# ASSESSMENT OF LONG-TERM CHANGES IN WATER QUALITY FROM HALIFAX REGION LAKES (NOVA SCOTIA, CANADA) USING PALEOLIMNOLOGICAL TECHNIQUES

by

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***Affectionately dedicated to All My Loved Ones…including those near to me, and those that have gone far away in search of a Better Place.***

*Thanks for leaving "...the little bit of memories that can never be lost" And…*
*For constantly being "...the mirror, that shines back at me with a world of possibilities."*

**ABSTRACT**

The current study developed a paleolimnological approach to assess changes in diatom assemblages (class Bacillariophyceae) from present-day lake sediments in comparison to those deposited before significant human impact (ca. pre-1850) from 51 Halifax (Nova Scotia, Canada) region lakes in conjunction with a regional diatom-based transfer functions for pH and total phosphorus (TP). All 51 lakes showed changes in diatom assemblages between the present-day and pre-industrial assemblages that was greater than would be expected (i.e. similarity between 'top' and 'bottom' samples was much less than the similarities within triplicate 'top' and 'bottom' samples). To help identify the most important environmental stressors impacting diatom assemblages in these lakes, diatom-based reconstructions of inferred changes in pH (DI-pH) and TP(DI-TP) that were greater than the Root Mean Squared Error (RMSE) of the respective inference models were reconstructed for each of the 51 lakes. For example, a decrease in DI-pH greater than the RMSE of the pH model would be a strong indication of recent acidification, whereas an increase in DI-TP greater than the RMSE of the model indicates nutrient enrichment. Based on this approach, 4% of the lakes are showing acidification-related trends occurring in lakes with low pre-industrial pH values and relatively undisturbed watersheds. Almost 14% of the study lakes have been impacted by nutrients and characterized by watershed development and high concentrations of TP. Approximately 4% of lakes showed oligotrophication and acidification. Diatom assemblages from almost 20% of the study lakes that were relatively unimpacted by the afore-listed environmental stressors show trends consistent with climate warming. These lakes show an increase in DI-pH greater than the RMSE of the inference model, and floristic changes typically showed a decrease in the relative abundance of *Aulacoseira distans* paralleled with increase in *Cyclotella stelligera* and other planktonic diatoms in the modern sediments.  In addition, *Diatoma tenue* and *Diploneis parma*, diatoms tolerant of high conductivity, increased in 45% of the study lakes suggesting road salt as an additional stressor.  This thesis provides a rapid paleolimnological-based technique to assess regional water-quality changes, and further demonstrates the complexity of ecological changes within freshwater resources.

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## CO-AUTHORSHIP

For all of the chapters presented in the thesis, I was the lead author. Chapter 2 (Rajaratnam et al. 2009, formatted for submission to *Lake and Reservoir Management*), was co-authored by my supervisors Drs. Brian F. Cumming and John P. Smol, and Brian K. Ginn. In this paleolimnological assessment, I was part of all field collections in 2006 (core retrieval, water chemistry sampling, etc.), and was responsible for diatom preparation, enumeration, statistical analyses, interpretations and preparation of the manuscript including drafting of all tables and figures. Brian K. Ginn has been involved in the planning and sampling in 2005 and 2006 field seasons, and has contributed the diatom preparation, and enumeration for 6 of the 51 study lakes (Governor, Kearney, Paper Mill, Russell, Morris, and Pockwock). Diatom enumeration of Russell and Pockwock lakes was completed by Amy Tropea for an undergraduate thesis work and was incorporated in this study as the lakes are from the Halifax region.

## TABLE OF CONTENTS

## LIST OF TABLES

**Chapter 2**

**LIST OF FIGURES**

**Chapter 2**

## LIST OF APPENDICES

# CHAPTER 1

# GENERAL INTRODUCTION

*If there is magic on this planet, it is contained in water.*

LORAN EISELY, The Immense Journey, 1957

### *Water-Quality Crisis*

Aquatic ecosystems are not only imperative for human use, but also possess intrinsic environmental and ecological value. Unfortunately, freshwater resources have been susceptible to various natural and anthropogenic disturbances in eastern North America, and across many regions of the world. Both human and non-human impacts on water resources have led to significant water-quality issues that are of primary concern to scientists, government authorities, and the general public.

The use of the term "water quality" in this thesis refers to the physical and chemical conditions of the study lakes, as they play a key role for both the local human populations that are dependant on some of the lakes for drinking water and recreational purposes, and to the biological flora and fauna that exist within the aquatic ecosystems. Changes in water quality can cause significant impact on the structure and function of these communities, leading to drastic alterations in the aquatic ecosystem.

Water is an irreplaceable natural resource that serves multiple purposes. Approximately 70% to 90% of all living cells are comprised of water, and water constitutes almost 75 percent of the surface of the Earth (Wetzel 2001). Simply put, most species of plants and animals depend on water to sustain their lives. Such a life-supporting substance has been vulnerable to several natural and human-induced stressors (Schindler 2001).

Escalating human population combined with rapidly increasing residential and commercial development has led to water pollution and modification of many aquatic ecosystems to an undesirable state (Smol 2008). Such deterioration of water quality has contributed to the requirement of effective management protocols. However, the lack of data on baseline conditions (i.e., background, natural lake conditions) makes it extremely difficult for lake managers to infer the timing and source of the water-quality problems and develop reliable mitigation strategies and targets.

***Paleolimnological Analyses***

Due to the lack, or unavailability, of data on historical lake conditions (Dixit et al. 2000, Smol 2008), other methods of ecological assessment of aquatic systems are becoming increasingly important. Environmental monitoring, empirical and dynamic modeling techniques, and paleolimnology are the three primary approaches used to examine the past, present and future state of water bodies (Smol 2008). However, scientists, lake managers and the public at large have realized the value of obtaining long-term data, such as pre-impact nutrient levels of water bodies, in order to have a better understanding of the problem(s) at stake (Smol 2008).

Paleolimnology is the scientific approach that analyses the physical, chemical and biological remains in sedimentary profiles to reconstruct the history of inland water bodies (Smol 2008). The tools of paleolimnology are particularly useful in the absence of long-term measurements and historical or pre-impact conditions. Amongst other proxies, paleolimnology uses biological indicators, such as algal groups, to track long-term changes in aquatic environments (Charles and Smol 1994, Smol and Cumming, 2000, Smol 2008). Siliceous diatom valves, Bacillariophyceae, and scaled chrysophytes, Chrysophyceae and Synurophyceae, have been the pre-dominantly employed paleo-indicator groups (Smol 2008). This study will use the most widely-utilized algal proxy, diatoms (Stoermer and Smol 1999).

*Diatoms as Paleo-indicators*

Diatoms are unicellular, eukaryotic organisms that were essentially the only type of algal indicators that were used in limnological studies until recent years (Smol 2008). Diatom assemblages are highly abundant in sediment profiles, and are amongst the most sensitive paleoindicators that have been used for numerous studies on aquatic environments (Dixit et al. 1992, Stoermer and Smol 1999). Moreover, the siliceous cell walls and ornamented composition of the diatom valves (Dixit et al. 1992) are well-preserved in lake sediments (Smol and Cumming, 2000), and can be easily identified and enumerated in paleolimnological studies. In addition, most diatom floras are capable of fast migration rates and consequently can respond to, for example, increased nutrient inputs, and other natural and human-induced influences (Stoermer and Smol 1999).

There are thousands of diatom species with quantifiable optima and specific tolerances for various environmental conditions including acidity (pH) (Battarbee et al. 1999) and nutrient enrichment (Hall and Smol 1999). Quantification of the ecological preferences of diatom species can be estimated from regional calibration sets that include diatom assemblage data from several (usually >50) (Werner et al. 2005) lakes. Statistical techniques can then relate the diatom assemblages from surface sediments (representing present-day lake conditions) to a suite of regional environmental variables. Once the environmental preferences of taxa are estimated, a transfer function to infer environmental variables of interest (e.g. pH, nutrients) from specific species assemblage can be generated (Hall and Smol 1999). This method allows for the reconstruction of past environmental variables from diatom assemblages preserved in sedimentary profiles.

Aquatic ecosystems are continuously accumulating sediments from material within and outside the lake (Smol 2008). Careful collection of sediment cores (Glew et al. 2001), in conjunction with analysis of radioisotopes from many sediment intervals can be used to establish an age-depth profile (Appleby 2001). An examination of diatom fossils preserved at regular intervals throughout the sediment core can help determine past diatom assemblages and when used in conjunction with diatom-based transfer functions, the degree and extent of water-quality changes can be determined (Smol 2008).

The above paleolimnological techniques have been widely employed to track various environmental conditions including acid deposition (Battarbee et al. 1990, Cumming et al. 1992, Ginn et al. 2007a), nutrient enrichment (Reid 2005, Thienpont et al. 2008), climate warming (Smol and Cumming 2000, Laird et al. 2003, Rühland and Smol 2005, Smol and Douglas 2007), urban development (Meriläinen et al. 2003) and many other problems (Smol 2008). The long-term perspectives from paleoenvironmental research have provided immense amount of information on water-quality and quantity issues (Schindler 2001, Smol 2008), and have aided with the implementation of several innovative management protocols by lake managers, and government authorities (Schindler 2001, Smol et al. 2001).

*Top-bottom Approach*

Detailed analyses involving the examination of diatom assemblages at regular intervals throughout an entire sediment core are commonly employed in paleolimnological studies. Such a method is extremely informative as it can provide sufficient insights into the ecological and environmental trends over time (e.g. the last 200 years). However, it is very time-consuming, and often impractical from a management perspective (Smol 2008). Under such circumstances, paleolimnologists have developed the so called "top-bottom" approach. This is a time-efficient technique that is highly convenient, and offers a snapshot of present-day and pre-disturbance conditions in a number of lakes across a region. The top-bottom approach involves a comparison between paleo-indicators (diatoms in this case) preserved in the sediment sample from the 'top' of the core (e.g. ~0-0.5-cm representing present-day conditions) to the sample from the 'bottom' of the core (e.g. ~ >25-cm representing pre-industrial or pre-1850 time period).

The top-bottom sampling technique, initially described by Charles and Smol (1990), was used in the Paleoecological Investigation of Recent Lake Acidification, (PIRLA)-II project (Cumming et al. 1992). Since then, the approach has been advantageous for constructing calibration sets, and assessing water-quality changes in several regions including northeastern United States, the Arctic, southern and eastern Canada (e.g. Cumming et al. 1992, Dixit et al. 1999, Reavie et al. 2002, Rühland et al. 2003, Ginn et al. 2007a) and parts of Europe (e.g. Korsman 1999).

*Reproducibility of Sediment Cores: Quality Assurance*

Inter-and intra-core variability and inconsistent taxonomy can influence the dependability of diatom-inferred limnological variables (Hall and Smol 1996). However, the variability in diatom analyses (including sample preparation, identification and enumeration) is small, if percentage data are used. This has been demonstrated in previous studies (Anderson 1986, 1990, Charles et al. 1991, Cumming et al. 1992, Hall and Smol 1996, Ginn 2008a), which showed that replicate cores from a lake exhibits highly similar trends in diatom-inferred environmental variables. Moreover, variability associated with sedimentary diatom assemblages is extremely low when cores are retrieved from lake's deep basin (Hall and Smol 1996).

***Study Region***

*Nova Scotia, Canada*

Nova Scotia, one of Canada's smallest provinces, located on the Atlantic Coast is 55, 284 square kilometers in surface area, and has a population of 939, 531 (Statistics Canada 2009), and is the second-most densely populated province in Canada. The maritime climate of the province is mainly moderated by the Atlantic Ocean, providing warm winters and cool summers (Davis and Browne 1996). Generally, Nova Scotia's winters are controlled by cold arctic air masses combined with moist marine ones resulting in variable weather patterns, and freeze-thaw cycles. In comparison, storms and fogs associated with arctic and marine tropical air masses lead to the slow arrival of the spring season. The summer climate is considerably cooler and humid relative to other provinces such as Ontario and Quebec, while the fall season includes frequent storms (Davis and Browne 1996).

The province's geological bedrock history spans over 1.2 billion years (Davis and Browne 1996) and shows evidence of mountain building, erosion, sea invasions, earthquake and volcanic eruptions. The bedrock geology of the province ranges from Precambrian to Jurassic in origin (Davis and Browne 1996). Moreover, most parts of the province are highly vulnerable to acid deposition due to poorly-buffering, non-carbonate bedrock.

Human colonization in Nova Scotia was initiated ~11,000 years ago by Paleo-Indians; however, the land was later abandoned for a considerable period of time (Davis and Browne 1996). About ~1000 years ago, the land was re-colonized by First Nations, mainly Mi'kmaq peoples, which were mainly nomadic hunter-gatherers, and imposed little or no threats to the landscape or freshwaters (Davis and Browne 1996). Acadians, mainly interested in the fur trade and cod fishery, colonized the Annapolis basin of Nova Scotia around 1605. The population escalated in Nova Scotia between 1605 and 1755 with an estimate of 10,000 people in the mid-1700s (Davis and Browne 1996). Initially, there was little agricultural activity in the region. Later the Acadians mainly utilized the tidal marshes for agriculture, and had little impact on forests, which were occupied by Mi'kmaq (Davis and Browne 1996).

The British gained control of Nova Scotia around 1755, and there were moderate changes in landuse and settlement patterns (Davis and Browne 1996). A second wave of European settlement occurred in Nova Scotia between the 1770s and early 1800s, and substantial landscape changes started around the mid-1800s. Coal mining began in the late 1820s and initiated the industrial era in the province. Increased forest clearance, mining, and construction of buildings and roads occurred in the 19$^{th}$ century and progressed well into the 20$^{th}$ century (Davis and Browne 1996).

Nova Scotia contains approximately 9,400 freshwater lakes that are greater than 1 hectare in surface area, which constitutes around 5% of the total land surface (~ 2,408 $km^2$ ) (Davis and Browne 1996). Most of these lakes are surrounded by mixed deciduous-coniferous forest, mainly Acadian forest dominated by spruce-pine-maple-birch, and few areas have been cleared for farming and or residential purposes. In the past, most of these lakes have been somewhat isolated from anthropogenic impact. However, in recent decades, Euro-American settlement, land-use modifications, and increased human disturbances have posed a threat to their ecological integrity and have accounted for several water-quality changes in the region (Ginn 2006, Ginn et al. 2007a, Tropea et al. 2007, Thienpont et al. 2008). Despite the increased concern of water-quality changes in Nova Scotia, and the impact of urban development in the province, there has been no large-scale paleoecological assessment of environmental changes in the main urban centre of the province, Halifax.

*Halifax, Nova Scotia*

The city of Halifax, the capital of Nova Scotia, was established in 1841. It was amalgamated as the Halifax Regional Municipality (HRM) in 1996 with Dartmouth Bedford, Sackville and county of Halifax, making it the largest Canadian city on the east coast. HRM has a large number of lakes that are essential for water supply, wildlife habitat, and recreational purposes (Clement et al. 2007). The economy of the region is heavily dependent on agriculture, off-shore fisheries, and off-shore oil production. European settlement in the Halifax region began around 1749 and large-scale impacts by land-use changes, including forestry and agriculture, and more recently residential and industrial development began in the mid-1800s (Davis and Browne 1996). The number of residential dwellings, industrial buildings and transportation routes were constructed to harvest and process resources (e.g. lumber), which then led to the development of towns. Anthropogenic impact on the landscape continued well into the twentieth century (Davis and Browne 1996).

Most of Halifax region is located on poorly-buffering bedrocks including Meguma Terrane plutonic rocks (i.e. granite) and Cambrian-Devonian (i.e. quartzite, slate). The area is often described as an "urban landscape" due to high residential and industrial development (Davis and Browne 1996). Such urban development poses numerous environmental threats on lakes and their watersheds (Clement et al. 2007), and effective monitoring and assessment is essential to maintain the water quality in the region.

*Environmental Stressors and Paleolimnology in the Study Region*

Clement et al. (2007) acknowledged that most of the HRM lakes are impacted by anthropogenic activities, especially those with well-developed watersheds. Acid precipitation, increased nutrients, silt, and road salt have been identified as some of the major pollutants in HRM (Clement et al. 2007). Periodic water-quality surveys have been conducted on a number of Halifax region lakes over the last 20 years in an attempt to monitor and detect any undesirable changes in water quality (Keizer et al. 1993, Clement et al. 2007). Between the sampling periods of 1980, 1991, and 2000, Clement et al. (2007) reported increases in lakewater conductivity, major ions, Gran alkalinity and nitrate. The report also suggested that the increase in conductivity does not impose a considerable environmental threat, and was likely a result of increased road salt (sodium chloride) use in winter months.

Overall, the measured water chemistry variables from spot samples over three sampling periods indicated that most of the lakes are not impacted by acidification and/ or eutrophication issues, with the exception of a few lakes (Clement et al. 2007,

Appendix A). However, the lack of historical data and biomonitoring data limited their ability to offer definite conclusions on changes in water quality.

Cumulatively, lakes in Halifax region, and Nova Scotia in general, are subject to multiple stressors. Predominant threats include acid deposition, eutrophication due to increased nutrient inputs, and recent climate warming. As described below, previously published studies on freshwaters from the region have demonstrated these water-quality problems are indeed issues of concern.

*Acid Deposition*

Acidification is one of the significant environmental stressors on freshwater ecosystems in eastern North America and across the globe. Acid deposition involves four main steps: emissions, transport, transformation, and deposition (Environment Canada 2004). First, emissions of sulfur oxides ($SO_2$) and nitric oxides ($NO_x$) from natural (e.g. volcanoes, biological processes) and anthropogenic point sources (e.g. coal and oil combustion, sulfide-ore smelters, thermal electric generating stations) are released into the atmosphere. Second, the emitted oxides (usually in gaseous form) are carried via long-range transport over several thousands of kilometers. Third, the $SO_2$ and $NO_x$ combine with water ($H_2O$) to form sulfuric ($H_2SO_4$) and nitric ($HNO_3$) acids. Lastly, the transformed acids are deposited resulting in acid precipitation, or more accurately acid deposition (Environment Canada 2004), which then leads to adverse environmental effects depending on the geology, slope and vegetation of the areas.

Acid deposition leading to decreases in lakewater pH has been an environmental issue of concern since the 1970s. It has been one of the primary issues of concern to aquatic scientists in the Atlantic provinces, and so the federal government established monitoring programs in the 1980s for assessing changes in pH and other limnological variables in Nova Scotia lakes. Nova Scotia is one of the areas that has a number of lakes that are reported to have been impacted by acid deposition (Clair et al. 2002), which is primarily due to records of low pH precipitation, and the low-buffering bedrock geology in the region (Kerekes et al. 1982). As suggested by Environment Canada (2004), the problems of acid deposition has not been sufficiently addressed, and the understanding of long-term impact of acid deposition on freshwater resources of eastern Canada is necessary for the understanding and efficient management of this ecological issue.

Environment Canada has been conducting semi-annual sampling of Nova Scotian lakes since 1983 for a number of water chemistry variables including pH and acid neutralizing capacity (ANC), and has recorded little recovery from acidification during this period (Clair et al. 2002). The Keizer et al. (1993) report, which contains several water chemistry variables and trends, also proposes some recovery from acidification. However, the lack of data on pre-impact limnological conditions makes it difficult to determine if the proposed changes are indeed resulting from an environmental stressor (e.g. acid deposition).

Most of the water-quality studies in Nova Scotia were primarily concerned with the issue of acidification due to the low buffering capacity of the bedrock and increased amounts of atmospheric deposition in the province. Gorham (1957) conducted one of the earliest water-quality studies on the chemical composition of Halifax region lakes. He measured the concentrations of Na, K, Ca, Mg, $HCO_3$, Cl, $SO_4$, dissolved organic carbon, optical density, pH, and specific conductivity for 23 lakes in 1955 (Gorham 1957). Gorham's (1957) water chemistry measurements led him to conclude that most of the lakes from the study region were dilute, low in calcium bicarbonate and high in sodium chloride. In addition, he reported that most acid lakes had high dissolved organic carbon and that lakewater pH was heavily reliant on the amount of carbonate in the bedrock (Gorham 1957). He suggested that the geology of the province, proximity to the sea, and human-induced landscape disturbances from burning and cutting of vegetation areas, may have contributed to the observed changes in the lakewater chemistry (Gorham 1957). Furthermore, he suggested that higher sulphate levels were likely due to peat bogs or pyrite-bearing bed rock (Gorham 1957). It is important to note that these observations and conclusions reflect the extent of limnological knowledge and information on acid deposition available in the 1950s. Another study by Hayes and Anthony (1958) sampled 16 lakes across the Maritimes and attributed the bedrock geology of the region for the observed variance in lakewater pH. A few decades later, Watt et al. (1979) analysed 21 of the lakes that were initially surveyed by Gorham (1957) and reported slight decreases in pH from Gorham's data. Watt et al. (1979) were the first to propose atmospheric deposition of acid substances as a threat to this environment. They suggested that higher levels of sulphate in the region was due to the doubling of sulphur emissions from power stations and oil refineries in Halifax since 1955 (Watt et al. 1979). This suggestion was later recognized and re-emphasized by Gorham et al. (1986), who confirmed that anthropogenic and natural acidification was occurring in Nova Scotia. Some of the results from these early studies must be interpreted with caution. The early method for determining sulphate concentrations used methyl thymol blue (MTB), which interacts with the organic acids from the water samples with high DOC concentrations and often results in an over-estimation of sulphate levels (Clair 1992, Ehrman et al. 1996).

Moreover, the lack of long-term limnological information from these studies makes it difficult to assess the extent and cause of the suggested water-quality changes.

Few paleolimnological studies from the 1980s attempted to study the impact of acid deposition in various regions of the Atlantic provinces (Delorme et al. 1984, Elner and Ray 1987, Duthie 1989). Delorme et al. (1984) collected a single core from Kejimkujik Lake, Nova Scotia, sectioned it at 1-cm intervals, and used the appearance of *Ambrosia* pollen to indicate human settlement. The authors attributed climate, land-use changes by settlers, and associated increased in DOC concentrations for the observed changes in diatom assemblages (Delorme et al. 1984). It is important to acknowledge that there were a number of common problems with the paleolimnological approach used, including the diatom taxonomy at the time and not using modern dating techniques, and modern sampling equipment (e.g. corer) to mention a few (Ginn 2006).

Four years after the Delorme et al. (1984) study, Duthie (1989) re-analysed the Kejimkujik Lake core and re-identified the dominant diatom taxon as more acid species, and suggested that some diatom changes were likely a result of acid deposition leading to low dissolved organic carbon concentrations. Duthie (1989) concluded that Kejimkujik Lake had undergone slight acidification attributable to land-use modifications since 1950. Another study by Elner and Ray (1987) reconstructed past lakewater pH from diatom assemblages from sediment cores from three Nova Scotia lakes and four lakes from New Brunswick. The study found a decline in pH for some unbuffered lakes from both provinces, and suggested that increased acidification of the lakes was likely due to high levels of acid precipitation in the region. The authors acknowledged that an appropriate calibration set for the study region was necessary for relating diatom assemblage data to changes in lakewater pH (Elner and Ray 1987). The major problems with these studies were that they were conducted before the development of high-resolution sediment sectioning, and they have utilized older inference methods using Index α (summarized in Battarbee et al. 1999) to infer pH from diatoms, as opposed to contemporary, more rigorous statistical approaches (e.g. maximum likelihood techniques) that are used in more recent paleolimnological studies (e.g. Ginn 2006).

The lack of data on pre-impact conditions, the wide range of results from the afore-mentioned studies, in conjunction with the number of problems associated with the earlier studies, provide an opportunity to use contemporary paleolimnological approaches to assess the impact, if any, of acid deposition in the HRM region. Recently there have been a number of paleolimnological studies tracking acidification in Nova Scotian lakes (Ginn 2006), including Pockwock Lake from Halifax (Tropea et al. 2007).

Ginn et al.( 2007a) conducted a paleolimnological study of 51 low-alkalinity lakes from Bridgewater, Cape Breton Highlands National Park, Ecum Secum, Kejimkujik National Park, and Yarmouth regions of Nova Scotia. The researchers observed that lakes with low pre-industrial diatom-inferred pH values, high present-day DOC concentrations, and high sulphate loadings in the province, especially lakes from Kejimkujik National Park, exhibited more pronounced biological changes with increased abundance of acidophilous diatoms in modern sediments (Ginn et al. 2007a). A detailed study of fourteen lakes (eight lakes from Kejimkujik National Park that receives an annual sulphate deposition of ~10.5 kg $ha^{-1}$ $yr,^{-1}$ and six lakes from Cape Breton with comparatively lower sulphate deposition) showed that acidified lakes were located in Kejimkujik National Park, an area receiving high sulphate loading (Ginn et al. 2007b). In contrast, lakes under relatively low sulphate deposition, did not exhibit any consistent patterns in diatom assemblage shifts and inferences towards acidification, but showed changes indicative of recent climate change in the region (Ginn et al. 2007b). Another paleolimnological study by Ginn et al. (2008a) analysed a set of nine sediment cores from Kejimkujik Lake, Nova Scotia. Comparing this study to the two previously discussed studies from Kejimkujik Lake (Delorme et al. 1984, Duthie 1989), Ginn et al. (2008a) used nine cores as opposed to the single core analysis by the earlier studies. In addition, Ginn et al. (2008a) used 0.25 cm sections representing ~2.5 year intervals in comparison to the decadal scale of 1 cm utilized by Delorme et al. (1984) and Duthie (1989). Moreover, Ginn et al. (2008a) utilized contemporary, up-to-date paleolimnological techniques and reported changes in diatom assemblages indicated acidification with a dominance of acidophilous *Asterionella ralfsii* var. *americana* in present-day sediments, along with low measured pH, and low diatom-inferred pre-industrial and present-day pH for the lake indicated surface-water acidification. In addition, a study by Gerber et al. (2008), which used both paleolimnological techniques and a biogeochemical model (MAGIC), showed that among six lakes from Cape Breton Highlands National Park, Glasglow Lake was the most impacted by acid deposition since the early 1900s. The authors concluded that Glasglow Lake had the lowest buffering capacity compared to the other study lakes, and served as a sentinel of acidification trends and recovery in the study region (Gerber et al. 2008). Another paleolimnological study of Pockwock Lake from Halifax also tracked acidification trends using diatoms (Tropea et al. 2007). The decrease in diatom-inferred pH since pre-industrial times, and high abundance of acidophilous *Fragilaria acidobiontica*, *Frustulia pseudomagaliesmontana* and *Eunotia* spp. in modern sediments, allowed the authors to suggest that Pockwock Lake was impacted by acid deposition and showed trends similar to other clearwater (low DOC) Nova Scotian lakes (Tropea et al. 2007). The authors suggested that continued acidification and loss of DOC in Pockwock Lake (Tropea et al. 2007), which indicated surface-water acidification trends, can lead to increased availability of metals and decreased water quality in the future (Babich et al. 1980). Considering that several Nova Scotian lakes have indicated long-term acidification trends, as discussed above, Halifax region lakes may also be impacted by acid deposition. Based on previous acidification trends observed in freshwater lakes from the region, and given the limited available historical data for Halifax region lakes, paleolimnology is an effective tool to assess the impact of acid deposition, if any, on lakes in the HRM.

*Nutrient Enrichment*

One well-recognized indicator of water-quality deterioration is eutrophication, which can be defined as the nutrient enrichment of aquatic ecosystems (Lotter et al. 1998, Smol 2008). Eutrophication of lakes is often linked with increased productivity, oversimplification of the biotic communities, and a consequent decrease in metabolism of bottom-dwelling species that are unable to cope with the associated increase in nutrient loading (Wetzel 2001). Several water bodies have been susceptible to additional nutrient inputs due to poor watershed management, forest harvesting, malfunctioning septic systems and impact of over fishing (Smol 2008, Khan and Ansari 2005).

Eutrophication can lead to changes in community structure, devastating impacts on the food web, and alterations in biochemical cycles (Hall and Leavitt 1999, Lotter et al. 1998, Khan and Ansari 2005, Smol 2008). Modified nutrient ratios, such as nitrogen

(N): phosphorus (P), can lead to a shift in the primary production of lakes going from diatoms and other microscopic algal groups towards better competitors in low N environments, such as cyanobacteria (Hall and Smol 1999). Moreover, nutrient enrichment of water resources can cause increased amounts of plant and algal decomposition and consequent decreases in deep water oxygen levels (Khan and Ansari 2005). Thus the entire aquatic food web structure, including the species in higher trophic levels, such as fish, may be impacted by increased nutrient loading (Hall and Smol 1999).

Excess amount of nutrients in the waters can disturb an ecosystem via massive fish kills, decreased biodiversity, toxicity, increased susceptibility to species invasions, and several other biological, social and economic consequences (Hall and Smol 1999, Khan and Ansari 2005). Eutrophic conditions can have huge impacts on humans by limiting access to clean drinking water, and other recreational activities such as fishing and swimming (Anderson 1995, Khan and Ansari 2005). Such deleterious effects have contributed to increased research interests, and the need for establishment of effective management protocols for the widespread problem of lake eutrophication. In response to the increased interest in historical conditions of aquatic environments, numerous paleolimnological analyses have been conducted to assess if and when a lake becomes enriched with nutrients.

Humans have been one of the primary inducers of watershed disturbances and consequently water-quality issues, such as nutrient enrichment of water resources. Earlier eutrophication research, from the 1960s and 1970s, along with numerous current studies, has pointed out the cultural or anthropogenic causes of lake eutrophication (Carlson 1977, Anderson 1995, Khan and Ansari 2005). Human activities, such as agriculture, forest clearance, mining, and urbanisation have contributed to the onset of eutrophication in many regions across the globe including Australia (Newall and Walsh 2005), Europe (Tikkanen et al. 1997, Nedwell et al. 2002, Bennion et al. 2004, 2005, Vaalgamaa 2004), Asia ( Khan and Ansari 2005), Africa (Gasse 1987, Verschuren et al. 2002), South America (Rodriguez et al. 2002) and North America (Hall and Smol 1999, Hall et al. 1999, Dixit et al. 2000, Bowen and Valiela 2001, Ramstack et al. 2003, Reinhardt et al. 2005, Werner et al. 2005). Increased industrial development leads to increases in human population and consequent increase in urban areas. Landscape modifications, manure and sewage inputs, fertilizer use and agricultural runoff can increase nutrient levels in water bodies (Schindler and Donahue 2006). Nutrients such as nitrogen and phosphorus have increased in concentration in lakes, rivers and streams due to anthropogenic disturbances to watersheds (Reavie et al. 2002, Khan and Ansari 2005). As such, amplified total phosphorus concentrations can exceed that of nitrogen (Schindler and Donahue 2006), which would lead to lower N: P ratios and cyanobacterial blooms that could modify dissolved nitrogen sources within fresh waters.

There is a lack of eutrophication studies in Nova Scotian lakes. The provincial government has mainly been involved with water-quality investigations to address public concerns. Residents of Nova Scotia have raised complaints about, and concerns regarding, the impact of highway and cottage construction, increased agricultural run-off into lakes, and their cumulative effects on the fishing industry (Tropea 2005). Urbanization and human-induced impacts on landscapes and watersheds have been a primary concern to environmental agencies, and other residents of Nova Scotia. Thus, the current study on the impact of anthropogenic activities on Halifax region lakes can help address the afore-mentioned concerns.

Previous paleolimnological studies in the region have reported the varying degree and extent of anthropogenic-impact on the nutrient status of Nova Scotian lakes. Tropea (2005) reported marked changes in diatom assemblages of Russell Lake. The operation of a nearby pig farm, which may have discharged waste into Russell Lake, coincided with the increased abundance of eutrophic diatoms (e.g. *Asterionella formosa*) and increased lake productivity (Tropea 2005). While the closure of the pig farm may have contributed to decreased abundance of eutrophic diatoms in present-day sediments, indicating decrease productivity. Thus, this study demonstrated that anthropogenic-related nutrient inputs into lakes can have significant impact on the trophic status of aquatic ecosystems. In addition, the water-quality survey of HRM lakes by Clement et al. (2007) showed concern about the human impact on these lakes. Due to the limited number of studies, and the small number of study lakes on the nutrient status of Nova Scotian lakes, it is difficult to draw overall conclusions about the potential eutrophication trends consistent with anthropogenic impact on these lakes. Thus, a regional water-quality assessment of urban lakes may allow us to track nutrient-related trends in relation to human-impact on freshwater resources. Moreover, the very well-established ability of paleolimnological analyses using sediment diatoms in tracking changes in trophic status and associated water-quality issues (Hall and Smol 1996) will enable the current study to assess trends toward nutrient enrichment, if any, in Halifax region lakes.

*Climate Warming*

In the past, natural changes in climate occurred due to variations in solar activity, changes in ocean circulation and volcanism (Le Treut et al. 2007). At present, it is difficult to deny the impact of humans on climate fluctuations. Anthropogenic activities (e.g. accelerated greenhouse gas emissions) are altering the thermal properties of the Earth's atmosphere (Le Treut et al. 2007). High concentrations of greenhouse gases (e.g. carbon dioxide, $CO_2$) can lead to increased absorption of infrared radiation (Le Treut et al. 2007). As a result, more heat is retained in the atmosphere and oceans (Le Treut et al. 2007). Such anthropogenically enhanced greenhouse gas effect can lead to deleterious climate changes. Climate warming can affect several physical, chemical and biological processes in aquatic ecosystems.

A study by Schindler et al. (1996) reported that increased air temperatures and declines in precipitation in the late 1980s resulted in a decrease in ground water and stream flow. Lower flow resulted in declines in phosphorus and DOC (Schindler et al. 1996). Consequently, lakes became warmer and increasingly transparent due to lower inputs of DOC from catchment, combined with more photodegradation of dissolved organic carbon (DOC) compounds (Schindler et al. 1996). As a result, climate change resulted in warmer waters, a deeper epilimnion, and a longer ice-free season in the main reference lake from the Experimental Lakes Area (Schindler et al. 1996). Another potential impact of increasing air temperatures is on lake thermal stability. In the summer, lakes in temperate areas stratify frequently and form layers or zones based on the relationship between water temperature and density (Wetzel 2001). The established layers can mix at various times during the year including the cool periods of spring and fall (Wetzel 2001). Lake mixing distributes oxygen and various nutrients throughout the water column and is therefore ecologically significant. Climate warming likely will lead to increased resistance to lake mixing and enhanced lake stability. A study by Livingstone (2003) tested the hypothesis using ~50-year record of monthly temperature to depth data of Lake Zurich and reported ~20% increase in thermal stability and approximately 2-3 weeks extension of the stratification periods under warming. A similar trend was noted by Winder and Schindler (2004a) from Lake Washington where warming trends led to increased lake stability and extended stratification period by 25 days over the last ca. 40 years.

Climate change can lead to substantial changes in aquatic food web interactions. Under warming, Winder and Schindler (2004b) found that the well-established balance in the population dynamics of phytoplankton and zooplankton was disrupted. Increased temperatures led to early seasonal blooms of phytoplankton; however, the zooplankton populations were reported to be less capable of responding to the change in the timing of food abundance due to warming trends (Winder and Schindler 2004b). Such changes in the timing of primary producers in lakes have the potential for cascading effects to the upper trophic levels within aquatic food webs (Winder and Schindler 2004b).

Sedimentary diatoms have also demonstrated the impact of climate change on freshwater resources. Paleolimnological studies from subarctic regions of Finland (Sorvari et al. 2002) and Canada (Rühland et al. 2003, Rühland and Smol 2005) have reported that the increased percent abundance of small *Cyclotella* species paralleled with decreases in heavily-silicified *Aulacoseira* species is likely due to recent climate warming in the region. The studies have concluded that under warming lakewater properties likely favour small planktonic species (e.g. *Cyclotella*) over larger and heavier species (e.g. *Aulacoseira*), which cannot maintain their position in the water column for longer period of time (Rühland et al. 2008). Most paleolimnological studies that have tracked long-term climate changes have been from the Arctic, as the area is otherwise unimpacted by human-related environmental stressors such as acidification and eutrophication (Smol et al. 2005). However, in the recent past, studies from temperate regions across Canada or elsewhere (Harris et al. 2006, Rühland et al. 2008, Enache et al. submitted), including Nova Scotia (Ginn et al. 2008b, Thienpont et al. 2008) have also demonstrated the potential impact of climate warming on aquatic ecosystems.

To date, there has been no extensive long-term research on the impact of climate warming on Halifax region lakes. Instrumental air temperature records (Environment Canada 2002) from Halifax have recorded an increase ~1.5°C since 1870. Similar data from New Brunswick have also indicated an increase in temperature associated with diatom assemblage shifts beginning ~1900 CE (Harris et al. 2006). As discussed earlier, a study by Ginn et al. (2008b) on three lakes from Bridgewater has also implicated climatic-related changes in diatom species (e.g. increased relative abundance of *C. stelligera* and decreased in *Aulacoseira distans* in modern sediments). Similarly, Thienpont et al. (2008) found that some lakes from King's County, Nova Scotia were also impacted by climate changes, and observed a dominance of planktonic *Cyclotella stelligera* paralleled with decreased abundance of *Aulacoseira* spp. in present-day sediments. It is important to note that these changes in diatom assemblages suggested that other environmental stressors, such as nutrient enrichment and acidification, were not responsible for the observed changes.

The importance of climate change on lake systems make it a significant ecological issue of concern to be detected and examined in Halifax region lakes. Paleolimnological techniques using diatom assemblages have been used extensively to detect the influence of climate change (Smol and Cumming 2000). Paleolimnological research has tracked potential impacts of climate change including nutrient declines (Hall and Smol 1996), and pH changes (Koinig et al. 1998). Thus, the current study also uses diatoms as paleo-indicators to detect the impact of climate warming, if any, on Halifax region lakes.

*Local Watershed Activities*

Aside from the large-scale environmental stressors discussed above, Halifax region lakes may be susceptible to the impacts of local watershed activities. For example, the influence of increased specific conductivity often associated with anthropogenically-induced salinization of freshwater lakes. One of the major changes from the water-quality surveys using physical and chemical measurements from 1980, 1991 and 2000 was a marked increase in measured specific conductivity (here on referred to as 'conductivity') levels in Halifax region lakes (Clement et al. 2007). Conductivity of lakes is a measure of the water's ionic content, which is a reflection of the water's ability to conduct electricity (Wetzel 2001). Moreover, increased conductivity is often a representation of increased salinity of the lakes due to the high sodium chloride content from winter use of road salts and other atmospheric pollutants (Smol 2008). Road salts, which are used to de-ice the roads in winter to keep the roads passable, can enter the lakes via storm water run off (Clement et al. 2007). High conductivity values, which may reflect increased salinization of freshwater resources, is a serious water-quality issue with ecological and economical consequences (Williams

1987). As salinity increases, the value of the water supply for drinking, agriculture, and or industrial use decreases (Williams 1987). In addition, the runoff from urban areas has significantly higher salinities than runoff from forested areas (Prowse 1987). Thus, most of the study lakes from the urban Halifax region are also likely to be impacted by higher conductivity. Moreover, diatom assemblages have tracked conductivity levels and associated salinity in freshwater lakes, streams and rivers (Tuchman et al. 1984, Siver et al. 1999, Potapova and Charles 2003).

To date, there have been no published scientific studies on the impact of local watershed activities (such as use of road salts) on long-term changes in Halifax region lakes. A paleolimnological study by Ginn et al. (2008c) analysed the potential long-term impact of local watershed activities on French and Freshwater lakes from Cape Breton Highlands National Park, Nova Scotia. French Lake did not show any significant change in diatom assemblages since pre-industrial times (Ginn et al. 2008c). However, Freshwater Lake was moderately influenced by cultural activities around the catchment and observed increases in diatom-inferred specific conductivity and pH (Ginn et al. 2008c). The authors concluded that there may have been a short-term impact of highway construction on French Lake but changes in diatom assemblages were likely due to other catchment activities (Ginn et al. 2008c).

As discussed, aside from the patterns in water chemistry measurements from 1980, 1991, and 2000 (Clement et al. 2007), there is minimal historical information on the timing and extent of increased conductivity in Halifax region lakes. Considering the high sensitivity of diatom assemblages in detecting ecological changes, including conductivity and associated salinity levels, the current study attempts to assess the impact of the high conductivity recordings on the species composition and water-quality of Halifax region lakes.

***Rationale and Study Objectives***

As discussed above, several natural and anthropogenic stressors, including forest clearance, acid deposition via long-range transport, increased nutrient inputs, elevated use of road salts and other chemicals, and climate change, have been assessed from lakes in the Halifax region. However, the relative importance of these stressors in the Halifax region is uncertain. Such lack of knowledge in the area is due to the scarcity of long-term data, and the limited number of studies that have quantified the effects relative to pre-impact conditions in Nova Scotian lakes. This study was designed to assess the predominance of various stressors on all lakes in Halifax region.

In this study, we develop a rapid assessment technique to help determine the effects of important stressors on lakes in the Halifax region. Using a top-bottom approach (i.e. analysis of present-day diatom assemblages from surface and ~pre-1850 sediments), 51 Halifax region lakes are assessed to determine if they have changed since pre-industrial times. Regional diatom inference techniques, in conjunction with observed changes in diatom assemblages, were used to determine the likely stressor of the observed changes (e.g. acidification, eutrophication or climate).

On a broad scale, this study aims to provide a regional assessment of water-quality changes in relation to urbanization by addressing the following questions:

1) Have the diatom assemblages changed from pre-industrial to present-day times in the 51 Halifax Region lakes?

2) If yes, do the changes in sedimentary assemblages and diatom-inferred limnological variables indicate any regional ecological or water-quality issues of concern (e.g. acidification, eutrophication)?
3) And, can the observed changes since pre-industrial times be related to trends in measured limnological variables, and or degree and extent of anthropogenic-impact on the study lakes?

Collectively, the results will provide valuable information on diatom species distributions, and long-term water-quality changes in Halifax region lakes, and thus provide important information for limnologists, lake managers, and the general public.

Chapter 2 of this thesis outlines the water-quality changes in 51 Halifax region lakes, as observed from the changes in, and inferences from diatom species composition from pre-to-post industrial times.  The main conclusions of the water-quality assessment, along with the implications of the proposed study, and possibilities for future research are outlined in Chapter 3.  Some supplementary data including the trends from water chemistry measurements from Clement et al. (2007) are included in the Appendix.

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# CHAPTER 2:

## Assessment of long-term changes in water-quality from Halifax region lakes (Nova Scotia, Canada) using paleolimnological techniques

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Supplementary data are presented in Appendix A, B and C.

**Assessment of long-term changes in water-quality from Halifax region lakes (Nova Scotia, Canada) using paleolimnological techniques**

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## ABSTRACT

A rapid assessment paleolimnological approach was developed to assess the amount of environmental change in a population of lakes over the past ~150 years as well as to help identify important local and regional environmental stressors that likely contributed to the observed changes in diatom assemblages (i.e. acidification, eutrophication, climate and road salt). This approach is based on the analysis of diatom assemblages in 'top' (surface sediments, present-day) and 'bottom' (generally from >25 cm deep, representing pre-impact conditions) samples from a sediment core in conjunction with a regional diatom-based inference models for pH and total phosphorus (TP). Environmental change was assessed by calculating the change in species composition between 'present-day' and pre-industrial' diatom assemblages and changes in diatom-inferred pH and TP, in conjunction with the observed species shift. All lakes have changed since pre-industrial (>150 years) times, but different environmental stressors were identified. Inferences with declines in pH greater than the root-mean-squared error (RMSE) occurred in 4% of the 51 lakes, whereas increases in TP occurred in 14% of the lakes. Increases in pH greater than the RMSE with floristic changes consistent with climate warming occurred in 20% of the lakes. Characteristics of the acidified lakes include low measured present-day pH, low diatom-inferred pre-industrial pH, and relatively undeveloped watersheds. The nutrient-enriched systems were characterized by increased developmental pressure and high measured TP concentrations. The two lakes that were inferred to have become less productive and acidified had relatively less developmental pressure and high concentrations of monomeric aluminum. Lakes that were identified as showing changes consistent with climate warming showed an increase in lake water pH and species shifts from a dominance of heavily-silicified *Aulacoseira distans* in pre-industrial samples to dominance of small, planktonic *Cyclotella stelligera* in 'present-day' samples. These lakes generally had little or no watershed disturbance and were circumneutral and oligotrophic. Approximately 58% of lakes did not show changes in diatom-inferred TP and pH greater than the RMSE of the inference models. Increased relative abundances of *Diatoma tenue* and *Diploneis parma*, diatoms tolerant of relatively high conductivity waters, in present-day samples of 23 study lakes corresponded with high measured lake water conductivity. Lakes that showed conductivity-related changes were situated close to highways and roads. This rapid assessment approach to assess water quality and identify important stressors can provide important insights for lake managers to develop more effective management strategies.

**Key Words:** Acidification, nutrient enrichment, climate change, urban development, multiple-stressors, Nova Scotia, Halifax, paleolimnology

## Introduction

Aquatic ecosystems are constantly being impacted by multiple, large-scale stressors such as acidification, eutrophication, and climate change. Anthropogenic influences on freshwater systems can often initiate and accelerate the degree of environmental change in freshwaters (Schindler 2001). The Halifax Region, Nova Scotia, Canada (Fig. 1) is located in Atlantic Canada, has numerous freshwater habitats with over 9,400 lakes that are larger than 1 ha in surface area (Kerekes et al. 1982). Halifax, the capital of Nova Scotia, is the largest Atlantic Canadian city and in 1996 was amalgamated with Dartmouth, Bedford, Sackville and the county of Halifax to form the Halifax Regional Municipality (HRM), or Metro Halifax, with land area of ~5,490 km$^2$ and a population of 372, 679 (Statistics Canada 2006). The economy of the region is heavily dependent on agriculture, off-shore fisheries, and off-shore oil production. European settlement in the region began in ~1749, but consisted of a small coastal settlement which was dependent on an inland fishery until the mid-18$^{th}$ century (Davis and Browne 1996). Significant anthropogenic stressors to the HRM likely included: acid rain, land-use changes including forestry and agriculture, and more recently (20$^{th}$ century) residential and industrial development around watersheds. In addition, local gold-mining activities around the Waverley area near Halifax have contributed to substantial increases in arsenic levels in the region, especially around some HRM lakes (e.g. Lake Charles, Brooks et al. 1982, DeSisto 2008).

Nova Scotia lakes have been substantially affected by the deposition of strong acid anions (Clair et al. 2002). The poorly-weathered bedrock (granites, slates, and other metamorphic (gneiss) rocks), increased sulphate and nitrate deposition via long-range transport from major North American industrial centers (e.g. northeastern USA, Ohio River valley, Ontario, and Quebec), and the resultant low-pH of precipitation (Kerekes et al. 1982, Ginn et al. 2007a) have contributed to lake acidification in Nova Scotia.

Previous studies in the region were pre-dominantly concerned with sulphate deposition, acid precipitation and chemical composition of acidified lakes (e.g. Gorham 1957, Hayes and Anthony 1958, Watt et al. 1979, Vaughan et al. 1982, Delorme et al. 1984, Gorham et al. 1986, Elner and Ray 1987, Kelly et al. 1987, Watt 1987, Duthie 1989, Watt et al. 2000). Recent paleolimnological studies in the province have tracked several environmental stressors, including acidification (Tropea et al. 2007, Ginn et al. 2007a,b, 2008c, Gerber et al. 2008), nutrient enrichment (Tropea 2005), and climate warming (Ginn et al. 2008b, Thienpont et al. 2008). Fortunately, unlike several other Canadian cities, Halifax region lakes have water-quality monitoring data from three synoptic water-quality surveys conducted over the last 20 years (Clement et al. 2007). But, until now, there has been no comprehensive long-term regional water-quality assessment of lakes in the HRM. Thus, such an assessment is of paramount interest to general public, and necessary for both scientists, and policy makers

For lake management purposes of HRM lakes, three regional water-quality monitoring efforts were undertaken in selected sites, and were based on measured trends in standard limnological variables (e.g. pH, conductivity, nutrients) from 1981, 1991 and 2000 (Keizer et al. 1993, Clement et al. 2007). All three synoptic water-quality surveys were conducted around the same time of the year: April 14, 1980; April 16, 1991; March 28$^{th}$-29$^{th}$, 2000 (Keizer et al. 1993, Clement et al. 2007). Changes in water chemistry were assessed by comparing chemical data from the three sampling periods to assess changes in water quality. Based on the three periodic surveys, there were some notable changes related to nutrient and acidity of HRM lakes. Many lakes with 1980 TP values less than15 μg/L had higher TP values in 1991 in comparison to 1980 (Appendix A). Lakes with 1991 TP values less than 10 μg/L increased further in the TP survey of 2000, whereas lakes with TP values greater than 10 μg/L showed substantially lower values in 2000 (Appendix A). Very few lakes (Bissett and Russell) were categorized as eutrophic, and Clement et al. (2007) concluded that there were no significant trends in nutrient concentrations (except for an increase in nitrate concentrations) among the three sampling years (Clement et al. 2007). Measured pH values were similar in both the 1980 and 1991 surveys (Appendix A). However, the majority of lakes showed increases (0.2 to over 1 pH unit) between 1991 and 2000, a trend that was paralleled by an increase in alkalinity (Appendix A). A substantial change was observed in measured conductivity levels, which was attributed to anthropogenic sources (i.e. use of road salt, fertilizers) (Clement et al. 2007). Conductivity showed a substantial increase in the vast majority of lakes with increases from 1980 to 1991 and with further, but smaller increases from 1991 to 2000 (Appendix A). The authors acknowledged the dynamic seasonal nature of aquatic systems and suggested that the observed trends in water chemistry measurements to be interpreted cautiously (Clement et al. 2007). As suggested by Clement et al. (2007), efforts were taken to minimize spatial variability in the measured variables by sampling at the time of spring turnover, and collecting replicate samples from large lakes. Whereas, the temporal variability was minimized by collecting samples on the same day, except in 2000 where the sampling was done over two days due to weather conditions, and ~30 hours elapsed between the first and last sample collection (Clement et al. 2007).

In addition, based on the standard deviation among the replicate samples from four sampled lakes, the precision in measurements for some variables (e.g. Gran alkalinity, total nitrogen, TP) were considerably less (standard deviation > 5%) than other variables such as pH and conductivity (Clement et al. 2007). Given these uncertainties and sampling only over a two decade period, pre-impact lake conditions are difficult to assess.

Fortunately, paleolimnological techniques using diatoms have been an effective approach to infer missing monitoring data (Smol 2008). Diatoms (Bacillariophyceae) have been extensively used as ecological indicators due to their high abundance in lake sediments, sensitivity, and quantifiable response to various environmental conditions (Dixit et al. 1992a, Stoermer and Smol 1999). Sedimentary diatom assemblages have been successfully used to track numerous anthropogenic stressors (Quinlan et al. 2008) including surface-water acidification (Battarbee et al. 1990, Cumming et al. 1992, 1994, Tropea et al. 2007, Ginn et al. 2007a,b), recovery from acidification, and associated change in metals (Dixit et al. 1992b, Kingston et al. 1992), cultural eutrophication (Hall and Smol 1996, Hall and Smol 1999, Meriläinen et al. 2003, Bennion et al. 2004, Werner et al. 2005), human-induced salinization (Tuchman et al. 1984, Siver et al. 1999) and climate change (Smol and Cumming 2000, Rühland and Smol 2002, Laird et al.2003, Smol and Douglas 2007). Diatoms from surface (top) sediments can be identified and "calibrated" to infer present-day water chemistry of lakes (Smol 2008). Such calibrations can then be used to produce transfer functions, which can reconstruct past lake history from pre-industrial (e.g. down-core) lake sediments (Birks 1998). Similar reconstructions or transfer functions have been produced for a number of areas impacted by various environmental changes (Cumming et al. 1992b, Battarbee et al. 2001, 2005, Charles and Smol 1994, Hall and Smol 1996). For example, a 494-lake diatom-based calibration set, including sites from northeastern North America was constructed to infer lake water pH and other related limnological variables (Ginn et al. 2007c), which has been used by other paleolimnological studies in Nova Scotia (Ginn et al. 2007a,b, 2008a,b, Tropea et al. 2007, Thienpont et al. 2008). This study will also apply these diatom-inference models to infer lake-water pH and TP concentrations from lakes of Halifax region, Nova Scotia.

Furthermore, the cumulative effects of multiple anthropogenic stressors on lakes cannot be assessed using observed trends from water-chemistry measurements, as the environmental changes have occurred over longer time frames and are often more complex (Paterson et al. 2008, Quinlan et al. 2008). As reported earlier, previous studies from Nova Scotia have documented evidence of different environmental changes occurring in the lakes. Such findings give rise to the probability of multiple stressors having various degrees of influence on aquatic systems. To date, there has been no regional, large-scale paleolimnological assessment of the impact of urban development on water-quality change in lakes of the HRM. Therefore, the relative roles of different stressors on HRM lakes remain, for the most part, unknown.

In addition to the impact of acid deposition, nutrient enrichment, and climate change, the study lakes from the Halifax region may also be susceptible to the influence of increased salinization. As mentioned earlier, the most pronounced change from the 1980, 1991 and 2000 water-quality surveys for selected Halifax region lakes was the marked increase in measured specific conductivity (Clement et al. 2007). Specific conductivity of lakes is a measure of the resistance of a solution to electrical flow corrected to a standard temperature (Wetzel 2001). In simple terms, specific conductivity (referred as 'conductivity' from here onwards) is a measure of the water's ionic content, which is a reflection of the water's ability to conduct electricity. The increased conductivity levels are primarily from elevated use of road salts for de-icing purposes, and increased use of lime and fertilizers near the watersheds (Clement et al. 2007). These water soluble chemicals will enter the lakes via storm water run off (Clement et al. 2007). Thus, higher conductivity levels is a serious water-quality issue with ecological and economical consequences (Williams 1987). As conductivity increases, the value of the water supply for drinking, agriculture, and or industrial use decreases (Williams 1987). In addition, the runoff from urban areas has significantly higher conductivities than runoff from forested areas (Prowse 1987). Moreover, diatom assemblages have tracked high conductivity levels and associated salinity in freshwater lakes (Tuchman et al. 1984, Siver et al. 1999, Potapova and Charles 2003). Therefore, we also hypothesize that diatom assemblages from Halifax region lakes may track the effects of increased conductivity.

Given the uncertainties in long-term water chemistry changes, and the limited number of paleolimnological studies in the region, we developed a rapid assessment procedure and applied it to conduct a regional water-quality assessment of Halifax Region lakes. In this study, we use sediment diatom assemblages to assess the water-quality changes that have occurred since pre-industrial times in 51 Halifax region lakes of Nova Scotia. To quantitatively evaluate the water-quality changes, we will use the 494-lake NENA diatom-calibration set (Ginn et al. 2007c) and infer changes in TP and lakewater pH between modern and pre-impact (~ pre-1850) conditions to track the environmental stressors that have affected the study lakes. This study is the first to offer a paleoecological assessment of water-quality changes in Halifax region lakes in response to urban development. Moreover, regional water-quality assessments used in a collaborative manner by combining the trends from water chemistry measurements, and paleolimnological studies, such as this one, can be more effective (Cumming et al. 1992, Smol 2008) than those that depend on a single approach (e.g. historical chemical data, empirical geochemical models).

Based on previous paleoecological evidence of significant changes in biological species composition from pre- to post-industrial times (Ginn et al. 2007 a,b, Tropea et al. 2008, Thienpont et al. 2009), we hypothesize that the diatom species composition in these study lakes will also exhibit significant, long-term changes in the region. In addition, our results may illustrate that typical lake management techniques, which use water-quality measurements to assess limnological change over decades, and single stressor-response models that are produced and utilized to develop lake management strategies for remediation purposes (e.g. Lake Shore Capacity Model; Paterson et al. 2006), are likely not sufficient to study freshwater resources that are impacted by multiple environmental stressors (e.g. Quinlan et al. 2008).

**Methods**

***Rationale***

A 'top-bottom' paleolimnological analysis of the present-day and pre-industrial sediment core samples are effective for regional water-quality assessments (Smol 2008). Thus, all study lakes, including the replicates (described below), were processed for before-after (i.e. top-bottom) sediment approach, which has been successfully used in several paleoecological studies in the Adirondacks, New York (Cumming et al. 1992), Northwest Territories (Rühland et al. 2003), Ontario (Hall and Smol 1996), and Nova Scotia (Ginn 2006, Ginn et al. 2007a, Thienpont et al. 2008), and elsewhere (Smol 2008).

Diatom assemblages were analyzed in the 'top' (0-0.5-cm interval) and from a depth between ~16.5 to 25.5 cm (called the "bottom" sample) in all sediment cores, thus representing the modern and pre-development diatom assemblages, respectively. A depth of ~15- to 20-cm has typically corresponded to pre-industrial or ~1850 conditions in lakes from northeastern North America (Cumming et al. 1992, 1994, Smol 2008). Also, $^{210}$Pb radio-isotopic dating of over 25 sediment cores from the lakes in Nova Scotia indicate that the pre-industrial (ca. 1850) sediment intervals are usually below 20 cm (Ginn 2006, Ginn et al. 2007a,b,c, 2008a,b,c, Tropea et al. 2007, Thienpont et al. 2008), and an interval of 25 cm has typically corresponded to the mid-1700s to early to late 1800s (Ginn et al. 2006). Moreover, analyses of paleolimnological inferences of water pH from sediment core intervals of 15- to 15.5-cm and 25-to 25-5-cm for 51 Nova Scotia lakes (Ginn 2006, Ginn et al. 2007a) were highly similar. Most of the 'bottom' samples in this study were around 25 cm, and none were below 16cm, which suggest that our diatom assemblages from the down-core samples represented pre-industrial (ca. 1850) conditions.

***Study Area and Site Selection***

The 51 study lakes are located in the HRM (Table 1, Fig. 1). Water-quality surveys have been conducted in HRM over the past ~20 years (Clement et al. 2007). Most of the study lakes were selected following the Keizer et al. (1993) report on water-quality surveys in Halifax-Dartmouth Metro Area, and more recent water-chemistry measurements were obtained from a subsequent report (Clement et al. 2007). Physical and chemical variables for most of the study lakes have been measured in 1980, 1991, and 2000, and are described in detail in Clement et al. (2007). Measured pH for the study lakes ranged from 4.7-7.5 pH units, and TP ranged from 2-22 µg/L (Table 2).

Some of the lakes in the Halifax region, including Pockwock, Major, First and Second Chain lakes, are a significant source of water supply for industrial and domestic purposes, and are controlled by the Halifax Regional Water Commission. Protection of the water supply is in effect for most of these afore-mentioned lakes via prohibition of further watershed development, boating, swimming, and other direct activities. Furthermore, cottages and permanent residence have increased on a number of other watersheds and lake managers have expressed concerns about the resulting impact on water quality.

***Field sampling***

Two field seasons, during July 2005 and July 2006, were conducted in Halifax to obtain the sediment samples used in this study. Sediment cores were obtained from the deep flat basin for all study lakes using a 3" Glew (1989) gravity corer. The sediment samples were sectioned at 0.5-cm intervals using a Glew (1988) vertical extruder, and were placed in labeled, sealable Whirlpack® bags, and stored on ice and subsequently stored in our cold room at approximately 4°C.

***Quality assurance***

Several studies have demonstrated the reproducibility of paleolimnological data and the marginal variability associated within the preparation of diatom samples (e.g.

Charles et al. 1991, Hall and Smol 1996, Ginn et al. 2008c). However, for additional quality assurance, eight study lakes (Bayers, First Chain, Fraser, Frenchman, Frog Pond, Second Chain, Settle and Whimsical) were selected, across the pH and TP gradients (i.e. lakes would span the lower, middle and higher end of the TP range: 2-22µg/L, and pH range: 4.7-7.5 pH units in the 51 lake dataset) of HRM lakes, for multi-core analyses to examine the reliability of paleolimnological techniques in inferring present and pre-industrial water quality.

***Diatom preparation and analysis***

In the laboratory, diatom assemblages were separated from the sediment using a 1:1 molar ratio of $HNO_3$ and $H_2SO_4$, following Battarbee et al. (2001), and were mounted on microscope slides using Naphrax®. Diatom assemblages were identified to the lowest taxonomic level using standardized taxonomic references (Patrick and Reimer 1966, 1975, Krammer and Lange-Bertalot 1991-2000, Cumming et al. 1995, Round et al. 1990, Camburn and Charles 2000, Fallu et al. 2000, Wehr and Sheath 2002) and other detailed references in Ginn et al. (2006). A minimum of 400 diatom valves per slide were enumerated along parallel transects under an oil immersion using a Leica® DMRB microscope at 1000X magnification (NA = 1.3) with differential interference contrasts (DIC) optics.

***Statistical Analyses***

Detection of patterns of variation in the measured water chemistry

The physical (e.g. lake area) and chemical (e.g. pH) variables available for the study lakes (Clement et al. 2007, Table 2) were transformed where appropriate and a

Pearson correlation analysis (Table 3) was used to detect correlations among the measured variables. Environmental variables that required log transformations included: area, max depth, conductivity, total nitrogen, Na, TP, Cl, $NH_4$, $SiO_2$ and $NO_3$. The metric of developmental pressure (e.g. index of development from 1 to 5, where 1 indicates little or no development, and 5 indicated extensive development and pressure on lakes) was obtained from the Halifax Regional Water Commission (T. Blouin 2008). It is a qualitative and subjective ranking for each lake, primarily based on the degree of development risk or perceived impact the lake might be subject to. The rankings are influenced by factors such as percent watershed development (subjective), protected status (e.g. First and Second Chain lakes, Pockwock, Topsail, Lamont and Lake Major have some degree of protected status as water supplies or backups), sewage treatment plant discharges and degree of use for recreation (T. Blouin 2008). For example, lakes with relatively undisturbed watersheds (e.g. away from residential and industrial areas and relatively unavailable for recreational activities) were given a developmental index of 1, whereas lakes under moderate pressure from development and or human-related activities were given a value of 2-3, and lakes in highly developed watersheds and or those used for recreational purposes were assigned developmental index of 4-5.

Assessment of changes in diatom assemblages since pre-development times

Diatom taxa that did not attain a relative abundance of >2% in at least one of the 51 lakes were eliminated from statistical analyses, in order to help eliminate the influence of rare taxa and taxonomic misidentification. A Bray-Curtis similarity coefficient (Bray and Curtis 1957) was calculated between the 'top' and 'bottom' diatom assemblages in each core as a metric of change over this time period (Clarke and Warwick 2001); the lower the similarity coefficient, the larger the inferred change. To obtain an estimate of similarity between replicate samples from 'top'-only and 'bottom'-only samples, Bray-Curtis similarity coefficients were calculated between all 'top' and 'bottom' samples from replicate cores from the same lake. The lowest similarity coefficients were used to define an approximate cut-off of when an observed change would be greater than expected between replicates from the same lake. The lowest similarity coefficients were used as a threshold to define the significance of the changes between 'top' and 'bottom' samples from each of the 51 study lakes.

Similarity coefficients and diatom-inferred pH and TP

The lakes of primary concern in this analysis are those that showed 'significant' changes between 'top' and 'bottom' samples as identified by Bray-Curtis similarity coefficient (i.e. the similarity between 'top' and 'bottom' samples was less than expected based on replicate samples- see above). The use of diatom-inferred pH and TP from the diatom assemblages present in the 'top' and 'bottom' core samples can provide an indication of the potentially important stressors (e.g. acid deposition, eutrophication, and climate) that may have affected each of the 51 Halifax region lakes. To aid in this examination, past pH and TP values were inferred, based on a previously developed diatom-inference models for pH and TP (Ginn et al. 2007c). The pH and TP diatom inference models are based on a modern diatom dataset of 494 lakes from eastern North America (the NENA dataset, Ginn et al. 2007c) that were developed based on a maximum likelihood model using the computer program C2 v.1.51 (Juggins 2003). The pH model was the strongest and highly significant ($r^2_{boot}$ = 0.88; RMSE = 0.40) followed by TP model ($r^2_{boot}$ = 0.39; RMSE = 0.40) (Ginn 2006). Just over ~75% of the taxa from the sediment core assemblages of this study are represented in the calibration set. The diatom-inferred changes in pH and TP between the 'top' and 'bottom' samples from each core were plotted, and lakes that exhibited changes that were significantly greater than the RMSE (Root Mean Squared Error) of each of the respective predictive models were identified. Acidification was a potentially important stressor, if the diatom-inferred change in pH showed declines of ~>0.4 of a pH unit. An increase in pH and TP greater than the RMSE would be identified as a potential signal of eutrophication, and an increase in pH alone may be an indication of alkalinisation of a lake due to the indirect effects of acid deposition (Cumming et al. 1992, Ginn et al. 2007a,b), or changes in seasonality and or stratification patterns of a lake (Harris et al. 2006, Enache et al. submitted). Lakes that exhibited a significant difference in similarity of the Bray-Curtis similarity coefficient between the 'top' and 'bottom' samples would not be associated with simple limnological changes related to eutrophication or acidification or the changes were not large enough to exceed the RMSE of the inference models. Based on the criteria for classification of environmental stressor, changes in study lakes that do not exceed the RMSE of the inference models will be categorized as those that exhibit non-significant ecological changes. However, the degree of change between the diatom-inferred pH and TP values from pre-industrial to present-day times as well as floristic changes for this group of lakes will be used to discuss any trend toward water-quality changes (e.g. acidification, nutrient enrichment, etc.). Patterns in measured physical and chemical characteristics of the lakes, along with the development index were used to offer plausible explanations for the diatom-inferred changes.

**Results and Discussion**

A Pearson correlation matrix of the 22 measured environmental variables and development index available for the study lakes revealed high correlations among many of the variables (Table 3). Lakes were of variable size (range ~4-801 ha; median = 72.6 ha) and depth (range 1.5-65 m; median = 11.5 m). As expected, lake area was correlated to maximum depth; conductivity was correlated to several variables (GRAN ALK, pH, Na, Mg, $SO_4$, Cl, K, and Ca); pH was positively correlated with many variables (Na, Cl, K, Ca , $SiO_2$ and $NO_3$) and negatively correlated to Al. Development index, TP and DOC did not reveal any significant correlations with other variables.

The lowest Bray-Curtis similarity coefficients between all 'tops' and all 'bottoms' from the replicate samples of the 8 lakes chosen for multiple-core analysis (Appendix C, Similarity index: Tops, minimum: 78.1%, median: 89.6%; Bottoms, minimum: 82.6%, median: 90.5%) was used as a threshold to define change for all study lakes. All 51 study lakes have recorded marked changes in diatom species composition from pre-development to modern times (maximum similarity between 'top' and 'bottom' sediment was 81.3%, see Table 4 for details). Changes in diatom-inferred pH and TP values (Fig. 2) indicate that 2 (~4%) lakes are showing a trend toward acidification, 7 (~14%) are showing signs of nutrient enrichment, 10 (~20%) show a climate change or alkalinization signal, 2 (4%) are becoming increasingly oligotrophic, and diatom species composition have changed since pre-industrial times in 30 (~58%), but exhibited changes in pH and

TP inferences less than the RMSE of the inference models. In addition, 45% of the study lakes showed increases in diatom taxa (*Diatoma tenue* Agardh and or *Diploneis parma* Cleve et Grunow in Cleve) that are indicative of elevated lakewater conductivity.

**Decreasing Diatom-inferred pH: Acidification**

About 4% of the study lakes showed a significant decrease (range ~ -0.3 to -1.4 pH units) in diatom-inferred pH (Fig.2, Appendix B) from pre-industrial times to the present-day period. Consistent with the decline, diatom assemblages exhibited an increase in the relative abundance of acidophilous *Fragilariforma acidobiontica* (D.F. Charles) D.M. Williams et Round (pH optima: ~4.9, Ginn et al. 2007c) and *Eunotia* spp. (pH optima ~5.5, Ginn et al. 2007c), and a subsequent decrease in the circumneutral *Cyclotella stelligera* Cleve et Grunow in Cleve (pH optima ~7.1, Ginn et al. 2007c) in Pockwock and Topsail lakes (Fig.3 i and ii). These shifts in diatom assemblages are similar to trends recorded in other acidified lakes of Nova Scotia (Ginn et al. 2006, 2007a, Tropea et al. 2007). These lakes have acidified more than others studied thus far in the province, as the net mean diatom-inferred pH decline for these systems (0.6 ± 0.20 pH units) is slightly higher than the recorded change of ~ 0.5 pH units in other parts of Nova Scotia (Ginn et al. 2007b). Although the diatom-inferred pH declines are not as high as those reported from other areas of northeastern North America (e.g. Adirondack region of New York and New England, Cumming et al. 1992), the shifts in diatom assemblages and changes in diatom-inferred pH are indicative of acidification. The mean measured pH of the lakes that show a decreasing trend in diatom-inferred pH is the lowest (5.7 pH units, bottom $10^{th}$ percentile) in comparison to that of other 51 lakes in this study (Table 2). Lakes with a pH of 6.0 or less are increasingly susceptible to acid precipitation (Keizer et al. 1993, Clement et al. 2007), which has been recorded in other Nova Scotia lakes (Ginn et al. 2006, 2007a,b, 2008c), including Halifax (Watt et al. 1979). Moreover, input of acid pollutants are brought to Nova Scotia lakes via atmospheric transport (Ginn et al. 2007a,b), while the Halifax region can also receive deposition from more local sources (Watt et al. 1979) including local power generation plants, oil refineries and other industries. Sulphate ($SO_4$) deposition is linked to acid precipitation (Babich et al., 1980, Smol et al. 1998), and it is a dominant anion in most anthropogenically acidified lakes around the world. Industrial areas, such as those in Halifax, can contribute to the amount of sulfur dioxide being emitted and air-transported as sulfur dioxide emissions measured in Halifax were double than those of other rural centers (Underwood et al. 1987). Elevated sulphate deposition combined with the poorly-weathered bedrock geology of the lakes consisting of mostly granite, gneiss and silica-based metamorphic rocks from the Halifax Formation of the Meguma Group, with limited carbonate sources (Gorham et al. 1986, Underwood et al. 1987, Watt et al. 2000), can make lakes especially susceptible to acidification. Moreover, both the acidified lakes (Pockwock, Topsail) had a naturally low pre-industrial pH (median: 6.3 pH units), which implies that these naturally acid-sensitive lakes may be susceptible to the current annual sulphate deposition in the region.

