.021	0.002	0.014	-
Nitrate - nitrogen	0.006	<0.005	0.009	<0.001	<0.001	-	0.226	0.003	0.002	-
Nitrite - nitrogen	0.001	<0.001	<0.001	0.002	0.002	-	<0.001	<0.001	<0.001	-
Total Metals (µg/L)										
Aluminium	***141***	25	***346***	92	64	***122***	37	44	***109***	88
Antimony	0.10	<0.05	0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	1.0	<1	1.0	0.3	0.3	0.2	0.8	0.2	0.3	0.2
Barium	3.97	3.26	7.05	-	-	-	20.00	<10	<10	<10
Beryllium	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-
Boron	3.0	5.0	<1	-	-	-	-	-	-	-
Cadmium	<0.2	***0.06***	<0.05	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	4760	4720	6670	6660	5820	5130	21600	3170	3980	3110
Chromium	0.5	0.7	-	<1	<1	<1	***3.0***	<1	<1	<1
Cobalt	0.16	<0.1	0.10	<1	<1	<1	<1	<1	<1	<1
Copper	1.0	1.6	***2.3***	2.0	2.0	1.0	***30.0***	2.0	2.0	2.0
Cyanide	-	-	-	-	-	-	-	-	-	-
Iron	***450***	110	***650***	***360***	***390***	270	***1840***	240	230	240
Lead	0.40	0.12	0.20	***7.00***	***2.00***	<1	<1	***6.00***	<1	<1
Lithium	1	<1	-	-	-	-	-	-	-	-
Magnesium	1610	1460	1890	1970	1590	1500	6800	930	1270	1000
Manganese	2.4	0.4	6.3	<5	<5	<5	150.0	<5	<5	6.0
Mercury	<0.05	-	-	<0.05	-	<0.05	<0.05	-	<0.05	<0.05
Molybdenum	0.10	0.08	0.10	<1	<1	<1	<1	<1	<1	<1
Nickel	1.4	1.1	1.8	1.0	1.0	1.0	4.0	<1	<1	<1
Potassium	320	440	640	480	370	430	2250	360	440	440
Selenium	1.0	-	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	0.5
Silicon	-	430	2310	600	670	460	3380	290	240	240
Silver	0.01	<0.01	0.04	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	5450	4690	5240	5640	4180	3380	17000	2490	2650	2130
Strontium	23.1	29.2	30.7	37.0	30.0	32.0	59.0	16.0	19.0	17.0
Thallium	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Tin	0.20	0.30	<1	-	-	-	-	-	-	-
Titanium	0.50	<1	18.00	-	-	-	-	-	-	-
Tungsten	0.10	-	-	-	-	-	-	-	-	-
Uranium	-	0.04	0.04	-	-	-	-	-	-	-
Vanadium	1.0	<1	<1	-	-	-	-	-	-	-
Zinc	7.0	1.0	2.0	<5	<5	<5	9.0	<5	<5	<5
Dissolved Metals (µg/L)										
Aluminium	53	12	76	38	32	-	-	19	17	-
Antimony	0.10	<0.05	0.05	<0.1	<0.1	-	-	<0.1	<0.1	-
Arsenic	1.0	<1	<1	0.3	0.3	-	-	0.2	0.2	-
Barium	3.56	3.15	3.90	<10	<10	-	-	<10	<10	-
Beryllium	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-
Boron	1.0	4.0	<1	<100	<100	-	-	-	-	-
Cadmium	***0.20***	***0.06***	<0.05	<0.2	<0.2	-	-	<0.2	<0.2	-
Calcium	4270	4430	6210	6460	5740	-	-	3120	3870	-
Chromium	0.5	0.2	-	1.0	<1	-	-	<1	<1	-
Cobalt	0.08	<0.1	<0.1	<1	<1	-	-	<1	<1	-
Copper	0.9	1.1	1.5	2.0	2.0	-	-	2.0	1.0	-
Iron	150	60	150	180	210	-	-	130	70	-
Lead	0.10	<0.5	0.07	***2.00***	1.00	-	-	***2.00***	<1	-
Lithium	1	<1	-	<10	<10	-	-	-	-	-
Magnesium	1450	1420	1610	1930	1550	-	-	920	1220	-
Manganese	0.2	<0.05	0.3	<5	<5	-	-	<5	<5	-
Mercury	***0.05***	-	-	<0.05	-	-	-	-	<0.05	-
Molybdenum	0.10	<0.05	0.07	<1	<1	-	-	<1	<1	-
Nickel	1.0	0.6	1.2	1.0	1.0	-	-	<1	<1	-
Potassium	280	330	500	450	360	-	-	360	410	-
Selenium	1.0	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	-
Silicon	-	420	1040	490	600	-	-	250	130	-
Silver	0.01	<0.01	0.01	<0.1	<0.1	-	-	<0.1	<0.1	-
Sodium	4880	4460	4300	5410	4170	-	-	2490	2630	-
Strontium	21.5	28.5	25.4	35.0	29.0	-	-	16.0	19.0	-
Thallium	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Tin	0.1	<0.1	<0.1	-	-	-	-	-	-	-
Titanium	0.5	<1	<1	-	-	-	-	-	-	-
Tungsten	0.10	-	-	-	-	-	-	-	-	-
Uranium	-	<0.01	<0.01	-	-	-	-	-	-	-
Vanadium	1.0	0.2	<0.1	<30	<30	-	-	-	-	-
Zinc	1.0	<1	2.0	<5	<5	-	-	<5	<5	-
Field WQ										
Temperature (°C)	7.5	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	12.2	-	-	-	-	-	-	-	-	-
pH	7.5	-	-	-	-	-	-	-	-	-
Secchi (m)	-	-	-	-	-	-	-	-	-	-
Chlorophyll a (mg/m)	-	-	-	-	-	-	-	-	-	-

Appendix A6. Analytical results for water quality samples from Boston area streams, 1992-2000.

Parameter	Aimaokatalok NE Inflow							Aimaokatalok Outflow		
	1-Aug-95	4-Aug-96	25-Aug-96	15-Jun-97	22-Jul-97	25-Aug-97	28-Jun-98	31-May-98	27-Jun-98	02-Aug-98
Physical										
Conductivity (µS/cm)	63	83	63	57	78	105	44	57	36	36
pH	***5.70***	7.00	6.90	***6.26***	6.71	6.84	6.74	6.88	6.70	6.88
Total Diss. Solids (mg/L)	52	56	75	43	50	62	26	38	19	35
Total Susp. Solids (mg/L)	5	<1	15	57	5	6	2	4	1	2
Turbidity (NTU)	0.6	3.0	6.4	26.3	6.4	6.3	4.7	1.0	2.5	1.1
Dissolved Anions (mg/L)										
Hardness ($CaCO_3$)	14.0	13.0	16.0	11.3	17.3	20.2	11.4	13.6	9.5	10.0
Total Alkalinity	6.0	13.0	10.0	9.0	13.0	12.0	7.0	9.0	6.0	6.0
Chloride	12.8	16.0	8.7	9.8	14.3	19.0	8.1	8.8	6.1	5.7
Fluoride	0.05	0.06	0.07	0.03	0.04	0.10	0.05	0.07	0.02	0.03
Sulphate	1.2	1.2	2.0	<1	2.0	2.0	1.0	2.0	1.0	1.0
Nutrients (mg/L)										
Dissolved Phosphorus	0.006	0.006	0.016	0.009	0.002	0.001	-	0.008	-	-
Total Phosphorus	0.024	0.025	0.017	***0.041***	0.015	0.026	-	0.001	-	-
Ammonia Nitrogen	0.020	<0.020	<0.005	0.035	0.161	0.185	-	0.008	-	-
Nitrate	0.008	<0.005	0.005	0.006	0.006	0.010	-	0.045	-	-
Nitrite	0.001	<0.001	<0.001	0.005	0.011	0.005	-	<0.001	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)										
Aluminum	***183***	29	***231***	***368***	***126***	***155***	***177***	12	80	26
Antimony	0.10	<0.05	0.06	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	1.0	<1	2.0	0.3	0.6	0.4	0.2	0.1	0.2	0.1
Barium	3.34	2.02	5.86	<10	<10	<10	<10	<10	<10	<10
Beryllium	0.5	<0.5	<0.5	<5	<5	<5	<5	-	-	-
Bismuth	0.07	<0.5	<0.5	-	-	-	-	-	-	-
Boron	4.0	8.0	<1	-	-	-	-	-	-	-
Cadmium	<0.2	***0.14***	<0.05	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	2580	2980	3620	2260	3300	3840	2140	2850	2180	1970
Chromium	0.5	0.7	-	1.0	<1	<1	<1	<1	<1	<1
Cobalt	0.08	<0.1	0.10	<1	<1	<1	<1	<1	<1	<1
Copper	0.5	1.5	***2.7***	1	2	2	1	1	***3***	<1
Iron	***470***	220	***420***	***990***	***780***	***590***	***430***	30	180	70
Lead	0.10	0.09	0.24	<1	<1	<1	<1	-	-	-
Lithium	1	<1	-	-	-	-	-	<1	<1	<1
Magnesium	1750	1800	2010	1620	2290	2750	1500	1700	1200	1200
Manganese	13.4	3.9	10.1	33.0	18.0	33.0	10.0	<5	17.0	7.0
Mercury	<0.05	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	0.10	0.16	0.10	<1	<1	<1	<1	<1	<1	<1
Nickel	0.7	1.0	1.8	<1	<1	<1	<1	<1	<1	<1
Potassium	920	810	670	910	900	890	520	750	630	590
Selenium	1.0	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8
Silicon	-	380	2570	1010	390	490	560	300	400	210
Silver	0.01	<0.01	0.06	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	7060	7500	4410	4530	7900	9840	4050	4430	3500	3120
Strontium	15	18	20	14	26	29	20	14	19	20
Thallium	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Tin	0.2	0.7	<0.1	-	-	-	-	-	-	-
Titanium	2.2	1.0	9.0	20.0	-	-	<10	-	-	-
Tungsten	0.10	-	-	-	-	-	-	-	-	-
Uranium	-	0.03	0.05	-	-	-	-	-	-	-
Vanadium	1.0	<1	1.0	-	-	-	-	-	-	-
Zinc	7.0	***31.0***	6.0	<5	<5	<5	<5	<5	<5	<5
Dissolved Metals (µg/L)										
Aluminum	37	10	***156***	39	59	33	-	8	16	-
Antimony	0.10	<0.05	0.05	<0.1	<0.1	<0.1	-	<0.1	<0.1	-
Arsenic	1.0	<1	<1	0.2	0.4	0.4	-	0.1	0.1	-
Barium	2.2	1.8	3.8	<10	<10	<10	-	<10	<10	-
Beryllium	0.5	<0.5	<0.5	<5	<5	<5	-	<5	<5	-
Bismuth	0.07	<0.5	<0.5	<100	<100	<100	-	-	-	-
Boron	4.0	7.0	<1	<100	<100	<100	-	-	-	-
Cadmium	***0.20***	***0.06***	<0.05	<0.2	<0.2	<0.2	-	<0.2	<0.2	-
Calcium	2520	2510	3600	2160	3210	3700	-	2740	1890	-
Chromium	0.5	0.2	-	<1	<1	<1	-	<1	<1	-
Cobalt	0.08	<0.1	<0.1	<1	<1	<1	-	<1	<1	-
Copper	0.5	1.0	***2.1***	1.0	2.0	1.0	-	1.0	<1	-
Iron	120	100	210	***320***	***420***	130	-	20	60	-
Lead	0.10	<0.05	<0.05	<1	<1	<1	-	<1	<1	-
Lithium	1	<1	-	<10	<10	<10	-	<10	<10	-
Magnesium	1750	1740	1800	1440	2240	2660	-	1700	1200	-
Manganese	0.2	1.2	4.1	<5	<5	<5	-	<5	11.0	-
Mercury	***0.05***	-	-	-	-	<0.05	-	<0.05	<0.05	-
Molybdenum	0.10	0.16	0.05	<1	<1	<1	-	<1	<1	-
Nickel	0.7	0.5	1.7	<1	<1	<1	-	<1	<1	-
Potassium	850	660	580	810	850	830	-	740	580	-
Selenium	1.0	-	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	-
Silicon	-	340	2430	450	300	260	-	290	260	-
Silver	0.01	<0.01	<0.01	<0.1	<0.1	<0.1	-	<0.1	<0.1	-
Sodium	7010	7490	4400	4500	7740	9550	-	4450	2960	-
Strontium	14.8	17.9	18.2	12.0	26.0	28.0	-	14.0	19.0	-
Thallium	0.05	<0.05	<0.05	<100	<100	<100	-	-	-	-
Tin	0.2	<0.1	<0.1	<30	<30	<30	-	-	-	-
Titanium	2.0	<1	1.0	<10	<10	<10	-	-	-	-
Tungsten	0.1	-	-	-	-	-	-	-	-	-
Uranium	-	0.02	<0.01	-	-	-	-	-	-	-
Vanadium	1.0	0.1	<0.1	<30	<30	<30	-	-	-	-
Zinc	2.0	<1	5.0	<5	<5	<5	-	<5	<5	-
Field WQ										
Temperature (°C)	11.9	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	11.9	-	-	-	-	-	-	-	-	-
pH	7.1	-	-	-	-	-	-	-	-	-

Appendix A6. Analytical results for water quality samples from Boston area streams, 1992-2000.

Parameter	Aimaokatalok River					Stickleback Outflow			
	17-Jun-97	31-May-98	27-Jun-98	21-Jul-97	24-Aug-97	Jun-93	22-Jun-96	15-Jun-97	26-Jun-98
Physical									
Conductivity (µS/cm)	34	75	19	27	37	149	92	202	102
pH	***6.08***	6.85	6.65	***6.32***	6.53	7.16	7.10	7.06	6.96
Total Diss. Solids (mg/L)	23	52	11	18	20	119	58	113	70
Total Susp. Solids (mg/L)	19	4	<1	<1	2	-	<1	4	2
Turbidity (NTU)	4.1	0.4	1.3	0.8	1.0	1.0	1.1	1.3	0.9
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	7.5	22.0	5.7	6.7	7.8	44.3	23.0	59.0	31.0
Total Alkalinity	6.0	14.0	4.0	5.0	5.0	41.2	19.0	40.0	14.0
Chloride	4.6	10.2	3.2	4.3	4.6	-	15.0	36.7	21.4
Fluoride	0.03	0.09	0.03	0.03	0.05	-	0.04	0.05	0.03
Sulphate	1.0	3.0	<1	1.0	1.0	2.3	<1	<1	<1
Nutrients (mg/L)									
Dissolved Phosphorus	0.004	0.002	-	0.002	0.002	-	0.008	0.005	-
Total Phosphorus	0.012	0.013	-	0.004	0.006	0.012	0.008	0.020	-
Ammonia Nitrogen	0.022	0.023	-	0.041	0.023	<0.005	0.015	0.020	-
Nitrate	0.020	0.077	-	0.017	0.015	<0.005	<0.005	0.010	-
Nitrite	0.004	0.001	-	0.003	0.010	<0.001	<0.001	0.006	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)									
Aluminum	74	25	32	17	14	-	13	6	15
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.05	<0.1	<0.1
Arsenic	0.2	0.2	0.1	0.1	<0.1	-	<2	0.3	0.2
Barium	<10	<10	<10	<10	<10	<10	3.18	<10	<10
Beryllium	-	-	-	-	-	<5	<0.5	<5	<5
Bismuth	-	-	-	-	-	-	<0.5	-	-
Boron	-	-	-	-	-	-	6.0	-	-
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<10	***0.09***	<0.2	<0.2
Calcium	1350	4990	1100	1290	1480	10000	5920	14300	7920
Chromium	<1	<1	<1	<1	<1	-	0.6	<1	<1
Cobalt	<1	<1	<1	<1	<1	-	0.20	<1	<1
Copper	1	2	<1	1	<1	-	0.5	<1	<1
Iron	***550***	240	120	170	90	96	50	170	60
Lead	<1	<1	<1	<1	<1	-	<0.05	<1	<1
Lithium	-	-	-	-	-	<15	2	<10	<10
Magnesium	1010	2300	700	870	1040	4700	2330	5460	2700
Manganese	34.0	57.0	<5	<5	<5	207.0	12.5	114.0	28.0
Mercury	-	<0.05	<0.05	-	<0.05	-	-	-	<0.05
Molybdenum	<1	<1	<1	<1	<1	-	<0.05	<1	<1
Nickel	<1	1.0	<1	<1	<1	-	0.5	<1	<1
Potassium	640	1970	370	430	510	-	950	1530	830
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5
Silicon	550	520	150	100	110	-	150	510	180
Silver	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.01	<0.1	<0.1
Sodium	2200	4420	1520	2280	2260	13700	5980	11500	5000
Strontium	8	17	15	13	14	23	29	70	57
Thallium	-	-	-	-	-	-	<0.05	-	-
Tin	-	-	-	-	-	-	<0.1	-	-
Titanium	-	-	-	-	-	<10	<1	<10	<10
Tungsten	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	<0.01	-	-
Vanadium	-	-	-	-	-	-	<1	-	-
Zinc	<5	<5	<5	<5	<5	<5	1.0	<5	<5
Dissolved Metals (µg/L)									
Aluminum	17	-	-	8	<5	-	<1	<5	-
Antimony	<0.1	-	-	<0.1	<0.1	-	<0.05	<0.1	-
Arsenic	0.1	-	-	0.1	0.1	-	<1	0.3	-
Barium	<10	-	-	<10	<10	-	2.9	<10	-
Beryllium	-	-	-	-	-	-	<0.5	<5	-
Bismuth	-	-	-	-	-	-	<0.5	<100	-
Boron	-	-	-	-	-	-	6.0	<100	-
Cadmium	<0.2	-	-	<0.2	<0.2	-	***0.09***	<0.2	-
Calcium	1350	-	-	1240	1450	-	5680	14300	-
Chromium	<1	-	-	<1	<1	-	0.3	<1	-
Cobalt	<1	-	-	<1	<1	-	<0.1	<1	-
Copper	<1	-	-	<1	<1	-	0.4	<1	-
Iron	230	-	-	90	10	-	20	20	-
Lead	<1	-	-	<1	<1	-	<0.05	<1	-
Lithium	-	-	-	-	-	-	2	<10	-
Magnesium	990	-	-	860	1010	-	2140	5460	-
Manganese	6.0	-	-	<5	<5	-	1.6	<5	-
Mercury	-	-	-	-	<0.05	-	-	-	-
Molybdenum	<1	-	-	<1	<1	-	<0.05	<1	-
Nickel	<1	-	-	<1	<1	-	0.2	<1	-
Potassium	560	-	-	420	470	-	950	1530	-
Selenium	<0.5	-	-	<0.5	<0.5	-	<0.5	<0.5	-
Silicon	430	-	-	90	90	-	150	510	-
Silver	<0.1	-	-	<0.1	<0.1	-	<0.01	<0.1	-
Sodium	2140	-	-	2170	2240	-	5240	11500	-
Strontium	8.0	-	-	13.0	14.0	-	30.2	70.0	-
Thallium	-	-	-	-	-	-	<0.05	<100	-
Tin	-	-	-	-	-	-	<0.1	<30	-
Titanium	-	-	-	-	-	-	<1	<10	-
Tungsten	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	<0.01	-	-
Vanadium	-	-	-	-	-	-	<0.1	<30	-
Zinc	<5	-	-	<5	<5	-	1.0	<5	-
Field WQ									
Temperature (°C)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-

Appendix A6. Analytical results for water quality samples from Boston area streams, 1992-2000.

Parameter	Stickleback Outflow								Fickle Duck Outflow	
	Aug-92	Aug-93	Aug-94	31-Jul-95	05-Aug-96	25-Aug-96	21-Jul-97	25-Aug-97	Jun-93	22-Jun-96
Physical										
Conductivity (µS/cm)	35	120	170	160	179	284	186	203	40	37
pH	***6.36***	7.10	8.10	***5.80***	7.30	7.50	7.10	7.32	6.95	7.10
Total Diss. Solids (mg/L)	28	84	110	120	-	123	130	119	32	24
Total Susp. Solids (mg/L)	-	-	6	1	<1	1	2	3	-	1
Turbidity (NTU)	1.8	4.0	6.3	0.8	0.6	2.0	0.6	1.2	2.4	2.4
Dissolved Anions (mg/L)										
Hardness ($CaCO_3$)	9.2	36.4	64.0	48.0	47.0	50.2	53.2	59.2	13.3	9.0
Total Alkalinity	5.5	32.2	53.0	26.0	32.0	30.0	32.0	28.0	9.4	10.0
Chloride	-	17.0	35.0	36.4	35.9	41.2	37.0	36.9	-	4.3
Fluoride	-	0.03	0.05	0.04	0.06	0.05	0.04	0.09	-	0.04
Sulphate	<1	1.8	<0.5	0.3	0.3	0.4	2.0	<1	3.3	<1
Nutrients (mg/L)										
Dissolved Phosphorus	-	0.007	0.008	0.004	0.001	0.002	0.002	<0.001	-	0.008
Total Phosphorus	-	0.013	0.022	0.004	0.008	0.019	0.006	0.008	0.016	0.016
Ammonia Nitrogen	-	0.027	0.012	0.140	<0.020	<0.005	0.382	0.390	0.015	0.012
Nitrate	-	0.025	0.013	0.015	0.021	<0.005	0.005	0.002	<0.005	<0.005
Nitrite	-	<0.001	<0.001	0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)										
Aluminum	-	-	33	11	<1	43	<5	17	-	65
Antimony	-	-	<0.2	0.10	<0.05	0.06	<0.1	<0.1	-	<0.05
Arsenic	0.4	-	3.0	1.0	<1	1.0	0.4	0.4	-	<1
Barium	<10	-	5.22	4.32	5.17	4.85	<10	<10	-	2.51
Beryllium	<5	-	1.7	0.5	<0.5	<0.5	<5	<5	-	<0.5
Bismuth	-	-	<0.03	0.06	<0.05	<0.5	-	-	-	<0.5
Boron	-	-	32.2	15.0	16.0	17.0	-	-	-	4.0
Cadmium	<0.2	-	***0.12***	<0.2	***0.06***	<0.05	<0.2	<0.2	-	<0.05
Calcium	2080	-	20300	13400	12500	12000	14000	14600	3740	2860
Chromium	-	-	0.8	0.9	0.5	-	<1	<1	-	1.0
Cobalt	-	-	0.88	0.22	<0.1	0.10	<1	<1	-	<0.1
Copper	***3***	-	1.6	1.2	0.2	0.7	<1	<1	-	1.1
Iron	101	-	***1640***	120	30	120	90	100	222	210
Lead	1.00	-	0.38	0.10	<0.5	0.14	<1	<1	-	0.06
Lithium	<15	-	63	2	3	-	<10	<10	-	<1
Magnesium	982	-	10300	5120	4250	5050	4880	5330	967	863
Manganese	<5	-	317.0	12.1	2.7	9.2	10.0	12.0	<5	1.3
Mercury	-	-	<0.05	<0.05	-	-	-	<0.05	-	-
Molybdenum	<1	-	<0.16	0.10	0.06	<0.05	<1	<1	-	0.08
Nickel	-	-	2.6	1.2	0.4	0.1	<1	<1	-	0.6
Potassium	-	-	1800	2140	1250	1450	1530	1440	-	290
Selenium	-	-	<1	1.0	-	<0.5	<0.5	<0.5	-	<0.6
Silicon	303	-	-	-	380	90	210	250	-	340
Silver	-	-	<0.01	0.02	<0.01	0.04	<0.1	<0.1	-	<0.01
Sodium	2400	-	18500	12700	10100	11400	11200	11000	2500	2050
Strontium	6	-	35	64	57	59	90	93	10	10
Thallium	-	-	<0.03	<0.05	<0.05	<0.05	-	-	-	<0.05
Tin	-	-	<0.09	0.2	<0.1	<0.1	-	-	-	<0.1
Titanium	<10	-	0.7	0.5	<1	6.0	<10	<10	-	1.0
Tungsten	-	-	0.08	0.10	-	-	-	-	-	-
Uranium	-	-	-	-	<0.01	0.05	-	-	-	<0.01
Vanadium	-	-	<1	1.0	<1	<1	-	-	-	<1
Zinc	<5	-	5.8	7.0	<1	5.0	<5	<5	<5	2.0
Dissolved Metals (µg/L)										
Aluminum	-	-	1	2	<1	<1	7	<5	-	16
Antimony	-	-	<0.2	0.10	<0.05	<0.05	<0.1	<0.1	-	<0.05
Arsenic	-	-	1.0	1.0	<1	<1	0.4	0.3	-	<1
Barium	-	-	4.5	4.2	5.2	4.0	<10	<10	-	2.1
Beryllium	-	-	<0.5	0.5	<0.5	<0.5	<5	<5	-	<0.5
Bismuth	-	-	<0.03	0.05	<0.5	<0.5	<100	<100	-	<0.5
Boron	-	-	5.2	6.0	15.0	15.0	<100	<100	-	4.0
Cadmium	-	-	<0.07	***0.20***	<0.05	<0.05	<0.2	<0.2	-	<0.05
Calcium	-	-	14900	11700	11900	11800	13500	14800	-	2620
Chromium	-	-	0.8	0.9	0.1	-	<1	<1	-	0.2
Cobalt	-	-	<0.06	0.08	<0.1	<0.1	<1	<1	-	<0.1
Copper	-	-	<0.4	0.5	0.1	0.2	1.0	<1	-	0.8
Iron	-	-	136	10	<1	<1	<10	<10	-	70
Lead	-	-	<0.06	0.10	<0.5	<0.05	<1	<1	-	<0.05
Lithium	-	-	9	1	3	-	<10	<10	-	<1
Magnesium	-	-	6410	4450	4200	5030	4730	5370	-	634
Manganese	-	-	82.9	0.2	0.2	<0.05	<5	<5	-	0.4
Mercury	-	-	<0.05	***0.05***	-	-	-	<0.05	-	-
Molybdenum	-	-	<0.16	0.10	<0.05	<0.05	<1	<1	-	<0.05
Nickel	-	-	0.8	1.1	0.4	0.1	<1	<1	-	0.5
Potassium	-	-	1110	1500	1150	1420	1470	1400	-	290
Selenium	-	-	<1	1.0	-	<0.5	<0.5	<0.5	-	<0.5
Silicon	-	-	-	-	350	70	200	220	-	180
Silver	-	-	<0.01	0.01	<0.01	<0.01	<0.1	<0.1	-	<0.01
Sodium	-	-	11000	11200	9950	10600	11200	11200	-	1790
Strontium	-	-	31.6	58.5	56.5	55.7	87.0	93.0	-	9.8
Thallium	-	-	<0.03	0.05	<0.05	<0.05	<100	<100	-	<0.05
Tin	-	-	<0.09	0.1	<0.1	<0.1	<30	<30	-	<0.1
Titanium	-	-	0.6	0.5	<1	<1	<10	<10	-	<1
Tungsten	-	-	0.1	0.1	-	-	-	-	-	-
Uranium	-	-	-	-	<0.01	0.02	-	-	-	<0.01
Vanadium	-	-	<1	1.0	<0.1	0.4	<30	<30	-	<0.1
Zinc	-	-	<1	2.0	<1	<1	<5	<5	-	1.0
Field WQ										
Temperature (°C)	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-

Appendix A6. Analytical results for water quality samples from Boston area streams, 1992-2000.

Parameter	Fickle Duck Outflow									
	15-Jun-97	26-Jun-98	Aug-92	Aug-93	Aug-94	31-Jul-95	05-Aug-96	25-Aug-96	21-Jul-97	25-Aug-97
Physical										
Conductivity (µS/cm)	43	34	33	57	200	62	74	78	63	87
pH	***6.31***	6.84	6.60	7.17	6.80	***5.70***	7.00	7.20	6.89	6.78
Total Diss. Solids (mg/L)	23	19	27	35	160	53	70	64	54	60
Total Susp. Solids (mg/L)	10	1	-	-	27	3	74	18	2	5
Turbidity (NTU)	5.9	2.2	1.9	6.2	13.0	4.1	40.0	25.0	2.3	6.8
Dissolved Anions (mg/L)										
Hardness ($CaCO_3$)	13.6	13.7	8.7	19.6	72.0	18.0	17.0	23.0	18.9	25.3
Total Alkalinity	12.0	10.0	5.4	14.4	79.0	14.0	14.0	18.0	18.0	16.0
Chloride	3.2	3.4	-	7.9	23.0	10.0	11.6	9.6	8.5	11.9
Fluoride	0.03	0.02	-	0.03	0.05	0.04	0.05	0.05	0.04	0.08
Sulphate	2.0	<1	1.5	1.6	0.5	0.9	0.8	2.3	2.0	1.0
Nutrients (mg/L)										
Dissolved Phosphorus	0.008	-	-	0.007	0.010	0.004	0.006	0.018	0.002	0.001
Total Phosphorus	0.015	-	-	0.015	0.010	0.018	***0.039***	***0.036***	0.010	0.017
Ammonia Nitrogen	0.030	-	-	0.015	0.099	0.100	0.110	<0.005	0.133	0.397
Nitrate	0.002	-	-	<0.005	<0.005	0.006	<0.005	<0.005	<0.001	<0.001
Nitrite	0.007	-	-	0.005	0.002	0.001	<0.001	<0.001	0.010	0.010
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-
Total Metals (µg/L)										
Aluminum	***136***	72	-	-	72	***132***	43	***387***	49	***226***
Antimony	<0.1	<0.1	-	-	<0.2	0.10	<0.05	<0.05	<0.1	<0.1
Arsenic	0.1	0.2	0.5	-	<1	1.0	<1	2.0	0.3	0.3
Barium	<10	<10	-	-	6.50	4.56	4.32	7.68	<10	<10
Beryllium	-	-	-	-	<0.5	0.5	<0.5	<0.5	-	-
Bismuth	-	-	-	-	<0.03	0.09	<0.5	<0.5	-	-
Boron	-	-	-	-	10.7	8.0	5.0	<1	-	-
Cadmium	<0.2	<0.2	<0.2	-	<0.07	<0.2	***0.14***	<0.05	<0.2	<0.2
Calcium	4020	3920	1840	-	28300	5520	4810	6630	5540	6710
Chromium	<1	<1	-	-	1.0	0.7	0.8	-	<1	<1
Cobalt	<1	<1	-	-	0.96	0.08	<0.1	0.40	<1	<1
Copper	1	1	2	-	***3.5***	0.9	1.3	2	1	2
Iron	***390***	240	76	-	***2320***	***890***	180	***640***	***440***	***580***
Lead	<1	<1	<1	-	0.31	0.10	<0.5	0.15	<1	<1
Lithium	<10	<10	-	-	-	1	<1	-	-	-
Magnesium	980	1000	995	-	9560	1830	1460	1870	1520	2120
Manganese	9.0	<5	<5	-	118.0	8.7	0.2	5.9	6.0	5.0
Mercury	-	<0.05	-	-	<0.05	<0.05	-	-	-	<0.05
Molybdenum	<1	<1	<1	-	<0.16	0.10	0.13	0.23	<1	<1
Nickel	<1	<1	-	-	3.3	2.2	0.8	2.0	1.0	1.0
Potassium	720	270	-	-	3030	630	360	680	360	510
Selenium	<0.5	<0.5	-	-	<1	1.0	-	<0.5	<0.5	<0.5
Silicon	830	470	277	-	-	-	490	2590	500	1320
Silver	<0.1	<0.1	-	-	0.01	0.01	0.01	0.06	<0.1	<0.1
Sodium	2270	1740	2400	-	9430	5320	4620	4070	4120	5560
Strontium	13	23	6	-	67	24	27	29	28	35
Thallium	-	-	-	-	<0.03	0.05	<0.05	<0.05	-	-
Tin	-	-	-	-	<0.09	0.2	0.4	<0.1	-	-
Titanium	-	-	-	-	2.7	3.4	1.0	21.0	-	-
Tungsten	-	-	-	-	0.07	0.10	-	-	-	-
Uranium	-	-	-	-	-	-	0.05	<0.01	-	-
Vanadium	-	-	-	-	<1	1.0	<1	1.0	-	-
Zinc	<5	<5	<5	-	4.5	5.0	5.0	2.0	<5	<5
Dissolved Metals (µg/L)										
Aluminum	27	-	-	-	<1	28	23	98	24	53
Antimony	<0.1	-	-	-	<0.2	0.10	<0.05	<0.05	<0.1	<0.1
Arsenic	0.1	-	-	-	<1	1.0	<1	<1	0.3	0.3
Barium	<10	-	-	-	4.8	3.3	4.0	4.0	<10	<10
Beryllium	<5	-	-	-	<0.5	0.5	<0.5	<0.5	<5	<5
Bismuth	<100	-	-	-	<0.03	0.06	<0.5	<0.5	<100	<100
Boron	<100	-	-	-	<1.2	1.0	3.0	<1	<100	<100
Cadmium	<0.2	-	-	-	<0.07	***0.20***	***0.08***	<0.05	<0.2	<0.2
Calcium	3890	-	-	-	19600	4820	4570	6330	5220	6710
Chromium	<1	-	-	-	1.0	0.5	0.2	-	<1	<1
Cobalt	<1	-	-	-	<0.06	0.08	<0.1	<0.1	<1	<1
Copper	1.0	-	-	-	0.5	0.5	1.2	1.5	2.0	2.0
Iron	150	-	-	-	115	250	120	170	250	260
Lead	<1	-	-	-	<0.06	0.10	<0.5	0.05	<1	<1
Lithium	<10	-	-	-	<5	1	<1	-	<10	<10
Magnesium	940	-	-	-	5710	1560	1390	1630	1430	2080
Manganese	<5	-	-	-	1.1	0.2	<0.05	0.3	<5	<5
Mercury	-	-	-	-	<0.05	***0.05***	-	-	-	<0.05
Molybdenum	<1	-	-	-	<0.16	0.10	0.12	0.18	<1	<1
Nickel	<1	-	-	-	1.8	1.1	0.8	1.6	1.0	1.0
Potassium	690	-	-	-	1840	330	330	500	360	440
Selenium	<0.5	-	-	-	<1	1.0	-	<0.5	<0.5	<0.5
Silicon	630	-	-	-	-	-	470	1190	460	970
Silver	<0.1	-	-	-	<0.01	0.01	<0.01	<0.01	<0.1	<0.1
Sodium	1710	-	-	-	5180	4550	4360	4040	4090	5340
Strontium	13.0	-	-	-	56.5	22.6	23.3	24.8	27.0	34.0
Thallium	<100	-	-	-	<0.03	0.05	<0.05	<0.05	<100	<100
Tin	<30	-	-	-	<0.09	0.1	<0.1	<0.1	<30	<30
Titanium	<10	-	-	-	<0.5	0.5	<1	<1	<10	<10
Tungsten	-	-	-	-	<0.07	0.1	-	-	-	-
Uranium	-	-	-	-	-	-	0.04	<0.01	-	-
Vanadium	<30	-	-	-	<1	1.0	0.3	<0.7	<30	<30
Zinc	<5	-	-	-	<1	1.0	<1	2.0	<5	<5
Field WQ										
Temperature (°C)	-	-	-	-	8.8	6.0	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	12.4	***8.2***	-	-	-	-
pH	-	-	-	-	6.8	6.7	-	-	-	-

Appendix A6. Analytical results for water quality samples from Boston area streams, 1992-2000.

Parameter	Koignuk River				Reference Outflow				
	03-Jun-98	20-Jun-00	03-Aug-98	15-Sep-00	01-Jun-98	28-Jun-98	21-Jul-97	25-Aug-97	01-Aug-98
Physical									
Conductivity (µS/cm)	90	61	65	169	37	27	39	56	38
pH	6.88	7.21	6.82	7.39	6.54	6.69	6.79	6.71	6.81
Total Diss. Solids (mg/L)	74	47	48	101	38	15	32	32	34
Total Susp. Solids (mg/L)	12	10	2	6	4	<1	4	3	3
Turbidity (NTU)	36.3	10.4	3.2	8.5	3.1	1.8	2.4	3.5	2.9
Dissolved Anions (mg/L)									
Hardness ($CaCO_3$)	22.7	16.2	13.7	36.4	12.0	10.4	12.7	17.4	14.8
Total Alkalinity	11.0	9.0	8.0	14.0	10.0	8.0	11.0	13.0	12.0
Chloride	14.9	9.1	14.9	35.0	3.4	3.0	4.1	4.6	3.0
Fluoride	0.09	0.04	0.05	0.06	0.02	0.03	0.03	0.07	0.06
Sulphate	4.0	2.0	2.0	9.0	1.0	<1	1.0	2.0	1.0
Nutrients (mg/L)									
Dissolved Phosphorus	0.007	-	-	-	0.007	-	0.001	<0.001	-
Total Phosphorus	***0.051***	-	-	0.014	0.026	-	0.008	0.016	-
Ammonia Nitrogen	0.020	0.031	-	0.011	<0.005	-	0.132	0.184	-
Nitrate	0.012	0.009	-	<0.005	<0.005	-	0.003	0.004	-
Nitrite	0.001	0.001	-	<0.001	0.002	-	0.001	0.001	-
Total Organic Carbon	-	6.5	-	5.7	-	-	-	-	-
Total Metals (µg/L)									
Aluminum	***1400***	***429***	***100***	***282***	38	78	42	***133***	47
Antimony	<0.1	<0.05	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.4	0.2	0.3	0.3	0.4	0.2	0.4	0.4	0.5
Barium	20.00	6.40	<10	6.23	<10	<10	<10	<10	<10
Beryllium	<5	<0.5	<5	<0.5	<5	<5	<5	<5	<5
Bismuth	-	<0.5	-	<0.5	-	-	-	-	-
Boron	-	5.0	-	8.0	-	-	-	-	-
Cadmium	<0.2	<0.05	<0.2	<0.05	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	4070	3450	2610	6630	3160	2830	3570	4660	4010
Chromium	***3.0***	0.9	<1	0.7	<1	<1	<1	<1	<1
Cobalt	<1	0.30	<1	0.20	<1	<1	<1	<1	<1
Copper	***3***	1.5	1	1.6	2	1	2	2	2
Iron	***1200***	***560***	140	***360***	***410***	140	280	***320***	***420***
Lead	<1	0.24	<1	0.23	<1	<1	<1	<1	<1
Lithium	-	1	-	2	-	-	-	-	-
Magnesium	3100	1900	1700	4800	1000	800	990	1410	1200
Manganese	41.0	23.7	9.0	11.5	158.0	<5	6.0	6.0	13.0
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05
Molybdenum	<1	0.06	<1	0.09	<1	<1	<1	<1	<1
Nickel	2.0	1.1	<1	0.9	<1	<1	<1	<1	<1
Potassium	1940	-	650	1350	2450	320	370	510	350
Selenium	0.5	<1	0.6	<1	<0.5	<0.5	<0.5	<0.5	0.6
Silicon	3790	-	300	-	330	290	200	520	230
Silver	<0.1	0.02	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	9000	5000	6000	14900	1680	1610	2370	2620	2200
Strontium	22	-	24	-	6	15	16	19	20
Thallium	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-
Titanium	70.0	-	<10	-	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-	-
Uranium	-	0.05	-	0.05	-	-	-	-	-
Vanadium	-	<1	-	<1	-	-	-	-	-
Zinc	<5	2.0	<5	2.0	7.0	<5	<5	<5	<5
Dissolved Metals (µg/L)									
Aluminum	-	-	-	-	-	-	16	29	-
Antimony	-	-	-	-	-	-	<0.1	<0.1	-
Arsenic	-	-	-	-	-	-	0.3	0.4	-
Barium	-	-	-	-	-	-	<10	<10	-
Beryllium	-	-	-	-	-	-	<5	<5	-
Bismuth	-	-	-	-	-	-	-	-	-
Boron	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	<0.2	<0.2	-
Calcium	-	-	-	-	-	-	3510	4650	-
Chromium	-	-	-	-	-	-	<1	<1	-
Cobalt	-	-	-	-	-	-	<1	<1	-
Copper	-	-	-	-	-	-	1.0	2.0	-
Iron	-	-	-	-	-	-	140	100	-
Lead	-	-	-	-	-	-	<1	<1	-
Lithium	-	-	-	-	-	-	-	-	-
Magnesium	-	-	-	-	-	-	970	1420	-
Manganese	-	-	-	-	-	-	<5	<5	-
Mercury	-	-	-	-	-	-	-	<0.05	-
Molybdenum	-	-	-	-	-	-	<1	<1	-
Nickel	-	-	-	-	-	-	<1	<1	-
Potassium	-	-	-	-	-	-	350	490	-
Selenium	-	-	-	-	-	-	<0.5	<0.5	-
Silicon	-	-	-	-	-	-	160	350	-
Silver	-	-	-	-	-	-	<0.1	<0.1	-
Sodium	-	-	-	-	-	-	2320	2590	-
Strontium	-	-	-	-	-	-	16.0	19.0	-
Thallium	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-
Titanium	-	-	-	-	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	<5	<5	-
Field WQ									
Temperature (°C)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen (mg/L)	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-

Appendix A7. Analytical results for water quality samples from marine stations in Hope Bay, 1997-1998.

Parameter	Hope Bay							
	Station 1 23-Aug-97 1 m	**Station 1** 23-Aug-97 15m	**Station 2** 23-Aug-97 1 m	**Station 3** 23-Aug-97 1 m	**Station 1** 21-Jul-98 1 m	**Station 1** 21-Jul-98 5 m	**Station 2** 21-Jul-98 1 m	**Station 3** 21-Jul-98 1 m
Physical								
Conductivity (µS/cm)	32 500	-	15 300	34 100	27 200	48 800	34 900	42 500
pH	7.73	-	7.70	7.36	7.87	7.88	7.90	7.91
Total Dissolved Solids (mg/L)	21 700	-	11 900	17 800	21 700	25 600	18 300	22 500
Total Suspended Solids (mg/L)	4	-	2	10	9	21	10	15
Turbidity (NTU)	0.5	-	1.5	1.9	0.6	1.1	2.1	2.6
Salinity (‰)	19	-	10	-	20	-	-	-
Dissolved Anions (mg/L)		-						
Hardness ($CaCO_3$)	3 890	-	2 030	2 530	3 860	4 430	2 980	4 140
Total Alkalinity	90	-	60	80	90	103	81	94
Chloride	12 100	-	6 310	10 300	11 600	14 800	9 880	12 300
Fluoride	0.66	-	0.42	0.54	0.66	0.70	0.51	0.28
Sulphate	1 560	-	630	1 080	1 590	1 420	1 080	1 330
Nutrients (mg/L)		-						
Dissolved Phosphorus	-	-	-	0.0046	-	0.0178	0.0112	0.0112
Total Phosphorus	-	-	-	0.0180	-	0.0280	0.0180	0.0230
Ammonia Nitrogen	-	-	-	0.0086	-	0.0104	0.0037	0.0036
Nitrate - nitrogen	-	-	-	0.0039	-	0.0016	0.0008	0.0006
Nitrite - nitrogen	-	-	-	0.0009	-	<0.001	<0.001	<0.001
Dissolved Metals (µg/L)								
Antimony	<0.2	<0.2	<0.2	<0.1	<0.2	<0.1	<0.1	<0.1
Arsenic	1.0	0.5	0.4	0.4	0.6	0.8	0.4	0.6
Cadmium	0.03	0.03	0.02	0.03	0.03	0.04	0.03	0.04
Calcium	243 000	233 000	128 000	159 000	241 000	287 000	194 000	272 000
Chromium	<1	<1	<1	<1	<1	<1	<1	<1
Cobalt	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	0.64	0.49	0.64	0.71	0.49	0.59	0.81	0.79
Iron	<10	<10	<10	<10	<10	<10	10	<10
Lead	<0.05	<0.05	<0.05	0.09	0.40	0.11	0.18	0.22
Magnesium	796 000	766 000	415 000	517 000	792 000	903 000	607 000	841 000
Manganese	1.58	1.65	1.88	1.05	1.58	0.95	1.09	1.55
Mercury	0.01	0.01	0.01	0.02	0.02	<0.01	<0.01	<0.01
Molybdenum	6	7	4	6	8	9	5	7
Nickel	0.55	0.57	0.51	0.51	0.56	0.67	0.57	0.71
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	1.22	1.62	0.86	1.12	0.59	0.81	0.88	1.33
Zinc	<0.5	0.5	<0.5	0.5	0.5	0.9	1.2	2.3

APPENDIX B

PRIMARY PRODUCERS

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	AIMAOKATALOK LAKE																	
	Aug-93	Aug-94		Aug-95			04-Aug-96			04-Aug-96			24-Aug-96			24-Aug-96		
	WQ5	WQ4	WQ5	WQ5	WQ9		Station 5			Station 6			Station 5			Station 6		
					0 m	5 m	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Bacillariophyta																		
Centrales																		
Cyclotella glomerata				290.1	221.9	304.4												
Cyclotella	91.0	79.6	19.9	11.4		19.9	5.7	8.5	2.8	34.1	11.4	11.4	85.3	79.6	39.8	102.4	68.3	53.3
Melosira granulata v. angustissima																		
Melosira italica																88.2		
Melosira	*	45.5	*	5.7	56.9	28.4	2.8	<2.8	8.5	17.1	11.4	<2.8	<5.7	79.6	<2.8		37.0	88.9
Rhizosolenia																		
Pennales																		
Achnanthes minutissima				5.7	**								34.1	22.8	14.2	14.2	<2.8	<17.8
Achnanthes	22.8	17.1	14.2			**	5.7	2.8	11.4	<5.7	<5.7	2.8						<17.8
Amphora	*					**	<2.8	<2.8	<2.8				11.4			<2.8	<2.8	<17.8
Asterionella formosa				**	5.7	**	11.4	22.8	8.5	45.5	11.4	8.5	250.3	233.2	156.4	358.4	100.0	426.7
Asterionella	250.3	119.5	19.9															
Ceratoneis arcus					**	**												
Ceratoneis	*	*	*									<2.8	<5.7		<2.8	<2.8	<2.8	<17.8
Cocconeis placentula																		
Cocconeis	*	*						2.8	<2.8	<5.7		<2.8			<2.8		<2.8	
Cymatopleura			*						<2.8				<5.7	<5.7				<17.8
Cymbella minuta																		
Cymbella	11.4	11.4	2.8		**		<2.8	<2.8	<2.8	<5.7	<5.7	<2.8	34.1	34.1	<2.8	5.7	2.8	<17.8
Diatoma elongatum				39.8	11.4	**												
Diatoma tenue v. elongatum																		
Diatoma							5.7	<2.8	<2.8		<5.7	<2.8	<5.7	<5.7				<17.8
Diploneis decipiens																		
Epithemia sorex					**													
Epithemia																		
Eunotia	*	*	*			**							<5.7	<5.7		<2.8	<2.8	
Fragilaria crotonensis				28.4	5.7	14.2											<2.8	
Fragilaria	11.4	28.4	34.1		**		11.4	<2.8	<2.8	<5.7	<5.7	<2.8	34.1	11.4	11.4	17.1	17.1	<17.8
Frustulia		*	*								<5.7		5.7	<5.7		<2.8	<2.8	<17.8
Gomphonema													<5.7			<2.8		<17.8
Gyrosigma																		
Meridion																		
Navicula radiosa																		
Navicula	*	22.8	5.7		**	**	<2.8	8.5	2.8	<5.7		<2.8	45.5	17.1	<2.8	37.0	19.9	35.6
Neidium																		
Nitzschia palea																		
Nitzschia	*	*	*	**	**	**		<2.8			<5.7		11.4	<5.7		<2.8	<2.8	<17.8
Pleurosigma / Gyrosigma	*	*						2.8	<2.8			<2.8						
Stauroneis	*	*												<5.7			<2.8	<17.8
Surirella	*	*	*		**	**				<5.7	<5.7	<2.8	<5.7	<5.7	<2.8	<2.8	<2.8	<17.8
Synedra ulna					**													
Synedra	*	*															<2.8	
Tabellaria fenestrata				**				<2.8	<2.8				<5.7	<5.7	<2.8			<17.8
Tabellaria flocculosa				**	**	**			<2.8	<5.7	<5.7	<2.8	34.1	<5.7	<2.8	17.1	22.8	<17.8
Tabellaria	*	*	*															
Chlorophyta																		
Chlorococcales																		
Ankistrodesmus falcatus							37.0	37.0	37.0	56.9	5.7	5.7	11.4	<5.7	5.7	2.8	2.8	<17.8
Ankistrodesmus	17.1	51.2	56.9	5.7	5.7	8.5												
Botryococcus braunii				**	45.5	**	<2.8	<2.8	91.0	<5.7	364.1	91.0	<5.7	227.6	34.1	182.0	<2.8	<17.8
Botryococcus	*	91.0	*															
Coelastrum													<5.7	<5.7				<17.8
Crucigenia quadrata				45.5	22.8	**	147.9	76.8	250.3	341.3	273.1	22.8	45.5	22.8	34.1	68.3	11.4	853.3
Crucigenia rectangularis										<5.7	45.5			<5.7				
Crucigenia tetrapedia				**	45.5		238.9	221.9	56.9	68.3	113.8	11.4	386.8	1 035.4	750.9	421.0	625.8	2 204.4
Crucigenia	819.2	91.0	159.3															
Dictyosphaerium pulchellum					**													
Dictyosphaerium								22.8	<2.8	<5.7	<5.7	<2.8	<5.7	45.5	<2.8	<2.8	<2.8	<17.8
Dictyosphaerius	*	113.8	*															
Elakatothrix gelatinosa																		
Elakatothrix	*	11.4	*	**	45.5	11.4	22.8	11.4	8.5	17.1	39.8	<2.8	<5.7	22.8	17.1	8.5	8.5	<17.8
Kirchneriella														<5.7				
Lagerheimia																		
Nephrocytium	22.8	*	11.4				<2.8	<2.8	11.4	22.8	<5.7	22.8		<5.7	<2.8		<2.8	
Oocystis lacustris																		
Oocystis	22.8	*	*	**			<2.8	<2.8	<2.8	<5.7	22.8	<2.8	<5.7	<5.7	<2.8	62.6	<2.8	<17.8
Pediastrum	*	*	*	**	**	22.8	<2.8	<2.8	<2.8	<5.7	<5.7	14.2	79.6	<5.7		<2.8		<17.8
Quadrigula	45.5	*			**				<2.8				<5.7		<2.8			
Scenedesmus quadricauda																		
Scenedesmus	45.5	68.3	5.7	**	**	11.4	11.4	45.5	<2.8	22.8	<5.7	<2.8	22.8	45.5	22.8	22.8	22.8	142.2
Schroederia setigera																		
Selenastrum minutum																		
Selenastrum			*															
Sphaerocystis schroeteri				**	409.6	**	59.3	113.8	39.8	56.9	227.6	11.4	<5.7	364.1		17.1	<2.8	
Sphaerocystis	91.0	91.0	91.0															
Tetraedron minimum					**	**												
Tetraedron	*	*	11.4				<2.8			<5.7		<2.8	<5.7	<5.7				
Treubaria																		
Euglenales																		
Euglena											<5.7							
Phacus					**													
Trachelomonas																		<17.8
Oedogoniales																		
Oedogonium																	<2.8	
Tetrasporales																		
Gloeocystis ampla							110.9	37.0	62.6	142.2	56.9	142.2	45.5	<5.7	<2.8	119.5	34.1	391.1
Gloeocystis	85.3	*	5.7	11.4	**													
Ulothricales																		
Geminella	*																	
Ulothrix		*																

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	AIMAOKATALOK LAKE																	
	Aug-93	**Aug-94**		**Aug-95**			**04-Aug-96**			**04-Aug-96**			**24-Aug-96**			**24-Aug-96**		
	WQ5	**WQ4**	**WQ5**	**WQ5**	**WQ9**		**Station 5**			**Station 6**			**Station 5**			**Station 6**		
					0 m	**5 m**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**
Chlorophyta																		
Ulvales																		
Shcizomeris		*																
Volvocales																		
Carteria																		
Chlamydomonas	5.7	*					2.8	8.5	5.7	<5.7	5.7	5.7	<5.7	<5.7			<2.8	<17.8
Eudorina	*	*	*															<17.8
Zygnematales																		
Arthrodesmus	*	*	2.8	**	**		<2.8	<2.8	<2.8	<5.7	<5.7	<2.8	<5.7	5.7	<2.8	<2.8	<2.8	<17.8
Closteriopsis																		
Closterium																		
Cosmarium		*					2.8		<2.8		<5.7	<2.8	<5.7	<5.7	<2.8		2.8	<17.8
Euastrum																		
Gonatozygon		*											<5.7					
Hyalotheca																		
Mougeotia																		
Pleurotaenium				**														
Spondylosium planum				5.7	**	**	11.4	79.6	5.7	34.1	22.8	71.1	142.2	5.7	34.1	11.4	34.1	71.1
Spondylosium	11.4	28.4	8.5															
Staurastrum paradoxum																		
Staurastrum	*	*		**		**			<2.8		<5.7	<2.8		<5.7	<2.8	<2.8	<2.8	<17.8
Xanthidium				**	**	**					<5.7	<2.8						
Zygnema		*																
Chrysophyta																		
Ochromonadales																		
Chrysosphaerella longispina											<5.7	<2.8						
Dinobryon bavaricum																		
Dinobryon cylindricum							<2.8	31.3	11.4	45.5	11.4	11.4	28.4	45.5	28.4	8.5		53.3
Dinobryon bavaricum / cylindricum				68.3	**	48.4												
Dinobryon divergens				**	**		<2.8	<2.8				<2.8		<5.7				
Dinobryon elegantissimum				5.7	28.4	45.5	2.8	<2.8	<2.8	<5.7	<5.7							17.8
Dinobryon sertularia				56.9	5.7	45.5	14.2	8.5	22.8	<5.7	17.1	2.8						
Dinobryon sociale																		
Dinobryon	11.4	5.7	65.4	**									11.4		<2.8	5.7	2.8	17.8
Mallomonas akrokomoos																		
Mallomonas pseudocoronata																		
Mallomonas	*	5.7	*		**	2.8	<2.8	2.8	2.8	<5.7	5.7		<5.7	5.7	2.8	2.8	<2.8	<17.8
Ochromonas																		
Uroglenopsis americana																		
Prymnesiales																		
Chrysochromulina																		
Rhizochrysidales																		
Diceras phaseolus							<2.8	<2.8	<2.8			<2.8				<2.8		
Diceras	*	5.7			**													
Unidentified flagellate																		
Cryptophyta																		
Cryptomonadales																		
Chroomonas acuta				96.7	56.9	65.4	207.6	122.3	125.2	136.5	159.3	48.4	147.9	79.6	39.8	71.1	22.8	35.6
Chroomonas	256.0	130.8	85.3															
Cryptomonas ovata / erosa				5.7	11.4	17.1												
Cryptomonas ovata																		
Cryptomonas	45.5	5.7	11.4				39.8	22.8	37.0	<5.7	17.1	5.7	22.8	5.7	<2.8	25.6	17.1	<17.8
Cyanophyta																		
Chroococcales																		
Agmenellum tenuissima																		<17.8
Agmenellum	*	*	22.8	**	**	**		<2.8				<2.8						
Anacystis elachista				**	**								1 001.2	227.6	56.9	156.4	341.3	355.6
Anacystis limneticus																		
Anacystis	341.3	22.8	*	**	**	**	<2.8	11.4	<2.8	<5.7	<5.7	<2.8	<5.7	<5.7	<2.8	<2.8	<2.8	<17.8
Aphanizomenon flos-aquae													<5.7	45.5	<2.8	<2.8		
Gloeocapsa																		
Gomphosphaeria pallidum							227.6	682.7	512.0	625.8	910.2	128.0	<5.7					355.6
Gomphosphaeria	796.0	824.9	298.7		**								<5.7	<5.7	<2.8	<2.8	<2.8	
Merismopedia																		
Pseudanabaena catenata																<2.8		
Rhabdoderma												<2.8						
Nostocales																		
Anabaena affinis																		
Anabaena flos-aquae																		
Anabaena helicoidea																		
Anabaena planctonica																		
Anabaena	*	*	*	**	**	**	<2.8	<2.8	<2.8	<5.7	<5.7	<2.8	<5.7	<5.7		<2.8	<2.8	<17.8
Gloeotrichia																		
Nostoc							<2.8											
Oscillatoriales																		
Lyngbya limnetica				182.0	153.6	17.1	438.0	256.0	238.9	802.1	250.3	304.4	853.3	540.4	156.4	492.1	179.2	1 422.2
Lyngbya	216.2	45.5	*															
Oscillatoria tenuis				705.4	608.7	475.0												
Oscillatoria	*	*																
Pyrrophyta																		
Dinokontae																		
Gymnodinium																		
Peridinium inconspicuum				5.7	**		2.8	14.2	2.8	5.7	5.7	2.8	<5.7	11.4	11.4	<2.8		<17.8
Peridinium	*	*	*															
Peridinium / Glenodinium				5.7	11.4	8.5	<2.8	<2.8	<2.8	<5.7	<5.7	<2.8	<5.7	5.7		2.8	<2.8	<17.8
TOTAL	**3 220**	**1 917**	**933**	**1 582**	**1 752**	**1 146**	**1 621**	**1 855**	**1 556**	**2 475**	**2 589**	**925**	**3 345**	**3 220**	**1 416**	**2 321**	**1 573**	**6 525**

