A SHORT PALEOLIMNOLOGICAL HISTORY OF TWO RIVERINE IMPOUNDMENTS ON THE SAINT CROIX RIVER

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619 Second Street
Hudson, Wisconsin 54016

Nels H. Troelstrup, Jr.
John L. Foley
Daniel R. Engstrom
LLoyd P. Queen

Department of Forest Resources
University of Minnesota
St. Paul, Minnesota 55108

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EXECUTIVE SUMMARY

Sediment cores were extracted from the impounded basin above St. Croix Falls, Wisconsin (SCF) and Lake St. Croix (LSC) along the Minnesota-Wisconsin border to examine changes in trophic status of the basins over the last 150 years. High activities of ^{137}Cs were observed in sediment at depths greater than 1.2 meters in cores extracted from the SCF basin suggesting that over 1.2 meters of sediment had been deposited in less than 40 years. Cores extracted from Lake St. Croix near Bayport, MN, Lakeland, MN and Afton, MN were found to contain sediments deposited prior to settlement (i.e, before 1850). Deposition and accumulation rates were an order of magnitude lower in LSC and similar to estimates obtained by the Wisconsin Department of Natural Resources for Squaw Lake near Somerset, WI.

Sedimentation patterns within the SCF basin appear to be correlated with stream discharge (esp., during the autumnal period of leaf abscission). Peaks in organic matter, carbonates and chlorophyll and midge community characteristics (density, species richness, composition) appear to track stream flow patterns during the fall of the year when allochthonous organic matter enters the tributaries and mainstem of the St. Croix River.

Increases in organic matter, carbonates and chlorophyllous pigments and shifts in benthic midge communities within the more recently deposited sediments of both basins provide evidence of cultural eutrophication over the last 40-50 years. These changes are consistent with large-scale forest harvest and conversion to agriculture within the watershed since settlement and urbanization and development along the river corridor over the last 20 years.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the cooperation of Dr. Richard A. Wiesbrod (USDI, National Park Service) for providing a service boat used during core extraction. Special thanks are also extended to Mr. Ron Lawrenz (Science Museum of Minnesota) for his assistance in the field and to Dr. James A. Perry for the use of his laboratory during this project.

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INTRODUCTION

Biological monitoring has become an important aspect of water quality management and a variety of monitoring tools have been developed to facilitate examination of the resource from different spatial and temporal perspectives. Microbiological methods have been developed to search for the presence or likelihood of pathogenic organisms, multi-metric approaches have been developed to examine structural and functional characteristics of invertebrate and fish communities and measures of habitat fragmentation and fractality have been developed to examine the effects of disturbance on a landscape scale (Hunsacker and Carpenter 1990; Johnson et al. 1993).

Traditional physical and chemical methods provide point-in-time assessments of water quality conditions, often missing hydrologic events which cause many water quality problems (Karr 1991). Biological methods provide a means of integrating water quality characteristics over the life-histories of the organisms examined and all of the methods above provide some level of integration both in space and time. However, few of these methods provide a longer-term picture of water quality and biological responses.

Paleoecology is the study of historical ecology and paleolimnology is the historical study of the limnology of a lake basin. Major natural events (e.g., floods, landslides, fires) and anthropogenic activities (e.g., deforestation, cultivation, urban development) contribute material and energy to downstream receiving systems within a drainage. Signatures of these large scale processes may be found in sedimentary deposits of reservoir and lake basins which serve as sinks within the drainage basin. The tools of paleoecology provide a holistic approach to resource assessment through a study of the sediments deposited within a lake basin . Rates of sediment accumulation, plant pigment concentrations and fossilized remains of plants and animals provide a chronological history of the processes operating within the basin over long periods of time (Frey 1988; Pennington 1981; Smeltzer and Swain 1985; Walker 1993).

These techniques have been used by other authors in the study of climate change (Hofman 1983), descriptions of historical changes in floristic composition (Turner 1984; Watts 1984), documentation of changes in erosion and flora associated with settlement and development within a basin (Davis 1976; Dearing 1991; Likens and Davis 1975) and trophic state changes over time within lake basins (Adams and Prentki 1986; Engstrom et al. 1985; Warwick 1980). High and variable sedimentation rates normally prevent the use of paleolimnological methods as biological monitoring tools for water quality assessment in riverine systems (except see Klink 1989). However, riverine impoundments may be viewed as sinks for erosional processes operating above them within a watershed Walker (1993). Sediment within these sinks may thus provide a chronological history of large-scale events shaping the landscape of the watershed.

This study was conducted to (1) examine differences in sediment accumulation rates between the impoundment above Saint Croix Falls, WI and Lake St. Croix, (2) describe changes in the trophic state of both basins as reflected by organic matter, pigment and midge fossil remains in the sediment and (3) describe the relationships between basin changes and historical changes in land and water-use above each basin.

METHODS

Basin Descriptions and Historical Limnology

Lake sediment studies were conducted on cores extracted from the impoundment at St. Croix Falls, WI (SCF) and in Lake St. Croix (LSC) on the Lower St. Croix National Scenic Riverway (Fig 1; Appendix A). The upper basin is impounded by a dam constructed in the narrows of the dalles on the St. Croix River in 1904. This impoundment has been managed for hydropower production on a peaking mode for the last 90 years. Graczyk (1986) reported an average annual stream flow through the dam of 119 cms. The impounded basin is approximately 4 km long with a surface area of 127 hectares and a maximum depth of approximately 18 meters. A typical sonar profile of the basin is shown in Figure 2a. This profile shows that the basin is generally steep sided, particularly along the west bank with a gentle upward sloping east bank. Watershed area above this basin is reported to be 16,162 square kilometers draining peatland and bog areas in northeastern Minnesota and Northern Wisconsin (Grazcyk 1986).

Figure 1 (following page). Saint Croix Falls (SCF) and Lake Saint Croix (LSC) basins on the Lower St. Croix National Scenic Riverway, Minnesota-Wisconsin. Municipalities shown on the map for reference include Saint Croix Falls, WI (Sf); Stillwater, MN (St); Hudson, WI (Hu); Lakeland, MN (La); and Prescott, WI (Pr). Geographic coordinates of coring sites shown in Appendix A.

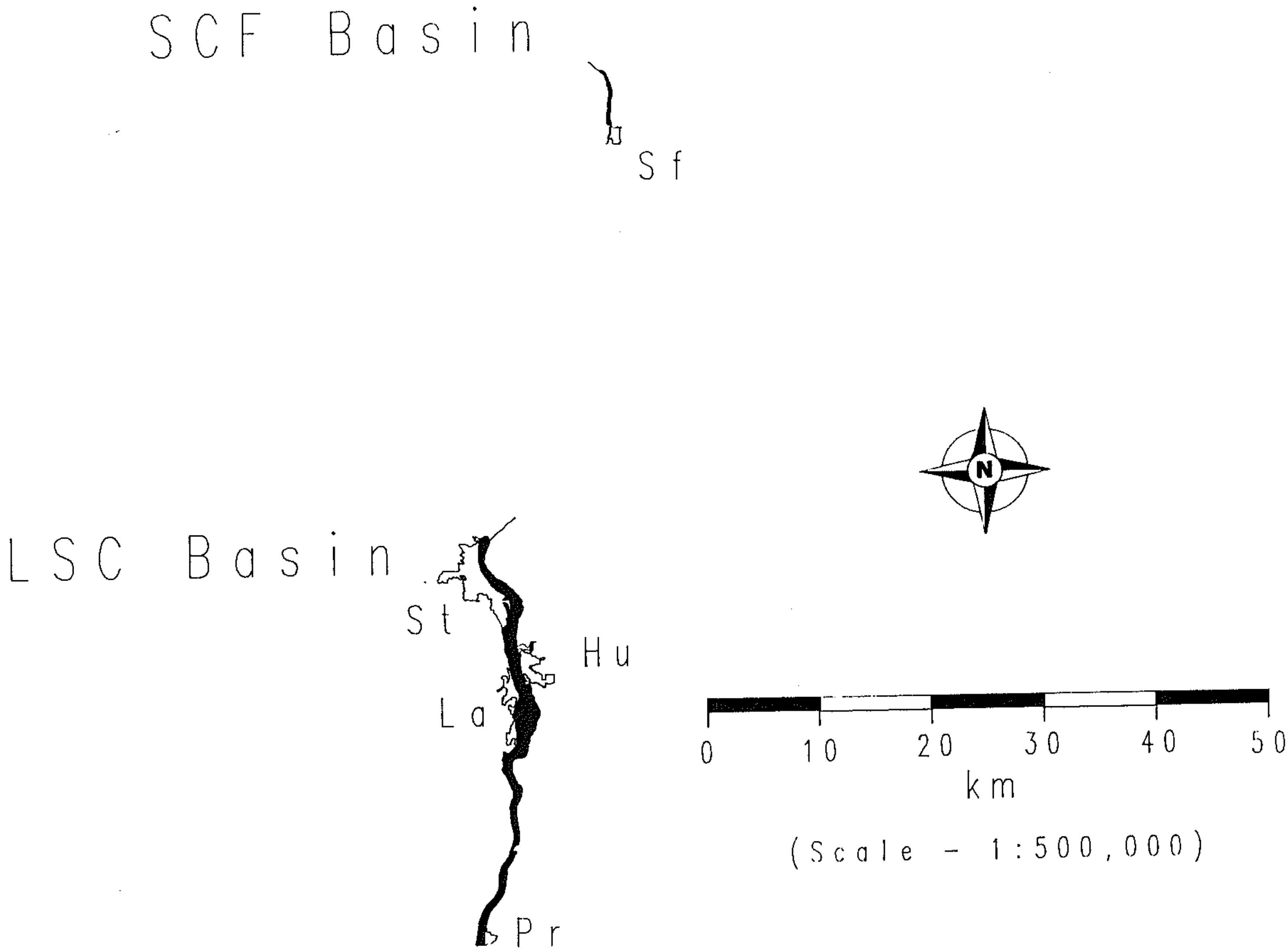
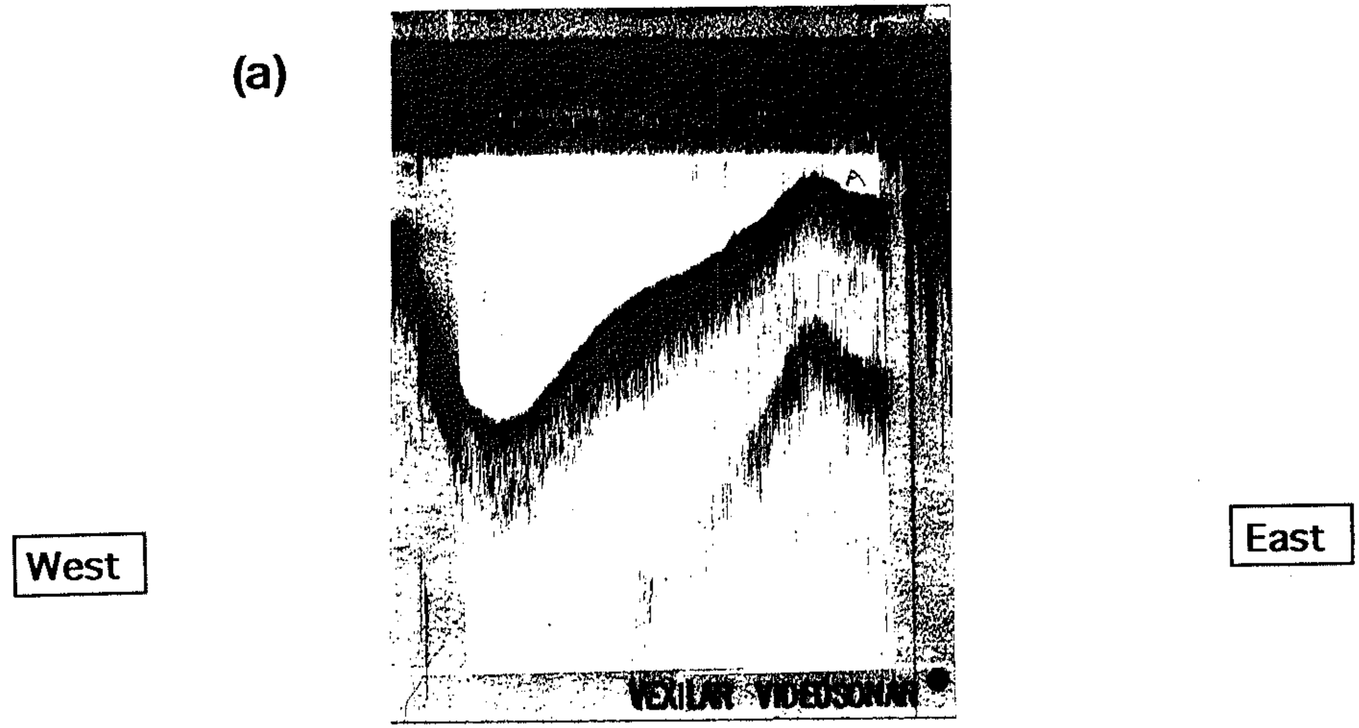
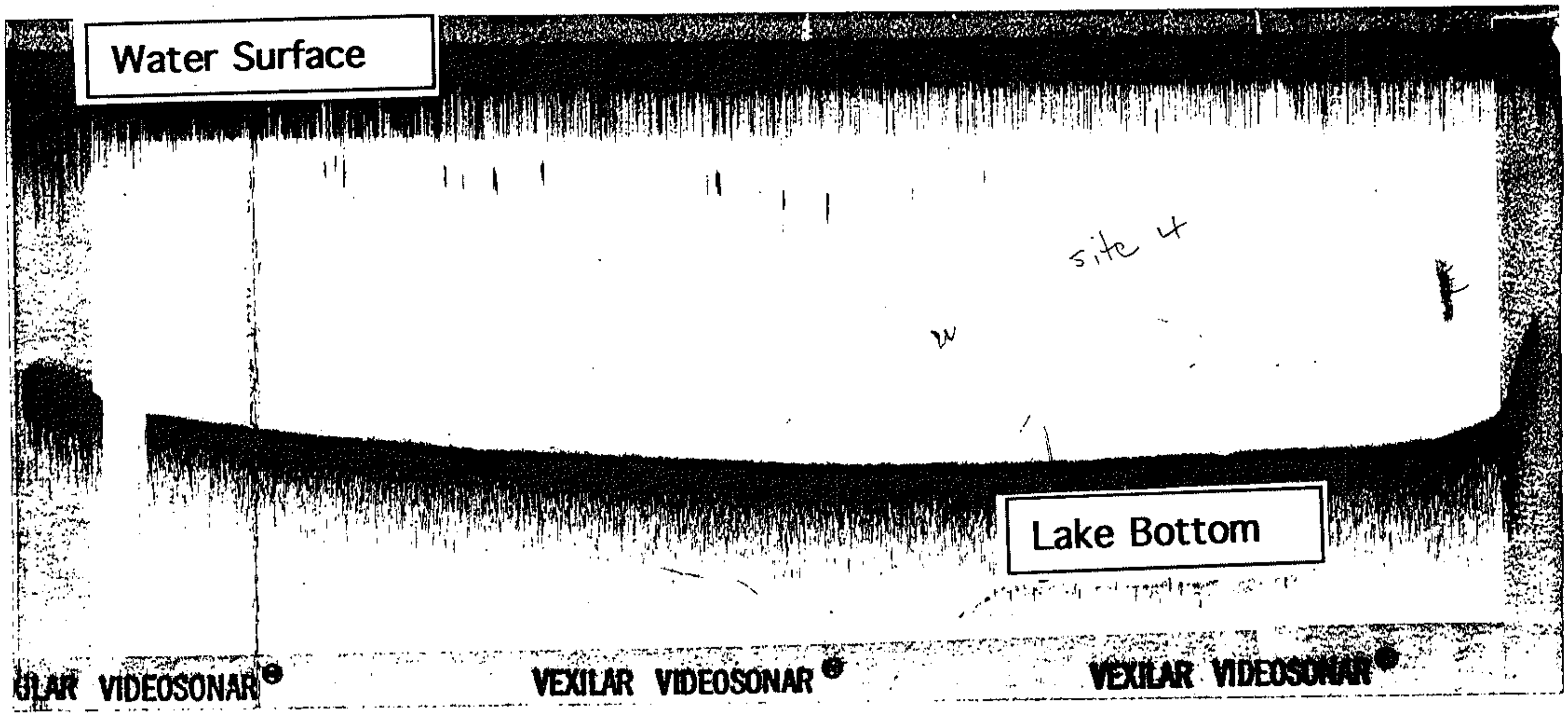

SCF Basin
Sf
LSC Basin
St
Hu
La
Pr
N
0
10
20
30
40
50
km
(Scale - 1:500,000)

Figure 2 (following page). Sonar profiles of the St. Croix Falls basin (a) and the Lake St. Croix basin near Bayport, MN (b) (Not to scale).

(a)


West
East
VEXILAR VIDEOSONAR

(b)


Water Surface
site 4
Lake Bottom
VEXILAR VIDEOSONAR
VEXILAR VIDEOSONAR
VEXILAR VIDEOSONAR

Lake St. Croix is a much larger basin (3,275 hectares) and serves as the outflow for the St. Croix River to the Mississippi at Prescott, WI. Eyster-Smith, et al. (1991) provided an excellent review of the development of this basin. The basin was formed from two events that occurred as a result of glacial history. The first event was the development of an alluvial fan at the confluence of the Chippewa River with the Mississippi River forming a natural dam. This dam partially impounded the Mississippi leading to the development of Lake Pepin. Water impounded by this fan extended back upstream to St. Paul and up the St. Croix River basin. The second event contributing to the formation of this basin was the decrease in discharge of Glacial River Warren which drained Lake Agassiz. Lower discharge in this river caused the formation of a river delta at the headwaters of Lake Pepin forming the natural alluvial deposit at Point Douglas which impounds Lake St. Croix. These events are estimated to have occurred c. 9500 YBP (Eyster-Smith et al. 1991). The basin is 37 km long with four distinct sub-basins that receive the total drainage of the St. Croix River to its confluence with the Mississippi River at Prescott, WI (Total Drainage Area of 22,196 km^2; Graczyk 1986). Average discharge into the lake is c. 142 cms (Eyster-Smith 1977). The first sub-basin extends from just above Stillwater, MN to Hudson, WI, the second from Lakeland, MN to just above Afton, MN, the third from Afton to the mouth of the Kinnickinnic River, and the fourth from the Kinnickinnic R. to the confluence of the St. Croix with the Mississippi River at Prescott. Sub-basin profiles within Lake St. Croix are more gradual with deep pools approximately 18-24m deep (Fig 2b).

Temperature, oxygen and conductivity profiles within the water column of the SCF and LSC basins are shown with Secchi depths taken at the time of core extraction in Appendix A. From these profiles (taken in early August, 1991) it can be seen that neither basin develops strong summer stratification and both basins suffer from near anoxic to anoxic conditions at the sediment-water interface. This was especially pronounced in the SCF basin were degassing was observed as cores were extracted providing evidence of anaerobic decomposition. Despite reports of blue-green algal blooms (Brook 1966). Secchi depths extended to over 1m at all but 1 site.

Coring

Cores were extracted from the SCF basin on August 6 and August 7, 1991 and from the LSC basin on August 9, 1991. Three cores approximately 1.5 meters long were extracted from each basin using a 10cm diameter polycarbonate tube fitted with a piston and operated from a pontoon platform on the lake surface by rigid zirconium drive rods. In addition, overlapping cores were extracted from two locations within the SCF basin using a Livingstone piston corer (Cushing and Wright 1965). Sediments taken with polycarbonate corers were extruded vertically in the field at stratified intervals. These intervals increased with depth in each core (0-10cm depth - 1cm interval, 10-30cm depth - 2cm interval, >30cm depth - 4 cm interval). Overlapping Livingstone cores were wrapped in plastic and tinfoil and extruded horizontally within the lab based on visual delineation of discontinuities in texture and organic matter within the core. Extruded samples were transferred to glass jars and stored under refrigeration until subsampled for analyses.

Dating and Sedimentation Rates

SCF sediment samples were initially examined using ^{210}Pb as described below for the LSC samples. However, high deposition rates and subsequent dilution of ^{210}Pb within these sediments precluded the use of this methodology to age sediments from this basin. In lieu of these results, we chose to analyze SCF sediments for excess ^{137}Cs activity to obtain a chronological marker corresponding to the beginning of atmospheric testing of nuclear weapons in 1954 (Appleby et al. 1991; Pennington et al. 1973; Ritchie et al. 1973). . A high purity germanium gamma detector was calibrated using normal standards (Standard #4353) and used to measure the 667 keV line gamma emissions from ^{137}Cs in sediment samples. These analyses were performed on 20g DW sediment samples from each core for 24 hours in the laboratory of Dr. Daniel Steck (Physics Department, St. Johns University, Collegeville, MN). Greater resources were allocated to dating multiple sections of the core extracted from the SCF3 site since the last section of this core was collected down to bedrock (Appendix B). Only lower sections of cores SCF1 and SCF2 were dated since ^{137}Cs was found nearly to the bottom of the SCF3 core.

Lower sedimentation rates within LSC allowed the use of ^{210}Pb for more accurate dating within the lower basin. LSC sediment cores were analyzed for excess ^{210}Pb activity to determine age and sediment accumulation rates for the past 120-140 years (Appendix B). Lead-210 was measured at 12-14 depth intervals in each core through its grand-daughter product ^{210}Po with ^{208}Po added as an internal yield tracer. The polonium isotopes were distilled from 1-3 g dry sediment at 550°C following pretreatment with concentrated HCl and plated directly (without HNO_3 oxidation) onto silver planchets from a 0.5N HCL solution (modified from Eakins and Morrison 1976). Activity was measured for 1-6 x 10^5 s with Si-depleted surface barrier detectors and an Ortec Adcam™ alpha spectroscopy system. Unsupported ^{210}Pb was calculated by subtracting supported activity from the total activity measured at each level; supported ^{210}Pb was estimated from the asymptotic activity at depth (the mean of the lowermost samples in each core). Dates and sediment accumulation rates were determined according to the constant rate of supply (c.r.s.) model (Appleby and Oldfield 1978) with confidence intervals calculated by first-order error analysis of counting uncertainty (Binford 1990). First-order analysis, also called general error propagation, is concerned with the precision and accuracy of sedimentary measurements and the nature of the c.r.s. model and not that controlled by external forces such as depositional changes that violate model assumptions, inaccuracies of stratigraphic sampling, or laboratory contamination. The utility of ^{210}Pb as a dating tool diminishes in sediments older than 100-120 years as due to the natural decay of the isotope. Thus, dates of older sections of each core were estimated by extrapolating from the cumulative dry mass and the mean sediment accumulation rate for the bottom dated section of each core where sedimentation rates approach a constant low value (Appendix B). Uncertainty around these estimates is high.

Organic Matter and Carbonates

Organic matter and carbonate content of core sections was determined through loss on ignition of 1-2cc subsamples based on the methodology of Dean (1974). Subsamples from each core section were dried at 60°C for 48 hours, ashed at 530°C for 2 hours and volatilized at 1000°C for 2 hours within tared porcelain crucibles. Gravimetric differences following each oven treatment allowed for determination of the three fractions. Replicate analyses were conducted at random within each core to assess the precision of our analyses.

Pigments

Homogenized subsamples from each core section were processed for chlorophyll derivatives and percent native chlorophyll following the methodology of Sanger and Gorham (1972), Swain (1985) and American Public Health Association et al. (1991). Spectrophotometric determination of chlorophyllous pigments was done following 4 serial extractions of c. 2.5g WW sediment subsamples using 90% acetone. Replicate analyses were performed at random within each core to assess the precision of our analyses.

Midge Fossils

Sections of each core (n = 18-20) were selected for midge analysis based on stratigraphic patterns displayed by carbonate, organic matter and chlorophyll content. At least 2 sections were examined for major peaks and valleys in the stratigraphy of these parameters. Midge fossils (Diptera, Chironomidae) were subsampled from these sections after homogenization using a modified syringe. Subsamples were washed over a set of nested sieves (final mesh size 80um) to facilitate sorting. Sorted head capsules were mounted on microscope slides and identified to the lowest possible taxon using the keys of Merritt and Cummins (1984), Simpson and Bode (1980) and Wiederholm (1983) and the illustrations of Lawrenz (1975). In many cases fossils could be identify to genus.