Environment Canada has recommended a decrease in deposition of strongly acid anions for Atlantic Canada. They suggested that the acid deposition levels currently exceed critical loads for ~21-75% of eastern Canada, and that an additional 75% reduction in sulphur dioxide ($SO_2$) emissions is necessary to protect these aquatic resources from the adverse damages (Environment Canada 2004).

Even though all the study lakes are generally characterized by similar granitic bedrock geology, thin soils, and excess sulphate loading, the low diatom-inferred pre-industrial pH for the 2 acidified lakes, in comparison to others in the study, suggest that these lakes would be more sensitive. This is consistent with a study by Smol et al. (1998), which reported that Adirondack lakes with low pre-industrial pH (range 5.0-7.0) acidified despite low $SO_4^{2-}$ deposition relative to Sudbury lakes with higher pre-industrial pH (range 6.0-7.8). Moreover, the Adirondack lakes did not respond to post 1970 decreases in sulphate deposition. Thus, it is reasonable to suggest that these 2 Halifax region lakes have acidified and have yet to recover, similar to the acid-sensitive lakes from other studies (e.g. Cumming et al. 1994, Smol et al. 1998).

The developmental index for the acidified lakes was relatively low (Table 2), implying that the acidified lakes were relatively undisturbed by watershed development and other anthropogenic activities. Measured pH values for lakes with little or no anthropogenic impact, or urban development, were lower than the values in lakes with well-developed watersheds (Keizer et al. 1993, Clement et al. 2007).

In addition, currently low measured pH and alkalinity for the 2 acidified lakes (Fig. 3) listed above can also explain the observed acidification trend. The measured pH values for the 2 acidified lakes were relatively low (median: 5.7 pH units) and were in the lower $10^{th}$ percentile in pH of all study lakes. Moreover, both the acidified lakes had low Gran alkalinity (median: 0.26 mg $CaCO_3$/L). As alkalinity is often used as an indicator of recovery from acidification (Stoddard et al. 1999), the low values for the 2 lakes that infer acidification can suggest the lack of recovery from acid deposition. Similar patterns were observed in the Adirondack lakes (Cumming et al. 1994). As suggested by

Stoddard et al. (1999), the lack of recovery from decreased sulphate loading, and observed acidification trends in these acidified lakes, may be due to excessive declines in base-cations, which results from the leaching and severe depletion of cations from sensitive watershed soils being impacted by acid depositions. Based on our observations from diatom inferences and species composition (discussed above), we conclude that the naturally acid-sensitive nature of Pockwock and Topsail lakes combined with acid deposition, led to their acidification.

Thus far, paleolimnological studies of acidification in Nova Scotia lakes have documented two major floristic changes in diatom assemblages as a result of recent acidification: a change from coloured, higher dissolved organic carbon (DOC) acid waters to more acid clear water lakes; and from clear water lakes to a more acidic flora and higher concentration of inorganic aluminum concentrations (Ginn 2006). The latter is characterized by a change from an assemblage dominated by circumneutral *C. stelligera* pre-industrially with a change to acidophilous *Frustulia pseudomagaliesmontana* Camburn et D.F. Charles, *Eunotia* spp. and *F. acidobiontica* (Ginn 2006). Humic, high DOC, lakes are characterized by a shift from species found in slightly acid lakes, such as *Aulacoseira* spp., to diatoms indicative of further acidification, such as *Asterionella ralfsii* var. *americana* Körner (Ginn 2006). This change is similar to the observed changes in our 2 lakes (Fig. 3). Acidified lakes often show a loss in DOC as a result of increased organic acid protonation (Kingston and Birks 1990, Tropea et al. 2007). As DOC increases, the buffering capacity for lakes against pH declines (Ek and Korsman 2001), and lakes low in DOC will often show greater floristic changes indicative of acidification than high DOC humic lakes (Ginn et al. 2007b, Tropea et al. 2007). Similar to this phenomenon, the Pockwock and Topsail lakes with low measured DOC (Table 2) showed an increase in acidophilous *F.acidobiontica* and subsequent decrease in *C. stelligera* (Fig. 3 i and ii), indicative of acidification (Charles et al. 1990, 1991, Dixit et al. 1993, Ginn et al. 2007a,b, Tropea et al. 2007). Therefore, the changes in diatom assemblages (Fig. 3) suggest that Pockwock and Topsail lakes have undergone a more pronounced acidification trend.

Based on the paleolimnological data and water chemistry trends for Pockwock and Topsail lakes, we conclude that these 2 lakes have undergone acidification since pre-industrial times. The low pre-industrial pH implying the acid-sensitive nature of these set of lakes in combination with anthropogenic deposition of strong acid anions (from acid deposition) and acid-sensitive geology likely resulted in the acidification of these 2 lakes.

**Nutrient Enrichment/Increasing Diatom-inferred Total Phosphorus**

Seven study lakes (Settle, Penhorn, Morris, Charles, Fletchers, Bissett and Banook) showed an increase in diatom-inferred TP (range: 3.7 to 29.4 µg/L) (Fig.2, Appendix B) and pH (with the exception of Lake Charles) since pre-industrial times. Furthermore, the measured mean pH (7.3; range 7-7.5; Top 25$^{th}$ percentile) and TP (14.6 µg/L; range 8-22 µg/L; Top 25$^{th}$ percentile) values for the lakes are amongst the highest of the available values for the 51 lakes (Table 2). However, the observed shifts in diatom assemblages varied among the 7 lakes, and will be discussed in detail below.

The dominant diatom assemblages from 6 of the 7 nutrient-enriched lakes (Settle, Penhorn, Morris, Fletchers, Bissett and Banook lakes (Fig. 4a and b) showed similar trends between pre-industrial and present-day samples. Diatom assemblages were dominated by *Cyclotella* spp., taxa tolerant of circumneutral and oligotrophic conditions, and *Aulacoseira distans* (Ehrenb.) Simonsen, indicative of nutrient-poor conditions in the pre-impact period, were replaced by mesotrophic, alkaliphilous *Asterionella formosa* Hassell (TP optimum ~18 μg/L) and *Diploneis* spp. (TP optima ~11 μg/L), taxa indicative of higher TP conditions (Bigler et al. 2007, Meriläinen et al. 2000, Ginn et al. 2007c), and meso-eutrophic *D. tenue* (Anneville et al. 2002) in Settle, Penhorn, Morris, Fletchers, Bissett and Banook lakes (Fig. 4a and b). The observed decrease in the oligotrophic *C. stelligera* in present-day samples for the afore-listed study lakes (Fig. 4a and b), and subsequent increase in taxa indicative of nutrient-rich waters, have been reported from other Nova Scotia lakes that indicated eutrophication (Ginn et al. 2007c, Thienpont et al. 2008). Based on the increases in diatom-inferred TP (Fig. 2), (Appendix B), and shifts in diatom assemblages (Fig. 4a and b) for Settle, Penhorn, Morris, Fletchers, Bissett and Banook lakes, we conclude that the lakes have undergone nutrient enrichment. The diatom-inferred TP (Appendix B), Banook, Settle, Morris and Fletchers lakes have gone from an oligotrophic (TP <10 μg/L) to mesotrophic (TP 10-30 μg/L) status, while Penhorn Lake have shifted from an oligotrophic (TP 5.3 μg/L) to eutrophic (TP >30 μg/L) state, and Lake Charles remains relatively oligotrophic from pre-industrial times (TP 4.8 μg/L) to present-day (TP 14.1 μg/L).

The diatom species composition of Lake Charles was somewhat different than the other 6 nutrient-enriched lakes listed above. Lake Charles (Fig. 4a iv) showed an increase in the relative abundances of *A. distans*, as well as *Fragilaria capucina* (Rabenh.), and subsequent decrease in *A. formosa* and *C. stelligera*. As the diatom-inferred pH for Lake Charles shows a slight decrease in pH, it may also indicate a trend toward acidification. However, there was a significant increase in diatom-inferred TP

(0.97 log µg/L), compared to a smaller change in pH (-0.14) from pre-disturbance to present-day. Also, Lake Charles was categorized as oligotrophic, while the other nutrient enriched lakes were either mesotrophic (Morris, Fletchers, Banook, Penhorn), or eutrophic (Settle and Bissett) (Keizer et al. 1993). However, there are no other consistent patterns in the measured water-chemistry variables (e.g. DOC, pH) of Lake Charles in comparison to others in the nutrient enriched lakes (Table 2) to offer plausible explanation for the observed trend. Therefore, we suggest that the significant increase in diatom-inferred TP for Lake Charles indicated nutrient enrichment; and the observed differences in diatom species composition for this lake (Fig. 4a iv) in comparison to the other nutrient enriched lakes (Fig. 4a and b) can be attributed to the oligotrophic conditions of Lake Charles, versus meso-eutrophic nature of the others. The extent of developmental pressure on the watershed for Lake Charles can perhaps provide a likely explanation for the observed trends. Lake Charles had low (2) developmental index (Table 2) in comparison with the other 6 nutrient enriched lakes (median: 4). This indicates that Lake Charles is relatively under less pressure from anthropogenic impact, which could have contributed to its oligotrophic nature. The development index for the set of nutrient enriched lakes (median: 4) is higher than that of all other lakes, with 6 of the 7 lakes under moderate (3) to severe (4-5) pressure from watershed development, and or other anthropogenic-related activities in and around the watersheds (Table 2). Thus, most of the lakes in this group have developed watersheds, which is a characteristic often linked with nutrient enrichment of freshwaters, and is a plausible reason for the observed nutrient enrichment of Settle, Penhorn, Morris, Charles, Fletcher's, Bissett and Banook lakes. The observed nutrient enrichment of the 7 lakes listed above can also be attributed to other anthropogenic-induced changes including faulty septic fields in Halifax County, overflow of sewers or treatment plant wastes from heavy rain and increased use of lawn and garden fertilizers, and anthropogenic inputs (Keizer et al. 1993, Clement et al. 2003, Werner et al. 2005, Thienpont et al. 2008, Beyene et al. 2009). Moreover, anthropogenic activities in and around watersheds, including clearance of natural vegetation, construction of highways (Hinch and Underwood 1990) and other residential, recreational and industrial activities, can increase the nutrient inputs in freshwaters (Dixit et al. 1999, Smol, 2008, Schiller et al. 2008, Krivokapic et al. 2009), and these lakes are no exception.

**Climate Change**

Ten of the study lakes (Frog Pond, McCabe, Williams, Big Albro, Rocky, Loon, Second, Micmac, Paper Mill and William) showed an increase in diatom-inferred pH, and a decrease or little change in diatom-inferred TP (Fig.2, Appendix B). In general, the mean diatom-inferred pH for these lakes increased by 1.5 pH units, while there was only a slight change in diatom-inferred TP. Present-day inferences, along with mean measured values for pH (7.1), and TP (9.0 μg/L) indicated that most, if not all of the lakes were currently circumneutral and oligotrophic. This suggests that these set of lakes were not impacted by acidification (in comparison to the low-pH acidified lakes), and nutrient inputs (in comparison to the nutrient enriched lakes).

Sedimentary diatom assemblages showed relatively similar changes for most of the ten lakes listed above, with the exception of a few, which will be discussed below. The small planktonic *C. stelligera* was highly abundant in present-day sediment samples of 9 (Frog Pond, McCabe, Williams, Big Albro, Rocky, Loon, Second, Mic Mac and

William) of the 10 lakes (Fig. 5). In most of the lakes, *C. stelligera* increased in relative abundance with a subsequent decrease in the tychoplanktonic *Aulacoseira* complex from pre-industrial to present-day conditions (Fig. 5). Mean relative abundance of *C. stelligera* was greater in the top (14%) versus bottom (4%) samples, while that of *Aulacoseira* complex was higher in bottom (15%) versus top (9%) samples. Battarbee et al. (1999) suggested that the relative abundance of *C. stelligera* generally decreases with acidification, and these lakes have indicated a consistent increase in *C. stelligera* (Fig. 5). In addition, the observed shifts from *Aulacoseira* complex (pH optima = ~5.7 to 6.7) to *C. stelligera* (pH optima = ~7.0) infer increased pH (or decreased acidity) for these lakes, as reported earlier (Fig. 2). Climate change may be a plausible mechanism for the observed diatom trends in these study lakes.

The increased abundance in the modern sediments of *C. stelligera*, a small, low-nutrient indicating planktonic diatom, and decrease in heavily-silicified *Aulacoseira* complex that we observed has also been well documented trend indicative of climate change in other studies (Catalan et al. 2002, Sorvari et al. 2002, Rühland et al. 2003, Rühland and Smol 2005, Smol et al. 2005, Harris et al. 2006, Ginn et al. 2008b, Rühland et al. 2008, Thienpont et al. 2008, Enache et al. submitted). Also, climate warming trends have been observed in other Nova Scotia lakes (Ginn et al. 2008b, Thienpont et al. 2008), New Brunswick (Harris et al. 2006), and numerous lakes around the globe (Rühland et al. 2002, 2003, Smol et al. 2005, Rühland et al. 2008). Thus, it is reasonable to suggest that a climate-induced change in diatom species composition is a possibility in Halifax region.

Instrumental temperature record from Halifax region (Environment Canada 2002) have indicated a temperature increase of ~1.5°C since 1870, and mean summer temperature increase of ~0.8°C from 1948 (see Ginn et al. 2008b). In addition, the neighbouring province of New Brunswick has also recorded a statistically significant increase in temperature since ~1900 (Harris et al. 2006). Such recorded temperature increase in the study region can be related to the observed climate change signal expressed by the diatoms in these set of study lakes (Fig. 5), and is consistent with those findings reported from previous paleolimnological studies from Nova Scotia (Ginn et al. 2008b, Thienpont et al. 2008).

Detailed-core analyses from a set of Nova Scotia lakes have clearly illustrated the link between the recent increases in air temperature and the high relative abundance of planktonic diatoms in modern sediment samples. The warm temperature trend since ~1870 corresponded to an increased dominance of *C. stelligera* and parallel decrease in *Aulacoseira* complex in lakes from Nova Scotia (Ginn et al. 2008b). The observed shifts in diatom assemblages are probably associated with warming temperatures and longer ice-free season and prolonged thermal stratification (Catalan et al. 2002, Sorvari et al. 2002, Rühland et al. 2003, Smol et al. 2005, Rühland et al. 2008). Increased open-water period can increase planktonic habitats, and the small planktonic *C. stelligera* which can remain in the photic zone exhibits high abundance during this time (Catalan et al. 2002). In contrast, *Aulacoseira* complex favour decreased thermal stability and requires turbulent waters stay up in the water column (McCausland et al. 2002, Rühland et al. 2008), which explains the decrease abundance of these species in the modern sediments of the set of study lakes (Fig. 5).

The mean developmental index (2.6) for the 'climate' group of lakes was the second lowest of all other groups (the acidified lakes had the lowest developmental pressure, as discussed earlier). Thus, the lakes are under very low-to-moderate pressure from development. As reported earlier in this section, the slight changes in diatom-inferred TP (range: - 3.6 μg/L to + 6.4 μg/L), observed oligotrophic conditions from measured TP, and the relatively undisturbed watersheds for these lakes (Table 2) indicate that they have not been affected by nutrient enrichment. Moreover, 7 of the 10 lakes have declined in diatom-inferred TP (Appendix B). These may be a sign of declining phosphorus levels that have been observed in some Ontario lakes (Hall and Smol 1996), which can also be related to climatic fluctuations that decrease nutrient inputs from lake catchments by decreasing inflows to lakes (Hall and Smol 1996). Therefore, we conclude that the changes in diatom assemblages and inferences between pre-impact and present-day conditions for these lakes are consistent with a climate change signal.

Paper Mill Lake showed slight variation in the diatom species composition, but the overall changes were consistent with recent climate warming. In Paper Mill Lake, *C. stelligera* is absent in both pre-industrial and present-day samples (Fig. 5). However, the lakes showed an increase in abundance of other planktonic diatoms such as *Tabellaria flocculosa* complex and a decrease in some benthic taxa (Fig. 5) such as *Eunotia* spp, *Tabellaria quadriseptata* B.M. Knudson. Overall, benthic diatoms were more represented in pre-industrial sediments relative to present-day samples (Fig. 5). However, a few benthic taxa, such as *D. tenue*, *D. marginestriata,* and *Fragilariforma exigua* (Grunow) Krammer et Lange-Bert, have increased in the modern sediments (Paper Mill, William and Rocky). Despite the absence of *C. stelligera* in Paper Mill Lake (Fig. 5), the diatom assemblage composition indicated oligotrophic, non-acidified waters; and shows an increase abundance of planktonic diatoms and subsequent decrease in benthic *Eunotia* taxa. The shift from benthic in pre-industrial period to planktonic species in modern sediments, has been extensively observed and documented in high-latitude lakes (Smol et al. 2005), as well as numerous other North American and European lakes (Rühland et al. 2008). Moreover, increased air temperatures can lead to late freezing and early breakup of ice cover on lakes (Magnuson et al. 2000), which in turn gives rise to planktonic habitats in the study region (discussed below in detail). Thus, recent climate warming can be attributed to the observed diatom trends from benthic to planktonic species in Paper Mill and all the other afore-listed lakes.

Based on the diatom-based reconstructions, and observed shifts in diatom assemblages, these ten lakes listed above were mostly impacted by recent climate warming in comparison to other environmental stressors such as acidic deposition, and nutrient enrichment. Moreover, climate change signals were pre-dominantly observed in high-latitude regions as the circumpolar area is highly sensitive to climate warming (Smol et al. 2005), while its impact on other regions are likely overshadowed by anthropogenically-induced environmental stressors. However, in the recent past, there has been considerable evidence of climate warming in temperate regions that were not impacted by acidification or eutrophication (Harris et al. 2006, Rühland et al. 2008, Enache et al. submitted), including Nova Scotia (Ginn et al. 2008 b, Thienpont et al. 2008). Thus, we conclude that the observed trends in diatom assemblages and diatom reconstructions are indicative of the impact of climate change in the afore-listed group of Halifax region lakes.

**Decreasing Diatom-inferred Total Phosphorus: Oligotrophication/Acidification**

Two of the study lakes showed a decline in diatom-inferred TP greater than the RMSE of inference model (Fig.2, Appendix B), and indicate a trend toward oligotrophication coupled with acidification. First Chain Lake (oligotrophic during pre-industrial times) and Chocolate Lake (mesotrophic during pre-industrial times) have apparently become more oligotrophic since the pre-impact period. Both lakes had the lowest measured TP in comparison to others (Table 2) and showed a consistent decrease in TP and chlorophyll *a* concentrations from 1980 to 2000 (Clement et al. 2007), which corresponds to the diatom-inferences. The diatom assemblages in First Chain Lake indicated an increased abundance of *F. acidobiontica* and *F. pseudomagaliesmontana* and *Eunotia* spp. (Fig. 6 ii). This trend is similar to that of acidified lakes. Similarly, Chocolate Lake (Fig. 6 i) shows an increase in acidophilous *Cavinula cocconeiformis* (Ehrenb.) (pH optima 4.7, Ginn et al. 2007c) and a decrease in *A. formosa*, taxa that are typically abundant in productive lakes. The decrease in *A. formosa* indicates a change to a low-productivity lake, while the increase in acidophilous species can be a sign of acidification of watersheds. Oligotrophication of lakes is often a result of acidification (Olsson and Pettersson 1993). Decreases in TP can be a result of acidification as phosphorus is often trapped within catchments, and or more readily lost from lakes via formation of phosphorus-aluminum compounds (Jansson et al. 1986, Olsson and Pettersson 1993, Hall and Smol 1996).

The exact reason for the decline in diatom-inferred TP remains unknown, but there are several possibilities, in combination with the acidification trend, for both First Chain and Chocolate lakes. The mean aluminum concentration for the two lakes was the highest among all other groups (Table 2), and was considerably higher than other lakes in 1991 (Clement et al. 2007). Aluminum, produced from leaching of rock and soil, is often high in lakes with low pH (Keizer et al. 1993) and has significant impact on acidification and species composition of freshwaters (Kingston et al. 1992). The oligotrophication/acidification trend for the two lakes suggests that P may have been retained within the catchments, or depleted rapidly due to increased formation and precipitation of P-Al compounds in the water column. As reported by Hall and Smol (1996), three south-central Ontario lakes that showed substantial decline in diatom-inferred TP also exhibited marked decrease in diatom-inferred pH, and lakes that declined in pH had no increase in TP. Similar patterns or changes were reported from several lakes that indicated combined decline in diatom-inferred TP and pH (Quinlan et al. 2008). These findings suggest a potential relationship among pH and TP trends in lakes including those observed from First Chain and Chocolate lakes in this study.

Furthermore, the mean measured Gran alkalinity for First Chain and Chocolate lakes is the lowest among other groups (Table 2), and indicates poor buffering capacity (Keizer et al. 1993, Clement et al. 2007, Ginn et al. 2007a,b). Pre-industrial pH (median: 5.7 pH units) for both First Chain and Chocolate lakes (Appendix B) are lower than all other lakes (with the exception of the acidified lakes). Thus, as suggested earlier for acidified lakes, these two lakes had naturally acidic background pHs due to sensitive bedrock geology, and organic acid inputs from forested catchments and acid bogs around the watersheds (Ginn et al. 2006). It is likely that increased acid deposition in the area contributed to the observed trend toward oligotrophication and acidification.

Although both First Chain and Chocolate lakes tracked an acidification trend, they were not grouped with the acidified lakes due to the observed changes in nutrients. The pre-industrial diatom-inferred TP for these lakes (median: 12.2 µg/L) was much higher than the pre-industrial TP of the 2 acidified lakes median: 6.3 µg/L, suggesting that these two lakes were slightly more productive (than the acidified lakes) during pre-disturbance times. For example, the abundance of productive diatoms (e.g. *A. formosa*) in the pre-industrial sediments of these lakes (Fig. 6) and the high diatom-inferred natural TP (Appendix B) in pre-impact times (mean pre-industrial TP: 12.2 µg/L and mean present-day TP: 3.9 µg/L) indicate that both lakes were nutrient-rich in pre-industrial period. Moreover, First Chain Lake is protected by Halifax Water Commission for water supply purposes, and thus has very little development, which can result in decreased nutrient inputs (Hall and Smol 1996), and may further explain the declining inferred TP in First Chain Lake. Therefore, both Chocolate and First Chain lakes were naturally mesotrophic and have recently undergone a significant decrease in TP and pH leading to oligotrophication coupled with acidification, and several factors are attributable to the observed trend.

**No Change in Diatom-inferred pH and Total Phosphorus**

Thirty lakes showed changes in diatom-inferred TP and pH less than the RMSE of the inference models (mean change DI-pH: 0.04; mean change DI-TP: -0.04 log TP), but the diatom assemblages have changed since pre-industrial times (Table 4) as indicated by Bray-Curtis similarity coefficients (range 44.8-81.3%). However, as expected, mean Bray-Curtis similarity coefficients between ‘top’ and ‘bottom’ samples for this group (59.4%) is high in comparison to lakes that showed larger change in DI-pH and TP, which indicates that the change in diatom assemblage from pre-industrial to present-day conditions was less than that of other study lakes. The measured pH range (4.7-7.5) indicates that some lakes are acid and others are circumneutral and alkaline (Table 2). The nutrient status of the lakes are in the oligo-mesotrophic range (TP range: 4.0-22 μg/L). However, the mean diatom-inferred change in log TP (-0.04) was less than the RMSE of the inference model, cut-off range used in the study (± 0.4 log μg/L).

Although these lakes did not exhibit changes greater than the RMSE, there were floristic changes between the pre-industrial and present-day samples of the lakes that illustrated modest trends towards environmental stressors (e.g. acidification, nutrient enrichment) and are worthy of discussion.

A plot of diatom-inferred change in log TP versus pH for this group of lakes (Fig. 7) indicated that, of the thirty lakes, eleven (Little Springfield, Bayers, Frenchman, Soldier, Bell, Miller, Whimsical, Cranberry, Second Chain, Major and Shubenacadie Grand) show a trend towards a have decrease in pH and TP (Fig. 7). Acidophilous *Eunotia* spp. has increased in all these lakes, while *F. acdidobiontica* (in Soldier, Second Chain, Major and Shubenacadie Grand lakes), and *F. pseudomagaliesmontana* (in Soldier, Bell, Second Chain, Major and Shubenacadie Grand lakes) are abundant in present-day samples (Fig. 8 a and b). Similar diatom-related trends have been documented in other acidified lakes of Nova Scotia (Tropea et al. 2007, Ginn et al. 2007a,b), as was discussed earlier. Moreover, the mean measured sulphate concentrations (14.1 mg/L) are higher and pH (5.9) is lower than that of other lakes within this group, which is consistent with a modest acidification (Babich et al. 1980, Ginn et al. 2007). Mean diatom-inferred pH for pre-industrial conditions (5.7) show that the lakes in this category were naturally acid. There is no consistent pattern in other physical and chemical characteristics of these lakes.

Little Springfield, Frenchman, Soldier and Bell lakes showed an increase in acidophilous *Eunotia* spp., and *Tabellaria quadriseptata* B.M. Knudson (pH optima ~4.9) and a decrease in *C. stelligera* from pre-to-post industrial period (Fig. 8a and b). The afore-listed lakes had a higher DOC (mean: 4.2 mgC/L) in comparison to other lakes in this group (Table 2) and showed a shift from circumneutral *C. stelligera* and *Aulacoseira* complex to *Eunotia* spp. (Fig. 8a and b), which is characteristic of humic lakes that exhibit a modest trend toward acidification (Ginn et al. 2007a,b, Tropea et al. 2007). Therefore, the changes in diatom assemblages (Fig.8a and b) suggest that Little Springfield, Frenchman, Soldier and Bell lakes have undergone a modest acidification trend in comparison. In general, the changes in diatom-based reconstructions, trends from diatom assemblages, and measured water chemistry data for the eleven lakes listed above suggest a slight acidification.

Nine (Thomas, Kinsac, Sheldrake, Little Albro, Powder Mill, Anderson, Maynards, Third and Fraser) of the thirty lakes (Fig. 7) indicate slight increases in diatom-inferred TP and pH. Corresponding to the inferences, present-day assemblages from these nine lakes show an increase in diatoms indicative of higher nutrient concentrations such as *A. formosa* (in Sheldrake, Powder Mill, Anderson and Fraser lakes) and a decrease in acidophilous *Eunotia* spp. (Fig. 9a, b and c). Diatom changes in the nine lakes suggest a slight increase in nutrient concentrations, but remain oligotrophic (mean DI-TP: 9.4 μg/L). This trend is consistent with the presently oligotrophic status of these lakes based on their measured present-day TP (mean: 9.1 μg/L). The degree of inferred changes is small and the lack of definite difference in other physical and chemical characteristics among these lakes makes it impossible to determine the likely cause for the observed trend. However, pre-impact TP was lower than the modern period, and the developmental indices for most of these lakes are moderate (3) to high (4). It is therefore reasonable to attribute increased anthropogenic inputs and influence on these lakes to a slight increase in nutrients.

Furthermore, sedimentary diatom assemblages from Lake Thomas, Kinsac, Powder Mill, Anderson, Maynards and Third lakes (Fig. 9a, b and c) were slightly different than those discussed above, and may indicate nutrient enrichment combined with a climate warming signal. This set of lakes showed a slight increase in *Cyclotella* spp. and subsequent decrease in *A. distans* (TP optima ~5µg/L) indicative of a well-documented trend toward climate warming (Catalan et al. 2002, Sorvari et al. 2002, Rühland et al. 2003, Rühland and Smol 2005, Smol et al. 2005, Harris et al. 2006, Ginn et al. 2008b, Rühland et al. 2008, Enache et al. submitted). The observed increase in planktonic *C. stelligera*, paralleled with a relative decrease in tycoplanktonic *A. distans* in the surface-sediment samples of these lakes (Fig. 9a, b and c) corresponded with previously recorded significant increase in air temperature (of ~1.5 °C from 1890-2001) in Halifax region (Environment Canada 2002), and is consistent with previously reported diatom trends from other Nova Scotia lakes that have expressed a climate change signal (Ginn et al. 2007c, Thienpont et al. 2008). Therefore, based on changes in diatom species composition (Fig. 9a, b and c), and inferences (Appendix B) between pre-industrial to present-day samples, we conclude that the diatoms in the afore-listed lakes are tracking modest increase in nutrients, due to watershed disturbances, and climate change, in response to recent climate warming in the region.

Ten of the thirty lakes that did not show changes greater than the RMSE of the TP and pH inference models indicate slight increases in diatom-inferred pH and decrease in diatom-inferred TP (Fig. 7). There were slight variation in the diatom species composition of these ten lakes, but the overall changes were corresponding to recent climate warming. Six of these ten lakes (First, Springfield, Kearney, Lamont, Sandy and Russell) indicate an increase in *C. stelligera* and paralleled with a decrease in *Aulacoseira* spp. in modern sediment samples (Fig. 10a, b and c), consistent with the climate warming trend discussed earlier. Russell Lake shows a small decline in diatom-inferred TP (8.1 μg/L) and little or no change in pH (-0.03). The diatom assemblages show little or no change since pre-impact conditions (Bray-Curtis similarity index: 81.3%). Both pre-industrial and current sediment samples are dominated by mesotrophic, alkaliphilous diatoms including *A. formosa* and *Aulacoseira ambigua* (Grunow) Simonsen (Fig. 10c). The diatom species composition, along with pre-impact TP for Russell (23.4 μg/L), suggested that the lake was naturally productive, and now shows slight decrease in nutrient content, (present-day diatom-inferred TP: 16.3 μg/L). Detailed core-analysis on Russell Lake indicated that the lake became increasingly productive between ~1970 and ~1995 possible related with eutrophication linked to a hog farm, followed by subsequent decrease in nutrients between ~1995 and ~2002 possibly corresponding to the closure of hog farm (Tropea 2005). Moreover, there is an increased abundance of small, planktonic *C. stelligera* paralleled with decrease in tycoplanktonic *A. distans* (Fig. 8), which has been a well-documented trend toward climate warming

(Rühland et al. 2008). Therefore, it is reasonable to conclude that Russell Lake shows slight recovery from eutrophication due to decreased nutrient inputs from surrounding watershed, in conjunction with a climate warming signal.

In Oathill, Governor, Power Pond and Long lakes *C. stelligera* is absent in both pre-industrial and present-day samples (Fig. 10a and b). However, the lakes showed an increase in abundance of other planktonic diatoms such as *Tabellaria flocculosa* complex (in Power Pond and Long) and *A. formosa* (in Oathill), and a decrease in some benthic taxa (Fig. 10a and b) such as *Eunotia* spp, *Tabellaria quadriseptata* B.M. Knudson (in Papermill), and *Fragilaria brevistriata* and *Brachysira styriaca* Lange-Bert. Et G. Moser (in Oathill Lake). Overall, benthic diatoms were mostly represented in pre-industrial sediments relative to present-day samples (Fig. 10a and b). However, a few benthic taxa, such as *D. tenue*, *D. marginestriata,* and *Fragilariforma exigua* (Grunow) Krammer et Lange-Bert, have increased in the modern sediments (Oathill). Despite the absence of *C. stelligera* in these four lakes (Fig. 10 and b), the diatom assemblage composition indicated oligotrophic, non-acidified waters; and show an increase abundance of planktonic diatoms and subsequent decrease in benthic *Eunotia* taxa (with the exception of Power Pond with low pH, and increase abundance of *Eunotia* spp.). These trends in diatom assemblages, shifting from benthic in pre-industrial period to planktonic species in modern sediments, have been extensively observed and documented in high-latitude lakes (Smol et al. 2005), as well as numerous other North American and European lakes (Rühland et al. 2008). Increased air temperatures can lead to late freezing and early breakup of ice cover on lakes (Magnuson et al. 2000), which in turn gives rise to planktonic habitats in the study region. Thus, recent climate warming can be attributed to the observed diatom trends from benthic to planktonic species in these lakes.

Long and Governor lakes indicated a decline in diatom-inferred log TP and an increase pH (Fig. 7). The present-day diatom assemblages showed an increased relative abundance of *Eunotia* spp. and a parallel decrease in *A. formosa* (Fig. 10b). Average pre-impact TP (8.4 μg/L) for both lakes showed that they were naturally oligotrophic and are becoming more nutrient poor. Furthermore, the lakes were naturally acid (mean pH 5.9) and the change in inferred pH from pre-impact conditions is very small (Fig. 7). Monomeric aluminum concentrations for these two lakes (0.25 mg/L) is higher than that of the other lake groups that indicated little change in DI-TP and DI-pH. As discussed earlier, high Al content has been previously recorded in acid lakes (Jansson et al. 1986, Kingston et al. 1992, Olsson and Pettersson 1993, Hall and Smol 1996), and the binding of Al and P and the resulting Al-P compound can lead to decreased nutrient concentrations. Also, these lakes remain acid as indicated by the abundance of acidophilous *Eunotia* spp. in the top sediments. It is therefore reasonable to conclude that the two lakes have become increasingly nutrient-poor, but remain acidic.

Thirty of the fifty-one study lakes showed change in diatom-inferred pH and TP smaller than the RMSE of the inference models. However, there were modest changes between the diatom assemblages from pre-impact to pre-industrial times and eleven of the thirty lakes indicated acidification, nine lakes showed nutrient enrichment while ten others showed changes consistent with climate change. Although the observed environmental changes in the thirty lakes are not substantial in comparison to the others, it is important to continue to monitor the lakes as the current stressors may become increasingly apparent in the future and have detrimental impact on the aquatic systems.

**Increasing Measured Conductivity: Implications of Lake Salinization**

As reported earlier, water chemistry measurements from Halifax region lakes revealed a two-fold increase in specific conductivity measurements between 1980 and 1991 for most of the study lakes (Keizer et al. 1993), and smaller increases between 1991 and 2000 (Clement et al. 2007). The NENA diatom-calibration dataset does not have a strong predictive model for lake water conductivity, but a number of indicator taxa of higher conductivity have been consistently identified in the literature (Tuchman et al. 1984, Potapova and Charles 2003). To illustrate the potential impact of the problem of increase conductivity, we use two well known taxa that are indicative of higher conductivity (*D. tenue* and *D. parma*). Consistent with the trends from water chemistry, diatom taxa tolerant of increased salinity (e.g. *D. tenue*) were observed in ~ 45% of the study lakes (Fig. 11). For example, *D. tenue*, a halophilic taxon, sensitive to increased salinity (Tuchman et al. 1984), increased in relative abundance in the present-day samples of several lakes (Whimsical, Bissett, Cranberry, Penhorn, Oathill, Frog Pond, Chocolate, Settle, First, Banook, Maynard, Mic Mac, Big Albro, Rocky, Morris, Loon, Powder Mill, Thomas, William, Fletcher, Kearney, Third, and Lamont) and decreased in Miller and Major lakes (Fig. 11). Overall, the increased percent abundance of *D. tenue* in the above-listed lakes corresponds with high measured conductivity levels (Fig. 12) for these lakes (mean: 369 μS/cm; range 61-643 μS/cm) in comparison to other study lakes (mean: 208 μS/cm; range: 37-469 μS/cm). In addition, *D. tenue* decreased in relative abundance in present-day samples of Major and Miller lakes (Fig. 12), which had comparatively lower conductivity levels (mean: 157 μS/cm). Low conductivity measurements likely correspond to the natural levels of conductivity resulting from dissolved ions produced from the weathering of rock and influence of marine conditions (Clement et al. 2007). Thus, low conductivity levels are generally observed in lakes with relatively undisturbed watersheds. Consistent with this, lakes with increased *D. tenue* and high measured conductivity (Fig. 12), on average, were under moderate to high pressure from human-induced watershed disturbances (range developmental index: 3-5) in comparison to the lakes that tracked a decrease present-day relative abundance of *D. tenue* (range developmental index: 1-3). Similar observations were reported by Siver et al. (1999), where lakes with catchments of at least 80% forested area rarely increased in conductivity, while those lakes with a minimum of ~25% or over deforested catchment area (associated with more road construction) recorded significant changes in conductivity. In addition, most of the above-listed lakes that showed an increase abundance of *D. tenue* and high conductivity measurements are surrounded by local roads and highways in comparison to Lake Major which was relatively far from any major roads and or highways, and showed a decrease in *D. tenue* in modern sediments. Therefore, it is reasonable to conclude that increased winter usage of road salts in the area likely impacted this set of lakes, which has led to increased salt concentrations, and high conductivity levels and the observed high abundance of *D. tenue* in present-day sediments of these lakes.

Another diatom taxon with high tolerance for conductivity, *D. parma* (conductivity optima ~398 μs/cm, and tolerance up to ~979 μS/cm, Potapova and Charles 2003), was also highly abundant in the present-day samples of seven study lakes (Bissett, Settle, Banook, Big Albro, Rocky, Little Albro, and Fletcher's, Fig. 11), all with relatively high conductivity measurements (mean conductivity: 383 µS/cm, range: 159-602 µS/cm, Table 2). Meanwhile, Lamont Lake with relatively low conductivity (61.2 µS/cm), tracked a decrease in *D. parma* (Fig. 11). The above-listed lakes with increased relative abundance of *D. parma* and high conductivity readings were subjected to relatively high developmental pressure (mean development index: 3.7, Table 2), than Lamont Lake (developmental index: 2.0), which showed a decrease in *D. parma* in modern sediments. Therefore, as suggested earlier, this set of lakes is situated in catchments that may have lost some forested area due to road construction and/ or residential development, and are thus receiving increased anthropogenic-inputs of road salts, as well as erosional events leading to high measured conductivity. As well, the runoff from urbanized or residential areas are higher than those of forested or undisturbed areas (Prowse 1987, Siver et al. 1999), which is consistent with the observed trends from these study lakes. Thus, it is reasonable to conclude that the afore-listed lakes that tracked an increase percent abundance of *D. parma*, and *D. tenue* (Fig. 11), and increased conductivity levels over the three water chemistry sampling periods (1980, 1991, and 2000, Fig. 12), along with the high developmental indices indicative of relatively disturbed watersheds (Table 2) have been impacted by elevated anthropogenic-use of road salts, and/or associated problems with erosion.

In addition to the floristic changes discussed above, it is also important to note that diatom-inferred pH, and TP increased for most of the lakes that tracked changes related to conductivity levels. For example, of the 26 lakes that tracked ecological changes corresponding with measured conductivity levels, 12 were lakes that tracked nutrient enrichment and/or climate change signals from pre-to-post-industrial times (as discussed earlier). The 12 lakes (Bissett, Penhorn, Frog Pond, Settle, Banook, Mic Mac, Big Albro, Rocky, Morris, Loon, William and Fletcher's) show an increase in diatom-inferred pH (Appendix B). This is also consistent with the observed correlation between pH and conductivity (Table 3). Similar observations were reported from a previous paleolimnological study of Freshwater Lake from Cape Breton Highlands National Park, Nova Scotia (Ginn et al. 2008 a). The study suggested that increased conductivity and diatom-inferred pH levels likely indicate anthropogenic-related influences on the watersheds along with soil erosion (Ginn et al. 2008 a). Considering that the nutrient enriched study lakes were in relatively disturbed watersheds (as discussed earlier), increases in nutrients and conductivity are not unexpected.

**Multiple cores/reproducibility of paleolimnological data**

In terms of reproducibility, the changes in diatom-inferred TP and pH values between the pre-industrial and present-day samples of the eight replicate cores (Fig. 13) were highly similar, with generally low variability. For example, the three cores from each of the eight lakes are consistently showing the same trends, and the same categorization of lakes based on the inferred changes did arise from multiple cores. Similarly, diatom assemblage compositions among the three tops and bottoms of the eight lakes are also very similar (Fig.14), as indicated by the high degree of similarity among the Bray-Curtis coefficients among the tops and bottoms of individual lakes (Appendix C). Moreover, there is good agreement and less variability between the diatom-inferred pH (Fig.15) and TP (Fig.16) for the three tops and bottoms of all eight lakes. These findings are consistent with other paleolimnological studies with replicate cores that showed the reliability of paleolimnological techniques and core reproducibility (Anderson 1986, 1990, Charles et al. 1991, Cumming et al. 1992, Hall and Smol 1996, Heiri et al. 2003, Ginn et al. 2006) by showing highly similar trends in diatom assemblage composition and inferences.

**Summary and Conclusions**

In conclusion, the rapid ecological assessment using the RMSE of TP and pH inference models as a critical-threshold value to determine change since pre-industrial times of a population of 51 lakes from HRM has indicated important environmental stressors including lake acidification (4% of lakes) and nutrient enrichment (14% of lakes). Ten lakes that were generally unimpacted by acid deposition and nutrient enrichment tracked a well-documented diatom shift indicative of climate warming, that is an increased relative abundance of planktonic *C. stelligera* and decreased *A. distans*, which also corresponded with increases in measured air temperature in Halifax. Two study lakes exhibited oligotrophication trends paralleled with acidification, while thirty showed no significant change in diatom-inferred pH and TP. In addition, ~ 51% of the study lakes tracked diatom assemblage changes associated with conductivity increases. The high abundance of *D. tenue* and *D. parma*, taxa with relatively high conductivity optima, in twenty three study lakes corresponded with high measured conductivity levels, while decreased abundance of these diatom flora in present day sediments of three study lakes correlated with low conductivity levels. The observed changes are somewhat complex, and clearly showed that cumulative effects of multiple natural and anthropogenic-related stressors can bring broad-scale ecological changes in the region. Furthermore, diatom profiles and inferences from eight lakes with multiple cores showed very little variability among each replicate sample and thus confirm the reproducibility of paleolimnological data. This study offers an efficient method of performing a rapid assessment of regional water-quality change in freshwater ecosystems.

Although it is difficult to offer the exact timing and cause of the observed environmental changes with the before-after paleolimnological approach used in this study, our results indicate that diatom species composition has changed since pre-industrial times, and that a number of natural and anthropogenic-related stressors are attributable to the inferred water-quality changes. Moreover, the possibility for synergistic effects of multiple stressors on the study lakes has illustrated the complexity of conducting large-scale water-quality assessments. Consequently, the results from the study clearly indicate that typical modeling techniques, which employ a single stressor-response model to assess and predict environmental changes, and monitoring practices that utilize accumulated data on water chemistry measurements to infer lake-water quality and recovery, may not be sufficient. Thus, assessments of regional water quality, and biological changes should include appropriate techniques incorporating multiple spatial and temporal scales (Quinlan et al. 2008). The methodology from this study can assist governing authorities, lake managers, and the general public to assess the environmental changes in the region, sensitivity of the lakes, and to develop realistic mitigation targets.

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**List of Tables**

**List of Figures**

**Figure 1.-** Map showing the location of the 51 study lakes in Halifax Region, Nova Scotia, Canada. Inset A shows the location of Canada within North America. Insect B shows the location of Halifax within Nova Scotia. Insect C shows the location of the study sites within Halifax Region. Corresponding lake names for the lake codes are listed in Table 1.

**Figure 2.-** Diatom-inferred change in pH from pre-industrial to modern times versus change in diatom-inferred Log TP from pre-industrial to modern times. The rectangular box in the middle is drawn based on the ~RMSE (Root-Mean-Squared-Error) value for pH (0.4) and TP (0.4) from the calibration set. Refer to Table 2 for lake codes and associated names.

**Figure 3.-** Diatom taxa with relative abundances greater than 2% in modern and/or pre-industrial sediments for the 2 study sites that indicate a decreasing trend in diatom-inferred pH. Modern and fossil samples are represented by solid bars and open bars, respectively. The lakes are organized in order of increasing similarities among surface and bottom diatom assemblages, as measured by Bray-Curtis similarity coefficients. Diatom taxa are organized in order of change between surface and bottom sediments; those that are increasing in modern sediments on the left and decreasing on the right. Note the varying percentage scales for different taxa.

**Figures 4 a and b.-** Diatom taxa with relative abundances greater than 2% in modern and/or pre-industrial sediments for the 7 study sites that indicate a trend toward nutrient enrichment/increasing diatom-inferred TP. Modern and fossil samples are represented by solid bars and open bars, respectively. The lakes are organized in order of increasing similarities among surface and bottom diatom assemblages, as measured by Bray-Curtis similarity coefficients. Diatom taxa are organized in order of change between surface and bottom sediments; those that are increasing in modern sediments on the left and decreasing on the right. Note the varying percentage scales for different taxa.

**Figure 5.-** Stratigraphic plot of the dominant diatom taxa in 10 study sites that indicate a trend toward climate change. The lakes are organized in order of increasing similarities among surface and bottom diatom assemblages, as measured by Bray-Curtis similarity coefficients. Diatom taxa are arranged as planktonic (left) and benthic (right).

**Figure 6.-** Diatom taxa with relative abundances greater than 2% in modern and/or pre-industrial sediments for the 2 study sites that indicate a trend toward decreasing diatom-inferred TP. Modern and fossil samples are represented by solid bars and open bars, respectively. The lakes are organized in order of increasing similarities among surface and bottom diatom assemblages, as measured by Bray-Curtis similarity coefficients. Diatom assemblages are organized in order of change between surface and bottom sediments, those that are increasing in modern sediments on the left and decreasing on the right. Note the varying percentage scales for different taxa.

**Figure 7.-** Plot of change in diatom-inferred pH (DI-pH) versus diatom-inferred log total phosphorus (DI-TP) from pre-to-post- industrial period for the 30 study sites that indicated change less than the RMSE value of pH (0.40) and TP (0.40) inference models. Refer to Table 2 for lake codes and associated names.

**Figures 8 a, b and c.-** Diatom taxa with relative abundances greater than 2% in modern and/or pre-industrial sediments for 11 lakes that indicate acidification trends. Note that these sites are part of the 30 study sites that that indicate change less than the RMSE value of pH (0.40) and TP (0.40) inference models. Modern and fossil samples are represented by solid bars and open bars, respectively. The lakes are organized in order of increasing similarities among surface and bottom diatom assemblages, as measured by Bray-Curtis similarity coefficients. Diatom taxa are organized in order of change between surface and bottom sediments, those that are increasing in modern sediments on the left and decreasing on the right. Note the varying percentage scales for different taxa.

**Figures 9 a, b and c.-** Diatom taxa with relative abundances greater than 2% in modern and/or pre-industrial sediments for 9 lakes that indicate nutrient enrichment. Note that these sites are part of the 30 study sites that that indicate change less than the RMSE value of pH (0.40) and TP (0.40) inference models. Modern and fossil samples are represented by solid bars and open bars, respectively. The lakes are organized in order of increasing similarities among surface and bottom diatom assemblages, as measured by Bray-Curtis similarity coefficients. Diatom taxa are organized in order of change between surface and bottom sediments, those that are increasing in modern sediments on the left and decreasing on the right. Note the varying percentage scales for different taxa.

**Figures 10 a, b and c.-** Diatom taxa with relative abundances greater than 2% in modern and/or pre-industrial sediments for 10 lakes that indicate climate change and other environmental stressors. Note that these sites are part of the 30 study sites that that indicate change less than the RMSE value of pH (0.40) and TP (0.40) inference models. Modern and fossil samples are represented by solid bars and open bars, respectively. The lakes are organized in order of increasing similarities among surface and bottom diatom assemblages, as measured by Bray-Curtis similarity coefficients. Diatom taxa are organized in order of change between surface and bottom sediments, those that are increasing in modern sediments on the left and decreasing on the right. Note the varying percentage scales for different taxa.

**Figure 11.-** Change in relative abundance (> 1%) of *Diatoma tenue* and *Diploneis parma* from pre-industrial (bottom) to present-day (top) samples. Lakes are ordered in order of decreasing conductivity measurements from top to bottom.

**Figure 12.-** Measured specific conductivity (µS) from (i) 1980 and 1991 and (ii) 1991 and 2000 for lakes with *Diatoma tenue* and *Diploneis parma*. Data courtesy of Clement et al. (2007).

**Figure 13.-** Graph of change in diatom-inferred pH from pre-industrial to modern times versus change in diatom-inferred log TP from pre-industrial to modern times for lakes with triplicate samples to show reproducibility. The rectangular box is drawn based on the RMSE value for pH (0.4) and TP (0.4) from pH and TP inference models.

**Figure 14.-** Stratigraphic plot showing reproducibility of the relative abundance of dominant diatom taxa in present (solid bars) and pre-industrial (open bars) for samples among three cores from eight lakes.

**Figure 15.-** Graphs showing reproducibility of diatom-inferred pH for top (surface) and bottom samples among three cores (1-3) from eight lakes: (i) Bayers Lake; (ii) First Chain Lake; (iii) Frog Pond; (iv) Fraser Lake; (v) Frenchman Lake; (vi) Second Chain Lake; (vii) Settle Lake; (viii) Whimsical Lake. Error bars represent standard deviation (~0.2) for pH inferences of triplicate samples.

**Figure 16.-** Graphs showing reproducibility of diatom-inferred log TP for top (surface) and bottom samples among three cores (1-3) from eight lakes: (i) Bayers Lake; (ii) First Chain Lake; (iii) Fraser Lake; (iv) Frenchman Lake; (v) Frog Pond; (vi) Second Chain Lake; (vii) Settle Lake; (viii) Whimsical Lake. Error bars represent standard deviation for the log TP inferences of triplicate samples.

**Table 1.-** Geographical co-ordinates of the 51 study sites from Halifax Region, Nova Scotia, Canada.

| Lake Codes | Lakes | LAT (N) | LONG (W) |
|---|---|---|---|
| 1 | Anderson Lake | 44°42.273' | 63°30.538' |
| 2 | Bayers Lake | 44°38.525' | 63°40.390' |
| 3 | Bell Lake | 44°40.435' | 63°30.560' |
| 4 | Big Albro Lake | 44°41.301' | 63°34.591' |
| 5 | Bissett Lake | 44°39.236' | 63°28.178' |
| 6 | Chocolate Lake | 44°38.319' | 63°37.342' |
| 7 | Cranberry Lake | 44°41.437' | 63°29.857' |
| 8 | First Chain Lake | 44°38.288' | 63°38.310' |
| 9 | First Lake | 44°46.480' | 63°37.979' |
| 10 | Fletcher's Lake | 44°50.159' | 63°36.729' |
| 11 | Fraser Lake | 44°40.203' | 63°45.219' |
| 12 | Frenchman Lake | 44°41.804' | 63°34.491' |
| 13 | Frog Pond | 44°37.463' | 63°36.245' |
| 14 | Governor Lake | 44°38.404' | 63°42.052' |
| 15 | Kearney Lake | 44°42.049' | 63°42.631' |
| 16 | Kinsac Lake | 44°49.388' | 63°39.093' |
| 17 | Lake Banook | 44°40.880' | 63°33.341' |
| 18 | Lake Charles | 44°43.594' | 63°33.051' |
| 19 | Lake Major | 44°43.696' | 63°28.912' |
| 20 | Lake McCabe | 44°46.389' | 63°45.051' |
| 21 | Lake Micmac | 44°41.487' | 63°33.103' |
| 22 | Lake Thomas | 44°47.656' | 63°36.514' |
| 23 | Lake William | 44°46.087' | 63°35.206' |
| 24 | Lamont Lake | 44°41.395' | 63°31.295' |
| 25 | Little Albro Lake | 44°41.050' | 63°34.642' |
| 26 | Little Springfield | 44°48.074' | 63°45.053' |
| 27 | Long Lake | 44°37.156' | 63°37.931' |
| 28 | Loon Lake | 44°42.273' | 63°30.538' |
| 29 | Maynards Lake | 44°40.266' | 63°33.173' |
| 30 | Miller Lake | 44°48.571' | 63°35.673' |
| 31 | Morris Lake | 44°38.414' | 63°29.436' |
| 32 | Oathill Lake | 44°40.440' | 63°33.019' |
| 33 | Paper Mill Lake | 44°43.270' | 63°41.414' |
| 34 | Penhorn Lake | 44°40.545' | 63°32.473' |
| 35 | Pockwock Lake | 44°47.401' | 63°51.602' |
| 36 | Powder Mill Lake | 44°46.314' | 63°36.412' |
| 37 | Power Pond | 44°38.599' | 63°40.380' |
| 38 | Rocky Lake | 44°45.036' | 63°37.761' |
| 39 | Russell Lake | 44°40.271' | 63°31.802' |
| 40 | Sandy Lake | 44°44.109' | 63°41.984' |
| 41 | Second Chain Lake | 44°38.228' | 63°38.310' |
| 42 | Second Lake | 44°46.865' | 63°39.308' |
| 43 | Settle Lake | 44°40.721' | 63°30.296' |
| 44 | Sheldrake Lake | 44°40.593' | 63°47.877' |
| 45 | Shubenacadie Grand Lake | 44°54.001' | 63°36.601' |
| 46 | Soldier Lake | 44°49.201' | 63°34.201' |
| 47 | Springfield Lake | 44°48.613' | 63°44.532' |
| 48 | Third Lake | 44°47.515' | 63°37.996' |
| 49 | Topsail Lake | 44°41.710' | 63°31.129' |
| 50 | Whimsical Lake | 44°37.584' | 63°36.546' |
| 51 | Williams Lake | 44°37.189' | 63°35.986' |

Abbreviations:
LAT(N)= latitude (north).
LONG(W)= longitude (west).

**Table 2.-** Measured limnological variables,and development index for the 51 study sites from Halifax Region, Nova Scotia, Canada including minimum, maximum, mean, and median values for each measured variable (data courtesy of Clement et al. 2007 and Halifax Regional Water Commission). The development index is assigned based on the degree of pressure on the lakes from watershed development.

| **LAKE** | **AREA** | **MAX DEPTH** | **CORING DEPTH** | **pH** | **TP** | **COND** | **GRAN ALK** | **DEV. INDEX** |
|---|---|---|---|---|---|---|---|---|
| | **ha** | **m** | **m** | | **µg/L** | **µS/cm** | **mg $CaCo_3$/L** | **1 = least & 5 = most pressure** |
| Anderson Lake | n/a | n/a | 26.8 | 5.6 | 8 | 61.8 | -0.2 | 1 |
| Bayers Lake | 36.0 | 8.0 | 2.2 | 5.2 | 14 | 434.0 | -0.6 | 5 |
| Bell Lake | 9.9 | 8.5 | 8.0 | 5.8 | 8 | 56.0 | -0.2 | 4 |
| Big Albro Lake | 19.8 | 6.0 | 5.8 | 7.1 | 8 | 351.0 | 8.2 | 3 |
| Bissett Lake | 88.0 | 9.0 | 7.9 | 7.4 | 22 | 602.0 | 23.7 | 3 |
| Chocolate Lake | 7.1 | 13.0 | 13.0 | 6.7 | 2 | 497.0 | 1.5 | 4 |
| Cranberry Lake | 12.8 | 3.0 | 3.8 | 7.5 | 13 | 565.0 | 19.8 | 3 |
| First Chain Lake | 72.6 | 13.9 | 5.2 | 4.8 | 2 | 328.0 | -1.1 | 3 |
| First Lake | 83.5 | 23.0 | 8.7 | 7.5 | 10 | 483.0 | 21.9 | 3 |
| Fletcher's Lake | 105.2 | 10.1 | 11.3 | 6.9 | 12 | 159.1 | 3.6 | 4 |
| Fraser Lake | 12.5 | 14.0 | 14.2 | 5.1 | 12 | 65.1 | -0.6 | 3 |
| Frenchman Lake | 8.4 | 1.5 | 1.6 | 6.1 | 12 | 469.0 | 0.6 | 3 |
| Frog Pond | 4.6 | 6.0 | 5.0 | 7.4 | 20 | 534.0 | 17.0 | 2 |
| Governor Lake | n/a | n/a | n/a | 6.3 | 13 | 412.0 | 0.3 | 2 |
| Kearney Lake | n/a | n/a | n/a | 6.5 | 11 | 150.0 | 2.9 | 2 |
| Kinsac Lake | 172.0 | 18.0 | 16.5 | 6.5 | 10 | 77.4 | 1.0 | 2 |
| Lake Banook | 33.3 | 12.0 | 12.7 | 7.5 | 14 | 403.0 | 15.0 | 5 |
| Lake Charles | 113.6 | 28.0 | 26.1 | 7.1 | 10 | 243.0 | 9.9 | 2 |
| Lake Major | 343.0 | 65.0 | 21.8 | 4.7 | 4 | 38.3 | -1.1 | 1 |
| Lake McCabe | n/a | n/a | 14.4 | n/a | n/a | n/a | n/a | 3 |
| Lake Micmac | 92.3 | 6.0 | 4.5 | 7.2 | 7 | 365.0 | 12.5 | 4 |
| Lake Thomas | 113.3 | 15.0 | 10.0 | 7.1 | 9 | 178.6 | 6.9 | 2 |
| Lake William | 235.0 | 28.0 | 26.5 | 7.1 | 6 | 170.0 | 8.0 | 2 |
| Lamont Lake | 9.3 | 6.0 | 4.7 | 5.4 | 6 | 61.2 | -0.4 | 2 |
| Little Albro Lake | 72.6 | 13.9 | 4.2 | 7.1 | 8 | 333.0 | 9.3 | 4 |
| Little Springfield | n/a | n/a | 7.8 | n/a | n/a | n/a | n/a | 3 |
| Long Lake | 158.8 | 30.0 | 15.0 | 5.3 | 7 | 220.0 | -0.4 | 1 |
| Loon Lake | 74.9 | 6.1 | 5.5 | 7.2 | 6 | 316.0 | 9.4 | 2 |
| Maynards Lake | 7.4 | 7.0 | 15.0 | 7.5 | 10 | 392.0 | 14.9 | 4 |
| Miller Lake | 104.3 | 13.0 | 11.3 | 5.7 | 12 | 98.7 | -0.3 | 3 |
| Morris Lake | 72.6 | n/a | n/a | 7.2 | 14 | 320.0 | 9.0 | 3 |
| Oathill Lake | 4.9 | 9.0 | 9.0 | 7.5 | 15 | 544.0 | 25.0 | 4 |
| Paper Mill Lake | n/a | n/a | n/a | 6.6 | 11 | 154.0 | 2.1 | 3 |
| Penhorn Lake | 4.3 | 9.0 | 9.7 | 7.5 | 8 | 558.0 | 21.3 | 4 |
| Pockwock Lake | 800.8 | 47.0 | n/a | 5.8 | 4 | 37.0 | 1.0 | 1 |
| Powder Mill Lake | 41.3 | 13.0 | 8.1 | 7.2 | 8 | 214.0 | 14.0 | 3 |
| Power Pond | 9.7 | 9.0 | 7.8 | 5.9 | 10 | 172.0 | 0.5 | 3 |
| Rocky Lake | 141.6 | 11.0 | 10.5 | 7.4 | 7 | 339.0 | 18.5 | 3 |
| Russell Lake | na | 9.0 | n/a | 7.2 | 22 | 533.0 | 12.1 | 4 |
| Sandy Lake | 18.0 | 8.0 | 15.9 | 5.9 | 8 | 132.0 | 0.2 | 3 |
| Second Chain Lake | 72.6 | 13.9 | 10.3 | 4.8 | 4 | 372.0 | -0.8 | 2 |
| Second Lake | 90.3 | 12.0 | 11.5 | 7.0 | 8 | 156.0 | 6.6 | 2 |
| Settle Lake | 6.6 | 7.0 | 7.4 | 7.4 | 22 | 496.0 | 21.4 | 4 |
| Sheldrake Lake | n/a | n/a | 6.3 | n/a | n/a | n/a | n/a | 3 |
| Shubenacadie Grand La | 99.5 | 30.0 | 25.3 | 6.6 | 17 | 98.1 | 1.6 | 1 |
| Soldier Lake | 189.8 | 31.0 | 17.4 | 5.2 | 12 | 95.0 | -0.3 | 2 |
| Springfield Lake | n/a | n/a | 4.5 | n/a | n/a | n/a | n/a | 3 |
| Third Lake | 84.8 | 24.0 | 24.8 | 7.0 | 8 | 137.3 | 5.3 | 2 |
| Topsail Lake | 59.1 | 7.0 | 6.4 | 5.5 | 3 | 65.3 | -0.5 | 2 |
| Whimsical Lake | 72.6 | 13.9 | 6.3 | 7.5 | 9 | 643.0 | 19.4 | 3 |
| Williams Lake | 49.6 | 2.0 | 18.3 | 6.4 | 8 | 182.0 | 1.0 | 2 |
| MEAN | 90.7 | 14.8 | 11.3 | 6.5 | 10 | 283.2 | 7.2 | 3 |
| MEDIAN | 72.6 | 11.5 | 9.7 | 6.9 | 9 | 243.0 | 3.6 | 3 |
| MINIMUM | 4.3 | 1.5 | 1.6 | 4.7 | 2 | 37.0 | -1.1 | 1 |
| MAXIMUM | 800.8 | 65.0 | 26.8 | 7.5 | 22 | 643.0 | 25.0 | 5 |

Abbreviations:
n/a= not available.
Max Depth= maximum depth.
TP= total phosphorus.
COND= specific conductivity at 25°C.
GRAN ALK= granulated alkalinity.
DOC= dissolved organic carbon.
TN= total nitrogen.
DEV INDEX= development index/qualitative assessment (courtesy of C.J.Deacoff, HRM)

**Table 2. cont'd.-** Measured limnological variables for the 51 study sites from Halifax Region, Nova Scotia, Canada including minimum, maximum, mean, and median values for each measured variable (data courtesy of Clement et al., 2007 and Halifax Regional Water Commission).

| LAKE | Al | Ca | Fe | K | Mg | Na | Cl | Mn | NH4 | NO3 | PO4 | SiO2 | SO4 | TN | DOC | CHLOROPHYLL *a* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | mg/L | | | | | | | | µg/L |
| Anderson Lake | 0.1 | 2.0 | 0.1 | 0.4 | 0.6 | 7.2 | 12.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.7 | 0.1 | 3.6 | 4.6 |
| Bayers Lake | 0.2 | 12.2 | 0.1 | 1.4 | 2.7 | 61.5 | 106.0 | 0.5 | 0.0 | 0.1 | 0.0 | 0.0 | 26.5 | 0.2 | 2.5 | 1.2 |
| Bell Lake | 0.1 | 2.4 | 0.1 | 0.6 | 1.0 | 5.1 | 9.4 | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 7.8 | 0.1 | 1.7 | 2.3 |
| Big Albro Lake | 0.0 | 8.7 | 0.1 | 0.8 | 1.2 | 56.2 | 89.2 | 0.0 | 0.0 | 0.1 | 0.0 | 0.5 | 11.8 | 0.1 | 4.1 | 3.9 |
| Bissett Lake | 0.0 | 17.4 | 0.1 | 1.9 | 2.4 | 91.6 | 152.0 | 0.1 | 0.0 | 0.3 | 0.0 | 0.0 | 16.5 | 0.4 | 7.1 | 11.4 |
| Chocolate Lake | 0.1 | 11.6 | 0.1 | 1.0 | 1.7 | 76.7 | 122.0 | 0.1 | 0.0 | 0.2 | 0.0 | 0.1 | 26.4 | 0.3 | 0.4 | 0.1 |
| Cranberry Lake | 0.0 | 15.7 | 0.1 | 1.7 | 2.2 | 85.7 | 144.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.3 | 16.9 | 0.6 | 5.0 | 3.8 |
| First Chain Lake | 0.8 | 5.5 | 0.1 | 0.6 | 1.4 | 48.1 | 80.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 18.3 | 0.1 | 0.9 | 0.4 |
| First Lake | 0.0 | 16.4 | 0.1 | 1.6 | 2.1 | 72.1 | 114.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 17.1 | 0.2 | 2.3 | 3.3 |
| Fletcher's Lake | 0.1 | 6.0 | 0.1 | 0.8 | 1.0 | 21.2 | 33.7 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 9.3 | 0.2 | 4.2 | 1.2 |
| Fraser Lake | 0.2 | 2.1 | 0.2 | 0.6 | 0.7 | 7.6 | 12.9 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 5.0 | 0.1 | 7.0 | 1.2 |
| Frenchman Lake | 0.1 | 8.6 | 0.2 | 0.7 | 1.5 | 74.5 | 126.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 15.2 | 0.1 | 5.9 | 4.5 |
| Frog Pond | 0.1 | 17.0 | 0.1 | 1.5 | 1.8 | 78.4 | 129.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.6 | 21.9 | 0.3 | 3.2 | 0.6 |
| Governor Lake | 0.3 | 10.6 | 0.3 | 1.2 | 1.8 | 60.0 | 104.0 | 0.1 | 0.0 | 0.6 | 0.0 | 0.1 | 16.0 | 0.6 | 2.2 | 1.0 |
| Kearney Lake | 0.2 | 4.7 | 0.1 | 0.6 | 1.0 | 20.4 | 33.8 | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 7.3 | 0.3 | 3.3 | 0.4 |
| Kinsac Lake | 0.1 | 3.5 | 0.1 | 0.5 | 0.8 | 8.5 | 14.6 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 6.1 | 0.1 | 4.7 | 0.9 |
| Lake Banook | 0.0 | 13.8 | 0.1 | 1.2 | 1.7 | 59.1 | 90.5 | 0.0 | 0.0 | 0.3 | 0.0 | 0.4 | 17.8 | 0.3 | 4.3 | 2.1 |
| Lake Charles | 0.0 | 8.8 | 0.1 | 1.1 | 1.5 | 32.3 | 52.6 | 0.1 | 0.0 | 0.4 | 0.0 | 0.2 | 12.8 | 0.3 | 2.6 | 1.0 |
| Lake Major | 0.2 | 1.0 | 0.1 | 0.2 | 0.5 | 3.6 | 5.3 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 4.5 | 0.1 | 4.6 | 0.4 |
| Lake McCabe | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Lake Micmac | 0.0 | 12.4 | 0.1 | 1.0 | 1.6 | 51.6 | 86.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.2 | 16.7 | 0.4 | 2.4 | 1.0 |
| Lake Thomas | 0.0 | 7.1 | 0.1 | 1.0 | 1.0 | 23.7 | 37.8 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 9.4 | 0.2 | 3.6 | 1.0 |
| Lake William | 0.0 | 6.6 | 0.1 | 1.0 | 1.1 | 23.0 | 36.5 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 9.5 | 0.2 | 3.6 | 0.8 |
| Lamont Lake | 0.1 | 2.9 | 0.1 | 0.3 | 0.7 | 5.8 | 10.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 8.5 | 0.0 | 3.6 | 0.7 |
| Little Albro Lake | 0.0 | 8.6 | 0.1 | 0.8 | 1.1 | 51.9 | 81.3 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 12.9 | 0.1 | 1.7 | 0.7 |
| Little Springfield | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Long Lake | 0.2 | 5.0 | 0.3 | 0.7 | 1.1 | 32.0 | 52.6 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 10.3 | 0.2 | 6.6 | 0.4 |
| Loon Lake | 0.0 | 8.6 | 0.1 | 1.2 | 1.5 | 46.6 | 74.7 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 12.0 | 0.3 | 3.8 | 0.8 |
| Maynards Lake | 0.0 | 11.0 | 0.1 | 1.2 | 1.9 | 58.7 | 94.1 | 0.1 | 0.0 | 0.2 | 0.0 | 0.4 | 13.5 | 0.2 | 4.5 | 0.7 |
| Miller Lake | 0.2 | 3.3 | 0.2 | 0.5 | 0.7 | 13.1 | 20.4 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | 7.4 | 0.3 | 5.3 | 3.9 |
| Morris Lake | 0.1 | 9.7 | 0.1 | 1.1 | 1.4 | 46.0 | 75.5 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 13.4 | 0.3 | 2.3 | 3.6 |
| Oathill Lake | 0.0 | 19.2 | 0.1 | 2.0 | 2.9 | 76.4 | 124.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.7 | 20.1 | 0.7 | 4.5 | 2.3 |
| Paper Mill Lake | 0.2 | 5.0 | 0.1 | 0.6 | 1.0 | 21.2 | 36.4 | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 7.4 | 0.3 | 3.7 | 0.3 |
| Penhorn Lake | 0.0 | 16.7 | 0.1 | 1.0 | 1.8 | 85.4 | 139.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.4 | 13.2 | 0.2 | 5.5 | 0.5 |
| Pockwock Lake | 0.1 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | <0.02 | n/a | n/a | 4.8 | n/a | n/a | n/a |
| Powder Mill Lake | 0.0 | 10.5 | 0.1 | 1.6 | 1.3 | 26.5 | 43.3 | 0.0 | 0.0 | 0.3 | 0.0 | 0.6 | 11.2 | 0.2 | 3.1 | 1.8 |
| Power Pond | 0.2 | 4.0 | 0.2 | 0.6 | 1.0 | 25.6 | 39.7 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 8.9 | 0.1 | 6.4 | 1.4 |
| Rocky Lake | 0.0 | 15.2 | 0.1 | 1.8 | 1.6 | 44.1 | 73.7 | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 15.3 | 0.4 | 3.1 | 1.4 |
| Russell Lake | 0.0 | 13.3 | 0.1 | 1.1 | 1.7 | 79.9 | 138.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 16.5 | 0.1 | 5.3 | 8.2 |
| Sandy Lake | 0.2 | 4.0 | 0.2 | 0.7 | 1.0 | 17.7 | 30.2 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 9.1 | 0.2 | 5.1 | 0.7 |
| Second Chain Lake | 0.9 | 7.6 | 0.1 | 0.7 | 1.6 | 53.5 | 91.7 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 20.2 | 0.1 | 1.0 | 0.2 |
| Second Lake | 0.1 | 5.9 | 0.1 | 0.8 | 1.1 | 21.1 | 34.8 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 6.9 | 0.1 | 4.5 | 1.6 |
| Settle Lake | 0.1 | 14.9 | 0.2 | 1.8 | 2.2 | 75.5 | 120.0 | 0.1 | 0.0 | 0.3 | 0.0 | 0.7 | 14.9 | 0.3 | 3.7 | 2.2 |
| Sheldrake Lake | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Shubenacadie Grand Lake | 0.1 | 4.9 | 0.1 | 0.5 | 0.8 | 11.7 | 18.4 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 9.1 | 0.1 | 3.7 | 2.2 |
| Soldier Lake | 0.2 | 3.2 | 0.2 | 0.5 | 0.7 | 11.4 | 19.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | 7.4 | 0.3 | 5.2 | 4.6 |
| Springfield Lake | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Third Lake | 0.0 | 5.8 | 0.1 | 0.8 | 1.1 | 17.3 | 28.7 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 7.2 | 0.1 | 3.3 | 2.6 |
| Topsail Lake | 0.1 | 3.1 | 0.1 | 0.3 | 0.7 | 6.6 | 11.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 8.6 | 0.1 | 1.8 | 0.4 |
| Whimsical Lake | 0.1 | 19.8 | 0.1 | 1.6 | 2.1 | 95.2 | 160.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.3 | 26.4 | 0.4 | 2.6 | 1.5 |
| Williams Lake | 0.2 | 5.0 | 0.1 | 0.7 | 1.0 | 27.4 | 42.2 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 11.2 | 0.2 | 3.6 | 1.3 |
| MEAN | 0.1 | 8.7 | 0.1 | 1.0 | 1.4 | 41.7 | 68.5 | 0.1 | 0.0 | 0.2 | 0.0 | 0.2 | 12.7 | 0.2 | 3.8 | 2.0 |
| MEDIAN | 0.1 | 8.1 | 0.1 | 0.8 | 1.2 | 38.2 | 63.2 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 11.8 | 0.2 | 3.7 | 1.2 |
| MINIMUM | 0.0 | 1.0 | 0.1 | 0.2 | 0.5 | 3.6 | 5.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.5 | 0.0 | 0.4 | 0.1 |
| MAXIMUM | 0.9 | 19.8 | 0.3 | 2.0 | 2.9 | 95.2 | 160.0 | 0.5 | 0.1 | 0.7 | 0.0 | 0.7 | 26.5 | 0.7 | 7.1 | 11.4 |

Abbreviations:
n/a= not available.
Max Depth= maximum depth.
DOC= dissolved organic carbon.
TN= total nitrogen.

