

A SURVEY OF THE ALGAE AND AQUATIC MACROINVERTEBRATES
OF WESO LAKE, BAYFIELD COUNTY, WISCONSIN, WITH SPECIFIC
REFERENCE TO THE DRUMMOND WASTEWATER TREATMENT SYSTEM

by

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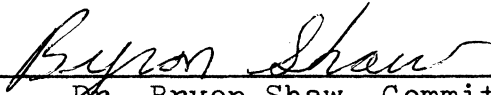
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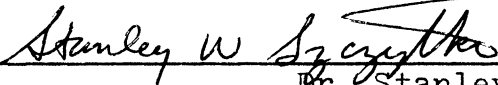
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ABSTRACT

The algae, aquatic macroinvertebrates, and water quality of Weso Lake, Bayfield County, Wisconsin, were investigated from May 1979 to September 1980. Objectives were: (1) to determine the taxonomic composition and relative abundance of the algae and aquatic macroinvertebrates, (2) to monitor the physicochemical characteristics of the lake water, and (3) to use laboratory bioassays to define the algal growth potential of Weso Lake water with effluent and nutrient additions. The data provide an information base for the long term evaluation of the impacts on Weso Lake of effluent drainage from the Drummond bog wastewater treatment system.

Background water quality values were generally typical of an acidic, dimictic, brown-water lake. Significantly higher chloride and conductivity levels in Weso Lake in 1980 were attributed to effluent drainage from the Drummond system. Significant reductions in true and apparent color, and in concentrations of total and soluble reactive phosphorus, and total Kjeldahl nitrogen, were also noted during 1980.

The mid-summer surface phytoplankton counts were dominated by green algae, particularly Sphaerocystis sp. Melosira sp. and Cryptomonas spp. were the most abundant taxa in other seasons. The mean surface phytoplankton densities for the summer periods (May-September) were 1927 cells ml⁻¹ in 1979 and 2969 cells ml⁻¹ in 1980. The average chlorophyll a concentrations for the corresponding periods were 7.1 and 6.8 mg l⁻¹. Algal aufwuchs densities on Sphagnum were variable,

ranging from 3230 to 29,400 cells mg^{-1} host dry weight.

Eunotia spp. and Anabaena spp. dominated the algal aufwuchs.

Benthic macroinvertebrate density and number of taxa were significantly different with depth and year. The deep profundal fauna was generally restricted to Chaoborus sp. Chironomus plumosus (Linnaeus) 1758 dominated the macroinvertebrate biomass in the upper profundal and sublittoral zones. Thirty-one taxa of invertebrates, including 14 taxa of chironomids, were collected in the littoral region. The average macroinvertebrate densities for 1979 and 1980 were 8969, 1322, 2214, and 735 m^{-2} at 1, 2, 4, and 6 m depths, respectively. Chironomidae and Odonata, primarily Leucorrhinia spp., dominated the macroinvertebrate aufwuchs in sweep net samples, which were collected in the littoral vegetation. Macroinvertebrate aufwuchs numbers and biomass were not significantly different for either cover type or year.

Laboratory bioassays using Drummond secondary lagoon effluent diluted with Weso Lake water indicated that the effluent did not stimulate exponential growth of the test alga, Anabaena sp. Nutrient addition bioassay of the secondary effluent indicated that phosphorus was the primary limiting nutrient. Algal nutrient assay showed that lake water, if buffered and fertilized with phosphorus, resulted in exponential growth.

A discussion of the fish species in Weso Lake is also presented.

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INTRODUCTION

The Drummond tertiary wastewater treatment system utilizes a natural sphagnum peat bog for renovation of secondary lagoon effluent. Normal nutrient transformation processes in the bog may purify the effluent as it flows through the wetland. Water from the Drummond bog outlet drains into Weso Lake.

Research on the use of natural and artificial wetlands for wastewater renovation was reviewed by Farnham and Boelter (1976), Sloey et al. (1978), Kadlec (1979), and Mechenich (1980). Most of the investigations to date have considered nutrient uptake and transfer rates, water quality, decomposition rates, and net primary production. Although these studies have generally been limited to short term applications of secondary effluent, research has demonstrated the significant potential of wetlands for wastewater purification.

Alteration of the biotic components of wetlands has occurred, however, even in the presence of effective wastewater renovation (Kadlec and Kadlec 1979). Floristic changes have been the most obvious. Studies in Michigan of a perched northern peatland indicated increased growth of most peatland species receiving nutrient loadings, but grasses and aster decreased (Richardson et al. 1976). Whigham and Simpson (1976) reported the elimination of touch-me-not (Impatiens capensis) within one season of sewage application to a tidal marsh. Bur marigold (Bidens laevis) was reduced in enclosures receiving continuous aerial spraying, while halberd tearthumb (Polygonum

artifolium) increased in all treated enclosures. The perennials, wild rice (Zizania aquatica var. aquatica) and water-hemp (Achnida cannabina), were not affected. Investigations by Mudroch and Capobianco (1979) on a sewage affected marsh in southern Ontario, Canada, revealed the elimination of cattail (Typha sp.) from areas formerly occupied by a mixed stand of cattail and manna grass (Glyceria grandis). Ewell (1976) observed an intrusion of duckweed into cypress domes receiving treated wastewater.

Several studies have noted the effects of wastewater application on wetland fauna. Jetter and Harris (1976, cited by Heimborg 1977) reported a change in the food web of sewage treated cypress domes. A food chain starting with insects and snails which were eaten by passerine birds, replaced a food chain that began with aquatic detritivores (fish, crayfish, tadpoles, benthic invertebrates) which had been eaten by raccoons, otters, and wading birds. McMahan (1972) collected significantly more amphipods and tubificids in a Spartina marsh receiving wastewater than in a sewage free marsh. Shellfish from creeks draining fertilized plots in a Massachusetts salt marsh had higher concentrations of cadmium than those from control creeks (Valiela et al. 1976). Hartland-Rowe and Wright (1975) noted a decrease in zooplankton, nekton and benthos in a swampland receiving slightly treated sewage in the Northwest Territories, Canada.

The impacts of wetland wastewater treatment systems on downstream waters is uncertain because a data base spanning decades would be necessary to determine the effects of long

term wastewater discharges (Kadlec and Kadlec 1979). The changes in the physical and biological characteristics of a wetland receiving wastewater discharges may ultimately affect lakes or streams within the watershed. Evaluation of any type of wetland treatment system should, therefore, include a consideration of the fate of waters beyond the wetland (Tilton 1976).

The primary objective of this research was to provide an information base on the algal and aquatic macroinvertebrate communities of Weso Lake that could be used to assess the long term impacts on the lake of the Drummond bog wastewater treatment system. This included: 1. analyzing the taxonomic composition and relative abundance of the algae and aquatic macroinvertebrates in the lake, 2. monitoring physicochemical characteristics of the lake water, and 3. utilizing laboratory bioassays to define the algal growth potential of Weso Lake water with various effluent and nutrient additions.

This study supplemented other research at the Drummond site, including studies of the baseline water chemistry and initial treatment efficiency of the bog (Mechenich 1980), hydrologic budgeting (USFS), long term studies of changes in vegetation composition (USFS North Central Forest Experiment Station), vegetation nutrient and mineral content and uptake studies (UW-Milwaukee and UW-Stout), continued monitoring of water chemistry and nutrient loading studies (UW-Stevens Point), and impact studies on wildlife and invertebrates in the bog (UW-Stevens Point).

Synthesis of these investigations should provide a basis

for evaluating the feasibility and impacts of utilizing this type of wetland for tertiary wastewater treatment.

STUDY AREA

Weso Lake, a northern Wisconsin bog lake, is located near Drummond in the drainage basin of the Long Lake Branch of the White River (T.45N., R.7W., Sec. 28, Bayfield Co.). It developed in a morainic kettle hole following withdrawal of the Wisconsin glacier, approximately 10,000 years ago. The region is underlain by Precambrian sandstone and igneous rock. Thick glacial deposits cover the bedrock providing the characteristic end moraine knob and kettle topography (Young and Skinner 1974). The glacial upland soils consist of a heterogeneous mass of stones, sands, silts, and red clays. Water quality of landlocked lakes in the region is affected by the pitted nature of the underlying granitic bedrock and the impervious clay pockets in the glacial till. Acidic soils along with stabilized water levels create ideal conditions for encroaching bogs to form in these depressions (Johannes et al. 1970).

Southern Bayfield County has a humid, continental climate with long cold winters and short, moderately warm summers. The mean annual temperature is 5°C (USDC 1963). The mean snowfall of 127 cm contributes approximately 25-30% of the annual precipitation of 78 cm. An estimated 32 cm of the annual precipitation runs off into stream channels. Evapotranspiration accounts for a major portion (45 cm) of the hydrologic budget due to significant transpiration losses from

the forested basin (Young and Skinner 1974). Underflow is negligible because of the impervious clay soils in the region.

Lowland swampy soils consisting of Greenwood peat (Ableiter and Hole 1961) surround about 90% of the shoreline to the south and west of the lake. The water table is high in this area and the soil is fibrous, spongy organic matter that is strongly acidic. Vegetation in this zone includes sphagnum moss (Sphagnum spp.), leatherleaf (Chamaedaphne calyculata), cranberry (Vaccinium macrocarpon), cottongrass (Eriophorum sp.), and further landward, sedge (Carex sp.), cattail (Typha sp.), black spruce (Picea mariana), and tamarack (Larix laricina). The north and west margins of the lake are adjacent to the surrounding hills. The moderately coarse and medium textured soils of these uplands support a mixed forest of conifers and hardwoods, dominated by white pine (Pinus strobus) and paper birch (Betula papyrifera).

The bottom sediments of Weso Lake consist predominantly of brown humic matter and are classified as "dy" (Lindeman 1941). A zone of sand and gravel substrate, approximately 2 m wide, extends 75 m along the northwest border of the lake. Rooted aquatic vegetation, including watershield (Brasenia schreberi), water-milfoil (Myriophyllum sp.), and tape grass (Vallisneria americana), occurs intermittently along the bog margin out to 2 m water depth. The littoral flora along the gravel and sand border is dominated by sedge (C. lacustris), wool grass (Scirpus cyperinus), arrowhead (Sagittaria spp.), water-milfoil, and yellow water lily (Nuphar sp.).

Weso Lake has one outlet from the north end of the lake

to the Long Lake Branch of the White River. It flows only at times of high water level. During this study, streamflow was observed only between May through July 1979 and in September 1980. The small stream draining the Drummond treatment bog enters a slough at the south end and constitutes the only inlet to the lake. The watershed is federally-owned and, except for the wetland treatment system, undeveloped.

The town of Drummond wastewater treatment system consists of a series of 3 lagoons with a 180 day holding capacity (Figure 1). A gated irrigation pipe is used to disperse secondary effluent across the surface of the 9 hectare treatment bog. Effluent is added to the bog in approximately 380 m^3 increments. Discharges are scheduled to prevent peak runoff and maximize effluent retention time in the bog. Application criteria include a consideration of the bog outlet flow and antecedent and predicted precipitation (Mechenich 1980).

Initial discharges to the bog system occurred in 1979, when 8350 m^3 of effluent were applied to the bog from June 14 to October 24. Bog outflow during the first effluent discharge period was comparable to the 1978 baseline period. The average discharge was 0.0017 cms for both intervals (Mechenich 1980). A reduced application schedule in 1980 resulted in the discharge of only 5050 m^3 of effluent from June 10 to August 27. The average outlet discharge was 0.0010 cms during this period.

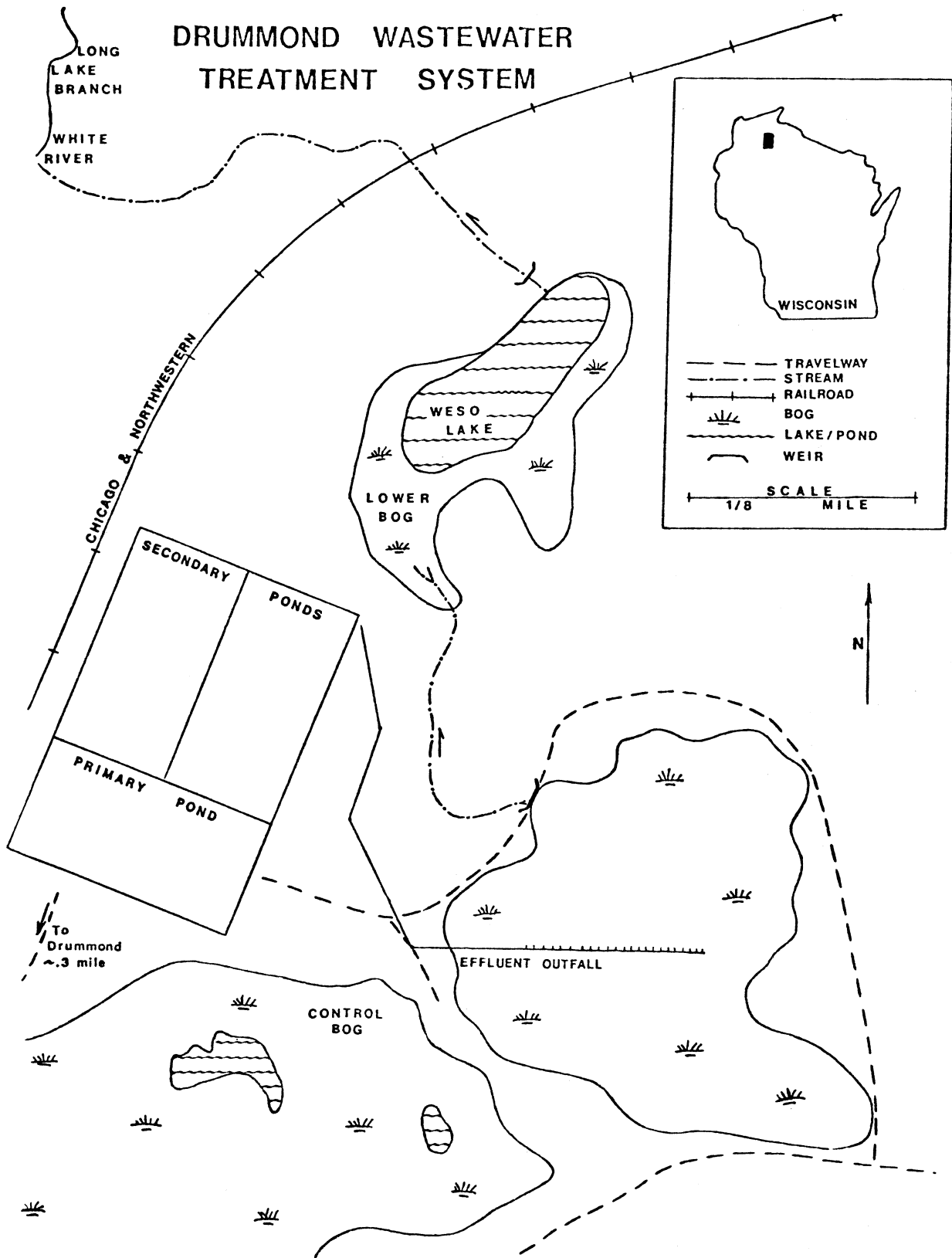


Figure 1. The Drummond wastewater treatment system and Weso Lake (Mechenich 1980).

MATERIALS AND METHODS

Physicochemical Characteristics

Water quality samples were collected at 13 sites in Weso Lake (Figure 2), including:

- 6 surface sites in the open water zone (sites 1 to 6),
- 2 sites at 3 and 6 m depths near the center of the lake (sites 5-3 and 5-6, respectively),
- 1 site at the southwest border of the lake in the surface interstitial water of the floating sphagnum mat (site 7), and
- 4 sites directly over the bottom at 1, 2, 4, and 6 m depths (sites 11 to 14, respectively).

All lake samples for chemical analysis were obtained with a 4.2-liter PVC vertical Van Dorn sampler. Each surface site was a composite of 2 samples taken in sequence through the depth of the photic zone. Deep sites consisted of single collections from the appropriate depths. Grab sampling was used in the collection of water from the surface of the sphagnum mat.

Sampling at most sites was conducted monthly from May through September 1979 and from May through September 1980. Sites 1 and 3 were eliminated from the sampling schedule in 1980. Sites 2, 5, 5-3, and 5-6 were also sampled monthly, weather permitting, from October 1979 through April 1980.

Samples for dissolved oxygen and temperature profiles were obtained with a 2.2-liter Van Dorn sampler. Temperature was immediately determined in the field. Samples for dissolved oxygen analysis were transferred to 300-ml glass BOD bottles and chemically fixed in the field. Light conditions were measured with a Montedoro-Whitney submarine photometer

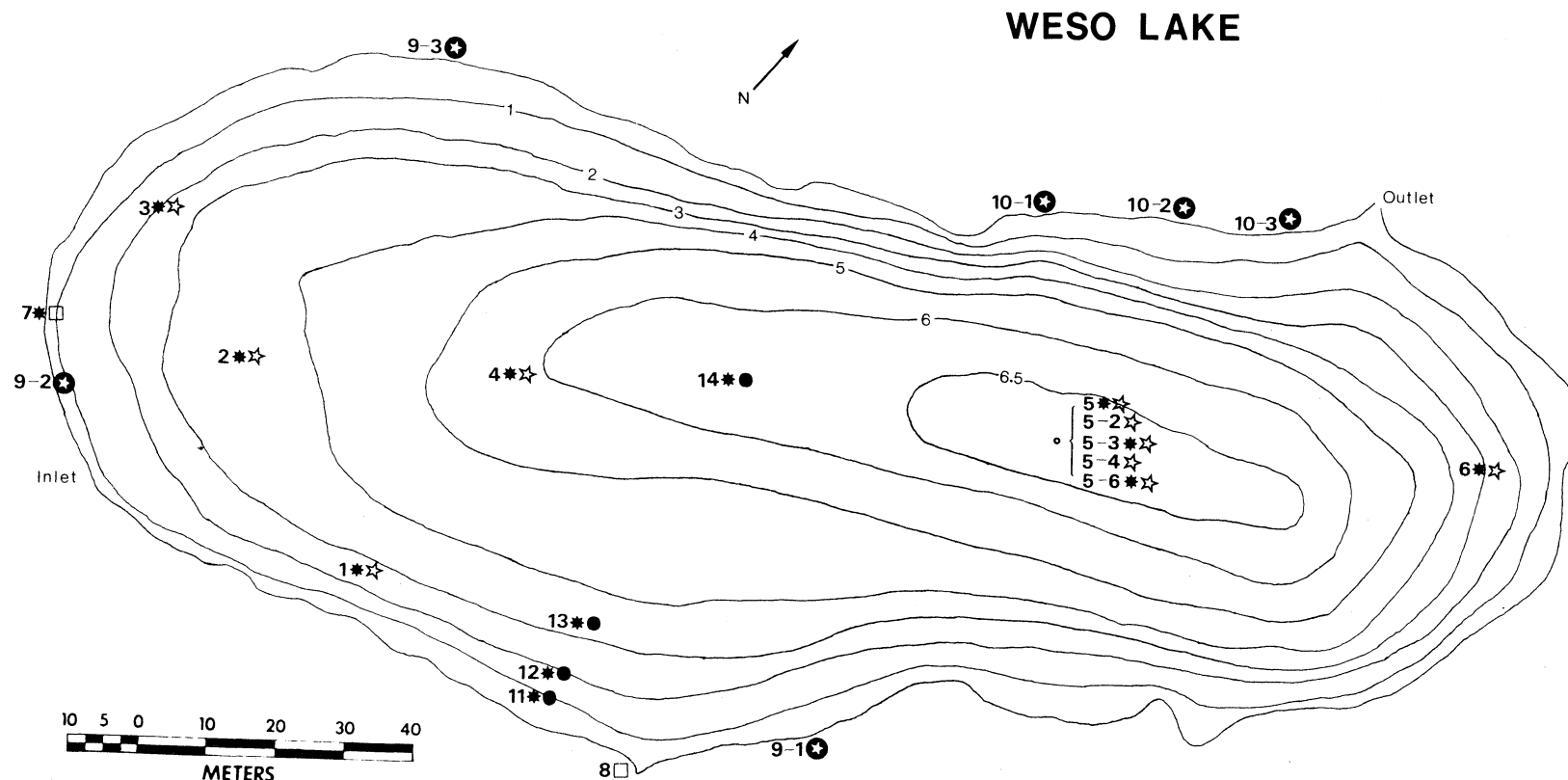


Figure 2. Hydrographic map of Weso Lake with sampling sites indicated as follows: (*) water chemistry, (☆) phytoplankton, (□) algal aufwuchs, (●) benthic invertebrates, and (⊙) invertebrate aufwuchs. Depth contours in meters. (Adapted from a map prepared by Northland College, Ashland, Wisconsin.)

and Schott color filters VG9 (green), RG610 (red), and BG12 (blue). Additional data on light penetration were collected with a 20-cm diameter secchi disc.

Samples for chemical analysis were stored in polyethylene bottles and were transported to the University of Wisconsin-Stevens Point on the day of collection. Samples were refrigerated at 4°C until analyses were complete, usually within one week.

Routine laboratory chemical analyses included pH, conductivity, chloride, alkalinity, calcium and total hardness, reactive and total phosphorus, ammonia and nitrate+nitrite nitrogen, and total Kjeldahl nitrogen. True and apparent color, silica, dissolved oxygen, COD, BOD₅, and total dissolved solids were also determined on some samples.

Ammonia and nitrate+nitrite nitrogen, total Kjeldahl nitrogen, and total phosphorus were determined by Technicon Autoanalyzer (Technicon 1977). Total phosphorus was analyzed by the two reagent Technicon method through October 1979 and, subsequently, by a single reagent EPA procedure (Jirka et al. n.d.). Chloride was determined with a specific ion electrode. Color was measured by the 1973 method of the National Council of the Paper Industry for Air and Stream Improvement (Carpenter and Berger 1973). Apparent color was run on unfiltered samples. Samples for true color were filtered through Whatman GF/C filters. Other tests followed procedures listed in Standard Methods, 14th edition (APHA 1976). pH and conductivity were measured with a Corning Digital 110 pH meter and a Lab-Line Instruments Lectro-Mho meter, respectively. Alkalinity and

total and calcium hardness were determined by titration. Dissolved oxygen was determined by the azide modification of the Winkler method, reactive phosphorus was measured by the stannous chloride method, and silica was analyzed as molybdate-reactive silica, utilizing a partial color blank correction.

Algae

Surface phytoplankton samples were collected monthly at sites 1 to 6 from May through September 1979 and at sites 2, 4, 5, and 6 from May through September 1980 (Figure 2). Sites 2 and 5 were also sampled monthly, weather permitting, from October 1979 through April 1980. Samples were obtained monthly at 2, 3, 4, and 6 m depths (sites 5-2, 5-3, 5-4, and 5-6, respectively) from May through September 1980.

All phytoplankton samples were collected with a 4.2-liter PVC vertical Van Dorn sampler. Each surface site was a composite of 2 samples taken in sequence through the depth of the photic zone. Deep sites consisted of single collections from the appropriate depths.

Algal aufwuchs samples were collected monthly at sites 7 and 8 from May through September 1979 and from May through September 1980. Each collection consisted of enough 5-15 cm portions of Sphagnum to fill a 250-ml container.

Phytoplankton samples were concentrated by sedimentation and were preserved with Lugol's solution (APHA 1976). Removal of algal aufwuchs from the Sphagnum was accomplished by a combination of agitation and acid hydrolysis, generally

according to Gough and Woelkerling (1976). Host material was dried at 70°C for 24 hr and weighed on an analytical balance to the nearest 1 mg.

The membrane filter method (Greeson et al. 1977) was used to make all quantitative algae counts at 400X. The total number of organisms for each taxa was enumerated on one filter grid (equivalent to 169 Whipple grids at 400X). Densities of phytoplankton were reported as cells per milliliter. Algal aufwuchs densities were expressed as the number of cells per milligram dry weight of Sphagnum. Cell counts for colonial and filamentous taxa were determined by multiplying the number of colonies or lengths of filaments by the average number of cells per colony or average number of cells per unit length of filament, respectively. The taxonomic keys of Hustedt (1930), Smith (1950), Prescott (1962,1964), Patrick and Reimer (1966), Weber (1966), and Prescott et al. (1972) were used to identify the algae.

Phytoplankton biomass was determined by the trichromatic chlorophyll method (APHA 1976). Whatman GF/C filters were used to filter chlorophyll samples. Calculations of chlorophyll a, b, and c were made from the EPA formulas (Weber 1973). A spectrophotometric phaeophytin determination was made on samples collected from May through September 1980 (APHA 1976).

Aquatic Macroinvertebrates

Aquatic macroinvertebrate samples were taken monthly from May through September 1979 and from May through September 1980.

Benthic invertebrates were collected with a 252-cm² Tall

Ekman sampler. Four replicate samples (2 replicates in September 1980) were taken at 1, 2, 4, and 6 m depths (sites 11 to 14, respectively) along a single transect from the shoreline (Figure 2).

Invertebrate aufwuchs sampling was stratified on the basis of two dominant vegetation zones (ericaceous emergent and herbaceous floating-leaved and emergent). Sample sites were selected so that all portions of a given cover type would be represented and was entirely random. Three samples were collected from each vegetation zone (sites 9-1 to 9-3 and 10-1 to 10-3). Figure 2 outlines the approximate locations of the sampling sites. The collection technique was a systematic sweep net procedure (Reinecke 1977). Each sample was a composite of three 2-m sweeps directly below the water surface. The net (18 meshes per cm) had a cross-sectional area of 0.0792 cm^2 ; each sampling unit filtered approximately 0.48 m^3 of water.

All samples were placed in plastic pails and preserved with adequate formalin to produce a 5% solution (Lind 1974). In the laboratory, samples were sieved through a U.S. No. 40 (0.425 um) soil screen. The invertebrates were sorted from the debris, identified to genus, if possible, and counted. Identification was facilitated by the taxonomic keys of Needham and Westfall (1955), Hilsenhoff and Narf (1968), Mason (1968), Hilsenhoff (1975), Edmunds et al. (1976), Merritt and Cummins (1978), Pennak (1978), and Wiggins (1978).

Invertebrate biomass was determined as wet weight. Organisms were generally soaked in water for 30 minutes,

centrifuged at 650 rpm for 3 minutes, including acceleration and deceleration, and weighed on a Mettler H54 balance to the nearest 0.001 g (Howmiller 1972; Stanford 1973). Nepidae, Zygoptera, and Decapoda were soaked in water for 30 minutes, blotted dry, and weighed to the nearest 0.001 g.

Effluent and Nutrient Bioassays

Samples for the effluent bioassays were collected on August 11, 1979 and June 22, August 10, and September 13, 1980. Lake water samples were collected from site 5 (Figure 2) with a Van Dorn bottle. Secondary effluent from the final lagoon was used for the August 1979, June 1980, and September 1980 assays. Discharge from the treatment bog was used for the August 1980 bioassay. Lake water and effluent samples were filtered through 0.45 μ m Millipore membrane filters after pre-filtration with Whatman GF/C glass fiber filters. Dilutions of 10, 25, 50, and 75% effluent were prepared with filtered lake water and effluent. Filtered samples, without additions, served as controls.

Additional bioassays were conducted on the August 1980 lake water sample and on the September 1980 secondary effluent sample to determine the response to various treatments and nutrient additions. On the date of collection, a portion of each sample was double filtered as described above and the remainder was autoclaved and then double filtered.

Final spike concentrations for both nutrient assays consisted of the following:

P: .006 mg l⁻¹ P as K₂HPO₄

N: $.14 \text{ mg l}^{-1}$ N as NaNO_3

P+N: $.006 \text{ mg l}^{-1}$ P + $.14 \text{ mg l}^{-1}$ N

EDTA: 1.0 mg l^{-1} EDTA as Disodium (ethylenedinitrilo) tetraacetate

EDTA+P: 1.0 mg l^{-1} EDTA + $.006 \text{ mg l}^{-1}$ P

EDTA+P+N: 1.0 mg l^{-1} EDTA + $.006 \text{ mg l}^{-1}$ P +
 $.14 \text{ mg l}^{-1}$ N

Buffered treatments included in the lake water bioassay were:

C: 15 mg l^{-1} NaHCO_3

C+P: 15 mg l^{-1} NaHCO_3 + $.006 \text{ mg l}^{-1}$ P

C+P+N: 15 mg l^{-1} NaHCO_3 + $.006 \text{ mg l}^{-1}$ P +
 $.14 \text{ mg l}^{-1}$ N

Treatments were made on both double filtered, and autoclaved and double filtered samples. Controls were prepared on double filtered samples.

Bioassay techniques for all effluent and nutritional assays followed the Algal Assay Procedure (AAP) Bottle Test (Miller et al. 1978). Fifty milliliter treatments were set up in triplicate in 250-ml Erlenmeyer flasks. Inoculum for the tests was prepared from a sterile, unialgal culture of a filamentous blue-green alga, Anabaena sp., obtained from Carolina Biological Supply. Each treatment was inoculated from a seven day old culture of Anabaena grown in a modified PAAP media (Bartsch 1969) to give a final concentration of $10,000 \text{ cells ml}^{-1}$ (Shiroyama et al. 1976a). Cultures were shaken daily to prevent clumping of filaments. Growth response was determined by monitoring optical density at 750 nm with a Bausch and Lomb Spectronic 88. Optical density was

measured several times during a 16-day incubation period. In cultures containing at least 5 mg of algae (Fitzgerald 1975), final yield was measured by filtering the assays through tared Whatman GF/C filters to determine the dry weight of the algal cells.

Fish Survey

Fish were collected between May and August in 1979 and 1980 with the aid of funnel traps, minnow traps, and hook-and-line sampling. Five rectangular funnel traps (119 x 61 x 51 cm, 6 or 13 mm mesh, 7.6 cm diameter opening) were placed in shallow water near snags or vegetation (Figure 3). Cylindrical minnow traps (41 x 19 cm, 6 mm mesh, 2 cm diameter opening) were set in various locations along the shoreline. Five transects were established for hook-and-line fishing. Transects, which were perpendicular to the northwest shoreline, were located at 0, 40, 80, 120, and 160 m from the lake outlet (Figure 3). Each transect was fished with both worms and artificial baits once per sampling day. The casting pattern was oriented to a 16-point compass and was repeated along the transect at intervals determined by casting range. Fishing effort was approximately 30 minutes per transect.

Total length (Hile 1948) and weight measurements to the nearest millimeter and to the nearest 2 grams were obtained for most fish. No weights were obtained for 55 black bullheads and 41 pumpkinseeds taken in minnow traps in August 1980. Lower caudal and left pelvic fin clips were applied in 1979 and 1980, respectively, to facilitate identification of

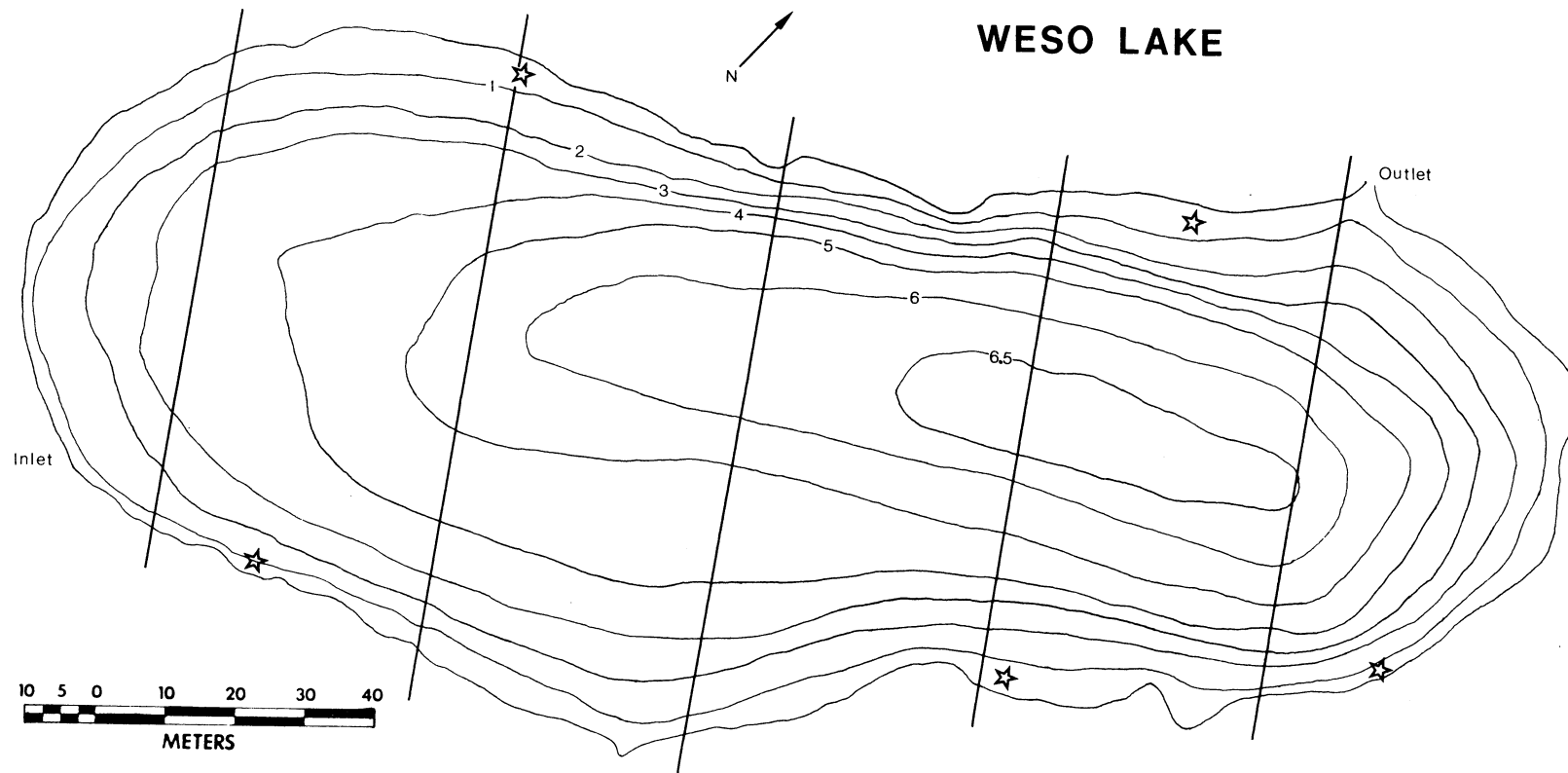


Figure 3. Hydrographic map of Weso Lake showing location of hook-and-line transects (—) and funnel traps (☆) for the fish survey. Depth contours in meters. (Adapted from a map prepared by Northland College, Ashland, Wisconsin.)

recaptures. Representative specimens of each species were preserved for positive identification in the laboratory.

Scale samples from black crappie were taken from the left side of the fish beneath the tip of the folded pectoral fin. Impressions of scales were made on 0.75 mm thick acetate slides (Smith 1954). Scale impressions were magnified 40 times on a microprojector (Van Oosten et al. 1934) and the center-most scale radius was measured from the middle of the focus to each annulus and to the anterior margin (Hile 1941). Age determinations were made from a linear regression calculated to describe the body length versus scale radius relationship (Bagenal and Tesch 1978).

Statistical Analyses

Two and three-way analyses of variance used in this research were available as statistical packages on a Burroughs 6700 digital computer. Multiple regression analysis was performed utilizing the Statistical Package for the Social Sciences program (Nie et al. 1975). Other statistical analyses used the "Minitab" program (Ryan et al. 1976).

Analysis of variance procedures required that the data were normally distributed, the variance of a sample was independent of the mean, and that the components of variance were additive (Zar 1974; Elliott 1977). Sample variances for invertebrate numbers and biomass (data in Appendices K and N) and phytoplankton counts (data in Appendix F) exceeded the sample means, indicating that the distributions were contagious (Elliott 1977; Downing 1979; Resh 1979).