RESULTS

Sediment Age and Deposition Rates

Sediments extracted from all three SCF cores were found to be less than 40 years old. All three cores (except for the deepest section of core SCF3) were found to contain significant quantities of ^{137}Cs a radioactive isotope contributed via atmospheric fallout from bomb testing in the 1950's and 1960's (Table 1; Appendix B). The sharp decrease in activity observed in the last section of SCF3 suggests that this sediment was deposited before fallout from atmospheric testing of atomic weapons which began in 1954. If we assume that (1) the drop in ^{137}Cs at the SCF3 site does correspond with the initiation of bomb testing in 1954, (2) there has been no vertical redistribution of deeper sediments (>1m) in this basin and (3) ^{137}Cs has not migrated to lower sediment layers then 1.5-2.0 meters of sediment has been deposited within the SCF basin at our three coring sites in less than 37 years! Thus, current estimates of sediment deposition within this basin are estimated to range from 3 to over 6 cm/yr and accumulations are estimated to range from 1 to 4 mg/cm^2/yr.

In contrast to the high deposition observed for the SCF basin, rates of deposition from LSC are approximately one order of magnitude lower (Table 1; Appendix B). This allowed the use of ^{210}Pb as a tool to age sediments within this basin. Using this method, cores (1.2-1.6m) collected near Bayport, Lakeland and Afton were found to date back 150-250 years. Rates of sediment loading were also much lower, ranging from 0.11 - 0.43 mg/cm^2/yr. Supplemental pollen analyses were conducted on selected sections of the LSC cores to confirm ^{210}Pb dating. Data from these counts indicate a decrease in white pine pollen (*Pinus strobus*) at c. 1850 and an increase in *Ambrosia* sp. pollen at c. 1880 in all three LSC cores (Appendix B). These pollen counts and dates correspond nicely with historical records of white pine harvest and the onset of major agricultural development within the basin. The data also suggest differing effects of

Table 1. Summary of sediment age, deposition rates and accumulation rates within each core collected from SCF and LSC coring sites (detailed dating and deposition data in Appendix B).

Coring Site	Core Depth (cm)	Age (yrs)	Deposition Rate * (cm/yr)	Accumulation Rate* (mg/cm²/yr)
SCF1	118	<37	>3.19	>1.28
SCF2	231	<37	>6.24	>4.05
SCF3	162	37	4.38	2.61
LSC1	122	157	0.78	0.43
LSC2	126	238	0.53	0.16
LSC3	106	169	0.63	0.17

*Estimated sediment loading rate (g DW/cm^2/yr) for upper most sections from LSC. Estimates for SCF determined by multiplying the average bulk density of sediments within SCF3 (g/cm^3) (Appendix B) times the rate of deposition (cm/yr) over the entire length of the dated core (last section estimated at 37 YBP).

settlement and development within the watershed on the three sub-basins within LSC. The Bayport basin (LSC1) was found to have the highest deposition and accumulation rates of the three basins.

Organic Matter and Carbonates

Organic matter content of sediment within the SCF cores ranged from less than 3% to over 25% and stratigraphy appeared to vary significantly among sections within each core (Fig's 3a-c; Appendix C). Three distinct increases in organic matter were observed within the sediments of each core although the depths varied from site to site. Similar stratigraphy was noted for carbonates which ranged from less than 0.5% to over 2.0% by weight within sediment samples from the three cores at SCF. Peaks in carbonate content were observed to coincide with organic matter peaks in all three cores (Fig's 3d-f; Appendix C).

In contrast to the highly variable organic matter and carbonate stratigraphy of the upper basin, LSC sediments displayed much more gradual changes in these parameters (Fig's 4a-f; Appendix C). Organic matter content of sediments ranged from 8% to over 18% by weight while

Figure 3 (following page). Percent organic matter and carbonates observed from SCF1(a,d), SCF2(b,e) and SCF3(c,f) (Note arrow on SCF3 plots indicating period preceding bomb testing - 1954).

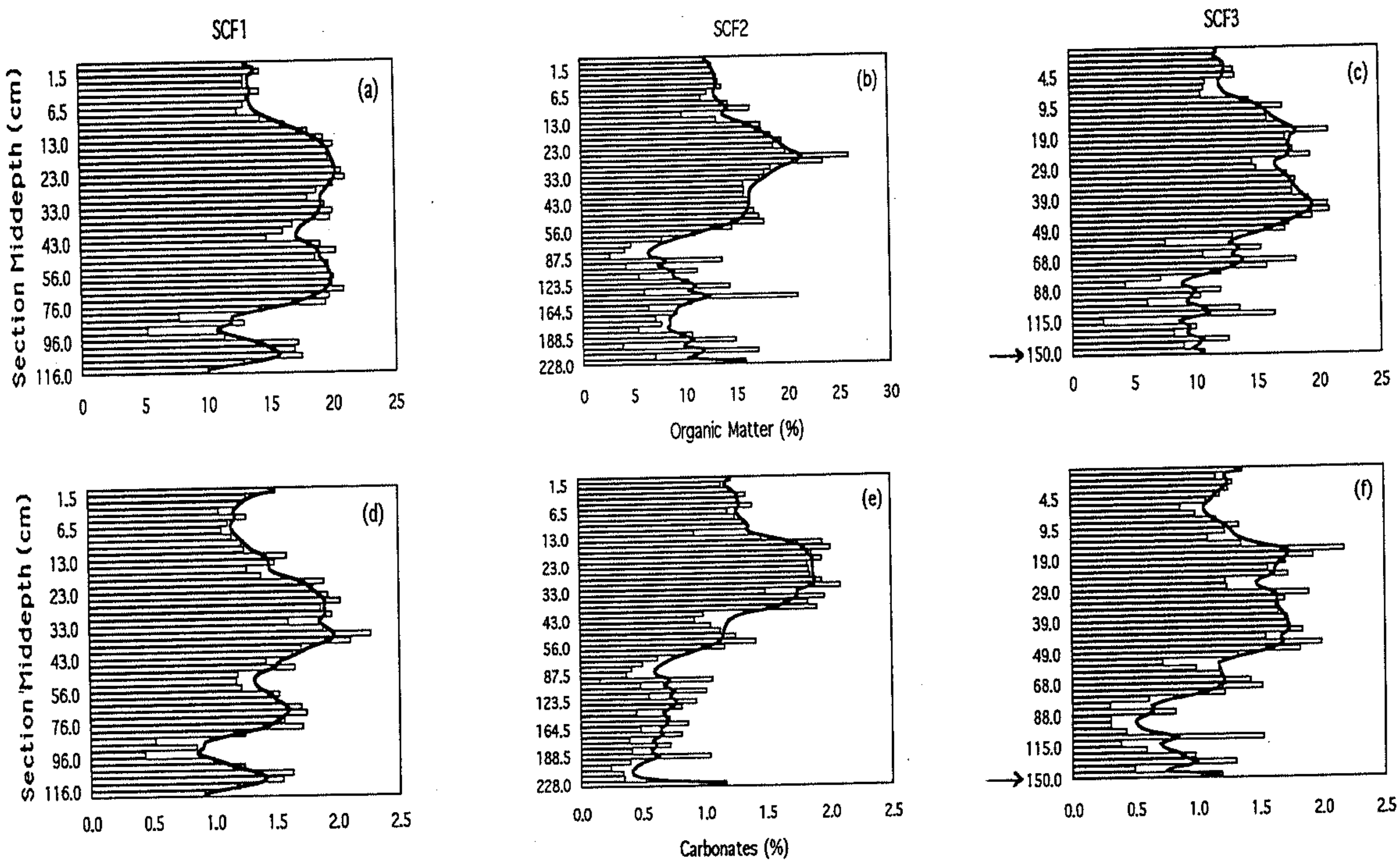
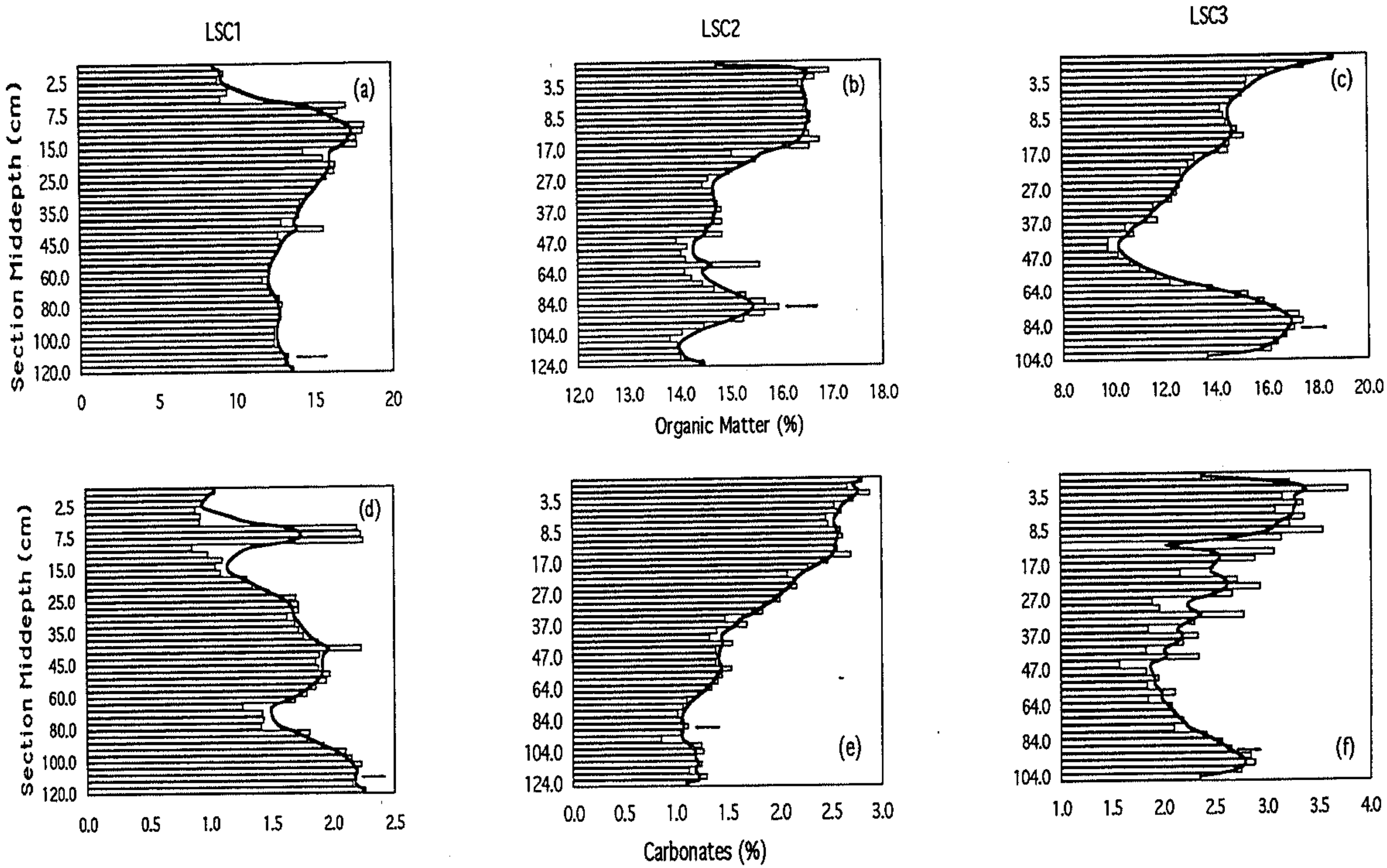

SCF1
SCF2
SCF3
(a)
(b)
(c)
(d)
(e)
(f)
Section Middepth (cm)
1.5
6.5
13.0
23.0
33.0
43.0
56.0
76.0
96.0
116.0
87.5
123.5
164.5
188.5
228.0
4.5
9.5
19.0
29.0
39.0
49.0
68.0
88.0
115.0
→150.0
0
5
10
15
20
25
30
Organic Matter (%)
0.0
0.5
1.0
1.5
2.0
2.5
Carbonates (%)

Figure 4 (following page). Percent organic matter and carbonates observed from LSC1(a,d), LSC2(b,e) and LSC3(c,f) (Note lines on figures indicating settlement period of 1840-1860).



LSC1
LSC2
LSC3
(a)
(b)
(c)
(d)
(e)
(f)
Section Middepth (cm)
2.5 7.5 15.0 25.0 35.0 45.0 60.0 80.0 100.0 120.0
3.5 8.5 17.0 27.0 37.0 47.0 64.0 84.0 104.0 124.0
0 5 10 15 20
12.0 13.0 14.0 15.0 16.0 17.0 18.0
8.0 10.0 12.0 14.0 16.0 18.0 20.0
Organic Matter (%)
0.0 0.5 1.0 1.5 2.0 2.5
0.0 0.5 1.0 1.5 2.0 2.5 3.0
1.0 1.5 2.0 2.5 3.0 3.5 4.0
Carbonates (%)

Figure 5 (following page). Chlorophyll derivatives and percent native chlorophyll observed in sediment samples from SCF1(a,d), SCF2(b,e) and SCF3(c,f) (Note line on SCF3 plots indicating period preceding bomb testing - 1954).

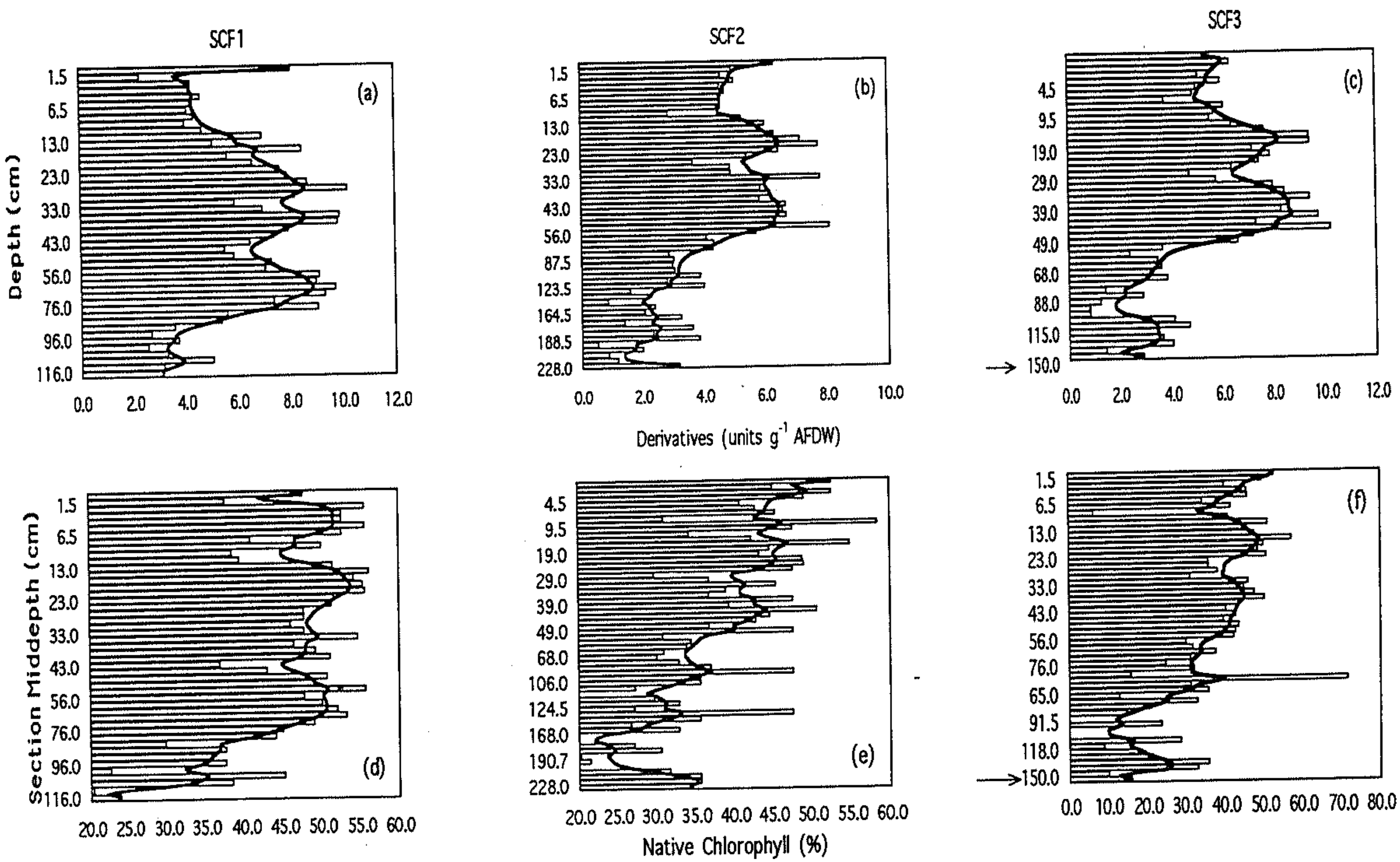
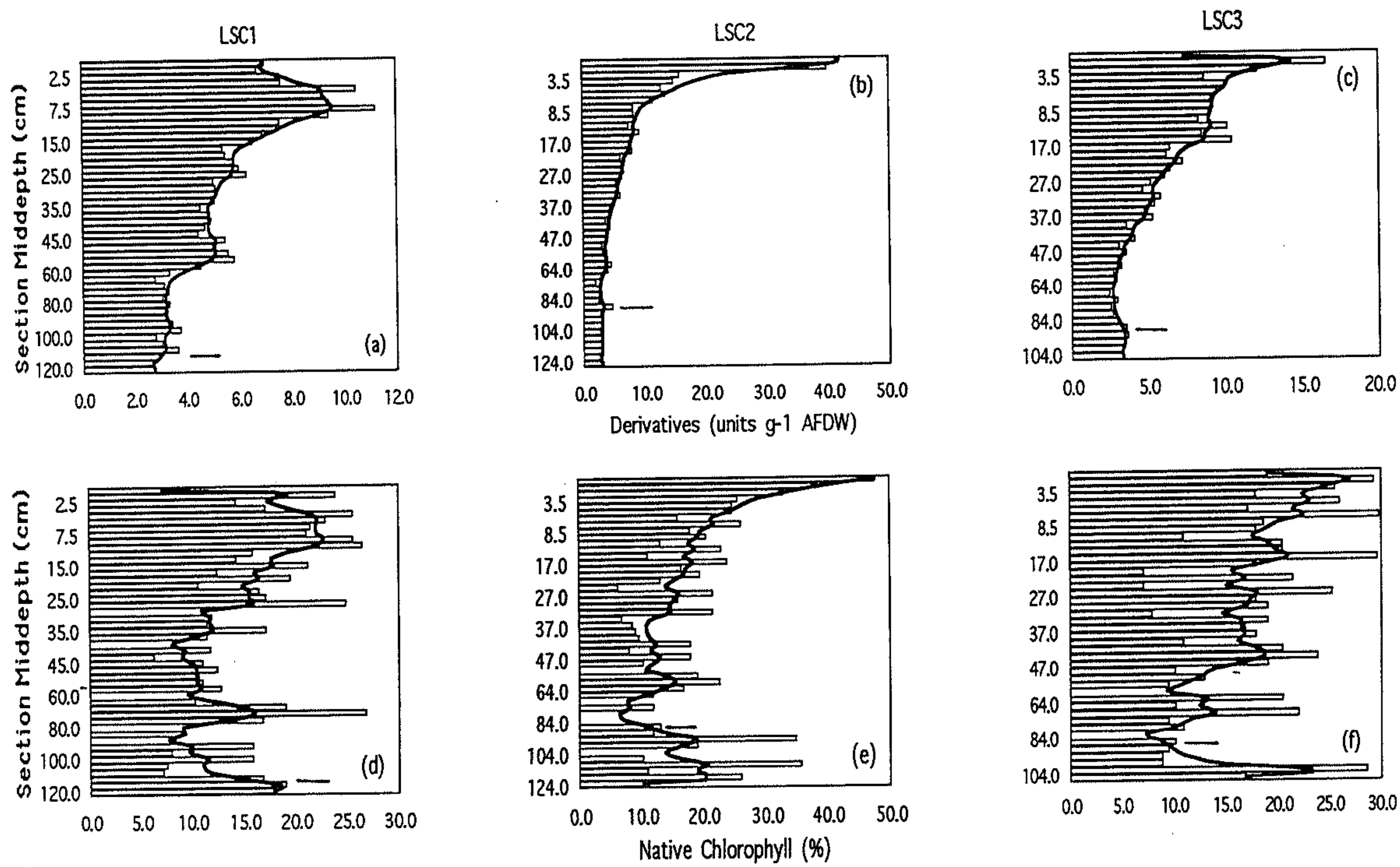

SCF1
SCF2
SCF3
(a)
(b)
(c)
(d)
(e)
(f)
Depth (cm)
Section Middepth (cm)
Derivatives (units g^{-1} AFDW)
Native Chlorophyll (%)

Figure 6 (following page). Chlorophyll derivatives and percent native chlorophyll observed in sediment samples from LSC1(a,d), LSC2(b,e) and LSC3(c,f) (Note lines on plots indicating period of settlement 1840-1860).



LSC1
LSC2
LSC3
(a)
(b)
(c)
(d)
(e)
(f)
Section Middepth (cm)
Section Middepth (cm)
2.5
7.5
15.0
25.0
35.0
45.0
60.0
80.0
100.0
120.0
3.5
8.5
17.0
27.0
37.0
47.0
64.0
84.0
104.0
124.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
0.0
10.0
20.0
30.0
40.0
50.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Derivatives (units g-1 AFDW)
Native Chlorophyll (%)

Figure 7 (following page). Midge community composition, total density and generic richness from the SCF1 coring site.