**Table 3.-** Pearson Correlation matrix for measured environmental variables (following transformation) of the study lakes. McCabe, Little Springfield, Springfield and Sheldrake lakes were not included as data were not available. Values in **bold** and **<u>bold and underlined</u>** indicate significant correlations at P <0.05 and P <0.01, respectively, based on Bonferroni-adjusted probabilities.

| | AREA | MAX DEPTH | DEV INDEX | COND | TN | GRAN ALK | DOC | Fe | pH | Na | Mg | TP | $SO_4$ | Cl | K | Ca | Al | Mn | $NH_4$ | $SiO_2$ | $PO_4$ | $NO_3$ | CHLOROPHYLL *a* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA | 1.00 | | | | | | | | | | | | | | | | | | | | | | |
| MAX DEPTH | **0.56** | 1.00 | | | | | | | | | | | | | | | | | | | | | |
| DEV INDEX | -0.49 | -0.30 | 1.00 | | | | | | | | | | | | | | | | | | | | |
| COND | -0.33 | -0.33 | 0.48 | 1.00 | | | | | | | | | | | | | | | | | | | |
| TN | -0.05 | -0.11 | 0.32 | 0.54 | 1.00 | | | | | | | | | | | | | | | | | | |
| GRAN ALK | -0.25 | -0.09 | 0.36 | **<u>0.69</u>** | 0.69 | 1.00 | | | | | | | | | | | | | | | | | |
| DOC | -0.08 | -0.06 | -0.14 | -0.13 | 0.12 | 0.06 | 1.00 | | | | | | | | | | | | | | | | |
| Fe | -0.02 | 0.05 | -0.11 | -0.18 | -0.04 | -0.39 | 0.55 | 1.00 | | | | | | | | | | | | | | | |
| pH | -0.17 | -0.18 | 0.30 | **<u>0.59</u>** | **<u>0.67</u>** | **<u>0.83</u>** | -0.01 | -0.42 | 1.00 | | | | | | | | | | | | | | |
| Na | -0.32 | -0.34 | 0.47 | **<u>1.00</u>** | 0.53 | **<u>0.67</u>** | -0.10 | -0.13 | **0.58** | 1.00 | | | | | | | | | | | | | |
| Mg | -0.38 | -0.23 | 0.56 | **<u>0.85</u>** | **0.58** | **<u>0.73</u>** | -0.10 | -0.23 | 0.49 | **<u>0.82</u>** | 1.00 | | | | | | | | | | | | |
| TP | -0.20 | -0.15 | 0.20 | 0.21 | 0.48 | 0.44 | 0.54 | 0.22 | 0.41 | 0.21 | 0.33 | 1.00 | | | | | | | | | | | |
| $SO_4$ | -0.31 | -0.23 | 0.48 | **<u>0.82</u>** | 0.40 | 0.43 | -0.43 | -0.24 | 0.28 | **<u>0.80</u>** | **<u>0.81</u>** | 0.00 | 1.00 | | | | | | | | | | |
| Cl | -0.33 | -0.35 | 0.47 | **<u>1.00</u>** | 0.52 | **<u>0.66</u>** | -0.11 | -0.13 | **0.57** | **<u>1.00</u>** | **<u>0.83</u>** | 0.21 | 0.80 | 1.00 | | | | | | | | | |
| K | -0.24 | -0.17 | 0.42 | **<u>0.77</u>** | 0.73 | **<u>0.88</u>** | -0.03 | -0.28 | **<u>0.71</u>** | **<u>0.74</u>** | **<u>0.88</u>** | 0.44 | **<u>0.63</u>** | 0.74 | 1.00 | | | | | | | | |
| Ca | -0.33 | -0.19 | 0.48 | **<u>0.88</u>** | **<u>0.67</u>** | **<u>0.90</u>** | -0.09 | -0.34 | **<u>0.71</u>** | **<u>0.85</u>** | **<u>0.89</u>** | 0.35 | 0.77 | 0.85 | 0.90 | 1.00 | | | | | | | |
| Al | 0.13 | 0.11 | -0.19 | -0.08 | -0.49 | -0.48 | -0.22 | 0.20 | **<u>-0.70</u>** | -0.07 | -0.12 | -0.45 | 0.12 | -0.06 | -0.36 | -0.31 | 1.00 | | | | | | |
| Mn | -0.06 | -0.03 | 0.29 | 0.09 | -0.14 | -0.32 | -0.11 | 0.23 | -0.47 | 0.08 | 0.28 | -0.01 | 0.37 | 0.10 | 0.00 | -0.02 | 0.31 | 1.00 | | | | | |
| $NH_4$ | 0.00 | 0.20 | 0.13 | -0.03 | 0.34 | -0.03 | 0.18 | 0.55 | -0.11 | -0.03 | 0.04 | 0.31 | 0.03 | -0.03 | 0.03 | 0.03 | -0.09 | 0.34 | 1.00 | | | | |
| $SiO_2$ | -0.27 | 0.00 | 0.38 | 0.48 | 0.48 | **<u>0.66</u>** | -0.33 | -0.45 | **<u>0.74</u>** | 0.46 | 0.43 | 0.17 | 0.32 | 0.45 | **0.57** | **<u>0.59</u>** | -0.40 | -0.38 | -0.01 | 1.00 | | | |
| $PO_4$ | -0.17 | -0.11 | 0.29 | 0.07 | 0.33 | 0.37 | 0.21 | -0.18 | 0.35 | 0.04 | 0.24 | 0.52 | 0.05 | 0.05 | 0.28 | 0.30 | -0.44 | -0.20 | -0.01 | 0.24 | 1.00 | | |
| $NO_3$ | -0.11 | -0.06 | 0.39 | 0.45 | **<u>0.93</u>** | **<u>0.68</u>** | -0.01 | -0.15 | **<u>0.70</u>** | 0.43 | 0.53 | 0.47 | 0.34 | 0.42 | 0.72 | **<u>0.62</u>** | -0.54 | -0.24 | 0.27 | **<u>0.61</u>** | 0.46 | 1.00 | |
| CHLOROPHYLL *a* | 0.04 | -0.13 | 0.08 | 0.20 | 0.32 | 0.32 | 0.43 | 0.06 | 0.20 | 0.20 | 0.26 | 0.51 | 0.02 | 0.20 | 0.32 | 0.26 | -0.22 | 0.00 | 0.03 | -0.20 | 0.42 | 0.29 | 1.00 |

Abbreviations:
AREA= lake area.
Max Depth= maximum depth.
DEV INDEX= Development index.
TP= total phosphorus.
COND= specific conductivity at 25°C.
GRAN ALK= granulated alkalinity.
DOC= dissolved organic carbon.
TN= total nitrogen.

**Table 4.-** Summary table of Bray-Curtis similarity index values (comparison between surface and bottom sediment) of the 51 study sites.

| Lakes | Similarity Index |
|---|---|
| Anderson Lake | 67.0 |
| Bayers Lake | 48.0 |
| Bell Lake | 58.6 |
| Big Albro Lake | 53.0 |
| Bisset Lake | 51.5 |
| Chocolate Lake | 53.6 |
| Cranberry Lake | 60.9 |
| First Chain Lake | 40.7 |
| First Lake | 45.0 |
| Fletcher's Lake | 50.3 |
| FraserLake | 74.3 |
| Frenchmans Lake | 54.7 |
| Frog Pond | 45.1 |
| Governor Lake | 55.5 |
| Kearney Lake | 52.1 |
| Kinsac Lake | 45.4 |
| Lake Banook | 51.6 |
| Lake Charles | 43.8 |
| Lake Major Lake | 66.9 |
| Lake McCabe | 45.3 |
| Lake Mic Mac | 57.3 |
| Lake Thomas | 45.0 |
| Lake William | 59.4 |
| Lemont Lake | 71.0 |
| Little Albro Lake | 63.7 |
| Little Springfield lake | 47.7 |
| Long Lake | 59.2 |
| Loon Lake | 55.1 |
| Maynard Lake | 67.3 |
| Miller Lake | 58.8 |
| Morris Lake | 43.8 |
| Oathill Lake | 44.8 |
| Papermill Lake | 59.0 |
| Penhorn Lake | 37.7 |
| Pockwock Lake | 38.8 |
| Powder Mill Lake | 63.9 |
| Powers Pond | 59.2 |
| Rocky Lake | 55.0 |
| Russell Lake | 81.3 |
| Sandy Lake | 75.6 |
| Second Chain Lake | 64.4 |
| Second Lake | 56.1 |
| Settle Lake | 30.1 |
| Sheldrake Lake | 45.5 |
| Shubenacadie Grand Lake | 74.6 |
| Soldier Lake | 55.7 |
| Springfield Lake | 45.8 |
| Third Lake | 71.7 |
| Topsail Lake | 49.5 |
| Whimsical Lake | 59.7 |
| Williams Lake | 50.9 |

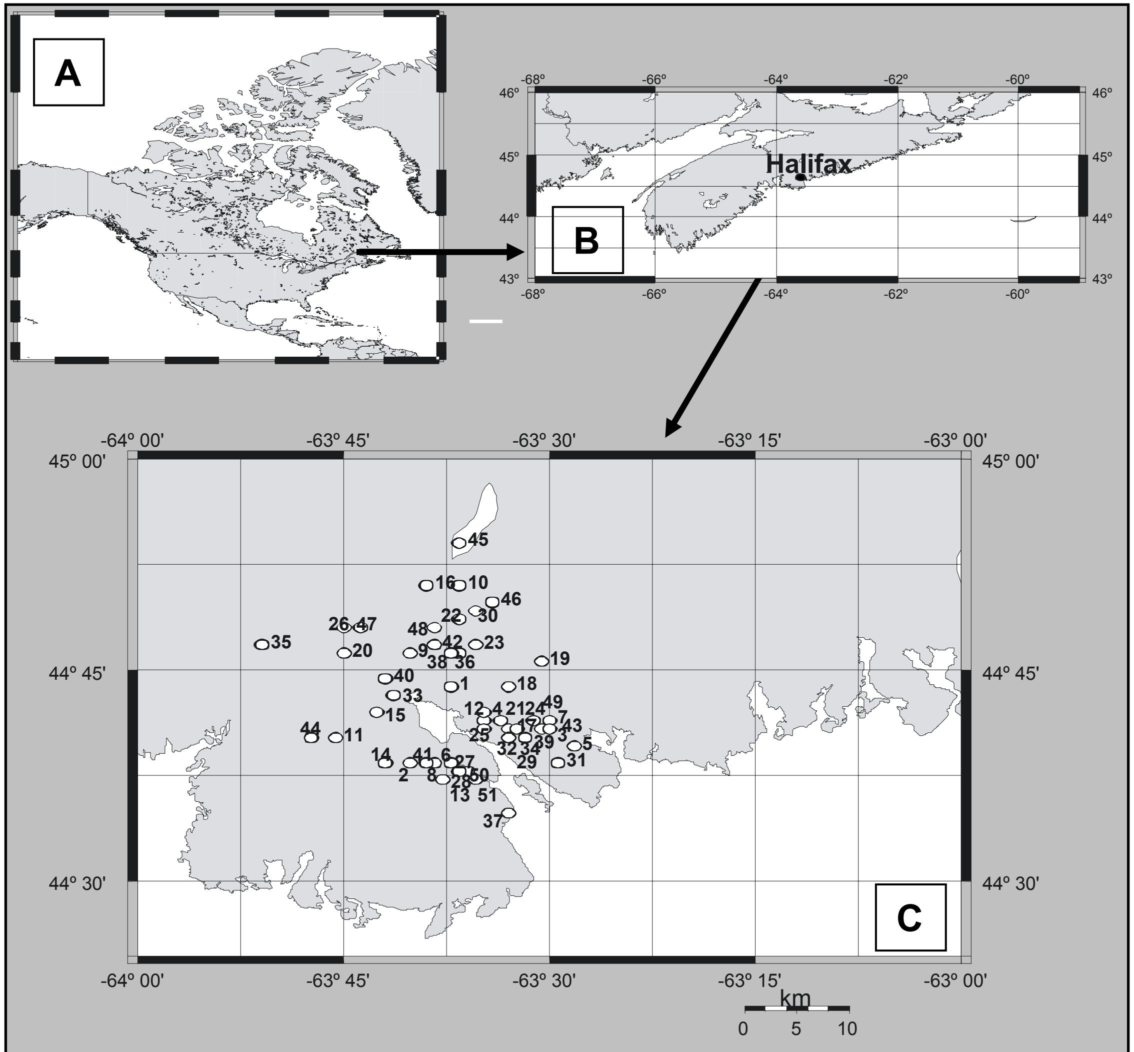

A
B
Halifax
-68°
-66°
-64°
-62°
-60°
46°
45°
44°
43°
C
-64° 00'
-63° 45'
-63° 30'
-63° 15'
-63° 00'
45° 00'
44° 45'
44° 30'
km
0
5
10

Figure 1.-

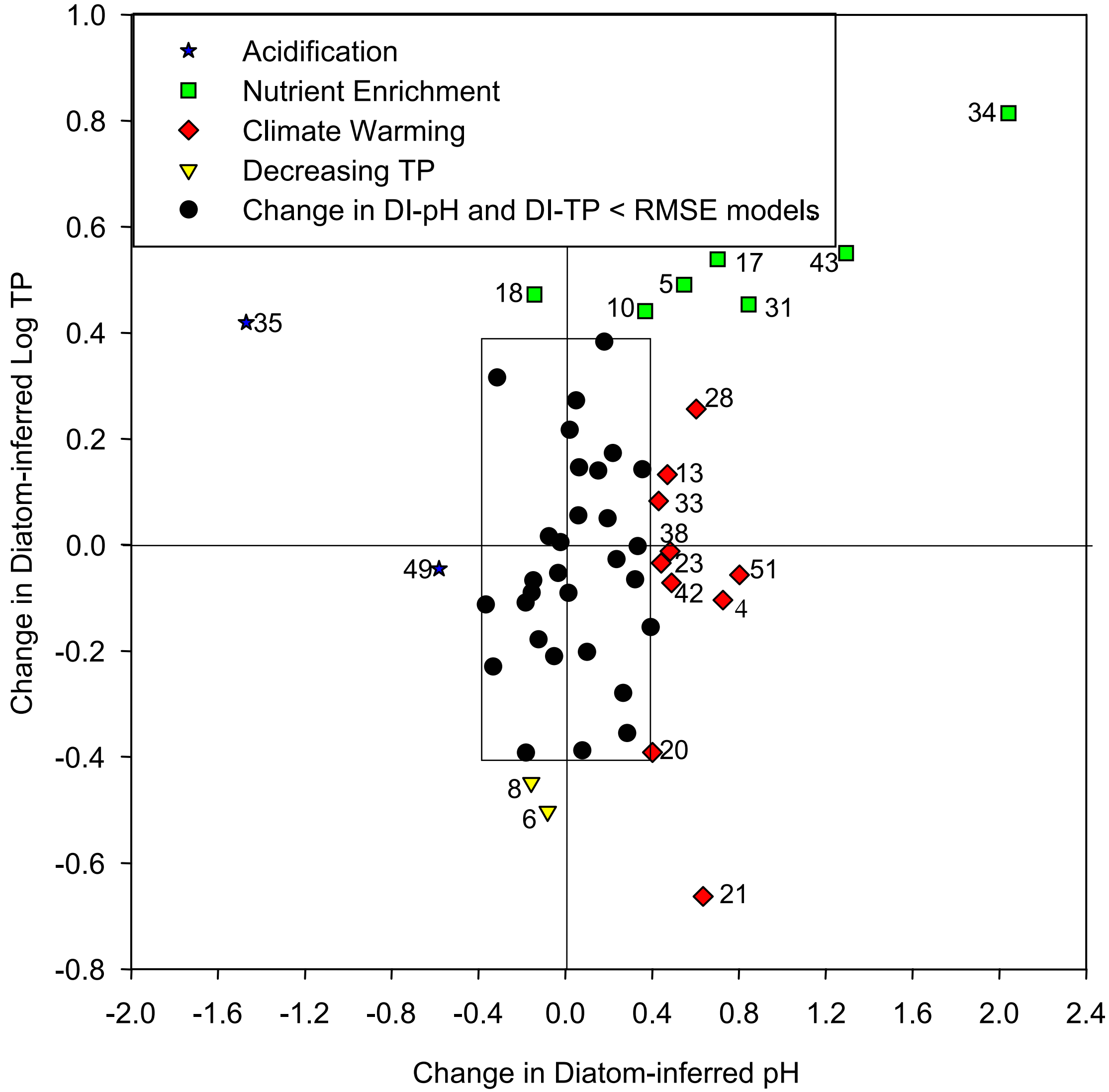

Acidification
Nutrient Enrichment
Climate Warming
Decreasing TP
Change in DI-pH and DI-TP < RMSE models
Change in Diatom-inferred Log TP
Change in Diatom-inferred pH
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-2.0
-1.6
-1.2
-0.8
-0.4
0.0
0.4
0.8
1.2
1.6
2.0
2.4
34
43
17
5
31
18
10
35
28
13
33
38
23
51
42
4
49
20
8
6
21

Figure 2.-

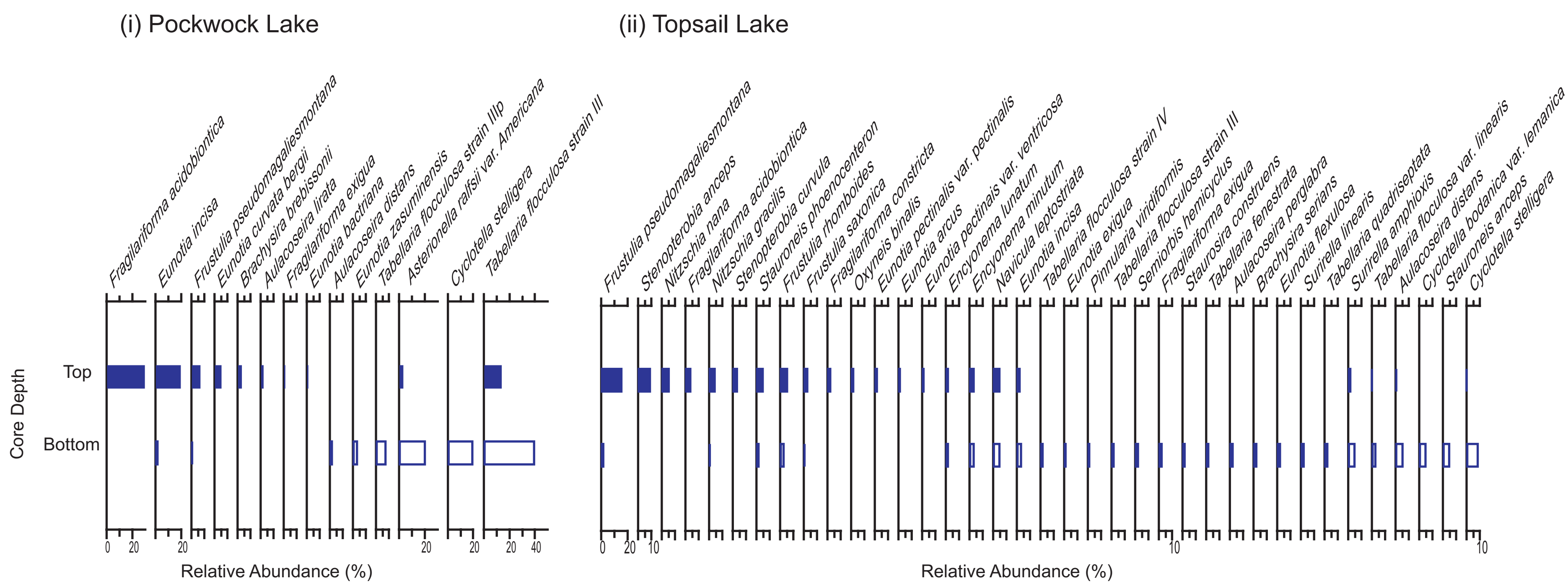

(i) Pockwock Lake
(ii) Topsail Lake
Fragilariforma acidobiontica
Eunotia incisa
Frustulia pseudomagaliesmontana
Eunotia curvata bergii
Brachysira brebissonii
Aulacoseira lirata
Fragilariforma exigua
Eunotia bactriana
Aulacoseira distans
Eunotia zasuminensis
Tabellaria flocculosa strain IIIp
Asterionella ralfsii var. Americana
Cyclotella stelligera
Tabellaria flocculosa strain III
Frustulia pseudomagaliesmontana
Stenopterobia anceps
Nitzschia nana
Fragilariforma acidobiontica
Nitzschia gracilis
Stenopterobia curvula
Stauroneis phoenocenteron
Frustulia rhomboides
Frustulia saxonica
Fragilariforma constricta
Oxyneis binalis
Eunotia pectinalis var. pectinalis
Eunotia arcus
Eunotia pectinais var. ventricosa
Encyonema lunatum
Encyonema minutum
Navicula leptostriata
Eunotia incisa
Tabellaria flocculosa strain IV
Eunotia exigua
Pinnularia viridiformis
Tabellaria flocculosa strain III
Semiorbis hemicyclus
Fragilariforma exigua
Staurosira construens
Tabellaria fenestrata
Aulacoseira perglabra
Brachysira serians
Eunotia flexulosa
Surirella linearis
Tabellaria quadriseptata
Surirella amphioxis
Tabellaria flocculosa var. linearis
Aulacoseira distans
Cyclotella bodanica var. lemanica
Stauroneis anceps
Cyclotella stelligera
Core Depth
Top
Bottom
0
20
20
20
20
20
40
0
20
10
10
10
Relative Abundance (%)
Relative Abundance (%)

**Figure 3.-**

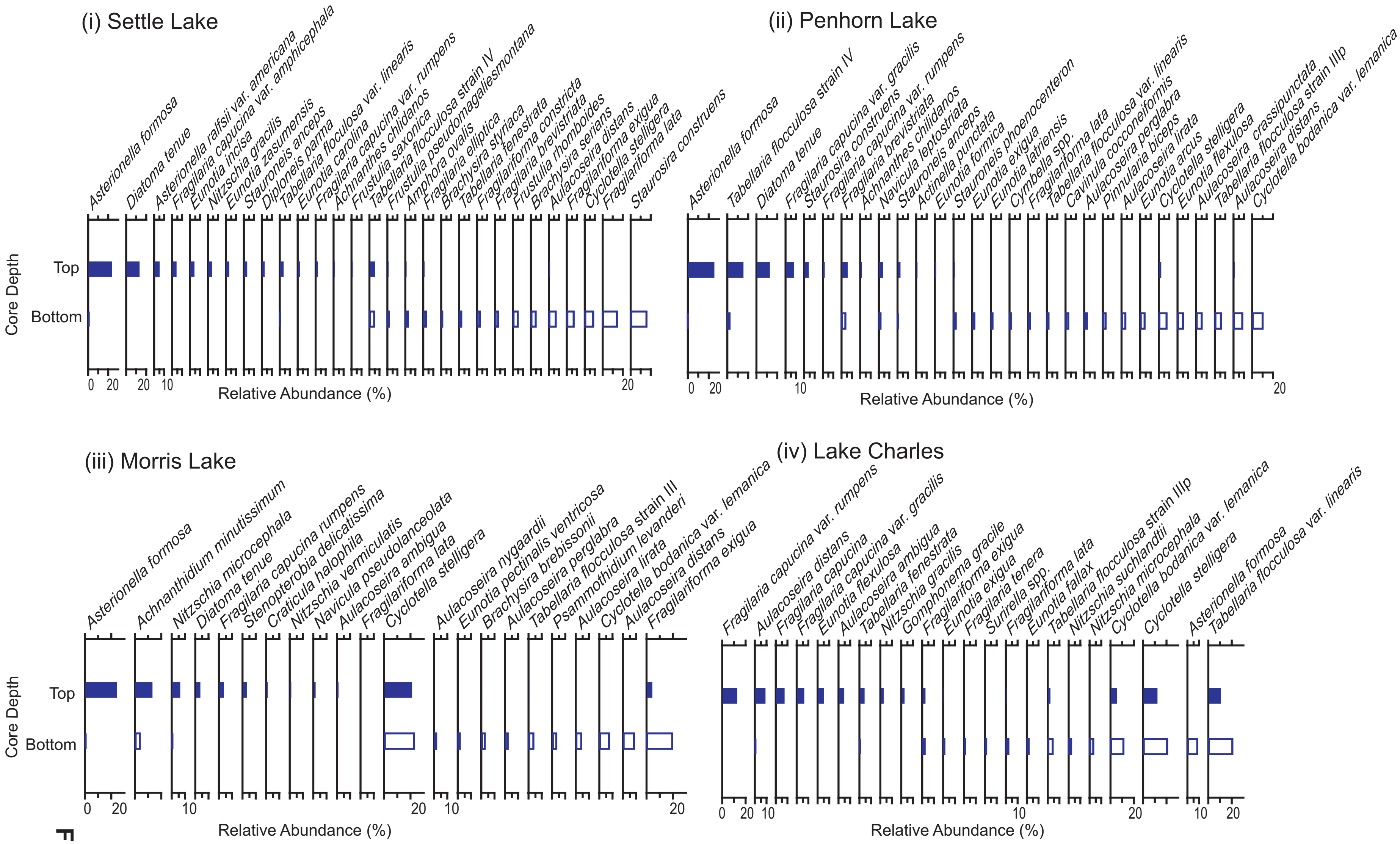

(i) Settle Lake
Asterionella formosa
Diatoma tenue
Asterionella ralfsii var. americana
Fragilaria capucina var. amphicephala
Eunotia incisa
Nitzschia gracilis
Eunotia zasumensis
Stauroneis anceps
Diploneis parma
Tabellaria flocculosa var. linearis
Eunotia carolina
Fragilaria capucina var. rumpens
Achnanthes chlidanos
Frustulia saxonica
Tabellaria flocculosa strain IV
Frustulia pseudomagaliesmontana
Amphora ovalis
Fragilaria elliptica
Brachysira styriaca
Tabellaria fenestrata
Fragilariforma constricta
Fragilaria brevistriata
Frustulia rhomboides
Brachysira serians
Aulacoseira distans
Fragilariforma exigua
Cyclotella stelligera
Fragilariforma lata
Staurosira construens
Core Depth
Top
Bottom
Relative Abundance (%)
(ii) Penhorn Lake
Asterionella formosa
Tabellaria flocculosa strain IV
Diatoma tenue
Fragilaria capucina var. gracilis
Staurosira construens
Fragilaria capucina var. rumpens
Fragilaria brevistriata
Achnanthes chlidanos
Navicula leptostriata
Stauroneis anceps
Actinella punctata
Eunotia formica
Stauroneis phoenocenteron
Eunotia exigua
Eunotia latriensis
Cymbella spp.
Fragilariforma lata
Tabellaria flocculosa var. linearis
Cavinula cocconeiformis
Aulacoseira perglabra
Pinnularia biceps
Aulacoseira lirata
Eunotia arcus
Cyclotella stelligera
Eunotia flexulosa
Aulacoseira crassipunctata
Tabellaria flocculosa strain IIIp
Aulacoseira distans
Cyclotella bodanica var. lemanica
Relative Abundance (%)
(iii) Morris Lake
Asterionella formosa
Achnanthidium minutissimum
Nitzschia microcephala
Diatoma tenue
Fragilaria capucina rumpens
Stenopterobia delicatissima
Craticula halophila
Nitzschia vermiculatis
Navicula pseudolanceolata
Aulacoseira ambigua
Fragilariforma lata
Cyclotella stelligera
Aulacoseira nygaardii
Eunotia pectinalis ventricosa
Brachysira brebissonii
Aulacoseira perglabra
Tabellaria flocculosa strain III
Psammothidium levanderi
Aulacoseira lirata
Cyclotella bodanica var. lemanica
Aulacoseira distans
Fragilariforma exigua
Core Depth
Top
Bottom
Relative Abundance (%)
(iv) Lake Charles
Fragilaria capucina var. rumpens
Aulacoseira distans
Fragilaria capucina
Fragilaria capucina var. gracilis
Eunotia flexulosa
Aulacoseira ambigua
Tabellaria fenestrata
Nitzschia gracilis
Gomphonema gracile
Fragilariforma exigua
Eunotia exigua
Fragilaria tenera
Surirella spp.
Fragilariforma lata
Eunotia fallax
Tabellaria flocculosa strain IIIp
Nitzschia suchlandtii
Nitzschia microcephala
Cyclotella bodanica var. lemanica
Cyclotella stelligera
Asterionella formosa
Tabellaria flocculosa var. linearis
Relative Abundance (%)

**Figure 4a.-**

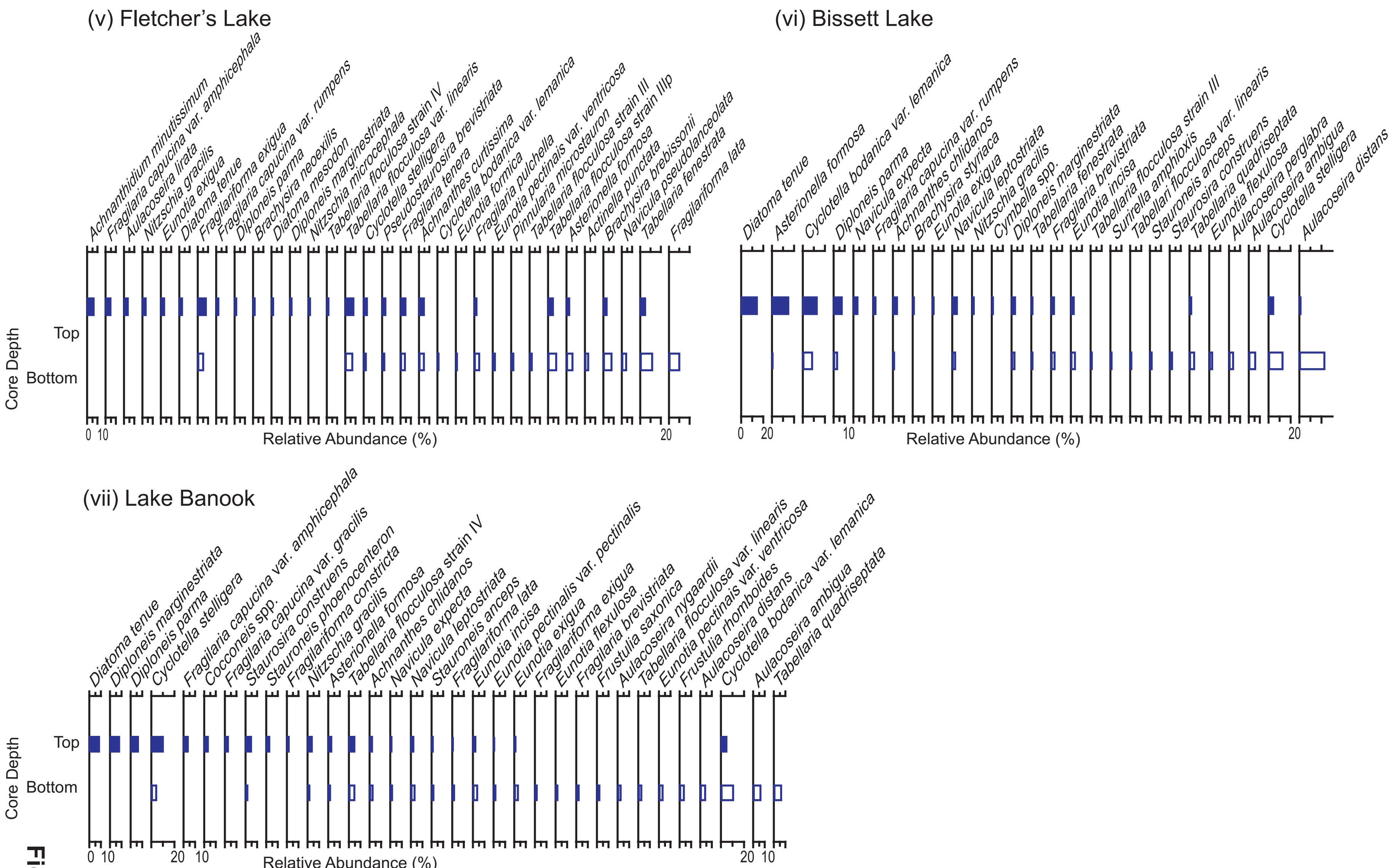

(v) Fletcher's Lake
Achnanthidium minutissinum
Fragilaria capucina var. amphicephala
Aulacoseira lirata
Nitzschia gracilis
Eunotia exigua
Diatoma tenue
Fragilariforma exigua
Fragilaria capucina var. rumpens
Diploneis parma
Brachysira neoexilis
Diatoma mesodon
Diploneis marginestriata
Nitzschia microcephala
Tabellaria floculosa strain IV
Tabellaria flocculosa var. linearis
Cyclotella stelligera
Pseudostaurosira brevistriata
Fragilaria tenera
Achnanthes curtissima
Cyclotella bodanica var. lemanica
Eunotia formica
Fragilaria pulchella
Eunotia pectinalis var. ventricosa
Pinnularia microstauron
Tabellaria flocculosa strain III
Tabellaria flocculosa strain IIIp
Asterionella formosa
Actinella punctata
Brachysira brebissonii
Navicula pseudolanceolata
Tabellaria fenestrata
Fragilariforma lata
Top
Bottom
Core Depth
0 10
20
Relative Abundance (%)
(vi) Bissett Lake
Diatoma tenue
Asterionella formosa
Cyclotella bodanica var. lemanica
Diploneis parma
Navicula expecta
Fragilaria capucina var. rumpens
Achnanthes chlidanos
Brachysira styriaca
Eunotia exigua
Navicula leptostriata
Nitzschia gracilis
Cymbella spp.
Diploneis marginestriata
Tabellaria fenestrata
Fragilaria brevistriata
Eunotia incisa
Tabellaria flocculosa strain III
Surirella amphioxis
Tabellari flocculosa var. linearis
Stauroneis anceps
Staurosira construens
Tabellaria quadriseptata
Eunotia flexulosa
Aulacoseira perglabra
Aulacoseira ambigua
Cyclotella stelligera
Aulacoseira distans
0 20
10
20
Relative Abundance (%)
(vii) Lake Banook
Diatoma tenue
Diploneis marginestriata
Diploneis parma
Cyclotella stelligera
Fragilaria capucina var. amphicephala
Cocconeis spp.
Fragilaria capucina var. gracilis
Staurosira construens
Stauroneis phoenocenteron
Fragilariforma constricta
Nitzschia gracilis
Asterionella formosa
Tabellaria flocculosa strain IV
Achnanthes chlidanos
Navicula expecta
Navicula leptostriata
Stauroneis anceps
Fragilariforma lata
Eunotia incisa
Eunotia pectinalis var. pectinalis
Eunotia exigua
Fragilariforma exigua
Eunotia flexulosa
Fragilaria brevistriata
Frustulia saxonica
Aulacoseira nygaardii
Tabellaria flocculosa var. linearis
Eunotia pectinais var. ventricosa
Frustulia rhomboides
Aulacoseira distans
Cyclotella bodanica var. lemanica
Aulacoseira ambigua
Tabellaria quadriseptata
Top
Bottom
Core Depth
0 10
20 10
20 10
Relative Abundance (%)

**Figure 4b.-**

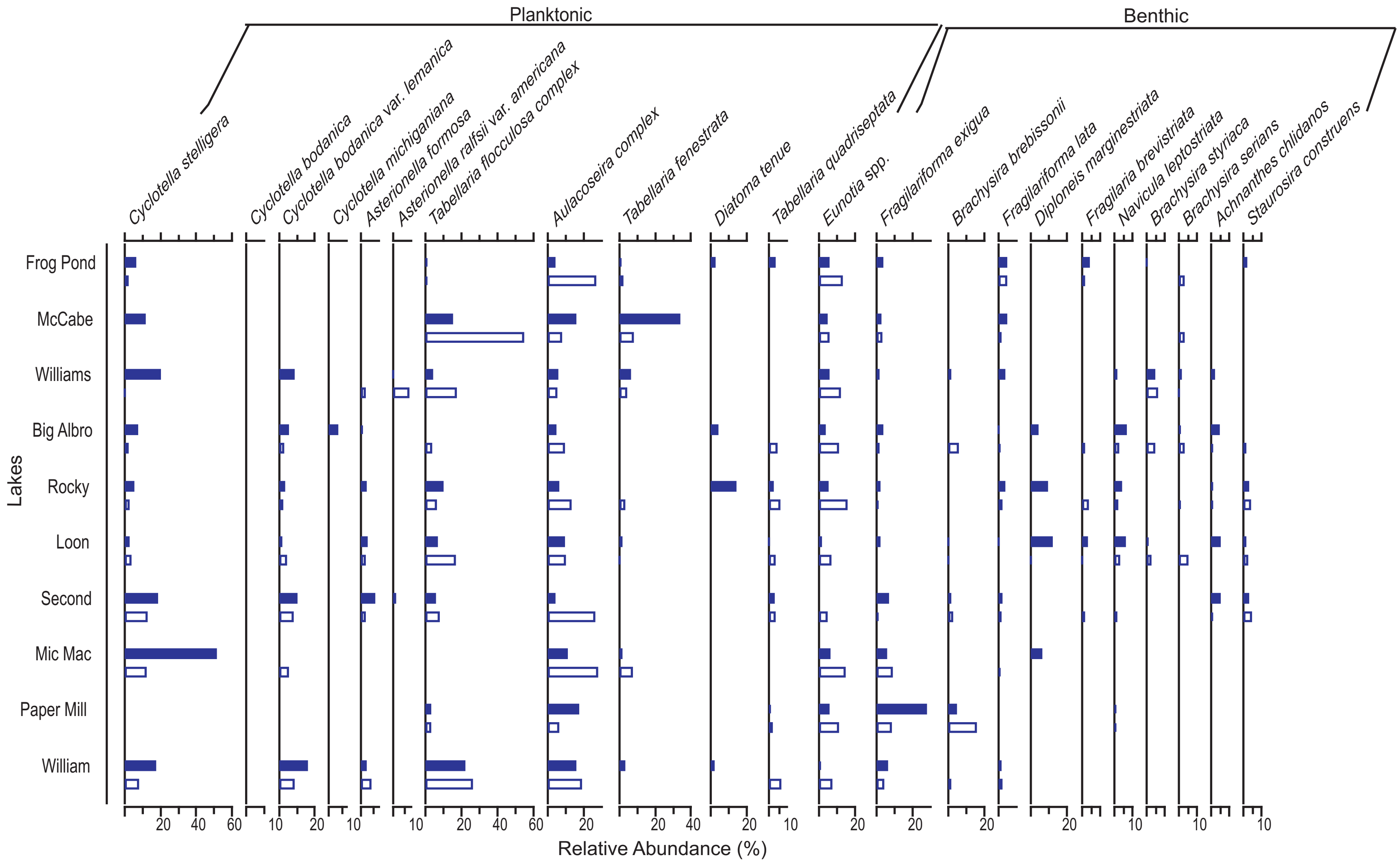
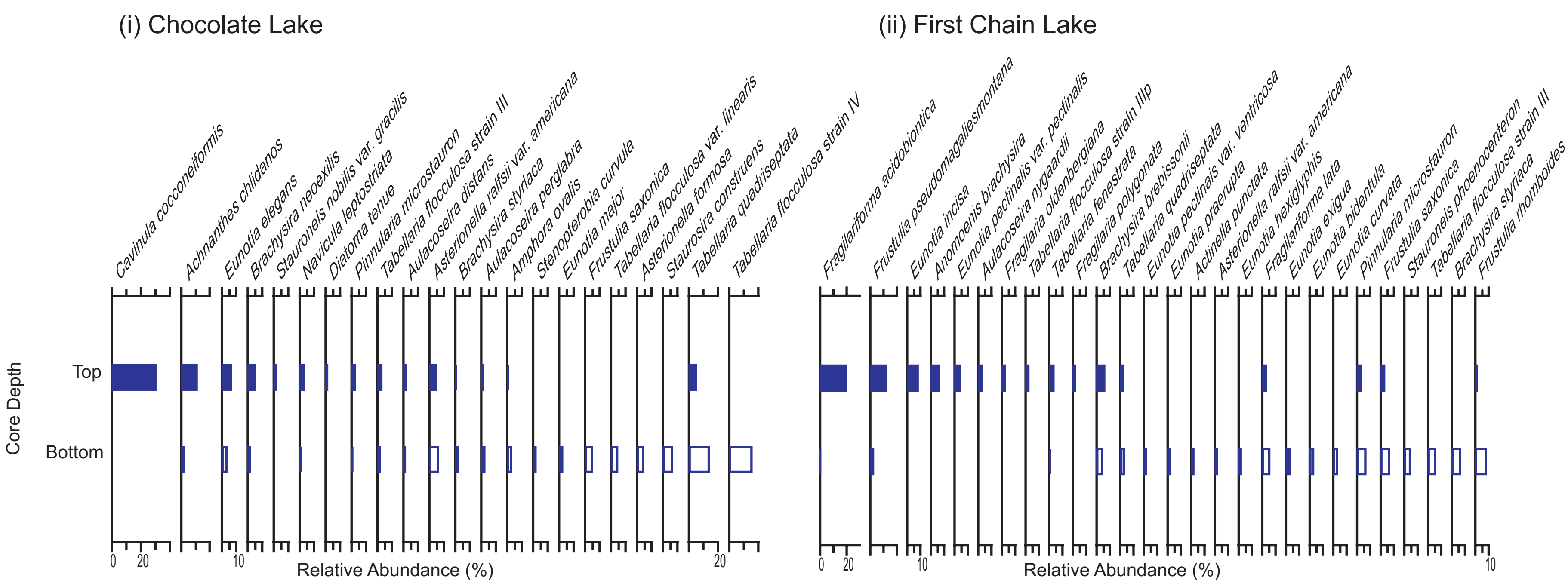

Planktonic
Benthic
Cyclotella stelligera
Cyclotella bodanica
Cyclotella bodanica var. lemanica
Cyclotella michiganiana
Asterionella formosa
Asterionella ralfsii var. americana
Tabellaria flocculosa complex
Aulacoseira complex
Tabellaria fenestrata
Diatoma tenue
Tabellaria quadriseptata
Eunotia spp.
Fragilariforma exigua
Brachysira brebissonii
Fragilariforma lata
Diploneis marginestriata
Fragilaria brevistriata
Navicula leptostriata
Brachysira styriaca
Brachysira serians
Achnanthes chlidanos
Staurosira construens
Lakes
Frog Pond
McCabe
Williams
Big Albro
Rocky
Loon
Second
Mic Mac
Paper Mill
William
Relative Abundance (%)

Figure 5.-



(i) Chocolate Lake
(ii) First Chain Lake
Core Depth
Top
Bottom
Relative Abundance (%)
Cavinula cocconeiformis
Achnanthes chlidanos
Eunotia elegans
Brachysira neoexilis
Stauroneis nobilis var. gracilis
Navicula leptostriata
Diatoma tenue
Pinnularia microstauron
Tabellaria flocculosa strain III
Aulacoseira distans
Asterionella ralfsii var. americana
Brachysira styriaca
Aulacoseira perglabra
Amphora ovalis
Stenopterobia curvula
Eunotia major
Frustulia saxonica
Tabellaria flocculosa var. linearis
Asterionella formosa
Staurosira construens
Tabellaria quadriseptata
Tabellaria flocculosa strain IV
Fragilariforma acidobiontica
Frustulia pseudomagaliesmontana
Eunotia incisa
Anomoenis brachysira
Eunotia pectinalis var. pectinalis
Aulacoseira nygaardii
Fragilaria oldenbergiana
Tabellaria flocculosa strain IIIp
Tabellaria fenestrata
Fragilaria polygonata
Brachysira brebissonii
Tabellaria quadriseptata
Eunotia pectinalis var. ventricosa
Eunotia praerupta
Actinella punctata
Asterionella ralfsii var. americana
Eunotia hexiglyphis
Fragilariforma lata
Eunotia exigua
Eunotia bidentula
Eunotia curvata
Pinnularia microstauron
Frustulia saxonica
Stauroneis phoenocenteron
Tabellaria flocculosa strain III
Brachysira styriaca
Frustulia rhomboides
0
20
10
20
0
20
10
10


**Figure 6.-**

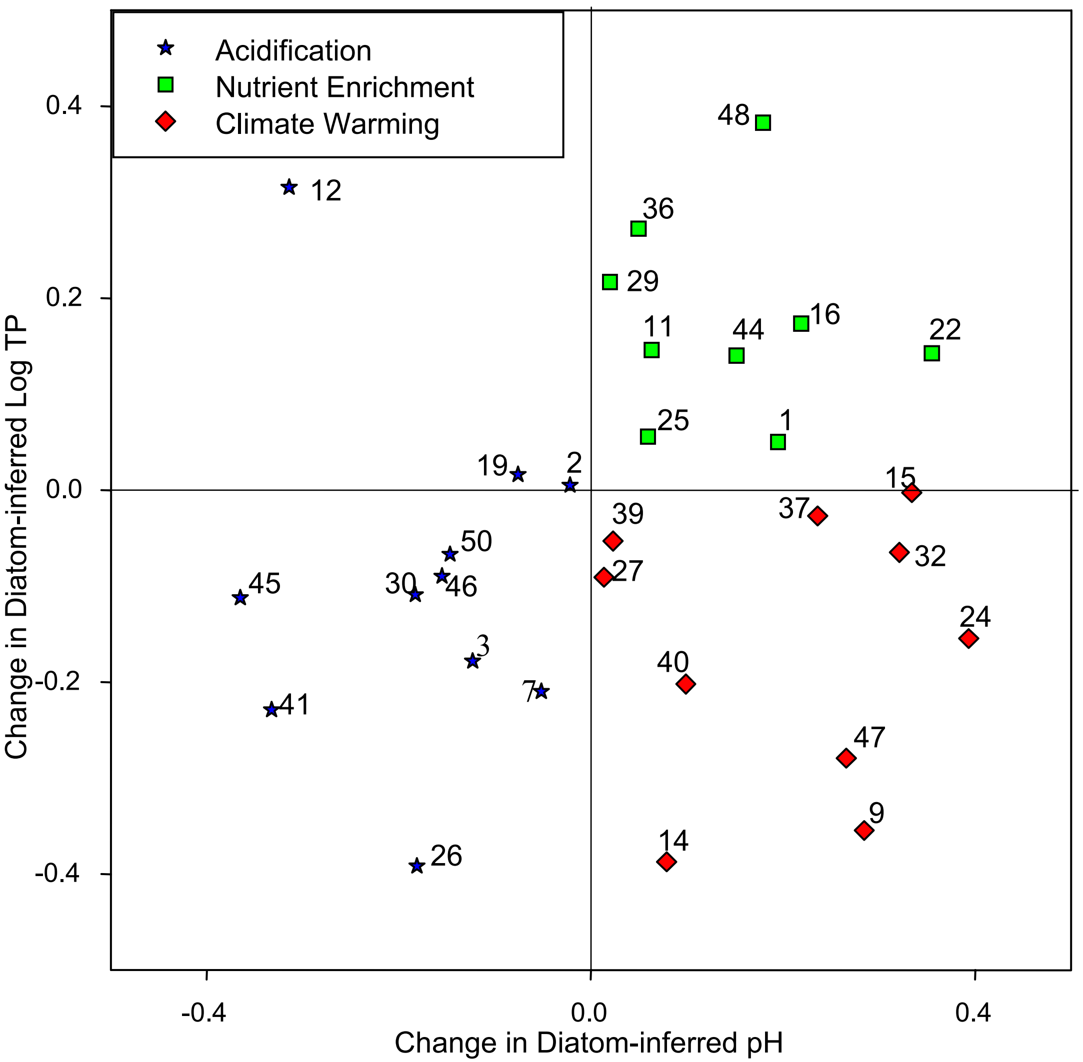

Acidification
Nutrient Enrichment
Climate Warming
Change in Diatom-inferred Log TP
Change in Diatom-inferred pH
0.4
0.2
0.0
-0.2
-0.4
-0.4
0.0
0.4
48
12
36
29
11
44
16
22
25
1
19
2
15
37
39
32
50
27
45
30
46
24
3
40
7
41
47
9
14
26

**Figure 7.-**

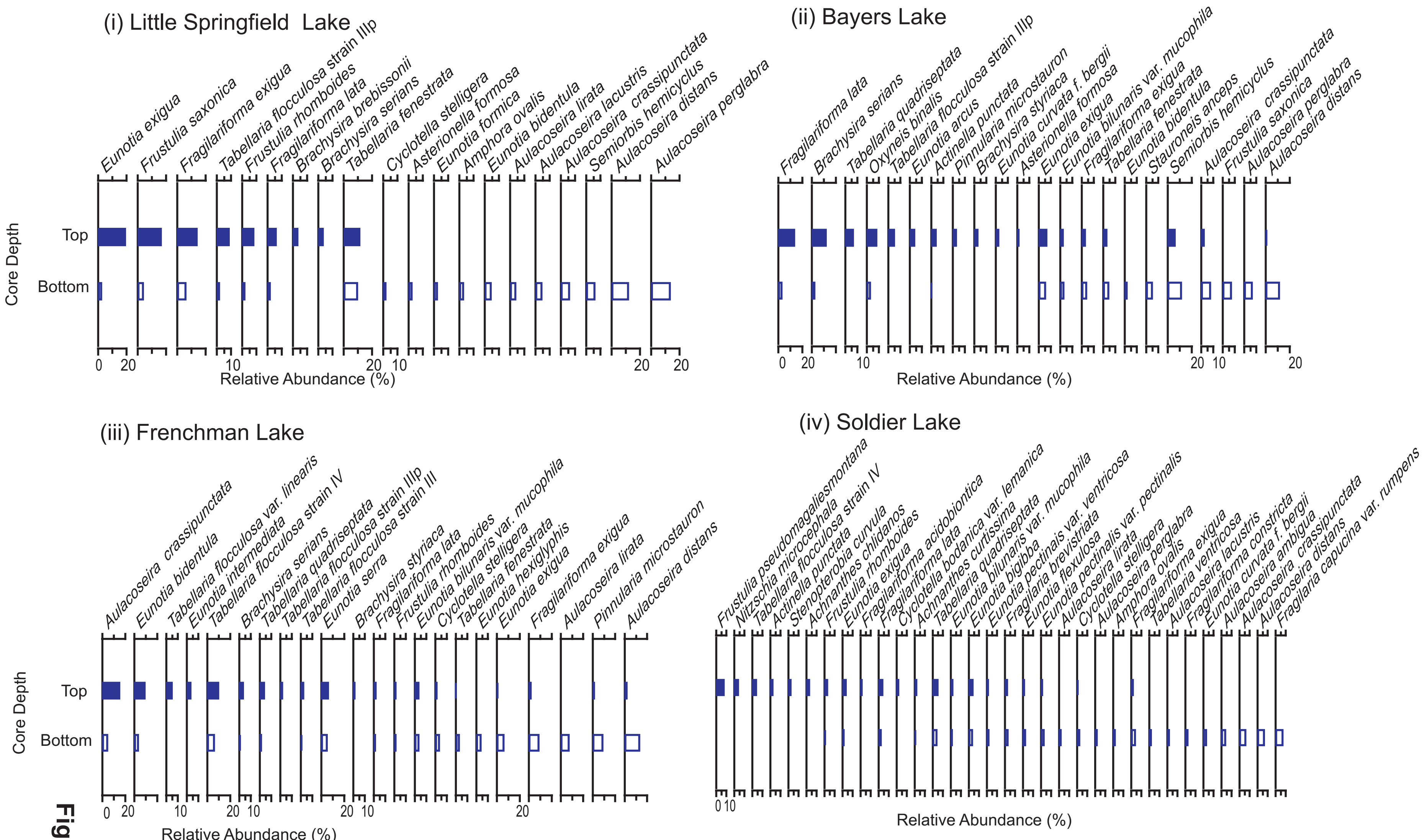

(i) Little Springfield Lake
Eunotia exigua
Frustulia saxonica
Fragilariforma exigua
Tabellaria flocculosa strain IIIp
Frustulia rhomboides
Fragilariforma lata
Brachysira brebissonii
Brachysira serians
Tabellaria fenestrata
Cyclotella stelligera
Asterionella formosa
Eunotia formica
Amphora ovalis
Eunotia bidentula
Aulacoseira lirata
Aulacoseira lacustris
Aulacoseira crassipunctata
Semiorbis hemicyclus
Aulacoseira distans
Aulacoseira perglabra
Core Depth
Top
Bottom
0 20 10 20 10 20 20
Relative Abundance (%)
(ii) Bayers Lake
Fragilariforma lata
Brachysira serians
Tabellaria quadriseptata
Oxyneis binalis
Tabellaria flocculosa strain IIIp
Eunotia arcus
Actinella punctata
Pinnularia microstauron
Brachysira styriaca
Eunotia curvata f. bergii
Asterionella formosa
Eunotia exigua
Eunotia bilunaris var. mucophila
Fragilariforma exigua
Tabellaria fenestrata
Eunotia bidentula
Stauroneis anceps
Semiorbis hemicyclus
Aulacoseira crassipunctata
Frustulia saxonica
Aulacoseira perglabra
Aulacoseira distans
0 20 10 20 10 20
Relative Abundance (%)
(iii) Frenchman Lake
Aulacoseira crassipunctata
Eunotia bidentula
Tabellaria flocculosa var. linearis
Eunotia intermediata
Tabellaria flocculosa strain IV
Brachysira serians
Tabellaria quadriseptata
Tabellaria flocculosa strain IIIp
Tabellaria flocculosa strain III
Eunotia serra
Brachysira styriaca
Fragilariforma lata
Frustulia rhomboides
Eunotia bilunaris var. mucophila
Cyclotella stelligera
Tabellaria fenestrata
Eunotia hexiglyphis
Eunotia exigua
Fragilariforma exigua
Aulacoseira lirata
Pinnularia microstauron
Aulacoseira distans
Core Depth
Top
Bottom
0 20 10 20 10 20 10 20
Relative Abundance (%)
(iv) Soldier Lake
Frustulia pseudomagaliesmontana
Nitzschia microcephala
Tabellaria flocculosa strain IV
Actinella punctata
Stenopterobia curvula
Achnanthes chlidanos
Frustulia rhomboides
Eunotia exigua
Fragilariforma acidobiontica
Fragilariforma lata
Cyclotella bodanica var. lemanica
Achnanthes curtissima
Tabellaria quadriseptata
Eunotia bilunaris var. mucophila
Eunotia bigibba
Eunotia pectinalis var. ventricosa
Fragilaria brevistriata
Eunotia flexulosa
Eunotia pectinalis var. pectinalis
Aulacoseira lirata
Cyclotella stelligera
Aulacoseira perglabra
Amphora ovalis
Fragilariforma exigua
Tabellaria ventricosa
Aulacoseira lacustris
Fragilariforma constricta
Eunotia curvata f. bergii
Aulacoseira ambigua
Aulacoseira crassipunctata
Aulacoseira distans
Fragilaria capucina var. rumpens
0 10
Relative Abundance (%)

**Figure 8a.-**

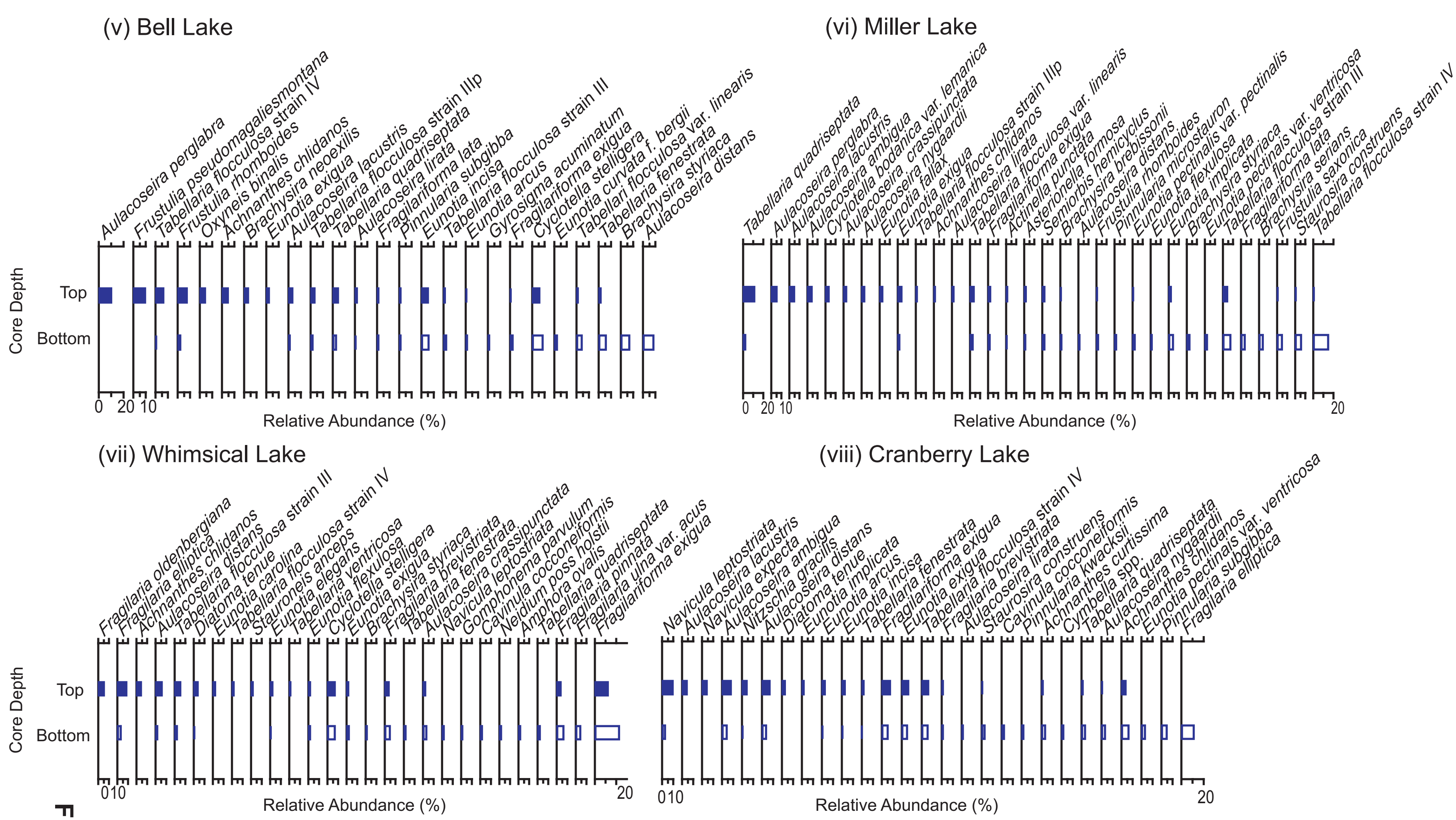
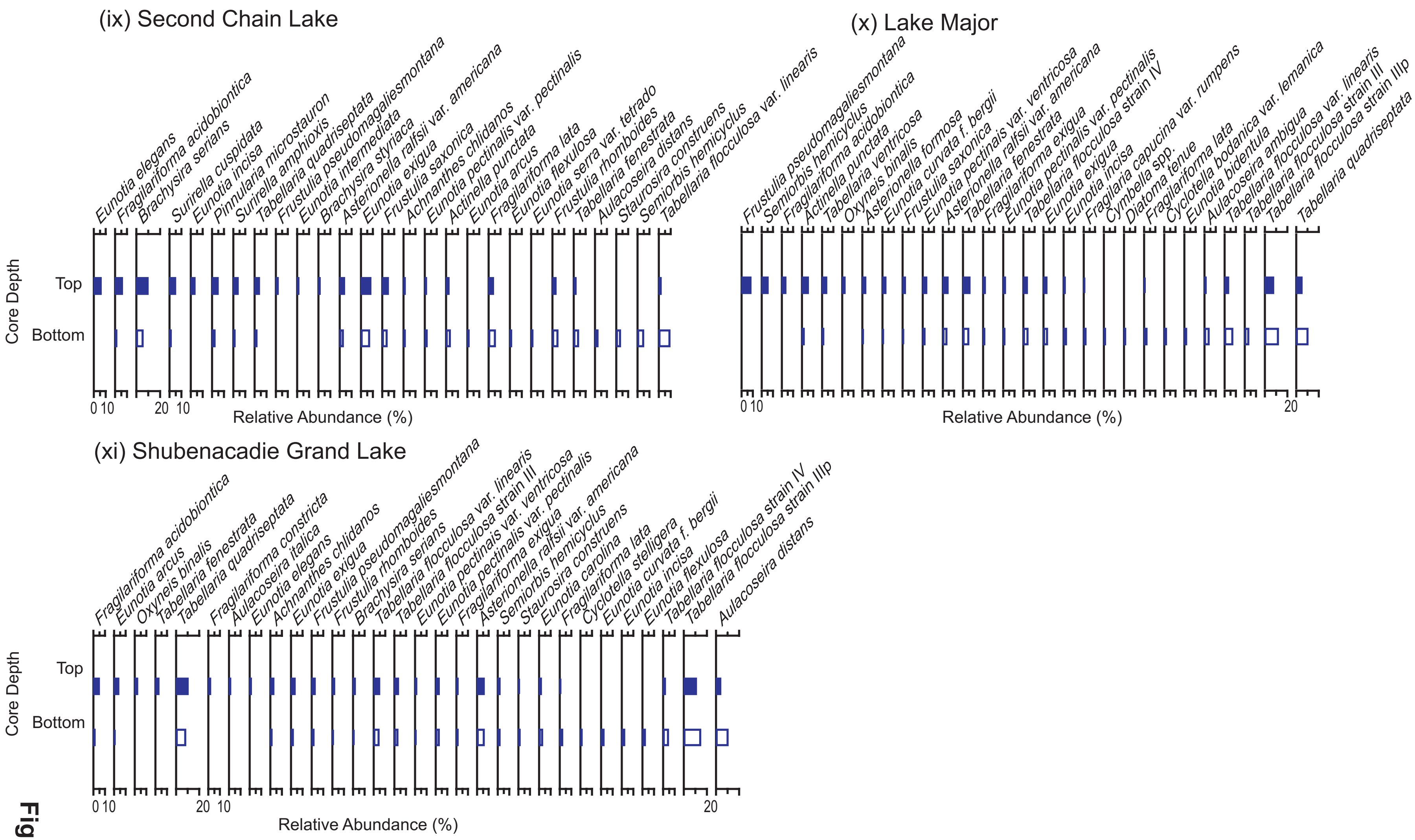

(v) Bell Lake
Aulacoseira perglabra
Frustulia pseudomagaliesmontana
Tabellaria flocculosa strain IV
Frustulia rhomboides
Oxyneis binalis
Achnanthes chlidanos
Brachysira neoexilis
Eunotia exigua
Aulacoseira lacustris
Tabellaria flocculosa strain IIIp
Tabellaria quadriseptata
Aulacoseira lirata
Fragilariforma lata
Pinnularia subgibba
Eunotia incisa
Tabellaria flocculosa strain III
Eunotia arcus
Gyrosigma acuminatum
Fragilariforma exigua
Cyclotella stelligera
Eunotia curvata f. bergii
Tabellari flocculosa var. linearis
Tabellaria fenestrata
Brachysira styriaca
Aulacoseira distans
Core Depth
Top
Bottom
0 20 10
Relative Abundance (%)
(vi) Miller Lake
Tabellaria quadriseptata
Aulacoseira perglabra
Aulacoseira lacustris
Aulacoseira ambigua
Cyclotella bodanica var. lemanica
Aulacoseira crassipunctata
Aulacoseira nygaardii
Eunotia fallax
Eunotia exigua
Tabellaria flocculosa strain IIIp
Achnanthes chlidanos
Aulacoseira lirata
Tabellaria flocculosa var. linearis
Fragilariforma exigua
Actinella punctata
Asterionella formosa
Semiorbis hemicyclus
Brachysira brebissonii
Aulacoseira distans
Frustulia rhomboides
Pinnularia microstauron
Eunotia pectinalis var. pectinalis
Eunotia flexulosa
Eunotia implicata
Brachysira styriaca
Eunotia pectinalis var. ventricosa
Tabellaria flocculosa strain III
Fragilariforma lata
Brachysira serians
Frustulia saxonica
Staurosira construens
Tabellaria flocculosa strain IV
0 20 10
20
Relative Abundance (%)
(vii) Whimsical Lake
Fragilaria oldenbergiana
Fragilaria elliptica
Achnanthes chlidanos
Aulacoseira distans
Tabellaria flocculosa strain III
Diatoma tenue
Eunotia carolina
Tabellaria flocculosa strain IV
Stauroneis anceps
Eunotia elegans
Tabellaria ventricosa
Eunotia flexulosa
Cyclotella stelligera
Eunotia exigua
Brachysira styriaca
Fragilaria brevistriata
Tabellaria fenestrata
Aulacoseira crassipunctata
Navicula leptostriata
Gomphonema parvulum
Cavinula cocconeiformis
Neidium poss holstii
Amphora ovalis
Tabellaria quadriseptata
Fragilaria pinnata
Fragilaria ulna var. acus
Fragilariforma exigua
Core Depth
Top
Bottom
010
20
Relative Abundance (%)
(viii) Cranberry Lake
Navicula leptostriata
Aulacoseira lacustris
Navicula expecta
Aulacoseira ambigua
Nitzschia gracilis
Aulacoseira distans
Diatoma tenue
Eunotia implicata
Eunotia arcus
Eunotia incisa
Tabellaria fenestrata
Fragilariforma exigua
Eunotia exigua
Tabellaria flocculosa strain IV
Fragilaria brevistriata
Aulacoseira lirata
Staurosira construens
Cavinula cocconeiformis
Pinnularia kwacksii
Achnanthes curtissima
Cymbella spp.
Tabellaria quadriseptata
Aulacoseira nygaardii
Achnanthes chlidanos
Eunotia pectinalis var. ventricosa
Pinnularia subgibba
Fragilaria elliptica
010
20
Relative Abundance (%)

