Paleolimnological assessment of Tchesinkut, Takysie and Francois lakes, British Columbia

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BACKGROUND

Eutrophication is a problem in many lake regions, as the export of limiting nutrients, such as phosphorus and nitrogen, to lakes has increased. Direct nutrient inputs include sewage, domestic detergents and industrial waste. Some inputs are more diffuse, such as from urban runoff, agricultural fertilizers, pastures, and erosion from road construction and deforestation. In British Columbia, a variety of mitigation methods have been proposed (Rysavy & Sharpe 1995) and applied (Henderson-Sellers & Markland 1987) in efforts to return lakes to their pre-impact water quality conditions. There is concern, however, that mitigation efforts may be being applied to naturally eutrophic lakes, for which restoration is unnecessary and probably futile. In such cases, more realistic targets should be set.

Mining activities have also seriously impacted some lake ecosystems (e.g. Horowitz et al. 1995; Fritz & Carlson 1982). In the past, mining wastes have been poorly treated, resulting in pollution by metal-contaminated runoff and groundwater. However, as in studies of eutrophication, metal contamination in lake ecosystems has been poorly monitored, and pollution histories are often unknown.

Because data on past lake conditions are lacking, paleolimnology is the only method available to determine the natural background conditions of disturbed lakes (Smol 1992). Moreover, it is the only method for reconstructing the effects of past cultural disturbances, as long-term monitoring data are usually lacking.

Paleolimnologists have repeatedly shown that lakes and their biota are very sensitive to events occurring within their catchments (Smol 1992). Briefly, paleolimnology deals with assessing the physical, chemical and biological indicators preserved in dated sedimentary profiles, and using these proxy data to infer past environmental conditions. The study of algal remains (especially diatoms) has allowed reliable reconstructions of eutrophication in BC (Reavie et al. 1995a,b; Hall & Smol 1992), as well as many other regions. Of the many biomarkers available to paleolimnologists, diatoms are the most widely used group of indicators for eutrophication research (Dixit et al. 1992). Diatom valves are particularly useful in paleolimnological studies because their siliceous cell walls are resistant to dissolution; diatom taxonomy is well defined, in that the size, shape, and sculpturing of their valves are taxon-specific; many species have well-defined environmental optima and tolerances; they are present in almost all aquatic environments, including lakes, rivers, wetlands, oceans and soils; and fossil assemblages are often abundant and diverse (Dixit et al. 1992).

Use of diatoms in paleolimnological studies of trends in lake trophic status can provide information to policy makers on the effects of cultural activities (Smol 1992). Quite often, human activities result in degradation of lakewater quality, and paleolimnology is the only way to determine the extent of environmental damage, as long-term monitoring data are almost never available. For example, Stockner & Benson (1967) used fossil diatoms to track ca. 80 years of sewage enrichment in Lake Washington. They observed a shift from *Melosira italica* to the eutrophic *Fragilaria crotonensis*, coinciding with the establishment of the city of Seattle. Suburban housing development was shown by Brugam (1978) to cause diatom communities to shift to hypereutrophic assemblages. Brugam & Vallarino (1989) evaluated trophic disturbance in short cores from four western Washington lakes, and demonstrated that prior to settlement and land perturbation, these lakes were oligotrophic. Following settlement, *Asterionella formosa*, an indicator of elevated nutrient concentrations, increased in abundance, corresponding to deforestation and land development in the lakes' watersheds. O'Sullivan (1992) documented the limnological consequences of sewage inputs, land use, fertilizer application and numbers of livestock, to infer 75 years of eutrophication trends in southwest England. The water quality in his study lake eutrophied from "permissible" to "dangerous" levels in the period from 1905-1980. Reavie et al. (1995a) used diatoms in a paleolimnological assessment of six inland BC lakes to determine that three of the lakes had become severely eutrophic due to human disturbance, whereas the other lakes were likely naturally eutrophic. These findings have important implications for lake management.

In a previous report, we inferred the eutrophication history of Tyhee Lake (report submitted April 1997). Tyhee Lake underwent a gradual increase in total phosphorus levels following human settlement. This current report presents a similar assessment of three more dimictic lakes from the same region. A recent environmental assessment of Takysie, Tchesinkut and Francois lakes (Northern BC) highlighted that they would make good subjects for paleolimnological study, primarily because of current concern over water quality by residents. While several lake management policies have been considered, the natural conditions of these lakes are still unknown. We document the diatom assemblages preserved in the recent sediments of ^{210}Pb-dated lake sediment cores, and, using recently-developed diatom transfer functions (Reavie et al. 1995b, B. Cumming et al. unpub. data), reconstruct past changes in lake trophic status. Additionally, we document the geochemistry of the Lake Francois cores, to track the effects of a large mining operation in the catchment.

STUDY REGION

The three study lakes are in close proximity to each other, within the same forest district, in the Caribou Aspen - Lodgepole Pine biogeoclimatic zone (Beil et al. 1976). This area is mainly a farming, ranching and logging community, and at Francois Lake, a molybdenum mine operates in the catchment.

Takysie Lake: Takysie Lake is a small (5.14 km^2), shallow, slightly alkaline, mesotrophic to eutrophic lake (Table 1) located in inland BC at 53°52' N, 125°49' W. The time of first human settlement in Takysie Lake's catchment is unknown, but most development is known to have occurred since ca. 1930, primarily at the west end of the lake. Small logging operations were undertaken in the catchment during the early 1960s, but more intensive logging occurred between 1979 and 1986. A small fire burned near the southern shore in ca. 1993. Extensive macrophyte growth and algal blooms have been noticed, and are often a symptom of eutrophic lake conditions. Potential sources of water quality degradation in Takysie Lake include leaking or failing septic systems, runoff from animal waste, fertilizers and residential (between 16 and 20 residents) and resort/campground use in the west end of the lake. Other issues of concern are shoreline and streambank erosion from grazing animals, sedimentation from forestry roads and reduction of flushing rate due to a beaver dam in Takysie Creek, upstream of the lake.

Tchesinkut Lake: Tchesinkut Lake is located north of Takysie and Francois lakes at 54°06' N, 125°41' W. It is a large (33.83 km^2), deep (Z_{max} = 149 m), alkaline lake with relatively low concentrations of nutrients in the water column (morphometric and chemical data are summarized in Table 1). Diameter-limited logging activities around Tchesinkut Lake occurred between ca. 1930 and 1960, and local sawmills were prominent between 1946 and 1952. In 1970, clear-cut logging methods began around the lake, and in 1989, a large aspen/cottonwood area on the north shore was cleared for wildlife enhancement purposes. Human settlement patterns are believed to have corresponded to logging activities, with most development occurring since ca. 1930. Human development in the catchment consists primarily of houses (approximately 75 residents), cottages, industries and agriculture, with the west end of the lake supporting greater development than the east end. Potential sources of water quality degradation are leaking or failing septic systems, sewage from small vessels, fertilizers, herbicides, road salt, animal waste and forestry activities. Inlets and outlets of the lake have also been partially blocked by beaver dams, likely resulting in modifications to flushing rate.

Francois Lake: Francois Lake is also located in the same region as the other study lakes (53°58' N, 126°23' W), but due to its great length, it extends into three forest districts (Morice, Vanderhoof and Lakes Forest Districts). This lake has a large surface area (258 km^2) in comparison to Takysie and Tchesinkut lakes (Table 1). Francois is also deep (Z_{max} = 244 m) and slightly alkaline, and recent measurements indicate that the lake is probably oligotrophic to mesotrophic (Table 1). The first recorded settlement of this area occurred in 1917, followed by an influx of settlers during the 1920s. By 1930, about 50 homes were present in the catchment. From 1919 to 1952, a herd of about 150 cattle ranged on the north shore, but the herd is currently between 2000 and 3000. The most extensive logging occurred between 1930 and 1960, when several small sawmills were constructed. Logs were boomed during this time, but this activity was eventually stopped due to damage to fish habitat. In the early 1930s, the first catchment fire was recorded, but between 1920 and 1950 the south slopes were burned annually to enhance grazing. Burning continued, albeit less frequently, until ~1975. Farming has continued steadily in the catchment. The Endako mining facility at the east end of the lake is the world's largest producer of molybdenum, and may be a potential source of contamination to surface water, ground water and sediments. The mine was in full production in 1965, but pit stripping may have occurred for several years before that time. In latter years, more stringent rules regarding effluent emissions have been implemented. Residents of Francois Lake's catchment are concerned that the following characteristics may cause water quality degradation: failing septic systems, animal waste, sewage from watercraft, fertilizers, herbicides, residential and resort/campground use, road salt, sedimentation from forestry roads, road construction, beaver dams and runoff of dust control chemicals.

MATERIALS AND METHODS

Five sediment cores were collected for this study: one core from Takysie lake (53°52'42.5" N, 125°49'34.5" W), two cores (east (54°05'38.5" N, 125°37'0" W) and west (54°06'3.5" N, 125°41'16.4" W)) from Tchesinkut Lake, and two cores (east (54°00'2.5" N, 125°3'44.4" W) and west (53°58'47.8" N, 126°23'19.2" W)) from Francois Lake. Cores of varying lengths (Takysie = 32 cm, Tchesinkut west = 39 cm, Tchesinkut east = 43 cm, Francois west = 40 cm, Francois east = 30 cm) were collected by Ministry personnel from deep basins of each lake using a Glew (1989) modified KB-type gravity corer equipped with a 6.35 cm inside diameter core tube. Each core was sectioned by Ministry personnel using a close-interval extruder (Glew 1988) and 1 cm slices were stored in Whirlpak® bags prior to subsampling. At PEARL, subsamples of sediment were taken for water, organic and mineral content analyses, ^{210}Pb dating, geochemical analyses (Francois Lake), and diatom preparation.

Chemical analyses

For ^{210}Pb analyses, sediment subsamples (approx. 30 g) of selected intervals were weighed, oven-dried (24 hr at 110 °C) and ground in a mortar. Samples were reweighed to determine dry weight and submitted to Mycore Ltd. The dating models were run at PEARL. ^{210}Pb dating is calculated from determinations of ^{210}Po, a decay product of ^{210}Pb. Quantitative measurements were made using alpha spectroscopy (Cornett et al. 1984). Unsupported ^{210}Pb was calculated by subtracting supported ^{210}Pb (the baseline ^{210}Pb activity naturally present in the sediments) from total activity at each level. Dates were then determined from unsupported isotopes using the constant rate of supply (C.R.S.) model (Appleby & Oldfield 1978); a computer program designed by Binford (1990) was used to perform these calculations. ^{210}Pb dating is limited to ~150 years before present, so extrapolations beyond this period were made based on calculated sediment accumulation rates for the lowest intervals of the core.

Sediment water, organic and mineral matter contents were determined by weight loss during 1 hour drying at 100 °C, 1 hour ignition at 550 °C, and residual weight after 1 hour ashing at 1000 °C, respectively (Dean 1974).

Sediment geochemical analyses (for Lake Francois sediments only) were performed according to methods currently documented in the Pacific Environmental Science Centre (1997) manual. Samples were dried at 60°C, sieved with a 150 µm mesh, finely ground and digested with nitric acid (HNO_3) and hydrochloric acid (HCl) in a microwave oven. Samples were cooled, settled and decanted. Analysis for each sample was then performed via inductively coupled argon plasma atomic emission spectrometry (ICP-AES) (simultaneous multi-element analysis), graphite furnace atomic absorption spectrometry (GF-AAS) (low level analysis) and cold vapour atomic fluorescence spectrometry (CV-AFS) (mercury analysis) (PESC 1997).

Diatom Preparation

For each core, 16 sediment intervals were selected for diatom analysis. Subsamples of wet sediment (0.3 - 1.0 g) were heated for one hour in a mixture of potassium dichromate and sulphuric acid to digest organic matter. Samples were then repeatedly washed in distilled water and allowed to settle until they were free of residual acid. The siliceous remains were settled onto coverslips, and the coverslips were mounted on glass slides using a permanent mounting medium (Naphrax®). For each slide, at least 300 diatom valves were identified and counted along transects under oil immersion at 1000X. Diatom taxonomy was based primarily on Krammer & Lange-Bertalot (1986, 1988, 1991a, b), Camburn et al. (1984-1986), and Patrick & Reimer (1966).

Inferring Total Lakewater Phosphorus

The diatom transfer functions we used to reconstruct lakewater total phosphorus concentration (TP) from fossil diatom assemblages were constructed by determining the relationship between water chemistry variables and diatom distributions in the surface sediments of BC lakes. Two models were used: 1) based on 64 calibration lakes, to reconstruct TP levels during the ice-free season (spring and summer) (Reavie et al. 1995b); and 2) based on 111 calibration lakes, to reconstruct late summer TP (B. Cumming et al. unpub. data). Briefly, the models operate as follows. Several BC lakes (a "training" or "calibration" set) were selected. One set contained 64 lakes, which were sampled during spring and summer seasons, and the other contained 111 lakes, which were sampled during late summer. At each lake, several physical (e.g. depth, surface area, watershed area, temperature) and chemical (e.g. total phosphorus, conductivity, salinity, oxygen, nitrates, etc.) environmental variables were measured. Surface sediment, containing the most recent fossil diatom assemblages, was also obtained from each lake. Once the diatom species were identified from each sample, the relationships between environmental variables and diatom assemblages were determined statistically (see review by Charles & Smol (1994) for details). Essentially, the environmental optima of the diatom taxa were determined. Variables (in this case, total phosphorus) with a strong influence on the species patterns in the diatom assemblages were deemed suitable for reconstructive applications. The transfer functions created by the merging of environmental and diatom data allows the inference of past (usually unknown) environmental conditions from fossil diatom assemblages in sediment cores.

Quantitative TP inferences were performed using the computer program WACALIB version 3.3 (Line et al. 1994). The distribution of TP measurements for both calibration sets (Reavie et al. 1995b, B. Cumming et al. unpub. data) was skewed toward the oligotrophic extreme of the spectrum, so calculations were performed using transformed (ln(TP + 1)) data (see Birks et al. 1990 or Birks 1995 for details). The diatom-inferred total phosphorus concentration (DI-TP) values generated by WACALIB were subsequently back-transformed.

Fit to TP and analog tests

Fossil diatom assemblages that exhibit a close relationship to TP concentration, or that have close modern analogues with calibration lake-set data, are likely to provide reliable qualitative and quantitative TP inferences. The following fit and analogue methods are described in detail by Birks et al. (1990), and have been applied to fossil data by Reavie et al. (1995a) and Hall & Smol (1993).

For determination of 'lack-of-fit' to TP, the residual distance of modern samples to the TP axis in a constrained canonical correspondence analysis (CCA; using the computer program CANOCO version 3.12) of each calibration lake-set provides a measure to assess the 'fit' of fossil samples to TP. Samples with high residual distance from the TP axis exhibit 'poor fit' to TP. When run passively, fossil samples were also positioned about the TP axis by means of transition formulae. Fossil samples with a residual distance greater than the distance of the extreme 10% of the calibration set were considered to have 'poor fit' to TP.

Analogue matching was used to identify fossil diatom assemblages with poor analogy to modern assemblages in the calibration lake sets. Briefly, a dissimilarity index (χ^2) was used to compare every fossil sample with all calibration samples. Using Monte Carlo permutation tests, fossil samples with a minimum squared χ^2 greater than the extreme 5% of the squared χ^2 for the modern samples were considered to have no 'good' modern analogue. These calculations were performed using the computer program ANALOG version 1.6 (Line & Birks unpublished program).

RESULTS AND INTERPRETATIONS

Fit to TP and analogue tests

Three lines of evidence suggest our diatom-inferred TP concentrations should be reliable. First, the 167 diatom taxa included in the spring TP inference model (Reavie et al. 1995b) included 89% or more of the diatom sum in each of the fossil samples, indicating a good overlap between modern and fossil samples. For the 111-lake late summer TP inference model, this overlap was at least 84%. Second, sediment diatom samples exhibited a 'good fit' to TP in a constrained CCA of the BC training sets, except for the following samples: 31-32 cm, Takysie Lake core (poor fit to late-summer TP); 29-30 cm, Tchesinkut Lake west core (poor fit to spring TP). Third, all fossil diatom assemblages had 'good' modern analogues within the calibration lake sets.