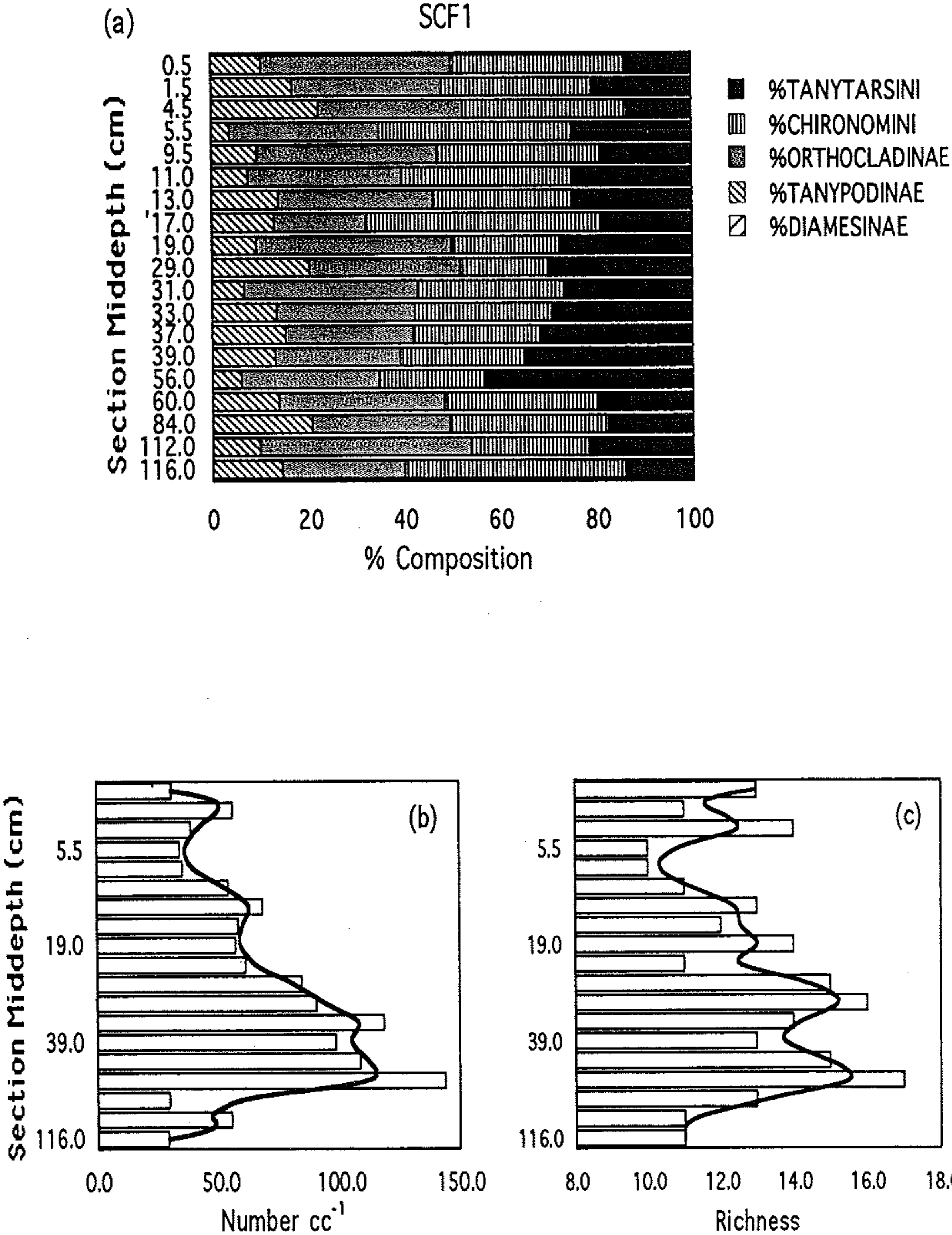

(a)
SCF1
Section Middepth (cm)
0.5
1.5
4.5
5.5
9.5
11.0
13.0
17.0
19.0
29.0
31.0
33.0
37.0
39.0
56.0
60.0
84.0
112.0
116.0
%TANYTARSINI
%CHIRONOMINI
%ORTHOCLADINAE
%TANYPODINAE
%DIAMESINAE
0
20
40
60
80
100
% Composition
(b)
Section Middepth (cm)
5.5
19.0
39.0
116.0
0.0
50.0
100.0
150.0
Number cc-1
(c)
5.5
19.0
39.0
116.0
8.0
10.0
12.0
14.0
16.0
18.0
Richness

Figure 8 (following page). Midge community composition, total density and generic richness from the SCF2 coring site.

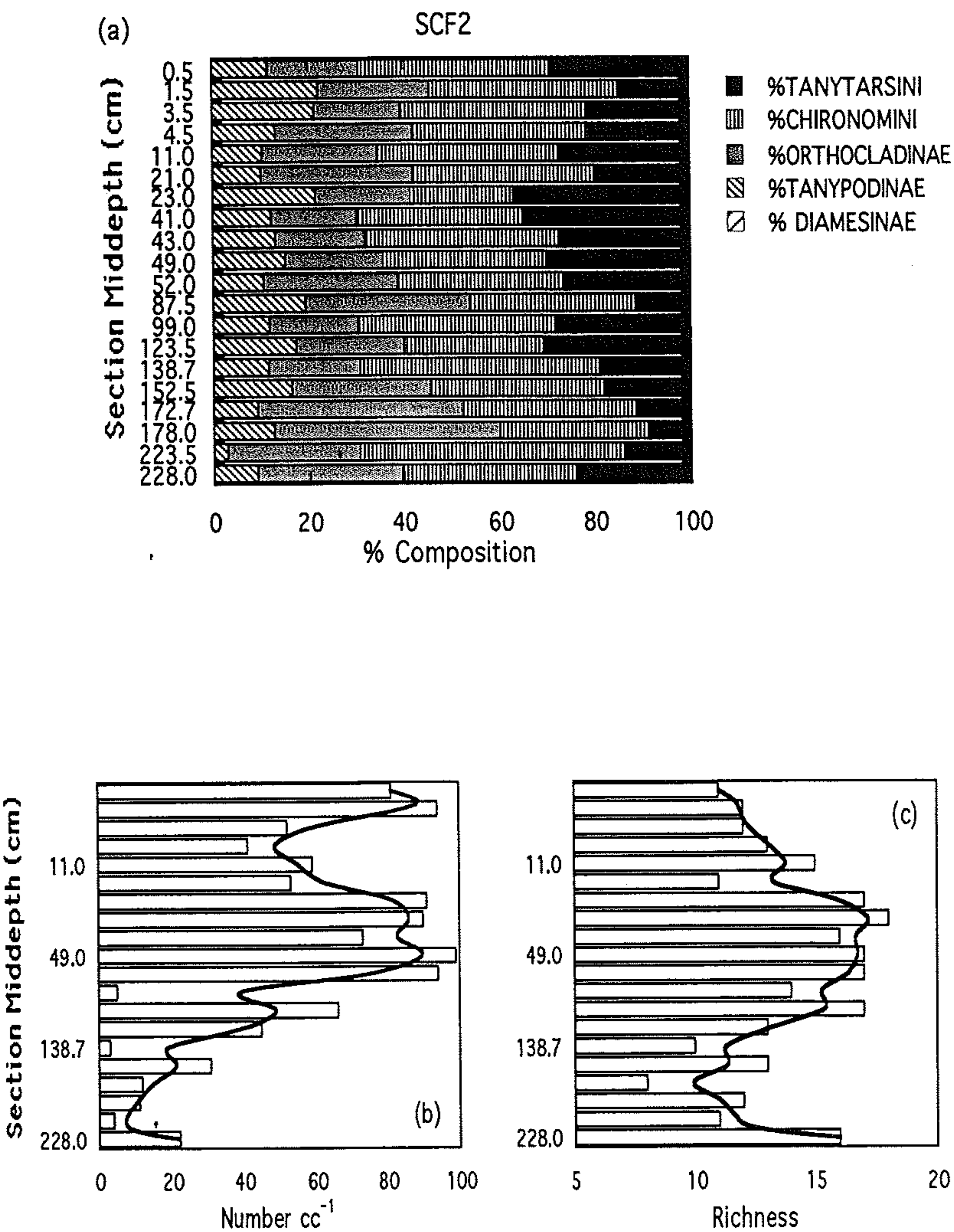
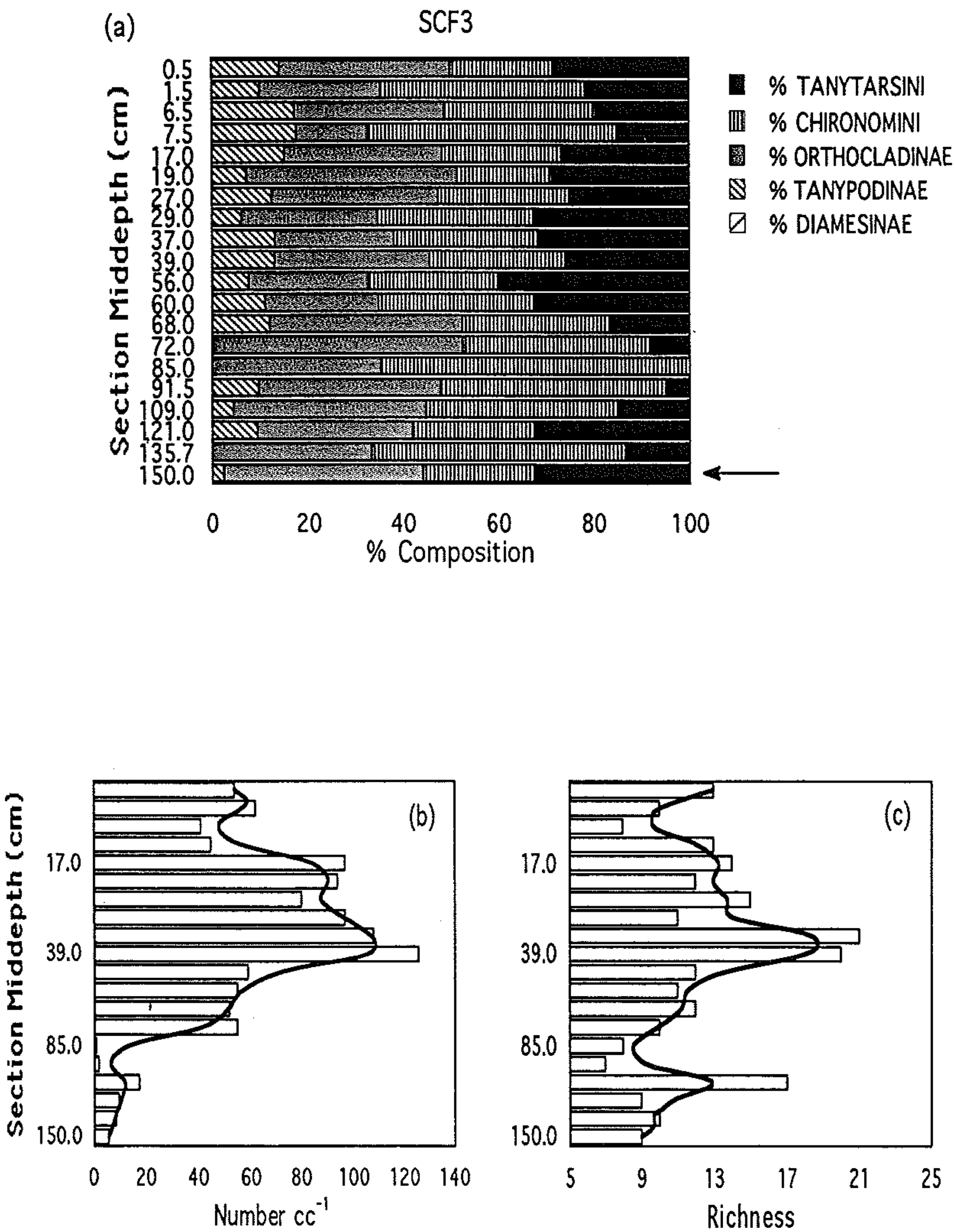

(a)
SCF2
Section Middepth (cm)
0.5
1.5
3.5
4.5
11.0
21.0
23.0
41.0
43.0
49.0
52.0
87.5
99.0
123.5
138.7
152.5
172.7
178.0
223.5
228.0
%TANYTARSINI
%CHIRONOMINI
%ORTHOCLADINAE
%TANYPODINAE
% DIAMESINAE
0 20 40 60 80 100
% Composition
Section Middepth (cm)
11.0
49.0
138.7
228.0
(b)
0 20 40 60 80 100
Number cc^-1
11.0
49.0
138.7
228.0
(c)
5 10 15 20
Richness

Figure 9 (following page). Midge community composition, total density and generic richness from the SCF3 coring site (Note arrows on plots indicating period preceding bomb testing - 1954).



(a)
SCF3
% TANYTARSINI
% CHIRONOMINI
% ORTHOCLADINAE
% TANYPODINAE
% DIAMESINAE
Section Middepth (cm)
0.5
1.5
6.5
7.5
17.0
19.0
27.0
29.0
37.0
39.0
56.0
60.0
68.0
72.0
85.0
91.5
109.0
121.0
135.7
150.0
0 20 40 60 80 100
% Composition
(b)
Section Middepth (cm)
17.0
39.0
85.0
150.0
0 20 40 60 80 100 120 140
Number cc-1
(c)
17.0
39.0
85.0
150.0
5 9 13 17 21 25
Richness

in the LSC. Greater variability in this parameter within LSC versus SCF probably reflects year to year variability in oxygen and temperature at the sediment water interface (both factors which influence chlorophyll degradation). These data suggest that primary production within Lake St. Croix has increased significantly since the cultural horizon and particularly over the last 40-50 years.

Midge Fossils

Midge densities and species richness in the SCF basin generally followed the patterns observed for other measures (Fig's 7-9). Maximum density and richness values were observed in the same general areas of the core where organic matter, carbonates and chlorophyll values were high. Midge densities were also high in the SCF basin with most values exceeding 50 capsules per cubic centimeter. Taxa richness values ranged from 7-18 per sample.

The composition of the midge community was fairly evenly distributed among the Tanytarsini, Chironomini and Orthocladiinae (all ranging from 10-20% by number) in the SCF basin (Fig's 7-9). Tanypodinae were somewhat less abundant (ranging from <5% to 20% by number) in SCF cores. This is not surprising since this group is made up of predatory midges who's numbers are typically lower than herbivores, shredders and collectors lower in the food chain (Merritt and Cummins 1984). Unlike LSC samples, the midge communities in this basin were not dominated by *Procladius* sp. and *Chironomus* sp. but appeared to be more representative of a riverine community (see Table 2). Orthocladiinae contributed a much larger proportion of total numbers in these cores than in the cores collected from LSC. Changes in composition failed to indicate a consistent pattern among cores and did not appear to be tightly correlated with changes in midge densities or taxa richness.

Densities of midges in LSC were higher in deeper sections and decreased near the surface of all three cores (Fig's 10-12; Appendix D). In addition, midge densities were uniformly lower in the sediments of this basin than from those at SCF ranging from 1 to near 15 per cubic centimeter. Taxa richness was also lower in LSC than in SCF ranging from 4 to 16 genera in a section and

Table 2. Midge assemblages found in the SCF and LSC basins on the St. Croix River.

GENERA	SCF1	SCF2	SCF3	LSC1	LSC2	LSC3	BASIN
			(% of Sections Observed)				
Chironomus sp.	57.9	80.0	80.0	94.4	95.2	100.0	LSC
Cladopelma sp.	5.3	0.0	0.0	22.2	19.0	0.0	LSC
Clinotanypus sp.	0.0	0.0	0.0	5.6	0.0	0.0	LSC
Coelotanypus sp.	0.0	0.0	0.0	11.1	4.8	25.0	LSC
Cryptotendipes sp.	0.0	0.0	0.0	5.6	0.0	5.0	LSC
Epoicocladius sp.	0.0	0.0	0.0	0.0	0.0	5.0	LSC
Hydrobaenus sp.	0.0	0.0	0.0	5.6	0.0	0.0	LSC
Larsia sp.	0.0	0.0	0.0	0.0	0.0	5.0	LSC
Macropelopia sp.	0.0	0.0	0.0	0.0	4.8	10.0	LSC
Orthocladius sp.	0.0	0.0	0.0	5.6	4.8	0.0	LSC
Pagastia sp.	0.0	0.0	0.0	0.0	0.0	10.0	LSC
Paralauterborniella sp.	0.0	0.0	0.0	0.0	4.8	0.0	LSC
Procladius spp.	73.7	65.0	35.0	100.0	100.0	95.0	LSC
Rheotanytarsus sp.	0.0	0.0	0.0	0.0	33.3	0.0	LSC
Tanypus sp.	0.0	0.0	0.0	5.6	0.0	0.0	LSC
Brillia sp.	5.3	0.0	0.0	0.0	0.0	0.0	SCF
Corynoneura sp.	78.9	45.0	60.0	33.3	14.3	10.0	SCF
Cricotopus sp.	94.7	100.0	100.0	88.9	57.1	35.0	SCF
Dicrotendipes sp.	84.2	85.0	40.0	50.0	52.4	30.0	SCF
Glyptotendipes sp.	63.2	55.0	55.0	38.9	14.3	25.0	SCF
Krenopelopia sp.	94.7	80.0	80.0	0.0	0.0	10.0	SCF
Lenziella sp.	78.9	60.0	55.0	44.4	57.1	45.0	SCF
Microtendipes sp.	52.6	95.0	90.0	5.6	0.0	10.0	SCF
Nilotanypus sp.	47.4	75.0	60.0	22.2	4.8	0.0	SCF
Nilothauma sp.	5.3	0.0	0.0	0.0	0.0	0.0	SCF
Nimbocera sp.	5.3	0.0	0.0	0.0	0.0	0.0	SCF
Paracladius sp.	5.3	5.0	0.0	0.0	0.0	0.0	SCF
Parametriocnemus sp.	0.0	5.0	0.0	0.0	0.0	0.0	SCF
Paratanytarsus sp.	63.2	70.0	55.0	27.8	42.9	35.0	SCF
Phaenopsectra sp.	73.7	70.0	80.0	11.1	0.0	0.0	SCF
Polypedilum sp.	100.0	100.0	100.0	72.2	61.9	70.0	SCF
Robackia sp.	15.8	15.0	15.0	0.0	0.0	0.0	SCF
Stenochironomus sp.	10.5	20.0	15.0	5.6	0.0	0.0	SCF
Symposiocladius sp.	0.0	10.0	0.0	0.0	0.0	0.0	SCF
Synorthocladius sp.	10.5	5.0	25.0	0.0	0.0	0.0	SCF
Tanytarsus sp.	100.0	100.0	95.0	77.8	57.1	80.0	SCF
Tvetenia sp.	5.3	35.0	20.0	0.0	0.0	0.0	SCF

*See Appendix D for detailed descriptions of midge genera.

Figure 10 (following page). Midge community composition, total density and generic richness from the LSC1 coring site (Note lines on plots indicating period of settlement 1840-1860).

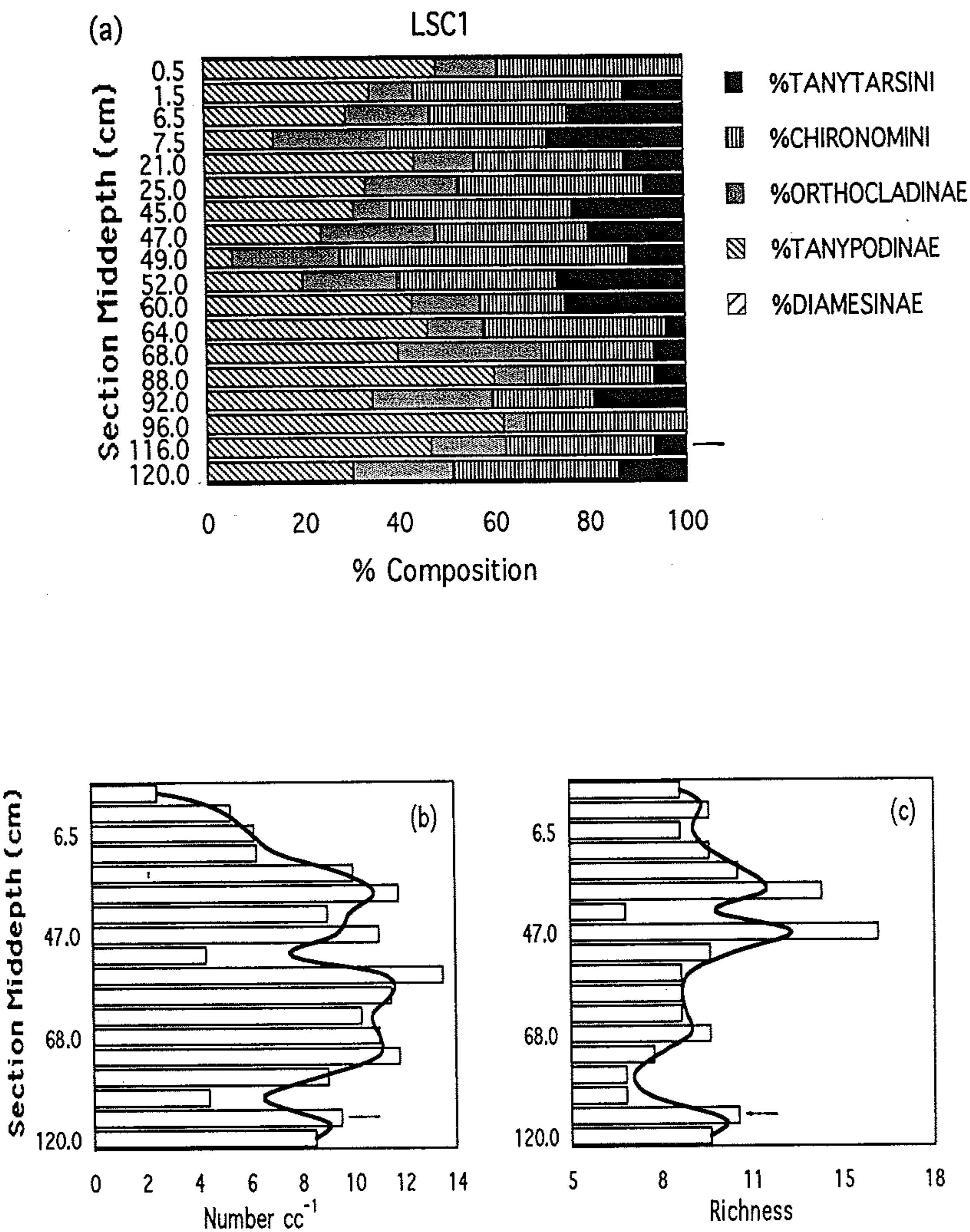
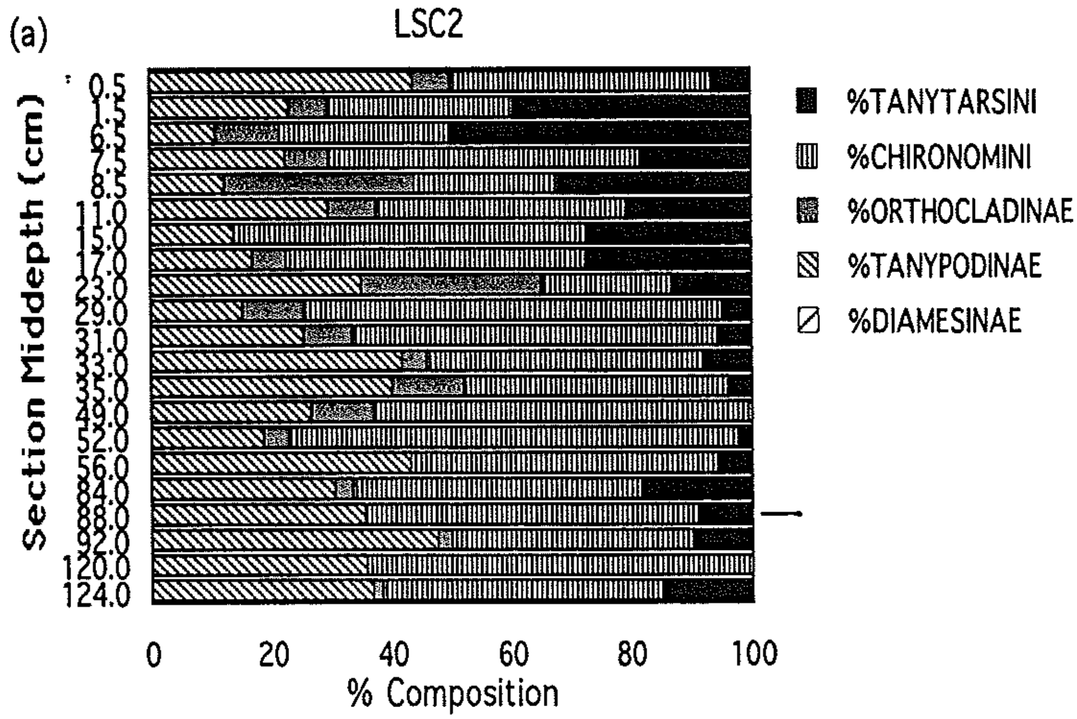
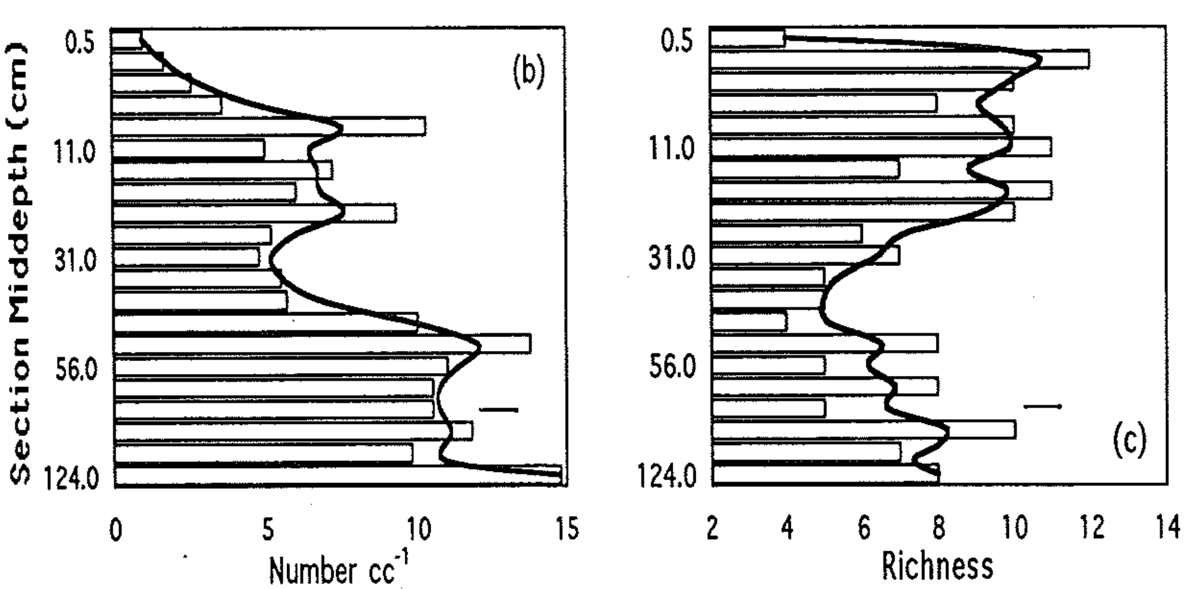

(a)
LSC1
Section Middepth (cm)
0.5
1.5
6.5
7.5
21.0
25.0
45.0
47.0
49.0
52.0
60.0
64.0
68.0
88.0
92.0
96.0
116.0
120.0
0 20 40 60 80 100
% Composition
%TANYTARSINI
%CHIRONOMINI
%ORTHOCLADINAE
%TANYPODINAE
%DIAMESINAE
(b)
Section Middepth (cm)
6.5
47.0
68.0
120.0
0 2 4 6 8 10 12 14
Number cc-1
(c)
6.5
47.0
68.0
120.0
5 8 11 15 18
Richness

Figure 11 (following page). Midge community composition, total density and generic richness from the LSC2 coring site (Note lines on plots indicating period of settlement 1840-1860).