Log-log regressions of variances on means were calculated for invertebrate samples to determine if the variances were independent of the means. Significant positive correlations between variances and means were found in all of the benthic invertebrate ($r=0.7-0.9$, $P<0.001$, d.f.=30) and invertebrate aufwuchs ($r=0.5-0.6$, $P<0.05$, d.f.=18) samples examined. Invertebrate replicate counts or biomass were transformed to $X^{0.25}$ (Downing 1979) as an approximation of exact transformations based on the slopes of the regression lines (Taylor 1961). Loss of the significant relationships between variances and means for both benthic invertebrate ($r=0.1-0.2$, $P>0.05$, d.f.=30) and invertebrate aufwuchs ($r=0.1-0.2$, $P>0.05$, d.f.=18) samples after transformation indicated that the variances were stabilized by transformation. Transformations that removed correlation between variances and means often normalize distributions and ensure that components of variance are additive (Southwood 1966; Zar 1974; Elliott 1977; Downing 1979).

The log-log regression of variances on means for phytoplankton densities failed to detect a significant relationship between variances and means ($r=0.5$, $P>0.05$, d.f.=8). The phytoplankton counts were, nevertheless, transformed to $\log(x+1)$ to improve the symmetrical distributions of the data about the means (Vollenweider 1974; Venrick 1978).

Factorial analyses of variance were performed on the transformed variates of invertebrate and phytoplankton samples. Because equal cell sizes were required in the factorial model, comparisons were limited to data with corresponding values

for both years.

RESULTS AND DISCUSSION

Physicochemical Characteristics

The physical and chemical conditions of Weso Lake were representative of the following classical boreal bog characteristics: 1. open water with a marginal, semi-floating mat consisting of sphagnum mosses and ericaceous shrubs; 2. large quantities of humic materials from allochthonous sources; 3. brown-stained acidic water poor in minerals; 4. poor drainage; 5. false bottom; 6. oxygen depletion; and 7. enrichment of the hypolimnion with the products of decomposition (Bricker and Gannon 1976; Ruttner 1963).

Physical and limnological data of the study area are summarized in Table 1.

Table 1. Physical and limnological data of Weso Lake.

Surface Area	1.7	ha	Breadth	102	m
Volume	59,834	m ³	Shoreline Length	625	m
Maximum Depth	6.5	m	Shoreline Dev. Factor	1.4	
Mean Depth	3.5	m	Wetland Area	2.0	ha
Length	248	m	Watershed Area	23.3	ha

Weso Lake was dimictic and, due to the protected nature of the basin, it stratified early in spring and remained stratified until late fall. The lake's epilimnion was shallow and remained at about 1.5 m throughout most of each summer (Figure 4).

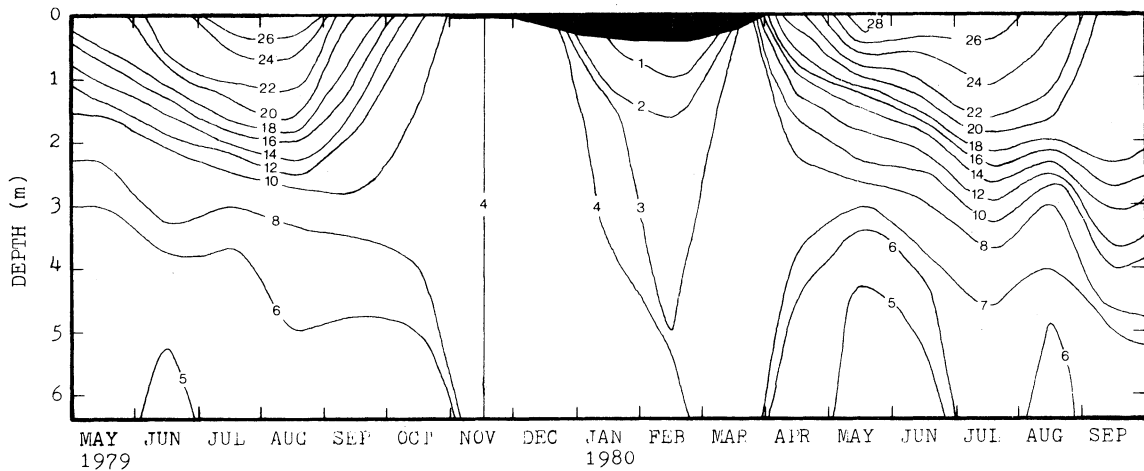


Figure 4. Depth-time diagram of isotherms ($^{\circ}\text{C}$) in Weso Lake from May 1979 through September 1980. Ice-cover drawn to scale. Data was not collected in December 1979 or March 1980.

The metalimnion was also narrow and extended from about 1.5 to 3 m. Surface water temperatures reached 26°C during mid-summer, while the bottom temperature stayed near 6°C . The lake was isothermal in mid-November 1979. Ice then covered the entire lake until early April 1980, with inverse stratification occurring beneath the ice. Direct stratification was restored by late April.

Weso Lake's dark brown water was stained with organic humic materials and surface samples averaged 157 units on the platinum-cobalt color scale. Light was rapidly attenuated in this water. The mean depth of 1% light transmittance was 1.7 m in the summer. Shorter wavelengths were quickly absorbed by dissolved organic compounds in the water (Figure 5), with red light penetrating the deepest (1% at 2.9 m). Disappearance of the secchi disc ranged from 0.6 to 1.4 m and averaged 0.9 m throughout the study period.

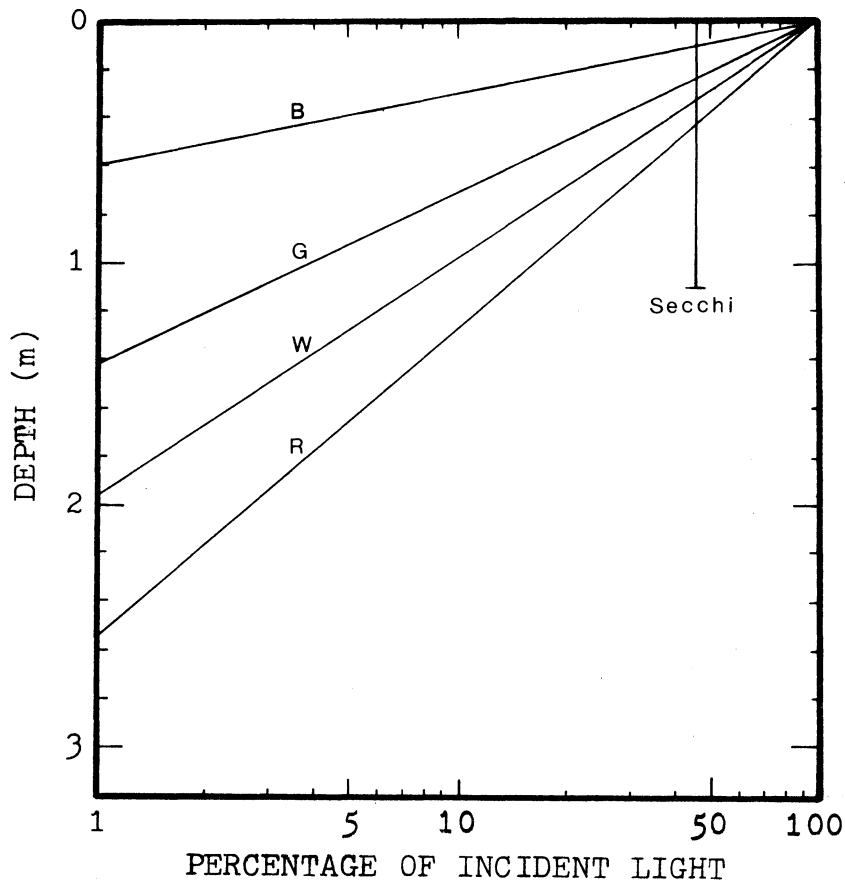


Figure 5. Percentage transmission of incident light in blue (B), green (G), white (W), and red (R) spectral blocks in Weso Lake on September 8, 1979.

Dissolved oxygen was confined to the upper water during summer and winter stratification (Figure 6). Mean summer saturation ranged from 75% at the surface to 0% at 3 m. Winter oxygen saturation decreased from 40% below the ice surface to 0% near 5 m. Dissolved oxygen was present throughout the water column during the fall overturn.

Weso Lake water was acidic and very soft (Table 2). Mean surface pH values ranged between 5.24 and 5.99 and varied little with depth. Alkalinity increased with depth ranging from 4 mg $\text{CaCO}_3 \text{ l}^{-1}$ at the surface to 11 mg $\text{CaCO}_3 \text{ l}^{-1}$ at 6 m.

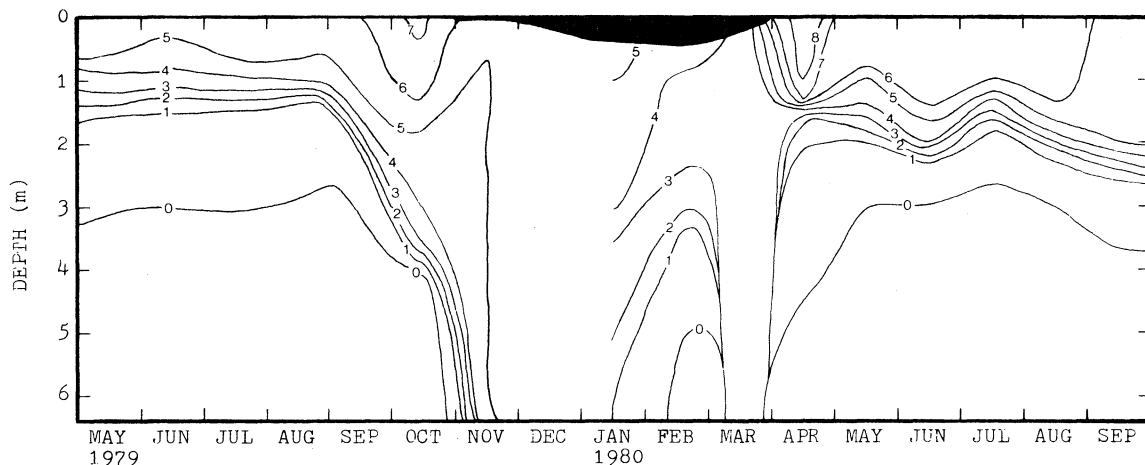


Figure 6. Depth-time diagram of isopleths of dissolved oxygen concentration in mg l^{-1} for Weso Lake from May 1979 through September 1980. Ice-cover drawn to scale. Data was not collected in December 1979 or March 1980.

All electrolytes measured were very low. Specific conductance of surface water did not exceed 30 umhos cm^{-1} from May through October 1979. A value of 36 umhos cm^{-1} was recorded at 6 m during the same period. Mean chloride concentration was below the detection limit of 1 mg l^{-1} during the summer of 1979. Total and calcium hardness averaged $12 \text{ mg CaCO}_3 \text{ l}^{-1}$ and $7 \text{ mg CaCO}_3 \text{ l}^{-1}$, respectively, during the study period. Silica was high, however, averaging 3.0 mg l^{-1} at the surface in summer 1980. Regeneration of silica was evident during summer with values near bottom reaching 8.4 mg l^{-1} .

BOD_5 was much lower than COD in the lake. The high average COD:BOD ratio (40:1) indicated that most dissolved organic material was very resistant to biological breakdown. The highest COD values were found in the hypolimnion because of settling organic materials and anaerobic conditions.

Phosphorus and nitrogen levels were affected by

Table 2. Average water quality for Weso Lake based on samples collected from May 1979 through September 1980.

Variable	Surface (Sites 1 to 6)			Mid-depth (3m) (Site 5-3)			Bottom (6m) (Site 5-6)			Bog Margin (Site 7)		
	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N
pH	5.58	.21	58	5.54	.20	15	5.83	.17	15	4.51	.15	10
Conductivity umhos cm^{-1}	29	6	58	31	4	15	39	8	15	38	9	10
Alkalinity $\text{mg CaCO}_3 \text{ l}^{-1}$	4	1	58	5	1	15	11	4	15	0	--	10
Total Hardness $\text{mg CaCO}_3 \text{ l}^{-1}$	11	1	58	12	1	15	13	2	15	10	2	10
Ca^{++} Hardness $\text{mg CaCO}_3 \text{ l}^{-1}$	7	1	58	7	1	15	8	1	15	6	1	10
DO mg l^{-1}	6.2	.9	24	1.1	1.8	15	.4	1.3	15	6.2	.7	10
COD mg l^{-1}	45	7	20	52	10	15	59	14	15	--	--	--
BOD ₅ mg l^{-1}	1.5	.6	17	1.1	.3	15	1.3	.4	15	--	--	--
Reactive P mg l^{-1}	.009	.010	58	.012	.010	15	.085	.067	15	.023	.026	10
Total P mg l^{-1}	.045	.025	58	.045	.019	15	.154	.093	15	.218	.290	9
$\text{NH}_4 \text{ N}$ mg l^{-1}	.08	.09	58	.10	.11	15	.62	.40	15	.09	.12	10
$\text{NO}_{2-3} \text{ N}$ mg l^{-1}	<.02	--	58	<.02	--	15	<.02	--	15	<.02	--	10
Kjeldahl N mg l^{-1}	.97	.32	57	.89	.24	15	1.66	.56	15	2.26	1.57	9
Chloride mg l^{-1}	1.8	1.4	58	1.7	1.1	15	1.8	1.1	15	5.5	4.2	10
Apparent Color pt-co units	177	49	58	253	31	15	511	93	5	--	--	--
True Color pt-co units	157	51	58	194	31	15	333	48	15	156	60	10
Silica mg l^{-1}	3.0	1.6	23	4.6	.3	15	5.4	2.1	6	2.5	.9	5
Total Suspended Solids mg l^{-1}	2.5	1.1	25	7.4	3.6	15	22.6	6.9	15	--	--	--

temperature and oxygen stratifications. Soluble reactive and total phosphorus were highest at 6 m during summer stratification due to sedimentation and reducing conditions in the hypolimnion. Ammonia was low except for the anaerobic bottom sites, and nitrates were below detection ($<.01 \text{ mg l}^{-1}$) at all depths during the stratified periods.

Biological uptake may have lowered inorganic nitrogen in surface waters, and reducing conditions in the hypolimnion caused an accumulation of ammonia. Kjeldahl nitrogen increased with depth, reflecting the increased ammonia and settling organic nitrogen. Phosphorus and nitrogen were uniformly distributed throughout the water column during isothermal conditions. Nitrates were found in measurable quantities only during fall overturn and winter stratification periods.

Interstitial water of the bog margin was more acidic than lake water. pH values at site 7 ranged from 4.39 to 4.76 during the study period. The lower pH of the bog water reflected the capacity of Sphagnum plants to secrete whole organic acid molecules and to exchange hydrogen ions for base cations in solution (Clymo 1964). Mean total phosphorus and Kjeldahl nitrogen concentrations were higher in the bog than in lake water (Table 2). These differences were possibly spurious because bog samples contained large quantities of solids and were not filtered prior to the analyses. The effect of particulates on total soluble organic nitrogen at site 7 is indicated by the relatively small contribution of ammonia (average 0.09 mg l^{-1}) to Kjeldahl nitrogen (average 2.26 mg l^{-1}). Higher reactive phosphorus values in shallow interstitial water than in surface lake water could have reflected the conservation and cycling of nutrients by plant communities in the bog.

Statistical comparisons were used to analyze yearly variation in the chemical characteristics of the lake water. Initially, sampling location was included as a factor in the

analyses of variance by pooling data from each summer stratification period. Significant differences between sites were detected in 14 of the 18 chemical variables analyzed (Appendix A). Student-Neuman-Keuls multiple comparisons (Zar 1974) were subsequently used to separate site means of the significant ANOVA. All of the multiple comparisons failed to detect differences in the means of surface sites, and indicated that site 5-6 was different from all other lake sites (Appendix A). Site 5-3 could be separated from other sites in some of the comparisons, but was grouped with surface sites in 9 of the 14 tests. The final analysis of variance designs, therefore, included surface sites as replicates with sampling day and year as the variables under consideration (Appendix B). Sites 5-3, 5-6, and 7 were analyzed separately with two-sample t-tests comparing paired means between years (Appendix C).

Yearly means of both chloride concentration and conductivity were statistically different for all lake sites (Table 3).

Table 3. Average chloride concentrations (mg l^{-1}) and conductivity (umhos cm^{-1}) for Weso Lake and significance of changes between 1979 and 1980. Averages for each year were based on samples collected from May through September.

Site/Year		CHLORIDE				CONDUCTIVITY			
		Mean	S.D.	N	Signi- ficance	Mean	S.D.	N	Signi- ficance
Sites 1 to 6	(1979)	1.0	0.7	28	P<0.001	25	2	28	P<0.001
	(1980)	3.1	0.7	20		31	4	20	
Site 5-3	(1979)	1.0	0.6	5	P<0.001	27	1	5	P<0.001
	(1980)	2.5	0.4	5		33	2	5	
Site 5-6	(1979)	1.0	0.9	5	P<0.05	33	2	5	P<0.05
	(1980)	2.6	0.6	5		48	7	5	
Site 7	(1979)	7.4	5.5	5	NS	42	9	5	NS
	(1980)	3.6	0.7	5		33	7	5	

NS = Not Significant ($P < 0.05$).

Surface chloride concentration steadily increased during the study period from a mean of less than detection to an average 4.1 mg l^{-1} in September 1980 (Figure 7B). Sites 5-3 and 5-6 experienced similar chloride increases, although concentrations were generally lower than in surface water. Conductivity increases in the lake mirrored the chloride changes (Table 3, Figure 7A). Conductivity was significantly correlated with chloride concentration at all sites through the study period (sites 1 to 6: $r=.85$, $P<0.001$, d.f.=46; site 5-3: $r=.95$, $P<0.001$, d.f.=8; site 5-6: $r=.84$, $P<0.05$, d.f.=8). Average conductivities increased 22, 24, and 45% at surface, mid-depth, and bottom, respectively. Conductivities at site 5-6 were generally higher and more variable than at other lake sites due to the flux of materials from the sediments under reducing conditions in the hypolimnion.

Statistical analysis of bog water samples failed to detect any significant differences between yearly means for either chloride concentration or conductivity. Sample variability, resulting from the high and irregular amounts of solids in surface interstitial water, may have contributed to the negative results of these tests. The average conductivity at site 7 in summer 1979 was 50% higher than the mean for all lake sites. Conductivities in the bog were lower in 1980 and were similar to values for surface lake samples (Table 3). A similar pattern was exhibited by chloride concentrations with averages of 7.4 mg l^{-1} and 3.6 mg l^{-1} in 1979 and 1980, respectively.

Chloride and conductivity monitoring in the Drummond

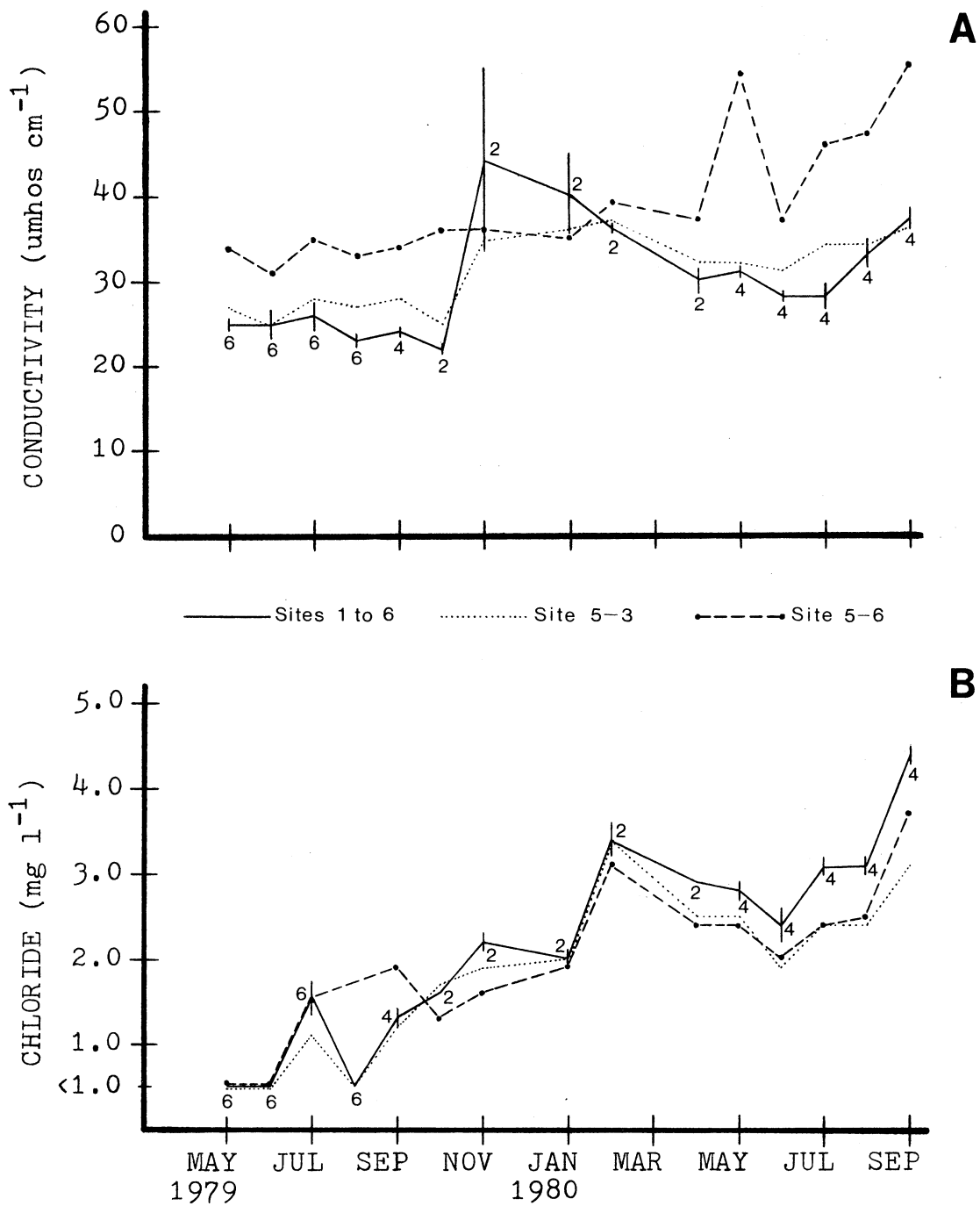


Figure 7. Seasonal conductivity (A) and chloride (B) trends at three depths in Weso Lake. Vertical bars on sites 1 to 6 plots indicate ± 1 standard deviation; numbers are sample size.

treatment bog during the 1979 discharge season revealed that the effluent water primarily moved through the bog in the upper 0.5 m (Mechenich 1980). The bog discharge chloride concentration increased from less than detection to 18.1 mg l^{-1} and conductivity increased 89% during the initial discharge period. Conductivity in the 1980 bog outflow varied little from the corresponding 1979 discharge period. Chloride concentrations decreased during the second discharge year, but remained above 1978 baseline levels (Table 4).

Chloride ions were mobile and concentrations above 1 mg l^{-1} were consistently measured in Weso Lake after August 1979. Conductivity, which is an index of the amount of dissolved ionic solids, reflected chloride increases in the lake. During the 1979 effluent discharge season, the treatment bog outflow volume was approximately one-third the volume of water in the lake. Assuming no other inputs to the lake, water from the treatment bog would require a minimum of three years to completely recharge the water in the lake. Although the chloride and conductivity changes in Weso Lake were significant, the effects of the bog discharge on these variables was reduced due to the large volume of water available for dilution compared to the flow from the treatment bog.

The high chloride concentrations and conductivities at site 7 during 1979 may have represented a sampling anomaly. Sampling and analytical procedures, however, were not changed during the study period. Mechenich (1980) reported a chloride increase from 1.2 to 11.5 mg l^{-1} at a surface bog site adjacent to Weso Lake during 1979. Conductivity at the same site

Table 4. Average water quality of the treatment bog discharge and % change after effluent application based on average values for the last half of each effluent discharge period and the corresponding 1978 baseline period (data from Mechenich 1980; Wright 1981).

Variable	Baseline			1979 Effluent Discharge Period				1980 Effluent Discharge Period			
	Mean	S.D.	N	Mean	S.D.	N	% Change	Mean	S.D.	N	% Change
pH	4.18	.12	6	4.04	.11	6	--	4.10	.10	6	--
Conductivity umhos cm ⁻¹	44	6	6	83	10	6	+89	84	11	6	+91 (+1) ¹
Alkalinity mg CaCO ₃ l ⁻¹	0	0	6	0	0	6	0	0	0	6	0 (0)
COD mg l ⁻¹	137	9	6	85	9	6	-40	120	27	6	-12 (+41)
BOD ₅ mg l ⁻¹	1.4	.3	6	1.5	.3	6	+7	2.3	2.4	6	+64 (+53)
Reactive P mg l ⁻¹	.019	.006	6	.010	.006	5	-47	.001	.001	6	-95 (-90)
Total P mg l ⁻¹	.050	.027	6	.033	.014	6	-34	.026	.004	6	-48 (-21)
NH ₄ N mg l ⁻¹	<.02	.01	5	.02	.02	6	0.01 ²	.02	.02	6	0 (0.01 ²)
NO ₂₋₃ N mg l ⁻¹	<.02	--	6	<.02	--	6	0	<.02	--	6	0 (0)
Kjeldahl N mg l ⁻¹	1.36	.36	6	.91	.15	6	-33	1.25	.28	6	-8 (+37)
Chloride mg l ⁻¹	<1.0	--	5	18.1	4.8	6	--	12.7	2.8	6	-- (-29)
Total Suspended Solids mg l ⁻¹	3.1	5.0	4	1.1	.5	6	-65	3.5	.7	2	+13 (+218)

¹ Values enclosed in parentheses are percent changes from 1979 effluent discharge period.

² Actual change in concentration from baseline below detection.

increased, but was not significantly different from the base-line average of 54 umhos cm^{-1} . These data were within the range of values recorded at site 7 in 1979 (Appendix D). The decrease in chloride and conductivity values at site 7 in 1980 could have reflected the reduced volume of discharge from the treatment bog.

Significant decreases in apparent and true color occurred in Weso Lake surface water during the sampling period (Table 5). The mean apparent and true color declined 45 and 50%, respectively, during 1980. A similar reduction (47%) was noted for true color at site 7. Mid-depth lake samples also reflected significant decreases in true color. True color at site 5-6 declined, but not significantly within the normal variation.

True color in bog water is composed of resistant soluble organic compounds, particularly humic acids (Wetzel 1975).

Table 5. Average apparent and true color (platinum-cobalt units) for Weso Lake and significance of changes between 1979 and 1980. Averages for each year were based on samples collected from May through September.

Site/Year	APPARENT COLOR					TRUE COLOR				
	Mean	S.D.	N	Signi-	fance	Mean	S.D.	N	Signi-	fance
Sites 1 to 6	(1979)	211	21	28	P<0.001	191	29	28	P<0.001	
	(1980)	117	18	20		96	17	20		
Site 5-3	(1979)	273	36	5	NS	213	20	5	P<0.001	
	(1980)	238	18	5		158	7	5		
Site 5-6	(1979)	---	--	-		372	22	5	NS	
	(1980)	---	--	-		310	56	5		
Site 7	(1979)	---	--	-		203	48	5	P<0.05	
	(1980)	---	--	-		107	16	5		

NS = Not Significant (P<0.05).

These acids originate in decomposing vegetation. Apparent color combines true color with suspended particulate materials such as algae, bacteria, detritus, and soil and other inorganic particles.

The dark brown color of Weso Lake was primarily attributed to true color (Figure 8). Drainage from surrounding bogs, which contain large amounts of decomposing and soluble organic matter, was probably the main source of true color. Mean true color comprised 86% of surface and 72% of mid-depth apparent color during the sampling period. Both apparent and true color, as well as the proportion of suspended particulates, increased with depth. Precipitation of humic colloids and ferric compounds near the lake sediments may have contributed to this trend.

The seasonal variation of true color in water is mainly influenced by precipitation (Whipple 1914). There are usually two maxima in the yearly color cycle, one in May or June and one in November or December. In winter and early spring, snow and snowmelt cause color dilution. Drainage from wetland areas in spring increases color. Color decreases during the summer since wetland drainage is low except during heavy rains. Fall rains again increase color.

Color values for Weso Lake surface water were highest during November and probably reflected the circulation of highly colored hypolimnetic water and sediments during fall overturn. Surface water color was high in May 1979 and decreased during the summer. In 1980, color followed a similar pattern, but at significantly lower intensities (Figure 8).

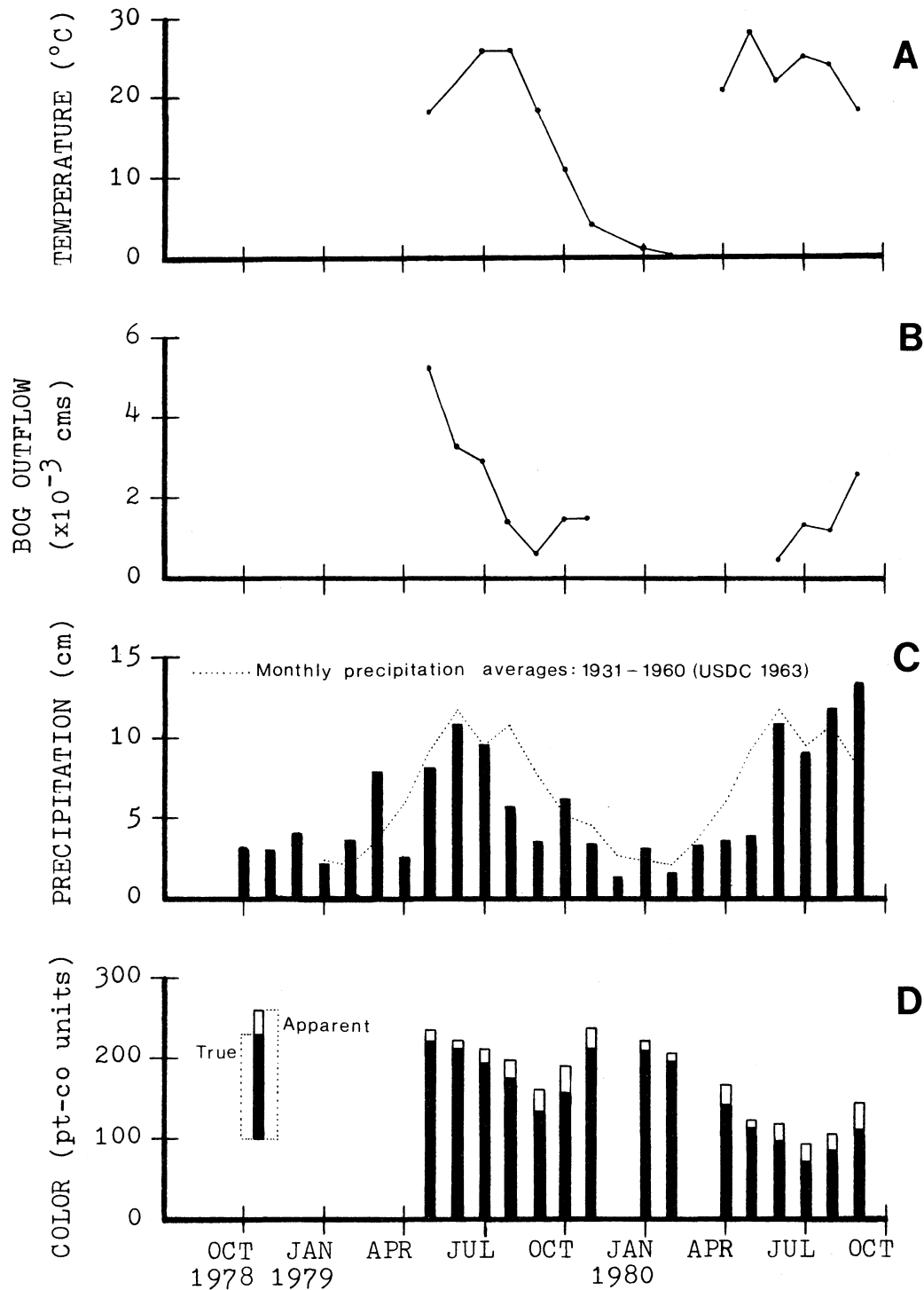


Figure 8. (A) mean monthly surface water temperature of Weso Lake. (B) mean monthly discharge from the Drummond treatment bog. (C) mean monthly precipitation as measured at the USFS weather station in Drummond. (D) mean monthly surface true and apparent color of Weso Lake for the period October 1978 to September 1980.

Average surface true color values during summer stratifications were statistically compared to mean monthly surface temperature, mean monthly treatment bog discharge, and mean precipitation (Table 6). True color in Weso Lake did not

Table 6. Correlation coefficients with surface true color (platinum-cobalt units) of Weso Lake as the dependent variable and precipitation (cm), lake temperature ($^{\circ}\text{C}$), and treatment bog discharge (cms) as the independent variables (N=10).

Independent Variable	r	Significance
Temperature	.38	NS
Precipitation	.64	NS
Bog Discharge	.51	$P < 0.05$

NS = Not Significant.

show a clear relationship with either temperature or precipitation. Small sample sizes may have reduced the sensitivity of these tests. Surface lake temperatures averaged 22 and 23 $^{\circ}\text{C}$ during summer 1979 and 1980, respectively. The water temperature in late April 1980, however, was 21 $^{\circ}\text{C}$, and temperatures in May 1980 averaged 10 $^{\circ}\text{C}$ higher than in May 1979. Although total precipitation in water year 1980 (71.59 cm) was higher than in water year 1979 (64.73 cm), precipitation from March through May 1980 was 42% lower than in the corresponding period of 1979. High temperature and low precipitation during these months could have reduced the normal spring flushing of highly colored water from wetlands.

True color showed a significant positive correlation with treatment bog discharge through the sampling period.

The occurrence of high lake color at high bog outflows reflected the enhanced contribution of allochthonous organic materials to the lake from treatment bog drainage.

Light transmission through the water column was affected by changes in true color. Secchi disc readings showed a significant negative correlation with surface true color ($r=.94$, $P<0.001$, d.f.=8). Mean secchi disc visibility increased from 0.8 m in 1979 to 1.2 m in 1980. Color also had a significant effect on the composite light extinction coefficients for Weso Lake (Figure 9). The results indicated that light penetration increased with decreases in true color.

Yearly means for total reactive phosphorus concentrations were statistically different for surface and mid-depth lake sites and bog samples (Table 7). Differences in yearly total phosphorus levels were detected only in surface lake samples.

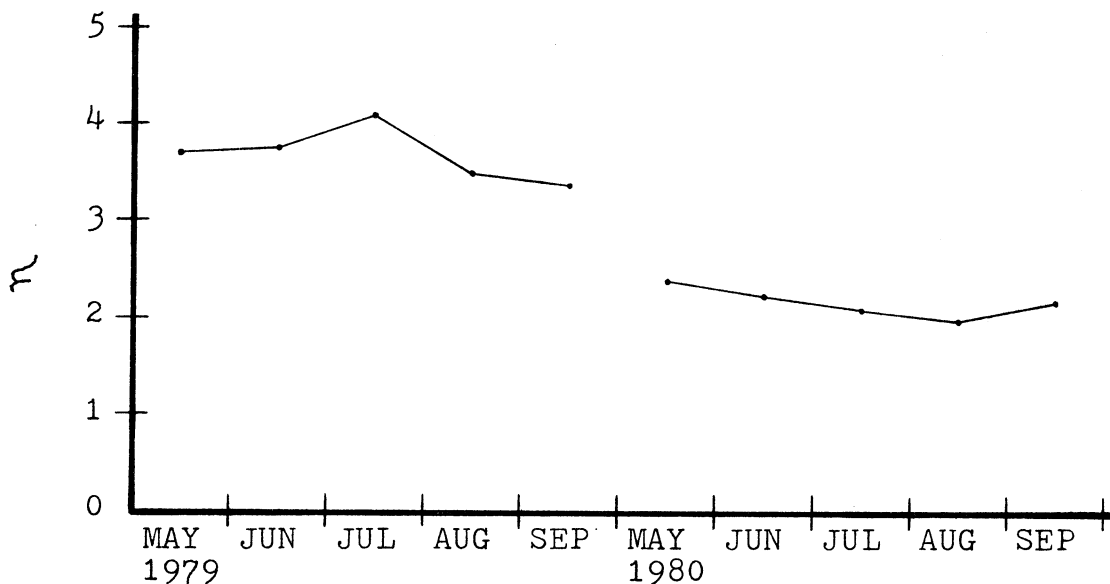


Figure 9. Average composite light extinction coefficients for the first meter of surface water in Weso Lake, 1979 and 1980.