^{210}Pb and sediment accumulation

Geochronological analyses indicated fairly consistent sequences of sediment accumulation. Increases in ^{210}Pb concentration from bottom to surface sediments were measured in each core (Fig. 1), hence we are confident that relatively undisturbed sedimentary profiles have been obtained. Both Tchesinkut Lake cores show typical exponential profiles, as would be expected if accumulation rate remained relatively constant (Binford 1990). Replicate cores for Tchesinkut Lake have almost identical depth/time relationships (e.g. ca. 1900 occurs at approximately 12 cm depth in each core), suggesting that accumulation rate has been similar in the east and west cores. Replicate cores for Francois Lake exhibit similar rates of sediment accumulation (i.e. background ^{210}Pb concentrations were reached at a much shallower depth in the east core). Accumulation rates were also fairly consistent, but since ~1850, rates have gradually decreased. The Takysie Lake core does not provide a typical ^{210}Pb profile. Above the 30 cm interval, the increase of ^{210}Pb is nearly linear, indicating that the rate of sediment accumulation has likely been increasing in Takysie lake, resulting in greater dilution of ^{210}Pb near the surface of the core. Accumulation rates for the Takysie Lake core also suggest an increase in sediment deposition since ca. 1900. ^{210}Pb counts were converted to calendar years, and it appears that each core represents more than 150 years of sediment accumulation.

Takysie Lake

Sediment characteristics

Takysie Lake's geochemical profile indicates that water content gradually decreased downcore, reflecting increasing compaction of the lower sediments (Fig. 2). Organic content (LOI) was highest during the mid-1800s, followed by a decrease to 28.2% at ca. 1970, and a subsequent increase until the surface of the core (1997). Carbonates fluctuated between 3.5 and 5.8% until ca. 1980, and increased to 7.0% at the surface interval. These fluctuations in organic material and carbonates may indicate temporal variations in inputs to the lake, such as elevated organic and inorganic carbon inputs during the last decade, or by autochthonous processes. However, the ranges of fluctuations were relatively narrow (7% for LOI, 3.5% for carbonates), so such interpretations should be made with caution.

Qualitative Assessment of Diatoms

A total of 141 diatom taxa were identified in the Takysie Lake core. Fifteen 'common' diatom taxa were identified in the Takysie Lake core (Fig. 3; 'common' species were presented in diatom profiles if they occurred at ≥3% in any interval). Sediment deposited before ca. 1900 was already dominated by the eutrophic centric taxon *Stephanodiscus parvus*. Several other eutrophic taxa were also present at lower relative abundance (*S. hantzschii*, *S. minutulus*, *Asterionella formosa* and *Fragilaria crotonensis*, among others). Presuming that anthropogenic impacts on this lake were minor prior to ca. 1900, it is likely that Takysie Lake is naturally eutrophic. Between ca. 1900 and ca. 1965, *Stephanodiscus* taxa decreased in relative abundance, to be partially replaced by several benthic (e.g. *Fragilaria pinnata*) and tychoplanktonic (e.g. *Tabellaria quadriseptata*) taxa. These shifts occurred when first settlement occurred in the area, and it might reflect an expansion of littoral habitat, such as the increased abundance of macrophytes (Reavie & Smol 1997; Douglas & Smol 1995). Between ca. 1960 and ca. 1985, *Stephanodiscus* taxa again dominated in relative abundance, but these diatoms again declined, and by 1997, the eutrophic *F. crotonensis* comprised the largest portion of the population. *Stephanodiscus parvus* and *F. crotonensis* are both considered eutrophic taxa, and multi-species calibration approaches (Reavie et al. 1995b; Wunsam & Schmidt 1995) rank these taxa with similar nutrient (i.e. total phosphorus concentration) optima. Hence, this recent change reflects continued high nutrient conditions, but eutrophication has probably not been severe.

Total Phosphorus Reconstruction

To reiterate, the 64-lake model (Reavie et al. 1995b) reconstructs spring/summer TP because environmental measurements from those seasons were related to diatom assemblages for the construction of the transfer function. Meanwhile, the 111-lake model (B. Cumming et al. unpub. data) reconstructs late summer TP, because the lake set, and associated limnological data, were sampled in late summer.

Diatom-inferred total phosphorus concentration (DI-TP), using the Reavie et al. (1995b) model, indicates that Takysie was likely a mesotrophic lake prior to the ca. 1950s, as spring DI-TP fluctuated between 17 and 18.2 μg L^{-1} during this time (Fig. 4). The interval between ca. 1950 and ca. 1993, which was characterized by increased human development and logging in the catchment, is marked by a slightly higher DI-TP, with concentrations fluctuating between 22.8 and 25.1 μg/L. DI-TP for the surface interval suggests continued eutrophication, reaching 27.9 μg/L. This recent inferred eutrophication was influenced by the recent increase in *Fragilaria crotonensis*, which has a TP optimum within the eutrophic range, according to Reavie et al. (1995b)'s calibration data.

Late-summer DI-TP suggests a very different trend than that reconstructed for spring. The basal interval, which probably represents the early 1800s, suggests a relatively high (30.7 μg/L) pre-disturbance TP. This reconstruction may be unreliable, however, as the basal interval contained an anomalously high abundance of planktonic diatoms (particularly *Stephanodiscus* *parvus*). Reasons for this occurrence are difficult to assess, but further confirms that Takysie Lake is naturally productive. A post-settlement increase in summer TP is not suggested by this profile, as levels fluctuated between 4.8 and 19.7 μg/L, below the eutrophic range (Wetzel 1983). Such lower summer levels of TP are typical for a dimictic lake such as Takysie. As a dimictic lake stratifies during the summer, pelagic nutrients become depleted by competitive planktonic organisms (primarily green and blue-green algae), resulting in reduced levels of TP during the late summer/early fall months.

In summary, increased anthropogenic nutrients appear to have resulted in some eutrophication during spring months. However, prior to human settlement, Takysie Lake was probably already a mesotrophic system. Human influences have had relatively little impact on this system.

Tchesinkut Lake

Sediment characteristics

Tchesinkut Lake's sedimentary profiles indicate that water content gradually decreased downcore, reflecting increasing compaction of the lower sediments (Fig. 5). Organic content (LOI) of the east core increased gradually from ~10.5 to 16.0% from basal to surface sediments. The west core shows erratic ~20-year fluctuations in LOI throughout this profile, but a fitted line roughly concurs with the east core profile. The wider range of organic content observed in the west core might reflect variations in sedimentation patterns, possibly resulting from greater human activity and development in the west end of the lake. Carbonate composition of the sediments outlines a recent gradual increase in the sediments of the east core. In contrast, carbonates in the west core fluctuate erratically throughout the 39-cm profile, with no obvious increasing trend. Like the Takysie Lake carbonate profiles, however, the range of carbonate proportions occurred within a narrow range (2.2%), so conclusions based on these data would be suspect.

Qualitative assessment of diatoms

One hundred and forty nine diatom taxa were identified in sediments from Tchesinkut Lake. Despite some variation in species proportions between the west and east cores, the diatom flora profiles of the two cores are similar (Figs. 6, 7). Hence, the west and east cores are discussed together in this section.

Diatoms of both cores from Tchesinkut Lake reveal rather monotonous histories of relatively stable diatom assemblages (Figs. 6, 7). *Aulacoseira subarctica*, a heavy, mesotrophic (Reavie et al. 1995b) plankter, was the dominant contributor to the diatom assemblages in both cores. Secondarily, the eutrophic *Stephanodiscus minutulus* was also abundant. The basal portions of these cores represent at least 100 years of pre-settlement sedimentation, so it is very likely that Tchesinkut is a naturally productive system. Furthermore, peaks in the relative abundance of some species (e.g. *A. subarctica* in the 28-29 cm interval of the east core, and at 29-30 cm in the west core; *S. minutulus* at 35-36 cm in the west core) prior to extensive human development of the catchment, are of similar magnitude to peaks observed during the 1900s. Hence, most fluctuations in diatom relative abundance may not be attributed to nutrient inputs during the 20th century. Nonetheless, the following exception might represent recent anthropogenic changes in nutrient status. Since ca. 1980, the eutrophic diatom *Asterionella formosa* increased in both cores, corresponding to when large-scale clear-cut deforestation projects occurred. *Asterionella formosa* has been a common indicator of anthropogenic eutrophication in several paleolimnological investigations (e.g. Engstrom et al. 1985; Brugam 1988; O'Sullivan 1992; Wolin et al. 1991). However, Sabater & Haworth (1995) noted that high TP favoured the abundance of *Aulacoseira subarctica* over *A. formosa*. Hence, although the recent increase in *A. formosa* is relatively minor, it might reflect a water quality improvement trend in Tchesinkut Lake. Further monitoring of this system is suggested in order to clarify this recent ecological change.

Total phosphorus reconstruction

As observed in the diatom profiles, it appears that there have been no noteable ecological changes within the time periods covered by the two profiles (Fig. 8). Fluctuations in DI-TP cover a wide range of TP concentration (27.6-42.2 μg/L in spring, 21.1-52.0 μg/L in late summer). However, drastic fluctuations in DI-TP occur prior to, and during, the apparent period of human development in Tchesinkut Lake's catchment. Inferred TP trends within the last ~15 years indicate a reduction of TP concentration, inferred primarily by the relatively low TP optimum for *Asterionella formosa*. As described above, this occurrence may suggest a slight improvement in response to rehabilitation measures. We suggest that, in light of the entire microfossil history of this lake, further monitoring be undertaken to determine the water quality trajectory. However, as in Takysie Lake, human activities have had relatively little impact on the lake's trophic status.

Francois Lake

Sediment characteristics

Water content in the sedimentary profiles of Francois Lake gradually decreased downcore, reflecting increasing compaction of the lower sediments (Fig. 9). Relative amounts of organic material fluctuated unpredictably (between 3 and 23% LOI) throughout both cores. Carbonates, on the other hand, gradually increased slightly from approximately 1.7% to about 2.6% in the post-settlement sediments. As in previous cores, this range is rather narrow, but may reflect an increase in inorganic carbon inputs from human activities.

Qualitative assessment of diatoms

We identified 159 diatom taxa in the sediment cores from Francois Lake. Little difference is observed between the diatom histories of the east and west cores from Francois Lake (Figs. 10, 11), so they are discussed together in this section. Although stratigraphic resolution is limited due to a low sedimentation rate (e.g. the 20th century is recorded in the uppermost 7 cm of the east core), broad changes in the diatom flora are obvious. Francois Lake's pre-settlement diatom assemblage is similar to that of Tchesinkut Lake. The dominant taxa prior to ca. 1900 were the mesotrophic *Aulacoseira subarctica*, the planktonic *Cyclotella bodanica* var. *lemanica*, and the benthic taxa *Fragilaria construens* and *F. brevistriata*. These early assemblages suggest a relatively productive system, probably in the mesotrophic range. During the 20th century, the relative abundance of eutrophic taxa (*Stephanodiscus minutulus*, *C. stelligera* and *F. crotonensis*) have been increasing, displacing *A. subarctica*, suggesting eutrophication. As observed in Takysie and Tchesinkut lakes, these shifts correspond to human settlement and deforestation in Francois Lake's catchment. However, although these taxa are indicative of eutrophic conditions, detailed calibration studies that consider nutrient variables (e.g. Hall & Smol 1992; Christie & Smol 1993; Reavie et al. 1995b) have shown that *A. subarctica* has a consistently high TP optimum when compared to most *Stephanodiscus*, *Cyclotella* and *Fragilaria* species. However, the TP optimum for *A. subarctica* is not well documented. We believe this recent change reflects a slight trophic shift during the 20th century, but more autecological work is required for these taxa.

Total phosphorus reconstruction

Prior to ca. 1850, diatom-inferred total phosphorus concentrations in Francois Lake fluctuated between 27 and 40 μg/L for spring TP, and between 19 and 44 for late-summer TP (Fig. 12). As in Takysie and Tchesinkut lakes, it is likely that Francois was a productive lake, well before human activity in the area. Changes in trophic status apparently began in the early 1900s, when, surprisingly, DI-TP began to decrease. The surface intervals showed the lowest DI-TP levels (25.1 μg/L in the spring, 9.8 μg/L in the late summer). This recent trend may appear to contrast that inferred from qualitative diatom analysis. However, because the inference models (Reavie et al. 1995b; Cumming et al. unpub. data) are quite strong, and because they apply a multiple-species approach, it is possible that DI-TP is tracking 20th century changes not apparent through casual observation of the diatom profiles. Hence, it is possible that recent human activities have resulted in reductions of nutrients in the water column. One likely reason for this may be introduction of metals to the lake, following construction of the Endako Mine. Metals, such as Fe (present as iron oxides), which often leach from tailings, will bind available P in the water column, causing nutrients to precipitate and become biologically unavailable. In fact, during the period following ca. 1940, when the greatest decrease in DI-TP occurred, the highest concentrations of metals were observed in the sedimentary profiles (Figs. 13, 14). This period coincides with intense mining operations in the catchment. Meromixis, caused by inputs of road salt from major roads along the north end of the lake, may be contributing to the recent reduction in nutrients in the water column. By forming a dense saline 'monimolimnion' within the hypolimnion of the lake, meromixis effectively prevents resuspension of sedimented nutrients, sometimes leading to oligotrophication (Smol et al. 1983). Unfortunately, measurements of hypolimnion salinity are not available.

Geochemistry

Geochemical profiles (Figs. 13, 14) for Francois Lake provide a detailed account of water quality shifts in the last ~400 years. Prior to 1930, most of the elements (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Sr, Ti, V, Zn) maintained a consistent concentration. Following Engstrom & Wright (1984) and Engstrom & Hanson (1985), we consider Al, Ca, Fe, K, Mn and Na to be almost entirely derived from the erosion of silicate minerals within the catchments during this time. Profiles of P, S and Si show pre-settlement fluctuations. In the east core, P fluctuated unpredictably between 1100 and 7440 μg/g (sediment dry weight), S had a distinct peak during the mid-1700s, and Si peaked in the early 1800s. In the west core, P showed the same erratic trends, and S showed peaks during the mid-1600s, late 1700s and early 1800s. Although we are unable to determine reasons for these pre-settlement events, early fluctuations probably resulted from catchment and/or climatological variations.

Catchment erosional processes are probably playing a role in the determination of diatom assemblages in this lake. For example, the success of *Aulacoseira* species is often intimately associated with erosional supplies of catchment-derived silica, as this taxon has high demands for Si (e.g. Kilham et al. 1986). The consistently high (>600 μg/g of sediment) concentration of Si likely contributed to the competitive advantage of *A. subarctica*.

Throughout the late 20th century, several metals increased in concentration, directly related to the onset of mining activities. Because of the low resolution of the top ~6 intervals of each core, pinpointing the peak time of metal inputs is difficult to assess, but likely occurred between ca. 1950 and ca. 1970. First mining inputs of metals appeared at a more recent date in the west core. Because the west site is much farther from the mine than the east core, it is likely that a delay in metals deposition occurred between sites. This discrepancy may also be, in part, due to low resolution, resulting from a low sedimentation rate. Concentrations of the various elements peaked at two distinct times: Ag, As, Ba, Be, Cd, Fe, Pb, Sb and Sn peaked early, and invariably decreased soon after; Mn, Mo, Ni, Se and Si all obtained a more recent peak. Resource exhaustion and stripping of new pits (B. Riordan pers. comm.) may be responsible for temporal changes in metals inputs. In other words, a shift in a bedrock type may have provided different elements in tailings waste, resulting in inputs of different elements in runoff. Some chemicals (Al, Cr, K, Mg, Na and Ti) exhibited notably lower concentrations during mining activities.

Concentrations of metals are generally higher in the east core, nearer to the Endako Mine. For instance, Fe peaked at 144,400 μg/g dry weight in the east core, but only reached 83,460 μg/g dry weight in the west core.

Interpretation of geochemical profiles of phosphorus are difficult because of the variety of potential sources of P (e.g. smelting, agriculture, detergents, atmospheric deposition, autochthonous material, etc.). Furthermore, P retention in the sediments is strongly controlled by sorption onto iron oxides, which is variably controlled by Fe content and redox conditions. Hence, a variety of occurrences may have resulted in the erratic geochemical fluctuations of P. Nonetheless, the recent peak in elemental P is probably due to increased metals inputs from tailing wastes (which will bind P), and some agricultural input.

Although geochemical conditions have been severely altered in recent decades, concentrations since ca. 1980 have returned to pre-mining levels, indicating a likely rehabilitation of water quality for Francois Lake. This improvement coincides with recent measures to reduce untreated effluents and smoke stack emissions.

GENERAL CONCLUSIONS

The trends in relative abundance of diatoms in BC lakes have provided several insights on the influence of cultural activities on water quality. This study is an important extension to previous paleoecological studies of lake eutrophication in BC (Reavie 1997; Reavie et al. 1995a, b; Walker et al. 1994; Hall & Smol 1992). In this new study, many interesting eutrophication trends have been observed. In the case of Takysie Lake, cultural activities apparently caused a recent slight increase in phosphorus levels. However, as observed in other regions of BC, these lakes were naturally productive since pre-European settlement.