NOTES: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	AIMAOKATALOK LAKE																	
	24-Jul-97			22-Jul-97			24-Jul-97			26-Aug-97			26-Aug-97			25-Aug-97		
	Station 1			Station 5			Station 6			Station 1			Station 5			Station 6		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Bacillariophyta																		
Centrales																		
Cyclotella glomerata														3.0		58.8	52.3	46.8
Cyclotella			2.2	2.0	1.0	5.0	1.0	3.0	7.0	21.8	30.0	24.2	15.0	21.0	12.0	13.4	26.2	31.2
Melosira granulata v. angustissima	<1.7				<1.0	<1.0	3.0	4.0	6.0	21.8	<2.0	77.0	14.0	27.0	22.0	21.8	52.3	21.8
Melosira italica																		
Melosira																	<2.2	18.7
Rhizosolenia				3.0	8.0	1.0	3.0	7.0	1.0						4.0	13.4		
Pennales																		
Achnanthes minutissima	1.7	8.7	4.4							15.3		<2.2				3.4		
Achnanthes	6.8	2.2								<2.2	2.0	4.4	<1.0	1.0			2.2	
Amphora																		
Asterionella formosa	3.4	<2.2	4.4	<1.0	4.0	<1.0	4.0	5.0	22.0	26.2	54.0	41.8	14.0	<1.0	4.0	18.5	32.7	6.2
Asterionella																		
Ceratoneis arcus																		
Ceratoneis																		
Cocconeis placentula																		
Cocconeis																		
Cymatopleura																		
Cymbella minuta																		
Cymbella	<1.7									4.4			<1.0	<1.0				
Diatoma elongatum																		
Diatoma tenue v. elongatum	22.1	<2.2	2.2	2.0	<1.0	3.0	2.0		2.0	13.1	6.0	17.6	1.0	5.0	<1.0	5.0	6.5	6.2
Diatoma																		
Diploneis decipiens																		
Epithemia sorex																		
Epithemia																		
Eunotia																		
Fragilaria crotonensis										8.7	4.0					<1.7		
Fragilaria	3.4	4.4	<2.2	1.0	<1.0		2.0		2.0	19.6	8.0	41.8	14.0	25.0	12.0	35.3	13.1	12.5
Frustulia																		
Gomphonema		<2.2	<2.2													<1.7		
Gyrosigma	1.7																	
Meridion																		
Navicula radiosa																		
Navicula								<1.0		<2.2	2.0	2.2					2.2	
Neidium														1.0				
Nitzschia palea		<2.2	6.5							<2.2		<2.2				<1.7		
Nitzschia																		
Pleurosigma / Gyrosigma																		
Stauroneis														1.0				
Surirella		<2.2																
Synedra ulna																		
Synedra	<1.7									<2.2								
Tabellaria fenestrata																	<2.2	
Tabellaria flocculosa	5.1	4.4	6.5				<1.0			21.8	10.0	13.2	<1.0	3.0		1.7		3.1
Tabellaria																		
Chlorophyta																		
Chlorococcales																		
Ankistrodesmus falcatus	<1.7	<2.2	8.7	3.0	<1.0	<1.0				13.1		4.4	<1.0	2.0			2.2	
Ankistrodesmus	27.2	21.8	30.5		1.0	4.0	3.0		1.0	4.4	22.0	4.4	10.0	4.0	2.0	10.1	6.5	3.1
Botryococcus braunii																		<3.1
Botryococcus																		
Coelastrum																		
Crucigenia quadrata																		
Crucigenia rectangularis	6.8	<2.2							<1.0	26.2	8.0	8.8	16.0	8.0	4.0	<1.7	17.4	37.4
Crucigenia tetrapedia											<2.0				8.0	23.5	8.7	
Crucigenia						4.0				87.2	32.0		32.0	16.0	16.0	27.2	34.9	49.9
Dictyosphaerium pulchellum																		
Dictyosphaerium																		
Dictyosphaerius																		
Elakatothrix gelatinosa						2.0			1.0	<2.2	4.0	8.8				<1.7		6.2
Elakatothrix			<2.2	<1.0									3.0	2.0	<1.0		10.9	
Kirchneriella											<2.0					3.4		3.1
Lagerheimia																		
Nephrocytium																		
Oocystis lacustris													4.0			20.2		
Oocystis								<1.0							<1.0			
Pediastrum		<2.2	2.2						1.0	<2.2	<2.0			1.0				
Quadrigula																		
Scenedesmus quadricauda																		
Scenedesmus	6.8	<2.2	13.1						8.0	26.2	8.0	8.8	16.0	8.0	<1.0	<1.7	8.7	<3.1
Schroederia setigera																		
Selenastrum minutum																		
Selenastrum																		
Sphaerocystis schroeteri	71.4		<2.2	20.0	16.0	3.0				<2.2	160.0		4.0	35.0	10.0	<1.7		<3.1
Sphaerocystis																		
Tetraedron minimum																		
Tetraedron																		
Treubaria																		
Euglenales																		
Euglena																		
Phacus																		
Trachelomonas																		
Oedogoniales																		
Oedogonium																		
Tetrasporales																		
Gloeocystis ampla																		
Gloeocystis						3.0		<1.0	4.0				<1.0	<1.0	24.0			
Ulothricales																		
Geminella																		
Ulothrix																		

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	AIMAOKATALOK LAKE																	
	24-Jul-97			22-Jul-97			24-Jul-97			26-Aug-97			26-Aug-97			25-Aug-97		
	Station 1			Station 5			Station 6			Station 1			Station 5			Station 6		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Chlorophyta																		
Ulvales																		
Shcizomeris																		
Volvocales																		
Carteria								<1.0		<2.2	<2.0							
Chlamydomonas																		
Eudorina	1.7																	
Zygnematales																		
Arthrodesmus											<2.0	<2.2		<1.0				
Closteriopsis																		
Closterium																		
Cosmarium	6.8										<2.0	2.2	3.0	1.0		1.7	<2.2	
Euastrum	<1.7	<2.2	2.2											1.0				
Gonatozygon																		
Hyalotheca																		
Mougeotia																5.0		
Pleurotaenium																		
Spondylosium planum	5.1	8.7	2.2				<1.0			<2.2	<2.0	<2.2				10.1	13.1	
Spondylosium																		
Staurastrum paradoxum																		
Staurastrum		4.4	<2.2							<2.2								
Xanthidium																		
Zygnema																		
Chrysophyta																		
Ochromonadales																		
Chrysosphaerella longispina																		
Dinobryon bavaricum	17.0	48.0	26.2	38.0	12.0	102.0	<1.0	12.0	21.0	2.2	4.0	15.4	22.0	11.0	2.0	8.4	13.1	15.6
Dinobryon cylindricum																		
Dinobryon bavaricum / cylindricum																		
Dinobryon divergens																		
Dinobryon elegantissimum																		
Dinobryon sertularia		65.4	<2.2	12.0	7.0	13.0	10.0	11.0	9.0	13.1	<2.0	2.2	<1.0	2.0	4.0	21.8	17.4	
Dinobryon sociale	42.5	8.7	34.9	14.0	47.0	38.0	23.0	15.0	12.0	6.5	6.0	26.4						
Dinobryon	<1.7		4.4	1.0	<1.0	1.0											24.0	<3.1
Mallomonas akrokomoos																		
Mallomonas pseudocoronata																		
Mallomonas	<1.7	4.4	4.4	1.0	<1.0	1.0		1.0	8.0	8.7	8.0	2.2	2.0	3.0	3.0	1.7	<2.2	9.4
Ochromonas	11.9	4.4	6.5	2.0	2.0	4.0		5.0	4.0	17.4	6.0	11.0	8.0	2.0	5.0	57.1	63.2	18.7
Uroglenopsis americana																		
Prymnesiales																		
Chrysochromulina																3.4		
Rhizochrysidales																		
Diceras phaseolus																		
Diceras															1.0			
Unidentified flagellate																		
Cryptophyta																		
Cryptomonadales																		
Chroomonas acuta	6.8	8.7	2.2	1.0	3.0	5.0	16.0	17.0	23.0	4.4	6.0	<2.2	4.0		<1.0	5.0	24.0	40.6
Chroomonas																		
Cryptomonas ovata / erosa																		
Cryptomonas ovata	1.7	4.4					<1.0	<1.0	4.0			11.0				16.8	15.3	9.4
Cryptomonas	5.1	6.5	2.2	2.0	1.0	8.0	8.0	4.0	11.0	15.3	14.0	35.2	13.0	9.0	9.0	6.7	15.3	9.4
Cyanophyta																		
Chroococcales																		
Agmenellum tenuissima																		
Agmenellum																		
Anacystis elachista																		
Anacystis limneticus																		
Anacystis		132.0		20.0	10.0			10.0	10.0		40.0			60.0	10.0			
Aphanizomenon flos-aquae																		
Gloeocapsa											<2.0							
Gomphosphaeria pallidum																		
Gomphosphaeria							<1.0	4.0			<2.0	26.4	30.0	22.0		<1.7	<2.2	<3.1
Merismopedia	20.4																	
Pseudanabaena catenata																		
Rhabdoderma																		
Nostocales																		
Anabaena affinis	<1.7		<2.2							<2.2	<2.0	<2.2	6.0	8.0	16.0			
Anabaena flos-aquae																		
Anabaena helicoidea																		
Anabaena planctonica														<1.0				
Anabaena				<1.0							<2.0					43.7		<3.1
Gloeotrichia																		
Nostoc																		
Oscillatoriales																		
Lyngbya limnetica			<2.2	<1.0	<1.0		45.0				52.0	26.4	66.0	90.0	65.0	<1.7	87.2	<3.1
Lyngbya																		
Oscillatoria tenuis																		
Oscillatoria			<2.2	30.0		<1.0	<1.0			21.8	<2.0	99.0	<1.0	<1.0	30.0			
Pyrrophyta																		
Dinokontae																		
Gymnodinium	1.7	2.2	<2.2		1.0	1.0	<1.0	<1.0			<2.0			1.0	<1.0			
Peridinium inconspicuum																		
Peridinium	1.7	15.3	13.1			1.0			<1.0	2.2	4.0	<2.2	4.0	2.0			2.2	<3.1
Peridinium / Glenodinium																		
TOTAL	**279**	**355**	**179**	**152**	**113**	**199**	**120**	**98**	**157**	**401**	**490**	**515**	**301**	**375**	**263**	**437**	**552**	**349**

NOTES: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	AIMAOKATALOK LAKE						STICKLEBACK LAKE										
	18-Jul-98 Station 4			18-Jul-98 Station 6			Aug-94	Aug-95	05-Aug-96			25-Aug-96			23-Jul-97		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3			Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Bacillariophyta																	
Centrales																	
Cyclotella glomerata			16.8	<11.4	<11.4	<2.8											
Cyclotella	<2.8	<5.7	8.4	<11.4	<11.4	11.2	11.4	**		<17.8		5.7	<2.8		<2.0	8.0	
Melosira granulata v. angustissima																	
Melosira italica																	
Melosira	22.4	11.4	<2.8	<11.4	<11.4	33.6	*										
Rhizosolenia																	
Pennales																	
Achnanthes minutissima	25.2	79.8	11.2	22.8	<11.4	8.4		5.7				136.5	187.7	315.7			<2.0
Achnanthes						<2.8	113.8		<5.7	53.3	177.8				2.0		
Amphora			<2.8							<17.8		2.8	<2.8				
Asterionella formosa	11.2	39.9	16.8	<11.4	<11.4	<2.8		11.4	91.0	515.6	88.9	102.4	76.8	74.0	48.0	4.0	12.0
Asterionella							153.6										
Ceratoneis arcus																	
Ceratoneis		<5.7	<2.8		<11.4		*		<5.7			<2.8	<2.8				
Cocconeis placentula																	
Cocconeis	<2.8							2.8		<17.8		2.8	5.7	<2.8			
Cymatopleura	<2.8	<5.7		11.4	<11.4	<2.8											
Cymbella minuta		<5.7	<2.8	<11.4	<11.4	<2.8											
Cymbella			2.8	<11.4	<11.4		11.4	**	17.1	<17.8	<17.8	37.0	17.1	28.4			
Diatoma elongatum			<2.8		11.4												
Diatoma tenue v. elongatum															26.0	160.0	136.0
Diatoma	<2.8	<5.7				2.8	*				<17.8	5.7	2.8	<2.8			
Diploneis decipiens																	
Epithemia sorex								**									
Epithemia												<2.8	<2.8	<2.8			
Eunotia	<2.8	<5.7		<11.4	<11.4		*	**		<17.8	<17.8	<2.8	<2.8	<2.8			
Fragilaria crotonensis		11.4	5.6	34.2	11.4	22.4		2.8	17.1								
Fragilaria		5.7	<2.8	<11.4		<2.8	17.1		<5.7	<17.8	88.9	11.4	22.8	<2.8	6.0	12.0	20.0
Frustulia												<2.8					
Gomphonema	<2.8			11.4	<11.4		*	2.8		<17.8	<17.8	<2.8	<2.8	<2.8			
Gyrosigma																	
Meridion								**									
Navicula radiosa																	
Navicula	<2.8	5.7	<2.8	<11.4	<11.4	36.4	11.4	2.8	5.7	<17.8	17.8	14.2	34.1	5.7			
Neidium																	
Nitzschia palea																	
Nitzschia		5.7	2.8		<11.4	<2.8	5.7			<17.8	<17.8	<2.8		<2.8			
Pleurosigma / Gyrosigma	<2.8							**	<5.7			<2.8	<2.8				
Stauroneis							*				<17.8	<2.8	<2.8	<2.8			
Surirella	5.6	<5.7	<2.8	<11.4	<11.4	<2.8						<2.8					
Synedra ulna																	
Synedra	2.8		<2.8	<11.4		<2.8	*	**	5.7	<17.8	<17.8		<2.8				
Tabellaria fenestrata				<11.4													
Tabellaria flocculosa	<2.8	<5.7	<2.8	91.2	<11.4							<2.8	<2.8	<2.8			
Tabellaria							*										
Chlorophyta																	
Chlorococcales																	
Ankistrodesmus falcatus									56.9	266.7	88.9	108.1	74.0	187.7			
Ankistrodesmus	16.8	28.5	58.8	91.2	34.2	47.6	392.5	2.8							4.0	10.0	6.0
Botryococcus braunii	33.6	<5.7	<2.8	<11.4	<11.4	<2.8		**	<5.7	<17.8	<17.8	<2.8	<2.8				
Botryococcus							*										
Coelastrum		<5.7											<2.8				
Crucigenia quadrata	<2.8		22.4		91.2			**	45.5	<17.8	71.1	22.8	22.8	<2.8			
Crucigenia rectangularis															8.0		
Crucigenia tetrapedia	<2.8	22.8	11.2	45.6		<2.8		45.5	45.5	853.3	355.6	250.3	34.1	136.5			8.0
Crucigenia	<2.8		<2.8	<11.4		<2.8	455.1										
Dictyosphaerium pulchellum																	
Dictyosphaerium		<5.7							<5.7		71.1	<2.8	<2.8	<2.8			
Dictyosphaerius							*										
Elakatothrix gelatinosa																	
Elakatothrix	<2.8	<5.7	<2.8	<11.4	<11.4			**	<5.7	<17.8	<17.8			<2.8		6.0	2.0
Kirchneriella												<2.8	17.1			16.0	
Lagerheimia				<11.4			22.8										
Nephrocytium			<2.8				22.8		<5.7	<17.8	<17.8		<2.8	<2.8			
Oocystis lacustris																	
Oocystis	<2.8	<5.7	<2.8						<5.7	35.6	<17.8			<2.8			
Pediastrum	<2.8	<5.7	<2.8		<11.4	<2.8	*	**	<5.7	<17.8	<17.8	22.8	<2.8	<2.8	<2.0		
Quadrigula																	
Scenedesmus quadricauda	22.4	<5.7	22.4		45.6	<2.8		96.7									
Scenedesmus	<2.8	22.8	<2.8	<11.4	<11.4	<2.8	113.8		91.0	71.1	355.6	79.6	<2.8	11.4	16.0		
Schroederia setigera																	
Selenastrum minutum													<2.8				
Selenastrum			<2.8					2.8									
Sphaerocystis schroeteri	<2.8	<5.7	<2.8		91.2			**	22.8	<17.8							
Sphaerocystis																	
Tetraedron minimum								76.8									
Tetraedron	<2.8	5.7	<2.8	<11.4	22.8		74.0		<5.7	302.2	142.2	34.1	22.8	11.4			
Treubaria					<11.4												
Euglenales																	
Euglena	<2.8											<2.8					
Phacus														<2.8			
Trachelomonas								**	<5.7			<2.8	<2.8	<2.8			
Oedogoniales																	
Oedogonium											<17.8	<2.8		<2.8			
Tetrasporales																	
Gloeocystis ampla	11.2								<5.7	<17.8	160.0	2.8		68.3			
Gloeocystis							*										
Ulothricales																	
Geminella																	
Ulothrix	<2.8		<2.8				*										

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	**AIMAOKATALOK LAKE**						**STICKLEBACK LAKE**										
	18-Jul-98 Station 4			**18-Jul-98 Station 6**			**Aug-94**	**Aug-95**	**05-Aug-96**			**25-Aug-96**			**23-Jul-97**		
	Rep 1	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**			**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**
Chlorophyta																	
Ulvales																	
Shcizomeris																	
Volvocales																	
Carteria																<2.0	
Chlamydomonas	2.8	<5.7					*			<17.8	<17.8	2.8	<2.8				
Eudorina		<5.7	<2.8									<2.8					
Zygnematales																	
Arthrodesmus	<2.8	<5.7	<2.8	<11.4	<11.4						<17.8	<2.8	<2.8				
Closteriopsis																	
Closterium						<2.8							<2.8	<2.8			
Cosmarium							*		<5.7		<17.8	<2.8	<2.8	<2.8			
Euastrum																	
Gonatozygon		<5.7											<2.8				
Hyalotheca																	
Mougeotia							*					<2.8					
Pleurotaenium																	
Spondylosium planum	<2.8	5.7	<2.8	<11.4	<11.4	<2.8			22.8	35.6	17.8		<2.8	5.7			
Spondylosium							11.4										
Staurastrum paradoxum																	
Staurastrum		<5.7					*	**		<17.8	<17.8	<2.8	<2.8				
Xanthidium		<5.7		<11.4									<2.8				
Zygnema																	
Chrysophyta																	
Ochromonadales																	
Chrysosphaerella longispina																	
Dinobryon bavaricum	39.2	57.0	56.0	79.8	45.6	25.2									2.0		4.0
Dinobryon cylindricum									96.7					<2.8			
Dinobryon bavaricum / cylindricum								**									
Dinobryon divergens	44.8	68.4	53.2	91.2	34.2	100.8		19.9			<17.8	56.9	125.2				
Dinobryon elegantissimum	<2.8			<11.4													
Dinobryon sertularia								**							2.0	12.0	34.0
Dinobryon sociale															94.0	130.0	94.0
Dinobryon	16.8	114.0	61.6	125.4	102.6	75.6	*			320.0	<17.8	2.8	11.4	2.8	2.0		2.0
Mallomonas akrokomoos		<5.7															
Mallomonas pseudocoronata	11.2	17.1	25.2	34.2	22.8	<2.8											
Mallomonas			<2.8											<2.8			
Ochromonas															14.0	<2.0	20.0
Uroglenopsis americana				<11.4													
Prymnesiales																	
Chrysochromulina																	
Rhizochrysidales																	
Diceras phaseolus				<11.4													
Diceras																	
Unidentified flagellate	<2.8	<5.7	<2.8	<11.4	<11.4	<2.8			<5.7	<17.8	<17.8						
Cryptophyta																	
Cryptomonadales																	
Chroomonas acuta	98.0	119.7	53.2	91.2	364.8	173.6		162.1	102.4	106.7	160.0	184.9	91.0	139.4	14.0	6.0	30.0
Chroomonas							256.0										
Cryptomonas ovata / erosa								14.2									
Cryptomonas ovata															6.0	8.0	<2.0
Cryptomonas	25.2	17.1	25.2	45.6	68.4	44.8	17.1		51.2	160.0	35.6	25.6	39.8	19.9	36.0	30.0	28.0
Cyanophyta																	
Chroococcales																	
Agmenellum tenuissima	<2.8		<2.8	410.4	410.4	134.4											
Agmenellum							*										
Anacystis elachista					<11.4	<2.8		**	3 185.8	7 217.8	7 857.8	355.6	227.6	412.4			
Anacystis limneticus	22.4	<5.7		<11.4	182.4	134.4											
Anacystis	<2.8	<5.7	<2.8	<11.4			2 104.9	**					<2.8	<2.8	120.0	150.0	
Aphanizomenon flos-aquae																	
Gloeocapsa																	
Gomphosphaeria pallidum	<2.8		<2.8														
Gomphosphaeria							*						<2.8				
Merismopedia																	
Pseudanabaena catenata												<2.8					
Rhabdoderma									<5.7	<17.8	<17.8						
Nostocales																	
Anabaena affinis			<2.8														
Anabaena flos-aquae																	
Anabaena helicoidea																	
Anabaena planctonica																	
Anabaena	<2.8		<2.8	<11.4			*	**	<5.7	<17.8		<2.8	<2.8	<2.8		196.0	
Gloeotrichia													<2.8	<2.8			
Nostoc																	
Oscillatoriales																	
Lyngbya limnetica	78.4	108.3	<2.8	524.4	399.0	106.4		**	<5.7	144.0	<17.8	<2.8	187.7	<2.8		<2.0	
Lyngbya	<2.8						*										
Oscillatoria tenuis	299.6	575.7	137.2	433.2	<11.4	<2.8		51.2				<2.8	<2.8	<2.8			
Oscillatoria							159.3		<5.7	<17.8	<17.8				<2.0		20.0
Pyrrophyta																	
Dinokontae																	
Gymnodinium															<2.0		<2.0
Peridinium inconspicuum	5.6	11.4	<2.8	11.4	<11.4	2.8		34.1	79.6	53.3	71.1	28.4	28.4	5.7			
Peridinium							45.5								8.0	8.0	2.0
Peridinium / Glenodinium	5.6	<5.7	<2.8	<11.4	<11.4	<2.8		**	<5.7	35.6	17.8	2.8	2.8	2.8			
TOTAL	**801**	**1 334**	**591**	**2 155**	**1 938**	**960**	**4 000**	**534**	**3 937**	**10 171**	**9 778**	**1 499**	**1 232**	**1 428**	**408**	**756**	**418**

NOTES: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	STICKLEBACK LAKE						FICKLE DUCK LAKE										
	26-Aug-97			19-Jul-98			Aug-95	05-Aug-96			25-Aug-96			23-Jul-97		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Bacillariophyta																	
Centrales																	
Cyclotella glomerata																	
Cyclotella		<2.0					39.8	2.8	<5.7		2.8			<1.0	<1.0	
Melosira granulata v. angustissima																	
Melosira italica																	
Melosira					<35.6								<2.8			
Rhizosolenia																	
Pennales																	
Achnanthes minutissima		<2.0	<4.4	106.8	106.8	35.6				<5.7	19.9	<2.8	<2.8			
Achnanthes			<4.4					14.2	<5.7							
Amphora					<35.6			2.8	5.7		<2.8					
Asterionella formosa		<2.0	<4.4	<17.8	<35.6		17.1	<2.8	17.1	45.5	5.7	<2.8	5.7	9.0	11.0	9.0
Asterionella																	
Ceratoneis arcus																	
Ceratoneis						<17.8		2.8	<5.7		<2.8					
Cocconeis placentula	2.0															
Cocconeis					<35.6	<17.8			<5.7							
Cymatopleura					<35.6	<17.8			<5.7		<2.8	<2.8	<2.8			
Cymbella minuta																	
Cymbella				<17.8	<35.6		**	2.8	<5.7	<5.7	5.7	<2.8	5.7	<1.0		1.0
Diatoma elongatum							11.4									
Diatoma tenue v. elongatum		<2.0												4.0	1.0	
Diatoma				<17.8	<35.6	17.8		<2.8	<5.7	5.7	2.8		2.8			
Diploneis decipiens																	
Epithemia sorex																	
Epithemia									<5.7		<2.8		<2.8			
Eunotia					<35.6	<17.8	**		<5.7	<5.7	<2.8	2.8	<2.8			
Fragilaria crotonensis			<4.4			71.2	**		39.8	51.2						
Fragilaria	2.0	<2.0	4.4	<17.8	35.6	<17.8	**	22.8	<5.7	<5.7	<2.8	5.7	8.5	4.0	3.0	3.0
Frustulia																	
Gomphonema		2.0				<17.8		<2.8	<5.7		<2.8					<1.0
Gyrosigma																	
Meridion																	
Navicula radiosa																	
Navicula			4.4	<17.8	<35.6	<17.8	5.7	5.7	5.7	<5.7	<2.8	2.8	17.1			
Neidium																	
Nitzschia palea																	
Nitzschia				<17.8	<35.6			<2.8	<5.7	<5.7	<2.8	<2.8				
Pleurosigma / Gyrosigma					<35.6		**		<5.7		<2.8		<2.8			
Stauroneis						<17.8		<2.8					<2.8			
Surirella					<35.6	<17.8		<2.8			<2.8					
Synedra ulna																	
Synedra											<2.8	<2.8	5.7			
Tabellaria fenestrata							**				<2.8	<2.8	<2.8			
Tabellaria flocculosa							22.8	<2.8	34.1	5.7	22.8	68.3	34.1			<1.0
Tabellaria				<17.8												
Chlorophyta																	
Chlorococcales																	
Ankistrodesmus falcatus								5.7	74.0	34.1	11.4	2.8	17.1			
Ankistrodesmus	20.0	22.0	165.7	<17.8	35.6	<17.8	17.1									<1.0
Botryococcus braunii						<17.8	45.5	<2.8	<5.7	<5.7	<2.8	<2.8	<2.8			
Botryococcus																	
Coelastrum																	
Crucigenia quadrata					<35.6	<17.8	91.0	22.8	91.0	<5.7			<2.8			
Crucigenia rectangularis			70.4													
Crucigenia tetrapedia	<2.0	8.0	35.2	71.2	142.4	<17.8	22.8	307.2	295.8	165.0	68.3	22.8	68.3			8.0
Crucigenia														<1.0		<1.0
Dictyosphaerium pulchellum																	
Dictyosphaerium													<2.8			
Dictyosphaerius																	
Elakatothrix gelatinosa																	
Elakatothrix					<35.6		22.8	5.7	<5.7	56.9		<2.8	<2.8			
Kirchneriella				<17.8						<5.7						
Lagerheimia				<17.8	<35.6	<17.8										
Nephrocytium							**	45.5	<5.7	<5.7		<2.8				
Oocystis lacustris																	
Oocystis					<35.6		**		<5.7				<2.8			
Pediastrum				<17.8	<35.6	<17.8	**	42.7	182.0	45.5	<2.8	<2.8	22.8			1.0
Quadrigula								<2.8	<5.7			5.7				
Scenedesmus quadricauda																	
Scenedesmus	8.0		17.6	<17.8	<35.6	71.2		22.8	<5.7	<5.7	<2.8	<2.8	<2.8	<1.0		4.0
Schroederia setigera																4.0
Selenastrum minutum																	
Selenastrum																	
Sphaerocystis schroeteri				<17.8			45.5					<2.8				15.0
Sphaerocystis																	
Tetraedron minimum																	
Tetraedron				35.6	35.6	17.8			<5.7	17.1						
Treubaria																	
Euglenales																	
Euglena								<2.8	<5.7	5.7	<2.8	5.7	<2.8			
Phacus													<2.8			
Trachelomonas				<17.8		<17.8										
Oedogoniales																	
Oedogonium													<2.8			
Tetrasporales																	
Gloeocystis ampla					<35.6			22.8	<5.7	<5.7						
Gloeocystis							**									
Ulothricales																	
Geminella																	
Ulothrix																	

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	STICKLEBACK LAKE						FICKLE DUCK LAKE									
	26-Aug-97			19-Jul-98			Aug-95	05-Aug-96			25-Aug-96			23-Jul-97		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Chlorophyta																
Ulvales																
Shcizomeris																
Volvocales																
Carteria																
Chlamydomonas									<5.7	<5.7		<2.8				
Eudorina								<2.8	22.8	<5.7	182.0	128.0	182.0	<1.0	<1.0	24.0
Zygnematales																
Arthrodesmus								<2.8	<5.7	<5.7			<2.8			
Closteriopsis																
Closterium								<2.8					<2.8			
Cosmarium	2.0		4.4					<2.8	<5.7			<2.8	<2.8			
Euastrum								<2.8		<5.7	<2.8	<2.8	<2.8			
Gonatozygon																
Hyalotheca								<2.8								
Mougeotia																
Pleurotaenium																
Spondylosium planum				<17.8	<35.6	<17.8			22.8	22.8	2.8	<2.8	<2.8			
Spondylosium																
Staurastrum paradoxum																
Staurastrum							**	<2.8	<5.7	<5.7	<2.8		2.8			
Xanthidium								<2.8			<2.8	<2.8	2.8	<1.0		
Zygnema																
Chrysophyta																
Ochromonadales																
Chrysosphaerella longispina																
Dinobryon bavaricum	<2.0		17.6	1 068.0	534.0	427.2										
Dinobryon cylindricum								250.3	682.7	210.5						
Dinobryon bavaricum / cylindricum							125.2									
Dinobryon divergens				<17.8	<35.6	<17.8	102.4	<2.8		45.5						
Dinobryon elegantissimum				35.6	<35.6					165.0						
Dinobryon sertularia					<35.6	<17.8	22.8									
Dinobryon sociale	108.0	48.0	145.2											<1.0	3.0	7.0
Dinobryon					<35.6	<17.8			<5.7		<2.8					
Mallomonas akrokomoos					<35.6											
Mallomonas pseudocoronata																
Mallomonas		<2.0	<4.4	<17.8	<35.6	<17.8	**									
Ochromonas		14.0	<4.4											1.0	<1.0	
Uroglenopsis americana																
Prymnesiales																
Chrysochromulina																
Rhizochrysidales																
Diceras phaseolus									<5.7							
Diceras																
Unidentified flagellate				<17.8	142.4	106.8		<2.8	<5.7	<5.7						
Cryptophyta																
Cryptomonadales																
Chroomonas acuta	54.0	48.0	140.8	249.2	35.6	71.2	5.7	<2.8	5.7	<5.7		<2.8		2.0	2.0	5.0
Chroomonas																
Cryptomonas ovata / erosa							**									
Cryptomonas ovata		<2.0														
Cryptomonas	4.0	8.0	22.0	17.8	<35.6	<17.8		11.4	51.2	22.8	14.2	28.4	17.1	<1.0		3.0
Cyanophyta																
Chroococcales																
Agmenellum tenuissima					<35.6											
Agmenellum																
Anacystis elachista				<17.8		<17.8				<5.7						
Anacystis limneticus				<17.8	<35.6	213.6										
Anacystis	240.0	280.0	1 047.2		<35.6		**	<2.8	<5.7							<1.0
Aphanizomenon flos-aquae																
Gloeocapsa														12.0		
Gomphosphaeria pallidum								<2.8		<5.7						
Gomphosphaeria				<17.8			**		<5.7		<2.8		<2.8			
Merismopedia																
Pseudanabaena catenata											<2.8					
Rhabdoderma									22.8							
Nostocales																
Anabaena affinis							659.9	878.9	1 968.4	1 900.1	714.0	1 103.6	682.7			
Anabaena flos-aquae							**	<2.8								
Anabaena helicoidea								122.3	119.5	119.5	34.1	238.9	270.2			<1.0
Anabaena planctonica								625.8	1 655.5	381.2						
Anabaena	<2.0			<17.8		<17.8		<2.8		<5.7				24.0		
Gloeotrichia																
Nostoc																
Oscillatoriales																
Lyngbya limnetica	<2.0			<17.8	<35.6	<17.8	62.6	119.5	102.4	466.5	110.9	110.9	91.0		<1.0	
Lyngbya																
Oscillatoria tenuis																
Oscillatoria	<2.0		<4.4	<17.8	<35.6	<17.8										
Pyrrophyta																
Dinokontae																
Gymnodinium	<2.0	<2.0	<4.4													<1.0
Peridinium inconspicuum				<17.8	<35.6	<17.8	**	<2.8	<5.7	<5.7	<2.8	8.5	<2.8			
Peridinium	2.0		<4.4													
Peridinium / Glenodinium				<17.8	<35.6	<17.8						<2.8				
TOTAL	**442**	**430**	**1 675**	**1 584**	**1 068**	**1 032**	**1 320**	**2 537**	**5 399**	**3 766**	**1 197**	**1 735**	**1 436**	**56**	**20**	**84**

NOTES: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	FICKLE DUCK LAKE						REFERENCE LAKE								
	26-Aug-97			19-Jul-98			23-Jul-97			27-Aug-97			22-Jul-98		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Bacillariophyta															
Centrales															
Cyclotella glomerata															
Cyclotella	<2.7	<4.4	3.1				4.4	<1.4	2.2			5.5			
Melosira granulata v. angustissima															
Melosira italica															
Melosira					<2.8								<17.8		<17.8
Rhizosolenia															
Pennales															
Achnanthes minutissima					22.4	11.2			4.4					<35.6	71.2
Achnanthes	13.5	4.4	<3.1					<1.4	2.2	11.0					
Amphora					<2.8	<2.8									
Asterionella formosa	32.4	13.1	3.1	79.8	64.4	39.2	4.4	<1.4	<2.2	22.0	<10.9	<5.5	53.4	<35.6	17.8
Asterionella															
Ceratoneis arcus															
Ceratoneis					<2.8	<2.8							<17.8	<35.6	
Cocconeis placentula										5.5					
Cocconeis															
Cymatopleura				<5.7	<2.8	<2.8							<17.8	71.2	<17.8
Cymbella minuta				11.4		<2.8							<17.8	<35.6	<17.8
Cymbella	2.7	8.7		<5.7	<2.8	2.8				<5.5	10.9		<17.8	<35.6	<17.8
Diatoma elongatum				5.7		<2.8							<17.8		
Diatoma tenue v. elongatum	2.7	4.4	6.2					<1.4	2.2						
Diatoma															<17.8
Diploneis decipiens										5.5					
Epithemia sorex							<1.1								
Epithemia															
Eunotia		<4.4			<2.8								<17.8	<35.6	17.8
Fragilaria crotonensis	5.4	<4.4	<3.1	34.2	11.2	14.0	2.2	1.4			<10.9		35.6	106.8	17.8
Fragilaria	8.1	4.4	15.6	<5.7		<2.8	2.2	2.7	10.9	11.0	<10.9	<5.5		<35.6	<17.8
Frustulia				<5.7											
Gomphonema				5.7		<2.8								<35.6	
Gyrosigma	<2.7						<1.1			5.5					
Meridion															
Navicula radiosa										<5.5					
Navicula	2.7	<4.4	3.1	<5.7	<2.8	5.6				<5.5		<5.5	35.6	<35.6	35.6
Neidium															
Nitzschia palea			3.1				2.2	4.1	2.2	27.5	21.8				
Nitzschia		13.1				<2.8							<17.8	<35.6	17.8
Pleurosigma / Gyrosigma				<5.7	<2.8	<2.8							<17.8	<35.6	17.8
Stauroneis														<35.6	<17.8
Surirella				<5.7	2.8	<2.8					<10.9		<17.8	<35.6	<17.8
Synedra ulna			<3.1	<5.7		<2.8									
Synedra															<17.8
Tabellaria fenestrata			<3.1										<17.8	<35.6	
Tabellaria flocculosa	2.7	<4.4	<3.1		36.4	<2.8	<1.1	2.7	<2.2	5.5	10.9	5.5	178.0	<35.6	249.2
Tabellaria															
Chlorophyta															
Chlorococcales															
Ankistrodesmus falcatus	27.0	21.8	15.6							16.5					
Ankistrodesmus		26.2		11.4	8.4	5.6	6.6	5.4	6.6	11.0	10.9		35.6	106.8	35.6
Botryococcus braunii				<5.7	44.8	<2.8							<17.8		<17.8
Botryococcus															
Coelastrum															
Crucigenia quadrata													71.2	<35.6	<17.8
Crucigenia rectangularis							17.6	16.3	8.7		43.6	21.8			
Crucigenia tetrapedia	140.4	157.0	62.4	91.2	22.4	123.2			17.4		<10.9		213.6	284.8	142.4
Crucigenia							8.8	10.9					<17.8	<35.6	<17.8
Dictyosphaerium pulchellum															
Dictyosphaerium					67.2								<17.8	<35.6	
Dictyosphaerius															
Elakatothrix gelatinosa	2.7	21.8	3.1								<10.9				
Elakatothrix				<5.7	5.6	<2.8								<35.6	
Kirchneriella	2.7					<2.8									
Lagerheimia														<35.6	
Nephrocytium															
Oocystis lacustris												<5.5			
Oocystis															
Pediastrum		<4.4		45.6	22.4	<2.8							<17.8	<35.6	<17.8
Quadrigula															
Scenedesmus quadricauda				22.8	33.6	11.2							<17.8		
Scenedesmus	<2.7	17.4	<3.1		<2.8		4.4	<1.4					<17.8	71.2	<17.8
Schroederia setigera															
Selenastrum minutum															
Selenastrum															
Sphaerocystis schroeteri				<5.7	<2.8	123.2							<17.8		
Sphaerocystis															
Tetraedron minimum															
Tetraedron				5.7	2.8	<2.8							<17.8	35.6	<17.8
Treubaria															
Euglenales															
Euglena				<5.7		<2.8							<17.8	<35.6	<17.8
Phacus															
Trachelomonas					<2.8								<17.8		<17.8
Oedogoniales															
Oedogonium						<2.8									
Tetrasporales															
Gloeocystis ampla														<35.6	
Gloeocystis															
Ulothricales															
Geminella															
Ulothrix				<5.7											

Appendix B1. Phytoplankton abundance (cells/mL) in Boston area lakes, 1993-1998.

Taxa / Species	FICKLE DUCK LAKE						REFERENCE LAKE								
	26-Aug-97			19-Jul-98			23-Jul-97			27-Aug-97			22-Jul-98		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Chlorophyta															
Ulvales															
Shcizomeris															
Volvocales															
Carteria			3.1					1.4	4.4	5.5		<5.5			
Chlamydomonas													<17.8		17.8
Eudorina	<2.7	<4.4	<3.1		89.6	<2.8							<17.8	<35.6	
Zygnematales															
Arthrodesmus					<2.8										<17.8
Closteriopsis													<17.8		
Closterium						<2.8									
Cosmarium	5.4			<5.7	<2.8					<5.5		<5.5			<17.8
Euastrum		4.4				<2.8							<17.8		
Gonatozygon															
Hyalotheca															
Mougeotia															
Pleurotaenium															
Spondylosium planum				<5.7				2.7			10.9		35.6	<35.6	<17.8
Spondylosium															
Staurastrum paradoxum					<2.8								<17.8		<17.8
Staurastrum		<4.4										<5.5			
Xanthidium													<17.8	<35.6	
Zygnema															
Chrysophyta															
Ochromonadales															
Chrysosphaerella longispina															
Dinobryon bavaricum				45.6	<2.8	33.6			10.9	11.0			35.6	106.8	89.0
Dinobryon cylindricum	5.4	21.8	46.8												
Dinobryon bavaricum / cylindricum															
Dinobryon divergens														<35.6	<17.8
Dinobryon elegantissimum				<5.7		<2.8									
Dinobryon sertularia												<5.5			
Dinobryon sociale															
Dinobryon				<5.7		<2.8	5.5	25.8	24.0	<5.5			<17.8	<35.6	<17.8
Mallomonas akrokomoos															
Mallomonas pseudocoronata															
Mallomonas						<2.8	2.2	5.4						<35.6	
Ochromonas	8.1	4.4	3.1				16.5	17.7	32.7	33.0	32.7	103.6			
Uroglenopsis americana															
Prymnesiales															
Chrysochromulina															
Rhizochrysidales															
Diceras phaseolus						<2.8									17.8
Diceras								1.4							
Unidentified flagellate				<5.7	<2.8	<2.8							<17.8	<35.6	<17.8
Cryptophyta															
Cryptomonadales															
Chroomonas acuta		<4.4		51.3	<2.8	14.0	2.2	<1.4	2.2	5.5	21.8		71.2	<35.6	<17.8
Chroomonas															
Cryptomonas ovata / erosa															
Cryptomonas ovata							4.4	<1.4							
Cryptomonas	8.1	4.4	3.1	11.4	14.0	2.8	15.4	12.2	10.9	38.5	54.5	49.1	53.4	<35.6	<17.8
Cyanophyta															
Chroococcales															
Agmenellum tenuissima				182.4	<2.8	<2.8							284.8	<35.6	<17.8
Agmenellum															<17.8
Anacystis elachista				<5.7									<17.8	2 136.0	
Anacystis limneticus				91.2	44.8	<2.8								<35.6	71.2
Anacystis													<17.8		<17.8
Aphanizomenon flos-aquae													2 919.2	6 764.0	3 132.8
Gloeocapsa															
Gomphosphaeria pallidum					168.0	56.0							<17.8	<35.6	
Gomphosphaeria							<1.1							<35.6	<17.8
Merismopedia															
Pseudanabaena catenata						22.4									
Rhabdoderma															
Nostocales															
Anabaena affinis	248.4	518.8	343.2	136.8	378.0	78.4				1 078.0	1 853.0	506.9	2 598.8	5 019.6	587.4
Anabaena flos-aquae				<5.7						<5.5	<10.9	<5.5	<17.8	<35.6	
Anabaena helicoidea															
Anabaena planctonica	<2.7	148.2	205.9							143.0	<10.9	<5.5			
Anabaena						<2.8	8.8	<1.4	146.1	115.5	218.2	<5.5	<17.8	<35.6	<17.8
Gloeotrichia															
Nostoc															
Oscillatoriales															
Lyngbya limnetica	267.3	13.1	<3.1	661.2	380.8	<2.8		1.4	<2.2	3 685.0	36 515.0	2 861.3	<17.8	<35.6	<17.8
Lyngbya															
Oscillatoria tenuis															
Oscillatoria						<2.8									
Pyrrophyta															
Dinokontae															
Gymnodinium		<4.4	<3.1				1.1	4.1	<2.2	11.0					
Peridinium inconspicuum				<5.7	2.8	2.8							<17.8	35.6	71.2
Peridinium							<1.1		2.2	27.5	<10.9	16.4			
Peridinium / Glenodinium															
TOTAL	**786**	**1 007**	**721**	**1 493**	**1 422**	**546**	**109**	**116**	**290**	**5 275**	**38 804**	**3 570**	**6 622**	**14 738**	**4 610**

NOTES: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B2. Abundance (cells/mL) and percent composition of main taxa of phytoplankton in Boston area lakes, 1993-1998.

Lake	Date (Site)	No. Repl.	Bacillariophyta			Chlorophyta			Chrysophyta			Cryptophyta			Cyanophyta			Pyrrophyta			All Taxa	
			Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE
Aimaokatalok	17-Aug-93 (WQ5)	1	**387**	-	*12.0*	**1 166**	-	*36.2*	**11**	-	*0.4*	**302**	-	*9.4*	**1 354**	-	*42.0*	**0**	-	*0.0*	**3 220**	-
	Aug-94 (WQ4)	1	**324**	-	*16.9*	**546**	-	*28.5*	**17**	-	*0.9*	**137**	-	*7.1*	**893**	-	*46.6*	**0**	-	*0.0*	**1 917**	-
	Aug-94 (WQ5)	1	**97**	-	*10.4*	**353**	-	*37.8*	**65**	-	*7.0*	**97**	-	*10.4*	**322**	-	*34.5*	**0**	-	*0.0*	**933**	-
	Aug-95 (WQ5)	1	**381**	-	*24.1*	**68**	-	*4.3*	**131**	-	*8.3*	**102**	-	*6.5*	**887**	-	*56.1*	**11**	-	*0.7*	**1 582**	-
	Aug-95 (WQ9 0m)	1	**302**	-	*17.2*	**575**	-	*32.8*	**34**	-	*1.9*	**68**	-	*3.9*	**762**	-	*43.5*	**11**	-	*0.7*	**1 752**	-
	Aug-95 (WQ9 5m)	1	**367**	-	*32.0*	**54**	-	*4.7*	**142**	-	*12.4*	**83**	-	*7.2*	**492**	-	*42.9*	**9**	-	*0.7*	**1 146**	-
	04-Aug-96 (Station 5)	3	**42**	4	*2.5*	**623**	27	*37.1*	**32**	8	*1.9*	**185**	32	*11.0*	**789**	84	*47.0*	**7**	4	*0.4*	**1 677**	91
	04-Aug-96 (Station 6)	3	**51**	23	*2.6*	**780**	225	*39.1*	**31**	9	*1.6*	**122**	36	*6.1*	**1 007**	297	*50.4*	**5**	1	*0.2*	**1 996**	537
	24-Aug-96 (Station 5)	3	**415**	99	*15.6*	**1 136**	323	*42.7*	**41**	6	*1.5*	**99**	38	*3.7*	**960**	479	*36.1*	**10**	5	*0.4*	**2 660**	623
	24-Aug-96 (Station 6)	3	**504**	119	*14.5*	**1 773**	946	*51.1*	**36**	27	*1.0*	**57**	20	*1.7*	**1 101**	518	*31.7*	**1**	1	*0.0*	**3 473**	1 541
	24-Jul-97 (Station 1)	3	**30**	7	*11.1*	**73**	27	*27.0*	**93**	19	*34.3*	**13**	4	*4.6*	**51**	41	*18.8*	**11**	4	*4.2*	**271**	51
	22-Jul-97 (Station 5)	3	**10**	2	*6.5*	**19**	2	*12.1*	**98**	30	*63.6*	**7**	3	*4.3*	**20**	15	*12.9*	**1**	1	*0.6*	**155**	25
	24-Jul-97 (Station 6)	3	**25**	8	*19.7*	**6**	5	*4.8*	**44**	6	*34.9*	**28**	5	*22.1*	**23**	11	*18.4*	**0**	0	*0.0*	**125**	17
	26-Aug-97 (Station 1)	3	**164**	31	*34.9*	**143**	57	*30.5*	**43**	10	*9.2*	**29**	9	*6.1*	**89**	38	*18.9*	**2**	1	*0.4*	**469**	34
	26-Aug-97 (Station 5)	3	**66**	10	*21.2*	**77**	7	*24.5*	**22**	5	*6.9*	**12**	3	*3.7*	**134**	23	*42.9*	**2**	1	*0.7*	**313**	33
	25-Aug-97 (Station 6)	3	**168**	12	*37.8*	**101**	1	*22.7*	**85**	22	*19.0*	**48**	10	*10.7*	**44**	25	*9.8*	**1**	1	*0.2*	**446**	59
	18-Jul-98 (Station 4)	3	**97**	31	*10.7*	**96**	10	*10.5*	**188**	42	*20.7*	**113**	18	*12.4*	**407**	158	*44.8*	**8**	4	*0.8*	**908**	221
	18-Jul-98 (Station 6)	3	**103**	43	*6.1*	**156**	69	*9.3*	**246**	42	*14.6*	**263**	88	*15.6*	**912**	289	*54.1*	**5**	3	*0.3*	**1 684**	367
Stickleback	Aug-94	1	**324**	-	*8.1*	**1 092**	-	*27.3*	**0**	-	*0.0*	**273**	-	*6.8*	**2 264**	-	*56.6*	**46**	-	*1.1*	**4 000**	-
	Aug-95	1	**28**	-	*5.3*	**225**	-	*42.0*	**20**	-	*3.7*	**176**	-	*33.0*	**51**	-	*9.6*	**34**	-	*6.4*	**534**	-
	05-Aug-96	3	**360**	125	*4.5*	**1 037**	386	*13.0*	**139**	95	*1.7*	**205**	33	*2.6*	**6 135**	1 482	*77.1*	**86**	3	*1.1*	**7 962**	2 016
	25-Aug-96	3	**363**	31	*26.2*	**372**	105	*26.8*	**66**	39	*4.8*	**167**	23	*12.0*	**394**	19	*28.5*	**24**	8	*1.7*	**1 386**	80
	23-Jul-97	3	**145**	32	*27.4*	**25**	5	*4.8*	**137**	12	*25.9*	**53**	4	*10.0*	**162**	96	*30.7*	**6**	2	*1.1*	**527**	114
	26-Aug-97	3	**5**	2	*0.6*	**118**	88	*13.9*	**111**	29	*13.1*	**92**	35	*10.9*	**522**	263	*61.5*	**1**	1	*0.1*	**849**	413
	19-Jul-98	3	**125**	10	*10.1*	**136**	39	*11.1*	**771**	171	*62.8*	**125**	72	*10.1*	**71**	71	*5.8*	**0**	0	*0.0*	**1 228**	178
Fickle Duck	Aug-95	1	**97**	-	*7.3*	**245**	-	*18.5*	**250**	-	*19.0*	**6**	-	*0.4*	**723**	-	*54.7*	**0**	-	*0.0*	**1 320**	-
	05-Aug-96	3	**88**	17	*2.3*	**504**	100	*12.9*	**451**	126	*11.6*	**30**	14	*0.8*	**2 827**	613	*72.5*	**0**	0	*0.0*	**3 901**	829
	25-Aug-96	3	**73**	7	*5.0*	**242**	39	*16.6*	**0**	0	*0.0*	**20**	4	*1.4*	**1 119**	176	*76.8*	**3**	3	*0.2*	**1 456**	155
	23-Jul-97	3	**15**	1	*28.1*	**19**	19	*35.0*	**4**	2	*6.9*	**4**	2	*7.5*	**12**	12	*22.5*	**0**	0	*0.0*	**53**	19
	26-Aug-97	3	**51**	10	*6.1*	**170**	48	*20.3*	**30**	11	*3.6*	**5**	1	*0.6*	**582**	50	*69.4*	**0**	0	*0.0*	**838**	87
	19-Jul-98	3	**116**	21	*10.0*	**246**	36	*21.3*	**26**	14	*2.3*	**31**	16	*2.7*	**733**	290	*63.6*	**2**	1	*0.2*	**1 154**	305
Reference	23-Jul-97	3	**17**	4	*9.8*	**37**	0	*21.6*	**47**	13	*27.6*	**16**	3	*9.2*	**52**	47	*30.4*	**2**	1	*1.4*	**172**	59
	27-Aug-97	3	**49**	24	*0.3*	**40**	13	*0.3*	**60**	22	*0.4*	**56**	10	*0.4*	**15 659**	11 474	*98.6*	**18**	11	*0.1*	**15 883**	11 471
	22-Jul-98	3	**309**	77	*3.6*	**350**	87	*4.0*	**83**	24	*1.0*	**42**	42	*0.5*	**7 838**	3 096	*90.5*	**36**	21	*0.4*	**8 657**	3 096

SE = Standard Error

Appendix B3. Periphyton abundance (cells/cm^2) in Boston area streams, 1993-1998.

Species List	STICKLEBACK OUTFLOW												
	Aug 1995	25-Aug 1996			21-Jul 1997			24-25 Aug 1997			26-30-Jul 1998		
		Rep A	Rep B	Rep C	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Bacillariophyta													
Centrales													
Cyclotella						<897			<836	2,444			
Melosira					<433								
Pennales													
Achnanthes flexella	**												
Achnanthes minutissima	93,560		19,480	28,080	3,464	6,279	13,038	9,360	118,712	202,852	75,413	66,576	27,562
Achnanthes		4,608			1,299	1,794	2,173	1,872	5,258	8,554	<603	1,097	634
Amphipleura pellucida						<897	<2173				<603		
Amphora	4,924	1,152	<2,435		<433	<897	2,173	<208	836	1,222	<603	<366	<158
Asterionella formosa		<1,152	4,870	5,265		<897	2,173				<603	<366	
Asterionella													
Caloneis													
Ceratoneis arcus	**												
Ceratoneis													
Cocconeis	**						<2173	<208	<836	<1,222	<603	366	158
Cymatopleura								<208					
Cymbella	4,924	11,520	14,610	8,775	1,299	2,691	10,865	1,040	4,180	9,776	1,207	2,195	475
Denticula								<208	<836				
Diatoma elongatum	68,939	14,976	7,305	7,020	153,715	234,117	525,866	3,744	14,212	3,666	10,859	11,340	317
Diatoma		1,152	2,435	1,755	2,165	4,485	19,557	208	836	1,222	1,207	732	<158
Diploneis	**		<2,435										
Epithemia sorex	4,924		2,435	1,755	<433		<2173	<208	<836	<1,222	603	<366	<158
Epithemia													
Eunotia	**	2,304	<2,435	1,755		<897	2,173	<208	<836	<1,222	603	<366	158
Fragilaria crotonensis	4,924				<433	<897	15,211	416	<836	<1,222	603	<366	475
Fragilaria		9,216	31,655	15,795	2,165	1,794	23,903	2,704	9,196	3,666	3,620	2,561	317
Frustulia	**												
Gomphonema		1,152	9,740	7,020	866	3,588	4,346	1,872	11,704	13,442	3,017	1,097	475
Meridion	**												
Navicula radiosa					<433	<897	4,346	<208	836	<1,222	<603	<366	
Navicula	4,924	5,760	21,915	14,040	866	4,485	8,692	1,664	7,524	6,110	3,017	2,926	634
Neidium								<208		<1,222	<603	<366	
Nitzschia acicularis					866	1,794	6,519	<208	<836		<603	366	
Nitzschia	**	4,608	14,610	7,020	433	2,691	10,865	1,248	7,524	8,554	1,810	732	<158
Pinnularia		<1,152		1,755	<433	<897	2,173	<208	<836	<1,222	<603	<366	
Pleurosigma / Gyrosigma	**		<2,435		<433						<603		
Stauroneis	**	<1,152	<2,435	<1,755	<433	<897	<2173	208		<1,222	<603	<366	<158
Surirella			<2,435		<433		<2173	<208		<1,222	<603	<366	
Synedra ulna		6,912	<2,435		433	<897	<2173	<208	<836	<1,222	<603	<366	<158
Synedra		<1,152	2,435	<1,755	11,258	15,249	32,595	1,040	5,852	9,776	1,207	732	317
Tabellaria fenestrata													
Tabellaria flocculosa	19,697	1,152	19,480	14,040	433	2,691	4,346	208	836	<1,222	2,413	5,853	634
Tabellaria													
Unidentified		2,304		3,510									
Chlorophyta													
Chaetophorales													
Coleochaete ?									<836				
Draparnaldia													
Stigeoclonium	**							<208	<836	<1,222	7,240	732	5,544
Unidentified													
Chlorococcales													
Ankistrodesmus falcatus					<433	<897	4,346	<208	<836	<1,222	<603	<366	<158
Ankistrodemus spiralis						<897	<2173						<158
Ankistrodemus													
Botryococcus braunii	**				<433	<897							
Botryococcus													
Coelastrum					5,196	<897			<836		7,240	<366	<158
Crucigenia quadrata						<897	<2173			<1,222			
Crucigenia rectangularis											<603		
Crucigenia tetrapedia	19,697				<433	<897	<2173	832	3,344	4,888	2,413	2,926	<158
Crucigenia		4,608	9,740	7,020					<836				
Dictyosphaerium								<208	<836				
Elakatothrix													
Euastropsis													
Kirchneriella													
Lagerheimia		1,152			<433			<208	<836				
Nephrocytium													
Oocystis				3,510		897	4,346		836			<366	<158
Pediastrum	**	<1,152	<2,435	<1,755	3,031	4,485	32,595	<208	1,672	<1,222	<603	8,048	<158
Quadrigula													
Scenedesmus	39,394	<1,152			1,732	5,382	13,038	416	<836	2,444	2,413	1,829	634
Schroederia													
Selenastrum minutum								<208			<603		
Sphaerocystis schroeteri								<208	<836			<366	1,267
Tetraedron				1,755	866	897	13,038	<208	<836		1,810	366	158
Euglenales													
Euglena	**				<433	<897		<208	<836	1,222			
Phacus										<1,222	<603		
Trachelomonas	**	1,152	4,870	1,755	<433	<897	<2173	416	836	1,222	603	<732	158
Oedogoniales													
Bulbochaete										<1,222	<603	<366	<158
Oedogonium		8,064	9,740	8,775	<433	1,794	2,173	1,040	4,180	<1,222	<603	732	475
Siphonocladales													
Rhizoclonium					<433								
Tetrasporales													
Apiocystis brauniana													
Gloeocystis ampla										<1,222	<603		
Tetraspora lamellosa													
Tetraspora					<433	<897	<2173				<603	<366	<158
Tetraspora ?													
Ulothrichales													
Cylindrocapsa ?													
Geminella													
Microspora		<1,152			<433	897	<2173			<1,222	<603		<158
Stigeoclonium ?		<1,152											
Ulothrix		5,760		<1,755									
Volvocales													
Chlamydomonas												<366	
Eudorina													

Appendix B3. Periphyton abundance (cells/cm^2) in Boston area streams, 1993-1998.