Table 7. Average reactive and total phosphorus (mg l^{-1}) for Weso Lake and significance of changes between 1979 and 1980. Averages for each year were based on samples collected from May through September.

Site/Year	REACTIVE PHOSPHORUS				TOTAL PHOSPHORUS			
	Mean	S.D.	N	Signi- ficance	Mean	S.D.	N	Signi- ficance
Sites 1 to 6	(1979) .014	.011	28	$P < 0.001$	.053	.018	28	$P < 0.001$
	(1980) .002	.002	20		.023	.012	20	
Site 5-3	(1979) .022	.005	5	$P < 0.001$	.054	.021	5	NS
	(1980) .002	.003	5		.030	.012	5	
Site 5-6	(1979) .136	.060	5	NS	.220	.089	5	NS
	(1980) .074	.063	5		.144	.103	5	
Site 7	(1979) .041	.024	5	$P < 0.05$	.376	.388	5	NS
	(1980) .004	.002	5		.091	.097	5	

NS = Not Significant ($P < 0.05$).

Phosphorus concentrations generally exhibited a high degree of spatial and seasonal variability (Figures 10 and 11). This variability and limited sample collection may have masked similar differences at other sites.

Mean surface and mid-depth reactive phosphorus concentrations decreased 86 and 91%, respectively, during 1980. Drops in reactive phosphorus in surface and mid-depth water could have reflected the continued sedimentation of erosion materials introduced during the 1978 construction of the Drummond sewage lagoons. Mechenich (1980) noted a 37% decrease in total suspended solids and a 38% increase in secchi disc readings in Weso Lake from 1978 to 1979. My field studies indicated a similar 40% decline in total suspended solids and a 33% increase in secchi disc readings from 1979 to 1980. Surface water inorganic phosphorus may also have

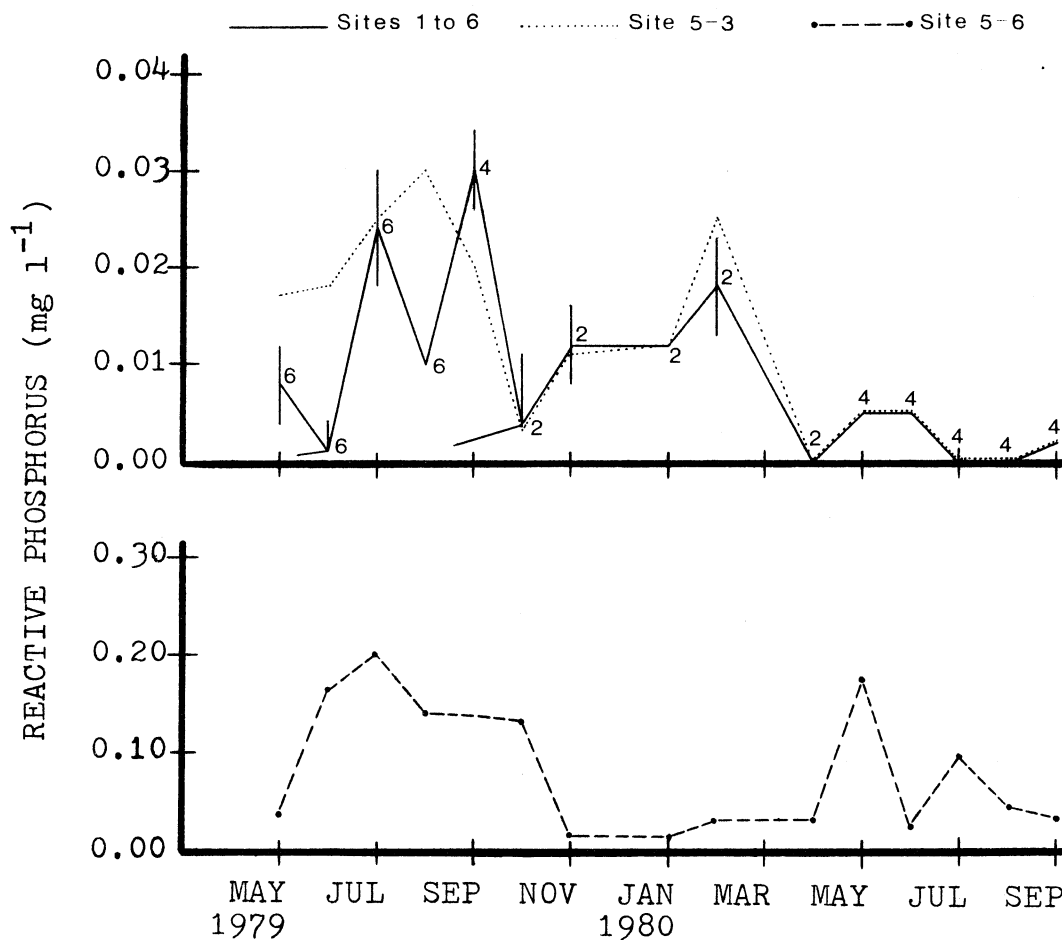


Figure 10. Seasonal reactive phosphorus trends at three depths in Weso Lake. Vertical bars on sites 1 to 6 plot indicate ± 1 standard deviation; numbers are sample size.

been removed by biological uptake in algae and vascular plants or through precipitation reactions favored by a more aerobic environment.

Site 5-6 experienced a 46% decrease in reactive phosphorus concentrations during the sampling period, and that decrease could be explained by natural variability (Table 7, Figure 10). Statistically significant decreases in reactive phosphorus occurred in the bog interstitial water. Site 7 exhibited a 90% reduction in reactive phosphorus levels from

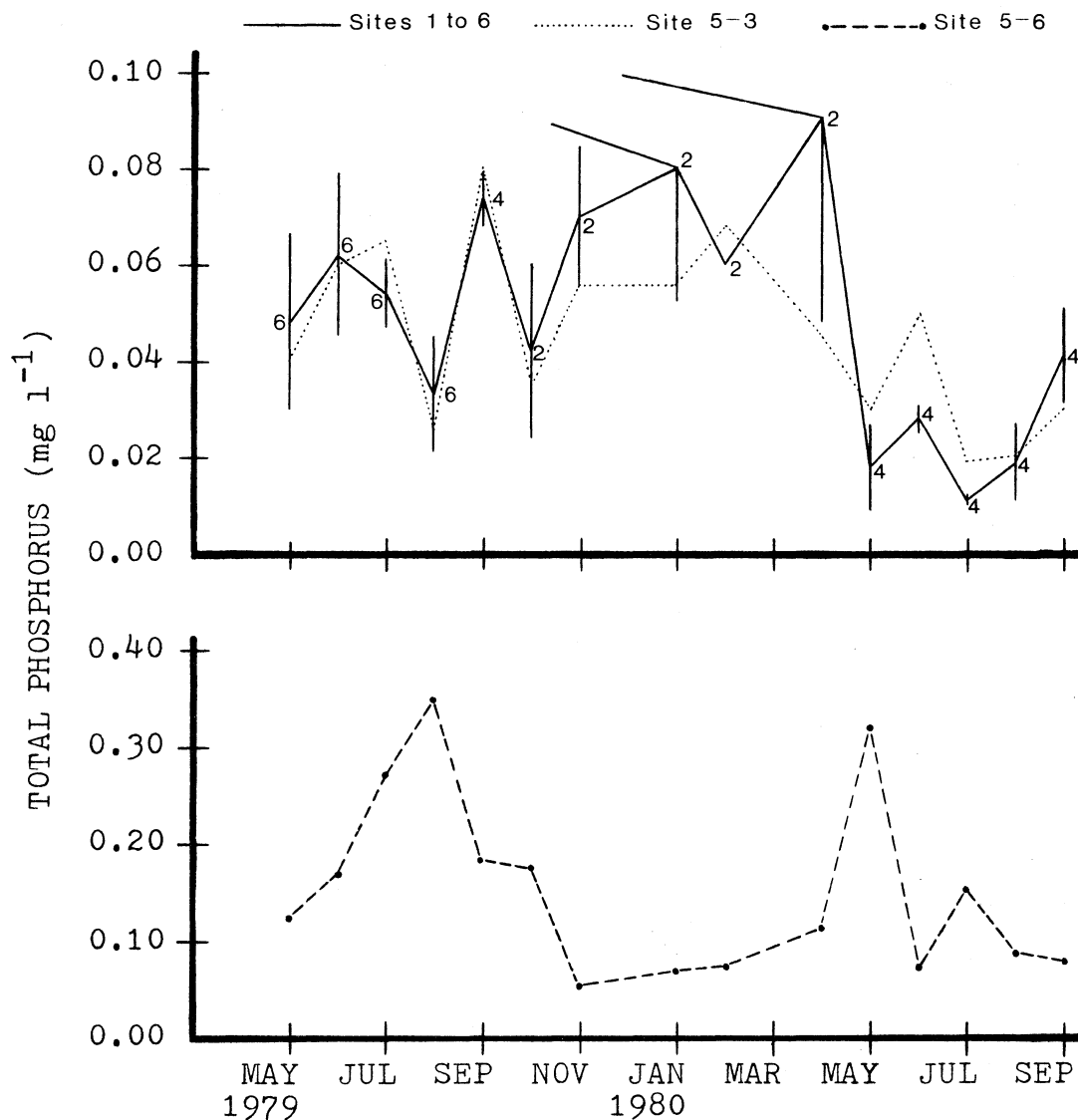


Figure 11. Seasonal total phosphorus trends at three depths in Weso Lake. Vertical bars on sites 1 to 6 plot indicate ± 1 standard deviation; numbers are sample size.

1979 to 1980. Possible explanations for this decline could have been reduced phosphorus loading from the treatment bog and increased uptake of nutrients by bog plant communities responding to favorable spring and early summer weather.

Total phosphorus yearly trends in Weso Lake mirrored reactive phosphorus trends (Figure 11). Although mean total

phosphorus concentrations decreased at all depths during 1980, only surface samples were statistically different between years (Table 7). A partial explanation for this decline may have been the use after October 1979 of a different analytical procedure which corrected for silica interference in the total phosphorus determination. Since reactive phosphorus concentrations decreased significantly at surface and mid-depth sites, there was potential for total phosphorus to exhibit similar trends. Reduced allochthonous organic inputs from low spring runoff could have accounted for natural decreases in total phosphorus levels.

Total phosphorus decreases of 44 and 35% for mid-depth and bottom, respectively, were not significant, and reflected natural yearly variation. The flux of materials from sediments under reducing conditions could have been responsible for this seasonal variability. Significantly lower total phosphorus at site 7 in 1980 could be attributed to increased decomposition of particulate organic matter under more aerobic conditions.

Mean phosphorus concentrations in the treatment bog discharge were consistently below Weso Lake surface water values during the sampling period (Table 4). The dramatic decrease in bog discharge phosphorus from 1978 baseline levels mirrored the trend of declining phosphorus in the lake. Phosphorus reductions may have been caused by increased biological uptake or decreased runoff of organic compounds from the treatment bog. Nutrient assimilation by a dense growth of Elodea sp. in one of the secondary treatment lagoons and fewer discharges

during 1980 may also have contributed to lower bog outflow phosphorus levels.

Like phosphorus, nitrogen in Weso Lake exhibited considerable natural variability (Figure 12). No consistent

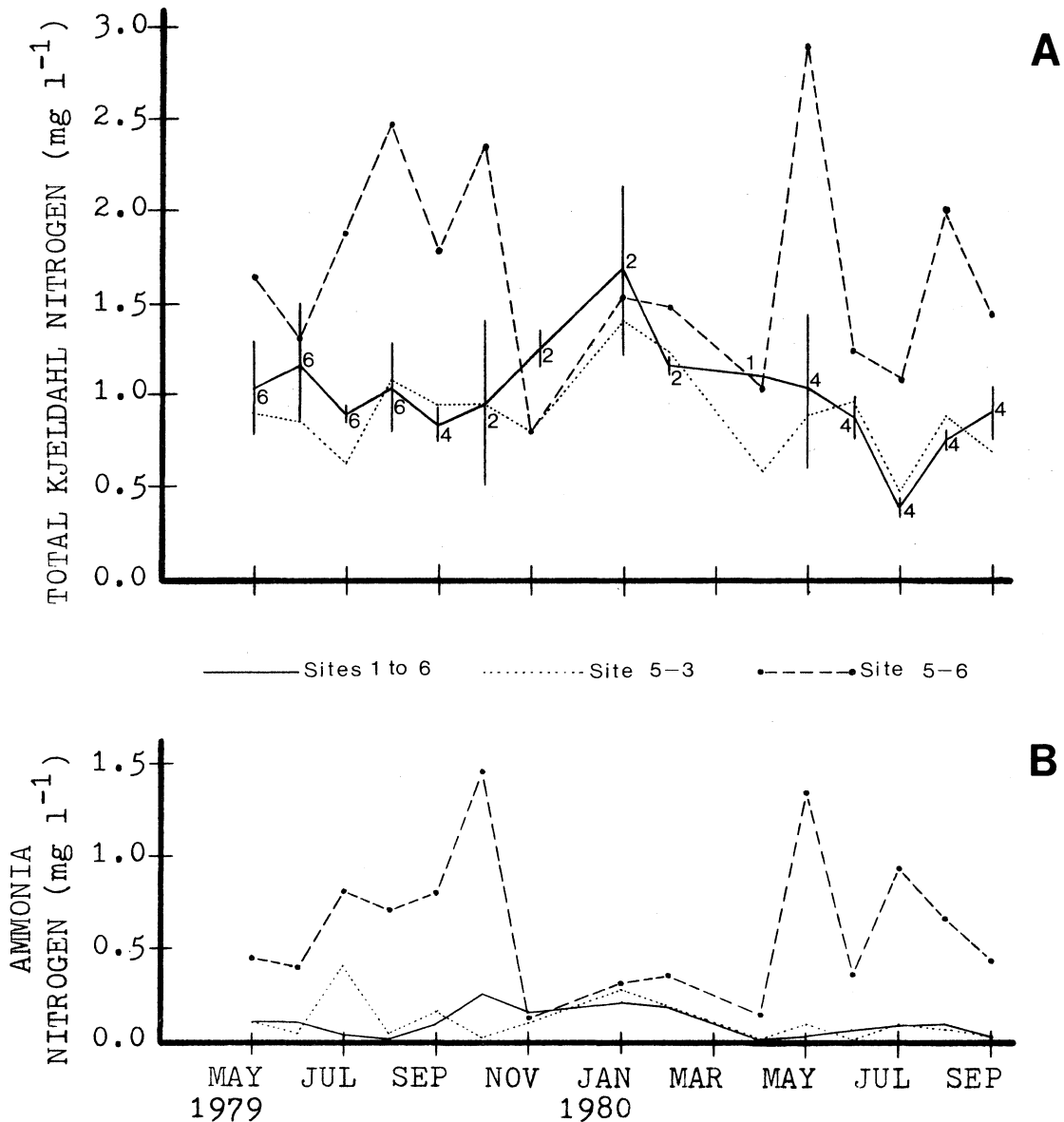


Figure 12. Seasonal total Kjeldahl nitrogen (A) and ammonia nitrogen (B) trends at three depths in Weso Lake. Vertical bars on sites 1 to 6 (A) plot indicate ± 1 standard deviation; numbers are sample size.

trend was apparent for yearly total Kjeldahl nitrogen (TKN) concentrations, except for statistically significant decreases at surface lake sites and in the bog margin (Table 8). Decreases in soluble organic nitrogen were primarily responsible for lower TKN values in surface lake water because ammonia levels were similar during both summers. Lower total soluble nitrogen in 1980 could have reflected increased sedimentation or decreased organic loading from low spring runoff. The 65% reduction in total Kjeldahl nitrogen at site 7 was similar to the total phosphorus reduction. This decline could have represented decreased treatment bog discharge or decomposition of particulate organic nitrogen due to the consistently lower water table.

A relatively large decrease in ammonia was responsible for the yearly decline in total Kjeldahl nitrogen in mid-depth

Table 8. Average ammonia and Kjeldahl nitrogen (mg l^{-1}) for Weso Lake and significance of changes between 1979 and 1980. Averages for each year were based on samples collected from May through September.

Site/Year	AMMONIA N				Signi-	KJELDAHL N				Signi-
	Mean	S.D.	N			Mean	S.D.	N		
Sites 1 to 6	(1979) 0.06	0.06	28		NS	1.01	0.24	28		$P < 0.05$
	(1980) 0.06	0.04	20			0.79	0.30	20		
Site 5-3	(1979) 0.15	0.15	5		NS	0.88	0.16	5		NS
	(1980) 0.05	0.04	5			0.78	0.19	5		
Site 5-6	(1979) 0.64	0.20	5		NS	1.82	0.42	5		NS
	(1980) 0.74	0.40	5			1.71	0.70	5		
Site 7	(1979) 0.11	0.18	5		NS	3.54	1.40	4		$P < 0.05$
	(1980) 0.06	0.03	5			1.23	0.71	5		

NS = Not Significant ($P < 0.05$).

samples. Low ammonia could have reflected biological uptake or conversion to nitrate at the aerobic/anaerobic interface. Ammonia comprised about 40% of the TKN in bottom samples during both summers and reflected the anaerobic conditions in the hypolimnion.

Nitrate+nitrite nitrogen was not found at any depth during stratified periods. Nitrates from conversion of ammonia nitrogen were apparently removed by biological uptake or denitrification processes.

Bog discharge nitrogen levels varied over time, but displayed no consistent trends (Table 4). Mean inorganic nitrogen was at or below detection limits throughout the sampling period suggesting biological uptake or denitrification in the bog or weir pond. The 37% increase in total Kjeldahl nitrogen in 1980 was within the range of natural variability. In 1980, total Kjeldahl nitrogen levels in the bog outflow averaged 63% higher than in Weso Lake surface water. Transformation and biological uptake of organic nitrogen apparently occurred in the bog stream. Slow percolation of water through the slough at the inlet to the lake was probably inefficient for transporting large particulate nitrogen compounds.

Other chemical characteristics, including pH, alkalinity, calcium and total hardness, COD, and BOD₅, were statistically analyzed, but differences in yearly means could generally be explained by spatial or seasonal variability. The average values for the study period are presented in Table 2, and the results of ANOVA and t-tests are provided in Appendix B and Appendix C, respectively.

Phytoplankton

Phytoplankton community structure and relative abundance were determined by direct enumeration and by measurement of chlorophyll a concentrations. Phytoplankton identification and counting were used to establish the significance of various taxa to the overall community composition and to monitor changes in the composition of the phytoplankton. Chlorophyll a analysis was used to assess fluctuations in phytoplankton biomass. The dominant phytoplankton taxa of Weso Lake are presented in Appendix E. Chlorophyll a data are provided in Appendix F. Results of analyses of variance comparing yearly phytoplankton density and diversity are given in Appendix G.

No great variation within monthly surface samples (sites 1 to 6) was observed in either phytoplankton counts or chlorophyll a analyses. The average coefficients of variation for phytoplankton numbers and chlorophyll a measurements were 21.1 and 30.3%, respectively. The regular shape and moderate depth of the basin may have contributed to the homogeneous distribution of algae in surface water by providing uniform environmental conditions within the same stratum over the entire lake. Data from monthly collections at sites 1 to 6 were, therefore, pooled as replicate surface samples.

Phytoplankton counts for surface samples generally paralleled changes in chlorophyll a throughout the study period (Figure 13). Significant positive correlation was found between total cell numbers and chlorophyll a values ($r=.58$, $P<0.05$, $d.f.=56$). The average surface phytoplankton density

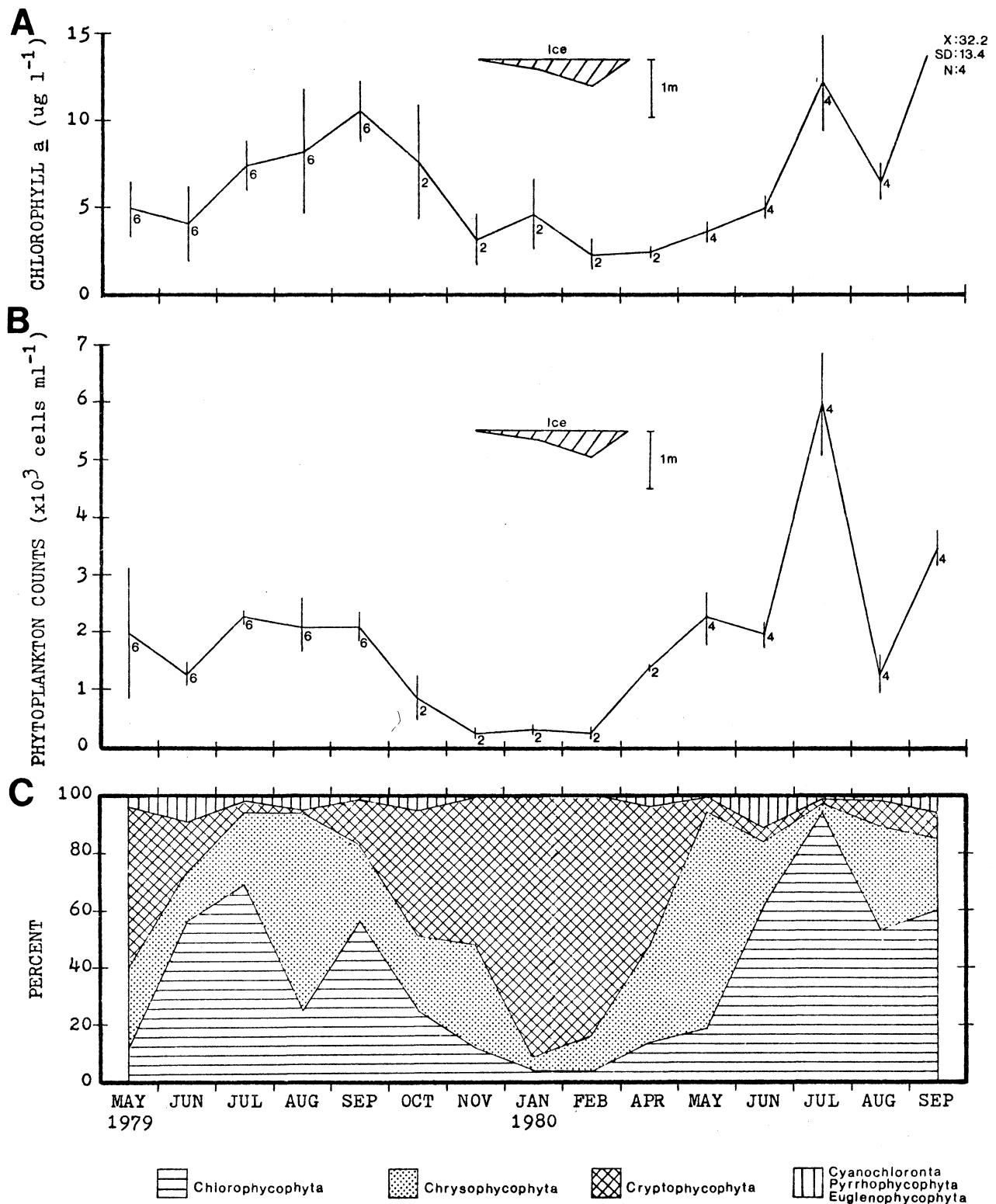


Figure 13. Seasonal changes in phytoplankton (A) biomass and (B) cell density, and (C) percent composition of Weso Lake phytoplankton. Average of all surface samples. Vertical bars indicate ± 1 standard deviation; numbers are sample size.

during summer stratifications (May through September) was 2498 cells ml^{-1} . Mean surface chlorophyll a concentration for the corresponding periods was 9.5 ug l^{-1} . The average chlorophyll a concentration was inflated by a high mean value (32.2 ug l^{-1}) in September 1980. Large numbers (average 82 organisms ml^{-1}) of the dinoflagellate, Peridinium sp., contributed to the unusually high chlorophyll measurements during that month. The mean surface chlorophyll a concentration, excluding September 1980 samples, was 7.0 ug l^{-1} .

Vollenweider et al. (1974) suggested that chlorophyll a concentrations between 4.5 and 9.0 ug l^{-1} were indicative of mesotrophic lakes. Chlorophyll a values between 2 and 15 ug l^{-1} were classified as mesotrophic according to Wetzel's (1975) scheme. Welch (1980) considered chlorophyll a concentrations exceeding 6 ug l^{-1} as eutrophic. Consequently, Weso Lake would be mesotrophic or meso-eutrophic based upon phytoplankton standing stock.

Carlson (1977) produced a trophic state index which could be calculated from secchi disc transparency, total phosphorus concentration, or chlorophyll a levels. The trophic number, based on a scale of 0-100, was intended to avoid the use of the terms oligotrophic, mesotrophic, and eutrophic. Labels have been applied to Carlson's system, however, with numbers less than 40 considered oligotrophic, and numbers greater than 50, eutrophic (Reckhow 1979). Although secchi disc depth and total phosphorus concentration yield erroneous index numbers in highly colored lakes, chlorophyll a values are apparently free from interference. The average index value for Weso Lake

surface chlorophyll a levels was 50, again emphasizing its meso-eutrophic nature.

The dystrophic lake type has generally been separated from the oligotrophic-eutrophic continuum in trophic classification systems. Low production has been considered a primary requisite of a dystrophic lake. Other investigators (Birge and Juday 1927; Bricker and Gannon 1976) have observed acid bog lakes with high plankton production. Hansen (1962) suggested that dystrophy was not a well chosen term in lake trophic classification because "trophism means something about nutrition." Dystrophy refers to brown-stained water high in humic content with peat accumulation in the sediments. Dystrophic lakes, however, may be eutrophic as well as oligotrophic.

Forty-six taxa of phytoplankton were observed in Weso Lake surface samples, including 18 genera of Chlorophycophyta and 20 genera of Chrysophycophyta. Members of the Chlorophycophyta, Chrysophycophyta, and Cryptophycophyta dominated phytoplankton densities throughout the study period (Figure 13), comprising 54, 28, and 14% of the total cell numbers, respectively. The Cyanochloronta, Pyrrophyphyta, and Euglenophycophyta were also represented in the plankton, but only accounted for 4% of the total plankton density. Diatoms contributed 80% of the chrysophyte cell numbers.

The results of my investigation support the conclusions of Round (1957) and Duthie (1965) that organically rich water is unfavorable to blue-green algae growth, but favors an abundance of diatoms, Chlorophyceae, and flagellates. Round (1957)

also found evidence that green algae preferred both extremes of calcium content. Yan and Stokes (1978) have shown that conditions of decreasing pH favored increasing dominance of Cryptophyceae. Diatoms can apparently attain high densities in soft water environments. Lund (1950) and Hayward (1957) observed abundant diatom growth in habitats containing less than $3 \text{ mg CaCO}_3 \text{ l}^{-1}$ calcium hardness. An investigation of the algae of 28 acid bog lakes in Wisconsin revealed that diatoms accounted for 25% of the plankton density in 26 of the lakes (Woelkerling 1976).

In Weso Lake, six genera of desmids contributed less than one percent to the total plankton density. Woelkerling (1976) studied the desmid communities of 28 acid bog lakes, 5 alkaline bogs, and 12 closed bogs in Wisconsin. Acid bog lakes harbored the greatest diversity of desmids. He reported that, in 26 of the acid bog lakes studied, desmids accounted for 30.3% or less of the total plankton population.

The spring phytoplankton (April-May) of Weso Lake in 1979 was represented mainly by a centric diatom (Melosira sp.) and by cryptophytes (Cryptomonas spp.) (Figure 14). Most diatoms achieve their maximum development under spring conditions of low light intensity and cool water (Hutchinson 1967). Cryptophytes are intolerant to high irradiance (Jones and Ilmavirta 1978). The biomass and density of the spring flora had declined by June (Figure 13). Although zooplankton predation may have been partially responsible for the decline, Lund (1965) believed that overall seasonal succession of algae is little affected by grazing. Silica has been implicated as a

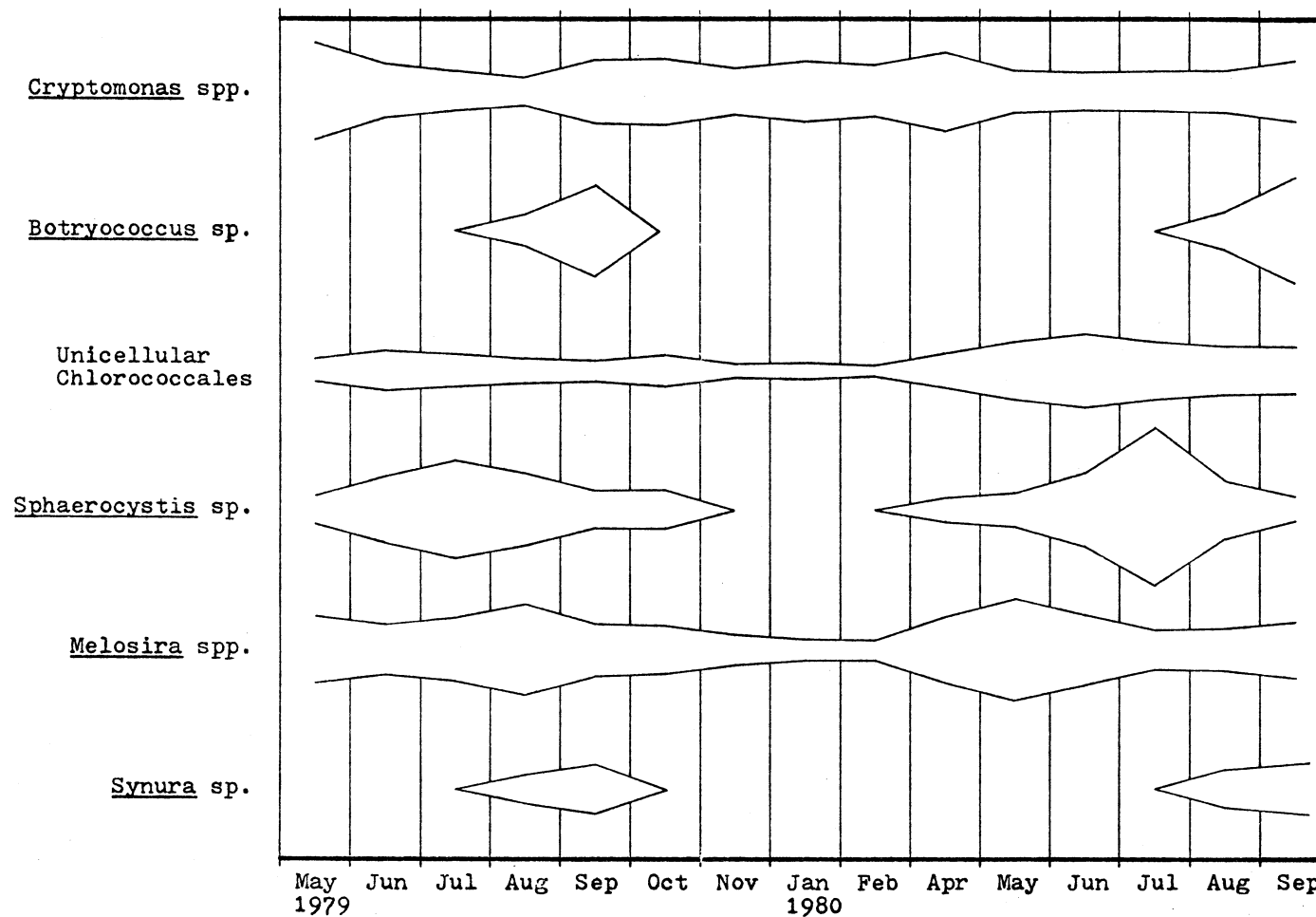


Figure 14. Relative changes in the dominant phytoplankton cell densities in Weso Lake using "spherical curves" (Schwoerbel 1970). Average of all surface samples.

primary limiting nutrient. Pearsall (1932) associated the disappearance of spring diatoms in the English Lake District with a fall in silica below 0.5 mg l^{-1} . In 1980, molybdate-reactive silica concentrations in Weso Lake declined from 4 mg l^{-1} in April to below the detection limit ($<1 \text{ mg l}^{-1}$) in June, indicating that available silica had been depleted by the spring "bloom." A decrease in the spring diatom community may have also been associated with reduced circulation which could have led to increased sinking loss of the diatom flora (Riley 1942). The higher intensity of sunlight and longer photoperiod in late spring could account for the decline in cryptophyte densities.

The summer maximum of green algae occurred during July (Figure 13). Sphaerocystis sp. and unidentified unicellular Chlorococcales were primarily responsible for the dominance of green algae in the July phytoplankton (Figure 14). These taxa represented an average 75% of the total phytoplankton density during this month. Other Chlorophycophyta, including the desmids, attained their greatest diversity and abundance in June and July (Appendix E), but their combined numbers were generally less than ten percent of the total phytoplankton density. Green algae favor high light and high temperature conditions (Hutchinson 1967). The average July surface water temperature in Weso Lake was 26°C . Cairns (1956) has shown that algae in stream water shift from diatoms to green algae as temperatures approach 30°C . Patrick (1969) observed that the maintenance of an average temperature of 30.4°C in White Clay Creek, Pennsylvania, caused a shift from

a diatom dominated community to one dominated by a mixture of green and blue-green algae and diatoms. Many other factors such as day length and intensity of sunlight interact with temperature. It would seem unlikely that any one of these could be the major factor in determining the occurrence of a species at a particular time (Fogg 1975).

Pearsall (1932) has suggested that the summer plankton organisms develop under conditions in which the nutritive substances in the water have been reduced to their lowest levels, particularly by the effects of the spring diatom maxima. It is during the period of lower nitrate and phosphate content that green algae develop. Nitrate and phosphate levels in Weso Lake did not display a consistent pattern during the summer. Nitrate values were below detection through the summer stratification period (Appendix D). Total reactive phosphorus concentrations fluctuated irregularly in the epilimnial water during the summer (Figure 10), but these fluctuations seemed to have no relationship with the occurrence of the summer phytoplankton pulse. Tucker (1957) speculated that measurements of available soluble phosphorus probably could not be correlated with algal growth because phytoplankton are able to store phosphorus in excess of their requirements.

The summer phytoplankton community was replaced by Melosira and Cryptomonas in August and September. The colonial green alga, Botryococcus sp., and the flagellated chrysophyte, Synura sp., were also prevalent in the September plankton (Figure 14). Melosira remained very common throughout the summer. The late summer increase in numbers may have been a

response to nutrients liberated from decomposing green algae. Decreasing photoperiod could have also favored the development of diatoms and cryptophytes. Botryococcus comprised 50% of the plankton density in September. This alga was a conspicuous member of the fall plankton because an accumulation of carotenoid pigments in the colonies imparted an orange color to the bloom. Fogg (1975) suggested that this physiological condition might be attributed to nitrate starvation.

Phytoplankton biomass was minimal during the winter period (Figure 13). Cryptophytes were the dominant phytoplankton from November through February. The observed predominance of cryptophytes in Weso Lake during winter conforms with previous descriptions of winter phytoplankton under ice cover (Pechlaner 1971; Jones and Ilmavirta 1978). Since little incident light generally penetrates ice, especially with additional snow cover, motility is needed by winter phytoplankton to permit them to remain at the top of the water column during the rather still conditions prevailing under ice.

The general pattern of diatom-green algae-diatom succession was repeated during the second summer of the study. Total cell densities, however, were statistically different in 1980 (Appendix G). The average surface phytoplankton density increased from 1927 cells ml^{-1} in 1979 to 2969 cells ml^{-1} in 1980. The green algae were primarily responsible for the 54% increase in mean phytoplankton cell numbers. Sphaerocystis and unicellular Chlorococcales densities averaged 146 and 538% higher, respectively, in 1980. Conversely, Cryptomonas densities declined 63%, averaging 386 cells ml^{-1} in 1979 and

144 cells ml^{-1} in 1980. Although Melosira mean cell counts were only 5% higher in 1980, the main pulse of this alga developed at different times during the two summers. In 1979, maximum densities of Melosira occurred in August, while in 1980 the highest cell counts were recorded in May.

The increased dominance of green algae in the 1980 phytoplankton could be attributed to more favorable environmental conditions resulting from the warm, dry spring. Surface water temperatures in 1980 were 10°C higher than in May 1979 (Figure 8). Since green algae prefer high temperatures (Hutchinson 1967), the warmer water may have been partially responsible for the increase in unicellular Chlorococcales density from 24 cells ml^{-1} in May 1979 to 288 cells ml^{-1} in May 1980.