Nutrient loading presumably has increased since settlement of this area, but the three study lakes have varied in their responses. In brief, Takysie and Tchesinkut have been little affected, and Francois might even be seeing a reduction in available nutrient concentrations following intensive mining activities in the catchment. Existing rehabilitation measures, such as water treatment and effluent controls, have probably improved water quality to some degree. However, it is more likely that the natural characteristics of these lakes allowed them to withstand long-term human impacts. For example, Tchesinkut is a large (207,929,230 dam^3) lake system. Due to its size, Tchesinkut Lake may have been relatively little affected by nutrient inputs thus far. Francois Lake is also relatively deep. In contrast, Takysie Lake is a smaller, shallower system. Hence, it is not surprising that Takysie showed the strongest tendency towards increased eutrophication. Furthermore, Takysie Lake has the highest watershed area relative to the lake's size (Table 1), so it is again not surprising that cultural activities have affected Takysie to a greater degree (Prairie & Kalff 1986). The ratio of shoreline development to lake size is similar for these lakes, so it is difficult to assess the relative effects of human development on water quality between lakes.

Diatom-inferred TP for surface intervals of each core give an estimation of modern TP conditions. For Takysie Lake, spring TP is inferred to be 27.6 μg/L, corresponding well with recent TP measurements (Table 1). Because measured TP values for Takysie Lake are from multiple measurements, this correlation is not surprising. Recent DI-TP for Tchesinkut and Francois lakes appear to overestimate measured data. However, this is also not surprising, because recent measurements (Table 1) were taken at a single point in time, and during February, typically before spring phosphorus inputs occur. Hence, inferred values for TP are probably better estimates of spring TP than current measured data from Tchesinkut and Francois lakes.

Because the Takysie Lake core represented approximately 200 years of sediment, it provided an excellent resolution for human-induced changes to the ecosystem. Whereas, the other cores incorporated 400 or more years of sediment accumulation, resulting in a lower resolution for interpretation of recent cultural effects. However, these longer records provide us with an excellent opportunity to observe natural variability in fossil data for these systems. In Tchesinkut Lake, for example, some event occurred in the early 1700s, resulting in a peak of eutrophic diatoms (primarily *Aulacoseira subarctica* at 28-29 cm in the west core, and 29-30 cm in the east core). Long-term records such as this illustrate that striking changes can occur from natural events, and that caution must be used when attributing human influence to shifts in water quality. In the case of Tchesinkut Lake, shifts in the relative abundance of *A. subarctica* during the last century are of no greater magnitude than shifts observed between, say, 1600 and 1750.

The analysis of multiple cores has been useful in describing the reproducibility of paleolimnological investigations of lakes or lake regions. Our analyses for these three lakes indicate that human influences from approximately the same time period (~1930-1997) are represented in all cores. Hence, the analysis of five cores from the same area was an excellent method to describe regional paleoecology. Also, replicate cores for Francois Lake allowed us to describe the relative effect of mining and development in two regions of the lake. Replicate cores for Tchesinkut Lake are similar enough that a single core would probably have been adequate to describe the lake's recent ecological history. Nonetheless, without the assessment of replicate cores, spatial differences in paleoecology may have been overlooked.

This study has provided evidence of natural, as well as anthropogenically-induced eutrophication for BC lakes. In order to fully understand the extent and causes of eutrophication in BC, such studies should be extended to other regions of the province. Furthermore, continued lake calibration and autecological analysis of important indicator taxa will refine the current TP inference models.

SUMMARY

1) Five cores, ranging between 32 and 43 cm in length, were obtained from Takysie Lake (1 core), Tchesinkut Lake (2 cores) and Francois Lake (2 cores), and ^{210}Pb dating techniques indicate that they contain 200 to >400 years of sediment accumulation.

2) Diatom microfossils in the sedimentary profiles from all cores indicate that these lakes are probably naturally productive (mesotrophic/eutrophic).

3) Diatom records and diatom-inferred total phosphorus concentrations indicate that some increased nutrient loading has likely occurred in response to human development. However, in

Tchesinkut and Francois lakes, some reduction in TP may have occurred in recent decades.

4) Geochemical analyses for Francois Lake illustrate that significant inputs of metals to the lake have occurred in response to mining and metallurgical activities this century. However, metal concentrations are lower in the most recent sediments.

ACKNOWLEDGMENTS

This work was supported by funds from BC Environment. We thank Lisa A. Westenhofer for providing background research and other information on the lakes. Field work was performed by personnel from BC Environment. Metals data were provided by Environment Canada Laboratories (Pacific Environmental Science Centre), and ^{210}Pb analyses were performed by Mycore Ltd.

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Table 1: Summary of morphometric data and recent chemical measurements for Takysie, Tchesinkut, and Francois Lakes, BC. Chemical measurements were taken from the surface (1 m) water at each coring site (February 1997). On-site measurements and water quality measurements performed by PESC were combined, and ranges are presented where appropriate. Additional total phosphorus data for Takysie Lake were obtained from previous measurements. Missing data are indicated by '--'.

Attribute (units)	**Takysie**	**Tchesinkut**	**Francois**
Elevation (m)	771.8	760.0	714.8
Surface area (km^2)	5.14	35.38	257.70
Watershed area (km^2)	149.2	344.3	3600.0
Volume (dam^3)	32,893	~~207,929,230~~ 2,079,292.3	23,087,948
Mean depth (m)	6.4	61.5	86.7
Maximum depth (m)	11.6	149	244
Perimeter (m)	14,630	47,100	--
Mean water retention time (years)	--	--	35
Total phosphorus (µg/L)	22-130	4-8	6-10
Total nitrogen (µg/L)	920-1200	200	250-320
Conductivity (µS/cm)	150-168	135-136	84-93
pH	7.1-7.9	7.91-8.08	7.63-7.80
Total calcium (mg/L)	16-18	17	9.5-11.0
Total magnesium (mg/L)	5.7-6.0	4.4	2.5-2.9
colour	35-55	5	7-15

Figure captions

Figure 1. Plots of ^{210}Pb counts (illustrating exponential radioactive decay with depth) and sediment accumulation rates in the five sediment cores. Accumulation rates below ^{210}Pb 'background' levels may be suspect, as they were estimated by temporal extrapolation.

Figure 2. Plots of water content, organic (loss-on-ignition) and carbonate components of core sediments from Takysie Lake.

Figure 3. Profiles of the dominant siliceous microfossils for Takysie Lake. Diatom taxa were combined ecologically to generate the categories "total benthics" and "total planktonics".

Figure 4. Profiles of inferred total phosphorus concentrations for Takysie Lake. Spring/summer reconstructions were generated using Reavie et al. (1995b)'s model, and late summer reconstructions were generated using B. Cumming et al. (unpublished data)'s model.

Figure 5. Plots of water content, organic (loss-on-ignition) and carbonate components of core sediments from Tchesinkut Lake. Open circles represent the west core, and small squares represent the east core.

Figure 6. Profiles of the dominant siliceous microfossils for Tchesinkut Lake west core. Diatom taxa were combined ecologically to generate the categories "total benthics" and "total planktonics".

Figure 7. Profiles of the dominant siliceous microfossils for Tchesinkut Lake east core. Diatom taxa were combined ecologically to generate the categories "total benthics" and "total planktonics".

Figure 8. Profiles of inferred total phosphorus concentrations for Tchesinkut Lake. Spring/summer reconstructions were generated using Reavie et al. (1995b)'s model, and late summer reconstructions were generated using B. Cumming et al. (unpublished data)'s model. Open circles represent the west core, and small squares represent the east core.

Figure 9. Plots of water content, organic (loss-on-ignition) and carbonate components of core sediments from Francois Lake. Open circles represent the west core, and small squares represent the east core.

Figure 10. Profiles of the dominant siliceous microfossils for Francois Lake west core. Diatom taxa were combined ecologically to generate the categories "total benthics" and "total planktonics".

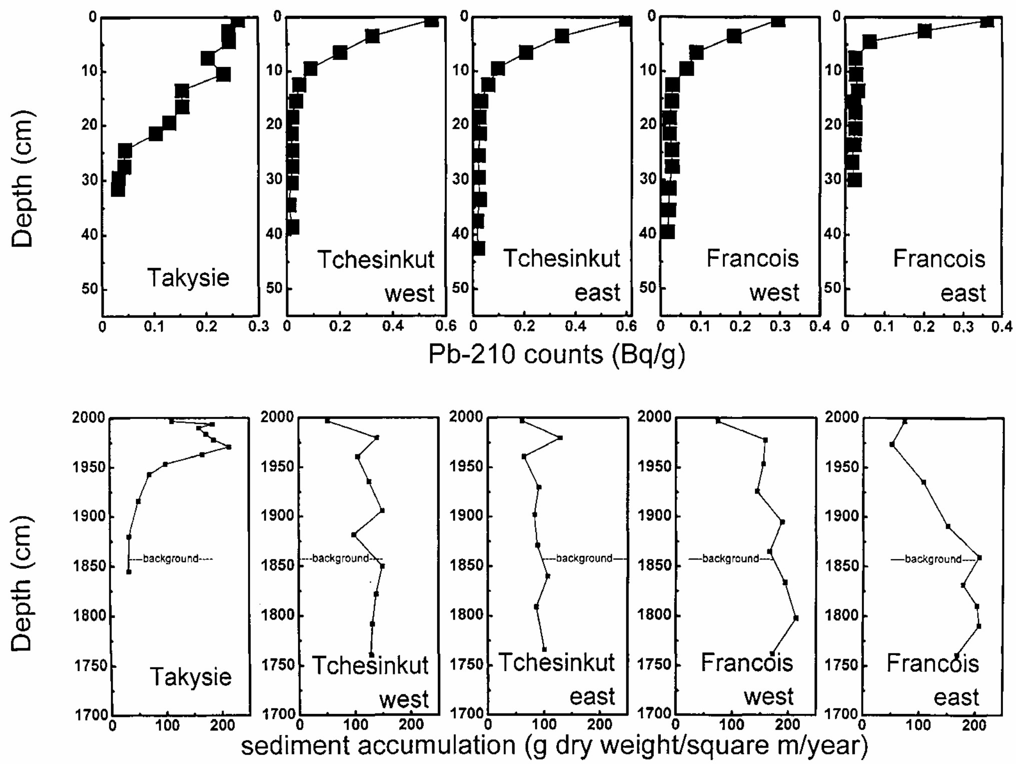
Figure 11. Profiles of the dominant siliceous microfossils for Francois Lake east core. Diatom taxa were combined ecologically to generate the categories "total benthics" and "total

planktonics".

Figure 12. Profiles of inferred total phosphorus concentrations for Francois Lake. Spring/summer reconstructions were generated using Reavie et al. (1995b)'s model, and late summer reconstructions were generated using B. Cumming et al. (unpublished data)'s model. Open circles represent the west core, and small squares represent the east core.

Figure 13. Geochemical profiles for the Francois Lake west core.

Figure 14. Geochemical profiles for the Francois Lake east core.


Depth (cm)
Takysie
Tchesinkut west
Tchesinkut east
Francois west
Francois east
Pb-210 counts (Bq/g)
Depth (cm)
background
Takysie
Tchesinkut west
Tchesinkut east
Francois west
Francois east
sediment accumulation (g dry weight/square m/year)

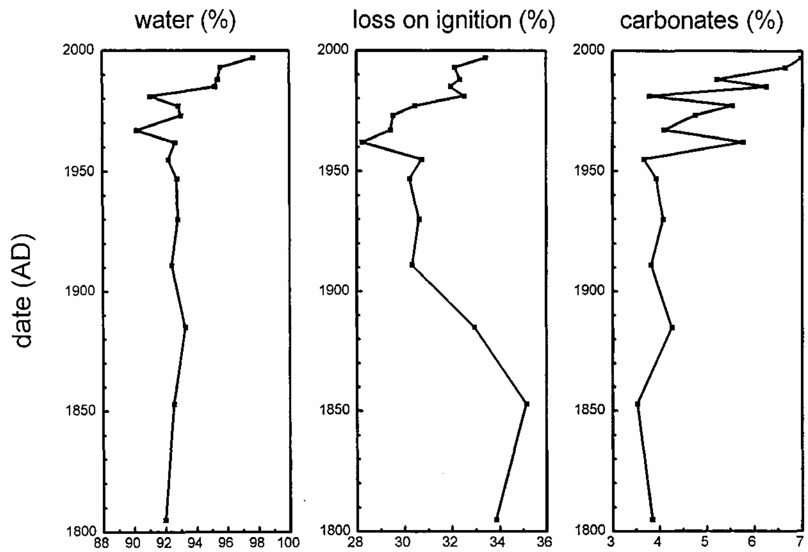
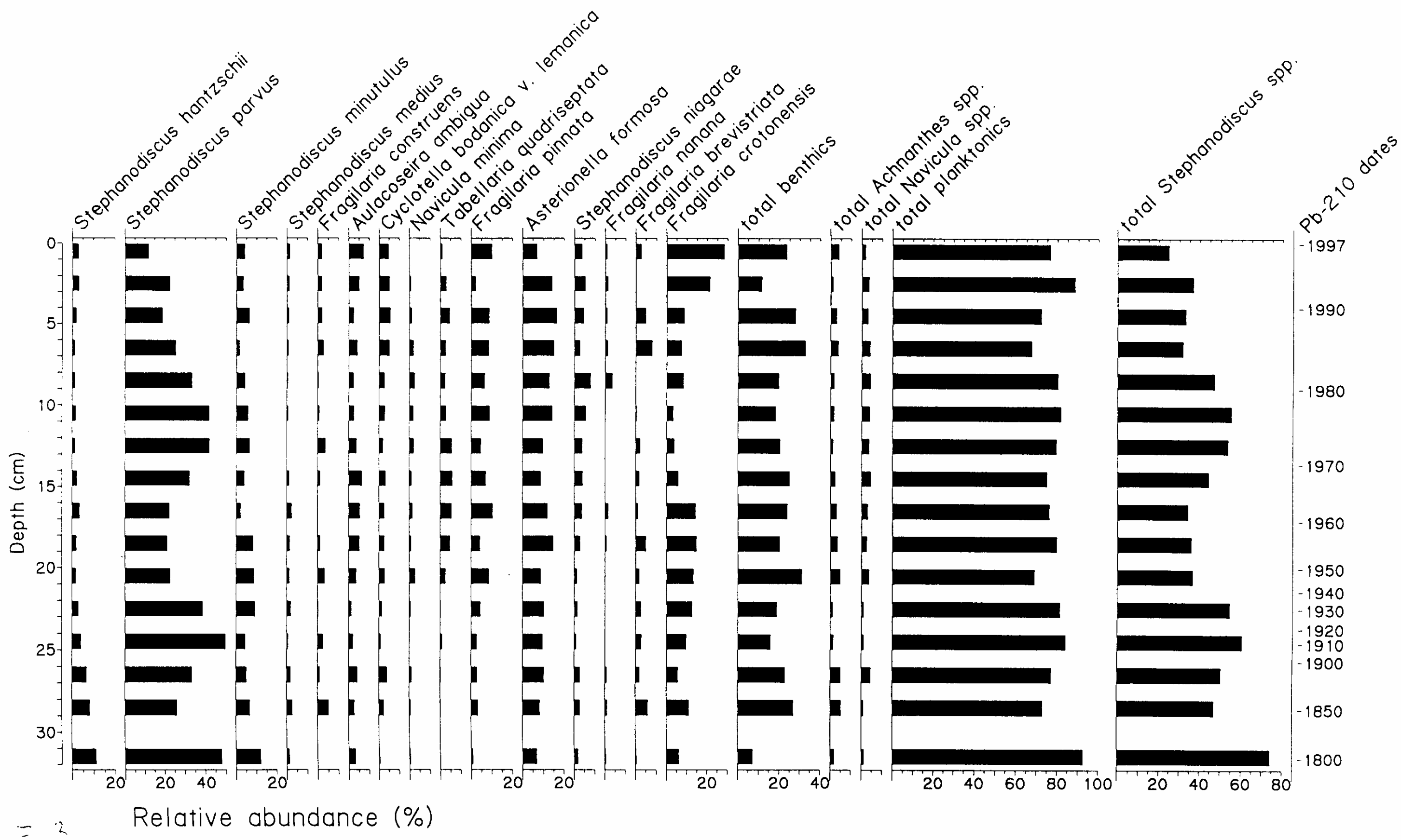
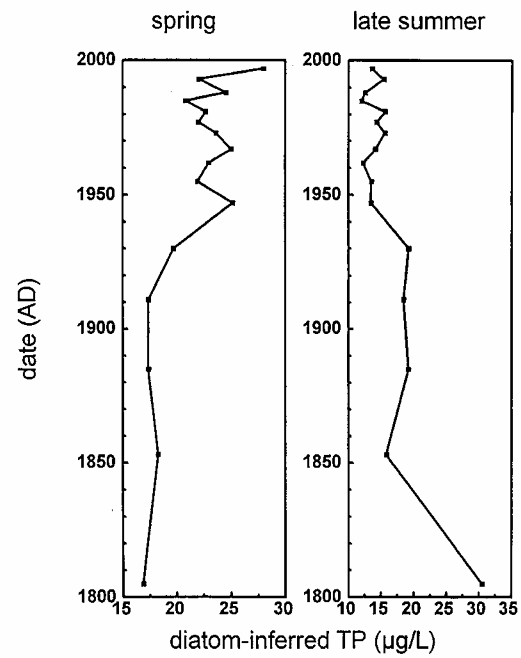

water (%)
loss on ignition (%)
carbonates (%)
date (AD)
2000
1950
1900
1850
1800
88 90 92 94 96 98 100
28 30 32 34 36
3 4 5 6 7