Species List	STICKLEBACK OUTFLOW												
	Aug 1995	25-Aug 1996			21-Jul 1997			24-25 Aug 1997			26-30-Jul 1998		
		Rep A	Rep B	Rep C	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Chlorophyta													
Zygnematales													
Arthrodesmus													
Closterium		<1,152	<2,435	<1,755	<433	<897	<2173	<208	<836	<1,222	<603	<366	<158
Cosmarium	**	4,608	2,435	1,755	<433	897	4,346	208	1,672	1,222	1,207	366	158
Desmidium													
Euastrum				<1,755			<2173	<208		<1,222			
Gonatozygon													
Hyalotheca	**												
Micrasterias													
Mougeotia	**	1,152	<2,435	8,775	<433	<897	<2173	832	<836	2,444	3,017	1,097	<158
Netrium												<366	
Onychonema ?													
Penium													
Pleurotaenium		<1,152						<208		<1,222			
Sphaerozosma									<836				
Spirogyra					<433	<897	<2173	<208	<836			<366	
Spondylosium planum	**								<836				
Spondylosium													
Staurastrum paradoxum													
Staurastrum	**	1,152	<2,435	<1,755	<433	<897	<2173	<208	<836	<1,222	<603	<366	
Teilingia granulata													
Xanthidium													
Zygnema	**				433	897						<366	<158
Unidentified unicellular													
Unidentified flagellate											603		317
Chrysophyta													
Chromulinales													
Hydrurus foetidus													
Mischococcales													
Mischococcus					<433								
Ophiocytium						<897		<208		<1,222			
Ochromonadales													
Dinobryon bavaricum					433	897	4,346						
Dinobryon cylindricum						897	8,692				<603		
Dinobryon divergens						<897							
Dinobryon elegantissimum					<433	<897	6,519						
Dinobryon sociale							<2173						
Dinobryon sertularia					<433	<897	<2173						
Dinobryon		<1,152	2,435	3,510	<433			208					
Kephyrion / Pseudokephyrion													
Mallomonas		<1,152	<2,435										
Tribonematales													
Tribonema					433	<897	4,346	<208					<158
Unidentified flagellate					866	<897	<2173				1,207	2,195	
Unidentified unicellular													
Unidentified								<208	<836				
Cryptophyta													
Cryptomonadales													
Chroomonas acuta					<433		<2173					366	158
Cryptomonas	**				<433	<897		<208			<603	<366	<158
Cyanophyta													
Chamaesiphonales													
Clastidium setigerum					<433				<836	3,666	<603	732	634
Chroococcales													
Agmenellum glauca													
Agmenellum						<897		<208	<836	<1,222	<603		
Anacystis aeruginosa										105,092			
Anacystis elachista								8,320	25,080	97,760			
Anacystis		46,080	133,925	140,400	3,464	<897	145,591	832	3,344	<1,222			
Anacystis / Coccochloris											44,041	17,924	3,168
Coccochloris										<1,222			
Dactylococcopsis		10,368	12,175	7,020									
Gomphosphaeria naegelianum					<433	<897			<836	<1,222			
Gomphosphaeria						<897		<208	16,720	<1,222			
Rhabdoderma													
Unidentified													
Nostocales													
Anabaena affinis													
Anabaena	**	<1,152	73,050	<1,755	2,598	<897	39,114	2,496	<836	3,666	13,876	<366	<158
Aphanizomenon flos-aquae													
Gloeotrichia ?			17,045	8,775									
Nostoc			<2,435		<433								<158
Pseudanabaena catenata													
Rivularia	315,149								<836				
Tolypothrix			<2,435		<433		47,806	<208		<1,222			
Oscillatoriales													
Lyngbya limnetica	615,525		107,140	<1,755				2,080	<836				
Lyngbya						<897				8,554	<603	10,974	1,584
Oscillatoria tenuis					23,815	4,485	30,422	<208	34,276	31,772			
Oscillatoria	**	28,800	17,045	17,550	12,124	31,395	60,844	9,360	22,572	8,554	3,620	6,950	1,426
Phormidium mucicola										30,550			
Spirulina							<2173			<1,222			
Unidentified sheathed filament											<603	<366	950
Pyrrophyta													
Dinokontae													
Peridinium inconspicuum	**												
Peridinium / Glenodinium	**	1,152	2,435		1,299	1,794	6,519	<208	836	<1,222	603	1,829	317
Peridinium													
Rhodophyta													
Nemalionales													
Audouinella													
Batrachospermum													
Total	1,196,580	180,864	543,005	328,185	235,552	337,272	1,119,095	52,624	302,874	574,340	195,469	153,636	49,104

NOTE: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B3. Periphyton abundance (cells/cm^2) in Boston area streams, 1993-1998.

Species List	FICKLE DUCK OUTFLOW								AIMAOKATALOK NE INFLOW						
	17-18 Aug 1993	Aug 1995	25-Aug 1997			26-31 Jul 1998			5-6 Aug 1996			25-Aug 1997	28-Jun to 31-Jul 1998		
			Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3
Bacillariophyta															
Centrales															
Cyclotella	*								<872						
Melosira	*								<872				<1,725		<2,514
Pennales															
Achnanthes flexella		**													
Achnanthes minutissima		**	8,015	1,298	5,325	2,147	4,164	1,408		6,316	6,002	4,228	3,450	6,290	7,541
Achnanthes	36,223		17,175	5,841	30,175	3,067	4,164	1,610		<197		384	6,900	2,097	7,541
Amphipleura pellucida															
Amphora	*							<201			<375				<2,514
Asterionella formosa												192			
Asterionella	*														
Caloneis													<1,725	<2,097	
Ceratoneis arcus		**													
Ceratoneis	*								<872						
Cocconeis											<375	<192		<2,097	<2,514
Cymatopleura	3,019								<872						
Cymbella	12,074	44,405	4,580	5,192	14,200	307		201	<872	987	2,626	192	1,725	6,290	5,027
Denticula															
Diatoma elongatum		152,245	1,145	2,596	1,775	2,147	1,041	402				5,382	6,900	23,064	27,649
Diatoma	*								2,617	395	2,251				
Diploneis															
Epithemia sorex															
Epithemia										<197					
Eunotia	3,019		1,145	2,596	8,875	613	3,123	201	872	197	375	<192	<1,725	<2,097	2,514
Fragilaria crotonensis		50,748							2,617	<197	4,126			<2,097	
Fragilaria	15,093		3,435	1,947	8,875	613	4,164	201	3,489	<197	3,751	192	3,450	6,290	2,514
Frustulia	*														
Gomphonema			4,580	<649	1,775	<307		<201	<872	197		384	<1,725	4,193	2,514
Meridion															
Navicula radiosa			<1,145	<649	<1,775										
Navicula	15,093	12,687	<1,145	649	1,775	<307	<1,041	<201	2,617	395	6,002	384	1,725	4,193	2,514
Neidium															
Nitzschia acicularis				<649	<1,775	<307								2,097	<2,514
Nitzschia	*		1,145	1,947	10,650			201	<872			192	1,725	2,097	<2,514
Pinnularia				<649	<1,775	<307		<201				<192	<1,725	<2,097	<2,514
Pleurosigma / Gyrosigma	*	6,344			<1,775				872						
Stauroneis	3,019							<201	<872	<197	<375				
Surirella	3,019										<375	<192	<1,725		<2,514
Synedra ulna		38,061	<1,145	<649	<1,775			<201				<192	<1,725		
Synedra	21,130		<1,145	1,947	7,100			604	<872			192	<1,725	2,097	
Tabellaria fenestrata		25,374	1,145	1,298	7,100		<1,041	201					<1,725		
Tabellaria flocculosa		418,673	4,580	11,033	31,950	307	1,041	1,811	294,837	7,895	<375	769	1,725	4,193	12,568
Tabellaria	196,209														
Unidentified															
Chlorophyta															
Chaetophorales															
Coleochaete ?															
Draparnaldia															
Stigeoclonium	*	2,232,921	<1,145	<649											
Unidentified															
Chlorococcales															
Ankistrodesmus falcatus			2,290	<649	5,325	1,534	1,041	2,012	5,234	7,303	14,254	5,382	12,075	44,031	50,270
Ankistrodemus spiralis			<1,145	<649	<1,775							3,075	<1,725	8,387	10,054
Ankistrodemus	3,019	57,092													
Botryococcus braunii		**		<649	<1,775			<201	<872	6,316	<375	<192		<2,097	
Botryococcus	*														
Coelastrum										<197	<375		<1,725	<2,097	<2,514
Crucigenia quadrata		**													
Crucigenia rectangularis						<307									
Crucigenia tetrapedia		**	4,580	<649		<307	<1,041	805		790	3,001	961	6,900	8,387	<2,514
Crucigenia				<649											
Dictyosphaerium	*	**								2,961	1,500	2,691	20,700	<2,097	17,595
Elakatothrix							<1,041				375	<192		<2,097	
Euastropsis								<201							
Kirchneriella												<192			
Lagerheimia			<1,145					201							<2,514
Nephrocytium		**								<197	<375				
Oocystis										<197		192	<1,725	2,097	<2,514
Pediastrum	*		<1,145	<649	<1,775	<307		<201	<872	4,145	7,877	2,306	<1,725	14,677	12,568
Quadrigula															
Scenedesmus	*	25,374	<1,145	<649	7,100	1,227	<1,041	<201	3,489	17,369	9,002	2,306	27,600	25,160	90,486
Schroederia															
Selenastrum minutum												961			
Sphaerocystis schroeteri					<1,775					<197	6,002	769		12,580	10,054
Tetraedron	*						<1,041			<197	375	577			
Euglenales															
Euglena	*	**	<1,145			<307			<872	<197	<375			<2,097	<2,514
Phacus															
Trachelomonas				<649	<1,775	307	<1,041			<197		<192	5,175	4,193	2,514
Oedogoniales															
Bulbochaete	33,205	**		<649	<1,775					<197			<1,725	<2,097	<2,514
Oedogonium	*	**	<1,145	1,947	3,550	<307	<1,041	<201	<872	4,145	1,125	2,883	<1,725	<2,097	5,027
Siphonocladales															
Rhizoclonium															
Tetrasporales															
Apiocystis brauniana															
Gloeocystis ampla												<192			
Tetraspora lamellosa			<1,145												
Tetraspora				<649	<1,775								<1,725		
Tetraspora ?			428,230	66,847	165,075	46,005	320,659	13,682					6,900	8,387	
Ulothrichales															
Cylindrocapsa ?															
Geminella		177,619							<872	<197			<1,725		
Microspora			2,290	1,298	1,775										
Stigeoclonium ?															
Ulothrix	*														
Volvocales															
Chlamydomonas												<192		<2,097	2,514
Eudorina	*	**									<375				

Appendix B3. Periphyton abundance (cells/cm^2) in Boston area streams, 1993-1998.

Species List	FICKLE DUCK OUTFLOW								AIMAOKATALOK NE INFLOW						
	17-18 Aug 1993	Aug 1995	25-Aug 1997			26-31 Jul 1998			5-6 Aug 1996			25-Aug 1997	28-Jun to 31-Jul 1998		
			Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3
Chlorophyta															
Zygnematales															
Arthrodesmus	3,019	6,344		<649						<197	<375				
Closterium	*	12,687	1,145	<649	3,550	307	<1,041	402	<872	395	<375	384	<1,725	2,097	<2,514
Cosmarium	*	19,031	<1,145	649	1,775	307	1,041	1,408	872	592	750	192	5,175	25,160	17,595
Desmidium					<1,775										
Euastrum	*	**	<1,145	<649	1,775	<307		201	872	<197		<192		<2,097	2,514
Gonatozygon	*	12,687							<872	<197					
Hyalotheca		**	4,580	7,788	24,850	<307	<1,041	<201	<872			<192			<2,514
Micrasterias				<649	<1,775							<192	<1,725		
Mougeotia	3,019	12,687	<1,145	<649	<1,775	<307	<1,041	<201	<872		<375		3,450	8,387	12,568
Netrium															
Onychonema ?		114,184													
Penium															
Pleurotaenium			<1,145	<649	<1,775			<201			<375				
Sphaerozosma			<1,145	<649	3,550							384			
Spirogyra	*	**	<1,145	<649	3,550					<197	<375		6,900	8,387	5,027
Spondylosium planum		25,374			<1,775	<307	<1,041		1,745	987	<375	<192	<1,725	<2,097	<2,514
Spondylosium	*														
Staurastrum paradoxum		12,687													
Staurastrum	*	12,687	<1,145	649	<1,775	613	<1,041	1,006	2,617	197	<375	<192	<1,725	2,097	5,027
Teilingia granulata						1,840	1,041	604					<1,725	4,193	<2,514
Xanthidium	*	**		<649	<1,775	<307		<201	<872	<197	<375	<192		<2,097	
Zygnema	*	**	<1,145	<649	<1,775	<307			<872			15,184	22,425	23,064	15,081
Unidentified unicellular								<201					1,725	6,290	<2,514
Unidentified flagellate														2,097	5,027
Chrysophyta															
Chromulinales															
Hydrurus foetidus		**													
Mischococcales															
Mischococcus															
Ophiocytium					<1,775										
Ochromonadales															
Dinobryon bavaricum															
Dinobryon cylindricum															
Dinobryon divergens							<1,041								
Dinobryon elegantissimum															
Dinobryon sociale															
Dinobryon sertularia												577	1,725	<2,097	
Dinobryon	12,074	**	<1,145			307	<1,041		<872				<1,725		
Kephyrion / Pseudokephyrion															
Mallomonas	3,019			<649				<201							
Tribonematales															
Tribonema					<1,775										
Unidentified flagellate					1,775	307	2,082	402				<192	3,450	2,097	<2,514
Unidentified unicellular													1,725		
Unidentified															
Cryptophyta															
Cryptomonadales															
Chroomonas acuta															
Cryptomonas	*	**			<1,775			<201	<872	592					
Cyanophyta															
Chamaesiphonales															
Clastidium setigerum			5,725		<1,775	19,936	38,521	8,450				1,730			<2,514
Chroococcales															
Agmenellum glauca									41,870	<197	6,002				
Agmenellum	422,604					3,680						3,075	<1,725	16,774	<2,514
Anacystis aeruginosa				<649							<375				
Anacystis elachista															
Anacystis	*	**	<1,145	<649	122,475	<307		805	<872	<197	<375	9,418	158,700	92,255	110,594
Anacystis / Coccochloris															
Coccochloris															
Dactylococcopsis															
Gomphosphaeria naegelianum					<1,775							41,131	412,275	526,272	821,915
Gomphosphaeria		**				<307			<872	8,882	16,879		<1,725		
Rhabdoderma											<375				
Unidentified						286,458	780,825	179,068							
Nostocales															
Anabaena affinis												<192			
Anabaena	42,260	**	<1,145	2,596	1,775	<307	<1,041	1,207	20,935	1,579	15,754	9,226	10,350	20,967	<2,514
Aphanizomenon flos-aquae						<307	<1,041	<201							
Gloeotrichia ?															
Nostoc										3,750	51,388				
Pseudanabaena catenata											<375				
Rivularia	*	355,237							71,528	3,750	<375				
Tolypothrix															
Oscillatoriales															
Lyngbya limnetica		107,840							284,369	43,027	67,517	4,805			
Lyngbya	166,023					3,374		<201					17,250		<2,514
Oscillatoria tenuis												<192			
Oscillatoria	54,335	**	<1,145	<649	23,075	18,402	12,493	3,219	<872	<197	6,002			12,580	<2,514
Phormidium mucicola															
Spirulina												<192			
Unidentified sheathed filament						6,134									
Pyrrophyta															
Dinokontae															
Peridinium inconspicuum									1,745	<197	<375				
Peridinium / Glenodinium		**				<307				<197			<1,725		
Peridinium	*														
Rhodophyta							8,329	604					<1,725		
Nemalionales															
Audouinella			<1,145	<649								<192			
Batrachospermum															
Total	1,050,472	3,932,986	495,785	118,118	500,550	399,937	1,183,731	220,918	743,198	123,159	232,932	120,700	752,100	943,515	1,266,804

NOTE: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B3. Periphyton abundance (cells/cm^2) in Boston area streams, 1993-1998.

Species List	AIMAOKATALOK RIVER					REFERENCE OUTFLOW					
	24-Aug 1997		27-Jun to 01-Aug-98			25-Aug 1997			28-Jun to 01-Aug 1998		
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Bacillariophyta											
Centrales											
Cyclotella	<227								<1,709	<342	
Melosira				<612							
Pennales											
Achnanthes flexella											
Achnanthes minutissima	454	1,890	7,961	7,342	5,506	13,534	848	848	1,709	683	186
Achnanthes	908	378	8,846	5,506	8,258	28,110		2,545	10,252	3,759	372
Amphipleura pellucida											
Amphora			<885						<1,709		<186
Asterionella formosa	<227								<1,709		
Asterionella											
Caloneis									<1,709		<186
Ceratoneis arcus											
Ceratoneis											
Cocconeis											
Cymatopleura											
Cymbella		<126	885	1,224	688	9,370	566	3,393	3,417		372
Denticula											
Diatoma elongatum	6,810	1,260	16,807	16,519	9,635	130,138	23,755	39,022	18,795	342	558
Diatoma	<227							<848			
Diploneis									1,709	<342	<186
Epithemia sorex											
Epithemia											
Eunotia	<227	<126	1,769	<612	688	1,041	283	<848	1,709	342	<186
Fragilaria crotonensis				1,224		<1,041			<1,709		<186
Fragilaria		126	13,269	8,565	4,129		566	2,545	11,960	342	744
Frustulia									<1,709		
Gomphonema	227			612		11,452	9,898	19,511		342	<186
Meridion											
Navicula radiosa											
Navicula		<126	885	1,224	688	4,164		<848	3,417	<342	372
Neidium											
Nitzschia acicularis		<126	<885			<1,041			1,709	342	186
Nitzschia	454		2,654	612	1,376	<1,041			8,543		186
Pinnularia				<612	<688				<1,709		
Pleurosigma / Gyrosigma											
Stauroneis									<1,709		
Surirella				<612							
Synedra ulna	<227							<848	1,709	<342	
Synedra	2,270	252	1,769	1,224	688	5,206	283	3,393	6,834		186
Tabellaria fenestrata	<227								<1,709		
Tabellaria flocculosa	4,540	5,922	174,266	102,171	106,671	1,041	283	<848	11,960	3,759	2,231
Tabellaria											
Unidentified											
Chlorophyta											
Chaetophorales											
Coleochaete ?										<342	
Draparnaldia						6,247					
Stigeoclonium									<1,709	<342	<186
Unidentified											372
Chlorococcales											
Ankistrodesmus falcatus	1,589	3,024	28,307	11,624	22,022	8,329	1,131	11,876	8,543	1,367	1,301
Ankistrodemus spiralis	<227	504	3,538	<612	<688	<1,041		<848	<1,709		<186
Ankistrodemus	454	<126									
Botryococcus braunii			<885	<612	<688						
Botryococcus											
Coelastrum			<885	4,894	<688		<283		<1,709	1,367	<186
Crucigenia quadrata	<227	<126	<885	<612	<688						
Crucigenia rectangularis											<186
Crucigenia tetrapedia	<227	504	<885	4,894	5,506	<1,041	<283		<1,709	<342	<186
Crucigenia				2,447							<186
Dictyosphaerium	<227	<126	7,077	2,447						1,367	
Elakatothrix											
Euastropsis			<885	<612							
Kirchneriella		<126	<885	<612	<688						
Lagerheimia	454	126	<885	<612							186
Nephrocytium											
Oocystis	227	126	1,769	7,342	4,817	<1,041		<848	<1,709	<342	<186
Pediastrum	<227	<126	8,846	8,565	13,174				<1,709	<342	<186
Quadrigula	<227										
Scenedesmus	908	252	14,154	20,801	19,270	<1,041		<848	10,252	1,367	1,487
Schroederia								<848			
Selenastrum minutum	<227										
Sphaerocystis schroeteri	908	2,520	7,077	2,447	2,753	<1,041				<342	<186
Tetraedron		<126	<885	<612	688					<342	<186
Euglenales											
Euglena									<1,709		<186
Phacus											
Trachelomonas	<227	<126	885						<1,709	<342	<186
Oedogoniales											
Bulbochaete			<885	<612	<688	<1,041			1,709	2,392	1,487
Oedogonium	<227	<126	3,538	2,447	1,376	5,206	283	1,697	49,549	2,734	3,160
Siphonocladales											
Rhizoclonium											
Tetrasporales											
Apiocystis brauniana										<342	186
Gloeocystis ampla											
Tetraspora lamellosa											
Tetraspora								3,393			
Tetraspora ?						73,918	<283	2,545	10,252	3,759	186
Ulothrichales											
Cylindrocapsa ?				612	8,253				<1,709	1,367	<186
Geminella		<126	<885	<612	<688				<1,709		
Microspora			<885	<612		<1,041	<283	848			372
Stigeoclonium ?											
Ulothrix						<1,041					
Volvocales											
Chlamydomonas										<342	
Eudorina											

Appendix B3. Periphyton abundance (cells/cm^2) in Boston area streams, 1993-1998.

Species List	AIMAOKATALOK RIVER					REFERENCE OUTFLOW					
	24-Aug 1997		27-Jun to 01-Aug-98			25-Aug 1997			28-Jun to 01-Aug 1998		
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Chlorophyta											
Zygnematales											
Arthrodesmus	454		885	612	688						
Closterium	<227	126	<885	612	1,376	4,164	848	3,393	<1,709	342	<186
Cosmarium	1,362	756	12,384	15,295	20,646	1,041	283	848	3,417	1,709	930
Desmidium											
Euastrum	<227		1,769	1,224	1,376	<1,041	<283	<848	<1,709	<342	<186
Gonatozygon			<885	<612	<688						
Hyalotheca			<885	<612	<688	<1,041	<283	<848	<1,709		<186
Micrasterias											
Mougeotia	<227	126	<885	612	6,194			<848	<1,709	342	372
Netrium											
Onychonema ?											
Penium					<688					<342	
Pleurotaenium			<885	<612	<688					<342	<186
Sphaerozosma	681	504				<1,041	283	<848			
Spirogyra	<227	<126	<885	<612	6,194		<283		3,417	<342	<186
Spondylosium planum	<227	<126	<885	<612	<688	<1,041		<848			
Spondylosium											
Staurastrum paradoxum											
Staurastrum	227	<126	5,308	5,506	4,129	<1,041	283	848	6,834	342	558
Teilingia granulata			9,731	9,177	11,699				<1,709		558
Xanthidium											
Zygnema	1,816	3,024	7,077	<612	<688	<1,041	566	23,752			
Unidentified unicellular			23,000	22,637	33,722					<342	186
Unidentified flagellate			885	1,835	688					<342	
Chrysophyta											
Chromulinales											
Hydrurus foetidus											
Mischococcales											
Mischococcus											
Ophiocytium											
Ochromonadales											
Dinobryon bavaricum											
Dinobryon cylindricum											
Dinobryon divergens											
Dinobryon elegantissimum						1,041	<283				
Dinobryon sociale											
Dinobryon sertularia			<885	2,447	<688						<186
Dinobryon		<126								<342	186
Kephyrion / Pseudokephyrion				612							
Mallomonas								<848			<186
Tribonematales											
Tribonema											
Unidentified flagellate		<126	885	612	1,376	3,123	<283	1,697	<1,709	683	186
Unidentified unicellular									<1,709	1,367	186
Unidentified											
Cryptophyta											
Cryptomonadales											
Chroomonas acuta											
Cryptomonas									<1,709	342	<186
Cyanophyta											
Chamaesiphonales											
Clastidium setigerum	681	630	1,769	<612	<688	22,904	51,470	26,297	3,417	1,367	<186
Chroococcales											
Agmenellum glauca											
Agmenellum	<227		7,076	9,789	8,258				<1,709	<342	
Anacystis aeruginosa											
Anacystis elachista											
Anacystis	<227	504	70,768	41,602	100,477		8,201	2,545	34,172	30,070	5,205
Anacystis / Coccochloris											
Coccochloris											
Dactylococcopsis											
Gomphosphaeria naegelianum			199,035	55,062	138,328	<1,041		<848	59,801	54,672	46,475
Gomphosphaeria	908	<126				<1,041	3,959	13,573			8,366
Rhabdoderma					<688						
Unidentified											
Nostocales											
Anabaena affinis							<283	<848			
Anabaena			4,423	<612	<688	12,493	7,636	2,545	11,960	5,467	1,301
Aphanizomenon flos-aquae										<342	
Gloeotrichia ?											
Nostoc											
Pseudanabaena catenata			10,615					<848			
Rivularia											
Tolypothrix	<227										
Oscillatoriales											
Lyngbya limnetica						54,137	33,936	16,118			
Lyngbya	<227			9,177	<688	12,493	<283		<1,709		5,019
Oscillatoria tenuis						<1,041		<848			
Oscillatoria	2,043	1,386	61,922	47,109	32,345	<1,041		<848	17,086	12,301	1,115
Phormidium mucicola											
Spirulina						<1,041	566	2,545			
Unidentified sheathed filament											
Pyrrophyta											
Dinokontae											
Peridinium inconspicuum											
Peridinium / Glenodinium	<227		1,769	612	<688			<848	<1,709	342	186
Peridinium											
Rhodophyta											930
Nemalionales											
Audouinella						<1,041	<283				
Batrachospermum	<227										
Total	28,375	23,940	723,602	439,272	583,687	409,152	145,927	185,777	304,131	134,972	85,886

NOTE: * Genus was identified in fields that fell outside of the specified counting area during laboratory analysis.
** Genus was present in the remainder of the sample that was not sub-sampled for enumeration.

Appendix B4. Mean abundance (cells/cm^2) and percent composition of main taxa of periphyton in Boston area streams, 1993-1998.

Stream	Sample Date	No. Repl.	Bacillariophyta			Chlorophyta			Chrysophyta			Cryptophyta			Cyanophyta			Pyrrophyta			Rhodophyta			All Taxa	
			Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE
Stickleback Outflow	Aug-95	1	206 816	-	17.3	59 090	-	4.9	0	-	0.0	0	-	0.0	930 674	-	77.8	0	-	0.0	0	-	0.0	1196 580	-
	25-Aug-96	3	111 790	24 465	31.9	29 259	2 058	8.3	1 982	1 038	0.6	0	0	0.0	206 458	81 090	58.9	1 196	703	0.3	0	0	0.0	350 685	105 145
	21-Jul-97	3	383 978	156 338	68.1	33 762	20 110	6.0	9 143	7 380	1.6	0	0	0.0	133 886	94 962	23.7	3 204	1,664	0.6	0	0	0.0	563 973	279 110
	24-25 Aug-97	3	161 458	72 113	52.1	9 909	3 093	3.2	69	69	0.0	0	0	0.0	138 231	79 044	44.6	279	279	0.1	0	0	0.0	309 946	150 648
	26-Jun-98 to 30-Jul-98	3	78 101	23 120	58.8	17 117	5 173	12.9	1 134	635	0.9	175	106	0.1	35 293	15 537	26.6	916	464	0.7	0	0	0.0	132 736	43 525
Fickle Duck Outflow	17-18 Aug-93	1	307 897	-	29.3	42 260		4.0	15 093	-	1.4	0	-	0.0	685 222	-	65.2	0	-	0.0	0	-	0.0	1050 472	-
	Aug-95	1	748 536	-	19.0	2721 373		69.2	0	-	0.0	0	-	0.0	463 077	-	11.8	0	-	0.0	0	-	0.0	3932 986	-
	25-Aug-97	3	70 955	29 469	19.1	248 056	105 872	66.8	592	592	0.2	0	0	0.0	51 882	47 730	14.0	0	0	0.0	0	0	0.0	371 484	126 691
	26-Jun-98 to 31-Jul-98	3	11 247	3 297	1.9	132 081	96 290	22.0	1 033	528	0.2	0	0	0.0	454 191	193 423	75.5	0	0	0.0	2,977	2,681	0.5	601 528	295 653
Aimaokatalok NE Inflow	5-6 Aug-96	3	116 478	95 755	31.8	34 763	9 970	9.5	0	0	0.0	197	197	0.1	214 410	106 350	58.5	582	582	0.2	0	0	0.0	366 430	191 031
	25-Aug-97	1	12 491	-	10.3	38 247		31.7	577	-	0.5	0	-	0.0	69 385		57.5	0	-	0.0	0	-	0.0	120 700	-
	28-Jun-98 to 31-Jul-98	3	53 626	13 191	5.4	197 537	42 264	20.0	2 999	2 042	0.3	0	0	0.0	733 310	101 644	74.3	0	0	0.0	0	0	0.0	987 473	150 199
Aimaokatalok River	24-Aug-97	2	12 746	2 918	48.7	10 336	1 256	39.5	0	0	0.0	0	0	0.0	3 076	556	11.8	0	0	0.0	0	0	0.0	26 158	2 218
	27-Jun-98 to 01-Aug-98	3	171 220	29 035	29.4	142 277	11 530	24.4	1 977	859	0.3	0	0	0.0	265 919	56 084	45.7	794	519	0.1	0	0	0.0	582 187	82 082
Reference Outflow	25-Aug-97	3	103 932	51 059	42.1	50 594	27 499	20.5	1 954	1 209	0.8	0	0	0.0	90 473	13 468	36.6	0	0	0.0	0	0	0.0	246 952	81 912
	28-Jun-98 to 01-Aug-98	3	33 007	25 391	18.9	41 255	26 439	23.6	869	612	0.5	114	114	0.1	99 265	17 174	56.7	176	99	0.1	310	310	0.2	174 996	66 104

SE = Standard Error

APPENDIX C

SECONDARY PRODUCERS

Appendix C1. Zooplankton abundance (organisms/m^3) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE															
		Aug-93	02-Aug-95			04-Aug-96			04-Aug-96			24-Aug-96			24-Aug-96		
		WQ5	Station WQ5			Station 5			Station 6			Station 5			Station 6		
			Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ROTIFERA																	
Asplanchna																	
Brachionus																	
Conochilus unicornis	colony																
Conochilus unicornis																	
Filinia																	
Kellicottia longispina						14 500	12 760	13 340				13 920	6 960	18 560	6 500	3 250	3 575
Kellicottia			260	215	1 040												
Keratella cochlearis				7													
Keratella quadrata																	
Lepadella																	
Polyarthra							58										
Trichotriidae																	
Unidentified									43 550	12 350	17 550				650		
Unidentified		12 264															
CLADOCERA																	
Alona guttata																	
Alona rectangulata																	
Alona rustica																	
Alonella	juvenile																
Bosmina longirostris			1		1		17	29	7	13	39	41	290	41	91	59	104
Chydorus sphaericus						6						17	17	23	39	20	26
Daphnia galatea mandotea																	
Daphnia longiremis			16	98	46	1 972	1 102	3 132	15 600	18 200	11 700	11 020	9 280	4 698	20 800	10 075	8 190
Daphnia middendorffiana		189									1				1		
Daphnia	juvenile																
Holopedium gibberum		566	22	33	59	406	81	696	11 050	14 300	8 450	638	812	986			13
COPEPODA																	
Calanoida																	
Diaptomus pribilofensis	male								20	1	1	6					
Diaptomus pribilofensis	female								7	1	2	23		6			1
Diaptomus ashlandi	male								3	1	3	52	17	17	39	52	25
Diaptomus ashlandi	female								150	3	9	58	23	35	39	39	36
Diaptomus	cop. V		1	20	20					455	299		6	17	26	26	12
Diaptomus	cop. IV	472								130							
Diaptomus	cop. III																
Diaptomus	cop. II																
Diaptomus	cop. I																
Diaptomus		94															
Epischura lacustris	male								3	5	3			12	1		
Epischura lacustris	female								8	7	7				1		
Epischura lacustris	cop. V								1	1							
Epischura lacustris	cop. IV																
Epischura lacustris	cop. III																
Epischura lacustris	cop. II																
Epischura lacustris	cop. I																7
Epischura nevadensis	male																
Epischura nevadensis	female																
Epischura nevadensis	cop. V																
Epischura nevadensis	cop. IV																
Epischura nevadensis	cop. III																
Epischura nevadensis	cop. II																
Epischura nevadensis	cop. I																
Heterocope septentrionalis	male																
Heterocope septentrionalis	female																
Heterocope septentrionalis	cop. V																
Heterocope septentrionalis	cop. IV																
Heterocope septentrionalis	cop. III																
Leptodiaptomus ashlandi	male																
Leptodiaptomus ashlandi	female																
Leptodiaptomus pribilofensis	male																
Leptodiaptomus pribilofensis	female																
Leptodiaptomus	cop. V																
Leptodiaptomus	cop. IV																
Leptodiaptomus	cop. III																
Leptodiaptomus	cop. II																
Leptodiaptomus	cop. I																
Limnocalanus macrurus	male		21	26	14	6			6	5	5	6		6	5	5	3
Limnocalanus macrurus	female		20	17	16				5	4	6	12		6	4	4	2
Limnocalanus macrurus	cop. V																1
Limnocalanus macrurus	cop. IV																
Limnocalanus macrurus	cop. III																
Limnocalanus macrurus	cop. I																
Limnocalanus macrurus		94															
Unidentified Calanoida	nauplius								65	65							
Cyclopoida																	
Cyclops bicuspidatus thomasi	male		7														
Cyclops bicuspidatus thomasi	female		13														1
Cyclops scutifer	male		208	676	507	290	87	232	455	455	325	12			7		1
Cyclops scutifer	female		936	1 138	1 053	2 320	1 624	5 800	3 445	2 990	3 380	6	12	23	46	52	18
Cyclops scutifer		1 132															
Cyclops capillatus	male																
Cyclops	male																
Cyclops	copepodite		2 210	3 257	2 925												
Cyclops	cop. III-IV	1 981															
Cyclops	cop. I-II	943															
Cyclops																	
Lichomolgidae (parasitic)	copepodite																
Lichomolgidae (parasitic)	nauplius					23 780	17 400	49 880	3 900	7 800	12 350	20 300	21 460	20 300	39 650	21 450	23 400
Unidentified Cyclopoida	male																
Unidentified Cyclopoida	copepodite					11 020	6 380	23 200	9 750	9 100	9 750	8 584	4 060	7 540	2 860	3 185	2 080
Unidentified Cyclopoida	nauplius																
Harpacticoida																	
OSTRACODA																	
Unidentifed Ostracoda	juvenile																
MALACOSTRACA																	
Gammarus lacustris																	
Mysis relicta	female																
Unidentified Crustacean larvae	nauplius	23 208															
TOTAL		**40 943**	**3 714**	**5 483**	**5 679**	**54 300**	**39 510**	**96 309**	**88 022**	**65 885**	**63 880**	**54 694**	**42 937**	**52 270**	**70 757**	**38 215**	**37 495**

Appendix C1. Zooplankton abundance (organisms/m^3) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE														
		24-Jul-97			22-Jul-97			24-Jul-97			26-Aug-97			25-Aug-97		
		Station 1			Station 5			Station 6			Station 5			Station 6		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ROTIFERA																
Asplanchna			6	6	47	67	27				117					
Brachionus																
Conochilus unicornis	colony															
Conochilus unicornis								2 237	3 203	3 355	12					
Filinia																
Kellicottia longispina		585	1 227	877	1 236	1 737	1 002	661	356	407	40 337	14 030	17 538	11 692	11 692	11 042
Kellicottia																
Keratella cochlearis			6	6	67	200	67								130	
Keratella quadrata																
Lepadella																
Polyarthra																
Trichotriidae																
Unidentified																
Unidentified			12	6												
CLADOCERA																
Alona guttata																
Alona rectangulata																
Alona rustica																
Alonella	juvenile															
Bosmina longirostris		23	12	12	3						1 169	643	585	1 104	260	390
Chydorus sphaericus		6	6	6	3		3									
Daphnia galatea mandotea																
Daphnia longiremis									10		1 812	1 403	2 280	2 079	3 118	1 949
Daphnia middendorffiana																
Daphnia	juvenile															
Holopedium gibberum		18	18	41	27	57	23	112	81	168				715	1 559	1 039
COPEPODA																
Calanoida																
Diaptomus pribilofensis	male															
Diaptomus pribilofensis	female															
Diaptomus ashlandi	male															
Diaptomus ashlandi	female															
Diaptomus	cop. V															
Diaptomus	cop. IV															
Diaptomus	cop. III															
Diaptomus	cop. II															
Diaptomus	cop. I															
Diaptomus																
Epischura lacustris	male															6
Epischura lacustris	female		6										6			6
Epischura lacustris	cop. V															
Epischura lacustris	cop. IV															
Epischura lacustris	cop. III															
Epischura lacustris	cop. II															
Epischura lacustris	cop. I															
Epischura nevadensis	male															
Epischura nevadensis	female															
Epischura nevadensis	cop. V															
Epischura nevadensis	cop. IV															
Epischura nevadensis	cop. III															
Epischura nevadensis	cop. II															
Epischura nevadensis	cop. I															
Heterocope septentrionalis	male															
Heterocope septentrionalis	female															
Heterocope septentrionalis	cop. V															
Heterocope septentrionalis	cop. IV															
Heterocope septentrionalis	cop. III															
Leptodiaptomus ashlandi	male											23	23	13	13	32
Leptodiaptomus ashlandi	female									5	18	12	6	26	13	26
Leptodiaptomus pribilofensis	male	6												6		
Leptodiaptomus pribilofensis	female	12														
Leptodiaptomus	cop. V	47						10		5				13		
Leptodiaptomus	cop. IV		6		13	10	7	5		10						
Leptodiaptomus	cop. III	6	6		23	23	20									
Leptodiaptomus	cop. II			6	37	67	43									
Leptodiaptomus	cop. I				10	23	33									
Limnocalanus macrurus	male							15	10	20	53	76	88	45	65	58
Limnocalanus macrurus	female							5	25	25	105	70	76	26	58	26
Limnocalanus macrurus	cop. V							56	31	56						
Limnocalanus macrurus	cop. IV								5							
Limnocalanus macrurus	cop. III															
Limnocalanus macrurus	cop. I															
Limnocalanus macrurus																
Unidentified Calanoida	nauplius	228	35	47	1 604	2 372	768	15	153	102	58	585				
Cyclopoida																
Cyclops bicuspidatus thomasi	male	29	12	23	17	30	13	36	10	10	58				13	6
Cyclops bicuspidatus thomasi	female		6	6	13	10	7	5	10	5	6			65		
Cyclops scutifer	male	64	164	53	200	334	401	1 525	1 423	1 881	2 338	292	292	260	110	65
Cyclops scutifer	female	94	164	99	167	301	234	1 169	712	864		4 092	1 754	1 364	779	909
Cyclops scutifer																
Cyclops capillatus	male															
Cyclops	male															
Cyclops	copepodite	456	292	397	1 670	1 871	1 336	1 373	1 627	1 627	7 015	4 092	6 430	2 988	2 403	3 118
Cyclops	cop. III-IV															
Cyclops	cop. I-II															
Cyclops																
Lichomolgidae (parasitic)	copepodite															
Lichomolgidae (parasitic)	nauplius															
Unidentified Cyclopoida	male															
Unidentified Cyclopoida	copepodite															
Unidentified Cyclopoida	nauplius	158	47	35	768	802	1 236	102	102		1 228			65	1 039	2 144
Harpacticoida																
OSTRACODA																
Unidentifed Ostracoda	juvenile															
MALACOSTRACA																
Gammarus lacustris		18	18	41	27	57	23							715	1 559	1 039
Mysis relicta	female							1								
Unidentified Crustacean larvae	nauplius															
TOTAL		**1 748**	**2 040**	**1 660**	**5 933**	**7 961**	**5 245**	**7 326**	**7 757**	**8 540**	**54 326**	**25 319**	**29 078**	**21 175**	**22 812**	**21 857**

Appendix C1. Zooplankton abundance (organisms/m^3) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE						STICKLEBACK LAKE									
		18-Jul-98 Station 4			18-Jul-98 Station 6			Aug-93	03-Aug-95			04-Aug-96			25-Aug-96		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ROTIFERA																	
Asplanchna		38	75	75	19		10		296	638	17	29	348	139			
Brachionus															58		
Conochilus unicornis	colony	75		38													
Conochilus unicornis																	
Filinia												81	116	1 914			
Kellicottia longispina		6 792	5 283	1 000	1 456	98	857					151	348	58			
Kellicottia									1 740	2 784	10 730						
Keratella cochlearis					10				302	406	812		58				
Keratella quadrata																	
Lepadella																	
Polyarthra											58						
Trichotriidae																	
Unidentified												41	232	580			
Unidentified								893 584									
CLADOCERA																	
Alona guttata																	58
Alona rectangulata																	
Alona rustica																	
Alonella	juvenile																
Bosmina longirostris		113	226	45	29	1	1		400	23	46	29	348	238			
Chydorus sphaericus			4						29	6	6			6	116	290	58
Daphnia galatea mandotea																	
Daphnia longiremis		226	26	42	87	148	57				6	17	23	23			
Daphnia middendorffiana								3 019									
Daphnia	juvenile	415	642	113		39	95	3 019									
Holopedium gibberum		2 000	2 038	1 358	476	441	267					23					
COPEPODA																	
Calanoida																	
Diaptomus pribilofensis	male																
Diaptomus pribilofensis	female																
Diaptomus ashlandi	male																
Diaptomus ashlandi	female																
Diaptomus	cop. V												6				
Diaptomus	cop. IV																
Diaptomus	cop. III												6				
Diaptomus	cop. II																
Diaptomus	cop. I																
Diaptomus																	
Epischura lacustris	male																
Epischura lacustris	female																
Epischura lacustris	cop. V																
Epischura lacustris	cop. IV	8															
Epischura lacustris	cop. III																
Epischura lacustris	cop. II				1												
Epischura lacustris	cop. I				1												
Epischura nevadensis	male								23	70	29						
Epischura nevadensis	female								70	75	23						
Epischura nevadensis	cop. V								151	290	52						
Epischura nevadensis	cop. IV								41	186	64						
Epischura nevadensis	cop. III								52	110	23						
Epischura nevadensis	cop. II								29	93	35						
Epischura nevadensis	cop. I								6	17	6						
Heterocope septentrionalis	male																
Heterocope septentrionalis	female																
Heterocope septentrionalis	cop. V																
Heterocope septentrionalis	cop. IV			19													
Heterocope septentrionalis	cop. III		4	4													
Leptodiaptomus ashlandi	male	38	38	38													
Leptodiaptomus ashlandi	female			4													
Leptodiaptomus pribilofensis	male																
Leptodiaptomus pribilofensis	female																
Leptodiaptomus	cop. V	38	75	189	19	20	29										
Leptodiaptomus	cop. IV	416	755	83	78	127	86										
Leptodiaptomus	cop. III	528	64	64	39	98	114										
Leptodiaptomus	cop. II	83	642	528	10	29	48										
Leptodiaptomus	cop. I	38	75	75													
Limnocalanus macrurus	male				2	32	33			6							
Limnocalanus macrurus	female	4			24	23	28										
Limnocalanus macrurus	cop. V				98	137	143										
Limnocalanus macrurus	cop. IV	4		4	10	10											
Limnocalanus macrurus	cop. III						10										
Limnocalanus macrurus	cop. I																
Limnocalanus macrurus																	
Unidentified Calanoida	nauplius	340	566	170	10	69			23	23	6						
Cyclopoida																	
Cyclops bicuspidatus thomasi	male	1 170	642	943	39	88	95			6							
Cyclops bicuspidatus thomasi	female	604	264	264	19		39		12								
Cyclops scutifer	male	1 358	981	1 132	3 689	2 157	2 476		17	12	6						6
Cyclops scutifer	female	2 226	2 453	2 264	165	1 275	476		29	6	6	6	17	12	6		6
Cyclops scutifer								3 019									
Cyclops capillatus	male																
Cyclops	male																
Cyclops	copepodite								2 314	2 668	1 334						
Cyclops	cop. III-IV																
Cyclops	cop. I-II																
Cyclops								3 019									
Lichomolgidae (parasitic)	copepodite														58		
Lichomolgidae (parasitic)	nauplius											441	2 146	3 944	232	406	232
Unidentified Cyclopoida	male																
Unidentified Cyclopoida	copepodite	5 660	6 453	9 057	34	246	495					180	1 624	1 798	754	580	522
Unidentified Cyclopoida	nauplius								522	1 276	464						
Harpacticoida																	
OSTRACODA																	
Unidentifed Ostracoda	juvenile								151	58	58						
MALACOSTRACA																	
Gammarus lacustris																	
Mysis relicta	female				1	1											
Unidentified Crustacean larvae	nauplius							6 038									
TOTAL		**22 175**	**21 306**	**17 509**	**6 318**	**5 040**	**5 358**	**911 697**	**6 206**	**8 752**	**13 781**	**998**	**5 272**	**8 712**	**1 224**	**1 276**	**882**

Appendix C1. Zooplankton abundance (organisms/m^3) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	STICKLEBACK LAKE									FICKLE DUCK LAKE					
		23-Jul-97			26-Aug-97			19-Jul-98			03-Aug-95			05-Aug-96		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ROTIFERA																
Asplanchna					12	6		42	52	43	1 720	473	215	30	473	17
Brachionus																
Conochilus unicornis	colony							633	196	71						
Conochilus unicornis																
Filinia									65							
Kellicottia longispina		58			310	550	509	17 449	7 832	125 983				10 363	61 060	11 868
Kellicottia											6 450	2 150	3 870			
Keratella cochlearis				58	12	18	12	316	65							
Keratella quadrata																
Lepadella														4	129	
Polyarthra					12	23	23								43	43
Trichotriidae																
Unidentified																
Unidentified					53	88	94	15	14							
CLADOCERA																
Alona guttata																
Alona rectangulata																
Alona rustica															4	
Alonella	juvenile															
Bosmina longirostris		292	234	58	64	187	164	221	65	100	43			4		
Chydorus sphaericus			58	53	12	12		95	39	28					26	
Daphnia galatea mandotea											301	344	774			
Daphnia longiremis		643				6	6				473	86	86	52	69	47
Daphnia middendorffiana																
Daphnia	juvenile															
Holopedium gibberum					6						65	26	13	13	13	4
COPEPODA																
Calanoida																
Diaptomus pribilofensis	male															
Diaptomus pribilofensis	female															
Diaptomus ashlandi	male															
Diaptomus ashlandi	female															
Diaptomus	cop. V										13	172	1 720			
Diaptomus	cop. IV										2 580	4 300	1 290			
Diaptomus	cop. III															
Diaptomus	cop. II														9	
Diaptomus	cop. I														39	9
Diaptomus																
Epischura lacustris	male			6		6		2		14						
Epischura lacustris	female				6	29	6	2		14						
Epischura lacustris	cop. V	6	82	41				42	33	57						
Epischura lacustris	cop. IV	12	58	47				169	124	157						
Epischura lacustris	cop. III		6	23				190	144	242						
Epischura lacustris	cop. II			58			6	527	170	214						
Epischura lacustris	cop. I			58				843	117	14						
Epischura nevadensis	male										17	4				
Epischura nevadensis	female										17					
Epischura nevadensis	cop. V												9			
Epischura nevadensis	cop. IV															
Epischura nevadensis	cop. III										3 870	2 150	3 870			
Epischura nevadensis	cop. II										1 333	516	258			
Epischura nevadensis	cop. I										43		43			
Heterocope septentrionalis	male										77	22	60			
Heterocope septentrionalis	female										133	90	52			
Heterocope septentrionalis	cop. V												4			
Heterocope septentrionalis	cop. IV															
Heterocope septentrionalis	cop. III															
Leptodiaptomus ashlandi	male															
Leptodiaptomus ashlandi	female															
Leptodiaptomus pribilofensis	male															
Leptodiaptomus pribilofensis	female															
Leptodiaptomus	cop. V															
Leptodiaptomus	cop. IV			58												
Leptodiaptomus	cop. III															
Leptodiaptomus	cop. II															
Leptodiaptomus	cop. I															
Limnocalanus macrurus	male	6														
Limnocalanus macrurus	female															
Limnocalanus macrurus	cop. V															
Limnocalanus macrurus	cop. IV															
Limnocalanus macrurus	cop. III															
Limnocalanus macrurus	cop. I															
Limnocalanus macrurus																
Unidentified Calanoida	nauplius	58			725	848	590	2 318	2 796	1 281	43			4	172	129
Cyclopoida																
Cyclops bicuspidatus thomasi	male	585	643	292		70	23	137	117	142						
Cyclops bicuspidatus thomasi	female	175	409	351	6				7	7						
Cyclops scutifer	male	58	6	23							258	17	22			
Cyclops scutifer	female	818	6	6										17	9	9
Cyclops scutifer																
Cyclops capillatus	male														4	
Cyclops	male															
Cyclops	copepodite	28 060	49 690	46 767	520	1 152	783				129					
Cyclops	cop. III-IV															
Cyclops	cop. I-II															
Cyclops																
Lichomolgidae (parasitic)	copepodite															
Lichomolgidae (parasitic)	nauplius													3 354	15 480	3 225
Unidentified Cyclopoida	male															
Unidentified Cyclopoida	copepodite							15 275	13 265	14 947				43	34	17
Unidentified Cyclopoida	nauplius	58			82	94	82		196	71	3 010	3 870	1 290			
Harpacticoida					12											
OSTRACODA																
Unidentifed Ostracoda	juvenile															
MALACOSTRACA																
Gammarus lacustris		6			6				7							
Mysis relicta	female															
Unidentified Crustacean larvae	nauplius															
TOTAL		**30 837**	**51 193**	**47 901**	**1 836**	**3 087**	**2 297**	**38 273**	**25 302**	**143 386**	**20 576**	**14 220**	**13 575**	**13 885**	**77 563**	**15 368**

Appendix C1. Zooplankton abundance (organisms/m^3) in Boston area lakes, 1993-1998.

Taxa / Species	**Stage**	**FICKLE DUCK LAKE**											
		25-Aug-96			**23-Jul-97**			**26-Aug-97**			**19-Jul-98**		
		Rep 1	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**
ROTIFERA													
Asplanchna		40 850	54 610	38 700	21 045	34 296	32 737	1 743	765	2 211	42 137	445	3 953
Brachionus													
Conochilus unicornis	colony										235	4 329	4 115
Conochilus unicornis						2 338	1 559	4 252	1 275	2 551			
Filinia		430											
Kellicottia longispina		80 840	116 960	80 840	2 338	2 338	390	68 025	15 731	45 492	9 364	7 215	953
Kellicottia													
Keratella cochlearis		1 290								85			
Keratella quadrata													
Lepadella													
Polyarthra													
Trichotriidae		2 580	2 580	2 580									
Unidentified		86	215	43									
Unidentified										170			
CLADOCERA													
Alona guttata													
Alona rectangulata				43									
Alona rustica													
Alonella	juvenile		86	86									
Bosmina longirostris				43	16	8	78	5 527	1 020	2 381	4 623	6 854	577
Chydorus sphaericus		172	43	43				17	4	4			
Daphnia galatea mandotea													
Daphnia longiremis		645	731	387	47	312	234	850	102	468			
Daphnia middendorffiana													
Daphnia	juvenile										59		82
Holopedium gibberum					7 015	14 030	4 677	4	9	4	936	2 381	988
COPEPODA													
Calanoida													
Diaptomus pribilofensis	male												
Diaptomus pribilofensis	female												
Diaptomus ashlandi	male												
Diaptomus ashlandi	female												
Diaptomus	cop. V												
Diaptomus	cop. IV												
Diaptomus	cop. III												
Diaptomus	cop. II												
Diaptomus	cop. I												
Diaptomus													
Epischura lacustris	male	9	4		1 169	234	140	26	9	30	29	173	16
Epischura lacustris	female				468	86	47	9		13		22	8
Epischura lacustris	cop. V			4	1 559	249	171	38	4	21	123	281	132
Epischura lacustris	cop. IV	4	4	9	1 481	312	468	77	4	26	170	556	75
Epischura lacustris	cop. III				1 325	468	468	17	4	9	527	184	247
Epischura lacustris	cop. II				390	624	468	34	4	13	819	1 732	170
Epischura lacustris	cop. I					312	234			4	50	866	658
Epischura nevadensis	male												
Epischura nevadensis	female												
Epischura nevadensis	cop. V												
Epischura nevadensis	cop. IV												
Epischura nevadensis	cop. III												
Epischura nevadensis	cop. II												
Epischura nevadensis	cop. I												
Heterocope septentrionalis	male												
Heterocope septentrionalis	female												
Heterocope septentrionalis	cop. V												
Heterocope septentrionalis	cop. IV												
Heterocope septentrionalis	cop. III												
Leptodiaptomus ashlandi	male												
Leptodiaptomus ashlandi	female												
Leptodiaptomus pribilofensis	male							4					
Leptodiaptomus pribilofensis	female												
Leptodiaptomus	cop. V					23	86						
Leptodiaptomus	cop. IV				55	468	234				18	22	16
Leptodiaptomus	cop. III				8		312						8
Leptodiaptomus	cop. II												
Leptodiaptomus	cop. I												
Limnocalanus macrurus	male												
Limnocalanus macrurus	female				16	8							
Limnocalanus macrurus	cop. V				78	8							
Limnocalanus macrurus	cop. IV				312								
Limnocalanus macrurus	cop. III				78								
Limnocalanus macrurus	cop. I				78								
Limnocalanus macrurus													
Unidentified Calanoida	nauplius	172	860	430	78	78	156	213	170	128	77	722	411
Cyclopoida													
Cyclops bicuspidatus thomasi	male				702		78						82
Cyclops bicuspidatus thomasi	female				312		16						
Cyclops scutifer	male				8		8						
Cyclops scutifer	female								4				
Cyclops scutifer													
Cyclops capillatus	male												
Cyclops	male		4										
Cyclops	copepodite				1 247	390	468	298	34	72			
Cyclops	cop. III-IV												
Cyclops	cop. I-II												
Cyclops													
Lichomolgidae (parasitic)	copepodite												
Lichomolgidae (parasitic)	nauplius	12 040	12 900	8 600									
Unidentified Cyclopoida	male										59		
Unidentified Cyclopoida	copepodite	43	129	129							1 639	11	75
Unidentified Cyclopoida	nauplius				779	156	234	4 252	1 871	3 274			
Harpacticoida													
OSTRACODA													
Unidentifed Ostracoda	juvenile												
MALACOSTRACA													
Gammarus lacustris					7 015	14 030	4 677	4	9	4			
Mysis relicta	female												
Unidentified Crustacean larvae	nauplius												
TOTAL		**139 161**	**189 127**	**131 937**	**47 617**	**70 767**	**47 937**	**85 388**	**21 020**	**56 958**	**60 863**	**25 792**	**12 567**

Appendix C1. Zooplankton abundance (organisms/m^3) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	REFERENCE LAKE								
		23-Jul-97			27-Aug-97*			22-Jul-98		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ROTIFERA										
Asplanchna								3 376	288	28
Brachionus										
Conochilus unicornis	colony							16	8	4
Conochilus unicornis										
Filinia										
Kellicottia longispina		292	409	175	226	22 604	21 045	3 344	32	352
Kellicottia										
Keratella cochlearis					156	156				
Keratella quadrata			58							
Lepadella										
Polyarthra										
Trichotriidae										
Unidentified										
Unidentified							8	48		
CLADOCERA										
Alona guttata										
Alona rectangulata										
Alona rustica										
Alonella	juvenile									
Bosmina longirostris		23	12	175	47	23		14	728	568
Chydorus sphaericus					8	8	8	8		
Daphnia galatea mandotea										
Daphnia longiremis		6		29	23			8		16
Daphnia middendorffiana										
Daphnia	juvenile							64	48	12
Holopedium gibberum		29	210	134				4	48	24
COPEPODA										
Calanoida										
Diaptomus pribilofensis	male									
Diaptomus pribilofensis	female									
Diaptomus ashlandi	male									
Diaptomus ashlandi	female									
Diaptomus	cop. V									
Diaptomus	cop. IV									
Diaptomus	cop. III									
Diaptomus	cop. II									
Diaptomus	cop. I									
Diaptomus										
Epischura lacustris	male	12	18	53		8			8	48
Epischura lacustris	female		12	117						88
Epischura lacustris	cop. V			6		23		16	16	4
Epischura lacustris	cop. IV					16		8	8	4
Epischura lacustris	cop. III					8	23	32		8
Epischura lacustris	cop. II					8	23	8	24	32
Epischura lacustris	cop. I						8	32	4	4
Epischura nevadensis	male									
Epischura nevadensis	female									
Epischura nevadensis	cop. V									
Epischura nevadensis	cop. IV									
Epischura nevadensis	cop. III									
Epischura nevadensis	cop. II									
Epischura nevadensis	cop. I									
Heterocope septentrionalis	male	35	105	29						
Heterocope septentrionalis	female	12	123	23						
Heterocope septentrionalis	cop. V		18							
Heterocope septentrionalis	cop. IV									
Heterocope septentrionalis	cop. III									
Leptodiaptomus ashlandi	male									8
Leptodiaptomus ashlandi	female							8	16	
Leptodiaptomus pribilofensis	male	70	117	88						24
Leptodiaptomus pribilofensis	female	58	152	23				8	8	
Leptodiaptomus	cop. V	526	994	526				16		24
Leptodiaptomus	cop. IV		29	41						
Leptodiaptomus	cop. III									
Leptodiaptomus	cop. II				8					
Leptodiaptomus	cop. I									
Limnocalanus macrurus	male									
Limnocalanus macrurus	female									
Limnocalanus macrurus	cop. V									
Limnocalanus macrurus	cop. IV									
Limnocalanus macrurus	cop. III									
Limnocalanus macrurus	cop. I									
Limnocalanus macrurus										
Unidentified Calanoida	nauplius							176	14	88
Cyclopoida										
Cyclops bicuspidatus thomasi	male	23	18	23	8			184	14	64
Cyclops bicuspidatus thomasi	female	6	18	18					8	
Cyclops scutifer	male		12	6						
Cyclops scutifer	female	41	47	58						
Cyclops scutifer										
Cyclops capillatus	male									
Cyclops	male									
Cyclops	copepodite	146	292	117	218	249	218			
Cyclops	cop. III-IV									
Cyclops	cop. I-II									
Cyclops										
Lichomolgidae (parasitic)	copepodite									
Lichomolgidae (parasitic)	nauplius									
Unidentified Cyclopoida	male									
Unidentified Cyclopoida	copepodite							74	584	336
Unidentified Cyclopoida	nauplius			58	1 442	2 416	779	48	112	8
Harpacticoida			6							
OSTRACODA										
Unidentifed Ostracoda	juvenile									
MALACOSTRACA										
Gammarus lacustris		29	210	134						
Mysis relicta	female									
Unidentified Crustacean larvae	nauplius									
TOTAL		**1 310**	**2 859**	**1 836**	**2 136**	**25 519**	**22 113**	**7 492**	**1 968**	**1 744**

* Samples badly preserved with ethyl alcohol

Appendix C2. Mean abundance (organisms/m^3) and percent composition of main taxa of zooplankton in Boston area lakes, 1993-1998.