**Figure 8b.-**



(ix) Second Chain Lake
Eunotia elegans
Fragilariforma acidobiontica
Brachysira serians
Surirella cuspidata
Eunotia incisa
Pinnularia microstauron
Surirella amphioxis
Tabellaria quadriseptata
Frustulia pseudomagaliesmontana
Eunotia intermediata
Brachysira styriaca
Asterionella ralfsii var. americana
Eunotia exigua
Frustulia saxonica
Achnanthes chlidanos
Eunotia pectinalis var. pectinalis
Actinella punctata
Eunotia arcus
Fragilariforma lata
Eunotia flexulosa
Eunotia serra var. tetrado
Frustulia rhomboides
Tabellaria fenestrata
Aulacoseira distans
Staurosira construens
Semiorbis hemicyclus
Tabellaria flocculosa var. linearis
Core Depth
Top
Bottom
0 10
20 10
Relative Abundance (%)
(x) Lake Major
Frustulia pseudomagaliesmontana
Semiorbis hemicyclus
Fragilariforma acidobiontica
Actinella punctata
Tabellaria ventricosa
Oxyneis binalis
Asterionella formosa
Eunotia curvata f. bergii
Frustulia saxonica
Eunotia pectinalis var. ventricosa
Asterionella ralfsii var. americana
Tabellaria fenestrata
Fragilariforma exigua
Eunotia pectinalis var. pectinalis
Tabellaria flocculosa strain IV
Eunotia exigua
Eunotia incisa
Fragilaria capucina var. rumpens
Cymbella spp.
Diatoma tenue
Fragilariforma lata
Cyclotella bodanica var. lemanica
Eunotia bidentula
Aulacoseira ambigua
Tabellaria flocculosa var. linearis
Tabellaria flocculosa strain III
Tabellaria flocculosa strain IIIp
Tabellaria quadriseptata
0 10
20
Relative Abundance (%)
(xi) Shubenacadie Grand Lake
Fragilariforma acidobiontica
Eunotia arcus
Oxyneis binalis
Tabellaria fenestrata
Tabellaria quadriseptata
Fragilariforma constricta
Aulacoseira italica
Eunotia elegans
Achnanthes chlidanos
Eunotia exigua
Frustulia pseudomagaliesmontana
Frustulia rhomboides
Brachysira serians
Tabellaria flocculosa var. linearis
Tabellaria flocculosa strain III
Eunotia pectinalis var. ventricosa
Eunotia pectinalis var. pectinalis
Fragilariforma exigua
Asterionella ralfsii var. americana
Semiorbis hemicyclus
Staurosira construens
Eunotia carolina
Fragilariforma lata
Cyclotella stelligera
Eunotia curvata f. bergii
Eunotia incisa
Eunotia flexulosa
Tabellaria flocculosa strain IV
Tabellaria flocculosa strain IIIp
Aulacoseira distans
Core Depth
Top
Bottom
0 10
20 10
20
Relative Abundance (%)


**Figure 8c.-**

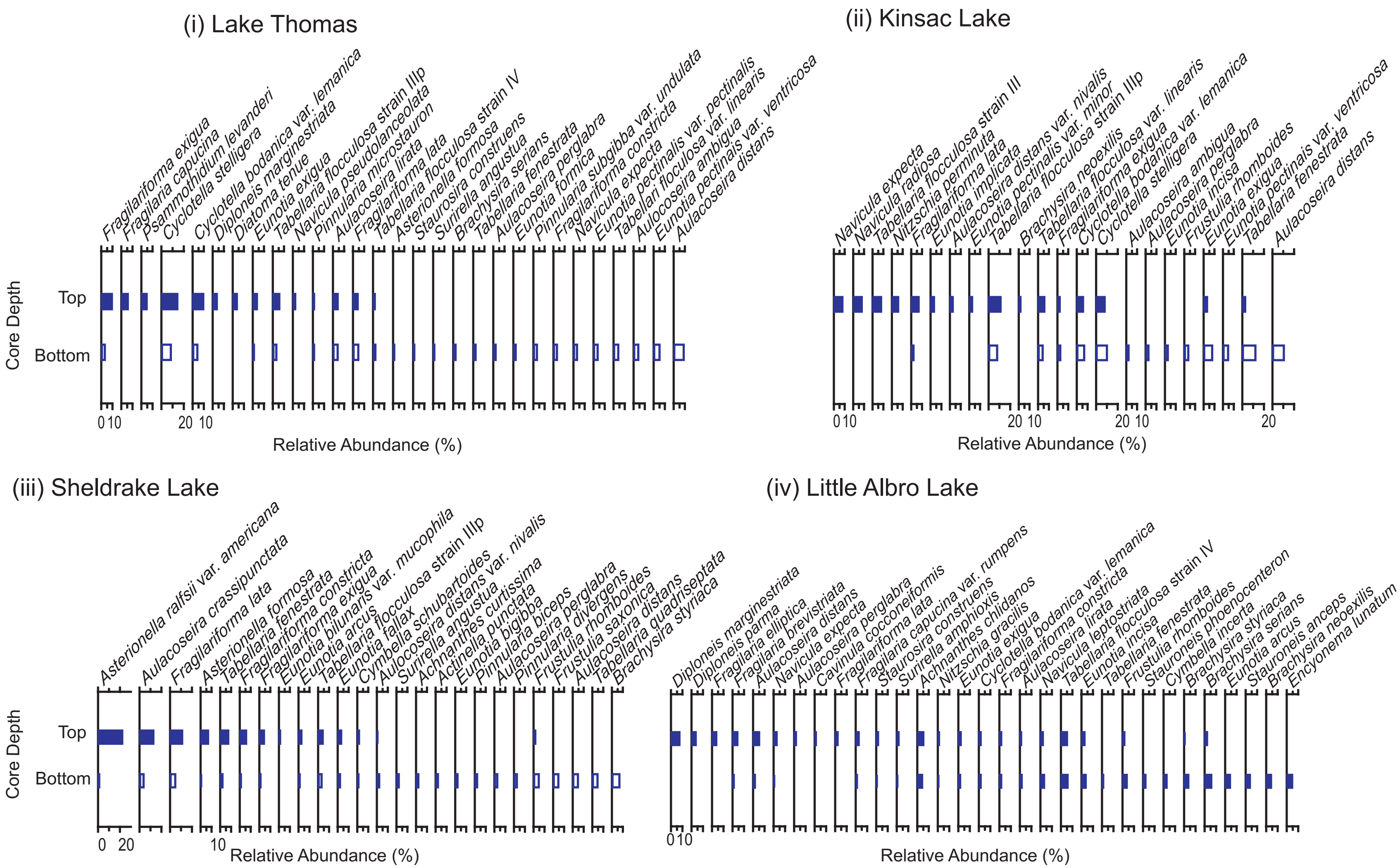
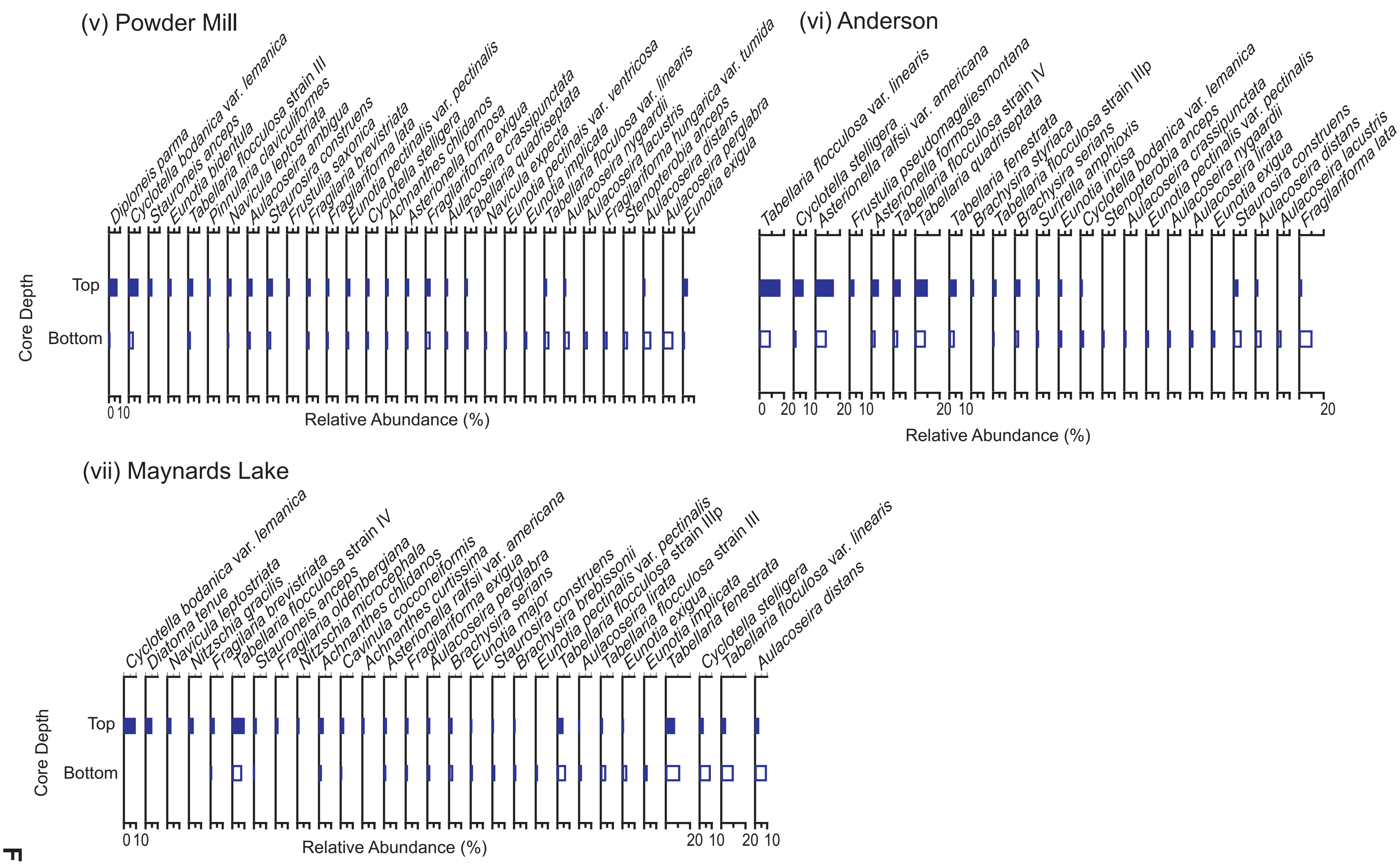

(i) Lake Thomas
Fragilariforma exigua
Fragilaria capucina
Psammothidium levanderi
Cyclotella stelligera
Cyclotella bodanica var. lemanica
Diploneis marginestriata
Diatoma tenue
Eunotia exigua
Tabellaria flocculosa strain IIIp
Navicula pseudolanceolata
Pinnularia microstauron
Aulacoseira lirata
Fragilariforma lata
Tabellaria flocculosa strain IV
Asterionella formosa
Staurosira construens
Surirella angustua
Brachysira seriens
Tabellaria fenestrata
Aulacoseira perglabra
Eunotia formica
Pinnularia subgibba var. undulata
Fragilariforma constricta
Navicula expecta
Eunotia pectinalis var. pectinalis
Tabellari floculosa var. linearis
Aulocoseira ambigua
Eunotia pectinais var. ventricosa
Aulacoseira distans
Top
Bottom
Core Depth
0 10
20 10
Relative Abundance (%)
(ii) Kinsac Lake
Navicula expecta
Navicula radiosa
Tabellaria flocculosa strain III
Nitzschia perminuta
Fragilariforma lata
Eunotia implicata
Aulacoseira distans var. nivalis
Eunotia pectinalis var. minor
Tabellaria flocculosa strain IIIp
Brachysira neoexilis
Tabellaria flocculosa var. linearis
Fragilariforma exigua
Cyclotella bodanica var. lemanica
Cyclotella stelligera
Aulacoseira ambigua
Aulacoseira perglabra
Eunotia incisa
Frustulia rhomboides
Eunotia exigua
Eunotia pectinais var. ventricosa
Tabellaria fenestrata
Aulacoseira distans
0 10
20 10
20 10
20
Relative Abundance (%)
(iii) Sheldrake Lake
Asterionella ralfsii var. americana
Aulacoseira crassipunctata
Fragilariforma lata
Asterionella formosa
Tabellaria fenestrata
Fragilariforma constricta
Fragilariforma exigua
Eunotia bilunaris var. mucophila
Eunotia arcus
Tabellaria flocculosa strain IIIp
Eunotia fallax
Cymbella schubartoides
Aulocoseira distans var. nivalis
Surirella angustua
Achnanthes curtissima
Actinella punctata
Eunotia bigibba
Pinnularia biceps
Aulacoseira perglabra
Pinnularia divergens
Frustulia rhomboides
Frustulia saxonica
Aulacoseira distans
Tabellaria quadriseptata
Brachysira styriaca
Top
Bottom
Core Depth
0 20
10
Relative Abundance (%)
(iv) Little Albro Lake
Diploneis marginestriata
Diploneis parma
Fragilaria elliptica
Fragilaria brevistriata
Aulacoseira distans
Navicula expecta
Aulacoseira perglabra
Cavinula cocconeiformis
Fragilariforma lata
Fragilaria capucina var. rumpens
Staurosira construens
Surirella amphioxis
Achnanthes chlidanos
Nitzschia gracilis
Eunotia exigua
Cyclotella bodanica var. lemanica
Fragilariforma constricta
Aulacoseira lirata
Navicula leptostriata
Tabellaria flocculosa strain IV
Eunotia incisa
Tabellaria fenestrata
Frustulia rhomboides
Stauroneis phoenocenteron
Cymbella incerta
Brachysira styriaca
Eunotia seriens
Eunotia arcus
Stauroneis anceps
Brachysira neoexilis
Encyonema lunatum
0 10
Relative Abundance (%)

**Figure 9a.-**



(v) Powder Mill
Diploneis parma
Cyclotella bodanica var. lemanica
Stauroneis anceps
Eunotia bidentula
Tabellaria flocculosa strain III
Pinnularia claviculiformes
Navicula leptostriata
Aulacoseira ambigua
Staurosira construens
Frustulia saxonica
Fragilaria brevistriata
Fragilariforma lata
Eunotia pectinalis var. pectinalis
Cyclotella stelligera
Achnanthes chlidanos
Asterionella formosa
Fragilariforma exigua
Aulacoseira crassipunctata
Tabellaria quadriseptata
Navicula expecta
Eunotia pectinalis var. ventricosa
Eunotia implicata
Tabellaria flocculosa var. linearis
Aulacoseira nygaardii
Aulacoseira lacustris
Fragilariforma hungarica var. tumida
Stenopterobia anceps
Aulacoseira distans
Aulacoseira perglabra
Eunotia exigua
Core Depth
Top
Bottom
0 10
Relative Abundance (%)
(vi) Anderson
Tabellaria flocculosa var. linearis
Cyclotella stelligera
Asterionella ralfsii var. americana
Frustulia pseudomagaliesmontana
Asterionella formosa
Tabellaria flocculosa strain IV
Tabellaria quadriseptata
Tabellaria fenestrata
Brachysira styriaca
Tabellaria flocculosa strain IIIp
Brachysira serians
Surirella amphioxis
Eunotia incisa
Cyclotella bodanica var. lemanica
Stenopterobia anceps
Aulacoseira crassipunctata
Eunotia pectinalis var. pectinalis
Aulacoseira nygaardii
Aulacoseira lirata
Eunotia exigua
Staurosira construens
Aulacoseira distans
Aulacoseira lacustris
Fragilariforma lata
0 20 10 20 10 20 10 20
Relative Abundance (%)
(vii) Maynards Lake
Cyclotella bodanica var. lemanica
Diatoma tenue
Navicula leptostriata
Nitzschia gracilis
Fragilaria brevistriata
Tabellaria flocculosa strain IV
Stauroneis anceps
Fragilaria oldenbergiana
Nitzschia microcephala
Achnanthes chlidanos
Cavinula cocconeiformis
Achnanthes curtissima
Asterionella ralfsii var. americana
Fragilariforma exigua
Aulacoseira perglabra
Brachysira serians
Eunotia major
Staurosira construens
Brachysira brebissonii
Eunotia pectinalis var. pectinalis
Tabellaria flocculosa strain IIIp
Aulacoseira lirata
Tabellaria flocculosa strain III
Eunotia exigua
Eunotia implicata
Tabellaria fenestrata
Cyclotella stelligera
Tabellaria floculosa var. linearis
Aulacoseira distans
Core Depth
Top
Bottom
0 10 20 10 20 10
Relative Abundance (%)


Figure 9b.-

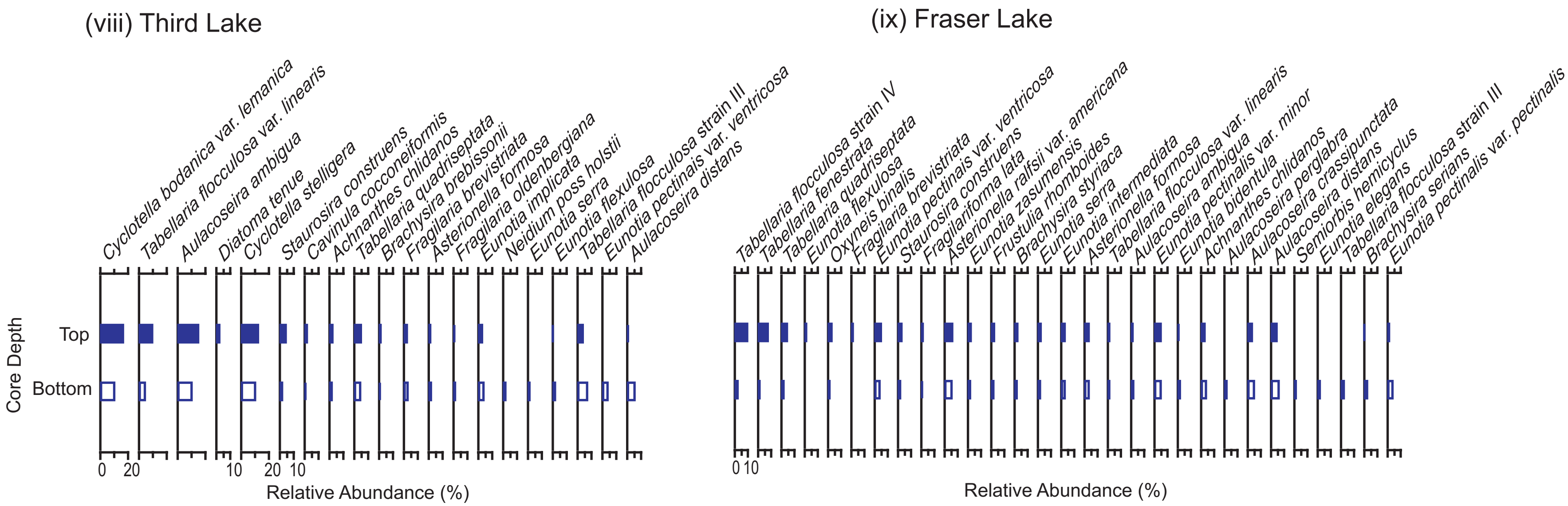

(viii) Third Lake
Cyclotella bodanica var. lemanica
Tabellaria flocculosa var. linearis
Aulacoseira ambigua
Diatoma tenue
Cyclotella stelligera
Staurosira construens
Cavinula cocconeiformis
Achnanthes chlidanos
Tabellaria quadriseptata
Brachysira brebissonii
Fragilaria brevistriata
Asterionella formosa
Fragilaria oldenbergiana
Eunotia implicata
Neidium poss holstii
Eunotia serra
Eunotia flexulosa
Tabellaria flocculosa strain III
Eunotia pectinais var. ventricosa
Aulacoseira distans
Core Depth
Top
Bottom
0
20
10
20
10
Relative Abundance (%)
(ix) Fraser Lake
Tabellaria flocculosa strain IV
Tabellaria fenestrata
Tabellaria quadriseptata
Eunotia flexulosa
Oxyneis binalis
Fragilaria brevistriata
Eunotia pectinais var. ventricosa
Staurosira construens
Fragilariforma lata
Asterionella ralfsii var. americana
Eunotia zasumensis
Frustulia rhomboides
Brachysira styriaca
Eunotia serra
Eunotia intermediata
Asterionella formosa
Tabellaria flocculosa var. linearis
Aulacoseira ambigua
Eunotia pectinalis var. minor
Eunotia bidentula
Achnanthes chlidanos
Aulacoseira perglabra
Aulacoseira crassipunctata
Aulacoseira distans
Semiorbis hemicyclus
Eunotia elegans
Tabellaria flocculosa strain III
Brachysira serians
Eunotia pectinalis var. pectinalis
0 10
Relative Abundance (%)

**Figure 9c.-**

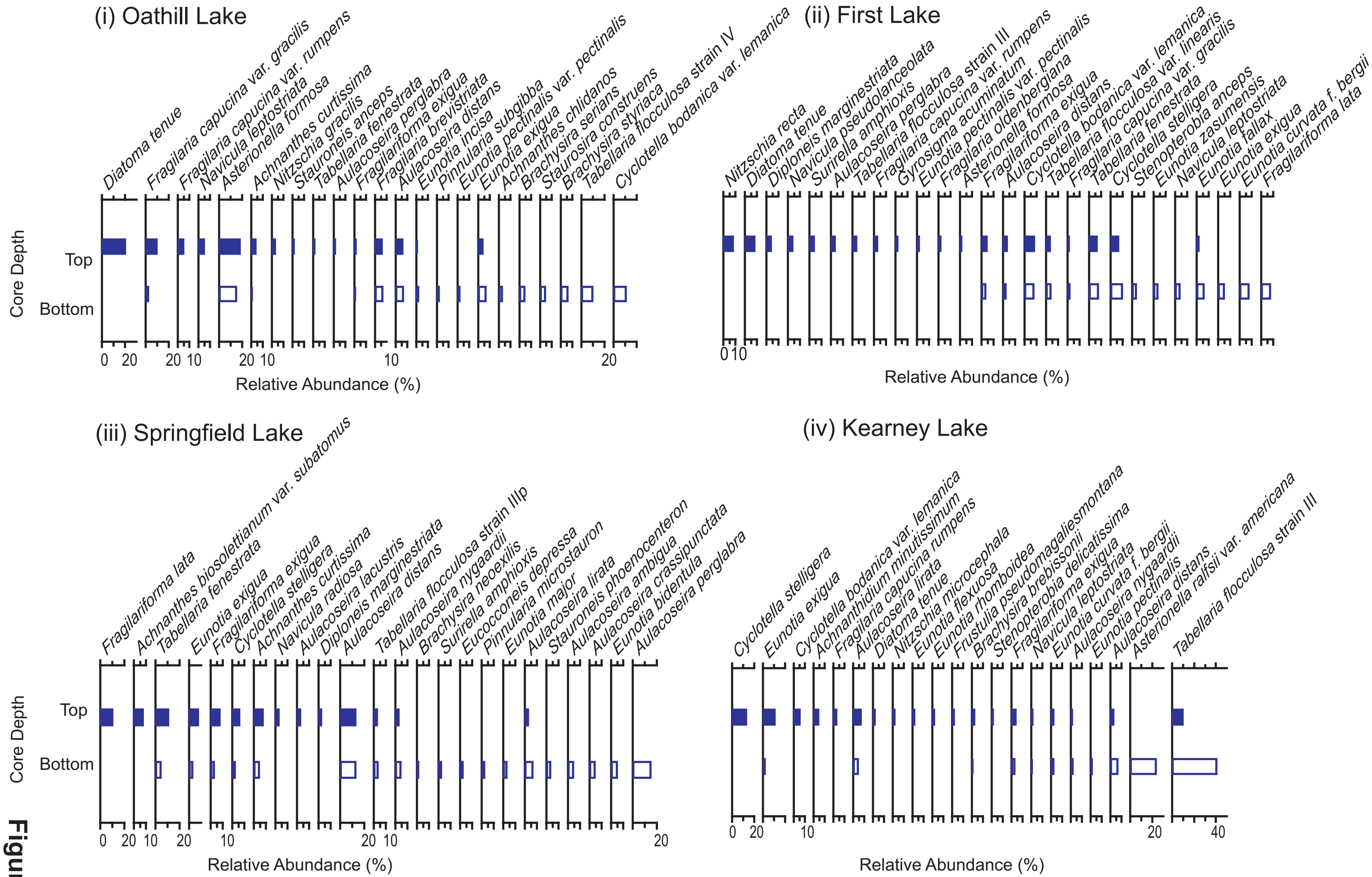
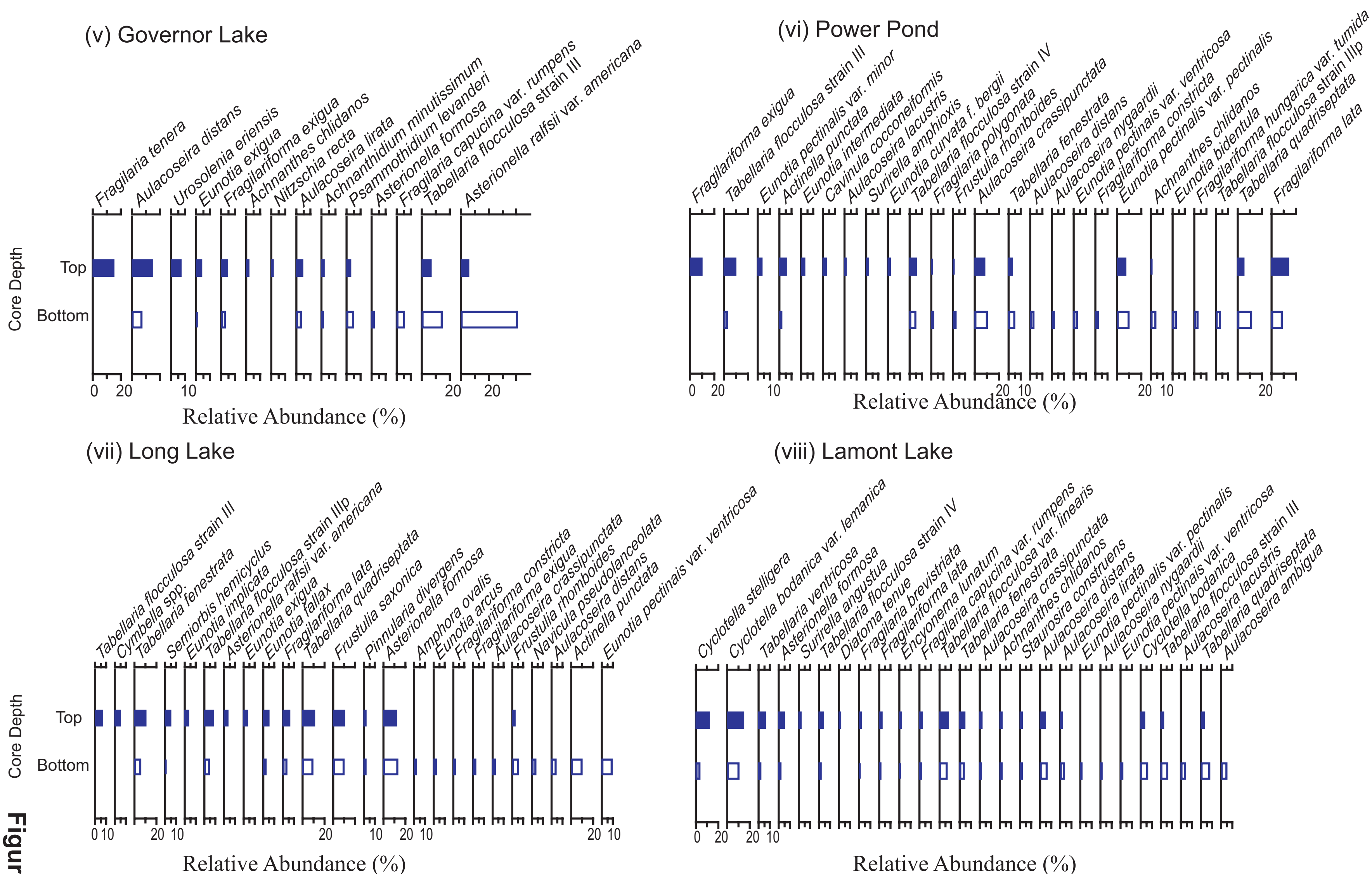

(i) Oathill Lake
Diatoma tenue
Fragilaria capucina var. gracilis
Fragilaria capucina var. rumpens
Navicula leptostriata
Asterionella formosa
Achnanthes curtissima
Nitzschia gracilis
Stauroneis anceps
Tabellaria fenestrata
Aulacoseira perglabra
Fragilariforma exigua
Fragilaria brevistriata
Aulacoseira distans
Eunotia incisa
Pinnularia subgibba
Eunotia pectinalis var. pectinalis
Eunotia exigua
Achnanthes chlidanos
Brachysira serians
Staurosira construens
Brachysira styriaca
Tabellaria flocculosa strain IV
Cyclotella bodanica var. lemanica
Core Depth
Top
Bottom
0 20
20 10
20 10
10
20
Relative Abundance (%)
(ii) First Lake
Nitzschia recta
Diatoma tenue
Diploneis marginestriata
Navicula pseudolanceolata
Surirella amphioxis
Aulacoseira perglabra
Tabellaria flocculosa strain III
Fragilaria capucina var. rumpens
Gyrosigma acuminatum
Eunotia pectinalis var. pectinalis
Fragilaria oldenbergiana
Asterionella formosa
Fragilariforma exigua
Aulacoseira distans
Cyclotella bodanica var. lemanica
Tabellaria flocculosa var. linearis
Fragilaria capucina var. gracilis
Tabellaria fenestrata
Cyclotella stelligera
Stenopterobia anceps
Eunotia zasumensis
Navicula leptostriata
Eunotia fallax
Eunotia exigua
Eunotia curvata f. bergii
Fragilariforma lata
0 10
Relative Abundance (%)
(iii) Springfield Lake
Fragilariforma lata
Achnanthes biosolettianum var. subatomus
Tabellaria fenestrata
Eunotia exigua
Fragilariforma exigua
Cyclotella stelligera
Achnanthes curtissima
Navicula radiosa
Aulacoseira lacustris
Diploneis marginestriata
Aulacoseira distans
Tabellaria flocculosa strain IIIp
Aulacoseira nygaardii
Brachysira neoexilis
Surirella amphioxis
Eucocconeis depressa
Pinnularia microstauron
Eunotia major
Aulacoseira lirata
Stauroneis phoenocenteron
Aulacoseira ambigua
Aulacoseira crassipunctata
Eunotia bidentula
Aulacoseira perglabra
Core Depth
Top
Bottom
0 20 10 20 10
20 10
20
Relative Abundance (%)
(iv) Kearney Lake
Cyclotella stelligera
Eunotia exigua
Cyclotella bodanica var. lemanica
Achnanthidium minutissimum
Fragilaria capucina rumpens
Aulacoseira lirata
Diatoma tenue
Nitzschia microcephala
Eunotia flexuosa
Eunotia rhomboidea
Frustulia pseudomagaliesmontana
Brachysira brebissonii
Stenopterobia delicatissima
Fragilariforma exigua
Navicula leptostriata
Eunotia curvata f. bergii
Aulacoseira nygaardii
Eunotia pectinalis
Aulacoseira distans
Asterionella ralfsii var. americana
Tabellaria flocculosa strain III
0 20
10
20
40
Relative Abundance (%)

**Figure 10a.-**



(v) Governor Lake
Fragilaria tenera
Aulacoseira distans
Urosolenia eriensis
Eunotia exigua
Fragilariforma exigua
Achnanthes chlidanos
Nitzschia recta
Aulacoseira lirata
Achnanthidium minutissimum
Psammothidium levanderi
Asterionella formosa
Fragilaria capucina var. rumpens
Tabellaria flocculosa strain III
Asterionella ralfsii var. americana
Core Depth
Top
Bottom
0 20 20 10 20 20
Relative Abundance (%)
(vi) Power Pond
Fragilariforma exigua
Tabellaria flocculosa strain III
Eunotia pectinalis var. minor
Actinella punctata
Eunotia intermediata
Cavinula cocconeiformis
Aulacoseira lacustris
Surirella amphioxis
Eunotia curvata f. bergii
Tabellaria flocculosa strain IV
Fragilaria polygonata
Frustulia rhomboides
Aulacoseira crassipunctata
Tabellaria fenestrata
Aulacoseira distans
Aulacoseira nygaardii
Eunotia pectinalis var. ventricosa
Fragilariforma constricta
Eunotia pectinalis var. pectinalis
Achnanthes chlidanos
Eunotia bidentula
Fragilariforma hungarica var. tumida
Tabellaria flocculosa strain IIIp
Tabellaria quadriseptata
Fragilariforma lata
0 20 10 20 10 20 10 20
Relative Abundance (%)
(vii) Long Lake
Tabellaria flocculosa strain III
Cymbella spp.
Tabellaria fenestrata
Semiorbis hemicyclus
Eunotia implicata
Tabellaria flocculosa strain IIIp
Asterionella ralfsii var. americana
Eunotia exigua
Eunotia fallax
Fragilariforma lata
Tabellaria quadriseptata
Frustulia saxonica
Pinnularia divergens
Asterionella formosa
Amphora ovalis
Eunotia arcus
Fragilariforma constricta
Fragilariforma exigua
Aulacoseira crassipunctata
Frustulia rhomboides
Navicula pseudolanceolata
Aulacoseira distans
Actinella punctata
Eunotia pectinais var. ventricosa
Core Depth
Top
Bottom
0 10 20 10 20 10 20 10 20 10
Relative Abundance (%)
(viii) Lamont Lake
Cyclotella stelligera
Cyclotella bodanica var. lemanica
Tabellaria ventricosa
Asterionella formosa
Surirella angustua
Tabellaria flocculosa strain IV
Diatoma tenue
Fragilaria brevistriata
Fragilariforma lata
Encyonema lunatum
Fragilaria capucina var. rumpens
Tabellaria flocculosa var. linearis
Tabellaria fenestrata
Aulacoseira crassipunctata
Achnanthes chlidanos
Staurosira construens
Aulacoseira distans
Aulacoseira lirata
Eunotia pectinalis var. pectinalis
Aulacoseira nygaardii
Eunotia pectinalis var. ventricosa
Cyclotella bodanica
Tabellaria flocculosa strain III
Aulacoseira lacustris
Tabellaria quadriseptata
Aulacoseira ambigua
0 20 20 10
Relative Abundance (%)


**Figure 10b.-**

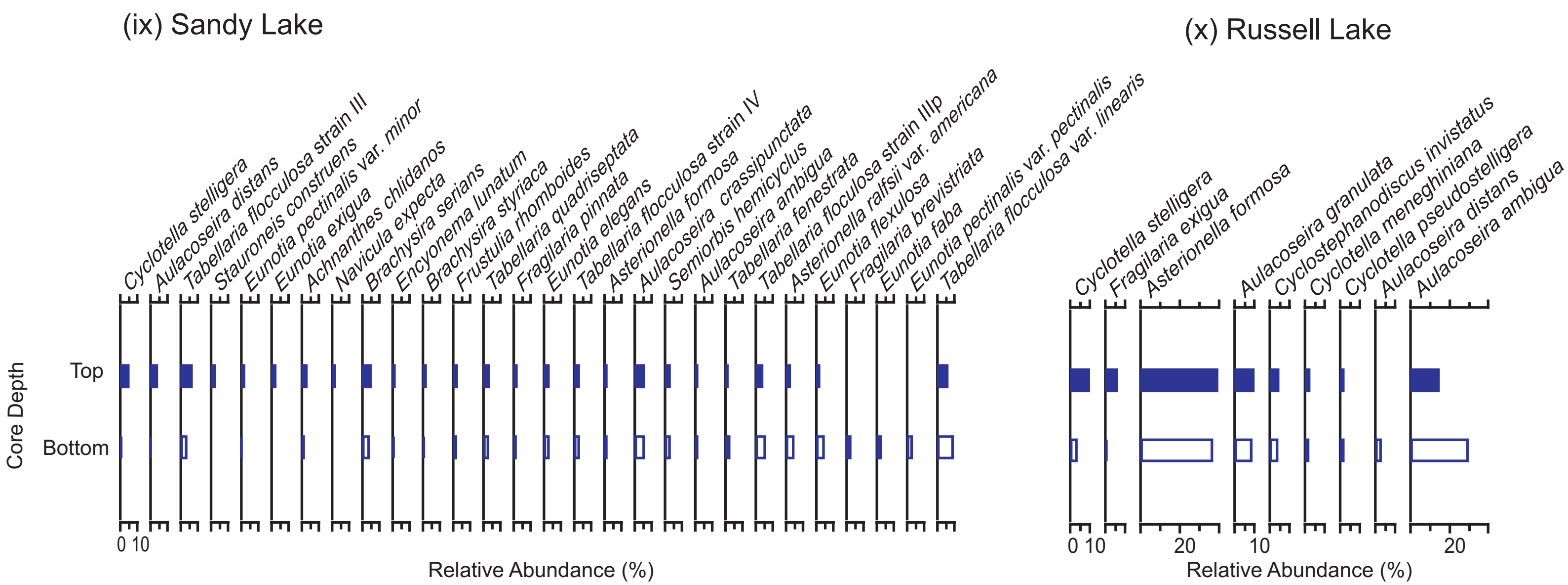

(ix) Sandy Lake
Cyclotella stelligera
Aulacoseira distans
Tabellaria flocculosa strain III
Stauroneis construens
Eunotia pectinalis var. minor
Eunotia exigua
Achnanthes chlidanos
Navicula expecta
Brachysira serians
Encyonema lunatum
Brachysira styriaca
Frustulia rhomboides
Tabellaria quadriseptata
Fragilaria pinnata
Eunotia elegans
Tabellaria flocculosa strain IV
Asterionella formosa
Aulacoseira crassipunctata
Semiorbis hemicyclus
Aulacoseira ambigua
Tabellaria fenestrata
Tabellaria floculosa strain IIIp
Asterionella ralfsii var. americana
Eunotia flexulosa
Fragilaria brevistriata
Eunotia faba
Eunotia pectinalis var. pectinalis
Tabellaria flocculosa var. linearis
Core Depth
Top
Bottom
0 10
Relative Abundance (%)
(x) Russell Lake
Cyclotella stelligera
Fragilaria exigua
Asterionella formosa
Aulacoseira granulata
Cyclostephanodiscus invistatus
Cyclotella meneghiniana
Cyclotella pseudostelligera
Aulacoseira distans
Aulacoseira ambigua
0 10
20
10
20
Relative Abundance (%)

**Figure 10c.-**

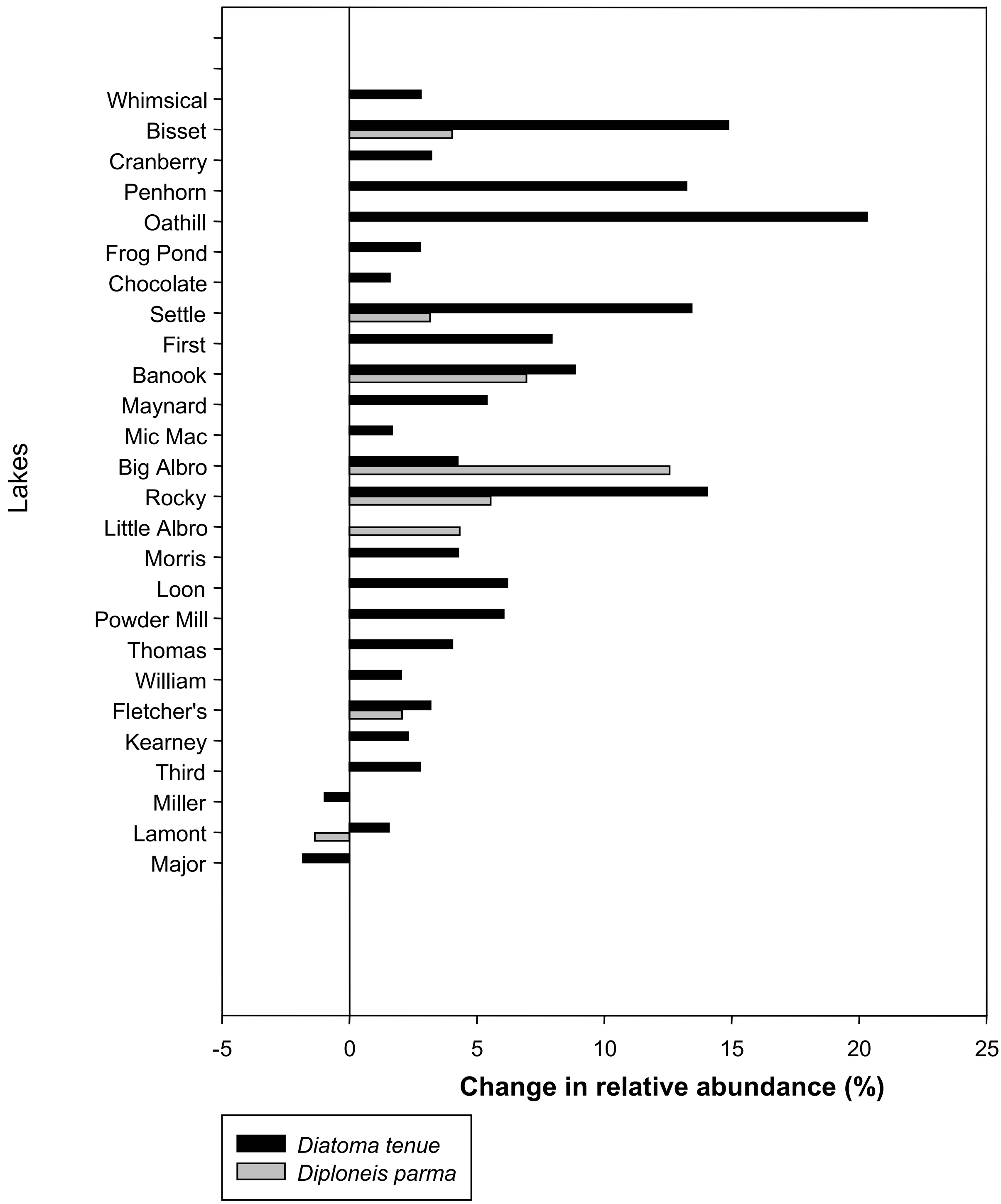

Whimsical
Bisset
Cranberry
Penhorn
Oathill
Frog Pond
Chocolate
Settle
First
Banook
Maynard
Mic Mac
Big Albro
Rocky
Little Albro
Morris
Loon
Powder Mill
Thomas
William
Fletcher's
Kearney
Third
Miller
Lamont
Major
Lakes
-5
0
5
10
15
20
25
Change in relative abundance (%)
Diatoma tenue
Diploneis parma

**Figure 11.-**

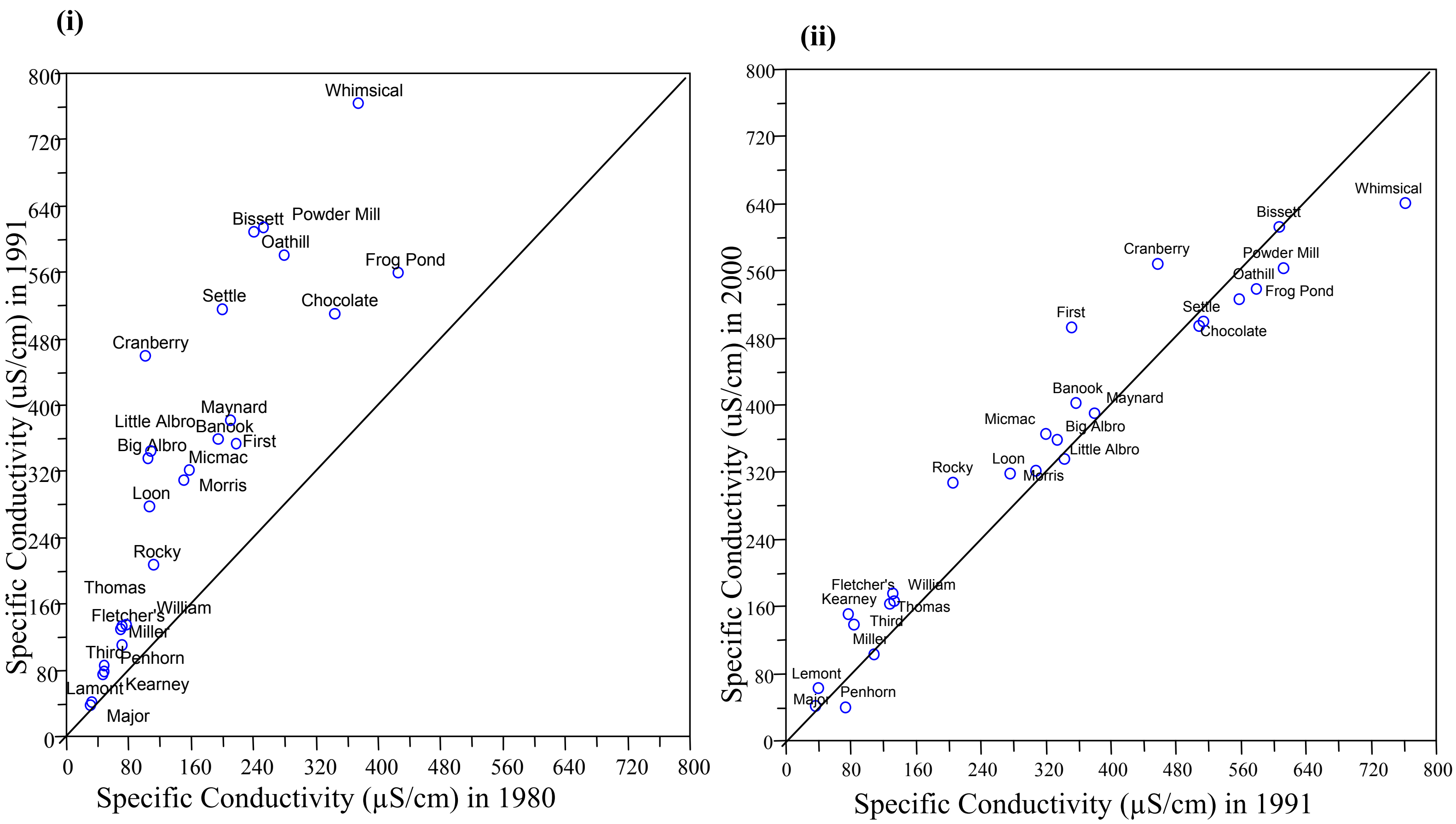

(i)
Specific Conductivity (uS/cm) in 1991
Specific Conductivity (µS/cm) in 1980
Whimsical
Bissett
Powder Mill
Oathill
Frog Pond
Settle
Chocolate
Cranberry
Maynard
Little Albro
Banook
First
Big Albro
Micmac
Morris
Loon
Rocky
Thomas
William
Fletcher's
Miller
Third
Penhorn
Lamont
Kearney
Major
(ii)
Specific Conductivity (uS/cm) in 2000
Specific Conductivity (µS/cm) in 1991
Whimsical
Bissett
Cranberry
Powder Mill
Oathill
Frog Pond
First
Settle
Chocolate
Banook
Maynard
Micmac
Big Albro
Little Albro
Rocky
Loon
Morris
Fletcher's
William
Kearney
Thomas
Third
Miller
Lemont
Major
Penhorn

Figure 12.-

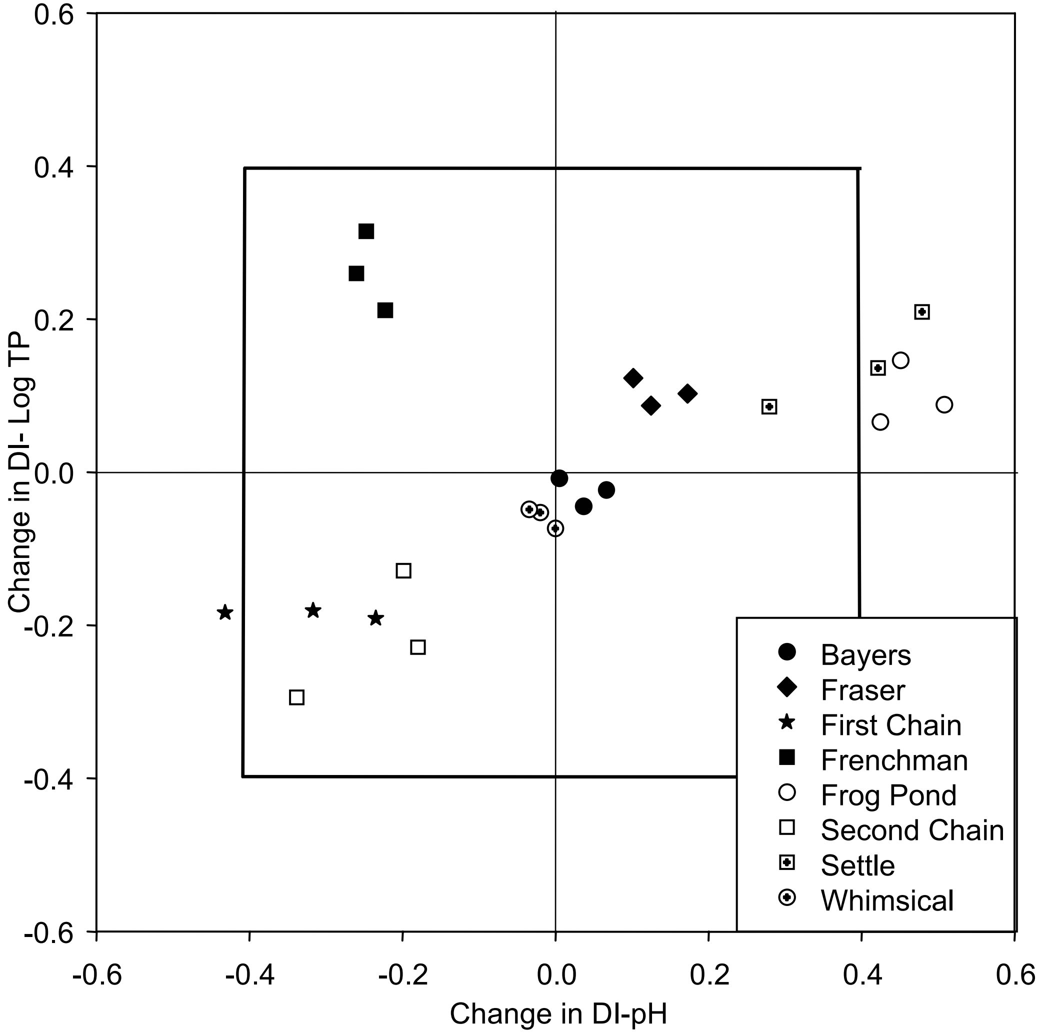

0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
Change in DI- Log TP
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
Change in DI-pH
Bayers
Fraser
First Chain
Frenchman
Frog Pond
Second Chain
Settle
Whimsical

**Figure 13.-**

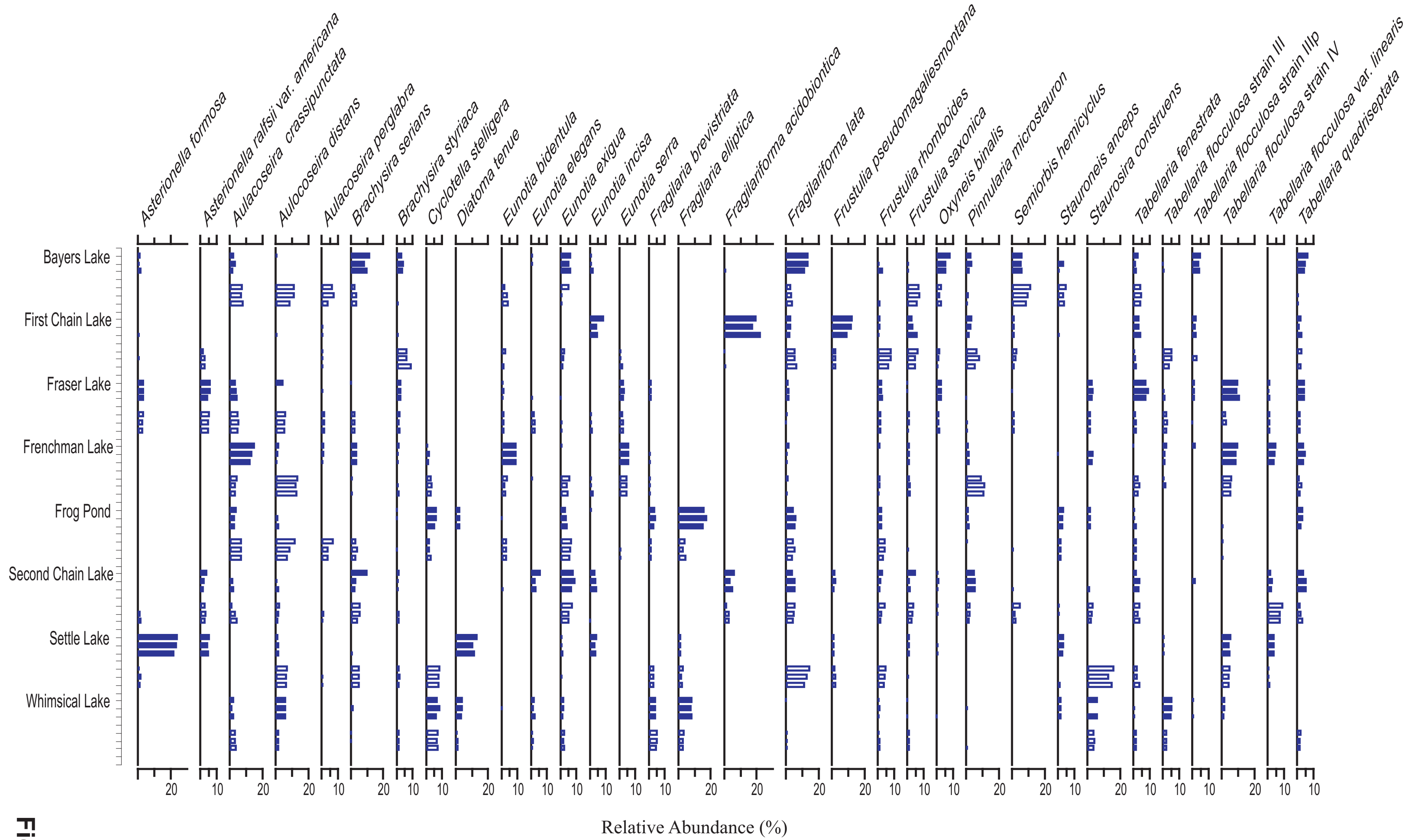

Asterionella formosa
Asterionella ralfsii var. americana
Aulacoseira crassipunctata
Aulocoseira distans
Aulacoseira perglabra
Brachysira serians
Brachysira styriaca
Cyclotella stelligera
Diatoma tenue
Eunotia bidentula
Eunotia elegans
Eunotia exigua
Eunotia incisa
Eunotia serra
Fragilaria brevistriata
Fragilaria elliptica
Fragilariforma acidobiontica
Fragilariforma lata
Frustulia pseudomagaliesmontana
Frustulia rhomboides
Frustulia saxonica
Oxyneis binalis
Pinnularia microstauron
Semiorbis hemicyclus
Stauroneis anceps
Staurosira construens
Tabellaria fenestrata
Tabellaria flocculosa strain III
Tabellaria flocculosa strain IIIp
Tabellaria floculosa strain IV
Tabellaria flocculosa var. linearis
Tabellaria quadriseptata
Bayers Lake
First Chain Lake
Fraser Lake
Frenchman Lake
Frog Pond
Second Chain Lake
Settle Lake
Whimsical Lake
20
10
Relative Abundance (%)

**Figure 14.-**

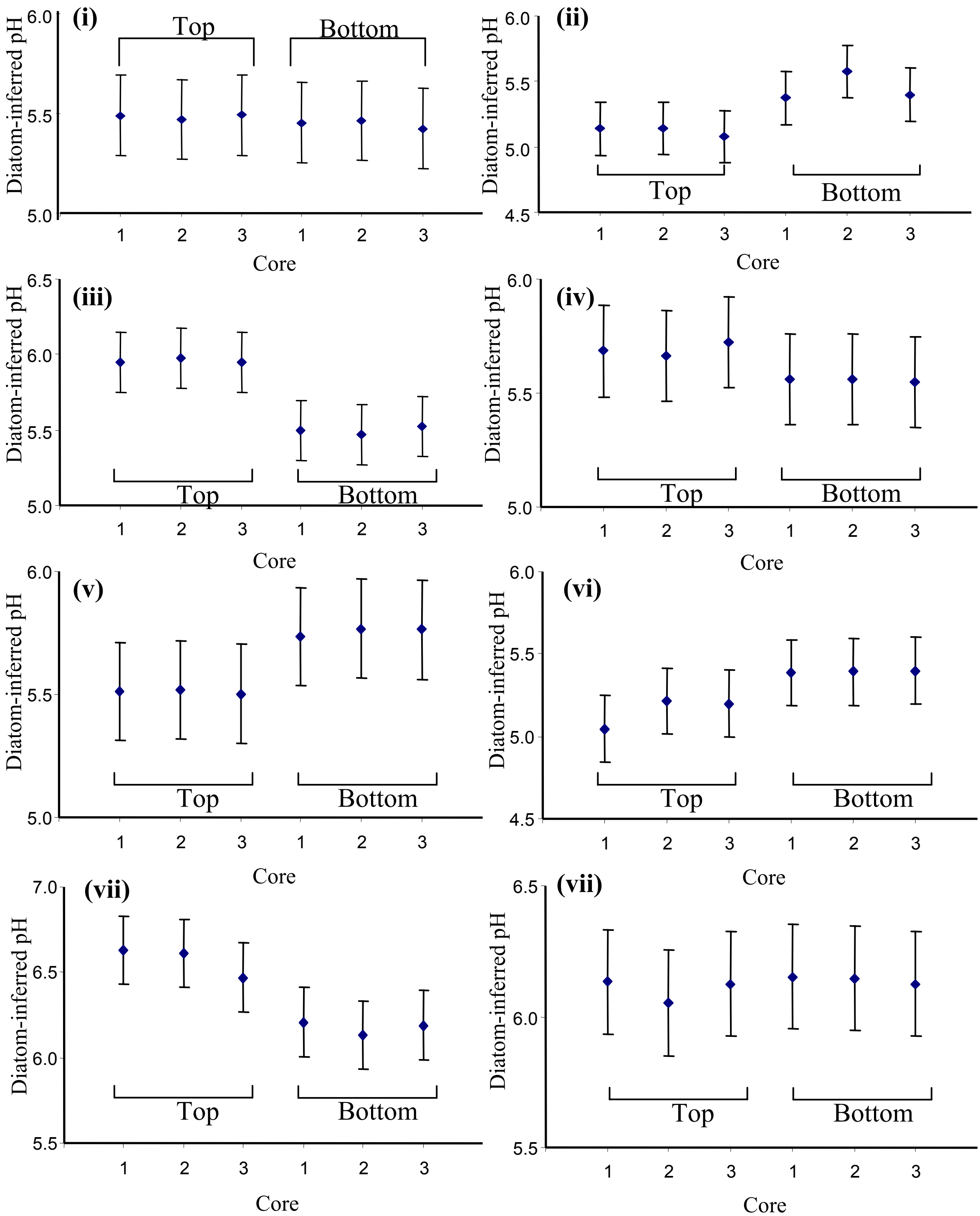

(i)
Top
Bottom
Diatom-inferred pH
6.0
5.5
5.0
1
2
3
1
2
3
Core
(ii)
Top
Bottom
Diatom-inferred pH
6.0
5.5
5.0
4.5
Core
(iii)
Diatom-inferred pH
6.5
6.0
5.5
5.0
Top
Bottom
Core
(iv)
Diatom-inferred pH
6.0
5.5
5.0
Top
Bottom
Core
(v)
Diatom-inferred pH
6.0
5.5
5.0
Top
Bottom
Core
(vi)
Diatom-inferred pH
6.0
5.5
5.0
4.5
Top
Bottom
Core
(vii)
Diatom-inferred pH
7.0
6.5
6.0
5.5
Top
Bottom
Core
(vii)
Diatom-inferred pH
6.5
6.0
5.5
Top
Bottom
Core

**Figure 15.-**

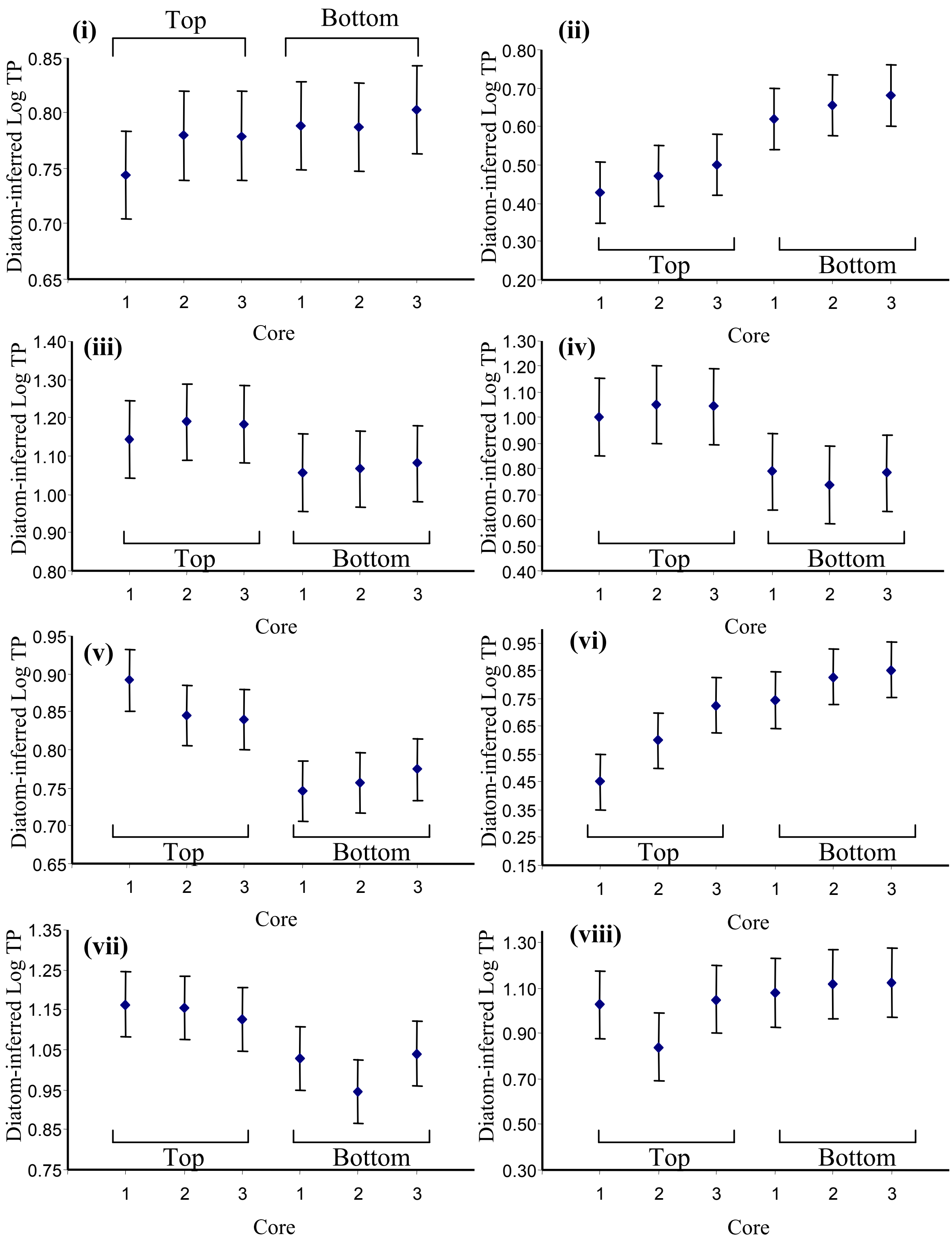

(i)
Top
Bottom
Diatom-inferred Log TP
0.85
0.80
0.75
0.70
0.65
1
2
3
1
2
3
Core
(ii)
Diatom-inferred Log TP
0.80
0.70
0.60
0.50
0.40
0.30
0.20
Top
Bottom
1
2
3
1
2
3
Core
(iii)
Diatom-inferred Log TP
1.40
1.30
1.20
1.10
1.00
0.90
0.80
Top
Bottom
1
2
3
1
2
3
Core
(iv)
Diatom-inferred Log TP
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
Top
Bottom
1
2
3
1
2
3
Core
(v)
Diatom-inferred Log TP
0.95
0.90
0.85
0.80
0.75
0.70
0.65
Top
Bottom
1
2
3
1
2
3
Core
(vi)
Diatom-inferred Log TP
0.95
0.85
0.75
0.65
0.55
0.45
0.35
0.25
0.15
Top
Bottom
1
2
3
1
2
3
Core
(vii)
Diatom-inferred Log TP
1.35
1.25
1.15
1.05
0.95
0.85
0.75
Top
Bottom
1
2
3
1
2
3
Core
(viii)
Diatom-inferred Log TP
1.30
1.10
0.90
0.70
0.50
0.30
Top
Bottom
1
2
3
1
2
3
Core

**Figure 16.-**

# CHAPTER 3

# GENERAL DISCUSSION AND CONCLUSIONS

Previous paleolimnological studies in Nova Scotia were primarily concerned with the impact of acidification (Ginn 2006). Moreover, there were only a few long-term limnological studies from Halifax region in particular. Water-quality surveys from Metro Halifax over ~20 years (Clement et al. 2007) inferred changes in some lakes in measured specific conductivity, nutrient status and pH. However, the lack of long-term monitoring data made it difficult to infer pre-impact lake conditions, which then limits the ability to infer the presence of water-quality changes in the lakes, if any. Therefore, this 'before'-and-'after' study of 51 Halifax region lakes incorporates paleolimnological techniques to assess the water-quality changes since the pre-industrial (>150 year) period and examines possible environmental stressors and potential impact of urban development and other human-related activities in the region.

Sedimentary diatom assemblages from the 'top' (0 to 0.5-cm interval) and from a depth typically ~25 to 25.5 cm (representing pre-impact conditions) were analysed for 51 lakes from the Halifax region, Nova Scotia. Bray-Curtis similarity coefficients calculated to detect change between pre-industrial and present-day samples showed that diatom assemblages have changed since pre-industrial times in all 51 lakes (see Chapter 2 for details). However, the degree and extent of change in species composition varied among the lakes. A previously developed 487-lake diatom calibration set from northeastern North America including lakes from Nova Scotia (Ginn et al. 2007a) was used to reconstruct pH and total phosphorus concentration from the diatom assemblages for all lakes. Changes in diatom-inferred pH and log TP greater/less than the root-mean-squared error (RMSE) of the inference models (± 0.40 for pH, ± 0.40 log TP) were used as the cut-off value to determine the potentially important stressors to implicate a strong rate of acidification, eutrophication, or climate). For example, a decrease in pH greater than RMSE would indicate acidification. An increase in diatom-inferred TP greater than RMSE of the inference model would indicate eutrophication. Finally, an increase in pH greater than RMSE of the diatom-inference model would be consistent with a recent change in climate, or a recovery from acidification.

Two (Pockwock and Topsail) of the 51 lakes indicated a trend toward acidification with decreasing diatom-inferred pH greater than the RMSE from pre-to post-development periods. The pH change was driven by increases in acidophilous diatom taxa such as *Fragilariforma acidobiontica* and *Eunotia* spp. and decreases in the circumneutral taxon *Cyclotella stelligera*. This trend is well-documented from other paleo-studies in the region (see Chapter 2). A combination of factors including: lowest measured pH, low DOC, low pre-industrial pH, previously recorded impact of sulphate emissions from industrial centers of Halifax (Ginn et al. 2007b,c), poor buffering capacity, relatively undisturbed watersheds, and climatic variability in the region are attributable to the observed acidification trend.