Low precipitation and reduced wetland drainage during the spring caused a decrease in the color of surface lake water (Figure 8). A decrease in color intensity allowed increased light transmission through the water column (Figure 9). High irradiance also favors green algae (Hutchinson 1967). The maximum density of Chlorophycophyta observed during the study (5659 cells ml^{-1} in July 1980) coincided with the lowest levels of true color (94 pt-co units).

Pearsall (1932) concluded that more green algae occur during periods when concentrations of phosphates in the water are low. Total reactive phosphorus values were significantly lower in 1980 (Table 7), dropping below detection during July and August (Figure 10). High spring temperatures, enhanced light penetration, and low phosphorus levels may all have contributed to the increased dominance of green algae in the

1980 phytoplankton.

Cryptomonas comprised 58% of the total phytoplankton density in May 1979, but only accounted for 5% of cell numbers in May 1980. Cryptophytes are adapted to low irradiance (Jones and Ilmavirta 1978). Increased light transmission associated with declining color levels may have contributed to the lower densities of this taxa during late spring.

Reasons for the differences in Melosira growth are obscure. The seasonal periodicity of Weso Lake diatoms in 1980 broadly corresponded with the classical pattern for temperate lakes. A major growth of diatoms in spring was accompanied by a more moderate pulse of diatoms in autumn. The usual explanation (Hutchinson 1967) for this pattern is that increasing light availability stimulates growth of cold water diatoms in spring, and that diatoms increase again as the water cools towards the end of the year. In Weso Lake, however, the spring 1980 diatom pulse coincided with the highest surface water temperatures of the study period. Diatom growth in 1979 contrasted with the typical pattern. Maximum cell densities occurred in August, again, while summer temperatures were still high. Since moderate numbers of Melosira were present throughout both summers, temperature may not be a major factor controlling the growth of this diatom. No seasonal variation in the concentration of nitrate was noticeable during either summer, nor could any correlation be found between total reactive phosphorus levels and Melosira densities. In 1980, phosphorus depletion by the July bloom of green algae may have prohibited a late summer diatom pulse.

The interaction of many factors, including nutrients, temperature, and light, probably accounted for the differences in growth of Melosira.

Phytoplankton diversity and biomass were not significantly different between 1979 and 1980 (Appendix G). The mean number of taxa encountered during each summer was 25. Chlorophyll a concentrations averaged 7.1 and 6.8 $\mu\text{g l}^{-1}$ for 1979 and 1980, respectively (average for 1980 excluded the atypically high chlorophyll a levels in August).

The results of stepwise multiple regression analysis using chlorophyll a as the dependent variable and various environmental characteristics as independent variables are presented in Table 9. Correlation coefficients for chlorophyll a and environmental factors are listed in Table 10.

During 1979, true color and total reactive phosphorus

Table 9. Results of forward stepwise multiple regression using chlorophyll a as the dependent variable and various environmental characteristics as the independent variables. The results are for surface samples collected during May through September of each year.

Intercept	N	Independent Variable	b	R ²
<u>May-Sept 1979</u>				
10.86	28	Total Color**	-.05	.533**
		Reactive P*	115.38	
<u>May-Sept 1980</u>				
-9.53	20	Chloride**	15.98	.826**
		Total P*	406.45	
		Conductivity*	-1.23	

* $P < 0.05$.

** $P < 0.001$.

Table 10. Correlation coefficients using chlorophyll a as the dependent variable and various environmental characteristics as the independent variables. The results are for surface samples collected during May through September of each year.

Variable	May-Sept 1979		May-Sept 1980	
	N	R	N	R
Secchi	28	.487*	20	.124
Temperature	28	.131	20	.713**
Conductivity	28	.222	20	.629*
Alkalinity	28	.524*	20	.557*
DO	6	.342	10	.775*
Reactive P	28	.618**	20	.265
Total P	28	.247	20	.685**
NH ₄ N	28	.343	20	.421
Kjeldahl N	28	.059	20	.038
Chloride	28	.440*	20	.845**
Apparent Color	28	.597**	20	.632*
True Color	28	.640**	20	.171
Silica	ND		19	.302

* $P < 0.05$.

** $P < 0.001$.

ND = Not Determined.

explained about 53% of the variation in chlorophyll a concentration (Table 9). True color and chlorophyll a exhibited the highest correlation ($r = .640$) during this period as compared to total phosphorus and chlorophyll a (Table 10). The significant and negative relationship between true color and phytoplankton biomass was expected for 1979. Color intensity

was the primary factor governing the depth and quality of light transmittance through the water column. Light was an important density-independent factor influencing phytoplankton growth. The significant correlation ($r=.487$) between secchi depth and chlorophyll a further supported this conclusion. The significant positive relationship ($r=.618$) between reactive phosphorus and chlorophyll a suggested that phosphorus may also have been a limiting factor in phytoplankton development.

Chloride, total phosphorus, and conductivity explained almost 83% of the variation in phytoplankton biomass in 1980 (Table 9). The reason for the significant correlations between chloride and chlorophyll a ($r=.845$) and conductivity and chlorophyll a ($r=.629$) was obscure (Table 10). Petersen (1943, cited in Patrick 1977) found in a study of lakes and bogs in Denmark that the threshold effect of chloride on diatoms was at about 100 mg l^{-1} . Above 100 mg l^{-1} , indifferent species decreased in abundance and halophilic and mesophilic species increased correspondingly. Specifically, he observed that a chloride content between $16\text{-}42 \text{ mg l}^{-1}$ was of no significance, since other factors were more important. Gough (1977) determined that chloride concentrations up to 118 mg l^{-1} had no effect on the growth of 3 genera of desmids. Weso Lake chloride levels, which never exceeded 5 mg l^{-1} , would probably not have an effect on the phytoplankton biomass. The significant correlation ($r=.713$) of temperature and chlorophyll a may have reflected the important relationship between temperature and the development of the summer

green algae bloom. Dissolved oxygen and chlorophyll *a* also exhibited a significant correlation ($r=.775$) during this period. Increased phytoplankton biomass led to elevated photosynthetic activity.

Vertical variation in phytoplankton density and diversity was pronounced during thermal stratification. Populations up to 20,000 cells ml^{-1} were observed in the lower level of the epilimnion from May through July 1980 (Figure 15). Phytoplankton diversity was also greatest at this depth with a mean taxa number of 28 compared to 25 for surface sites. Both phytoplankton density and diversity declined through the metalimnion and became uniformly low in the hypolimnion. The mean phytoplankton cell count and number of taxa in the

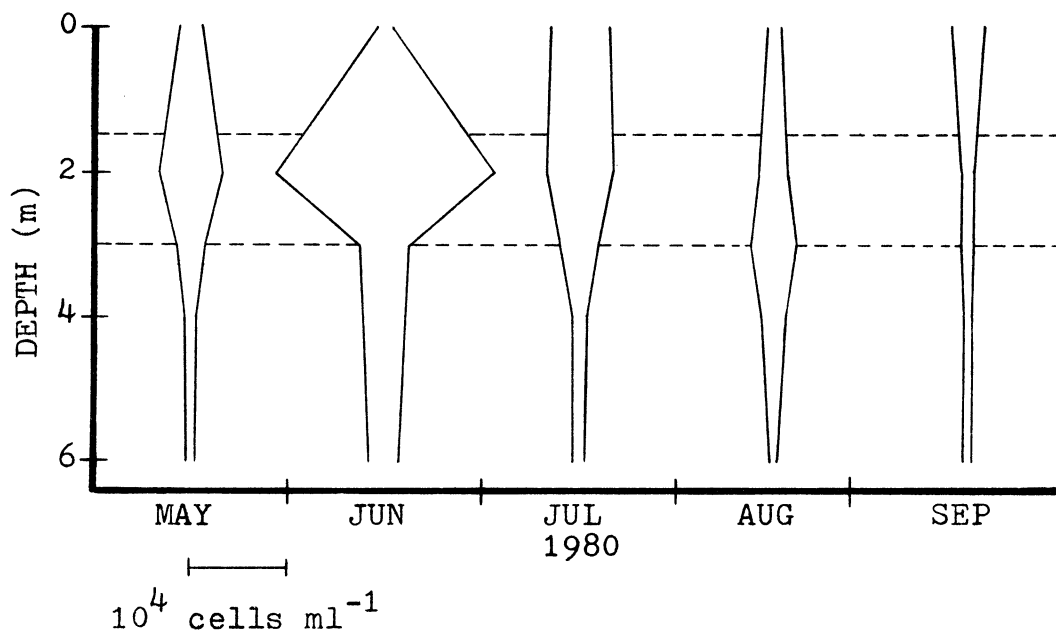


Figure 15. Depth distribution of total phytoplankton cell densities in Weso Lake from May through September 1980. Horizontal lines at 1.5 and 3 m indicate the limits of the metalimnion.

hypolimnion during summer 1980 was $1785 \text{ cells ml}^{-1}$ and 16 taxa, respectively. Only one new genus was identified in the deep samples. Trachelmonas sp., a member of the Pyrrophyta, displayed a preference for the oxygen boundary.

Light penetration measurements in summer 1980 showed that the photic zone extended to no more than 2.5 m, and below this depth net oxygen production by photosynthesis would have been, by definition, impossible. The effective depth to which phytoplankton can grow, however, is usually reduced to the depth of the epilimnion (Round 1965). In the epilimnion, cells continually circulate in wind induced currents and are, thus, retained in the photic zone. Below the epilimnion, algae are trapped in a zone where currents are slowing and rates of sedimentation are increasing. Sinking rates of cells are fastest in the hypolimnion. The effective depth of the photic zone in Weso Lake was 1.5 to 2.0 m. Population maxima at 2 and 3 m during the summer might, therefore, have reflected a delay in sinking in the metalimnion, rather than continued net population increase. Organisms can remain suspended or be slowed in the metalimnion because of the greater density and viscosity of colder water (Ruttner 1963). This hypothesis may be further supported by the apparent delay in population maxima for both Melosira and Sphaerocystis at successively lower depths through the summer (Figure 16). Mean chlorophyll a-phaeophytin levels at 2 m were not significantly higher than in surface samples (Figure 17), again suggesting delayed sinking and not continued plankton growth. More frequent sampling over a greater range of depths

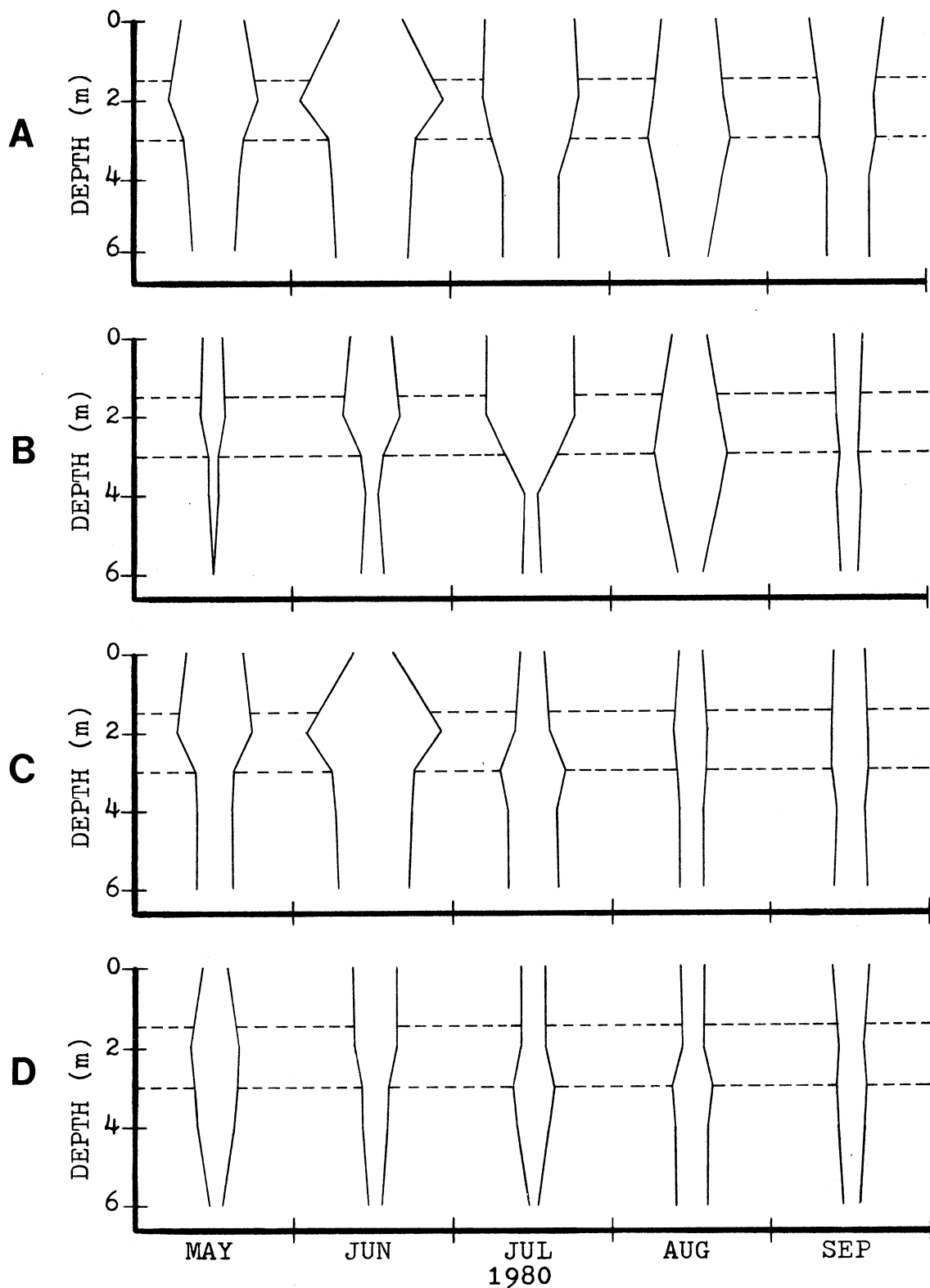


Figure 16. Relative changes in the depth distribution of cell numbers for (A) total phytoplankton, (B) *Sphaerocystis*, (C) *Melosira*, and (D) *Cryptomonas* in Weso Lake from May through September 1980 using "spherical curves" (Schwoerbel 1970). Horizontal lines at 1.5 and 3 m indicate the limits of the metalimnion.

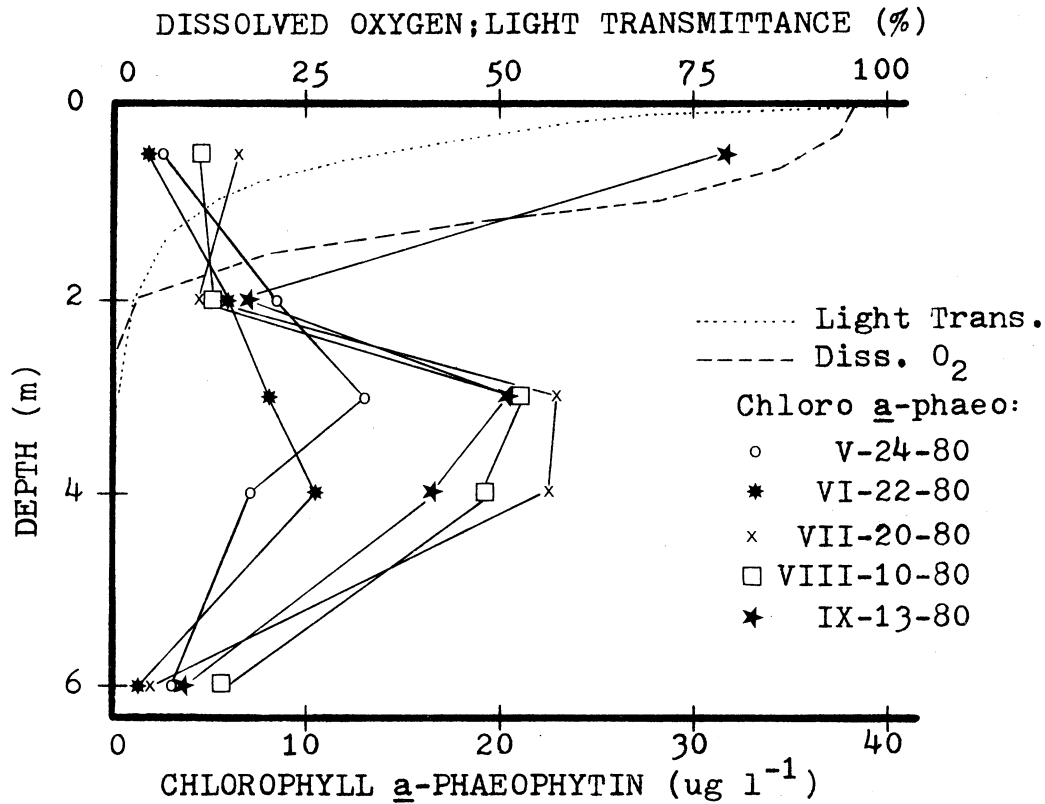


Figure 17. Depth distribution of chlorophyll *a*-phaeophytin pigments in Weso Lake from May through September 1980. Dissolved oxygen and light transmittance curves are averages for summer 1980.

would have been required to test this supposition.

The occurrence of high chlorophyll *a*-phaeophytin concentrations at 3 and 4 m was an enigma (Figure 17). Deep chlorophyll maxima have been shown to exist in many lakes. Manning and Juday (1941), in a study of Nebish Lake in northeastern Wisconsin, attributed high chlorophyll concentrations in the hypolimnion to the presence of a small unidentified flagellate. In Hoop Lake, Michigan, a chlorophyll *a* maximum, primarily due to the green alga, *Dictyosphaerium pulchellum*, was consistently observed below the level of detectable light penetration during the summer (Bricker and Gannon 1976).

Phenomenal numbers of unidentified unicellular and colonial nannoplankton were observed in Weso Lake at 4 m throughout the summer (Figure 18). Cell densities in excess of 120,000 cells ml^{-1} were recorded for July 1980. This group of plankton included minute, bacteria-like organisms which were weakly pigmented. The cells were either spherical (1-2 μm in diameter) and arranged in hollow, amorphous colonies, or the cells were bacilliform, straight or spirally twisted (2-4 μm in length). The organisms did not appear to stain with Lugol's solution, indicating that they may have been either blue-green algae or bacteria. High chlorophyll b

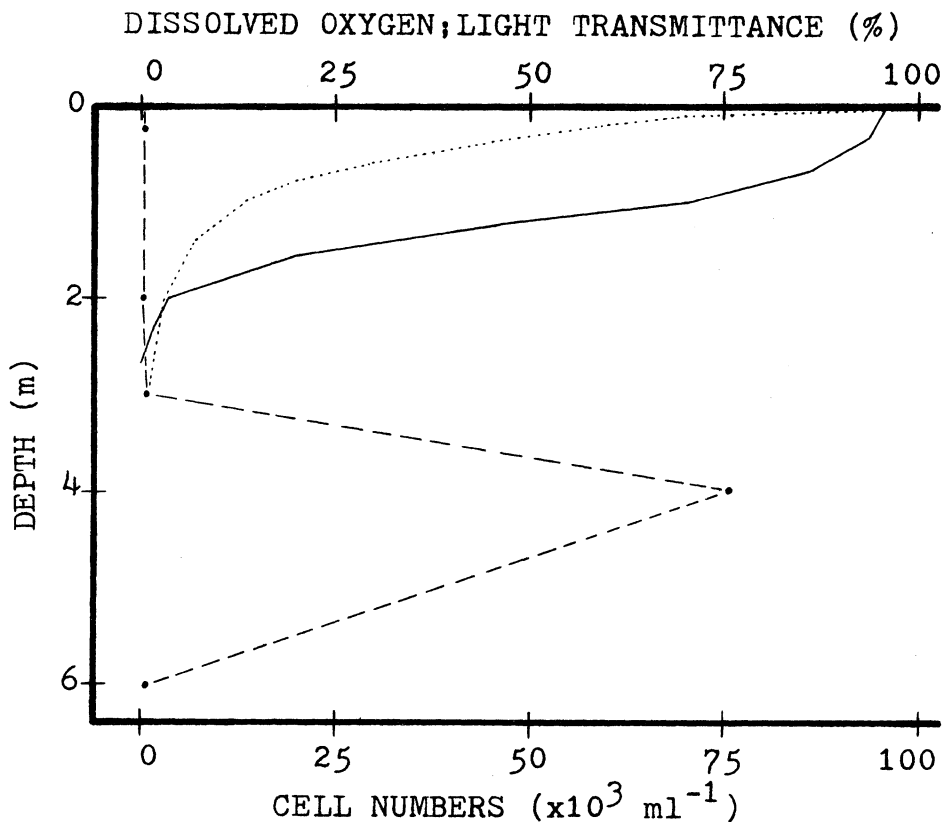


Figure 18. Depth distribution of unidentified nannoplankton cell numbers (----), dissolved oxygen (—), and light transmittance (....) in Weso Lake. Mean values for May through September 1980.

values were recorded at 4 m (Appendix F), however, which suggested the presence of green algae.

Bacterial plates often occur in a thin layer where oxygen and hydrogen sulfide come into contact (Ruttner 1963). Lawrence et al. (1978) discovered a 30-cm stratum of bacteria at the interface of the chemocline and the monimolimnion in a meromictic saline lake. Photoautotrophic bacteria can grow in all anaerobic waters where there is sufficient light for a positive assimilation balance. Chlorobacteria and purple sulfur bacteria oxidize reduced sulfur compounds to sulfur or sulfate to gain hydrogen for the reduction of carbon dioxide (Rheinheimer 1974). The putrefication of proteins in the stagnant hypolimnion of Weso Lake could supply the ammonia and hydrogen sulfide for this process. The maximum nanoplankton densities, however, occurred well below the oxygen boundary (Figure 18). The chlorobium chlorophylls contained in green bacteria have spectral properties different from chlorophyll a (Echlin and Morris 1965). Phototrophic bacteria were, therefore, not responsible for the deep chlorophyll a maxima.

Pigmented algae have been shown to utilize dissolved organic substances for energy and growth in both light and dark conditions (Samejima and Myers 1958; Parker et al. 1961; Danforth 1962). Laboratory experiments by Wiedeman and Bold (1965) revealed that Chlorella grew on acetate and glucose aerobically and anaerobically, in light and darkness. Van Baalen et al. (1974) demonstrated that blue-green algae were able to assimilate glucose heterotrophically. It may have

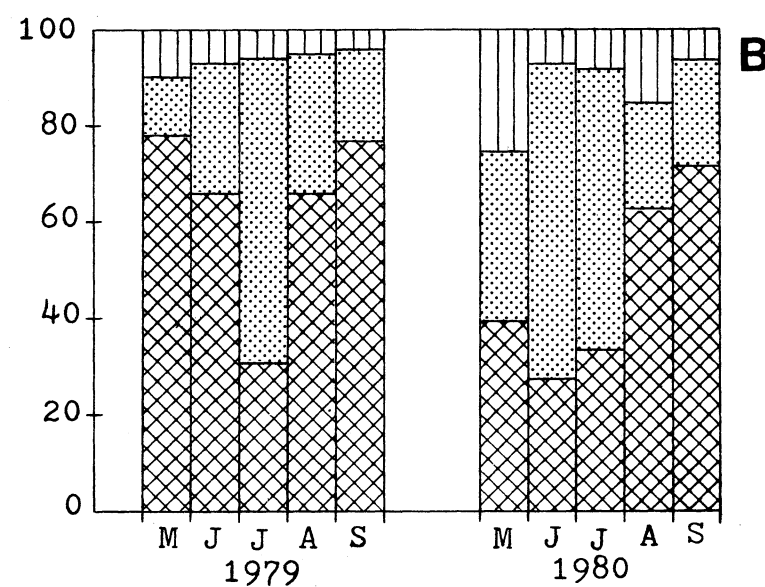
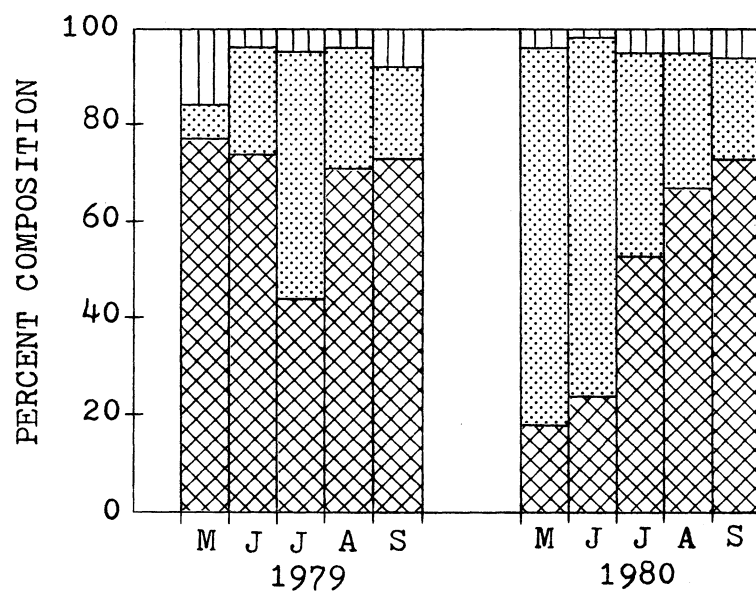
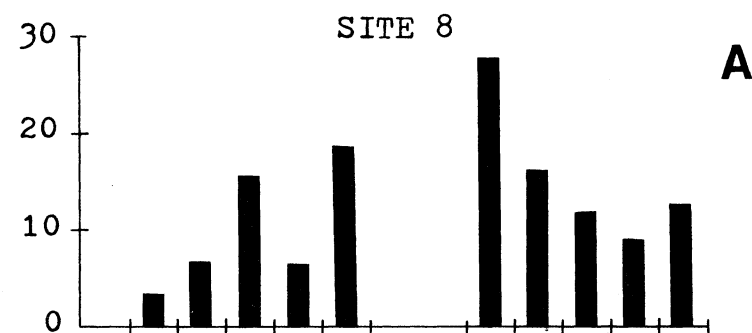
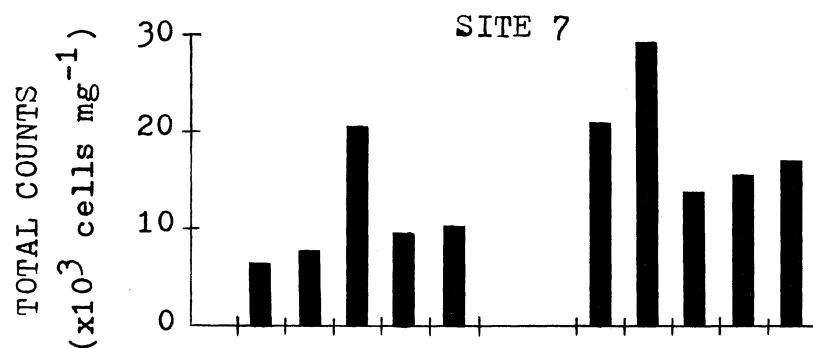
been possible that heterotrophy accompanied some photosynthesis under exceedingly low light conditions and could have accounted for high nanoplankton blooms at 4 m in Weso Lake.

Algal Aufwuchs

Forty-two taxa of algae occurred in the Sphagnum aufwuchs samples analyzed during the study (Appendix H). Diatoms and filamentous blue-green algae dominated the aufwuchs (Figure 19). Twenty-one taxa of diatoms contributed 50% of total cell counts, while 7 taxa of filamentous blue-green algae comprised 42% of total aufwuchs densities. Two taxa of colonial blue-green algae contributed another 1% of the organisms present. The green algae were represented by 12 taxa, but this group was only responsible for 7% of the total aufwuchs numbers. The mean number of taxa encountered in a collection was 26.

My results were in accord with the research of Woelkerling (1976). In his study of 28 acid bog lakes in Wisconsin, Woelkerling observed that Bacillariophyceae and Cyanophyceae were most conspicuous both in terms of population densities and percentage contribution to the total population. Diatoms constituted at least 25% of the total population on 25 of 35 hosts examined. Blue-green algae registered similar percentages on 18 of 35 acid bog hosts.

Population densities of aufwuchs in Weso Lake were quite variable and ranged from 3.23×10^3 to 2.94×10^4 cells mg^{-1} host dry weight (Figure 19). Densities greater than 1.5×10^4 cells mg^{-1} host dry weight occurred on 9 of the 20 Sphagnum



 Bacillariophyceae

 Filamentous Cyanochloronta

 Other

Figure 19. (A) total cell density and (B) percent composition of dominant algal aufwuchs on Sphagnum in Weso Lake, 1979 and 1980.

samples; densities less than 5.0×10^3 cells mg^{-1} host dry weight occurred on only 1 of the samples analyzed. Woelkerling (1976) found that aufwuchs densities exceeded 1.5×10^4 cells mg^{-1} host dry weight on 9 of 15 Sphagnum samples. Similarly, only one of his samples harbored less than 5.0×10^3 organisms mg^{-1} host dry weight.

Eunotia, the most prevalent diatom genus, accounted for 38% of the total diatom cell numbers. Eunotia spp., along with Navicula spp., Pinnularia spp., and Frustulia spp., represented 37% of the total aufwuchs density. Many species of Eunotia, Pinnularia, Frustulia, and a few species of Navicula are characteristic of low pH humate rich water (Patrick 1954, 1977). Eunotia consistently occurred in greater diversity than the other diatom genera. Few diatoms achieve optimum growth in base-poor bog habitats (Flensburg and Sparling 1973). The abundance and variation of Eunotia in Weso Lake aufwuchs, therefore, suggested the rapid development commonly associated with optimum environmental conditions. Christensen (1969) found that Eunotia comprised 27% of the total diatom population in Dead Man's Lake, Iowa. He attributed the abundance and diversity of this genus to the special conditions of the habitat, including low pH, rich organics, and high silica content of the water.

Many of the diatom genera of Weso Lake were common to both the aufwuchs and the phytoplankton. Pennate diatoms, however, other than those of the Araphidineae, are not normally components of the phytoplankton of temperate lakes (Moss 1972). Typically benthic genera such as Nitzschia and

Navicula were only sporadically encountered in the open water zone. Individuals of the raphe-bearing genera may have been introduced into the plankton by wave disturbances of the Sphagnum mat, where they were typically found.

Anabaena spp. dominated the filamentous blue-green algae, contributing an average 63% to the cyanophyte cell numbers. Plants of Anabaena, Hapalosiphon sp., and Nostoc spp. accounted for 39% of the total aufwuchs density during the study. Wetzel (1975) reported that the presence of macrophytes favors the dominance and biomass of some blue-green algae, while it is inhibitory to other groups, and perhaps is influential in the successful competition of blue-green algae with other algal groups by heterotrophic utilization of certain excreted organic compounds.

Ten genera of desmids occurred in the aufwuchs collections, but the densities of desmids were less than one percent of the total aufwuchs populations in all instances. Cylindrocystis, the most prevalent desmid genus, averaged 20 cells mg^{-1} host dry weight. Five of the fifteen Sphagnum samples analyzed by Woelkerling (1976) harbored desmid populations greater than 10^3 cells mg^{-1} host dry weight. In only three of his collections, however, did desmids account for more than 5% of the total aufwuchs population.

Desmid diversity in Weso Lake was greater in the aufwuchs than in the plankton. All of the 10 desmid genera detected during this study occurred in the bog mat samples and 4 were confined to that environment. Only 6 genera, in contrast, occurred in the open water, and none of these was

confined to that environment. The richness of the desmid aufwuchs may be due in part to the ability of Sphagnum to reduce the pH of the surrounding water (Clymo 1964), thereby increasing the availability of CO_2 which Moss (1973) feels would favor desmid growth. Pearsall (1932) regarded water with low Ca^{++} levels and with low NO_3 to PO_4 ratios as more conducive to desmid development, and Wade (1957) classified most desmids as calciphobic. The open water of Weso Lake had pH values ranging from 5.00 to 6.04 as compared to bog mat values of 4.31 to 4.76. In addition, the open water contained noticeably greater Ca^{++} hardness and total alkalinity concentrations than did mat water (Table 2). These chemical differences in the water, coupled with physical selective factors of the host, may have been responsible for greater desmid diversity in the aufwuchs.

Seasonal patterns and periodicity of the aufwuchs was masked by sample variability. Population dynamics of epiphytic algae growing on submerged portions of macrophytes are complex because the surface area for colonization and growth is continually changing as the plants grow, senesce, and enter detrital phases (Wetzel 1975). Aufwuchs population changes may also have been complicated by the collection of four species of Sphagnum host, including S. recurvum, S. magellanicum, S. capillifolium, and S. fimbriatum (Bowers 1981). Significant variation in aufwuchs community composition and population density has been found among different supporting macrophyte communities (Foerster and Schlichting 1965; Round 1965; Woelkerling 1976). Host specific differences

in aufwuchs community structure may have contributed to sample variability.

Attempts to compare aufwuchs populations between years was hampered by the sample variability and insufficient sample size. Conspicuous changes in the epiphytic algae, however, were observed during the study. Mean total cell density increased 65% from 10,516 cells mg^{-1} host dry weight in 1979 to 17,364 cells mg^{-1} host dry weight in 1980. Increases in filamentous blue-green algae were primarily responsible for the higher total population densities. In 1980, Anabaena and Hapalosiphon cell counts increased by 119 and 714%, respectively. The dominance of filamentous blue-green algae in the 1980 aufwuchs was particularly evident during May to June (Figure 19) when they averaged 63% of the total cell densities compared to only 17% during the corresponding period of 1979. Generally, blue-green algae are adapted to the low light and high temperature conditions of late summer and autumn, while diatoms prefer the cooler temperatures of spring (Hutchinson 1967). The abnormally high water temperatures in spring 1980 (Figure 8), may have favored the phenomenal development of blue-green algae during May and June. The occurrence of large numbers of algae during a warm, dry period does not conform with the findings of Malins-Smith (1942) for Miles Rough Bog from which he concluded that maximal development of algae is correlated with conditions of maximal wetness.

The increased growth of blue-green algae was apparently not inhibitory to the total population of diatoms. Mean total diatom density increased 17%, from 6425 cells mg^{-1} host

dry weight in 1979 to 7536 cells mg^{-1} host dry weight in 1980. Eunotia was the most prevalent diatom genus throughout the study. Although Eunotia maintained its dominance in the chrysophyte community, its numbers declined by 34% in 1980.

Other diatom genera increased in abundance during 1980, balancing the decline in Eunotia cell counts. Densities of Pinnularia, Melosira, and Navicula increased by 10, 116, and 128%, respectively. The rise in other diatom genera concurrently with the fall in Eunotia suggested that Eunotia was typically favored at the expense of the others. As conditions in the bog became less than optimal for the growth of Eunotia, other species equally adapted to the changing conditions could coexist in confined niches (Patrick and Strawbridge 1963). The non-coincidence of maxima of different diatom genera indicated that the causes of periodicity were not simple and implied that a complex interaction of several factors may have been involved, including possibly that of exudates from one genus upon others in its vicinity and even the effects of the decomposition products of dead organisms (Hayward 1957).

Benthic Macroinvertebrates

Elliott (1977), Downing (1979), and Resh (1979) suggested that a reasonable error for bottom samples was a percentage error of precision of 20% calculated as $(SE)(100)/\bar{x}=20\%$. I computed the sample size required for a 20% error for mean total invertebrate density and biomass collected with an Ekman grab (Elliott 1977). Data were pooled during analysis to reduce the large variation associated with invertebrate

sampling. The percentage error for mean total invertebrate counts and biomass was generally less than 20% (Appendices I and J). Coefficients of variation calculated for a large number of samples were approximately 70% for invertebrate numbers and 65% for biomass. These values were higher than the coefficients reported by Weber (1973) for dredge and core samplers.

The class Oligochaeta, the family Chironomidae, and Chaoborus sp. were the dominant benthic invertebrates in Weso Lake during the study period (Table 11, Figures 20 and 21). Other less common taxa of benthic invertebrates only comprised 4% of total numbers and 13% of total biomass. These groups included: Nematoda, Coleoptera, Ephemeroptera, Odonata, Trichoptera, Ceratopogonidae, Ancyliidae, and Sphaeriidae.