Lake	Date	No.	Rotifera			Cladocera			Calanoida			Cyclopoida			Harpacticoida			Ostracoda			Malacostraca			Unid. Crustacea			All Taxa	
		Repl.	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE
Aimaokatalok	Aug-93 (WQ5)	1	12 264	-	30.0	755	-	1.8	660	-	1.6	4 057	-	9.9	0	-	0.0	0	-	0.0	0	-	0.0	23 208	-	56.7	40 943	-
	2-Aug-95 (WQ5)	3	507	267	10.2	91	27	1.8	51	6	1.0	4 310	498	86.9	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	4 959	625
	4-Aug-96 (Station 5)	3	13 553	497	21.4	2 480	768	3.9	2	2	<0.1	47 338	16 255	74.7	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	63 373	17 013
	6-Aug-96 (Station 6)	3	24 483	9 651	33.7	26 453	3 559	36.4	426	127	0.6	21 233	2 424	29.2	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	72 596	7 735
	24-Aug-96 (Station 5)	3	13 147	3 371	26.3	9 288	1 810	18.6	101	32	0.2	27 432	996	54.9	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	49 967	3 584
	24-Aug-96 (Station 6)	3	4 658	1 249	9.5	13 139	3 931	26.9	109	11	0.2	30 916	5 828	63.3	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	48 823	10 969
	24-Jul-97 (Station 1)	3	910	193	50.1	47	7	2.6	134	82	7.4	699	55	38.5	0	0	0.0	0	0	0.0	25	8	1.4	0	0	0.0	1 816	115
	22-Jul-97 (Station 5)	3	1 483	271	23.3	39	9	0.6	1 685	469	26.4	3 137	154	49.2	0	0	0.0	0	0	0.0	36	11	0.6	0	0	0.0	6 380	815
	24-Jul-97 (Station 6)	3	3 406	261	43.3	124	23	1.6	185	39	2.3	4 160	147	52.8	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	7 875	355
	26-Aug-97 (Station 5)	3	24 011	8 289	66.3	2 631	294	7.3	399	183	1.1	9 199	723	25.4	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	36 241	9 108
	25-Aug-97 (Station 6)	3	11 519	241	52.5	4 071	458	18.5	145	8	0.7	5 110	578	23.3	0	0	0.0	0	0	0.0	1 104	246	5.0	0	0	0.0	21 948	475
	18-Jul-98 (Station 4)	3	4 459	1 732	21.9	2 416	432	11.9	1 630	308	8.0	11 824	921	58.2	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	20 330	1 432
	18-Jul-98 (Station 6)	3	817	401	14.7	547	64	9.8	442	77	7.9	3 765	105	67.6	0	0	0.0	0	0	0.0	1	0	<0.1	0	0	0.0	5 572	384
Stickleback	Aug-93	1	893 584	-	98.0	6 038	-	0.7	0	-	0.0	6 038	-	0.7	0	-	0.0	0	-	0.0	0	0	0.0	6 038	-	0.7	911 697	-
	03-Aug-95	3	5 928	2 877	61.9	172	129	1.8	501	190	5.2	2 890	623	30.2	0	0	0.0	89	31	0.9	0	0	0.0	0	0	0.0	9 580	2 225
	04-Aug-96	3	1 365	702	27.3	236	88	4.7	4	4	0.1	3 389	1 493	67.9	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	4 994	2 231
	25-Aug-96	3	19	19	1.7	174	58	15.4	0	0	0.0	934	86	82.8	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1 127	124
	27-Jul-97	3	39	19	0.1	446	250	1.0	173	62	0.4	42 650	6 518	98.5	0	0	0.0	0	0	0.0	2	2	<0.1	0	0	0.0	43 310	6 309
	26-Aug-97	3	573	89	23.8	152	37	6.3	739	81	30.7	937	206	38.9	4	4	0.2	0	0	0.0	2	2	<0.1	0	0	0.0	2 407	365
	19-Jul-98	3	50 925	37 702	73.8	183	67	0.3	3 155	616	4.6	14 721	573	21.3	0	0	0.0	0	0	0.0	2	2	<0.1	0	0	0.0	68 987	37 387
Fickle Duck	03-Aug-95	3	4 959	1 660	30.8	737	140	4.6	7 562	283	46.9	2 865	790	17.8	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	16 124	2 234
	05-Aug-96	3	28 010	16 853	78.7	77	18	0.2	120	63	0.3	7 397	4 065	20.8	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	35 605	20 983
	25-Aug-96	3	140 868	16 787	91.8	760	80	0.5	499	199	0.3	11 282	1 306	7.4	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	153 408	17 981
	23-Jul-97	3	32 348	4 650	58.3	8 805	2 837	15.9	4 248	1 423	7.7	1 465	795	2.6	0	0	0.0	0	0	0.0	8 574	2 810	15.5	0	0	0.0	55 440	7 664
	26-Aug-97	3	47 433	16 310	87.1	3 464	1 549	6.4	285	67	0.5	3 268	763	6.0	0	0	0.0	0	0	0.0	6	1	<0.1	0	0	0.0	54 455	18 624
	19-Jul-98	3	24 249	13 770	73.3	5 500	2 192	16.6	2 704	927	8.2	622	539	1.9	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	33 074	14 409
Reference	23-Jul-97	3	312	85	15.6	207	81	10.3	1 062	258	53.1	294	49	14.7	2	2	0.1	0	0	0.0	125	53	6.2	0	0	0.0	2 001	455
	27-Aug-97	3	14 732	7 192	88.8	39	21	0.2	42	17	0.3	1 777	485	10.7	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	16 589	7 293
	22-Jul-98	3	2 499	2 143	66.9	514	216	13.8	245	74	6.6	477	124	12.8	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	3 735	1 880

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE																	
		Aug-93	Aug-94	Aug-94	2-Aug-95			4-Aug-96			4-Aug-96			24-Aug-96			24-Aug-96		
		WQ3	WQ4	WQ5	Station WQ-5 (10 m)			Station 5 (2 m)			Station 6 (24 m)			Station 5 (3.5 m)			Station 6 (29 m)		
			(18 m)	(18 m)	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
HYDROZOA																			
Hydra canadensis																			
Hydra																			
TURBELLARIA																133			
ROTIFERA								267	533	178		1 111	533			178			
Filinia																			
Kellicottia								89	311	667	311	222	89						
Keratella								44											
Lecane																			
Polyarthra																178			
NEMATODA		9 337		74				3 200	2 755	2 489	44	44		44	267	2 444	89	267	89
BIVALVIA (PELECYPODA)				311															
Sphaeriidae	Juvenile				89		622												
Pisidium nitidum				430															
Pisidium	Juvenile																		
Pisidium								178	267	444	178	178	178	3 022	1 022	1 955	578	578	311
Sphaerium nitidum			2 474																
Sphaerium								178	444	578			267			1 644	578	444	222
GASTROPODA																			
Muricidae																			
Typhis			44																
Valvatidae	Juvenile																		
Valvata sincera helicoidea																			
Valvata sincera sincera																			
Valvata sincera									44	44				444	356	2 355			
ANNELIDA																			
OLIGOCHAETA	Juvenile	3 916																	
OLIGOCHAETA	Egg																		
Enchytraeidae			948						222	44	44								
Lumbriculidae		803		104															
Lumbriculidae	Juvenile																		
Lumbriculus																			
Lumbriculus variegatus																			
Naididae (damaged)																			
Chaetogaster									44	44									
Nais																			
Tubificidae											44	44			44	44	533	889	755
Tubificidae	Juvenile	803						44	267										
Tubificidae (damaged)																			
Tubificidae (sp. A)																			
Tubificidae (sp. B)				193															
TARDIGRADA																			44
ACARI (ACARINA)																			
Oribatidae																			
Hydracarina		803						44				44		44		89			
Hydracarina	Adult				44		44												
Forelli	Adult																		
Frontipoda								89											
INSECTA	Larva	100																	
INSECTA	Egg																		
DIPTERA																			
Chironomidae	Larva				222	133													
Chironomidae	Pupa																		
Chironomidae	Adult												44						
Chironomidae	Juvenile	3 414		1 274															
Chironominae																	44		
Chironominae	Pupa											44							
Chironomini				178															
Chironomini	Larva																		
Chironomini	Pupa								89	89									
Chironomus																	178	133	178
Chironomus	Larva																		
Cladopelma	Larva																		
Cryptochironomus																			
Cryptochironomus	Larva																		
Demicryptochironomus	Larva																		
Demicryptochironomus	Pupa																		
Dicrotendipes																			
Dicrotendipes	Larva																		
Glyptotendipes										44									
Glyptotendipes	Larva																		
Lipiniella	Larva																		
Lipiniella	Pupa																		
Microtendipes	Larva																		
Phaenopsectra		201									89	44	89	44		133			
Phaenopsectra	Larva																		
Phaenopsectra	Pupa																		
Stictochironomus																			
Tanytarsini				74															
Tanytarsini	Juvenile								44	44									
Tanytarsini	Larva																		
Tanytarsini	Pupa																		
Corynocera	Larva																		
Micropsectra	Larva																		
Paratanytarsus	Larva																		
Rheotanytarsus								222	1 155	1 111		133						44	44
Rheotanytarsus	Larva																		
Rheotanytarsus	Pupa																		
Stempellinella																44			
Stempellinella	Larva																		
Stempellinella	Pupa																		
Tanytarsus			385					44	844	311	44	356		133	133	400			
Tanytarsus	Larva																		
Tanytarsus	Pupa																		
Diamesinae	Pupa																		
Diamesa	Larva																		
Potthastia	Larva																		
Protanypus	Larva																		
Protanypus	Pupa																		
Orthocladiinae	Juvenile							44	44	44									
Orthocladiinae	Larva				89	44	44												

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE																	
		Aug-93	Aug-94	Aug-94	2-Aug-95			4-Aug-96			4-Aug-96			24-Aug-96			24-Aug-96		
		WQ3	WQ4	WQ5	Station WQ-5 (10 m)			Station 5 (2 m)			Station 6 (24 m)			Station 5 (3.5 m)			Station 6 (29 m)		
			(18 m)	(18 m)	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Orthocladiinae	Pupa							44	44										
Orthocladiinae	Adult				89														
Acamptocladius	Larva																		
Corynoneura																			
Corynoneura	Larva					44	44												
Corynoneura	Pupa																		
Cricotopus																			
Cricotopus	Larva																		
Eukiefferiella																44			
Eukiefferiella	Larva																		
Euryhapsis																			
Heterotrissocladius	Larva				89	44													
Heterotrissocladius								178	578	400				44		44			
Orthocladius	Larva																		
Paracladius								89	356	533			44	44					
Psectrocladius	Larva																		
Rheocricotopus	Larva																		
Thienemaniella	Larva																		
Zalutschia	Larva																		
Zalutschia	Pupa																		
Zavrelia	Larva																		
Prodiamesinae																			
Monodiamesa								44	133	44		44		89					
Monodiamesa	Larva																		
Tanypodinae				444															
Tanypodinae	Pupa																		
Paramerina	Larva																		
Procladius								89	133	44	44	133	133	311	267	267			
Procladius	Larva					44	133												
Tanypus			1 630																
Thienemannimyia																			
Empididae																			
Chelifera	Larva																		
Simuliidae																			
Simulium	Adult																		
Simulium	Larva																		
Tipulidae																			
Hexatoma	Larva																		
EPHEMEROPTERA																			
Baetidae	Nymph																		
Leptophlebiidae																			
Paraleptophlebia debilis	Nymph																		
HEMIPTERA	Nymph						44												
PLECOPTERA																			
Podmosta																			
Zapada	Nymph																		
TRICHOPTERA																			
Brachycentridae	Larva																		
Brachycentrus americanus	Larva																		
Limnephilidae	Pupa																		
Clostoeca																			
Ecclisomyia	Larva																		
Grensia praeterita																			
Grensia																89			
CLADOCERA																			
Chydorus sphaericus																			
Daphnia longiremis								444		178	178	311	89	178	44	89	267	89	44
Daphnia	Juvenile	1 606																	
Daphnia																			
Holopedium gibberum				15				44	44	133	222	222	133	133	44				
Holopedium																			
Ophryoxus gracilis									89										
COPEPODA	Nauplius							755	356	667	267	178	133						
Calanoida											44	133	133		44				
Diaptomus		1 606		415															
Leptodiaptomus pribilofensis																			
Cyclopoida		201		785				1 200	1 467	1 111	267	222	89	267	44	89	44		
Cyclops capillatus																			
Cyclops scutifer							222												
Cyclops	Juvenile				44														
Cyclops																			
Eucyclops agilis																			
Macrocyclops albidus																			
Macrocyclops ater																			
Harpacticoida			89					44											
Canthocamptidae																			
OSTRACODA																	44		44
OSTRACODA	Juvenile																		
OSTRACODA (damaged)					222														
OSTRACODA (sp. A)				356															
OSTRACODA (sp. B)																			
Candona									44										
Cypria																			
Cypridopsis			1 052																
Cypris																			
Cyprois marginata					44		44												
Ilyocypris																			
Limnocythere																			
MALACOSTRACA																			
Amphipoda																			
Gammarus lacustris																			
Gammarus lacustris	Juvenile																		
Gammarus																			
Mysis relicta																			
Isopoda																			
Saduria entomon									44										
PISCES (FISH)																			
Pungitius pungitius																			
Unidentified	Egg															44			
TOTAL		**19 378**	**6 622**	**3 437**	**800**	**311**	**978**	**4 533**	**7 555**	**6 310**	**489**	**1 067**	**711**	**4 222**	**2 089**	**9 688**	**2 044**	**2 355**	**1 689**

Shaded rows indicate terrestrial invertebrate or adult forms of aquatic invertebrates or non benthic forms and are excluded from the total.

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE																	
		24-Jul-97			22-Jul-97			24-Jul-97			26-Aug-97			26-Aug-97			25-Aug-97		
		Station 1 (<5 m)			Station 5 (<5 m)			Station 6 (>10 m)			Station 1 (<5 m)			Station 5 (<5 m)			Station 6 (>10 m)		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
HYDROZOA																			
Hydra canadensis																			
Hydra																			
TURBELLARIA																			
ROTIFERA																			
Filinia																			
Kellicottia																			
Keratella																			
Lecane																			
Polyarthra																			
NEMATODA					44	133	44					44					44		
BIVALVIA (PELECYPODA)																			
Sphaeriidae	Juvenile				1 422	667	1 156	133	267	89				311	133		89		311
Pisidium nitidum																			
Pisidium	Juvenile																		
Pisidium			133		44	133	133							44					
Sphaerium nitidum																			
Sphaerium		89	44																
GASTROPODA																			
Muricidae																			
Typhis																			
Valvatidae	Juvenile																		
Valvata sincera helicoidea																			
Valvata sincera sincera		44	400		89	44	89							44	267	133			
Valvata sincera																			
ANNELIDA																			
OLIGOCHAETA	Juvenile																		
OLIGOCHAETA	Egg																		
Enchytraeidae																			
Lumbriculidae																			
Lumbriculidae	Juvenile																		
Lumbriculus			44																
Lumbriculus variegatus																			
Naididae (damaged)																			
Chaetogaster																			
Nais																			
Tubificidae																			
Tubificidae	Juvenile		133		44														
Tubificidae (damaged)																			
Tubificidae (sp. A)																			
Tubificidae (sp. B)																			
TARDIGRADA																			
ACARI (ACARINA)																			
Oribatidae																			
Hydracarina										44									
Hydracarina	Adult																		
Forelli	Adult																		
Frontipoda																			
INSECTA	Larva																		
INSECTA	Egg																		
DIPTERA																			
Chironomidae	Larva	89	89							44				44					
Chironomidae	Pupa		44			44	133											44	
Chironomidae	Adult																		
Chironomidae	Juvenile																		
Chironominae																			
Chironominae	Pupa																		
Chironomini																			
Chironomini	Larva												89						
Chironomini	Pupa																		
Chironomus																			
Chironomus	Larva											44	178						
Cladopelma	Larva																		
Cryptochironomus																			
Cryptochironomus	Larva					89													
Demicryptochironomus	Larva																		
Demicryptochironomus	Pupa																		
Dicrotendipes																			
Dicrotendipes	Larva																		
Glyptotendipes																			
Glyptotendipes	Larva																		
Lipiniella	Larva																		
Lipiniella	Pupa																		
Microtendipes	Larva											44							
Phaenopsectra																			
Phaenopsectra	Larva							44	89	89		44			44				
Phaenopsectra	Pupa																		
Stictochironomus																			
Tanytarsini																			
Tanytarsini	Juvenile																		
Tanytarsini	Larva		44					44											
Tanytarsini	Pupa																		
Corynocera	Larva																		
Micropsectra	Larva		44																
Paratanytarsus	Larva						44												
Rheotanytarsus																			
Rheotanytarsus	Larva	44	44										89						
Rheotanytarsus	Pupa	44	222																
Stempellinella																			
Stempellinella	Larva														44				
Stempellinella	Pupa																		
Tanytarsus																			
Tanytarsus	Larva		133		622	133	489												
Tanytarsus	Pupa																		
Diamesinae	Pupa																		
Diamesa	Larva																		
Potthastia	Larva																		
Protanypus	Larva																		
Protanypus	Pupa																		
Orthocladiinae	Juvenile																		
Orthocladiinae	Larva		44			44													44

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE																	
		24-Jul-97			22-Jul-97			24-Jul-97			26-Aug-97			26-Aug-97			25-Aug-97		
		Station 1 (<5 m)			Station 5 (<5 m)			Station 6 (>10 m)			Station 1 (<5 m)			Station 5 (<5 m)			Station 6 (>10 m)		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Orthocladiinae	Pupa																		
Orthocladiinae	Adult																		
Acamptocladius	Larva																		
Corynoneura																			
Corynoneura	Larva																		
Corynoneura	Pupa																		
Cricotopus																			
Cricotopus	Larva																		
Eukiefferiella																			
Eukiefferiella	Larva				89	89													
Euryhapsis																			
Heterotrissocladius	Larva				44														
Heterotrissocladius																			
Orthocladius	Larva																		
Paracladius																			
Psectrocladius	Larva		44			44													
Rheocricotopus	Larva																		
Thienemaniella	Larva																		
Zalutschia	Larva																		
Zalutschia	Pupa																		
Zavrelia	Larva																		
Prodiamesinae																			
Monodiamesa																			
Monodiamesa	Larva		44	44	44		44												
Tanypodinae																			
Tanypodinae	Pupa																		
Paramerina	Larva																		
Procladius																			
Procladius	Larva	44				44	44		44	178		44		44					133
Tanypus																			
Thienemannimyia																			
Empididae																			
Chelifera	Larva																		
Simuliidae																			
Simulium	Adult					44													44
Simulium	Larva				44		44												
Tipulidae																			
Hexatoma	Larva																		
EPHEMEROPTERA																			
Baetidae	Nymph																		
Leptophlebiidae																			
Paraleptophlebia debilis	Nymph																		
HEMIPTERA	Nymph																		
PLECOPTERA																			
Podmosta																			
Zapada	Nymph																		
TRICHOPTERA																			
Brachycentridae	Larva																		
Brachycentrus americanus	Larva		44																
Limnephilidae	Pupa																		
Clostoeca																			
Ecclisomyia	Larva																		
Grensia praeterita																			
Grensia																			
CLADOCERA																			
Chydorus sphaericus																			
Daphnia longiremis																			
Daphnia	Juvenile																		
Daphnia																			
Holopedium gibberum																			
Holopedium																			
Ophryoxus gracilis																			
COPEPODA	Nauplius																		
Calanoida																			
Diaptomus																			
Leptodiaptomus pribilofensis																			
Cyclopoida																			
Cyclops capillatus																			
Cyclops scutifer									44										
Cyclops	Juvenile																		
Cyclops																			
Eucyclops agilis																			
Macrocyclops albidus																			
Macrocyclops ater																			
Harpacticoida																			
Canthocamptidae																			
OSTRACODA																			
OSTRACODA	Juvenile																		
OSTRACODA (damaged)																			
OSTRACODA (sp. A)																			
OSTRACODA (sp. B)																			
Candona																			
Cypria																			
Cypridopsis																			
Cypris																			
Cyprois marginata																			
Ilyocypris																			
Limnocythere							44												
MALACOSTRACA																			
Amphipoda																			
Gammarus lacustris																			
Gammarus lacustris	Juvenile																		
Gammarus																			
Mysis relicta																			
Isopoda																			
Saduria entomon									44										
PISCES (FISH)																			
Pungitius pungitius																			
Unidentified	Egg																		
TOTAL		**356**	**1 556**	**44**	**2 489**	**1 467**	**2 267**	**222**	**444**	**444**		**222**	**356**	**489**	**489**	**133**	**133**	**44**	**489**

Shaded rows indicate terrestrial invertebrate or adult forms of aquatic invertebrates or non benthic forms and are excluded from the total.

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE												STICKLEBACK LAKE						
		17-Jul-98			18-Jul-98			17-Jul-98			18-Jul-98			Aug-94	3-Aug-95			5-Aug-96		
		Station 1 (1.2 m)			Station 4 (6.5 m)			Station 5 (3 m)			Station 6 (29 m)				2 m			2.5 m		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
HYDROZOA																				
Hydra canadensis														156						
Hydra																			44	
TURBELLARIA		44		44					89											
ROTIFERA																		13 643	8 221	
Filinia																				
Kellicottia																		44	444	
Keratella																				
Lecane																				
Polyarthra																				
NEMATODA		1 644	1 778	4	89	89	89	4 222	5 156	3 289		44	44	3 800	3 778	1 333	2 222	29 730	27 597	21 864
BIVALVIA (PELECYPODA)																				
Sphaeriidae	Juvenile														3 556	4 000	7 556			
Pisidium nitidum														178						
Pisidium	Juvenile													178						
Pisidium																		3 866	1 244	2 044
Sphaerium nitidum														1 067	533	800	400			
Sphaerium					89	1 244	1 244	5 956	489	2 978								2 311	978	1 467
GASTROPODA																				
Muricidae																				
Typhis																				
Valvatidae	Juvenile																			
Valvata sincera helicoidea														578						
Valvata sincera sincera					44	267														
Valvata sincera															1 200	1 467	667	933	222	222
ANNELIDA																				
OLIGOCHAETA	Juvenile	133	44	89										1 422						
OLIGOCHAETA	Egg																			
Enchytraeidae		311	533	356				44	622	44										
Lumbriculidae																				
Lumbriculidae	Juvenile	44	267	267																
Lumbriculus																				
Lumbriculus variegatus																				
Naididae (damaged)															667					
Chaetogaster																		622	711	1 378
Nais		44	44	44														44	89	
Tubificidae																		1 955	1 600	356
Tubificidae	Juvenile	2 578	2 711	522																
Tubificidae (damaged)															267	444	533			
Tubificidae (sp. A)														822						
Tubificidae (sp. B)														956						
TARDIGRADA																				
ACARI (ACARINA)															1 111					
Oribatidae																				
Hydracarina					133	44		44	89					22					133	
Hydracarina	Adult														667	267	44			
Forelli	Adult																			
Frontipoda																				
INSECTA	Larva																			
INSECTA	Egg																			
DIPTERA																				
Chironomidae	Larva	889	667	167				133		311					222	222	1 333			
Chironomidae	Pupa																			
Chironomidae	Adult																			
Chironomidae	Juvenile													3 689						
Chironominae																				
Chironominae	Pupa																			
Chironomini														400						
Chironomini	Larva	1 156	267	44																
Chironomini	Pupa																	44		
Chironomus																		2 800	267	844
Chironomus	Larva									44	44						133			
Cladopelma	Larva																489			
Cryptochironomus																		44		
Cryptochironomus	Larva																			
Demicryptochironomus	Larva		222	178																
Demicryptochironomus	Pupa														356	44	89			
Dicrotendipes																				
Dicrotendipes	Larva																			
Glyptotendipes																				
Glyptotendipes	Larva																89			
Lipiniella	Larva	178	222	44																
Lipiniella	Pupa																			
Microtendipes	Larva																			
Phaenopsectra																		400	311	222
Phaenopsectra	Larva	711	756	578	44										1 111	1 378	800			
Phaenopsectra	Pupa															44				
Stictochironomus																		89	267	178
Tanytarsini														2 133						
Tanytarsini	Juvenile																	444	533	
Tanytarsini	Larva	2 889	1 378	289		44	44	133	2 578	667					444					
Tanytarsini	Pupa			44																
Corynocera	Larva														2 889	1 022	3 644			
Micropsectra	Larva		44	267																
Paratanytarsus	Larva	178	489	844				267	622	44										
Rheotanytarsus																		1 200	667	1 733
Rheotanytarsus	Larva	167	4	889											667	889	1 022			
Rheotanytarsus	Pupa	89		311																
Stempellinella																				
Stempellinella	Larva	89	356	222				133	178											
Stempellinella	Pupa		133	311				89	89											
Tanytarsus																				
Tanytarsus	Larva	133	133	133		89	89	444	2 311	578					444	800	667	978		755
Tanytarsus	Pupa	44															178			
Diamesinae	Pupa																			
Diamesa	Larva																			
Potthastia	Larva																44			
Protanypus	Larva					44														
Protanypus	Pupa						44													
Orthocladiinae	Juvenile																	1 289	267	1 333
Orthocladiinae	Larva			222				44	89	89					222	44	89			

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK LAKE												STICKLEBACK LAKE						
		17-Jul-98			18-Jul-98			17-Jul-98			18-Jul-98			Aug-94	3-Aug-95			5-Aug-96		
		Station 1 (1.2 m)			Station 4 (6.5 m)			Station 5 (3 m)			Station 6 (29 m)				2 m			2.5 m		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Orthocladiinae	Pupa		89	44											222	44				
Orthocladiinae	Adult																			
Acamptocladius	Larva																			
Corynoneura																		89		
Corynoneura	Larva																			
Corynoneura	Pupa																			
Cricotopus																		133		711
Cricotopus	Larva														222	178	89			
Eukiefferiella																				44
Eukiefferiella	Larva	44																		
Euryhapsis														489						
Heterotrissocladius	Larva				267	356	89		267											
Heterotrissocladius																				
Orthocladius	Larva																			
Paracladius																				
Psectrocladius	Larva		133							356					1 111	222	400			
Rheocricotopus	Larva																			
Thienemaniella	Larva																			
Zalutschia	Larva							89	444	4	44									
Zalutschia	Pupa																			
Zavrelia	Larva																			
Prodiamesinae																				
Monodiamesa																				
Monodiamesa	Larva								89	44										
Tanypodinae																				
Tanypodinae	Pupa																44			
Paramerina	Larva																			
Procladius																		178	44	
Procladius	Larva	133		89	44	89	267			89		89	44		178	44	222			
Tanypus																				
Thienemannimyia																				
Empididae																				
Chelifera	Larva	356	533	4																
Simuliidae																				
Simulium	Adult																			
Simulium	Larva																			
Tipulidae																				
Hexatoma	Larva																			
EPHEMEROPTERA																				
Baetidae	Nymph																			
Leptophlebiidae																				
Paraleptophlebia debilis	Nymph																			
HEMIPTERA	Nymph																			
PLECOPTERA																				
Podmosta																				
Zapada	Nymph																			
TRICHOPTERA																				
Brachycentridae	Larva																			
Brachycentrus americanus	Larva																			
Limnephilidae	Pupa																			
Clostoeca																				
Ecclisomyia	Larva																			
Grensia praeterita						44								178	44	178		89	44	44
Grensia																				
CLADOCERA																				
Chydorus sphaericus		44	44																	
Daphnia longiremis																				
Daphnia	Juvenile																			
Daphnia																				
Holopedium gibberum																				
Holopedium																				
Ophryoxus gracilis																				
COPEPODA	Nauplius																			
Calanoida																				
Diaptomus																				
Leptodiaptomus pribilofensis						44														
Cyclopoida														667			444			
Cyclops capillatus																				
Cyclops scutifer																				
Cyclops	Juvenile																			
Cyclops		44																		
Eucyclops agilis					89	44	44	89		44										
Macrocyclops albidus		44																		
Macrocyclops ater																				
Harpacticoida		1 867	8	133					89					4 133				1 067	267	444
Canthocamptidae															444					
OSTRACODA																		1 955	1 022	1 111
OSTRACODA	Juvenile																			
OSTRACODA (damaged)																				
OSTRACODA (sp. A)														2 489						
OSTRACODA (sp. B)														3 978						
Candona		267	222	444				133	444	89										
Cypria		44													222	444	2 400			
Cypridopsis															222		889			
Cypris																				
Cyprois marginata																222	444			
Ilyocypris															444		1 067			
Limnocythere																				
MALACOSTRACA																				
Amphipoda																				
Gammarus lacustris															400	578	356	1 422	311	622
Gammarus lacustris	Juvenile														889	44	311			
Gammarus														400						
Mysis relicta		44							89	44										
Isopoda																				
Saduria entomon								89												
PISCES (FISH)																				
Pungitius pungitius																				
Unidentified	Egg																			
TOTAL		**14 078**	**11 034**	**6 586**	**711**	**2 311**	**1 867**	**11 822**	**13 733**	**8 671**	**89**	**133**	**89**	**27 067**	**21 422**	**14 711**	**26 222**	**51 684**	**36 619**	**35 374**

Shaded rows indicate terrestrial invertebrate or adult forms of aquatic invertebrates or non benthic forms and are excluded from the total.

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	STICKLEBACK LAKE												FICKLE DUCK LAKE					
		25-Aug-96			23-Jul-97			26-Aug-97			19-Jul-98			3-Aug-95Station WQ-8			23-Jul-97		
		2.5 m			<5 m			<5 m			2.6 m			1.5 m			<5 m		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
HYDROZOA																			
Hydra canadensis																			
Hydra		89	89	311															
TURBELLARIA		44		44															
ROTIFERA		1 378	1 155	1 067															
Filinia		44																	
Kellicottia																			
Keratella			89	89															
Lecane		44	178																
Polyarthra			267	89															
NEMATODA		5 688	5 288	7 733	755	7 467		44			4 356	133	489	44	489	133	44		44
BIVALVIA (PELECYPODA)																			
Sphaeriidae	Juvenile													133					489
Pisidium nitidum																			
Pisidium	Juvenile																		
Pisidium			44	44	622	267												489	
Sphaerium nitidum																			
Sphaerium			44		533	711	311	1 911	222	667	444	311	311				178	2 000	
GASTROPODA																			
Muricidae																			
Typhis																			
Valvatidae	Juvenile										1 244								
Valvata sincera helicoidea																			
Valvata sincera sincera					2 444	10 622	711	222	1 333	178	489	356	1 111				89	400	133
Valvata sincera														44		133			
ANNELIDA																			
OLIGOCHAETA	Juvenile										356	178	133						
OLIGOCHAETA	Egg					133													
Enchytraeidae				133															
Lumbriculidae																			
Lumbriculidae	Juvenile																		
Lumbriculus																			44
Lumbriculus variegatus				44															
Naididae (damaged)																			
Chaetogaster		889	489	2 000															
Nais					133	889		133		89	6 578	2 444	2 756						
Tubificidae		44	89	667															
Tubificidae	Juvenile				89	44						44	44						44
Tubificidae (damaged)														222	2 489	222			
Tubificidae (sp. A)																			
Tubificidae (sp. B)																			
TARDIGRADA		89	178		44			44											
ACARI (ACARINA)																			
Oribatidae																			
Hydracarina			44		133	1 467	44			44	444	178	311				44	44	
Hydracarina	Adult													44	44	311			
Forelli	Adult																		
Frontipoda																			
INSECTA	Larva																		
INSECTA	Egg	2 400		267															
DIPTERA																			
Chironomidae	Larva				933	6 800	44	311		44	1 689	89	4			89		44	
Chironomidae	Pupa																		
Chironomidae	Adult																		
Chironomidae	Juvenile																		
Chironominae		44																	
Chironominae	Pupa																		
Chironomini																			
Chironomini	Larva										444	756	1 511						
Chironomini	Pupa																		
Chironomus			44																
Chironomus	Larva				755	2 667	1 244		1 556			622	756		133		89	178	44
Cladopelma	Larva																		
Cryptochironomus				44															
Cryptochironomus	Larva																		
Demicryptochironomus	Larva																		
Demicryptochironomus	Pupa																		
Dicrotendipes		667	44	133															
Dicrotendipes	Larva				89														
Glyptotendipes																			
Glyptotendipes	Larva										178	489	133						
Lipiniella	Larva																		
Lipiniella	Pupa																		
Microtendipes	Larva																		
Phaenopsectra		2 711	933	889															
Phaenopsectra	Larva										133					44	89		
Phaenopsectra	Pupa																		
Stictochironomus																			
Tanytarsini																			
Tanytarsini	Juvenile																		
Tanytarsini	Larva				89	533		44			1 244	133	178		44			44	
Tanytarsini	Pupa																		
Corynocera	Larva																		
Micropsectra	Larva																	44	44
Paratanytarsus	Larva					667		178	133		622	178	267				89	178	
Rheotanytarsus		3 377	489	3 333															
Rheotanytarsus	Larva				4 266	11 733	133	44	133	89	1 778	978	3 289				44		
Rheotanytarsus	Pupa																		
Stempellinella				222															
Stempellinella	Larva														44				
Stempellinella	Pupa																44		
Tanytarsus		2 933	400	3 200															
Tanytarsus	Larva				89	1 378					178	356	578	44	44		400	489	44
Tanytarsus	Pupa				89	178	44						44				400	311	44
Diamesinae	Pupa														44				
Diamesa	Larva																		
Potthastia	Larva				222	178		44		44									
Protanypus	Larva																		
Protanypus	Pupa																		
Orthocladiinae	Juvenile	1 289	267	1 422															
Orthocladiinae	Larva				89	533					1 111	133	178						

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	STICKLEBACK LAKE												FICKLE DUCK LAKE					
		25-Aug-96			23-Jul-97			26-Aug-97			19-Jul-98			3-Aug-95 Station WQ-8			23-Jul-97		
		2.5 m			<5 m			<5 m			2.6 m			1.5 m			<5 m		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Orthocladiinae	Pupa														133	44			
Orthocladiinae	Adult																		
Acamptocladius	Larva													44					
Corynoneura																			
Corynoneura	Larva				44	44		44			89	89							
Corynoneura	Pupa										89								
Cricotopus		889	267	578															
Cricotopus	Larva														44				
Eukiefferiella																			
Eukiefferiella	Larva																		
Euryhapsis																			
Heterotrissocladius	Larva																		
Heterotrissocladius																			
Orthocladius	Larva				489	2 444	44	89											
Paracladius																			
Psectrocladius	Larva										444	444	4				44	311	
Rheocricotopus	Larva												89						
Thienemaniella	Larva																		
Zalutschia	Larva											44		4 756	3 467	2 800			
Zalutschia	Pupa														44				
Zavrelia	Larva																1 689	400	1 244
Prodiamesinae																			
Monodiamesa		89																	
Monodiamesa	Larva													44	400	267			
Tanypodinae																			
Tanypodinae	Pupa																		
Paramerina	Larva					133			44										
Procladius		44		89															
Procladius	Larva												89	178	400		1 289	1 600	1 422
Tanypus																			
Thienemannimyia						178													
Empididae																			
Chelifera	Larva																		
Simuliidae																			
Simulium	Adult																		
Simulium	Larva																		
Tipulidae																			
Hexatoma	Larva																		
EPHEMEROPTERA																			
Baetidae	Nymph					44													
Leptophlebiidae																			
Paraleptophlebia debilis	Nymph																		
HEMIPTERA	Nymph																		
PLECOPTERA																			
Podmosta				44															
Zapada	Nymph																		
TRICHOPTERA																			
Brachycentridae	Larva																		
Brachycentrus americanus	Larva																		
Limnephilidae	Pupa	44																	
Clostoeca				89															
Ecclisomyia	Larva		44																
Grensia praeterita					44													44	
Grensia																			
CLADOCERA																			
Chydorus sphaericus													44						
Daphnia longiremis																			
Daphnia	Juvenile																		
Daphnia														44	178	222			
Holopedium gibberum																			
Holopedium																			
Ophryoxus gracilis																			
COPEPODA	Nauplius																		
Calanoida																			
Diaptomus																			
Leptodiaptomus pribilofensis											89								
Cyclopoida		44		222															
Cyclops capillatus																			
Cyclops scutifer								44											
Cyclops	Juvenile																		
Cyclops											89								
Eucyclops agilis						178						89	89					44	
Macrocyclops albidus													89						
Macrocyclops ater																			
Harpacticoida		178	44	844							89	578	933						
Canthocamptidae					444	4 489		222		44									
OSTRACODA																		44	
OSTRACODA	Juvenile										178		89						
OSTRACODA (damaged)																			
OSTRACODA (sp. A)																			
OSTRACODA (sp. B)																			
Candona			89	133	222	44			44		178		133						
Cypria						5 867		44			244	978	756		89	89		44	
Cypridopsis																			
Cypris				755		38 044	311		1 422		444	2 444	4 489						
Cyprois marginata																			
Ilyocypris															89				
Limnocythere																			
MALACOSTRACA																			
Amphipoda																			
Gammarus lacustris		44	133	222	222	178	178		89				222						
Gammarus lacustris	Juvenile																		
Gammarus																			
Mysis relicta																			
Isopoda																			
Saduria entomon																			
PISCES (FISH)																			
Pungitius pungitius																			
Unidentified	Egg																		
TOTAL		**19 154**	**9 021**	**22 975**	**12 843**	**97 733**	**3 067**	**3 378**	**4 978**	**1 200**	**23 045**	**11 956**	**18 897**	**5 556**	**8 000**	**4 133**	**4 533**	**6 667**	**3 600**

Shaded rows indicate terrestrial invertebrate or adult forms of aquatic invertebrates or non benthic forms and are excluded from the total.

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	FICKLE DUCK LAKE						REFERENCE LAKE								
		26-Aug-97			19-Jul-98			23-Jul-97			27-Aug-97			22-Jul-98		
		<5 m			2.9 m			<5 m			<5 m			2.5 m		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
HYDROZOA																
Hydra canadensis																
Hydra																
TURBELLARIA																
ROTIFERA																
Filinia																
Kellicottia																
Keratella																
Lecane																
Polyarthra																
NEMATODA						89		1 778			178			267	89	
BIVALVIA (PELECYPODA)																
Sphaeriidae	Juvenile							267	1 644	844			44			
Pisidium nitidum																
Pisidium	Juvenile															
Pisidium			89													
Sphaerium nitidum																
Sphaerium		311	622	1 911	133	311	89	400	1 822	489	489	578	267	1 733	2 622	3 778
GASTROPODA																
Muricidae																
Typhis																
Valvatidae	Juvenile															
Valvata sincera helicoidea																
Valvata sincera sincera		44	133	44				400	133	311	178	89	178	44	711	44
Valvata sincera																
ANNELIDA																
OLIGOCHAETA	Juvenile															
OLIGOCHAETA	Egg															
Enchytraeidae																
Lumbriculidae																
Lumbriculidae	Juvenile				44											
Lumbriculus																
Lumbriculus variegatus																
Naididae (damaged)																
Chaetogaster																
Nais																
Tubificidae																
Tubificidae	Juvenile	44		89		44		222	400	133	178		133	133		44
Tubificidae (damaged)																
Tubificidae (sp. A)																
Tubificidae (sp. B)																
TARDIGRADA																
ACARI (ACARINA)																
Oribatidae		44														
Hydracarina		44				44	133			44	44	44				
Hydracarina	Adult															
Forelli	Adult				178		44							133		
Frontipoda																
INSECTA	Larva															
INSECTA	Egg															
DIPTERA																
Chironomidae	Larva			44	89	44	44									
Chironomidae	Pupa				44											
Chironomidae	Adult															
Chironomidae	Juvenile															
Chironominae																
Chironominae	Pupa															
Chironomini																
Chironomini	Larva				178	222						133		622	44	178
Chironomini	Pupa															
Chironomus																
Chironomus	Larva	711		44	311				44		44	178	133			
Cladopelma	Larva		44					178	44							
Cryptochironomus																
Cryptochironomus	Larva							44	44							
Demicryptochironomus	Larva															
Demicryptochironomus	Pupa															
Dicrotendipes																
Dicrotendipes	Larva										44					
Glyptotendipes																
Glyptotendipes	Larva				178	89								933	844	311
Lipiniella	Larva															
Lipiniella	Pupa													44		44
Microtendipes	Larva															
Phaenopsectra																
Phaenopsectra	Larva	44									400	489	89			
Phaenopsectra	Pupa					89										
Stictochironomus																
Tanytarsini																
Tanytarsini	Juvenile															
Tanytarsini	Larva				356	222		133	89		400	44	89	178	133	44
Tanytarsini	Pupa														44	
Corynocera	Larva															
Micropsectra	Larva				133	44	44	178	89							44
Paratanytarsus	Larva				89	44								267	267	133
Rheotanytarsus																
Rheotanytarsus	Larva	44			44	44	44	89	267		5 556	800	2 667			
Rheotanytarsus	Pupa															
Stempellinella																
Stempellinella	Larva					44										
Stempellinella	Pupa				44		44							44		44
Tanytarsus																
Tanytarsus	Larva		44	400	667	489	444	89		44	133	44	89		311	533
Tanytarsus	Pupa							178	133	44				89		
Diamesinae	Pupa															
Diamesa	Larva												44			
Potthastia	Larva				44											
Protanypus	Larva															
Protanypus	Pupa															
Orthocladiinae	Juvenile															
Orthocladiinae	Larva							222	44		133				44	

Appendix C3. Benthic macroinvertebrate abundance (organisms/m^2) in Boston area lakes, 1993-1998.

Taxa / Species	Stage	FICKLE DUCK LAKE						REFERENCE LAKE								
		26-Aug-97			19-Jul-98			23-Jul-97			27-Aug-97			22-Jul-98		
		<5 m			2.9 m			<5 m			<5 m			2.5 m		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Orthocladiinae	Pupa				44											
Orthocladiinae	Adult															
Acamptocladius	Larva															
Corynoneura																
Corynoneura	Larva															
Corynoneura	Pupa															
Cricotopus																
Cricotopus	Larva															
Eukiefferiella																
Eukiefferiella	Larva															
Euryhapsis																
Heterotrissocladius	Larva															
Heterotrissocladius																
Orthocladius	Larva															
Paracladius																
Psectrocladius	Larva			89				533	267	311				622	1 156	622
Rheocricotopus	Larva															
Thienemaniella	Larva			44												
Zalutschia	Larva				2 267	244	167									
Zalutschia	Pupa															
Zavrelia	Larva	133	489	844							178	400	44			
Prodiamesinae																
Monodiamesa																
Monodiamesa	Larva															
Tanypodinae																
Tanypodinae	Pupa															
Paramerina	Larva												44			
Procladius																
Procladius	Larva	444	178	933	222	267	89	178	222	133	311	222	267	444	356	356
Tanypus																
Thienemannimyia																
Empididae																
Chelifera	Larva								133							
Simuliidae																
Simulium	Adult															
Simulium	Larva															
Tipulidae																
Hexatoma	Larva			44												
EPHEMEROPTERA																
Baetidae	Nymph															
Leptophlebiidae																
Paraleptophlebia debilis	Nymph												44			
HEMIPTERA	Nymph															
PLECOPTERA																
Podmosta																
Zapada	Nymph												44			
TRICHOPTERA																
Brachycentridae	Larva										44					
Brachycentrus americanus	Larva															
Limnephilidae	Pupa															
Clostoeca																
Ecclisomyia	Larva															
Grensia praeterita																
Grensia																
CLADOCERA																
Chydorus sphaericus																
Daphnia longiremis																
Daphnia	Juvenile															
Daphnia																
Holopedium gibberum																
Holopedium								44								
Ophryoxus gracilis																
COPEPODA	Nauplius															
Calanoida																
Diaptomus																
Leptodiaptomus pribilofensis																
Cyclopoida																
Cyclops capillatus																
Cyclops scutifer																
Cyclops	Juvenile															
Cyclops																
Eucyclops agilis																
Macrocyclops albidus																
Macrocyclops ater											44		133			
Harpacticoida																
Canthocamptidae																
OSTRACODA																
OSTRACODA	Juvenile															
OSTRACODA (damaged)																
OSTRACODA (sp. A)																
OSTRACODA (sp. B)																
Candona					89		89	44			133	44	89		133	
Cypria					178			44								
Cypridopsis																
Cypris					44	178	89									
Cyprois marginata																
Ilyocypris																
Limnocythere																
MALACOSTRACA																
Amphipoda																
Gammarus lacustris																
Gammarus lacustris	Juvenile															
Gammarus																
Mysis relicta																
Isopoda																
Saduria entomon																
PISCES (FISH)																
Pungitius pungitius													44			
Unidentified	Egg															
TOTAL		**1 822**	**1 600**	**4 489**	**5 378**	**2 511**	**1 322**	**4 978**	**5 378**	**2 356**	**8 444**	**3 067**	**4 267**	**5 555**	**6 756**	**6 177**

Shaded rows indicate terrestrial invertebrate or adult forms of aquatic invertebrates or non benthic forms and are excluded from the total.

Appendix C4. Mean abundance (organisms/m^2) and percent composition of main taxa of benthic invertebrates in Boston area lakes, 1993-1998.

Lake	Date	Station	Depth (m)	No. Repl	Nematoda			Bivalvia (Pelecypoda)			Gastropoda			Oligochaeta			Acarina			Ostracoda			Malacostraca			Ephemeroptera Plecoptera Trichoptera		
					Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%
Aimaokatalok	Aug-93	WQ3	<5 m	1	9 337	-	48.2	0	-	0.0	0	-	0.0	5 522	-	28.5	803	-	4.1	0	-	0.0	0	-	0.0	0	-	0.0
	Aug-94	WQ4	<5 m	1	0	-	0.0	2 474	-	37.4	44	-	0.7	948	-	14.3	0	-	0.0	1 052	-	15.9	0	-	0.0	0	-	0.0
	Aug-94	WQ5	18 m	1	74	-	2.2	741	-	21.6	0	-	0.0	296	-	8.6	0	-	0.0	356	-	10.3	0	-	0.0	0	-	0.0
	02-Aug-95	WQ5	10 m	3	0	0	0.0	237	194	34.0	0	0	0.0	0	0	0.0	30	15	4.3	104	82	14.9	0	0	0.0	0	0	0.0
	04-Aug-96	Stn. 5	2 m	3	2 815	207	45.9	696	193	11.4	30	15	0.5	222	156	3.6	44	44	0.7	15	15	0.2	15	15	0.2	0	0	0.0
	04-Aug-96	Stn. 6	24 m	3	30	15	3.9	267	89	35.3	0	0	0.0	44	26	5.9	15	15	2.0	0	0	0.0	0	0	0.0	0	0	0.0
	24-Aug-96	Stn. 5	3.5 m	3	918	766	17.2	2 548	781	47.8	1 052	652	19.7	30	15	0.6	44	26	0.8	0	0	0.0	0	0	0.0	30	30	0.6
	24-Aug-96	Stn. 6	29 m	3	148	59	7.3	904	189	44.5	0	0	0.0	726	104	35.8	0	0	0.0	30	15	1.5	0	0	0.0	0	0	0.0
	24-Jul-97	Stn. 1	<5 m	3	0	0	0.0	89	51	13.6	148	127	22.7	59	59	9.1	0	0	0.0	0	0	0.0	0	0	0.0	15	15	2.3
	22-Jul-97	Stn. 5	<5 m	3	74	30	3.6	1 185	199	57.1	74	15	3.6	15	15	0.7	0	0	0.0	15	15	0.7	0	0	0.0	0	0	0.0
	24-Jul-97	Stn. 6	>10 m	3	0	0	0.0	163	53	44.0	0	0	0.0	0	0	0.0	15	15	4.0	0	0	0.0	15	15	4.0	0	0	0.0
	26-Aug-97	Stn. 1	<5 m	3	15	15	7.7	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
	26-Aug-97	Stn. 5	<5 m	3	0	0	0.0	163	104	44.0	148	65	40.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
	25-Aug-97	Stn. 6	>10 m	3	15	15	6.7	133	93	60.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
	17-Jul-98	Stn. 1	1.2 m	3	1 142	570	10.8	0	0	0.0	0	0	0.0	2 663	707	25.2	0	0	0.0	326	65	3.1	15	15	0.1	0	0	0.0
	18-Jul-98	Stn. 4	6.5 m	3	89		5.5	859	385	52.7	104	82	6.4	0	0	0.0	59	39	3.6	0	0	0.0	0	0	0.0	15	15	0.9
	17-Jul-98	Stn. 5	3 m	3	4 222	539	37.0	3 141	1 580	27.5	0	0	0.0	237	193	2.1	44	26	0.4	222	112	1.9	74	15	0.6	0	0	0.0
	18-Jul-98	Stn. 6	29 m	3	30	15	28.6	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Stickleback	Aug-94		<5 m	1	3 800	-	14.0	1 422	-	5.3	578	-	2.1	3 200	-	11.8	22	-	0.1	6 467	-	23.9	400	-	1.5	178		0.7
	03-Aug-95		2 m	3	2 444	714	11.8	5 615	1 188	27.0	1 111	235	5.3	637	150	3.1	326	182	1.6	2 119	1 342	10.2	859	215	4.1	74	53	0.4
	05-Aug-96		2.5 m	3	26 397	2 349	64.0	3 970	1 165	9.6	459	237	1.1	2 252	267	5.5	44	44	0.1	1 363	297	3.3	785	331	1.9	59	15	0.1
	25-Aug-96		2.5 m	3	6 236	757	36.5	44	26	0.3	0	0	0.0	1 452	704	8.5	15	15	0.1	326	283	1.9	133	51	0.8	74	30	0.4
	23-Jul-97		<5 m	3	2 741	2 373	7.2	815	257	2.2	4 593	3 056	12.1	430	325	1.1	548	460	1.4	14 830	14 563	39.1	193	15	0.5	30	15	0.1
	26-Aug-97		<5 m	3	15	15	0.5	933	505	29.3	578	378	18.1	74	39	2.3	15	15	0.5	504	482	15.8	30	30	0.9	0	0	0.0
	19-Jul-98		2.6 m	3	1 659	1 352	9.2	356	44	2.0	1 067	398	5.9	4 178	1 380	23.3	311	77	1.7	3 311	1 278	18.4	74	74	0.4	0	0	0.0
Fickle Duck	03-Aug-95		1.5 m	3	222	136	3.8	44	44	0.8	59	39	1.0	978	756	16.6	133	89	2.3	89	51	1.5	0	0	0.0	0	0	0.0
	23-Jul-97		<5 m	3	30	15	0.6	1 052	724	21.3	207	97	4.2	30	30	0.6	30	15	0.6	30	30	0.6	0	0	0.0	15	15	0.3
	26-Aug-97		<5 m	3	0	0	0.0	978	481	37.1	74	30	2.8	44	26	1.7	15	15	0.6	0	0	0.0	0	0	0.0	0	0	0.0
	19-Jul-98		2.9 m	3	30	30	1.0	178	68	5.8	0	0	0.0	30	15	1.0	133	44	4.3	222	44	7.2	0	0	0.0	0	0	0.0
Reference	23-Jul-97		<5 m	3	593	593	14.0	1 822	844	43.0	281	78	6.6	252	78	5.9	15	15	0.3	30	30	0.7	0	0	0.0	0	0	0.0
	27-Aug-97		<5 m	3	59	59	1.1	459	78	8.7	148	30	2.8	104	53	2.0	30	15	0.6	89	26	1.7	0	0	0.0	44	26	0.8
	22-Jul-98		2.5 m	3	119	78	1.9	2 711	592	44.0	266	222	4.3	59	39	1.0	44	44	0.7	44	44	0.7	0	0	0.0	0	0	0.0

Lake	Date	Station	Depth (m)	No. Repl.	Chironomini			Tanytarsini			Orthocladiinae			Tanypodinae			Other Chironomids			Other Taxa			All Taxa		
					Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%
Aimaokatalok	Aug-93	WQ3	<5 m	1	201	-	1.0	0	-	0.0	0	-	0.0	0	-	0.0	3 514	-	18.1	0	-	0.0	19 378	-	100.0
	Aug-94	WQ4	<5 m	1	0	-	0.0	385	-	5.8	0	-	0.0	1 630	-	24.6	0	-	0.0	89	-	1.3	6 622	-	100.0
	Aug-94	WQ5	18 m	1	178	-	5.2	74	-	2.2	0	-	0.0	444	-	12.9	1 274	-	37.1	0	-	0.0	3 437	-	100.0
	02-Aug-95	WQ-5	10 m	3	0	0	0.0	0	0	0.0	133	26	19.1	59	39	8.5	119	65	17.0	15	15	2.1	696	199	100.0
	04-Aug-96	Stn. 5	2 m	3	74	39	1.2	1 259	524	20.5	785	215	12.8	89	26	1.4	74	30	1.2	15	15	0.2	6 133	877	100.0
	04-Aug-96	Stn. 6	24 m	3	74	15	9.8	178	156	23.5	15	15	2.0	104	30	13.7	30	30	3.9	0	0	0.0	755	168	100.0
	24-Aug-96	Stn. 5	3.5 m	3	59	39	1.1	237	104	4.4	59	30	1.1	281	15	5.3	30	30	0.6	44	44	0.8	5 333	2 263	100.0
	24-Aug-96	Stn. 6	29 m	3	163	15	8.0	30	15	1.5	0	0	0.0	0	0	0.0	15	15	0.7	15	15	0.7	2 029	193	100.0
	24-Jul-97	Stn. 1	<5 m	3	0	0	0.0	193	150	29.5	30	30	4.5	15	15	2.3	104	39	15.9	0	0	0.0	652	461	100.0
	22-Jul-97	Stn. 5	<5 m	3	30	30	1.4	430	150	20.7	104	53	5.0	30	15	1.4	89	44	4.3	30	15	1.4	2 074	310	100.0
	24-Jul-97	Stn. 6	>10 m	3	74	15	20.0	15	15	4.0	0	0	0.0	74	53	20.0	15	15	4.0	0	0	0.0	370	74	100.0
	26-Aug-97	Stn. 1	<5 m	3	133	77	69.2	30	30	15.4	0	0	0.0	15	15	7.7	0	0	0.0	0	0	0.0	193	104	100.0
	26-Aug-97	Stn. 5	<5 m	3	15	15	4.0	15	15	4.0	0	0	0.0	15	15	4.0	15	15	4.0	0	0	0.0	370	119	100.0
	25-Aug-97	Stn. 6	>10 m	3	0	0	0.0	0	0	0.0	15	15	6.7	44	44	20.0	15	15	6.7	0	0	0.0	222	136	100.0
	17-Jul-98	Stn. 1	1.2 m	3	1 452	346	13.7	3 146	315	29.8	178	68	1.7	74	39	0.7	574	214	5.4	997	643	9.4	10 566	2 175	100.0
	18-Jul-98	Stn. 4	6.5 m	3	15	15	0.9	89	44	5.5	237	78	14.5	133	68	8.2	30	15	1.8	0	0	0.0	1 630	477	100.0
	17-Jul-98	Stn. 5	3 m	3	15	15	0.1	2 711	1 535	23.8	461	193	4.0	30	30	0.3	193	82	1.7	59	59	0.5	11 409	1 476	100.0
	18-Jul-98	Stn. 6	29 m	3	15	15	14.3	0	0	0.0	15	15	14.3	44	26	42.9	0	0	0.0	0	0	0.0	104	15	100.0
Stickleback	Aug-94		<5 m	1	400	-	1.5	2 133	-	7.9	489	-	1.8	0	-	0.0	3 689	-	13.6	4 289		15.8	27 067	-	100.0
	03-Aug-95		2 m	3	1 511	44	7.3	4 222	816	20.3	948	416	4.6	163	65	0.8	607	385	2.9	148	148	0.7	20 785	3 338	100.0
	05-Aug-96		2.5 m	3	1 822	786	4.4	2 103	453	5.1	1 289	538	3.1	74	53	0.2	0	0	0.0	607	233	1.5	41 226	5 241	100.0
	25-Aug-96		2.5 m	3	1 837	793	10.8	4 651	1 886	27.3	1 570	521	9.2	44	26	0.3	44	44	0.3	637	283	3.7	17 065	4 163	100.0
	23-Jul-97		<5 m	3	1 585	553	4.2	6 400	4 235	16.9	1 230	912	3.2	104	104	0.3	2 726	2 150	7.2	1 659	1 422	4.4	37 881	30 059	100.0
	26-Aug-97		<5 m	3	519	519	16.3	207	59	6.5	44	44	1.4	15	15	0.5	148	107	4.7	104	82	3.3	3 185	1 095	100.0
	19-Jul-98		2.6 m	3	1 674	484	9.3	3 274	829	18.2	905	433	5.0	30	30	0.2	594	548	3.3	533	245	3.0	17 966	3 235	100.0
Fickle Duck	03-Aug-95		1.5 m	3	59	39	1.0	59	39	1.0	3 778	566	64.1	193	116	3.3	281	121	4.8	0	0	0.0	5 896	1 129	100.0
	23-Jul-97		<5 m	3	133	44	2.7	726	297	14.7	1 230	295	24.9	1 437	90	29.1	15	15	0.3	0	0	0.0	4 933	908	100.0
	26-Aug-97		<5 m	3	281	237	10.7	163	119	6.2	533	245	20.2	519	221	19.7	15	15	0.6	15	15	0.6	2 637	928	100.0
	19-Jul-98		2.9 m	3	356	194	11.6	933	219	30.4	907	702	29.6	193	53	6.3	89	44	2.9	0	0	0.0	3 070	1 204	100.0
Reference	23-Jul-97		<5 m	3	119	65	2.8	444	180	10.5	459	148	10.8	178	26	4.2	0	0	0.0	44	44	1.0	4 237	948	100.0
	27-Aug-97		<5 m	3	504	167	9.6	3 274	1 516	62.3	252	107	4.8	281	30	5.4	15	15	0.3	0	0	0.0	5 259	1 630	100.0
	22-Jul-98		2.5 m	3	1 007	314	16.3	711	68	11.5	815	193	13.2	385	30	6.3	0	0	0.0	0	0	0.0	6 163	347	100.0

NOTE: Terrestrial animals (e.g., adult Culicidae = mosquitoes) were excluded from these data but not from Rescan's original reports. In addition, non-benthic forms were removed (e.g., cladocerans and most copepods).
Due to rounding, total numbers may not match the sum of the major taxonomic groups.