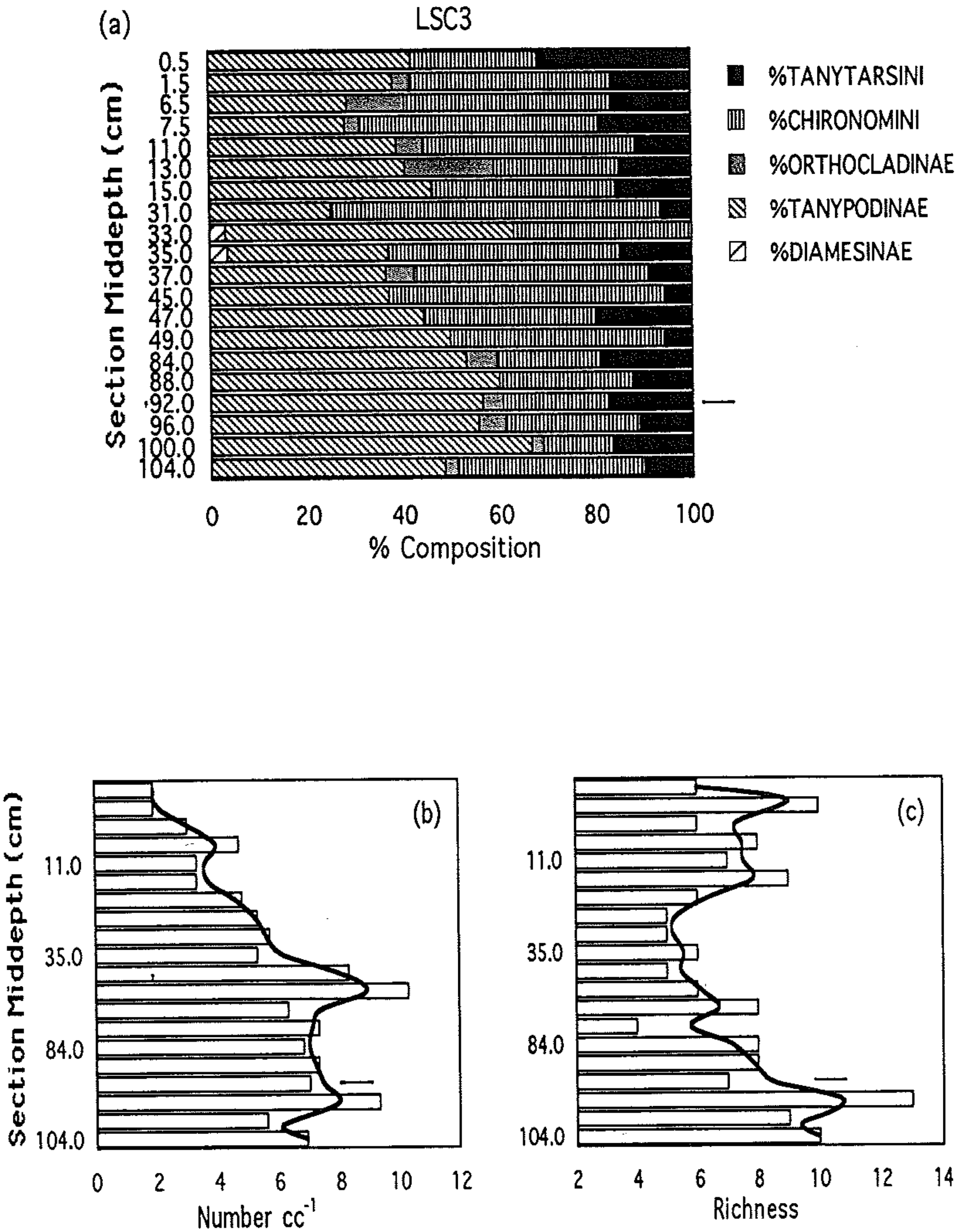


(a)
LSC2
Section Middepth (cm)
0.5
1.5
6.5
7.5
8.5
11.0
15.0
17.0
23.0
29.0
31.0
33.0
35.0
49.0
52.0
56.0
84.0
88.0
92.0
120.0
124.0
%TANYTARSINI
%CHIRONOMINI
%ORTHOCLADINAE
%TANYPODINAE
%DIAMESINAE
0
20
40
60
80
100
% Composition



Section Middepth (cm)
0.5
11.0
31.0
56.0
124.0
(b)
0
5
10
15
Number cc-1
0.5
11.0
31.0
56.0
124.0
(c)
2
4
6
8
10
12
14
Richness

Figure 12 (following page). Midge community composition, total density and generic richness from the LSC3 coring site (Note lines on plots indicating period of settlement 1840-1860).



(a)
LSC3
Section Middepth (cm)
0.5
1.5
6.5
7.5
11.0
13.0
15.0
31.0
33.0
35.0
37.0
45.0
47.0
49.0
84.0
88.0
92.0
96.0
100.0
104.0
0
20
40
60
80
100
% Composition
%TANYTARSINI
%CHIRONOMINI
%ORTHOCLADINAE
%TANYPODINAE
%DIAMESINAE
(b)
Section Middepth (cm)
11.0
35.0
84.0
104.0
0
2
4
6
8
10
12
Number cc-1
(c)
11.0
35.0
84.0
104.0
2
4
6
8
10
12
14
Richness

varying both within a core and among cores within LSC. Richness at LSC1 appeared to be highest in the middle portions of the core while those of LSC2 were highest in the upper sections. Richness in the LSC3 core was highest in older sections. *Procladius* sp. and *Chironomus* sp dominated the communities of all three LSC cores. At LSC3 the percent contribution of Chironomini increased and Tanypodini decreased toward the surface. Tanytarsini also increased slightly in their contribution to total abundance in more recent sections of the core.

Several midge genera were more prevalent in one of the two basins (Table 2). In general, most of the taxa found in higher numbers in LSC cores are known to prefer littoral or profundal habitat while those found in higher numbers in SCF cores prefer stream habitat (Appendix D). These results are consistent with our observations of carbonate, organic matter and chlorophyll stratigraphy and the hypothesis that depositional patterns within the upper impoundment may be controlled largely by stream discharge. High stream discharge may cause a catastrophic drift response in benthic invertebrates within the stream channel (Waters 1972). This response could flush large numbers of lotic invertebrates into a basin where their remains would become mixed with truly lentic forms.

Stratigraphic Plots

To provide an integrated picture of the sediment core analyses, stratigraphic plots were created to display changes in sediment characteristics within each core (Fig's 13-18). From these plots, it is possible to see the general correspondence between changes in organic matter, chlorophyll, and midge community characteristics within each core. Since all of the SCF cores (except the last section of SCF3) are believed to be younger than 1954, stratigraphic patterns observed in the SCF plots are representative of relatively short-term changes within the basin. In all three cores, midge densities and the percentage of Tanytarsini appear to roughly follow changes in percent native chlorophyll and organic matter in the core sediments which in-turn correspond with autumnal stream flows through the dam (Fig 19). Thus, changes in deposition within the SCF basin appear to be strongly related to patterns of St. Croix River discharge.

Figure 13 (following page). Stratigraphy of the SCF1 coring site.

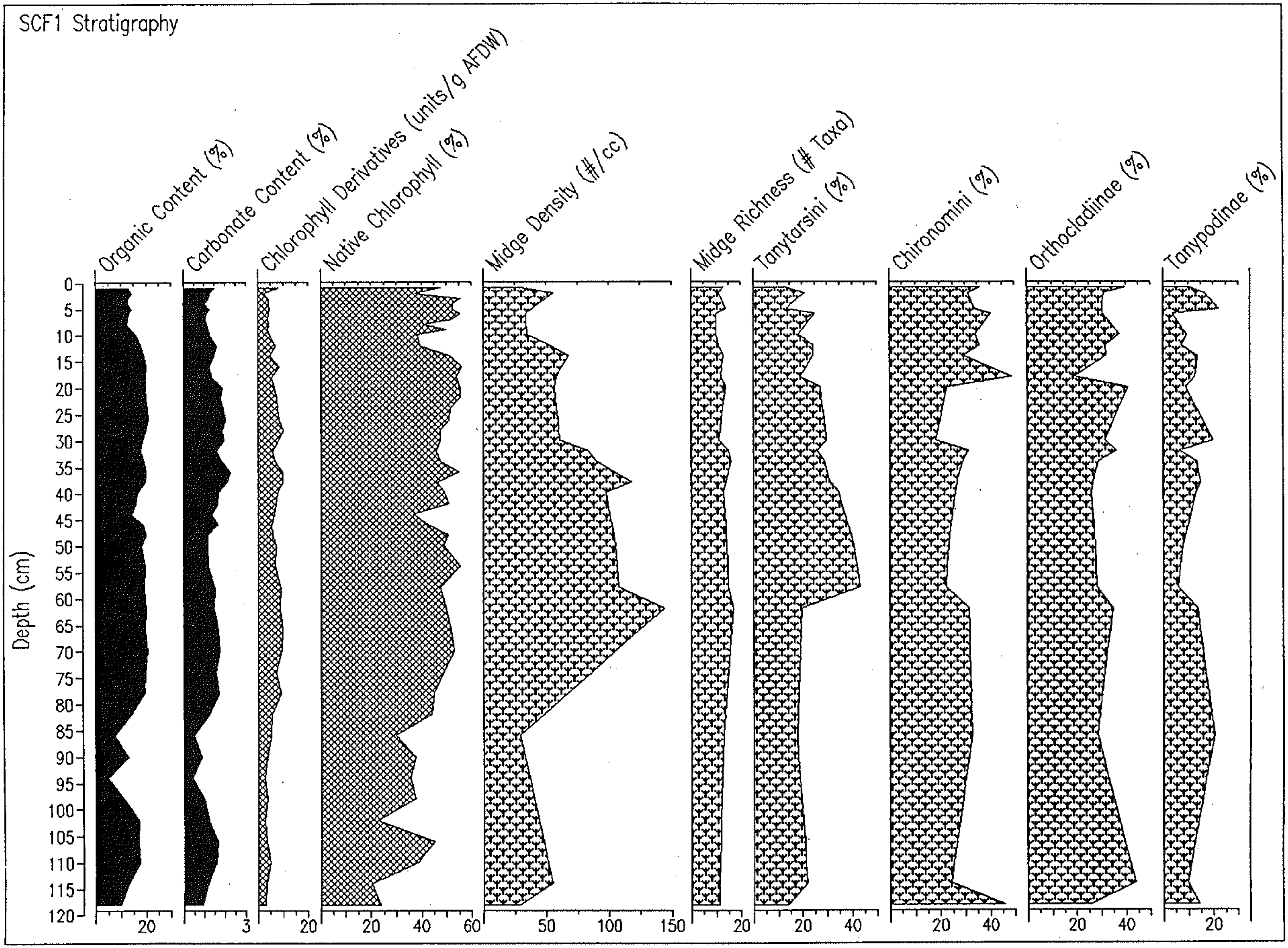
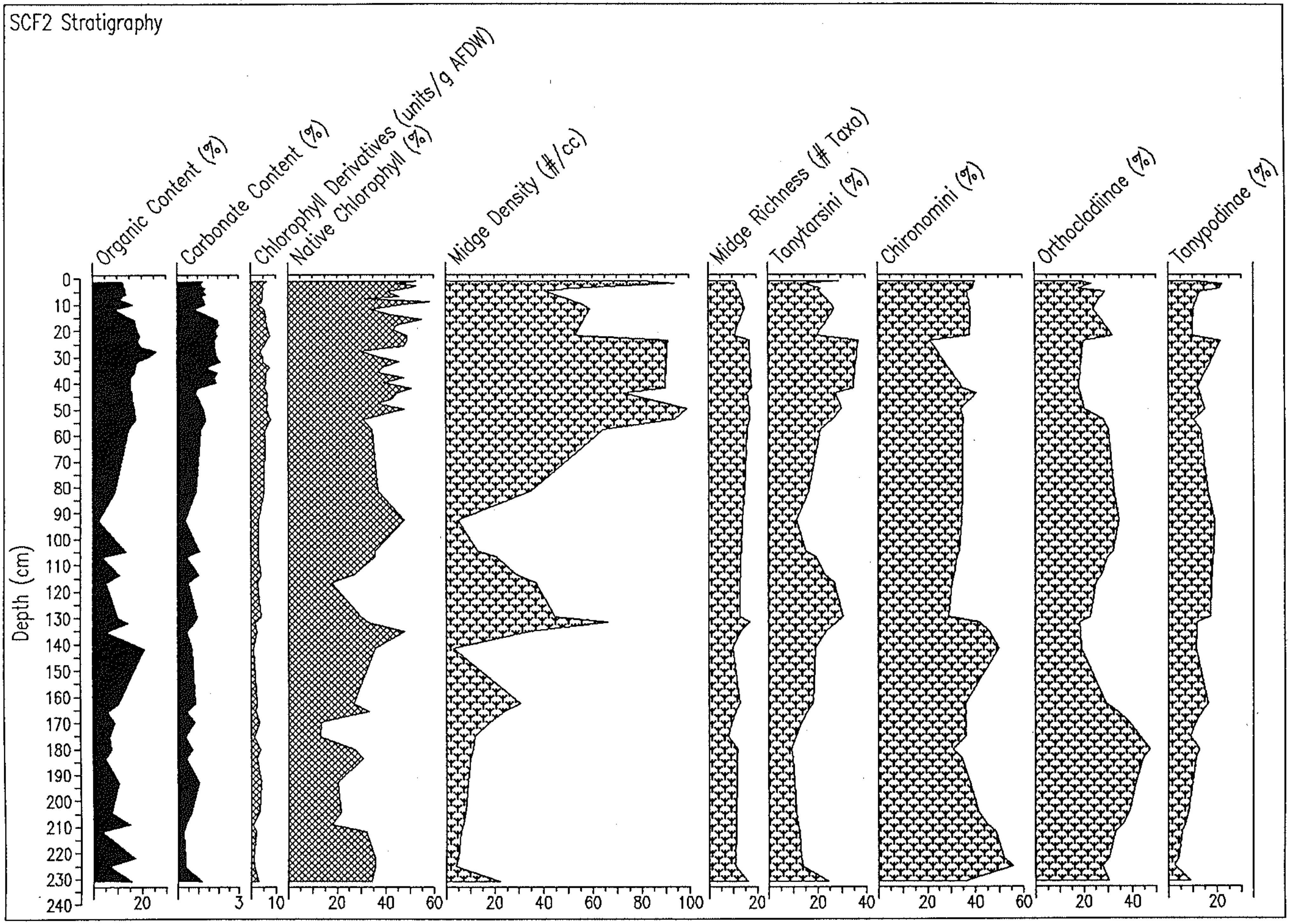

SCF1 Stratigraphy
Organic Content (%)
Carbonate Content (%)
Chlorophyll Derivatives (units/g AFDW)
Native Chlorophyll (%)
Midge Density (#/cc)
Midge Richness (# Taxa)
Tanytarsini (%)
Chironomini (%)
Orthocladiinae (%)
Tanypodinae (%)
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
20
3
20
20
40
60
50
100
150
20
20
40
20
40
20
40
20

Figure 14 (following page). Stratigraphy of the SCF2 coring site.



SCF2 Stratigraphy
Organic Content (%)
Carbonate Content (%)
Chlorophyll Derivatives (units/g AFDW)
Native Chlorophyll (%)
Midge Density (#/cc)
Midge Richness (# Taxa)
Tanytarsini (%)
Chironomini (%)
Orthocladiinae (%)
Tanypodinae (%)
Depth (cm)

Figure 15 (following page). Stratigraphy of the SCF3 coring site.

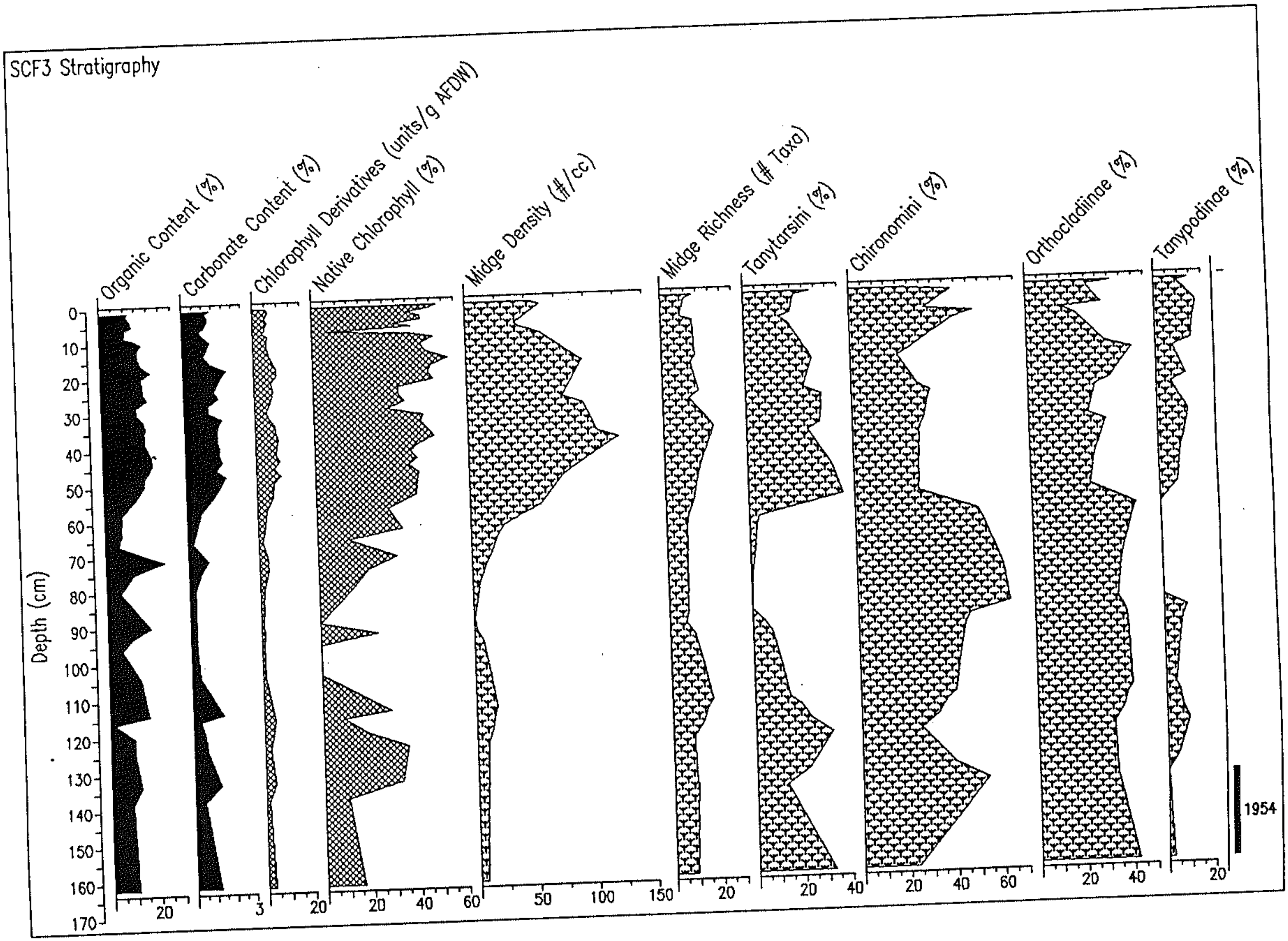
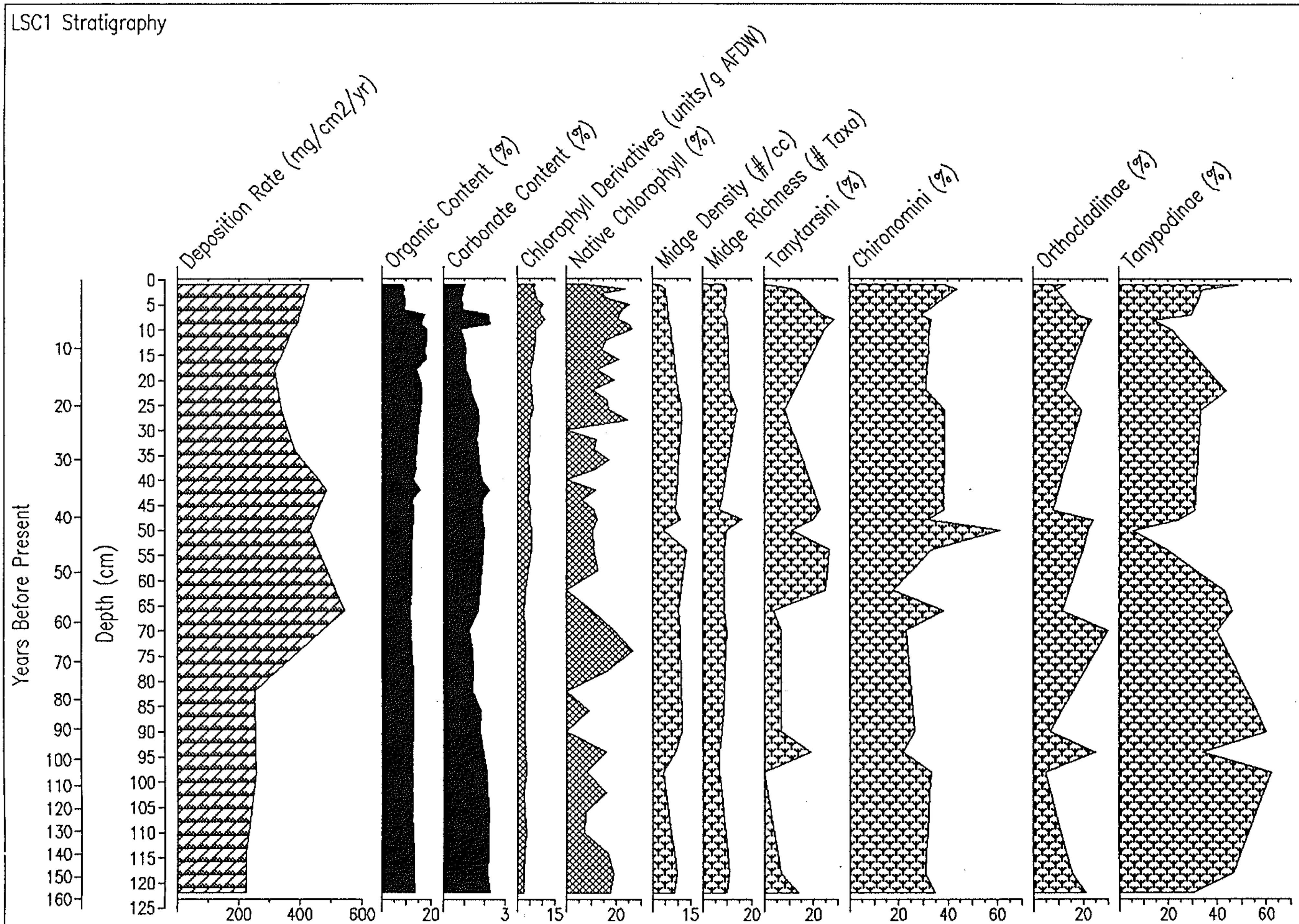

SCF3 Stratigraphy
Organic Content (%)
Carbonate Content (%)
Chlorophyll Derivatives (units/g AFDW)
Native Chlorophyll (%)
Midge Density (#/cc)
Midge Richness (# Taxa)
Tanytarsini (%)
Chironomini (%)
Orthocladiinae (%)
Tanypodinae (%)
Depth (cm)
1954

Figure 16 (following page). Stratigraphy of the LSC1 coring site.