Chironomidae, the most abundant family in 1979 and 1980, accounted for 53% of the total benthic invertebrate density and 68% of the biomass (Appendix K). Fourteen taxa of chironomids were identified during the study period. Nine taxa of the subfamily Chironominae were responsible for 81% of the chironomid density and 94% of the biomass, while five taxa of the subfamily Tanypodinae accounted for only 19% of the chironomid density and 6% of the biomass. Chironomus was the most prevalent genus of the Chironomidae.

Another dipteran, Chaoborus, comprised 22% of the total benthic invertebrate density and 17% of the biomass. Oligochaeta contributed 20% of the total benthic invertebrate numbers, but only accounted for 2% of the biomass.

Results of analyses of variance indicated significant

Table 11. List of macroinvertebrate taxa collected with a 252-cm² Ekman grab sampler, Weso Lake (X=present).

Taxa	May-Sept 1979				May-Sept 1980			
	Site				Site			
	11	12	13	14	11	12	13	14
Nematoda	X			X	X		X	X
Annelida								
Oligochaeta	X	X			X	X		
Arthropoda								
Insecta								
Coleoptera								
Chrysomelidae								
<u>Donacia</u> sp.	X				X			
Diptera								
Ceratopogonidae	X				X	X		
Chaoboridae								
<u>Chaoborus</u> sp.	X	X	X	X	X	X	X	X
Chironomidae								
Chironominae								
<u>Chironomus</u> (<u>Chironomus</u>) sp.	X	X	X		X	X	X	
<u>C.</u> (<u>Cryptochironomus</u>) sp.	X				X			
<u>C.</u> (<u>Dicrotendipes</u>) sp.	X				X			
<u>C.</u> (<u>Endochironomus</u>) sp.	X				X			
<u>Cryptocladopelma</u> sp.	X				X	X		
<u>Glyptotendipes</u> sp.	X				X			
<u>Microtendipes</u> sp.	X				X			
<u>Polypedilum</u> spp.					X			
<u>Tanytarsus</u> spp.	X				X	X		
Tanypodinae								
<u>Ablabesmyia</u> sp.	X		X		X	X	X	
<u>Anatopynia</u> sp.	X					X		
<u>Clinotanypus</u> sp.					X			
<u>Procladius</u> spp.	X				X	X		
<u>Tanypus</u> sp.	X				X	X		
Ephemeroptera								
Caenidae								
<u>Caenis</u> sp.	X				X			
Odonata								
Corduliidae								
<u>Cordulia</u> sp.	X							
Libellulidae								
<u>Ladona</u> sp.	X				X	X		
<u>Leucorrhinia</u> spp.					X	X		
Unidentified spp.	X				X	X		
Trichoptera								
Hydroptilidae								
<u>Oxyethira</u> sp.					X			
Leptoceridae								
<u>Oecetis</u> sp.					X			
Limnephilidae								
Unidentified sp.	X							
Phryganeidae								
<u>Fabria</u> sp.					X			
Polycentropodidae								
<u>Polycentropus</u> sp.	X				X			
Mollusca								
Gastropoda								
Ancylidae								
<u>Ferrissia</u> sp.					X			
Pelecypoda								
Sphaeriidae								
<u>Sphaerium</u> sp.	X	X			X	X		
Number of Taxa	24	4	3	2	28	14	4	2

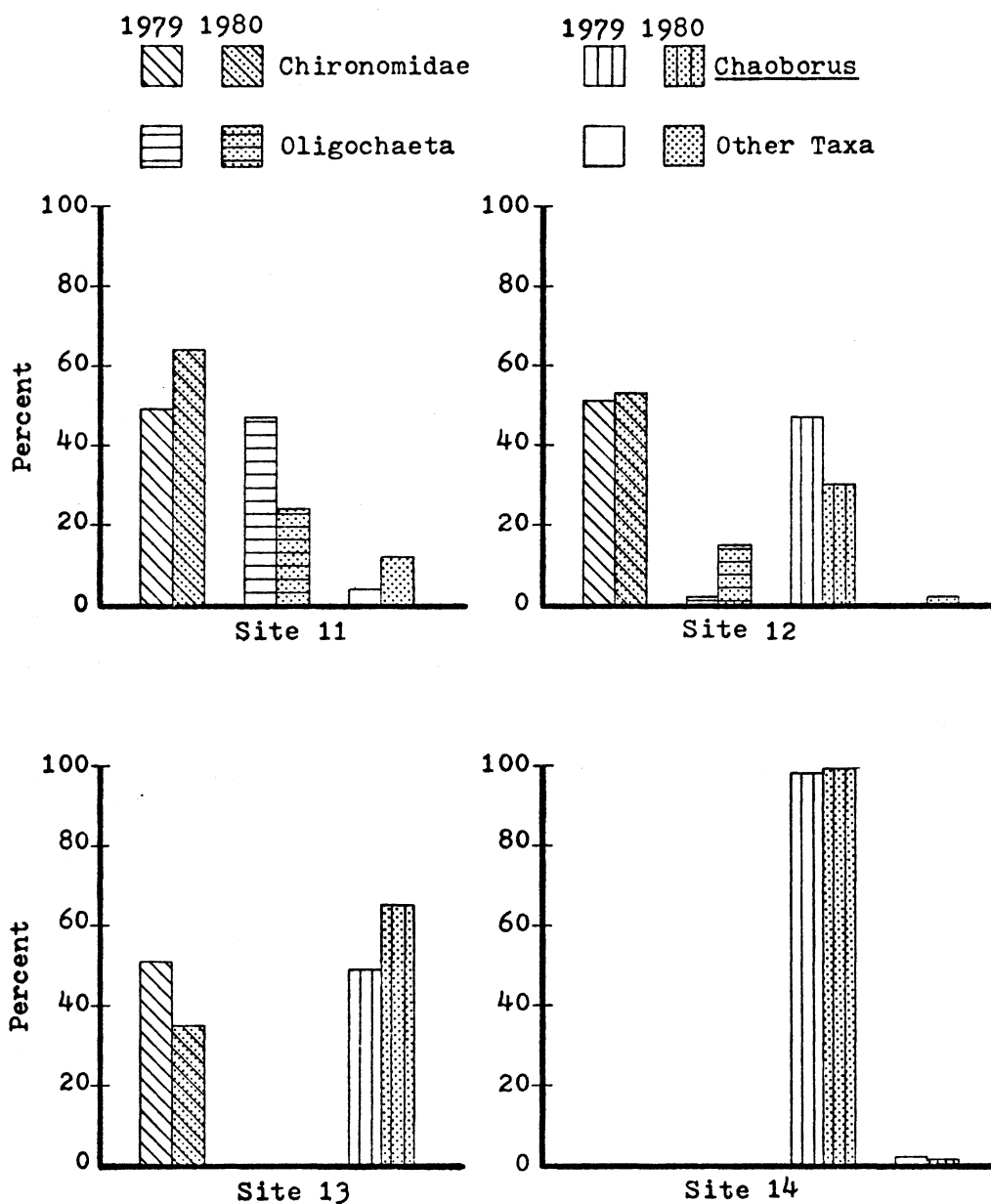


Figure 20. Mean percent composition by numbers of dominant benthic macroinvertebrate taxa in Weso Lake, 1979 and 1980, based on samples collected from May through September of each year.

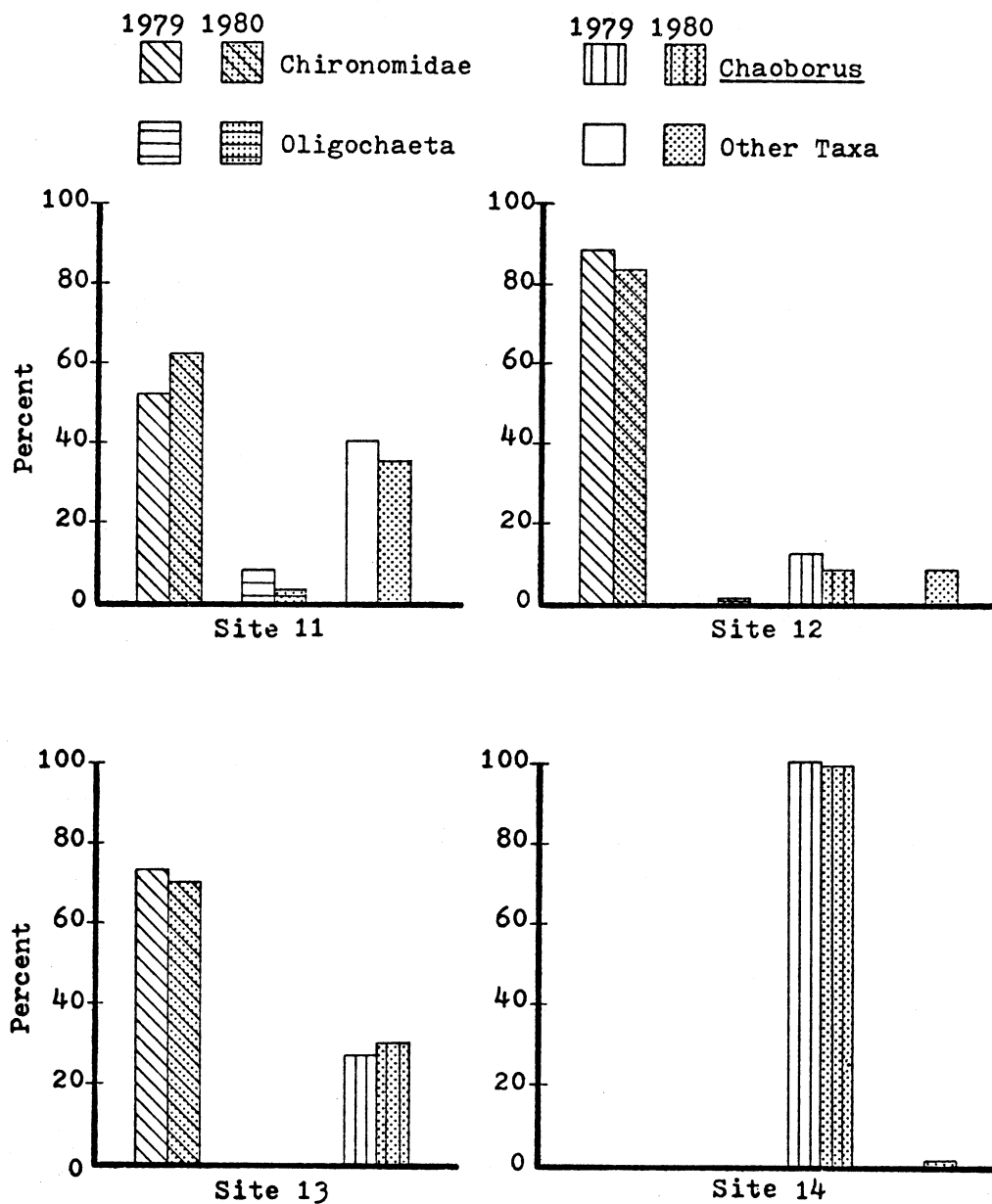


Figure 21. Mean percent composition by wet weight of dominant benthic macroinvertebrate taxa in Weso Lake, 1979 and 1980, based on samples collected from May through September of each year.

differences in invertebrate density and number of taxa between sites (Appendix L). The greatest abundance and diversity of invertebrates occurred at Site 11 (1 m). Thirty-one taxa of invertebrates were observed at this station during the study period (Table 11). The largest total invertebrate density collected was $19,619 \text{ m}^{-2}$ in June 1980 (Figure 22). All 14 taxa of Chironomidae identified in the benthic collections occurred at this site and contributed 63% of the density and 57% of the biomass. Chironominae, the most abundant chironomid subfamily, comprised 75% of the chironomid density and 77% of the biomass. Oligochaetes were responsible for 31% of the invertebrate density, but only accounted for 5% of the biomass. The remaining taxa, including members of the Ephemeroptera, Odonata, Trichoptera, Diptera, Coleoptera, Nematoda, and Mollusca, represented less than 7% of invertebrate numbers at 1 m, but contributed 38% of the biomass.

Fourteen taxa of invertebrates occurred at site 12 (2 m) during the study period (Table 11). The greatest number of invertebrates obtained at this station was 1860 m^{-2} in May 1980. Chironomids, the most abundant taxa at 2 m, accounted for 47% of the invertebrate density and 86% of the biomass. Chironominae, primarily Chironomus plumosus (Linnaeus) 1758, comprised 93% of the chironomid density and 99% of the biomass. The phantom midge, Chaoborus, was also prevalent at this depth, accounting for 38% of the invertebrate numbers and 8% of the biomass. Oligochaetes were present, but only represented 10% of the invertebrate density and less than 1% of the biomass. The infrequent occurrence of three genera of

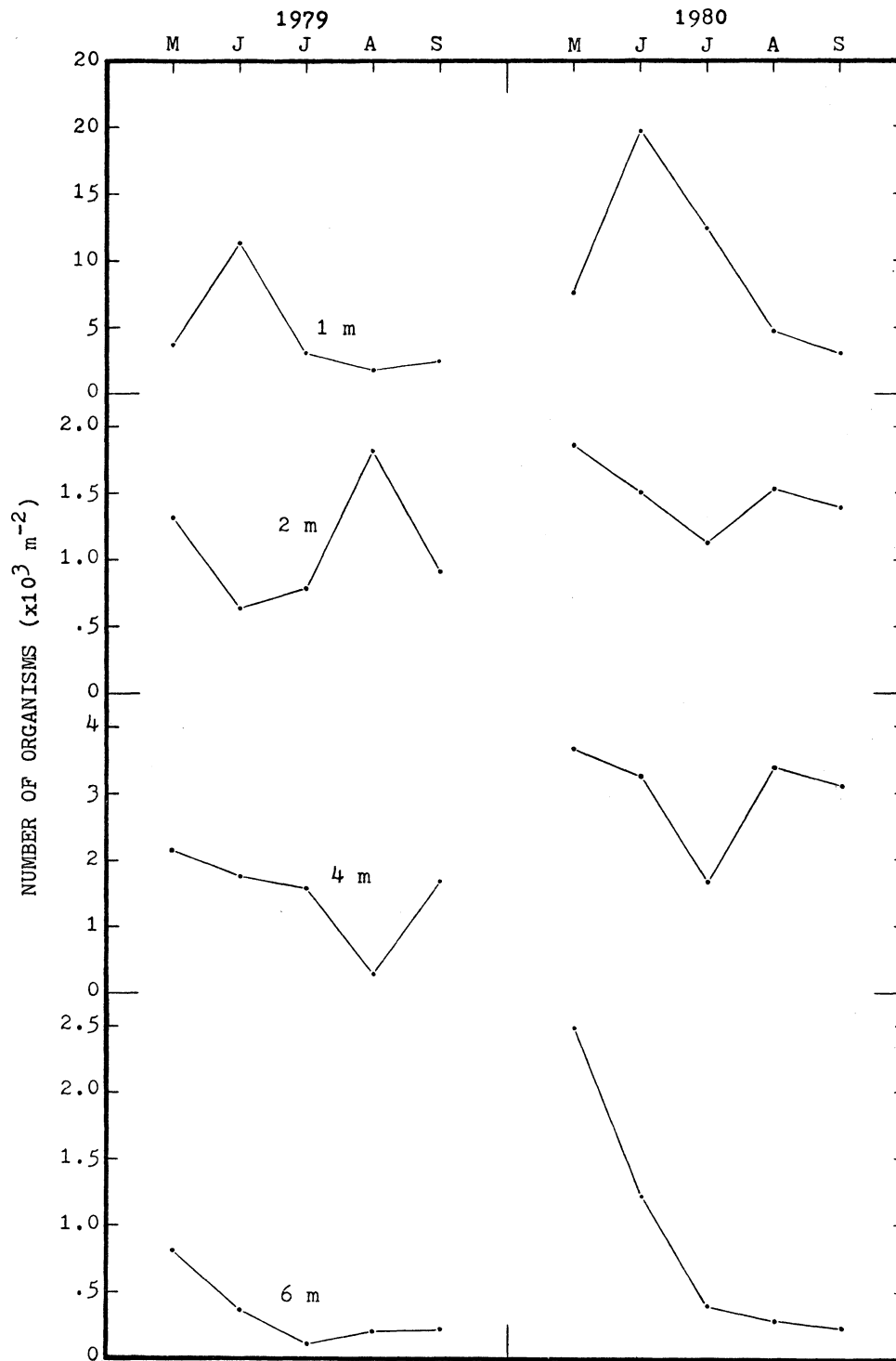


Figure 22. Seasonal fluctuations in mean total density of benthic macroinvertebrates at different depths in Weso Lake, 1979 and 1980. Standard deviations and sample sizes are given in Appendix K.

odonates, a ceratopogonid, and Sphaerium sp. at this depth was regarded as accidental and probably represented littoral fauna that strayed into deeper water.

With the exception of a single nematode and one Ablabesmyia sp. taken in 1980, only 2 taxa of invertebrates were observed at site 13 (4 m) during the investigation (Table 11). Chaoborus was the most abundant taxa at 4 m comprising 60% of the invertebrate density and 30% of the biomass. C. plumosus dominated the benthic biomass at site 13, accounting for 40% of the density and 70% of the biomass. The largest total invertebrate density collected at this station was 3655 m^{-2} in May 1980 (Figure 22).

Nematodes occurred sporadically at site 14 (6 m) during the study period, but they contributed less than 1% of the invertebrate density and biomass. Chaoborus was the only other taxa encountered at this station (Table 11). The greatest number of Chaoborus obtained at site 14 was 2483 m^{-2} in May 1980.

Eggleson (1931) defined the littoral zone of a lake as the region from the shore to the edge of aquatic vegetation. He described the profundal as the zone from the deepest point of a lake to "somewhat" above the average level of the hypolimnion. The sublittoral constituted the region between the profundal and littoral zones. The southern perimeter of Weso Lake did not have a well-defined littoral zone because the floating Sphagnum-Chamedaphne mat encroached into the open water. B. schreberi formed sparse beds of vegetation along the mat margin. Site 11 was located at the mat edge

and it could, therefore, be considered in this littoral region. Hypolimnetic sites 13 and 14 were in the profundal zone. Site 12, located at the upper boundary of the metalimnion, was included in the sublittoral area of Weso Lake.

The generalized curve of benthos abundance with depth in stratified lakes presents a sublittoral minimum with two population maxima, one in the littoral and another in the profundal zone (Brinkhurst 1974; Wetzel 1975; Jonasson 1978). Invertebrate density in Weso Lake exhibited a sublittoral minimum. The average density for the study period was 8969, 1322, and 2214 m^{-2} at sites 11, 12, and 13, respectively. Invertebrate biomass, in contrast, peaked in the sublittoral and declined to low values in the profundal. Biomass during the study period averaged 6.737, 7.054, and 5.869 g m^{-2} at sites 11, 12, and 13, respectively. Jonasson (1978) attributes the littoral density maximum to the faster growth rates of invertebrates with higher temperatures and higher oxygen levels in shallow water during summer. Faster growth in the littoral allows more generations per unit time and, consequently, greater numbers of organisms. In the sublittoral, the periods of growth and exposure to predation are longer, resulting in lower numbers and higher larval weights. A lack of predation and slow growth in cold hypolimnetic water contributes to larger populations and lower biomass in the profundal zone.

Dissolved oxygen may have been one of the primary factors determining invertebrate distribution in Weso Lake. Above the metalimnion, diversity was high and the fauna was abundant

with a high oxygen demand. Deeper sites harbored a few specialists tolerating the low oxygen tension. Sites 11 and 12 maintained measurable oxygen levels throughout the stratified periods. Sites 13 and 14 were anoxic during both summers (Table 12). Carnivores, such as Tanypodinae, Ceratopogonidae, and Odonata, constituted only about 10% of the total invertebrate fauna. Since the distribution of carnivorous invertebrates is limited by low oxygen saturation during summer stratification (Jonasson 1978), they were present only at sites 11 and 12.

Table 12. Average water quality for Weso Lake sites 11 to 14 based on samples collected during the stratified periods (May-September) of 1979 and 1980 (N=10).

Variable	Site 11 (1m)		Site 12 (2m)		Site 13 (4m)		Site 14 (6m)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
pH	5.47	.25	5.49	.16	5.60	.18	5.82	.21
Temperature °C	21	4	14	3	8	2	6	1
Conductivity umhos cm ⁻¹	28	4	29	4	32	5	41	9
Alkalinity mg CaCO ₃ l ⁻¹	4	1	4	1	7	1	12	4
Total Hardness mg CaCO ₃ l ⁻¹	11	1	12	1	12	1	14	2
Ca ⁺⁺ Hardness mg CaCO ₃ l ⁻¹	6	1	7	1	8	1	8	1
DO mg l ⁻¹	5.4	1.0	1.6	1.9	0	0	0	0
Reactive P mg l ⁻¹	.010	.010	.014	.015	.021	.028	.105	.066
Total P mg l ⁻¹	.044	.027	.032	.016	.059	.050	.182	.100
NH ₄ N mg l ⁻¹	.06	.05	.10	.08	.15	.12	.69	.30
NO ₂₋₃ N mg l ⁻¹	<.02	--	<.02	--	<.02	--	<.02	--
Kjeldahl N mg l ⁻¹	.87	.32	.80	.14	1.00	.30	1.77	.55
Chloride mg l ⁻¹	1.8	1.5	1.7	1.3	1.6	1.1	1.6	1.3

Only fourth instar larvae of C. plumosus were collected at site 13 during the study period. These mature larvae were dark red in contrast to the light red larvae observed at the shallower sites. The deeper color of the fourth instar larvae may have been due to increased haemoglobin content of blood of larvae in response to low dissolved oxygen (Fox 1955). Two major and one minor haemoglobin found in late instar larvae, which early instar C. plumosus larvae lack (Manwell 1966), may explain the survival of large larvae in anoxic conditions. Small larvae prefer shallow oxygenated water and, because of different haemoglobins, probably do not use low dissolved oxygen concentrations with the efficiency of large larvae.

In addition to the lack of oxygen at 6 m, the water at this depth was loaded with the products of reducing conditions (Table 12). Chemical stagnation may have contributed to the almost complete absence of a truly benthic fauna at site 14. The first 2 instars of Chaoborus larvae are limnetic, and 3rd-instar larvae and some 4th-instar larvae may also be limnetic during daylight hours under certain conditions (Hilsenhoff and Narf 1968). Most 4th-instar Chaoborus apparently remain in the uppermost layers of the bottom ooze during daylight hours, but ascend into the epilimnion at night (Ruttner 1963). This migratory habit may allow them to temporarily endure anaerobic conditions in the hypolimnion.

Correlation of chemical and physical conditions in the water with the distribution and abundance of benthos is obscured by microstratification at the mud-water interface

(Brinkhurst 1974). Significant ANOVA were obtained between sites for almost all of the chemical variables analyzed (Appendix M). Student-Newman-Keuls multiple comparisons (Zar 1974) were used to separate sites having significantly different levels of each chemical characteristic. Site 14 was separated from the other benthic sites for most of the variables, again emphasizing the chemical stagnation at this depth (Appendix M). The comparisons failed to detect any consistent pattern of differences in the water quality between the other benthic sites. Eggleton (1931) suggested that the effectiveness of the physical and chemical conditions is probably not due to variations of any one factor in complex, but the combined action of the variations of each factor in the presence of variations in the others.

The nature of the substrate may also have influenced vertical variation in the benthos. Benthic samples were taken from a portion of the lake basin composed exclusively of peat. The organic material had been decomposed to varying degrees, however, so that a range of particle sizes occurred from shallow to deep water. Coarse Sphagnum and Chamedaphne fragments characterized the lake bottom near shore, while deep deposits of fine particles occurred in the profundal area. This pattern was described by McLachlan and McLachlan (1975) for Blaxter Lough, England, and is typical of many bog lakes. Substrate particle size has been shown to be important in determining the distribution of freshwater invertebrates (Cummins and Lauff 1969; McLachlan and McLachlan 1971, 1975; McLachlan and Dickinson 1977). Taxonomic diversity was

greatest in the littoral where the large peat fragments provided a heterogeneous habitat, and made ecological segregation easier (Jonasson 1978). Fine particles in the profundal zone, by contrast, created a more homogeneous substrate and taxonomic diversity was low.

Time of year also affected total invertebrate density in the study area (Appendix L). The life cycle characteristics of the dominant aquatic insects, Chironomidae and Chaoborus, were probably responsible for seasonal fluctuations in benthic density. Seasonal variability followed a different course at each depth (Figure 22). The occurrence of a single population maximum at 1 m suggested that many of the littoral chironomids had either one or two generations each year. Overwintering 4th-instar larvae probably pupated and emerged in April or May and their progeny were first collected in June. Low numbers of larvae in July and August and the presence of pupae in the collections indicated that another emergence may have occurred in late July and in August. The low populations in September could be attributed to the inefficiency of the sampling gear to collect the early instars of the invertebrates. The number of generations per year in aquatic insects is a function of the species, water temperature, and food availability (Lindeman 1942; Coffman 1978). In littoral areas, water temperatures are generally high and primary production provides a continuous supply of fresh food during the summer. Littoral taxa, especially the herbivores, undergo faster growth and shorter life cycles than the benthos of deeper water. Most littoral species are bivoltine

(Jonasson 1978).

Although the pattern was not consistent in both years, fluctuations in total faunal density at sites 12 and 13 showed a periodicity with a single summer minimum followed by a slow increase until fall (Figure 22). The dominant taxon at these depths, C. plumosus, probably had a one-year life cycle. Detritivores, such as C. plumosus, show slower growth in deeper water (Eggleson 1931; Brinkhurst 1974; Jonasson 1978). In dimictic Lake Esrom, Denmark, Chironomus anthracinus (Zetterstedt) 1860 exhibited a one-year life cycle in shallow water (1 m), while deep (20 m) populations had a two-year life cycle (Jonasson 1978). Jonasson attributed the slower growth of the profundal population to low water temperatures and low oxygen concentrations. During summer stratification food was abundant in the profundal of Lake Esrom, but growth stopped when oxygen concentrations of the hypolimnion were reduced below 1 mg l^{-1} . Growth of C. anthracinus was limited to two brief periods during the spring and autumnal circulations when the water was oxygen rich. In Weso Lake, low oxygen levels and cool water temperatures at sites 12 and 13 (Table 12) could have contributed to the longer generation time of C. plumosus.

The seasonal distribution of invertebrates at 2 and 4 m may have been complicated by the horizontal migration of chironomid larvae during the year. In Weso Lake, the mean individual length of C. plumosus at sites 12 and 13 was large (12 mm) because the population was composed primarily of 4th-instars. C. plumosus in the littoral area, however, were

generally less than 5 mm long. Hilsenhoff and Narf (1968) speculated that small Chironomus larvae were absent from the profundal of Booth Lake and Lake Oneota, Wisconsin, during the summer because the progeny of the spring emergence may have lived exclusively in the littoral zone where food would be more abundant. Repopulation of the profundal zone of these lakes in October was attributed to recruitment by progeny of a fall emergence.

Gerking (1962) contended that Chironomus larvae migrate horizontally toward shore in summer and away from it in fall. Wirth and Stone (1968) described a similar pattern in which C. plumosus larvae migrated to different habitats depending on instar. Late instars (3rd and 4th) moved from littoral areas to greater depths, while early instar larvae (1st and 2nd) remained in littoral areas (Wirth and Stone 1968). The most likely cause of chironomid migration is low dissolved oxygen levels (Bay et al. 1966). The degree of chironomid movement in Weso Lake could not be determined from my study.

Chaoborus displayed a gradual decline in density at site 14 throughout the summer (Figure 22). The main emergence occurred in late May or early June, but pupation and emergence as adults continued until September. Since early instars of Chaoborus are limnetic (Wetzel 1975), repopulation of the benthos would not have taken place until the fourth larval stage was reached in the fall.

Seasonal fluctuations in invertebrate biomass in Weso Lake were not as pronounced as changes in invertebrate density (Figure 23). Date of sample collection was not a significant

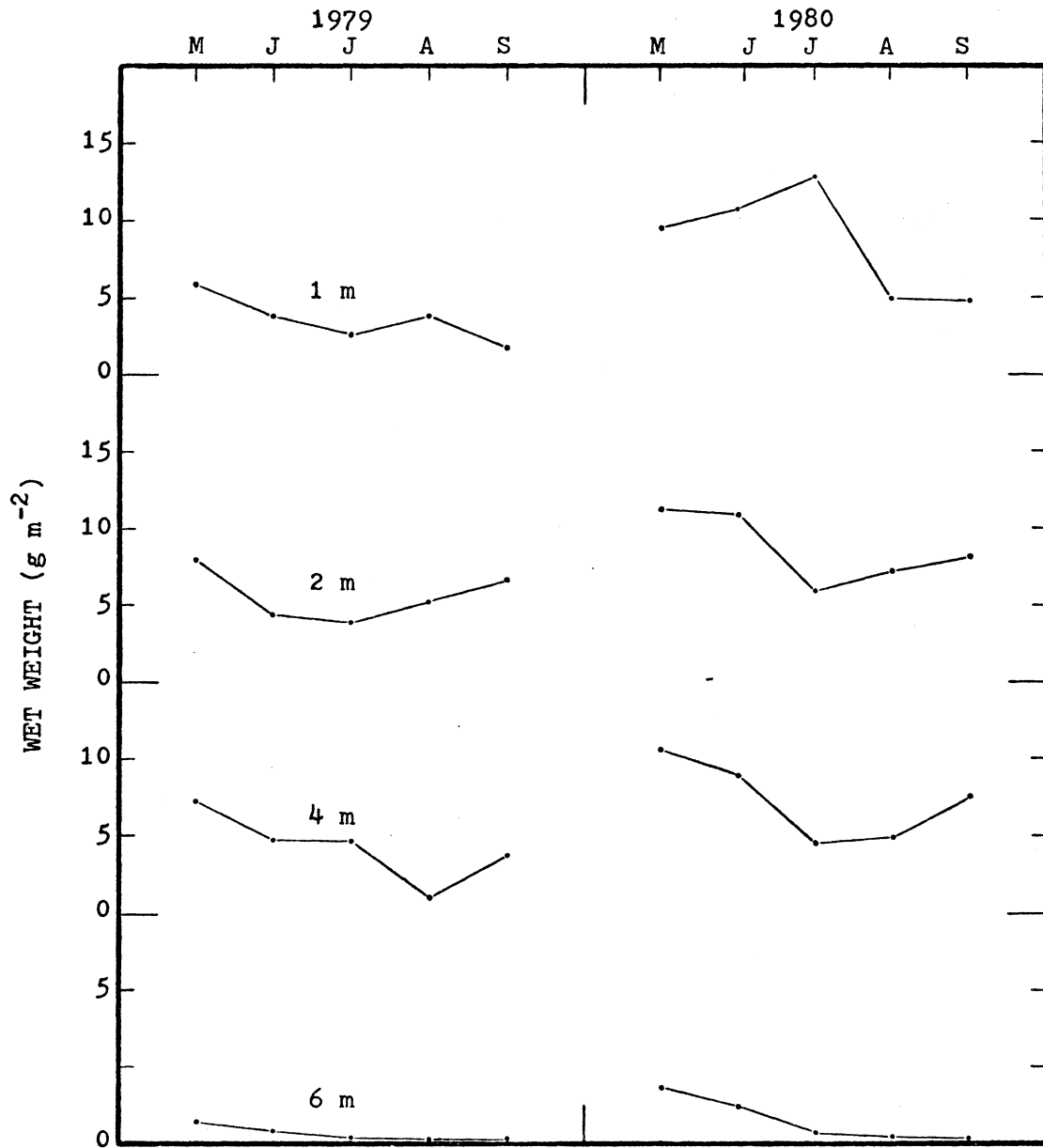


Figure 23. Seasonal fluctuations in mean total wet weight of benthic macroinvertebrates at different depths in Weso Lake, 1979 and 1980. Standard deviations and sample sizes are given in Appendix K.

factor in ANOVA of benthic invertebrate biomass (Appendix L). Cummins (1973) has suggested that stable freshwater systems in temperate regions have a relatively constant macroinvertebrate biomass because invertebrates are supplied with consistent and abundant food of similar calorific and protein content throughout the year.

Differences between years were significant for benthic invertebrate density and number of taxa (Appendix L). Total invertebrate densities at sites 11, 13, and 14 doubled in 1980 (Appendix K, Figure 22). Benthic counts at site 12 were 36% higher during the second summer of the study. The large annual variation in invertebrates observed in this study was not unique to benthic investigations. Halving, doubling, and even six-fold changes in benthic invertebrate standing stocks have been reported for stratified temperate lakes (Alm 1922, Lundbeck 1926, cited in Brinkhurst 1974; Oliver 1960; Morgan and Waddell 1961). Natural annual variability is usually more prevalent in invertebrate numbers rather than in biomass. Insects with aerial stages in their life histories fluctuate seasonally because of that emergence, but they may also be affected by year-to-year changes in climate or breeding success to a greater extent than fully aquatic forms (Brinkhurst 1974).

Larger phytoplankton populations in summer 1980 may have contributed to the natural increase in benthic invertebrates. Food manufactured in the water column is a prime factor in determining benthic production (Lellak 1965). Surface feeding chironomids are directly dependent on a supply of phytoplankton

from the water column. Chaoborus, which feed on pelagic zooplankton, maintain an indirect trophic dependence on the phytoplankton. Hilsenhoff (1967) found that a feeding stimulus was necessary for C. plumosus to pupate and emerge in Lake Winnebago, Wisconsin, and that this stimulus was provided by settling diatoms from the spring bloom. Greater inputs of decomposing phytoplankton on the bottom sediments of Weso Lake during 1980 could also have enhanced the development of the bottom fauna.

The increase in taxonomic diversity in 1980 was attributed to the occurrence of several trichopterans at site 11 and the presence of Tanypodinae, Ceratopogonidae and Odonata in site 12 samples (Table 11). Trichoptera found at site 11 in 1980 included: Oecetis sp., Oxyethira sp., and Fabria sp. These taxa were typical components of the mat edge fauna (Appendix N). The sporadic occurrence of these trichopterans in the benthos suggested that they may have been displaced invertebrate aufwuchs. Tanypodinae were frequently encountered in site 12 collections during 1980. The distribution of the predaceous Tanypodinae is limited by low dissolved oxygen concentrations (Jonasson 1978), and in Weso Lake during 1979, Tanypodinae were restricted to the littoral zone. The mean oxygen saturation at site 12, however, increased from 5% in 1979 to 26% in 1980. Colonization of the sublittoral by Tanypodinae in 1980 may have been a response to the more favorable dissolved oxygen levels. Similarly, higher oxygen concentrations in the littoral region during 1980 may have accounted for the increased abundance of

Ephemeroptera, Odonata, Trichoptera, Ceratopogonidae, and Mollusca at site 11 (Appendix K, Figures 20 and 21).

No attempt was made in this study to correlate changes in the chemical characteristics of the water with yearly variation in benthic invertebrates. Chemical properties of the water probably affected the biology of the invertebrates indirectly by regulating the growth of the phytoplankton.

Macroinvertebrate Aufwuchs

Aufwuchs comprises only organisms that are firmly attached to a substrate (Ruttner 1963). Macroinvertebrate aufwuchs sampling in Weso Lake was complicated by shallow water. Surface sediments were obtained in the sweep samples at both sites 9 and 10. Although some invertebrates collected in these sediments are generally considered benthic fauna, the term aufwuchs used in the following discussion has been applied to all invertebrates obtained in the net collections. Surface sediments in the littoral area were primarily dead macrophytes undergoing decomposition. Plants, whether living or dead, were still the dominant substrate, and probably influenced the distribution of the littoral fauna.

Coefficients of variation calculated for invertebrate aufwuchs samples were approximately 52% for numbers and 50% for biomass. These values are similar to the coefficients reported by Reinecke (1977) for sweep net samples from Maine beaver flowages.

The phylum Mollusca, the class Oligochaeta, and the

orders Diptera, Ephemeroptera, Odonata, and Trichoptera were the dominant macroinvertebrate aufwuchs in the study area (Appendix N). The remaining less common taxa of invertebrate aufwuchs accounted for 3% of total numbers and less than 5% of the total biomass. These groups included: Nematoda, Hirudinea, Decapoda, Amphipoda, Coleoptera, Hemiptera, Megaloptera, Neuroptera, and Lepidoptera.