Appendix C5. Drift invertebrate abundance (organisms/1000 m^3) in Boston area streams, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK NE INFLOW								AIMAOKATALOK RIVER				STICKLEBACK OUTFLOW					
		22-Jul-97		24-Aug-97		27-Jun-98		31-Jul-98		27-Jun-98		31-Jul-98		21-Jul-97		26-Jun-98		30-Jul-98	
		Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
ARACHNIDA																			
Aranea			0.2			355.0					356.9								
Oribatidae											178.4		925.7		85.8			129.9	443.1
Parasitic Mite												178.6		343.2					
CLADOCERA																			
Unknown Chydoridae																			
Alonella																			
Bosmina longirostris										126.0									
Chydorus sphaericus								528.3										175.8	147.7
Daphnia longiremis										816.7									
Daphnia middendorffiana						294.4	155.6				535.3								
Eurycercus glacialis				1.9	2.1					627.7					85.8				
Holopedium gibberum										627.7									
COELENTERATA																			
Hydra								528.3	286.9			178.6						129.9	
COLEOPTERA																			
Carabidae	Adult									627.7	356.9								
	Larva																		
Dytiscidae											356.9								
Agabus	Larva						485.7									335.2			
Brachyvatus	Adult									156.6	963.6								
Brachyvatus	Larva									627.7									
Hydroporus	Larva							264.2	819.7				277.5						
Elmidae	Larva																		
Haliplidae																			
Haliplus	Adult						242.8												
Haliplus	Larva					799.8	242.8			125.5									
Hydrophiloidea								264.2											
Helophorus	Larva																		
Oreodytes	Larva	0.2																	
Staphylinidae	Adult				1.0	355.0				628.0								130.0	
Unidentified (terrestrial)	Adult					355.0													
COLLEMBOLA																			
Entomobryidae			1.6	4.5	2.1		242.8							343.2			834.7		
Isotomidae																			
Isotoma				5.1	4.1											335.2			
Isotomura																			295.4
Sminthuridae																			
Sminthurus				2.6	1.0													129.9	
COPEPODA																			
Calanoida																			
Heterocope septentrionalis																			
Epischura lacustris																			
Leptodiaptomus pribilofensis																			
Limnocalanus macrurus		0.2			7.2														
Cyclopoida																			
Cyclops capillatus		0.4	1.6																
Cyclops scutifer				23.1	64.4	113.6	742.3	156.3	245.9	269.9	0.5		185.1			674.7	254.2		147.7
Eucyclops agilis				4.5	4.1									3 882.5	2 917.2				
Macrocyclops albidus						674.5	364.3		819.7	753.3	0.5								
Harpacticoida												357.1							147.7
DIPTERA Unidentified (terrestrial)	Adult		2.2		0.6			264.2	498.4		356.9	357.1							
Unidentified (terrestrial)	Pupa						242.8												
Ceratopogonidae																			
Bezzia	Larva																		
Chironomidae	Larva	0.4	3.3	0.6	46.3			781.3	249.2	627.7	892.2	3.0	175.8	1 029.6		674.7	417.4	236.9	1 273.1
Chironomidae	Pupa	1.0	29.9	124.7	61.7	355.0	971.3		245.9	169.5				343.2	193.1				147.7
Chironomini	Larva			0.6	1.3						178.4								
Chironomini	Pupa						485.7			125.5				10.7					
Demicryptochironomus	Larva										356.9								
Dicrotendipes	Larva					114.6	599.6				713.8							129.9	
Glyptotendipes	Larva	0.2	1.6	1.9	0.6				498.4										
Phaenopsectra	Larva					248.5	485.7			627.7									
Phaenopsectra	Pupa																834.7		
Diamesinae	Larva																		
Monodiamesa	Larva	0.2				799.8													
Diamesa	Larva																		
Potthastia	Larva			1.3	0.6		485.7												
Pseudokiefferiella	Larva					461.5	218.6	264.2	819.7	252.0	176.6	357.1	277.5						
Pseudokiefferiella	Pupa					177.5	485.7												
Orthocladiinae	Adult					213.0	218.6												
Orthocladiinae	Larva	0.4			16.5	799.8	242.8	781.3	498.4	627.7	178.4	714.3	462.5			335.2	834.7		886.3
Orthocladiinae	Pupa	5.3	44.7	25.7	1.3	142.0	728.6			565.0	0.4	171.4	185.1					259.7	443.1
Corynoneura	Larva	0.4						141.7	498.4		178.4	714.3	925.7					411.9	147.7
Corynoneura	Pupa		4.9	9.6	3.2			234.4	249.2			125.0	832.6					259.7	134.0
Cricotopus	Larva	0.4	0.4					731.3	221.3		713.8	642.9	185.1	10.7					
Cricotopus	Pupa											142.9	185.1						
Eukiefferiella	Larva	2.6	24.4					234.4	498.4			214.3	745.6						147.7
Eukiefferiella	Pupa	3.0	52.9	0.6	0.6														
Gymnometriocnemus	Larva											171.4	832.6						
Metriocnemus	Pupa					165.0	121.4		498.4										
Orthocladius	Larva												185.1				834.7		
Orthocladius	Pupa			0.6		142.0	485.7			252.0		357.1							
Psectrocladius	Larva	0.4					242.8	264.2	819.7			714.3	185.1			335.2		389.6	738.6
Psectrocladius	Pupa	0.2				284.0	145.7												
Synorthocladius	Larva							264.2											
Thienemanniella	Larva							264.2	498.4				277.5						
Zavrelia	Larva																	129.9	
Tanypodinae	Larva				2.1							2.5	166.5					389.6	
Tanypodinae	Pupa																		
Nilotanypus	Larva								498.4							368.8			
Paramerina	Larva					177.5	971.3												
Procladius	Larva			1.3	1.9	213.0	971.3					357.1					834.7		
Procladius	Pupa					165.0	728.6	264.2											
Thiennemannimyia	Larva	0.2		6.4	4.2	142.0	534.2		819.7		356.9	714.3	185.1		257.4	167.6	333.9	129.9	
Thiennemannimyia	Pupa											357.1							

Appendix C5. Drift invertebrate abundance (organisms/1000 m^3) in Boston area streams, 1993-1998.

Taxa / Species	Stage	AIMAOKATALOK NE INFLOW								AIMAOKATALOK RIVER				STICKLEBACK OUTFLOW					
		22-Jul-97		24-Aug-97		27-Jun-98		31-Jul-98		27-Jun-98		31-Jul-98		21-Jul-97		26-Jun-98		30-Jul-98	
		Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Tanytarsini	Larva		6.5	3.9	3.1	355.0		416.7	286.9	627.7		357.1	277.5			335.2	333.9	259.7	147.7
Tanytarsini	Pupa	0.6																	
Paratanytarsus	Larva						485.7												
Paratanytarsus	Pupa																		
Rheotanytarsus	Larva	0.4	1.6		4.4	248.5	971.3	156.3	491.8	313.9	713.8	714.3					834.7		
Rheotanytarsus	Pupa	0.4	6.9					264.2	249.2	627.7		171.4	925.7					259.7	738.6
Stempellinella	Larva				3.1	284.0	291.4			188.3	249.8	357.1				739.9	834.7	129.9	
Stempellinella	Pupa																		
Tanytarsus	Larva											357.1							295.4
Tanytarsus	Pupa			0.6	1.0														443.1
Culicidae																			
Anopheles	Adult	0.4	0.2												10.7				
Empididae	Adult																		
Clinocera	Larva										356.9								
Ephydridae	Adult																	259.7	147.7
Simuliidae	Larva															134.9	417.4		
Simuliidae	Pupa	63.2	64.0	1.9	2.6			781.3	498.4			357.1						389.6	147.7
Simulium	Adult											357.1							
Simulium	Larva	6.9	18.3	0.6	0.6	923.0	412.8	151.4	819.7	125.5	214.1	714.3			343.2				443.1
Muscidae	Adult		0.4																
Tipulidae	Adult		0.2																
Unidentified	Larva													10.7					
Tipula	Larva					142.0	485.7						925.7				834.7		443.1
EPHEMEROPTERA																			
Ameletidae	Nymph																		
Baetidae	Nymph	0.6		1.3								178.6							
Baetis bicaudatus	Nymph																		
Baetis tricaudatus	Nymph		15.0					396.3	249.2			392.9	555.4						
Ephemerellidae	Nymph																		
Ephemerella inermis	Nymph												925.7						
Paraleptophlebia	Nymph														85.8				
EUBRANCHIOPODA																			
Triops longicaudatus						418.9	361.8			753.3	535.3		925.7					129.9	147.7
HEMIPTERA	Nymph					355.0	242.8	264.2											
HIRUDINEA																			
Piscicola salmositica				2.6	1.3		485.7	264.2										129.9	
HOMOPTERA																			
Coccoidea						355.0				188.3									
HYDRACARINA		5.3	16.1	57.2	78.7	124.2		191.4	282.0		1.0	857.1	148.1	81 381.4	62 526.8	134.9	333.9	123.6	443.1
Forelli						799.8		156.3	286.9			714.3							
HYMENOPTERA																			
Aphidiidae	Adult																		
Braconidae	Adult	0.2																	
Chalcoidea	Adult																		
Scelionidae	Adult	0.4				799.8	242.8				535.3								147.7
LEPIDOPTERA																			
Estigmene			0.2																
MALACOSTRACA																			
Gammarus lacustris														139.4	32.2	211.4		129.9	
MOLLUSCA																			
Sphaeriidae	Juvenile														171.6				
Sphaerium		0.2																129.9	
Physidae																			
Physa		0.2			0.6	799.8	194.3	264.2	819.7		142.8								
Valvatidae	Juvenile					165.0	242.8	781.3	245.9										
Valvata sincera sincera			0.2	1.3		355.0	364.3	182.3	163.9	125.5				10.7					
NEMATODA						394.9	242.8	264.2	163.9	695.2	166.0		745.6			674.7	918.2	514.9	
OLIGOCHAETA	Juvenile									627.7		357.1	277.5						
Enchytraeidae																			
Naididae									249.2								333.9	259.7	118.2
Naididae	Juvenile																		
Chaetogaster																		411.9	177.3
Nais								264.2	458.2			428.6	647.5	343.2					
Vejdovskyella					1.0														
Lumbriculidae							242.8										834.7		
Tubificidae	Juvenile										713.8							129.9	
OSTRACODA																		514.9	
Candona			1.6	106.0	83.2		485.7	148.4	258.2	627.7	356.9		185.1					257.5	177.3
Cypria		0.2			8.2		485.7		498.4	916.6	0.7	535.7	277.5	142 513.9	22 973.0	234.7	751.3	0.9	5 792.5
Cypris					8.2	355.0		264.2					925.7	686.4	450.5	174.3	233.4	259.7	1 181.7
PISCES																			
Unidentified	Egg					165.0											254.2		
Pungitius pungitius				0.6										118.0		674.7	166.9	556.1	443.1
Thymallus arcticus	Juvenile																		
PLECOPTERA																			
Nemouridae																			
Nemoura	Nymph			0.6		165.0	145.7			627.7									
TARDIGRADA												178.6							
THYSANOPTERA	Adult		1.6																
TRICHOPTERA																			
	Larva							528.3		627.7						335.2	254.2		
Brachycentridae	Larva								123.0										
Brachycentrus americanus	Larva			0.6		789.7	242.8	528.3	249.2	627.7	142.8		277.5						
Micrasema	Larva					799.8	485.7												
Hydropsychidae	Larva													343.2					
Cheumatopsyche	Larva	0.2																	
Lepidostomatidae																			
Lepidostoma	Larva					355.0													
Leptoceridae	Larva		1.6																
Neureclipsis	Larva	0.8																	
Limnephilidae	Larva															335.2			
Grensia praeterita	Larva		0.2							627.7	178.4			85.8	53.6		834.7	416.5	443.1
Grensia praeterita	Pupa		0.2																
Phryganeidae	Larva																		
TURBELLARIA												357.1							
TOTAL		**95**	**298**	**392**	**421**	**14,099**	**18,251**	**12,234**	**15,479**	**15,519**	**9,375**	**13,502**	**14,290**	**231,478**	**90,090**	**6,537**	**12,929**	**7,221**	**15,796**

Shaded rows indicate terrestrial invertebrate or adult forms of aquatic invertebrates and are excluded from the total.

Appendix C5. Drift invertebrate abundance (organisms/1000 m^3) in Boston area streams, 1993-1998.

Taxa / Species	Stage	FICKLE DUCK OUTFLOW								REFERENCE OUTFLOW							
		21-Jul-97		25-Aug-97		26-Jun-98		30-Jul-98		21-Jul-97		25-Aug-97		27-Jun-98		01-Aug-98	
		Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
ARACHNIDA																	
Aranea																	
Oribatidae							863.9	152.9			3.5				594.9		
Parasitic Mite								764.6									
CLADOCERA																	
Unknown Chydoridae									314.7								245.7
Alonella																583.7	
Bosmina longirostris																	
Chydorus sphaericus								456.3	157.4						594.9	778.2	163.8
Daphnia longiremis														484.7	416.4		
Daphnia middendorffiana														646.2	178.5		
Eurycercus glacialis		2.5	7.6	18.0	4.5						3.5	1.2			119.0		
Holopedium gibberum																972.8	
COELENTERATA																	
Hydra																	
COLEOPTERA																	
Carabidae	Adult	1.3															
	Larva									0.2							
Dytiscidae																	
Agabus	Larva		1.3			119.9	216.0										
Brachyvatus	Adult																
Brachyvatus	Larva																
Hydroporus	Larva	3.4	7.6					382.3									
Elmidae	Larva	3.4															
Haliplidae																	
Haliplus	Adult						259.2				0.2				119.0		
Haliplus	Larva	1.3	1.3			198.5		114.7						129.2	177.9		819.8
Hydrophiloidea																	
Helophorus	Larva						863.9										
Oreodytes	Larva																
Staphylinidae	Adult																
Unidentified (terrestrial)	Adult																
COLLEMBOLA																	
Entomobryidae																	
Isotomidae																	
Isotoma																	
Isotomura			1.3				432.0	382.3									
Sminthuridae																	
Sminthurus		6.7						764.6									
COPEPODA																	
Calanoida															119.0		
Heterocope septentrionalis										0.9							
Epischura lacustris										0.9							
Leptodiaptomus pribilofensis											2.5				594.9		
Limnocalanus macrurus										1.7	3.5						
Cyclopoida																	
Cyclops capillatus																	
Cyclops scutifer						754.3	863.9	382.3		0.9				0.1	0.4	194.6	819.8
Eucyclops agilis			50.6		4.5				314.7	14.8	34.9						
Macrocyclops albidus		27.0						152.9	942.2		7.0			0.0	0.1		
Harpacticoida			1.3	13.5	4.5									969.4		972.8	
DIPTERA Unidentified (terrestrial)	Adult					794.0			314.7								
Unidentified (terrestrial)	Pupa																
Ceratopogonidae																	
Bezzia	Larva													323.1	476.0		
Chironomidae	Larva	48.5	11.4	919.9	248.0	397.0	734.3	1.7	317.2	1.7	17.4	5.8		323.1	238.0	117.7	1 155.6
Chironomidae	Pupa	193.9	10.1	13.5	9.0	794.0	863.9		125.6	41.0	465.3	197.9				116.7	245.7
Chironomini	Larva																
Chironomini	Pupa													484.7			
Demicryptochironomus	Larva					397.0											
Dicrotendipes	Larva																
Glyptotendipes	Larva		1.3								2.2						
Phaenopsectra	Larva																
Phaenopsectra	Pupa																
Diamesinae	Larva																
Monodiamesa	Larva																
Diamesa	Larva										3.7	1.2					
Potthastia	Larva				4.5								1.2				
Pseudokiefferiella	Larva									0.2		7.0	3.5				819.8
Pseudokiefferiella	Pupa													484.7	119.0		
Orthocladiinae	Adult					397.0											
Orthocladiinae	Larva	24.0	6.3	4.5	9.0	198.5		114.7		13.1	6.3	5.8		258.5	0.0	972.8	245.7
Orthocladiinae	Pupa	94.4	19.0			397.0		764.6				314.3	58.2	646.2	142.8	972.8	163.8
Corynoneura	Larva	37.1	72.1	63.1	13.5		432.0	270.0	157.4						119.0	389.2	
Corynoneura	Pupa	3.4						342.3	314.7	0.9						252.9	188.4
Cricotopus	Larva	13.5	6.3	4.5	4.5					7.2	5.0						327.6
Cricotopus	Pupa																
Eukiefferiella	Larva	21.5	1.3	9.0	9.0			382.3		38.4	27.5	4.6	1.2				
Eukiefferiella	Pupa	3.4			13.5					24.4	72.4	12.8	16.3				
Gymnometriocnemus	Larva																
Metriocnemus	Pupa																
Orthocladius	Larva	3.4					432.0										
Orthocladius	Pupa						259.2					1.2		323.1			
Psectrocladius	Larva	29.5	7.6			297.7	827.3	191.1	314.7			2.3		969.4			163.8
Psectrocladius	Pupa	3.4	3.8			476.4	259.2							646.2		689.3	327.6
Synorthocladius	Larva																
Thienemanniella	Larva												1.2				
Zavrelia	Larva																
Tanypodinae	Larva	3.4		13.5	18.0											486.4	819.8
Tanypodinae	Pupa																
Nilotanypus	Larva																
Paramerina	Larva																
Procladius	Larva																
Procladius	Pupa													581.6	511.6		
Thiennemannimyia	Larva	4.6	5.1	4.5	13.5	794.0					0.2						163.8
Thiennemannimyia	Pupa													161.6	119.0		

Appendix C5. Drift invertebrate abundance (organisms/1000 m^3) in Boston area streams, 1993-1998.

Taxa / Species	Stage	FICKLE DUCK OUTFLOW								REFERENCE OUTFLOW							
		21-Jul-97		25-Aug-97		26-Jun-98		30-Jul-98		21-Jul-97		25-Aug-97		27-Jun-98		01-Aug-98	
		Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
Tanytarsini	Larva	10.1	5.1	4.5	9.0		345.6	722.4	628.1							145.9	384.9
Tanytarsini	Pupa																
Paratanytarsus	Larva																
Paratanytarsus	Pupa						863.9	382.3									
Rheotanytarsus	Larva	10.1								3.5	12.6	1.2			238.0	486.4	196.6
Rheotanytarsus	Pupa	23.6	2.5			397.0	863.9			11.3	76.3			646.2	356.9	165.4	1 000.0
Stempellinella	Larva			248.0	85.7	436.7	142.5	418.3	157.4					323.1	356.9		163.8
Stempellinella	Pupa													484.7			
Tanytarsus	Larva		1.3			397.0											
Tanytarsus	Pupa	11.4	3.8					191.1	628.1					161.6	119.0		
Culicidae																	
Anopheles	Adult	3.8	7.6								0.4				119.0		
Empididae	Adult		1.3														
Clinocera	Larva					397.0											
Ephydridae	Adult																
Simuliidae	Larva					357.3	134.0							646.2	476.0		
Simuliidae	Pupa	41.7	31.6	9.0	9.0					32.3	256.8	9.3	7.0				163.8
Simulium	Adult															194.6	573.4
Simulium	Larva	277.0	21.5			581.4	0.0	382.3	125.6	46.2	58.4		1.2	0.1	0.8		163.8
Muscidae	Adult																
Tipulidae	Adult																
Unidentified	Larva																
Tipula	Larva														119.0		163.8
EPHEMEROPTERA																	
Ameletidae	Nymph		2.5														
Baetidae	Nymph	6.7									20.9	3.5					
Baetis bicaudatus	Nymph									2.6	3.5		1.2				
Baetis tricaudatus	Nymph		1.3							0.2	3.9	1.2					819.8
Ephemerellidae	Nymph																
Ephemerella inermis	Nymph																
Paraleptophlebia	Nymph																
EUBRANCHIOPODA																	
Triops longicaudatus						238.2	112.3		942.2					1.0	1.8		163.8
HEMIPTERA	Nymph																
HIRUDINEA																	
Piscicola salmositica						397.0						1.2					
HOMOPTERA																	
Coccoidea																972.8	
HYDRACARINA		57.3	84.7	699.0	293.1	127.3	146.9	1 342.3	199.2	19.8	128.6	21.0	55.9		0.1	711.2	122.9
Forelli						365.2	0.0	676.9	942.2							184.8	819.8
HYMENOPTERA																	
Aphidiidae	Adult										0.2						
Braconidae	Adult								314.7	0.2							819.8
Chalcoidea	Adult											1.2					
Scelionidae	Adult	3.4		4.5					942.2		3.5					972.8	
LEPIDOPTERA																	
Estigmene																	
MALACOSTRACA																	
Gammarus lacustris																	
MOLLUSCA																	
Sphaeriidae	Juvenile	3.4								0.9							
Sphaerium								764.6									
Physidae																	
Physa								382.3	314.7					161.6			819.8
Valvatidae	Juvenile							266.2	482.9							389.2	819.8
Valvata sincera sincera		19.4	3.8	9.0	13.5			114.7	942.2	0.4	0.7	1.2		161.6	238.0		245.7
NEMATODA		6.7	1.3			397.0	172.8	191.1			0.4	3.5	2.3			291.8	
OLIGOCHAETA	Juvenile							266.2									819.8
Enchytraeidae											3.7						
Naididae																194.6	
Naididae	Juvenile																
Chaetogaster																	
Nais		3.4	3.8	99.2	85.7		432.0	988.6	628.1	0.9						485.6	1 000.0
Vejdovskyella																	
Lumbriculidae							432.0										
Tubificidae	Juvenile			4.5													
OSTRACODA								764.6	219.8								
Candona		13.5	13.9	248.0	36.1	357.3	777.5	152.9		5.2		4.7	7.0				327.6
Cypria		80.9	63.2	18.0	9.0	238.2	345.6	4 828.9	241.5	0.9	101.2				594.9	272.4	819.8
Cypris		107.9	2.5		13.5	158.8	863.9	152.9	125.6			2.3	1.2	969.4	0.1	194.6	163.8
PISCES																	
Unidentified	Egg											1.2		145.4	119.0		
Pungitius pungitius			2.5		18.0	397.0		382.3				4.7	111.7			972.8	819.8
Thymallus arcticus	Juvenile											10.5	4.7				
PLECOPTERA																	
Nemouridae																	
Nemoura	Nymph			4.5							0.2						
TARDIGRADA																194.6	
THYSANOPTERA	Adult																
TRICHOPTERA																	
	Larva			4.5	4.5		432.0										
Brachycentridae	Larva																
Brachycentrus americanus	Larva	3.4								0.2				161.6			
Micrasema	Larva					397.0					0.2						
Hydropsychidae	Larva	3.4									0.2						
Cheumatopsyche	Larva																
Lepidostomatidae																	
Lepidostoma	Larva																
Leptoceridae	Larva																
Neureclipsis	Larva																
Limnephilidae	Larva																
Grensia praeterita	Larva									2.6	0.2						
Grensia praeterita	Pupa									0.4							
Phryganeidae	Larva				13.5							1.2					
TURBELLARIA																	
TOTAL		**1,208**	**458**	**2,412**	**929**	**10,066**	**12,508**	**18,455**	**9,537**	**274**	**1,319**	**604**	**157**	**11,149**	**6,547**	**11,216**	**15,850**

Shaded rows indicate terrestrial invertebrate or adult forms of aquatic invertebrates and are excluded from the total.

Appendix C6. Mean abundance (organisms/1000 m^3) and percent composition of main taxa of macroinvertebrate drift in Boston area streams, 1997-1998.

Site	Date	No.	Oligochaeta			Cladocera			Copepoda			Ostracoda			Acarina			Ephemeroptera			Plecoptera			Trichoptera			Coleoptera		
		Repl.	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%
Aimaokatalok NE Inflow	22-Jul-97	2	**0**	0	*0.0*	**0**	0	*0.0*	**1**	1	*0.5*	**1**	1	*0.4*	**11**	5	*5.2*	**8**	7	*4.0*	**0**	0	*0.0*	**2**	1	*0.8*	**0**	0	*0.1*
	24-Aug-97	2	**1**	1	*0.1*	**2**		*0.5*	**52**	24	*12.7*	**103**	3	*25.3*	**68**	11	*16.7*	**1**	1	*0.2*	**0**	0	*0.1*	**0**	0	*0.1*	**0**	0	*0.0*
	27-Jun-98	2	**121**	121	*0.8*	**225**	69	*1.4*	**947**	159	*5.9*	**663**	308	*4.1*	**462**	462	*2.9*	**0**	0	*0.0*	**155**	10	*1.0*	**1 336**	608	*8.3*	**886**	86	*5.5*
	31-Jul-98	2	**486**	222	*3.5*	**264**	264	*1.9*	**611**	455	*4.4*	**585**	172	*4.2*	**458**	111	*3.3*	**323**	74	*2.3*	**0**	0	*0.0*	**714**	342	*5.2*	**674**	146	*4.9*
Aimaokatalok River	27-Jun-98	2	**671**	43	*5.4*	**1 367**	831	*11.0*	**512**	511	*4.1*	**951**	593	*7.6*			*0.0*	**0**	0	*0.0*	**314**	314	*2.5*	**1 102**	781	*8.9*	**1 115**	205	*9.0*
	31-Jul-98	2	**855**	70	*6.2*	**0**	0	*0.0*	**271**	86	*2.0*	**962**	426	*6.9*	**860**	712	*6.2*	**1 026**	455	*7.4*	**0**	0	*0.0*	**139**	139	*1.0*	**139**	139	*1.0*
Stickleback Outflow	21-Jul-97	2	**172**	172	*0.1*	**43**	49	*<0.1*	**3 400**	483	*2.1*	**83 312**	59 888	*51.8*	**71 954**	9 427	*44.8*	**43**	43	*0.0*	**0**	0	*0.0*	**241**	188	*0.2*	**0**	0	*0.0*
	26-Jun-98	2	**584**	584	*6.0*	**0**	0	*0.0*	**464**	210	*4.8*	**697**	288	*7.2*	**234**	99	*2.4*	**0**	0	*0.0*	**0**	0	*0.0*	**880**	209	*9.0*	**168**	168	*1.7*
	30-Jul-98	2	**548**	253	*4.8*	**162**	14	*1.4*	**148**	148	*1.3*	**4 092**	3 059	*35.6*	**283**	160	*2.5*	**0**	0	*0.0*	**0**	0	*0.0*	**430**	13	*3.7*	**0**	0	*0.0*
Fickle Duck Outflow	21-Jul-97	2	**4**		*0.4*	**5**	3	*0.6*	**39**	12	*4.7*	**141**	61	*16.9*	**71**	14	*8.5*	**5**	1	*0.6*	**0**	0	*0.0*	**3**	3	*0.4*	**9**	1	*1.1*
	25-Aug-97	2	**95**	9	*5.7*	**11**	7	*0.7*	**11**	2	*0.7*	**162**	104	*9.7*	**496**	203	*29.7*	**0**	0	*0.0*	**2**	2	*0.1*	**11**	7	*0.7*	**0**	0	*0.0*
	26-Jun-98	2	**432**	432	*3.8*	**0**	0	*0.0*	**809**	55	*7.2*	**1 371**	616	*12.1*	**320**	173	*2.8*	**0**	0	*0.0*	**0**	0	*0.0*	**414**	17	*3.7*	**829**	510	*7.3*
	30-Jul-98	2	**941**	313	*6.7*	**464**	8	*3.3*	**896**	361	*6.4*	**3 243**	2 656	*23.2*	**1 580**	439	*11.3*	**0**	0	*0.0*	**0**	0	*0.0*	**0**	0	*0.0*	**248**	248	*1.8*
Reference Outflow	21-Jul-97	2	**2**	1	*0.3*	**2**	2	*0.2*	**34**	14	*4.2*	**54**	48	*6.7*	**74**	54	*9.3*	**16**	13	*2.0*	**0**	0	*0.0*	**2**	1	*0.2*	**0**	0	*0.0*
	25-Aug-97	2	**0**	0	*0.0*	**1**	1	*0.2*	**0**	0	*0.0*	**8**	1	*2.0*	**38**	17	*10.1*	**3**	2	*0.8*	**0**	0	*0.0*	**1**	1	*0.2*	**0**	0	*0.0*
	27-Jun-98	2	**0**	0	*0.0*	**1 220**	89	*13.8*	**842**	128	*9.5*	**782**	187	*8.8*			*<0.1*	**0**	0	*0.0*	**0**	0	*0.0*	**81**	81	*0.9*	**213**	84	*2.4*
	01-Aug-98	2	**1 250**	570	*9.2*	**1 372**	963	*10.1*	**994**	174	*7.3*	**889**	422	*6.6*	**919**	23	*6.8*	**410**	410	*3.0*	**0**	0	*0.0*	**0**	0	*0.0*	**410**	410	*3.0*

Site	Date	No.	Simuliidae			Unid. Chironomidae			Tanypodinae			Tanytarsini			Chironomini			Orthocladiinae			Diamesinae			Other Taxa			All Taxa		
		Repl.	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%
Aimaokatalok NE Inflow	22-Jul-97	2	**76**	6	*37.0*	**17**	16	*8.4*			*<0.1*	**8**	7	*4.0*	**1**	1	*0.4*	**80**	67	*38.9*			*<0.1*	**1**	1	*0.6*	**196**	102	*100.0*
	24-Aug-97	2	**3**		*0.7*	**117**	9	*28.7*	**8**		*2.0*	**8**	4	*2.0*	**2**		*0.5*	**29**	7	*7.2*	**1**		*0.2*	**13**	4	*3.1*	**406**	15	*100.0*
	27-Jun-98	2	**668**	255	*4.1*	**663**	308	*4.1*	**1 952**	1 254	*12.1*	**1 318**	430	*8.1*	**967**	604	*6.0*	**1 750**	217	*10.8*	**1 314**	124	*8.1*	**2 747**	116	*17.0*	**16 175**	2 076	*100.0*
	31-Jul-98	2	**1 125**	193	*8.1*	**638**	143	*4.6*	**791**	527	*5.7*	**932**	95	*6.7*	**249**	249	*1.8*	**3 349**	433	*24.2*	**542**	278	*3.9*	**2 114**	434	*15.3*	**13 856**	1 623	*100.0*
Aimaokatalok River	27-Jun-98	2	**170**	44	*1.4*	**845**	47	*6.8*	**178**	178	*1.4*	**1 361**	397	*10.9*	**1 001**	248	*8.0*	**1 258**	187	*10.1*	**214**	38	*1.7*	**1 388**	187	*11.1*	**12 447**	3 072	*100.0*
	31-Jul-98	2	**536**	536	*3.9*	**89**	86	*0.6*	**891**	540	*6.4*	**1 580**	377	*11.4*	**0**	0	*0.0*	**4 485**	517	*32.3*	**317**	40	*2.3*	**1 745**	852	*12.6*	**13 896**	394	*100.0*
Stickleback Outflow	21-Jul-97	2	**172**	172	*0.1*	**783**	590	*0.5*	**129**	129	*0.1*	**0**	0	*0.0*	**5**	5	*<0.1*	**5**	5	*0.0*	**0**	0	*0.0*	**526**	322	*0.3*	**160 784**	70 694	*100.0*
	26-Jun-98	2	**276**	141	*2.8*	**546**	129	*5.6*	**852**	316	*8.8*	**1 539**	464	*15.8*	**417**	417	*4.3*	**1 170**	499	*12.0*	**0**	0	*0.0*	**1 904**	683	*19.6*	**9 733**	3 196	*100.0*
	30-Jul-98	2	**490**	101	*4.3*	**829**	592	*7.2*	**260**	260	*2.3*	**1 137**	488	*9.9*	**65**	65	*0.6*	**1 974**	523	*17.2*	**0**	0	*0.0*	**1 090**	204	*9.5*	**11 508**	4 288	*100.0*
Fickle Duck Outflow	21-Jul-97	2	**186**	133	*22.3*	**132**	110	*15.8*	**7**	1	*0.8*	**34**	21	*4.1*	**1**	1	*0.1*	**175**	59	*21.0*	**0**	0	*0.0*	**21**	15	*2.6*	**833**	375	*100.0*
	25-Aug-97	2	**9**	0	*0.5*	**595**	338	*35.6*	**25**	7	*1.5*	**174**	79	*10.4*	**0**	0	*0.0*	**65**	16	*3.9*	**2**	2	*0.1*	**11**	2	*0.7*	**1 670**	742	*100.0*
	26-Jun-98	2	**536**	402	*4.8*	**1 395**	204	*12.4*	**397**	397	*3.5*	**1 723**	493	*15.3*	**198**	198	*1.8*	**1 790**	420	*15.9*	**0**	0	*0.0*	**1 073**	356	*9.5*	**11 287**	1 221	*100.0*
	30-Jul-98	2	**254**	128	*1.8*	**222**	221	*1.6*	**0**	0	*0.0*	**1 564**	150	*11.2*	**0**	0	*0.0*	**1 426**	639	*10.2*	**0**	0	*0.0*	**3 156**	474	*22.6*	**13 996**	4 459	*100.0*
Reference Outflow	21-Jul-97	2	**197**	118	*24.7*	**263**	220	*33.0*			*<0.1*	**52**	37	*6.5*	**1**	1	*0.1*	**98**	14	*12.3*	**2**	2	*0.2*	**1**		*0.2*	**797**	523	*100.0*
	25-Aug-97	2	**9**	1	*2.3*	**102**	102	*26.7*	**0**	0	*0.0*	**1**	1	*0.2*	**0**	0	*0.0*	**209**	132	*54.9*	**6**	2	*1.7*	**4**	2	*1.1*	**381**	224	*100.0*
	27-Jun-98	2	**562**	85	*6.3*	**281**	43	*3.2*	**687**	56	*7.8*	**1 343**	272	*15.2*	**242**	242	*2.7*	**1 553**	1 291	*17.5*	**302**	183	*3.4*	**741**	94	*8.4*	**8 848**	2 301	*100.0*
	01-Aug-98	2	**164**	164	*1.2*	**818**	583	*6.0*	**735**	249	*5.4*	**1 271**	474	*9.4*	**0**	0	*0.0*	**2 347**	930	*17.3*	**410**	410	*3.0*	**1 544**	669	*11.4*	**13 533**	2 317	*100.0*

NOTE: Terrestrial animals (e.g., adult Culicidae or mosquitoes) were excluded from these data, but not from Rescan's original reports.

Appendix C7. Benthic invertebrate abundance (organisms/m^2) in Boston area streams, 1994-1998.

Taxa / Species	Stage	STICKLEBACK OUTFLOW															
		01-Aug-95			05-Aug-96				21-Jul-97			25-Aug-97			26-Jun to 30-Jul-98		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 4	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ARACHNIDA																	
Acarina (parasitic)	Adult	40	20	20													
Hydracarina	Adult	1	1		2	7	13	22	59	10	382	59	29	29	175	121	77
Oribatidae	Adult																
CLADOCERA																	
Chydoridae	Juvenile																
Alona																	
Alonella																	
Alonella nana				140													
Chydorus sphaericus		20		400													44
Daphniidae																	
Daphnia		40															
Macrothricidae (damaged)			10														
COLEOPTERA																	
Dytiscidae																	
Brachyvatus	Adult																
Elmidae	Larva																
Haliplidae																	
Haliplus	Larva																
COLLEMBOLA																	
Isotomidae																	
Isotoma	Adult												10				
COPEPODA	Nauplius					44		178									
Calanoida																	
Canthocamptidae										20		10					
Cyclopidae																	
Cyclopoida																	
Cyclops capillatus																	
Cyclops scutifer																	
Cyclops sp.																	44
Cyclops sp.	Copep.																
Eucyclops agilis																	
Macrocyclops albidus																	
Harpacticoida								222									
DIPTERA	Adult																
Chironomidae	Adult				2												
Chironomidae	Juvenile				76	16	18	82									
Chironomidae	Larva	260	130	420						10		29			88	44	1 075
Chironomidae	Pupa								88	39	49						
Chironomini	Larva																
Chironomini	Pupa																
Demicryptochironomus	Larva														11		
Glyptotendipes	Larva																
Phaenopsectra	Larva	1	2			2								10			
Diamesinae																	
Diamesa	Larva													88			
Monodiamesa	Larva																
Potthastia	Larva																
Pseudokiefferiella	Larva	5	1							10							
Orthocladiinae	Larva	80	30	3													22
Orthocladiinae	Pupa	2															
Chaetocladius	Larva	16	10														
Corynoneura	Larva	340	300	180											307	88	461
Corynoneura	Pupa	1	1	41													44
Cricotopus	Larva	27	40	40	4		2	4									
Cricotopus	Pupa																
Eukiefferiella	Larva							2				10					
Eukiefferiella	Pupa																
Gymnometriocnemus	Larva																
Heterotrissocladius	Larva																
Heterotrissocladius	Pupa																
Orthocladius	Larva	7										10					
Psectrocladius	Larva	16	1													11	175
Psectrocladius	Pupa																
Rheocricotopus	Larva																
Rheocricotopus	Pupa																
Thienemaniella	Larva																
Tanypodinae	Larva		1													22	
Paramerina	Larva									10				10			
Procladius	Larva	1	1														
Thienemannimyia	Larva		6	2	4	4	25	18					10				
Thienemannimyia	Pupa																
Tanytarsini	Larva																132
Tanytarsini	Pupa																
Paratanytarsus	Larva	2	3	42								20					
Rheotanytarsus	Larva				2		16	11	10						44	11	11
Rheotanytarsus	Pupa								20								
Stempellinella	Larva						2	29									
Tanytarsus	Larva	1	2	1	778	368	591	921		20							
Tanytarsus	Pupa		1														

Appendix C7. Benthic invertebrate abundance (organisms/m^2) in Boston area streams, 1994-1998.

Taxa / Species	Stage	STICKLEBACK OUTFLOW															
		01-Aug-95			05-Aug-96				21-Jul-97			25-Aug-97			26-Jun to 30-Jul-98		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 4	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Culicidae																	
Anopheles	Adult										10						
Empididae	Pupa	1															
Simuliidae	Pupa								10								
Simuliidae	Larva																
Prosimulium	Larva																
Simulium	Adult																33
Simulium	Larva	5	1					13	98	20							
Simulium	Pupa	2	27														
Tipulidae																	
Dicranota	Larva																
Priuncera sp.								9									
Tipula	Larva				2												
Unidentified	Adult		1														
EPHEMEROPTERA																	
Baetidae	Larva																
Baetis bicaudatus	Larva																
Baetis tricaudatus	Larva	3															
Ephemerellidae																	
Ephemerella inermis																	
GASTROPODA																	
Valvatidae															44	22	
Valvata sincera sincera							2					20		88			
HYDROZOA																	
Hydra								2					10			44	285
MALACOSTRACA																	
Gammarus lacustris						2			88	167	88	29	59		44	99	154
Idoteidae																	
Saduria entomon									10								
NEMATODA		60	50	121	98	22	74	539	10		10	10	29				
OLIGOCHAETA															44	175	219
Enchytraeidae		120	80	10				2									
Lumbriculidae			6	2								10			11		
Lumbriculus																	
Lumbriculus variegatus								2									
Naididae																	
Chaetogaster					4		4	13									
Nais								2					20		88	482	175
Tubificidae							2										
Tubificidae	Juvenile																
OSTRACODA																	
Candona							4	4			10	49			88		197
Cyclocypris			10														
Cypria									29		39				263	1 864	833
Cypridopsis		700	550	2 160													
Cypris									118	20	78	20			16 052	2 653	3 048
Cyprois marginata		880	600	4 640													
Ilyocypris		20	120	49													
PELECYPODA																	
Sphaeriidae																	
Psidium																	
Sphaerium					4										11		
Physidae																	
Physa																	
PISCES																	
Pungitius pungitius		1	1	2													
unidentified				6													
PLECOPTERA																	
Nemouridae																	
Nemoura	Larva									20	10		10		55		22
Podmosta						2											
Chloroperlidae																	
Suwallia	Larva																
ROTIFERA					4 977	3 333	889	2 844									
Kellicottia					356	178											
Lecane					267	89											
Polyarthra						222	178										
TRICHOPTERA																	
Brachycentridae																	
Brachycentrus americanus																	
Micrasema																	
Limnephilidae		2	6	2													
Clostoeca sp.					4	7											
Grensia praeterita	Larva								69	20	59	10	49	10	77	22	22
Grensia praeterita	Pupa											10		20			
TURBELLARIA							2	2									
TOTAL		**2 593**	**2 000**	**7 733**	**978**	**430**	**755**	**1 899**	**608**	**363**	**725**	**294**	**225**	**255**	**17 401**	**5 658**	**6 951**

Shaded rows indicate terrestrial invertebrates or non-benthic forms that were excluded from the total.

Appendix C7. Benthic invertebrate abundance (organisms/m^2) in Boston area streams, 1994-1998.

Taxa / Species	Stage	AIMAOKATALOK NE INFLOW						AIMAOKATALOK RIVER					
		25-Aug-97			28-Jun to 31-Jul-98			24-Aug-97			27-Jun to 1-Aug-98		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ARACHNIDA													
Acarina (parasitic)	Adult												
Hydracarina	Adult	10			11		22				66	22	
Oribatidae	Adult												
CLADOCERA													
Chydoridae	Juvenile												
Alona													
Alonella					33						22	33	
Alonella nana													
Chydorus sphaericus					11						121	132	11
Daphniidae													
Daphnia													
Macrothricidae (damaged)													
COLEOPTERA													
Dytiscidae													
Brachyvatus	Adult												
Elmidae	Larva												
Haliplidae													
Haliplus	Larva												
COLLEMBOLA													
Isotomidae													
Isotoma	Adult												
COPEPODA	Nauplius												
Calanoida													
Canthocamptidae													
Cyclopidae													
Cyclopoida													
Cyclops capillatus													
Cyclops scutifer													
Cyclops sp.											33	11	44
Cyclops sp.	Copep.												
Eucyclops agilis													
Macrocyclops albidus											55	44	66
Harpacticoida											77	88	
DIPTERA	Adult												
Chironomidae	Adult												
Chironomidae	Juvenile												
Chironomidae	Larva	78	10	10	11	44	44	10			175	219	219
Chironomidae	Pupa							10					
Chironomini	Larva				22	11	11						
Chironomini	Pupa												
Demicryptochironomus	Larva					11							
Glyptotendipes	Larva				33								11
Phaenopsectra	Larva						22						
Diamesinae													
Diamesa	Larva	88	49										
Monodiamesa	Larva												
Potthastia	Larva												
Pseudokiefferiella	Larva					11							
Orthocladiinae	Larva	49	10		11	11					11	33	22
Orthocladiinae	Pupa												
Chaetocladius	Larva												
Corynoneura	Larva					33	99				11		
Corynoneura	Pupa					11							
Cricotopus	Larva												
Cricotopus	Pupa												
Eukiefferiella	Larva		10			11							
Eukiefferiella	Pupa												
Gymnometriocnemus	Larva										11		
Heterotrissocladius	Larva												
Heterotrissocladius	Pupa												
Orthocladius	Larva												
Psectrocladius	Larva												11
Psectrocladius	Pupa												
Rheocricotopus	Larva					44							
Rheocricotopus	Pupa												
Thienemaniella	Larva					11							
Tanypodinae	Larva						22					99	99
Paramerina	Larva				11								
Procladius	Larva				11								
Thienemannimyia	Larva				186	99	252				11	55	55
Thienemannimyia	Pupa						11						
Tanytarsini	Larva	29			88	66	99				164	77	99
Tanytarsini	Pupa				22								
Paratanytarsus	Larva											11	
Rheotanytarsus	Larva	245	39			154	164				88	44	44
Rheotanytarsus	Pupa											11	
Stempellinella	Larva	10			11	22					33	121	33
Tanytarsus	Larva	10											
Tanytarsus	Pupa												

Appendix C7. Benthic invertebrate abundance (organisms/m^2) in Boston area streams, 1994-1998.

Taxa / Species	Stage	AIMAOKATALOK NE INFLOW						AIMAOKATALOK RIVER					
		25-Aug-97			28-Jun to 31-Jul-98			24-Aug-97			27-Jun to 1-Aug-98		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Culicidae													
Anopheles	Adult												
Empididae	Pupa												
Simuliidae	Pupa								10				
Simuliidae	Larva												
Prosimulium	Larva												
Simulium	Adult											11	11
Simulium	Larva		10	10		11			39	10			
Simulium	Pupa												
Tipulidae													
Dicranota	Larva												
Priuncera sp.													
Tipula	Larva				22		22						
Unidentified	Adult												
EPHEMEROPTERA													
Baetidae	Larva												
Baetis bicaudatus	Larva												
Baetis tricaudatus	Larva	69	29	10		22							
Ephemerellidae													
Ephemerella inermis		10						69	20	10			
GASTROPODA													
Valvatidae											22		121
Valvata sincera sincera		39	10		1 009	647	877	29	20	29			11
HYDROZOA													
Hydra													
MALACOSTRACA													
Gammarus lacustris													
Idoteidae													
Saduria entomon													
NEMATODA							11				11	11	132
OLIGOCHAETA													
Enchytraeidae													
Lumbriculidae					11		11						
Lumbriculus													
Lumbriculus variegatus													
Naididae													
Chaetogaster													
Nais													
Tubificidae													
Tubificidae	Juvenile						44						
OSTRACODA													
Candona		20			1 447	219	943			598	66	121	66
Cyclocypris													
Cypria													
Cypridopsis													
Cypris						11	66			29			
Cyprois marginata													
Ilyocypris													
PELECYPODA													
Sphaeriidae													
Psidium		10							10				
Sphaerium													
Physidae													
Physa					219	88	143	10			11		11
PISCES													
Pungitius pungitius													
unidentified													
PLECOPTERA													
Nemouridae													
Nemoura	Larva				11		11						
Podmosta													
Chloroperlidae													
Suwallia	Larva												
ROTIFERA													
Kellicottia													
Lecane													
Polyarthra													
TRICHOPTERA													
Brachycentridae		29	10										
Brachycentrus americanus								98	578	10			
Micrasema					22								
Limnephilidae													
Clostoeca sp.													
Grensia praeterita	Larva												11
Grensia praeterita	Pupa												
TURBELLARIA													
TOTAL		**696**	**176**	**29**	**3 158**	**1 535**	**2 873**	**225**	**676**	**686**	**757**	**910**	**943**

Shaded rows indicate terrestrial invertebrates or non-benthic forms that were excluded from the total.

Appendix C7. Benthic invertebrate abundance (organisms/m^2) in Boston area streams, 1994-1998.

Taxa / Species	Stage	FICKLE DUCK OUTFLOW										REFERENCE OUTFLOW					
		Aug 94	01-Aug-95			25-Aug-97			26-Jun to 31-Jul-98			25-Aug-97			28-Jun to 1-Aug-98		
			Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
ARACHNIDA																	
Acarina (parasitic)	Adult																
Hydracarina	Adult	4	3	40		49	29	108	132	252	88	10	20	10	5 691	1 458	395
Oribatidae	Adult		10														
CLADOCERA																	
Chydoridae	Juvenile								22		175						22
Alona			10														
Alonella																	
Alonella nana			40														
Chydorus sphaericus				70					22	132	614					88	
Daphniidae																	
Daphnia		28		2													
Macrothricidae (damaged)																	
COLEOPTERA																	
Dytiscidae																	
Brachyvatus	Adult									11							
Elmidae	Larva																
Haliplidae																	
Haliplus	Larva									11							
COLLEMBOLA																	
Isotomidae																	
Isotoma	Adult							10									
COPEPODA	Nauplius																
Calanoida																	
Canthocamptidae																	
Cyclopidae																	
Cyclopoida		7															
Cyclops capillatus			10	6	40												
Cyclops scutifer						10											
Cyclops sp.									44							88	
Cyclops sp.	Copep.		80	20													
Eucyclops agilis																	
Macrocyclops albidus								402	22	44	186	59	49				
Harpacticoida		160							154	88	175				175	1 491	44
DIPTERA	Adult																
Chironomidae	Adult																
Chironomidae	Juvenile																
Chironomidae	Larva		1 110	420	240	88	206	10	1 020	2 237	10 011	29		20	7 368	4 035	1 053
Chironomidae	Pupa	1 855															
Chironomini	Larva														175	11	88
Chironomini	Pupa	333															
Demicryptochironomus	Larva															11	
Glyptotendipes	Larva																
Phaenopsectra	Larva	4	1	1	1												
Diamesinae												88	88	49			
Diamesa	Larva																
Monodiamesa	Larva														175		
Potthastia	Larva														888		22
Pseudokiefferiella	Larva																
Orthocladiinae	Larva		130	190	50	147	294	39	33	44	88	10	39	29	3 684	526	175
Orthocladiinae	Pupa																
Chaetocladius	Larva																
Corynoneura	Larva		710	240	230				208	1 096	2 631					263	22
Corynoneura	Pupa		30	30	11				33	175	351						
Cricotopus	Larva		50		1							98	69	20			
Cricotopus	Pupa											29		10			
Eukiefferiella	Larva																
Eukiefferiella	Pupa							10				20	10	10			
Gymnometriocnemus	Larva																
Heterotrissocladius	Larva		280	90	50												
Heterotrissocladius	Pupa																
Orthocladius	Larva																
Psectrocladius	Larva											10	10		22	22	11
Psectrocladius	Pupa																
Rheocricotopus	Larva								88	22	219				3 224	55	11
Rheocricotopus	Pupa														11		
Thienemaniella	Larva								22		88						
Tanypodinae	Larva	52							11	88	614					175	175
Paramerina	Larva															11	
Procladius	Larva																
Thienemannimyia	Larva					294	157	196	121	307	132				197	1 042	461
Thienemannimyia	Pupa																
Tanytarsini	Larva					29	98		735	1 447	4 309	69	29	10	6 491	6 140	1 623
Tanytarsini	Pupa																
Paratanytarsus	Larva							10	439	44	175					33	33
Rheotanytarsus	Larva		1	1	1			10		132	263	29	39	29	49 461	11 677	3 574
Rheotanytarsus	Pupa		1														
Stempellinella	Larva					745	10	245	329	5 756	2 456			10		263	66
Tanytarsus	Larva	10				20										11	
Tanytarsus	Pupa																

Appendix C7. Benthic invertebrate abundance (organisms/m^2) in Boston area streams, 1994-1998.

Taxa / Species	Stage	FICKLE DUCK OUTFLOW										REFERENCE OUTFLOW					
		Aug 94	01-Aug-95			25-Aug-97			26-Jun to 31-Jul-98			25-Aug-97			28-Jun to 1-Aug-98		
			Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Culicidae																	
Anopheles	Adult								22								
Empididae	Pupa																
Simuliidae	Pupa											10		10			
Simuliidae	Larva																22
Prosimulium	Larva																
Simulium	Adult								22								
Simulium	Larva																
Simulium	Pupa																
Tipulidae																	
Dicranota	Larva			1	1												
Priuncera sp.																	
Tipula	Larva						10	10	11			10		10		88	
Unidentified	Adult																
EPHEMEROPTERA																	
Baetidae	Larva													10			
Baetis bicaudatus	Larva																
Baetis tricaudatus	Larva																
Ephemerellidae																	
Ephemerella inermis												10		59			
GASTROPODA																	
Valvatidae									33	263						175	197
Valvata sincera sincera					1							255	39	137	11		11
HYDROZOA																	
Hydra		17															
MALACOSTRACA																	
Gammarus lacustris		28															
Idoteidae																	
Saduria entomon																	
NEMATODA		201	90	22	30			20	44	44	175				351	351	110
OLIGOCHAETA		42							11							88	
Enchytraeidae			30		1												
Lumbriculidae		42	19	1												11	
Lumbriculus																	
Lumbriculus variegatus																	
Naididae																	
Chaetogaster																	
Nais							20									1 678	110
Tubificidae		208															
Tubificidae	Juvenile	113					10									88	
OSTRACODA		728															
Candona						176	88	49	77	1 710	1 140	88	29		351	175	88
Cyclocypris			20	2													
Cypria																	
Cypridopsis			380	123	434												
Cypris							10		11	44	175		10		175		
Cyprois marginata			90	42	91												
Ilyocypris			30	11													
PELECYPODA																	
Sphaeriidae																	
Psidium																	
Sphaerium																	
Physidae																	
Physa												10	59	29			
PISCES																	
Pungitius pungitius																	
unidentified																	
PLECOPTERA		21															
Nemouridae																	
Nemoura	Larva					10		10						20	11		11
Podmosta																	
Chloroperlidae																	
Suwallia	Larva					10											
ROTIFERA																	
Kellicottia																	
Lecane																	
Polyarthra																	
TRICHOPTERA																	
Brachycentridae													10				
Brachycentrus americanus										11							
Micrasema						29	10										
Limnephilidae																	
Clostoeca sp.																	
Grensia praeterita	Larva	4															
Grensia praeterita	Pupa																
TURBELLARIA		4															
TOTAL		**3 823**	**2 985**	**1 214**	**1 142**	**1 597**	**941**	**725**	**3 509**	**13 771**	**23 091**	**774**	**451**	**470**	**78 461**	**29 878**	**8 300**

Shaded rows indicate terrestrial invertebrates or non-benthic forms that were excluded from the total.

Appendix C8. Mean abundance (organisms/m^2) and percent composition of main taxa of benthic invertebrates in Boston area streams, 1994-1998.