LSC1 Stratigraphy
Deposition Rate (mg/cm2/yr)
Organic Content (%)
Carbonate Content (%)
Chlorophyll Derivatives (units/g AFDW)
Native Chlorophyll (%)
Midge Density (#/cc)
Midge Richness (# Taxa)
Tanytarsini (%)
Chironomini (%)
Orthocladiinae (%)
Tanypodinae (%)
Years Before Present
Depth (cm)

Figure 17 (following page). Stratigraphy of the LSC2 coring site.

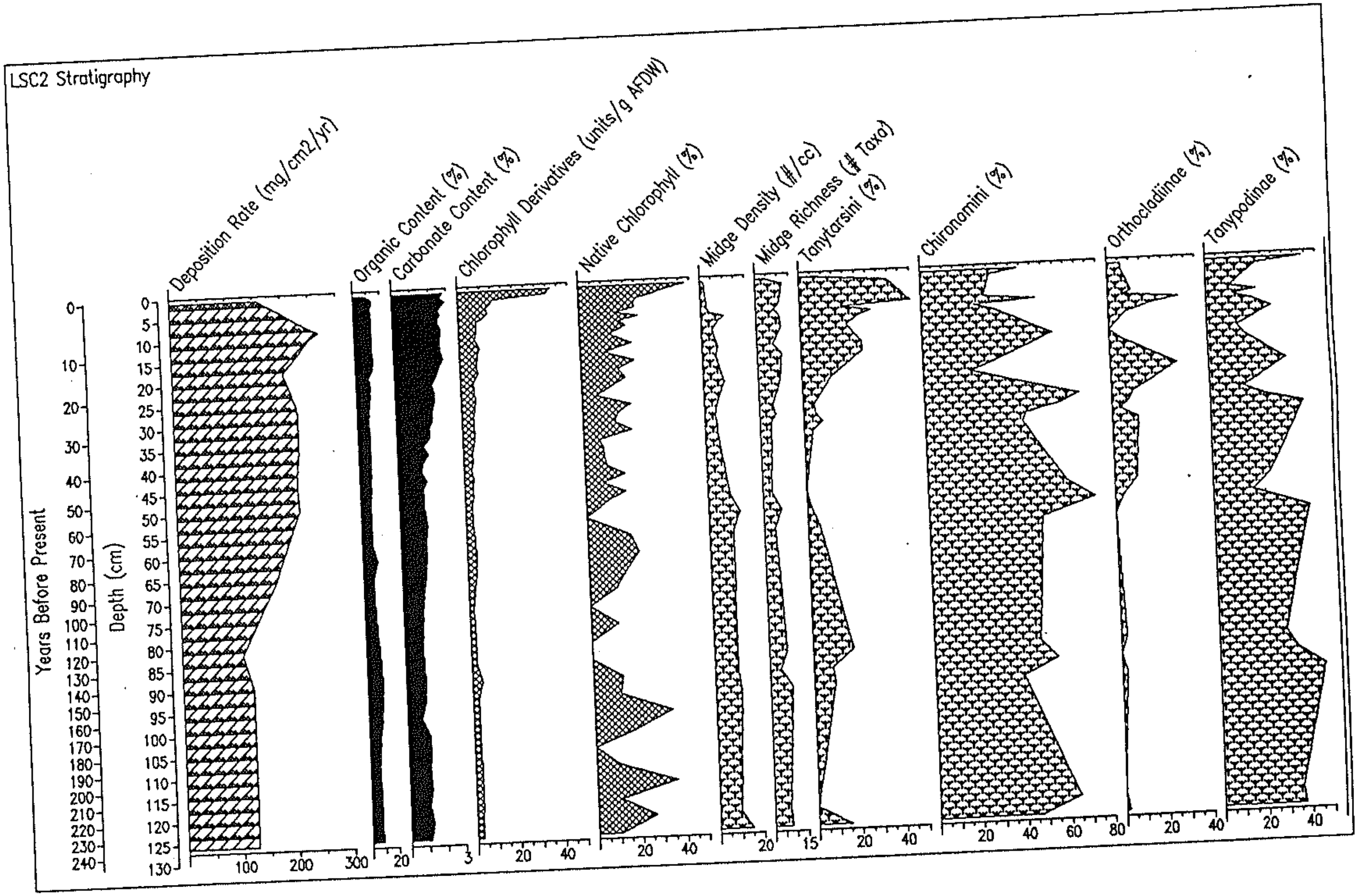
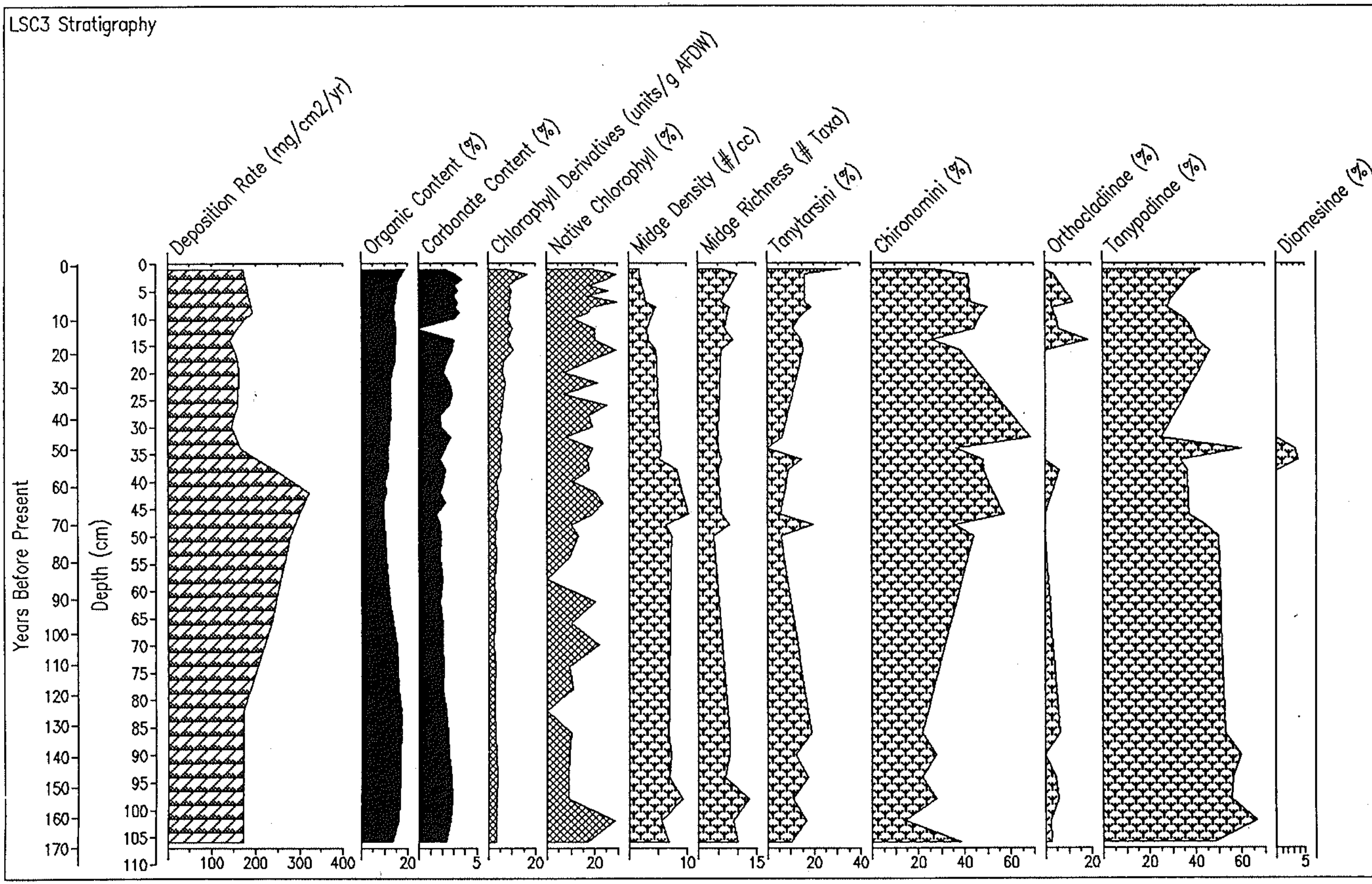

LSC2 Stratigraphy
Years Before Present
Depth (cm)
Deposition Rate (mg/cm2/yr)
Organic Content (%)
Carbonate Content (%)
Chlorophyll Derivatives (units/g AFDW)
Native Chlorophyll (%)
Midge Density (#/cc)
Midge Richness (# Taxa)
Tanytarsini (%)
Chironomini (%)
Orthocladiinae (%)
Tanypodinae (%)

Figure 18 (following page). Stratigraphy of the LSC3 coring site.


LSC3 Stratigraphy
Deposition Rate (mg/cm2/yr)
Organic Content (%)
Carbonate Content (%)
Chlorophyll Derivatives (units/g AFDW)
Native Chlorophyll (%)
Midge Density (#/cc)
Midge Richness (# Taxa)
Tanytarsini (%)
Chironomini (%)
Orthocladiinae (%)
Tanypodinae (%)
Diamesinae (%)
Years Before Present
Depth (cm)

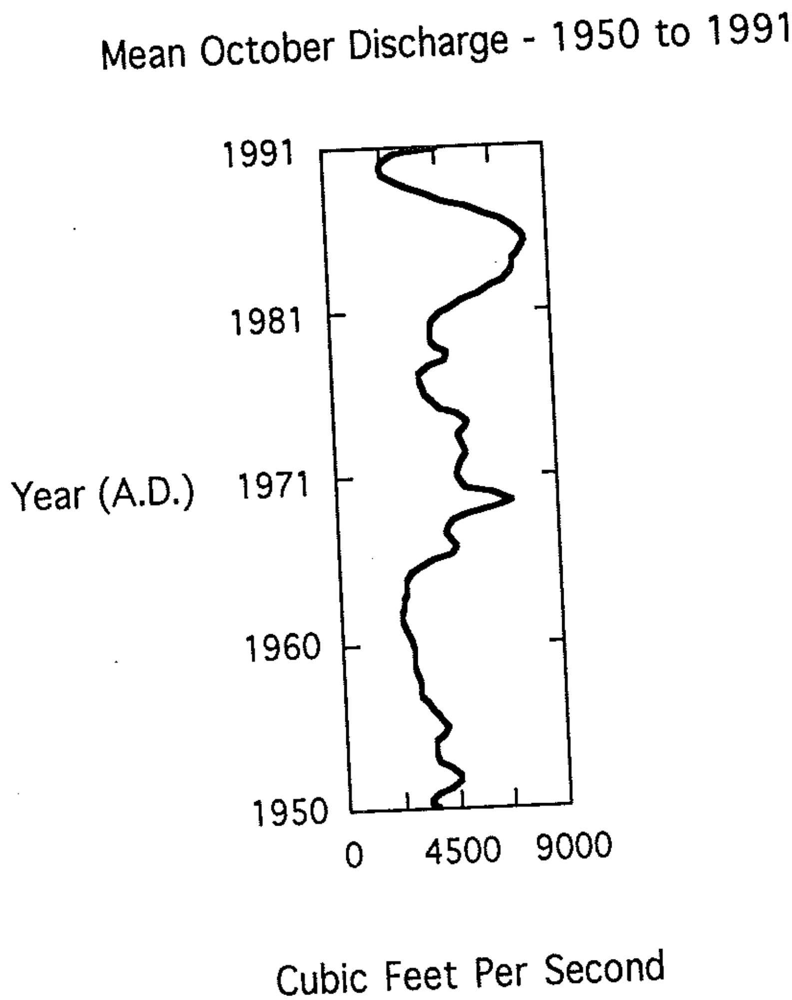


Figure 19. Mean monthly flows for the month of October from 1950 to 1991 at the St. Croix Falls dam site (data from the United States Geological Survey, Reston Virginia).

The LSC stratigraphic plots show the general trend of increasing chlorophyll and organic matter values toward the surface of each core signalling the effects of cultural eutrophication. Total midge densities in this basin are not as responsive to chlorophyll and organic matter. However, Tanytarsini appear to somewhat track chlorophyll values as do the Chironomini at LSC3. The percentage of Orthocladiinae appear to track deposition rates within the cores. It is interesting to note that deposition rates within the upper two sub-basins (LSC1, LSC2) have increased by a factor of 2-3 from levels at the base of the cores while those of LSC3 have stayed the same or decreased. This probably reflects the proximity of these upper sub-basins to the delta of the river where higher deposition rates would be expected.

DISCUSSION

The results of this study suggest that paleoecological tools may assist watershed managers in interpretation of long-term water quality changes within riverine basins. Our data from the SCF basin support the hypothesis that short-term variability in stream hydrology could influence inputs of organic matter and stream insects and subsequently change sediment carbonates and chlorophyll as nutrients are released during decomposition. Sediment stratigraphy suggests long-term changes in LSC since the period of settlement in the middle 1800's. Forest harvest and agricultural development within the basin are reflected by increases in sediment organic matter and carbonates deep in the core while recent rapid increases in these parameters, chlorophyll and midge community characteristics appears to be reflective of cultural eutrophication over the last 40-50 years.

Sedimentation characteristics within the SCF basin appear to be typical of those found in most reservoir systems. In a study of deposition in reservoirs across the United States, Ritchie (1989) found an average deposition rate of 3.8 cm/yr (n=58). This rate corresponds well with the estimates we obtained for the SCF basin (3-6 cm/yr). Ritchie also noted that the sediment and organic matter accumulation rates within his reservoirs were more dependent on watershed and reservoir characteristics (local scale) than regional or cultural factors. This fits with our hypothesis that stratigraphic patterns observed within this basin are tied to hydrologic characteristics of the St. Croix River (particularly in the fall of the year). Rough correspondence is evident between deposition patterns within the basin and discharge patterns during the fall of the year in the St. Croix River. This correspondence may be attributed to changes in riparian canopies at this time of the year. Leaf abscission contributes large quantities of leaf material to the tributaries and main channels of most temperate stream ecosystems (Fisher and Likens 1973; Kauschik and Hynes 1971). High stream flows during this period would flush large quantities of coarse organic material and associated invertebrates into the basin, producing the distinctive peaks in organic matter and predominance of lotic midges within the sediment. Nutrient mobilization during the initial stages of leaf decay within the basin may then stimulate primary production leading to higher peaks in carbonates and chlorophyll values within the sediment.

Deposition patterns within LSC appeared to be controlled by processes operating within the watershed over much longer periods of time. With the exception of percent native chlorophyll, measured parameters generally indicated long gradual changes in the character of the basin over the last 150-250 years. Sediment deposition and accumulation rates within this basin are well below those observed in constructed reservoirs (Ritchie 1989) and are not dissimilar to current estimates of accumulation reported for Squaw Lake (also within the drainage basin) (Garrison 1991). However, distinct differences were apparent among the cores extracted from the three sub-basins of LSC. LSC1 was extracted near the Eyster-Smith site at Bayport (Eyster-Smith 1977; Eyster-Smith et al. 1991). This core displayed the highest sediment deposition and accumulation rates of the three sub-basins. These results are consistent with those obtained by Eyster-Smith et al. (1991) and may be explained by the location of this site in relation to the St. Croix River delta within Lake St. Croix. Deposition and accumulation rates decreased in a downstream direction at our other coring sites near Lakeland, MN (LSC2) and Afton, MN (LSC3). This downstream gradient was also apparent for chlorophyll levels and midge community characteristics.

Percent native chlorophyll appeared to vary over a short time frame at SCF and LSC. This may be explained by year to year or even season to season differences in temperature and dissolved oxygen at the sediment-water interface (Swain 1985). Chlorophyll is preserved under anaerobic conditions while microbial activity under aerobic conditions promote its degradation (Hurley and Armstron 1990). Thus, year to year changes in stratification patterns within each basin may account for the large variability in this parameter.

The long-term trends exhibited by the cores of LSC are consistent with historical developments within the watershed over the last 150 years. European settlement in the basin and large-scale harvest of the white pine forest began in the late 1840's and early 1850's. These landscape level changes are revealed in the organic matter deposits within the LSC basin as peaks in organic matter in lower sections of all three cores (80-90cm). The extensive log drives down the St. Croix undoubtedly introduced a considerable load of organic matter to LSC (Verry 1992) and these activities within the basin are reflected in our core data. Further development in the basin proceeded in the late 1800's and early 1900's with extensive agricultural production. This development proceeded through most of this decade as is evidenced by the large-scale fragmentation of remaining forest tracts within the watershed (Queen et al. 1993). In recent decades, development along the riverway has placed ever increasing demands on the resource. This led to the inclusion of the lower river as a scenic and recreational river of the National Scenic and Wild Rivers Act in 1972.

Forest harvest, clearance of land for agriculture and urbanization and development along the riverway have resulted in changes in both basins. Recent (over the last 40-50 years) rapid increases in organic matter, carbonates and chlorophyll in LSC suggest increasing pressure on the basin from cultural eutrophication. Similar observations have been made by other authors using similar techniques. Moller and Scharf (1986) observed vertical increases in chlorophyll a and phaeopigments toward the surface of cores extracted from nine volcanic lakes in the Eifel region of Germany. They attributed long-term changes in pigment concentrations to the effects of glaciation and more recent dramatic increases in pigments to anthropogenic eutrophication of these basins. Adams and Prentki (1986) observed a strong correlation between pigment concentrations in the sediments of Lake Mead, Nevada and management within the watershed. Chlorophyll values in lake sediments were observed to stabilize at approximately the same time that tertiary sewage treatment was implemented for effluent entering the basin. Garrison (1991) observed large increases in organic matter and chlorophyll a content of sediments from Squaw Lake, WI over the period 1900 to the present. Post-1980 sediment accumulation rates were significantly higher (> 0.16 g/cm^2/yr versus 0.02-0.06 g/cm^2/yr) than those observed prior to 1980. In addition, large increases in organic matter and chlorophyll were noted from sediments aged after 1940 which corresponds roughly to the major period of increase in the LSC cores. Diatom cell influxes were observed to increase dramatically during this same period of time. These changes in lake sediment characteristics were attributed to cultural eutrophication of the lake basin from development within the watershed.

Our observations are also supported by long-term monitoring of the basin by the Minnesota Pollution Control Agency. The Carlson Trophic State Index which the agency uses to classify lakes within the state, indicates that the LSC basin should be classified as eutrophic (Minnesota Pollution Control Agency 1992). This was also the conclusion of Brook (1966), consultant for Northern States Power Company. His reports of phytoplankton studies within the river and Lake St. Croix suggest that blue-green algal blooms were common in the lake even prior to 1966.

Midge densities and richness appeared to track changes in organic matter, carbonates and chlorophyll within the basins. In general, higher densities and richness values were observed in sections of the core with higher organic matter and chlorophyll values. In LSC cores, the percentage of Tanytarsini and Chironomini increased toward the surface while Tanypodinae (primarily *Procladius* sp.) tended to contribute a larger percentage to total numbers in lower sections. Orthocladiinae in LSC did not display a significant pattern over time but they were relatively abundant within the SCF community. Differences in community composition between the two basins suggested a predominance of lotic forms in the SCF basin. This observation is consistent with our hypothesis that organic matter, carbonates and chlorophyll values in the SCF basin closely correlated with the hydrologic regime of the St. Croix River during the period of leaf abscission. Midges are a prevalent component of stream drift (Waters 1972) and lotic forms would be expected to wash in during freshets.

Midges have been used historically to classify and evaluate the trophic status of lake basins (Brundin 1958; Saether 1975 1979; Stahl 1969; Thienemann 1922). Brundin (1958) provided a classification of lakes based on midge communities. In his classification the communities of oligotrophic lakes would be dominated by *Orthocladius*, *Heterotrissocladius* and *Tanytarsus*. Communities of mesotrophic lakes would be dominated by *Stictochironomus* and *Sergentia* and communities of eutrophic lakes would be dominated by *Bathophilus* and *Chironomus*. Megard (1964) found the midge fauna of Dead Man Lake, NM was dominated by Orthocladiinae and Tanytarsini. According to european classifications, these groups should indicate oligotrophic conditions. However, Dead Man Lake is known to be a eutrophic basin. Megard concluded that midge communities are more indicative of oxygen stratification and concentrations in the profundal zone of lakes than lake trophic status. In the SCF and LSC basins, neither basin had strong thermal stratification and dissolved oxygen levels were observed to be at or near zero on the lake bottom. In the SCF basin, we observed degassing (methane production from anaerobic decomposition) of sediments as cores were being collected. Thus, oxygen levels in the sediments of both basins are apparently very low. This may explain the high relative abundance of *Chironomus* sp. in LSC sediments. Haemoglobin production and utilization by this midge is an adaptation to low oxygen concentrations (Walker 1993). The low numbers of this genus in SCF sediments may be due to absolute anoxic conditions in the sediment and a high deposition rate which would smother benthic forms. The higher densities of midges observed in the SCF basin may only reflect the high recruitment of lotic forms from catastrophic drift during storm flow events.

Midges have also been used to indicate deteriorating water quality conditions in lake sediments subject to high contaminant concentrations. Warwick (1980) found a relationship between lake pollution and morphological abnormalities from midges in the Bay of Quinte, Ontario and Klink (1989) has found increased evidence of pollution induced abnormalities in midges from the Rhine River of Europe. We did not observe a significant number of aberrations that would suggest severe trace metal or organic contamination from our samples in either basin. However, densities of midges in Lake St. Croix sediments are extremely low. Walker (1993) reported normal midge densities for temperate lakes exceeding 100 per cubic centimeter. Densities in the sediments of Lake St. Croix were an order of magnitude below this value. These low densities and the prevalence of *Chironomus* sp. in collections suggests that the midge fauna may be stressed by anoxia in Lake St. Croix.

Paleoecological evidence developed from this effort provides a chronological picture of changes in the SCF basin over the last 40 years and LSC over the last 150 years. Considerable change has been observed in the St. Croix River Basin since settlement (middle 1800's) and even recently over the last 20 years since a plan was initiated to manage the river as part of the National Scenic and Wild River System. Historical reconstruction of vegetation patterns within this watershed have revealed that pre-settlement forest acreage was over 2x higher than it is today (Mr. Steve Warren, University of Minnesota, pers. comm.). This forest has been fragmented and largely converted to cultivated agriculture which now comprises over 60% of the watershed in the lower riverway (Queen et al. 1993). Increased urbanization within the river corridor over the last 20 years (Queen et al. 1993) and heavy utilization of the river for recreation also contribute point and nonpoint sources of nutrients and contaminants to the basins along the river corridor. Malischke et al. (1993) reported that all three of the major tributaries entering the Lower St. Croix National Scenic Riverway (Apple River, Willow River, Kinnickinnic River) were impaired by nonpoint source water quality problems. These tributaries contribute sediment and nutrient loading to the St. Croix and this material eventually finds its way into both basins. These large-scale changes in development and use both along the river corridor and in the whole watershed threaten the ecological balance of the river and the basins. Proactive management and innovative monitoring techniques such as those described in this study are needed to meet the challenges of multiple-use management on the riverway.