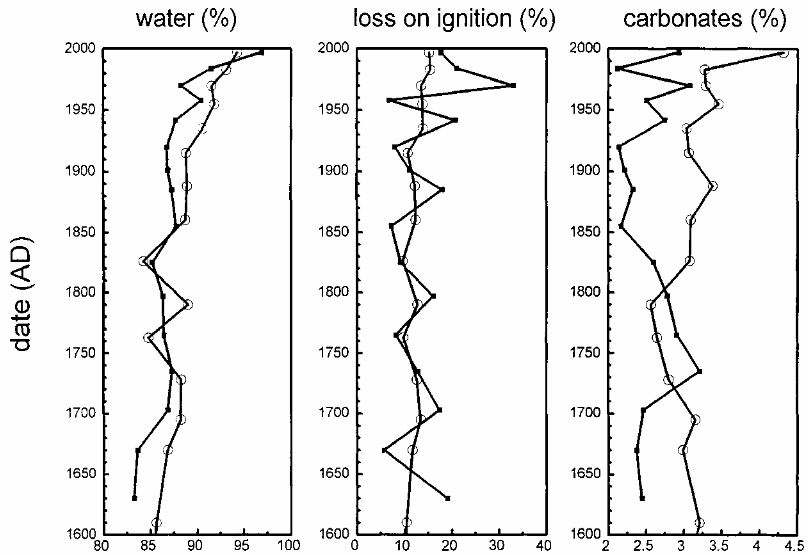
Fig. 2


Stephanodiscus hantzschii
Stephanodiscus parvus
Stephanodiscus minutulus
Stephanodiscus medius
Fragilaria construens
Aulacoseira ambigua
Cyclotella bodanica v. lemanica
Navicula minima
Tabellaria quadriseptata
Fragilaria pinnata
Asterionella formosa
Stephanodiscus niagarae
Fragilaria nanana
Fragilaria brevistriata
Fragilaria crotonensis
total benthics
total Achnanthes spp.
total Navicula spp.
total planktonics
total Stephanodiscus spp.
Pb-210 dates
Depth (cm)
Relative abundance (%)
1997
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1850
1800



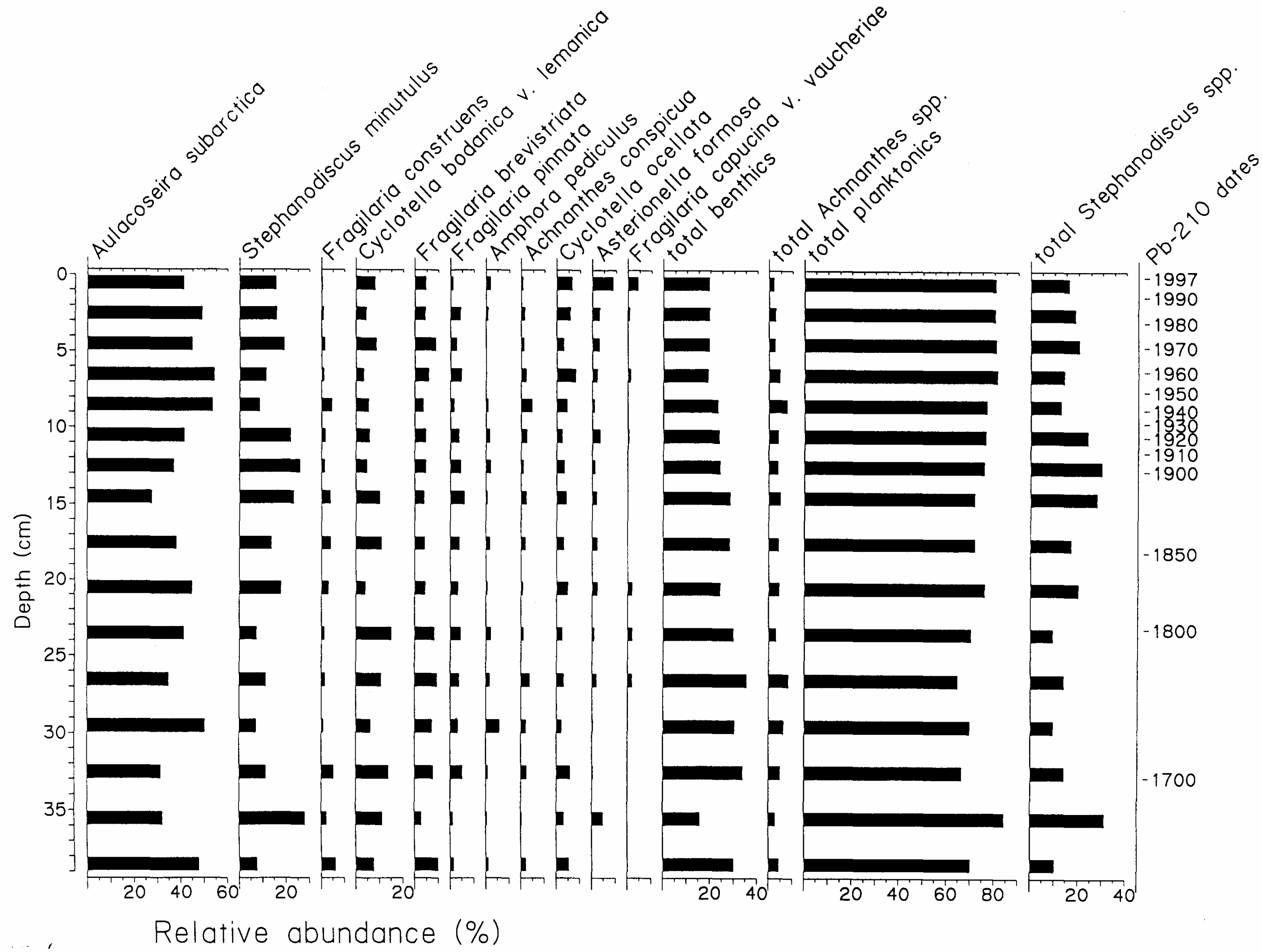
spring
late summer
date (AD)
2000
1950
1900
1850
1800
15
20
25
30
10
15
20
25
30
35
diatom-inferred TP (µg/L)

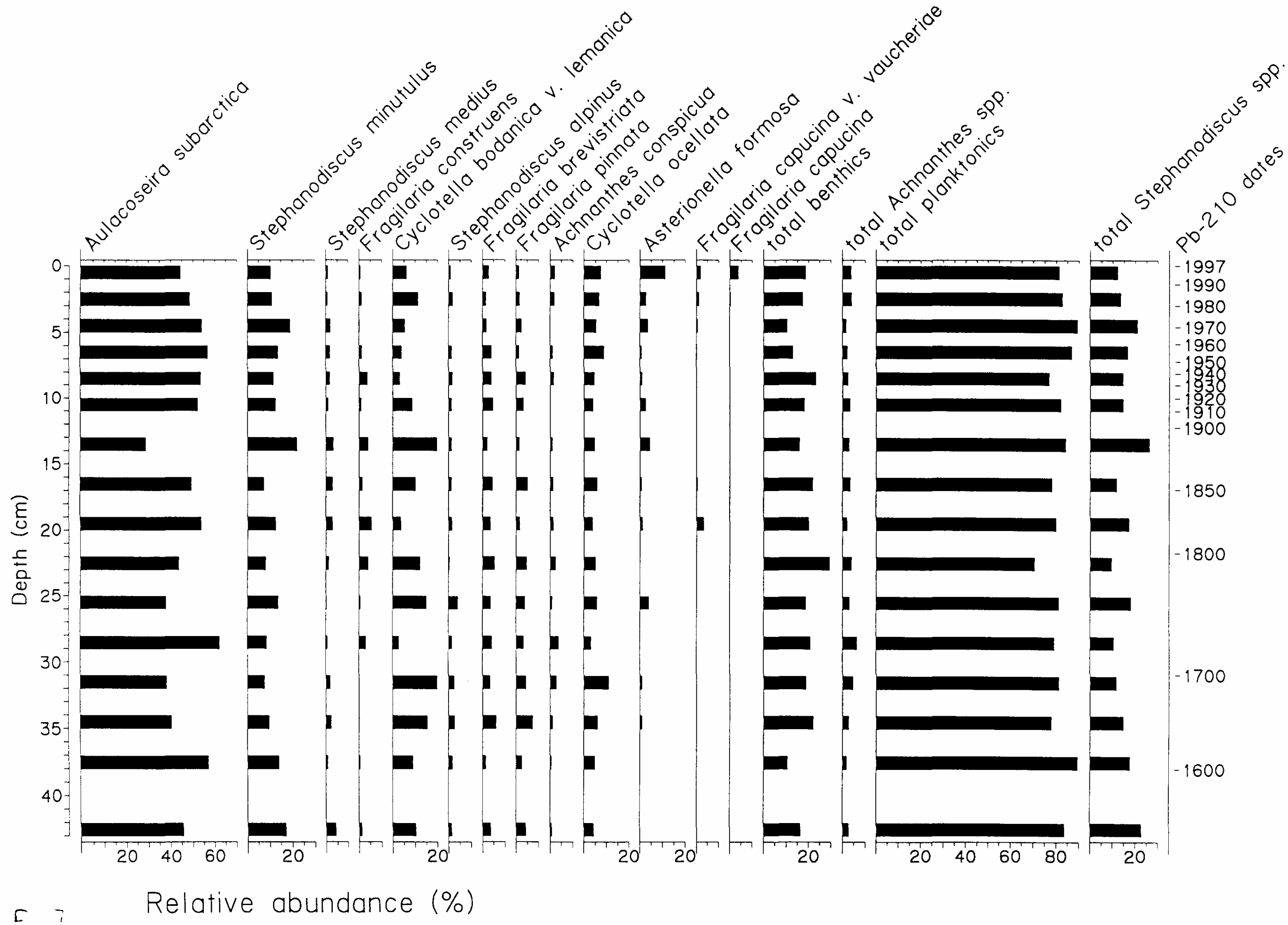
Fig. 4



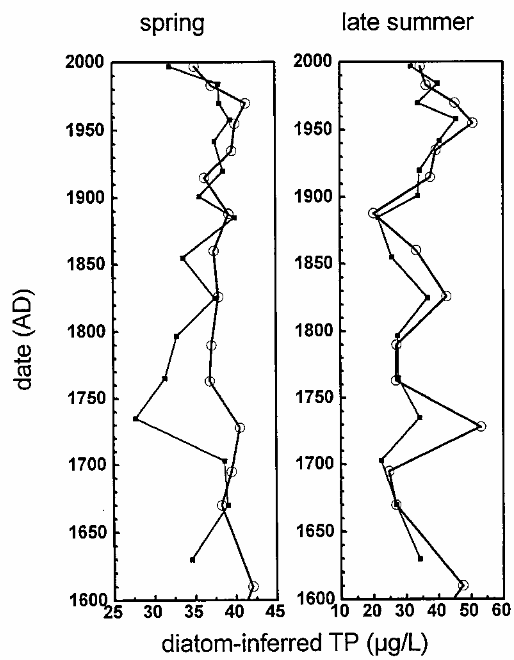
water (%)
loss on ignition (%)
carbonates (%)
date (AD)
2000
1950
1900
1850
1800
1750
1700
1650
1600
80
85
90
95
100
0
10
20
30
40
2
2.5
3
3.5
4
4.5

Fig. 5


Aulacoseira subarctica
Stephanodiscus minutulus
Fragilaria construens
Cyclotella bodanica v. lemanica
Fragilaria brevistriata
Fragilaria pinnata
Amphora pediculus
Achnanthes conspicua
Cyclotella ocellata
Asterionella formosa
Fragilaria capucina v. vaucheriae
total benthics
total Achnanthes spp.
total planktonics
total Stephanodiscus spp.
Pb-210 dates
Depth (cm)
0
5
10
15
20
25
30
35
1997
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1850
1800
1700
20 40 60
20
20
20 40
20 40 60 80
20 40
Relative abundance (%)

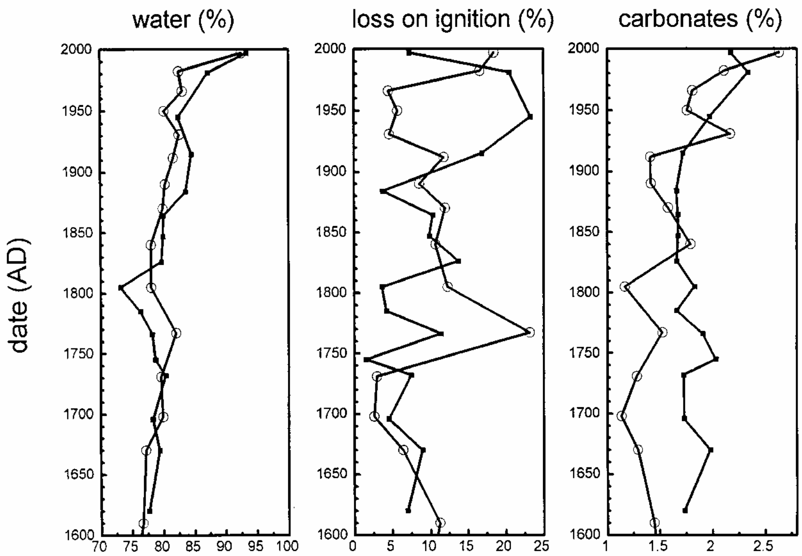


Aulacoseira subarctica
Stephanodiscus minutulus
Stephanodiscus medius
Fragilaria construens
Cyclotella bodanica v. lemanica
Stephanodiscus alpinus
Fragilaria brevistriata
Fragilaria pinnata
Achnanthes conspicua
Cyclotella ocellata
Asterionella formosa
Fragilaria capucina v. vaucheriae
Fragilaria capucina
total benthics
total Achnanthes spp.
total planktonics
total Stephanodiscus spp.
Pb-210 dates
Depth (cm)
0
5
10
15
20
25
30
35
40
1997
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1850
1800
1700
1600
20 40 60
20
20
20
20
20
20 40 60 80
20
Relative abundance (%)