Seven lakes (Settle, Penhorn, Morris, Charles, Fletcher's, Bissett and Banook) showed an increase in diatom-inferred total phosphorus concentrations greater than the RMSE of the inference model since pre-industrial times. The inferred changes were driven by shifts in diatom species composition from taxa indicative of nutrient-poor conditions (i.e. *C. stelligera*) to species indicative of lake productivity (i.e. *Asterionella formosa*) in most of the lakes. Some of the lakes in the group also indicated an increase in planktonic *C. stelligera* and decrease *Aulacoseira distans*, which is a well-documented trend which is consistent with enhanced warming (Rühland et al. 2008). The current measured TP for the 7 lakes were higher than that of all others, and most if not all of systems are susceptible to moderate to high pressure from urban development from the watersheds can explain the increased inferred nutrient enrichment of this group. Some lakes in this group are potentially influenced by recent changes in climate.

Almost 20% (Frog Pond, McCabe, Williams, Big Albro, Rocky, Loon, Second, Micmac, Paper Mill and William) of the 51 lakes showed an increase in diatom-inferred pH, and little or no change in diatom-inferred TP. There was an overall increase in small, planktonic *C. stelligera* (preferring open-water habitat) paralleled with a decrease in heavily-silicified tycoplanktonic *A. distans* (preferring shallower habitats) in the modern samples of this group of lakes. This shift is consistent with enhanced thermal stratification coupled with reduced lake mixing in response to accelerated climate warming (Rühland et al. 2008), which has been observed in 20$^{th}$ century. Moreover, climate change has been implicated in a number of lakes in the world (Smol and Cumming 2000, Rühland et al. 2008) including those from Nova Scotia (Ginn et al. 2008, Thienpont et al. 2008) and nearby New Brunswick (Harris et al. 2006). Furthermore, instrumental air temperature records from Halifax region (Ginn et al. 2008, Chapter 2) indicate recent warming in the area. All lakes are susceptible to the impact of climate warming (Smol and Cumming 2000); however, the influence is often blurred by other environmental stressors such as acidification and eutrophication (Smol 2008). Considering that most of the lakes that showed climate change signal were neutral (pH ~7.1); and oligotrophic, while the developmental pressure on the watersheds were minimal, diatom assemblages were not markedly influenced by other anthropogenic factors resulting in a more clearly expressed climate signal.

Both First Chain and Chocolate lakes showed a trend toward oligotrophication (decreasing diatom-inferred TP) with associated acidification of the systems. High monomeric aluminum concentrations and the potential effects of Al-P compounds leading to decreased nutrients (as detailed in Chapter 2), moderate developmental pressure on watersheds implying decreased nutrient inputs, and low pre-industrial pH due to acid-producing bedrocks (Keizer et al. 1993) have led to the observed oligotrophication and acidification trend for these lakes.

The remaining thirty of the 51 lakes did showed very little change in diatom-inferred pH and TP. However, marginal trends toward acidification, nutrient enrichment, or oligotrophication coupled with acidification, and climate change were observed.

In addition, our paleolimnological data indicate that increased use of road-salt for de-icing purposes (as reported from water-quality surveys) in the Halifax region have affected the diatom assemblages and water quality of ~ 45% of the study lakes. The increased relative abundance of *Diatoma tenue* and *Diploneis parma*, diatoms tolerant of higher conductivity levels, in the present-day samples of 23 study lakes corresponded with high measured conductivity levels. While, the decreased abundance of these diatom flora in three lakes with low recorded conductivity readings illustrated the impact of elevated anthropogenic use of road salts (for de-icing purposes) on diatom flora and lake water-quality in Halifax region.

Multiple-core analysis (three cores collected and sampled from eight of the study lakes) was used to help define expected similarities among the ‘top’ and ‘bottom’ samples of all study lakes, and was also used as a quality control and assessment for the utilized paleolimnological techniques. Overall, the variability associated with sedimentary diatom assemblages between the ‘tops’ to ‘tops’, and ‘bottoms’ with ‘bottoms’ (compared using Bray-Curtis similarity coefficients), and diatom-inferred pH and TP of each of the triplicate lakes were small. Thus, our techniques and analyses appear to highly reproducible and robust.

The current study is one of the first regional paleolimnological water-quality assessment of a large number of lakes in Halifax region, and provides insight into previously unavailable historic limnological conditions of lakes. Evidence for multiple human-induced stressors impacting the water-quality of the study lakes indicated that it is imperative to exercise caution in the development and use of typical single-stressor to response modeling techniques, as well as water chemistry measurements to infer biological recovery of, and water quality changes in aquatic ecosystems. Further detailed-core analyses, with documented evidence of potential anthropogenic alterations to the systems, can contribute to a better understanding of the exact timing and cause of the changes for each study lake. In sum, this study can be used as a starting point to initiate more effective monitoring and management of aquatic systems, and develop detailed analyses of the primary environmental changes in the lakes to preserve quality-freshwaters for the future.

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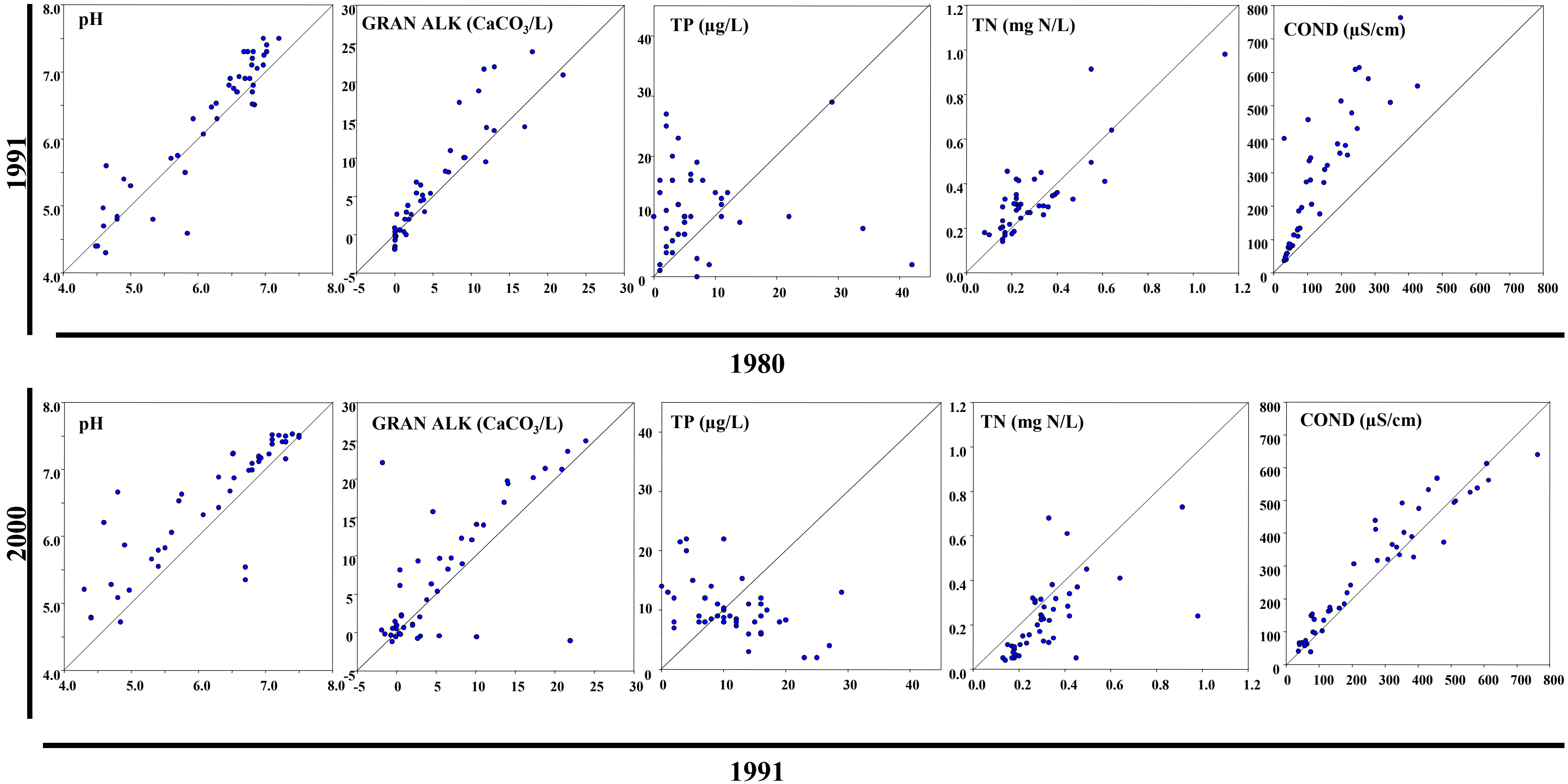
## Appendix A

**Measured water-chemistry data available for study lakes from 1991 compared to data measured in 1980; and data from 2000 (Clement et al. 2007). Diagonal lines represent 1:1 ratio. Selected variables are pH, Gran alkalinity, total phosphorus (TP), total nitrogen (TN) and specific conductivity (COND).**



**Appendix B**

**Summary table with diatom-inferred total phosphorus (DI-TP) and pH (DI-pH) values for top and bottom sediments, and change between the inferred values for top and bottom sediments for the 51 study sites. The pH and TP diatom inference models are based on a modern diatom dataset of 494 lakes from eastern North America (the NENA dataset, Ginn 2006) that were developed based on a maximum likelihood model.**

| LAKE | DI-pH TOP | DI-pH BOTTOM | CHANGE IN DI-pH | DI-TP TOP (log) | DI-TP BOTTOM (log) | CHANGE IN DI-TP (log) |
|---|---|---|---|---|---|---|
| Anderson Lake | 5.98 | 5.79 | 0.19 | 0.83 | 0.78 | 0.05 |
| Bayers Lake | 5.40 | 5.42 | -0.02 | 0.65 | 0.65 | 0.01 |
| Bell Lake | 5.71 | 5.83 | -0.12 | 0.50 | 0.68 | -0.18 |
| Big Albro Lake | 6.39 | 5.67 | 0.73 | 0.59 | 0.69 | -0.10 |
| Bissett Lake | 6.69 | 6.14 | 0.55 | 1.20 | 0.71 | 0.49 |
| Chocolate Lake | 6.01 | 6.09 | -0.08 | 0.81 | 1.31 | -0.50 |
| Cranberry Lake | 5.92 | 5.97 | -0.05 | 0.76 | 0.97 | -0.21 |
| First Chain Lake | 5.13 | 5.28 | -0.16 | 0.16 | 0.61 | -0.45 |
| First Lake | 6.20 | 5.92 | 0.28 | 0.41 | 0.77 | -0.35 |
| Fletcher's Lake | 6.41 | 6.05 | 0.37 | 0.76 | 0.32 | 0.44 |
| Fraser Lake | 5.66 | 5.60 | 0.06 | 1.05 | 0.90 | 0.15 |
| Frenchman Lake | 5.36 | 5.68 | -0.31 | 0.95 | 0.64 | 0.32 |
| Frog Pond | 5.94 | 0.82 | 5.12 | 0.82 | 0.69 | 0.13 |
| Governor Lake | 6.32 | 6.24 | 0.08 | 0.67 | 1.06 | -0.39 |
| Kearney Lake | 6.14 | 5.80 | 0.33 | 0.71 | 0.72 | 0.00 |
| Kinsac Lake | 6.26 | 6.04 | 0.22 | 0.59 | 0.42 | 0.17 |
| Lake Banook | 6.67 | 5.97 | 0.70 | 1.30 | 0.76 | 0.54 |
| Lake Charles | 6.54 | 6.68 | -0.14 | 1.15 | 0.68 | 0.47 |
| Lake Major | 5.31 | 5.38 | -0.08 | 0.69 | 0.68 | 0.02 |
| Lake McCabe | 6.23 | 5.82 | 0.40 | 0.39 | 0.78 | -0.39 |
| Lake Micmac | 6.67 | 6.03 | 0.64 | -0.30 | 0.36 | -0.66 |
| Lake Thomas | 6.43 | 6.07 | 0.36 | 0.67 | 0.53 | 0.14 |
| Lake William | 6.65 | 6.21 | 0.44 | 0.90 | 0.93 | -0.03 |
| Lamont Lake | 6.31 | 5.91 | 0.39 | 0.73 | 0.89 | -0.15 |
| Little Albro Lake | 5.79 | 5.73 | 0.06 | 0.63 | 0.58 | 0.06 |
| Little Springfield | 5.50 | 5.68 | -0.18 | 0.27 | 0.66 | -0.39 |
| Long Lake | 5.76 | 5.74 | 0.01 | 0.64 | 0.73 | -0.09 |
| Loon Lake | 6.37 | 5.77 | 0.60 | 1.16 | 0.90 | 0.26 |
| Maynards Lake | 6.05 | 6.03 | 0.02 | 0.78 | 0.57 | 0.22 |
| Miller Lake | 5.62 | 5.80 | -0.18 | 0.79 | 0.90 | -0.11 |
| Morris Lake | 7.28 | 6.44 | 0.85 | 1.05 | 0.59 | 0.45 |
| Oathill Lake | 6.58 | 6.26 | 0.32 | 0.99 | 1.05 | -0.07 |
| Paper Mill Lake | 5.94 | 5.51 | 0.43 | 0.73 | 0.64 | 0.08 |
| Penhorn Lake | 7.99 | 5.95 | 2.04 | 1.54 | 0.73 | 0.81 |
| Pockwock Lake | 5.06 | 6.53 | -1.47 | 0.78 | 0.36 | 0.42 |
| Powder Mill Lake | 6.03 | 5.98 | 0.05 | 1.09 | 0.82 | 0.27 |
| Power Pond | 5.57 | 5.34 | 0.24 | 0.74 | 0.77 | -0.03 |
| Rocky Lake | 6.25 | 0.82 | 5.43 | 0.82 | 0.83 | -0.01 |
| Russell Lake | 8.16 | 8.20 | -0.03 | 1.21 | 1.37 | -0.16 |
| Sandy Lake | 5.68 | 5.59 | 0.10 | 0.75 | 0.95 | -0.20 |
| Second Chain Lake | 5.03 | 5.36 | -0.33 | 0.41 | 0.64 | -0.23 |
| Second Lake | 6.57 | 6.08 | 0.49 | 0.79 | 0.86 | -0.07 |
| Settle Lake | 7.50 | 6.21 | 1.29 | 1.45 | 0.90 | 0.55 |
| Sheldrake Lake | 5.71 | 5.55 | 0.15 | 0.81 | 0.67 | 0.14 |
| Shubenacadie Grand La | 5.12 | 5.49 | -0.37 | 0.63 | 0.74 | -0.11 |
| Soldier Lake | 5.54 | 5.69 | -0.16 | 0.73 | 0.82 | -0.09 |
| Springfield Lake | 6.00 | 5.73 | 0.27 | 0.42 | 0.70 | -0.28 |
| Third Lake | 6.47 | 6.29 | 0.18 | 1.46 | 1.08 | 0.38 |
| Topsail Lake | 5.42 | 6.00 | -0.58 | 0.64 | 0.68 | -0.05 |
| Whimsical Lake | 6.16 | 6.30 | -0.15 | 1.08 | 1.14 | -0.07 |
| Williams Lake | 6.21 | 5.41 | 0.80 | 0.55 | 0.61 | -0.06 |

**Appendix C.**
**Summary table showing Bray-Curtis Similarity Coefficients for the replicate cores for 8 lakes (tops and bottoms reported separately) with mean, median,minimum and maximum calculations.**

| TOPS | | BOTTOMS | |
|---|---|---|---|
| **Compared Samples** | **Similarity index** | **Compared Samples** | **Similarity index** |
| Bayers-T1 & T2 | 85.5 | Bayers-B1 &B2 | 86.6 |
| Bayers-T2 &T3 | 91.3 | Bayers-B2 & B3 | 90.8 |
| Bayers-T3 & T1 | 84.9 | Bayers-B3 & B1 | 82.6 |
| First Chain-T1 & T2 | 91.1 | First Chain-B1 &B2 | 90.5 |
| First Chain-T2 &T3 | 85.4 | First Chain-B2 & B3 | 85.5 |
| First Chain-T3 & T1 | 87.1 | First Chain-B3 & B1 | 90.1 |
| Fraser-T1 & T2 | 92.5 | Fraser-B1 &B2 | 93.6 |
| Fraser-T2 &T3 | 91.8 | Fraser-B2 & B3 | 94.0 |
| Fraser-T3 & T1 | 87.4 | Fraser-B3 & B1 | 90.4 |
| Frenchman-T1 & T2 | 78.1 | Frenchman-B1 &B2 | 86.8 |
| Frenchman-T2 &T3 | 94.3 | Frenchman-B2 & B3 | 89.2 |
| Frenchman-T3 & T1 | 90.3 | Frenchman-B3 & B1 | 91.5 |
| Frog Pond-T1 & T2 | 93.5 | Frog Pond-B1 &B2 | 93.4 |
| Frog Pond-T2 &T3 | 93.3 | Frog Pond-B2 & B3 | 94.8 |
| Frog Pond-T3 & T1 | 88.7 | Frog Pond-B3 & B1 | 91.5 |
| Second Chain-T1 & T2 | 83.0 | Second Chain-B1 &B2 | 87.7 |
| Second Chain-T2 &T3 | 88.8 | Second Chain-B2 & B3 | 91.3 |
| Second Chain-T3 & T1 | 80.4 | Second Chain-B3 & B1 | 83.6 |
| Settle-T1 & T2 | 92.3 | Settle-B1 &B2 | 90.6 |
| Settle-T2 &T3 | 91.7 | Settle-B2 & B3 | 89.2 |
| Settle-T3 & T1 | 90.0 | Settle-B3 & B1 | 90.3 |
| Whimsical-T1 & T2 | 89.1 | Whimsical-B1 &B2 | 96.4 |
| Whimsical-T2 &T3 | 89.2 | Whimsical-B2 & B3 | 96.3 |
| Whimsical-T3 & T1 | 96.1 | Whimsical-B3 & B1 | 95.3 |
| MEAN | 89.0 | MEAN | 90.5 |
| MEDIAN | 89.6 | MEDIAN | 90.5 |
| MINIMUM | 78.1 | MINIMUM | 82.6 |
| MAXIMUM | 96.1 | MAXIMUM | 96.4 |

Abbreviations:
T1: Top sample for core 1
T2: Top sample for core 2
T3: Top sample for core 3
B1: Bottom sample for core 1
B2: Bottom sample for core 2
B3: Bottom sample for core 3

## Appendix D
## List of 203 diatom species from 51 HRM lakes and authorities.

| Taxa | Authorities |
|---|---|
| *Achnanthes bahusiensis* | (Grunow) Lange-Bertalot |
| *Achnanthes biosolettianum* var. *subatomus* | (Grunow) Round and Bukhtiyarova |
| *Achnanthes chlidanos* | Hohn and Hellermann |
| *Achnanthes curtissima* | Carter |
| *Achnanthes impexiformis* | Lange-Bertalot |
| *Achnanthes minutissima* var. *inconspicud* | Kützing |
| *Achnanthes stewartii* | Patrick |
| *Achnanthidium biasole lettianum* var. *subatomus* | (Grunow) Round and Bukhtiyarova |
| *Achnanthidium minutissimum* | (Kützing) Czarn |
| *Actinella brasiliensis* | Grunow |
| *Actinella punctata* | Lewis |
| *Amphora ovalis* | (Kützing) Kützing |
| *Amphora pediculus* | (Kützing) Grunow |
| *Anomoenis brachysira* | (Brébisson) Grunow |
| *Asterionella formosa* | Hassell |
| *Asterionella ralfsii* var. *americana* | Körner |
| *Aulacoseira ambigua* | (Grunow) Simonsen |
| *Aulacoseira crassipunctata* | Krammer |
| *Aulacoseira distans* | (Ehrenb.) Simonsen |
| *Aulacoseira distans* var. *nivalis* | (W. Smith) E.Y. Haw |
| *Aulacoseira granulata* | (Ehrenberg) Simonsen |
| *Aulacoseira italica* | (Ehrenberg) Simonsen |
| *Aulacoseira lacustris* | (Grunow) Krammer |
| *Aulacoseira lirata* | (Ehrenb.) R. Ross |
| *Aulacoseira nygaardii* | Camburn in Camburn et Kingston |
| *Aulacoseira perglabra* | (Østrup) E.Y. Haw |
| *Brachysira brebissonii* | Ross (in Hartley) |
| *Brachysira follis* | (Ehrenberg) Ross in Hartley |
| *Brachysira intermedia* | Lange-Bertalot |
| *Brachysira manfredii* | Lange-Bertalot |
| *Brachysira neoexilis* | Lange-Bertalot |
| *Brachysira poss procera* | Lange-Bertalot |
| *Brachysira serians* | (Brébisson) Round and Mann |

| Taxa | Authorities |
|---|---|
| *Brachysira styriaca* | (Grunow) Ross in Hartley |
| *Caloneis bacillum* | (Grunow) Cleve |
| *Caloneis silicula* | (Ehrenberg) Cleve |
| *Cavinula cocconeiformis* | (Gregory) Mann and Stickle in Round |
| *Cavinula pseudoscutiformis* | (Hustedt) Mann and Stickle in Round |
| *Cocconeis poss neothumensis* | Krammer |
| *Chamaepinnularia bremensis* | (Hustedt) Lange-Bertalot in Lange-Bertalot and Metzeltin |
| *Chamaepinnularia mediocris* | (Krasske) Lange-Bertalot in Lange-Bertalot and Metzeltin |
| *Craticula cuspidata* | (Kützing) Mann in Round |
| *Cyclotella bodanica* | (O. Müller ex. Schröter) Bachmann |
| *Cyclotella bodanica* var. *lemanica* | (O. Müller ex. Schröter) Bachmann |
| *Cyclotella michiganiana* | Skvortzow |
| *Cyclotella stelligera* | Cleve et Grunow in Cleve |
| *Cymbella hungarica* | (Grunow) Pantocsek |
| *Cymbella incerta* | (Grunow) Cleve |
| *Cymbella schubartoides* | Camburn and Charles |
| *Cymbopleura subcuspidata* | (Krammer) Krammer |
| *Diatoma anceps* | (Ehrneberg) Kirchn. |
| *Diatoma mesodon* | (Ehrenberg) Kützing |
| *Diatoma tenue* | Agardh |
| *Diploneis marginestriata* | Hustedt |
| *Diploneis parma* | Cleve |
| *Encyonema herbidicum* | Grunow ex Cleve |
| *Encyonema lunatum* | (W. Smith in Gregory) Van Heurck |
| *Encyonema minutum* | (hilse ex Rabenhorst) Mann in Round |
| *Encyonopsis cesatii* | (Rabenhorst) Krammer |
| *Eucocconeis depressa* | (Cleve) Hustedt |
| *Eunotia arcus* | Ehrenberg |
| *Eunotia bidentula* | W. Smith |
| *Eunotia bigibba* | Kützing *sensu* camburn and Charles |
| *Eunotia bilunaris* var. *mucophila* | Lange-Bertalot and Nörpel |
| *Eunotia carolina* | Patrick |
| *Eunotia curvata* | (Kützing) Lagerst |
| *Eunotia curvata f . bergii* | Woodhead and Tweed |
| *Eunotia elegans* | Østrup |

| Taxa | Authorities |
|---|---|
| *Eunotia exigua* | (Brébisson) Rabenhorst |
| *Eunotia faba* | Ehrenberg |
| *Eunotia fallax* | Cleve |
| *Eunotia flexulosa* | (Brébisson) Kützing |
| *Eunotia formica* | Ehrenberg |
| *Eunotia hexiglyphis* | Ehrenberg |
| *Eunotia implicata* | Nörpel |
| *Eunotia incisa* | Gregory |
| *Eunotia intermediata* | (Krasske) Nörpel and Lange-Bertalot |
| *Eunotia latriensis* | Foged |
| *Eunotia major* | (W. Smith) Robenhorst |
| *Eunotia parallela* var. *parallela* | Ehrenberg |
| *Eunotia pectinalis* var. *pectinalis* | (Müller) Rabenhorst |
| *Eunotia pectinalis* var. minor | (Kützing) Rabenh. |
| *Eunotia pectinais* var. *ventricosa* | Grunow in Van Heurck |
| *Eunotia praerupta* | Ehrenberg |
| *Eunotia serra* | Ehrenberg |
| *Eunotia serra* var. *tetrado* | (Ehrenberg) Nörpel |
| *Eunotia zasumensis* | (Cabejsz.) Körner |
| *Fragilaria brevistriata* | Grunow (in Van Heurck) |
| *Fragilaria capucina* | (Grunow) Lange-Bertalot |
| *Fragilaria capucina* var. *amphicephala* | (Rabenh.) Rabenh |
| *Fragilaria capucina* var. *rumpens* | (Kützing) Lange-Bertalot |
| *Fragilaria capucina* var. *gracilis* | (Oestrup) Hustedt |
| *Fragilaria construens f. exigua* | (Ehrenberg) Hutstedt |
| *Fragilaria elliptica* | Schumann in Van Heurck |
| *Fragilaria oldenbergiana* | Hustedt |
| *Fragilaria parasitica* | (W. Smith) Grunow (in Van Heurck) |
| *Fragilaria pinnata* | Ehrenberg |
| *Fragilaria polygonata* | Cleve-Euler |
| *Fragilaria pulchella* | (Ralfs ex Kützing) Lange-Bertalot |
| *Fragilaria tenera* | (W. Smith) Lange-Bertalot |
| *Fragilaria ulna* var. *acus* | (Nitzsch) Lange-Bertalot |
| *Fragilariforma acidobiontica* | (D.F. Charles) D.M. Williams et Round |
| *Fragilariforma constricta* | (Ehrenberg) Williams et Round |

| Taxa | Authorities |
| --- | --- |
| *Fragilariforma constricta f. stricta* | (A. Cleve) Pulin in Hamilton |
| *Fragilariforma exigua* | (Grunow) Krammer et Lange-Bertalot |
| *Fragilariforma hungarica* var. *tumida* | (Cleve-Euler) Hamilton |
| *Fragilariforma lata* | (Cleve-Euler) Williams et Round |
| *Frustulia bahlsii* | Edlund and Brant |
| *Frustulia crassinervia* | (Brébisson) Lange-Bertalot and Krammer |
| *Frustulia pseudomagaliesmontana* | Camburn et D.F. Charles |
| *Frustulia rhomboides* | (Ehrenberg) De Toni |
| *Frustulia saxonica* | Rabenh |
| *Gomphonema acuminatum* | Ehrenberg |
| *Gomphonema angustatum* | (Kützing) Rabenh |
| *Gomphonema gracile* | Ehrenberg |
| *Gomphonema minutum* | (Agardh) Agardh |
| *Gomphonema parvulum* | Kützing |
| *Gomphonema truncatum* | Ehrenberg |
| *Gyrosigma acuminatum* | (Kützing) Rabenhorst |
| *Gyrosigma obscurum* | (W. Smith) Griffith and Henfrey |
| *Hantzschia rhaetica* | Lange-Bertalot |
| *Kobayasia subtillissima* | (Cleve) Lange-Bertalot |
| *Melosira arentii* | (Kolbe) Nagumo and Kobayasi |
| *Meridian circulare* | (Grev.) Agardh in Patrick and Reimer |
| *Navicula constans* | Hustedt |
| *Navicula cryptocephala* | Kützing |
| *Navicula expecta* | Van Landingham |
| *Navicula halophila* | (Grunow) Cleve |
| *Navicula helensis (Fallacia helensis)* | Schulz |
| *Navicula impexa* | Hustedt |
| *Navicula leptostriata* | JØrgensen |
| *Navicula lundi* | Reichardt |
| *Navicula pseudolanceolata* | Lange-Bertalot |
| *Navicula radiosa* | Kützing |
| *Navicula schumassmanni* | Hustedt |
| *Navicula stroemii* | Hustedt |
| *Neidium affine* | (Ehrenberg) Pfitzer |
| *Neidium bisulcatum* | (lagerstedt) Cleve |

| Taxa | Authorities |
|---|---|
| *Neidium bisulcatum* var. *baicalense* | (Skvortsov and Mey) Reimer |
| *Neidium bisulcatum* var. *bisulcatum* | (lagerstedt) Cleve |
| *Neidium densestriatum* | (Østrup) Krammer |
| *Neidium iridis* | (Ehrenb.) Cleve |
| *Nitzschia filiformis* | (W. Smith) Van Heurck |
| *Nitzschia gracilis* | Hantzsch |
| *Nitzschia intermedia* | Hantzsch in Rabenhorst |
| *Nitzschia microcephala* | Grunow in Cleve and Möller |
| *Nitzschia nana* | Grunow in Van Heurck |
| *Nitzschia perminuta* | (Grunow) Peragallo |
| *Nitzschia recta* | Hantzsch in Rabenhorst |
| *Nitzschia suchlandtii* | Hantzsch |
| *Nitzschia vermicularis* | (Kützing) Hantzsch in Rabenhorst |
| *Oxyneis binalis* | (Ehrenb.) Round |
| *Pinnularia archospaeria* var. *turgidula* | Grunow in Cleve |
| *Pinnularia biceps* | W. Gregory |
| *Pinnularia brauniana* | (Grunow) Mills |
| *Pinnularia cardinalis* | (Ehrenberg) W. Smith |
| *Pinnularia claviculiformes* | Metzeltin and Krammer |
| *Pinnularia divergens* | W. Smith |
| *Pinnularia divert gentissima* var. *subrostrata* | Cleve-Euler |
| *Pinnularia gibba* | Ehrenberg |
| *Pinnularia gibbiformis* | Krammer |
| *Pinnularia kwacksii* | Camburn and Charles |
| *Pinnularia legumen* | (Ehrenberg) Ehrenberg |
| *Pinnularia microstauron* | (Ehrenberg) Cleve |
| *Pinnularia microstauron* var. *non fasciata* | Krammer |
| *Pinnularia nobilis* var. *linearis* | Krammer |
| *Pinnularia nobilis vilincaris* | Krammer |
| *Pinnularia nodosa* | (Ehrenberg) W. Smith |
| *Pinnularia polynoca* | (Brébisson) W. Smith |
| *Pinnularia silvatica* | Petersen |
| *Pinnularia subgibba* | Krammer |
| *Pinnularia subgibba* var. *undulata* | Krammer |
| *Pinnularia subrupestris* | Krammer |

| Taxa | Authorities |
|---|---|
| *Psammothidium bioretii* | (Germain) Bukhtiyarova and Round |
| *Psammothidium levanderi* | (Hust.) L. Bukhtiyarova et Round |
| *Psammothidium subatomoides* | (Hustedt) Bukhtiyarova and Round |
| *Pseudostaurosira brevistriata* | (Grunow in Van Heurck) Williams and Round |
| *Pseudostaurosira parasitia* | (W. Smith) Morales |
| *Sellaphora pupula* var. *pupula* | (Kützing) Mereschk |
| *Semiorbis hemicyclus* | (Ehrenberg) Patrick in Patrick and Reimer |
| *Stauroneis anceps* | Ehrenberg |
| *Stauroneis construens* | Ehrenberg |
| *Stauroneis nobilis* var. *gracilis* | Kobayasi in Ando and Kobayasi |
| *Stauroneis phoenocenteron* | (Nitzsch) Ehrenberg |
| *Staurosira construens* | Ehrenb |
| *Staurosirella pinnata* | (Ehrenb.) D.M. Williams et Round |
| *Staurosirella pinnata* var. *trigona* | (Ehrenberg) Williams et Round |
| *Stenopterobia anceps* | (Lewis) Brébisson ex Van Heurck |
| *Stenopterobia curvula* | (W. Smith) Krammer |
| *Surirella amphioxis* | W. Smith |
| *Surirella angustua* | Kützing |
| *Surirella cuspidata* | Hustedt |
| *Surirella linearis* | W. Smith |
| *Surirella pinnata* | (Ehrenberg) Williams et Round |
| *Surirella spendida* | (Ehrenberg) Williams et Round |
| *Tabellaria fenestrata* | (Lyngbyne) Kützing |
| *Tabellaria flocculosa* strain III | (Roth) Kützing *sensu* J.D. Koppen |
| *Tabellaria flocculosa* strain IIIp | (Roth) Kützing *sensu* J.D. Koppen |
| *Tabellaria flocculosa* strain IV | (Roth) Kützing *sensu* J.D. Koppen |
| *Tabellaria flocculosa* var. *linearis* | J.D. Koppen |
| *Tabellaria quadriseptata* | B.M. Knudson |
| *Tabellaria ventricosa* | (Roth) Kützing *sensu* J.D. Koppen |
| *Urosolenia eriensis* | (H. L. Smith) Round and Crawford |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' refers to Top sample and '-B' refers to the Bottom sample for the respe**

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Anderson-T** | **Anderson-B** | **Banook-T** | **Banook-B** | **Bayers-T** | **Bayers-B** | **Bayers-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21.5-22 cm | 0-0.5 cm |
| *Achnanthes bahusiensis* | | 4 | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | |
| *Achnanthes chlidanos* | | 2 | 22 | 28 | | | |
| *Achnanthes curtissima* | 3 | | 4 | 4 | 3 | 28 | 2 |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | | | | | | | |
| *Achnanthes stewartii* | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | | | | | 3 | 1 | 32 |
| *Amphora ovalis* | | | 4 | 7 | 4 | | 5 |
| *Amphora pediculus* | | | | | | | |
| *Anomoenis brachysira* | | | | | | | |
| *Asterionella formosa* | 53 | 33 | 28 | 18 | 12 | | 12 |
| *Asterionella ralfsii* var. *americana* | 134 | 99 | | | | | |
| *Aulacoseira ambigua* | | | | 62 | | | |
| *Aulacoseira crassipunctata* | | 19 | | | 18 | 47 | 36 |
| *Aulacoseira distans* | 17 | 52 | 4 | 43 | 7 | 67 | |
| *Aulacoseira distans* var. *nivalis* | | | | | | | |
| *Aulacoseira granulata* | | | | | | | |
| *Aulacoseira italica* | | | | | | | |
| *Aulacoseira lacustris* | | 34 | | | | | |
| *Aulacoseira lirata* | 7 | 32 | | 6 | | | |
| *Aulacoseira nygaardii* | | 23 | | 28 | 3 | | 5 |
| *Aulacoseira perglabra* | | | | | | 41 | |
| *Brachysira brebissonii* | | | | | | 5 | |
| *Brachysira follis* | | | | | 2 | | 9 |
| *Brachysira intermedia* | | | | | 7 | | 1 |
| *Brachysira manfredii* | | | | | | 2 | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Anderson-T** | **Anderson-B** | **Banook-T** | **Banook-B** | **Bayers-T** | **Bayers-B** | **Bayers-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21.5-22 cm | 0-0.5 cm |
| *Brachysira neoexilis* | | | | | | | |
| *Brachysira poss procera* | | | 3 | | | | |
| *Brachysira serians* | 38 | 36 | 4 | 8 | 86 | 15 | 82 |
| *Brachysira styriaca* | 19 | 8 | 8 | 3 | 22 | | 44 |
| *Caloneis bacillum* | | | | | | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | | | | | | | |
| *Cavinula pseudoscutiformis* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 13 | 31 | 43 | 13 | | | |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | 73 | 22 | 88 | 42 | | 2 | |
| *Cymbella hungarica* | | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | | | | |
| *Cymbella* spp. | | | | | 5 | 15 | 17 |
| *Cymbopleura subcuspidata* | | | | 9 | | | |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | | | | | |
| *Diatoma tenue* | | | 74 | | | | |
| *Diploneis marginestriata* | | | 72 | | | | |
| *Diploneis parma* | | | 58 | | | | |
| *Encyonema herbidicum* | | | | | | | |
| *Encyonema lunatum* | 4 | | | | | | |
| *Encyonema minutum* | | | | | | | |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | | | | | | |
| *Eunotia arcus* | | | 3 | | 29 | | 35 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Anderson-T | Anderson-B | Banook-T | Banook-B | Bayers-T | Bayers-B | Bayers-T |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21.5-22 cm | 0-0.5 cm |
| *Eunotia bidentula* | | | | | 2 | 13 | 7 |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | 3 | | 2 | 18 | 22 |
| *Eunotia carolina* | | | | | | | |
| *Eunotia curvata* | | | | | | | |
| *Eunotia curvata f . bergii* | | | | | 19 | | 22 |
| *Eunotia elegans* | | | | 3 | 6 | | 8 |
| *Eunotia exigua* | | 27 | 14 | 32 | 48 | 33 | 55 |
| *Eunotia faba* | | | | | | | |
| *Eunotia fallax* | | | | | | | |
| *Eunotia flexulosa* | | | 12 | | | | |
| *Eunotia flexulosa* (straight) | 13 | 9 | | 22 | | | |
| *Eunotia formica* | | | | | | | |
| *Eunotia hexiglyphis* | | | | | | | |
| *Eunotia implicata* | 2 | | | | | | |
| *Eunotia incisa* | 22 | 28 | 22 | 38 | 9 | | 8 |
| *Eunotia intermediata* | | | | | | | |
| *Eunotia latriensis* | | | | | | | |
| *Eunotia major* | | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | 22 | 7 | 22 | 6 | | 7 |
| *Eunotia pectinalis* var. minor | | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | 33 | | | |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | | | | | | |
| *Eunotia serra* | | | | | | | |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | | | | | | | |
| *Fragilaria brevistriata* | 3 | 8 | | 23 | | | |
| *Fragilaria capucina* | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | 33 | | | | |
| *Fragilaria capucina* var. *rumpens* | | | 8 | 13 | | | |
| *Fragilaria capucina* var. *gracilis* | | | 28 | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Anderson-T** | **Anderson-B** | **Banook-T** | **Banook-B** | **Bayers-T** | **Bayers-B** | **Bayers-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21.5-22 cm | 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | | |
| *Fragilaria oldenbergiana* | | | | | | | |
| *Fragilaria parasitica* | | | | | | | |
| *Fragilaria pinnata* | | | | | | | |
| *Fragilaria polygonata* | | | | | | | |
| *Fragilaria pulchella* | | | | | | | |
| *Fragilaria* spp. 5 | | | | | | | |
| *Fragilaria tenera* | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | | 7 |
| *Fragilariforma constricta* | | 12 | 17 | | | 4 | |
| *Fragilariforma constricta f. stricta* | | 28 | | | | | |
| *Fragilariforma exigua* | 3 | 13 | 4 | 22 | 24 | 26 | 24 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | |
| *Fragilariforma lata* | 18 | 118 | 8 | 22 | 97 | 2 | 127 |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | | | | |
| *Frustulia pseudomagaliesmontana* | 32 | | | | | | |
| *Frustulia rhomboides* | 3 | 7 | | 38 | 3 | | 9 |
| *Frustulia saxonica* | | | | 23 | 4 | 43 | 8 |
| *Gomphonema acuminatum* | | | | | | | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | | | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | | | | | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | | 12 | | | | |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Anderson-T** | **Anderson-B** | **Banook-T** | **Banook-B** | **Bayers-T** | **Bayers-B** | **Bayers-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21.5-22 cm | 0-0.5 cm |
| *Melosira arentii* | | | | | | | |
| *Meridian circulare* | | | | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | | | 14 | 22 | 1 | | 6 |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | |
| *Navicula impexa* | | | | | | | |
| *Navicula leptostriata* | 3 | 12 | 22 | 32 | | | |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | |
| *Navicula pseudolanceolata* | | | | | | | |
| *Navicula radiosa* | | | | | | | |
| *Navicula schumassmanni* | | | | | | | |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | 4 | | | 4 | | 9 |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | |
| *Neidium densestriatum* | | | | | | | |
| *Neidium iridis* | | | | | | | |
| *Neidium poss holstii* | | | | | | | |
| *Nitzschia filiformis* | | | | | | | |
| *Nitzschia gracilis* | | | 36 | 22 | | | 7 |
| *Nitzschia intermedia* | | | | | | | |
| *Nitzschia microcephala* | | | | | | | 4 |
| *Nitzschia nana* | | | | | | | |
| *Nitzschia perminuta* | | | | | | | |
| *Nitzschia recta* | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | |
| *Nitzschia vermicularis* | | | 9 | | | | |
| *Oxyneis binalis* | | | | | 61 | 19 | 55 |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Anderson-T | Anderson-B | Banook-T | Banook-B | Bayers-T | Bayers-B | Bayers-T |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21.5-22 cm | 0-0.5 cm |
| *Pinnularia biceps* | | | | | | | |
| *Pinnularia brauniana* | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | |
| *Pinnularia divergens* | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | | | | | | | |
| *Pinnularia gibbiformis* | | | | | | | |
| *Pinnularia kwacksii* | | | | | | 11 | 19 |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | | 6 | | 3 | 24 | | 33 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | | | | | | | |
| *Pinnularia polynoca* | | | | | | | |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | | 9 | | | 2 | 3 | 6 |
| *Pinnularia subgibba* var. *undulata* | | | | | | | |
| *Pinnularia subrupestris* | | | | | | | |
| *Pinnularia viridiformis* var. morph I | | 2 | | | | 9 | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | |
| *Semiorbis hemicyclus* | 9 | 8 | | 3 | 47 | 68 | 55 |
| *Stauroneis anceps* | 2 | | 12 | 22 | 2 | 31 | 37 |
| *Stauroneis construens* | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | |
| *Stauroneis phoenocenteron* | | 2 | 27 | 3 | | 7 | |
| *Staurosira construens* | 34 | 69 | 44 | 22 | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Anderson-T** | **Anderson-B** | **Banook-T** | **Banook-B** | **Bayers-T** | **Bayers-B** | **Bayers-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21.5-22 cm | 0-0.5 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | 18 | | | | | |
| *Stenopterobia curvula* | 8 | | | | 2 | | 2 |
| *Surirella amphioxis* | 17 | 18 | 2 | | | 2 | 5 |
| *Surirella angustua* | | | | | | | |
| *Surirella cuspidata* | | | | | | | |
| *Surirella linearis* | | | | | 2 | | 8 |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | 52 | 46 | | 12 | 24 | 28 | 14 |
| *Tabellaria flocculosa* strain III | 7 | 13 | | | | | 2 |
| *Tabellaria flocculosa* strain IIIp | 23 | 14 | 12 | 4 | 36 | | 38 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | 52 | 42 | 42 | 48 | | | |
| *Tabellaria flocculosa* var. *linearis* | 154 | 12 | | 28 | | | |
| *Tabellaria quadriseptata* | 92 | 92 | | 62 | 49 | 4 | 52 |
| *Tabellaria ventricosa* | | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' rective lake.**

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Bayers-B** 25-25.5cm | **Bayers-T** 0-0.5 cm | **Bayers-B** 25-25.5 cm | **Bell-T** 0-0.5 cm | **Bell-B** 19-19.5 cm | **Big Albro-T** 0-0.5 cm | **Big Albro-B** 25-25.5 cm | **Bissett-T** 0-0.5 cm |
| *Achnanthes bahusiensis* | | | | | | | 7 | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | | |
| *Achnanthes chlidanos* | | | | 42 | 4 | 37 | 12 | 28 |
| *Achnanthes curtissima* | 17 | 2 | 19 | | 6 | 3 | 2 | |
| *Achnanthes impexiformis* | | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | | |
| *Achnanthes* spp. 3 | | | | | | 2 | | |
| *Achnanthes stewartii* | | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | | |
| *Actinella brasiliensis* | | | | | | | | |
| *Actinella punctata* | 4 | 36 | 2 | | 2 | | | |
| *Amphora ovalis* | | 7 | | 23 | 6 | 3 | | 7 |
| *Amphora pediculus* | | | | | | | | |
| *Anomoenis brachysira* | | | | | | | | |
| *Asterionella formosa* | | 19 | | | 4 | 8 | | 12 |
| *Asterionella ralfsii* var. *americana* | | | | | | | | |
| *Aulacoseira ambigua* | | | | | | | | |
| *Aulacoseira crassipunctata* | 54 | 23 | 67 | | | | | |
| *Aulacoseira distans* | 86 | | 72 | 4 | 64 | 28 | 52 | 12 |
| *Aulacoseira distans* var. *nivalis* | 2 | | 7 | | | | | |
| *Aulacoseira granulata* | | | | | | | | |
| *Aulacoseira italica* | | | | | | | | |
| *Aulacoseira lacustris* | | | | 32 | 12 | | | |
| *Aulacoseira lirata* | | | | 18 | 7 | 7 | 4 | 3 |
| *Aulacoseira nygaardii* | | 7 | | | | | | |
| *Aulacoseira perglabra* | 56 | | 34 | 88 | 2 | | 33 | |
| *Brachysira brebissonii* | 12 | | 12 | | 3 | 3 | 53 | |
| *Brachysira follis* | | 5 | | | | | | |
| *Brachysira intermedia* | | 7 | | | | | | |
| *Brachysira manfredii* | 8 | | 9 | | | | | |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Bayers-B** 25-25.5cm | **Bayers-T** 0-0.5 cm | **Bayers-B** 25-25.5 cm | **Bell-T** 0-0.5 cm | **Bell-B** 19-19.5 cm | **Big Albro-T** 0-0.5 cm | **Big Albro-B** 25-25.5 cm | **Bissett-T** 0-0.5 cm |
| *Brachysira neoexilis* | | 3 | | 29 | | | | |
| *Brachysira poss procera* | | | | | | | | |
| *Brachysira serians* | 27 | 12 | 29 | | 44 | 7 | 28 | 4 |
| *Brachysira styriaca* | | 37 | 8 | 3 | 52 | | 44 | 12 |
| *Caloneis bacillum* | | | | | | | | |
| *Caloneis silicula* | | | | | | | | |
| *Cavinula cocconeiformis* | | | | 9 | 3 | | 7 | |
| *Cavinula pseudoscutiformis* | | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | | |
| *Craticula cuspidata* | | | | | | | | |
| *Cyclotella bodanica* | | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | | | | 4 | 23 | 88 |
| *Cyclotella michiganiana* | | | | | | 42 | | |
| *Cyclotella stelligera* | 5 | | 6 | 54 | 62 | 58 | 22 | 33 |
| *Cymbella hungarica* | | | | | | | | |
| *Cymbella incerta* | | | | | | | | |
| *Cymbella schubartoides* | 8 | | 22 | | | | | |
| *Cymbella* spp. | 13 | 9 | 13 | 19 | 13 | 4 | 49 | 12 |
| *Cymbopleura subcuspidata* | | | | | | | | |
| *Diatoma anceps* | | | | | | | | |
| *Diatoma mesodon* | | | | | | | | |
| *Diatoma tenue* | | | | | | 33 | | 1 |
| *Diploneis marginestriata* | | | | | | 32 | | 24 |
| *Diploneis parma* | | | | | | 11 | 4 | 53 |
| *Encyonema herbidicum* | | | | | | | | |
| *Encyonema lunatum* | | | | | | | | |
| *Encyonema minutum* | | | | | | | | |
| *Encyonopsis cesatii* | | | | | | | | |
| *Eucocconeis depressa* | | | | | | | | |
| *Eunotia arcus* | 5 | 42 | 4 | 7 | 12 | 3 | 38 | |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Bayers-B 25-25.5cm | Bayers-T 0-0.5 cm | Bayers-B 25-25.5 cm | Bell-T 0-0.5 cm | Bell-B 19-19.5 cm | Big Albro-T 0-0.5 cm | Big Albro-B 25-25.5 cm | Bissett-T 0-0.5 cm |
| *Eunotia bidentula* | 28 | 5 | 37 | | | | | |
| *Eunotia bigibba* | | | | | | 22 | 64 | |
| *Eunotia bilunaris* var. *mucophila* | 24 | 32 | 25 | | | | | |
| *Eunotia carolina* | | | | | | | | |
| *Eunotia curvata* | | | | | | | | |
| *Eunotia curvata f . bergii* | | 29 | | | 18 | | 14 | |
| *Eunotia elegans* | | 7 | | | | | | 3 |
| *Eunotia exigua* | 7 | 65 | 8 | 22 | 3 | 8 | 3 | 12 |
| *Eunotia faba* | | | | | | | | |
| *Eunotia fallax* | | | | | | | | |
| *Eunotia flexulosa* | | | | | | | | |
| *Eunotia flexulosa* (straight) | | | | | 4 | | 13 | |
| *Eunotia formica* | | | | | | | | |
| *Eunotia hexiglyphis* | | | | | | | | |
| *Eunotia implicata* | | | | | | | | |
| *Eunotia incisa* | | 22 | | 48 | 44 | 22 | 28 | 22 |
| *Eunotia intermediata* | | | | | | | | |
| *Eunotia latriensis* | | | | | | | | |
| *Eunotia major* | | | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | 9 | 12 | 6 | | | 23 | 4 |
| *Eunotia pectinalis* var. minor | | | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | | | | | |
| *Eunotia poss teineckii* | | | | | | | | |
| *Eunotia praerupta* | | | | | | | | |
| *Eunotia serra* | | | | | | | | |
| *Eunotia serra* var. *tetrado* | | | | | | | | |
| *Eunotia zasumensis* | | | | | | | | |
| *Fragilaria brevistriata* | | | | 12 | 4 | 5 | 14 | 22 |
| *Fragilaria capucina* | | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | | | | 18 |
| *Fragilaria capucina* var. *gracilis* | | | | | | 42 | 18 | 4 |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Bayers-B 25-25.5cm | Bayers-T 0-0.5 cm | Bayers-B 25-25.5 cm | Bell-T 0-0.5 cm | Bell-B 19-19.5 cm | Big Albro-T 0-0.5 cm | Big Albro-B 25-25.5 cm | Bissett-T 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | | | |
| *Fragilaria elliptica* | | | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | | | |
| *Fragilaria oldenbergiana* | | | | | | | | |
| *Fragilaria parasitica* | | | | | | | | |
| *Fragilaria pinnata* | | | | | | | | |
| *Fragilaria polygonata* | 7 | | 23 | | | | | |
| *Fragilaria pulchella* | | | | | | | | |
| *Fragilaria* spp. 5 | | | | | | | | |
| *Fragilaria tenera* | | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | | |
| *Fragilariforma acidobiontica* | | 9 | | | | | | |
| *Fragilariforma constricta* | 8 | | 9 | | | 7 | | |
| *Fragilariforma constricta f. stricta* | | | | | | | | |
| *Fragilariforma exigua* | 34 | 18 | 29 | 7 | 18 | 28 | 13 | |
| *Fragilariforma exigua* (girdles) | | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | | |
| *Fragilariforma lata* | 28 | 119 | 33 | 12 | 12 | 2 | 12 | |
| *Frustulia bahlsii* | | | | | | | | |
| *Frustulia crassinervia* | | | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | 83 | 2 | | | |
| *Frustulia rhomboides* | 2 | 34 | 15 | 68 | 17 | 2 | 53 | |
| *Frustulia saxonica* | 57 | 9 | 52 | | 37 | | 22 | |
| *Gomphonema acuminatum* | | | | | | | | |
| *Gomphonema angustatum* | | | | | | | | |
| *Gomphonema gracile* | | | | | | | | |
| *Gomphonema minutum* | | | | | | | | |
| *Gomphonema parvulum* | | | | | | | | |
| *Gomphonema truncatum* | | | | | | | | |
| *Gyrosigma acuminatum* | | | | | 12 | 3 | | |
| *Gyrosigma obscurum* | | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | | 3 |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Bayers-B 25-25.5cm | Bayers-T 0-0.5 cm | Bayers-B 25-25.5 cm | Bell-T 0-0.5 cm | Bell-B 19-19.5 cm | Big Albro-T 0-0.5 cm | Big Albro-B 25-25.5 cm | Bissett-T 0-0.5 cm |
| *Melosira arentii* | | | | | | | | 4 |
| *Meridian circulare* | | | | | | | | |
| *Navicula constans* | | | | | | | | |
| *Navicula cryptocephala* | | | | | | | | |
| *Navicula expecta* | | 9 | | | 7 | 23 | 7 | 27 |
| *Navicula halophila* | | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | | |
| *Navicula impexa* | | | | | | | | |
| *Navicula leptostriata* | | | | 7 | 38 | 52 | 23 | 32 |
| *Navicula lundi* | | | | | | | | |
| *Navicula poss bottnica* | | | | | | | | |
| *Navicula pseudolanceolata* | | | | | | | | |
| *Navicula radiosa* | | | | | | | | |
| *Navicula schumassmanni* | | | | | | | | |
| *Navicula stroemii* | | | | | | | | |
| *Neidium affine* | | | | | | | | |
| *Neidium bisulcatum* | | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | 13 | | | | | 17 | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | | |
| *Neidium densestriatum* | | | | | | | | |
| *Neidium iridis* | | | | | | | | |
| *Neidium poss holstii* | | | | 8 | | | | |
| *Nitzschia filiformis* | | | | | | | | |
| *Nitzschia gracilis* | | 7 | | 2 | | 42 | 33 | 13 |
| *Nitzschia intermedia* | | | | | | | | |
| *Nitzschia microcephala* | | 9 | | | | | | |
| *Nitzschia nana* | | | | | | | | |
| *Nitzschia perminuta* | | | | | | | | |
| *Nitzschia recta* | | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | | |
| *Nitzschia vermicularis* | | | | | | | | |
| *Oxyneis binalis* | 14 | 56 | 24 | 38 | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | | |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Bayers-B 25-25.5cm | Bayers-T 0-0.5 cm | Bayers-B 25-25.5 cm | Bell-T 0-0.5 cm | Bell-B 19-19.5 cm | Big Albro-T 0-0.5 cm | Big Albro-B 25-25.5 cm | Bissett-T 0-0.5 cm |
| *Pinnularia biceps* | | | | | | | 1 | |
| *Pinnularia brauniana* | | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | | |
| *Pinnularia divergens* | | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | | |
| *Pinnularia gibba* | | | | | | | | |
| *Pinnularia gibbiformis* | | | | | | | | |
| *Pinnularia kwacksii* | 18 | 15 | 17 | 4 | 8 | | | |
| *Pinnularia legumen* | | | | | | | | |
| *Pinnularia microstauron* | 1 | 22 | 9 | 3 | 4 | 12 | 2 | |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | | |
| *Pinnularia nodosa* | | | | | | | | |
| *Pinnularia polynoca* | | | | | | | | |
| *Pinnularia silvatica* | | | | | | | | |
| *Pinnularia subgibba* | 19 | 7 | 32 | 12 | 13 | 8 | 18 | |
| *Pinnularia subgibba* var. *undulata* | | | | | | | | |
| *Pinnularia subrupestris* | | | | | | | | |
| *Pinnularia viridiformis* var. morph I | 8 | | 18 | | | | 4 | |
| *Psammothidium bioretii* | | | | | | | | |
| *Psammothidium levanderi* | | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | | |
| *Semiorbis hemicyclus* | 73 | 64 | 75 | | | 12 | 13 | |
| *Stauroneis anceps* | 28 | 8 | 34 | | | 33 | 42 | |
| *Stauroneis construens* | | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | | |
| *Stauroneis phoenocenteron* | 12 | | 8 | | | 4 | 3 | |
| *Staurosira construens* | | | | | | | 14 | |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Bayers-B** | **Bayers-T** | **Bayers-B** | **Bell-T** | **Bell-B** | **Big Albro-T** | **Big Albro-B** | **Bissett-T** |
| | 25-25.5cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 19-19.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Staurosirella pinnata* | | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | | |
| *Stenopterobia anceps* | | | | | | | | |
| *Stenopterobia curvula* | | 9 | | | | 23 | | |
| *Surirella amphioxis* | 8 | 8 | 9 | 6 | 32 | 12 | 17 | |
| *Surirella angustua* | | | | | | | | |
| *Surirella cuspidata* | | | | | | | | |
| *Surirella linearis* | | 8 | | | | | | |
| *Surirella pinnata* | | | | | | | | |
| *Surirella poss elegans* | | | | | | | | |
| *Surirella spendida* | | | | | | | | |
| *Tabellaria fenestrata* | 38 | 19 | 37 | 18 | 43 | | 7 | 12 |
| *Tabellaria flocculosa* strain III | | 8 | | 14 | 17 | | 13 | 2 |
| *Tabellaria flocculosa* strain IIIp | | 47 | | 33 | 14 | | 4 | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | | |
| *Tabellaria flocculosa* strain IV | | | | 58 | 7 | | 7 | 2 |
| *Tabellaria flocculosa* var. *linearis* | | | | 13 | 34 | | 12 | |
| *Tabellaria quadriseptata* | 7 | 46 | 9 | 38 | 22 | 4 | 42 | 14 |
| *Tabellaria ventricosa* | | | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Bissett-B** | **Charles-T** | **Charles-B** | **Chocolate-T** | **Chocolate-B** | **Cranberry-T** | **Cranberry-B** |
| | 25-25.5 cm | 0-0.5 cm | 18.5-19 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm | 24.5-25 cm |
| *Achnanthes bahusiensis* | | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | |
| *Achnanthes chlidanos* | 12 | | | 122 | 22 | 28 | 52 |
| *Achnanthes curtissima* | | 1 | 6 | | | 9 | 26 |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | | | 4 | | | 2 | 7 |
| *Achnanthes stewartii* | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | | | | 18 | | | |
| *Amphora ovalis* | 3 | 2 | | 12 | 29 | | |
| *Amphora pediculus* | | | | | | | |
| *Anomoenis brachysira* | | | | | | | |
| *Asterionella formosa* | 6 | | 4 | | 49 | | |
| *Asterionella ralfsii* var. *americana* | | | | 57 | 62 | | |
| *Aulacoseira ambigua* | 43 | 24 | | | | 58 | 34 |
| *Aulacoseira crassipunctata* | | | | 3 | | 7 | 1 |
| *Aulacoseira distans* | 164 | 44 | 5 | 22 | 14 | 52 | 32 |
| *Aulacoseira distans* var. *nivalis* | | | | | | | |
| *Aulacoseira granulata* | | | | | | | |
| *Aulacoseira italica* | | 4 | | | | | |
| *Aulacoseira lacustris* | | | | | | 32 | |
| *Aulacoseira lirata* | | | | | | | 13 |
| *Aulacoseira nygaardii* | | | | | | 8 | 27 |
| *Aulacoseira perglabra* | 28 | | | 18 | 28 | | |
| *Brachysira brebissonii* | | 4 | | 7 | | | |
| *Brachysira follis* | | | | | | | |
| *Brachysira intermedia* | | | | | | | |
| *Brachysira manfredii* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Bissett-B** 25-25.5 cm | **Charles-T** 0-0.5 cm | **Charles-B** 18.5-19 cm | **Chocolate-T** 0-0.5 cm | **Chocolate-B** 23.5-24 cm | **Cranberry-T** 0-0.5 cm | **Cranberry-B** 24.5-25 cm |
| *Brachysira neoexilis* | | | | 57 | 22 | | |
| *Brachysira poss procera* | | | | | | | |
| *Brachysira serians* | | | 4 | 2 | 4 | 9 | |
| *Brachysira styriaca* | | | | 14 | 23 | 2 | |
| *Caloneis bacillum* | | | | | | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | | | | 327 | | 4 | 18 |
| *Cavinula pseudoscutiformis* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 62 | 27 | 52 | | | | 2 |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | 93 | 6 | 94 | | 12 | 6 | 7 |
| *Cymbella hungarica* | | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | | | | |
| *Cymbella* spp. | 4 | | | | | | 17 |
| *Cymbopleura subcuspidata* | | | | | | | |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | | | | | |
| *Diatoma tenue* | | | | 17 | | 22 | |
| *Diploneis marginestriata* | 21 | | | | | | |
| *Diploneis parma* | 27 | | | | | | |
| *Encyonema herbidicum* | | | | | | | |
| *Encyonema lunatum* | | | | | | | |
| *Encyonema minutum* | | | | | | | |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | | | | | | |
| *Eunotia arcus* | | | | | | 23 | 8 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Bissett-B** | **Charles-T** | **Charles-B** | **Chocolate-T** | **Chocolate-B** | **Cranberry-T** | **Cranberry-B** |
| | 25-25.5 cm | 0-0.5 cm | 18.5-19 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm | 24.5-25 cm |
| *Eunotia bidentula* | | | | | | | |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | | | |
| *Eunotia carolina* | | | | | | | |
| *Eunotia curvata* | | | | | | | |
| *Eunotia curvata f . bergii* | 4 | | | | | | |
| *Eunotia elegans* | | | | 76 | 39 | | |
| *Eunotia exigua* | | 4 | 8 | 7 | | 42 | 38 |
| *Eunotia faba* | | | | | | | |
| *Eunotia fallax* | | | 9 | | | | |
| *Eunotia flexulosa* | | | 24 | | | 27 | 23 |
| *Eunotia flexulosa* (straight) | 22 | 27 | | 2 | 8 | | |
| *Eunotia formica* | | | | 2 | | 6 | 2 |
| *Eunotia hexiglyphis* | 7 | | | | | | |
| *Eunotia implicata* | | | | | | 16 | |
| *Eunotia incisa* | 28 | | | 13 | | 22 | 8 |
| *Eunotia intermediata* | | | | | | | |
| *Eunotia latriensis* | | | | | | | |
| *Eunotia major* | | | | | 26 | | |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | | | | | | |
| *Eunotia pectinalis* var. minor | | 4 | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | | | | 28 |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | | | | | | |
| *Eunotia serra* | | | | | | | |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | | | | | 7 | | |
| *Fragilaria brevistriata* | 24 | | | | | 12 | 12 |
| *Fragilaria capucina* | | 36 | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | 7 | 9 | | |
| *Fragilaria capucina* var. *rumpens* | | 62 | | | | 5 | |
| *Fragilaria capucina* var. *gracilis* | | 32 | | | | | |