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APPENDIX A

Location of Coring Sites and Lake Characteristics

Paleoecology of St. Croix River Basins

Coring Site Locations*

Coring Site	Degrees Longitude (W)	Degrees Latitude (N)
SCF1	92.649	45.422
SCF2	92.649	45.419
SCF3	92.651	45.422
LSC1	92.764	45.018
LSC2	92.755	44.941
LSC3	92.764	44.876

*Site locations determined through compass bearings and triangulation by L.P. Queen (Department of Forest Resources, University of Minnesota).

Key for Basin Water Column Characteristics

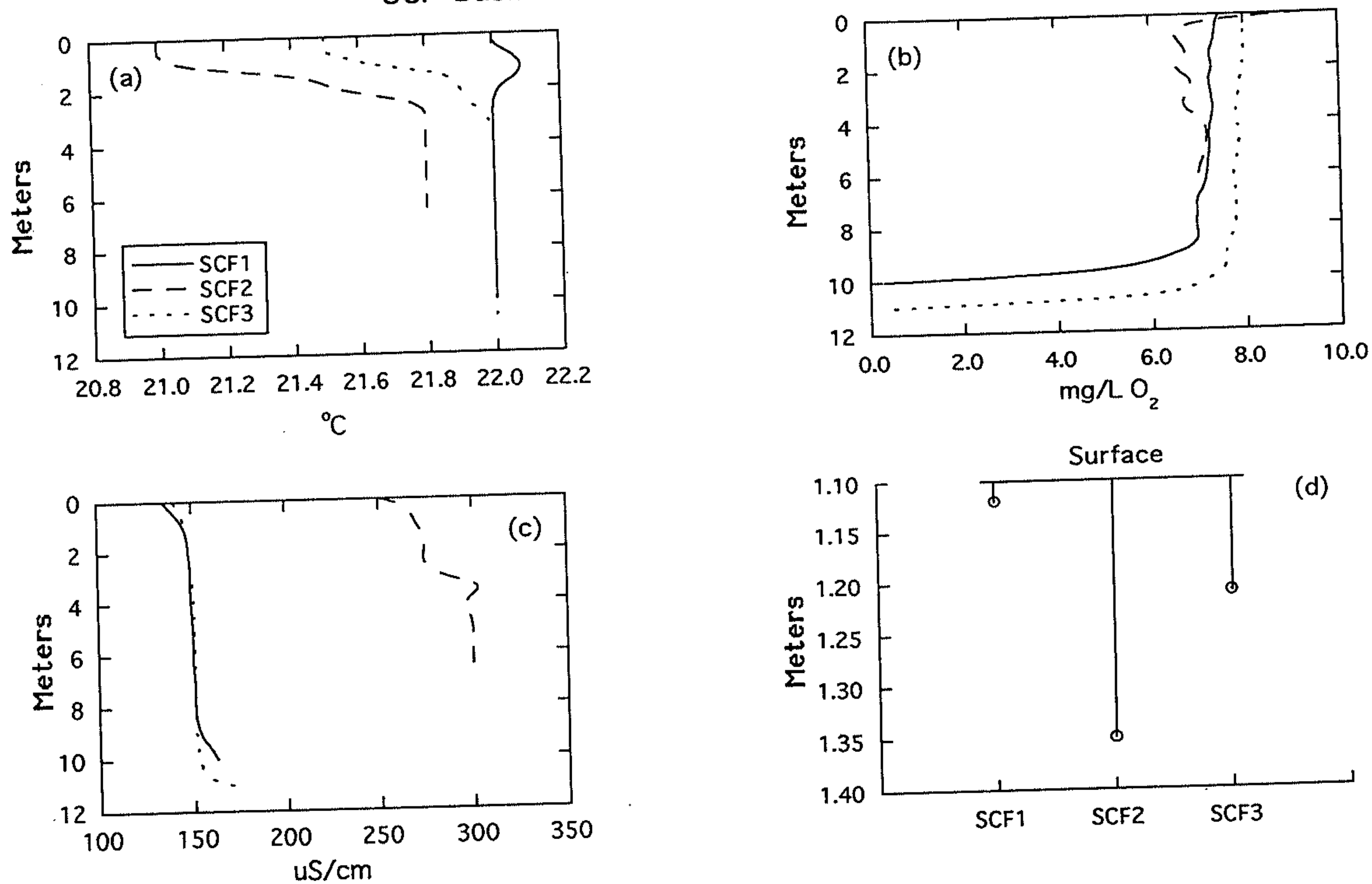
Figure **(a)** - water column temperature profile based on readings every 5 meters on the date of core extraction.

Figure **(b)** - water column dissolved oxygen profile based on readings every 0.5 meters on the date of core extraction.

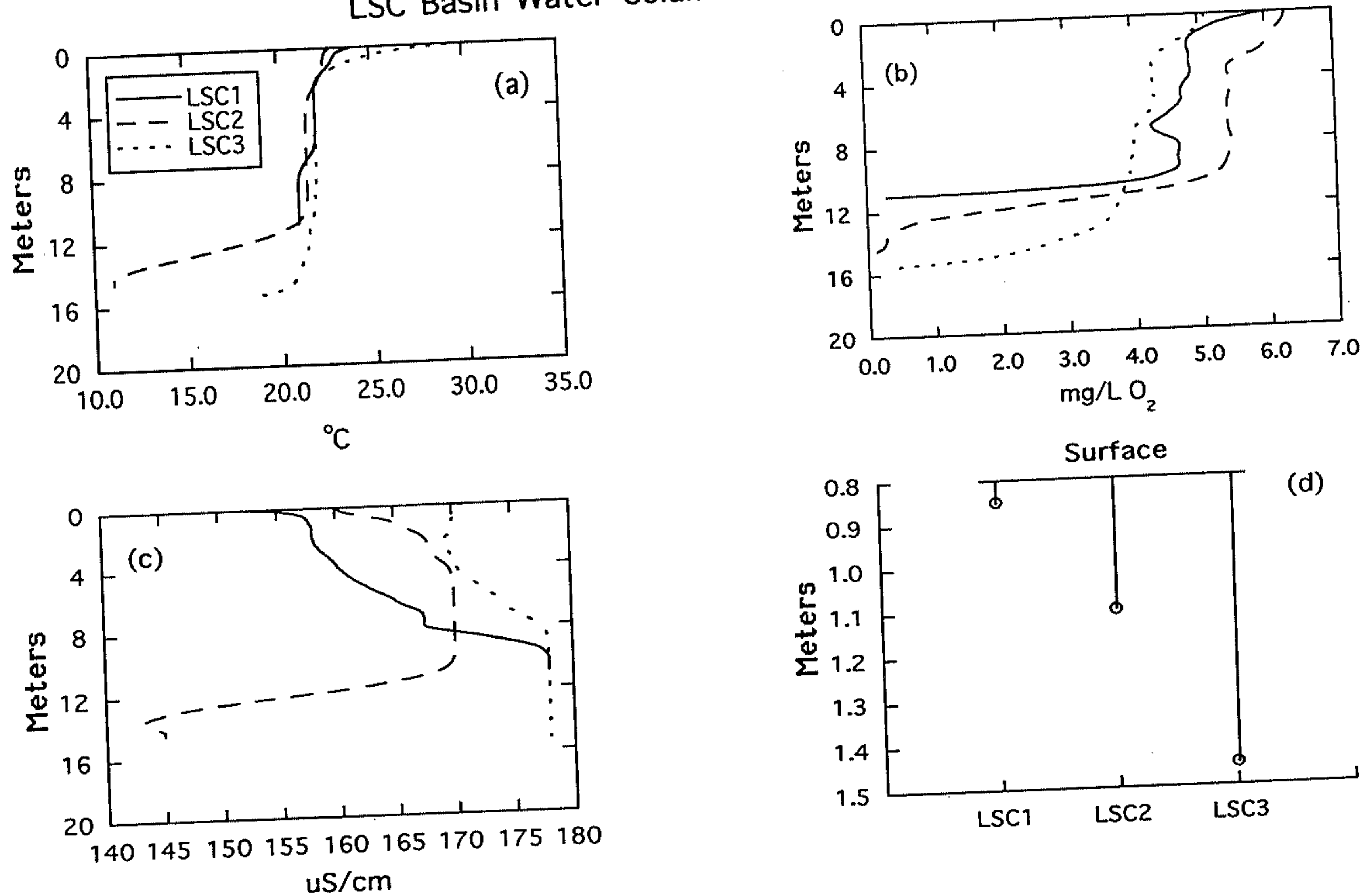
Figure **(c)** - water column specific conductance profile based on readings every 0.5 meters on the date of core extraction.

Figure **(d)** - water column Secchi depth readings taken on the date of core extraction from each site.

SCF Basin Water Column Characteristics



LSC Basin Water Column Characteristics



APPENDIX B

Dating Results and Accumulation Rates

Cesium Dating Results from the SCF Basin

Site	Depth cm	Cs-137 Bq/kg	Cs-137 Error	Ra-226 Bq/kg	Ra-226 Error	Ra-228 Bk/kq	Ra-228 Error	K-40 Bk/kq	K-40 Error
1	116	43	3	39	5	32	5	600	40
2	70	34	3	23	3	26	4	600	30
2	125	41	3	33	5	29	85	610	40
2	155	44	4	38	4	28	5	580	30
2	190	55	4	25	4	27	5	636	60
3	13	40	3	52	4	41	6	530	30
3	21	52	4	51	5	40	8	500	30
3	29	38	3	55	5	30	6	532	30
3	37	50	3	82	6	44	6	490	30
3	45	53	4	67	6	33	6	440	30
3	52	46	3	55	5	36	5	533	30
3	60	40	3	37	3	28	4	640	30
3	68	48	3	43	4	27	4	450	30
3	76	50	3	41	4	28	6	540	30
3	88	40	3	33	4	26	5	610	30
3	109	110	6	35	4	25	4	560	30
3	129	75	5	27	3	29	5	530	30
3	150	0.7	0.7	38	4	32	5	620	30

Counting Statistics for Sections Other Than SCF3 @ 150cm

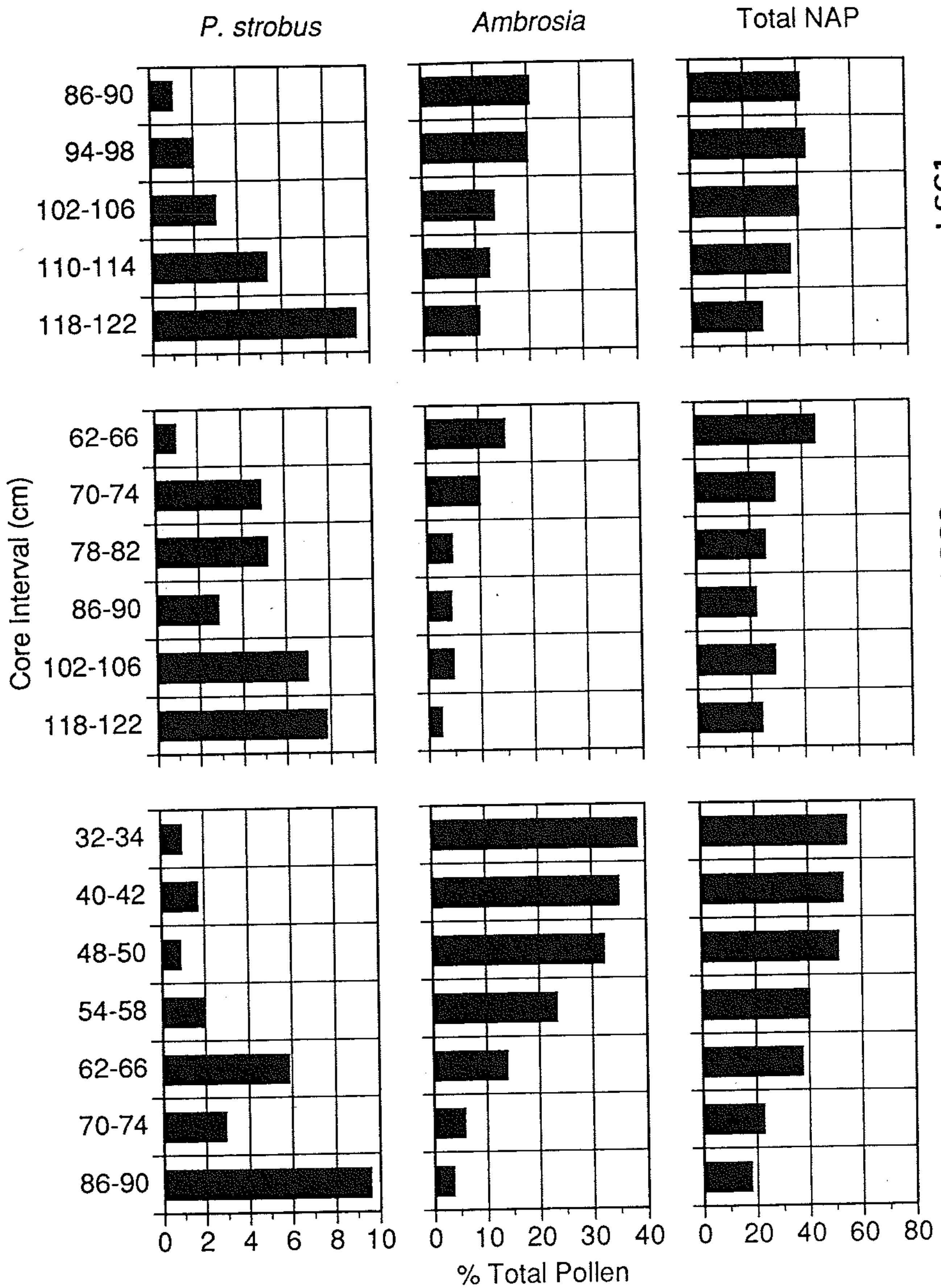
	Cs-137	Ra-226	Ra-228	K-40
25 Percentile	40	33	27	522.5
Median	45	38.5	29	550
75 Percentile	52.25	52.75	33.75	610

Results of Direct Gamma Emitter Analyses

Data as reported by Dr. Daniel Steck, Department of Physics, St. John's University, Collegeville, MN - 56321.

Pb-210 Dating Results from the LSC Basin

Core	Top (cm)	Bottom (cm)	Base Age (yr)	Age Error (+/-s.d.)	Date A.D.	Accumulation (g/cm2/yr)	Accum. Error (+/- s.d.)
LSC1	0	1	0.82	2.56	1990.8	0.426	0.031
LSC1	8	9	6.29	2.80	1985.3	0.388	0.031
LSC1	16	18	13.70	3.24	1977.9	0.317	0.029
LSC1	24	26	20.99	3.71	1970.6	0.338	0.036
LSC1	32	34	28.54	4.33	1963.1	0.380	0.050
LSC1	40	42	35.32	4.99	1956.3	0.483	0.082
LSC1	48	50	42.38	6.05	1949.2	0.428	0.084
LSC1	62	66	57.36	7.77	1934.2	0.541	0.149
LSC1	78	82	77.59	13.85	1914.0	0.250	0.103
LSC1	94	98	104.30	27.68	1887.3	0.256	0.212
LSC1	110	114	139.76	79.07	1851.8	0.188	0.405
LSC1	114	118	EXTRAPOLATED		1843.0	EXTRAPOLATED	
LSC1	118	122			1834.0		
LSC2	0	1	0.45	2.84	1991.2	0.159	0.011
LSC2	8	9	5.77	2.66	1985.8	0.267	0.016
LSC2	16	18	14.14	3.02	1977.5	0.200	0.014
LSC2	24	26	22.81	3.26	1968.8	0.223	0.019
LSC2	32	34	31.83	3.79	1959.8	0.225	0.024
LSC2	40	42	42.13	4.66	1949.5	0.220	0.030
LSC2	48	50	54.23	6.08	1937.4	0.221	0.040
LSC2	62	66	83.24	8.96	1908.4	0.174	0.045
LSC2	78	82	120.81	19.61	1870.8	0.109	0.059
LSC2	86	90	141.64	36.16	1850.0	0.131	0.136
LSC2	90	94			1841.0		
LSC2	94	98			1830.0		
LSC2	98	102			1817.0		
LSC2	102	106	EXTRAPOLATED		1807.0	EXTRAPOLATED	
LSC2	106	110			1796.0		
LSC2	110	114			1785.0		
LSC2	114	118			1775.0		
LSC2	118	122			1764.0		
LSC2	122	126			1753.0		
LSC3	0	1	0.71	3.80	1990.9	0.172	0.015
LSC3	8	9	8.18	4.15	1983.4	0.193	0.020
LSC3	12	14	15.71	4.81	1975.9	0.142	0.017
LSC3	16	18	22.84	5.62	1968.8	0.160	0.024
LSC3	20	22	29.16	6.58	1962.4	0.162	0.030
LSC3	24	26	35.46	7.78	1956.1	0.160	0.036
LSC3	28	30	43.00	9.61	1948.6	0.146	0.040
LSC3	32	34	49.90	11.72	1941.7	0.166	0.058
LSC3	36	38	56.42	14.22	1935.2	0.177	0.075
LSC3	40	42	61.62	16.58	1930.0	0.321	0.171
LSC3	62	66	96.74	42.60	1894.9	0.236	0.295
LSC3	78	82	125.36	101.15	1866.2	0.172	0.501
LSC3	82	86			1859.0		
LSC3	86	90			1853.0		
LSC3	90	94	EXTRAPOLATED		1847.0	EXTRAPOLATED	
LSC3	94	98			1840.0		
LSC3	98	102			1832.0		
LSC3	102	106			1822.0		


P. strobus
Ambrosia
Total NAP
Core Interval (cm)
86-90
94-98
102-106
110-114
118-122
LSC1
62-66
70-74
78-82
86-90
102-106
118-122
LSC2
32-34
40-42
48-50
54-58
62-66
70-74
86-90
LSC3
0 2 4 6 8 10
0 10 20 30 40
0 20 40 60 80
% Total Pollen

Stratigraphic Data for the SCF Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
SCF1	1	0.0	1.0	1.43	0.34	0.04	76.3	13.1	1.5	8.0	47.6
SCF1	2	1.0	2.0	2.21	0.59	0.08	73.4	14.3	1.3	2.3	37.6
SCF1	3	2.0	3.0	1.50	0.45	0.06	69.8	13.0	1.2	4.2	55.6
SCF1	4	3.0	4.0	1.49	0.48	0.06	68.0	13.0	1.0	4.2	52.6
SCF1	5	4.0	5.0	1.27	0.39	0.06	68.9	14.3	1.3	4.6	52.6
SCF1	6	5.0	6.0	1.38	0.44	0.06	68.3	13.3	1.1	4.3	55.6
SCF1	7	6.0	7.0	1.40	0.49	0.06	65.2	13.0	1.1	4.1	52.6
SCF1	8	7.0	8.0	1.50	0.50	0.06	66.8	12.5	1.1	4.3	40.8
SCF1	9	8.0	9.0	1.46	0.47	0.07	67.9	14.3	1.2	4.0	50.0
SCF1	10	9.0	10.0	1.49	0.43	0.07	71.0	16.3	1.2	4.7	38.5
SCF1	11	10.0	12.0	1.19	0.29	0.05	75.3	18.1	1.6	6.9	39.4
SCF1	12	12.0	14.0	1.41	0.35	0.07	75.5	19.4	1.5	5.1	51.4
SCF1	13	14.0	16.0	1.14	0.23	0.05	79.9	20.1	1.3	8.5	56.1
SCF1	14	16.0	18.0	1.44	0.36	0.07	74.9	19.8	1.4	5.6	54.2
SCF1	15	18.0	20.0	1.41	0.33	0.07	76.4	19.7	1.9	6.6	55.3
SCF1	16	20.0	22.0	1.42	0.33	0.07	77.0	20.2	1.8	7.6	55.6
SCF1	17	22.0	24.0	1.27	0.30	0.06	76.4	20.8	1.9	7.9	51.6
SCF1	18	24.0	26.0	1.35	0.29	0.06	78.4	21.0	2.0	8.7	51.3
SCF1	19	26.0	28.0	1.24	0.27	0.05	78.0	20.1	1.9	10.2	47.6
SCF1	20	28.0	30.0	1.21	0.26	0.05	78.4	18.8	2.0	8.2	47.6
SCF1	21	30.0	32.0	1.54	0.35	0.06	77.4	18.1	1.6	5.9	45.9
SCF1	22	32.0	34.0	1.44	0.30	0.06	79.4	19.4	1.9	6.9	47.6
SCF1	23	34.0	36.0	1.27	0.24	0.05	81.3	20.1	2.3	9.9	54.6
SCF1	24	36.0	38.0	1.30	0.25	0.05	80.7	19.8	2.1	9.8	46.3
SCF1	25	38.0	40.0	1.49	0.32	0.05	78.4	16.9	1.7	7.9	49.1
SCF1	26	40.0	42.0	1.37	0.32	0.05	76.5	16.1	1.6	7.3	51.0
SCF1	27	42.0	44.0	1.42	0.41	0.06	71.2	14.8	1.4	6.5	36.9
SCF1	28	44.0	46.0	1.45	0.37	0.07	74.4	19.0	1.7	5.5	42.9
SCF1	29	46.0	48.0	1.34	0.35	0.07	73.6	20.3	1.2	5.8	50.7
SCF1	30	48.0	50.0	1.31	0.35	0.06	73.5	18.6	1.2	7.3	49.0
SCF1	31	50.0	54.0	1.37	0.36	0.07	73.7	19.7	1.2	7.0	55.6
SCF1	32	54.0	58.0	1.32	0.31	0.06	76.2	19.6	1.5	9.1	47.6
SCF1	33	58.0	62.0	1.25	0.30	0.06	76.0	20.1	1.5	9.0	50.0

Stratigraphic Data for the SCF Basin

Core	Section	Top cm	Bottom cm	FW g/cc	DW g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
SCF1	34	62.0	66.0	1.32	0.31	0.06	76.5	19.9	1.7	9.7	51.9
SCF1	35	66.0	70.0	1.32	0.30	0.06	77.0	20.9	1.7	9.3	53.2
SCF1	36	70.0	74.0	1.42	0.32	0.06	77.2	19.7	1.6	7.3	49.0
SCF1	37	74.0	78.0	1.15	0.26	0.05	77.1	19.4	1.7	9.0	44.9
SCF1	38	78.0	82.0	1.52	0.42	0.06	72.1	14.3	1.3	5.6	44.0
SCF1	39	82.0	86.0	1.50	0.70	0.05	53.6	7.7	0.5	5.4	29.8
SCF1	40	86.0	90.0	1.33	0.52	0.07	60.9	12.9	0.9	3.6	37.6
SCF1	41	90.0	94.0	1.70	1.07	0.06	37.2	5.2	0.4	2.7	35.7
SCF1	42	94.0	98.0	1.54	0.57	0.06	63.2	11.3	1.0	3.7	37.6
SCF1	43	98.0	102.0	1.44	0.50	0.09	65.3	17.2	1.2	2.5	22.6
SCF1	44	102.0	106.0	1.48	0.45	0.08	70.0	17.0	1.6	3.3	45.1
SCF1	45	106.0	110.0	1.28	0.37	0.07	70.8	17.5	1.6	5.1	38.5
SCF1	46	110.0	114.0	1.49	0.59	0.08	60.5	12.8	1.2	3.2	20.4
SCF1	47	114.0	118.0	1.51	0.67	0.07	55.4	10.0	0.9	3.1	23.8
Min				1.14	0.23	0.04	37.2	5.2	0.4	2.3	20.4
Max				2.21	1.07	0.09	81.3	21.0	2.3	10.2	56.1
Mean				1.41	0.40	0.06	71.8	16.7	1.4	6.2	45.8
Median				1.41	0.35	0.06	74.4	18.1	1.5	5.9	47.6
n				47	47	47	47	47	47	47	47
SCF2	1	0.0	1.0	1.18	0.27	0.03	76.8	12.2	1.2	6.3	52.6
SCF2	2	1.0	2.0	1.32	0.39	0.05	70.2	12.8	1.1	4.9	45.1
SCF2	3	2.0	3.0	1.47	0.44	0.06	69.9	12.9	1.2	4.6	52.6
SCF2	4	3.0	4.0	1.37	0.41	0.05	70.1	13.3	1.3	5.0	49.2
SCF2	5	4.0	5.0	1.47	0.44	0.06	70.0	13.5	1.3	4.6	40.8
SCF2	6	5.0	6.0	1.35	0.40	0.06	70.2	13.8	1.4	4.7	42.9
SCF2	7	6.0	7.0	1.50	0.52	0.06	65.3	12.3	1.2	4.5	45.5
SCF2	8	7.0	8.0	1.45	0.52	0.06	64.1	11.8	1.3	4.6	31.1
SCF2	9	8.0	9.0	1.48	0.48	0.07	67.4	14.4	1.3	4.5	58.4
SCF2	10	9.0	10.0	1.56	0.50	0.08	67.6	16.6	1.3	2.9	47.6
SCF2	11	10.0	12.0	1.40	0.60	0.06	57.0	9.8	0.9	5.2	34.3
SCF2	12	12.0	14.0	1.33	0.44	0.06	67.0	13.3	1.5	6.0	42.3