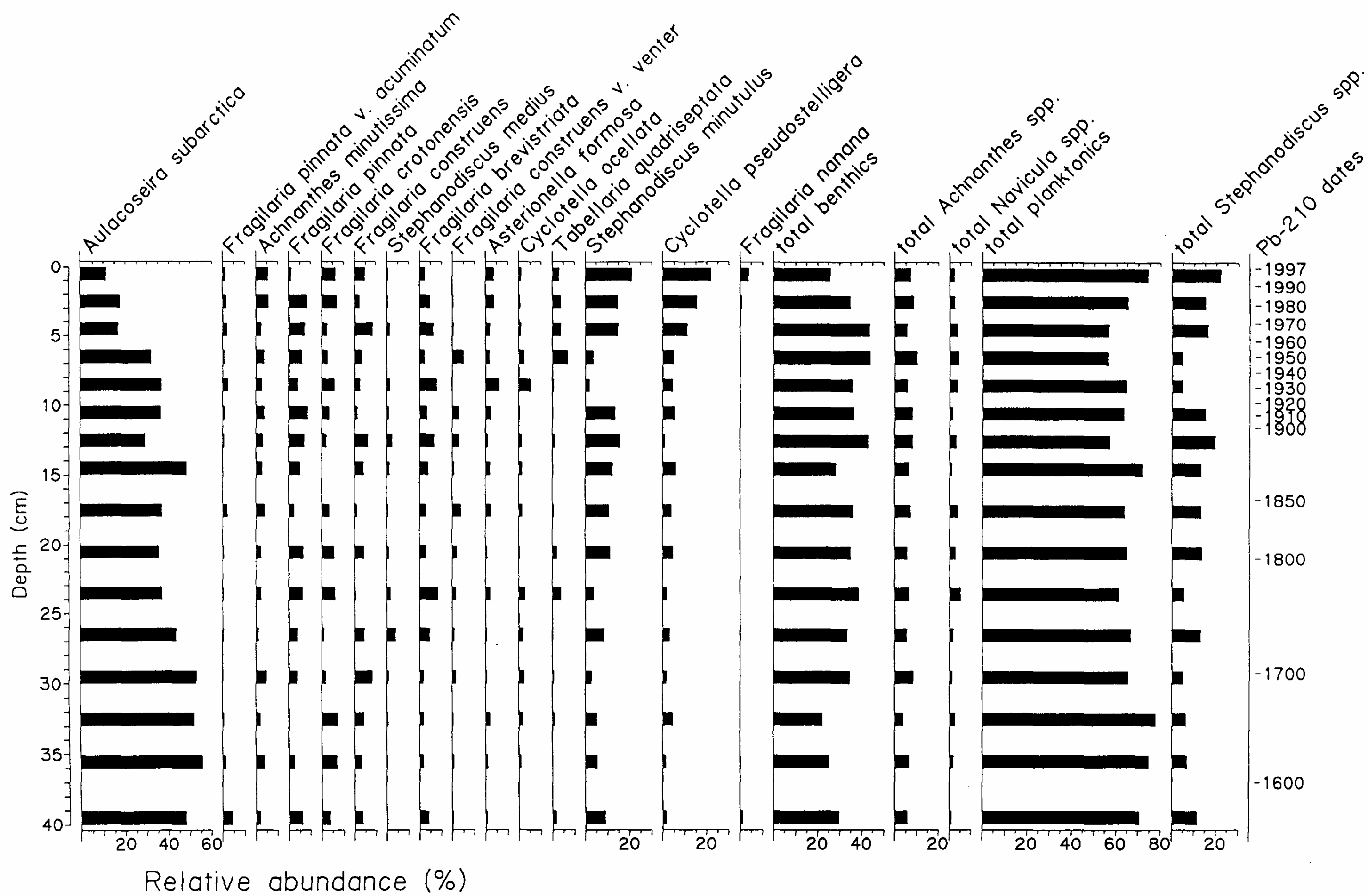
spring
late summer
date (AD)
2000
1950
1900
1850
1800
1750
1700
1650
1600
25 30 35 40 45
10 20 30 40 50 60
diatom-inferred TP (µg/L)

Fig. 8

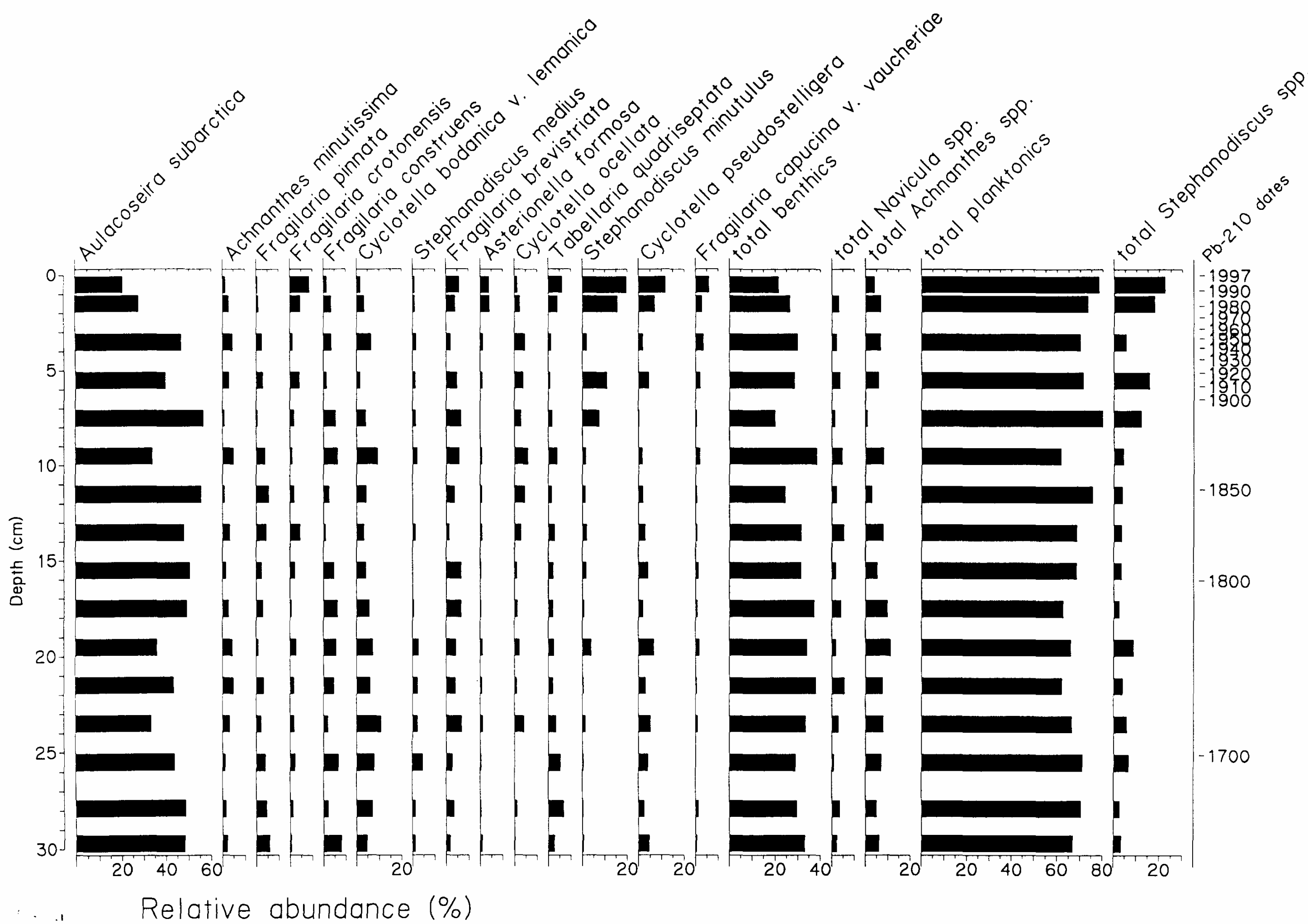


water (%)
loss on ignition (%)
carbonates (%)
date (AD)
2000
1950
1900
1850
1800
1750
1700
1650
1600
70 75 80 85 90 95 100
0 5 10 15 20 25
1 1.5 2 2.5

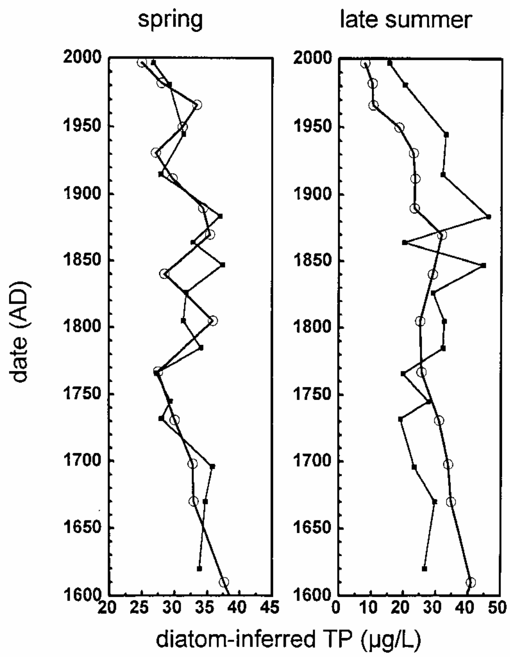
Fig. 9



Aulacoseira subarctica
Fragilaria pinnata v. acuminatum
Achnanthes minutissima
Fragilaria pinnata
Fragilaria crotonensis
Fragilaria construens
Stephanodiscus medius
Fragilaria brevistriata
Fragilaria construens v. venter
Asterionella formosa
Cyclotella ocellata
Tabellaria quadriseptata
Stephanodiscus minutulus
Cyclotella pseudostelligera
Fragilaria nanana
total benthics
total Achnanthes spp.
total Navicula spp.
total planktonics
total Stephanodiscus spp.
Pb-210 dates
Depth (cm)
Relative abundance (%)
1997
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1850
1800
1700
1600



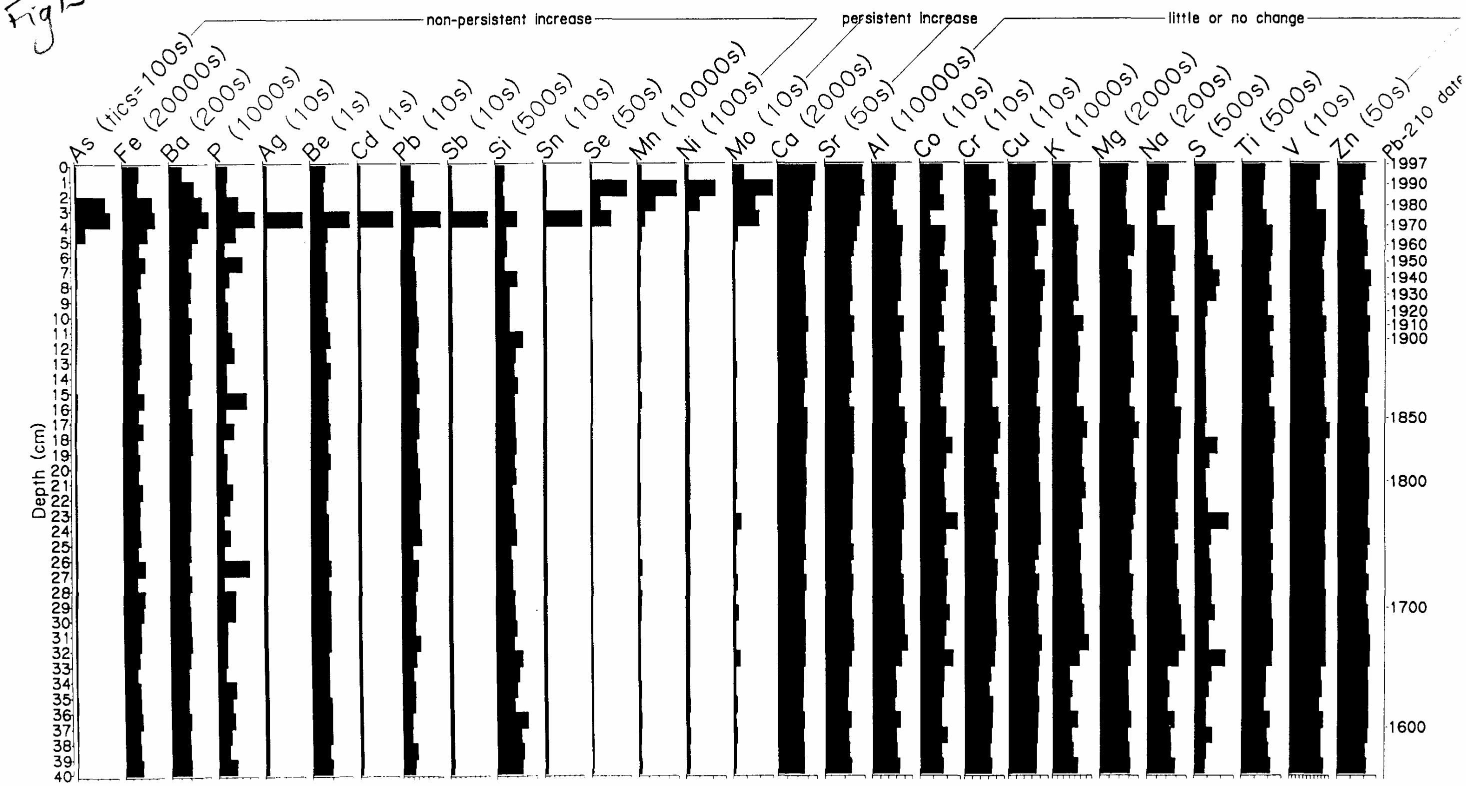
Aulacoseira subarctica
Achnanthes minutissima
Fragilaria pinnata
Fragilaria crotonensis
Fragilaria construens
Cyclotella bodanica v. lemanica
Stephanodiscus medius
Fragilaria brevistriata
Asterionella formosa
Cyclotella ocellata
Tabellaria quadriseptata
Stephanodiscus minutulus
Cyclotella pseudostelligera
Fragilaria capucina v. vaucheriae
total benthics
total Navicula spp.
total Achnanthes spp.
total planktonics
total Stephanodiscus spp.
Pb-210 dates
Depth (cm)
Relative abundance (%)
1997
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1850
1800
1700



spring
late summer
date (AD)
2000
1950
1900
1850
1800
1750
1700
1650
1600
20 25 30 35 40 45
0 10 20 30 40 50
diatom-inferred TP (µg/L)

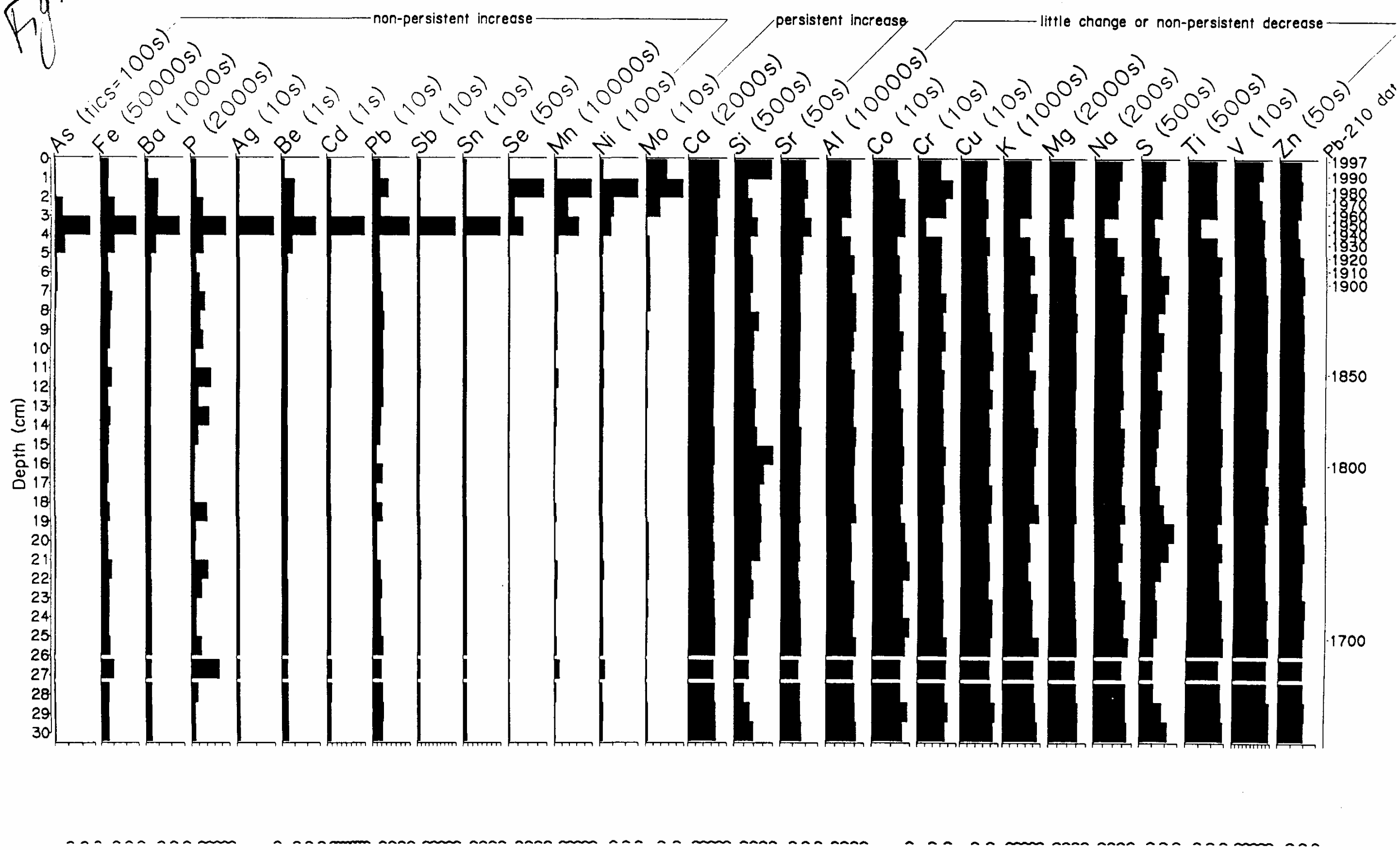
Fig. 12

Fig 13



non-persistent increase
persistent increase
little or no change
As (tics=100s)
Fe (20000s)
Ba (200s)
P (1000s)
Ag (10s)
Be (1s)
Cd (1s)
Pb (10s)
Sb (10s)
Si (500s)
Sn (10s)
Se (50s)
Mn (10000s)
Ni (100s)
Mo (10s)
Ca (2000s)
Sr (50s)
Al (10000s)
Co (10s)
Cr (10s)
Cu (10s)
K (1000s)
Mg (2000s)
Na (200s)
S (500s)
Ti (500s)
V (10s)
Zn (50s)
Pb-210 date
Depth (cm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
1997
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1850
1800
1700
1600

Fig 14.


non-persistent increase
persistent increase
little change or non-persistent decrease
As (tics=100s)
Fe (50000s)
Ba (1000s)
P (2000s)
Ag (10s)
Be (1s)
Cd (1s)
Pb (10s)
Sb (10s)
Sn (10s)
Se (50s)
Mn (10000s)
Ni (100s)
Mo (10s)
Ca (2000s)
Si (500s)
Sr (50s)
Al (10000s)
Co (10s)
Cr (10s)
Cu (10s)
K (1000s)
Mg (2000s)
Na (200s)
S (500s)
Ti (500s)
V (10s)
Zn (50s)
Pb-210 da
Depth (cm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
1997
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1850
1800
1700

Counts of ^{210}Pb in sediments from four BC cores. Sediment depth is indicated by the top and bottom of each interval (in cm), and ^{210}Pb counts are in Bq/g.