| Taxa | Interval | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | **Bissett-B** 25-25.5 cm | **Charles-T** 0-0.5 cm | **Charles-B** 18.5-19 cm | **Chocolate-T** 0-0.5 cm | **Chocolate-B** 23.5-24 cm | **Cranberry-T** 0-0.5 cm | **Cranberry-B** 24.5-25 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | 3 | | | | | | 88 |
| *Fragilaria elliptica (girdles)* | | | | | | | |
| *Fragilaria oldenbergiana* | | | | | | | |
| *Fragilaria parasitica* | | | | | | | |
| *Fragilaria pinnata* | | | | | | | |
| *Fragilaria polygonata* | | | | | | | |
| *Fragilaria pulchella* | | | | | | | |
| *Fragilaria* spp. 5 | | | | | | | 29 |
| *Fragilaria tenera* | | | 7 | | | | |
| *Fragilaria ulna* var. *acus* | | | | 42 | 28 | | |
| *Fragilariforma acidobiontica* | | | | | | | |
| *Fragilariforma constricta* | | | | | | | |
| *Fragilariforma constricta f. stricta* | | | | | | | |
| *Fragilariforma exigua* | | 15 | 12 | 17 | | 53 | 44 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | |
| *Fragilariforma lata* | 2 | 5 | 12 | 2 | | | |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | 4 | 8 | | |
| *Frustulia pseudomagaliesmontana* | | | | | | | |
| *Frustulia rhomboides* | | | | 2 | 21 | 4 | 3 |
| *Frustulia saxonica* | | | | 8 | 52 | 7 | 9 |
| *Gomphonema acuminatum* | | | | | | | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | | 14 | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | 6 | | | | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | | | | | | |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bissett-B | Charles-T | Charles-B | Chocolate-T | Chocolate-B | Cranberry-T | Cranberry-B |
| | 25-25.5 cm | 0-0.5 cm | 18.5-19 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm | 24.5-25 cm |
| *Melosira arentii* | | | | | | | |
| *Meridian circulare* | | | | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | | | | 4 | 4 | 32 | 4 |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | 7 | 22 |
| *Navicula impexa* | | | 4 | | | | |
| *Navicula leptostriata* | 22 | | | 32 | 12 | 68 | 23 |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | |
| *Navicula pseudolanceolata* | | | | | | | |
| *Navicula radiosa* | | | | | | | |
| *Navicula schumassmanni* | | | | | | | |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | |
| *Neidium densestriatum* | | | | | | | |
| *Neidium iridis* | | | | | | | |
| *Neidium poss holstii* | | | | | | | |
| *Nitzschia filiformis* | | | | | | | |
| *Nitzschia gracilis* | 4 | 16 | | 9 | 7 | 33 | 7 |
| *Nitzschia intermedia* | | | | | | | |
| *Nitzschia microcephala* | | | 17 | | | | |
| *Nitzschia nana* | | | | | | | |
| *Nitzschia perminuta* | | | | | | | |
| *Nitzschia recta* | | | | | | | |
| *Nitzschia suchlandtii* | | | 12 | | | | |
| *Nitzschia vermicularis* | | | | | | | |
| *Oxyneis binalis* | | | | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Bissett-B** 25-25.5 cm | **Charles-T** 0-0.5 cm | **Charles-B** 18.5-19 cm | **Chocolate-T** 0-0.5 cm | **Chocolate-B** 23.5-24 cm | **Cranberry-T** 0-0.5 cm | **Cranberry-B** 24.5-25 cm |
| *Pinnularia biceps* | | | | | | | 2 |
| *Pinnularia brauniana* | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | |
| *Pinnularia divergens* | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | | | | | | | |
| *Pinnularia gibbiformis* | | | | | | | |
| *Pinnularia kwacksii* | | | | | | | 16 |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | | | | 29 | 12 | 2 | 2 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | | | | | | | |
| *Pinnularia polynoca* | | | | | | | |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | | | | | 2 | 3 | 38 |
| *Pinnularia subgibba* var. *undulata* | | | | | | | |
| *Pinnularia subrupestris* | | | | 4 | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | |
| *Semiorbis hemicyclus* | | 2 | | | | | |
| *Stauroneis anceps* | 13 | | | | 4 | 4 | 2 |
| *Stauroneis construens* | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | 22 | | | |
| *Stauroneis phoenocenteron* | | | | | 2 | | 7 |
| *Staurosira construens* | 17 | | | | 68 | 8 | 22 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Bissett-B** | **Charles-T** | **Charles-B** | **Chocolate-T** | **Chocolate-B** | **Cranberry-T** | **Cranberry-B** |
| | 25-25.5 cm | 0-0.5 cm | 18.5-19 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm | 24.5-25 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | | | | | | |
| *Stenopterobia curvula* | | | | | 22 | | |
| *Surirella amphioxis* | 12 | | | | 4 | | 7 |
| *Surirella angustua* | | | | | | | |
| *Surirella cuspidata* | | | | | | | |
| *Surirella linearis* | | | | 9 | 8 | 2 | |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | 11 | 22 | 4 | 12 | 12 | 14 | 1 |
| *Tabellaria flocculosa* strain III | 12 | | | 34 | 22 | 2 | |
| *Tabellaria flocculosa* strain IIIp | 7 | 13 | 22 | | | | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | 6 | | | | 158 | 43 | 42 |
| *Tabellaria flocculosa* var. *linearis* | 12 | 52 | 94 | | 48 | | |
| *Tabellaria quadriseptata* | 32 | | | 57 | 142 | 9 | 27 |
| *Tabellaria ventricosa* | | | | | | | |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **First-T** | **First-B** | **First Chain-T** | **First Chain-B** | **First Chain-T** | **First Chain-B** |
| | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Achnanthes bahusiensis* | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | |
| *Achnanthes chlidanos* | | 3 | 5 | | 7 | |
| *Achnanthes curtissima* | 8 | 4 | | | | |
| *Achnanthes impexiformis* | 2 | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | |
| *Achnanthes* spp. 3 | | | | | | |
| *Achnanthes stewartii* | | | | 12 | | 24 |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | |
| *Achnanthidium minutissimum* | | 4 | | | | |
| *Actinella brasiliensis* | | | | | | |
| *Actinella punctata* | | | | 23 | | 27 |
| *Amphora ovalis* | | | | | | |
| *Amphora pediculus* | | | | | | |
| *Anomoenis brachysira* | | | 64 | | 67 | |
| *Asterionella formosa* | 11 | | 4 | 4 | 8 | 14 |
| *Asterionella ralfsii* var. *americana* | | 4 | | 24 | | 38 |
| *Aulacoseira ambigua* | | | | | | |
| *Aulacoseira crassipunctata* | | | | | | |
| *Aulacoseira distans* | 23 | 15 | 7 | | 7 | |
| *Aulacoseira distans* var. *nivalis* | | | | | | |
| *Aulacoseira granulata* | | | | | | |
| *Aulacoseira italica* | | | | | | |
| *Aulacoseira lacustris* | | | | | | |
| *Aulacoseira lirata* | 6 | 4 | | | | |
| *Aulacoseira nygaardii* | | | 32 | | 32 | |
| *Aulacoseira perglabra* | 24 | | 7 | 12 | 12 | 12 |
| *Brachysira brebissonii* | | | 63 | 53 | 63 | 58 |
| *Brachysira follis* | | | | | | |
| *Brachysira intermedia* | | | | 2 | | 6 |
| *Brachysira manfredii* | | | | 4 | | 2 |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **First-T** | **First-B** | **First Chain-T** | **First Chain-B** | **First Chain-T** | **First Chain-B** |
| | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Brachysira neoexilis* | 4 | 8 | | | | |
| *Brachysira poss procera* | | | | | | |
| *Brachysira serians* | | | | | | |
| *Brachysira styriaca* | | 12 | | 72 | | 84 |
| *Caloneis bacillum* | | | | | | |
| *Caloneis silicula* | | | | | | |
| *Cavinula cocconeiformis* | | 6 | | | | |
| *Cavinula pseudoscutiformis* | | 4 | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Craticula cuspidata* | | | | | | |
| *Cyclotella bodanica* | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 54 | 44 | | | | |
| *Cyclotella michiganiana* | | | | | | |
| *Cyclotella stelligera* | 43 | 54 | | | | |
| *Cymbella hungarica* | | | 14 | | 18 | |
| *Cymbella incerta* | | | | | | |
| *Cymbella schubartoides* | | | | | | |
| *Cymbella* spp. | 6 | | | | | |
| *Cymbopleura subcuspidata* | | | | 12 | | 22 |
| *Diatoma anceps* | 2 | | | | | |
| *Diatoma mesodon* | | | | | | |
| *Diatoma tenue* | 54 | 2 | | | | |
| *Diploneis marginestriata* | 28 | | | | | |
| *Diploneis parma* | 3 | | | | | |
| *Encyonema herbidicum* | | | | 24 | | 24 |
| *Encyonema lunatum* | | | | | | |
| *Encyonema minutum* | | | | | | |
| *Encyonopsis cesatii* | 2 | | | | | |
| *Eucocconeis depressa* | | | | | | |
| *Eunotia arcus* | | | | 2 | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | First-T | First-B | First Chain-T | First Chain-B | First Chain-T | First Chain-B |
| | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Eunotia bidentula* | | 3 | | 32 | | |
| *Eunotia bigibba* | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | 6 | 14 | | 22 | |
| *Eunotia carolina* | | | | | | |
| *Eunotia curvata* | | | | 32 | | 34 |
| *Eunotia curvata f . bergii* | | 42 | | 12 | | 17 |
| *Eunotia elegans* | | | | | | |
| *Eunotia exigua* | | 3 | 4 | 33 | 8 | 28 |
| *Eunotia faba* | | | | 14 | | 13 |
| *Eunotia fallax* | 12 | 33 | | | | |
| *Eunotia flexulosa* | 17 | | | | | |
| *Eunotia flexulosa* (straight) | | | | | | |
| *Eunotia formica* | | | 8 | | 6 | |
| *Eunotia hexiglyphis* | | | | 24 | | 34 |
| *Eunotia implicata* | | | | 7 | | 7 |
| *Eunotia incisa* | 9 | 4 | 84 | 8 | 53 | 1 |
| *Eunotia intermediata* | | | | | | |
| *Eunotia latriensis* | | | | | | |
| *Eunotia major* | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | 12 | | 45 | 8 | 42 | 9 |
| *Eunotia pectinalis* var. minor | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | 22 | | 23 |
| *Eunotia poss teineckii* | | | | | | |
| *Eunotia praerupta* | | | | 22 | | 32 |
| *Eunotia serra* | | | | 14 | | 14 |
| *Eunotia serra* var. *tetrado* | | 6 | | | | |
| *Eunotia zasumensis* | | 21 | | | | |
| *Fragilaria brevistriata* | | | | | | |
| *Fragilaria capucina* | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | 4 | | 13 | |
| *Fragilaria capucina* var. *rumpens* | 2 | | | | | |
| *Fragilaria capucina* var. *gracilis* | 11 | 12 | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | First-T | First-B | First Chain-T | First Chain-B | First Chain-T | First Chain-B |
| | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Fragilaria construens f. exigua* | | | | | | |
| *Fragilaria elliptica* | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | |
| *Fragilaria oldenbergiana* | 12 | | 24 | | 26 | |
| *Fragilaria parasitica* | | | | | | |
| *Fragilaria pinnata* | | | | | | |
| *Fragilaria polygonata* | | | 22 | | 33 | |
| *Fragilaria pulchella* | | | | | | |
| *Fragilaria* spp. 5 | | | 4 | | 2 | |
| *Fragilaria tenera* | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | |
| *Fragilariforma acidobiontica* | | | 195 | 2 | 24 | 8 |
| *Fragilariforma constricta* | | | 14 | 2 | 16 | 3 |
| *Fragilariforma constricta f. stricta* | | | | | | |
| *Fragilariforma exigua* | 32 | 2 | 12 | 12 | 12 | 16 |
| *Fragilariforma exigua* (girdles) | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | |
| *Fragilariforma lata* | 2 | 44 | 32 | 62 | 36 | 72 |
| *Frustulia bahlsii* | | | | | | |
| *Frustulia crassinervia* | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | 125 | 28 | 144 | 32 |
| *Frustulia rhomboides* | 2 | 11 | 14 | 93 | 18 | 13 |
| *Frustulia saxonica* | | 4 | 31 | 74 | 44 | 63 |
| *Gomphonema acuminatum* | | | | | 14 | |
| *Gomphonema angustatum* | | | | | | |
| *Gomphonema gracile* | | | | | | |
| *Gomphonema minutum* | | | | | | |
| *Gomphonema parvulum* | | | | | | |
| *Gomphonema truncatum* | | | | | | |
| *Gyrosigma acuminatum* | 15 | | | | | |
| *Gyrosigma obscurum* | | | | | | |
| *Hantzschia rhaetica* | | | | | | |
| *Kobayasia subtillissima* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **First-T** | **First-B** | **First Chain-T** | **First Chain-B** | **First Chain-T** | **First Chain-B** |
| | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Melosira arentii* | | | | | | |
| *Meridian circulare* | | | | | | |
| *Navicula constans* | 6 | | | | | |
| *Navicula cryptocephala* | 6 | | | | | |
| *Navicula expecta* | 7 | 4 | | | | |
| *Navicula halophila* | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | |
| *Navicula impexa* | | | | | | |
| *Navicula leptostriata* | | 22 | | | | |
| *Navicula lundi* | | | | | | |
| *Navicula poss bottnica* | 6 | | | | | |
| *Navicula pseudolanceolata* | 27 | | | | | |
| *Navicula radiosa* | 3 | | | | | |
| *Navicula schumassmanni* | | | | | | |
| *Navicula stroemii* | | | | | | |
| *Neidium affine* | | | | | | |
| *Neidium bisulcatum* | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | 7 | | 12 | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | |
| *Neidium densestriatum* | | | | | | |
| *Neidium iridis* | | | | | | |
| *Neidium poss holstii* | | | | | | |
| *Nitzschia filiformis* | | | | | | |
| *Nitzschia gracilis* | | | | | | |
| *Nitzschia intermedia* | | | | | | |
| *Nitzschia microcephala* | | | | | | |
| *Nitzschia nana* | | | | | | |
| *Nitzschia perminuta* | | | | | | |
| *Nitzschia recta* | 54 | | | | | |
| *Nitzschia suchlandtii* | | | | | | |
| *Nitzschia vermicularis* | | | | | | |
| *Oxyneis binalis* | | | | 22 | | 22 |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **First-T** | **First-B** | **First Chain-T** | **First Chain-B** | **First Chain-T** | **First Chain-B** |
| | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Pinnularia biceps* | | | | | | |
| *Pinnularia brauniana* | | 3 | | | | |
| *Pinnularia cardinalis* | | | | | | |
| *Pinnularia claviculiformes* | | | | | | |
| *Pinnularia divergens* | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | |
| *Pinnularia gibba* | | | | | | |
| *Pinnularia gibbiformis* | | | | 14 | | 14 |
| *Pinnularia kwacksii* | | | 2 | | 7 | |
| *Pinnularia legumen* | | | | | | |
| *Pinnularia microstauron* | | | 34 | 72 | 38 | 14 |
| *Pinnularia microstauron* var. *non fasciata* | | | | 2 | | 7 |
| *Pinnularia nobilis* var. *linearis* | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | |
| *Pinnularia nodosa* | | | | | | |
| *Pinnularia polynoca* | | | | | | |
| *Pinnularia silvatica* | | | | | | |
| *Pinnularia subgibba* | | | | | | |
| *Pinnularia subgibba* var. *undulata* | | | | | | |
| *Pinnularia subrupestris* | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | |
| *Psammothidium bioretii* | | | | | | |
| *Psammothidium levanderi* | | | | | | |
| *Psammothidium subatomoides* | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | |
| *Semiorbis hemicyclus* | | 24 | 14 | 33 | 19 | 33 |
| *Stauroneis anceps* | | | | | | |
| *Stauroneis construens* | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | 28 | | 29 |
| *Stauroneis phoenocenteron* | | | | 52 | | 64 |
| *Staurosira construens* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **First-T** | **First-B** | **First Chain-T** | **First Chain-B** | **First Chain-T** | **First Chain-B** |
| | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Staurosirella pinnata* | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | |
| *Stenopterobia anceps* | | 2 | | | | |
| *Stenopterobia curvula* | | 4 | | | | |
| *Surirella amphioxis* | 29 | 3 | 4 | 12 | 8 | 4 |
| *Surirella angustua* | | | | | | |
| *Surirella cuspidata* | 2 | | | | | |
| *Surirella linearis* | 4 | | | | | |
| *Surirella pinnata* | | | | | | |
| *Surirella poss elegans* | | | | | | |
| *Surirella spendida* | | | | | | |
| *Tabellaria fenestrata* | 43 | 43 | 34 | 13 | 42 | 18 |
| *Tabellaria flocculosa* strain III | 24 | | 3 | 64 | 8 | 72 |
| *Tabellaria flocculosa* strain IIIp | | | 24 | | 22 | 38 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | |
| *Tabellaria flocculosa* strain IV | | | | | | |
| *Tabellaria flocculosa* var. *linearis* | 24 | 22 | | | | |
| *Tabellaria quadriseptata* | | | 24 | 32 | 16 | |
| *Tabellaria ventricosa* | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **First Chain-T** | **First Chain-B** | **Fletcher-T** | **Fletcher-B** | **Fraser-T** | **Fraser-B** | **Fraser-T** |
| | 0-0.5 cm | 22.5-23 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 12-12.5 cm | 0-0.5 cm |
| *Achnanthes bahusiensis* | | | | 2 | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | |
| *Achnanthes chlidanos* | 9 | | | | 38 | 49 | 36 |
| *Achnanthes curtissima* | | | 33 | 24 | | | |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | | | | | | | |
| *Achnanthes stewartii* | | 11 | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | 42 | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | | 43 | 2 | 16 | 12 | | 9 |
| *Amphora ovalis* | | | | | | 7 | 2 |
| *Amphora pediculus* | | | | | | | |
| *Anomoenis brachysira* | 44 | | | | | | |
| *Asterionella formosa* | 8 | 7 | 21 | 27 | 44 | 42 | 42 |
| *Asterionella ralfsii* var. *americana* | | 34 | | | 78 | 67 | 79 |
| *Aulacoseira ambigua* | | | | | 22 | 22 | 19 |
| *Aulacoseira crassipunctata* | | | | | 48 | 62 | 53 |
| *Aulacoseira distans* | 9 | | 4 | | 56 | 72 | 7 |
| *Aulacoseira distans* var. *nivalis* | | | | | | | |
| *Aulacoseira granulata* | | | | | 18 | | |
| *Aulacoseira italica* | | | | | | | |
| *Aulacoseira lacustris* | | | | | | | |
| *Aulacoseira lirata* | | | 27 | | 3 | 12 | 2 |
| *Aulacoseira nygaardii* | | | | | | | |
| *Aulacoseira perglabra* | 8 | 13 | | | 7 | 22 | 12 |
| *Brachysira brebissonii* | 44 | 44 | 23 | 38 | | 2 | |
| *Brachysira follis* | | | | | | | |
| *Brachysira intermedia* | | 5 | | | | | |
| *Brachysira manfredii* | | 3 | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | First Chain-T 0-0.5 cm | First Chain-B 22.5-23 cm | Fletcher-T 0-0.5 cm | Fletcher-B 25-25.5 cm | Fraser-T 0-0.5 cm | Fraser-B 12-12.5 cm | Fraser-T 0-0.5 cm |
| *Brachysira neoexilis* | | | 12 | | | | |
| *Brachysira poss procera* | | | | | | | |
| *Brachysira serians* | | | | | 2 | 34 | 4 |
| *Brachysira styriaca* | 9 | 12 | | | 33 | 28 | 31 |
| *Caloneis bacillum* | | | | | | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | | | | | 17 | 21 | 21 |
| *Cavinula pseudoscutiformis* | | | 2 | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | | 7 | | | 2 |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | | | 23 | 11 | | | |
| *Cymbella hungarica* | 16 | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | 2 | 18 | 17 | 19 |
| *Cymbella* spp. | | | | | 2 | 4 | 6 |
| *Cymbopleura subcuspidata* | | 14 | | | | | |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | 12 | | | | |
| *Diatoma tenue* | | | 2 | | | | |
| *Diploneis marginestriata* | | | 12 | | | | |
| *Diploneis parma* | | | 13 | | | | |
| *Encyonema herbidicum* | | 23 | | | | | |
| *Encyonema lunatum* | | | | | | | |
| *Encyonema minutum* | | | | | | | |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | | | | | | |
| *Eunotia arcus* | | 2 | | | | 2 | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | First Chain-T 0-0.5 cm | First Chain-B 22.5-23 cm | Fletcher-T 0-0.5 cm | Fletcher-B 25-25.5 cm | Fraser-T 0-0.5 cm | Fraser-B 12-12.5 cm | Fraser-T 0-0.5 cm |
| *Eunotia bidentula* | | 21 | | | 12 | 23 | 19 |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | 14 | | | | | | |
| *Eunotia carolina* | | | | | 4 | 3 | 6 |
| *Eunotia curvata* | | 23 | | | | | |
| *Eunotia curvata f . bergii* | | 17 | | | | | |
| *Eunotia elegans* | | | | | 7 | 26 | 8 |
| *Eunotia exigua* | 4 | 17 | 22 | | | 8 | |
| *Eunotia faba* | | 18 | | | | | 2 |
| *Eunotia fallax* | | | 7 | | | | |
| *Eunotia flexulosa* | | | | | 28 | 21 | 22 |
| *Eunotia flexulosa* (straight) | | | | | 22 | | 24 |
| *Eunotia formica* | 8 | | | 7 | 13 | 8 | 12 |
| *Eunotia hexiglyphis* | | 23 | | | | 13 | |
| *Eunotia implicata* | | 8 | | | | | |
| *Eunotia incisa* | 44 | 8 | 4 | | | 11 | 7 |
| *Eunotia intermediata* | | | | | 37 | 35 | 28 |
| *Eunotia latriensis* | | 7 | | | | | |
| *Eunotia major* | | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | 36 | | | | 18 | 51 | 22 |
| *Eunotia pectinalis* var. minor | | | | | 63 | 63 | 63 |
| *Eunotia pectinais* var. *ventricosa* | | 67 | | 12 | 62 | 47 | 63 |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | 22 | | | | | |
| *Eunotia serra* | | 22 | | | 32 | 28 | 37 |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | | | | | 32 | 23 | 28 |
| *Fragilaria brevistriata* | | | | | 22 | 7 | 18 |
| *Fragilaria capucina* | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | 12 | | 34 | | | | |
| *Fragilaria capucina* var. *rumpens* | | | 16 | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | First Chain-T | First Chain-B | Fletcher-T | Fletcher-B | Fraser-T | Fraser-B | Fraser-T |
| | 0-0.5 cm | 22.5-23 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 12-12.5 cm | 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | | |
| *Fragilaria oldenbergiana* | 36 | | | | | | |
| *Fragilaria parasitica* | | | | | | | |
| *Fragilaria pinnata* | | | | | | | |
| *Fragilaria polygonata* | 27 | | | | | 8 | |
| *Fragilaria pulchella* | | | 17 | 23 | | | |
| *Fragilaria* spp. 5 | | | | | | | |
| *Fragilaria tenera* | | | 34 | 22 | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | |
| *Fragilariforma acidobiontica* | 196 | 9 | | | | | |
| *Fragilariforma constricta* | 12 | 4 | | | | 8 | |
| *Fragilariforma constricta f. stricta* | | | | | | 34 | |
| *Fragilariforma exigua* | 7 | 12 | 54 | 25 | | 7 | 2 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | 12 | |
| *Fragilariforma lata* | 24 | 78 | | 46 | 22 | 12 | 27 |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | | | | |
| *Frustulia pseudomagaliesmontana* | 84 | 28 | | | | | |
| *Frustulia rhomboides* | 8 | 74 | | | 32 | 26 | 33 |
| *Frustulia saxonica* | 57 | 57 | | | 1 | 17 | 3 |
| *Gomphonema acuminatum* | | | | | | 3 | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | | | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | | | | 2 | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | | | | | | |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | First Chain-T | First Chain-B | Fletcher-T | Fletcher-B | Fraser-T | Fraser-B | Fraser-T |
| | 0-0.5 cm | 22.5-23 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 12-12.5 cm | 0-0.5 cm |
| *Melosira arentii* | | | | | | | |
| *Meridian circulare* | | | | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | | | | | | | |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | |
| *Navicula impexa* | | | | | | | |
| *Navicula leptostriata* | | | | | 4 | | 2 |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | |
| *Navicula pseudolanceolata* | | | | 22 | | | |
| *Navicula radiosa* | | | | | | | |
| *Navicula schumassmanni* | | | | | | | |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | 5 | | | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | |
| *Neidium densestriatum* | | | | | | | |
| *Neidium iridis* | | | | | | | |
| *Neidium poss holstii* | | | | | 2 | 3 | 7 |
| *Nitzschia filiformis* | | | | | | | |
| *Nitzschia gracilis* | | | 24 | | | | |
| *Nitzschia intermedia* | | | | | | | |
| *Nitzschia microcephala* | | | 12 | | | | |
| *Nitzschia nana* | | | | | | | |
| *Nitzschia perminuta* | | | | | | | |
| *Nitzschia recta* | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | |
| *Nitzschia vermicularis* | | | | | | | |
| *Oxyneis binalis* | | 12 | | | 38 | 18 | 37 |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **First Chain-T** 0-0.5 cm | **First Chain-B** 22.5-23 cm | **Fletcher-T** 0-0.5 cm | **Fletcher-B** 25-25.5 cm | **Fraser-T** 0-0.5 cm | **Fraser-B** 12-12.5 cm | **Fraser-T** 0-0.5 cm |
| *Pinnularia biceps* | | | | | | | |
| *Pinnularia brauniana* | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | |
| *Pinnularia divergens* | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | | | | | | | |
| *Pinnularia gibbiformis* | | 15 | | | | | |
| *Pinnularia kwacksii* | 2 | | | | | | |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | 18 | 67 | | 12 | | 9 | |
| *Pinnularia microstauron* var. *non fasciata* | | 2 | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | | | | | | | |
| *Pinnularia polynoca* | | | | | 9 | 1 | 8 |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | | | | | | 2 | |
| *Pinnularia subgibba* var. *undulata* | | | | | | | |
| *Pinnularia subrupestris* | | | | | | | |
| *Pinnularia viridiformis* var. morph I | 9 | | | | | | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | |
| *Pseudostaurosira brevistriata* | | | 24 | 12 | | | |
| *Pseudostaurosira parasitia* | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | |
| *Semiorbis hemicyclus* | 12 | 18 | | | | 18 | 2 |
| *Stauroneis anceps* | 8 | 7 | | | | | |
| *Stauroneis construens* | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | 22 | | | | | |
| *Stauroneis phoenocenteron* | 3 | 37 | | | | | |
| *Staurosira construens* | | | | | 38 | 27 | 42 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | First Chain-T 0-0.5 cm | First Chain-B 22.5-23 cm | Fletcher-T 0-0.5 cm | Fletcher-B 25-25.5 cm | Fraser-T 0-0.5 cm | Fraser-B 12-12.5 cm | Fraser-T 0-0.5 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | | | | | | |
| *Stenopterobia curvula* | | | | | | | |
| *Surirella amphioxis* | 6 | 14 | | | 9 | 18 | 8 |
| *Surirella angustua* | | | | | | | |
| *Surirella cuspidata* | | | | | | | |
| *Surirella linearis* | | | | | | | |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | 42 | 24 | 34 | 53 | 99 | 21 | 117 |
| *Tabellaria flocculosa* strain III | 5 | 47 | | 12 | 7 | 32 | 1 |
| *Tabellaria flocculosa* strain IIIp | 23 | | 34 | 36 | 17 | 4 | 16 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | | | 12 | | 122 | 29 | 116 |
| *Tabellaria flocculosa* var. *linearis* | | | 54 | 32 | 18 | 18 | 15 |
| *Tabellaria quadriseptata* | 27 | 28 | | | 59 | 27 | 58 |
| *Tabellaria ventricosa* | | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | Fraser-B 15-15.5 cm | Fraser-T 0-0.5 cm | Fraser-B 22-22.5 cm | Frenchmans-T 0-0.5 cm | Frenchman-B 18-18.5 cm | Frenchman-T 0-0.5 cm |
| *Achnanthes bahusiensis* | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | |
| *Achnanthes chlidanos* | 38 | 39 | 37 | 7 | 6 | 9 |
| *Achnanthes curtissima* | | | | | 3 | |
| *Achnanthes impexiformis* | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | 2 | | |
| *Achnanthes* spp. 3 | | | | | | |
| *Achnanthes stewartii* | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | |
| *Achnanthidium minutissimum* | | | | | | |
| *Actinella brasiliensis* | | | | | | |
| *Actinella punctata* | | 12 | | | | 1 |
| *Amphora ovalis* | 8 | 3 | 9 | 13 | | 8 |
| *Amphora pediculus* | | | | | | |
| *Anomoenis brachysira* | | | | | | |
| *Asterionella formosa* | 38 | 46 | 36 | | | |
| *Asterionella ralfsii* var. *americana* | 66 | 58 | 64 | | | |
| *Aulacoseira ambigua* | 22 | 28 | 24 | | | |
| *Aulacoseira crassipunctata* | 69 | 56 | 62 | 12 | 33 | 122 |
| *Aulacoseira distans* | 74 | 8 | 73 | 17 | 92 | 12 |
| *Aulacoseira distans* var. *nivalis* | | | | | | |
| *Aulacoseira granulata* | | | | | | |
| *Aulacoseira italica* | | | | | | |
| *Aulacoseira lacustris* | | | | | | 12 |
| *Aulacoseira lirata* | 18 | 4 | 18 | 4 | 52 | 7 |
| *Aulacoseira nygaardii* | | | | 3 | | 22 |
| *Aulacoseira perglabra* | 28 | | 26 | 11 | | 14 |
| *Brachysira brebissonii* | 4 | | 6 | | | |
| *Brachysira follis* | | | | | | |
| *Brachysira intermedia* | | | | | | |
| *Brachysira manfredii* | | | | | | |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Fraser-B** 15-15.5 cm | **Fraser-T** 0-0.5 cm | **Fraser-B** 22-22.5 cm | **Frenchmans-T** 0-0.5 cm | **Frenchman-B** 18-18.5 cm | **Frenchman-T** 0-0.5 cm |
| *Brachysira neoexilis* | | | | 3 | | |
| *Brachysira poss procera* | | | | | | |
| *Brachysira serians* | 32 | 4 | 34 | 31 | 8 | 32 |
| *Brachysira styriaca* | 23 | 33 | 26 | 12 | 3 | 8 |
| *Caloneis bacillum* | | | | | | |
| *Caloneis silicula* | | | | | | |
| *Cavinula cocconeiformis* | 22 | 28 | 24 | | | |
| *Cavinula pseudoscutiformis* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Craticula cuspidata* | | | | | | |
| *Cyclotella bodanica* | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 2 | 4 | 6 | | 6 | 3 |
| *Cyclotella michiganiana* | | | | | | |
| *Cyclotella stelligera* | | | | 11 | 24 | 18 |
| *Cymbella hungarica* | | | | | | |
| *Cymbella incerta* | | | | | | |
| *Cymbella schubartoides* | 18 | 18 | 19 | | | |
| *Cymbella* spp. | 3 | 7 | 4 | | | |
| *Cymbopleura subcuspidata* | | | | | | |
| *Diatoma anceps* | | | | | | |
| *Diatoma mesodon* | | | | | | |
| *Diatoma tenue* | | | | | | |
| *Diploneis marginestriata* | | | | | | |
| *Diploneis parma* | | | | | | |
| *Encyonema herbidicum* | | | | | | |
| *Encyonema lunatum* | | | | | | |
| *Encyonema minutum* | | | | 5 | | |
| *Encyonopsis cesatii* | | | | | | |
| *Eucocconeis depressa* | | | | | | |
| *Eunotia arcus* | | | | | | |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | Fraser-B | Fraser-T | Fraser-B | Frenchmans-T | Frenchman-B | Frenchman-T |
| | 15-15.5 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm |
| *Eunotia bidentula* | 21 | 17 | 23 | 77 | 25 | 86 |
| *Eunotia bigibba* | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | 29 | 24 | 32 |
| *Eunotia carolina* | 7 | 7 | 6 | | | |
| *Eunotia curvata* | | | | | | |
| *Eunotia curvata f . bergii* | | 3 | | | | |
| *Eunotia elegans* | 33 | 11 | 32 | | 9 | |
| *Eunotia exigua* | 12 | 3 | 11 | 1 | 42 | |
| *Eunotia faba* | | 6 | | | | |
| *Eunotia fallax* | | | | | | |
| *Eunotia flexulosa* | 27 | 19 | 28 | | | |
| *Eunotia flexulosa* (straight) | | 22 | 4 | | | 12 |
| *Eunotia formica* | 12 | 14 | 3 | 7 | 4 | |
| *Eunotia hexiglyphis* | 12 | | 23 | 3 | 28 | |
| *Eunotia implicata* | | | | | | 24 |
| *Eunotia incisa* | 13 | 6 | 21 | | 9 | |
| *Eunotia intermediata* | 22 | | 26 | 31 | | 33 |
| *Eunotia latriensis* | | | | | 3 | |
| *Eunotia major* | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | 48 | 26 | 47 | 11 | | 13 |
| *Eunotia pectinalis* var. minor | 57 | 71 | 49 | | | |
| *Eunotia pectinais* var. *ventricosa* | 49 | 58 | 52 | 9 | | 12 |
| *Eunotia poss teineckii* | | | | | | 8 |
| *Eunotia praerupta* | | | | | | |
| *Eunotia serra* | 33 | 34 | 37 | 5 | 34 | 53 |
| *Eunotia serra* var. *tetrado* | | | | | | |
| *Eunotia zasumensis* | 28 | 29 | 29 | | | |
| *Fragilaria brevistriata* | 7 | 19 | 8 | | 8 | 9 |
| *Fragilaria capucina* | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | | | |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Fraser-B** | **Fraser-T** | **Fraser-B** | **Frenchmans-T** | **Frenchman-B** | **Frenchman-T** |
| | 15-15.5 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | |
| *Fragilaria elliptica* | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | |
| *Fragilaria oldenbergiana* | | | | | | |
| *Fragilaria parasitica* | | | | | | |
| *Fragilaria pinnata* | | | | | | |
| *Fragilaria polygonata* | 22 | | 22 | | | |
| *Fragilaria pulchella* | | | | | | |
| *Fragilaria* spp. 5 | | | | | | |
| *Fragilaria tenera* | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | |
| *Fragilariforma constricta* | 12 | 4 | 6 | | 5 | |
| *Fragilariforma constricta f. stricta* | 28 | | 28 | | | |
| *Fragilariforma exigua* | | 2 | | 16 | 6 | 8 |
| *Fragilariforma exigua* (girdles) | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | 9 | | 12 | | | |
| *Fragilariforma lata* | 2 | 28 | | 15 | 9 | 9 |
| *Frustulia bahlsii* | | | | | | |
| *Frustulia crassinervia* | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | | |
| *Frustulia rhomboides* | 28 | 37 | 29 | 12 | 9 | 5 |
| *Frustulia saxonica* | 22 | 4 | 14 | 11 | 1 | 12 |
| *Gomphonema acuminatum* | 6 | | 7 | 2 | | |
| *Gomphonema angustatum* | | | | | | |
| *Gomphonema gracile* | | | | | | |
| *Gomphonema minutum* | | | | | | |
| *Gomphonema parvulum* | 7 | | 8 | | | |
| *Gomphonema truncatum* | | | | | | |
| *Gyrosigma acuminatum* | | | | | | |
| *Gyrosigma obscurum* | | | | | | |
| *Hantzschia rhaetica* | | | | | | |
| *Kobayasia subtillissima* | | | | | | |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Fraser-B** | **Fraser-T** | **Fraser-B** | **Frenchmans-T** | **Frenchman-B** | **Frenchman-T** |
| | 15-15.5 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm |
| *Melosira arentii* | | | | | 4 | |
| *Meridian circulare* | | | | | | |
| *Navicula constans* | | | | | | |
| *Navicula cryptocephala* | | | | | | |
| *Navicula expecta* | | | | 3 | | 4 |
| *Navicula halophila* | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | |
| *Navicula impexa* | | | | | | |
| *Navicula leptostriata* | | 6 | | | | |
| *Navicula lundi* | | | | | | |
| *Navicula poss bottnica* | | | | | | |
| *Navicula pseudolanceolata* | | | | | | |
| *Navicula radiosa* | | | | | | |
| *Navicula schumassmanni* | | | | | | |
| *Navicula stroemii* | | | | | | |
| *Neidium affine* | | | | | | |
| *Neidium bisulcatum* | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | | 2 |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | |
| *Neidium densestriatum* | | | | | | |
| *Neidium iridis* | | | | | | |
| *Neidium poss holstii* | 2 | 8 | 7 | | | |
| *Nitzschia filiformis* | | | | | | |
| *Nitzschia gracilis* | 3 | | 7 | | | |
| *Nitzschia intermedia* | | | | | | |
| *Nitzschia microcephala* | | | | 45 | | 38 |
| *Nitzschia nana* | | | | | | |
| *Nitzschia perminuta* | | | | | | |
| *Nitzschia recta* | | | | | | |
| *Nitzschia suchlandtii* | | | | | | |
| *Nitzschia vermicularis* | | | | | | |
| *Oxyneis binalis* | 19 | 39 | 23 | 3 | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | 12 | | 9 |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Fraser-B** | **Fraser-T** | **Fraser-B** | **Frenchmans-T** | **Frenchman-B** | **Frenchman-T** |
| | 15-15.5 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 18-18.5 cm | 0-0.5 cm |
| *Pinnularia biceps* | | | | 2 | | |
| *Pinnularia brauniana* | | | | | | |
| *Pinnularia cardinalis* | | | | | | |
| *Pinnularia claviculiformes* | | | | | | |
| *Pinnularia divergens* | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | |
| *Pinnularia gibba* | | | | | | |
| *Pinnularia gibbiformis* | | | | | | |
| *Pinnularia kwacksii* | | | | | | |
| *Pinnularia legumen* | | | | | | |
| *Pinnularia microstauron* | 11 | 2 | 16 | 11 | 62 | 18 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | |
| *Pinnularia nodosa* | | | | | | |
| *Pinnularia polynoca* | 3 | 7 | 7 | | | |
| *Pinnularia silvatica* | | | | | | |
| *Pinnularia subgibba* | 2 | 3 | 3 | | 4 | 2 |
| *Pinnularia subgibba* var. *undulata* | | | | | | |
| *Pinnularia subrupestris* | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | 2 | | |
| *Psammothidium bioretii* | | | | | | |
| *Psammothidium levanderi* | | | | | | |
| *Psammothidium subatomoides* | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | |
| *Semiorbis hemicyclus* | 19 | 7 | 18 | | | |
| *Stauroneis anceps* | | | | | | 2 |
| *Stauroneis construens* | | | | | 7 | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | |
| *Stauroneis phoenocenteron* | | | | | | |
| *Staurosira construens* | 27 | 38 | 27 | | | 33 |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | Fraser-B<br>15-15.5 cm | Fraser-T<br>0-0.5 cm | Fraser-B<br>22-22.5 cm | Frenchmans-T<br>0-0.5 cm | Frenchman-B<br>18-18.5 cm | Frenchman-T<br>0-0.5 cm |
| *Staurosirella pinnata* | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | |
| *Stenopterobia anceps* | | | | | | |
| *Stenopterobia curvula* | | | | | | |
| *Surirella amphioxis* | 16 | 7 | 17 | 6 | 6 | 8 |
| *Surirella angustua* | | | | | | |
| *Surirella cuspidata* | | | | | | |
| *Surirella linearis* | | | | | 2 | 7 |
| *Surirella pinnata* | | | | | | |
| *Surirella poss elegans* | | | | | | |
| *Surirella spendida* | | | | | | |
| *Tabellaria fenestrata* | 24 | 96 | 27 | 2 | 22 | |
| *Tabellaria flocculosa* strain III | 36 | 17 | 34 | 19 | 6 | 16 |
| *Tabellaria flocculosa* strain IIIp | 3 | 17 | 4 | 18 | | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | |
| *Tabellaria flocculosa* strain IV | 38 | 134 | | 79 | 43 | 82 |
| *Tabellaria flocculosa* var. *linearis* | 19 | 18 | 19 | 41 | | 42 |
| *Tabellaria quadriseptata* | 28 | 59 | 29 | 32 | 11 | 46 |
| *Tabellaria ventricosa* | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | Frenchman-B | Frenchman-T | Frenchman-B | Frog Pond-T | Frog Pond-B | Frog Pond-T |
| | 16-16.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Achnanthes bahusiensis* | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | |
| *Achnanthes chlidanos* | 2 | 12 | 4 | | | 12 |
| *Achnanthes curtissima* | | 3 | 2 | | | |
| *Achnanthes impexiformis* | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | |
| *Achnanthes* spp. 3 | | | | | | |
| *Achnanthes stewartii* | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | |
| *Achnanthidium minutissimum* | | | | | | |
| *Actinella brasiliensis* | | | | | | |
| *Actinella punctata* | | 4 | | 3 | 3 | |
| *Amphora ovalis* | | 7 | | 9 | 3 | 7 |
| *Amphora pediculus* | | | | | | |
| *Anomoenis brachysira* | | | | | | |
| *Asterionella formosa* | | 5 | | | | 7 |
| *Asterionella ralfsii* var. *americana* | | | | | | |
| *Aulacoseira ambigua* | | | | | | |
| *Aulacoseira crassipunctata* | 22 | 119 | 23 | 57 | 75 | 39 |
| *Aulacoseira distans* | 74 | 12 | 82 | | 119 | 18 |
| *Aulacoseira distans* var. *nivalis* | | | | | | |
| *Aulacoseira granulata* | | | | 12 | | |
| *Aulacoseira italica* | | | | 24 | | 27 |
| *Aulacoseira lacustris* | 2 | 13 | 4 | | | |
| *Aulacoseira lirata* | 43 | 6 | 38 | | | |
| *Aulacoseira nygaardii* | 3 | 28 | 7 | | | |
| *Aulacoseira perglabra* | | 12 | | | 72 | |
| *Brachysira brebissonii* | | | | | | |
| *Brachysira follis* | | | | | | |
| *Brachysira intermedia* | | | | | | |
| *Brachysira manfredii* | | | | | | |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | Frenchman-B | Frenchman-T | Frenchman-B | Frog Pond-T | Frog Pond-B | Frog Pond-T |
| | 16-16.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Brachysira neoexilis* | | | | | | |
| *Brachysira poss procera* | | | | | | |
| *Brachysira serians* | 4 | 34 | 7 | | 32 | |
| *Brachysira styriaca* | 8 | 9 | 11 | 2 | 3 | 2 |
| *Caloneis bacillum* | | | | | | |
| *Caloneis silicula* | | | | | | |
| *Cavinula cocconeiformis* | | | | 14 | 37 | 12 |
| *Cavinula pseudoscutiformis* | | | | | | |
| *Cocconeis poss neothumensis* | | | | 9 | | 6 |
| *Chamaepinnularia bremensis* | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Craticula cuspidata* | | | | | | |
| *Cyclotella bodanica* | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 7 | 4 | 7 | | | |
| *Cyclotella michiganiana* | | | | | | |
| *Cyclotella stelligera* | 22 | 16 | 22 | 87 | 22 | 82 |
| *Cymbella hungarica* | | | | | | |
| *Cymbella incerta* | | | | | | |
| *Cymbella schubartoides* | | | | | | |
| *Cymbella* spp. | | | | | 12 | |
| *Cymbopleura subcuspidata* | | | | 8 | | 7 |
| *Diatoma anceps* | | | | | | |
| *Diatoma mesodon* | | | | | | |
| *Diatoma tenue* | | | | 37 | | 32 |
| *Diploneis marginestriata* | | | | | | |
| *Diploneis parma* | | | | | | |
| *Encyonema herbidicum* | | | | | 22 | |
| *Encyonema lunatum* | | | | 44 | | 42 |
| *Encyonema minutum* | | | | 28 | 32 | 27 |
| *Encyonopsis cesatii* | | | | | | |
| *Eucocconeis depressa* | | | | | | |
| *Eunotia arcus* | | 2 | | 17 | | 14 |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Frenchman-B** | **Frenchman-T** | **Frenchman-B** | **Frog Pond-T** | **Frog Pond-B** | **Frog Pond-T** |
| | 16-16.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Eunotia bidentula* | 14 | 92 | 18 | 8 | 32 | 3 |
| *Eunotia bigibba* | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | 13 | 34 | 23 | 18 | | 22 |
| *Eunotia carolina* | | | | | | |
| *Eunotia curvata* | | | | | | |
| *Eunotia curvata f . bergii* | | | | | 3 | |
| *Eunotia elegans* | | | | | | |
| *Eunotia exigua* | 27 | | 32 | 48 | 72 | 48 |
| *Eunotia faba* | | | | | | |
| *Eunotia fallax* | | | | | | |
| *Eunotia flexulosa* | | | | 36 | 17 | 33 |
| *Eunotia flexulosa* (straight) | | 23 | | | | |
| *Eunotia formica* | 8 | | 7 | | 2 | |
| *Eunotia hexiglyphis* | 28 | | 25 | | 2 | |
| *Eunotia implicata* | | 27 | | | | |
| *Eunotia incisa* | 8 | | 12 | 12 | | 7 |
| *Eunotia intermediata* | | 38 | | | | |
| *Eunotia latriensis* | | | 5 | | | |
| *Eunotia major* | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | 16 | | 18 | 24 | 15 |
| *Eunotia pectinalis* var. minor | | | | | 4 | |
| *Eunotia pectinais* var. *ventricosa* | | 11 | | | | |
| *Eunotia poss teineckii* | | 12 | | | | |
| *Eunotia praerupta* | | | | | | |
| *Eunotia serra* | 28 | 58 | 32 | | 7 | |
| *Eunotia serra* var. *tetrado* | | | | | | |
| *Eunotia zasumensis* | | | | | | |
| *Fragilaria brevistriata* | 8 | 12 | 6 | 55 | 17 | 52 |
| *Fragilaria capucina* | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | 7 | | 4 |
| *Fragilaria capucina* var. *rumpens* | | | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | 23 | | 16 |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Frenchman-B** | **Frenchman-T** | **Frenchman-B** | **Frog Pond-T** | **Frog Pond-B** | **Frog Pond-T** |
| | 16-16.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | |
| *Fragilaria elliptica* | | | | 218 | 44 | 219 |
| *Fragilaria elliptica (girdles)* | | | | 72 | | 42 |
| *Fragilaria oldenbergiana* | | | | | | |
| *Fragilaria parasitica* | | | | | | |
| *Fragilaria pinnata* | | | | | | |
| *Fragilaria polygonata* | | | | | | |
| *Fragilaria pulchella* | | | | | | |
| *Fragilaria* spp. 5 | | | | | | |
| *Fragilaria tenera* | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | |
| *Fragilariforma constricta* | 3 | | 5 | | 36 | |
| *Fragilariforma constricta f. stricta* | | | | | | |
| *Fragilariforma exigua* | 52 | 12 | 56 | 46 | 7 | 42 |
| *Fragilariforma exigua* (girdles) | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | |
| *Fragilariforma lata* | 4 | 11 | 8 | 63 | 47 | 76 |
| *Frustulia bahlsii* | | | | | | |
| *Frustulia crassinervia* | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | | |
| *Frustulia rhomboides* | 8 | 5 | 8 | 37 | 47 | 33 |
| *Frustulia saxonica* | 12 | 14 | 14 | | 6 | |
| *Gomphonema acuminatum* | | | | 9 | | 8 |
| *Gomphonema angustatum* | | | | | | |
| *Gomphonema gracile* | | | | | | |
| *Gomphonema minutum* | | | | | | |
| *Gomphonema parvulum* | | | | | | |
| *Gomphonema truncatum* | | | | | | |
| *Gyrosigma acuminatum* | | | | | | |
| *Gyrosigma obscurum* | | | | | | |
| *Hantzschia rhaetica* | | | | | | |
| *Kobayasia subtillissima* | | | | | | |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Frenchman-B** | **Frenchman-T** | **Frenchman-B** | **Frog Pond-T** | **Frog Pond-B** | **Frog Pond-T** |
| | 16-16.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Melosira arentii* | 18 | | | | 4 | |
| *Meridian circulare* | | | | | 7 | |
| *Navicula constans* | | | | | | |
| *Navicula cryptocephala* | | | | | | |
| *Navicula expecta* | | 6 | | 17 | | 16 |
| *Navicula halophila* | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | |
| *Navicula impexa* | | | | | | |
| *Navicula leptostriata* | | | | | | |
| *Navicula lundi* | | | | | | |
| *Navicula poss bottnica* | | | | | | |
| *Navicula pseudolanceolata* | | | | | | |
| *Navicula radiosa* | | | | | | |
| *Navicula schumassmanni* | | | | | | |
| *Navicula stroemii* | | | | | | |
| *Neidium affine* | | | | | | |
| *Neidium bisulcatum* | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | 5 | | | 3 | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | |
| *Neidium densestriatum* | | | | | | |
| *Neidium iridis* | | | | | | |
| *Neidium poss holstii* | | | | | 32 | |
| *Nitzschia filiformis* | | | | | | |
| *Nitzschia gracilis* | | | | | | |
| *Nitzschia intermedia* | | | | | | |
| *Nitzschia microcephala* | | 27 | | | | |
| *Nitzschia nana* | | | | | | |
| *Nitzschia perminuta* | | | | | | |
| *Nitzschia recta* | | | | | | |
| *Nitzschia suchlandtii* | | | | | | |
| *Nitzschia vermicularis* | | | | | | |
| *Oxyneis binalis* | | | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | 11 | | | | |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | Frenchman-B 16-16.5 cm | Frenchman-T 0-0.5 cm | Frenchman-B 16-16.5 cm | Frog Pond-T 0-0.5 cm | Frog Pond-B 25-25.5 cm | Frog Pond-T 0-0.5 cm |
| *Pinnularia biceps* | | | | | | |
| *Pinnularia brauniana* | | | | | | |
| *Pinnularia cardinalis* | | | | | | |
| *Pinnularia claviculiformes* | | | | | 17 | |
| *Pinnularia divergens* | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | |
| *Pinnularia gibba* | | | | | 32 | |
| *Pinnularia gibbiformis* | | | | | | |
| *Pinnularia kwacksii* | | | | 3 | 3 | |
| *Pinnularia legumen* | | | | | | |
| *Pinnularia microstauron* | 66 | 19 | 68 | 18 | 8 | 18 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | |
| *Pinnularia nodosa* | | | | | 4 | |
| *Pinnularia polynoca* | | | | | | |
| *Pinnularia silvatica* | | | | | | |
| *Pinnularia subgibba* | 4 | 3 | 7 | | 22 | |
| *Pinnularia subgibba* var. *undulata* | | | | | | |
| *Pinnularia subrupestris* | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | |
| *Psammothidium bioretii* | | | | | | |
| *Psammothidium levanderi* | | | | | | |
| *Psammothidium subatomoides* | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | 28 | | 27 |
| *Semiorbis hemicyclus* | | | | | 4 | |
| *Stauroneis anceps* | | 7 | | 48 | 22 | 42 |
| *Stauroneis construens* | | | 7 | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | |
| *Stauroneis phoenocenteron* | | | | | 3 | |
| *Staurosira construens* | 3 | 29 | | 27 | | 24 |

| Taxa | | | | | | Interval |
|---|---|---|---|---|---|---|
| | **Frenchman-B** 16-16.5 cm | **Frenchman-T** 0-0.5 cm | **Frenchman-B** 16-16.5 cm | **Frog Pond-T** 0-0.5 cm | **Frog Pond-B** 25-25.5 cm | **Frog Pond-T** 0-0.5 cm |
| *Staurosirella pinnata* | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | |
| *Stenopterobia anceps* | | | | | | |
| *Stenopterobia curvula* | | | | 68 | | 67 |
| *Surirella amphioxis* | 2 | 7 | 4 | 9 | 4 | 7 |
| *Surirella angustua* | | | | 14 | | 12 |
| *Surirella cuspidata* | | | | | | |
| *Surirella linearis* | | 7 | 1 | | | |
| *Surirella pinnata* | | | | | | |
| *Surirella poss elegans* | | | | | | |
| *Surirella spendida* | | | | | | |
| *Tabellaria fenestrata* | 23 | | 18 | 13 | 19 | 12 |
| *Tabellaria flocculosa* strain III | 12 | 16 | 3 | 8 | | 4 |
| *Tabellaria flocculosa* strain IIIp | | | | | 4 | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | |
| *Tabellaria flocculosa* strain IV | 34 | 83 | 36 | 9 | 9 | 8 |
| *Tabellaria flocculosa* var. *linearis* | | 38 | | | | |
| *Tabellaria quadriseptata* | 18 | 38 | 12 | 47 | | 44 |
| *Tabellaria ventricosa* | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Frog Pond-B** 25-25.5 cm | **Frog Pond-T** 0-0.5 cm | **Frog Pond-B** 23-23.5 cm | **Kinsac-T** 0-0.5 cm | **Kinsac-B** 25-25.5 cm | **Lamont-T** 0-0.5 cm | **Lamont-B** 25-25.5 cm |
| *Achnanthes bahusiensis* | | | | | 2 | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | |
| *Achnanthes chlidanos* | | 14 | 7 | 4 | | 18 | 22 |
| *Achnanthes curtissima* | | | | 2 | 4 | 9 | 8 |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | | | | | | | |
| *Achnanthes stewartii* | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | 7 | | 9 | | | 3 | |
| *Amphora ovalis* | 5 | 7 | 6 | | 4 | 8 | |
| *Amphora pediculus* | | | | | | | |
| *Anomoenis brachysira* | | | | | | | |
| *Asterionella formosa* | | 7 | | | | 43 | 22 |
| *Asterionella ralfsii* var. *americana* | | | | | | | |
| *Aulacoseira ambigua* | | | | | 14 | | 53 |
| *Aulacoseira crassipunctata* | 74 | 43 | 78 | | | 16 | 18 |
| *Aulacoseira distans* | 87 | 28 | 76 | | 57 | 38 | 63 |
| *Aulacoseira distans* var. *nivalis* | | | | 12 | | | |
| *Aulacoseira granulata* | | | | | | | |
| *Aulacoseira italica* | | 27 | | | | | |
| *Aulacoseira lacustris* | | | | | | | 44 |
| *Aulacoseira lirata* | | | | | | 17 | 38 |
| *Aulacoseira nygaardii* | | | | | | | 19 |
| *Aulacoseira perglabra* | 42 | | 45 | | 15 | | |
| *Brachysira brebissonii* | | | | | | | |
| *Brachysira follis* | | | | | | | |
| *Brachysira intermedia* | | | | | | | |
| *Brachysira manfredii* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Frog Pond-B 25-25.5 cm | Frog Pond-T 0-0.5 cm | Frog Pond-B 23-23.5 cm | Kinsac-T 0-0.5 cm | Kinsac-B 25-25.5 cm | Lamont-T 0-0.5 cm | Lamont-B 25-25.5 cm |
| *Brachysira neoexilis* | | | | 8 | | | |
| *Brachysira poss procera* | | | | | | | |
| *Brachysira serians* | 42 | 7 | 34 | | 2 | | 3 |
| *Brachysira styriaca* | 2 | | 6 | | | | |
| *Caloneis bacillum* | | | | | | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | 34 | 14 | 42 | | | | |
| *Cavinula pseudoscutiformis* | | | | | | | |
| *Cocconeis poss neothumensis* | | 7 | | 4 | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | 31 | 64 |
| *Cyclotella bodanica* var. *lemanica* | | | | 24 | 38 | 123 | 19 |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | 19 | 76 | 33 | 32 | 55 | 12 | 39 |
| *Cymbella hungarica* | | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | | | | |
| *Cymbella* spp. | 9 | | 6 | | 14 | | |
| *Cymbopleura subcuspidata* | | 7 | | | | | 3 |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | | | | | |
| *Diatoma tenue* | | 38 | | | | 13 | |
| *Diploneis marginestriata* | | | | | | | |
| *Diploneis parma* | | | | | | | 14 |
| *Encyonema herbidicum* | 26 | | 23 | | | | |
| *Encyonema lunatum* | | 37 | | | | 16 | 12 |
| *Encyonema minutum* | 29 | 26 | 34 | | | | |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | | | | | | |
| *Eunotia arcus* | | 19 | | | 4 | 3 | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Frog Pond-B** | **Frog Pond-T** | **Frog Pond-B** | **Kinsac-T** | **Kinsac-B** | **Lamont-T** | **Lamont-B** |
| | 25-25.5 cm | 0-0.5 cm | 23-23.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Eunotia bidentula* | 34 | 4 | 32 | | | | |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | 23 | | | | | 2 |
| *Eunotia carolina* | | | | | | | |
| *Eunotia curvata* | | | | | | | |
| *Eunotia curvata f . bergii* | 7 | | 8 | | | | |
| *Eunotia elegans* | | | | | | | |
| *Eunotia exigua* | 63 | 58 | 66 | 14 | 42 | 12 | 14 |
| *Eunotia faba* | | | | | | | |
| *Eunotia fallax* | | | | | | | |
| *Eunotia flexulosa* | | 43 | | | 7 | | |
| *Eunotia flexulosa* (straight) | | | | | | | |
| *Eunotia formica* | 6 | | 7 | | | | |
| *Eunotia hexiglyphis* | 12 | | 17 | | | | |
| *Eunotia implicata* | | | | 14 | | | |
| *Eunotia incisa* | | 7 | | | 16 | 8 | 8 |
| *Eunotia intermediata* | | | | | | | |
| *Eunotia latriensis* | | | | | | | |
| *Eunotia major* | | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | 27 | 16 | 28 | | | | 18 |
| *Eunotia pectinalis* var. minor | 8 | | 13 | 12 | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | | 26 | | 23 |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | | | | | | |
| *Eunotia serra* | 9 | | 9 | | | | |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | | | | | | | |
| *Fragilaria brevistriata* | 17 | 42 | 18 | | | 19 | 13 |
| *Fragilaria capucina* | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | 7 | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | | 23 | 22 |
| *Fragilaria capucina* var. *gracilis* | | 12 | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Frog Pond-B 25-25.5 cm | Frog Pond-T 0-0.5 cm | Frog Pond-B 23-23.5 cm | Kinsac-T 0-0.5 cm | Kinsac-B 25-25.5 cm | Lamont-T 0-0.5 cm | Lamont-B 25-25.5 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | 33 | 23 | 52 | | | | |
| *Fragilaria elliptica (girdles)* | | 44 | | | | | |
| *Fragilaria oldenbergiana* | | | | | | | |
| *Fragilaria parasitica* | | | | | | | |
| *Fragilaria pinnata* | | | | | | | |
| *Fragilaria polygonata* | | | | | | | |
| *Fragilaria pulchella* | | | | | | | |
| *Fragilaria* spp. 5 | | | | | | | |
| *Fragilaria tenera* | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | | |
| *Fragilariforma constricta* | 32 | | 38 | | | 3 | |
| *Fragilariforma constricta f. stricta* | | | | | | | |
| *Fragilariforma exigua* | 7 | 56 | 5 | 1 | 15 | 12 | 13 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | |
| *Fragilariforma lata* | 57 | 77 | 44 | 28 | 14 | 22 | 18 |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | | | |
| *Frustulia rhomboides* | 44 | 38 | 36 | | 22 | 2 | 8 |
| *Frustulia saxonica* | 9 | 6 | 7 | | 7 | 3 | 3 |
| *Gomphonema acuminatum* | | 7 | | | | 2 | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | | | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | | | | | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | | | | | | |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Frog Pond-B 25-25.5 cm | Frog Pond-T 0-0.5 cm | Frog Pond-B 23-23.5 cm | Kinsac-T 0-0.5 cm | Kinsac-B 25-25.5 cm | Lamont-T 0-0.5 cm | Lamont-B 25-25.5 cm |
| *Melosira arentii* | 6 | | 7 | | | | |
| *Meridian circulare* | 6 | | 7 | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | | 17 | | 32 | | 3 | |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | |
| *Navicula impexa* | | | | | | | |
| *Navicula leptostriata* | | | | | | | |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | |
| *Navicula pseudolanceolata* | | | | | | | |
| *Navicula radiosa* | | | | 32 | | | |
| *Navicula schumassmanni* | | | | | | | |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | 6 | | 8 | 2 | | | 6 |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | |
| *Neidium densestriatum* | | | | | | | |
| *Neidium iridis* | | | | | | | |
| *Neidium poss holstii* | 38 | | 39 | | | | |
| *Nitzschia filiformis* | | | | | | | |
| *Nitzschia gracilis* | | | | 3 | | 4 | |
| *Nitzschia intermedia* | | | | | | | |
| *Nitzschia microcephala* | | | | | | | |
| *Nitzschia nana* | | | | | | | |
| *Nitzschia perminuta* | | | | 23 | | | |
| *Nitzschia recta* | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | |
| *Nitzschia vermicularis* | | | | | 2 | | |
| *Oxyneis binalis* | | | | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Frog Pond-B 25-25.5 cm | Frog Pond-T 0-0.5 cm | Frog Pond-B 23-23.5 cm | Kinsac-T 0-0.5 cm | Kinsac-B 25-25.5 cm | Lamont-T 0-0.5 cm | Lamont-B 25-25.5 cm |
| *Pinnularia biceps* | | | 2 | | | | |
| *Pinnularia brauniana* | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | 22 | | 22 | | | | |
| *Pinnularia divergens* | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | 33 | | 38 | | | | |
| *Pinnularia gibbiformis* | | | | | | | |
| *Pinnularia kwacksii* | 4 | | 6 | | | | |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | 7 | 28 | 8 | | 2 | | 3 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | 8 | | 9 | | | | |
| *Pinnularia polynoca* | | | | | | | |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | 25 | | 27 | | | | 4 |
| *Pinnularia subgibba* var. *undulata* | | | | | | | |
| *Pinnularia subrupestris* | | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | 28 | | | | | |
| *Semiorbis hemicyclus* | 8 | | 8 | 2 | 7 | | 2 |
| *Stauroneis anceps* | 22 | 39 | 24 | | 4 | | 4 |
| *Stauroneis construens* | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | |
| *Stauroneis phoenocenteron* | 7 | 3 | 8 | | | | |
| *Staurosira construens* | | 26 | | | | 18 | 23 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Frog Pond-B 25-25.5 cm | Frog Pond-T 0-0.5 cm | Frog Pond-B 23-23.5 cm | Kinsac-T 0-0.5 cm | Kinsac-B 25-25.5 cm | Lamont-T 0-0.5 cm | Lamont-B 25-25.5 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | | | | | | |
| *Stenopterobia curvula* | | 68 | | | | | |
| *Surirella amphioxis* | 6 | | 12 | | | 2 | 3 |
| *Surirella angustua* | | 22 | | | | 17 | |
| *Surirella cuspidata* | | | | | | | |
| *Surirella linearis* | | | | | | | |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | 22 | 26 | 24 | 12 | 64 | 38 | 42 |
| *Tabellaria flocculosa* strain III | | 7 | | 32 | 3 | 22 | 63 |
| *Tabellaria flocculosa* strain IIIp | 7 | | 7 | 42 | 44 | 7 | 14 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | 7 | 12 | 9 | | 5 | 33 | 22 |
| *Tabellaria flocculosa* var. *linearis* | | | | 24 | 24 | 64 | 73 |
| *Tabellaria quadriseptata* | | 38 | | | | 28 | 79 |
| *Tabellaria ventricosa* | | | | | | 52 | 22 |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Little Albro-T<br>0-0.5 cm | Little Albro-B<br>22-22.5 cm | Little Springfield -T<br>0-0.5 cm | Little Springfield -B<br>25-25.5 cm | Long-T<br>0-0.5 cm |
|---|---|---|---|---|---|
| *Achnanthes bahusiensis* | 23 | 22 | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | |
| *Achnanthes chlidanos* | 73 | 48 | | | |
| *Achnanthes curtissima* | 7 | | | | 4 |
| *Achnanthes impexiformis* | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | |
| *Achnanthes* spp. 3 | | | | | |
| *Achnanthes stewartii* | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | |
| *Achnanthidium minutissimum* | | | | | |
| *Actinella brasiliensis* | | | | | |
| *Actinella punctata* | 14 | | | 1 | 4 |
| *Amphora ovalis* | | 7 | | 16 | 3 |
| *Amphora pediculus* | | | | | |
| *Anomoenis brachysira* | | | | | |
| *Asterionella formosa* | 18 | | | 13 | 84 |
| *Asterionella ralfsii* var. *americana* | | | | | 24 |
| *Aulacoseira ambigua* | | | | | |
| *Aulacoseira crassipunctata* | | | | 33 | |
| *Aulacoseira distans* | 73 | 22 | | 64 | |
| *Aulacoseira distans* var. *nivalis* | | | | | |
| *Aulacoseira granulata* | | | | | |
| *Aulacoseira italica* | | | | | |
| *Aulacoseira lacustris* | | | | 24 | |
| *Aulacoseira lirata* | 18 | 18 | | 23 | |
| *Aulacoseira nygaardii* | | 4 | | | |
| *Aulacoseira perglabra* | 29 | | | 72 | |
| *Brachysira brebissonii* | 23 | 17 | 13 | | |
| *Brachysira follis* | | | | | |
| *Brachysira intermedia* | | | | | |
| *Brachysira manfredii* | | | | | |

| Taxa | Little Albro-T<br>0-0.5 cm | Little Albro-B<br>22-22.5 cm | Little Springfield -T<br>0-0.5 cm | Little Springfield -B<br>25-25.5 cm | Long-T<br>0-0.5 cm |
|---|---|---|---|---|---|
| *Brachysira neoexilis* | | 48 | | 8 | |
| *Brachysira poss procera* | | | | | |
| *Brachysira serians* | 35 | 62 | 13 | 4 | |
| *Brachysira styriaca* | 12 | 43 | | 4 | |
| *Caloneis bacillum* | | | | | |
| *Caloneis silicula* | | | | | |
| *Cavinula cocconeiformis* | 23 | | | | |
| *Cavinula pseudoscutiformis* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Chamaepinnularia bremensis* | | | | | |
| *Chamaepinnularia mediocris* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Craticula cuspidata* | | | | | |
| *Cyclotella bodanica* | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 26 | 18 | | | |
| *Cyclotella michiganiana* | | | | | |
| *Cyclotella stelligera* | 13 | 2 | 2 | 12 | |
| *Cymbella hungarica* | | | | | |
| *Cymbella incerta* | | 29 | | | |
| *Cymbella schubartoides* | | | | | |
| *Cymbella* spp. | 33 | 22 | | | 36 |
| *Cymbopleura subcuspidata* | | | | | |
| *Diatoma anceps* | | | | | |
| *Diatoma mesodon* | | | | | |
| *Diatoma tenue* | | 7 | | | |
| *Diploneis marginestriata* | 12 | | | | |
| *Diploneis parma* | 56 | | | | |
| *Encyonema herbidicum* | | | | | |
| *Encyonema lunatum* | | 49 | | | |
| *Encyonema minutum* | | | | | |
| *Encyonopsis cesatii* | | | | | |
| *Eucocconeis depressa* | | | | | |
| *Eunotia arcus* | 4 | 44 | | 1 | 4 |

| Taxa | Little Albro-T 0-0.5 cm | Little Albro-B 22-22.5 cm | Little Springfield -T 0-0.5 cm | Little Springfield -B 25-25.5 cm | Long-T 0-0.5 cm |
|---|---|---|---|---|---|
| *Eunotia bidentula* | | | 2 | 24 | |
| *Eunotia bigibba* | 12 | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | |
| *Eunotia carolina* | | | | | |
| *Eunotia curvata* | | | | | |
| *Eunotia curvata f . bergii* | | | | | |
| *Eunotia elegans* | | | | | |
| *Eunotia exigua* | 33 | 22 | 73 | 14 | 24 |
| *Eunotia faba* | | | | | |
| *Eunotia fallax* | | | | | 37 |
| *Eunotia flexulosa* | | | | | |
| *Eunotia flexulosa* (straight) | 9 | | | | |
| *Eunotia formica* | | | | 13 | |
| *Eunotia hexiglyphis* | | | 1 | 2 | |
| *Eunotia implicata* | | | | | 26 |
| *Eunotia incisa* | 38 | 38 | | | |
| *Eunotia intermediata* | | | | | |
| *Eunotia latriensis* | | | | 2 | |
| *Eunotia major* | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | 19 | 9 | | | |
| *Eunotia pectinalis* var. minor | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | 3 | | | |
| *Eunotia poss teineckii* | | | | | |
| *Eunotia praerupta* | | | | | |
| *Eunotia serra* | | | | | |
| *Eunotia serra* var. *tetrado* | | | | | |
| *Eunotia zasumensis* | | | | | |
| *Fragilaria brevistriata* | 63 | 13 | | | |
| *Fragilaria capucina* | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | |
| *Fragilaria capucina* var. *rumpens* | 38 | 14 | | | |
| *Fragilaria capucina* var. *gracilis* | 18 | 13 | | | |

| Taxa | Little Albro-T<br>0-0.5 cm | Little Albro-B<br>22-22.5 cm | Little Springfield -T<br>0-0.5 cm | Little Springfield -B<br>25-25.5 cm | Long-T<br>0-0.5 cm |
|---|---|---|---|---|---|
| *Fragilaria construens f. exigua* | | | | | |
| *Fragilaria elliptica* | 52 | | | | |
| *Fragilaria elliptica (girdles)* | | | | | |
| *Fragilaria oldenbergiana* | | | | | |
| *Fragilaria parasitica* | | | | | |
| *Fragilaria pinnata* | | | | | |
| *Fragilaria polygonata* | | | | | |
| *Fragilaria pulchella* | | | | | |
| *Fragilaria* spp. 5 | | | | | |
| *Fragilaria tenera* | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | |
| *Fragilariforma acidobiontica* | | | | | |
| *Fragilariforma constricta* | 29 | 22 | | | |
| *Fragilariforma constricta f. stricta* | | | | | |
| *Fragilariforma exigua* | 24 | 18 | 52 | 33 | 2 |
| *Fragilariforma exigua* (girdles) | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | |
| *Fragilariforma lata* | 32 | 7 | 23 | 12 | 44 |
| *Frustulia bahlsii* | | | | | |
| *Frustulia crassinervia* | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | |
| *Frustulia rhomboides* | 26 | 42 | 31 | 12 | 17 |
| *Frustulia saxonica* | 8 | 27 | 63 | 23 | 72 |
| *Gomphonema acuminatum* | | | | | |
| *Gomphonema angustatum* | | | | | |
| *Gomphonema gracile* | | | | | |
| *Gomphonema minutum* | | | | | |
| *Gomphonema parvulum* | | | | | |
| *Gomphonema truncatum* | | | | | |
| *Gyrosigma acuminatum* | | | | | |
| *Gyrosigma obscurum* | | | | | |
| *Hantzschia rhaetica* | | | | | |
| *Kobayasia subtillissima* | | | | | |

| Taxa | Little Albro-T 0-0.5 cm | Little Albro-B 22-22.5 cm | Little Springfield -T 0-0.5 cm | Little Springfield -B 25-25.5 cm | Long-T 0-0.5 cm |
|---|---|---|---|---|---|
| *Melosira arentii* | | | | | |
| *Meridian circulare* | | | | | |
| *Navicula constans* | | | | | |
| *Navicula cryptocephala* | | | | | |
| *Navicula expecta* | 41 | 8 | | | |
| *Navicula halophila* | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | |
| *Navicula impexa* | | | | | |
| *Navicula leptostriata* | 33 | 33 | | | |
| *Navicula lundi* | | | 2 | | |
| *Navicula poss bottnica* | | | | | |
| *Navicula pseudolanceolata* | | | | | |
| *Navicula radiosa* | | | | | |
| *Navicula schumassmanni* | | | | | |
| *Navicula stroemii* | | | | | |
| *Neidium affine* | | | | | |
| *Neidium bisulcatum* | | | | | |
| *Neidium bisulcatum* var. *baicalense* | 8 | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | |
| *Neidium densestriatum* | | | | | |
| *Neidium iridis* | | | | | |
| *Neidium poss holstii* | | 3 | | | |
| *Nitzschia filiformis* | | | | | |
| *Nitzschia gracilis* | 22 | 12 | | | |
| *Nitzschia intermedia* | | | | | |
| *Nitzschia microcephala* | | | | | |
| *Nitzschia nana* | | | | | |
| *Nitzschia perminuta* | | | | | |
| *Nitzschia recta* | | | | | |
| *Nitzschia suchlandtii* | | | | | |
| *Nitzschia vermicularis* | | | | | |
| *Oxyneis binalis* | | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | |

| Taxa | Little Albro-T<br>0-0.5 cm | Little Albro-B<br>22-22.5 cm | Little Springfield -T<br>0-0.5 cm | Little Springfield -B<br>25-25.5 cm | Long-T<br>0-0.5 cm |
|---|---|---|---|---|---|
| *Pinnularia biceps* | | | | | |
| *Pinnularia brauniana* | | | | | |
| *Pinnularia cardinalis* | 4 | | | | |
| *Pinnularia claviculiformes* | | | | | |
| *Pinnularia divergens* | | | | | 16 |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | |
| *Pinnularia gibba* | | | | | |
| *Pinnularia gibbiformis* | | | | | |
| *Pinnularia kwacksii* | | | | | |
| *Pinnularia legumen* | | | | | |
| *Pinnularia microstauron* | 17 | 4 | 21 | 23 | |
| *Pinnularia microstauron* var. *non fasciata* | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | |
| *Pinnularia nodosa* | | | | | |
| *Pinnularia polynoca* | | | | | |
| *Pinnularia silvatica* | | | | | |
| *Pinnularia subgibba* | 9 | 2 | | | |
| *Pinnularia subgibba* var. *undulata* | | | | | |
| *Pinnularia subrupestris* | | | | | |
| *Pinnularia viridiformis* var. morph I | 2 | 7 | | | |
| *Psammothidium bioretii* | | | | | |
| *Psammothidium levanderi* | | | | | |
| *Psammothidium subatomoides* | | | | | |
| *Pseudostaurosira brevistriata* | | | | | |
| *Pseudostaurosira parasitia* | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | |
| *Semiorbis hemicyclus* | | | | 33 | 35 |
| *Stauroneis anceps* | | 42 | | | |
| *Stauroneis construens* | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | |
| *Stauroneis phoenocenteron* | | 23 | | | |
| *Staurosira construens* | 29 | 8 | | | |