Stratigraphic Data for the SCF Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
SCF2	13	14.0	16.0	1.33	0.35	0.06	73.8	17.5	1.9	5.9	54.9
SCF2	14	16.0	18.0	1.43	0.38	0.07	73.5	17.6	2.0	6.3	44.6
SCF2	15	18.0	20.0	1.27	0.32	0.06	74.5	18.5	1.9	7.2	43.3
SCF2	16	20.0	22.0	1.40	0.34	0.07	76.0	19.6	1.9	7.8	48.9
SCF2	17	22.0	24.0	1.45	0.35	0.07	75.5	18.8	1.8	6.5	49.1
SCF2	18	24.0	26.0	1.20	0.33	0.07	72.3	19.9	1.8	5.4	47.6
SCF2	19	26.0	28.0	1.33	0.30	0.08	77.2	26.1	1.9	3.7	29.8
SCF2	20	28.0	30.0	1.47	0.34	0.08	76.8	23.6	1.9	4.9	36.9
SCF2	21	30.0	32.0	1.31	0.32	0.06	75.6	18.5	2.1	4.9	45.5
SCF2	22	32.0	34.0	1.17	0.30	0.05	74.2	17.9	1.5	7.8	39.0
SCF2	23	34.0	36.0	1.32	0.37	0.06	71.7	17.4	2.0	6.0	36.9
SCF2	24	36.0	38.0	1.35	0.39	0.06	71.3	15.8	1.8	5.9	47.6
SCF2	25	38.0	40.0	1.29	0.38	0.06	70.7	15.9	1.9	6.1	39.4
SCF2	26	40.0	42.0	1.46	0.45	0.07	68.9	15.8	1.0	5.8	50.7
SCF2	27	42.0	44.0	1.32	0.38	0.06	71.1	16.4	0.9	6.7	44.6
SCF2	28	44.0	46.0	1.28	0.36	0.06	71.7	16.4	1.1	6.6	42.9
SCF2	29	46.0	48.0	1.24	0.35	0.06	72.3	16.8	1.1	6.7	36.9
SCF2	30	48.0	50.0	1.39	0.37	0.06	73.6	17.3	1.3	6.3	47.6
SCF2	31	50.0	54.0	1.25	0.31	0.06	75.0	17.8	1.4	8.1	30.9
SCF2	32	54.0	58.0	1.38	0.43	0.06	68.8	14.6	1.2	5.7	34.5
SCF2	33	58.0	62.0	1.43	0.57	0.06	59.8	11.1	0.9	4.1	34.0
SCF2	34	62.0	66.0	1.65	0.84	0.06	49.4	7.7	0.6	4.3	31.1
SCF2	35	66.0	70.0	1.80	1.12	0.05	37.7	4.8	0.5	4.3	30.1
SCF2	36	70.0	74.0	2.13	1.35	0.06	36.5	4.1	0.4	2.9	33.0
SCF2	Livingstone Drive #1										
SCF2	L1	57.0	82.0	1.63	0.66	0.06	59.3	9.5	0.9	5.4	37.0
SCF2	L2	82.0	93.0	2.07	1.48	0.04	28.5	2.7	0.4	3.0	47.6
SCF2	L3	93.0	105.0	1.55	0.61	0.08	60.7	13.6	1.1	3.0	35.7
SCF2	L4	105.0	107.0	1.80	1.16	0.05	35.4	4.2	0.5	3.0	35.7
SCF2	L5	107.0	114.0	1.45	0.62	0.07	57.2	11.2	1.0	3.9	27.3
SCF2	L6	114.0	117.0	1.89	1.16	0.06	38.5	5.5	0.6	2.8	17.9
SCF2	L7	117.0	130.0	1.56	0.70	0.07	54.9	10.3	0.9	4.0	29.8
SCF2	L8	130.0	132.0	1.75	0.70	0.10	59.9	14.4	0.8	1.6	33.0

Stratigraphic Data for the SCF Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
SCF2	Livingstone Drive #2										
SCF2	L1	117.0	132.0	1.85	0.88	0.09	52.1	10.3	0.7	2.7	27.2
SCF2	L2	132.0	135.5	1.87	1.21	0.07	35.4	6.0	0.4	2.2	47.6
SCF2	L3	135.5	142.0	1.48	0.56	0.12	62.3	21.0	0.7	0.9	35.7
SCF2	L4	142.0	163.0	1.52	0.74	0.08	51.2	10.6	0.9	2.4	26.8
SCF2	L5	163.0	166.0	1.82	1.20	0.08	34.2	6.4	0.5	2.1	33.0
SCF2	L6	166.0	170.0	1.55	0.79	0.07	49.1	8.9	0.8	3.3	13.6
SCF2	L7	170.0	175.5	1.87	1.21	0.09	35.4	7.1	0.4	1.4	13.0
SCF2	L8	175.5	180.5	1.60	0.90	0.07	43.9	7.6	0.7	3.6	27.2
SCF2	L9	180.5	184.0	1.90	1.34	0.07	29.5	5.4	0.4	2.4	30.6
SCF2	L10	184.0	193.0	1.64	0.72	0.08	56.0	10.6	1.0	3.9	20.1
SCF2	Livingstone Drive #3										
SCF2	L1	177.0	204.5	1.65	0.88	0.07	46.5	7.6	0.7	3.5	21.4
SCF2	L2	204.5	209.0	1.88	1.15	0.17	38.8	14.9	0.4	0.5	17.9
SCF2	L3	209.0	212.0	2.08	1.40	0.05	32.9	3.9	0.2	2.0	31.7
SCF2	L4	212.0	222.0	1.47	0.66	0.11	55.3	17.2	0.3	0.9	35.7
SCF2	L5	222.0	225.0	1.85	1.19	0.08	35.7	7.1	0.4	1.2	35.7
SCF2	L6	225.0	231.0	1.51	0.62	0.10	59.0	15.8	1.2	3.2	34.3
Min				1.17	0.27	0.03	28.5	2.7	0.2	0.5	13.0
Max				2.13	1.48	0.17	77.2	26.1	2.1	8.1	58.4
Mean				1.53	0.65	0.07	59.6	13.0	1.1	4.3	37.3
Median				1.47	0.52	0.06	64.7	13.4	1.1	4.5	36.3
n				60	60	60	60	60	60	60	60
SCF3	1	0.0	1.0	1.37	0.33	0.04	75.8	12.0	1.4	5.3	52.6
SCF3	2	1.0	2.0	1.28	0.42	0.05	67.1	11.7	1.2	6.3	49.7
SCF3	3	2.0	3.0	1.39	0.45	0.06	67.7	12.4	1.3	5.7	40.0
SCF3	4	3.0	4.0	1.54	0.49	0.07	68.2	13.3	1.3	5.1	45.7
SCF3	5	4.0	5.0	1.45	0.46	0.06	68.0	13.4	1.2	5.9	45.9
SCF3	6	5.0	6.0	1.53	0.57	0.06	62.9	11.0	1.1	5.0	34.3
SCF3	7	6.0	7.0	1.37	0.59	0.06	57.0	10.9	0.9	4.8	41.7
SCF3	8	7.0	8.0	1.42	0.58	0.06	59.5	10.6	1.0	3.8	6.5

Stratigraphic Data for the SCF Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
SCF3	9	8.0	9.0	1.28	0.41	0.06	67.9	14.5	1.2	6.1	40.8
SCF3	10	9.0	10.0	1.37	0.39	0.07	71.7	17.2	1.3	5.7	51.0
SCF3	11	10.0	12.0	1.27	0.37	0.06	70.6	15.9	1.2	5.5	45.7
SCF3	12	12.0	14.0	1.33	0.39	0.06	70.3	15.9	1.1	6.4	47.6
SCF3	13	14.0	16.0	1.18	0.32	0.05	73.0	17.3	1.4	7.7	57.1
SCF3	14	16.0	18.0	1.20	0.28	0.06	77.1	20.9	2.2	9.4	50.0
SCF3	15	18.0	20.0	1.12	0.26	0.05	76.5	17.4	1.9	9.4	48.6
SCF3	16	20.0	22.0	1.35	0.33	0.06	75.2	17.5	1.7	7.2	50.7
SCF3	17	22.0	24.0	1.24	0.32	0.06	74.4	18.0	1.6	7.9	35.7
SCF3	18	24.0	26.0	1.24	0.31	0.06	74.9	19.4	1.7	7.4	35.7
SCF3	19	26.0	28.0	1.40	0.41	0.06	71.0	14.7	1.2	6.4	38.1
SCF3	20	28.0	30.0	1.35	0.40	0.06	70.7	15.1	1.2	4.7	31.1
SCF3	21	30.0	32.0	1.49	0.41	0.07	72.5	17.5	1.9	5.7	46.1
SCF3	22	32.0	34.0	1.23	0.32	0.06	74.0	18.1	1.7	8.0	44.9
SCF3	23	34.0	36.0	1.28	0.32	0.06	75.0	17.9	1.6	8.4	47.6
SCF3	24	36.0	38.0	1.18	0.30	0.05	74.9	17.9	1.6	9.4	50.2
SCF3	25	38.0	40.0	1.26	0.31	0.06	75.7	19.2	1.7	8.6	44.0
SCF3	26	40.0	42.0	1.27	0.29	0.06	77.2	20.8	1.7	8.3	40.3
SCF3	27	42.0	44.0	1.12	0.26	0.05	77.3	20.9	1.8	9.7	42.9
SCF3	28	44.0	46.0	1.38	0.32	0.06	76.6	19.5	1.5	7.3	39.7
SCF3	29	46.0	48.0	1.09	0.26	0.05	76.1	17.6	2.0	10.2	43.7
SCF3	30	48.0	50.0	1.27	0.31	0.05	75.4	17.3	1.8	7.2	42.9
SCF3	31	50.0	54.0	1.32	0.41	0.05	69.2	13.1	1.3	6.6	42.3
SCF3	32	54.0	58.0	1.62	0.83	0.06	48.6	7.6	0.7	3.6	30.1
SCF3	33	58.0	62.0	1.60	0.61	0.09	62.2	15.3	1.0	2.4	31.7
SCF3	34	62.0	66.0	1.53	0.65	0.07	57.4	10.6	1.2	3.4	37.6
SCF3	35	66.0	70.0	1.33	0.43	0.08	67.9	18.2	1.4	3.6	31.1
SCF3	36	70.0	74.0	1.45	0.52	0.08	64.1	15.8	1.5	3.3	24.8
SCF3	37	74.0	78.0	1.42	0.60	0.07	57.4	12.1	1.2	3.8	31.1
SCF3	38	78.0	82.0	1.72	1.09	0.08	36.3	7.1	0.6	2.6	15.9
SCF3	39	82.0	86.0	1.99	1.48	0.06	25.6	4.3	0.3	1.4	71.4
SCF3	40	86.0	90.0	1.52	0.75	0.09	50.4	12.1	0.8	2.9	31.3
SCF3	Livingstone Drive #1										

Stratigraphic Data for the SCF Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
SCF3	L1	58.0	63.5	1.82	1.07	0.08	41.2	7.1	0.4	2.6	35.7
SCF3	L2	63.5	66.5	1.93	1.35	0.08	29.9	5.7	0.3	1.6	13.0
SCF3	L3	66.5	71.5	1.34	0.36	0.09	73.1	24.5	1.0	3.6	33.0
SCF3	L4	71.5	75.0	1.55	0.72	0.08	53.8	11.4	0.6	3.8	21.2
SCF3	L5	75.0	80.0	1.91	1.17	0.07	38.6	6.2	0.3	1.5	14.8
SCF3	L6	80.0	90.0	1.48	0.58	0.11	60.4	18.4	0.3	0.8	0.0
SCF3	L7	90.0	93.0	1.94	1.10	0.11	43.3	10.4	0.3	1.2	23.8
SCF3	L8	93.0	96.0	2.06	1.24	0.07	39.7	6.0	0.3	0.8	0.0
SCF3	L9	96.0	104.0	1.86	0.97	0.13	47.7	13.6	0.4	0.8	0.0
SCF3	L10	104.0	114.0	1.43	0.45	0.07	68.9	16.4	1.5	4.1	28.6
SCF3	L11	114.0	116.0	1.94	1.46	0.04	24.9	2.5	0.4	4.7	8.9
SCF3	L12	116.0	120.0	1.94	1.00	0.10	48.5	10.0	0.6	3.5	18.4
SCF3	L13	120.0	130.0	1.70	0.77	0.06	55.0	8.2	1.0	3.6	21.4
SCF3	Livingstone Drive #2										
SCF3	L14	118.0	124.0	1.66	0.83	0.09	49.8	10.3	0.7	2.3	35.7
SCF3	L15	124.0	133.5	1.70	0.62	0.08	63.3	12.7	1.3	4.0	33.0
SCF3	L16	133.5	138.0	2.03	1.16	0.10	43.2	9.0	0.5	1.4	10.2
SCF3	L17	138.0	162.0	1.53	0.65	0.07	57.4	10.6	1.2	2.9	15.9
Min				1.09	0.26	0.04	24.9	2.5	0.3	0.8	0.0
Max				2.06	1.48	0.13	77.3	24.5	2.2	10.2	71.4
Mean				1.48	0.60	0.07	62.0	13.8	1.2	5.0	34.2
Median				1.42	0.45	0.06	67.9	13.6	1.2	4.8	35.7
n				57	57	57	57	57	57	57	57

Stratigraphic Data for the LSC Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
LSC1	1	0.0	1.0	1.18	0.29	0.02	75.9	8.6	1.1	7.0	7.1
LSC1	2	1.0	2.0	1.23	0.34	0.03	72.6	9.3	1.0	6.7	23.8
LSC1	3	2.0	3.0	1.15	0.33	0.03	71.3	8.9	0.9	7.5	14.3
LSC1	4	3.0	4.0	1.33	0.38	0.04	71.2	9.6	0.9	7.6	17.1
LSC1	5	4.0	5.0	1.21	0.33	0.03	72.5	9.5	0.9	10.4	25.5
LSC1	6	5.0	6.0	1.22	0.35	0.03	71.5	9.1	0.9	9.1	22.9
LSC1	7	6.0	7.0	1.14	0.19	0.03	83.2	17.1	2.2	9.4	21.4
LSC1	8	7.0	8.0	1.17	0.21	0.03	82.0	16.6	2.2	11.2	21.0
LSC1	9	8.0	9.0	1.19	0.22	0.04	81.8	16.1	2.3	9.4	25.5
LSC1	10	9.0	10.0	1.26	0.23	0.04	81.6	18.3	0.9	7.5	26.5
LSC1	11	10.0	12.0	1.21	0.22	0.04	81.6	18.2	1.0	7.4	15.9
LSC1	12	12.0	14.0	1.34	0.27	0.05	79.9	17.8	1.1	6.9	14.3
LSC1	13	14.0	16.0	1.29	0.27	0.05	79.2	17.8	1.0	6.5	21.2
LSC1	14	16.0	18.0	1.19	0.33	0.05	73.5	14.3	1.1	5.4	12.4
LSC1	15	18.0	20.0	1.25	0.29	0.05	76.5	15.6	1.3	5.5	19.5
LSC1	16	20.0	22.0	1.22	0.30	0.05	75.0	16.3	1.3	5.8	10.6
LSC1	17	22.0	24.0	1.15	0.30	0.05	74.1	16.3	1.5	6.0	16.5
LSC1	18	24.0	26.0	1.07	0.28	0.04	73.7	15.8	1.7	6.3	17.1
LSC1	19	26.0	28.0	1.35	0.35	0.05	73.9	15.2	1.7	5.0	24.8
LSC1	20	28.0	30.0	1.32	0.36	0.05	73.0	14.9	1.7	5.1	0.0
LSC1	21	30.0	32.0	1.23	0.35	0.05	71.6	14.5	1.6	5.1	11.9
LSC1	22	32.0	34.0	1.28	0.38	0.05	70.5	14.1	1.7	5.0	11.4
LSC1	23	34.0	36.0	1.45	0.45	0.06	69.1	13.9	1.7	4.5	17.1
LSC1	24	36.0	38.0	1.32	0.40	0.06	69.8	14.0	1.8	4.8	11.4
LSC1	25	38.0	40.0	1.18	0.38	0.05	68.0	12.9	1.9	4.9	0.0
LSC1	26	40.0	42.0	1.24	0.36	0.06	71.1	15.6	2.2	4.7	11.7
LSC1	27	42.0	44.0	1.39	0.43	0.05	69.1	12.7	1.9	4.4	6.2
LSC1	28	44.0	46.0	1.30	0.40	0.05	68.9	12.8	1.9	5.4	11.0
LSC1	29	46.0	48.0	1.31	0.39	0.05	69.9	12.7	1.9	5.0	12.4
LSC1	30	48.0	50.0	1.34	0.42	0.05	69.0	12.5	2.0	5.6	10.6
LSC1	31	50.0	54.0	1.28	0.39	0.05	69.4	12.3	1.9	5.8	11.0
LSC1	32	54.0	58.0	1.41	0.45	0.05	68.5	12.1	1.9	4.5	12.8
LSC1	33	58.0	62.0	1.42	0.45	0.05	68.2	12.1	1.8	3.3	0.0

Stratigraphic Data for the LSC Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
LSC1	34	62.0	66.0	1.45	0.47	0.05	67.6	11.7	1.7	2.7	10.2
LSC1	35	66.0	70.0	1.36	0.46	0.05	66.3	12.0	1.3	3.1	19.0
LSC1	36	70.0	74.0	1.45	0.48	0.06	67.1	12.2	1.4	3.3	26.8
LSC1	37	74.0	78.0	1.53	0.49	0.06	67.9	12.7	1.4	3.0	16.8
LSC1	38	78.0	82.0	1.28	0.40	0.05	68.7	12.9	1.4	3.3	0.0
LSC1	39	82.0	86.0	1.45	0.43	0.05	70.7	12.8	1.8	3.1	8.9
LSC1	40	86.0	90.0	1.48	0.45	0.06	69.7	12.9	1.8	3.1	0.0
LSC1	41	90.0	94.0	1.47	0.46	0.06	68.6	12.7	1.9	3.4	15.9
LSC1	42	94.0	98.0	1.27	0.41	0.05	67.7	12.4	2.1	3.7	7.9
LSC1	43	98.0	102.0	1.82	0.58	0.07	68.0	12.4	2.2	2.8	15.9
LSC1	44	102.0	106.0	1.58	0.53	0.07	66.3	12.4	2.2	3.0	7.5
LSC1	45	106.0	110.0	1.37	0.45	0.06	66.9	12.7	2.2	3.6	7.1
LSC1	46	110.0	114.0	1.49	0.50	0.07	66.7	13.3	2.2	2.9	16.8
LSC1	47	114.0	118.0	1.44	0.50	0.06	65.6	13.1	2.2	2.6	19.0
LSC1	48	118.0	122.0	1.46	0.49	0.07	66.5	13.6	2.3	2.7	17.9
Min				1.07	0.19	0.02	65.58	8.6	0.9	2.6	0.0
Max				1.82	0.58	0.07	83.23	18.3	2.3	11.2	26.8
Mean				1.32	0.38	0.05	71.69	13.5	1.6	5.3	14.1
Median				1.30	0.39	0.05	70.17	12.9	1.7	5.0	14.3
N				48	48	48	48	48	48	48	48
LSC2	1	0.0	1.0	1.02	0.06	0.01	94.3	14.8	2.8	41.9	47.6
LSC2	2	1.0	2.0	1.04	0.08	0.01	92.4	17.0	2.7	40.0	38.5
LSC2	3	2.0	3.0	1.22	0.12	0.02	90.1	16.7	2.9	15.8	33.0
LSC2	4	3.0	4.0	1.23	0.14	0.02	89.0	16.4	2.7	14.9	25.5
LSC2	5	4.0	5.0	1.24	0.16	0.03	86.9	16.4	2.5	12.8	24.6
LSC2	6	5.0	6.0	1.26	0.15	0.03	87.8	16.5	2.6	13.5	24.6
LSC2	7	6.0	7.0	1.12	0.16	0.03	85.9	16.6	2.5	11.5	15.9
LSC2	8	7.0	8.0	1.31	0.19	0.03	85.3	16.5	2.5	8.2	26.0
LSC2	9	8.0	9.0	1.26	0.20	0.03	84.4	16.6	2.6	8.3	17.9
LSC2	10	9.0	10.0	1.14	0.18	0.03	84.5	16.6	2.6	8.2	20.4
LSC2	11	10.0	12.0	1.21	0.20	0.03	83.8	16.5	2.6	7.4	13.0

Stratigraphic Data for the LSC Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
LSC2	12	12.0	14.0	1.12	0.19	0.03	83.0	16.6	2.6	9.2	22.9
LSC2	13	14.0	16.0	1.19	0.21	0.03	82.6	16.8	2.7	8.0	11.0
LSC2	14	16.0	18.0	1.18	0.22	0.04	81.6	16.6	2.5	7.8	23.8
LSC2	15	18.0	20.0	1.30	0.24	0.04	81.5	15.1	2.3	8.0	16.5
LSC2	16	20.0	22.0	1.42	0.27	0.04	81.0	15.5	2.1	6.0	19.5
LSC2	17	22.0	24.0	1.30	0.25	0.04	80.7	15.2	2.1	6.3	13.0
LSC2	18	24.0	26.0	1.20	0.24	0.04	80.1	15.0	2.2	6.7	6.2
LSC2	19	26.0	28.0	1.23	0.25	0.04	79.6	14.6	2.0	6.3	21.4
LSC2	20	28.0	30.0	1.21	0.26	0.04	78.5	14.5	2.0	5.3	15.9
LSC2	21	30.0	32.0	1.24	0.27	0.04	78.4	14.7	1.9	5.6	14.3
LSC2	22	32.0	34.0	1.19	0.26	0.04	78.2	14.7	1.8	6.0	21.4
LSC2	23	34.0	36.0	1.13	0.29	0.04	74.4	14.8	1.5	5.2	6.8
LSC2	24	36.0	38.0	1.24	0.28	0.04	77.6	14.8	1.7	4.4	8.4
LSC2	25	38.0	40.0	1.14	0.27	0.04	76.7	14.7	1.4	4.4	8.9
LSC2	26	40.0	42.0	1.23	0.30	0.04	75.6	14.9	1.3	3.6	9.5
LSC2	27	42.0	44.0	1.12	0.28	0.04	74.6	14.5	1.6	4.4	17.9
LSC2	28	44.0	46.0	1.24	0.32	0.05	74.4	14.9	1.4	4.0	7.9
LSC2	29	46.0	48.0	1.25	0.33	0.05	73.6	14.0	1.4	3.9	17.9
LSC2	30	48.0	50.0	1.34	0.35	0.05	73.8	14.2	1.4	3.0	10.2
LSC2	31	50.0	54.0	1.37	0.34	0.05	75.3	14.0	1.5	3.2	0.0
LSC2	32	54.0	58.0	1.27	0.31	0.04	75.4	14.1	1.4	3.9	19.0
LSC2	33	58.0	62.0	1.26	0.31	0.05	75.1	15.6	1.4	4.5	22.6
LSC2	34	62.0	66.0	1.34	0.34	0.05	74.6	14.1	1.3	3.9	16.8
LSC2	35	66.0	70.0	1.28	0.32	0.05	75.0	14.2	1.2	2.9	11.9
LSC2	36	70.0	74.0	1.36	0.34	0.05	74.8	14.5	1.1	2.0	0.0
LSC2	37	74.0	78.0	1.36	0.35	0.05	74.5	14.7	1.1	2.6	11.9
LSC2	38	78.0	82.0	1.11	0.28	0.04	74.5	15.3	1.0	2.5	0.0
LSC2	39	82.0	86.0	1.33	0.33	0.05	75.0	15.7	1.1	2.5	0.0
LSC2	40	86.0	90.0	1.33	0.32	0.05	75.7	15.9	1.1	4.7	13.0
LSC2	41	90.0	94.0	1.23	0.30	0.05	75.9	15.7	1.0	2.8	11.9
LSC2	42	94.0	98.0	1.32	0.34	0.05	74.5	15.3	0.9	3.0	34.7
LSC2	43	98.0	102.0	1.50	0.40	0.06	73.3	14.5	1.2	2.9	19.0
LSC2	44	102.0	106.0	1.21	0.31	0.04	73.9	14.0	1.3	2.7	0.0