Francois Lake East (E224946)

top	bottom	Bq/g
0.0	1.0	0.362
2.0	3.0	0.202
4.0	5.0	0.061
7.0	8.0	0.024
10.0	11.0	0.026
13.0	14.0	0.031
15.0	16.0	0.021
17.0	18.0	0.024
20.0	21.0	0.024
23.0	24.0	0.022
26.0	27.4	0.016
29.4	30.4	0.023

Francois Lake West (225165)

top	bottom	Bq/g
0.0	1.0	0.295
3.0	4.0	0.185
6.0	7.0	0.089
9.0	10.0	0.064
12.1	13.0	0.029
15.0	16.0	0.027
18.1	19.0	0.022
21.0	22.1	0.022
24.0	25.0	0.028
27.0	28.0	0.028
31.0	32.0	0.021
35.0	36.0	0.021
39.0	40.0	0.018

Tchesinkut Lake (E224893)

top	bottom	Bq/g
0.0	1.0	0.548
3.0	4.0	0.324
6.0	7.0	0.202
9.0	10.0	0.090
12.0	13.0	0.047
15.0	16.0	0.035
18.0	19.0	0.019
21.0	22.0	0.018
24.0	25.2	0.021
27.0	28.0	0.020
30.0	31.0	0.016
34.0	35.0	0.009
38.0	39.0	0.020

Tchesinkut Lake (E224844)

top	bottom	Bq/g
0.0	1.0	0.599
3.0	4.0	0.348
6.0	7.0	0.207
9.0	10.0	0.096
12.0	13.0	0.059
15.0	16.0	0.030
18.0	19.0	0.025
21.0	22.0	0.026
25.0	26.0	0.021
29.0	30.0	0.021
33.0	34.0	0.026
37.0	38.0	0.015
42.0	43.0	0.020

Takysie Lake

top	bottom	Bq/g
0	1	0.262
2	3	0.244
4	5	0.244
7	10	0.204
10	13	0.234
13	16	0.154
16	19	0.155
19	22	0.130
21	26	0.104
24	30	0.045
27	34	0.043
29	38	0.032
31	43	0.031

	Francois Lake E225165 Diatom counts entered September 1997		francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	Francois Lake E224 Diatom counts entered October	francois E224946	francois E224946	francois E224946	francois E224946	francois E22494
	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	17.5	20.5	23.5	26.5	29.5	32.5	35.5	39.5	0.5	1.5	3.5	5.5	7.5	9
ACAMOENA																	2					
ACBIASOL					2																	
ACCALCAR													3									
ACCLEVEI	2		1	2			1		2	1		1				3				4		
ACCHLIDA		2																				
ACCONSPI				1					1	2			1		2		4	2	1	2		
ACCURTIS					2																	
ACCURVIR															1							
ACDAONEN									2	2							1					
ACDIDYMA		2		1				1												1		
ACENGELB				2	2																	
ACEXIGUA																						
ACFLEXEL																		1				
ACFRIGID								1														
ACGRACIL							1															
ACGRANA											2			1	1							
ACJOURSA		4		3		2	1	1		2							2					
ACLAC-VU				3				2														
ACLANCVF	2	2	2		1	2	2	1	3	1	1	5		1	1	1			1			
ACLAVLSH																1						
ACLANCVR	1			2		1	2	3					1					2				
ACLATERO											5	3			2							
ACLAUENB				3							2					1			2			
ACLEMMER								2														
ACLEVAND																		2				
ACLUTHER																						
ACLINEAR			2																			
ACMINUTI	19	19	8	12	9	12	10	8	13	8	7	4	16	7	12	6	4	9	14	10	3	1
ACNITIDI									2													
ACNODOSA																						
ACOESTRU			2			2																
ACPERAGA																2						
ACROSENS						1																
ACSACCUL				2																		
ACSP????						1	2			1								1				
ACSUCHLA						2	4		1	3	2	2	6					5		4		
ACSUBATO	1		3	1	2	3	3					2	1	4	2	4	1		3			
ACVENTRA											1											
ACZIEGLE			1		1																	
AMAEQUAL																						
AMFOGEDI																						
AMPEDICU	2	2		1	5	5		2	4		5	2	2	3	3	1	2	2	3	6		
AMLIBYCA													2							2		
AMTHUMEN														1		2						
AMINARIE				1				1	1	2	1	2	3	1				1				
AMVENETA																						
AMSP???																						
ANVITREA									1						2	1		1	2			
ASFORMOS	13	13	7	6	20	8	4	6	8	3	7	2	2	7	3	2	13	13	4	3		
AUAMBIGU												2	1									
AUDISTAN																						
AUSUBARC	39	59	56	100	118	117	93	144	123	124	113	138	176	183	178	153	70	90	143	141	186	11
CABACILL			2		1	2				2		2					2		1	2		
CMAMPHVH																						
CMARCTIC																						
CMCAESPI																						
CMCISTUL				1	1								1						1			
CMCESATI																						
CMSP????		2	4																1			
CMLAEVIS																					2	
CMLAPPON						1																
CMMICROC					2	3					2		2	1				1		1		
CMMINUT		2	2	2			1		2	1										2		
CMNAVICU																						
CMOBSCUR			1																			
CMSILESI	1	1	2					2						2	4			2				
CMSINUAT											1	2							1			
CONEOTHU	2	2	2	3	4	2					2	1	2	1				1	1	1	1	
COPLACEN		2		1		1		1				2		1								
COPLACVE		1						2	2	3				1			2	4		2	2	
CODISCUL																						
CSTTHOLI						1																
CYPSSTEL	75	52	37	15	14	17	3	17	13	16	5	10	6	16	4	5	41	23	6	16	1	
CYBODAVL	2	4	7	3	1		4	2	2	8	2	6	2	10	6	7	6	11	20	6	14	3
CYCOMTVU																						
CYMICHIG					1									1					1			
CYOCELLA	3	2	3	7	17	1	4	4	5	1	9	6	8	6	3		5	8	15	14	10	2
CYTRIPUN									2	1	3											
DEKEUTZI																						
DETENUIS								1														
DIPL??												1		1								
DIELLIPT					1																	
DIMESODO																					1	
DIMODICA															1							
DIOCULAT			2						1		2		1						1	1		
DIOVALIS											1											
DIPETERS																						
DIPARMA																						
DIAVULMC										1												
DIMESODO											1											
EPITHEMI																						
EUNOTIA																						
FRARCUS						1										2			1			
FRBREVIS	8	16	21	7	25	11	21	12	9	11	26	15	6	6	6	13	20	13	6	17	22	1
FRCAPUCI			2												1							
FRCAPUVG	4																3		2	4		
FRCAPUVM				2			4			1						1				1		
FRCAPUVR					1			1						2								
FRCAPUVV	4	4			2	4	8		11	6	8	9	7	4			20	9	11	7	2	
FRCONSTR	16	7	28	10	8	4	20	12	3	15	1	14	27	15	10	12	5	11	11	5	18	2

	Francois Lake E225165 Diatom counts entered September 1997	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	Francois Lake E224 Diatom counts entered October	francois E224946	francois E224946	francois E224946	francois E224946	francoi E2249
	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	17.5	20.5	23.5	26.5	29.5	32.5	35.5	39.5	0.5	1.5	3.5	5.5	7.5	[illegible]
FRCONSVB																						
FRCONSVV		1	2	16		10	10	2	13	7	5	3	5	1	2	1	1	1				
FRCROTON	22	23	8	8	19	11	7		12	20	19	3	6	26	22	12	30	15	4	15	6	
FRCYCLOP										1												
FRFAMELI												3										
FRLAPPON							1			1												
FRLEPTOS				1	2	2	2	1				2										
FRMAZAME				2					2													
FRNANANA	13	2										1			1	4	5	6				
FROLDENB														1								
FRPARASI			2																		1	
FRPINNAT	4	28	24	19	13	28	22	15	8	23	19	12	12	1	8	19	2	3	8	11	2	
FRPINNVA	4	5	6	2	8	2	2		7	2	1	1		2	4	14		2				
FRPINNVI	2	2		10	4	1		1	2	2	2	8	5								2	
FRPINNVL																						
FRROBUST																			6		1	
FRSP????									4				1									
FRULNA	1									1	1							1			2	
FURHOMVS														2								
GOMPHONE									1										1			
GOGROVVL																						
GOMINUTU									2	2			3	1	4						2	
GOPARVUL										2									1			
GOPUMILU		1		2				1						1	2	1				1		
GOOLIVVO			1	2		5	2	5		4	2	2			1		1		1			
GYROSIGM																			1			
HANTZ??			2																			
MASMITHI																						
MELINEAT																						
MRCIRCUL																						
NAAGREST	1		3																	1		
NABACILL																						
NACARI																						
NACAPITA				2																2		
NACAPIVL		1			2				1	1		1										
NACOCCON					2							1				1						
NACRCEPH																						
NACRELLA				2										2					1		2	
NACRYOID											2	1										
NAFONTIC											2	1										
NAFRACTA																						
NAGOEPVO																						
NAGREGAR		1			1																	
NAHARDER				2																		
NAHELENS																						
NAIGNOVA								1														
NAIGNOVP														2				2				
NAJAERNF					1			1	2		2				1			2				
NAKRASSK											2											
NAKUELBS																						
NALATERO																						
NAMARGAL																						
NAMENISC							1														2	
NAMINIMA	2				1	1	1		3	4	2			3	1			3				
NAPORIVO				2																		
NAPROTRA																						
NAPSANGL																						
NAPSSCUT		1	2												1							
NAPUPULA										1				1		2						
NARADIOS																						
NARHYNCH																						
NAREINHA																						
NASAXONI											1											
NASAXOPH												1										
NASCHOEN																						
NASCUTTE																						
NASEMINU							4												1			
NASIMILI																						
NASP#2										2												
NASP????			4	1	1	4	2	1	7			1		1	1			1	2	3	1	
NASTRIOL																						
NASUBHAM																						
NASUBLUC			1																			
NASUBMIN																						
NASUBMUR	4	2		4	2						3		2					2	3	3		
NASUBROT	1	2					2				2									4		
NAUTERMO													2									
NAVITABU		1	2		2					2					2							
NEKOZLOW																						
NITZSCHI				2														1				
NIACICUL												1										
NIALPINA																						
NIAMPHIB				2		2		2		1					1							
NIANGUST																						
NIDISSIP				2					1	2												
NIFONTIC	4		6	1	4	3	5						1					1	4	2		
NIFRUSTU									1													
NIGRACIL																	2					
NIINCONS		1							6	1			2	3		2				2		
NILACUUM																2						
NILINEAR													1									
NIPALEA					1																	
NIPALEAC					1				2		2									1		
NIPERMIN														1	3							
NIPURA		1	2																			
NIRECTA				2																		
NIWUELLE												1										
OPEPHORA																						
PIIGNOBI	2																					
PIBOREAL																						
RHIERIEN			2			1			1								2					
RHIGRACI			1																			

	Francois Lake E225165 Diatom counts entered September 1997		francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	francois E225165	Francois Lake E224 Diatom counts entered October		francois E224946	francois E224946	francois E224946	francoi E22494
	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	17.5	20.5	23.5	26.5	29.5	32.5	35.5	39.5	0.5	1.5	3.5	5.5	7.5	9
RHABBREV			1																			
SIDELOGN				1																		
STALPINU																	3	1	2	6	4	
STHANTZS																						
STMINUTU	72	49	49	11	6	43	50	36	35	39	12	27	9	18	17	28	67	50	6	39	25	
STMEDIUS	2	1	4		5	2	8	3	2	3	5	13	2	2	1	1	3	3	5	5	5	
STNIAGAR	1	1	1	3	2	3	2		3	2		2	5		2	2			1			
STOREGON				1	3		2			2			1	2	2	1	4	4	3	6	6	
STPARVUS									4	1						2						
STSUBTRA																2						
SURI??			1																			
TAFLOCCU																						
TAQUADRI	10	13	13	22	2	1	4	1	2	7	12	1	2	3		5	21	13	4	3	6	
UNK PENN	1	2	1				2	1		1				4	2	2						
UNK CENT	2																					
CYSTS	6	1	5	4	4	2	2	4	7	3	4	50	6	8	2	1	5	13	10	10	2	
TOTAL	342	336	333	313	320	323	317	297	332	349	305	317	332	352	320	318	342	323	306	356	329	3:

	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	Tchesinkut Lake, BC E224893 diatom counts entered October 15, 1997	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893
	11.5	13.5	15.5	17.5	19.5	21.5	23.5	25.5	27.9	29.7	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	17.5	20.5	23.5	26.5
ACAMOENA				2	6			2	2			2										
ACBIASOL					1		2															
ACCALCAR																						
ACCLEVEI		2	1	6	4	2	2	1	4	7	1		3	1			1		5			3
ACCHLIDA																						
ACCONSPI	2	7	4	6	3	4	3	5	3	2	2	5	4	7	14	7	3	8	7	2	3	12
ACCURTIS																						
ACCURVIR																						
ACDAONEN																						
ACDIDYMA					1				1													
ACENGELB															4			3		2		5
ACEXIGUA																					2	1
ACFLEXEL																						
ACFRIGID																						
ACGRACIL																						
ACGRANA																						
ACJOURSA	2	1	3	2	2		2	3				1				1						
ACLAC-VU																						
ACLANCVF	1	1			1			1						1			1					
ACLAVLSH									1													
ACLANCVR																						
ACLATERO							2	3														
ACLAUENB		1																				
ACLEMMER																						
ACLEVAND																				1	1	
ACLUTHER																			1			
ACLINEAR																						
ACMINUTI	3	10	5	8	14	15	10	4	5	7	2			4	6	2	6	7		10	3	4
ACNITIDI																						
ACNODOSA																						
ACOESTRU							1															
ACPERAGA		1																				1
ACROSENS																						
ACSACCUL																						
ACSP????	1		2	4	1	2	1			2				3								
ACSUCHLA		1	2	1	2			3			1	1	2			2	2		3		1	1
ACSUBATO		1					1															
ACVENTRA																						
ACZIEGLE										1												
AMAEQUAL						1				1												
AMFOGEDI																		2				
AMPEDICU	1	8	8	2	2	2	1		4	6	6	3			3	5	7	2	7	2	7	6
AMLIBYCA																					1	
AMTHUMEN																			1			
AMINARIE	1								2													
AMVENETA							1														2	
AMSP???												2										
ANVITREA	1	1				1	1		5												2	
ASFORMOS	2	2	1	1	3	2	3	1	1	3	27	10	10	7	3	10	4	7	9	8	3	6
AUAMBIGU							1	1		1												
AUDISTAN																						
AUSUBARC	176	150	161	147	113	132	102	139	156	153	129	160	157	189	168	129	127	101	148	154	141	114
CABACILL		2				2		3											2		2	
CMAMPHVH																						2
CMARCTIC				1																		
CMCAESPI																						
CMCISTUL							2	1														
CMCESATI										1												
CMSP????						2	4			2												
CMLAEVIS																						
CMLAPPON																						
CMMICROC			2			3	2	1		1							2					
CMMINUT	4	3	1	2		1	1	1														
CMNAVICU					1																	
CMOBSCUR																						
CMSILESI	2	4	2	2	1	2	5	5				2	1						1			
CMSINUAT			2		3	2	1		1													
CONEOTHU	1			2	2	1	2	2			2	1	1					1	2	2	1	1
COPLACEN	2								1													
COPLACVE	3	1	2	1	1	2	1			2		2					1			1	2	
CODISCUL																		1			1	1
CSTTHOLI																						
CYPSSTEL	6	9	13	6	21	9	16	13	8	15								1	1		1	
CYBODAVL	14	10	13	17	23	18	33	25	23	15	25	14	30	11	17	18	16	37	42	14	51	35
CYCOMTVU																						
CYMICHIG	2	1	1		2	1	1															
CYOCELLA	15	9	4	4	7	3	13		4	1	20	19	10	28	14	7	11	15	12	16	8	10
CYTRIPUN										2												
DEKEUTZI																						
DETENUIS																						
DIPL??																						
DIELLIPT																	1			1		
DIMESODO																						
DIMODICA																						
DIOCULAT									1							2		1				
DIOVALIS					1		1		1													
DIPETERS										2												
DIPARMA				1												1						
DIAVULMC																						
DIMESODO																						1
EPITHEMI			1																		1	
EUNOTIA																						
FRARCUS											2		2				2					
FRBREVIS	12	4	21	20	14	12	21	9	11	6	14	14	31	20	11	14	16	14	16	15	28	31
FRCAPUCI								1														
FRCAPUVG																	2				2	
FRCAPUVM	2				1	1																
FRCAPUVR																						
FRCAPUVV	2	2	4	2	5	1	3		4	2	13	2		3		1				6	6	6
FRCONSTR	8	3	15	19	18	14	6	21	7	25	1	3	5	3	14	5	5	14	15	10	4	5