Diptera, the most abundant order during the study, comprised 51% of the invertebrate aufwuchs counts and 8% of the biomass. Eighteen taxa of chironomids (Table 13) were responsible for 96% of the dipteran density and 95% of the biomass. Ceratopogonidae represented 3% of the dipteran density and 3% of the biomass. The remaining families, including Culicidae, Tabanidae, Tipulidae, and Tetanoceridae, accounted for only 1% of the density and 2% of the dipteran biomass.

Odonata dominated invertebrate aufwuchs biomass, comprising 8% of the total density and 56% of the biomass. Anisoptera was the most prevalent suborder, representing 52% of the odonate density and 89% of the biomass. The most abundant dragonfly was Leucorrhinia spp., which accounted for 73% of the anisopteran density and 47% of the biomass. Aeschna spp. was responsible for 6% of the anisopteran density and 21% of the biomass. The remaining dragonflies included: Anax spp., Basiaeschna sp., Boyeria sp., Cordulia sp., Tetragoneuria spp., Ladona sp., and Libellulidae (early instars). These taxa represented 21% of the anisopteran density and 32% of the biomass.

The suborder Zygoptera comprised 48% of the odonate

Table 13. List of Chironomidae from Weso Lake collected with a sweep net during 1979 and 1980 (X=present).

Taxa	May-Sept 1979						May-Sept 1980					
	Site						Site					
	9-1	9-2	9-3	10-1	10-2	10-3	9-1	9-2	9-3	10-1	10-2	10-3
F:Chironomidae												
SF:Chironominae												
G:Chironomus (Chironomus) spp.				X	X					X	X	X
G:C. (Cryptochironomus) sp.	X	X	X	X	X	X	X	X	X	X	X	X
G:C. (Dicrotendipes) sp.	X	X	X	X	X	X	X	X	X	X	X	X
G:C. (Endochironomus) spp.	X	X	X	X	X	X	X	X	X	X	X	X
G:C. (Xenochironomus) sp.	X		X	X	X		X	X	X	X		
G:Cryptocladopelma sp.										X		X
G:Glyptotendipes spp.	X	X	X		X		X	X	X	X	X	
G:Microtendipes sp.		X		X	X	X	X	X		X	X	X
G:Polypedilum sp.	X	X	X	X	X	X	X	X	X	X	X	X
G:Pseudochironomus sp.		X							X			
G:Tanytarsus sp.	X	X	X	X	X	X	X	X	X	X	X	X
Unidentified spp.	X	X	X	X	X	X	X	X	X	X	X	
SF:Orthoclaadiinae												
G:Psectrocladius spp.	X	X	X	X	X	X	X	X	X	X	X	X
SF:Tanypodinae												
G:Ablabesmyia sp.	X	X	X	X	X	X	X	X	X	X	X	X
G:Clinotanypus sp.					X					X	X	
G:Larsia spp.	X	X	X	X	X	X			X		X	X
G:Procladius sp.				X	X	X				X	X	X
G:Tanypus spp.				X	X					X	X	
Number of Taxa	11	12	11	14	16	11	11	11	12	16	15	12

density and 11% of the biomass. Enallagma spp. accounted for 37% of the zygopteran density and 58% of the biomass. Early instars of the family Coenagrionidae contributed 36% of the zygopteran density and 10% of the biomass. Other zygopterans included: Chromagrion sp., Ishnura spp., Nehallenia spp., and Lestes sp. These taxa represented 27% of the zygopteran density and 32% of the biomass.

Oligochaeta comprised 18% of the invertebrate aufwuchs density and 3% of the biomass during the study period.

The phylum Mollusca accounted for 9% of the total invertebrate aufwuchs density and 16% of the biomass. The class Pelecypoda was represented by a single genus, Sphaerium, which was responsible for 66% of the mollusk density and 77% of the biomass. The class Gastropoda comprised 34% of the mollusk density and 23% of the biomass. The dominant snail was Lymnaea sp., which accounted for 70% of the gastropod density and 83% of the biomass. Two other taxa, Helisoma sp. and Ferrissia sp., contributed 30% of the gastropod density and 17% of the biomass.

Trichoptera comprised 7% of the total invertebrate aufwuchs density and 10% of the biomass during the study period. The most abundant trichopteran was Oecetis spp., which accounted for 39% of the trichopteran density and 11% of the biomass. Polycentropus sp. made up 21% of the trichopteran density and 12% of the biomass. A hydroptilid caddisfly, Oxyethira, contributed 13% of the trichopteran density, but only 2% of the biomass. The family Limnephilidae was responsible for 16% of the trichopteran density and 49% of the

biomass. Limnephilus spp. dominated limnephilid biomass, representing 8% of the density and 58% of the biomass. The most abundant limnephilid was Nemotaulius sp., which accounted for 42% of the limnephilid density and 14% of the biomass. Other taxa within the family included: Glyphopsyche sp., Platycentropus sp., and Limnephilidae (early instars).

Ephemeroptera comprised 4% of the total invertebrate aufwuchs density and 2% of the biomass. Caenis sp. contributed 97% of the ephemeropteran density and 96% of the biomass. Callibaetis sp. was the only other mayfly observed in the study area.

Seasonal fluctuations in invertebrate aufwuchs density and biomass are presented in Figure 24. The percent composition of invertebrate counts and biomass are illustrated in Figures 25 and 26, respectively. The effects of year, sampling date, and cover type (site) on invertebrate aufwuchs density, biomass, and number of taxa are summarized in Appendix O. The factors of primary interest are cover type and year.

Differences between cover type were not significant for either total invertebrate density or biomass. The total number of taxa in the herbaceous emergent and floating-leaved vegetation (site 10), however, was significantly higher than in the ericaceous vegetation (site 9). Sixty-three taxa of invertebrates were collected at site 10 during the investigation, while fifty-five taxa were found in site 9 samples (Appendix N). The average number of taxa in collections from sites 9 and 10 were 18 and 21, respectively.

The differences in macroinvertebrate diversity between

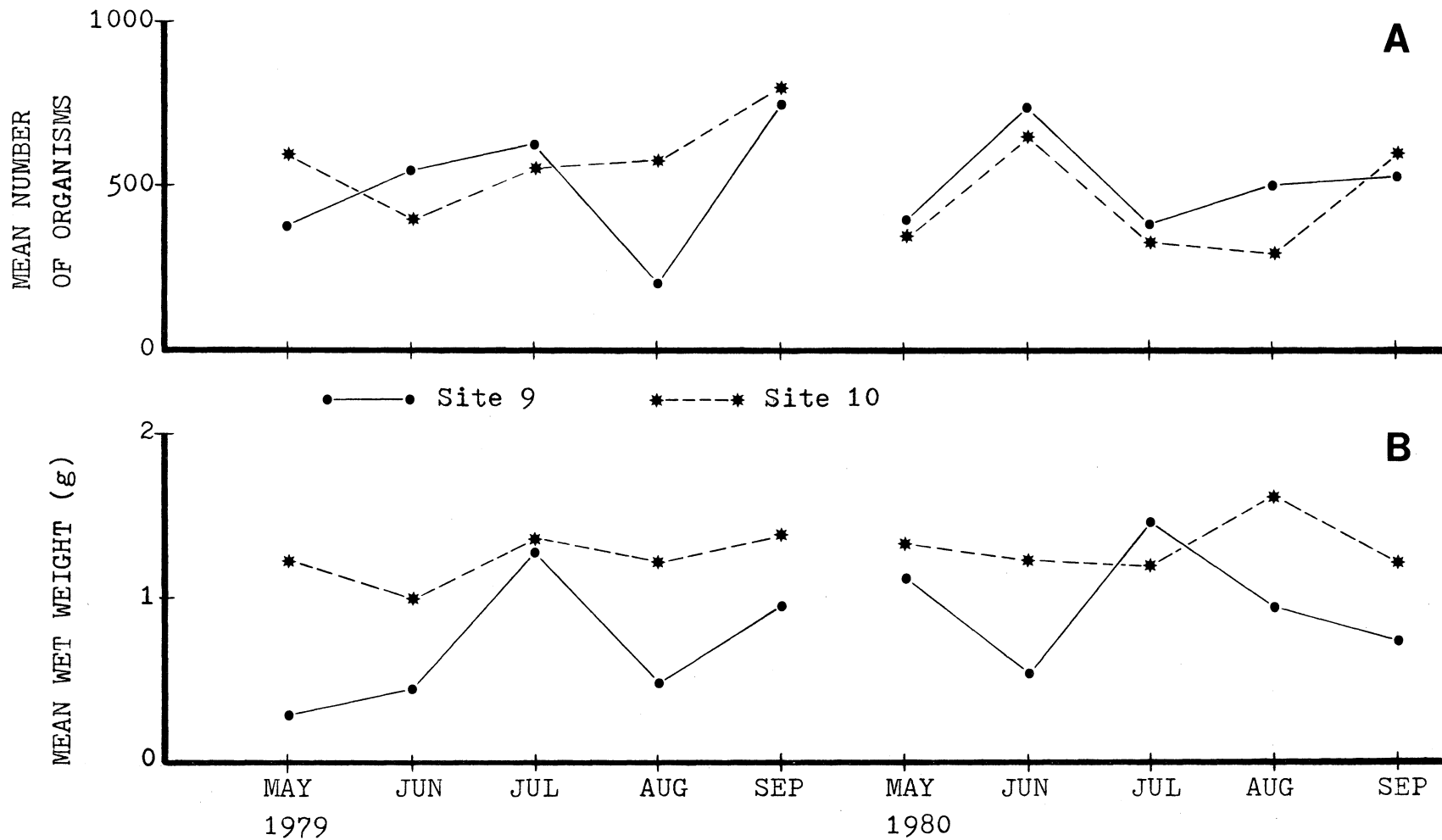


Figure 24. Mean monthly macroinvertebrate aufwuchs (A) density and (B) biomass for Weso Lake, 1979 and 1980. Standard deviations and sample sizes are given in Appendix 0.

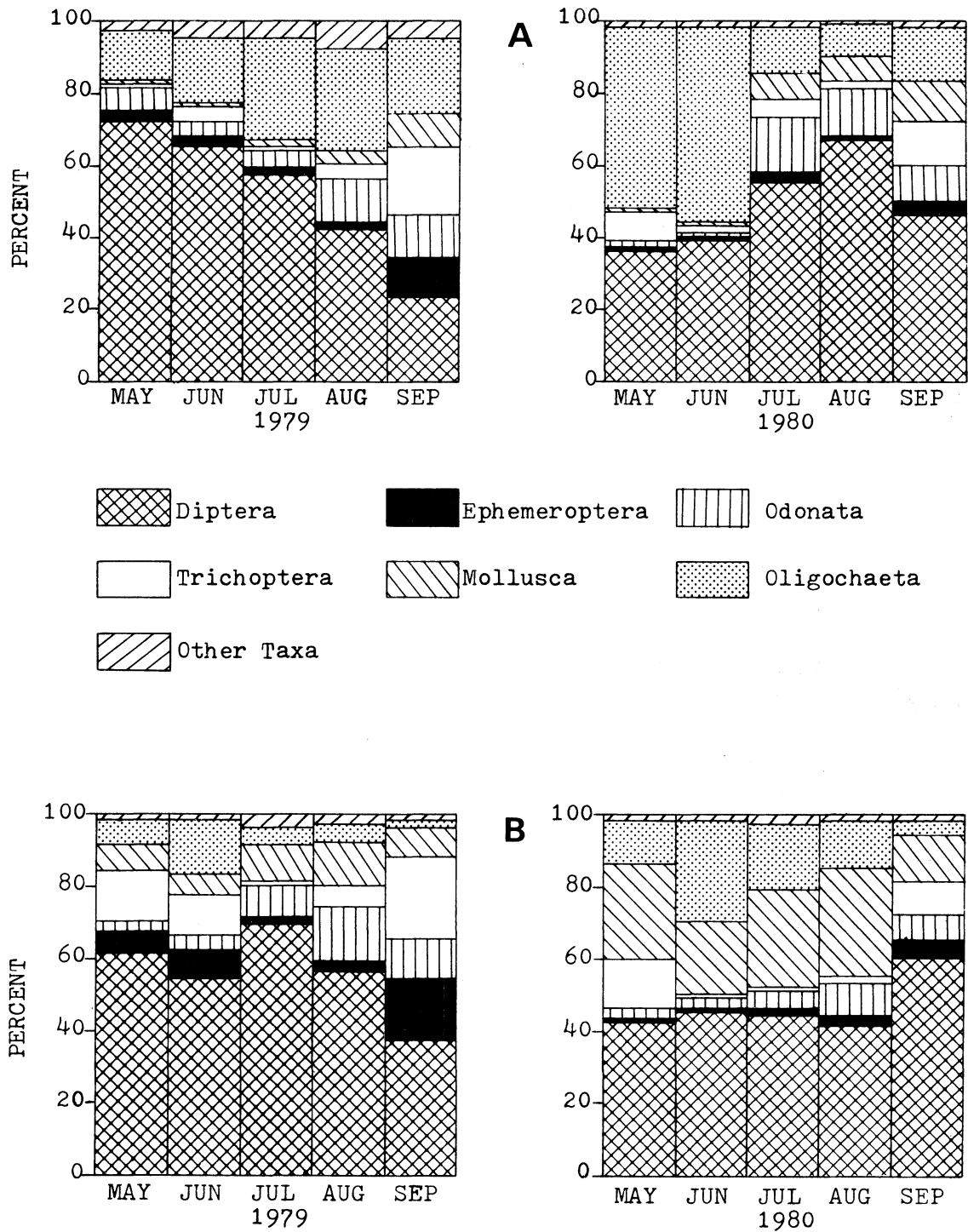


Figure 25. Mean monthly percent composition of dominant macroinvertebrate aufwuchs by number for (A) site 9 and (B) site 10 in Weso Lake, 1979 and 1980.

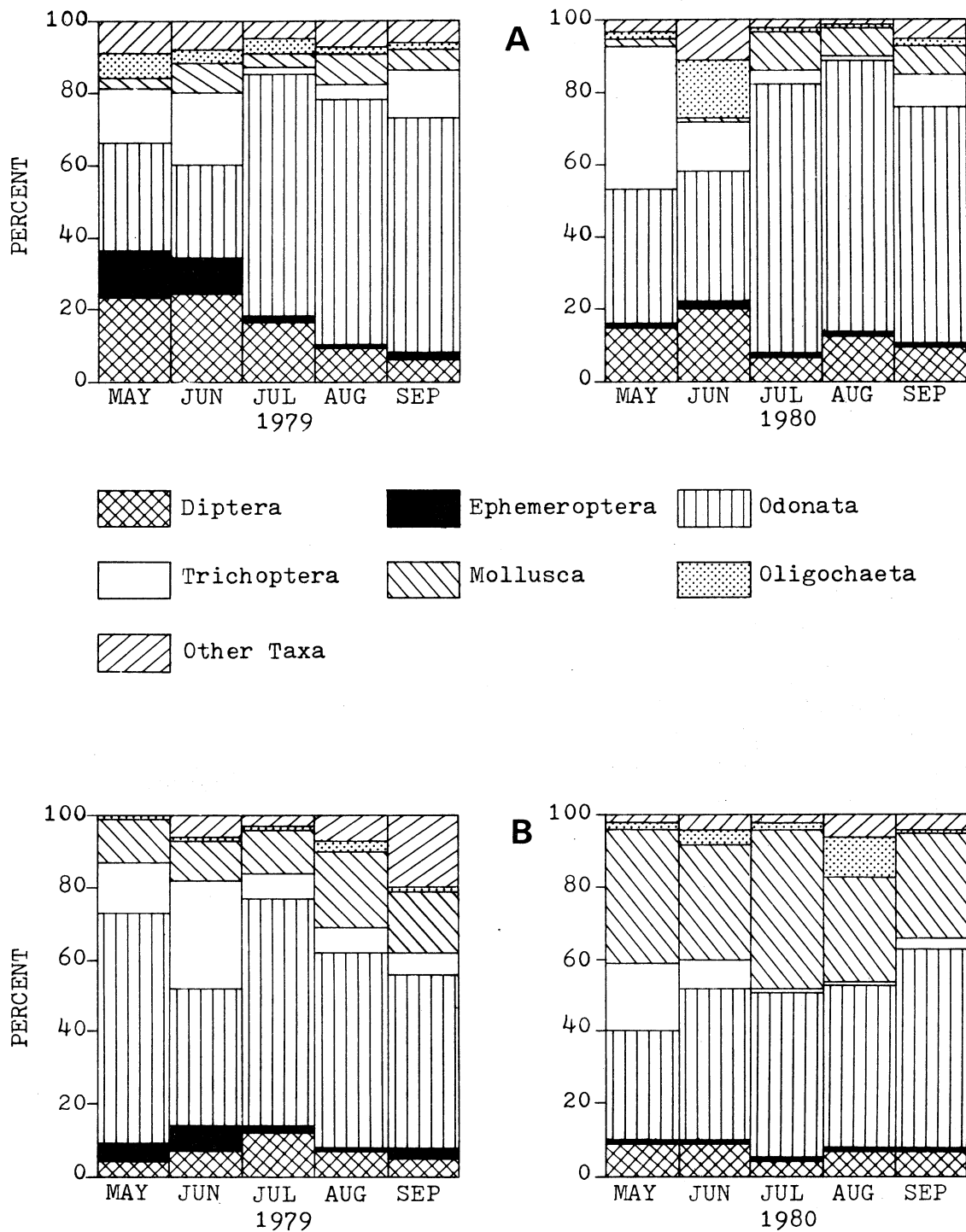


Figure 26. Mean monthly percent composition of dominant macroinvertebrate aufwuchs by weight for (A) site 9 and (B) site 10 in Weso Lake, 1979 and 1980.

cover types may have been related to a number of factors. First, the herbaceous emergent and floating-leaved community was structurally more complex than the ericaceous cover type. In the Chamedaphne, the peat sediment and the woody stems were the only substrates available. Floating-leaved vegetation added another layer to the system. The herbaceous stand had a more intricate three dimensional structure and a higher organic matter production. Kreckler (1939), Andrews and Hasler (1943), Rosine (1955), and Moyle (1961) explained the comparative diversity of macroinvertebrates on aquatic macrophytes in terms of substrate surface area. Increases in vegetational density also provide additional escape sites for prey organisms (Benke 1976).

Cover type differences in invertebrate diversity may have also indicated varying levels of energy input to the system. Increased structural complexity implies increased area for the attachment of periphyton (Harrod 1964). Although some of the primary production in wetland systems is consumed directly, most of the energy flows through the detrital pathway. Griffiths (1973) found that from 70 to 80% of the invertebrate fauna of a moorland pond in Great Britain were detritus consumers. Detritus is known to be a factor affecting the distribution of many macroinvertebrates (Egglishaw 1964). Since herbaceous species generally produce more easily decomposed organic matter than do ericaceous species (Moore and Bellamy 1974), the availability of energy may partially explain the greater diversity of macroinvertebrates in the herbaceous emergent and floating-leaved cover

type.

Dense growths of freshwater sponge, Spongilla sp., were observed only on submerged stems of Chamedaphne. Jewell (1939) found that Spongilla grew well on submerged wood and was best able to survive in water of high organic content. The neuropteran, Sisyrha sp., and the trichopteran, Ceraclea sp., were also limited to site 9 because they live in or on freshwater sponges (Evans 1978; Resh et al. 1976).

The density and biomass of mollusks was significantly different between sites (Appendix N). Sphaerium was primarily responsible for the greater abundance of mollusks at site 10. Ninety-nine percent of the Sphaerium collected during this study were found at site 10. Jewell and Brown (1929) suggested that pH 5.7 was the lower limit for the sphaeriid Pisidium since, below this point the deposition of lime in shells would theoretically cease to be possible. Morrison (1932) found that bivalves in northeastern Wisconsin lakes were generally restricted to waters with a pH greater than 5.0. The pH of the water in the mat edge of Weso Lake never exceeded 4.8, while other sites in the lake averaged pH 5.5 (Appendix D). The distribution of Sphaerium, a benthic detritivore, was probably influenced more by sediment composition and water chemistry than by cover type. Lymnaea, in contrast, occurred more frequently in the ericaceous vegetation. In a study of 823 Norwegian lakes, gastropods were found in only 3 lakes with pH values below 5.8 (Okland 1969, cited in Wiederholm and Erikson 1977). Seventy-five percent of Lymnaea collected in Weso Lake were found at site 9.

Mat edge samples, however, accounted for only 59% of the biomass of this snail. The shells of Lymnaea from site 9 were thin and translucent, suggesting limited calcium deposition in the more acidic conditions of the mat edge.

Differences in sediment composition between sites affected the distribution of Trichoptera. Oecetis, the most abundant trichopteran during the study period, was primarily restricted to samples from the herbaceous vegetation. Less than 2% of the Oecetis occurred in the mat edge collections. The sand grains that Oecetis used in the construction of its retreats were found only in the sediments at site 9.

Differences between years were not significant for either total invertebrate aufwuchs density or biomass (Appendix O, Figure 24). These results support the conclusion that the biomass of aquatic macroinvertebrates in freshwater systems is relatively constant (Cummins 1973). Although yearly differences in total aufwuchs counts and biomass were within the range of natural variability, several dominant taxonomic groups exhibited noticeable decreases in abundance during the study period (Appendix N, Figure 25). The density of the ephemeropteran Caenis declined by 70% in 1980. Trichopteran counts were 50% lower and Odonata decreased by 34% during the second summer of the study. Chironomid numbers were 23% lower in 1980.

Increases in abundance of Mollusca and Oligochaeta during 1980 partially compensated for the declining populations of aquatic insects. Oligochaete density and biomass increased by 53 and 183%, respectively. Mollusk counts were

67% higher in 1980, and mollusk biomass increased by 138%. Sphaerium, primarily responsible for the higher mollusk densities, exhibited a 137% increase in numbers during the second summer of the study.

Weather probably played a dominant role in determining the natural fluctuations in the invertebrate aufwuchs communities. An early spring dry period in 1980 caused a reduction in the water level of Weso Lake during summer. Declining water levels could have reduced the aquatic insect population by eliminating a portion of the macrophytic substrate or by affecting the breeding success of the adults. Oligochaeta and Sphaerium would be less susceptible to the deleterious effects of lower water because they are primarily benthic invertebrates and lack an aerial stage in their life cycles. Voigts (1976) found that total invertebrate abundance in several Iowa marshes increased with higher water levels as emergent vegetation was replaced by floating-leaved and submerged aquatic plants. Lower water levels in Weso Lake might also have indirectly favored oligochaetes and bivalves by reducing predator populations.

Algal Bioassays

The results of effluent enrichment bioassays using the test alga, Anabaena, are illustrated in Figure 27. Nutrient and pH analyses of the lake water and effluent controls used in these studies are presented in Table 14.

Secondary lagoon effluent or treatment bog effluent was added to filtered Weso Lake water samples at concentrations

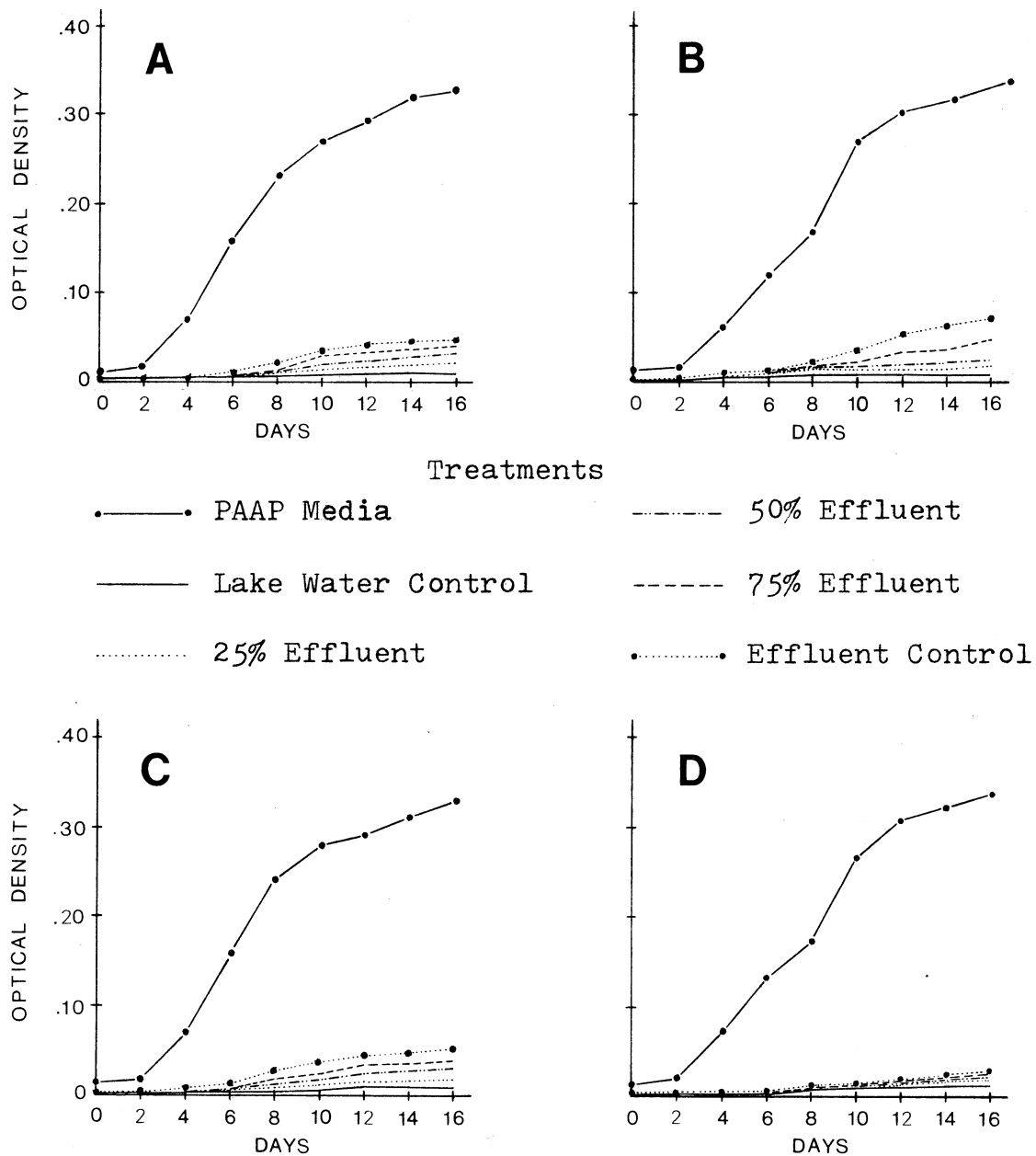


Figure 27. The effect of secondary lagoon effluent on the growth of *Anabaena* in filtered Weso Lake water sampled on (A) August 11, 1979, (B) June 22, 1980, and (C) September 13, 1980; and (D) the effect of bog effluent on the growth of *Anabaena* in filtered Weso Lake water sampled on August 10, 1980.

Table 14. Nutrient and pH data associated with effluent algal bioassays on Weso Lake water for 1979 and 1980. Values are for filtered samples.

Date/ Treatment	Nutrient (mg l ⁻¹)					pH
	Reactive P	Total P	NH ₄ -N	NO ₂₋₃ -N	Kjeldahl N	
VIII-11-79						
Lake Water	.010	.030	<.02	<.02	1.00	5.75
Secondary Effluent	.005	.045	<.02	<.02	1.00	8.82
VI-22-80						
Lake Water	.005	.030	.05	<.02	0.90	5.55
Secondary Effluent	.015	.045	<.02	<.02	1.12	9.84
VIII-10-80						
Lake Water	<.005	.010	.08	<.02	0.75	5.39
Bog Effluent	.007	.025	.04	<.02	1.02	3.95
IX-03-80						
Lake Water	<.005	.035	.02	<.02	0.90	5.60
Secondary Effluent	.010	.075	.04	<.02	1.28	9.80

of 10, 25, 50, and 75% effluent. Secondary lagoon effluent (Figure 27A-C) in concentrations of 25, 50, and 75% increased the growth of the alga over the lake control. Very little growth occurred in either 10% effluent or lake water alone. The results of each secondary effluent experiment indicated that growth of the test alga increased with increasing concentrations of secondary effluent. Additions of bog effluent to lake water (Figure 27D) sustained little or no growth of Anabaena. The bog effluent bioassay was repeated with buffered (15 mg l⁻¹ NaHCO₃) treatments, but the results were not significantly different from growth in the unbuffered treatments.

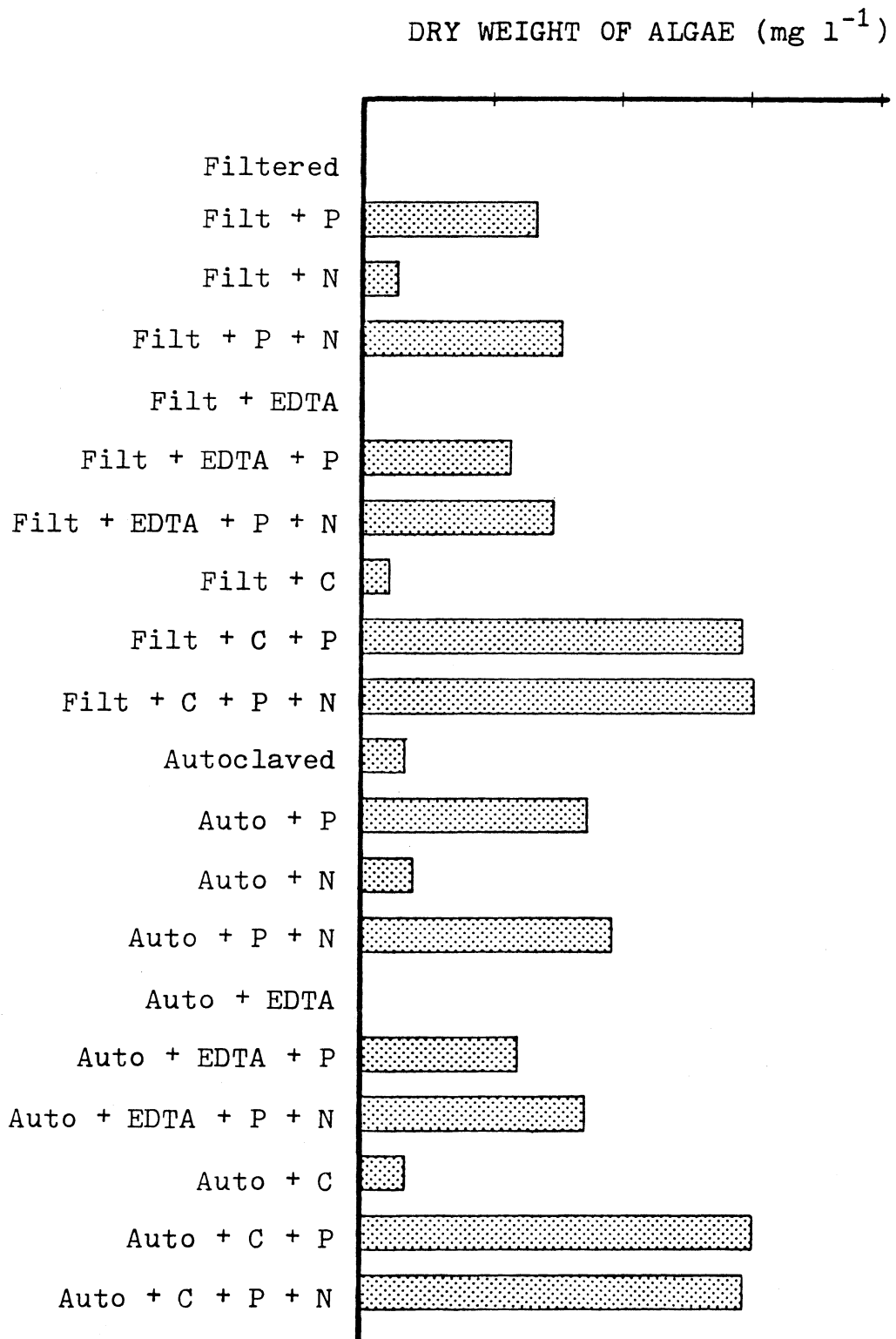
Final dry weights of the test alga were not reported

for these bioassays because the cultures generally contained less than 5 mg of algae. Dry weights are not suitable for low density cultures (Fitzgerald 1975). Exponential growth was not observed in any of the treatments including the secondary effluent controls. The lack of exponential growth during incubation indicates either sublethal toxic effects or marginal nutrient content of the test waters (Greene et al. 1975). Chemical analyses of the lake water samples (Table 14) suggested that growth may have been limited by low pH or low inorganic nutrient concentrations. DeCosta and Preston (1980) found that algal exponential growth could not be induced without the addition of a buffer in test waters with a pH lower than 5.5. Low soluble reactive phosphorus concentrations in the secondary effluent samples (Table 14) also suggested nutrient deficiency.

A nutrient addition bioassay was conducted on the August 1980 lake water sample to determine whether the test alga was limited by H^+ concentration or by lack of an available nutrient. Since Anabaena has nitrogen-fixing abilities, inorganic nitrogen requirements cannot be determined under conditions of free atmospheric gas exchange that are required by the Algal Assay Procedure Bottle Test (Shiroyama et al. 1976a). Blue-green algae, however, are stimulated to grow and store nutrients when external nitrogen concentrations are high (Stewart et al. 1978).

The results of the nutrient-lake water bioassay (Figure 28) showed that lake water alone or with either carbonate or nitrate alone sustained little or no growth of the alga.

Figure 28. Results of algal nutrient bioassay of Weso Lake water sampled on August 10, 1980, expressed as dry weight of Anabaena produced.



The treatments with carbonate + phosphorus and carbonate + phosphorus + nitrogen were similar, and demonstrated the highest final yield. Lake water with phosphorus alone exhibited exponential growth, but the final yield was significantly less than the treatment with carbonate + phosphorus. None of the treatments with phosphorus + nitrogen displayed significantly higher yields than the treatments with phosphorus alone. Although the buffering capacity conferred by the addition of carbonate had a significant effect on algal growth, phosphorus was the primary limiting nutrient in the lake water.

A synthetic organic ligand (EDTA) was added to several treatments to test for the inhibitory stress of heavy metals on biological productivity (Shiroyama et al. 1976b). The algal assay data (Figure 28) showed that addition of EDTA to phosphorus and phosphorus + nitrogen treatments did not produce an increase in growth response over that achieved in the corresponding treatments without EDTA. These results suggested that the lake water samples did not contain any heavy metals that could have inhibited laboratory algal growth.

Filtration as a sample pretreatment is used to remove indigenous organisms that might interfere with the growth of the unialgal test species. Filtration alone may lead to erroneous results, however, by removing some phosphorus forms which could later become biologically available to the test alga (Clasen and Bernhardt 1974). Autoclaving followed by filtration is used to determine the amount of algal biomass that can be grown from all nutrients in the water, including

those in filterable organisms and other particulate matter, which can be solubilized by autoclaving (Miller et al. 1978). Growth responses of Anabaena in the autoclaved-filtered assays were similar to the yields obtained in the filtered treatments. These results, as well as the chemical analyses of the lake water sample (Table 15), indicated that very little phosphorus was contained in indigenous organisms or was sorbed onto particles. The relatively high chlorophyll a value ($7.4 \mu\text{g l}^{-1}$), and the time of the year, suggested that Weso Lake phytoplankton are able to efficiently use low concentrations of phosphorus.

A nutrient bioassay was also conducted on the September 1980 secondary effluent sample to determine whether the test alga was inhibited by toxic effects or nutrient limitation. The results of the nutrient-effluent assay (Figure 29) showed phosphorus as the primary limiting nutrient. Algal growth in the original series of lake water-secondary effluent experiments, therefore, may have been limited by low levels of

Table 15. Nutrient and pH data associated with nutrient algal bioassays on Weso Lake water for August 1980 and secondary lagoon effluent for September 1980.