| Taxa | Little Albro-T<br>0-0.5 cm | Little Albro-B<br>22-22.5 cm | Little Springfield -T<br>0-0.5 cm | Little Springfield -B<br>25-25.5 cm | Long-T<br>0-0.5 cm |
|---|---|---|---|---|---|
| *Staurosirella pinnata* | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | |
| *Stenopterobia anceps* | | | | | |
| *Stenopterobia curvula* | 33 | 37 | | | |
| *Surirella amphioxis* | 26 | 12 | | 3 | |
| *Surirella angustua* | | | | | |
| *Surirella cuspidata* | | | | | |
| *Surirella linearis* | | | | | |
| *Surirella pinnata* | | | | | |
| *Surirella poss elegans* | | | | | |
| *Surirella spendida* | | | | 2 | |
| *Tabellaria fenestrata* | | 16 | 42 | 53 | 74 |
| *Tabellaria flocculosa* strain III | | | | | 48 |
| *Tabellaria flocculosa* strain IIIp | | | 33 | 12 | 57 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | |
| *Tabellaria flocculosa* strain IV | 73 | 63 | | | |
| *Tabellaria  flocculosa* var. *linearis* | | | | | |
| *Tabellaria quadriseptata* | 14 | 2 | | | 75 |
| *Tabellaria ventricosa* | | | | | |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Long-B** | **Loon-T** | **Loon-B** | **Major-T** | **Major-B** | **Maynards-T** | **Maynards-B** |
| | 25-25.5 cm | 0.5-1.0 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 20.5-21 cm |
| *Achnanthes bahusiensis* | | 12 | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | |
| *Achnanthes chlidanos* | | 53 | | 12 | 3 | 38 | 18 |
| *Achnanthes curtissima* | | 4 | 3 | | | 17 | 3 |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | | | | | | | |
| *Achnanthes stewartii* | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | 57 | | 24 | 47 | 19 | | 7 |
| *Amphora ovalis* | 13 | 23 | 4 | | | | 8 |
| *Amphora pediculus* | | | | | | | |
| *Anomoenis brachysira* | | | | | | | |
| *Asterionella formosa* | 74 | 36 | 33 | 29 | 8 | 11 | 3 |
| *Asterionella ralfsii* var. *americana* | | | | 42 | 33 | 22 | 12 |
| *Aulacoseira ambigua* | | 42 | 32 | 13 | 39 | | |
| *Aulacoseira crassipunctata* | 15 | | 43 | | | | |
| *Aulacoseira distans* | 24 | 33 | 4 | | 12 | 29 | 78 |
| *Aulacoseira distans* var. *nivalis* | | | | | | | |
| *Aulacoseira granulata* | | | | | | | |
| *Aulacoseira italica* | | | 7 | | | | |
| *Aulacoseira lacustris* | | | 13 | | | | |
| *Aulacoseira lirata* | | 3 | 12 | | 6 | 2 | 18 |
| *Aulacoseira nygaardii* | | 22 | 23 | | 2 | | |
| *Aulacoseira perglabra* | | | 4 | | | 22 | 16 |
| *Brachysira brebissonii* | | 2 | 3 | | 4 | 8 | 13 |
| *Brachysira follis* | | | | | | | |
| *Brachysira intermedia* | | | | | | | |
| *Brachysira manfredii* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Long-B | Loon-T | Loon-B | Major-T | Major-B | Maynards-T | Maynards-B |
| | 25-25.5 cm | 0.5-1.0 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 20.5-21 cm |
| *Brachysira neoexilis* | | | | | | | |
| *Brachysira poss procera* | | | | | | | |
| *Brachysira serians* | | 3 | 62 | 18 | 22 | 28 | 27 |
| *Brachysira styriaca* | | 12 | 33 | | 3 | 8 | 7 |
| *Caloneis bacillum* | | | | | | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | | 7 | 18 | 23 | 24 | 25 | 8 |
| *Cavinula pseudoscutiformis* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | 18 | 53 | | 18 | 93 | 6 |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | | 26 | 44 | 2 | 13 | 34 | 73 |
| *Cymbella hungarica* | | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | | | | |
| *Cymbella* spp. | | 23 | 12 | 3 | 14 | | |
| *Cymbopleura subcuspidata* | | | | | | | |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | | | | | |
| *Diatoma tenue* | | | | | 16 | 54 | |
| *Diploneis marginestriata* | | 123 | 3 | | | | 2 |
| *Diploneis parma* | | 64 | | | | | |
| *Encyonema herbidicum* | | | | | | | |
| *Encyonema lunatum* | | | 22 | 4 | | | |
| *Encyonema minutum* | | | | 2 | | | |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | | | | | | |
| *Eunotia arcus* | 14 | | 28 | | | | |

| Taxa | Interval | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | **Long-B** | **Loon-T** | **Loon-B** | **Major-T** | **Major-B** | **Maynards-T** | **Maynards-B** |
| | 25-25.5 cm | 0.5-1.0 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 20.5-21 cm |
| *Eunotia bidentula* | | | 8 | | 18 | | |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | 8 | 12 | | |
| *Eunotia carolina* | | | | | | | |
| *Eunotia curvata* | | | | | | | |
| *Eunotia curvata f . bergii* | | | | 28 | 8 | | |
| *Eunotia elegans* | | | 4 | | | 7 | |
| *Eunotia exigua* | | 14 | 43 | 28 | 33 | 12 | 32 |
| *Eunotia faba* | | | | | | | |
| *Eunotia fallax* | 15 | | | | | | |
| *Eunotia flexulosa* | | 8 | | | | | |
| *Eunotia flexulosa* (straight) | | | 28 | | | | |
| *Eunotia formica* | | 3 | | | | | |
| *Eunotia hexiglyphis* | | | | | | | 3 |
| *Eunotia implicata* | | | 9 | | 7 | | 23 |
| *Eunotia incisa* | | 33 | 32 | 12 | 22 | 4 | 12 |
| *Eunotia intermediata* | | | | | | | |
| *Eunotia latriensis* | | | | | | | |
| *Eunotia major* | | | | | | 9 | 13 |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | | 13 | 17 | 13 | 3 | 13 |
| *Eunotia pectinalis* var. minor | | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | 54 | | 3 | 33 | 19 | | |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | | | | | | |
| *Eunotia serra* | | | | | | 8 | 7 |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | | | | | | 28 | |
| *Fragilaria brevistriata* | | 33 | 3 | | 8 | 32 | 8 |
| *Fragilaria capucina* | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | 7 | | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | 9 | 19 | | |
| *Fragilaria capucina* var. *gracilis* | | 28 | | | | | |

| Taxa | Interval | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | **Long-B** | **Loon-T** | **Loon-B** | **Major-T** | **Major-B** | **Maynards-T** | **Maynards-B** |
| | 25-25.5 cm | 0.5-1.0 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 20.5-21 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | | |
| *Fragilaria oldenbergiana* | | | | | | 19 | |
| *Fragilaria parasitica* | | | | | | | |
| *Fragilaria pinnata* | | | | | | | |
| *Fragilaria polygonata* | | | | | | | |
| *Fragilaria pulchella* | | | | | | | |
| *Fragilaria* spp. 5 | | | | | | | |
| *Fragilaria tenera* | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | |
| *Fragilariforma acidobiontica* | | | | 32 | | | |
| *Fragilariforma constricta* | 11 | 3 | 4 | 3 | 13 | | |
| *Fragilariforma constricta f. stricta* | | | | | | | |
| *Fragilariforma exigua* | 14 | 22 | 9 | 18 | 13 | 22 | 12 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | |
| *Fragilariforma lata* | 21 | 2 | 6 | 7 | 24 | 3 | 3 |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | 73 | 6 | | |
| *Frustulia rhomboides* | 34 | 13 | 53 | 12 | 13 | 2 | 6 |
| *Frustulia saxonica* | 57 | 4 | 28 | 23 | 8 | 3 | 12 |
| *Gomphonema acuminatum* | | 4 | | | | 7 | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | | | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | | | | | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | 32 | | | | | |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Long-B** | **Loon-T** | **Loon-B** | **Major-T** | **Major-B** | **Maynards-T** | **Maynards-B** |
| | 25-25.5 cm | 0.5-1.0 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 20.5-21 cm |
| *Melosira arentii* | | | | | | | |
| *Meridian circulare* | | | | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | | 33 | | 3 | | 14 | |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | |
| *Navicula impexa* | | | | | | | |
| *Navicula leptostriata* | | 67 | 39 | 8 | | 32 | |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | |
| *Navicula pseudolanceolata* | 22 | | | | | | |
| *Navicula radiosa* | | | | | | | |
| *Navicula schumassmanni* | | | | | | | |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | 6 | | 2 |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | |
| *Neidium densestriatum* | | | | | | | |
| *Neidium iridis* | | | | | | | |
| *Neidium poss holstii* | | | | | | | |
| *Nitzschia filiformis* | | | | | | | |
| *Nitzschia gracilis* | | 54 | 13 | | | 36 | 4 |
| *Nitzschia intermedia* | | | | | | | |
| *Nitzschia microcephala* | | | | | | 18 | |
| *Nitzschia nana* | | | | | | | |
| *Nitzschia perminuta* | | | | | | | |
| *Nitzschia recta* | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | |
| *Nitzschia vermicularis* | | | | | | | |
| *Oxyneis binalis* | | | | 23 | | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Long-B | Loon-T | Loon-B | Major-T | Major-B | Maynards-T | Maynards-B |
| | 25-25.5 cm | 0.5-1.0 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 20.5-21 cm |
| *Pinnularia biceps* | | | | | | | |
| *Pinnularia brauniana* | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | |
| *Pinnularia divergens* | 11 | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | | | | | | | |
| *Pinnularia gibbiformis* | | | | | | | |
| *Pinnularia kwacksii* | 2 | | | | | 3 | |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | | | 3 | | | 4 | 2 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | | | | | | | |
| *Pinnularia polynoca* | | | | | | | |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | | | 8 | | | 8 | 3 |
| *Pinnularia subgibba* var. *undulata* | | | | | | | |
| *Pinnularia subrupestris* | | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | 4 | | | | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | |
| *Semiorbis hemicyclus* | 6 | | 17 | 48 | | | |
| *Stauroneis anceps* | | 33 | 43 | | 3 | 22 | 2 |
| *Stauroneis construens* | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | |
| *Stauroneis phoenocenteron* | | 12 | 23 | | | | |
| *Staurosira construens* | | 18 | 33 | | | 13 | 17 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Long-B | Loon-T | Loon-B | Major-T | Major-B | Maynards-T | Maynards-B |
| | 25-25.5 cm | 0.5-1.0 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 20.5-21 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | | | | | | |
| *Stenopterobia curvula* | | | | | | | |
| *Surirella amphioxis* | | 22 | 7 | | 2 | 7 | 8 |
| *Surirella angustua* | | | | | | | |
| *Surirella cuspidata* | | | | | | | |
| *Surirella linearis* | | | | | | | |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | 32 | 18 | 3 | 52 | 48 | 73 | 93 |
| *Tabellaria flocculosa* strain III | | 4 | 53 | 3 | 34 | 17 | 33 |
| *Tabellaria flocculosa* strain IIIp | 27 | 7 | 32 | 68 | 17 | 48 | 54 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | | 58 | 77 | 33 | 38 | 98 | 63 |
| *Tabellaria flocculosa* var. *linearis* | | | 34 | 33 | 63 | 38 | 82 |
| *Tabellaria quadriseptata* | 54 | 2 | 43 | 43 | 93 | 7 | 12 |
| *Tabellaria ventricosa* | | | | 38 | 13 | | |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **McCabe-T** | **McCabe-B** | **Mic Mac-T** | **Mic Mac-B** | **Miller-T** | **Miller-B** | **Oathill-T** | **Oathill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 21.5-22 cm |
| *Achnanthes bahusiensis* | | 3 | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | | |
| *Achnanthes chlidanos* | | 2 | | 2 | 19 | | | 18 |
| *Achnanthes curtissima* | 4 | | | | | | 21 | 6 |
| *Achnanthes impexiformis* | | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | | |
| *Achnanthes* spp. 3 | | | | | | | | |
| *Achnanthes stewartii* | | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | | |
| *Actinella brasiliensis* | | 4 | | | | | | |
| *Actinella punctata* | | | | | 18 | 12 | | |
| *Amphora ovalis* | | 18 | | | 2 | 9 | | 6 |
| *Amphora pediculus* | | | | | | | | |
| *Anomoenis brachysira* | | | | | | | | |
| *Asterionella formosa* | | | | | 23 | 18 | 93 | 93 |
| *Asterionella ralfsii* var. *americana* | | | | | | | | |
| *Aulacoseira ambigua* | 33 | | | | 54 | | | |
| *Aulacoseira crassipunctata* | 2 | 12 | | 11 | 38 | | | 6 |
| *Aulacoseira distans* | 34 | 4 | 4 | 1 | 9 | 18 | 32 | 43 |
| *Aulacoseira distans* var. *nivalis* | | | | | | | | |
| *Aulacoseira granulata* | | | | | | | | |
| *Aulacoseira italica* | | | | | | | | |
| *Aulacoseira lacustris* | | | | | 58 | | | |
| *Aulacoseira lirata* | 4 | 14 | 47 | 71 | 22 | 8 | | |
| *Aulacoseira nygaardii* | 2 | | | | 38 | | | 2 |
| *Aulacoseira perglabra* | | | | | 65 | | 8 | |
| *Brachysira brebissonii* | | | | | 12 | 17 | | 6 |
| *Brachysira follis* | | | | | | | | |
| *Brachysira intermedia* | | | | | | | | |
| *Brachysira manfredii* | | | | | | | | |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **McCabe-T** | **McCabe-B** | **Mic Mac-T** | **Mic Mac-B** | **Miller-T** | **Miller-B** | **Oathill-T** | **Oathill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 21.5-22 cm |
| *Brachysira neoexilis* | | | | | | | | |
| *Brachysira poss procera* | | | | | | | | |
| *Brachysira serians* | 2 | 13 | | | 4 | 42 | | 28 |
| *Brachysira styriaca* | | | | | 8 | 34 | | 38 |
| *Caloneis bacillum* | | | | | | | | |
| *Caloneis silicula* | | | | | | | | |
| *Cavinula cocconeiformis* | | | 6 | 4 | 11 | 8 | | |
| *Cavinula pseudoscutiformis* | | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | | |
| *Craticula cuspidata* | | | | | | | | |
| *Cyclotella bodanica* | | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | 3 | 17 | 44 | 4 | | 69 |
| *Cyclotella michiganiana* | | | | | | | | |
| *Cyclotella stelligera* | 56 | | 238 | 4 | 2 | 2 | | |
| *Cymbella hungarica* | | | | | | | | |
| *Cymbella incerta* | | | | | | | | |
| *Cymbella schubartoides* | | | | | | | | |
| *Cymbella* spp. | | | 2 | 7 | | | | |
| *Cymbopleura subcuspidata* | | | | | | | | |
| *Diatoma anceps* | | | | | | | | |
| *Diatoma mesodon* | | | | | | | | |
| *Diatoma tenue* | | | | | | | 13 | |
| *Diploneis marginestriata* | | | 28 | | 3 | 8 | | |
| *Diploneis parma* | | | 12 | 3 | 2 | 12 | | |
| *Encyonema herbidicum* | | | | | | | | |
| *Encyonema lunatum* | | | | | | | | |
| *Encyonema minutum* | | | | | | | | |
| *Encyonopsis cesatii* | | | | | | | | |
| *Eucocconeis depressa* | | | | | | | | |
| *Eunotia arcus* | | 2 | | | 15 | 12 | 3 | 3 |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **McCabe-T** | **McCabe-B** | **Mic Mac-T** | **Mic Mac-B** | **Miller-T** | **Miller-B** | **Oathill-T** | **Oathill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 21.5-22 cm |
| *Eunotia bidentula* | | | | | 6 | 2 | | 8 |
| *Eunotia bigibba* | | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | | | | |
| *Eunotia carolina* | | | | | | | | |
| *Eunotia curvata* | | | | | | | | |
| *Eunotia curvata f . bergii* | | | | | | 4 | | |
| *Eunotia elegans* | 7 | | | | 2 | 13 | | 7 |
| *Eunotia exigua* | 22 | 23 | 28 | 34 | 48 | 22 | 22 | 42 |
| *Eunotia faba* | | | | | | | | |
| *Eunotia fallax* | | | | | 38 | | | |
| *Eunotia flexulosa* | 7 | | 3 | 13 | | | 8 | 12 |
| *Eunotia flexulosa* (straight) | | | | | | 19 | | |
| *Eunotia formica* | | | 5 | 7 | 2 | 2 | | 2 |
| *Eunotia hexiglyphis* | | | | | 8 | 3 | | |
| *Eunotia implicata* | | | | | 32 | 52 | | |
| *Eunotia incisa* | | | | | | 12 | 6 | 13 |
| *Eunotia intermediata* | | | | | | | | |
| *Eunotia latriensis* | 6 | | | | | 4 | | |
| *Eunotia major* | 14 | 4 | | | | | 2 | |
| *Eunotia parallela* var. *parallela* | | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | | 2 | | 12 | 28 | 4 | 14 |
| *Eunotia pectinalis* var. minor | | | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | 14 | | 28 | | 8 |
| *Eunotia poss teineckii* | | | | | | | | |
| *Eunotia praerupta* | | | | | | | | |
| *Eunotia serra* | | | 4 | | | 14 | | |
| *Eunotia serra* var. *tetrado* | | | | | | | | |
| *Eunotia zasumensis* | | | | | | | | |
| *Fragilaria brevistriata* | | | | | 14 | | 33 | 42 |
| *Fragilaria capucina* | | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | | | 28 | |
| *Fragilaria capucina* var. *gracilis* | | | | | | | 52 | 17 |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **McCabe-T** | **McCabe-B** | **Mic Mac-T** | **Mic Mac-B** | **Miller-T** | **Miller-B** | **Oathill-T** | **Oathill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 21.5-22 cm |
| *Fragilaria construens f. exigua* | | | | | | | | |
| *Fragilaria elliptica* | | | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | | | |
| *Fragilaria oldenbergiana* | | | | 2 | | | | |
| *Fragilaria parasitica* | | | | | | | | |
| *Fragilaria pinnata* | | | | | | | | |
| *Fragilaria polygonata* | | | | | | | | |
| *Fragilaria pulchella* | | | | | | | | |
| *Fragilaria* spp. 5 | | | | 4 | | | | |
| *Fragilaria tenera* | | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | | | |
| *Fragilariforma constricta* | | | | | 12 | | 4 | 4 |
| *Fragilariforma constricta f. stricta* | | | | | | | | |
| *Fragilariforma exigua* | 13 | 13 | 26 | 29 | 32 | 22 | 8 | 6 |
| *Fragilariforma exigua* (girdles) | | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | | |
| *Fragilariforma lata* | 24 | 7 | 3 | 4 | 8 | 43 | | 8 |
| *Frustulia bahlsii* | | | | | | | | |
| *Frustulia crassinervia* | | | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | | | | |
| *Frustulia rhomboides* | | | | | 12 | 22 | | 4 |
| *Frustulia saxonica* | | | | | 13 | 56 | | 2 |
| *Gomphonema acuminatum* | | | | | 4 | 2 | | |
| *Gomphonema angustatum* | | | | | | | 4 | |
| *Gomphonema gracile* | | | | | | | | |
| *Gomphonema minutum* | | | | | | | | |
| *Gomphonema parvulum* | | | | | | | | |
| *Gomphonema truncatum* | | | | | | | | |
| *Gyrosigma acuminatum* | | | | | | | | |
| *Gyrosigma obscurum* | | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | | |
| *Kobayasia subtillissima* | 2 | | | | | | | |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **McCabe-T** | **McCabe-B** | **Mic Mac-T** | **Mic Mac-B** | **Miller-T** | **Miller-B** | **Oathill-T** | **Oathill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 21.5-22 cm |
| *Melosira arentii* | | | | 2 | | | | |
| *Meridian circulare* | | | | | | | | |
| *Navicula constans* | | | | | | | | |
| *Navicula cryptocephala* | | | | | | | | |
| *Navicula expecta* | | | 14 | | 12 | | 4 | |
| *Navicula halophila* | | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | | |
| *Navicula impexa* | | | | | | | | |
| *Navicula leptostriata* | | | | | 22 | | 28 | 3 |
| *Navicula lundi* | | | | | | | | |
| *Navicula poss bottnica* | | | | | | | | |
| *Navicula pseudolanceolata* | 2 | | 1 | | | | | |
| *Navicula radiosa* | | | | | | | | |
| *Navicula schumassmanni* | | | | | | | | |
| *Navicula stroemii* | | | | | | | | |
| *Neidium affine* | | | | | | | | |
| *Neidium bisulcatum* | | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | 9 | 18 | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | | |
| *Neidium densestriatum* | | | | | | | | |
| *Neidium iridis* | | | | | | | | |
| *Neidium poss holstii* | 4 | | | | 8 | 6 | | |
| *Nitzschia filiformis* | | | | | | | | |
| *Nitzschia gracilis* | | | | | | 9 | 16 | |
| *Nitzschia intermedia* | | | | | | | | |
| *Nitzschia microcephala* | | | | | | | | |
| *Nitzschia nana* | | | | | | | | |
| *Nitzschia perminuta* | | | | | | | | |
| *Nitzschia recta* | | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | | |
| *Nitzschia vermicularis* | | | | | | | | |
| *Oxyneis binalis* | 4 | | | | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | | |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **McCabe-T** | **McCabe-B** | **Mic Mac-T** | **Mic Mac-B** | **Miller-T** | **Miller-B** | **Oathill-T** | **Oathill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 21.5-22 cm |
| *Pinnularia biceps* | | 4 | | | 18 | 7 | | |
| *Pinnularia brauniana* | | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | | 4 |
| *Pinnularia divergens* | | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | | |
| *Pinnularia gibba* | | | | | | | | |
| *Pinnularia gibbiformis* | | | | | | | | |
| *Pinnularia kwacksii* | | | | | | 4 | | |
| *Pinnularia legumen* | | | | | | | | |
| *Pinnularia microstauron* | | 4 | | | 6 | 22 | | |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | | |
| *Pinnularia nodosa* | | | | | | | | |
| *Pinnularia polynoca* | | | | | | | | |
| *Pinnularia silvatica* | | | | | | | | |
| *Pinnularia subgibba* | | | 9 | 21 | 12 | 13 | 3 | 12 |
| *Pinnularia subgibba* var. *undulata* | | | | | | | | |
| *Pinnularia subrupestris* | | | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | | | |
| *Psammothidium bioretii* | | | | | | | | |
| *Psammothidium levanderi* | | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | | |
| *Semiorbis hemicyclus* | 3 | 4 | 5 | 3 | 28 | 28 | | |
| *Stauroneis anceps* | | | | 2 | 12 | 6 | 9 | |
| *Stauroneis construens* | | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | | |
| *Stauroneis phoenocenteron* | | | | 3 | 8 | | 7 | |
| *Staurosira construens* | | | | | 14 | 64 | | 29 |

| Taxa | Interval | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **McCabe-T** | **McCabe-B** | **Mic Mac-T** | **Mic Mac-B** | **Miller-T** | **Miller-B** | **Oathill-T** | **Oathill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 21.5-22 cm |
| *Staurosirella pinnata* | | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | 4 | | | | | | |
| *Stenopterobia anceps* | | | | | | | | |
| *Stenopterobia curvula* | | 4 | | | | | | |
| *Surirella amphioxis* | | 4 | | | 22 | 8 | | |
| *Surirella angustua* | | | | | | | | |
| *Surirella cuspidata* | | | | | | | | |
| *Surirella linearis* | | | 4 | | 8 | | | |
| *Surirella pinnata* | | | | | | | | |
| *Surirella poss elegans* | | | | | | | | |
| *Surirella spendida* | | | | | | | | |
| *Tabellaria fenestrata* | 164 | 3 | 7 | 24 | 14 | 3 | 9 | |
| *Tabellaria flocculosa* strain III | | | | | 52 | 82 | | |
| *Tabellaria flocculosa* strain IIIp | 74 | 113 | | | 2 | | | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | | |
| *Tabellaria flocculosa* strain IV | | 43 | | | 13 | 157 | | 62 |
| *Tabellaria flocculosa* var. *linearis* | | 52 | | | 48 | 34 | | |
| *Tabellaria quadriseptata* | | | | | 134 | 29 | | |
| *Tabellaria ventricosa* | | | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Penhorn-T** 0-0.5 cm | **Penhorn-B** 17.5-18 cm | **Powder Mill-T** 0-0.5 cm | **Powder Mill-B** 22-22.5 cm | **Power Pond-T** 0-0.5 cm | **Power Pond-B** 25-25.5 cm |
| *Achnanthes bahusiensis* | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | |
| *Achnanthes chlidanos* | 12 | 3 | 22 | 18 | 12 | 42 |
| *Achnanthes curtissima* | 3 | 4 | | 12 | | |
| *Achnanthes impexiformis* | | | 8 | | | 4 |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | |
| *Achnanthes* spp. 3 | | | | | | |
| *Achnanthes stewartii* | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | 2 | |
| *Achnanthidium minutissimum* | | | | | | |
| *Actinella brasiliensis* | | | | | | |
| *Actinella punctata* | 9 | | | 2 | 64 | 22 |
| *Amphora ovalis* | 4 | 4 | 12 | 22 | 7 | 1 |
| *Amphora pediculus* | | | | | | |
| *Anomoenis brachysira* | | | | | | |
| *Asterionella formosa* | 132 | 2 | 23 | 24 | | |
| *Asterionella ralfsii* var. *americana* | | | 4 | | 17 | |
| *Aulacoseira ambigua* | | | 42 | 28 | | |
| *Aulacoseira crassipunctata* | | 54 | 18 | 21 | 94 | 17 |
| *Aulacoseira distans* | 7 | 84 | 13 | 72 | 9 | 32 |
| *Aulacoseira distans* var. *nivalis* | | | | | 17 | |
| *Aulacoseira granulata* | | | | | | |
| *Aulacoseira italica* | | | | | | |
| *Aulacoseira lacustris* | | | | 32 | 19 | |
| *Aulacoseira lirata* | | 38 | 6 | 18 | | 1 |
| *Aulacoseira nygaardii* | | | 17 | 48 | | 24 |
| *Aulacoseira perglabra* | | 32 | | 93 | 6 | 7 |
| *Brachysira brebissonii* | | | 4 | 3 | | |
| *Brachysira follis* | | | | | | |
| *Brachysira intermedia* | | | | | | |
| *Brachysira manfredii* | | | | | 4 | 2 |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | Penhorn-T | Penhorn-B | Powder Mill-T | Powder Mill-B | Power Pond-T | Power Pond-B |
| | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Brachysira neoexilis* | | | | | | |
| *Brachysira poss procera* | | | | | | |
| *Brachysira serians* | | | | 1 | | |
| *Brachysira styriaca* | | | | 4 | 8 | 12 |
| *Caloneis bacillum* | | | | | | |
| *Caloneis silicula* | | | | | 1 | |
| *Cavinula cocconeiformis* | 2 | 28 | 3 | 28 | 39 | 8 |
| *Cavinula pseudoscutiformis* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Craticula cuspidata* | | | 12 | | | |
| *Cyclotella bodanica* | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | 98 | 83 | 42 | | |
| *Cyclotella michiganiana* | | | | | | |
| *Cyclotella stelligera* | 13 | 76 | 27 | 23 | | |
| *Cymbella hungarica* | | | | | | |
| *Cymbella incerta* | | | | | | |
| *Cymbella schubartoides* | | | | | | |
| *Cymbella* spp. | | 22 | 18 | 12 | | 7 |
| *Cymbopleura subcuspidata* | | | 2 | | | |
| *Diatoma anceps* | | | | | | |
| *Diatoma mesodon* | | | | | | |
| *Diatoma tenue* | 68 | | | | | |
| *Diploneis marginestriata* | | | 12 | 2 | | |
| *Diploneis parma* | 2 | | 68 | 11 | | |
| *Encyonema herbidicum* | | | | | | |
| *Encyonema lunatum* | | | | | | |
| *Encyonema minutum* | | | | | | |
| *Encyonopsis cesatii* | | | | | | |
| *Eucocconeis depressa* | | | | | | |
| *Eunotia arcus* | 2 | 44 | 13 | 2 | | 7 |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | Penhorn-T | Penhorn-B | Powder Mill-T | Powder Mill-B | Power Pond-T | Power Pond-B |
| | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Eunotia bidentula* | | | 24 | | | 34 |
| *Eunotia bigibba* | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | | |
| *Eunotia carolina* | | | | | | |
| *Eunotia curvata* | | | | | | |
| *Eunotia curvata f . bergii* | | | 4 | | 22 | 8 |
| *Eunotia elegans* | | 2 | 12 | 13 | | |
| *Eunotia exigua* | 3 | 23 | 38 | 14 | | 4 |
| *Eunotia faba* | | | | | | |
| *Eunotia fallax* | | | | | | |
| *Eunotia flexulosa* | | 7 | 19 | 7 | | |
| *Eunotia flexulosa* (straight) | | 53 | | | | |
| *Eunotia formica* | 9 | 4 | | | | 7 |
| *Eunotia hexiglyphis* | | 2 | | | | |
| *Eunotia implicata* | | | 4 | 24 | | 7 |
| *Eunotia incisa* | | | | 8 | | |
| *Eunotia intermediata* | | | | | 34 | |
| *Eunotia latriensis* | | 18 | 2 | | | |
| *Eunotia major* | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | 12 | 28 | 22 | 82 | 13 |
| *Eunotia pectinalis* var. minor | | | | | 44 | |
| *Eunotia pectinais* var. *ventricosa* | | | | 18 | 6 | 32 |
| *Eunotia poss teineckii* | | | | | | |
| *Eunotia praerupta* | | | | | 12 | |
| *Eunotia serra* | | | | | 4 | |
| *Eunotia serra* var. *tetrado* | | | | | | |
| *Eunotia zasumensis* | | | | | | |
| *Fragilaria brevistriata* | 32 | 38 | 29 | 22 | | |
| *Fragilaria capucina* | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | | |
| *Fragilaria capucina* var. *rumpens* | 12 | | | | 4 | |
| *Fragilaria capucina* var. *gracilis* | 42 | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Penhorn-T** 0-0.5 cm | **Penhorn-B** 17.5-18 cm | **Powder Mill-T** 0-0.5 cm | **Powder Mill-B** 22-22.5 cm | **Power Pond-T** 0-0.5 cm | **Power Pond-B** 25-25.5 cm |
| *Fragilaria construens f. exigua* | | | | | | |
| *Fragilaria elliptica* | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | |
| *Fragilaria oldenbergiana* | | | | | | 7 |
| *Fragilaria parasitica* | | | | | | |
| *Fragilaria pinnata* | | | | | | |
| *Fragilaria polygonata* | | | | | 12 | 22 |
| *Fragilaria pulchella* | | | | | | |
| *Fragilaria* spp. 5 | | | | | | 2 |
| *Fragilaria tenera* | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | |
| *Fragilariforma constricta* | | | | | | 27 |
| *Fragilariforma constricta f. stricta* | | | | | | |
| *Fragilariforma exigua* | 2 | 7 | 38 | 43 | 117 | 4 |
| *Fragilariforma exigua* (girdles) | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | 33 | | 34 |
| *Fragilariforma lata* | | 22 | 22 | 15 | 165 | 93 |
| *Frustulia bahlsii* | | | | | | |
| *Frustulia crassinervia* | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | | |
| *Frustulia rhomboides* | | 2 | 9 | 2 | 14 | 26 |
| *Frustulia saxonica* | | 3 | 18 | 8 | | |
| *Gomphonema acuminatum* | | | 3 | 4 | | |
| *Gomphonema angustatum* | | | | | | |
| *Gomphonema gracile* | | | | | | |
| *Gomphonema minutum* | | | | | | |
| *Gomphonema parvulum* | | | | | | |
| *Gomphonema truncatum* | | | | | | |
| *Gyrosigma acuminatum* | | | | | | |
| *Gyrosigma obscurum* | | | | | | |
| *Hantzschia rhaetica* | | | | | | |
| *Kobayasia subtillissima* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | Penhorn-T | Penhorn-B | Powder Mill-T | Powder Mill-B | Power Pond-T | Power Pond-B |
| | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Melosira arentii* | | | | | | |
| *Meridian circulare* | | | | | | |
| *Navicula constans* | | | | | | |
| *Navicula cryptocephala* | | | | | | |
| *Navicula expecta* | 3 | 3 | 3 | 17 | 2 | |
| *Navicula halophila* | | | 4 | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | |
| *Navicula impexa* | | | | | | |
| *Navicula leptostriata* | 22 | 22 | 28 | 12 | 2 | 7 |
| *Navicula lundi* | | | | | | |
| *Navicula poss bottnica* | | | | | | |
| *Navicula pseudolanceolata* | | | | | | |
| *Navicula radiosa* | | | | | | |
| *Navicula schumassmanni* | | | | | | |
| *Navicula stroemii* | | | | | | |
| *Neidium affine* | | | | | | |
| *Neidium bisulcatum* | | | | | 2 | 7 |
| *Neidium bisulcatum* var. *baicalense* | | 2 | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | |
| *Neidium densestriatum* | | | | | | |
| *Neidium iridis* | | | | | 6 | 2 |
| *Neidium poss holstii* | | | | | | |
| *Nitzschia filiformis* | | | | | | |
| *Nitzschia gracilis* | | 3 | 12 | 8 | 2 | 7 |
| *Nitzschia intermedia* | | | | | | |
| *Nitzschia microcephala* | | | | | | |
| *Nitzschia nana* | | | | | | |
| *Nitzschia perminuta* | | | | | | |
| *Nitzschia recta* | | | | | | |
| *Nitzschia suchlandtii* | | | | | | |
| *Nitzschia vermicularis* | | | | | | |
| *Oxyneis binalis* | | | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | 3 | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | Penhorn-T | Penhorn-B | Powder Mill-T | Powder Mill-B | Power Pond-T | Power Pond-B |
| | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Pinnularia biceps* | | 32 | | | | |
| *Pinnularia brauniana* | | | | | | |
| *Pinnularia cardinalis* | | | 2 | | | |
| *Pinnularia claviculiformes* | | | 18 | | | |
| *Pinnularia divergens* | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | |
| *Pinnularia gibba* | | | | | 7 | 12 |
| *Pinnularia gibbiformis* | | | | | | |
| *Pinnularia kwacksii* | | | | 8 | | |
| *Pinnularia legumen* | | | | | | |
| *Pinnularia microstauron* | 2 | 7 | 3 | 8 | | |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | |
| *Pinnularia nodosa* | | | | | | |
| *Pinnularia polynoca* | | | | | | |
| *Pinnularia silvatica* | | | 8 | | | |
| *Pinnularia subgibba* | 3 | 8 | 24 | 22 | | |
| *Pinnularia subgibba* var. *undulata* | | | | | | |
| *Pinnularia subrupestris* | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | |
| *Psammothidium bioretii* | | | | | | |
| *Psammothidium levanderi* | | | | | | |
| *Psammothidium subatomoides* | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | |
| *Semiorbis hemicyclus* | | 4 | | 7 | | |
| *Stauroneis anceps* | 16 | 12 | 28 | | | |
| *Stauroneis construens* | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | |
| *Stauroneis phoenocenteron* | 7 | 23 | 4 | 24 | | |
| *Staurosira construens* | 23 | 4 | 44 | 34 | 7 | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Penhorn-T** | **Penhorn-B** | **Powder Mill-T** | **Powder Mill-B** | **Power Pond-T** | **Power Pond-B** |
| | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Staurosirella pinnata* | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | |
| *Stenopterobia anceps* | 2 | | | 38 | | |
| *Stenopterobia curvula* | | | | | | |
| *Surirella amphioxis* | | | 5 | 3 | 22 | 7 |
| *Surirella angustua* | | | | | | |
| *Surirella cuspidata* | | | | | | |
| *Surirella linearis* | | | 9 | | | |
| *Surirella pinnata* | | | | | | |
| *Surirella poss elegans* | | | 12 | | | |
| *Surirella spendida* | | | | | | |
| *Tabellaria fenestrata* | | 14 | | 12 | 34 | 54 |
| *Tabellaria flocculosa* strain III | | 3 | 39 | 23 | 117 | 33 |
| *Tabellaria flocculosa* strain IIIp | | 58 | | 14 | | 38 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | |
| *Tabellaria flocculosa* strain IV | 82 | 23 | | | 68 | 52 |
| *Tabellaria flocculosa* var. *linearis* | | 22 | 18 | 47 | | |
| *Tabellaria quadriseptata* | | 12 | 22 | 26 | 62 | 119 |
| *Tabellaria ventricosa* | | | | | | |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Rocky-T** | **Rocky-B** | **Sandy-T** | **Sandy-B** | **Second-T** | **Second-B** | **Second Chain-T** |
| | 0-0.5 cm | 19-19.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm |
| *Achnanthes bahusiensis* | | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | |
| *Achnanthes chlidanos* | 12 | 12 | 42 | 24 | 32 | 11 | 18 |
| *Achnanthes curtissima* | | | 2 | | | | 8 |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | | | 4 | | | | |
| *Achnanthes stewartii* | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | | 28 | 13 | 32 | | | 26 |
| *Amphora ovalis* | 28 | 19 | | | | 4 | |
| *Amphora pediculus* | | | | | | | |
| *Anomoenis brachysira* | | | | | | | |
| *Asterionella formosa* | 32 | 7 | 21 | 24 | 48 | 22 | |
| *Asterionella ralfsii* var. *americana* | | | 32 | 62 | 8 | | 43 |
| *Aulacoseira ambigua* | | | 18 | 22 | | 58 | |
| *Aulacoseira crassipunctata* | 4 | 13 | 73 | 83 | | 32 | 7 |
| *Aulacoseira distans* | 44 | 62 | 52 | 2 | 22 | 53 | 4 |
| *Aulacoseira distans* var. *nivalis* | | | | | | | |
| *Aulacoseira granulata* | | | | | | | |
| *Aulacoseira italica* | | 22 | | | | | |
| *Aulacoseira lacustris* | | 32 | | | | | |
| *Aulacoseira lirata* | 13 | 2 | | | 4 | | 1 |
| *Aulacoseira nygaardii* | | 32 | | 3 | | 4 | 6 |
| *Aulacoseira perglabra* | | 26 | 12 | 12 | | 72 | |
| *Brachysira brebissonii* | 7 | 7 | | | 8 | 22 | 13 |
| *Brachysira follis* | | | | | | 18 | |
| *Brachysira intermedia* | | | 3 | | | | |
| *Brachysira manfredii* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Rocky-T** | **Rocky-B** | **Sandy-T** | **Sandy-B** | **Second-T** | **Second-B** | **Second Chain-T** |
| | 0-0.5 cm | 19-19.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm |
| *Brachysira neoexilis* | | | 2 | | | | |
| *Brachysira poss procera* | | | | | | | |
| *Brachysira serians* | 3 | 12 | 62 | 55 | | | 14 |
| *Brachysira styriaca* | | | 23 | 15 | | | 17 |
| *Caloneis bacillum* | | | | | | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | 7 | 14 | | | 11 | 42 | |
| *Cavinula pseudoscutiformis* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 33 | 23 | 5 | 7 | 62 | 66 | |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | 52 | 27 | 62 | 12 | 113 | 17 | |
| *Cymbella hungarica* | | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | | | | |
| *Cymbella* spp. | | | 2 | | | | |
| *Cymbopleura subcuspidata* | | | | | | | |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | | | | | |
| *Diatoma tenue* | 134 | | | | | | |
| *Diploneis marginestriata* | 88 | 3 | | | | | |
| *Diploneis parma* | 53 | | | | | | |
| *Encyonema herbidicum* | | | | | | | |
| *Encyonema lunatum* | | | 22 | 12 | | | |
| *Encyonema minutum* | | | 12 | 27 | | | |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | | | | | | |
| *Eunotia arcus* | | | | | | 2 | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Rocky-T | Rocky-B | Sandy-T | Sandy-B | Second-T | Second-B | Second Chain-T |
| | 0-0.5 cm | 19-19.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm |
| *Eunotia bidentula* | | | 2 | 12 | | | |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | 6 | | |
| *Eunotia carolina* | | | | | 17 | 2 | |
| *Eunotia curvata* | | | 7 | | | | 2 |
| *Eunotia curvata f . bergii* | | 37 | | | | 3 | |
| *Eunotia elegans* | 2 | 18 | 42 | 42 | | | 64 |
| *Eunotia exigua* | 4 | 26 | 34 | 9 | | 4 | 87 |
| *Eunotia faba* | | | | 38 | | | |
| *Eunotia fallax* | | | | | | | |
| *Eunotia flexulosa* | 17 | | | | 2 | | |
| *Eunotia flexulosa* (straight) | | 23 | 28 | 64 | 9 | 18 | |
| *Eunotia formica* | | | 3 | 2 | | | |
| *Eunotia hexiglyphis* | | | 12 | 13 | | | |
| *Eunotia implicata* | 24 | 68 | | | | | |
| *Eunotia incisa* | | | 4 | 16 | | | 35 |
| *Eunotia intermediata* | | | | | | 18 | 17 |
| *Eunotia latriensis* | | | | | | | |
| *Eunotia major* | | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | 8 | 32 | | 42 | | | 14 |
| *Eunotia pectinalis* var. minor | | | 28 | 2 | | | |
| *Eunotia pectinais* var. *ventricosa* | 16 | | | | 4 | 33 | |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | | | | | | |
| *Eunotia serra* | | 24 | 12 | 18 | | 2 | |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | | | | | | | 8 |
| *Fragilaria brevistriata* | 4 | 39 | | 37 | 3 | 13 | |
| *Fragilaria capucina* | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | | | |
| *Fragilaria capucina* var. *rumpens* | 32 | | | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Rocky-T** | **Rocky-B** | **Sandy-T** | **Sandy-B** | **Second-T** | **Second-B** | **Second Chain-T** |
| | 0-0.5 cm | 19-19.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | | |
| *Fragilaria oldenbergiana* | 12 | | | | | | |
| *Fragilaria parasitica* | | | | | 12 | | |
| *Fragilaria pinnata* | | | 26 | 22 | | | |
| *Fragilaria polygonata* | | | | | | | |
| *Fragilaria pulchella* | | | | | | | |
| *Fragilaria* spp. 5 | | | | | 3 | | |
| *Fragilaria tenera* | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | | 67 |
| *Fragilariforma constricta* | 8 | 18 | | 12 | 8 | 2 | |
| *Fragilariforma constricta f. stricta* | | | | | | | |
| *Fragilariforma exigua* | 18 | 13 | 42 | 46 | 4 | 8 | 7 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | |
| *Fragilariforma lata* | 33 | 22 | 13 | 22 | 12 | 12 | 44 |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | | | 22 |
| *Frustulia rhomboides* | 2 | 7 | 32 | 26 | | 3 | 32 |
| *Frustulia saxonica* | 4 | 13 | 8 | 2 | | 7 | 54 |
| *Gomphonema acuminatum* | 7 | | | | | | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | | | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | | | | | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | | | | | | 1 |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Rocky-T<br>0-0.5 cm | Rocky-B<br>19-19.5 cm | Sandy-T<br>0-0.5 cm | Sandy-B<br>16-16.5 cm | Second-T<br>0-0.5 cm | Second-B<br>23.5-24 cm | Second Chain-T<br>0-0.5 cm |
| *Melosira arentii* | | | | | | 4 | |
| *Meridian circulare* | | | | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | 27 | | 24 | 8 | | 2 | |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | |
| *Navicula impexa* | | | | | | | |
| *Navicula leptostriata* | 42 | 22 | 12 | | 4 | 13 | |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | |
| *Navicula pseudolanceolata* | | | | | | | |
| *Navicula radiosa* | | | | | 3 | | |
| *Navicula schumassmanni* | | | | | | | 2 |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | 14 |
| *Neidium bisulcatum* var. *baicalense* | | | | | | 2 | 4 |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | 7 | | |
| *Neidium densestriatum* | | | | | | 6 | |
| *Neidium iridis* | | | | | | | |
| *Neidium poss holstii* | | | | | 4 | 4 | 7 |
| *Nitzschia filiformis* | | | | | | | |
| *Nitzschia gracilis* | 4 | | 4 | 4 | 32 | 4 | |
| *Nitzschia intermedia* | | | | | | | 8 |
| *Nitzschia microcephala* | | | 3 | | | | |
| *Nitzschia nana* | | | | | | | |
| *Nitzschia perminuta* | | | | | 7 | 3 | |
| *Nitzschia recta* | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | |
| *Nitzschia vermicularis* | | | | | | | |
| *Oxyneis binalis* | | | 28 | 26 | | | 12 |
| *Pinnularia archospaeria* var. *turgidula* | | | | | 2 | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Rocky-T | Rocky-B | Sandy-T | Sandy-B | Second-T | Second-B | Second Chain-T |
| | 0-0.5 cm | 19-19.5 cm | 0-0.5 cm | 16-16.5 cm | 0-0.5 cm | 23.5-24 cm | 0-0.5 cm |
| *Pinnularia biceps* | | | | | | | |
| *Pinnularia brauniana* | | | | | | 8 | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | |
| *Pinnularia divergens* | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | | | | | 4 | | |
| *Pinnularia gibbiformis* | | | | | | | |
| *Pinnularia kwacksii* | | | | | | | |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | | 16 | | 6 | | | 52 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | 6 | | | | | | |
| *Pinnularia polynoca* | | | | | | | |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | | | 4 | 2 | | 6 | 4 |
| *Pinnularia subgibba* var. *undulata* | | | | | | | 4 |
| *Pinnularia subrupestris* | | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | |
| *Semiorbis hemicyclus* | | 13 | 36 | 42 | | 3 | 6 |
| *Stauroneis anceps* | 18 | 72 | | 26 | 22 | 2 | |
| *Stauroneis construens* | | | 32 | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | |
| *Stauroneis phoenocenteron* | | 8 | | | 17 | 3 | |
| *Staurosira construens* | 32 | 42 | | 24 | 18 | 38 | 7 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Rocky-T<br>0-0.5 cm | Rocky-B<br>19-19.5 cm | Sandy-T<br>0-0.5 cm | Sandy-B<br>16-16.5 cm | Second-T<br>0-0.5 cm | Second-B<br>23.5-24 cm | Second Chain-T<br>0-0.5 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | | | | | | |
| *Stenopterobia curvula* | | | | | | | 4 |
| *Surirella amphioxis* | | 6 | 1 | 12 | | 2 | 44 |
| *Surirella angustua* | | | | | | | |
| *Surirella cuspidata* | | | | | | | 52 |
| *Surirella linearis* | 4 | | 4 | 18 | 4 | 3 | |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | | 32 | 22 | 36 | | | 23 |
| *Tabellaria flocculosa* strain III | 56 | 31 | 87 | 54 | 2 | | |
| *Tabellaria flocculosa* strain IIIp | | | 51 | 82 | | 1 | 4 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | | | 42 | 42 | | | |
| *Tabellaria flocculosa* var. *linearis* | 38 | 36 | 78 | 132 | 32 | 58 | 22 |
| *Tabellaria quadriseptata* | 27 | 66 | 48 | 44 | 18 | 29 | 43 |
| *Tabellaria ventricosa* | | | | | | | |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Second Chain-B** | **Second Chain-T** | **Second Chain-B** | **Second Chain-T** | **Second Chain-B** |
| | 25-25.5 cm | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 24.5-25 cm |
| *Achnanthes bahusiensis* | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | |
| *Achnanthes chlidanos* | 22 | 22 | 32 | 28 | 38 |
| *Achnanthes curtissima* | 11 | 6 | 17 | 8 | 9 |
| *Achnanthes impexiformis* | 14 | | 18 | | 17 |
| *Achnanthes minutissima* var. *inconspicud* | | | | | |
| *Achnanthes* spp. 3 | | | | | |
| *Achnanthes stewartii* | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | |
| *Achnanthidium minutissimum* | | | | | |
| *Actinella brasiliensis* | | | | | |
| *Actinella punctata* | 57 | 18 | 42 | 25 | 43 |
| *Amphora ovalis* | | | | | |
| *Amphora pediculus* | | | | | |
| *Anomoenis brachysira* | | | | | |
| *Asterionella formosa* | 7 | | 27 | | 29 |
| *Asterionella ralfsii* var. *americana* | 47 | 28 | 56 | 19 | 48 |
| *Aulacoseira ambigua* | | | | | |
| *Aulacoseira crassipunctata* | 22 | 23 | 54 | 26 | 67 |
| *Aulacoseira distans* | 37 | 14 | 32 | 19 | 24 |
| *Aulacoseira distans* var. *nivalis* | | | | | |
| *Aulacoseira granulata* | | | | | |
| *Aulacoseira italica* | | | | | |
| *Aulacoseira lacustris* | | | | | |
| *Aulacoseira lirata* | | 19 | | 18 | 2 |
| *Aulacoseira nygaardii* | | 17 | 8 | 8 | 13 |
| *Aulacoseira perglabra* | | | 27 | | 18 |
| *Brachysira brebissonii* | 16 | | | | |
| *Brachysira follis* | | | | | |
| *Brachysira intermedia* | | | | | |
| *Brachysira manfredii* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Second Chain-B** 25-25.5 cm | **Second Chain-T** 0-0.5 cm | **Second Chain-B** 17.5-18 cm | **Second Chain-T** 0-0.5 cm | **Second Chain-B** 24.5-25 cm |
| *Brachysira neoexilis* | | | | | |
| *Brachysira poss procera* | | | | | |
| *Brachysira serians* | 87 | 34 | 88 | 27 | 64 |
| *Brachysira styriaca* | 7 | 9 | 28 | 9 | 27 |
| *Caloneis bacillum* | | | | | |
| *Caloneis silicula* | | | | | |
| *Cavinula cocconeiformis* | | | | | |
| *Cavinula pseudoscutiformis* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Chamaepinnularia bremensis* | | | | | |
| *Chamaepinnularia mediocris* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Craticula cuspidata* | | | | | |
| *Cyclotella bodanica* | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | | 7 | |
| *Cyclotella michiganiana* | | | | | |
| *Cyclotella stelligera* | | | | | |
| *Cymbella hungarica* | | | | | |
| *Cymbella incerta* | | | | | |
| *Cymbella schubartoides* | | | | | |
| *Cymbella* spp. | 38 | | 49 | | 44 |
| *Cymbopleura subcuspidata* | | | | | |
| *Diatoma anceps* | | | | | |
| *Diatoma mesodon* | | | | | |
| *Diatoma tenue* | | | | | |
| *Diploneis marginestriata* | | | | | |
| *Diploneis parma* | | | | | |
| *Encyonema herbidicum* | | | | | |
| *Encyonema lunatum* | | | | | |
| *Encyonema minutum* | | | | | |
| *Encyonopsis cesatii* | | | | | |
| *Eucocconeis depressa* | | | | | |
| *Eunotia arcus* | 23 | | | | 2 |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Second Chain-B<br>25-25.5 cm | Second Chain-T<br>0-0.5 cm | Second Chain-B<br>17.5-18 cm | Second Chain-T<br>0-0.5 cm | Second Chain-B<br>24.5-25 cm |
| *Eunotia bidentula* | | 7 | | 12 | |
| *Eunotia bigibba* | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | |
| *Eunotia carolina* | | | | | |
| *Eunotia curvata* | 14 | 25 | 14 | | 18 |
| *Eunotia curvata f . bergii* | | | | 18 | |
| *Eunotia elegans* | | 32 | | 36 | |
| *Eunotia exigua* | 114 | 13 | 87 | 76 | 78 |
| *Eunotia faba* | | | | | |
| *Eunotia fallax* | | | | | |
| *Eunotia flexulosa* | 42 | | 24 | | 37 |
| *Eunotia flexulosa* (straight) | 24 | | 43 | | 35 |
| *Eunotia formica* | | | | | |
| *Eunotia hexiglyphis* | | 4 | | 8 | |
| *Eunotia implicata* | | | | | |
| *Eunotia incisa* | | 44 | | 47 | 2 |
| *Eunotia intermediata* | | 17 | | 28 | |
| *Eunotia latriensis* | | | | | |
| *Eunotia major* | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | 31 | 17 | 28 | 17 | 24 |
| *Eunotia pectinalis* var. minor | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | | 14 |
| *Eunotia poss teineckii* | | | | | |
| *Eunotia praerupta* | | | | | |
| *Eunotia serra* | | | | | |
| *Eunotia serra* var. *tetrado* | 24 | | 27 | | 22 |
| *Eunotia zasumensis* | | 38 | | 32 | |
| *Fragilaria brevistriata* | | | | | |
| *Fragilaria capucina* | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Second Chain-B 25-25.5 cm | Second Chain-T 0-0.5 cm | Second Chain-B 17.5-18 cm | Second Chain-T 0-0.5 cm | Second Chain-B 24.5-25 cm |
| *Fragilaria construens f. exigua* | | | | | |
| *Fragilaria elliptica* | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | |
| *Fragilaria oldenbergiana* | | | | | |
| *Fragilaria parasitica* | | | | | |
| *Fragilaria pinnata* | | | | | |
| *Fragilaria polygonata* | | | | | |
| *Fragilaria pulchella* | | | | | |
| *Fragilaria* spp. 5 | | | | | |
| *Fragilaria tenera* | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | |
| *Fragilariforma acidobiontica* | 23 | 39 | 46 | 57 | 46 |
| *Fragilariforma constricta* | 32 | | 22 | | 2 |
| *Fragilariforma constricta f. stricta* | | | | | |
| *Fragilariforma exigua* | 37 | 8 | 33 | 5 | 39 |
| *Fragilariforma exigua* (girdles) | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | |
| *Fragilariforma lata* | 89 | 62 | 77 | 57 | 69 |
| *Frustulia bahlsii* | | | | | |
| *Frustulia crassinervia* | | | | | |
| *Frustulia pseudomagaliesmontana* | | 27 | | 17 | |
| *Frustulia rhomboides* | 74 | 24 | 43 | 15 | 34 |
| *Frustulia saxonica* | 67 | 18 | 57 | 24 | 48 |
| *Gomphonema acuminatum* | | | | | |
| *Gomphonema angustatum* | | | | | |
| *Gomphonema gracile* | | | | | |
| *Gomphonema minutum* | | | | | |
| *Gomphonema parvulum* | | | | | |
| *Gomphonema truncatum* | | | | | |
| *Gyrosigma acuminatum* | | 7 | | 9 | |
| *Gyrosigma obscurum* | | | | | |
| *Hantzschia rhaetica* | | | | | |
| *Kobayasia subtillissima* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Second Chain-B<br>25-25.5 cm | Second Chain-T<br>0-0.5 cm | Second Chain-B<br>17.5-18 cm | Second Chain-T<br>0-0.5 cm | Second Chain-B<br>24.5-25 cm |
| *Melosira arentii* | | | | | 7 |
| *Meridian circulare* | | | | | |
| *Navicula constans* | | | | | |
| *Navicula cryptocephala* | | | | | |
| *Navicula expecta* | | | | | |
| *Navicula halophila* | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | |
| *Navicula impexa* | | | | | |
| *Navicula leptostriata* | | | | 24 | |
| *Navicula lundi* | | | | | |
| *Navicula poss bottnica* | | | | | |
| *Navicula pseudolanceolata* | | | | | |
| *Navicula radiosa* | | | | | |
| *Navicula schumassmanni* | | 7 | | 8 | |
| *Navicula stroemii* | | | | | |
| *Neidium affine* | | | | | |
| *Neidium bisulcatum* | | 11 | | 12 | |
| *Neidium bisulcatum* var. *baicalense* | | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | 22 | | 45 | | 34 |
| *Neidium densestriatum* | | | | | |
| *Neidium iridis* | | | | | |
| *Neidium poss holstii* | | 8 | | 8 | |
| *Nitzschia filiformis* | | | | | |
| *Nitzschia gracilis* | | | | | |
| *Nitzschia intermedia* | | 8 | | 9 | |
| *Nitzschia microcephala* | | | | | |
| *Nitzschia nana* | | | | | |
| *Nitzschia perminuta* | | | | | |
| *Nitzschia recta* | | | | | |
| *Nitzschia suchlandtii* | | | | | |
| *Nitzschia vermicularis* | | | | | |
| *Oxyneis binalis* | 17 | 17 | 19 | 12 | 8 |
| *Pinnularia archospaeria* var. *turgidula* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Second Chain-B** 25-25.5 cm | **Second Chain-T** 0-0.5 cm | **Second Chain-B** 17.5-18 cm | **Second Chain-T** 0-0.5 cm | **Second Chain-B** 24.5-25 cm |
| *Pinnularia biceps* | | | | | |
| *Pinnularia brauniana* | | | | | |
| *Pinnularia cardinalis* | | | | | |
| *Pinnularia claviculiformes* | | | | | |
| *Pinnularia divergens* | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | |
| *Pinnularia gibba* | | | | | |
| *Pinnularia gibbiformis* | | | | | |
| *Pinnularia kwacksii* | | | | | |
| *Pinnularia legumen* | | | | | |
| *Pinnularia microstauron* | 37 | 63 | 43 | 59 | 32 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | |
| *Pinnularia nodosa* | | | | | |
| *Pinnularia polynoca* | | | | | |
| *Pinnularia silvatica* | | | | | |
| *Pinnularia subgibba* | 7 | 28 | 22 | 19 | 19 |
| *Pinnularia subgibba* var. *undulata* | 8 | 13 | 9 | 12 | 5 |
| *Pinnularia subrupestris* | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | |
| *Psammothidium bioretii* | | | | | |
| *Psammothidium levanderi* | | | | | |
| *Psammothidium subatomoides* | | | | | |
| *Pseudostaurosira brevistriata* | | | | | |
| *Pseudostaurosira parasitia* | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | |
| *Semiorbis hemicyclus* | 77 | 7 | 29 | 9 | 42 |
| *Stauroneis anceps* | 17 | | 12 | | |
| *Stauroneis construens* | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | |
| *Stauroneis phoenocenteron* | 24 | | 32 | | 28 |
| *Staurosira construens* | 56 | 8 | 48 | 14 | 42 |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Second Chain-B** 25-25.5 cm | **Second Chain-T** 0-0.5 cm | **Second Chain-B** 17.5-18 cm | **Second Chain-T** 0-0.5 cm | **Second Chain-B** 24.5-25 cm |
| *Staurosirella pinnata* | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | |
| *Stenopterobia anceps* | | | | | 19 |
| *Stenopterobia curvula* | | 8 | | 5 | |
| *Surirella amphioxis* | 27 | 22 | 26 | 22 | 28 |
| *Surirella angustua* | | | | | |
| *Surirella cuspidata* | 22 | 42 | 24 | 38 | 27 |
| *Surirella linearis* | | | | | |
| *Surirella pinnata* | | | | | |
| *Surirella poss elegans* | | | | | |
| *Surirella spendida* | | | | | |
| *Tabellaria fenestrata* | 64 | 44 | 46 | 37 | 59 |
| *Tabellaria flocculosa* strain III | | | | | |
| *Tabellaria flocculosa* strain IIIp | | 23 | | | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | |
| *Tabellaria flocculosa* strain IV | | | | | |
| *Tabellaria flocculosa* var. *linearis* | 147 | 34 | 116 | 29 | 118 |
| *Tabellaria quadriseptata* | 28 | 64 | 42 | 62 | 54 |
| *Tabellaria ventricosa* | | | | | |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Settle-T** | **Settle-B** | **Settle-T** | **Settle-B** | **Settle-T** | **Settle-B** | **Sheldrake-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Achnanthes bahusiensis* | | | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | | |
| *Achnanthes chlidanos* | 8 | 3 | 9 | 13 | 12 | 8 | |
| *Achnanthes curtissima* | | | 2 | 2 | 3 | | |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | 2 | | 4 | 6 | 3 | 3 | |
| *Achnanthes stewartii* | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | 7 | | 7 | 8 | 7 | | |
| *Amphora ovalis* | 7 | 16 | 9 | 12 | | 17 | |
| *Amphora pediculus* | | | | | | | |
| *Anomoenis brachysira* | | | | | | | |
| *Asterionella formosa* | 123 | 7 | 137 | 12 | 126 | 9 | 54 |
| *Asterionella ralfsii* var. *americana* | 28 | | 27 | | 29 | | 162 |
| *Aulacoseira ambigua* | | | | | | | |
| *Aulacoseira crassipunctata* | | | | | | | 96 |
| *Aulacoseira distans* | 9 | 38 | 12 | 39 | 12 | 39 | |
| *Aulacoseira distans* var. *nivalis* | | | | | | | 7 |
| *Aulacoseira granulata* | | | | | | | |
| *Aulacoseira italica* | | | | | | | |
| *Aulacoseira lacustris* | | | | | | | |
| *Aulacoseira lirata* | | 2 | | 3 | | 3 | 8 |
| *Aulacoseira nygaardii* | | | | | | | |
| *Aulacoseira perglabra* | | 3 | | 6 | | 7 | |
| *Brachysira brebissonii* | | | | | | | 14 |
| *Brachysira follis* | | | | | | | 2 |
| *Brachysira intermedia* | | | | | | | |
| *Brachysira manfredii* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Settle-T | Settle-B | Settle-T | Settle-B | Settle-T | Settle-B | Sheldrake-T |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Brachysira neoexilis* | | | | | | | |
| *Brachysira poss procera* | | | | | | | |
| *Brachysira serians* | | 28 | 3 | 33 | 6 | 32 | |
| *Brachysira styriaca* | | 9 | | 12 | | 11 | |
| *Caloneis bacillum* | | | | | | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | 6 | | 8 | | 7 | | |
| *Cavinula pseudoscutiformis* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | 2 |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | | | | | |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | | 48 | | 48 | | 47 | |
| *Cymbella hungarica* | | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | | | | 15 |
| *Cymbella* spp. | | 4 | | 7 | | 3 | 7 |
| *Cymbopleura subcuspidata* | | | | | | | |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | | | | | |
| *Diatoma tenue* | 68 | | 64 | | 67 | | |
| *Diploneis marginestriata* | | | | | | | |
| *Diploneis parma* | 16 | | 28 | | 18 | | |
| *Encyonema herbidicum* | | | | | | | |
| *Encyonema lunatum* | | | | | | | |
| *Encyonema minutum* | | | | | | | |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | | | | | | |
| *Eunotia arcus* | 4 | | 3 | | 3 | | 22 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Settle-T** 0-0.5 cm | **Settle-B** 25-25.5 cm | **Settle-T** 0-0.5 cm | **Settle-B** 25-25.5 cm | **Settle-T** 0-0.5 cm | **Settle-B** 25-25.5 cm | **Sheldrake-T** 0-0.5 cm |
| *Eunotia bidentula* | | | | | | | |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | | | 12 |
| *Eunotia carolina* | 12 | | 11 | | 16 | | |
| *Eunotia curvata* | | | | | | | |
| *Eunotia curvata f . bergii* | | | | | | | |
| *Eunotia elegans* | | | | | | 3 | |
| *Eunotia exigua* | 6 | 3 | 8 | 6 | 8 | 2 | |
| *Eunotia faba* | | | | | | | |
| *Eunotia fallax* | | | | | | | 25 |
| *Eunotia flexulosa* | | | | | | | 14 |
| *Eunotia flexulosa* (straight) | | | | | | | |
| *Eunotia formica* | | | | | | | |
| *Eunotia hexiglyphis* | | | | | | | |
| *Eunotia implicata* | 4 | | 7 | | 6 | | |
| *Eunotia incisa* | 23 | 2 | 18 | | 22 | 3 | |
| *Eunotia intermediata* | | | | | | | |
| *Eunotia latriensis* | | | | | | | |
| *Eunotia major* | | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | 5 | | 4 | | 12 | |
| *Eunotia pectinalis* var. minor | | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | 7 | | 8 | | 3 | |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | | | | | | |
| *Eunotia serra* | | | | | | | |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | 18 | | 24 | | 19 | | |
| *Fragilaria brevistriata* | | 19 | 2 | 21 | | 18 | |
| *Fragilaria capucina* | | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | 23 | | 26 | | 28 | | |
| *Fragilaria capucina* var. *rumpens* | 12 | | 13 | | 19 | | |
| *Fragilaria capucina* var. *gracilis* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Settle-T** | **Settle-B** | **Settle-T** | **Settle-B** | **Settle-T** | **Settle-B** | **Sheldrake-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | 7 | 16 | 8 | 14 | 9 | 17 | |
| *Fragilaria elliptica (girdles)* | | | | | | | |
| *Fragilaria oldenbergiana* | | | | | | | |
| *Fragilaria parasitica* | | | | | | | |
| *Fragilaria pinnata* | | | | | | | |
| *Fragilaria polygonata* | | | | | | | |
| *Fragilaria pulchella* | | | | | | | |
| *Fragilaria* spp. 5 | | | | | | | |
| *Fragilaria tenera* | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | | |
| *Fragilariforma constricta* | | 18 | 3 | 19 | | 18 | 44 |
| *Fragilariforma constricta f. stricta* | | | | | | | |
| *Fragilariforma exigua* | | 39 | | 37 | 3 | 37 | 35 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | |
| *Fragilariforma lata* | | 78 | | 77 | 2 | 68 | 84 |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | | | | |
| *Frustulia pseudomagaliesmontana* | 9 | 12 | 9 | 16 | 9 | 14 | |
| *Frustulia rhomboides* | 2 | 28 | 4 | 28 | 3 | 23 | 14 |
| *Frustulia saxonica* | 8 | 4 | 8 | 6 | 9 | 2 | 4 |
| *Gomphonema acuminatum* | | | | | | | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | | | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | | | | | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | | | | 3 | | |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Settle-T 0-0.5 cm | Settle-B 25-25.5 cm | Settle-T 0-0.5 cm | Settle-B 25-25.5 cm | Settle-T 0-0.5 cm | Settle-B 25-25.5 cm | Sheldrake-T 0-0.5 cm |
| *Melosira arentii* | | | | | | | |
| *Meridian circulare* | | | | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | | | | 3 | | | |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | |
| *Navicula impexa* | | | | | | | |
| *Navicula leptostriata* | | | 2 | 2 | 6 | 3 | |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | 2 |
| *Navicula pseudolanceolata* | | | | | | | |
| *Navicula radiosa* | | | | | | | |
| *Navicula schumassmanni* | | | | | | | |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | |
| *Neidium densestriatum* | | | | | | | |
| *Neidium iridis* | | | | | | | |
| *Neidium poss holstii* | | | | | | | |
| *Nitzschia filiformis* | | | | | | | |
| *Nitzschia gracilis* | 22 | 4 | 24 | 6 | 26 | 8 | 8 |
| *Nitzschia intermedia* | | | | | | | |
| *Nitzschia microcephala* | | | | | | | |
| *Nitzschia nana* | | | | | | | |
| *Nitzschia perminuta* | | | | | | | |
| *Nitzschia recta* | | | | | | | |
| *Nitzschia suchlandtii* | | | | | | | |
| *Nitzschia vermicularis* | | | | | | | |
| *Oxyneis binalis* | 3 | | 6 | | 7 | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Settle-T 0-0.5 cm | Settle-B 25-25.5 cm | Settle-T 0-0.5 cm | Settle-B 25-25.5 cm | Settle-T 0-0.5 cm | Settle-B 25-25.5 cm | Sheldrake-T 0-0.5 cm |
| *Pinnularia biceps* | | | | | | | |
| *Pinnularia brauniana* | | | | | | | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | |
| *Pinnularia divergens* | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | | | | | | | |
| *Pinnularia gibbiformis* | | | | | | | |
| *Pinnularia kwacksii* | | | | 2 | | 2 | |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | | 2 | | 3 | | 3 | |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | | | | | | | |
| *Pinnularia polynoca* | | | | | | | |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | | | | | | 2 | |
| *Pinnularia subgibba* var. *undulata* | | | | | | | |
| *Pinnularia subrupestris* | | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | | | |
| *Psammothidium subatomoides* | | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | | |
| *Semiorbis hemicyclus* | | | | | | | |
| *Stauroneis anceps* | 18 | | 22 | | 18 | 8 | |
| *Stauroneis construens* | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | |
| *Stauroneis phoenocenteron* | 7 | | 8 | | 8 | | |
| *Staurosira construens* | | 86 | | 78 | | 88 | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Settle-T<br>0-0.5 cm | Settle-B<br>25-25.5 cm | Settle-T<br>0-0.5 cm | Settle-B<br>25-25.5 cm | Settle-T<br>0-0.5 cm | Settle-B<br>25-25.5 cm | Sheldrake-T<br>0-0.5 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | | | | | | |
| *Stenopterobia curvula* | | | | | | | |
| *Surirella amphioxis* | | 3 | 2 | 6 | 2 | 7 | |
| *Surirella angustua* | | | | | | | |
| *Surirella cuspidata* | | | | | | | |
| *Surirella linearis* | | | | | | | |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | | 13 | | 14 | | 23 | 56 |
| *Tabellaria flocculosa* strain III | 4 | | 7 | | 7 | | |
| *Tabellaria flocculosa* strain IIIp | | | | | | | 34 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | 28 | 28 | 28 | 27 | 29 | 26 | |
| *Tabellaria flocculosa* var. *linearis* | 22 | 7 | 25 | 7 | 24 | 9 | |
| *Tabellaria quadriseptata* | | 2 | | 3 | | 3 | |
| *Tabellaria ventricosa* | | | | | | | |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Sheldrake-B** | **Shubenacadie Grand-T** | **Shubenacadie Grand-B** | **Soldier-T** | **Soldier-B** |
| | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Achnanthes bahusiensis* | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | |
| *Achnanthes chlidanos* | | 33 | 18 | 34 | 8 |
| *Achnanthes curtissima* | 24 | 4 | | 23 | 13 |
| *Achnanthes impexiformis* | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | |
| *Achnanthes* spp. 3 | | | | | |
| *Achnanthes stewartii* | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | |
| *Achnanthidium minutissimum* | | | | | |
| *Actinella brasiliensis* | | | | | |
| *Actinella punctata* | 24 | 13 | 14 | 28 | |
| *Amphora ovalis* | 8 | | | | 24 |
| *Amphora pediculus* | | | | | |
| *Anomoenis brachysira* | | | | | |
| *Asterionella formosa* | 1 | | | 4 | |
| *Asterionella ralfsii* var. *americana* | 14 | 68 | 69 | | |
| *Aulacoseira ambigua* | | | 13 | | 48 |
| *Aulacoseira crassipunctata* | 34 | | | | 73 |
| *Aulacoseira distans* | 44 | 43 | 112 | 3 | 78 |
| *Aulacoseira distans* var. *nivalis* | 24 | | | | |
| *Aulacoseira granulata* | | | | | |
| *Aulacoseira italica* | | 19 | | | |
| *Aulacoseira lacustris* | | | | | 27 |
| *Aulacoseira lirata* | | 6 | 14 | 4 | 23 |
| *Aulacoseira nygaardii* | | | | 28 | 18 |
| *Aulacoseira perglabra* | 27 | | | | 23 |
| *Brachysira brebissonii* | 33 | | | | 3 |
| *Brachysira follis* | | | | | |
| *Brachysira intermedia* | | | | | |
| *Brachysira manfredii* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Sheldrake-B | Shubenacadie Grand-T | Shubenacadie Grand-B | Soldier-T | Soldier-B |
| | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Brachysira neoexilis* | | | | | |
| *Brachysira poss procera* | | | | | |
| *Brachysira serians* | 6 | 23 | 14 | 39 | 37 |
| *Brachysira styriaca* | 62 | 1 | 3 | 3 | 23 |
| *Caloneis bacillum* | | | | | |
| *Caloneis silicula* | | | | | |
| *Cavinula cocconeiformis* | 7 | 7 | 7 | | |
| *Cavinula pseudoscutiformis* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Chamaepinnularia bremensis* | 14 | | | | |
| *Chamaepinnularia mediocris* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Craticula cuspidata* | | | | | |
| *Cyclotella bodanica* | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | | 22 | 8 |
| *Cyclotella michiganiana* | | | | | |
| *Cyclotella stelligera* | 8 | | 19 | 9 | 33 |
| *Cymbella hungarica* | | | | | |
| *Cymbella incerta* | | | | | |
| *Cymbella schubartoides* | 12 | | | | |
| *Cymbella* spp. | | | | 4 | 14 |
| *Cymbopleura subcuspidata* | | | | | |
| *Diatoma anceps* | | | | | |
| *Diatoma mesodon* | | | | | |
| *Diatoma tenue* | | | | | |
| *Diploneis marginestriata* | | | | 12 | |
| *Diploneis parma* | | 2 | | | |
| *Encyonema herbidicum* | | | | | |
| *Encyonema lunatum* | | 2 | 4 | 14 | 7 |
| *Encyonema minutum* | | | | | 23 |
| *Encyonopsis cesatii* | | | | | |
| *Eucocconeis depressa* | | | | | |
| *Eunotia arcus* | 14 | 43 | 13 | 12 | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Sheldrake-B** | **Shubenacadie Grand-T** | **Shubenacadie Grand-B** | **Soldier-T** | **Soldier-B** |
| | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Eunotia bidentula* | 12 | | | | |
| *Eunotia bigibba* | 24 | 12 | | 43 | 43 |
| *Eunotia bilunaris* var. *mucophila* | | 4 | | 23 | 18 |
| *Eunotia carolina* | | 22 | 32 | | |
| *Eunotia curvata* | | | | | |
| *Eunotia curvata f . bergii* | | 7 | 28 | 6 | 38 |
| *Eunotia elegans* | | 19 | | | |
| *Eunotia exigua* | | 38 | 24 | 38 | 19 |
| *Eunotia faba* | | | | | |
| *Eunotia fallax* | 23 | | | | |
| *Eunotia flexulosa* | 27 | | | 33 | 22 |
| *Eunotia flexulosa* (straight) | | | 28 | 19 | 28 |
| *Eunotia formica* | | 3 | 4 | | |
| *Eunotia hexiglyphis* | 14 | 4 | | | |
| *Eunotia implicata* | | | | | |
| *Eunotia incisa* | | 3 | 28 | | 17 |
| *Eunotia intermediata* | | | | | |
| *Eunotia latriensis* | | | | 3 | |
| *Eunotia major* | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | 33 | 33 | 18 | 38 |
| *Eunotia pectinalis* var. minor | | | | | |
| *Eunotia pectinais* var. *ventricosa* | 4 | 18 | 14 | 18 | 23 |
| *Eunotia poss teineckii* | | | | | |
| *Eunotia praerupta* | | | 9 | | |
| *Eunotia serra* | | | | | |
| *Eunotia serra* var. *tetrado* | | | | | |
| *Eunotia zasumensis* | | | | | |
| *Fragilaria brevistriata* | | 2 | 7 | 29 | 38 |
| *Fragilaria capucina* | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | 87 |
| *Fragilaria capucina* var. *gracilis* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Sheldrake-B | Shubenacadie Grand-T | Shubenacadie Grand-B | Soldier-T | Soldier-B |
| | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Fragilaria construens f. exigua* | | | | | |
| *Fragilaria elliptica* | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | |
| *Fragilaria oldenbergiana* | | | | | |
| *Fragilaria parasitica* | | | | | |
| *Fragilaria pinnata* | | | | | |
| *Fragilaria polygonata* | | | | | |
| *Fragilaria pulchella* | | | | | |
| *Fragilaria* spp. 5 | | | | | |
| *Fragilaria tenera* | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | |
| *Fragilariforma acidobiontica* | | 59 | 19 | 18 | |
| *Fragilariforma constricta* | 14 | 24 | | | 28 |
| *Fragilariforma constricta f. stricta* | | | | | |
| *Fragilariforma exigua* | 12 | 18 | 18 | 24 | 52 |
| *Fragilariforma exigua* (girdles) | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | |
| *Fragilariforma lata* | 44 | 13 | 28 | 45 | 33 |
| *Frustulia bahlsii* | | | | | |
| *Frustulia crassinervia* | | | | | |
| *Frustulia pseudomagaliesmontana* | | 37 | 24 | 82 | |
| *Frustulia rhomboides* | 44 | 23 | 13 | 33 | 13 |
| *Frustulia saxonica* | 45 | 8 | 7 | 19 | 18 |
| *Gomphonema acuminatum* | | | | | |
| *Gomphonema angustatum* | | | | | |
| *Gomphonema gracile* | | | | | |
| *Gomphonema minutum* | | | | | |
| *Gomphonema parvulum* | | | | | |
| *Gomphonema truncatum* | | | | | |
| *Gyrosigma acuminatum* | | | | | |
| *Gyrosigma obscurum* | | | | | |
| *Hantzschia rhaetica* | | | | | |
| *Kobayasia subtillissima* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Sheldrake-B | Shubenacadie Grand-T | Shubenacadie Grand-B | Soldier-T | Soldier-B |
| | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Melosira arentii* | | | | | |
| *Meridian circulare* | | | | | |
| *Navicula constans* | | | | | |
| *Navicula cryptocephala* | | | | | |
| *Navicula expecta* | | 3 | 4 | | 13 |
| *Navicula halophila* | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | |
| *Navicula impexa* | | | | | |
| *Navicula leptostriata* | | 2 | 13 | 23 | 23 |
| *Navicula lundi* | | | | | |
| *Navicula poss bottnica* | | | | | |
| *Navicula pseudolanceolata* | | | | | |
| *Navicula radiosa* | | | | | |
| *Navicula schumassmanni* | | | | | |
| *Navicula stroemii* | 3 | | | | |
| *Neidium affine* | | | | | |
| *Neidium bisulcatum* | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | 18 | 8 |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | |
| *Neidium densestriatum* | | | | | |
| *Neidium iridis* | 4 | | | | |
| *Neidium poss holstii* | | | | | |
| *Nitzschia filiformis* | | | | | |
| *Nitzschia gracilis* | | 3 | 3 | 34 | |
| *Nitzschia intermedia* | | | | | |
| *Nitzschia microcephala* | | | | 43 | |
| *Nitzschia nana* | | | | | |
| *Nitzschia perminuta* | | | | | |
| *Nitzschia recta* | | | | | |
| *Nitzschia suchlandtii* | | | | | |
| *Nitzschia vermicularis* | | | | | |
| *Oxyneis binalis* | 14 | 28 | | 7 | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Sheldrake-B | Shubenacadie Grand-T | Shubenacadie Grand-B | Soldier-T | Soldier-B |
| | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Pinnularia biceps* | 24 | | | | |
| *Pinnularia brauniana* | | | | | |
| *Pinnularia cardinalis* | | | | | |
| *Pinnularia claviculiformes* | | | | | |
| *Pinnularia divergens* | 27 | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | |
| *Pinnularia gibba* | | | | | |
| *Pinnularia gibbiformis* | | | | | |
| *Pinnularia kwacksii* | | | | | 2 |
| *Pinnularia legumen* | | | | | |
| *Pinnularia microstauron* | | | 4 | 4 | 8 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | |
| *Pinnularia nodosa* | | | | | |
| *Pinnularia polynoca* | | | | | |
| *Pinnularia silvatica* | | | | | |
| *Pinnularia subgibba* | | | | 3 | |
| *Pinnularia subgibba* var. *undulata* | | | | | |
| *Pinnularia subrupestris* | | | | | |
| *Pinnularia viridiformis* var. morph I | | | 2 | 8 | 7 |
| *Psammothidium bioretii* | | | | | |
| *Psammothidium levanderi* | | | | | |
| *Psammothidium subatomoides* | | | | | |
| *Pseudostaurosira brevistriata* | | | | | |
| *Pseudostaurosira parasitia* | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | |
| *Semiorbis hemicyclus* | | 23 | 24 | 13 | 18 |
| *Stauroneis anceps* | | 12 | | 3 | 8 |
| *Stauroneis construens* | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | |
| *Stauroneis phoenocenteron* | | | | | 4 |
| *Staurosira construens* | | 14 | 19 | 29 | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Sheldrake-B | Shubenacadie Grand-T | Shubenacadie Grand-B | Soldier-T | Soldier-B |
| | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Staurosirella pinnata* | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | |
| *Stenopterobia anceps* | 7 | | | | |
| *Stenopterobia curvula* | | | | 28 | |
| *Surirella amphioxis* | 12 | 3 | 9 | 18 | 3 |
| *Surirella angustua* | 21 | | | | |
| *Surirella cuspidata* | | | | | |
| *Surirella linearis* | | | | | |
| *Surirella pinnata* | | | | | |
| *Surirella poss elegans* | | | | | |
| *Surirella spendida* | | | | | |
| *Tabellaria fenestrata* | 24 | 33 | 6 | 4 | 9 |
| *Tabellaria flocculosa* strain III | | 38 | 33 | 9 | |
| *Tabellaria flocculosa* strain IIIp | 33 | 118 | 98 | 3 | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | 62 | | |
| *Tabellaria flocculosa* strain IV | | 23 | 54 | 43 | 4 |
| *Tabellaria flocculosa* var. *linearis* | | 58 | 53 | | |
| *Tabellaria quadriseptata* | 44 | 115 | 89 | 53 | 48 |
| *Tabellaria ventricosa* | | | | | 26 |