	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	Tchesinkut Lake, BC E224893 diatom counts entered October 15, 1997			tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893
	11.5	13.5	15.5	17.5	19.5	21.5	23.5	25.5	27.9	29.7	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	17.5	20.5	23.5	26.5
FRCONSVB										1							1		7			
FRCONSVV		2	2		5	1			3	3	4		2	2	5	2		5	1	3		3
FRCROTON	6	14	7	2	9	5	6	7	4	2			5								4	
FRCYCLOP																						
FRFAMELI																						
FRLAPPON																			1			
FRLEPTOS																						
FRMAZAME				1																		
FRNANANA							1	1														
FROLDENB																						
FRPARASI				1																		
FRPINNAT	18	14	8	9	3	10	7	13	15	19	3	14	9	16	5	11	15	22	15	11	15	12
FRPINNVA	1	4	5		1	2	1	5	2	1				1	2	2	4	5	1	3	2	
FRPINNVI		4			1	2	5	2	4	5	1	1	3		1	4	3	3	7	5	4	5
FRPINNVL																						
FRROBUST				2																2		
FRSP????																1	2					
FRULNA	1					1		1														
FURHOMVS																						
GOMPHONE												2										
GOGROVVL									1													
GOMINUTU						2			1					1								
GOPARVUL																						
GOPUMILU					3	5	1	1														
GOOLIVVO					1	2																
GYROSIGM									1								1					
HANTZ??																						
MASMITHI																						
MELINEAT	2																					
MRCIRCUL																						
NAAGREST							1												1			
NABACILL				1																		
NACARI																						
NACAPITA									1				2							1		2
NACAPIVL														1								
NACOCCON	1					1																
NACRCEPH						2											2					
NACRELLA			1			1										2			2	1		1
NACRYOID		1																				1
NAFONTIC																						
NAFRACTA		1								1												
NAGOEPVO																						
NAGREGAR																						
NAHARDER																						
NAHELENS																						
NAIGNOVA																						2
NAIGNOVP	1	3					1								2				1			
NAJAERNF				2			1	1						1								
NAKRASSK																						
NAKUELBS															2							
NALATERO																						
NAMARGAL																						
NAMENISC																						
NAMINIMA		1			1		2	2	1	1			1			1			2			
NAPORIVO																						
NAPROTRA																						
NAPSANGL																						
NAPSSCUT		1	1	1	1					2	2									2		
NAPUPULA						2																
NARADIOS							1															
NARHYNCH																						
NAREINHA		1																				
NASAXONI																						
NASAXOPH																						
NASCHOEN																						
NASCUTTE	1																					
NASEMINU				2		4			2													
NASIMILI						1																
NASP#2																						
NASP????	2	3	3			1	1		5	2	2	3		2	3	2	2	6	3		4	
NASTRIOL																						
NASUBHAM																		3				
NASUBLUC											2											
NASUBMIN																			1			
NASUBMUR	2	3		6	3	2	2		1		1	2				3					3	2
NASUBROT			1		1	3				1										1	1	
NAUTERMO																						
NAVITABU		3							1							1						
NEKOZLOW																						
NITZSCHI																						
NIACICUL																						
NIALPINA													2									
NIAMPHIB																						
NIANGUST			1				1		2													
NIDISSIP		1		1											1			1			2	
NIFONTIC		4	1	2	3				1		2	2					3	5	4			1
NIFRUSTU			1	1					1											1		5
NIGRACIL																						
NIINCONS	1		1																		2	
NILACUUM																			2			
NILINEAR																						
NIPALEA																2						
NIPALEAC							1									2			1			
NIPERMIN																						
NIPURA																						
NIRECTA																						
NIWUELLE																						
OPEPHORA																				1		
PIIGNOBI																						
PIBOREAL																1						
RHIERIEN											1											
RHIGRACI																						

	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	francois E224946	Tchesinkut Lake, BC E224893 diatom counts entered October 15, 1997			tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893
	11.5	13.5	15.5	17.5	19.5	21.5	23.5	25.5	27.9	29.7	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	17.5	20.5	23.5	26.5
RHABBREV																						
SIDELOGN												1										
STALPINU				1	2	1	2			2	1	1	3	1	6	3	10	7	7	1	5	2
STHANTZS										1												
STMINUTU	4	6	5	2	12	1	4	1	1	2	49	52	67	39	27	68	89	85	53	61	25	37
STMEDIUS		4		2	9	7	7	15	5	4		8	1	8	7	3	3	10	6	6	1	6
STNIAGAR	1		1																			
STOREGON	7	1	5	2	5	3	5	5	3	2				1						1	1	1
STPARVUS																						
STSUBTRA																						
SURI??																						
TAFLOCCU																						
TAQUADRI	5	9	7	6	8	6	11	17	22	9												
UNK PENN	2			2		3	2	1		2		1					1	1				2
UNK CENT								1														
CYSTS	14	9	11	4	7	8	7	7	9	7	8	5	7	11	8	3	6	4	8	10	9	10
TOTAL	318	314	318	300	314	303	306	316	320	317	313	326	351	350	315	312	343	367	387	344	342	327

	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	Tchesinkut Lake, BC Diatom counts entered Oct 20, 1997	E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944
	29.5	32.5	35.5	38.5	0.5	2.5	4.5	6.5	8.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	42.5
ACAMOENA		1		2		2											2			
ACBIASOL																				
ACCALCAR																				
ACCLEVEI			2				2		1	1		4		1		1		2	1	
ACCHLIDA																				
ACCONSPI	6	8	1	7	7	6		4	5		3	4	4	8	3	12	9	4	2	3
ACCURTIS																				
ACCURVIR																				
ACDAONEN																				
ACDIDYMA																				
ACENGELB					2						2	2			4	2				2
ACEXIGUA			1																	
ACFLEXEL																			1	
ACFRIGID																				
ACGRACIL																				
ACGRANA																				
ACJOURSA	1		1					2												1
ACLAC-VU																				
ACLANCVF	2			2											1			2		
ACLAVLSH																				
ACLANCVR		2																		
ACLATERO	1																			
ACLAUENB					2															
ACLEMMER																				
ACLEVAND	1	1									1									
ACLUTHER																				
ACLINEAR																				
ACMINUTI	5	4	2	4	2	5			2	5	1		2	4		4			2	3
ACNITIDI															1					
ACNODOSA																				
ACOESTRU																				
ACPERAGA							2													
ACROSENS																				
ACSACCUL																				
ACSP????								2				1				1		1		
ACSUCHLA	1		2							2	1				1		1			1
ACSUBATO	2																			
ACVENTRA											2									
ACZIEGLE							1			3							3			
AMAEQUAL																	1			
AMFOGEDI																				
AMPEDICU	18	3	2	4	2	3	1	3	2	4	2	6	3	4	2		5		6	6
AMLIBYCA																				
AMTHUMEN																				
AMINARIE														1						
AMVENETA																				
AMSP???				1																
ANVITREA	1				2	1												1		
ASFORMOS	1	1	15		38	9	11	2	3	8	15	2	3		13		3	3		
AUAMBIGU																				
AUDISTAN																				
AUSUBARC	154	105	162	172	150	160	170	200	177	174	100	155	166	140	123	194	126	136	190	171
CABACILL							1								2			1		
CMAMPHVH																				
CMARCTIC																				
CMCAESPI																				
CMCISTUL																				
CMCESATI																				
CMSP????																				
CMLAEVIS																				
CMLAPPON																				
CMMICROC						1	2													
CMMINUT																				
CMNAVICU																				
CMOBSCUR																				
CMSILESI												1								
CMSINUAT																				
CONEOTHU	2		1	1							1	1			1			2		
COPLACEN																				
COPLACVE		2												2						
CODISCUL			1			1														
CSTTHOLI																				
CYPSSTEL	5	1																		
CYBODAVL	19	46	36	27	21	37	17	14	10	29	68	32	11	39	49	9	65	52	30	39
CYCOMTVU																				
CYMICHIG																				
CYOCELLA	6	19	10	19	25	22	17	31	15	13	16	18	12	16	19	10	36	20	16	16
CYTRIPUN																				
DEKEUTZI																				
DETENUIS																				
DIPL??			2																	
DIELLIPT															1				1	
DIMESODO																				
DIMODICA																				
DIOCULAT	1											1				2		2		
DIOVALIS																				
DIPETERS																				
DIPARMA																				
DIAVULMC																				
DIMESODO																				
EPITHEMI								1												
EUNOTIA																				
FRARCUS						3														
FRBREVIS	22	26	9	35	9	5	6	14	13	15	7	14	11	17	12	13	11	20	5	14
FRCAPUCI					13	1														
FRCAPUVG																				
FRCAPUVM																				
FRCAPUVR																				
FRCAPUVV					6	4	2	1				1	10							
FRCONSTR	2	18	7	22	2	4	1	5	12	3	14	5	17	13	2	10		1	2	5

	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	Tchesinkut Lake, BC Diatom counts entered Oct 20, 1997		E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944
	29.5	32.5	35.5	38.5	0.5	2.5	4.5	6.5	8.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	42.5
FRCONSVB																				
FRCONSVV		2	1	2	1		1	2	3	1		3		10	2		5	2		
FRCROTON		4	5			1			1			1	2						2	2
FRCYCLOP		4																		
FRFAMELI																				
FRLAPPON														1						
FRLEPTOS																				
FRMAZAME																				
FRNANANA																				
FROLDENB																				
FRPARASI	2																			
FRPINNAT	10	17	4	5	4	5	8	5	14	11	5	16	5	15	13	10	14	25	9	16
FRPINNVA		4		1		3			2	4		4	2				3		1	2
FRPINNVI	4	5	3	8	2	6	1	2	8	2	4	4	1	6	4			2		3
FRPINNVL																				
FRROBUST							1													
FRSP????	1																			
FRULNA																				
FURHOMVS						1														
GOMPHONE																				
GOGROVVL																				
GOMINUTU	1											2								
GOPARVUL																				
GOPUMILU																				
GOOLIVVO																				
GYROSIGM														1						
HANTZ??																				
MASMITHI																				
MELINEAT																				
MRCIRCUL																	1			
NAAGREST				1																
NABACILL																				
NACARI																				
NACAPITA																				
NACAPIVL																	1			
NACOCCON																1				
NACRCEPH																				
NACRELLA			2			4			2	1					1					
NACRYOID											3					1		1	1	
NAFONTIC																				
NAFRACTA																				
NAGOEPVO																				
NAGREGAR																				
NAHARDER																				
NAHELENS								1												
NAIGNOVA																				
NAIGNOVP	2	1													1					
NAJAERNF		3									1									
NAKRASSK																				
NAKUELBS																				
NALATERO																				
NAMARGAL																				
NAMENISC																				
NAMINIMA		2						2							1	1	1	4		1
NAPORIVO									2							2				
NAPROTRA																				
NAPSANGL			2																	
NAPSSCUT																				
NAPUPULA																				
NARADIOS																				
NARHYNCH																				
NAREINHA																				
NASAXONI																				
NASAXOPH																				
NASCHOEN																				
NASCUTTE																				
NASEMINU																				
NASIMILI					2															
NASP#2															1					
NASP????	3			6	2	1	1	2	2		2		2	3	2		1	1	2	1
NASTRIOL	2																			
NASUBHAM																				
NASUBLUC			1	2																
NASUBMIN					1					1	1				1		1			
NASUBMUR	1	2	2	2			2		2					6					2	
NASUBROT																2				
NAUTERMO																				
NAVITABU					2				4						2					
NEKOZLOW																				1
NITZSCHI					1															
NIACICUL																				
NIALPINA																				
NIAMPHIB																				
NIANGUST																				
NIDISSIP																	1			
NIFONTIC		2			1	1			3	6	5			2	3	3	2	1		
NIFRUSTU	2	1		2																
NIGRACIL																				
NIINCONS		3	4				1						4					2		2
NILACUUM																				
NILINEAR																				
NIPALEA																				
NIPALEAC		2																		
NIPERMIN																				
NIPURA																				
NIRECTA																				
NIWUELLE																				
OPEPHORA																				
PIIGNOBI				1																
PIBOREAL																				
RHIERIEN																				
RHIGRACI																				

	tchesink. E224893	tchesink. E224893	tchesink. E224893	tchesink. E224893	Tchesinkut Lake, BC Diatom counts entered Oct 20, 1997		E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944	tchesink. E224944
	29.5	32.5	35.5	38.5	0.5	2.5	4.5	6.5	8.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	42.5
RHABBREV													1							
SIDELOGN										1										
STALPINU	3	6	6	6	3	6		5	5	4	4	4	4	1	13	4	8	9	6	5
STHANTZS																				
STMINUTU	22	38	89	27	35	36	60	48	38	42	76	23	39	26	45	27	25	33	47	64
STMEDIUS	4	1	4	4	3	2	6	6	5	3	11	9	9	4	1	2	6	8	3	16
STNIAGAR		1											1							
STOREGON		1				1						1							3	
STPARVUS																				
STSUBTRA																				
SURI??																				
TAFLOCCU																				
TAQUADRI																				
UNK PENN																				
UNK CENT																				
CYSTS	13	7	6	8	4	5	12	4	4	4	6	9	3	8	10	9	7	13	9	4
TOTAL	307	335	317	361	338	329	314	352	331	333	345	314	309	320	324	311	329	335	332	374

Takysie Lake core diatom data

depth	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	16.5	18.5	20.5	22.5	24.5	26.5	28.5	31.5
ACCONSPI	0.91	0.64	0.00	1.31	0.00	0.66	1.19	1.62	0.92	0.58	2.18	1.08	0.31	1.56	1.01	1.31
ACMINUTI	2.11	0.00	0.93	0.98	0.63	0.00	0.00	0.32	0.31	0.87	1.36	0.00	0.94	0.94	1.51	0.00
ASFORMOS	6.95	14.15	16.36	15.03	12.93	14.43	9.85	8.77	11.96	14.83	8.72	10.24	9.72	10.31	8.31	6.89
AUAMBIGU	7.25	5.14	2.47	4.25	2.52	2.62	3.88	6.49	5.52	5.23	3.81	1.35	2.19	4.38	2.77	3.28
CYBODAVL	4.83	5.14	5.56	5.23	2.84	2.95	2.09	3.57	2.76	2.91	3.00	1.62	0.94	4.06	2.52	0.33
FRBREVIS	2.42	0.00	4.63	7.84	0.00	0.33	2.09	1.62	0.92	4.94	1.63	2.43	2.82	1.88	6.05	0.33
FRCAPUCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.62	0.00	0.58	0.54	2.70	1.88	0.00	0.00	0.00
FRCONSTR	1.81	1.93	2.16	2.61	0.32	0.66	3.88	1.30	0.00	1.16	3.27	0.27	2.51	0.94	5.29	0.00
FRCROTON	28.10	21.22	8.64	7.52	8.20	3.28	3.88	5.84	14.42	14.83	13.35	12.67	9.72	5.63	11.08	6.23
FRNANANA	0.91	1.29	0.93	0.98	3.47	0.00	0.00	0.00	1.53	0.58	0.00	0.00	0.00	0.94	1.01	0.33
FRPINNAT	9.97	2.25	8.64	8.50	6.62	8.85	4.78	7.14	10.43	4.36	8.72	4.58	2.82	3.13	3.53	0.98
FRROBUST	0.60	0.00	2.16	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAMINIMA	0.00	0.64	0.93	1.96	2.52	1.97	2.09	0.97	1.53	0.87	2.72	0.54	0.00	0.94	0.50	0.33
STHANTZS	3.02	3.22	1.85	0.98	1.58	1.64	1.19	2.27	3.68	2.03	1.91	3.23	4.39	6.88	8.31	10.82
STMINUTU	4.23	3.54	6.48	1.63	4.42	5.90	6.87	4.22	2.15	8.43	8.99	9.43	4.70	5.31	7.05	12.13
STMEDIUS	1.21	0.96	0.93	0.65	0.32	0.66	0.00	1.30	2.45	1.45	1.36	1.89	0.63	1.88	2.77	1.31
STNIAGAR	3.63	5.14	4.63	2.61	7.89	5.57	3.88	4.22	3.68	2.91	1.36	1.62	0.94	2.81	2.77	1.97
STPARVUS	12.08	22.51	18.83	25.49	33.12	41.64	41.79	32.14	22.39	21.22	22.89	38.54	49.84	33.44	26.20	47.87
TAQUADRI	0.91	2.89	4.63	2.61	2.52	2.95	5.67	5.84	5.52	4.94	2.72	0.27	0.94	0.31	0.25	0.00
CYSTS	4.83	8.04	5.25	5.88	7.57	6.23	3.58	5.52	4.91	8.14	5.45	3.77	1.88	4.38	2.52	4.26
total benthics	23.56	11.58	27.78	32.68	19.87	18.36	20.60	25.00	23.93	20.35	31.06	18.87	15.99	22.81	26.95	7.21
total plankton	76.44	88.42	72.22	67.32	80.13	81.64	79.40	75.00	76.07	79.65	68.94	81.13	84.01	77.19	73.05	92.79
total Navicula	1.81	3.54	3.09	4.25	4.42	3.93	3.88	4.55	3.07	2.62	3.81	1.08	1.25	4.69	1.26	1.31
total Steph	24.77	36.66	33.02	31.70	47.32	55.41	53.73	44.48	34.36	36.05	36.78	54.72	60.50	50.31	47.10	74.10
total Achnan	3.93	0.96	2.78	3.59	1.58	1.64	1.19	2.27	3.07	3.49	4.63	1.08	1.57	5.00	5.04	1.97
total Nitzsch	0.00	0.32	0.31	0.65	0.95	0.00	0.30	0.65	0.92	0.87	0.27	0.54	0.63	1.25	1.26	0.00