Stream	Date	No.	Cnidaria			Nematoda			Oligochaeta			Ostracoda			Acarina			Ephemeroptera			Plecoptera			Trichoptera		
		Repl.	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%
Aimaokatalok	25-Aug-97	3	0	0	0.0	0	0	0.0	0	0	0.0	7	7	2.2	3	3	1.1	39	20	13.0	0	0	0.0	13	9	4.3
NE Inflow	28-Jun to 31-Jul-98	3	0	0	0.0	4	4	0.1	22	17	0.9	895	356	35.5	11	6	0.4	7	7	0.3	7	4	0.3	7	7	0.3
Aimaokatalok	24-Aug-97	3	0	0	0.0	0	0	0.0	0	0	0.0	209	209	39.5	0	0	0.0	33	18	6.2	0	0	0.0	229	177	43.2
River	27-Jun to 1-Aug-98	3	0	0	0.0	51	40	5.9	0	0	0.0	84	18	9.7	29	19	3.4	0	0	0.0	0	0	0.0	4	4	0.4
Stickleback	01-Aug-95	3	0	0	0.0	77	22	1.9	73	32	1.8	3 243	1 805	78.9	27	7	0.7	1	1	0.0	0	0	0.0	3	1	0.1
Outflow	05-Aug-96	4	1	1	0.0	183	120	18.0	7	4	0.7	2	1	0.2	11	4	1.1	0	0	0.0	1	1	0.0	3	2	0.3
	21-Jul-97	3	0	0	0.0	7	3	1.2	0	0	0.0	98	40	17.3	150	117	26.6	0	0	0.0	10	6	1.7	49	15	8.7
	25-Aug-97	3	3	3	1.3	13	9	5.1	10	6	3.8	23	23	8.9	39	10	15.2	0	0	0.0	3	3	1.3	33	9	12.7
	26-Jun to 30-Jul-98	3	110	89	1.1	0	0	0.0	398	149	4.0	8 333	4 037	83.3	124	29	1.2	0	0	0.0	26	16	0.3	40	18	0.4
Fickle Duck	Aug-94	1	17	-	0.5	201	-	5.3	405	-	10.6	728	-	19.0	4	-	0.1	0	-	0.0	21	-	0.5	4	-	0.1
Outflow	01-Aug-95	3	0	0	0.0	47	21	2.7	17	16	1.0	408	115	22.9	18	12	1.0	0	0	0.0	0	0	0.0	0	0	0.0
	25-Aug-97	3	0	0	0.0	7	7	0.6	10	10	0.9	108	37	9.9	62	24	5.7	0	0	0.0	10	6	0.9	13	9	1.2
	26-Jun to 31-Jul-98	3	0	0	0.0	88	44	0.7	4	4	0.0	1 053	499	7.8	157	49	1.2	0	0	0.0	0	0	0.0	4	4	0.0
Reference	25-Aug-97	3	0	0	0.0	0	0	0.0	0	0	0.0	42	26	7.5	13	3	2.3	26	21	4.6	7	7	1.2	3	3	0.6
Outflow	28-Jun to 1-Aug-98	3	0	0	0.0	270	80	0.7	658	604	1.7	263	134	0.7	2 515	1 617	6.5	0	0	0.0	7	4	0.0	0	0	0.0

Stream	Date	No.	Simuliidae			Unid. Chironomidae			Tanypodinae			Tanytarsini			Chironomini			Orthocladinae			Diamesinae			Remainder			All Taxa [a]		
		Repl.	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%
Aimaokatalok	25-Aug-97	3	7	3	2.2	33	23	10.9	0	0	0.0	111	92	37.0	0	0	0.0	23	14	7.6	46	26	15.2	20	15	6.5	301	202	100
NE Inflow	28-Jun to 31-Jul-98	3	4	4	0.1	33	11	1.3	197	54	7.8	208	44	8.3	37	10	1.4	77	33	3.0	4	4	0.1	1 009	150	40.0	2 522	500	100
Aimaokatalok	24-Aug-97	3	20	15	3.7	7	7	1.2	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	33	3	6.2	529	152	100
River	27-Jun to 1-Aug-98	3	0	0	0.0	205	15	23.5	106	48	12.2	241	33	27.7	4	4	0.4	33	0	3.8	0	0	0.0	113	16	13.0	870	57	100
Stickleback	01-Aug-95	3	12	8	0.3	270	84	6.6	4	2	0.1	17	13	0.4	1	1	0.0	378	65	9.2	2	2	0.0	0	0	0.0	4 109	1 820	100
Outflow	05-Aug-96	4	3	3	0.3	48	18	4.7	13	5	1.3	680	126	66.9	1	1	0.0	3	1	0.3	0	0	0.0	61	57	6.0	1 016	315	100
	21-Jul-97	3	42	33	7.5	62	13	11.0	3	3	0.6	16	9	2.9	0	0	0.0	0	0	0.0	3	3	0.6	124	31	22.0	565	107	100
	25-Aug-97	3	0	0	0.0	10	10	3.8	7	3	2.5	7	7	2.5	3	3	1.3	7	7	2.5	29	29	11.4	72	9	27.8	258	20	100
	26-Jun to 30-Jul-98	3	0	0	0.0	402	336	4.0	7	7	0.1	66	40	0.7	4	4	0.0	369	177	3.7	0	0	0.0	124	16	1.2	10 003	3 717	100
Fickle Duck	Aug-94	1	0	-	0.0	1 855	-	48.5	52	-	1.4	10	-	0.3	336	-	8.8	0	-	0.0	0	-	0.0	191	-	5.0	3 823	-	100
Outflow	01-Aug-95	3	0	0	0.0	590	265	33.1	0	0	0.0	1	0	0.1	1	0	0.1	697	258	39.2	0	0	0.0	1	1	0.1	1 780	603	100
	25-Aug-97	3	0	0	0.0	101	57	9.3	216	41	19.8	389	208	35.7	0	0	0.0	163	71	15.0	0	0	0.0	10	6	0.9	1 088	262	100
	26-Jun to 31-Jul-98	3	0	0	0.0	4 422	2 816	32.9	424	178	3.2	5 362	1 930	39.8	0	0	0.0	1 699	883	12.6	0	0	0.0	245	59	1.8	13 457	5 655	100
Reference	25-Aug-97	3	7	3	1.2	16	9	2.9	0	0	0.0	72	14	12.7	0	0	0.0	121	28	21.4	75	13	13.3	183	51	32.4	565	105	100
Outflow	28-Jun to 1-Aug-98	3	7	7	0.0	4 152	1 824	10.7	687	299	1.8	26 457	15 205	68.0	95	44	0.2	2 675	2 141	6.9	362	351	0.9	731	512	1.9	38 880	20 748	100

NOTES: Terrestrial animals (e.g., adult Culicidae or mosquitoes) were excluded from these data, but not from Rescan's original reports. In addition, non-benthic forms (e.g., cladocerans and most copepods) were removed from statistical analyses. Due to rounding, total numbers may not match the sum of the major taxonomic groups.

Appendix C9. Marine benthic invertebrate abundance (organisms/m^2) in Hope Bay, 1998.

Taxa/Species	Stage	HOPE BAY 21-Jul-1998								
		STATION 1 8.0 m depth			STATION 2 3.6 m depth			STATION 3 3.7 m depth		
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
AMPHIPODA	Juvenile									
Atylus tridens		133								
Orchomene		44			44					
Paramoera		133								
Pontoporeia femorata		267	533	44						
COLLEMBOLA										
Podura sp	Adult	44	44							
COPEPODA										
Harpacticoida							44	267		
CUMACEA										
Bathycuma			44							
Diastylis (abbotti?)								89		
DIPTERA										
Chironomidae	Larva		44	89						
Chironomini										
Chironomus	Larva			44				89		
Phaenopsectra	Larva	44								
Polypedilum	Larva		44	44			44			
Orthocladiinae										
Cricotopus	Larva	133				44	222			
Eukiefferiella	Larva	267	44				267			
Monodiamesa	Larva	44	133	89			89			
Saetheria	Larva		89							
Stilocladius	Larva	89		44						
Thienemanniella	Larva	178	178	178			89			
Tanytarsini										
Rheotanytarsus	Larva	44	44	44			356			
Tanypodinae										
Procladius	Larva		44	44						
Culicidae	Adult	89								
HIRUDINEA										
Piscicolidae?	Juvenile		44							
HYDRACARINA	Juvenile			44			44			
Lebertia			89							
Neumannia			44				89		44	
Sperchon							44			
HYMENOPTERA										
Formicidae	Adult					44				
ISOPODA	Juvenile	178								
Saduria entomon		44								
NEMATODA		89		44	311	1 844	44	3 556	122	396
OLIGOCHAETA	Juvenile									
Enchytraeidae			44					178	133	89
OSTRACODA		133	44	44			44			
POLYCHAETA	Juvenile	44						89		
Amphictenidae										
Pectinaria granulata		356	89	396						
Capitellidae										
Mediomastus		133	133	178				356	1 156	311
Cirratulidae	damaged			89	44					
Nephtyidae										
Nephthys ciliata										
Nephthys cornuta		122	1 467	711						
Paraonidae										
Aricidea lopezi		44								
Paronella spinifera								44		
Pholadidae										
Pholoe minuta		711	267	267						
Phyllodocidae										
Eteone longa		89	44	178			89			
Polynoidae dam		622	89							
Spionidae										
Laonice cf cirrata				44	356	533	222	167	489	178
PRIAPULIDA		44								
PELECYPODA										
Macoma inquinata		89			89			133		
TOTAL		**4 078**	**3 556**	**2 618**	**844**	**2 422**	**1 688**	**4 967**	**1 944**	**974**

NOTE: Shaded rows indicate terrestrial invertebrates or adult forms of aquatic invertebrates that were excluded from the total.

Designation "cf" indicates that positive identification could not be made to species.

Appendix C10. Mean abundance (organisms/m^2) and percent composition of main taxa of benthic invertebrates in Hope Bay, 21 July 1998.

Site	Depth (m)	No. Repl.	Nematoda			Polychaeta			Ostracoda			Cumacea		
			Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%
Station 1	8.0	3	**44**	26	*1.3*	**2 025**	82	*59.2*	**74**	30	*2.2*	**15**	15	*0.4*
Station 2	3.6	3	**733**	561	*44.4*	**415**	65	*25.1*	**15**	15	*0.9*	**0**	0	*0.0*
Station 3	3.7	3	**1 358**	1 102	*51.7*	**930**	361	*35.4*	**0**	0	*0.0*	**30**	30	*1.1*

Site	Depth (m)	No. Repl.	Amphipoda			Chironomidae			Pelecypoda			Other Taxa			All Taxa[a]	
			Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE	%	Mean	SE
Station 1	8.0	3	**385**	171	*11.3*	**667**	68	*19.5*	**30**	30	*0.9*	**178**	68	*5.2*	**3 417**	427
Station 2	3.6	3	**15**	15	*0.9*	**370**	348	*22.4*	**30**	30	*1.8*	**74**	74	*4.5*	**1 652**	456
Station 3	3.7	3	**0**	0	*0.0*	**30**	30	*1.1*	**44**	44	*1.7*	**237**	107	*9.0*	**2 628**	1 202

[a]Terrestrial animals (e.g., adult Culicidae or mosquitoes) were excluded from these data, but not from Rescan's original reports.

APPENDIX D

FISH POPULATIONS

Appendix D1. Fish capture summary for Boston area lakes, 1993-1997.

Lake	Year	Method	Effort (h)	Lake trout	Lake whitefish	Arctic grayling	Cisco	Ninespine stickleback	All Species
Aimaokatalok	1993	GN		7	6				13
	1994	GN		20	23	1			44
	1995	AN		2					2
	1995	GN	52.5	23	5				28
	1995	MT	46.0					75	75
	1996	GN		13	1				14
	1997	AN		30					30
	1997	GN		70	74		17		161
	1993-1997	**Total**	**98.5**	**165**	**109**	**1**	**17**	**75**	**367**
Stickleback	1993	GN						observed	0
	1994	GN						observed	0
	1995	MT	22.0					19	19
	1995	GN	11.5						0
	1997	GN						observed	0
	1993-1997	**Total**	**33.5**	**0**	**0**	**0**	**0**	**19**	**19**
Fickle Duck	1995	GN	9.5			4		observed	4
	1995	MT	22.0					3	3
	1996	GN				4		observed	4
	1995-1996	**Total**	**31.5**	**0**	**0**	**8**	**0**	**3**	**11**

Appendix D2. Catch and catch-per-unit-effort (CPUE) data for small mesh, large mesh, and index (38 mm mesh size) gill net sets in Aimaokatalok Lake, 1997.

Set ID	Date	Mesh Sizes (mm)	Net Area (m^2)	Set Time	Lift Time	Soak Time (min)	Lake trout		Lake whitefish		Cisco		All Species	
							n	CPUE	n	CPUE	n	CPUE	n	CPUE
SS1	10-Aug	19, 25, 38, 51	146.4	9:20	15:20	360	1	2.7	1	2.7			2	5.5
SS2	10-Aug	19, 25, 38, 51	146.4	15:45	21:45	360	4	10.9					4	10.9
SS3	11-Aug	19, 25, 38, 51	146.4	19:50	23:20	210	13	60.9	11	51.5	8	37.5	32	149.9
Small Mesh Gang Total						**930**	**18**		**12**		**8**		**38**	
	Mean CPUE (fish/100m^2/24h)							***24.9***		***18.1***		***12.5***		***55.4***
	St Dev of Mean CPUE							*31.5*		*29.0*		*21.6*		*81.8*
SL1	10-Aug	64, 76, 89	109.8	9:15	14:55	340	6	23.1	1	3.9			7	27.0
SL2	10-Aug	64, 76, 89	109.8	15:35	21:30	355	18	66.5	13	48.0			31	114.5
SL3	11-Aug	64, 76, 89	109.8	19:45	22:45	180	4	29.1	6	43.7			10	72.9
Large Mesh Gang Total						**875**	**28**		**20**				**48**	
	Mean CPUE (fish/100m^2/24h)							***39.6***		***31.9***				***71.5***
	St Dev of Mean CPUE							*23.5*		*24.4*				*43.8*
GN 1	10-Aug	38	109.8	9:30	10:30	60	1	21.9					1	21.9
GN 2	10-Aug	38	109.8	9:35	10:40	65	1	20.2					1	20.2
GN 3	10-Aug	38	109.8	9:40	10:50	70	1	18.7	1	18.7			2	37.5
GN 4	10-Aug	38	109.8	11:00	12:00	60	1	21.9	2	43.7			3	65.6
GN 5	10-Aug	38	109.8	11:05	12:10	65			3	60.5			3	60.5
GN 6	10-Aug	38	109.8	11:10	12:20	70	2	37.5	6	112.4			8	149.9
GN 7	10-Aug	38	109.8	11:15	12:45	90	1	14.6	2	29.1			3	43.7
GN 8	11-Aug	38	109.8	19:55	20:55	60	3	65.6	2	43.7			5	109.3
GN 9	11-Aug	38	109.8	20:00	21:10	70	2	37.5	5	93.7			7	131.1
GN 10	11-Aug	38	109.8	20:00	21:30	90	3	43.7	10	145.7	3	43.7	16	233.2
GN 11	11-Aug	38	109.8	20:05	22:00	115	9	102.6	11	125.4	6	68.4	26	296.5
Index Gill Net Total						**815**	**24**		**42**		**9**		**75**	
	Mean CPUE (fish/100m^2/24h)							***34.9***		***61.2***		***10.2***		***106.3***
	St Dev of Mean CPUE							*28.4*		*50.9*		*23.3*		*90.4*

Appendix D3. Size and age statistics for fish captured in Boston area lakes, 1993-1997.

Lake	Year	Species	Fork Length (mm)					Weight (g)					Condition Factor					Age (years)				
			n	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max
Aimaokatalok	1993	Lake trout	*7*	**557**	98	450	700	*7*	**1957**	1159	1000	3600	*7*	**1.03**	0.10	0.88	1.14	*7*	**7.1**	1.5	6	10
		Lake whitefish	*6*	**447**	62	360	500	*5*	**1212**	536	620	1700	*5*	**1.30**	0.08	1.17	1.36	*6*	**16.3**	4.4	10	21
	1994	Lake trout	*20*	**582**	185	170	880	*20*	**2459**	1888	35	6500	*20*	**0.97**	0.10	0.71	1.24	*13*	**11.0**	4.1	5	16
		Lake whitefish	*23*	**403**	95	172	507	*23*	**991**	608	45	1900	*23*	**1.23**	0.29	0.74	1.94	*11*	**14.8**	4.8	7	23
		Arctic grayling	*0*					*1*	**400**	-	400	400	*0*					*1*	**6.0**	-	6	6
	1995	Lake trout	*25*	**609**	109	347	805	*25*	**2528**	1351	500	7100	*23*	**1.03**	0.14	0.77	1.36	*7*	**28.0**	9.4	18	40
		Lake whitefish	*5*	**404**	26	379	440	*5*	**900**	255	700	1300	*5*	**1.34**	0.11	1.25	1.52	*2*	**15.5**	2.1	14	17
	1996	Lake trout	*9*	**576**	149	426	854	*5*	**1408**	515	825	1800	*5*	**0.82**	0.07	0.75	0.88	*3*	**20.0**	1.0	19	21
		Lake whitefish	*1*	**521**	-	521	521	*0*					*0*					*0*				
	1997	Lake trout	*99*	**488**	137	113	905	*98*	**1558**	1118	14	6000	*98*	**1.13**	0.21	0.67	1.97	*23*	**18.2**	5.4	11	29
		Lake whitefish	*72*	**434**	83	182	538	*72*	**1263**	538	72	2100	*72*	**1.37**	0.18	1.06	1.88	*24*	**27.6**	9.2	15	46
		Cisco	*17*	**207**	67	92	348	*17*	**125**	138	8	532	*17*	**0.99**	0.10	0.85	1.26	*0*				
	1993-1997	**Lake trout**	*160*	**527**	147	113	905	*153*	**1850**	1331	14	7100	*153*	**1.08**	0.19	0.67	1.97	*53*	**16.4**	8.1	5	40
		Lake whitefish	*107*	**430**	83	172	538	*105*	**1183**	553	45	2100	*105*	**1.33**	0.21	0.74	1.94	*43*	**22.2**	9.6	7	46
		Cisco	*17*	**207**	67	92	348	*17*	**125**	138	8	532	*17*	**0.99**	0.10	0.85	1.26	*0*				
		Arctic grayling	*0*					*1*	**400**	-	400	400	*0*					*1*	**6.0**	-	6	6
Fickle Duck	1995	Arctic grayling	*4*	**358**	19	335	380	*4*	**750**	129	600	900	*4*	**1.63**	0.02	1.60	1.65	*2*	**10.0**	2.8	8	12
	1996	Arctic grayling	*4*	**289**	82	224	407	*0*					*0*					*0*				
	1995-1996	**Arctic grayling**	*8*	**323**	66	224	407	*4*	**750**	129	600	900	*4*	**1.63**	0.02	1.60	1.65	*2*	**10.0**	2.8	8	12

NOTE: all sampling methods combined; SD = standard deviation

Appendix D4. Length-frequency (%) distribution of fish captured in Boston area lakes, 1993-1997.

Fork Length Interval (mm)	**AIMAOKATALOK LAKE**													**FICKLE DUCK LAKE**		
	Lake trout						Lake whitefish						Cisco	Arctic grayling		
	1993	1994	1995	1996	1997	**Total**	1993	1994	1995	1996	1997	**Total**	1997	1995	1996	**Total**
90 - 99													5.9			
100 - 109																
110 - 119					1.0	**0.6**										
120 - 129					1.0	**0.6**							5.9			
130 - 139					1.0	**0.6**										
140 - 149													5.9			
150 - 159																
160 - 169																
170 - 179		5.0				**0.6**		4.3				**0.9**	5.9			
180 - 189					1.0	**0.6**		4.3			1.4	**1.9**	29.4			
190 - 199													11.8			
200 - 209													5.9			
210 - 219																
220 - 229															25.0	**12.5**
230 - 239																
240 - 249					1.0	**0.6**					2.8	**1.9**	5.9		25.0	**12.5**
250 - 259					1.0	**0.6**										
260 - 269					1.0	**0.6**					1.4	**0.9**				
270 - 279					1.0	**0.6**										
280 - 289											1.4	**0.9**	5.9		25.0	**12.5**
290 - 299								4.3			2.8	**2.8**	5.9			
300 - 309					1.0	**0.6**					4.2	**2.8**	5.9			
310 - 319					2.0	**1.3**		4.3			1.4	**1.9**				
320 - 329																
330 - 339					1.0	**0.6**					1.4	**0.9**		25.0		**12.5**
340 - 349		5.0	4.0		1.0	**1.9**		4.3				**0.9**	5.9			
350 - 359								4.3				**0.9**		25.0		**12.5**
360 - 369		5.0				**0.6**	16.7	8.7				**2.8**		25.0		**12.5**
370 - 379			4.0			**0.6**			20.0		1.4	**1.9**				
380 - 389					2.0	**1.3**	16.7	8.7	20.0			**3.7**		25.0		**12.5**
390 - 399					1.0	**0.6**					4.2	**2.8**				
400 - 409									20.0		1.4	**1.9**			25.0	**12.5**
410 - 419		5.0			2.0	**1.9**		4.3			6.9	**5.6**				
420 - 429				11.1	3.0	**2.5**		4.3	20.0		2.8	**3.7**				
430 - 439					1.0	**0.6**					5.6	**3.7**				
440 - 449					5.1	**3.1**			20.0		2.8	**2.8**				
450 - 459	14.3			11.1	3.0	**3.1**		4.3			2.8	**2.8**				
460 - 469		5.0	4.0		6.1	**5.0**	16.7	8.7			2.8	**4.7**				
470 - 479		5.0		11.1	9.1	**6.9**		13.0			13.9	**12.1**				
480 - 489		5.0		11.1	8.1	**6.3**	16.7	8.7			6.9	**7.5**				
490 - 499	14.3				5.1	**3.8**		4.3			12.5	**9.3**				
500 - 509	14.3	5.0			6.1	**5.0**	33.3	8.7			8.3	**9.3**				
510 - 519	14.3		4.0		5.1	**4.4**					4.2	**2.8**				
520 - 529					2.0	**1.3**				100.0	5.6	**4.7**				
530 - 539		10.0	4.0		1.0	**2.5**					1.4	**0.9**				
540 - 549			4.0	11.1	4.0	**3.8**										
550 - 559					3.0	**1.9**										
560 - 569			4.0	11.1		**1.3**										
570 - 579	14.3	5.0			2.0	**2.5**										
580 - 589			4.0		3.0	**2.5**										
590 - 599			8.0		2.0	**2.5**										
600 - 609			8.0	11.1	2.0	**3.1**										
610 - 619																
620 - 629					2.0	**1.3**										
630 - 639			4.0		2.0	**1.9**										
640 - 649			12.0			**1.9**										
650 - 659			12.0			**1.9**										
660 - 669			4.0			**0.6**										
670 - 679																
680 - 689	14.3	5.0				**1.3**										
690 - 699		5.0	4.0		1.0	**1.9**										
700 - 709	14.3				1.0	**1.3**										
710 - 719		10.0				**1.3**										
720 - 729																
730 - 739		5.0	4.0			**1.3**										
740 - 749		5.0	4.0			**1.3**										
750 - 759																
760 - 769			4.0			**0.6**										
770 - 779					1.0	**0.6**										
780 - 789		5.0		11.1		**1.3**										
790 - 799																
800 - 809			4.0		2.0	**1.9**										
810 - 819																
820 - 829																
830 - 839		5.0				**0.6**										
840 - 849																
850 - 859				11.1		**0.6**										
860 - 869																
870 - 879																
880 - 889		5.0				**0.6**										
890 - 899					1.0	**0.6**										
900 - 909					1.0	**0.6**										
No. Sampled	***7***	***20***	***25***	***9***	***99***	***160***	***6***	***23***	***5***	***1***	***72***	***107***	***17***	***4***	***4***	***8***

Appendix D5. Age-specific length and weight statistics for fish captured in Boston area lakes, 1993-1997

Age (yr)	AIMAOKATALOK LAKE																				FICKLE DUCK LAKE									
	LAKE TROUT										LAKE WHITEFISH										ARCTIC GRAYLING									
	Fork Length (mm)					Weight (g)					Fork Length (mm)					Weight (g)					Fork Length (mm)					Weight (g)				
	n	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max
1-4																														
5	*2*	**355**	13	345	364	*2*	**425**	35	400	450																				
6	*5*	**465**	38	410	510	*5*	**1040**	230	700	1300																				
7	*2*	**535**	49	500	570	*2*	**1500**	566	1100	1900	*1*	**362**	-	362	362	*1*	**500**	-	500	500										
8	*1*	**680**	-	680	680	*1*	**3600**	-	3600	3600											*1*	**335**	-	335	335	*1*	**600**	-	600	600
9											*2*	**385**	6	380	389	*2*	**650**	71	600	700										
10	*2*	**601**	140	502	700	*2*	**2400**	1697	1200	3600	*1*	**360**	-	360	360	*1*	**620**	-	620	620										
11	*1*	**447**	-	447	447	*1*	**800**	-	800	800																				
12	*4*	**525**	235	306	742	*4*	**2149**	2128	298	4500	*1*	**380**	-	380	380	*1*	**640**	-	640	640	*1*	**380**	-	380	380	*1*	**900**	-	900	900
13	*2*	**518**	81	461	576	*2*	**1406**	699	912	1900																				
14	*5*	**506**	104	416	686	*5*	**1483**	986	732	3200	*2*	**403**	32	380	426	*2*	**800**	141	700	900										
15	*3*	**705**	189	504	880	*3*	**3892**	2564	1375	6500	*2*	**441**	16	430	453	*2*	**1177**	33	1154	1200										
16	*2*	**690**	203	547	834	*2*	**3529**	3070	1358	5700	*5*	**436**	31	411	489	*5*	**1116**	273	942	1600										
17	*4*	**505**	66	424	580	*4*	**1269**	410	780	1648	*6*	**457**	29	411	498	*5*	**1302**	250	912	1600										
18	*3*	**536**	59	475	592	*3*	**1687**	482	1244	2200	*1*	**480**	-	480	480	*1*	**1500**	-	1500	1500										
19	*3*	**475**	114	347	566	*3*	**1200**	608	500	1600	*1*	**462**	-	462	462	*1*	**1500**	-	1500	1500										
20	*2*	**535**	78	479	590	*2*	**1488**	937	825	2150	*1*	**500**	-	500	500	*1*	**1600**	-	1600	1600										
21	*2*	**580**	31	558	602	*2*	**1756**	62	1712	1800	*1*	**500**	-	500	500	*1*	**1700**	-	1700	1700										
22	*1*	**519**	-	519	519	*1*	**1810**	-	1810	1810	*1*	**493**	-	493	493	*1*	**1775**	-	1775	1775										
23	*2*	**637**	174	514	760	*2*	**2650**	1768	1400	3900	*3*	**485**	19	471	507	*3*	**1699**	221	1446	1852										
24											*4*	**482**	27	449	512	*4*	**1404**	218	1100	1612										
25	*1*	**577**	-	577	577	*1*	**2044**	-	2044	2044																				
26																														
27																														
28																														
29	*3*	**521**	90	448	621	*3*	**1623**	873	922	2600																				
30																														
31-33																														
34											*2*	**499**	35	474	523	*2*	**1712**	549	1324	2100										
35	*1*	**600**	-	600	600	*1*	**1900**	-	1900	1900	*1*	**498**	-	498	498	*1*	**1348**	-	1348	1348										
36											*5*	**496**	24	473	523	*5*	**1579**	335	1264	2000										
37											*2*	**497**	20	483	511	*2*	**1541**	83	1482	1600										
38	*1*	**805**	-	805	805	*1*	**7100**	-	7100	7100																				
39																														
40	*1*	**603**	-	603	603	*1*	**2100**	-	2100	2100																				
41-45																														
46											*1*	**479**	-	479	479	*1*	**1166**	-	1166	1166										
Total	***53***	**544**	**127**	**306**	**880**	***53***	**1909**	**1487**	**298**	**7100**	***43***	**459**	**45**	**360**	**523**	***42***	**1305**	**401**	**500**	**2100**	***2***	**358**	**32**	**335**	**380**	***2***	**750**	**212**	**600**	**900**

NOTE: all sampling periods and methods combined; SD = standard deviation

Appendix D6. Sex-specific length, age and condition factor characteristics for immature and mature fish captured in Boston area lakes, 1993-1997.

Sex	Maturity	Parameter		AIMAOKATALOK LAKE		
				LKTR	LKWH	CISC
Female	Immature	Fork Length	*n*	*10*	*5*	*1*
		(mm)	Minimum	129	182	305
			Maximum	461	379	305
		Age	*n*	*5*		
		(yr)	Minimum	12		
			Maximum	17		
		Condition Factor	*n*	*10*	*5*	*1*
			Mean	0.97	1.22	1.05
	Mature	Fork Length	*n*	*15*	*18*	*2*
		(mm)	Minimum	469	411	198
			Maximum	708	523	205
		Age	*n*	*12*	*14*	
		(yr)	Minimum	14	15	
			Maximum	29	36	
		Condition Factor	*n*	*14*	*18*	*2*
			Mean	1.04	1.35	0.99
	Combined	Fork Length	*n*	*25*	*23*	*3*
		(mm)	Minimum	129	182	198
			Maximum	708	523	305
		Age	*n*	*17*	*14*	
		(yr)	Minimum	12	15	
			Maximum	29	36	
		Condition Factor	*n*	*24*	*18*	*2*
			Mean	1.01	1.35	0.99
Male	Immature	Fork Length	*n*	*9*	*8*	*6*
		(mm)	Minimum	183	241	120
			Maximum	602	437	287
		Age	*n*	*3*		
		(yr)	Minimum	11		
			Maximum	21		
		Condition Factor	*n*	*9*	*8*	*6*
			Mean	0.95	1.16	0.94
	Mature	Fork Length	*n*	*8*	*13*	*2*
		(mm)	Minimum	448	413	293
			Maximum	566	511	348
		Age	*n*	*6*	*10*	
		(yr)	Minimum	14	16	
			Maximum	29	46	
		Condition Factor	*n*	*7*	*13*	*2*
			Mean	1.06	1.26	1.19
	Combined	Fork Length	*n*	*17*	*21*	*8*
		(mm)	Minimum	183	241	120
			Maximum	602	511	348
		Age	*n*	*9*	*10*	
		(yr)	Minimum	11	16	
			Maximum	29	46	
		Condition Factor	*n*	*16*	*21*	*8*
			Mean	1.00	1.22	1.00

Note: LKTR = lake trout; LKWH = lake whitefish; CISC = cisco

Appendix D7. Raw data for fish captured in Boston area lakes, 1993-1997.

Lake	Site #	Date	Meth	Mesh (mm)	Sample #	Species	TL (mm)	FL (mm)	Weight (g)	Cond. Fact.	Sex	Mat.	Rep. Stat.	Age (yr)	Age Str.	Tag Color	Tag #	Tissues	Mortality	Comments / Stomach Content
Aimaokatalok		Aug-93	GN		1	LKTR		680	3600	1.14	F			8				Y		
Aimaokatalok		Aug-93	GN		2	LKTR		490	1300	1.10	F			6				Y		
Aimaokatalok		Aug-93	GN		3	LKTR		570	1900	1.03	F			7				Y		
Aimaokatalok		Aug-93	GN		4	LKWH		500	1600	1.28	M			20				Y		
Aimaokatalok		Aug-93	GN		5	LKWH		360	620	1.33	M			10				Y		
Aimaokatalok		Aug-93	GN		6	LKWH		500	1700	1.36	M			21				Y		
Aimaokatalok		Aug-93	GN		7	LKTR		700	3600	1.05	F			10						
Aimaokatalok		Aug-93	GN		8	LKTR		500	1100	0.88	F			7						
Aimaokatalok		Aug-93	GN		9	LKTR		510	1200	0.90				6						
Aimaokatalok		Aug-93	GN		10	LKTR		450	1000	1.10				6						
Aimaokatalok		Aug-93	GN		11	LKWH		480	1500	1.36	M			18						
Aimaokatalok		Aug-93	GN		12	LKWH		380	640	1.17	F			12						
Aimaokatalok		Aug-93	GN		13	LKWH		460			F			17						
Aimaokatalok		24-Aug-94	GN	38-89	GR1	ARGR	340		400		M			6				Y		
Aimaokatalok		24-Aug-94	GN	89	LT1	LKTR	540	**502**	1200	0.95	F			10				Y		
Aimaokatalok		24-Aug-94	GN	89	LT2	LKTR	510	**474**	1000	0.94	F			14				Y		
Aimaokatalok		24-Aug-94	GN	89	LT3	LKTR	620	**576**	1900	1.00	F			13				Y		
Aimaokatalok		24-Aug-94	GN	89	LT4	LKTR	740	**686**	3200	0.99	F			14				Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT5	LKTR	950	**880**	6500	0.95	F			15				Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT6	LKTR	900	**834**	5700	0.98	F			16						
Aimaokatalok		24-Aug-94	GN	38-89	LT7	LKTR	370	**345**	400	0.97		1		5				Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT8	LKTR	790	**732**	3800	0.97	M			15						
Aimaokatalok		24-Aug-94	GN	38-89	LT9	LKTR	770	**714**	4500	1.24	F			12						
Aimaokatalok		24-Aug-94	GN	38-89	LT10	LKTR	800	**742**	3400	0.83	F			12				Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT11	LKTR	390	**364**	450	0.94		1		5				Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT12	LKTR	570	**530**	1500	1.01	M									
Aimaokatalok		24-Aug-94	GN	38-89	LT13	LKTR	750	**695**	3300	0.98	F									
Aimaokatalok		24-Aug-94	GN	38-89	LT14	LKTR	770	**714**	3300	0.91	F									
Aimaokatalok		24-Aug-94	GN	38-89	LT15	LKTR	570	**530**	1400	0.94	M									
Aimaokatalok		24-Aug-94	GN	38-89	LT16	LKTR	500	**465**	1000	0.99	F			6				Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT17	LKTR	850	**788**	4700	0.96	M									
Aimaokatalok		24-Aug-94	GN	38-89	LT18	LKTR	440	**410**	700	1.02	M			6				Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT19	LKTR	180	**170**	35	0.71		1						Y		
Aimaokatalok		24-Aug-94	GN	38-89	LT20	LKTR	520	**483**	1200	1.06	F									
Aimaokatalok		24-Aug-94	GN	89	WF1	LKWH	510	**471**	1400	1.34	M			17				Y		
Aimaokatalok		24-Aug-94	GN	89	WF2	LKWH	490	**453**	1200	1.29	M			15				Y		
Aimaokatalok		24-Aug-94	GN	89	WF3	LKWH	450	**417**	1400	1.94	M							Y		
Aimaokatalok		24-Aug-94	GN	89	WF4	LKWH	540	**498**	1600	1.29	M			17				Y		
Aimaokatalok		24-Aug-94	GN	89	WF5	LKWH	550	**507**	1800	1.38	M			23				Y		
Aimaokatalok		24-Aug-94	GN	89	WF6	LKWH	500	**462**	1500	1.52	F			19						
Aimaokatalok		24-Aug-94	GN	89	WF7	LKWH	460	**426**	900	1.17	F			14						
Aimaokatalok		24-Aug-94	GN	38-89	WF8	LKWH	180	**172**	45	0.88		1						Y		
Aimaokatalok		24-Aug-94	GN	38-89	WF9	LKWH	550	**507**	1800	1.38	F									
Aimaokatalok		24-Aug-94	GN	38-89	WF10	LKWH	410	**380**	600	1.09	F			9				Y		
Aimaokatalok		24-Aug-94	GN	38-89	WF11	LKWH	320	**299**	300	1.12		1								
Aimaokatalok		24-Aug-94	GN	38-89	WF12	LKWH	520	**480**	1400	1.27	M									
Aimaokatalok		24-Aug-94	GN	38-89	WF13	LKWH	390	**362**	500	1.05	F			7				Y		
Aimaokatalok		24-Aug-94	GN	38-89	WF14	LKWH	510	**471**	1300	1.24	F									
Aimaokatalok		24-Aug-94	GN	38-89	WF15	LKWH	190	**181**	50	0.84		1								
Aimaokatalok		24-Aug-94	GN	38-89	WF16	LKWH	420	**389**	700	1.18	M			9				Y		
Aimaokatalok		24-Aug-94	GN	38-89	WF17	LKWH	510	**471**	1900	1.82	M									
Aimaokatalok		24-Aug-94	GN	38-89	WF18	LKWH	500	**462**	1300	1.32	M			17				Y		
Aimaokatalok		24-Aug-94	GN	38-89	WF19	LKWH	530	**489**	1600	1.37	F			16				Y		
Aimaokatalok		24-Aug-94	GN	38-89	WF20	LKWH	370	**344**	400	0.98		1								
Aimaokatalok		24-Aug-94	GN	38-89	WF21	LKWH	380	**353**	350	0.79	M									
Aimaokatalok		24-Aug-94	GN	38-89	WF22	LKWH	340	**317**	400	1.25	F									
Aimaokatalok		24-Aug-94	GN	38-89	WF23	LKWH	390	**362**	350	0.74	F									
Aimaokatalok	A	Aug-95	AN		1	LKTR	630	580	1500	0.77	F							Y		
Aimaokatalok	A	Aug-95	AN		2	LKTR	490	465	1000	0.99	F							Y		
Aimaokatalok	F7	Aug-95	GN		1	LKTR	650	600	1900	0.88	M			35				Y		
Aimaokatalok	F7	Aug-95	GN		2	LKTR	680	640	2800	1.07	M							Y		
Aimaokatalok	F7	Aug-95	GN		3	LKTR	800	760	3900	0.89	F			23				Y		
Aimaokatalok	F7	Aug-95	GN		4	LKTR	700	638	2800	1.08	M							Y		
Aimaokatalok	F7	Aug-95	GN		5	LKTR	412	376	600	1.13	F							Y		
Aimaokatalok	F7	Aug-95	GN		6	LKTR	802	734	3700	0.94	M							Y		
Aimaokatalok	F7	Aug-95	GN		7	LKTR	570	530	1500	1.01	F							Y		
Aimaokatalok	F7	Aug-95	GN		8	LKTR	610	563	1700	0.95	M							Y		
Aimaokatalok	F7	Aug-95	GN		9	LKTR	380	347	500	1.20	F			19				Y		
Aimaokatalok	F7	Aug-95	GN		10	LKTR	690	660	3100	1.08	M							Y		
Aimaokatalok	F7	Aug-95	GN		11	LKWH	420	380	700	1.28	M			14				Y		
Aimaokatalok	F7	Aug-95	GN		12	LKWH	425	400	800	1.25	M							Y		
Aimaokatalok	F7	Aug-95	GN		13	LKWH	460	420	1000	1.35	M							Y		
Aimaokatalok	F7	Aug-95	GN		14	LKWH	470	440	1300	1.53	M			17				Y		
Aimaokatalok	F8	Aug-95	GN		1	LKTR	880	805	7100	1.36	F			38				Y		
Aimaokatalok	F8	Aug-95	GN		2	LKTR	690	650	3000	1.09	F							Y		
Aimaokatalok	F8	Aug-95	GN		3	LKTR	700	650	3400	1.24	M							Y		
Aimaokatalok	F8	Aug-95	GN		4	LKTR	684	642	2700	1.02	F							Y		
Aimaokatalok	F8	Aug-95	GN		5	LKTR	640	592	2200	1.06	F			18				Y		
Aimaokatalok	F8	Aug-95	GN		6	LKTR	748	694	3100	0.93	F							Y		
Aimaokatalok	F8	Aug-95	GN		7	LKTR	654	590	1700	0.83	F							Y		

Appendix D7. Raw data for fish captured in Boston area lakes, 1993-1997.

Lake	Site #	Date	Meth	Mesh (mm)	Sample #	Species	TL (mm)	FL (mm)	Weight (g)	Cond. Fact.	Sex	Mat.	Rep. Stat.	Age (yr)	Age Str.	Tag Color	Tag #	Tissues	Mort-ality	Comments / Stomach Content
Aimaokatalok	F8	Aug-95	GN		8	LKTR	592	544	2000	1.24	M							Y		
Aimaokatalok	F8	Aug-95	GN		9	LKTR	706	649	3100	1.13	M							Y		
Aimaokatalok	F8	Aug-95	GN		10	LKTR	638	603	2100	0.96	M			40				Y		
Aimaokatalok	F8	Aug-95	GN		11	LKTR	812	748	3800	0.91	M							Y		
Aimaokatalok	F8	Aug-95	GN		12	LKTR	538	514	1400	1.03	M			23				Y		
Aimaokatalok	F8	Aug-95	GN		13	LKTR	710	652	2600	0.94	F							Y		
Aimaokatalok	F8	Aug-95	GN		14	LKWH	404	379	700	1.29	F							Y		
Aimaokatalok	F7	7-Aug-96	GN	89	47	LKTR		602	1800	0.83	M	1		21					Y	
Aimaokatalok	F7	7-Aug-96	GN	127	48	LKTR		"672"	"700"	"0.23"	F	2		"11"					Y	
Aimaokatalok	F7	7-Aug-96	GN			LKTR														
Aimaokatalok	F7	7-Aug-96	GN	89		LKTR		784												
Aimaokatalok	F7	7-Aug-96	GN	38		LKTR		486												
Aimaokatalok	F7	7-Aug-96	GN	51		LKTR		426												
Aimaokatalok	F8	8-Aug-96	GN	38	49	LKTR		"826"	"2650"	"0.47"	M	2							Y	
Aimaokatalok	F8	8-Aug-96	GN	51	50	LKTR		566	1600	0.88	M	2		19					Y	
Aimaokatalok	F8	8-Aug-96	GN	89	51	LKTR		479	825	0.75	F	2		20					Y	
Aimaokatalok	F8	8-Aug-96	GN	38		LKTR		450												
Aimaokatalok	F8	8-Aug-96	GN	51		LKTR		540												
Aimaokatalok	F8	8-Aug-96	GN	51		LKTR														
Aimaokatalok	F8	8-Aug-96	GN	51		LKTR		854												
Aimaokatalok	F8	8-Aug-96	GN	51		LKWH		521												
Aimaokatalok	outlet	7-Aug-97	AN		1	LKTR		545	1800	1.11						red	590			
Aimaokatalok	outlet	7-Aug-97	AN		2	LKTR		623	2350	0.97						red	589			
Aimaokatalok	outlet	7-Aug-97	AN		3	LKTR		487	1400	1.21						red	588			
Aimaokatalok	outlet	7-Aug-97	AN		4	LKTR		513	1900	1.41						red	587			
Aimaokatalok	outlet	7-Aug-97	AN		5	LKTR		558	1800	1.04						red	586			
Aimaokatalok	outlet	7-Aug-97	AN		6	LKTR		462	1300	1.32						red	585			
Aimaokatalok	outlet	7-Aug-97	AN		7	LKTR		483	1200	1.06						red	584			
Aimaokatalok	outlet	7-Aug-97	AN		8	LKTR		503	1350	1.06						red	583			
Aimaokatalok	outlet	7-Aug-97	AN		9	LKTR		520	1650	1.17						red	582			
Aimaokatalok	outlet	7-Aug-97	AN		10	LKTR		483	1450	1.29						red	581			
Aimaokatalok	outlet	7-Aug-97	AN		11	LKTR		486	1400	1.22						red	580			
Aimaokatalok	outlet	7-Aug-97	AN		12	LKTR		501	1525	1.21						red	579			
Aimaokatalok	outlet	7-Aug-97	AN		13	LKTR		478	1400	1.28						red	578			
Aimaokatalok	outlet	7-Aug-97	AN		14	LKTR		474	1375	1.29						red	577			
Aimaokatalok	outlet	7-Aug-97	AN		15	LKTR		503	1525	1.20						red	576			
Aimaokatalok	outlet	7-Aug-97	AN		16	LKTR		455	1200	1.27						red	575			
Aimaokatalok	outlet	7-Aug-97	AN		17	LKTR		468	1475	1.44						red	574			
Aimaokatalok	outlet	7-Aug-97	AN		18	LKTR		488	1450	1.25						red	573			
Aimaokatalok	outlet	7-Aug-97	AN		19	LKTR		510	1525	1.15						red	572			
Aimaokatalok	outlet	7-Aug-97	AN		20	LKTR		470	1300	1.25						red	571			
Aimaokatalok	outlet	7-Aug-97	AN		21	LKTR		473	1300	1.23						red	570			
Aimaokatalok	outlet	7-Aug-97	AN		22	LKTR		814	5150	0.95						red	569			
Aimaokatalok	outlet	7-Aug-97	AN		23	LKTR		508	1600	1.22						red	568			
Aimaokatalok	outlet	7-Aug-97	AN		24	LKTR		441	1200	1.40						red	567			
Aimaokatalok	outlet	7-Aug-97	AN		25	LKTR		495	1500	1.24						red	566			
Aimaokatalok	outlet	7-Aug-97	AN		26	LKTR		473	1325	1.25					F	red	565			
Aimaokatalok	outlet	7-Aug-97	AN		27	LKTR		477	1700	1.57					F	red	564			
Aimaokatalok	outlet	7-Aug-97	AN		28	LKTR		449	1275	1.41					F	red	563			
Aimaokatalok	outlet	7-Aug-97	AN		29	LKTR		504	1400	1.09					F	red	562			
Aimaokatalok	outlet	7-Aug-97	AN		30	LKTR		522	1775	1.25					F	red	561			
Aimaokatalok	GN1	10-Aug-97	GN	38	31	LKTR		256	160	0.95					F	red	101			
Aimaokatalok	GN2	10-Aug-97	GN	38	32	LKTR		314	282	0.91					F	red	102			
Aimaokatalok	GN3	10-Aug-97	GN	38	33	LKTR		394	660	1.08					F	red	103			
Aimaokatalok	GN3	10-Aug-97	GN	38	34	LKWH		492	1800	1.51					F	red	104			
Aimaokatalok	GN4	10-Aug-97	GN	38	35	LKWH		494	1800	1.49					F	red	105			
Aimaokatalok	GN4	10-Aug-97	GN	38	36	LKTR		306	298	1.04	F	1	1	12	O,F			Y	Y	
Aimaokatalok	GN4	10-Aug-97	GN	38	37	LKWH		523	2000	1.40	F	2	2	36	O,F			Y	Y	
Aimaokatalok	GN5	10-Aug-97	GN	38	38	LKWH		538	1900	1.22					F	red	106			
Aimaokatalok	GN5	10-Aug-97	GN	38	39	LKWH		487	1556	1.35	F	2	2		O,F				Y	
Aimaokatalok	GN5	10-Aug-97	GN	38	40	LKWH		511	1600	1.20	M	2	2	37	O,F			Y	Y	
Aimaokatalok	GN6	10-Aug-97	GN	38	41	LKWH		528	1900	1.29					F	red	101			
Aimaokatalok	GN6	10-Aug-97	GN	38	42	LKWH		474	1600	1.50					F	red	108			
Aimaokatalok	GN6	10-Aug-97	GN	38	43	LKWH		523	2100	1.47	F	2	2	34	O,F			Y	Y	
Aimaokatalok	GN6	10-Aug-97	GN	38	44	LKWH		495	1950	1.61					F	red	110			
Aimaokatalok	GN6	10-Aug-97	GN	38	45	LKWH		508	1700	1.30					F	red	111			
Aimaokatalok	GN6	10-Aug-97	GN	38	46	LKWH		502	1700	1.34					F	red	112			
Aimaokatalok	GN6	10-Aug-97	GN	38	47	LKTR		445	1200	1.36					F	red	113			
Aimaokatalok	GN6	10-Aug-97	GN	38	48	LKTR		478	1200	1.10					F	red	114			
Aimaokatalok	SL1	10-Aug-97	GN	64-89	49	LKTR		504	1375	1.07	M	1	1	15	O,F			Y	Y	
Aimaokatalok	GN7	10-Aug-97	GN	38	50	LKWH		465	1400	1.39					F	red	109			
Aimaokatalok	GN7	10-Aug-97	GN	38	51	LKWH		443	1400	1.61					F	red	115			
Aimaokatalok	GN7	10-Aug-97	GN	38	52	LKTR		819	6000	1.09					F	red	116			
Aimaokatalok	SL1	10-Aug-97	GN	64-89	53	LKTR		897	5000	0.69					F	red	117			
Aimaokatalok	SL1	10-Aug-97	GN	64-89	54	LKTR		448	922	1.03	M	2	3	29	O,F			Y	Y	
Aimaokatalok	SL1	10-Aug-97	GN	64-89	55	LKTR		590	2150	1.05	F	2	2	20	O,F			Y	Y	
Aimaokatalok	SL1	10-Aug-97	GN	64-89	56	LKTR		483	1122	1.00	M	2	3	14	O,F			Y	Y	
Aimaokatalok	SL1	10-Aug-97	GN	64-89	57	LKTR		338	398	1.03	F	1	1	12	F			Y	Y	
Aimaokatalok	SL1	10-Aug-97	GN	64-89	58	LKWH		520	1875	1.33	F	2	2	36	O,F			Y	Y	
Aimaokatalok	SS1	10-Aug-97	GN	19-51	59	LKWH		493	1775	1.48	F	2	2	22	O,F			Y	Y	

Appendix D7. Raw data for fish captured in Boston area lakes, 1993-1997.

Lake	Site #	Date	Meth	Mesh (mm)	Sample #	Species	TL (mm)	FL (mm)	Weight (g)	Cond. Fact.	Sex	Mat.	Rep. Stat.	Age (yr)	Age Str.	Tag Color	Tag #	Tissues	Mortality	Comments / Stomach Content
Aimaokatalok	SS1	10-Aug-97	GN	19-51	60	LKTR		416	732	1.02	F	1	1	14	O,F			Y	Y	
Aimaokatalok	SL2	10-Aug-97	GN	64-89	61	LKWH		483	1482	1.32	M	2	2	37	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	62	LKWH		474	1324	1.24	F	2	2	34	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	63	LKWH		479	1166	1.06	M	2	2	46	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	64	LKWH		498	1348	1.09	M	2	2	35	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	65	LKWH		473	1264	1.19	F	2	2	36	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	66	LKWH		434	1032	1.26	M	2	2	16	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	67	LKWH		417	942	1.30	F	2	2	16	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	68	LKWH		411	912	1.31	F	2	2	17	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	69	LKWH		479	1338	1.22	F	2	2	36	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	70	LKWH		471	1852	1.77	F	2	2	23	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	71	LKWH		411	1006	1.45	F	2	2	16	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	72	LKWH		493	1488	1.24	M	2	2	24	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	73	LKWH		449	1100	1.22	M	2	2	24	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	74	LKTR		547	1358	0.83	F	2	2	16	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	75	LKTR		580	1648	0.84	F	2	2	17	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	76	LKTR		708	3700	1.04	F	2	2		O,F			Y	Y	10% fish remains
Aimaokatalok	SL2	11-Aug-97	GN	64-89	77	LKTR		484	1084	0.96	M	2	3	17	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	78	LKTR		519	1810	1.29	M	2	3	22	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	79	LKTR		621	2600	1.09	F	2	3	29	O,F			Y	Y	15% fish remains
Aimaokatalok	SL2	11-Aug-97	GN	64-89	80	LKTR		469	1362	1.32	F	2	3	14	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	81	LKTR		589	2625	1.28	F	2	3		O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	82	LKTR		542	1616	1.01	F	2	3	18	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	83	LKTR		493	1346	1.12	F	2	3	29	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	84	LKTR		512	1500	1.12	F	2	2	19	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	85	LKTR		530	1564	1.05	F	2	3	17	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	86	LKTR		447	800	0.90	M	1	1	11	O,F			Y	Y	
Aimaokatalok	SL2	11-Aug-97	GN	64-89	87	LKTR		461	912	0.93	F	1	1	13	O,F			Y	Y	50% fish remains
Aimaokatalok	SL2	11-Aug-97	GN	64-89	88	LKTR		424	780	1.02	F	1	1	17	O,F			Y	Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	89	LKTR		450	816	0.90	F	1	1		O,F				Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	90	LKTR		413	658	0.93	F	1	1		O,F				Y	empty stomach
Aimaokatalok	SL2	11-Aug-97	GN	64-89	91	LKTR		387	556	0.96	M	1	1		O,F				Y	10% diptera larvae
Aimaokatalok	SS2	11-Aug-97	GN	19-51	92	LKTR		340	398	1.01	M	1	1		O,F				Y	5% diptera larvae
Aimaokatalok	SS2	11-Aug-97	GN	19-51	93	LKTR		558	1712	0.99	F	2	3	21	O,F			Y	Y	50% fish remains
Aimaokatalok	SS2	11-Aug-97	GN	19-51	94	LKTR		577	2044	1.06	F	2	3	25	O,F			Y	Y	75% fish remains
Aimaokatalok	SS2	11-Aug-97	GN	19-51	95	LKTR		475	1244	1.16	M	2	3	18	O,F			Y	Y	empty stomach
Aimaokatalok	GN8	11-Aug-97	GN	38	96	LKWH		453	1500	1.61					F	red	118			
Aimaokatalok	GN8	11-Aug-97	GN	38	97	LKTR		498	1550	1.25					F	red	119			
Aimaokatalok	GN8	11-Aug-97	GN	38	98	LKTR		588	2250	1.11					F	red	120			
Aimaokatalok	GN8	11-Aug-97	GN	38	99	LKTR		467	1300	1.28					F	red	121			
Aimaokatalok	GN8	11-Aug-97	GN	38	100	LKWH		477	1446	1.33	M	2	3	23	O,F			Y	Y	
Aimaokatalok	GN9	11-Aug-97	GN	38	101	LKWH		417	1200	1.65					F	red	122			
Aimaokatalok	GN9	11-Aug-97	GN	38	102	LKWH		506	1850	1.43					F	red	123			
Aimaokatalok	GN9	11-Aug-97	GN	38	103	LKWH		435	1300	1.58					F	red	124			
Aimaokatalok	GN9	11-Aug-97	GN	38	104	LKWH		503	1800	1.41					F	red	126			
Aimaokatalok	GN9	11-Aug-97	GN	38	105	LKTR		697	3350	0.99					F	red	127			
Aimaokatalok	GN9	11-Aug-97	GN	38	106	LKTR		577	2250	1.17					F	red	128			
Aimaokatalok	GN9	11-Aug-97	GN	38	107	LKWH		512	1612	1.20	F	2	3	24	O,F			Y	Y	
Aimaokatalok	GN10	11-Aug-97	GN	38	108	LKWH		392	1000	1.66						red	129			
Aimaokatalok	GN10	11-Aug-97	GN	38	109	LKWH		483	1650	1.46						red	130			
Aimaokatalok	GN10	11-Aug-97	GN	38	110	LKWH		470	1650	1.59						red	131			
Aimaokatalok	GN10	11-Aug-97	GN	38	111	LKWH		492	1800	1.51						red	132			
Aimaokatalok	GN10	11-Aug-97	GN	38	112	LKWH		472	1650	1.57						red	133			
Aimaokatalok	GN10	11-Aug-97	GN	38	113	CISC		241	150	1.07										
Aimaokatalok	GN10	11-Aug-97	GN	38	114	LKWH		423	1150	1.52						red	134			
Aimaokatalok	GN10	11-Aug-97	GN	38	115	LKTR		775	5000	1.07						red	135			
Aimaokatalok	GN10	11-Aug-97	GN	38	116	LKTR		422	900	1.20						red	136			
Aimaokatalok	GN10	11-Aug-97	GN	38	117	LKTR		312	500	1.65						red	137			
Aimaokatalok	GN10	11-Aug-97	GN	38	118	LKWH		430	1154	1.45	F	2	3	15	O,F			Y	Y	
Aimaokatalok	GN10	11-Aug-97	GN	38	119	LKWH		475	1414	1.32	F	2	3	24	O,F			Y	Y	
Aimaokatalok	GN10	11-Aug-97	GN	38	120	LKWH		503	1638	1.29	F	2	2		O				Y	
Aimaokatalok	GN10	11-Aug-97	GN	38	121	LKWH		379	674	1.24	F	1	1		O				Y	
Aimaokatalok	GN10	11-Aug-97	GN	38	122	CISC		198	78	1.00	F	2	3		O,F				Y	possibly LSCS
Aimaokatalok	GN10	11-Aug-97	GN	38	123	CISC		183	60	0.98	M	1	1		O,F				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	124	LKWH		513	1950	1.44						red	138			
Aimaokatalok	GN11	11-Aug-97	GN	38	125	LKWH		394	1100	1.80						red	139			
Aimaokatalok	GN11	11-Aug-97	GN	38	126	LKWH		461	1600	1.63					F	red	140			
Aimaokatalok	GN11	11-Aug-97	GN	38	127	LKTR		595	2400	1.14					F	red	141			
Aimaokatalok	GN11	11-Aug-97	GN	38	128	LKTR		467	1350	1.33					F	red	142			
Aimaokatalok	GN11	11-Aug-97	GN	38	129	LKTR		602	2350	1.08					F	red	143			
Aimaokatalok	GN11	11-Aug-97	GN	38	130	LKTR		552	1750	1.04					F	red	144			
Aimaokatalok	GN11	11-Aug-97	GN	38	131	LKTR		603	2300	1.05					F	red	145			
Aimaokatalok	GN11	11-Aug-97	GN	38	132	LKTR		511	1400	1.05					F	red	146			
Aimaokatalok	GN11	11-Aug-97	GN	38	133	LKTR		"238"	"350"	"2.60"					F					
Aimaokatalok	GN11	11-Aug-97	GN	38	134	LKTR		260	152	0.86	F	1	1		O,F				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	135	LKTR		183	54	0.88	M	1	1		O,F				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	136	LKWH		413	940	1.33	M	2	2		O				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	137	LKWH		304	340	1.21	M	1	1		O,F				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	138	LKWH		317	394	1.24	M	1	1		O,F				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	139	LKWH		437	962	1.15	M	1	1		O				Y	

Appendix D7. Raw data for fish captured in Boston area lakes, 1993-1997.