Bioassay	Nutrient (mg l^{-1})					pH
	Reactive P	Total P	$\text{NH}_4\text{-N}$	$\text{NO}_{2-3}\text{-N}$	Kjeldahl N	
Lake Water						
Raw	<.005	.010	.08	<.02	0.75	5.39
Filtered	<.005	.007	.08	<.02	--	--
Autoclaved	.005	.012	.08	<.02	0.70	5.43
Secondary Effluent						
Raw	.010	.075	.04	<.02	1.28	9.80
Filtered	.005	.048	.04	<.02	--	--
Autoclaved	.012	.070	.04	.02	1.24	9.86

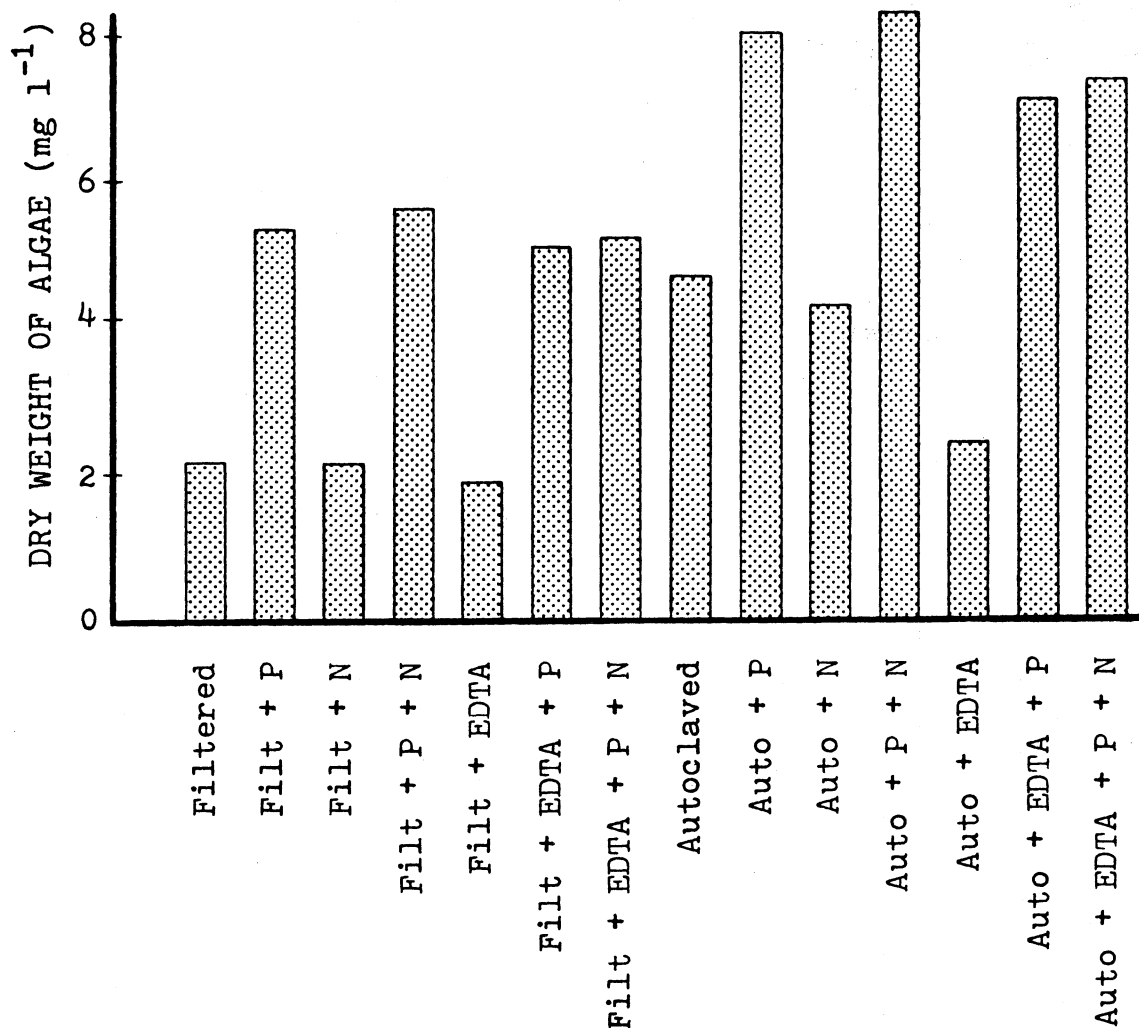


Figure 29. Results of algal nutrient bioassay of Drummond secondary lagoon effluent sampled on September 13, 1980, expressed as dry weight of Anabaena produced.

phosphorus in the secondary effluent. Phosphorus and phosphorus + nitrogen treatments were not significantly different from each other. Algal growth responses in the chelator (EDTA) additions suggested the absence of heavy metal toxicity in the secondary effluent.

The final yields in the autoclaved-filtered treatments were generally higher than in the filtered treatments. Filtering the secondary effluent without autoclaving removed about

50% of the phosphorus present in reactive forms (Table 15). Autoclaving followed by filtering, however, increased the amount of soluble reactive phosphorus present in the test water. These data, and the results of the bioassay suggested that a significant portion of the available phosphorus supply may have been contained in organisms or sorbed onto particles, and might have become biologically available in natural systems. The observed phosphorus limitation response may have been an erroneous result produced by sample pretreatment.

Maximum yield of Anabaena in a bioassay is predictable if phosphorus concentrations are known, other nutrients are in abundant supply, and toxicants are absent (Shiroyama et al. 1976b). Anabaena was selected for use in my experiments because the genus is present in Weso Lake and, further, because the yield factors for Anabaena and Selenastrum capricornutum Printz, the more commonly used bioassay test alga, are not statistically significantly different (Shiroyama et al. 1976a). The soluble reactive phosphorus concentration (if $\geq .01 \text{ mg l}^{-1}$) multiplied by 450 indicates the biomass of Anabaena that can be expected (in mg l^{-1} dry weight) if phosphorus is the limiting factor (Shiroyama et al. 1976b). The observed yields for the secondary effluent-nutrient bioassay (Figure 29) were not significantly different from the yields calculated from the soluble reactive phosphorus concentrations (Table 15). Yields observed for the unbuffered, autoclaved treatments of the lake water-nutrient assay (Figure 28) were 25-45% lower than predicted yields, again emphasizing the effect of H^+ concentration on the growth of the test alga under laboratory

conditions.

Fish Survey

The purpose of this survey was to determine the diversity and relative abundance of the fish community in Weso Lake. No attempt was made to conduct complete population estimates or detailed age and growth analyses of all fish species.

Five species of fish were caught with funnel traps, minnow traps, and hook-and-line fishing (Table 16). The most abundant species during the study period was black bullhead, which comprised 43% of the total catch density and 28% of the weight. Black crappie dominated the sample biomass, contributing 53% of the sample weight and 25% of the numbers. Pumpkinseed accounted for 26% of the catch density and 13% of the

Table 16. Total number and weight of each fish species caught with funnel traps, minnow traps and hook-and-line fishing in Weso Lake during 1979 and 1980.

Common Name	Scientific Name	Number Captured	Weight (g)
Black Bullhead	<u>Ictalurus melas</u>	128 ^a	3822
Black Crappie	<u>Pomoxis nigromaculatus</u>	76	7269
Pumpkinseed	<u>Lepomis gibbosus</u>	78 ^b	1811
Green Sunfish	<u>Lepomis cyanellus</u>	16	854
Central Mudminnow	<u>Umbra limi</u>	1	4

^a Includes 55 young-of-the-year black bullhead caught in August 1980.

^b Includes 41 young-of-the-year pumpkinseed caught in August 1980.

biomass. Forty-seven percent of pumpkinseed numbers, however, were young-of-the-year captured in August 1980. Only 5% of the sample density and 6% of the weight was attributed to green sunfish. One central mudminnow was taken in a funnel trap in June 1979. Cyprinidae were not present in any of the collections.

The catch rate for funnel traps never exceeded 13 fish/24 hr (Appendix P). The maximum catch rate for an individual species was 9 black bullhead/24 hr in June 1980. Black crappie was the only species obtained by hook-and-line sampling. The average catch rate for black crappie during the study period was 3.4 fish/hr. Although no fish were captured in the minnow traps during 1979, 55 young-of-the-year black bullheads and 41 young-of-the-year pumpkinseed were taken by this method during one 24-hr period in August 1980.

Other investigators have observed acid bog lakes with low diversity and abundance of fish fauna. Welch (1936) reported the total absence of fish in Bryant's Bog Lake, Cheboygan County, Michigan. Only bluegill (Lepomis macrochira), brown bullhead (Ictalurus nebulosus), and yellow perch (Perca flavescens), were found in Vincent Lake, Michigan (Jewell and Brown 1924). Bricker and Gannon (1976) indicated that the fish community in Hoop Lake, Michigan, consisted predominantly of stunted yellow perch. Prior to chemical treatment and trout stocking, the fish species of Spruce Lake in Taylor County, Wisconsin, included only largemouth bass (Micropterus salmoides), bluegill, and yellow perch (Snow 1969).

The average lengths and weights of fish species caught

in Weso Lake during 1979 and 1980 are summarized in Table 17. Length-frequency distributions of the catch are illustrated in Figures 30-32. The catch may not have been representative of the population as a whole because the sampling gear was selective by size and species. Ordinarily, the size of fish caught with hook-and-line is positively correlated both with the size of hook and with the size of lure used. Among the factors affecting the efficiency and selectivity of hook-and-line fishing are differences in attractiveness of baits, seasonal and diurnal patterns of feeding behavior, availability of natural food, density of fish, changes in hook condition with use, and skill of the operator (Lagler 1978). Hook-and-line fishing can produce good results, however, where fish are concentrated and capture by other means is impracticable; such as in Weso Lake where black crappie were concentrated in open water. Funnel traps can be both strongly selective by species and differently efficient by size (Bennett 1970). Factors affecting the efficiency and selectivity of funnel traps include: mesh size, diameter of throat, depth of placement,

Table 17. Summary of lengths (mm) and weights (g) of all fish species caught by funnel traps and hook-and-line fishing in Weso Lake during 1979 and 1980.

Species	Length					Weight				
	Mean	Range		SD	Sample Size	Mean	Range		SD	Sample Size
Black Bullhead	159.0	106	189	13.98	73	52.4	16	78	13.36	73
Black Crappie	189.5	80	283	35.88	76	95.6	6	300	44.57	76
Pumpkinseed	125.6	62	183	27.46	37	49.0	3	112	25.54	37
Green Sunfish	137.2	116	165	13.68	16	53.4	24	110	19.92	16
Central Mudminnow	89.0	89	89	0.00	1	4.0	4	4	0.00	1

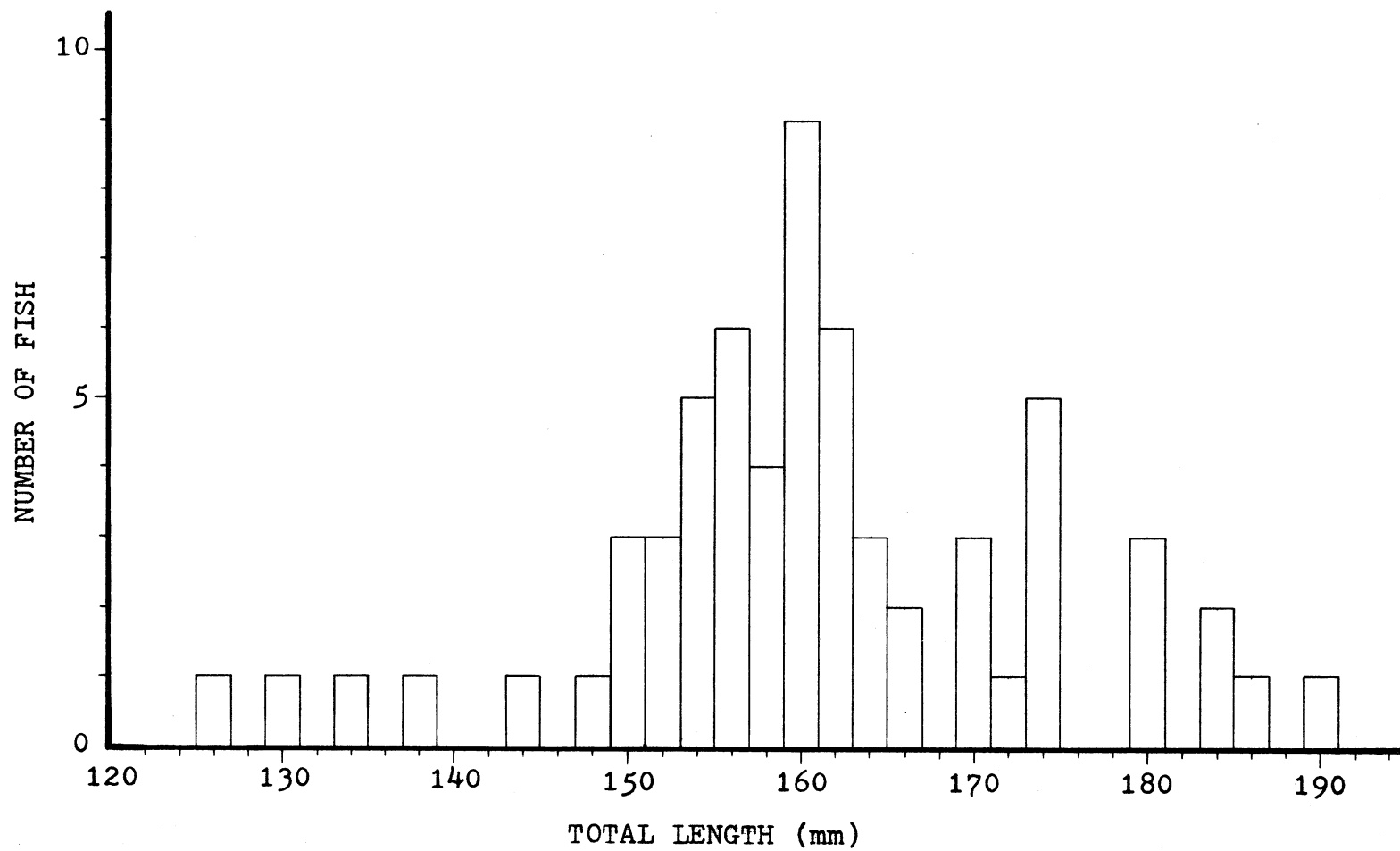


Figure 30. Length-frequency histogram for black bullhead caught in June 1979.

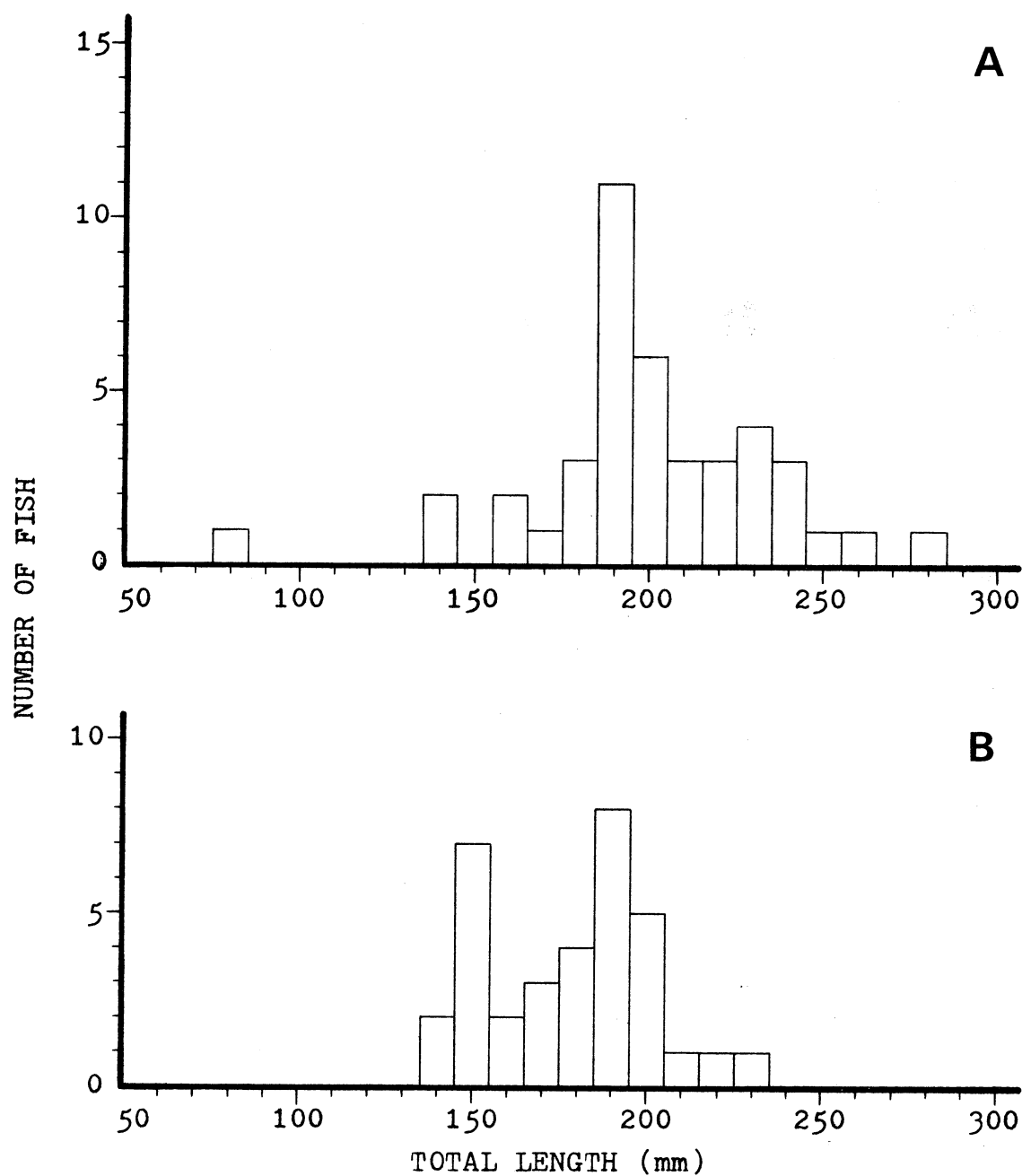


Figure 31. Length-frequency histogram for black crappie caught in (A) June 1979 and (B) June 1980.

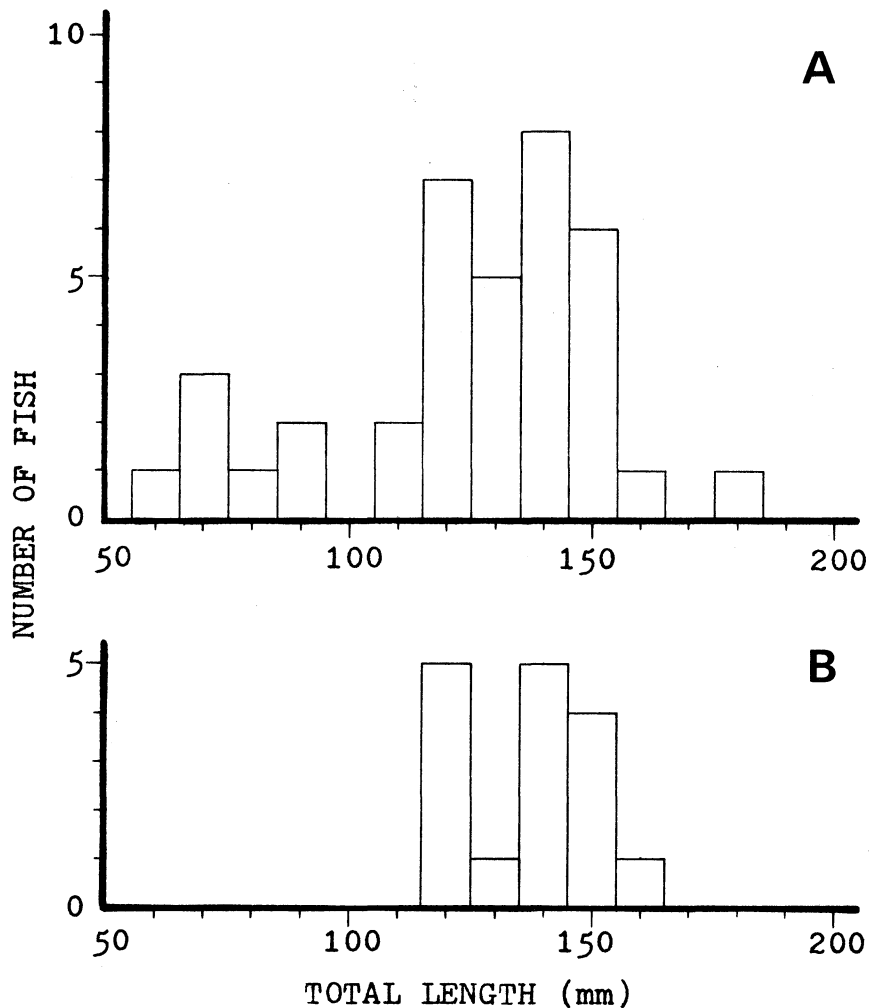


Figure 32. Length-frequency histogram for (A) pumpkinseed and (B) green sunfish caught in 1979 and 1980.

orientation of trap to shoreline, and diurnal and seasonal patterns of feeding behavior. Funnel traps are very effective for sunfishes, perch, and some minnows (Lagler 1978).

The mean lengths for fish species in Weso Lake were generally within the ranges reported in the literature. Trautman (1957) listed maximum size for black bullhead as 427 mm in length and a weight of 1247 g, but mentioned that adults were usually 144-305 mm in length and weighed 28-425 g.

Scott (1967) reported that black bullhead in Ontario average less than 203 mm in length. Large black crappies may weigh 900 g and reach 305-355 mm in length, but the average is closer to 227 g and 178-254 mm in length (Scott 1967).

Trautman (1957) listed the maximum size for black crappie in Ohio as 384 mm and 1020 g. Pumpkinseeds inhabiting lakes may reach a length of 203-229 mm, but in small ponds, adults reach only 102-127 mm in length (Scott 1967). Although green sunfish may grow up to 203 mm total length in Canada, specimens are usually not over 127 mm (Scott and Crossman 1973). Trautman (1957) gave 274 mm length and a weight of 411 g as the maximum for green sunfish in Ohio.

Black crappie caught in June 1980 were selected for age and growth analysis. The body length:scale radius relationship was determined to be linear (Figure 33); and the regression equation was fitted by least squares using standard regression procedures (Zar 1974). From the body length:scale radius relationship and measurements of annuli radii, the body lengths were calculated for each age represented by an annulus (Table 18). The work of Erickson (1952) supported the validity of the scale method for ageing black crappie. The length-frequency distribution for black crappie in Weso Lake (Figure 31A), however, was not consistent with the age groups delineated by backcalculation. The peaks in the length-frequency histogram for black crappie corresponded to modal length ranges for ages 5 and 6. A mode in the length-frequency distribution in this length range probably occurred because of gear selection. Hook-and-line sampling

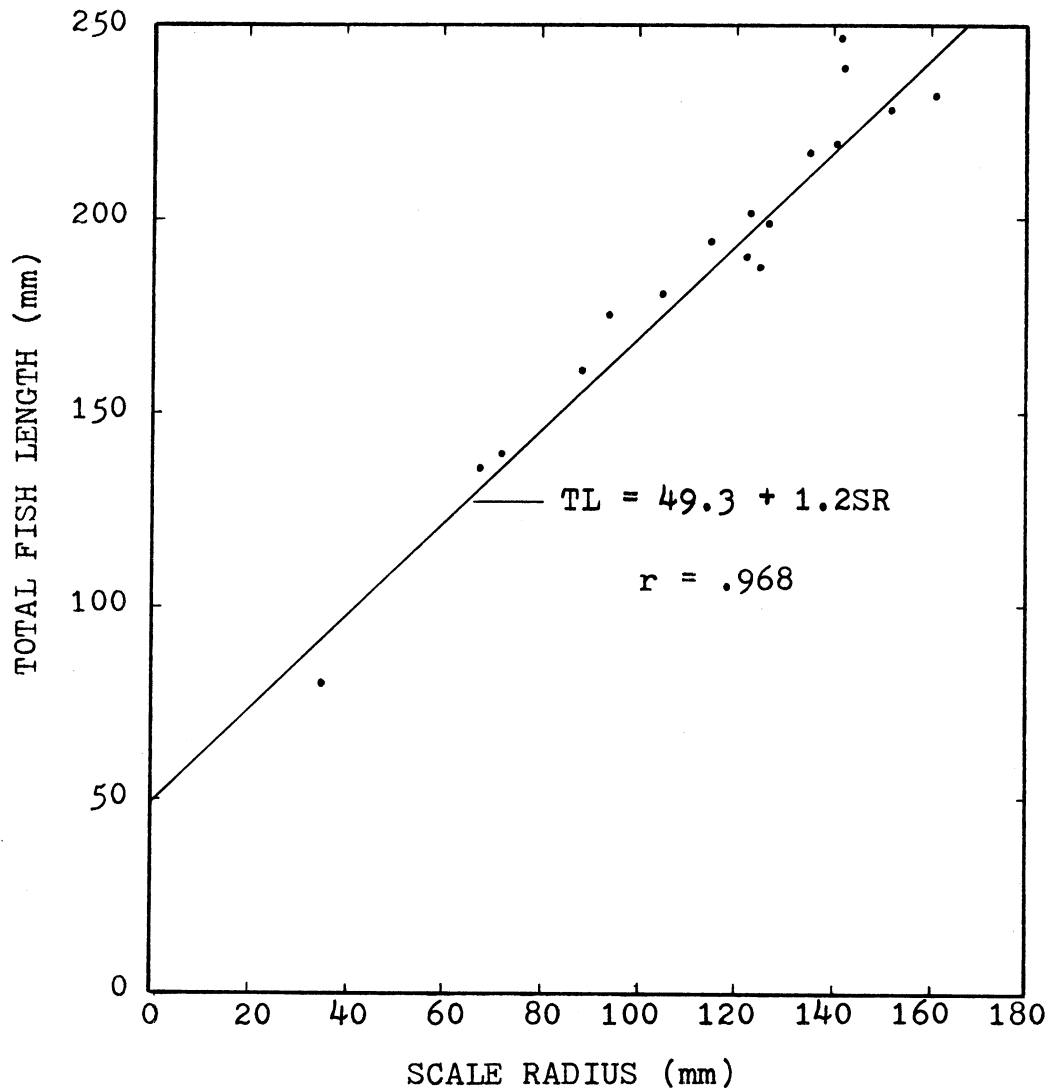


Figure 33. Body length:scale radius relationship for black crappie caught in June 1979.

tended to catch the larger individuals in the older age groups. Biased sampling and small sample size reduced the accuracy of the age and growth determination.

Snow (1969) compared the growth of black crappie in nine northern Wisconsin lakes. He found significant differences in the growth of black crappie in drainage (high alkalinity) lakes versus seepage (low alkalinity) lakes.

Table 18. Growth rates and backcalculated mean lengths (mm) at each annulus for black crappie in Weso Lake. Sample was obtained in June 1980.

Age (in years)	Sample Size	Calculated Mean Length at Each Annulus									
		1	2	3	4	5	6	7	8	9	10
1	1	79									
2	2	88	126								
3	3	88	130	151							
4	1	73	124	154	168						
5	6	83	134	163	178	192					
6	3	86	135	168	190	202	212				
7	0										
8	1	85	121	148	167	180	190	203	210		
9	0										
10	2	82	129	155	171	186	196	206	215	224	233
Column Means		82	128	156	175	190	199	204	212	224	233
Stand. Dev.		5	5	8	10	9	11	2	4	--	--
Increment		82	46	28	19	15	9	5	8	12	9

Average growth was generally fastest in drainage lakes and slowest in seepage lakes. The growth rate for Weso Lake black crappie corresponded to the average growth curve for the slowest growing population in Snow's investigation (Figure 34). Carlander (1977) has summarized growth data for black crappie from various regions of the United States, and the majority of these show faster growth than the Weso Lake population. Black crappie in Weso Lake grew slower than the average for Michigan, Minnesota, and Wisconsin waters. There is an indication, however, that black crappie live longer in Weso Lake. Although fish of 8-10 years have been reported for other waterbodies in Wisconsin, black crappies generally do not live more than five or six years (Schneberger 1972).

The growth rates of black crappie are primarily

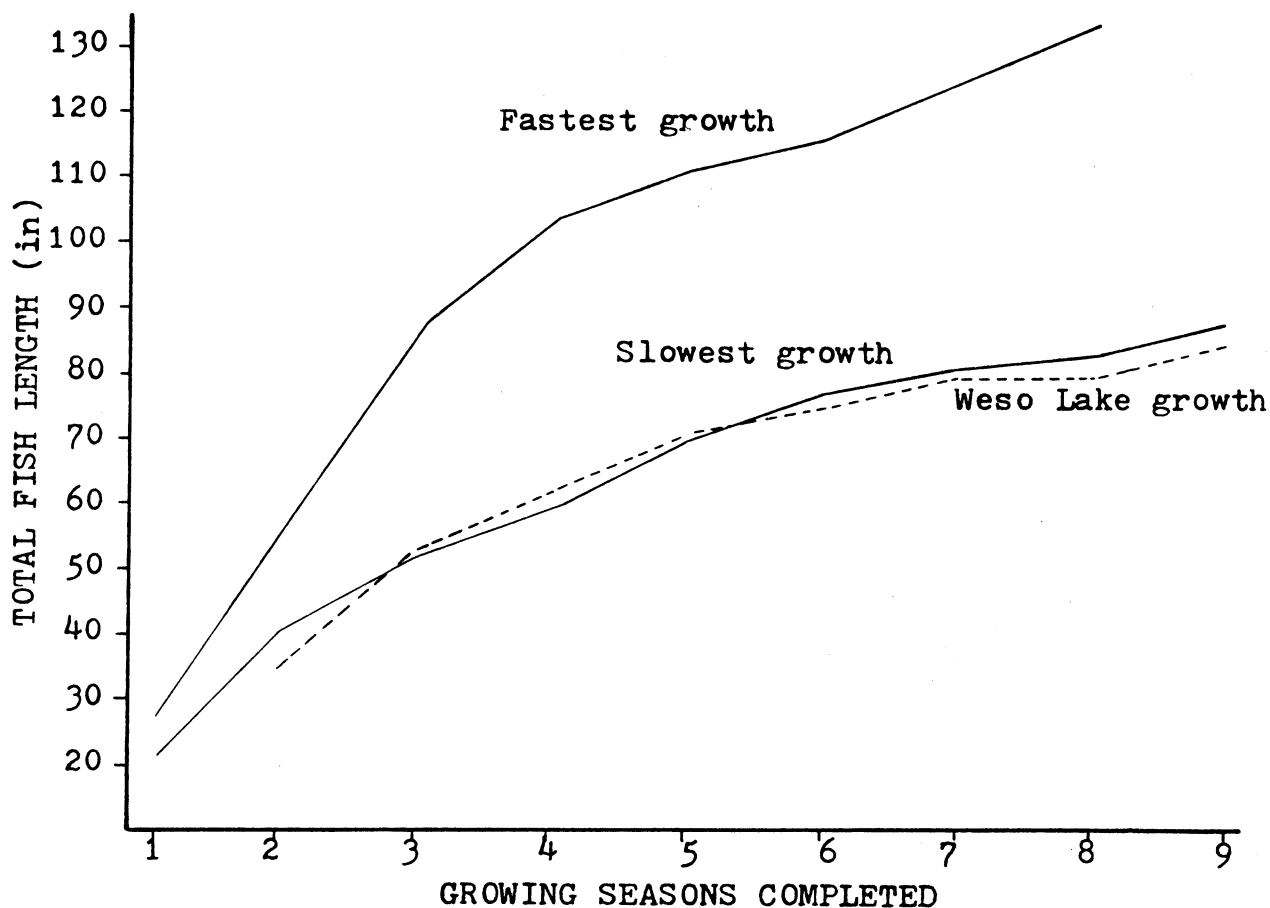


Figure 34. Comparison of growth of black crappie in Weso Lake (-----) with the fastest and slowest growing black crappie populations observed by Snow (1969) in his investigation of nine northern Wisconsin lakes.

influenced by habitat, oxygen concentration, temperature, food availability, geographic location, and population competition (Schneberger 1972). The suggested dissolved oxygen concentration for the survival, growth, and reproduction of a good mixed warmwater fish population is 5 mg l^{-1} (Doudoroff and Shumway 1967). Dissolved oxygen concentrations in surface waters of Weso Lake probably were not limiting to the survival and growth of black crappie. However, dissolved oxygen levels at the sediment-water interface, which were not measured, would be more critical to the reproduction of

the species. In August 1980, the stomachs of five black crappie were examined, and all were found to contain food. Food items included chironomids, odonates, Chaoborus, and terrestrial insects. Adult black crappie feed most actively in the open water, while black bullhead are nocturnal bottom feeders (Scott and Crossman 1973). This separation in feeding habits may have reduced interspecific competition between the dominant fish species. Overcrowding may have been a factor in the growth of black crappie in Weso Lake, but this could only be determined through more extensive sampling.

CONCLUSIONS

1. Considerable research has been directed toward the use of natural wetlands for tertiary treatment of domestic wastewater from small communities such as Drummond, Wisconsin (Tilton et al. 1976; Sloey et al. 1978; Kadlec 1979). Most of the investigations have been based on short term observations, however, and have emphasized nutrient inputs and outputs and production and decomposition rates of plants. Few data are available on the impacts of long term discharges of wastewater effluent on the physical and biological characteristics of wetland systems. Little is yet known of the fate of waters beyond the receiving wetlands. Careful monitoring of the Drummond demonstration project and Weso Lake will supplement the long term information base that is essential for an evaluation of the suitability of this type of wetland treatment system.

2. Water quality data for Weso Lake during the first two seasons of operation at the Drummond treatment system indicated increases in chloride concentrations and conductivity. Surface chloride concentrations increased from less than detection ($<1 \text{ mg l}^{-1}$) to an average 4.1 mg l^{-1} during the study period. Conductivity increases paralleled the chloride changes, increasing an average 30% at lake sites. True color decreased by 50% in surface water in summer 1980 due to reduced drainage of soluble organic compounds from surrounding bogs during an abnormally dry spring. Total and soluble reactive phosphorus and total Kjeldahl nitrogen levels in surface water decreased by 57, 86, and 22%, respectively, during summer 1980. Reductions in nutrient concentrations probably reflected increased biological uptake, sedimentation of erosion materials introduced during the 1978 construction of the Drummond sewage lagoons, and decreased runoff of organic compounds from peatlands in the watershed.

3. Earlier investigators considered acid bog lakes low in plankton productivity (Jewell and Brown 1929; Welch 1936). My observations indicated that Weso Lake supports relatively high standing stocks of phytoplankton. The mean surface phytoplankton densities for the summer periods (May-September) were $1927 \text{ cells ml}^{-1}$ in 1979 and $2969 \text{ cells ml}^{-1}$ in 1980. The average surface chlorophyll a concentrations for the corresponding periods were 7.1 ug l^{-1} and 6.8 ug l^{-1} , respectively. These biomass measurements are characteristic of mesotrophic temperate lakes. The mid-summer surface phytoplankton counts in Weso Lake were dominated by green algae,

particularly Sphaerocystis. The centric diatom, Melosira, and Cryptomonas were the dominant taxa in other seasons. Higher densities of green algae were responsible for the 54% increase in surface phytoplankton cell numbers during summer 1980. Increased growth of green algae was probably favored by higher spring water temperatures, lower true color levels with increased light penetration in the surface water column, and, perhaps, by lower soluble reactive phosphorus concentrations.

4. Diatoms and filamentous blue-green algae dominated the Sphagnum algal aufwuchs during the study. Diatoms contributed 50% of the total cell counts, while filamentous blue-green algae comprised 42% of the total aufwuchs densities. Eunotia, the most prevalent diatom genus, accounted for 38% of the total diatom cell numbers. Anabaena dominated the filamentous blue-green algae, contributing 63% of the total cyanophyte cell numbers. Higher filamentous blue-green algae densities accounted for the increase in mean total aufwuchs counts from 10,516 cells mg^{-1} host dry weight in 1979 to 17,364 cells mg^{-1} host dry weight in 1980. Unusually high water temperatures in spring 1980 could have contributed to the phenomenal development of blue-green algae during May and June.

5. The percentage error of precision for both benthic macroinvertebrate density and biomass was approximately 20%. Macroinvertebrate density and number of taxa were significantly different with depth and year. The deep profundal fauna was restricted to the semi-limnetic dipteran, Chaoborus.