SEDIMENT CHEMISTRY FOR FRANCOIS LAKE

* Samp: 974496 Id: FRANCOIS EAST Submld: 20017709

#	depth	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr	Ti	V	Zn
lowest		2		8				0.8								2	200					8	8		8				
001	0.5	2	25620	10	264.7	264.7	7900	0.9	13	29.7	34	34570	3632	5390	3910	28	560	28	1500	18	930	10	8	1910	8	96.6	1136	76	84
002	1.5	2	25260	10	1063	1063	8160	0.8	14	44.2	33.2	34060	3627	5240	48800	49	510	297	1600	35	815	8	185	704	8	105	1123	67	9
003	2.5	2	25610	66	1017	1017	7580	1	17	35.7	36.1	58730	3668	5140	18900	19	480	110	3340	20	807	10	36	916	8	94.1	1135	74	82
004	3.5	20	16400	270	2717	2717	7700	8	17	10	33	144400	2180	3300	32660	2	200	90	9400	80	520	100	80	1200	80	120	501	80	7
005	4.5	2	25110	82	874.5	874.5	7130	1	13	30.6	37.6	58650	3490	5150	6030	5	460	29	3430	17	693	8	8	845	8	88.1	1136	78	7
006	5.5	2	28620	18	493.2	493.2	6840	0.8	14	30	34.3	31990	4049	5550	2508	5	590	20	1500	18	756	8	8	944	8	80.6	1311	82	89
007	6.5	2	26520	21	425.3	425.3	6580	0.8	15	29.6	34.9	36370	3518	5520	3582	6	530	23	2280	20	1060	8	8	942	8	73.8	1213	83	94
008	7.5	2	30780	10	430.8	430.8	6600	0.8	14	35.6	35.1	47860	4421	5720	4970	6	650	35	3680	23	922	8	8	814	8	76.5	1309	87	88
009	8.5	2	30440	8	475.1	475.1	6780	0.8	14	32.4	37.4	41720	4180	5950	3950	2	610	28	2590	26	678	8	8	1250	8	77.2	1319	88	94
010	9.5	2	28140	8	468.6	468.6	6790	0.8	16	34.9	40.4	39640	3837	5670	4470	4	580	34	3240	23	880	8	8	1000	8	75.9	1260	87	95
011	10.5	2	26200	8	480.6	480.6	6750	1	15	30.5	42.3	31610	3386	5760	2049	2	570	26	1300	24	794	8	8	972	8	75.1	1241	85	9
012	11.5	2	29430	8	474.3	474.3	6640	1	14	33.8	38	47960	4223	5730	5330	2	580	33	5290	23	647	9	8	979	8	74.4	1309	87	96
013	12.5	2	28830	9	494.6	494.6	6680	0.8	15	32.6	41.7	34110	3982	5670	2633	3	600	26	2050	24	809	8	8	1110	8	76.4	1283	87	95
014	13.5	2	28190	8	461	461	6470	0.8	16	33.3	37.5	42390	4053	5560	3840	2	540	30	4830	20	765	8	8	1060	8	73	1284	85	95
015	14.5	2	30960	8	498.7	498.7	6890	0.8	16	33.7	39.2	36430	4597	5850	2623	2	630	27	2130	18	693	8	8	1180	8	80.7	1360	91	96
016	15.5	2	30210	8	507.3	507.3	6800	0.8	16.7	36.1	39.3	34090	4329	5900	1842	2	620	26	1300	10	625	8	8	1997	8	79.2	1353	89	99
017	16.5	2	29350	8	494.4	494.4	6590	0.8	16	34.3	37.6	34550	4134	5750	1721	2	590	26	1100	23	579	8	8	1550	8	77.3	1315	84	10
018	17.5	2	29390	8	503.7	503.7	6770	0.8	16	35.1	41.5	30810	4093	5830	1652	2	570	26	1100	10	739	8	8	1340	8	78.3	1346	92	92
019	18.5	2	31350	10	505	505	6630	0.9	15	33.1	40.2	39280	4682	5830	2983	2	640	23	4390	22	896	8	8	1400	8	78.7	1322	90	10
020	19.5	2	26000	10	476	476	6350	0.8	17	31.1	36.6	29950	3454	5400	1678	4	530	27	1400	10	1290	8	8	1380	8	73.1	1176	82	9
021	20.5	2	26300	10	461.2	461.2	6760	0.8	18	32.5	37.3	31090	3610	5400	1553	4	580	25	1100	10	1070	8	8	1310	8	76.6	1345	84	96.
022	21.5	2	25360	9	445	445	6370	0.8	19.3	31.8	38	45630	3325	5340	4560	4	500	33	4470	18	784	10	8	874	8	69.4	1214	83	9
023	22.5	2	28560	8	509.1	509.1	6610	0.8	16	32.3	36.5	36120	3674	5560	3624	2	560	24	2840	21	578	8	8	962	8	74.8	1245	84	87.
024	23.5	2	28920	8	496.2	496.2	6870	0.8	16	33.5	41.4	34900	3874	5680	1954	3	640	23	1500	18	641	8	8	825	8	78.6	1341	90	10
025	24.5	2	28100	8	492.8	492.8	7000	0.8	19.4	32.9	41.8	33990	3854	5860	1858	2	610	26	1400	19	653	8	8	719	8	79.2	1344	88	96.
026	25.5	2	31150	8	492.4	492.4	7010	0.8	17.3	37.3	39.2	38170	4667	6000	3047	2	710	28	2750	23	536	8	8	681	8	81.9	1410	92	91.
027	26.7	2	28140	8	457.4	457.4	6460	1	15	36.9	38.1	52960	3985	5620	6990	2	580	40	7440	20	522	8	8	762	8	71.2	1244	88	92.
028	27.9	2	29710	8	499.2	499.2	6870	1	15	34.9	39.9	35690	4110	5880	2350	2	660	22	1890	22	556	8	8	509	8	78.5	1328	89	9
029	28.9	2	30300	9	507	507	7060	0.8	18.6	39.1	45.3	34260	4261	6230	1599	3	660	28	1100	24	863	8	8	800	8	80	1365	97	10
030	29.9	2	31410	10	505.2	505.2	7180	0.8	16	35.6	42.8	33350	4532	6210	1504	3	690	24	1100	22	1090	8	8	975	8	83	1427	97	9

FRANCOIS LAKE SEDIMENT CHEMISTRY (WEST CORE)

* Samp: 974497 Id: FRANCOIS LAKE SubmId: 20017710

lowest		2		8				0.8								2	200					8	8		8				
#	depth	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr	Ti	V	Zn
001	0.5	2	29750	19	276.5	0.8	7710	1	17.1	30.7	35.2	43240	3227	5880	4500	9	440	30	1500	21	816	8	8	483	8	96.2	857.5	83	106
002	1.5	2	27510	20	515.6	0.7	7210	0.9	15	39.3	33.8	39760	3179	5450	39500	30	410	227	1400	28	779	9	140	397	9	99.8	804.5	73	95.3
003	2.5	2	25980	298	674.6	0.7	6880	0.9	17.9	31.7	31.6	76200	2930	5250	18400	17	360	110	2840	24	699	10	40	463	8	91.4	773.9	74	85.9
004	3.5	20	31180	340	800	2	6200	9	8	41	47	83460	3810	5600	8454	20	200	30	4900	80	470	80	80	1100	80	88	904	100	100
005	4.5	2	37700	110	585.8	0.9	6130	0.8	18.8	35.5	36.5	64260	4582	7020	4680	4	550	34	2460	28	471	8	8	569	8	81	1134	100	112
006	5.5	2	37430	20	471.4	0.8	5840	0.8	18.2	39.2	38.1	43220	4325	7040	3218	2	550	29	1100	26	495	8	8	623	8	73.4	1132	96	114
007	6.5	2	35580	24	409.2	0.8	5340	1	15	36.9	33.7	59700	4467	5840	4220	2	580	33	3370	29	691	8	8	507	8	68.5	1081	91	103
008	7.5	2	36480	23	458.5	0.9	5640	0.8	20.5	37.1	46.1	47270	4497	6620	3755	2	530	35	1720	32	924	8	8	1110	8	68.4	1021	95	127
009	8.5	2	35930	18	442.7	0.9	5740	0.9	19.4	40.4	43.7	39580	4664	6440	2882	2	550	34	1200	31	813	9	9	720	9	70.9	1107	95	118
010	9.5	2	31650	18	399.8	0.8	5630	0.8	16	32.9	40.5	44410	3791	6420	3139	2	490	31	1500	33	491	8	8	723	8	64.8	960	90	112
011	10.5	2	39420	20	458.7	0.9	6190	0.8	17.8	38.3	42.1	47650	5414	7600	3044	2	640	31	1500	36	390	9	8	707	8	73.9	1166	100	121
012	11.5	2	34470	20	421.5	1	5710	0.8	14	35.2	40.1	44800	4529	6690	3382	2	580	27	2030	35	418	9	8	1370	8	67.9	1032	95	115
013	12.5	2	35610	18	423	0.8	5740	0.8	18.2	40.1	38.1	48170	4878	6710	3568	2	610	30	2320	30	398	8	8	1010	8	69.5	1136	96	117
014	13.5	2	36780	10	459	1	5960	0.8	18	41.3	39	43070	4713	6920	2582	3	630	31	1300	33	403	8	8	938	8	72.9	1174	98	118
015	14.5	2	35320	10	423.4	0.9	5400	0.8	16.8	34.5	37.6	38700	4666	6290	2505	2	600	28	1300	36	409	8	8	1100	8	66.2	1075	93	113
016	15.5	2	32760	24	386.7	0.9	5170	0.8	15	34.7	35.4	54790	4330	5990	3980	2	550	29	3830	30	409	8	8	945	8	61.1	993.8	95	103
017	16.5	2	39610	20	462	0.9	5910	0.8	19.1	42.5	39.8	40220	5549	7020	2387	2	680	33	1200	36	432	8	8	955	8	73	1191	100	115
018	17.5	2	43330	22	469.8	1	6040	0.8	19.1	45.2	39.3	52940	6176	7940	3170	3	680	35	2250	36	396	8	8	1010	8	73.6	1234	110	117
019	18.5	2	40550	17	481	0.9	5880	0.8	24.1	42.4	39.6	39220	5388	6960	2098	3	660	33	1000	31	871	8	8	1060	8	74	1210	100	122
020	19.5	2	38660	20	442.9	1	5650	0.8	19.7	37.3	38.7	44470	5255	6840	2476	3	620	30	1400	33	575	8	8	966	8	68.8	1152	96	117
021	20.5	2	40800	18	447.6	0.9	5810	0.8	17.7	40	38.5	41050	5638	7090	2317	2	620	34	1300	37	415	8	8	1030	8	71.8	1164	100	120
022	21.5	2	41620	19	444	0.9	5770	0.8	18.2	43.1	40	50800	5844	7360	3103	3	630	36	2050	39	432	8	8	848	8	70.5	1188	100	120
023	22.5	2	38630	20	432.8	0.8	5680	0.8	19.1	38.3	40.1	43680	5190	7200	2690	2	580	31	1740	36	494	8	8	921	8	69.6	1140	99	117
024	23.5	2	39240	21	434.4	0.9	5560	0.8	27.8	41.6	40.6	43250	5376	6850	2191	6	630	38	1000	37	1270	8	8	972	8	69.8	1156	100	114
025	24.5	2	36010	20	412.1	0.9	5330	0.8	19.2	38.8	40.7	45460	4698	6480	2667	3	560	29	1740	41	615	8	8	1050	8	65.3	1067	97	121
026	25.5	2	37020	20	431.9	0.9	5640	0.8	17.8	37.8	38.2	38400	5018	6500	2040	2	630	31	990	23	557	8	8	782	8	71	1158	98	113
027	26.5	2	35300	25	396.8	1	5220	0.8	20.3	41.3	34.2	55280	4885	5980	4240	2	600	35	4080	34	597	8	8	831	8	65.3	1092	96	106
028	27.5	2	37850	17	443.5	0.9	5620	0.8	19.4	39.7	38.8	35880	5167	6750	1934	3	600	31	910	31	641	8	8	844	8	70.7	1152	96	116
029	28.5	2	37650	24	409.7	1	5370	0.8	19.4	38.6	36.1	55730	5307	6580	3819	2	640	31	2380	28	646	8	8	954	8	67.5	1106	100	108
030	29.5	2	39910	22	423.2	1	5340	0.8	21.8	39.2	38.2	52340	5576	6480	3416	4	680	32	2330	29	764	8	8	980	8	67.8	1121	100	115
031	30.5	2	40230	21	435.8	1	5650	0.8	19.2	40.1	37.8	45360	5593	6820	2448	2	690	29	1400	28	533	8	8	1040	8	71.6	1168	100	119
032	31.5	2	44010	20	454.9	1	5510	0.8	17.9	38.6	42.3	44870	6414	7180	2303	2	770	31	1300	38	542	8	8	916	8	72.2	1167	100	124
033	32.5	2	36420	20	417.1	0.9	5420	0.8	24.4	37.4	39.4	41180	4816	6310	2167	5	640	32	1300	29	1160	8	8	1320	8	67.2	1122	99	121
034	33.5	2	28750	17	383.3	0.9	5170	0.8	17.7	33	37.8	34560	3132	5750	2059	2	420	27	1100	23	640	8	8	1160	8	60.1	918.4	87	115
035	34.5	2	29990	18	381.1	0.9	5100	0.8	17.5	30.7	37	41770	3471	5880	3245	2	450	27	2350	27	543	8	8	1050	8	59.1	899.9	90	116
036	35.5	2	28280	20	370.9	1	4980	0.8	16	35.1	38.5	42530	3174	5950	2895	3	420	29	1870	26	433	8	8	919	8	56.9	826.3	82	116
037	36.5	2	34660	17	414.7	1	5330	0.8	16	34.6	37.5	46400	4506	6410	3180	2	550	25	2190	20	425	8	8	1560	8	65.4	1057	93	118
038	37.5	2	29720	18	385.8	1	5150	0.8	19.9	33.5	36.9	39620	3448	5710	2621	3	480	35	1740	19	673	8	8	1240	8	60.6	947.7	87	115
039	38.5	2	30680	10	392.9	0.9	5290	0.8	16	32.1	35.9	40310	3633	6070	2402	2	490	27	1500	29	449	8	8	1350	8	62.7	999	87	105
040	39.5	2	33920	10	412.1	1	5410	0.8	17.2	34	35.6	46980	4460	6190	3285	2	570	27	2400	25	405	9	8	1290	8	66.6	1086	95	109