Lake	Site #	Date	Meth	Mesh (mm)	Sample #	Species	TL (mm)	FL (mm)	Weight (g)	Cond. Fact.	Sex	Mat.	Rep. Stat.	Age (yr)	Age Str.	Tag Color	Tag #	Tissues	Mortality	Comments / Stomach Content
Aimaokatalok	GN11	11-Aug-97	GN	38	140	LKWH		283	290	1.28	F	1	1		O,F				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	141	CISC		205	84	0.98	F	2	3		O,F				Y	possibly LSCS
Aimaokatalok	GN11	11-Aug-97	GN	38	142	CISC		183	56	0.91									Y	frozen whole
Aimaokatalok	GN11	11-Aug-97	GN	38	143	CISC		177	50	0.90									Y	frozen whole
Aimaokatalok	GN11	11-Aug-97	GN	38	144	CISC		185	62	0.98									Y	frozen whole
Aimaokatalok	GN11	11-Aug-97	GN	38	145	CISC		183	52	0.85									Y	frozen whole
Aimaokatalok	GN11	11-Aug-97	GN	38	146	CISC		187	64	0.98	M	1	1		O				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	147	LKWH		182	72	1.19	F	1	1		O,F				Y	
Aimaokatalok	SL3	11-Aug-97	GN	64-89	148	LKWH		"309"	"600"	"2.03"					F	red	147			
Aimaokatalok	SL3	11-Aug-97	GN	64-89	149	LKWH		507	1600	1.23					F	red	148			
Aimaokatalok	SL3	11-Aug-97	GN	64-89	150	LKWH		"301"	"600"	"2.20"					F	red	149			
Aimaokatalok	SL3	11-Aug-97	GN	64-89	151	LKWH		407	900	1.33					F	red	150			
Aimaokatalok	SL3	11-Aug-97	GN	64-89	152	LKTR		435							F	orange	182			
Aimaokatalok	SL3	11-Aug-97	GN	64-89	153	LKTR		635	3100	1.21					F	orange	183			
Aimaokatalok	SL3	11-Aug-97	GN	64-89	154	LKTR		545	1750	1.08					F	orange	184			
Aimaokatalok	SL3	11-Aug-97	GN	64-89	155	LKTR		480	1260	1.14	M	2	3		O,F				Y	25% fish remains
Aimaokatalok	SL3	11-Aug-97	GN	64-89	156	LKWH		427	1000	1.28	M	2	2	16	O,F			Y	Y	empty stomach
Aimaokatalok	SL3	11-Aug-97	GN	64-89	157	LKWH		486	1418	1.24	M	2	3	36	O,F			Y	Y	empty stomach
Aimaokatalok	SS3	11-Aug-97	GN	19-51	158	LKWH		334	700	1.88						orange	185			
Aimaokatalok	SS3	11-Aug-97	GN	19-51	159	LKWH		392	1000	1.66						orange	186			
Aimaokatalok	SS3	11-Aug-97	GN	19-51	160	LKTR		905	5000	0.67					F	orange	187			
Aimaokatalok	SS3	11-Aug-97	GN	19-51	161	LKTR		453	1100	1.18						orange	188			
Aimaokatalok	SS3	11-Aug-97	GN	19-51	162	LKTR		498	2400	1.94						orange	189			
Aimaokatalok	SS3	11-Aug-97	GN	19-51	163	LKTR		494	1450	1.20						orange	190			
Aimaokatalok	SS3	11-Aug-97	GN	19-51	164	LKTR		633	2650	1.04						orange	191			
Aimaokatalok	SS3	11-Aug-97	GN	19-51	165	LKTR		273	400	1.97						orange	192			
Aimaokatalok	GN11	11-Aug-97	GN	38	166	LKWH		268	212	1.10	M	1	1		O				Y	
Aimaokatalok	GN11	11-Aug-97	GN	38	167	LKWH		241	158	1.13	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	168	LKWH		497	1558	1.27	F	2	2		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	169	LKWH		494	1590	1.32	M	2	2		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	170	LKWH		483	1654	1.47	M	2	3		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	171	LKWH		456	1270	1.34	F	2	3		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	172	LKWH		290	274	1.12	F	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	173	LKWH		306	324	1.13	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	174	LKWH		302	350	1.27	F	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	175	LKWH		293	298	1.18	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	176	LKWH		241	160	1.14	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	177	CISC		287	236	1.00	M	1	1		O				Y	damaged
Aimaokatalok	SS3	11-Aug-97	GN	19-51	178	CISC		348	532	1.26	M	2	3		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	179	CISC		293	280	1.11	M	2	2		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	180	CISC		305	298	1.05	F	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	181	CISC		193	64	0.89	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	182	CISC		120	16	0.93	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	183	CISC		147	28	0.88	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	184	CISC		92	8	1.03		1	1							
Aimaokatalok	SS3	11-Aug-97	GN	19-51	185	LKTR		470	996	0.96	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	186	LKTR		428	790	1.01	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	187	LKTR		383	544	0.97	M	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	188	LKTR		242	130	0.92	F	1	1		O				Y	
Aimaokatalok	SS3	11-Aug-97	GN	19-51	189	LKTR		129	22	1.02	F	1	1							
Aimaokatalok	SS3	11-Aug-97	GN	19-51	190	LKTR		113	14	0.97		1	1							
Aimaokatalok	SS3	11-Aug-97	GN	19-51	191	LKTR		135	24	0.98		1	1							
Fickle Duck	F13	Aug-95	GN		1	ARGR	410	380	900	1.64	M			12				Y		
Fickle Duck	F13	Aug-95	GN		2	ARGR	375	335	600	1.60	F			8				Y		
Fickle Duck	F13	Aug-95	GN		3	ARGR	405	365	800	1.65	F							Y		
Fickle Duck	F13	Aug-95	GN		4	ARGR	375	350	700	1.63	M							Y		
Fickle Duck	TRL-01	11-Aug-96	GN	38		ARGR		244												
Fickle Duck	TRL-01	11-Aug-96	GN	51		ARGR		407												
Fickle Duck	TRL-01	11-Aug-96	GN	38		ARGR		224												
Fickle Duck	TRL-01	11-Aug-96	GN	51		ARGR		282												

CODES:

Sampling Method
- GN Gill nets
- AN Angling

Species
- ARGR Arctic grayling
- CISC Cisco
- LKTR Lake trout
- LKWH Lake whitefish
- LSCS Least cisco

TL Total Length
FL Fork Length
Condition Factor (CF)
CF = Weight [in g] x 10^5 / (FL [in mm])^3

Ageing Structure
- O Otoliths
- F Fin rays

Tissues
- Y Tissue samples taken for metals analyses

Sex
- F Female
- M Male

Maturity
- 1 Immature
- 2 Mature

Reproductive Status
- 1 Undeveloped
- 2 Green
- 3 Ripe

" " Values in parenthesis were not used in data analysis (length data did not agree with corresponding weight)
Bold FL FL estimated through linear regression FL and TL data collected in 1995

Appendix D8. Catch and catch-per-unit-effort (CPUE) for fish captured in Boston area streams, 1993-2000.

Stream	**Site**	**Date**	**Method**	**Lake trout**		**Lake whitefish**		**Arctic grayling**		**Greenland cod**		**Ninespine stickleback**		**All Species**	
				n	CPUE	*n*	CPUE	*n*	CPUE	*n*	CPUE	*n*	CPUE	*n*	CPUE
Aimaokatalok NE Inflow	F9	01-Aug-95	EF					*4*	0.5					*4*	*0.5*
	F10	01-Aug-95	MT					*1*	n/a					*1*	*n/a*
	BP-F-01	10-Aug-96	EF	*34*	3.3									*34*	*3.3*
BP03		15-Jun-97	EF					*1*	0.1			*5*	0.5	*6*	*0.6*
BP05		16-Jun-97	EF					*1*	0.2			*2*	0.4	*3*	*0.6*
BP10		17-Jun-97	EF	*1*	0.4			*1*	0.4			*1*	0.4	*3*	*1.2*
BP11		17-Jun-97	EF									*7*	2	*7*	*2*
Fickle Duck Inflow	BP12	17-Jun-97	EF									*2*	0.4	*2*	*0.4*
Stickleback Outflow		Aug-93	EF									*31*	12.4	*31*	*12.4*
		Aug-94	MT	*1*	n/a							*40+*	n/a	*41+*	*n/a*
		3-Aug-95	MT									*68*	n/a	*68*	*n/a*
	BP-01	15-Jun-97	EF									*2*	0.3	*2*	*0.3*
Fickle Duck Outflow		Aug-93	EF									*2*	0.3	*2*	*0.3*
		Aug-94	MT	*1*	n/a							*40+*	n/a	*41+*	*n/a*
		31-Jul-95	EF									*40*	32.9	*40*	*32.9*
		31-Jul-95	MT									*82*	n/a	*82*	*n/a*
	BP-02	15-Jun-97	EF									*2*	0.4	*2*	*0.4*
Koignuk River		03-Aug-95	EF									*4*	0.7	*4*	*0.7*
		20-Aug-95	AL	*3*	n/a			*3*	n/a					*6*	*n/a*
		08-Aug-96	EF	*14*	n/a									*14*	*n/a*
		Aug-98	AL	*13*	n/a			*7*	n/a	*1*	n/a			*21*	*n/a*
		14-Aug-98	GN			*1*	n/a							*1*	*n/a*
Boulder Creek		03-Aug-95	EF					*7*	1.0					*7*	*1.0*
		13-Aug-96	EF	*26*	n/a									*26*	*n/a*
PRC13		29-Aug-00	EF									*3*	n/a	*3*	*n/a*
PRC14		25-Jun-00	EF									*16*	n/a	*16*	*n/a*
PRC15		29-Aug-00	EF					*1*	n/a			*3*	n/a	*4*	*n/a*
Total				***93***		***1***		***26***		***1***		***350+***		***471+***	

NOTE: EF = backpack electrofishing; AL = angling with lures; MT = minnow traps; n/a = effort data not available

CPUE values are calculated only for EF and are based on number of fish captured or observed per minute of active sampling.

Appendix D9. Size and age statistics for fish captured in Boston area streams, 1995-2000.

Stream	Year	Species	Fork Length (mm)					Weight (g)					Condition Factor					Age (years)				
			n	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max	*n*	**Mean**	SD	Min	Max
Aimaokatalok NE Inflow	1996	Lake trout	*34*	**64**	6	52	82															
BP03	1997	Arctic grayling	*1*	**358**	-	358	358	*1*	**460**	-	460	460	*1*	**1.00**	-	1.00	1.00					
	1997	Ninespine stickleback	*5*	**47**	3	43	50															
BP05	1997	Arctic grayling	*1*	**224**	-	224	224	*1*	**102**	-	224	224	*1*	**0.91**	-	0.91	0.91					
	1997	Ninespine stickleback	*2*	**52**	4	49	54															
BP10	1997	Lake trout	*1*	**733**	-	733	733	*1*	**4050**	-	4050	4050	*1*	**1.03**	-	1.03	1.03					
		Arctic grayling	*1*	**415**	-	415	415	*1*	**826**	-	826	826	*1*	**1.16**	-	1.16	1.16					
		Ninespine stickleback	*1*	**53**	-	53	53															
BP11	1997	Ninespine stickleback	*7*	**50**	3	47	55															
BP12 (Fickle Duck Inflow)	1997	Ninespine stickleback	*2*	**64**	10	57	71															
Stickleback Outflow	1997	Ninespine stickleback	*2*	**60**	1	59	61															
Fickle Duck Outflow	1997	Ninespine stickleback	*2*	**65**	6	61	69															
Koignuk River	1995	Lake trout	*3*	**473**	157	322	635															
		Arctic grayling	*3*	**343**	21	310	347											*3*	**5.3**	1.2	4	6
	1996	Lake trout	*14*	**58**	8	46	72															
	1998	Lake trout	*9*	**527**	113	410	795	*9*	**1856**	1564	670	5850	*9*	**1.09**	0.07	0.97	1.16	9	**14.7**	4.7	10	25
		Arctic grayling	*4*	**356**	42	293	383	*4*	**473**	131	280	570	*4*	**1.03**	0.10	0.91	1.13	*4*	**8.5**	2.4	5	10
		Lake whitefish	*1*	**173**	-	173	173	*1*	**51**	-	173	173	*1*	**0.98**	-	0.98	0.98					
		Greenland cod	*1*	**467**	-	467	467	*1*	**1180**	-	1180	1180	*1*	**1.16**	-	1.16	1.16	1	**4.0**	-	4	4
	1995-1998	**Lake trout**	*26*	**268**	245	46	795	*9*	**1856**	1564	670	5850	*9*	**1.09**	0.07	0.97	1.16	9	**14.7**	4.7	10	25
		Arctic grayling	*7*	**347**	34	293	383	*4*	**473**	131	280	570	*4*	**1.03**	0.10	0.91	1.13	7	**7.1**	2.5	4	10
		Lake whitefish	*1*	**173**	-	173	173	*1*	**51**	-	173	173	*1*	**0.98**	-	0.98	0.98					
		Greenland cod	*1*	**467**	-	467	467	*1*	**1180**	-	1180	1180	*1*	**1.16**	-	1.16	1.16	1	**4.0**	-	4	4
Boulder Creek	1996	Lake trout	*26*	**60**	18	48	116															
PRC13	2000	Ninespine stickleback	*3*	**29**	5	33	24															
PRC14	2000	Ninespine stickleback	*16*	**38**	11	26	69															
PRC15	2000	Arctic grayling	*1*	**55**	-	55	55															
		Ninespine stickleback	*3*	**31**	3	28	33															

NOTE: All sampling methods and sites combined; SD = standard deviation

Appendix D10. Raw data for fish captured in Boston area streams, 1995-2000.

Stream	Site #	Date	Samp Meth.	Sample #	Species	FL (mm)	Weight (g)	Cond. Fact.	Sex	Mat.	Rep. Stat.	Age (yr)	Age Str.	Tag Color	Tag #	Recapture	Comments
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	60											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	62											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	64											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	60											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	64											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	82											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	62											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	66											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	64											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	58											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	64											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	66											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	72											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	72											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	62											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	62											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	64											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	52											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	72											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	64											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	64											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	70											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	68											Pass # 1
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	60											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	62											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	62											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	58											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	68											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	74											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	70											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	66											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	56											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	62											Pass # 2
Aimaokatalok NE Inflow	BP-F-01	10-Aug-96	EF		LKTR	52											Pass # 2
Boulder Creek	F14	13-Aug-96	EF		LKTR	52											Pass # 1
Boulder Creek	F14	13-Aug-96	EF		LKTR	60											Pass # 1
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	108											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	116											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	102											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	52											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	62											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	62											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	56											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	48											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	48											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	50											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	50											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	56											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	54											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	58											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	50											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	50											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	56											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	54											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	58											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	50											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	54											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	52											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	54											Pass # 2
Boulder Creek	BP-F-01	13-Aug-96	EF		LKTR	52											Pass # 2
BP03	BP03	15-Jun-97	EF	5	ARGR	358	460	1.00	M	2			S	Red	100		
BP03	BP03	15-Jun-97	EF	6	NNST	43											released
BP03	BP03	15-Jun-97	EF	7	NNST	47											released
BP03	BP03	15-Jun-97	EF	8	NNST	49											released
BP03	BP03	15-Jun-97	EF	9	NNST	50											released
BP03	BP03	15-Jun-97	EF	10	NNST	46											released
BP05	BP05	16-Jun-97	EF	11	ARGR	224	102	0.91	M	1			S				
BP05	BP05	16-Jun-97	EF	12	NNST	54											released
BP05	BP05	16-Jun-97	EF	13	NNST	49											released
BP10	BP10	17-Jun-97	EF	14	LKTR	733	4050	1.03					F	Red	99		
BP10	BP10	17-Jun-97	EF	15	NNST	53											released
BP10	BP10	17-Jun-97	EF	16	ARGR	415	826	1.16					S	Red	98		
BP11	BP11	17-Jun-97	EF	17	NNST	48											released
BP11	BP11	17-Jun-97	EF	18	NNST	48											released
BP11	BP11	17-Jun-97	EF	19	NNST	55											released
BP11	BP11	17-Jun-97	EF	20	NNST	53											released
BP11	BP11	17-Jun-97	EF	21	NNST	49											released
BP11	BP11	17-Jun-97	EF	22	NNST	47											released
BP11	BP11	17-Jun-97	EF	23	NNST	51											released

Appendix D10. Raw data for fish captured in Boston area streams, 1995-2000.

Stream	Site #	Date	Samp Meth.	Sample #	Species	FL (mm)	Weight (g)	Cond. Fact.	Sex	Mat.	Rep. Stat.	Age (yr)	Age Str.	Tag Color	Tag #	Recap-ture	Comments
Fickle Duck Inflow	BP12	17-Jun-97	EF	24	NNST	57											released
Fickle Duck Inflow	BP12	17-Jun-97	EF	25	NNST	71											released
Fickle Duck Outflow	BP02	15-Jun-97	EF	3	NNST	69											released
Fickle Duck Outflow	BP02	15-Jun-97	EF	4	NNST	61											released
Koignuk River	21	20-Aug-95	AN	55	ARGR	347			M			6	S				near falls
Koignuk River	21	20-Aug-95	AN	56	ARGR	346			M			6	S				
Koignuk River	21	20-Aug-95	AN	57	ARGR	310			F			4	S				
Koignuk River	21	20-Aug-95	AN	58	LKTR	635											
Koignuk River	21	20-Aug-95	AN	59	LKTR	322											
Koignuk River	21	20-Aug-95	AN	60	LKTR	462											
Koignuk River	F21	08-Aug-96	EF		LKTR	50											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	62											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	62											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	62											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	46											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	48											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	52											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	50											Pass # 1
Koignuk River	F21	08-Aug-96	EF		LKTR	70											Pass # 2
Koignuk River	F21	08-Aug-96	EF		LKTR	72											Pass # 2
Koignuk River	F21	08-Aug-96	EF		LKTR	68											Pass # 2
Koignuk River	F21	08-Aug-96	EF		LKTR	58											Pass # 2
Koignuk River	F21	08-Aug-96	EF		LKTR	54											Pass # 2
Koignuk River	F21	08-Aug-96	EF		LKTR	56											Pass # 2
Koignuk River	KR1 - Km 1.25	14-Aug-98	AN	1	LKTR												escaped
Koignuk River	KR1 - Km 1.25	14-Aug-98	AN	2	LKTR	527	1680	1.15				11	F	Red	82, 83		
Koignuk River	KR1 - Km 1.25	14-Aug-98	AN	3	GRCD	467	1180	1.16				4	F	Red	84		
Koignuk River	KR1 - Km 1.25	14-Aug-98	GN	4	LKWH	173	51	0.98		1	1						
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	10	LKTR	548	1870	1.14				16	F	Red	79		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	11	LKTR	420	780	1.05				16	F	Red	78		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	12	LKTR	480	1220	1.10				17	F	Red	77		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	13	ARGR	383	510	0.91				9	F	Red	76		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	14	LKTR	795	5850	1.16				25	F	Red	75		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	15	ARGR	293	280	1.11				5	F				
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	16	LKTR	410	670	0.97				13	F	Red	908		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	17	LKTR	565	1970	1.09				14	F	Red	909		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	18	LKTR	510	1500	1.13				10	F				
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	19	LKTR	491	1160	0.98				10	F	Red	910		
Koignuk River	KR4 - Km 18.5	18-Aug-98	AN	20	ARGR	377	530	0.99				10	F	Red	911		
Koignuk River	KR5 - Km 23.8	19-Aug-98	AN	21	ARGR	370	570	1.13				10	F	Red	912		
PRC-13	PRC-13	29-Aug-00	EF	1	NNST	33											
PRC-13	PRC-13	29-Aug-00	EF	2	NNST	31											
PRC-13	PRC-13	29-Aug-00	EF	3	NNST	24											
PRC-14	PRC-14	25-Jun-00	EF	1	NNST	33											
PRC-14	PRC-14	25-Jun-00	EF	2	NNST	33											
PRC-14	PRC-14	25-Jun-00	EF	3	NNST	69											
PRC-14	PRC-14	25-Jun-00	EF	4	NNST	56											
PRC-14	PRC-14	25-Jun-00	EF	5	NNST	37											
PRC-14	PRC-14	25-Jun-00	EF	6	NNST	48											
PRC-14	PRC-14	25-Jun-00	EF	7	NNST	32											
PRC-14	PRC-14	25-Jun-00	EF	8	NNST	32											
PRC-14	PRC-14	25-Jun-00	EF	9	NNST	37											
PRC-14	PRC-14	25-Jun-00	EF	10	NNST	26											
PRC-14	PRC-14	25-Jun-00	EF	11	NNST	41											
PRC-14	PRC-14	25-Jun-00	EF	12	NNST	26											
PRC-14	PRC-14	25-Jun-00	EF	13	NNST	31											
PRC-14	PRC-14	25-Jun-00	EF	14	NNST	28											
PRC-14	PRC-14	25-Jun-00	EF	15	NNST	36											
PRC-14	PRC-14	25-Jun-00	EF	16	NNST	38											
PRC-15	PRC-15	29-Aug-00	EF	1	NNST	33											
PRC-15	PRC-15	29-Aug-00	EF	2	NNST	32											
PRC-15	PRC-15	29-Aug-00	EF	3	NNST	28											
PRC-15	PRC-15	29-Aug-00	EF	4	ARGR	55											
Stickleback Outflow	BP01	15-Jun-97	EF	1	NNST	59											released
Stickleback Outflow	BP01	15-Jun-97	EF	2	NNST	61											released

CODES:

Sampling Method
- AL Angling
- EF Backpack electrofishing
- GN Gill net

Species
- ARGR Arctic grayling
- GRCD Greenland cod
- LKTR Lake trout
- LKWH Lake whitefish
- NNST Ninespine stickleback

Sex
- F Female
- M Male

Maturity
- 1 Immature
- 2 Mature

Reproductive Status
- 1 Undeveloped
- 2 Green
- 3 Ripe

Ageing Structure
- O Otoliths
- S Scales
- F Fin rays

Recap
- Y Recaptured fish (previously tagged).

Site numbers are based on Rescan (1998) designations.

Condition Factor (CF)

CF = Weight [in g] x 10^5 / (FL [in mm])^3

FL = Fork Length

Appendix D11. Metal concentrations (µg/g wet weight) in fish tissues from Boston area lakes, 1993-1997.

Fish	Lake	Year	Species[a]	Tissue[b]	Length[c] (mm)	Weight (g)	Age (yr)	*Moisture[d] (%)*	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Tellurium	Zinc
1	Aimaokatalok	1993	LKTR	M	680	3600	8			0.025			<0.006				0.224		<0.04	311	0.144	0.332		<0.2	0.16	<0.01		4.26
2	Aimaokatalok	1993	LKTR	M	490	1300	6			0.015			<0.006				0.356		<0.04	316	0.123	0.166		<0.2	0.15	<0.01		3.79
3	Aimaokatalok	1993	LKTR	M	570	1900	7			0.022			<0.006				0.269		<0.04	269	0.109	0.570		<0.2	0.15	<0.01		3.62
1	Aimaokatalok	1994	LKTR	M	**502**	1200	10			0.041			<0.0015				0.207		0.003	246	0.109	0.387		0.014	0.188	<0.0023	<0.002	2.73
2	Aimaokatalok	1994	LKTR	M	**474**	1000	14			0.053			<0.0012				0.356		0.012	255	0.210	0.239		0.021	0.204	<0.0020	<0.002	3.24
3	Aimaokatalok	1994	LKTR	M	**576**	1900	13			0.053			<0.0015				1.440		0.049	244	0.141	0.538		0.024	0.155	<0.0024	<0.002	3.54
4	Aimaokatalok	1994	LKTR	M	**686**	3200	14			0.037			<0.0011				0.339		0.031	242	0.105	0.806		0.011	0.124	<0.0021	<0.002	3.31
5	Aimaokatalok	1994	LKTR	M	**880**	6500	15			0.074			<0.0015				0.254		0.006	252	0.090	0.895		0.080	0.199	<0.0024	<0.002	3.11
7	Aimaokatalok	1994	LKTR	M	**345**	400	5			<0.01			<0.0013				0.250		0.002	258	0.139	0.207		0.027	0.133	<0.0020	<0.002	2.86
10	Aimaokatalok	1994	LKTR	M	**742**	3400	12			0.048			<0.0015				0.354		0.015	260	0.093	0.672		0.018	0.186	<0.0023	<0.002	3.96
11	Aimaokatalok	1994	LKTR	M	**364**	450	5			0.050			<0.0012				0.353		0.003	303	0.137	0.259		0.014	0.171	<0.0021	<0.002	3.39
16	Aimaokatalok	1994	LKTR	M	**465**	1000	6			0.010			<0.0012				0.314		0.365	262	0.099	0.224		0.019	0.109	<0.0020	<0.002	3.87
18	Aimaokatalok	1994	LKTR	M	**410**	700	6			0.127			<0.0014				0.292		0.191	280	0.300	0.237		0.029	0.284	<0.0022	<0.002	5.84
19	Aimaokatalok	1994	LKTR	M	**170**	35				<0.01			<0.0021				0.321		0.012	101	0.146	<0.013		0.036	0.037	<0.0038	<0.002	6.06
F7-9	Aimaokatalok	1995	LKTR	M	347	500	19			<0.05			<0.005				0.380		0.034	289	0.179	0.432		0.070	0.22	<0.005	<0.005	5.6
F7-5	Aimaokatalok	1995	LKTR	M	376	600				<0.05			0.008				0.420		0.025	247	0.126	0.368		<0.05	0.22	0.009	<0.005	3.5
A-2	Aimaokatalok	1995	LKTR	M	465	1000				<0.05			<0.005				0.330		0.013	252	0.129	0.234		0.200	0.22	0.009	<0.007	5.5
F8-12	Aimaokatalok	1995	LKTR	M	514	1400	23			<0.05			<0.005				0.440		0.075	239	0.113	0.792		<0.05	0.16	<0.005	<0.009	4.4
F7-7	Aimaokatalok	1995	LKTR	M	530	1500				<0.05			0.008				0.460		0.046	257	0.137	0.512		0.910	0.20	<0.005	0.0050	8.1
F8-8	Aimaokatalok	1995	LKTR	M	544	2000				<0.05			<0.005				0.290		0.019	244	0.111	0.522		<0.05	0.15	0.005	<0.007	2.8
F7-8	Aimaokatalok	1995	LKTR	M	563	1700				<0.05			0.009				0.370		0.030	332	0.164	0.608		0.270	0.28	0.013	<0.006	4.8
A-1	Aimaokatalok	1995	LKTR	M	580	1500				<0.05			<0.005				0.310		0.024	210	0.098	0.288		0.130	0.12	<0.005	<0.008	5.6
F8-10	Aimaokatalok	1995	LKTR	M	603	2100	40			<0.05			0.017				0.290		0.099	218	0.126	1.150		0.170	0.20	<0.005	0.0100	5.8
F8-5	Aimaokatalok	1995	LKTR	M	592	2200	18			<0.05			<0.005				0.430		0.038	254	0.121	0.450		<0.05	0.14	<0.005	<0.007	3.3
F7-1	Aimaokatalok	1995	LKTR	M	600	1900	35			<0.05			0.006				0.450		0.087	248	0.137	1.040		<0.05	0.18	0.015	<0.005	4.4
F8-7	Aimaokatalok	1995	LKTR	M	590	1700				<0.05			<0.005				0.200		0.021	221	0.109	0.864		<0.05	0.20	<0.005	<0.006	3.4
F7-2	Aimaokatalok	1995	LKTR	M	640	2800				<0.05			0.013				0.370		0.035	242	0.086	0.800		0.330	0.22	0.013	0.0110	3.5
F8-4	Aimaokatalok	1995	LKTR	M	642	2700				<0.05			<0.005				0.400		0.028	269	0.091	0.450		<0.05	0.22	0.008	<0.007	3.0
F8-2	Aimaokatalok	1995	LKTR	M	650	3000				<0.05			<0.005				0.590		0.033	232	0.111	0.864		0.080	0.18	0.011	<0.007	5.0
F7-10	Aimaokatalok	1995	LKTR	M	660	3100				<0.05			0.008				0.370		0.045	274	0.284	0.736		0.170	0.06	0.060	<0.005	7.3
F7-4	Aimaokatalok	1995	LKTR	M	638	2800				<0.05			0.012				0.510		0.024	231	0.079	0.624		<0.05	0.36	0.009	<0.005	3.5
F8-3	Aimaokatalok	1995	LKTR	M	650	3400				<0.05			<0.005				0.690		0.083	237	0.152	0.558		0.210	0.22	0.011	<0.007	5.4
F8-9	Aimaokatalok	1995	LKTR	M	649	3100				<0.05			<0.005				0.360		0.128	232	0.107	0.684		0.060	0.14	<0.005	<0.007	3.2
F8-13	Aimaokatalok	1995	LKTR	M	652	2600				<0.05			<0.005				0.330		0.021	216	0.086	0.792		<0.05	0.10	<0.005	<0.009	4.4
F8-6	Aimaokatalok	1995	LKTR	M	694	3100				<0.05			<0.005				0.260		0.065	242	0.101	1.010		<0.05	0.21	0.006	<0.006	5.6
F7-3	Aimaokatalok	1995	LKTR	M	760	3900	23			<0.05			0.009				0.460		0.023	260	0.102	0.768		0.100	0.24	0.010	<0.005	4.2
F7-6	Aimaokatalok	1995	LKTR	M	734	3700				<0.05			0.006				0.450		0.098	258	0.149	0.720		0.120	0.22	<0.005	<0.005	6.1
F8-11	Aimaokatalok	1995	LKTR	M	748	3800				<0.05			0.007				0.290		0.164	217	0.121	0.936		<0.05	0.21	0.007	<0.006	5.0
F8-1	Aimaokatalok	1995	LKTR	M	805	7100	38			<0.05			<0.005				0.280		0.029	246	0.074	1.440		0.070	0.31	0.009	<0.006	3.1
#1	Aimaokatalok	1996	LKTR	M				80.3		<0.05			<0.02				0.180		<0.05	249	0.200	0.767		<0.2	<0.2	<0.01	<0.2	3.0
#2	Aimaokatalok	1996	LKTR	M				75.9		0.070			<0.02				0.290		<0.05	263	0.100	0.435		<0.2	<0.2	<0.01	<0.2	3.1
#3	Aimaokatalok	1996	LKTR	M				75.8		0.050			<0.02				0.260		<0.05	266	0.100	0.480		<0.2	<0.2	<0.01	<0.2	2.9
#36	Aimaokatalok	1997	LKTR	M	306	298	12		<5	<0.05	<0.5	<0.2	<0.02	116	<0.5	<0.5	<0.5	2	<0.05	275	<0.2	0.184	<1	<1	0.20	<0.1		3.1
#49	Aimaokatalok	1997	LKTR	M	504	1375	15		<5	<0.05	<0.5	<0.2	<0.02	181	<0.5	<0.5	<0.5	3	<0.05	269	<0.2	0.206	<1	<1	0.20	<0.1		2.8
#54	Aimaokatalok	1997	LKTR	M	448	922	29		<5	<0.05	<0.5	<0.2	<0.02	82	<0.5	<0.5	<0.5	4	<0.05	239	<0.2	0.427	<1	<1	0.20	<0.1		2.3
#55	Aimaokatalok	1997	LKTR	M	590	2150	20		<5	<0.05	<0.5	<0.2	<0.02	53	<0.5	<0.5	<0.5	3	<0.05	250	<0.2	0.503	<1	<1	0.20	<0.1		2.7
#56	Aimaokatalok	1997	LKTR	M	483	1122	14		<5	<0.05	<0.5	<0.2	<0.02	62	<0.5	<0.5	<0.5	2	<0.05	257	<0.2	0.441	<1	<1	0.20	<0.1		2.7
#57	Aimaokatalok	1997	LKTR	M	338	398	12		<5	<0.05	<0.5	<0.2	<0.02	182	<0.5	<0.5	<0.5	4	<0.05	278	<0.2	0.195	<1	<1	0.20	<0.1		3.1

Appendix D11. Metal concentrations (µg/g wet weight) in fish tissues from Boston area lakes, 1993-1997.

Fish	Lake	Year	Species[a]	Tissue[b]	Length[c] (mm)	Weight (g)	Age (yr)	*Moisture[d] (%)*	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Tellurium	Zinc
#60	Aimaokatalok	1997	LKTR	M	416	732	14		<5	<0.05	<0.5	<0.2	<0.02	69	<0.5	<0.5	<0.5	3	<0.05	251	<0.2	0.180	<1	<1	0.20	<0.1		2.8
#74	Aimaokatalok	1997	LKTR	M	547	1358	16		<5	<0.05	<0.5	<0.2	<0.02	92	<0.5	<0.5	<0.5	2	<0.05	279	<0.2	0.338	<1	<1	0.20	<0.1		2.7
#75	Aimaokatalok	1997	LKTR	M	580	1648	17		<5	<0.05	<0.5	<0.2	<0.02	144	<0.5	<0.5	<0.5	2	<0.05	258	<0.2	0.560	<1	<1	0.20	<0.1		2.8
#76	Aimaokatalok	1997	LKTR	M	708	3700			<5	0.060	<0.5	<0.2	<0.02	51	<0.5	<0.5	<0.5	2	<0.05	247	<0.2	0.764	<1	<1	0.20	<0.1		2.4
#77	Aimaokatalok	1997	LKTR	M	484	1084	17		<5	<0.05	<0.5	<0.2	<0.02	103	<0.5	<0.5	<0.5	4	<0.05	264	<0.2	0.427	<1	<1	0.20	<0.1		2.6
#78	Aimaokatalok	1997	LKTR	M	519	1810	22		<5	<0.05	<0.5	<0.2	<0.02	87	<0.5	<0.5	<0.5	4	<0.05	244	<0.2	0.212	<1	<1	0.20	<0.1		2.5
#79	Aimaokatalok	1997	LKTR	M	621	2600	29		<5	0.080	<0.5	<0.2	<0.02	120	<0.5	<0.5	<0.5	2	<0.05	253	<0.2	0.836	<1	<1	0.20	<0.1		2.2
#80	Aimaokatalok	1997	LKTR	M	469	1362	14		<5	<0.05	<0.5	<0.2	<0.02	75	<0.5	<0.5	<0.5	3	<0.05	282	<0.2	0.312	<1	<1	0.20	<0.1		2.5
#81	Aimaokatalok	1997	LKTR	M	589	2625			<5	<0.05	<0.5	<0.2	<0.02	60	<0.5	<0.5	<0.5	2	<0.05	265	<0.2	0.340	<1	<1	0.20	<0.1		2.5
#82	Aimaokatalok	1997	LKTR	M	542	1616	18		<5	<0.05	<0.5	<0.2	<0.02	113	<0.5	<0.5	<0.5	3	<0.05	255	<0.2	0.135	<1	<1	0.20	<0.1		2.3
#83	Aimaokatalok	1997	LKTR	M	493	1346	29		<5	<0.05	<0.5	<0.2	<0.02	164	<0.5	<0.5	<0.5	3	<0.05	229	<0.2	0.393	<1	<1	0.20	<0.1		2.2
#84	Aimaokatalok	1997	LKTR	M	512	1500	19		<5	<0.05	<0.5	<0.2	<0.02	85	<0.5	<0.5	<0.5	3	<0.05	254	<0.2	0.328	<1	<1	0.20	<0.1		2.6
#85	Aimaokatalok	1997	LKTR	M	530	1564	17		<5	<0.05	<0.5	<0.2	<0.02	119	<0.5	<0.5	<0.5	2	<0.05	243	<0.2	0.374	<1	<1	0.20	<0.1		2.2
#86	Aimaokatalok	1997	LKTR	M	447	800	11		<5	<0.05	<0.5	<0.2	<0.02	125	<0.5	<0.5	<0.5	2	<0.05	275	<0.2	0.236	<1	<1	0.20	<0.1		2.9
#87	Aimaokatalok	1997	LKTR	M	461	912	13		<5	<0.05	<0.5	<0.2	<0.02	56	<0.5	<0.5	<0.5	3	<0.05	266	<0.2	0.210	<1	<1	0.20	<0.1		2.9
#88	Aimaokatalok	1997	LKTR	M	424	780	17		<5	<0.05	<0.5	<0.2	<0.02	53	<0.5	<0.5	<0.5	2	<0.05	268	<0.2	0.280	<1	<1	0.20	<0.1		2.6
#93	Aimaokatalok	1997	LKTR	M	558	1712	21		<5	<0.05	<0.5	<0.2	<0.02	85	<0.5	<0.5	<0.5	1	<0.05	253	<0.2	0.358	<1	<1	0.10	<0.1		2.2
#94	Aimaokatalok	1997	LKTR	M	577	2044	25		<5	0.070	<0.5	<0.2	<0.02	70	<0.5	<0.5	<0.5	2	<0.05	265	<0.2	0.662	<1	<1	0.20	<0.1		2.3
#95	Aimaokatalok	1997	LKTR	M	475	1244	18		<5	<0.05	<0.5	<0.2	<0.02	84	<0.5	<0.5	<0.5	2	<0.05	250	<0.2	0.320	<1	<1	0.20	<0.1		2.5
1	Aimaokatalok	1993	LKTR	L	680	3600	8			0.012			0.010				9.517		<0.04	135	0.946	0.900		<0.2	0.76	0.062		27.6
2	Aimaokatalok	1993	LKTR	L	490	1300	6			0.023			0.063				26.030		<0.04	162	0.971	0.338		<0.2	1.26	0.122		38.2
3	Aimaokatalok	1993	LKTR	L	570	1900	7			0.025			0.144				13.483		<0.04	161	1.139	1.527		<0.2	1.06	0.058		33.56
1	Aimaokatalok	1994	LKTR	L	**502**	1200	10			0.038			0.080				13.400		0.008	123	1.170	0.683		0.036	0.56	0.139	<0.0024	21.9
2	Aimaokatalok	1994	LKTR	L	**474**	1000	14			0.026			0.039				17.500		0.026	178	1.300	0.599		0.050	0.80	0.202	<0.0025	34.7
3	Aimaokatalok	1994	LKTR	L	**576**	1900	13			0.032			0.042				16.700		0.009	125	0.920	0.918		0.021	0.72	0.303	<0.002	25.8
4	Aimaokatalok	1994	LKTR	L	**686**	3200	14			<0.01			0.058				21.500		0.019	140	1.100	1.820		0.042	0.52	0.235	<0.0024	28.4
5	Aimaokatalok	1994	LKTR	L	**880**	6500	15			0.147			0.062				13.000		0.004	134	1.140	2.310		0.042	1.23	0.081	0.0023	26.9
7	Aimaokatalok	1994	LKTR	L	**345**	400	5			0.081			0.034				8.490		0.010	140	1.270	0.329		0.044	1.05	0.086	<0.0028	23.2
10	Aimaokatalok	1994	LKTR	L	**742**	3400	12			<0.01			0.051				14.300		0.021	146	1.140	1.330		0.037	1.06	0.205	<0.002	26.9
11	Aimaokatalok	1994	LKTR	L	**364**	450	5			0.154			0.049				10.800		0.010	182	1.790	0.368		0.114	1.15	0.065	<0.0021	30.5
16	Aimaokatalok	1994	LKTR	L	**465**	1000	6			0.116			0.045				2.670		0.009	144	1.050	0.337		0.019	0.48	0.020	<0.0022	24.8
18	Aimaokatalok	1994	LKTR	L	**410**	700	6			0.309			0.040				14.600		0.012	170	1.570	0.377		0.033	1.86	0.085	0.0036	30.6
19	Aimaokatalok	1994	LKTR	L	**170**	35				<0.01			0.007				1.800		0.006	125	0.450	0.049		0.016	0.24	0.013	<0.002	17.6
F7-9	Aimaokatalok	1995	LKTR	L	347	500	19			0.110			0.039				11.600		0.064	220	2.250	0.672		<0.05	1.91	0.086	<0.005	36.5
F7-5	Aimaokatalok	1995	LKTR	L	376	600				<0.05			0.026				21.400		0.028	217	1.940	0.616		<0.05	0.84	0.127	<0.005	34.6
A-2	Aimaokatalok	1995	LKTR	L	465	1000				<0.05			0.072				11.500		0.040	168	1.660	0.197		0.320	0.68	0.080	<0.005	31.3
F8-12	Aimaokatalok	1995	LKTR	L	514	1400	23			<0.05			0.062				9.360		0.047	162	1.260	1.050		<0.05	0.39	0.120	<0.005	29.0
F7-7	Aimaokatalok	1995	LKTR	L	530	1500				<0.05			0.073				23.200		0.022	179	1.450	0.512		0.080	0.84	0.245	<0.005	46.2
F8-8	Aimaokatalok	1995	LKTR	L	544	2000				<0.05			0.047				8.750		0.031	129	0.974	0.741		<0.05	0.58	0.127	<0.005	28.0
F7-8	Aimaokatalok	1995	LKTR	L	563	1700				<0.05			0.033				11.500		0.025	177	1.250	0.704		0.060	0.74	0.126	<0.005	31.0
A-1	Aimaokatalok	1995	LKTR	L	580	1500				<0.05			0.082				20.400		0.026	166	1.850	0.381		<0.05	1.59	0.134	<0.005	33.0
F8-10	Aimaokatalok	1995	LKTR	L	603	2100	40			0.150			0.115				28.500		0.073	171	1.720	2.810		<0.05	2.77	0.415	<0.005	38.8
F8-5	Aimaokatalok	1995	LKTR	L	592	2200	18			<0.05			0.050				14.500		0.069	164	1.850	0.728		<0.05	1.10	0.220	<0.005	35.7
F7-1	Aimaokatalok	1995	LKTR	L	600	1900	35			<0.05			0.090				10.100		0.064	155	1.220	2.620		0.090	0.70	0.134	<0.005	30.8
F8-7	Aimaokatalok	1995	LKTR	L	590	1700				<0.05			0.132				23.700		0.067	170	1.780	2.070		<0.05	0.50	0.320	0.0070	34.6
F7-2	Aimaokatalok	1995	LKTR	L	640	2800				<0.05			0.011				16.500		0.051	172	1.320	1.470		0.060	0.40	0.123	<0.005	31.0
F8-4	Aimaokatalok	1995	LKTR	L	642	2700				<0.05			0.044				17.800		0.048	155	1.720	0.823		<0.05	0.50	0.234	<0.005	36.7
F8-2	Aimaokatalok	1995	LKTR	L	650	3000				<0.05			0.067				4.440		0.033	219	1.600	1.010		<0.05	0.69	0.152	<0.005	25.4
F7-10	Aimaokatalok	1995	LKTR	L	660	3100				<0.05			0.050				21.300		0.032	166	2.110	1.540		<0.05	1.01	0.205	0.0060	40.8

Appendix D11. Metal concentrations (µg/g wet weight) in fish tissues from Boston area lakes, 1993-1997.

Fish	Lake	Year	Species[a]	Tissue[b]	Length[c] (mm)	Weight (g)	Age (yr)	*Moisture[d] (%)*	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Tellurium	Zinc
F7-4	Aimaokatalok	1995	LKTR	L	638	2800				0.140			0.032				13.600		0.027	167	1.530	1.330		<0.05	2.24	0.106	<0.005	35.3
F8-3	Aimaokatalok	1995	LKTR	L	650	3400				<0.05			0.062				7.990		0.060	93	1.070	0.876		<0.05	0.62	0.190	<0.005	22.1
F8-9	Aimaokatalok	1995	LKTR	L	649	3100				<0.05			0.028				10.200		0.021	158	1.100	1.170		<0.05	0.47	0.150	<0.005	30.2
F8-13	Aimaokatalok	1995	LKTR	L	652	2600				<0.05			0.095				15.900		0.054	173	1.800	1.620		<0.05	0.31	0.214	<0.005	32.5
F8-6	Aimaokatalok	1995	LKTR	L	694	3100				<0.05			0.082				11.400		0.044	155	1.580	1.990		<0.05	0.26	0.138	<0.005	34.0
F7-3	Aimaokatalok	1995	LKTR	L	760	3900	23			0.080			0.023				13.000		0.024	167	1.090	1.840		<0.05	1.39	0.114	<0.005	30.5
F7-6	Aimaokatalok	1995	LKTR	L	734	3700				0.090			0.070				16.800		0.027	181	1.980	1.830		0.060	2.00	0.172	<0.005	33.1
F8-11	Aimaokatalok	1995	LKTR	L	748	3800				<0.05			0.064				16.400		0.030	155	1.220	2.110		<0.05	0.34	0.181	<0.005	33.0
F8-1	Aimaokatalok	1995	LKTR	L	805	7100	38			<0.05			0.053				7.510		0.083	150	1.230	3.480		0.090	0.34	1.570	<0.005	27.7
#1	Aimaokatalok	1996	LKTR	L				81.2		<0.05			0.160				15.100		<0.05	146	1.200	2.080		<0.2	1.80	0.130	<0.2	27.0
#2	Aimaokatalok	1996	LKTR	L				77.3		0.080			0.030				14.900		<0.05	104	1.100	1.260		<0.2	1.50	0.170	<0.2	28.8
#3	Aimaokatalok	1996	LKTR	L				76.0		0.080			0.060				34.100		<0.05	145	1.400	1.440		<0.2	1.50	0.300	<0.2	45.3
#36	Aimaokatalok	1997	LKTR	L	306	298	12		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.700	88	<0.05	15	<0.2	0.305	<1	<1	<0.3	<0.1		3.2
#49	Aimaokatalok	1997	LKTR	L	504	1375	15		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.800	183	<0.05	14	<0.2	0.433	<1	<1	<0.2	<0.1		3.0
#54	Aimaokatalok	1997	LKTR	L	448	922	29		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.700	761	<0.05	16	<0.2	1.400	<1	<1	0.20	0.100		3.4
#55	Aimaokatalok	1997	LKTR	L	590	2150	20		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.300	300	<0.05	11	<0.2	0.971	<1	<1	<0.1	0.100		2.8
#56	Aimaokatalok	1997	LKTR	L	483	1122	14		<5	<0.05	<0.5	<0.2	<0.02	12	<0.5	<0.5	1.800	269	<0.05	12	<0.2	0.547	<1	<1	0.10	0.100		3.2
#57	Aimaokatalok	1997	LKTR	L	338	398	12		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.700	84	<0.05	15	<0.2	0.269	<1	<1	<0.2	<0.1		3.1
#60	Aimaokatalok	1997	LKTR	L	416	732	14		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.600	178	<0.05	15	<0.2	0.361	<1	<1	0.10	0.100		3.7
#74	Aimaokatalok	1997	LKTR	L	547	1358	16		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	2.300	247	<0.05	12	<0.2	0.828	<1	<1	0.10	0.200		3.2
#75	Aimaokatalok	1997	LKTR	L	580	1648	17		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.400	116	<0.05	12	<0.2	0.801	<1	<1	0.10	0.200		2.7
#76	Aimaokatalok	1997	LKTR	L	708	3700			<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.900	1520	<0.05	13	<0.2	1.730	<1	<1	0.10	0.200		2.3
#77	Aimaokatalok	1997	LKTR	L	484	1084	17		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.800	1170	<0.05	14	<0.2	0.625	<1	<1	0.10	0.200		3.0
#78	Aimaokatalok	1997	LKTR	L	519	1810	22		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.200	2710	<0.05	12	<0.2	0.387	<1	<1	<0.1	0.100		2.5
#79	Aimaokatalok	1997	LKTR	L	621	2600	29		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	580	<0.05	18	<0.2	1.230	<1	<1	<0.1	<0.1		1.9
#80	Aimaokatalok	1997	LKTR	L	469	1362	14		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	529	<0.05	17	<0.2	0.536	<1	<1	<0.1	<0.1		1.7
#81	Aimaokatalok	1997	LKTR	L	589	2625			<5	<0.05	<0.5	<0.2	<0.02	11	<0.5	<0.5	0.600	1140	<0.05	14	<0.2	0.649	<1	<1	<0.1	0.100		2.0
#82	Aimaokatalok	1997	LKTR	L	542	1616	18		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.500	587	<0.05	19	<0.2	0.427	<1	<1	<0.1	0.100		2.1
#83	Aimaokatalok	1997	LKTR	L	493	1346	29		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	3100	<0.05	17	<0.2	0.552	<1	<1	<0.1	<0.1		2.0
#84	Aimaokatalok	1997	LKTR	L	512	1500	19		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.500	14600	<0.05	13	<0.2	0.570	<1	<1	<0.1	0.200		2.8
#85	Aimaokatalok	1997	LKTR	L	530	1564	17		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.900	2800	<0.05	21	<0.2	0.544	<1	<1	<0.1	0.200		2.5
#86	Aimaokatalok	1997	LKTR	L	447	800	11		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	695	<0.05	16	<0.2	0.258	<1	<1	0.10	0.100		2.9
#87	Aimaokatalok	1997	LKTR	L	461	912	13		<5	<0.05	<0.5	<0.2	<0.02	14	<0.5	<0.5	1.700	231	<0.05	16	<0.2	0.436	<1	<1	0.20	0.300		3.6
#88	Aimaokatalok	1997	LKTR	L	424	780	17		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.700	629	<0.05	17	<0.2	0.771	<1	<1	0.20	<0.1		3.2
#93	Aimaokatalok	1997	LKTR	L	558	1712	21		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.800	249	<0.05	19	<0.2	0.512	<1	<1	<0.1	<0.1		2.6
#94	Aimaokatalok	1997	LKTR	L	577	2044	25		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.900	173	<0.05	19	<0.2	1.100	<1	<1	<0.1	0.100		2.3
#95	Aimaokatalok	1997	LKTR	L	475	1244	18		<5	<0.05	<0.5	<0.2	<0.02	21	<0.5	<0.5	1.600	383	<0.05	15	<0.2	0.689	<1	<1	0.20	0.200		3.6
4	Aimaokatalok	1993	LKWH	M	500	1600	20			0.023			<0.006				0.235		<0.04	286	0.235	0.138		<0.2	0.19	<0.01		3.02
5	Aimaokatalok	1993	LKWH	M	360	600	10			0.013			<0.006				0.268		<0.04	321	0.212	0.046		<0.2	0.29	<0.01		3.83
6	Aimaokatalok	1993	LKWH	M	500	1700	21			0.030			<0.006				0.223		<0.04	274	0.215	0.291		<0.2	0.20	<0.01		3.12
1	Aimaokatalok	1994	LKWH	M	**471**	1400				0.078			<0.0012				0.308		0.006	325	0.757	0.477		0.047	0.267	<0.0022	<0.002	4.36
2	Aimaokatalok	1994	LKWH	M	**453**	1200				<0.01			<0.0012				0.204		0.007	285	0.156	0.092		0.014	0.333	<0.0020	<0.002	3.37
3	Aimaokatalok	1994	LKWH	M	**417**	1400				0.066			<0.0013				0.607		0.015	295	0.346	0.069		0.033	0.223	0.002	<0.002	4.31
4	Aimaokatalok	1994	LKWH	M	**498**	1600				0.058			<0.0016				0.172		0.009	302	0.395	0.170		0.041	0.340	<0.0025	<0.002	3.55
5	Aimaokatalok	1994	LKWH	M	**507**	1800				0.032			<0.0015				0.381		0.009	309	0.163	0.245		0.023	0.221	<0.0023	<0.002	3.46
8	Aimaokatalok	1994	LKWH	M	**172**	45				0.102			<0.0014				0.272		0.039	212	0.199	0.034		0.103	0.200	<0.0026	<0.002	8.86
10	Aimaokatalok	1994	LKWH	M	**380**	600				0.027			0.0013				0.240		0.003	317	0.188	0.067		0.022	0.220	<0.0023	<0.002	3.18
13	Aimaokatalok	1994	LKWH	M	**362**	500				0.086			<0.0013				2.090		0.005	289	0.108	0.119		0.019	0.159	<0.0021	<0.002	3.40
16	Aimaokatalok	1994	LKWH	M	**389**	700				0.011			<0.0008				0.119		0.003	206	0.103	0.034		0.011	0.139	<0.0014	<0.002	2.28

Appendix D11. Metal concentrations (µg/g wet weight) in fish tissues from Boston area lakes, 1993-1997.

Fish	Lake	Year	Species[a]	Tissue[b]	Length[c] (mm)	Weight (g)	Age (yr)	*Moisture[d] (%)*	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Tellurium	Zinc
18	Aimaokatalok	1994	LKWH	M	**462**	1300				0.044			<0.0013				0.375		0.003	264	0.126	0.115		0.150	0.151	<0.0020	<0.002	3.02
19	Aimaokatalok	1994	LKWH	M	**489**	1600				0.047			<0.0013				0.217		0.015	258	0.147	0.137		0.014	0.315	<0.0023	<0.002	3.29
F8-14	Aimaokatalok	1995	LKWH	M	379	700				<0.05			<0.005				0.330		0.054	274	0.133	0.198		<0.05	0.20	<0.005	<0.007	4.6
F7-11	Aimaokatalok	1995	LKWH	M	380	700	14			<0.05			<0.005				0.430		0.023	302	0.159	0.128		0.080	0.34	0.007	<0.005	4.7
F7-12	Aimaokatalok	1995	LKWH	M	400	800				<0.05			0.010				0.260		0.020	263	0.132	0.080		0.130	0.31	<0.005	<0.005	3.7
F7-13	Aimaokatalok	1995	LKWH	M	420	1000				<0.05			<0.005				0.310		0.030	264	0.153	0.096		0.090	0.31	<0.005	<0.005	5.1
F7-14	Aimaokatalok	1995	LKWH	M	440	1300	17			<0.05			0.005				0.340		0.019	253	0.108	0.096		0.180	0.31	0.007	<0.005	4.9
#37	Aimaokatalok	1997	LKWH	M	523	2000	36		<5	<0.05	<0.5	<0.2	<0.02	85	<0.5	<0.5	<0.5	3	<0.05	266	<0.2	0.339	<1	<1	0.30	<0.1		3.0
#40	Aimaokatalok	1997	LKWH	M	511	1600	37		<5	0.060	<0.5	<0.2	<0.02	93	<0.5	<0.5	<0.5	4	<0.05	266	<0.2	0.275	<1	<1	0.20	<0.1		2.8
#43	Aimaokatalok	1997	LKWH	M	523	2100	34		<5	<0.05	<0.5	<0.2	<0.02	99	<0.5	<0.5	<0.5	2	<0.05	251	<0.2	0.438	<1	<1	0.20	<0.1		2.9
#58	Aimaokatalok	1997	LKWH	M	520	1875	36		<5	<0.05	<0.5	<0.2	<0.02	156	<0.5	<0.5	<0.5	3	<0.05	243	<0.2	0.308	<1	<1	0.20	<0.1		3.1
#59	Aimaokatalok	1997	LKWH	M	493	1775	22		<5	0.090	<0.5	<0.2	<0.02	80	<0.5	<0.5	<0.5	2	<0.05	249	<0.2	0.214	<1	<1	0.20	<0.1		3.0
#61	Aimaokatalok	1997	LKWH	M	483	1482	37		<5	<0.05	<0.5	<0.2	<0.02	112	<0.5	<0.5	<0.5	4	<0.05	268	<0.2	0.247	<1	<1	0.20	<0.1		2.7
#62	Aimaokatalok	1997	LKWH	M	474	1324	34		<5	<0.05	<0.5	<0.2	<0.02	114	<0.5	<0.5	<0.5	3	<0.05	279	<0.2	0.370	<1	<1	0.20	<0.1		3.0
#63	Aimaokatalok	1997	LKWH	M	479	1166	46		<5	<0.05	<0.5	<0.2	<0.02	63	<0.5	<0.5	<0.5	5	<0.05	232	<0.2	0.427	<1	<1	0.20	<0.1		2.6
#64	Aimaokatalok	1997	LKWH	M	498	1348	35		<5	0.050	<0.5	<0.2	<0.02	71	<0.5	<0.5	<0.5	4	<0.05	314	<0.2	0.286	<1	<1	0.20	<0.1		2.8
#65	Aimaokatalok	1997	LKWH	M	473	1264	36		<5	<0.05	<0.5	<0.2	<0.02	96	<0.5	<0.5	<0.5	2	<0.05	294	<0.2	0.303	<1	<1	0.20	<0.1		2.8
#66	Aimaokatalok	1997	LKWH	M	434	1034	16		<5	0.050	<0.5	<0.2	<0.02	71	<0.5	<0.5	<0.5	2	<0.05	318	<0.2	0.103	<1	<1	0.20	<0.1		2.9
#67	Aimaokatalok	1997	LKWH	M	417	942	16		<5	<0.05	<0.5	<0.2	<0.02	94	<0.5	<0.5	<0.5	2	<0.05	296	<0.2	0.095	<1	<1	0.20	<0.1		2.8
#68	Aimaokatalok	1997	LKWH	M	411	912	17		<5	<0.05	<0.5	<0.2	<0.02	110	<0.5	<0.5	<0.5	2	<0.05	326	<0.2	0.069	<1	<1	0.30	<0.1		2.9
#69	Aimaokatalok	1997	LKWH	M	479	1338	36		<5	<0.05	<0.5	<0.2	<0.02	130	<0.5	<0.5	<0.5	3	<0.05	308	<0.2	0.231	<1	<1	0.20	<0.1		2.8
#70	Aimaokatalok	1997	LKWH	M	471	1852	23		<5	<0.05	<0.5	<0.2	<0.02	56	<0.5	<0.5	<0.5	2	<0.05	298	<0.2	0.181	<1	<1	0.30	<0.1		2.8
#71	Aimaokatalok	1997	LKWH	M	411	1006	16		<5	<0.05	<0.5	<0.2	<0.02	57	<0.5	<0.5	<0.5	2	<0.05	307	<0.2	0.109	<1	<1	0.20	<0.1		3.1
#72	Aimaokatalok	1997	LKWH	M	493	1488	24		<5	<0.05	<0.5	<0.2	<0.02	80	<0.5	<0.5	<0.5	2	<0.05	299	<0.2	0.168	<1	<1	0.20	<0.1		2.9
#73	Aimaokatalok	1997	LKWH	M	449	1100	24		<5	<0.05	<0.5	<0.2	<0.02	191	<0.5	<0.5	<0.5	2	<0.05	300	<0.2	0.138	<1	<1	0.30	<0.1		2.6
#100	Aimaokatalok	1997	LKWH	M	477	1446	23		<5	<0.05	<0.5	<0.2	<0.02	120	<0.5	<0.5	<0.5	3	<0.05	291	<0.2	0.220	<1	<1	0.20	<0.1		3.1
#107	Aimaokatalok	1997	LKWH	M	512	1612	24		<5	0.050	<0.5	<0.2	<0.02	78	<0.5	<0.5	<0.5	3	<0.05	307	<0.2	0.187	<1	<1	0.20	<0.1		3.1
#118	Aimaokatalok	1997	LKWH	M	430	1154	15		<5	0.050	<0.5	<0.2	<0.02	76	<0.5	<0.5	<0.5	2	<0.05	317	<0.2	0.091	<1	<1	0.20	<0.1		3.2
#119	Aimaokatalok	1997	LKWH	M	475	1414	24		<5	<0.05	<0.5	<0.2	<0.02	82	<0.5	<0.5	<0.5	2	<0.05	282	<0.2	0.213	<1	<1	0.20	<0.1		2.9
#156	Aimaokatalok	1997	LKWH	M	427	1000	16		<5	0.070	<0.5	<0.2	<0.02	95	<0.5	<0.5	<0.5	3	<0.05	321	<0.2	0.097	<1	<1	0.20	<0.1		3.1
#157	Aimaokatalok	1997	LKWH	M	486	1418	36		<5	<0.05	<0.5	<0.2	<0.02	83	<0.5	<0.5	<0.5	2	<0.05	294	<0.2	0.248	<1	<1	0.20	<0.1		2.4
4	Aimaokatalok	1993	LKWH	L	500	1600	20			0.093			0.133				7.616		<0.04	190	2.091	0.983		<0.2	1.54	0.079		30.96
5	Aimaokatalok	1993	LKWH	L	360	600	10			0.091			0.138				3.564		<0.04	198	1.715	0.211		<0.2	2.35	0.043		28.3
6	Aimaokatalok	1993	LKWH	L	500	1700	21			0.089			0.296				5.852		<0.04	173	1.541	1.404		<0.2	2.05	0.083		26.41
1	Aimaokatalok	1994	LKWH	L	**471**	1400				0.427			0.205				9.740		0.033	142	1.560	2.740		0.151	2.09	0.302	0.0400	27.8
2	Aimaokatalok	1994	LKWH	L	**453**	1200				0.139			0.132				4.830		0.012	116	1.170	0.309		0.054	0.92	0.029	<0.0021	22.3
3	Aimaokatalok	1994	LKWH	L	**417**	1400				0.201			0.057				7.320		0.013	183	1.720	0.339		0.077	0.91	0.059	<0.0025	30.5
4	Aimaokatalok	1994	LKWH	L	**498**	1600				0.173			0.296				7.940		0.021	149	1.410	0.992		0.135	1.36	0.096	<0.0026	24.5
5	Aimaokatalok	1994	LKWH	L	**507**	1800				0.127			0.160				11.800		0.014	127	1.100	0.814		0.053	0.92	0.159	0.0124	22.4
8	Aimaokatalok	1994	LKWH	L	**172**	45				0.051			0.019				1.890		0.017	196	0.799	0.125		0.021	0.41	0.013	0.0144	93.2
10	Aimaokatalok	1994	LKWH	L	**380**	600				0.158			0.090				3.570		0.016	178	1.300	0.235		0.029	0.83	0.034	<0.0024	27.4
13	Aimaokatalok	1994	LKWH	L	**362**	500				0.112			0.016				2.900		0.025	160	1.450	0.446		0.042	0.72	0.029	<0.0038	45.2
16	Aimaokatalok	1994	LKWH	L	**389**	700				0.164			0.058				4.000		0.007	198	1.980	0.271		0.064	0.92	0.039	<0.0030	24.6
18	Aimaokatalok	1994	LKWH	L	**462**	1300				0.035			0.110				6.400		0.008	140	1.310	0.536		0.084	0.83	0.091	0.0118	23.1
19	Aimaokatalok	1994	LKWH	L	**489**	1600				0.162			0.123				4.360		0.006	272	2.000	0.460		0.035	0.92	0.061	0.0049	25.3
F8-14	Aimaokatalok	1995	LKWH	L	379	700				<0.05			0.041				2.890		0.028	242	3.510	0.374		<0.05	1.37	0.054	<0.005	45.0
F7-11	Aimaokatalok	1995	LKWH	L	380	700	14			0.210			0.054				4.660		0.034	229	2.130	0.192		0.090	1.68	0.083	<0.005	29.5
F7-12	Aimaokatalok	1995	LKWH	L	400	800				<0.05			0.085				4.090		0.028	201	2.050	0.176		0.150	0.56	0.053	<0.005	49.2
F7-13	Aimaokatalok	1995	LKWH	L	420	1000				<0.05			0.079				11.700		0.050	208	1.680	0.208		0.130	0.34	0.212	<0.005	34.4

Appendix D11. Metal concentrations (µg/g wet weight) in fish tissues from Boston area lakes, 1993-1997.