Stratigraphic Data for the LSC Basin

Core	Section	Top cm	Bottom cm	FW g/cc	DW g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
LSC2	45	106.0	110.0	1.33	0.34	0.05	74.2	13.8	1.2	3.2	10.2
LSC2	46	110.0	114.0	1.26	0.34	0.05	73.1	14.0	1.2	3.2	35.7
LSC2	47	114.0	118.0	1.24	0.32	0.04	74.2	14.0	1.1	3.1	11.0
LSC2	48	118.0	122.0	1.30	0.35	0.05	73.4	14.0	1.3	2.7	26.0
LSC2	49	122.0	126.0	1.27	0.35	0.05	72.8	14.5	1.1	3.0	10.2
Min				1.02	0.06	0.01	72.80	13.8	0.9	2.0	0.0
Max				1.50	0.40	0.06	94.35	17.0	2.9	41.9	47.6
Mean				1.24	0.27	0.04	78.89	15.2	1.8	7.1	16.6
Median				1.24	0.28	0.04	75.89	14.9	1.5	4.5	15.9
n				49	49	49	49	49	49	49	49
LSC3	1	0.0	1.0	1.07	0.10	0.02	90.7	18.7	2.4	7.4	19.0
LSC3	2	1.0	2.0	0.95	0.13	0.02	86.2	17.5	3.2	16.6	29.3
LSC3	3	2.0	3.0	1.20	0.17	0.03	85.8	16.1	3.8	12.1	25.5
LSC3	4	3.0	4.0	1.31	0.20	0.03	84.5	15.3	3.2	8.7	17.9
LSC3	5	4.0	5.0	1.06	0.17	0.03	84.0	15.2	3.4	10.0	26.0
LSC3	6	5.0	6.0	1.17	0.20	0.03	83.4	15.1	3.1	9.5	17.1
LSC3	7	6.0	7.0	1.28	0.22	0.03	83.1	14.6	3.4	9.1	29.8
LSC3	8	7.0	8.0	1.24	0.20	0.03	84.0	14.2	3.2	9.3	18.6
LSC3	9	8.0	9.0	1.18	0.21	0.03	82.4	14.4	3.5	9.0	17.9
LSC3	10	9.0	10.0	1.27	0.23	0.03	81.7	14.5	3.1	8.3	11.0
LSC3	11	10.0	12.0	1.11	0.21	0.03	81.1	14.9	0.0	10.2	20.4
LSC3	12	12.0	14.0	1.26	0.25	0.04	80.4	15.1	3.1	8.5	20.4
LSC3	13	14.0	16.0	1.09	0.23	0.03	79.0	14.6	2.9	10.5	29.6
LSC3	14	16.0	18.0	1.33	0.29	0.04	78.4	14.5	2.5	6.5	17.9
LSC3	15	18.0	20.0	1.21	0.25	0.03	79.0	13.2	2.2	6.3	7.1
LSC3	16	20.0	22.0	1.12	0.24	0.03	78.3	13.0	2.7	7.3	21.4
LSC3	17	22.0	24.0	1.18	0.26	0.03	78.4	12.7	2.9	6.5	7.1
LSC3	18	24.0	26.0	1.17	0.26	0.03	78.1	12.7	2.7	6.2	25.2
LSC3	19	26.0	28.0	1.23	0.28	0.03	77.7	12.6	1.9	5.2	17.9
LSC3	20	28.0	30.0	1.36	0.29	0.04	78.6	12.5	2.0	4.7	19.0
LSC3	21	30.0	32.0	1.11	0.26	0.03	76.2	12.3	2.8	5.8	7.9

Stratigraphic Data for the LSC Basin

Core	Section	Top cm	Bottom cm	F W g/cc	D W g/cc	AFDW g/cc	Water %	Organic %	Carbonate %	Derivatives un/g AFDW	Native %
LSC3	22	32.0	34.0	1.08	0.27	0.03	75.1	11.6	2.3	5.4	19.0
LSC3	23	34.0	36.0	1.32	0.34	0.04	73.8	11.5	1.8	4.8	16.8
LSC3	24	36.0	38.0	1.02	0.29	0.03	72.0	11.7	2.3	5.3	17.9
LSC3	25	38.0	40.0	1.29	0.37	0.04	71.4	10.5	2.2	3.6	11.0
LSC3	26	40.0	42.0	1.15	0.37	0.04	68.2	10.8	1.8	4.0	20.4
LSC3	27	42.0	44.0	1.08	0.35	0.03	68.0	9.8	2.3	4.1	23.8
LSC3	28	44.0	46.0	1.69	0.56	0.05	66.8	9.8	1.6	3.1	19.0
LSC3	29	46.0	48.0	1.24	0.41	0.04	66.7	10.2	1.8	3.6	10.2
LSC3	30	48.0	50.0	1.20	0.37	0.04	68.7	10.7	1.9	3.0	13.0
LSC3	31	50.0	54.0	1.29	0.45	0.05	65.4	11.0	1.8	3.3	9.5
LSC3	32	54.0	58.0	1.32	0.44	0.05	66.6	11.7	2.1	2.7	0.0
LSC3	33	58.0	62.0	1.37	0.45	0.05	67.3	12.2	1.9	2.9	20.4
LSC3	34	62.0	66.0	1.32	0.41	0.06	69.0	13.9	2.1	2.6	10.2
LSC3	35	66.0	70.0	1.41	0.40	0.06	71.6	15.3	2.1	2.5	22.0
LSC3	36	70.0	74.0	1.27	0.34	0.05	73.5	15.9	2.2	3.0	9.5
LSC3	37	74.0	78.0	1.30	0.34	0.06	73.9	16.4	2.1	2.5	11.0
LSC3	38	78.0	82.0	1.27	0.30	0.05	76.2	17.3	2.4	2.7	0.0
LSC3	39	82.0	86.0	1.14	0.29	0.05	74.6	17.4	2.6	3.0	10.2
LSC3	40	86.0	90.0	1.12	0.26	0.05	76.4	17.1	2.7	3.5	9.5
LSC3	41	90.0	94.0	1.17	0.28	0.05	76.4	16.8	2.8	3.7	8.9
LSC3	42	94.0	98.0	1.24	0.30	0.05	76.2	16.4	2.9	3.5	8.9
LSC3	43	98.0	102.0	1.34	0.34	0.05	74.7	16.2	2.8	3.3	28.6
LSC3	44	102.0	106.0	1.32	0.41	0.06	68.6	13.7	2.3	3.4	16.8
Min				0.95	0.10	0.02	65.39	9.8	0.0	2.5	0.0
Max				1.69	0.56	0.06	90.68	18.7	3.8	16.6	29.8
Mean				1.22	0.29	0.04	76.18	13.9	2.5	5.8	16.4
Median				1.24	0.28	0.04	76.31	14.3	2.4	5.0	17.9
n				44	44	44	44	44	44	44	44

APPENDIX D

Data from Midge Analyses

Key for Headings of Midge Attribute Table

Habitat - defined as in Merritt and Cummins (1984) to describe the habitat preferred by the larvae of a particular midge taxon.

Lotic - inhabits the substrate of streams and rivers.

Lentic - inhabits the littoral or profundal zone of lakes or ponds.

Littoral - inhabits the littoral fringe of lakes or ponds.

Macrophyte - prefers to inhabit macrophyte stems in the littoral zone of lakes and ponds.

Sand - prefers to inhabit sandy bottom streams or lake shore areas.

Profundal - inhabits the deep sediments of lakes or ponds.

Habit - habitat utilization adaptation as defined in Merritt and Cummins (1984):

Burrower - adapted to inhabit bottom areas if streams and lakes by burrowing into wood or soft substrata.

Sprawler - adapted for inhabiting the surface of bottom sediments and organic matter.

Clinger - morphological and behavioral adaptations to inhabit littoral zones of lakes and streams.

NA - not defined for that taxon.

FFG - functional feeding group as defined in Merritt and Cummins (1984) to describe the morphological and behavioral adaptations for food gathering.

SHR - shredders; adapted to collect and utilize coarse organic matter as a food source

CG - collector-gatherers; adapted to gather loose, fine organic matter from the substrate.

CF - collector-filterer; adapted to collect fine particulate organic matter from the water column using constructed nets or morphological adaptations of mouthparts and seta.

SCR - scrapers; adapted to scrape attached algae and organic material from the substrate surface.

P - predator; adapted to overcome and devour living animals or capture prey and pierce the cuticle to feed on animal soft tissues.

Par - parasites; adapted to parasitize other organisms.

Distribution - description of the general distribution of the taxon within North America (Merritt and Cummins 1984).

No. of Species - approximate number of known species of a particular midge taxon in North America (Merritt and Cummins 1984).

Tolerance - qualitative ranking of each taxon's tolerance to organic pollution in stream environments from Hilsenhoff (1987). Values range from 0 (low tolerance) to 10 (high tolerance).

Basin - preference of a midge taxon to inhabit one or both basins (SCF or LSC) based on percentage of occurrence from core sections.

Midges Found in St. Croix Basin Core Samples

Genera	Subfamily	Tribe	Habitat	Habit	FFG	Distribution	No. of Species	Tolerance	Basin
Chironomus sp.	Chironominae	Chironomini	Littoral,Prof	Burrower	CG	Widespread	">20	10	LSC
Cladopelma sp.	Chironominae	Chironomini	Littoral	Burrower	CG	Widespread	"6-19	9	LSC
Cryptochironomus sp.	Chironominae	Chironomini	Littoral,Prof	Sprawl,Burr	P	Widespread	">20	8	BOTH
Cryptotendipes sp.	Chironominae	Chironomini	Littoral	Sprawler	NA	Widespread	"6-19	6	LSC
Dicrotendipes sp.	Chironominae	Chironomini	Littoral	Burrower	CG,CF,SCR	Widespread	"6-19	8	SCF
Endochironomus sp.	Chironominae	Chironomini	Littoral,Prof	Clingers	SHR,CF,CG	Widespread	"6-19	10	BOTH
Glyptotendipes sp.	Chironominae	Chironomini	Littoral,Prof	Burrow,Cling	SHR,CF,CG	Widespread	"6-19	10	SCF
Microchironomus sp.	Chironominae	Chironomini	Sand	Burrower	CG	Widespread?	"1	NA	BOTH
Microtendipes sp.	Chironominae	Chironomini	Littoral	Clinger	CF,CG	Widespread	"6-19	6	SCF
*Nilothauma sp.**	Chironominae	Chironomini	Lotic	NA	NA	Widespread	"1-5	2	SCF
Parachironomus sp.	Chironominae	Chironomini	Littoral	Sprawler	P,CG,Par	Widespread	">20	10	BOTH
Paralauterborniella sp.	Chironominae	Chironomini	Macrophytes	Clinger	CG	Widespread	"1-5	8	LSC
Paratendipes sp.	Chironominae	Chironomini	Littoral	Burrower	CG	Widespread	"6-19	8	BOTH
Phaenopsectra sp.	Chironominae	Chironomini	Littoral	Clinger	SCR,CG	Widespread	"6-19	7	SCF
Polypedilum sp.	Chironominae	Chironomini	Macrophytes	Climber,Cling	SHR,CG,P	Widespread	">20	6	SCF
Robackia sp.	Chironominae	Chironomini	Lotic/Lentic	Burrower	CG	Widespread	"1-5	NA	SCF
Saetheria sp.	Chironominae	Chironomini	Sand	Burrower	CG	Widespread	"1-5	4	BOTH
Stenochironomus sp.	Chironominae	Chironomini	Macrophyte	Burrower	CG,SHR	Widespread	"1-5	5	SCF
Stictochironomus sp.	Chironominae	Chironomini	Lotic	Burrower	CG,SHR	Widespread	"6-19	9	BOTH
Lenziella sp.	Chironominae	Tanytarsini	Sand	NA	NA	Widespread	"1-5	NA	SCF
*Nimbocera sp.**	Chironominae	Tanytarsini	Lentic	NA	NA	South	"1-5	NA	SCF
Paratanytarsus sp.	Chironominae	Tanytarsini	Littoral	Sprawler	NA	Widespread	"6-19	6	SCF
Rheotanytarsus sp.	Chironominae	Tanytarsini	Lotic	Clinger	CF	Widespread	"6-19	6	LSC
Stempellina sp.	Chironominae	Tanytarsini	Littoral	Climb,Sprawl	CG	Widespread	'6-19	2	BOTH
Tanytarsus sp.	Chironominae	Tanytarsini	Macro,Prof	Climb,Cling	CF,CG,SCR	Widespread	">20	6	SCF
Pagastia sp.	Diamesinae	Diamesini	NA	NA	NA	North	"3	1	LSC
Corynoneura sp.	Orthocladiinae	Corynoneurini	Littoral	Sprawler	CG	Widespread	"6-19	7	SCF
*Brillia sp.**	Orthocladiinae	Orthocladiini	Lotic	Sprawlers	SHR,CG	Widespread	"6-19	5	SCF
Cricotopus sp.	Orthocladiinae	Orthocladiini	Littoral	Cling,Burrow	SHR,CG	Widespread	">20	7	SCF
*Epoicocladius sp.**	Orthocladiinae	Orthocladiini	Lotic	NA	CG	Widespread	"1-5	4	LSC
Eukiefferiella sp.	Orthocladiinae	Orthocladiini	Littoral	Sprawler	CG,SCR,P	Widespread	">20	8	BOTH
Hydrobaenus sp.	Orthocladiinae	Orthocladiini	Littoral	Sprawlers	SCR,CG	Widespread	"6-19	8	LSC
Nanocladius sp.	Orthocladiinae	Orthocladiini	Littoral	Sprawler	CG	Widespread	"6-19	3	BOTH

Midges Found in St. Croix Basin Core Samples

Gènera	Subfamily	Tribe	Habitat	Habit	FFG	Distribution	No. of Species	Tolerance	Basin
Orthocladius sp.	Orthocladiinae	Orthocladiini	Littoral, Prof	Sprawl,Burr	CG	Widespread	">20	6	LSC
Paracladius sp.	Orthocladiinae	Orthocladiini	Littoral	Sprawler	CG	North	"1-5	NA	SCF
*Parametriocnemus sp.**	Orthocladiinae	Orthocladiini	Lotic	Sprawlers	CG	Widespread	"6-19	5	SCF
*Symposiocladius sp.**	Orthocladiinae	Orthocladiini	Lotic	Burrowers	SHR	Widespread	"1-5	NA	SCF
Synorthocladius sp.	Orthocladiinae	Orthocladiini	NA	NA	CG	NA	"1-5	2	SCF
Tvetenia sp.	Orthocladiinae	Orthocladiini	Lotic	Sprawler	CG	Widespread	"6-19	5	SCF
Clinotanypus sp.	Tanypodinae	Coelotanypodini	Littoral	Burrower	P	Eastern	"4	8	LSC
Coelotanypus sp.	Tanypodinae	Coelotanypodini	Littoral	Burrower	P	Eastern	"5	NA	LSC
Djalmabatista sp.	Tanypodinae	Macropelopiini	Lotic	Sprawler	P	East	"1-5	3	BOTH
Macropelopia sp.	Tanypodinae	Macropelopiini	Littoral	Sprawler	P	North	"1-5	NA	LSC
Procladius sp.	Tanypodinae	Macropelopiini	Profundal	Sprawler	P,CG	Widespread	"31	9	LSC
Psectrotanypus sp.	Tanypodinae	Macropelopiini	Lotic	Sprawler	P	Widespread	"7	10	BOTH
Ablabesmyia sp.	Tanypodinae	Pentaneurini	Littoral	Sprawler	P,CG	Widespread	"12	8	BOTH
Krenopelopia sp.	Tanypodinae	Pentaneurini	Lotic	Sprawler	P	North	"1	NA	SCF
Labrundinia sp.	Tanypodinae	Pentaneurini	Littoral	Sprawler	P	Widespread	"6	7	BOTH
*Larsia sp.**	Tanypodinae	Pentaneurini	Littoral	Sprawler	P	Widespread	"6	6	LSC
*Nilotanypus sp.**	Tanypodinae	Pentaneurini	Lotic	Sprawler	P?	Widespread	"2	6	SCF
Pentaneura sp.	Tanypodinae	Pentaneurini	Littoral	Sprawler	P,CG	Eastern	"2	6	BOTH
Tanypus sp.	Tanypodinae	Tanypodini	Littoral	Sprawlers	P,CG	Widespread	"11	10	LSC

*Tentative identification based on specimens in poor condition.

Midge Community Basin Preferences

TAXON	SCF1	SCF2	SCF3	LSC1	LSC2	LSC3	BASIN
(Percent Sections Found)							
Robackia sp.	15.8	15.0	15.0	0.0	0.0	0.0	SCF
Stenochironomus sp.	10.5	20.0	15.0	5.6	0.0	0.0	SCF
Symposiocladius sp.	0.0	10.0	0.0	0.0	0.0	0.0	SCF
Synorthocladius sp.	10.5	5.0	25.0	0.0	0.0	0.0	SCF
Tanytarsus sp.	100.0	100.0	95.0	77.8	57.1	80.0	SCF
Tvetenia sp.	5.3	35.0	20.0	0.0	0.0	0.0	SCF

Summary Table of Midge Analysis Results

Site	Depth (cm)	Count (#)	Volume (cc)	Density (#/cc)	Richness	Tanytarsini (%)	Chironomini (%)	Orthocladiinae (%)	Tanypodinae (%)	Diamesinae (%)
SCF2	142	56	18	3.1	10	19.2	50.0	19.2	11.5	0.0
SCF2	163	61	2	30.5	13	18.2	36.4	29.1	16.4	0.0
SCF2	175.5	59	5	11.8	8	11.4	36.4	43.2	9.1	0.0
SCF2	180.5	55	5	11.0	12	9.1	30.9	47.3	12.7	0.0
SCF2	225	56	14	4.0	11	13.9	55.6	27.8	2.8	0.0
SCF2	231	66	3	22.0	16	24.2	36.4	30.3	9.1	0.0
SCF3	1	54	1	54.0	13	28.0	22.0	36.0	14.0	0.0
SCF3	2	62	1	62.0	10	21.6	43.1	25.5	9.8	0.0
SCF3	7	41	1	41.0	8	19.5	31.7	31.7	17.1	0.0
SCF3	8	45	1	45.0	13	15.0	52.5	15.0	17.5	0.0
SCF3	18	97	1	97.0	14	26.7	25.0	33.3	15.0	0.0
SCF3	20	94	1	94.0	12	28.6	20.0	44.3	7.1	0.0
SCF3	28	80	1	80.0	15	24.6	28.1	35.1	12.3	0.0
SCF3	30	97	1	97.0	11	32.1	33.3	28.6	6.0	0.0
SCF3	38	108	1	108.0	21	31.3	30.4	25.2	13.0	0.0
SCF3	40	126	1	126.0	20	25.7	28.7	32.7	12.9	0.0
SCF3	58	59	1	59.0	12	40.0	27.5	25.0	7.5	0.0
SCF3	62	55	1	55.0	11	32.6	32.6	23.9	10.9	0.0
SCF3	70	52	1	52.0	12	16.7	31.0	40.5	11.9	0.0
SCF3	74	55	1	55.0	10	7.9	39.5	52.6	0.0	0.0
SCF3	90	27	48	0.6	8	0.0	64.7	35.3	0.0	0.0
SCF3	93	26	15	1.7	7	4.8	47.6	38.1	9.5	0.0
SCF3	114	69	4	17.3	17	14.9	40.4	40.4	4.3	0.0
SCF3	124	47	5	9.4	9	32.6	25.6	32.6	9.3	0.0
SCF3	138	41	5	8.2	10	12.8	53.8	33.3	0.0	0.0
SCF3	162	50	9	5.6	9	32.6	23.3	41.9	2.3	0.0
LSC1	1	65	26	2.5	9	0.0	38.7	12.9	48.4	0.0
LSC1	2	63	12	5.3	10	12.5	43.8	9.4	34.4	0.0
LSC1	7	37	6	6.2	9	23.5	29.4	17.6	29.4	0.0
LSC1	8	38	6	6.3	10	28.6	33.3	23.8	14.3	0.0
LSC1	22	40	4	10.0	11	12.5	31.3	12.5	43.8	0.0
LSC1	26	59	5	11.8	14	8.3	38.9	19.4	33.3	0.0
LSC1	46	36	4	9.0	7	23.1	38.5	7.7	30.8	0.0

Summary Table of Midge Analysis Results

Site	Depth (cm)	Count (#)	Volume (cc)	Density (#/cc)	Richness	Tanytarsini (%)	Chironomini (%)	Orthocladiinae (%)	Tanypodinae (%)	Diamesinae (%)
LSC3	2	26	14	1.9	10	16.4	41.8	3.6	38.2	0.0
LSC3	7	91	30	3.0	6	16.3	42.9	12.2	28.6	0.0
LSC3	8	56	12	4.7	8	18.8	50.0	3.1	28.1	0.0
LSC3	12	52	16	3.3	7	11.1	44.4	5.6	38.9	0.0
LSC3	14	33	10	3.3	9	14.8	25.9	18.5	40.7	0.0
LSC3	16	38	8	4.8	6	15.4	38.5	0.0	46.2	0.0
LSC3	32	32	6	5.3	5	6.3	68.8	0.0	25.0	0.0
LSC3	34	34	6	5.7	5	0.0	36.7	0.0	60.0	3.3
LSC3	36	32	6	5.3	6	14.8	48.1	0.0	33.3	3.7
LSC3	38	33	4	8.3	5	9.1	48.5	6.1	36.4	0.0
LSC3	46	41	4	10.3	6	5.7	57.1	0.0	37.1	0.0
LSC3	48	38	6	6.3	8	19.4	36.1	0.0	44.4	0.0
LSC3	50	44	6	7.3	4	5.9	44.1	0.0	50.0	0.0
LSC3	86	41	6	6.8	8	18.8	21.9	6.3	53.1	0.0
LSC3	90	29	4	7.3	8	12.0	28.0	0.0	60.0	0.0
LSC3	94	28	4	7.0	7	17.4	21.7	4.3	56.5	0.0
LSC3	98	37	4	9.3	13	11.1	27.8	5.6	55.6	0.0
LSC3	102	56	10	5.6	9	16.7	14.3	2.4	66.7	0.0
LSC3	106	55	8	6.9	10	10.3	38.5	2.6	48.7	0.0