**Appendix E**

**Raw diatom counts. Abbreviations: '-T' re**

| **Taxa** | **Interval** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Springfield-T** 0-0.5 cm | **Springfield-B** 25-25.5 cm | **Third-T** 0-0.5 cm | **Third-B** 21-21.5 cm | **Thomas-T** 0-0.5 cm | **Thomas-B** 25-25.5 cm | **Topsail-T** 0-0.5 cm |
| *Achnanthes bahusiensis* | | 2 | | | | | 3 |
| *Achnanthes biosolettianum* var. *subatomus* | 33 | | | | | | |
| *Achnanthes chlidanos* | | | 22 | 22 | | | |
| *Achnanthes curtissima* | 32 | 22 | 3 | 4 | 2 | 2 | 2 |
| *Achnanthes impexiformis* | | | | | | | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | | |
| *Achnanthes* spp. 3 | | | | | | | |
| *Achnanthes stewartii* | | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | | |
| *Achnanthidium minutissimum* | | | | | | | |
| *Actinella brasiliensis* | | | | | | | |
| *Actinella punctata* | | | 6 | 7 | | | |
| *Amphora ovalis* | 4 | 7 | 4 | 12 | | | 4 |
| *Amphora pediculus* | | | | 2 | | 2 | |
| *Anomoenis brachysira* | | | | | | | |
| *Asterionella formosa* | | | 12 | 22 | 4 | 14 | 3 |
| *Asterionella ralfsii* var. *americana* | | | | | | | 4 |
| *Aulacoseira ambigua* | | 22 | 122 | 14 | | 44 | |
| *Aulacoseira crassipunctata* | | 22 | 2 | 6 | | | |
| *Aulacoseira distans* | 53 | 64 | 9 | 59 | 4 | 87 | 7 |
| *Aulacoseira distans* var. *nivalis* | | | | | | | |
| *Aulacoseira granulata* | | | | | | | |
| *Aulacoseira italica* | | 4 | | | | | |
| *Aulacoseira lacustris* | 12 | | | | | | |
| *Aulacoseira lirata* | 13 | 32 | 5 | 12 | 27 | 44 | 6 |
| *Aulacoseira nygaardii* | 13 | 22 | | | | | 3 |
| *Aulacoseira perglabra* | | 72 | 7 | 4 | | 24 | |
| *Brachysira brebissonii* | | | 12 | 12 | 7 | 23 | |
| *Brachysira follis* | | | | 6 | | | |
| *Brachysira intermedia* | | | | | | | |
| *Brachysira manfredii* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Springfield-T** | **Springfield-B** | **Third-T** | **Third-B** | **Thomas-T** | **Thomas-B** | **Topsail-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Brachysira neoexilis* | | 8 | | | | | |
| *Brachysira poss procera* | | | | | | | |
| *Brachysira serians* | 2 | 4 | 6 | | | 22 | |
| *Brachysira styriaca* | | 4 | | | | | 4 |
| *Caloneis bacillum* | | | | | 2 | | |
| *Caloneis silicula* | | | | | | | |
| *Cavinula cocconeiformis* | | | 17 | 12 | | | |
| *Cavinula pseudoscutiformis* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | | |
| *Craticula cuspidata* | | | | | | | |
| *Cyclotella bodanica* | | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | 134 | 14 | 54 | 44 | 3 |
| *Cyclotella michiganiana* | | | | | | | |
| *Cyclotella stelligera* | 26 | 12 | 12 | 13 | 79 | 84 | 2 |
| *Cymbella hungarica* | | | | | | | |
| *Cymbella incerta* | | | | | | | |
| *Cymbella schubartoides* | | | | | | | |
| *Cymbella* spp. | | | | | | | |
| *Cymbopleura subcuspidata* | | | | | | | |
| *Diatoma anceps* | | | | | | | |
| *Diatoma mesodon* | | | | | | | |
| *Diatoma tenue* | | | 22 | | 22 | | |
| *Diploneis marginestriata* | 11 | | | | 23 | | |
| *Diploneis parma* | | | | | | | |
| *Encyonema herbidicum* | | | | | | | |
| *Encyonema lunatum* | | | | | | | 19 |
| *Encyonema minutum* | | 2 | | | | | 32 |
| *Encyonopsis cesatii* | | | | | | | |
| *Eucocconeis depressa* | | 12 | | | | | |
| *Eunotia arcus* | | | | | | 2 | 14 |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Springfield-T 0-0.5 cm | Springfield-B 25-25.5 cm | Third-T 0-0.5 cm | Third-B 21-21.5 cm | Thomas-T 0-0.5 cm | Thomas-B 25-25.5 cm | Topsail-T 0-0.5 cm |
| *Eunotia bidentula* | | 24 | | | | | 2 |
| *Eunotia bigibba* | | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | 4 | | 7 |
| *Eunotia carolina* | | | | | | | |
| *Eunotia curvata* | | | | | | | |
| *Eunotia curvata f . bergii* | | | | | | | 8 |
| *Eunotia elegans* | | | 3 | 7 | | | 4 |
| *Eunotia exigua* | 33 | 14 | 2 | 6 | 24 | 14 | |
| *Eunotia faba* | | | | | | | |
| *Eunotia fallax* | | | | | | | |
| *Eunotia flexulosa* | | | | 14 | | | |
| *Eunotia flexulosa* (straight) | | | 2 | 23 | | | |
| *Eunotia formica* | | | | | | 24 | |
| *Eunotia hexiglyphis* | | | | | | | |
| *Eunotia implicata* | | | 23 | 42 | | | 7 |
| *Eunotia incisa* | | | | | 4 | | 22 |
| *Eunotia intermediata* | 5 | | | | | | |
| *Eunotia latriensis* | | | | | | | |
| *Eunotia major* | | 14 | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | | | 7 | | 37 | 17 |
| *Eunotia pectinalis* var. minor | | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | 3 | | | 42 | | 54 | 13 |
| *Eunotia poss teineckii* | | | | | | | |
| *Eunotia praerupta* | | | | | | | |
| *Eunotia serra* | | | | 18 | | | |
| *Eunotia serra* var. *tetrado* | | | | | | | |
| *Eunotia zasumensis* | | | | | | | |
| *Fragilaria brevistriata* | | | 22 | 32 | | | 6 |
| *Fragilaria capucina* | | | | | 33 | | |
| *Fragilaria capucina* var. *amphicephala* | | | | 14 | 4 | | |
| *Fragilaria capucina* var. *rumpens* | | | 7 | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Springfield-T 0-0.5 cm | Springfield-B 25-25.5 cm | Third-T 0-0.5 cm | Third-B 21-21.5 cm | Thomas-T 0-0.5 cm | Thomas-B 25-25.5 cm | Topsail-T 0-0.5 cm |
| *Fragilaria construens f. exigua* | | | | | | | |
| *Fragilaria elliptica* | | | | | | | |
| *Fragilaria elliptica (girdles)* | | | | | | | |
| *Fragilaria oldenbergiana* | | | 7 | 18 | | | |
| *Fragilaria parasitica* | | | | | | | |
| *Fragilaria pinnata* | | | | | | | |
| *Fragilaria polygonata* | | | | | | | |
| *Fragilaria pulchella* | | | | | | | |
| *Fragilaria* spp. 5 | | | | | 24 | 24 | |
| *Fragilaria tenera* | | | | | | | |
| *Fragilaria ulna* var. *acus* | | | | | | | |
| *Fragilariforma acidobiontica* | | | | | | | 33 |
| *Fragilariforma constricta* | | | | | | 34 | 22 |
| *Fragilariforma constricta f. stricta* | | | | | | | |
| *Fragilariforma exigua* | 31 | 14 | 3 | 3 | 54 | 35 | 4 |
| *Fragilariforma exigua* (girdles) | | | | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | | | |
| *Fragilariforma lata* | 43 | | | 12 | 27 | 47 | 8 |
| *Frustulia bahlsii* | | | | | | | |
| *Frustulia crassinervia* | | | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | | | 128 |
| *Frustulia rhomboides* | | 2 | | 5 | 24 | 8 | 48 |
| *Frustulia saxonica* | | 3 | | 8 | | 9 | 27 |
| *Gomphonema acuminatum* | 3 | 2 | 3 | | | | |
| *Gomphonema angustatum* | | | | | | | |
| *Gomphonema gracile* | 2 | | | | | | |
| *Gomphonema minutum* | | | | | | | |
| *Gomphonema parvulum* | | | | | 4 | | |
| *Gomphonema truncatum* | | | | | | | |
| *Gyrosigma acuminatum* | | | 6 | | | | 3 |
| *Gyrosigma obscurum* | | | | | | | |
| *Hantzschia rhaetica* | | | 6 | | | | |
| *Kobayasia subtillissima* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Springfield-T** | **Springfield-B** | **Third-T** | **Third-B** | **Thomas-T** | **Thomas-B** | **Topsail-T** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Melosira arentii* | | | | | | | |
| *Meridian circulare* | | | | | | | |
| *Navicula constans* | | | | | | | |
| *Navicula cryptocephala* | | | | | | | |
| *Navicula expecta* | | | 7 | | | 34 | |
| *Navicula halophila* | | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | | |
| *Navicula impexa* | | 4 | | | | | |
| *Navicula leptostriata* | | | 4 | 7 | | | 43 |
| *Navicula lundi* | | | | | | | |
| *Navicula poss bottnica* | | | | | | | |
| *Navicula pseudolanceolata* | | | | | 14 | | |
| *Navicula radiosa* | 13 | | | | | | |
| *Navicula schumassmanni* | | | | | | | |
| *Navicula stroemii* | | | | | | | |
| *Neidium affine* | | | | | | | |
| *Neidium bisulcatum* | | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | | | 3 |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | | |
| *Neidium densestriatum* | | | | | | | |
| *Neidium iridis* | | | | 13 | | | |
| *Neidium poss holstii* | | | 4 | 22 | | | 7 |
| *Nitzschia filiformis* | | | | | | | 12 |
| *Nitzschia gracilis* | | | | 6 | | | 38 |
| *Nitzschia intermedia* | | | | | | | |
| *Nitzschia microcephala* | | | | | | | |
| *Nitzschia nana* | | | | | | | 47 |
| *Nitzschia perminuta* | | | | | | | |
| *Nitzschia recta* | 2 | | 6 | | | | |
| *Nitzschia suchlandtii* | | | | | | | |
| *Nitzschia vermicularis* | | | | | | | |
| *Oxyneis binalis* | | | | | | | 19 |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Springfield-T 0-0.5 cm | Springfield-B 25-25.5 cm | Third-T 0-0.5 cm | Third-B 21-21.5 cm | Thomas-T 0-0.5 cm | Thomas-B 25-25.5 cm | Topsail-T 0-0.5 cm |
| *Pinnularia biceps* | | 2 | | | | | |
| *Pinnularia brauniana* | | | | 8 | | | |
| *Pinnularia cardinalis* | | | | | | | |
| *Pinnularia claviculiformes* | | | | | | | |
| *Pinnularia divergens* | | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | | | |
| *Pinnularia gibba* | | | | | | | |
| *Pinnularia gibbiformis* | | | | | | | |
| *Pinnularia kwacksii* | 2 | | 2 | 3 | 2 | 4 | |
| *Pinnularia legumen* | | | | | | | |
| *Pinnularia microstauron* | | 12 | | 2 | 9 | 13 | |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | | | |
| *Pinnularia nodosa* | | | | | | | |
| *Pinnularia polynoca* | | | | | | | |
| *Pinnularia silvatica* | | | | | | | |
| *Pinnularia subgibba* | | | | | | | 2 |
| *Pinnularia subgibba* var. *undulata* | | | | | | 32 | |
| *Pinnularia subrupestris* | | | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | | | |
| *Psammothidium bioretii* | | | | | | | |
| *Psammothidium levanderi* | | | | | 3 | | |
| *Psammothidium subatomoides* | | | | | 17 | | |
| *Pseudostaurosira brevistriata* | | | | | | | |
| *Pseudostaurosira parasitia* | 4 | | | | | | |
| *Sellaphora pupula* var. *pupula* | | 4 | | | | | |
| *Semiorbis hemicyclus* | | 4 | | | | | 6 |
| *Stauroneis anceps* | 4 | | | | | | |
| *Stauroneis construens* | | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | | |
| *Stauroneis phoenocenteron* | | 18 | | | | | 44 |
| *Staurosira construens* | | | 38 | 23 | | 14 | |

| Taxa | Interval | | | | | | |
|---|---|---|---|---|---|---|---|
| | Springfield-T | Springfield-B | Third-T | Third-B | Thomas-T | Thomas-B | Topsail-T |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 21-21.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm |
| *Staurosirella pinnata* | | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | | | | | |
| *Stenopterobia anceps* | | | | | | | 76 |
| *Stenopterobia curvula* | | | | | | | 28 |
| *Surirella amphioxis* | 2 | 12 | 4 | 2 | | 12 | 18 |
| *Surirella angustua* | 3 | | | | | 14 | |
| *Surirella cuspidata* | | | | | | | |
| *Surirella linearis* | | | 2 | | | | |
| *Surirella pinnata* | | | | | | | |
| *Surirella poss elegans* | | | | | | | |
| *Surirella spendida* | | | | | | | |
| *Tabellaria fenestrata* | 44 | 22 | | | | 22 | |
| *Tabellaria flocculosa* strain III | | | 33 | 72 | | | |
| *Tabellaria flocculosa* strain IIIp | 13 | 17 | | | 34 | 33 | |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | | |
| *Tabellaria flocculosa* strain IV | | | | | 12 | 24 | 4 |
| *Tabellaria flocculosa* var. *linearis* | | | 81 | 48 | | 43 | 2 |
| *Tabellaria quadriseptata* | | | 42 | 49 | | | |
| *Tabellaria ventricosa* | | | | | | | |

**Appendix E**

**Raw diatom counts.  Abbreviations: '-T' re**

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Topsail-B** 23-23.5 cm | **Whimsical-T** 0-0.5 cm | **Whimsical-B** 17.5-18 cm | **Whimsical-T** 0-0.5 cm | **Whimsical-B** 22-22.5 cm | **Whimsical-T** 0-0.5 cm |
| *Achnanthes bahusiensis* | | 7 | | 5 | | 8 |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | | |
| *Achnanthes chlidanos* | 2 | 62 | | 61 | | 63 |
| *Achnanthes curtissima* | 4 | 1 | 4 | 12 | 3 | 11 |
| *Achnanthes impexiformis* | | 1 | | 4 | | 3 |
| *Achnanthes minutissima* var. *inconspicud* | | | | | | |
| *Achnanthes* spp. 3 | | | | | | |
| *Achnanthes stewartii* | | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | | |
| *Achnanthidium minutissimum* | | | | | | |
| *Actinella brasiliensis* | | | | | | |
| *Actinella punctata* | | | 5 | | 7 | |
| *Amphora ovalis* | 6 | | 38 | | 38 | |
| *Amphora pediculus* | | | | | | |
| *Anomoenis brachysira* | | | | | | |
| *Asterionella formosa* | 4 | | | | | |
| *Asterionella ralfsii* var. *americana* | 2 | | | | | |
| *Aulacoseira ambigua* | | | | | | |
| *Aulacoseira crassipunctata* | 2 | 32 | 63 | 22 | 62 | 34 |
| *Aulacoseira distans* | 48 | 84 | 32 | 82 | 38 | 82 |
| *Aulacoseira distans* var. *nivalis* | | | | | | |
| *Aulacoseira granulata* | | | | | 2 | |
| *Aulacoseira italica* | | | | | | |
| *Aulacoseira lacustris* | | | | | | |
| *Aulacoseira lirata* | 6 | | 8 | 2 | 9 | |
| *Aulacoseira nygaardii* | 4 | | | | | |
| *Aulacoseira perglabra* | 22 | | | | | |
| *Brachysira brebissonii* | | 16 | 18 | 18 | 16 | 13 |
| *Brachysira follis* | | | | | | |
| *Brachysira intermedia* | | | | | | |
| *Brachysira manfredii* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Topsail-B** | **Whimsical-T** | **Whimsical-B** | **Whimsical-T** | **Whimsical-B** | **Whimsical-T** |
| | 23-23.5 cm | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm |
| *Brachysira neoexilis* | | | 12 | | 14 | |
| *Brachysira poss procera* | | | | | | |
| *Brachysira serians* | 23 | | 4 | 24 | 4 | 4 |
| *Brachysira styriaca* | 7 | 9 | 28 | 7 | 27 | 9 |
| *Caloneis bacillum* | | | | | | |
| *Caloneis silicula* | | | | | | |
| *Cavinula cocconeiformis* | 2 | | 32 | | 33 | |
| *Cavinula pseudoscutiformis* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Chamaepinnularia bremensis* | | | | | | |
| *Chamaepinnularia mediocris* | | | | | | |
| *Cocconeis poss neothumensis* | | | | | | |
| *Craticula cuspidata* | | 18 | | 17 | | 29 |
| *Cyclotella bodanica* | | | | | | |
| *Cyclotella bodanica* var. *lemanica* | 47 | 3 | | 4 | | 6 |
| *Cyclotella michiganiana* | | | | | | |
| *Cyclotella stelligera* | 77 | 94 | 129 | 113 | 122 | 92 |
| *Cymbella hungarica* | | | | | | |
| *Cymbella incerta* | | | | | | |
| *Cymbella schubartoides* | | | | | | |
| *Cymbella* spp. | 7 | | | 8 | | |
| *Cymbopleura subcuspidata* | | | | | | |
| *Diatoma anceps* | | | | | | |
| *Diatoma mesodon* | | | | | | |
| *Diatoma tenue* | | 54 | 22 | 53 | 23 | 54 |
| *Diploneis marginestriata* | | | | 4 | | |
| *Diploneis parma* | | | | | | |
| *Encyonema herbidicum* | | | | | | |
| *Encyonema lunatum* | 19 | | | | | |
| *Encyonema minutum* | 34 | | 13 | | 14 | |
| *Encyonopsis cesatii* | | | | | | |
| *Eucocconeis depressa* | | | | | | |
| *Eunotia arcus* | | | | 3 | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Topsail-B** | **Whimsical-T** | **Whimsical-B** | **Whimsical-T** | **Whimsical-B** | **Whimsical-T** |
| | 23-23.5 cm | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm |
| *Eunotia bidentula* | | 7 | | 2 | | 8 |
| *Eunotia bigibba* | | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | | |
| *Eunotia carolina* | | 36 | 12 | 27 | 13 | 38 |
| *Eunotia curvata* | | | | | | |
| *Eunotia curvata f . bergii* | | | | | | |
| *Eunotia elegans* | 8 | 32 | 22 | 23 | 24 | 37 |
| *Eunotia exigua* | 14 | 28 | 44 | 3 | 33 | 21 |
| *Eunotia faba* | | | | | | |
| *Eunotia fallax* | | | 6 | | 9 | |
| *Eunotia flexulosa* | 16 | 7 | 22 | 9 | 27 | 1 |
| *Eunotia flexulosa* (straight) | 23 | 28 | 34 | 23 | 38 | 28 |
| *Eunotia formica* | | | | | | |
| *Eunotia hexiglyphis* | | | | | | |
| *Eunotia implicata* | 8 | | | | | |
| *Eunotia incisa* | 33 | | | | | |
| *Eunotia intermediata* | | | | | | |
| *Eunotia latriensis* | | | | | | |
| *Eunotia major* | | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | | | | | |
| *Eunotia pectinalis* var. minor | | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | | | |
| *Eunotia poss teineckii* | | | | | | |
| *Eunotia praerupta* | | | | | | |
| *Eunotia serra* | | | 7 | | 7 | |
| *Eunotia serra* var. *tetrado* | | | | | | |
| *Eunotia zasumensis* | | | | | | |
| *Fragilaria brevistriata* | 3 | 58 | 94 | 57 | 93 | 58 |
| *Fragilaria capucina* | | | | | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Topsail-B** 23-23.5 cm | **Whimsical-T** 0-0.5 cm | **Whimsical-B** 17.5-18 cm | **Whimsical-T** 0-0.5 cm | **Whimsical-B** 22-22.5 cm | **Whimsical-T** 0-0.5 cm |
| *Fragilaria construens f. exigua* | | 18 | 37 | 22 | 38 | 22 |
| *Fragilaria elliptica* | | 116 | 63 | 13 | 57 | 119 |
| *Fragilaria elliptica (girdles)* | | | | | | |
| *Fragilaria oldenbergiana* | | 79 | | 52 | | 58 |
| *Fragilaria parasitica* | | | | | | |
| *Fragilaria pinnata* | | 55 | 12 | 44 | 118 | 57 |
| *Fragilaria polygonata* | | | | | | |
| *Fragilaria pulchella* | | | | | | |
| *Fragilaria* spp. 5 | | | | | | |
| *Fragilaria tenera* | | | | | | |
| *Fragilaria ulna* var. *acus* | | | 83 | | 86 | |
| *Fragilariforma acidobiontica* | | | | | | |
| *Fragilariforma constricta* | 3 | | 14 | | 11 | |
| *Fragilariforma constricta f. stricta* | | | | | | |
| *Fragilariforma exigua* | 22 | 52 | 52 | 7 | 59 | 53 |
| *Fragilariforma exigua* (girdles) | | 58 | 172 | 57 | 99 | 52 |
| *Fragilariforma hungarica* var. *tumida* | | 5 | | 1 | | 7 |
| *Fragilariforma lata* | 3 | 3 | 14 | 8 | 19 | 6 |
| *Frustulia bahlsii* | | 11 | | 11 | | 14 |
| *Frustulia crassinervia* | | | | | | |
| *Frustulia pseudomagaliesmontana* | 19 | | | | | |
| *Frustulia rhomboides* | 26 | 17 | 22 | 22 | 23 | 15 |
| *Frustulia saxonica* | 7 | 2 | 23 | 9 | 23 | 1 |
| *Gomphonema acuminatum* | 2 | | 4 | | 5 | |
| *Gomphonema angustatum* | | | | | | |
| *Gomphonema gracile* | | | 8 | | 8 | |
| *Gomphonema minutum* | | | | | | |
| *Gomphonema parvulum* | | | 28 | | 26 | |
| *Gomphonema truncatum* | | | | | | |
| *Gyrosigma acuminatum* | | | | | | |
| *Gyrosigma obscurum* | | | 14 | | 11 | |
| *Hantzschia rhaetica* | | | | | | |
| *Kobayasia subtillissima* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | Topsail-B | Whimsical-T | Whimsical-B | Whimsical-T | Whimsical-B | Whimsical-T |
| | 23-23.5 cm | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm |
| *Melosira arentii* | | | | 8 | | |
| *Meridian circulare* | | | | | | |
| *Navicula constans* | | | | | | |
| *Navicula cryptocephala* | | | | | | |
| *Navicula expecta* | | | 7 | | 12 | |
| *Navicula halophila* | | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | | |
| *Navicula impexa* | | | | | | |
| *Navicula leptostriata* | 47 | 8 | 32 | 8 | 34 | 9 |
| *Navicula lundi* | | | | | | |
| *Navicula poss bottnica* | | | | | | |
| *Navicula pseudolanceolata* | | | | 2 | | |
| *Navicula radiosa* | | | | | | |
| *Navicula schumassmanni* | | | | | | |
| *Navicula stroemii* | | | | | | |
| *Neidium affine* | | | | | | |
| *Neidium bisulcatum* | | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | | |
| *Neidium densestriatum* | | | | | | |
| *Neidium iridis* | | | | | | |
| *Neidium poss holstii* | 9 | | 32 | | 32 | |
| *Nitzschia filiformis* | | | | | | |
| *Nitzschia gracilis* | 8 | 4 | 16 | 6 | 18 | 7 |
| *Nitzschia intermedia* | | | | | | |
| *Nitzschia microcephala* | | | | 4 | | |
| *Nitzschia nana* | | | | | | |
| *Nitzschia perminuta* | | | | | | |
| *Nitzschia recta* | | | | | | |
| *Nitzschia suchlandtii* | | | | | | |
| *Nitzschia vermicularis* | | | | | | |
| *Oxyneis binalis* | | 5 | | 4 | | 3 |
| *Pinnularia archospaeria* var. *turgidula* | | | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Topsail-B** | **Whimsical-T** | **Whimsical-B** | **Whimsical-T** | **Whimsical-B** | **Whimsical-T** |
| | 23-23.5 cm | 0-0.5 cm | 17.5-18 cm | 0-0.5 cm | 22-22.5 cm | 0-0.5 cm |
| *Pinnularia biceps* | | | | | | |
| *Pinnularia brauniana* | | | | | | |
| *Pinnularia cardinalis* | | | | | | |
| *Pinnularia claviculiformes* | | | | | | |
| *Pinnularia divergens* | | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | 7 | | 9 | | 7 |
| *Pinnularia gibba* | | | | | | |
| *Pinnularia gibbiformis* | | | | | | |
| *Pinnularia kwacksii* | | | | | | |
| *Pinnularia legumen* | | 11 | | 12 | | 9 |
| *Pinnularia microstauron* | 3 | 5 | 12 | 12 | 11 | 8 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | | |
| *Pinnularia nobilis* var. *linearis* | | 22 | | 24 | | 24 |
| *Pinnularia nobilis vilincaris* | | | | | | |
| *Pinnularia nodosa* | | | | | | |
| *Pinnularia polynoca* | | | | | | |
| *Pinnularia silvatica* | | | | | | |
| *Pinnularia subgibba* | 7 | | 4 | | 7 | |
| *Pinnularia subgibba* var. *undulata* | | | | | | |
| *Pinnularia subrupestris* | | | | | | |
| *Pinnularia viridiformis* var. morph I | 14 | | | | | |
| *Psammothidium bioretii* | | | | | | |
| *Psammothidium levanderi* | | | | | | |
| *Psammothidium subatomoides* | | | | | | |
| *Pseudostaurosira brevistriata* | | | | | | |
| *Pseudostaurosira parasitia* | | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | | |
| *Semiorbis hemicyclus* | 23 | | | | | |
| *Stauroneis anceps* | 44 | 27 | 6 | 28 | 7 | 27 |
| *Stauroneis construens* | | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | | |
| *Stauroneis phoenocenteron* | 17 | | 22 | | 24 | 2 |
| *Staurosira construens* | 18 | 82 | 76 | 1 | 77 | 83 |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Topsail-B** 23-23.5 cm | **Whimsical-T** 0-0.5 cm | **Whimsical-B** 17.5-18 cm | **Whimsical-T** 0-0.5 cm | **Whimsical-B** 22-22.5 cm | **Whimsical-T** 0-0.5 cm |
| *Staurosirella pinnata* | | | | | | |
| *Staurosirella pinnata* var. *trigona* | | | 22 | | 22 | |
| *Stenopterobia anceps* | | | | | | |
| *Stenopterobia curvula* | | 5 | 37 | 6 | 36 | 7 |
| *Surirella amphioxis* | 44 | | 8 | | 9 | |
| *Surirella angustua* | | | | | | |
| *Surirella cuspidata* | | | 7 | | 8 | |
| *Surirella linearis* | 23 | | | | | |
| *Surirella pinnata* | | | | | | |
| *Surirella poss elegans* | | | | | | |
| *Surirella spendida* | | | | | | |
| *Tabellaria fenestrata* | 18 | 9 | 33 | 13 | 34 | 12 |
| *Tabellaria flocculosa* strain III | 16 | 74 | 44 | 72 | 46 | 72 |
| *Tabellaria flocculosa* strain IIIp | | 12 | | 8 | | 12 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | | |
| *Tabellaria flocculosa* strain IV | 18 | 25 | | 26 | | 23 |
| *Tabellaria flocculosa* var. *linearis* | 29 | | | | | |
| *Tabellaria quadriseptata* | 23 | | 41 | | 37 | |
| *Tabellaria ventricosa* | | 22 | 12 | 24 | 16 | 21 |

## Appendix E

**Raw diatom counts. Abbreviations: '-T' re**

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Whimsical-B** | **William-T** | **William-B** | **Williams-T** | **Williams-B** |
| | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 22-22.5 cm |
| *Achnanthes bahusiensis* | | | | | |
| *Achnanthes biosolettianum* var. *subatomus* | | | | | |
| *Achnanthes chlidanos* | | | | 27 | |
| *Achnanthes curtissima* | 4 | 17 | | | |
| *Achnanthes impexiformis* | | | | 8 | |
| *Achnanthes minutissima* var. *inconspicud* | | | | | |
| *Achnanthes* spp. 3 | | | | | |
| *Achnanthes stewartii* | | | | | |
| *Achnanthidium biasole lettianum* var. *subatomus* | | | | | |
| *Achnanthidium minutissimum* | | | | | |
| *Actinella brasiliensis* | | | | | |
| *Actinella punctata* | 7 | | | | 48 |
| *Amphora ovalis* | 37 | | | | |
| *Amphora pediculus* | | | | | |
| *Anomoenis brachysira* | | | | | |
| *Asterionella formosa* | | 18 | 38 | | 34 |
| *Asterionella ralfsii* var. *americana* | | | | 3 | 17 |
| *Aulacoseira ambigua* | | 78 | 84 | | |
| *Aulacoseira crassipunctata* | 72 | | | 2 | |
| *Aulacoseira distans* | 34 | 2 | 14 | 52 | 22 |
| *Aulacoseira distans* var. *nivalis* | | | | | |
| *Aulacoseira granulata* | | | | | |
| *Aulacoseira italica* | | | | | |
| *Aulacoseira lacustris* | | | | | |
| *Aulacoseira lirata* | 8 | | | 18 | |
| *Aulacoseira nygaardii* | | 4 | 4 | | |
| *Aulacoseira perglabra* | | 8 | 2 | | 42 |
| *Brachysira brebissonii* | 19 | | 9 | 18 | |
| *Brachysira follis* | | | | | |
| *Brachysira intermedia* | | | | | |
| *Brachysira manfredii* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Whimsical-B 16-16.5 cm | William-T 0-0.5 cm | William-B 25-25.5 cm | Williams-T 0-0.5 cm | Williams-B 22-22.5 cm |
| *Brachysira neoexilis* | 14 | 7 | 2 | 22 | |
| *Brachysira poss procera* | | | | | |
| *Brachysira serians* | 7 | | | 18 | 3 |
| *Brachysira styriaca* | 28 | | | 62 | 75 |
| *Caloneis bacillum* | | | | | |
| *Caloneis silicula* | | | | | |
| *Cavinula cocconeiformis* | 33 | | | 8 | |
| *Cavinula pseudoscutiformis* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Chamaepinnularia bremensis* | | | | | |
| *Chamaepinnularia mediocris* | | | | | |
| *Cocconeis poss neothumensis* | | | | | |
| *Craticula cuspidata* | | | | | |
| *Cyclotella bodanica* | | | | | |
| *Cyclotella bodanica* var. *lemanica* | | 94 | 54 | 112 | |
| *Cyclotella michiganiana* | | | | | |
| *Cyclotella stelligera* | 128 | 12 | 5 | 257 | 2 |
| *Cymbella hungarica* | | | | | |
| *Cymbella incerta* | | | | | |
| *Cymbella schubartoides* | | | | | |
| *Cymbella* spp. | | | | | |
| *Cymbopleura subcuspidata* | | | | | |
| *Diatoma anceps* | | 4 | | | |
| *Diatoma mesodon* | | | | | |
| *Diatoma tenue* | 27 | 12 | | 4 | |
| *Diploneis marginestriata* | | | | 8 | |
| *Diploneis parma* | | | | | |
| *Encyonema herbidicum* | | | | | |
| *Encyonema lunatum* | | | | 18 | 9 |
| *Encyonema minutum* | 14 | | | 48 | 36 |
| *Encyonopsis cesatii* | | | | | |
| *Eucocconeis depressa* | | | | | |
| *Eunotia arcus* | | | | 19 | 37 |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Whimsical-B 16-16.5 cm | William-T 0-0.5 cm | William-B 25-25.5 cm | Williams-T 0-0.5 cm | Williams-B 22-22.5 cm |
| *Eunotia bidentula* | | | 8 | | 36 |
| *Eunotia bigibba* | | | | | |
| *Eunotia bilunaris* var. *mucophila* | | | | | |
| *Eunotia carolina* | 18 | | | | 8 |
| *Eunotia curvata* | | | | | |
| *Eunotia curvata f . bergii* | | | | | |
| *Eunotia elegans* | 23 | | | 7 | |
| *Eunotia exigua* | 43 | 7 | 34 | 52 | 64 |
| *Eunotia faba* | | | | | 8 |
| *Eunotia fallax* | 8 | | | | |
| *Eunotia flexulosa* | 24 | | | 14 | |
| *Eunotia flexulosa* (straight) | 33 | | | 13 | |
| *Eunotia formica* | | | | | |
| *Eunotia hexiglyphis* | | | | | |
| *Eunotia implicata* | | | | | 22 |
| *Eunotia incisa* | | | | 9 | |
| *Eunotia intermediata* | | | | | |
| *Eunotia latriensis* | | | | | |
| *Eunotia major* | | | | | |
| *Eunotia parallela* var. *parallela* | | | | | |
| *Eunotia pectinalis* var. *pectinalis* | | | 4 | 22 | 22 |
| *Eunotia pectinalis* var. minor | | | | | |
| *Eunotia pectinais* var. *ventricosa* | | | | | |
| *Eunotia poss teineckii* | | | | | |
| *Eunotia praerupta* | | | | | |
| *Eunotia serra* | 9 | | | | 22 |
| *Eunotia serra* var. *tetrado* | | | | | |
| *Eunotia zasumensis* | | | | | |
| *Fragilaria brevistriata* | 87 | | | | |
| *Fragilaria capucina* | | 2 | 14 | | |
| *Fragilaria capucina* var. *amphicephala* | | | | | |
| *Fragilaria capucina* var. *rumpens* | | | | | |
| *Fragilaria capucina* var. *gracilis* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | **Whimsical-B** | **William-T** | **William-B** | **Williams-T** | **Williams-B** |
| | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 22-22.5 cm |
| *Fragilaria construens f. exigua* | 39 | | | | |
| *Fragilaria elliptica* | 58 | | | | 12 |
| *Fragilaria elliptica (girdles)* | | | | | |
| *Fragilaria oldenbergiana* | | | | | |
| *Fragilaria parasitica* | | | | | |
| *Fragilaria pinnata* | 113 | | | | |
| *Fragilaria polygonata* | | | | 7 | |
| *Fragilaria pulchella* | | | | | |
| *Fragilaria* spp. 5 | | 2 | | | |
| *Fragilaria tenera* | | | | | |
| *Fragilaria ulna* var. *acus* | 84 | | | | |
| *Fragilariforma acidobiontica* | | | | | 8 |
| *Fragilariforma constricta* | 13 | | | 4 | |
| *Fragilariforma constricta f. stricta* | | | | | |
| *Fragilariforma exigua* | 54 | 37 | 27 | 22 | 8 |
| *Fragilariforma exigua* (girdles) | 1 | | | | |
| *Fragilariforma hungarica* var. *tumida* | | | | | |
| *Fragilariforma lata* | 17 | 1 | 14 | 49 | 9 |
| *Frustulia bahlsii* | | | | | |
| *Frustulia crassinervia* | | | | | |
| *Frustulia pseudomagaliesmontana* | | | | | |
| *Frustulia rhomboides* | 23 | | | 26 | 17 |
| *Frustulia saxonica* | 27 | 6 | | 32 | 54 |
| *Gomphonema acuminatum* | | | | | |
| *Gomphonema angustatum* | | | | | |
| *Gomphonema gracile* | 9 | | | | |
| *Gomphonema minutum* | | | | | |
| *Gomphonema parvulum* | 27 | | | 3 | |
| *Gomphonema truncatum* | | | | | |
| *Gyrosigma acuminatum* | | | | | |
| *Gyrosigma obscurum* | 17 | | | | |
| *Hantzschia rhaetica* | | | | | |
| *Kobayasia subtillissima* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Whimsical-B | William-T | William-B | Williams-T | Williams-B |
| | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 22-22.5 cm |
| *Melosira arentii* | | | | | |
| *Meridian circulare* | | | | | |
| *Navicula constans* | | | | | |
| *Navicula cryptocephala* | | | | | |
| *Navicula expecta* | 8 | | | 12 | 7 |
| *Navicula halophila* | | | | | |
| *Navicula helensis (Fallacia helensis)* | | | | | |
| *Navicula impexa* | | | | | |
| *Navicula leptostriata* | 35 | | | 22 | 8 |
| *Navicula lundi* | | | | | |
| *Navicula poss bottnica* | | | | | |
| *Navicula pseudolanceolata* | | | | | |
| *Navicula radiosa* | | 4 | | | |
| *Navicula schumassmanni* | | | | | |
| *Navicula stroemii* | | | | | |
| *Neidium affine* | | | | | |
| *Neidium bisulcatum* | | | | | |
| *Neidium bisulcatum* var. *baicalense* | | | | | |
| *Neidium bisulcatum* var. *bisulcatum* | | | | | 32 |
| *Neidium densestriatum* | | | | | |
| *Neidium iridis* | | | | | |
| *Neidium poss holstii* | 33 | | | | |
| *Nitzschia filiformis* | | | | | |
| *Nitzschia gracilis* | 17 | | 14 | 27 | |
| *Nitzschia intermedia* | | | | | |
| *Nitzschia microcephala* | | 3 | | 22 | |
| *Nitzschia nana* | | | | | |
| *Nitzschia perminuta* | | | | | |
| *Nitzschia recta* | | | | | |
| *Nitzschia suchlandtii* | | | | | |
| *Nitzschia vermicularis* | | | | | |
| *Oxyneis binalis* | | | | | |
| *Pinnularia archospaeria* var. *turgidula* | | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Whimsical-B | William-T | William-B | Williams-T | Williams-B |
| | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 22-22.5 cm |
| *Pinnularia biceps* | | | | 8 | 4 |
| *Pinnularia brauniana* | | | | | |
| *Pinnularia cardinalis* | | | | | |
| *Pinnularia claviculiformes* | | | | | |
| *Pinnularia divergens* | | | | | |
| *Pinnularia divert gentissima* var. *subrostrata* | | | | | |
| *Pinnularia gibba* | | | | | |
| *Pinnularia gibbiformis* | | | | | |
| *Pinnularia kwacksii* | | | | | |
| *Pinnularia legumen* | | | | | |
| *Pinnularia microstauron* | 14 | | 2 | | 18 |
| *Pinnularia microstauron* var. *non fasciata* | | | | | |
| *Pinnularia nobilis* var. *linearis* | | | | | |
| *Pinnularia nobilis vilincaris* | | | | | |
| *Pinnularia nodosa* | | | | | |
| *Pinnularia polynoca* | | | | | |
| *Pinnularia silvatica* | | | | | |
| *Pinnularia subgibba* | 8 | | | | |
| *Pinnularia subgibba* var. *undulata* | | | | | |
| *Pinnularia subrupestris* | | | | | |
| *Pinnularia viridiformis* var. morph I | | | | | |
| *Psammothidium bioretii* | | | | | |
| *Psammothidium levanderi* | | | | | |
| *Psammothidium subatomoides* | | | | | |
| *Pseudostaurosira brevistriata* | | | | | |
| *Pseudostaurosira parasitia* | | | | | |
| *Sellaphora pupula* var. *pupula* | | | | | |
| *Semiorbis hemicyclus* | | | | 52 | 52 |
| *Stauroneis anceps* | | | | 18 | 7 |
| *Stauroneis construens* | | | | | |
| *Stauroneis nobilis* var. *gracilis* | | | | | |
| *Stauroneis phoenocenteron* | 21 | | | 2 | |
| *Staurosira construens* | 75 | | | | |

| Taxa | Interval | | | | |
|---|---|---|---|---|---|
| | Whimsical-B | William-T | William-B | Williams-T | Williams-B |
| | 16-16.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 22-22.5 cm |
| *Staurosirella pinnata* | | | | | |
| *Staurosirella pinnata* var. *trigona* | 26 | | | | |
| *Stenopterobia anceps* | 7 | | | | |
| *Stenopterobia curvula* | 37 | | | 6 | 9 |
| *Surirella amphioxis* | 9 | 7 | | 9 | 8 |
| *Surirella angustua* | | | | | |
| *Surirella cuspidata* | 11 | | | | |
| *Surirella linearis* | | 17 | | | |
| *Surirella pinnata* | | | 16 | | |
| *Surirella poss elegans* | | | | | |
| *Surirella spendida* | | | | | |
| *Tabellaria fenestrata* | 34 | 18 | | 82 | 48 |
| *Tabellaria flocculosa* strain III | 42 | | | 27 | 74 |
| *Tabellaria flocculosa* strain IIIp | | 122 | 97 | 6 | 32 |
| *Tabellaria floccuosa* strain IIIp (girdles) | | | | | |
| *Tabellaria flocculosa* strain IV | | 7 | 34 | 22 | 52 |
| *Tabellaria flocculosa* var. *linearis* | | | 36 | | 49 |
| *Tabellaria quadriseptata* | 39 | | 44 | 7 | |
| *Tabellaria ventricosa* | 12 | | | | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Russell-T** | **Russell-B** | **Governor-T** | **Governor-B** | **Papermill-T** | **Papermill-B** |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Achnanthes chilidanos* | | | 6 | 1 | 1 | 1 |
| *Achnanthes flexella flexella* | | | | | | |
| *Achnanthes lanceolata* ssp. *frequentissima* | | 1 | | | | |
| *Achnanthes levanderi* | 3 | 1 | | | | |
| *Achnanthes minutissima* | 3 | 1 | | | | |
| *Achnanthes minutissma inconspucia* | 3 | | | | | |
| *Achnanthidium minutissimum* | | | 6 | 4 | 12 | 1 |
| *Actinella punctata* | | | | | | |
| *Asterionella formosa* | 12 | 115 | | 7 | | |
| *Asterionella ralfsii* var. *americana* | | | 18 | 125 | | |
| *Aulacoseira ambigua* | 45 | 94 | | | | |
| *Aulacoseira crassipunctata* | | | | 2 | 5 | |
| *Aulacoseira distans* | 1 | 1 | 45 | 22 | 22 | 7 |
| *Aulacoseira distans nivalis* | | | | 4 | | |
| *Aulacoseira granulata* | 3 | 28 | | | | |
| *Aulacoseira lirata* | | | 14 | 11 | 2 | 11 |
| *Aulacoseira nygaardii* | | 4 | | | 5 | 1 |
| *Aulacoseira perglabra* | | | | | | |
| *Brachysira brebissonii* | | | 4 | 3 | 14 | 48 |
| *Brachysira styriaca* | | | | | | 2 |
| *Brachysira vitrea* | | | | | 9 | 2 |
| *Cavinula coccneiformis* | | | | | 1 | |
| *Cavinula pseudoscutiformes* | | | | | | |
| *Cocconeis neothumensis* | | | | | | |
| *Cocconeis placentula* | 2 | | | | | |
| *Craticula halophila* | | | | | | |
| *Cyclostephanodiscus invistatus* | 15 | 13 | | | | |
| *Cyclotella bodanica* | 4 | 2 | | | | |
| *Cyclotella bodanica* var. *lemanica* | | | | | 2 | |
| *Cyclotella meneghiniana* | 8 | 7 | | | | |
| *Cyclotella pseudostelligra* | 6 | 6 | | | | |
| *Cyclotella stelligera* | 3 | 12 | 49 | | 2 | 2 |
| *Cymbella incerta* | | | 1 | | 5 | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | Russell-T 0-0.5 cm | Russell-B 25-25.5 cm | Governor-T 0-0.5 cm | Governor-B 25-25.5 cm | Papermill-T 0-0.5 cm | Papermill-B 25-25.5 cm |
| *Cymbella naviculiformis* | | | | | 2 | |
| *Diatoma tenuis* | 1 | 3 | | | | |
| *Diploneis marginestrata* | | | | | | |
| *Diploneis parma* | 1 | | | | | |
| *Encyonema hebridicum* | | | | | | 1 |
| *Encyonema lunatum* | | | | | 1 | 2 |
| *Encyonema minutum* | | | 3 | | 2 | 5 |
| *Eunotia bactriana* | | | | | | 2 |
| *Eunotia bilunaris mucophila* | | | 1 | 3 | 2 | 11 |
| *Eunotia curvata bergii* | | | 2 | 2 | 7 | 8 |
| *Eunotia elgans* | | | | | 5 | 2 |
| *Eunotia exigua* | | | 13 | 3 | 5 | 13 |
| *Eunotia faba* | | | | | 4 | |
| *Eunotia flexuosa* | 1 | | | | 4 | |
| *Eunotia iatriensis* | | | | 1 | | 4 |
| *Eunotia implicata* | | | | | | |
| *Eunotia incisa* | | 1 | | | 7 | |
| *Eunotia microcephala* | | | 1 | | | |
| *Eunotia pectinalis* | | | | | 5 | 13 |
| *Eunotia pectinalis minor* | | | 4 | 1 | | |
| *Eunotia pectinalis ventricosa* | | | | | 1 | |
| *Eunotia praerupta* | | | | 2 | | 7 |
| *Eunotia puncstriatum* | | | | 1 | | |
| *Eunotia rhomboidea* | | | | 2 | 2 | |
| *Eunotia tenella* | | | | | 1 | 8 |
| *Eunotia zasuminensis* | | | | | | |
| *Fragilaria capucina gracilis* | | | | | | 2 |
| *Fragilaria capucina rumpens* | 1 | | | 18 | | |
| *Fragilaria exigua* | 19 | 3 | | | | |
| *Fragilaria parisitica parisitica* | | 1 | | | | |
| *Fragilaria pinnata* | 3 | 2 | | | | |
| *Fragilaria polygonata* | | | | 1 | | |
| *Fragilaria suboldenburgiana* | | | | | 5 | |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Russell-T** 0-0.5 cm | **Russell-B** 25-25.5 cm | **Governor-T** 0-0.5 cm | **Governor-B** 25-25.5 cm | **Papermill-T** 0-0.5 cm | **Papermill-B** 25-25.5 cm |
| *Fragilaria tenera* | | | 46 | | | |
| *Fragilaria ulna var. acus* | 3 | 3 | | | | |
| *Fragilariforma acidobiontica* | | | | | | 9 |
| *Fragilariforma constricta* | | | | 2 | 4 | |
| *Fragilariforma constricta stricta* | | | | | 2 | |
| *Fragilariforma exigua* | | | 15 | 1 | 85 | 25 |
| *Fragilariforma hungarica tumida* | | | | | | |
| *Fragilariforma lata* | | | | | | 2 |
| *Frustulia crassinervia* | | | | | 1 | |
| *Frustulia pseudomagaliesmontana* | | | 1 | | | 2 |
| *Frustulia rhomboides* | | | | 2 | 3 | 7 |
| *Frustulia saxonica* | | | | | 2 | 18 |
| *Gomphonema parvulum* | | 1 | | | 1 | 5 |
| *Gomphonema truncatum* | | | | | | |
| *Gyrosigma acuminen* | | | | | 1 | |
| *Kobayasiella subtilissima* | | | | 1 | | 3 |
| *Melosira arentii* | | | | | | |
| *Meridion circulare* | | | | | 4 | |
| *M. krasskei* | | | | | | |
| *Navicula agrestis* | | | 1 | | | |
| *Navicula indifferns* | | 1 | | | | |
| *Navicula kuelbsii* | | | | | | |
| *Navicula leptostriata* | | | 3 | | 3 | 3 |
| *Navicula mediocris* | | | 1 | | | |
| *Navicula pseudolanceolata* | | | | | | |
| *Navicula seminuloides* | 1 | | | | | |
| *Neidium affine* | | | | | 1 | 2 |
| *Neidium iridis* | | | | | | 1 |
| *Nitzschia gracilis* | | | | | | 1 |
| *Nitzschia microcephala* | | | 4 | 4 | 3 | |
| *Nitzschia recta* | | | 5 | 1 | 8 | |
| *Nitzschia vermiculatis* | | | | | | |
| *Peronia fibula* | | | | | | 1 |

| Taxa | Interval | | | | | |
|---|---|---|---|---|---|---|
| | **Russell-T** 0-0.5 cm | **Russell-B** 25-25.5 cm | **Governor-T** 0-0.5 cm | **Governor-B** 25-25.5 cm | **Papermill-T** 0-0.5 cm | **Papermill-B** 25-25.5 cm |
| *Pinnularia biceps* | | | | | | |
| *Pinnularia biceps pusilla* | | | | 3 | | |
| *Pinnularua gibba* | | | 1 | | | 1 |
| *Pinnularia major* | 1 | | | | | |
| *Pinnularia microstauron adirondackensis* | | | | | | 2 |
| *Pinnularia nodosa* | | | | | | 3 |
| *Pinnularia pogoii* | | | | | 1 | 1 |
| *Pinnularia subcapitata* | | | | | 1 | |
| *Pinnularia substomatophota* | | | | 1 | | |
| *Psammothidium levanderi* | | | 1 | 16 | 2 | 3 |
| *Pseudostaurosira brevistriata* | | | | | | |
| *Rossithidium pusillum* | | | | | | |
| *Sellaphora pupula* | | | 1 | | | |
| *Semiorbis hemicyclus* | | | | 1 | 6 | 32 |
| *Stauroneis anceps* 1 PIRLA | | | | | | 1 |
| *Stauroneis nobilis gracilis* | | | 1 | | 2 | 1 |
| *Stauroneis phoenicenteron* | | | | | | |
| *Staurosira construens* | | | | | | 2 |
| *Staurosirea pinnata trigona* | | | | | | |
| *Stenopterobia curvata* | | | | 1 | 1 | 1 |
| *Stenopterobia delicatissima* | | | 1 | 1 | 6 | |
| *Surirella linearis* | | | | 1 | | |
| *Surirella linearis constricta* | | | | | | |
| *Surirella splendida* | | | 2 | | | |
| *Surirella spiralis* | | | | | | |
| *Tabellaria binalis* | | | | | 2 | 5 |
| *Tabellaria flocculosa* strain III | 2 | 1 | 2 | 44 | 6 | 9 |
| *Tabellaria flocculosa* strain IIIp | | | | | 2 | |
| *Tabellaria flocculosa* strain IV | | 2 | 1 | 1 | 2 | 1 |
| *Tabellaria flocculosa* var. *linearis* | | | | | | |
| *Tabellaria quadriseptata* | | | | 1 | 3 | 7 |
| *Urosolenia eriensis* | | | 23 | | | |

| Taxa | Interval | | | |
|---|---|---|---|---|
| | Kearney-T<br>0-0.5 cm | Kearney-B<br>25-25.5 cm | Morris-T<br>0-0.5 cm | Morris-B<br>25-25.5 cm |
| *Achnanthes chilidanos* | 3 | 2 | | 1 |
| *Achnanthes flexella flexella* | 2 | | | |
| *Achnanthes lanceolata* ssp. *frequentissima* | | | | |
| *Achnanthes levanderi* | | | | |
| *Achnanthes minutissima* | | | | |
| *Achnanthes minutissma inconspucia* | | | | |
| *Achnanthidium minutissimum* | 15 | | 45 | 12 |
| *Actinella punctata* | 2 | | | |
| *Asterionella formosa* | | | 81 | 3 |
| *Asterionella ralfsii* var. *americana* | 2 | 72 | | |
| *Aulacoseira ambigua* | | | 5 | 2 |
| *Aulacoseira crassipunctata* | | | | |
| *Aulacoseira distans* | 1 | 21 | | 27 |
| *Aulacoseira distans nivalis* | | | | |
| *Aulacoseira granulata* | | | | |
| *Aulacoseira lirata* | 22 | 15 | 1 | 14 |
| *Aulacoseira nygaardii* | 4 | 6 | | 6 |
| *Aulacoseira perglabra* | | | | 8 |
| *Brachysira brebissonii* | 8 | 4 | 3 | 1 |
| *Brachysira styriaca* | | | | |
| *Brachysira vitrea* | 3 | | | 3 |
| *Cavinula coccneiformis* | | 1 | | |
| *Cavinula pseudoscutiformes* | | | 2 | |
| *Cocconeis neothumensis* | | | 1 | |
| *Cocconeis placentula* | | | | |
| *Craticula halophila* | 2 | | 6 | |
| *Cyclostephanodiscus invistatus* | | | | |
| *Cyclotella bodanica* | | | | |
| *Cyclotella bodanica* var. *lemanica* | 18 | | | 24 |
| *Cyclotella meneghiniana* | | | | |
| *Cyclotella pseudostelligra* | | | | |
| *Cyclotella stelligera* | 4 | 2 | 71 | 7 |
| *Cymbella incerta* | 3 | | 1 | 1 |

| Taxa | Interval | | | |
| --- | --- | --- | --- | --- |
| | Kearney-T | Kearney-B | Morris-T | Morris-B |
| | 0-0.5 cm | 25-25.5 cm | 0-0.5 cm | 25-25.5 cm |
| *Cymbella naviculiformis* | 1 | | | |
| *Diatoma tenuis* | 7 | | 14 | |
| *Diploneis marginestrata* | | | | 3 |
| *Diploneis parma* | | | | |
| *Encyonema hebridicum* | | | | |
| *Encyonema lunatum* | | | | 1 |
| *Encyonema minutum* | | | 1 | |
| *Eunotia bactriana* | | | | |
| *Eunotia bilunaris mucophila* | | 3 | | 1 |
| *Eunotia curvata bergii* | 8 | 8 | | |
| *Eunotia elgans* | | | | |
| *Eunotia exigua* | 34 | 7 | | |
| *Eunotia faba* | | | | |
| *Eunotia flexuosa* | 6 | | | |
| *Eunotia iatriensis* | | | | |
| *Eunotia implicata* | | | | |
| *Eunotia incisa* | | | | |
| *Eunotia microcephala* | 1 | 1 | | |
| *Eunotia pectinalis* | 2 | 5 | | |
| *Eunotia pectinalis minor* | | | 1 | |
| *Eunotia pectinalis ventricosa* | | | | 6 |
| *Eunotia praerupta* | | | | |
| *Eunotia puncstriatum* | | | | |
| *Eunotia rhomboidea* | 6 | | 4 | 2 |
| *Eunotia tenella* | | | | |
| *Eunotia zasuminensis* | | 2 | | |
| *Fragilaria capucina gracilis* | | | | |
| *Fragilaria capucina rumpens* | 9 | | 13 | |
| *Fragilaria exigua* | | | | |
| *Fragilaria parisitica parisitica* | | | | |
| *Fragilaria pinnata* | | | | |
| *Fragilaria polygonata* | 1 | 1 | | |
| *Fragilaria suboldenburgiana* | 3 | | | |

| Taxa | Interval | | | |
| --- | --- | --- | --- | --- |
| | Kearney-T 0-0.5 cm | Kearney-B 25-25.5 cm | Morris-T 0-0.5 cm | Morris-B 25-25.5 cm |
| *Fragilaria tenera* | | | | |
| *Fragilaria ulna var. acus* | | | | |
| *Fragilariforma acidobiontica* | | | | |
| *Fragilariforma constricta* | | | | |
| *Fragilariforma constricta stricta* | 3 | | | |
| *Fragilariforma exigua* | 12 | 1 | 15 | 61 |
| *Fragilariforma hungarica tumida* | 1 | | | |
| *Fragilariforma lata* | 1 | 3 | 2 | |
| *Frustulia crassinervia* | | | | |
| *Frustulia pseudomagaliesmontana* | 6 | | | |
| *Frustulia rhomboides* | | | | |
| *Frustulia saxonica* | 3 | 1 | | 1 |
| *Gomphonema parvulum* | | 1 | | |
| *Gomphonema truncatum* | | | 1 | |
| *Gyrosigma acuminen* | | | | |
| *Kobayasiella subtilissima* | 2 | | | |
| *Melosira arentii* | 1 | | | |
| *Meridion circulare* | | | | |
| *M. krasskei* | | | | 1 |
| *Navicula agrestis* | | 1 | 1 | |
| *Navicula indifferns* | | | | |
| *Navicula kuelbsii* | | | | 3 |
| *Navicula leptostriata* | 5 | 4 | | 2 |
| *Navicula mediocris* | | | | 2 |
| *Navicula pseudolanceolata* | | | 7 | 1 |
| *Navicula seminuloides* | | | | |
| *Neidium affine* | | 1 | | |
| *Neidium iridis* | | | | |
| *Nitzschia gracilis* | | | | |
| *Nitzschia microcephala* | 7 | | 23 | 3 |
| *Nitzschia recta* | | | | 4 |
| *Nitzschia vermiculatis* | | | 6 | |
| *Peronia fibula* | 1 | | | |

| Taxa | Interval | | | |
|---|---|---|---|---|
| | **Kearney-T** 0-0.5 cm | **Kearney-B** 25-25.5 cm | **Morris-T** 0-0.5 cm | **Morris-B** 25-25.5 cm |
| *Pinnularia biceps* | 1 | | | |
| *Pinnularia biceps pusilla* | 1 | | | |
| *Pinnularua gibba* | | 1 | | |
| *Pinnularia major* | | | | |
| *Pinnularia microstauron adirondackensis* | | | | |
| *Pinnularia nodosa* | | | | |
| *Pinnularia pogoii* | | | | |
| *Pinnularia subcapitata* | | | | |
| *Pinnularia substomatophota* | | | | |
| *Psammothidium levanderi* | 3 | | | 11 |
| *Pseudostaurosira brevistriata* | | | | 1 |
| *Rossithidium pusillum* | 2 | | | 1 |
| *Sellaphora pupula* | | | | 1 |
| *Semiorbis hemicyclus* | | 3 | | |
| *Stauroneis anceps* 1 PIRLA | | | | |
| *Stauroneis nobilis gracilis* | | | | |
| *Stauroneis phoenicenteron* | | 1 | | |
| *Staurosira construens* | | | | |
| *Staurosirea pinnata trigona* | | | 1 | 1 |
| *Stenopterobia curvata* | 3 | | 4 | |
| *Stenopterobia delicatissima* | 5 | 1 | 12 | |
| *Surirella linearis* | | 1 | | 1 |
| *Surirella linearis constricta* | | | 2 | |
| *Surirella splendida* | | | | |
| *Surirella spiralis* | | | 1 | |
| *Tabellaria binalis* | | | | |
| *Tabellaria flocculosa* strain III | 3 | 125 | 3 | 13 |
| *Tabellaria flocculosa* strain IIIp | | | | |
| *Tabellaria flocculosa* strain IV | | | | |
| *Tabellaria flocculosa* var. *linearis* | | | | |
| *Tabellaria quadriseptata* | 4 | 2 | | |
| *Urosolenia eriensis* | | | | |