Fish	Lake	Year	Species[a]	Tissue[b]	Length[c] (mm)	Weight (g)	Age (yr)	*Moisture[d] (%)*	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Tellurium	Zinc
F7-14	Aimaokatalok	1995	LKWH	L	440	1300	17			<0.05			0.079				3.890		0.024	183	1.860	0.192		0.060	0.37	0.046	<0.005	30.5
#37	Aimaokatalok	1997	LKWH	L	523	2000	36		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.000	213	<0.05	14	<0.2	1.200	<1	<1	0.10	0.200		2.4
#40	Aimaokatalok	1997	LKWH	L	511	1600	37		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.700	211	<0.05	12	<0.2	1.060	<1	<1	0.20	0.200		2.3
#43	Aimaokatalok	1997	LKWH	L	523	2100	34		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.600	222	<0.05	16	<0.2	1.500	<1	<1	0.20	0.100		2.7
#58	Aimaokatalok	1997	LKWH	L	520	1875	36		<5	<0.05	<0.5	<0.2	0.020	<10	<0.5	<0.5	<0.5	201	<0.05	15	0.200	0.811	<1	<1	0.10	<0.1		2.2
#59	Aimaokatalok	1997	LKWH	L	493	1775	22		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.700	134	<0.05	13	<0.2	0.430	<1	<1	0.10	<0.1		2.6
#61	Aimaokatalok	1997	LKWH	L	483	1482	37		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	282	<0.05	12	<0.2	0.888	<1	<1	0.10	<0.1		1.9
#62	Aimaokatalok	1997	LKWH	L	474	1324	34		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.600	179	<0.05	15	<0.2	0.909	<1	<1	0.10	<0.1		2.2
#63	Aimaokatalok	1997	LKWH	L	479	1166	46		<5	<0.05	<0.5	<0.2	0.030	<10	<0.5	<0.5	1.100	219	<0.05	17	<0.2	5.720	<1	<1	0.40	0.500		3.5
#64	Aimaokatalok	1997	LKWH	L	498	1348	35		<5	<0.05	<0.5	<0.2	0.030	<10	<0.5	<0.5	1.200	473	<0.05	16	<0.2	1.710	<1	<1	0.30	0.200		3.0
#65	Aimaokatalok	1997	LKWH	L	473	1264	36		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.600	186	<0.05	15	<0.2	0.907	<1	<1	0.10	0.100		2.4
#66	Aimaokatalok	1997	LKWH	L	434	1034	16		<5	<0.05	<0.5	<0.2	<0.02	18	<0.5	<0.5	0.800	137	<0.05	20	0.200	0.455	<1	<1	<0.2	0.200		3.2
#67	Aimaokatalok	1997	LKWH	L	417	942	16		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.600	172	<0.05	17	<0.2	0.393	<1	<1	0.20	<0.1		3.1
#68	Aimaokatalok	1997	LKWH	L	411	912	17		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	148	<0.05	22	0.300	0.180	<1	<1	0.10	<0.1		2.9
#69	Aimaokatalok	1997	LKWH	L	479	1338	36		<5	<0.05	<0.5	<0.2	0.020	<10	<0.5	<0.5	<0.5	163	<0.05	18	0.400	0.583	<1	<1	0.10	<0.1		2.3
#70	Aimaokatalok	1997	LKWH	L	471	1852	23		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	58	<0.05	18	0.200	0.335	<1	<1	<0.1	<0.1		2.0
#71	Aimaokatalok	1997	LKWH	L	411	1006	16		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.600	144	<0.05	22	0.200	0.360	<1	<1	0.10	0.100		3.1
#72	Aimaokatalok	1997	LKWH	L	493	1488	24		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.900	169	<0.05	17	<0.2	0.673	<1	<1	0.20	0.500		3.4
#73	Aimaokatalok	1997	LKWH	L	449	1100	24		<5	<0.05	<0.5	<0.2	0.020	<10	<0.5	<0.5	0.700	284	<0.05	16	<0.2	0.583	<1	<1	<0.2	0.200		2.6
#100	Aimaokatalok	1997	LKWH	L	477	1446	23		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.300	203	<0.05	16	<0.2	0.963	<1	<1	0.20	0.300		3.7
#107	Aimaokatalok	1997	LKWH	L	512	1612	24		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.100	83	<0.05	16	<0.2	0.424	<1	<1	0.10	0.100		2.6
#118	Aimaokatalok	1997	LKWH	L	430	1154	15		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	0.600	78	<0.05	21	0.300	0.252	<1	<1	0.10	<0.1		3.1
#119	Aimaokatalok	1997	LKWH	L	475	1414	24		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	97	<0.05	16	<0.2	0.310	<1	<1	<0.1	<0.1		2.1
#156	Aimaokatalok	1997	LKWH	L	427	1000	16		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	<0.5	109	<0.05	18	<0.2	0.317	<1	<1	0.10	<0.1		3.1
#157	Aimaokatalok	1997	LKWH	L	486	1418	36		<5	<0.05	<0.5	<0.2	<0.02	<10	<0.5	<0.5	1.000	152	<0.05	16	<0.2	2.500	<1	<1	0.30	0.200		3.3
1	Aimaokatalok	1994	ARGR	M	340	400				<0.01			<0.0014				0.292		0.008	277	0.136	<0.008		0.012	0.102	<0.0023	<0.002	3.28
1	Aimaokatalok	1994	ARGR	L	340	400				<0.01			0.035				3.300		0.011	187	1.030	0.122		0.069	0.42	0.047	<0.0026	21.1
#1	Fickle Duck	1996	LKTR	M				80.7		0.060			<0.02				0.220		<0.05	236	<0.1	0.033		<0.2	0.40	<0.01	<0.2	3.0
#2	Fickle Duck	1996	LKTR	M				75.6		0.110			<0.02				0.300		<0.05	252	<0.1	0.008		<0.2	0.50	<0.01	<0.2	3.3
#3	Fickle Duck	1996	LKTR	M				79.4		0.070			<0.02				0.300		<0.05	229	0.100	0.035		<0.2	0.50	<0.01	<0.2	3.3
#1	Fickle Duck	1996	LKTR	L				74.7		0.560			0.040				27.700		0.060	155	1.100	0.607		<0.2	2.20	0.050	<0.2	41.5
#2	Fickle Duck	1996	LKTR	L				76.9		0.520			0.020				39.100		<0.05	163	1.100	0.021		<0.2	2.60	0.070	<0.2	47.8
#3	Fickle Duck	1996	LKTR	L				72.3		0.910			0.080				42.600		<0.05	156	1.900	0.092		<0.2	3.40	0.230	<0.2	49.4
F13-2	Fickle Duck	1995	ARGR	M	335	600	8			<0.05			0.005				0.510		0.034	337	0.407	0.032		0.060	0.31	0.006	<0.005	4.9
F13-4	Fickle Duck	1995	ARGR	M	350	700				<0.05			0.007				0.390		0.010	278	0.139	0.032		<0.05	0.25	0.006	<0.005	3.8
F13-3	Fickle Duck	1995	ARGR	M	365	800				<0.05			<0.005				0.410		0.036	221	0.125	0.096		<0.05	0.36	<0.005	0.0070	6.0
F13-1	Fickle Duck	1995	ARGR	M	380	900	12			<0.05			<0.005				1.210		0.048	274	0.131	0.080		<0.05	0.34	0.010	<0.006	5.8
#F13-2	Fickle Duck	1995	ARGR	L	335	600	8			0.190			0.020				1.580		0.018	174	2.860	<0.005		<0.05	1.11	0.023	<0.005	20.3
#F13-4	Fickle Duck	1995	ARGR	L	350	700				<0.05			0.015				2.050		0.016	160	1.230	<0.005		<0.05	1.03	0.029	<0.006	21.4
F13-3	Fickle Duck	1995	ARGR	L	365	800				<0.05			0.031				1.520		0.012	180	1.740	0.064		<0.05	0.99	0.021	<0.005	19.2
F13-1	Fickle Duck	1995	ARGR	L	380	900	12			<0.05			0.013				2.090		0.021	137	1.130	<0.005		<0.05	1.08	0.033	<0.005	18.9

[a] LKTR = lake trout; LKWH = lake whitefish; ARGR = Arctic grayling

[b] M = muscle (myomere); L = liver

[c] Fork length, except for ARGR from 1994, where only total length was reported. **Bolded length values for 1994 LKTR and LKWH were converted to fork length from total length** (see Appendix D7).

[d] Metal concentrations for all samples from 1996 were reported by Rescan (1997) as dry weight but based on magnesium content, these reported concnentrations have been assumed to be in wet weight.

NOTE: Shaded values indicate results that were less than the detection limit.

Appendix D12. Metal concentrations (µg/g wet weight) in fish tissues from Aimaokatalok Lake, 1993-1997.

Parameter		Lake Trout												Lake Whitefish										Arctic Grayling	
		1993		1994		1995		1996		1997		1993-1997[c]		1993		1994		1995		1997		1993-1997[c]		1994	
		Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle
Number sampled		*3*	*3*	*11*	*11*	*25*	*25*	*3*	*3*	*25*	*25*	*67*	*67*	*3*	*3*	*11*	*11*	*5*	*5*	*24*	*24*	*43*	*43*	*1*	*1*
Aluminum	*n<DL*[a]									25	25	25	25							24	24	24	24		
	Mean									2.5	2.5	2.5	2.5							2.5	2.5	2.5	2.5		
	SD[b]									0.0	0.0	0.0	0.0							0.0	0.0	0.0	0.0		
	Min.									2.5	2.5	2.5	2.5							2.5	2.5	2.5	2.5		
	Max.									2.5	2.5	2.5	2.5							2.5	2.5	2.5	2.5		
Arsenic	*n<DL*	*0*	*0*	*3*	*2*	*20*	*25*	*1*	*1*	*25*	*22*	*49*	*50*	*0*	*0*	*0*	*1*	*4*	*5*	*24*	*17*	*28*	*23*	*1*	*1*
	Mean	0.020	0.021	0.083	0.046	0.043	0.025	0.062	0.048	0.025	0.030	0.043	0.031	0.091	0.022	0.159	0.051	0.062	0.025	0.025	0.035	0.068	0.037	0.005	0.005
	SD	0.007	0.005	0.093	0.035	0.038	0.000	0.032	0.023	0.000	0.015	0.048	0.019	0.002	0.009	0.102	0.031	0.083	0.000	0.000	0.018	0.080	0.022	-	-
	Min.	0.012	0.015	0.005	0.005	0.025	0.025	0.025	0.025	0.025	0.025	0.005	0.005	0.089	0.013	0.035	0.005	0.025	0.025	0.025	0.025	0.025	0.005	0.005	0.005
	Max.	0.025	0.025	0.309	0.127	0.150	0.025	0.080	0.070	0.025	0.080	0.309	0.127	0.093	0.030	0.427	0.102	0.210	0.025	0.025	0.090	0.427	0.102	0.005	0.005
Barium	*n<DL*									*25*	*25*	*25*	*25*							*24*	*24*	*24*	*24*		
	Mean									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
	SD									0.00	0.00	0.00	0.00							0.00	0.00	0.00	0.00		
	Min.									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
	Max.									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
Beryllium	*n<DL*									*25*	*25*	*25*	*25*							*24*	*24*	*24*	*24*		
	Mean									0.1	0.1	0.1	0.1							0.1	0.1	0.1	0.1		
	SD									0.0	0.0	0.0	0.0							0.0	0.0	0.0	0.0		
	Min.									0.1	0.1	0.1	0.1							0.1	0.1	0.1	0.1		
	Max.									0.1	0.1	0.1	0.1							0.1	0.1	0.1	0.1		
Cadmium	*n<DL*	*0*	*3*	*0*	*11*	*0*	*14*	*0*	*3*	*25*	*25*	*25*	*56*	*0*	*3*	*0*	*10*	*0*	*3*	*19*	*24*	*19*	*40*	*0*	*1*
	Mean	0.072	0.003	0.046	0.001	0.060	0.006	0.083	0.010	0.010	0.010	0.041	0.006	0.189	0.003	0.115	0.001	0.068	0.005	0.013	0.010	0.058	0.006	0.035	0.001
	SD	0.067	0.000	0.018	0.000	0.029	0.004	0.068	0.000	0.000	0.000	0.036	0.004	0.093	0.000	0.083	0.000	0.019	0.003	0.006	0.000	0.073	0.004	-	-
	Min.	0.010	0.003	0.007	0.001	0.011	0.003	0.030	0.010	0.010	0.010	0.007	0.001	0.133	0.003	0.016	0.000	0.041	0.003	0.010	0.010	0.010	0.000	0.035	0.001
	Max.	0.144	0.003	0.080	0.001	0.132	0.017	0.160	0.010	0.010	0.010	0.160	0.017	0.296	0.003	0.296	0.001	0.085	0.010	0.030	0.010	0.296	0.010	0.035	0.001
Calcium	*n<DL*									*21*	*0*	*21*	*0*							*23*	*0*	*23*	*0*		
	Mean									6.5	97.2	6.5	97.2							5.5	95.5	5.5	95.5		
	SD									3.9	39.0	3.9	39.0							2.7	31.2	2.7	31.2		
	Min.									5.0	51.0	5.0	51.0							5.0	56.0	5.0	56.0		
	Max.									21.0	182.0	21.0	182.0							18.0	191.0	18.0	191.0		
Chromium	*n<DL*									*25*	*25*	*25*	*25*							*24*	*24*	*24*	*24*		
	Mean									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
	SD									0.00	0.00	0.00	0.00							0.00	0.00	0.00	0.00		
	Min.									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
	Max.									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
Cobalt	*n<DL*									*25*	*25*	*25*	*25*							*24*	*24*	*24*	*24*		
	Mean									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
	SD									0.00	0.00	0.00	0.00							0.00	0.00	0.00	0.00		
	Min.									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
	Max.									0.25	0.25	0.25	0.25							0.25	0.25	0.25	0.25		
Copper	*n<DL*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*4*	*25*	*4*	*25*	*0*	*0*	*0*	*0*	*0*	*0*	*7*	*24*	*7*	*24*	*0*	*0*
	Mean	16.34	0.28	12.25	0.41	14.69	0.39	21.37	0.24	1.06	0.25	9.58	0.33	5.68	0.24	5.89	0.45	5.45	0.33	0.70	0.25	2.93	0.31	3.30	0.29
	SD	8.62	0.07	6.01	0.35	5.91	0.11	11.03	0.06	0.58	0.00	8.44	0.17	2.03	0.02	3.06	0.56	3.55	0.06	0.42	0.00	3.18	0.29	-	-
	Min.	9.52	0.22	1.80	0.21	4.44	0.20	14.90	0.18	0.25	0.25	0.25	0.18	3.56	0.22	1.89	0.12	2.89	0.26	0.25	0.25	0.25	0.12	3.30	0.29
	Max.	26.03	0.36	21.50	1.44	28.50	0.69	34.10	0.29	2.30	0.25	34.10	1.44	7.62	0.27	11.80	2.09	11.70	0.43	1.90	0.25	11.80	2.09	3.30	0.29
Iron	*n<DL*									*0*	*0*	*0*	*0*							*0*	*0*	*0*	*0*		
	Mean									1332.9	2.6	1332.9	2.6							179.9	2.7	179.9	2.7		
	SD									2897.9	0.8	2897.9	0.8							85.4	0.9	85.4	0.9		
	Min.									84.0	1.0	84.0	1.0							58.0	2.0	58.0	2.0		
	Max.									14600.0	4.0	14600.0	4.0							473.0	5.0	473.0	5.0		

Appendix D12. Metal concentrations (µg/g wet weight) in fish tissues from Aimaokatalok Lake, 1993-1997.

Parameter		Lake Trout												Lake Whitefish										Arctic Grayling	
		1993		1994		1995		1996		1997		1993-1997[c]		1993		1994		1995		1997		1993-1997[c]		1994	
		Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle	Liver	Muscle
Number sampled		*3*	*3*	*11*	*11*	*25*	*25*	*3*	*3*	*25*	*25*	*67*	*67*	*3*	*3*	*11*	*11*	*5*	*5*	*24*	*24*	*43*	*43*	*1*	*1*
Lead	*n<DL*	*3*	*3*	*0*	*0*	*0*	*0*	*3*	*3*	*25*	*25*	*31*	*31*	*3*	*3*	*0*	*0*	*0*	*0*	*24*	*24*	*27*	*27*	*0*	*0*
	Mean	0.020	0.020	0.012	0.063	0.044	0.051	0.025	0.025	0.025	0.025	0.030	0.041	0.020	0.020	0.016	0.010	0.033	0.029	0.025	0.025	0.023	0.021	0.011	0.008
	SD	0.000	0.000	0.007	0.114	0.019	0.039	0.000	0.000	0.000	0.000	0.016	0.053	0.000	0.000	0.008	0.010	0.010	0.015	0.000	0.000	0.007	0.010	-	-
	Min.	0.020	0.020	0.004	0.002	0.021	0.013	0.025	0.025	0.025	0.025	0.004	0.002	0.020	0.020	0.006	0.003	0.024	0.019	0.025	0.025	0.006	0.003	0.011	0.008
	Max.	0.020	0.020	0.026	0.365	0.083	0.164	0.025	0.025	0.025	0.025	0.083	0.365	0.020	0.020	0.033	0.039	0.050	0.054	0.025	0.025	0.050	0.054	0.011	0.008
Magnesium	*n<DL*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	Mean	152.7	298.7	146.1	245.7	167.6	246.7	131.7	259.3	15.3	258.8	104.9	253.9	187.0	293.7	169.2	278.4	212.6	271.2	16.6	288.6	90.3	284.3	187.0	277.0
	SD	15.3	25.8	21.3	51.1	26.2	26.1	24.0	9.1	2.7	13.5	72.8	29.4	12.8	24.4	43.7	39.8	23.3	18.8	2.7	26.5	87.8	29.5	-	-
	Min.	135.0	269.0	123.0	101.0	92.9	210.0	104.0	249.0	11.0	229.0	11.0	101.0	173.0	274.0	116.0	206.0	183.0	253.0	12.0	232.0	12.0	206.0	187.0	277.0
	Max.	162.0	316.0	182.0	303.0	220.0	332.0	146.0	266.0	21.0	282.0	220.0	332.0	198.0	321.0	272.0	325.0	242.0	302.0	22.0	326.0	272.0	326.0	187.0	277.0
Manganese	*n<DL*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*25*	*25*	*25*	*25*	*0*	*0*	*0*	*0*	*0*	*0*	*17*	*24*	*17*	*24*	*0*	*0*
	Mean	1.019	0.125	1.173	0.143	1.542	0.124	1.233	0.133	0.100	0.100	0.906	0.118	1.782	0.221	1.436	0.244	2.246	0.137	0.146	0.100	0.834	0.150	1.030	0.136
	SD	0.105	0.018	0.343	0.063	0.356	0.042	0.153	0.058	0.000	0.000	0.694	0.040	0.281	0.013	0.365	0.194	0.728	0.020	0.083	0.000	0.870	0.115	-	-
	Min.	0.946	0.109	0.450	0.090	0.974	0.074	1.100	0.100	0.100	0.100	0.100	0.074	1.541	0.212	0.799	0.103	1.680	0.108	0.100	0.100	0.100	0.100	1.030	0.136
	Max.	1.139	0.144	1.790	0.300	2.250	0.284	1.400	0.200	0.100	0.100	2.250	0.300	2.091	0.235	2.000	0.757	3.510	0.159	0.400	0.100	3.510	0.757	1.030	0.136
Mercury	*n<DL*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
	Mean	0.922	0.356	0.829	0.406	1.368	0.706	1.593	0.561	0.677	0.369	1.012	0.509	0.866	0.158	0.661	0.142	0.228	0.120	0.978	0.223	0.802	0.186	0.122	0.004
	SD	0.595	0.203	0.709	0.282	0.823	0.281	0.431	0.180	0.366	0.182	0.706	0.283	0.605	0.124	0.735	0.127	0.082	0.047	1.146	0.106	0.963	0.113	-	-
	Min.	0.338	0.166	0.049	0.007	0.197	0.234	1.260	0.435	0.258	0.135	0.049	0.007	0.211	0.046	0.125	0.034	0.176	0.080	0.180	0.069	0.125	0.034	0.122	0.004
	Max.	1.527	0.570	2.310	0.895	3.480	1.440	2.080	0.767	1.730	0.836	3.480	1.440	1.404	0.291	2.740	0.477	0.374	0.198	5.720	0.438	5.720	0.477	0.122	0.004
Molybdenum	*n<DL*									*25*	*25*	*25*	*25*							*24*	*24*	*24*	*24*		
	Mean									0.5	0.5	0.4464	0.4464							0.5	0.5	0.5	0.5		
	SD									0.0	0.0	0.2	0.2							0.0	0.0	0.0	0.0		
	Min.									0.5	0.5	0	0							0.5	0.5	0.5	0.5		
	Max.									0.5	0.5	0.5	0.5							0.5	0.5	0.5	0.5		
Nickel	*n<DL*	*3*	*3*	*0*	*0*	*18*	*11*	*3*	*3*	*25*	*25*	*24*	*17*	*3*	*3*	*0*	*0*	*1*	*1*	*24*	*24*	*4*	*4*	*0*	*0*
	Mean	0.100	0.100	0.041	0.026	0.048	0.127	0.100	0.100	0.500	0.500	0.054	0.097	0.100	0.100	0.068	0.043	0.091	0.101	0.500	0.500	0.079	0.068	0.069	0.012
	SD	0.000	0.000	0.027	0.019	0.061	0.185	0.000	0.000	0.000	0.000	0.052	0.148	0.000	0.000	0.042	0.044	0.051	0.058	0.000	0.000	0.042	0.052	-	-
	Min.	0.100	0.100	0.016	0.011	0.025	0.025	0.100	0.100	0.500	0.500	0.016	0.011	0.100	0.100	0.021	0.011	0.025	0.025	0.500	0.500	0.021	0.011	0.069	0.012
	Max.	0.100	0.100	0.114	0.080	0.320	0.910	0.100	0.100	0.500	0.500	0.320	0.910	0.100	0.100	0.151	0.150	0.150	0.180	0.500	0.500	0.151	0.180	0.069	0.012
Selenium	*n<DL*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*14*	*0*	*14*	*3*	*0*	*0*	*0*	*0*	*0*	*0*	*4*	*0*	*4*	*0*	*0*	*0*
	Mean	1.023	0.156	0.879	0.163	0.928	0.199	1.600	0.100	0.096	0.196	0.644	0.186	1.982	0.224	0.985	0.233	0.864	0.294	0.146	0.217	0.572	0.230	0.417	0.102
	SD	0.251	0.004	0.453	0.063	0.678	0.064	0.173	0.000	0.054	0.020	0.635	0.053	0.412	0.059	0.428	0.072	0.619	0.054	0.087	0.038	0.627	0.055	-	-
	Min.	0.758	0.153	0.241	0.037	0.260	0.060	1.500	0.100	0.050	0.100	0.050	0.037	1.539	0.185	0.410	0.139	0.340	0.200	0.050	0.200	0.050	0.139	0.417	0.102
	Max.	1.256	0.161	1.860	0.284	2.770	0.360	1.800	0.100	0.200	0.200	2.770	0.360	2.354	0.291	2.090	0.340	1.680	0.340	0.400	0.300	2.354	0.340	0.417	0.102
Silver	*n<DL*	*0*	*3*	*0*	*11*	*0*	*10*	*0*	*3*	*8*	*25*	*8*	*52*	*0*	*3*	*0*	*10*	*0*	*3*	*11*	*24*	*11*	*40*	*0*	*1*
	Mean	0.081	0.005	0.130	0.001	0.227	0.009	0.200	0.005	0.120	0.050	0.164	0.023	0.069	0.005	0.083	0.001	0.090	0.004	0.144	0.050	0.117	0.029	0.047	0.001
	SD	0.036	0.000	0.094	0.000	0.290	0.011	0.089	0.000	0.071	0.000	0.192	0.023	0.022	0.000	0.084	0.000	0.070	0.002	0.132	0.000	0.113	0.024	-	-
	Min.	0.058	0.005	0.013	0.001	0.080	0.003	0.130	0.005	0.050	0.050	0.013	0.001	0.043	0.005	0.013	0.001	0.046	0.003	0.050	0.050	0.013	0.001	0.047	0.001
	Max.	0.122	0.005	0.303	0.002	1.570	0.060	0.300	0.005	0.300	0.050	1.570	0.060	0.083	0.005	0.302	0.002	0.212	0.007	0.500	0.050	0.500	0.050	0.047	0.001
Tellurium	*n<DL*			*9*	*11*	*23*	*22*	*3*	*3*			*35*	*36*									*0*	*0*	*1*	*1*
	Mean			0.001	0.001	0.003	0.004	0.100	0.100			0.010	0.010			0.008	0.001	0.003	0.003			0.007	0.002	0.001	0.001
	SD			0.001	0.000	0.001	0.002	0.000	0.000			0.026	0.026			0.012	0.000	0.000	0.000			0.010	0.001	-	-
	Min.			0.001	0.001	0.003	0.003	0.100	0.100			0.001	0.001			0.001	0.001	0.003	0.003			0.001	0.001	0.001	0.001
	Max.			0.004	0.001	0.007	0.011	0.100	0.100			0.100	0.100			0.040	0.001	0.003	0.004			0.040	0.004	0.001	0.001
Zinc	*n<DL*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	Mean	33.12	3.89	26.48	3.81	32.87	4.66	33.70	3.00	2.77	2.58	20.64	3.63	28.56	3.32	33.30	3.92	37.72	4.60	2.74	2.89	16.42	3.38	21.10	3.28
	SD	5.31	0.33	4.68	1.12	4.95	1.37	10.09	0.10	0.57	0.27	14.64	1.32	2.29	0.44	20.89	1.74	8.88	0.54	0.51	0.19	18.92	1.08	-	-
	Min.	27.60	3.62	17.60	2.73	22.10	2.80	27.00	2.90	1.70	2.20	1.70	2.20	26.41	3.02	22.30	2.28	29.50	3.70	1.90	2.40	1.90	2.28	21.10	3.28
	Max.	38.19	4.26	34.70	6.06	46.20	8.10	45.30	3.10	3.70	3.10	46.20	8.10	30.96	3.83	93.20	8.86	49.20	5.10	3.70	3.20	93.20	8.86	21.10	3.28

[a] Number of samples below detection limit [b] Standard deviation

[c] Nickel values were calculated for 1993 to 1996 data only (42 lake trout and 19 lake whitefish), because of very high detection limit used in 1997 (1 µg/g).

Appendix D13. Metal concentrations (µg/g wet weight) in fish tissues from Fickle Duck Lake, 1995-1996.

Parameter		Arctic Grayling (1995)		Lake Trout (1996)	
		Liver	Muscle	Liver	Muscle
Number sampled		*4*	*4*	*3*	*3*
Arsenic	*n<DL*	*3*	*4*	*0*	*0*
	Mean	0.066	0.025	0.663	0.080
	SD	0.083	0.000	0.215	0.026
	Min.	0.025	0.025	0.520	0.060
	Max.	0.190	0.025	0.910	0.110
Cadmium	*n<DL*	*0*	*2*	*0*	*3*
	Mean	0.020	0.004	0.047	0.010
	SD	0.008	0.002	0.031	0.000
	Min.	0.013	0.003	0.020	0.010
	Max.	0.031	0.007	0.080	0.010
Copper	*n<DL*	*0*	*0*	*0*	*0*
	Mean	1.81	0.63	36.47	0.27
	SD	0.30	0.39	7.79	0.05
	Min.	1.52	0.39	27.70	0.22
	Max.	2.09	1.21	42.60	0.30
Lead	*n<DL*	*0*	*0*	*2*	*3*
	Mean	0.017	0.032	0.037	0.025
	SD	0.004	0.016	0.020	0.000
	Min.	0.012	0.010	0.025	0.025
	Max.	0.021	0.048	0.060	0.025
Magnesium	*n<DL*	*0*	*0*	*0*	*0*
	Mean	162.8	277.5	158.0	239.0
	SD	19.1	47.4	4.4	11.8
	Min.	137.0	221.0	155.0	229.0
	Max.	180.0	337.0	163.0	252.0
Manganese	*n<DL*	*0*	*0*	*0*	*2*
	Mean	1.740	0.201	1.367	0.067
	SD	0.793	0.138	0.462	0.029
	Min.	1.130	0.125	1.100	0.050
	Max.	2.860	0.407	1.900	0.100
Mercury	*n<DL*	*3*	*0*	*0*	*0*
	Mean	0.018	0.060	0.240	0.025
	SD	0.031	0.033	0.320	0.015
	Min.	0.003	0.032	0.021	0.008
	Max.	0.064	0.096	0.607	0.035
Nickel	*n<DL*	*4*	*3*	*3*	*3*
	Mean	0.025	0.034	0.100	0.100
	SD	0.000	0.018	0.000	0.000
	Min.	0.025	0.025	0.100	0.100
	Max.	0.025	0.060	0.100	0.100
Selenium	*n<DL*	*0*	*0*	*0*	*0*
	Mean	1.053	0.315	2.733	0.467
	SD	0.053	0.048	0.611	0.058
	Min.	0.990	0.250	2.200	0.400
	Max.	1.110	0.360	3.400	0.500
Silver	*n<DL*	*0*	*1*	*0*	*3*
	Mean	0.027	0.006	0.117	0.005
	SD	0.006	0.003	0.099	0.000
	Min.	0.021	0.003	0.050	0.005
	Max.	0.033	0.010	0.230	0.005
Tellurium	*n<DL*	*4*	*3*	*3*	*3*
	Mean	0.003	0.004	0.100	0.100
	SD	0.000	0.002	0.000	0.000
	Min.	0.003	0.003	0.100	0.100
	Max.	0.003	0.007	0.100	0.100
Zinc	*n<DL*	*0*	*0*	*0*	*0*
	Mean	19.95	5.13	46.23	3.20
	SD	1.14	1.00	4.18	0.17
	Min.	18.90	3.80	41.50	3.00
	Max.	21.40	6.00	49.40	3.30

[a] Number of samples below detection limit [b] Standard deviation

APPENDIX E

FISH HABITAT

Appendix E1. Habitat Classification System for Arctic Streams

(from Rescan 1998, 2001)

Boulder Garden (BG) — Large boulders, usually only partially submerged, distributed through the stream channel and providing high quality cover for juvenile and small fish. Often associated or in combination with R3 habitat type.

Cascade (Ca) — A series of small steps where stream falls over channel obstructions such as boulders and organic debris. Often in series with Run and/or Pool habitat types.

Chute (Ch) — A steep section of the stream channel.

Falls (Fa) — Water flows over a channel obstruction and into a downstream plunge pool. Obstruction height greater than 0.75 m and forms an obvious barrier to fish passage.

Shelf (Sh) — Very shallow stream flow over a bedrock outcrop. When combined with a steep gradient, forms a fish passage barrier. Poor quality habitat.

Flat (F) — Areas of still, often stagnant water. Substrate usually covered in silt or organic matter. Though fish habitat quality is usually poor, deep flats can provide cover for holding fish.

- **F1** – best quality flat habitat; depth greater than 0.75 m.
- **F2** – intermediate quality flat habitat; depth 0.3 to 0.75 m.
- **F3** – poorest quality flat habitat; depth less than 0.3 m.

Pools (P) — Portions of the stream with reduced current velocity at low flow and deeper water than surrounding areas. Often associated with Run habitat types.

- **P1** – best quality pool habitat; depth greater than 0.75 m.
- **P2** – intermediate quality pool habitat; depth 0.3 to 0.75 m.
- **P3** – poorest quality pool habitat; depth less than 0.3 m.

Rapids (Ra) — Water flows swiftly over completely or partially submerged materials to produce intense surface agitation. Usually greater than 0.2 m in depth, with a gradient of greater than 4%.

Riffle (Rf) — Shallow rapids where the water flows swiftly over completely or partially submerged materials to produce surface agitation. Usually less than 0.2 m in depth, with a gradient of less than 4%.

Run (R) — Areas of swiftly flowing water, without surface waves, which approximates uniform flow and in which the slope of water surface is roughly parallel to the overall gradient of the stream reach.

- **R1** – best quality run habitat; depth greater than 0.75 m.
- **R2** – intermediate quality run habitat; depth 0.3 to 0.75 m.
- **R3** – poorest quality run habitat; depth less than 0.3 m.

STREAM MORPHOLOGY CLASSIFICATION

Channel Type (C)

C1 – single stream channel (no bars, islands, or side channels) throughout the survey section.

C2 – occasional bars, creating areas within the survey section with more than one channel. No more than 50 % of the survey section has multiple channels.

C3 – stream channel is heavily braided. More than 50 % of the survey section consists of multiple channels.

Channel Boundary Type (D)

D1 – stream is confined to a well defined channel with a distinct boundary at the waters edge.

D2 – up to 50 % of the stream survey section possesses no distinct channel.

D3 – there is no distinct channel. Stream is often dispersed through grasses and other vegetation.

STREAM HABITAT SUITABILITY CLASSIFICATION

The suitability of a stream's habitat with respect to spawning, rearing, adult feeding, overwintering, and migration is expressed using a qualitative numerical scale from 0 to 4. Under this scheme:

0 = no habitat present,
1 = poor,
2 = fair,
3 = good, and
4 = excellent habitat.

Appendix E2. Aquatic habitat survey results for Boston area streams, 1996-2000.

Parameter	Watercourse	Aimaokatalok NE Inflow				Aimaokatalok River		
	Site No.	BP-F-01				FP-20		
	Date	07-Jul-96			26-Jun-00	09-Aug-96		
	Location (m)	0-100	100-200	200-300		0-100	100-200	200-300
	Distance (m)	100	100	100	750	100	100	100
	Latitude	N67°41.619'	N67°41.667'	N67°41.620'		N13443926	N13443336	N13442566
	Longitude	W106°20.120'	W106°19.805'	W106°19.283'		W7497797	W7497797	W7498258
Stage					High			
Water Temperature (°C)								
Water Colour					clear tea			
Channel / Boundary Type [a]								
Gradient (%)					2			
Wetted Width (m)	Mean	9.4	11.3	16.5	20.0	14.3	10.2	22.5
	Min	7.8	7.8	14.0		10.6	9.6	15.1
	Max	12.7	17.9	18.3		18.4	14.3	30.7
Depth (m)	Mean							
	Mean Maximum Pool Depth							
	Mean Maximum Riffle Depth							
Mean Velocity (m/s)		0.48	0.87	0.47		0.58		
Instream Habitat[a] (%)	Pool - Class P1	15			5	20	15	80
	Pool - Class P2							
	Pool - Class P3							
	Riffle				15			
	Rapid	30	85	50	55	15	20	10
	Run - Class 1	55	15	50	15	65	65	10
	Run - Class 2							
	Run - Class 3							
	Flat - Class 1				5			
	Flat - Class 2							
	Chute				5			
	Cascade							
	Shelf							
Substrate (%)	Organic matter							
	Silt							
	Sand				5			
	Small Gravel							
	Large Gravel							
	Cobble				15			
	Boulder				65			
	Bedrock				15			
	Dominant Particle Size	Cobble	Cobble	Cobble		Boulder	Boulber	Cobble
	Co-dominant Particle Size	Boulder	Boulder	Boulder		Cobble	Cobble	Boulder
	Compaction (%)							
	Embeddedness (%)							
Instream Cover (%)	Pool				15			
	Boulder				85			
	Cutbank							
	Instream Vegetation							
	Overhanging Vegetation							
	Macrophytes/Vegetation							
Habitat Suitability[b]	Spawning				4			
	Rearing				4			
	Adult Feeding				4			
	Overwintering				1			
	Migration				4			
Bank Material	Dominant Particle Size	Gravel	Gravel	Cobble		Boulder	Boulder	Cobble
	Co-dominant Particle Size	Boulder	Boulder	Boulder		Cobble	Cobble	Boulder
	Right d/s Bank Height (m)				1			
	Right d/s Bank Stability (%)				100			
	Right d/s Bank Dominant Part. Size				Bo			
	Right d/s Bank Co-dominant Part. Size				Sa			
	Right d/s Bank Cover (%)				100			
	Left d/s Bank Height (m)				1			
	Left d/s Bank Stability (%)				100			
	Left d/s Bank Dominant Part. Size				Bo			
	Left d/s Bank Co-dominant Part. Size				Sa			
	Left d/s Bank Cover (%)				100			
Bank Vegetation (%)	lichens	20						
	willow	10	20	30		5	50	30
	grass	70	80	70		95	50	70

[a] See Appendix E1 for description of codes.

Appendix E2. Aquatic habitat survey results for Boston area streams, 1996-2000.

Parameter	Watercourse	Stickleback Outflow	Fickle Duck Outflow				Fickle Duck Inflow
	Site No.	BP1	BP02				BP12
	Date	15-Jun-97	07-Jul-96			15-Jun-97	17-Jun-97
	Location (m)		0-100	100-200	200-300		
	Distance (m)	175	100	100	100	80	210
	Latitude		N67°38.683'	N67°38.776'	N67°88.749'		
	Longitude		W106°21.400'	W106°21.406'	W106°21.525'		
Stage		Flood				Flood	Flood
Water Temperature (°C)							
Water Colour							
Channel / Boundary Type [a]		C1, D1				C1, D1	C1, D3
Gradient (%)							
Wetted Width (m)	Mean	4.5	2.2	1.6	3.2	6.5	6.2
	Min		0.8	0.7	1.1		
	Max		3.4	2.1	4.8		
Depth (m)	Mean	0.35				0.55	0.65
	Mean Maximum Pool Depth	1.25					1.95
	Mean Maximum Riffle Depth	0.30				1.25	0.35
Mean Velocity (m/s)			0.83	0.70	0.41		
Instream Habitat[a] **(%)**	Pool - Class P1	7.5					20
	Pool - Class P2	2.5					
	Pool - Class P3						
	Riffle	90				100	55
	Rapid		15	10	20		5
	Run - Class 1		85	90	80		
	Run - Class 2						10
	Run - Class 3						10
	Flat - Class 1						
	Flat - Class 2						
	Chute						
	Cascade						
	Shelf						
Substrate (%)	Organic matter	95				90	60
	Silt						15
	Sand	5					5
	Small Gravel						
	Large Gravel						
	Cobble					10	10
	Boulder						10
	Bedrock						
	Dominant Particle Size		Cobble	Cobble	Cobble		
	Co-dominant Particle Size		Rock	Rock	Rock		
	Compaction (%)						
	Embeddedness (%)						
Instream Cover (%)	Pool	10					25
	Boulder						10
	Cutbank						25
	Instream Vegetation	90				100	40
	Overhanging Vegetation						
	Macrophytes/Vegetation						
Habitat Suitability[b]	Spawning	0				1	1
	Rearing	3				2	3
	Adult Feeding	0				2	2
	Overwintering	0				0	1
	Migration	1				3	2
Bank Material	Dominant Particle Size		Cobble	Cobble	Mud/Silt		
	Co-dominant Particle Size		Rock	Mud/Silt	Rock		
	Right d/s Bank Height (m)						
	Right d/s Bank Stability (%)						
	Right d/s Bank Dominant Part. Size						
	Right d/s Bank Co-dominant Part. Size						
	Right d/s Bank Cover (%)						
	Left d/s Bank Height (m)						
	Left d/s Bank Stability (%)						
	Left d/s Bank Dominant Part. Size						
	Left d/s Bank Co-dominant Part. Size						
	Left d/s Bank Cover (%)						
Bank Vegetation (%)	lichens						
	willow		60	90	85		
	grass		40	10	15		

[a] See Appendix E1 for description of codes.

Appendix E2. Aquatic habitat survey results for Boston area streams, 1996-2000.

Parameter	Watercourse	Aimaokatalok Lake Inflows							
	Site No.	**BP03**	**BP04**	**BP05**	**BP06**	**BP07**	**BP08**	**BP09**	**BP10**
	Date	15-Jun-97	16-Jun-97	16-Jun-97	16-Jun-97	16-Jun-97	16-Jun-97	16-Jun-97	17-Jun-97
	Location (m)								
	Distance (m)	350	95	80	150	50	110	95	150
	Latitude								
	Longitude								
Stage		Flood	Flood	Flood	Flood	Flood	Flood	Flood	Flood
Water Temperature (°C)									
Water Colour									
Channel / Boundary Type [a]		C2, D2	C3, D3	C3, D3	C3, D3	C3, D3	C3, D3	C2, D3	C3, D3
Gradient (%)									
Wetted Width (m)	Mean	3.3	8.5	7.5	8.3	0.6	5.3	4.2	3.2
	Min								
	Max								
Depth (m)	Mean	0.40	0.35	0.25	0.35	0.15	0.25	0.30	0.35
	Mean Maximum Pool Depth	1.30	0.45	0.35	1.60	0.25	0.90	0.55	1.85
	Mean Maximum Riffle Depth	0.25	0.25	0.25	0.20	0.10	0.20	0.25	0.30
Mean Velocity (m/s)									
Instream Habitat[a] (%)	Pool - Class P1	10			15				15
	Pool - Class P2							7.5	10
	Pool - Class P3		2.5	2.5		2.5	10	2.5	
	Riffle	80	95	95	75	95	90	75	70
	Rapid								
	Run - Class 1								
	Run - Class 2								
	Run - Class 3	10	2.5	2.5	10	2.5			5
	Flat - Class 1								
	Flat - Class 2								
	Chute								
	Cascade								
	Shelf								
Substrate (%)	Organic matter	90	100	100	80	100	95	80	75
	Silt				5				25
	Sand	5			5		2	5	
	Small Gravel						1	7.5	
	Large Gravel								
	Cobble						2	5	
	Boulder	5						2.5	
	Bedrock				10				
	Dominant Particle Size								
	Co-dominant Particle Size								
	Compaction (%)								
	Embeddedness (%)								
Instream Cover (%)	Pool	20			35		20	7.5	30
	Boulder	5			5			2.5	
	Cutbank	10			5			10	
	Instream Vegetation	65	100	100	55	100	80	80	70
	Overhanging Vegetation								
	Macrophytes/Vegetation								
Habitat Suitability[b]	Spawning	0	0	0	0	0	1	3	0
	Rearing	3	2	2	2	0	1	4	2
	Adult Feeding	1	0	0	0	0	0	1	3
	Overwintering	0	0	0	0	0	0	0	0
	Migration	0	0	0	0	0	0	0	0
Bank Material	Dominant Particle Size								
	Co-dominant Particle Size								
	Right d/s Bank Height (m)								
	Right d/s Bank Stability (%)								
	Right d/s Bank Dominant Part. Size								
	Right d/s Bank Co-dominant Part. Size								
	Right d/s Bank Cover (%)								
	Left d/s Bank Height (m)								
	Left d/s Bank Stability (%)								
	Left d/s Bank Dominant Part. Size								
	Left d/s Bank Co-dominant Part. Size								
	Left d/s Bank Cover (%)								
Bank Vegetation (%)	lichens								
	willow								
	grass								

[a] See Appendix E1 for description of codes.

Appendix E2. Aquatic habitat survey results for Boston area streams, 1996-2000.

Parameter	Watercourse	Aimaokatalok Lake Inflows			Koignuk River		Boulder Creek		
	Site No.	**BP11**	**BP13**	**BP14**	**FP-21**		**FP-14**		
	Date	17-Jun-97	17-Jun-97	17-Jun-97	09-Aug-96	09-Aug-96	19-Aug-96	10-Aug-96	10-Aug-96
	Location (m)				0-100	100-200	0-100	100-200	200-300
	Distance (m)	160	225	310	100	100	100	100	100
	Latitude				N13434860	N13435102	N13432554	N13432688	N13432986
	Longitude				W7518118	W7518386	W7534559	W7534067	W7533698
Stage		Flood	Flood	Flood					
Water Temperature (°C)									
Water Colour									
Channel / Boundary Type [a]		C2, D3	C1, D2	C2, D2					
Gradient (%)									
Wetted Width (m)	Mean	0.7	3.2	3.1	25.5	-	15.6	9.9	5.2
	Min				21.8	-	10.7	6.5	2.4
	Max				33.2	-	20.6	15.1	8.2
Depth (m)	Mean	0.35	0.65						
	Mean Maximum Pool Depth	0.50	2.10	2.10					
	Mean Maximum Riffle Depth	0.20	0.30	0.35					
Mean Velocity (m/s)					1.02	1.30	1.04	0.14	0.16
Instream Habitat[a] **(%)**	Pool - Class P1		20	25		20	70	20	30
	Pool - Class P2			5					
	Pool - Class P3	5							
	Riffle	85	80	40					
	Rapid			20	80	30		30	40
	Run - Class 1				20	50	30	50	30
	Run - Class 2								
	Run - Class 3	10		10					
	Flat - Class 1								
	Flat - Class 2								
	Chute								
	Cascade								
	Shelf								
Substrate (%)	Organic matter	100	75	75					
	Silt		15						
	Sand			5					
	Small Gravel								
	Large Gravel								
	Cobble		5	10					
	Boulder		5	5					
	Bedrock			5					
	Dominant Particle Size				Cobble	Cobble	Cobble	Cobble	Boulder
	Co-dominant Particle Size				Boulder	Boulder	Boulder	Boulder	Cobble
	Compaction (%)								
	Embeddedness (%)								
Instream Cover (%)	Pool		25	15					
	Boulder		5	10					
	Cutbank								
	Instream Vegetation	100	70	65					
	Overhanging Vegetation			10					
	Macrophytes/Vegetation								
Habitat Suitability[b]	Spawning	0	1	1					
	Rearing	0	3	2					
	Adult Feeding	0	2	1					
	Overwintering	0	0	0					
	Migration	0	0	0					
Bank Material	Dominant Particle Size				Cobble	Cobble	Cobble	Mud/Silt	Boulder
	Co-dominant Particle Size				Boulder	Boulder	Boulder	Boulder	Cobble
	Right d/s Bank Height (m)								
	Right d/s Bank Stability (%)								
	Right d/s Bank Dominant Part. Size								
	Right d/s Bank Co-dominant Part. Size								
	Right d/s Bank Cover (%)								
	Left d/s Bank Height (m)								
	Left d/s Bank Stability (%)								
	Left d/s Bank Dominant Part. Size								
	Left d/s Bank Co-dominant Part. Size								
	Left d/s Bank Cover (%)								
Bank Vegetation (%)	lichens								
	willow				50	80	70	60	80
	grass				50	20	30	40	20

[a] See Appendix E1 for description of codes.

Appendix E2. Aquatic habitat survey results for Boston area streams, 1996-2000.

Parameter	Watercourse	Road Crossings near Boulder Creek					
	Site No.	PRC13		PRC14		PRC15	
	Date	25-Jun-00	29-Aug-00	25-Jun-00	29-Aug-00	26-Jun-00	29-Aug-00
	Location (m) Distance (m)	500	100	300	350		175
	Latitude Longitude						
Stage		High	Low	High	Low	High	Low
Water Temperature (°C)		12	6.5	7			6
Water Colour		Turbid	Turbid	Turbid		clear tea	
Channel / Boundary Type [a]							
Gradient (%)		<1	<1	2		<1	<1
Wetted Width (m)	Mean	8.0	2.0	2.2	2.5	3.0	1.0
	Min						
	Max						
Depth (m)	Mean	1.20	0.50	0.35	0.45		0.80
	Mean Maximum Pool Depth		1.60	1.50	1.30	1.50	2.00
	Mean Maximum Riffle Depth	0.35	0.35		0.05	0.65	0.45
Mean Velocity (m/s)							
Instream Habitat[a] (%)	Pool - Class P1	5	40		20	20	20
	Pool - Class P2	5	5	5	30		15
	Pool - Class P3			15	40		
	Riffle	5	10	35	10	25	5
	Rapid						
	Run - Class 1	65				15	
	Run - Class 2	20	15	10		40	10
	Run - Class 3		30	35			5
	Flat - Class 1						25
	Flat - Class 2						20
	Chute						
	Cascade						
	Shelf						
Substrate (%)	Organic matter	10	10	80	45	85	65
	Silt	75	65	20	45	5	25
	Sand	12.5				5	5
	Small Gravel		10				
	Large Gravel						5
	Cobble		5				
	Boulder	2.5	10		10	5	
	Bedrock						
	Dominant Particle Size						
	Co-dominant Particle Size						
	Compaction (%)	50	30	10			
	Embeddedness (%)	100	40	60			
Instream Cover (%)	Pool	30	40	85	80	80	35
	Boulder	10	10				
	Cutbank		5	10	5	20	10
	Instream Vegetation						
	Overhanging Vegetation	60	5	5	5		5
	Macrophytes/Vegetation		40		10		50
Habitat Suitability[b]	Spawning	1	0	0	0	1	0
	Rearing	2	2	1	1	2	1
	Adult Feeding	1	0	0	0	1	0
	Overwintering	0	0	0	0	0	0
	Migration	4	1	3	0	4	3
Bank Material	Dominant Particle Size						
	Co-dominant Particle Size						
	Right d/s Bank Height (m)	1.5	1.8	0.5		0.5	0.75
	Right d/s Bank Stability (%)	90	90	50		100	80
	Right d/s Bank Dominant Part. Size	Si	Si	OM		OM	OM
	Right d/s Bank Co-dominant Part. Size	OM	OM	Si		Si	Sa
	Right d/s Bank Cover (%)	100	100	60		100	100
	Left d/s Bank Height (m)	1.5	1.2	0.25		0.5	0.75
	Left d/s Bank Stability (%)	85	90	50		100	80
	Left d/s Bank Dominant Part. Size	Si	Si	OM		OM	OM
	Left d/s Bank Co-dominant Part. Size	OM	OM	Si		Si	Sa
	Left d/s Bank Cover (%)	100	100	65		100	100
Bank Vegetation (%)	lichens						
	willow						
	grass						

[a] See Appendix E1 for description of codes.

Plate 1. **Stream BP03**, 15 June 1997, showing the discharge point into Aimaokatloak Lake. The water flowed through a depression, over terrestrial grasses, and had no distinct channel.

Plate 2. **Stream BP06**, 16 June 1997, showing the stream discharging into Aimaokatalok Lake over a bedrock shelf. Elevated lake levels diminished the effect of the migration barrier.

Plate 3. **Stream BP09**, 16 June 1997, showing the stream discharging into Aimaokatalok Lake over boulders. Elevated lake levels diminished the effect of the migration barrier.

Plate 4. **Stream BP10**, 17 June 1997, showing a series of pool and riffle habitats. The pools were deep and contained mature Arctic grayling and lake trout.

Plate 5. **Stream BP14,** 17 June 1997, showing a thicket of willows overlaying a boulder garden. A juvenile Arctic grayling was observed in the pool to the right.

Plate 6. **Fickle Duck Inflow (BP12)**, 17 June 1997, showing a series of riffle/run habitat flooding terrestrial grasses. Ninespine stickleback were caught in this section of stream.

Plate 7. **Stickleback Outflow,** 15 June 1997, showing the dispersed flow through terrestrial vegetation.

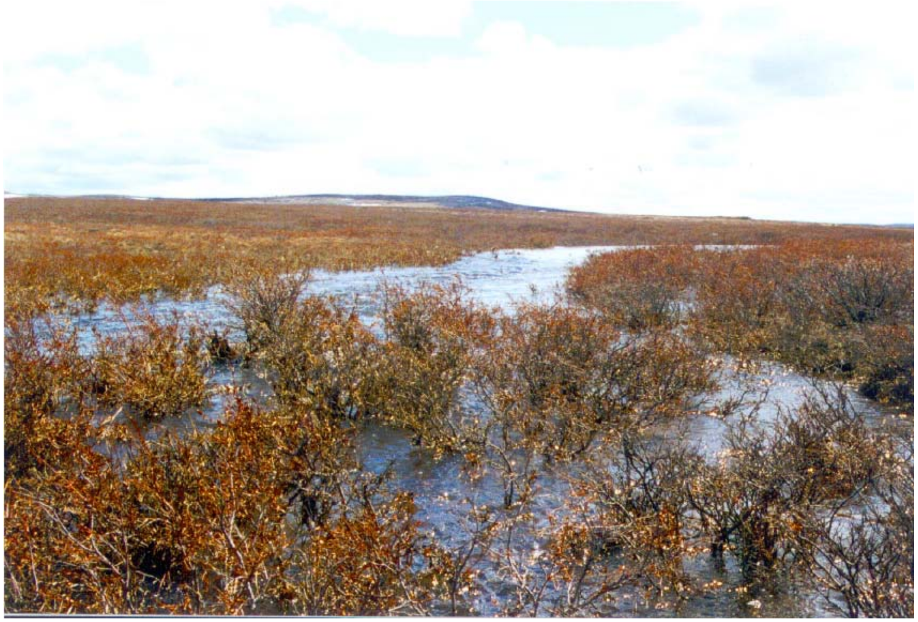

Plate 8. **Fickle Duck Outflow,** 15 June 1997, showing the dispersed flow through willows and grasses.