C. plumosus dominated the macroinvertebrate biomass in the upper profundal and sublittoral regions of the lake. Thirty-one taxa of invertebrates were observed in the littoral zone, including 14 taxa of the family Chironomidae and members of the class Oligochaeta, the phyla Nematoda and Mollusca, and the orders Ephemeroptera, Odonata, Trichoptera, Diptera, and Coleoptera. The average macroinvertebrate densities for the study period were 8969, 1322, 2214, and 735 m⁻² at 1, 2, 4, and 6 m depths, respectively. Dissolved oxygen concentrations and substrate composition may have been the primary factors in determining depth distribution of the invertebrate fauna. Total invertebrate densities were 36% higher during summer 1980. The annual variation in invertebrate numbers could be attributed to natural variability or fluctuations in the phytoplankton food supply.

6. Coefficients of variation for the net sampler used in the macroinvertebrate aufwuchs study (52% for numbers and 50% for biomass) were comparable to values reported in the literature. Eighteen taxa of chironomids were responsible for 49% of the total aufwuchs density and 8% of the biomass. Odonates dominated invertebrate aufwuchs biomass, contributing 56% of the total biomass and 8% of the density. The most abundant odonate was Leucorrhinia, which accounted for 39% of the odonate density and 43% of the biomass. The effect of cover type on invertebrate numbers and biomass was not significant. The total number of taxa in the herbaceous emergent and floating-leaved vegetation was significantly higher than in the ericaceous vegetation. Cover type differences in

invertebrate diversity may have been related to differences in substrate surface area or varying levels of detrital input to the system. Although differences between years were not significant for either total invertebrate aufwuchs abundance or biomass, the numbers of Ephemeroptera, Trichoptera, Odonata, and Diptera decreased and the abundance of Mollusca and Oligochaeta increased in summer 1980. Declining water levels during the dry spring may have influenced the natural fluctuations in the invertebrate aufwuchs communities.

7. Laboratory bioassays using secondary lagoon effluent diluted with Weso Lake water indicated that effluent stimulated growth of Anabaena. Exponential growth of the test alga was not observed in any of the treatments including the secondary effluent controls. Algal nutrient bioassay of the secondary effluent showed that phosphorus was the primary limiting nutrient in the effluent. Algal nutrient bioassay of the lake water suggested that the immediate limiting factor was carbon, while the ultimate limiting nutrient was phosphorus. The Algal Assay Bottle Test may be of limited value in extreme environments such as acid lakes. The results of bag experiments in acidic Cheat Lake, West Virginia, showed that the indigenous phytoplankton responded immediately to phosphorus addition alone despite pH values below 5.5, while stimulation of exponential growth in laboratory assays also required the addition of a buffer (DeCosta and Preston 1980). The laboratory bioassays of Weso Lake water could provide the basis for planning large scale lake experiments to determine the response of indigenous phytoplankton to the controlled

applications of secondary or bog effluent.

8. The fish community of Weso Lake consisted primarily of black bullhead, black crappie, pumpkinseed, and green sunfish. The most abundant species during the survey was black bullhead, which contributed 43% of the total catch density and 28% of the biomass. Black crappie dominated the sample biomass, comprising 53% of the sample weight and 25% of the numbers. Mean lengths for the fish species were generally within the ranges reported in the literature. Age and growth analysis of black crappie indicated that the population grew slower than the average for northern waters.

9. Data was collected on the taxonomic composition and seasonal changes of the algal and aquatic macroinvertebrate communities of Weso Lake under natural conditions. Future monitoring is needed to determine the long term impacts of continued effluent discharge from the Drummond experimental wastewater treatment system. This information is necessary for the responsible application and management of peatland treatment systems.

LITERATURE CITED

- Ableiter, J.K., and F.D. Hole. 1961. Soil survey of Bayfield County, Wisconsin. U.S. Government Printing Office, Washington, D.C. 77 pp.
- Alm, G. 1922. Bottenfauna och fisken biologi i Yxtasjön samt jämförande studier över bottenfauna och fiskavkastning i var sjöar. Medd. Landbruksstuyr. 236: 186.
- American Public Health Association. 1976. Standard methods for the examination of water and wastewater, 14th ed. American Public Health Association, New York. 1139 pp.
- Andrews, J.D., and A.D. Hasler. 1943. Fluctuations in the animal populations of the littoral zone in Lake Mendota. Trans. Wis. Acad. Sci. Arts Lett. 35: 175-185.
- Bagenal, T.B., and F.W. Tesch. 1978. Age and growth. In: Methods for assessment of fish production in fresh waters, T. Bagenal (ed.), Blackwell Scientific Publications, Oxford, Eng., pp. 101-136.
- Bartsch, A.F. 1969. Provisional algal assay procedures. Joint Ind./Govt. Task Force on Eutrophication, New York.
- Bay, E.C., A.A. Ingram, and L.D. Anderson. 1966. Physical factors influencing chironomid infestation of water-spreading basins. Ann. Entomol. Soc. Am. 59: 714-717.
- Benke, A.C. 1976. Dragonfly production and prey turnover. Ecology 57: 915-927.
- Bennett, G.W. 1970. Management of lakes and ponds. Van Nostrand Reinhold Co., New York. 375 pp.
- Birge, E.A., and C. Juday. 1927. The organic content of the water of small lakes. Proc. Am. Philos. Soc. 66: 357-372.
- Bowers, F. 1981. Personal communication. Dept. of Biology, University of Wisconsin-Stevens Point.
- Bricker, F.J., and J.E. Gannon. 1976. Limnological investigation of Hoop Lake-a Northern Michigan bog. Mich. Acad. 9: 25-42.
- Brinkhurst, R.O. 1974. The benthos of lakes. Macmillan, London. 190 pp.
- Cairns, J., Jr. 1956. Effects of increased temperatures on aquatic organisms. Industr. Wastes 1: 150-152.

- Carlander, K.D. 1977. Handbook of freshwater fishery biology. Vol. 2. Iowa State University Press, Ames, IA. 431 pp.
- Carlson, R.E. 1977. A trophic state index for lakes. Limnol. Oceanogr. 22: 361-369.
- Carpenter, W.L., and H.F. Berger. 1973. Development of improved procedures for measurement of mill effluent and receiving water color. In: Proc. of the 28th Industrial Waste Conference, Purdue University, Lafayette, IN, pp. 234-250.
- Christensen, C.L. 1969. Notes on Iowa diatoms. IX: Variation in the genus Eunotia. Proc. Iowa Acad. Sci. 76: 62-68.
- Clasen, J., and H. Bernhardt. 1974. The use of algal assays for determining the effect of iron and phosphorus compounds on the growth of various algal species. Water Res. 8: 31-44.
- Clymo, R.S. 1964. The origin of acidity in Sphagnum bogs. Bryologist 67: 427-431.
- Coffman, W.P. 1978. Chironomidae. In: An introduction to the aquatic insects of North America, R.W. Merritt and K.W. Cummins (eds.), Kendall/Hunt Pub. Co., Dubuque, IA, pp. 345-376.
- Cummins, K.W. 1973. Trophic relations of aquatic insects. Annu. Rev. Entomol. 18: 183-206.
- Cummins, K.W., and G.H. Lauff. 1969. The influence of substrate particle size on the microdistribution of stream macrobenthos. Hydrobiologia 34: 145-181.
- Danforth, W.F. 1962. Substrate assimilation and heterotrophy. In: Physiology and biochemistry of algae, R.A. Lewin (ed.), Academic Press, New York, pp. 99-123.
- DeCosta, J., and C. Preston. 1980. The phytoplankton productivity of an acidic lake. Hydrobiologia 70: 39-49.
- Doudoroff, P., and D.L. Shumway. 1967. Dissolved oxygen criteria for the protection of fish. In: A symposium on water quality criteria to protect aquatic life, E.L. Cooper (ed.), American Fisheries Society, Washington, D.C., pp. 13-19.
- Downing, J.A. 1979. Aggregation, transformation, and the design of benthos sampling programs. J. Fish. Res. Board Can. 36: 1454-1463.

- Duthie, H.C. 1965. A study of the distribution and periodicity of some algae in a bog pool. *J. Ecol.* 53: 343-359.
- Echlin, P., and I. Morris. 1965. The relationship between blue-green algae and bacteria. *Biol. Rev.* 40: 143-187.
- Edmunds, G.F., Jr., S.L. Jensen, and L. Berner. 1976. The mayflies of North and Central America. University of Minnesota Press, Minneapolis, MN. 330 pp.
- Eggleton, F.E. 1931. A limnological study of the profundal bottom fauna in certain fresh-water lakes. *Ecol. Monog.* 1: 231-331.
- Egglishaw, H.J. 1964. The distributional relationship between the bottom fauna and plant detritus in streams. *J. Anim. Ecol.* 33: 463-476.
- Elliott, J.M. 1977. Some methods for the statistical analysis of samples of benthic invertebrates, 2nd ed. Freshwater Biological Association, Ambleside, Eng. 160 pp.
- Erickson, J.G. 1952. Age and growth of the black and white crappies, Pomoxis nigro-maculatus (Le Sueur) and P. annularis Rafinesque, in Clear Lake, Iowa. *Iowa State J. Sci.* 26: 491-505.
- Evans, E.D. 1978. Megaloptera and aquatic Neuroptera. In: An introduction to the aquatic insects of North America, R.W. Merritt and K.W. Cummins (eds.), Kendall/Hunt Pub. Co., Dubuque, IA, pp. 133-145.
- Ewel, K.C. 1976. Effects of sewage effluent on ecosystem dynamics in cypress domes. In: Freshwater wetlands and sewage effluent disposal, D.L. Tilton, R.H. Kadlec, and C.J. Richardson (eds.), University of Michigan, Ann Arbor, MI, pp. 169-195.
- Farnham, R.S., and D.H. Boelter. 1976. Minnesota's peat resources: their characteristics and use in sewage treatment, agriculture, and energy. In: Freshwater wetlands and sewage effluent disposal, D.L. Tilton, R.H. Kadlec, and C.J. Richardson (eds.), University of Michigan, Ann Arbor, MI, pp. 241-255.
- Fitzgerald, G.P. 1975. Factors affecting the algal assay procedure. U.S. Environmental Protection Agency, Washington, D.C. 31 pp.
- Flensburg, T., and J.H. Sparling. 1973. The algal microflora of a string mire in relation to the chemical composition of water. *Can. J. Bot.* 51: 743-749.

- Foerster, J.W., and H.E. Schlichting, Jr. 1965. Phyco-periphyton in an oligotrophic lake. *Trans. Am. Microsc. Soc.* 84: 485-502.
- Fogg, G.E. 1975. *Algal cultures and phytoplankton ecology*, 2nd ed. University of Wisconsin Press, Madison, WI. 175 pp.
- Fox, H.M. 1955. The effect of oxygen on the concentration of haem in invertebrates. *Proc. R. Soc. Lond. B. Biol. Sci.* 143: 203-214.
- Gerking, S.D. 1962. Production and food utilization in a population of bluegill sunfish. *Ecol. Monogr.* 32: 31-78.
- Gough, S.B. 1977. The growth of selected desmid (desmidiaceae, chlorophyta) taxa, at different calcium and pH levels. *Am. J. Bot.* 64: 1297-1299.
- Gough, S.B., and W.J. Woelkerling. 1976. On the removal and quantification of algal aufwuchs from macrophyte hosts. *Hydrobiologia* 48: 203-207.
- Greene, J.C., W.E. Miller, T. Shiroyama, and T.E. Maloney. 1975. Utilization of algal assays to assess the effects of municipal, industrial and agricultural wastewater effluents upon phytoplankton production in the Snake River system. *Water Air Soil Pollut.* 4: 415-434.
- Greeson, P.E., T.A. Ehlke, G.A. Irwin, B.W. Lium, and K.V. Slack (eds.). 1977. *Techniques of water-resources investigations of the United States Geological Survey*, Chapter 4A. Methods for collection and analysis of aquatic biological and microbiological samples. U.S. Government Printing Office, Washington, D.C. 332 pp.
- Griffiths, D. 1973. The structure of an acid moorland pond community. *J. Anim. Ecol.* 42: 263-283.
- Hansen, K. 1962. The dystrophic lake type. *Hydrobiologia* 19: 183-191.
- Harrod, J.J. 1964. The distribution of invertebrates on submerged aquatic plants in a chalk stream. *J. Anim. Ecol.* 33: 335-348.
- Hartland-Rowe, R., and P.B. Wright. 1975. Effects of sewage effluent on a swampland stream. *Int. Ver. Theor. Angew. Limnol. Verh.* 19: 1575-1583.
- Hayward, J. 1957. The periodicity of diatoms in bogs. *J. Ecol.* 45: 947-954.

- Heimburg, K. 1977. Use of Florida cypress domes as tertiary treatment facilities. In: Wetlands ecology, values, and impacts-Proc. of the Waubesa conference on wetlands, C.B. DeWitt and E. Soloway (eds.), Institute for Environmental Studies, Madison, WI, pp. 166-177.
- Hile, R. 1941. Age and growth of the rock bass, Ambloplites rupestris (Rafinesque), in Nebish Lake, Wisconsin. Trans. Wis. Acad. Sci. Arts Lett. 33: 189-337.
- Hile, R. 1948. Standardization of methods of expressing lengths and weights of fish. Trans. Am. Fish. Soc. 75: 157-164.
- Hilsenhoff, W.L. 1967. Ecology and production dynamics of Chironomus plumosus (Diptera:Chironomidae) in Lake Winnebago, Wisconsin. Ann. Entomol. Soc. Am. 60: 1183-1194.
- Hilsenhoff, W.L. 1975. Aquatic insects of Wisconsin: generic keys and notes on biology, ecology, and distribution. Wisconsin Dept. of Natural Resources Tech Bull. No. 89. Wisconsin Dept. of Natural Resources, Madison, WI. 54 pp.
- Hilsenhoff, W.L., and R.P. Narf. 1968. Ecology of Chironomidae, Chaoboridae, and other benthos in fourteen Wisconsin lakes. Ann. Entomol. Soc. Am. 61: 1173-1181.
- Howmiller, R.P. 1972. Effects of preservatives on weights of some common macrobenthic invertebrates. Trans. Am. Fish. Soc. 101: 743-746.
- Hustedt, F. 1930. Bacillariophyta (Diatomeae). In: Die süsswasser-flora Mitteleuropas, Vol. 10, A. Pascher (ed.), Gustav Fisher, Jena. 466 pp.
- Hutchinson, G.E. 1967. A treatise on limnology. II. Introduction to lake biology and the limnoplankton. J. Wiley & Sons, New York. 1115 pp.
- Jetter, W., and L.D. Harris. 1976. The effects of perturbation on cypress dome animal communities. In: Cypress wetlands for water management, recycling, and conservation, H.T. Odum and K.C. Ewel (eds.), Center for Wetlands, University of Florida, pp. 577-653.
- Jewell, M.E. 1939. An ecological study of the fresh-water sponges of Wisconsin. II. The influence of calcium. Ecology 20: 11-28.
- Jewell, M.E., and H. Brown. 1924. The fishes of an acid lake. Trans. Am. Microsc. Soc. 43: 77-84.

- Jewell, M.E., and H. Brown. 1929. Studies on Northern Michigan bog lakes. *Ecology* 10: 427-475.
- Jirka, A.M., M.J. Carter, D. May, and F.D. Fuller. n.d. Ultra micro semi-automated method for the simultaneous determination of total phosphorus and total phosphorus + TKN in wastewaters. U.S. Environmental Protection Agency, Chicago.
- Johannes, S.I., L.M. Sather, and C.W. Threinen. 1970. Surface water resources of Bayfield County. Wisconsin Dept. of Natural Resources, Madison, WI. 372 pp.
- Jonasson, P.M. 1978. Zoobenthos of lakes. *Int. Ver. Theor. Angew. Limnol. Verh.* 20: 13-37.
- Jones, R.I., and V. Ilmavirta. 1978. Vertical and seasonal variation of phytoplankton photosynthesis in a brown-water lake with winter ice cover. *Freshw. Biol.* 8: 561-572.
- Kadlec, R.H. 1979. Wetlands for tertiary treatment. In: *Wetland functions and values: the state of our understanding*, P.E. Greeson, J.R. Clark, and J.E. Clark (eds.), American Water Resources Association, Minneapolis, MN, pp. 490-504.
- Kadlec, R.H., and J.A. Kadlec. 1979. Wetlands and water quality. In: *Wetland functions and values: the state of our understanding*, P.E. Greeson, J.R. Clark, and J.E. Clark (eds.), American Water Resources Association, Minneapolis, MN, pp. 436-456.
- Krecker, F.H. 1939. A comparative study of the animal population of certain submerged aquatic plants. *Ecology* 20: 553-562.
- Lagler, K.F. 1978. Capture, sampling and examination of fishes. In: *Methods for assessment of fish production in fresh waters*, T. Bagenal (ed.), Blackwell Scientific Publications, Oxford, Eng., pp. 7-47.
- Lawrence, J.R., R.C. Haynes, and U.T. Hammer. 1978. Contribution of photosynthetic green sulphur bacteria to total primary production in a meromictic saline lake. *Int. Ver. Theor. Angew. Limnol. Verh.* 20: 201-207.
- Lellak, J. 1965. The food supply as a factor regulating the population dynamics of bottom animals. *Mitt. Int. Ver. Theor. Angew. Limnol.* (13): 128-138.
- Lind, O.T. 1974. Handbook of common methods in limnology. C.V. Mosby Co., St. Louis, MO. 154 pp.

- Lindeman, R.L. 1941. The developmental history of Cedar Creek Bog, Minnesota. *Am. Midl. Nat.* 25: 101-112.
- Lindeman, R.L. 1942. Seasonal distribution of midge larvae in a senescent lake. *Am. Midl. Nat.* 27: 428-444.
- Lund, J.W.G. 1950. Studies on Asterionella formosa Hass. II. Nutrient depletion and the spring maximum. *J. Ecol.* 38: 1-14.
- Lund, J.W.G. 1965. The ecology of the freshwater phytoplankton. *Biol. Rev.* 40: 231-293.
- Lundbeck, J. 1926. Die bodentierwelt norddeutscher seen. *Arch. Hydrobiol. Suppl.* 7: 1-473.
- Malins-Smith, A. 1942. The algae of Miles Rough Bog, Bradford. *J. Ecol.* 30: 341-356.
- Manning, W.M., and R.E. Juday. 1941. The chlorophyll content and productivity of some lakes in northeastern Wisconsin. *Trans. Wis. Acad. Sci. Arts Lett.* 33: 363-393.
- Manwell, C. 1966. Starch-gel electrophoresis of the multiple hemoglobins of small and large larval Chironomus (Tendipes); a developmental hemoglobin sequence in an invertebrate. *J. Embryol. Exp. Morphol.* 16: 259-270.
- Mason, W.T. 1968. An introduction to the identification of chironomid larvae. Federal Water Pollution Control Administration, Washington, D.C. 89 pp.
- McLachlan, A.J., and C.H. Dickinson. 1977. Micro-organisms as a factor in the distribution of Chironomus lugubris Zetterstedt in a bog lake. *Arch. Hydrobiol.* 80: 133-146.
- McLachlan, A.J., and S.M. McLachlan. 1971. Benthic fauna and sediments in the newly created Lake Kariba (Central Africa). *Ecology* 52: 800-809.
- McLachlan, A.J., and S.M. McLachlan. 1975. The physical environment and bottom fauna of a bog lake. *Arch. Hydrobiol.* 76: 198-217.
- McMahan, E.A. 1972. Relative abundance of three marsh-floor organisms in a sewage-affected marsh and in a sewage-free marsh. *J. Elisha Mitchell Sci. Soc.* 88: 61-65.
- Mechenich, D.J. 1980. Tertiary wastewater treatment using a natural peat bog. Masters Thesis, University of Wisconsin, Stevens Point, WI. 136 pp.

- Merritt, R.W., and K.W. Cummins (eds.). 1978. An introduction to the aquatic insects of North America. Kendall/Hunt Pub. Co., Dubuque, IA. 441 pp.
- Miller, W.E., J.C. Greene, and T. Shiroyama. 1978. The Selenastrum capricornutum Printz, algal assay bottle test. U.S. Environmental Protection Agency, Corvallis, OR. 126 pp.
- Moore, P.D., and D.J. Bellamy. 1974. Peatlands. Springer-Verlag, New York. 221 pp.
- Morgan, N.C., and A.B. Waddell. 1961. Insect emergence from a small trout loch and its bearing on the food supply of fish. Scot. Dept. Agric. Fish. Freshw. Salmon Fish. Res. 25: 1-39.
- Morrison, J.P.E. 1932. A report on the Mollusca of the northeastern Wisconsin lake district. Trans. Wis. Acad. Sci. Arts Lett. 27: 359-396.
- Moss, B. 1972. Studies on Gull Lake, Michigan. I. Seasonal and depth distribution of phytoplankton. Freshw. Biol. 2: 289-307.
- Moss, B. 1973. The influence of environmental factors on the distribution of freshwater algae: an experimental study. II. The role of pH and the carbon dioxide-bicarbonate system. J. Ecol. 61: 157-177.
- Moyle, J.B. 1961. Aquatic invertebrates as related to larger water plants and waterfowl. Minnesota Dept. of Conservation Investigation Report No. 233. 24 pp.
- Mudroch, A., and J.A. Capobianco. 1979. Effects of treated effluent on a natural marsh. J. Water Pollut. Control Fed. 51: 2243-2256.
- Needham, J.G., and M.J. Westfall, Jr. 1955. A manual of the dragonflies of North America (Anisoptera) including the Greater Antilles and the provinces of the Mexican border. University of California Press, Berkeley, CA. 615 pp.
- Nie, N.H., C.H. Hull, J.G. Jenkins, K. Steinbrenner, and D. H. Bent. 1975. Statistical package for the social sciences, 2nd ed. McGraw-Hill, New York. 675 pp.
- Okland, J. 1969. Om forsuring av vassdrag og betydningen av surhetsgraden pH for fiskens naeringsdyr i ferskvann. Fauna 22: 140-147.
- Oliver, D.R. 1960. The macroscopic bottom fauna of Lac La Ronge, Saskatchewan. J. Fish. Res. Board Can. 17: 607-624.

- Parker, B.C., H.C. Bold, and T.R. Deason. 1961. Faculative heterotrophy in some Chlorococcacean algae. *Science* 133: 761-763.
- Patrick, R. 1954. The diatom flora of Bethany Bog. *J. Protozool.* 1: 34-37.
- Patrick, R. 1969. Some effects of temperature on freshwater algae. In: *Biological aspects of thermal pollution*, P.A. Krenkel and F.L. Parker (eds.), Vanderbilt University Press, Nashville, TN, pp.161-185.
- Patrick, R. 1977. Ecology of freshwater diatoms and diatom communities. In: *The biology of diatoms*, D. Werner (ed.), University of California Press, Berkeley, CA, pp.284-332.
- Patrick, R., and C.W. Reimer. 1966. The diatoms of the United States exclusive of Alaska and Hawaii. *Academy of Natural Sciences of Philadelphia*, Philadelphia, PA. 688 pp.
- Patrick, R., and D. Strawbridge. 1963. Variation in the structure of natural diatom communities. *Am. Nat.* 97: 51-57.
- Pearsall, W.H. 1932. Phytoplankton in the English lakes. II. The composition of the phytoplankton in relation to dissolved substances. *J. Ecol.* 20: 241-262.
- Pechlaner, R. 1971. Factors that control production rates and biomass of phytoplankton in high mountain lakes. *Mitt. Int. Ver. Theor. Angew. Limnol.* (19): 125-145.
- Pennak, R.W. 1978. *Freshwater invertebrates of the United States*, 2nd ed. J. Wiley & Sons, New York. 803 pp.
- Petersen, J.B. 1943. Some halobion spectra (Diatoms). *K. danske Vidensk. Selsk. Meddel.* Copenhagen 17(9): 3-95.
- Prescott, G.W. 1962. *Algae of the western Great Lakes area with an illustrated key to the genera of desmids and freshwater diatoms*. William C. Brown Co., Dubuque, IA. 977 pp.
- Prescott, G.W. 1964. *How to know the freshwater algae*. William C. Brown Co., Dubuque, IA. 272 pp.
- Prescott, G.W., H.T. Croasdale, and W.C. Vinyard. 1972. *Desmidiaceae, Pt. I. Saccodermatae, Mesotaeniaceae*. North American Flora, ser. 2, pt. 6. New York Botanical Garden, New York.

- Reckhow, K.H. 1979. Quantitative techniques for the assessment of lake quality. U.S. Environmental Protection Agency, Washington, D.C. 146 pp.
- Reinecke, K.J. 1977. The importance of freshwater invertebrates and female energy reserves for black ducks breeding in Maine. Ph.D. Dissertation, University of Maine, Orono, ME. 160 pp.
- Resh, V.H. 1979. Sampling variability and life history features: basic considerations in the design of aquatic insect studies. J. Fish. Res. Board Can. 36: 290-311.
- Resh, V.H., J.C. Morse, and I.D. Wallace. 1976. The evolution of the sponge feeding habit in the caddisfly genus Ceraclea (Trichoptera: Leptoceridae). Ann. Entomol. Soc. Am. 69: 937-941.
- Rheinheimer, G. 1974. Aquatic microbiology. J. Wiley & Sons, New York. 184 pp.
- Richardson, C.J., J.A. Kadlec, W.A. Wentz, J.P.M. Chamie, and R.H. Kadlec. 1976. Background ecology and the effects of nutrient additions on a central Michigan wetland. In: Proceedings: Third wetlands conference, M.W. Lefor, W.C. Kennard, and T.B. Helfgott (eds.), University of Connecticut, Storrs, CT, pp. 34-72.
- Riley, G.A. 1942. The relationship of vertical turbulence and spring diatom flowerings. J. Mar. Res. 5: 67-87.
- Rosine, W.N. 1955. The distribution of invertebrates on submerged aquatic plant surfaces in Muskee Lake, Colorado. Ecology 36: 308-314.
- Round, F.E. 1957. Studies on bottom-living algae in some lakes of the English Lake District. I. Some chemical features of the sediments related to algal productivities. J. Ecol. 45: 131-146.
- Round, F.E. 1965. The biology of the algae. St. Martin's Press, New York. 269 pp.
- Ruttner, F. 1963. Fundamentals of limnology. University of Toronto Press, Toronto. 295 pp.
- Ryan, T.A., B.L. Joiner, and B.F. Ryan. 1976. Minitab student handbook. Duxbury Press, Belmont, CA. 341 pp.
- Samejima, H., and J. Myers. 1958. On the heterotrophic growth of Chlorella pyrenoidosa. J. Gen. Microbiol. 18: 107-117.

- Schneberger, E. 1972. The black crappie: its life history, ecology and management. Wisconsin Dept. of Natural Resources, Madison, WI. 16 pp.
- Schwoerbel, J. 1970. Methods of hydrobiology (Freshwater Biology). Pergamon Press, Oxford, Eng. 200 pp.
- Scott, W.B. 1967. Freshwater fishes of Eastern Canada. University of Toronto Press, Toronto, Ont. 137 pp.
- Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Ottawa, 966 pp.
- Shiroyama, T., W.E. Miller, and J.C. Greene. 1976a. Comparison of the algal growth responses of Selenastrum capricornutum Printz and Anabaena flos-aquae (Lyngb.) DeBrebisson in waters collected from Shagawa Lake, Minnesota. In: Biostimulation and nutrient assessment, E.J. Middlebrooks, D.H. Falkenberg, and T.E. Maloney (eds.), Ann Arbor Science, Ann Arbor, MI, pp. 127-148.
- Shiroyama, T., W.E. Miller, J.C. Greene, and C. Shigihara. 1976b. Growth response of Anabaena flos-aquae (Lyngb.) DeBrebisson in waters collected from Long Lake Reservoir, Washington. In: Proc. of the symposium on terrestrial and aquatic ecological studies of the Northwest, R.D. Andrews (ed.), EWSC Press, Cheney, WA, pp. 267-275.
- Sloey, W.E., F.L. Spangler, and C.W. Fetter, Jr. 1978. Management of freshwater wetlands for nutrient assimilation. In: Freshwater wetlands: ecological processes and management potential, R.E. Good, D.F. Whigham, and R.L. Simpson (eds.), Academic Press, New York, pp. 321-340.
- Smith, G.M. 1950. The freshwater algae of the United States, 2nd ed. McGraw-Hill, New York. 719 pp.
- Smith, S.H. 1954. Method of producing plastic impressions of fish scales without using heat. Prog. Fish-Cult. 16: 75-78.
- Snow, H.E. 1969. Comparative growth of eight species of fish in thirteen northern Wisconsin lakes. Wisconsin Dept. of Natural Resources, Madison, WI. 23 pp.
- Southwood, T.R.E. 1966. Ecological methods with particular reference to the study of insect populations. Chapman and Hall, London. 391 pp.
- Stanford, A. 1973. A centrifuge method for determining live weights of aquatic insect larvae, with a note on weight loss in preservative. Ecology 54: 449-451.

- Stewart, W.D.P., M. Pemble, and L. Al-Ugaily. 1978. Nitrogen and phosphorus storage and utilization in blue-green algae. *Mitt. Int. Ver. Theor. Angew. Limnol.* (21): 224-247.
- Taylor, L.R. 1961. Aggregation, variance, and the mean. *Nature (Lond.)* 189: 732-735.
- Technicon. 1977. Nitrogen and phosphorus method 329-74 W/B revised 1977, and Nitrate and nitrite method 158-71 W/A revised 1977.
- Tilton, D.L. 1976. Preface. In: *Freshwater wetlands and sewage effluent disposal*, D.L. Tilton, R.H. Kadlec, and C.J. Richardson (eds.), University of Michigan, Ann Arbor, MI, pp. vii-ix.
- Tilton, D.L., R.H. Kadlec, and C.J. Richardson (eds.). 1976. *Freshwater wetlands and sewage effluent disposal*. University of Michigan, Ann Arbor, MI. 343 pp.
- Trautman, M.B. 1957. *The fishes of Ohio, with illustrated keys*. Ohio State University Press, Columbus, OH. 683 pp.
- Tucker, A. 1957. The relation of phytoplankton periodicity to the nature of the physico-chemical environment with special reference to phosphorus. II. Seasonal and vertical distribution of the phytoplankton in relation to the environment. *Am. Midl. Nat.* 57: 334-370.
- U.S. Dept. of Commerce. 1963. *Decennial census of United States climate-monthly averages for state climatic divisions 1931-1960*. U.S. Government Printing Office, Washington, D.C.
- Valiela, I., S. Vince, and J.M. Teal. 1976. Assimilation of sewage by wetlands. In: *Estuarine processes. Vol 1. Uses, stresses, and adaptation to the estuary*, M. Wiley (ed.), Academic Press, New York, pp. 234-253.
- Van Baalen, C., D.S. Hoare, and E. Brandt. 1974. Heterotrophic growth of blue-green algae in dim light. In: *Blue-green algae, III. Current research*, MSS Information Corp., New York, pp. 189-198.
- Van Oosten, J., H.J. Deason, and F.W. Jobes. 1934. A microprojection machine designed for the study of fish scales. *J. Cons. Cons. Int. Explor. Mer* 9: 241-248.
- Venrick, E.L. 1978. Statistical considerations. In: *Phytoplankton manual*, A. Sournia (ed.), UNESCO, Paris, pp. 238-250.

- Voigts, D.K. 1976. Aquatic invertebrate abundance in relation to changing marsh vegetation. *Am. Midl. Nat.* 95: 313-322.
- Vollenweider, R.A. 1974. A manual on methods for measuring primary production in aquatic environments, 2nd ed. Blackwell Scientific Publications, Oxford, Eng. 225 pp.
- Vollenweider, R.A., M. Munawar, and P. Stadelmann. 1974. A comparative review of phytoplankton and primary production in the Laurentian Great Lakes. *J. Fish. Res. Board Can.* 31: 739-762.
- Wade, W.E. 1957. Studies on the distribution of desmids of Michigan. *Trans. Am. Microsc. Soc.* 76: 80-86.
- Weber, C.I. 1966. A guide to the common diatoms at water pollution surveillance system stations. Federal Water Pollution Control Administration, Cincinnati, OH. 98 pp.
- Weber, C.I. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. U.S. Environmental Protection Agency, Cincinnati, OH. 187 pp.
- Welch, E.B. 1980. Ecological effects of wastewater. Cambridge University Press, Cambridge, Eng. 337 pp.
- Welch, P.S. 1936. A limnological study of a small sphagnum-leatherleaf-black spruce bog lake with special reference to its plankton. *Trans. Am. Microsc. Soc.* 55: 300-312.
- Wetzel, R. G. 1975. Limnology. W.B. Saunders Co., Philadelphia, PA. 743 pp.
- Whigham, D.F., and R.L. Simpson. 1976. The potential use of freshwater tidal marshes in the management of water quality in the Delaware River. In: Biological control of water pollution, J. Tourbier and R.W. Pierson, Jr. (eds.), University of Pennsylvania Press, Philadelphia, PA, pp. 173-186.
- Whipple, G.C. 1914. The microscopy of drinking water, 3rd ed. J. Wiley & Sons, New York. 409 pp.
- Wiedeman, V.E., and H.C. Bold. 1965. Heterotrophic growth of selected waste-stabilization pond algae. *J. Phycol.* 1: 66-69.
- Wiederholm, T., and L. Eriksson. 1977. Benthos of an acid lake. *Oikos* 29: 261-267.

- Wiggins, G.B. 1978. Larvae of the North American caddisfly genera (Trichoptera). University of Toronto Press, Toronto. 401 pp.
- Wirth, W.W., and A. Stone. 1968. Aquatic diptera In: Aquatic insects of California, R.L. Usinger (ed.), University of California Press, Los Angeles, CA, pp. 372-482.
- Woelkerling, W.J. 1976. Wisconsin desmids. I. Aufwuchs and plankton communities of selected acid bogs, alkaline bogs, and closed bogs. *Hydrobiologia* 48: 209-232.
- Wright, A. 1981. Personal communication. College of Natural Resources, University of Wisconsin-Stevens Point.
- Yan, N.D., and P. Stokes. 1978. Phytoplankton of an acidic lake, and its responses to experimental alterations of pH. *Environ. Conserv.* 5: 93-100.
- Young, H.L., and E.L. Skinner. 1974. Water resources of Wisconsin Lake Superior Basin. (Hydrologic investigations atlas HA-524). U.S. Geological Survey, Washington, D.C.
- Zar, J.H. 1974. Biostatistical analysis. Prentice-Hall, Englewood Cliffs, NJ. 620 pp.

Appendix A. Results of analyses of variance on chemical variables in Weso Lake with site and year as factors. Only samples collected during the stratified period of each year (May through September) were used in the comparisons.

Variable	Calculated F Value				Multiple Comparisons for Site Differences ^{ab}
	Site		Year		
	F	d.f.	F	d.f.	
Temperature	64.90 ^{**}	5,48	21.60 ^{**}	1,48	$u_2=u_4=u_5=u_6 \neq u_{5-3} \neq u_{5-6}$
pH	2.68	5,48	0.43	1,48	No Test
Conductivity	24.14 ^{**}	5,48	85.77 ^{**}	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{10}$
Alkalinity	37.77 ^{**}	5,48	7.79 [*]	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{5-6}$
Total Hardness	6.14 ^{**}	5,48	1.22	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{5-6}$
Ca Hardness	3.98 [*]	5,48	3.18	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{5-6}$
Dissolved Oxygen	758.69 ^{**}	2,24	1.13	1,24	$u_5=u_{5-3} \neq u_{5-6}$
COD	4.59 [*]	2,24	0.64	1,24	$\overline{u_5} \overline{u_9} \overline{u_{10}}$
BOD	3.14	2,24	0.28	1,24	No Test
Reactive Phosphorus	22.32 ^{**}	5,48	10.61 [*]	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{10}$
Total Phosphorus	18.91 ^{**}	5,48	12.62 ^{**}	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{5-6}$
NH ₄ -N	32.09 ^{**}	5,48	0.03	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{5-6}$
NO ₂₋₃ -N	0.49	5,48	0.14	1,48	No Test
Total Kjeldahl-N	12.16 ^{**}	5,48	4.72 [*]	1,48	$u_2=u_4=u_5=u_6=u_{5-3} \neq u_{5-6}$
Chloride	0.52	5,48	154.48 ^{**}	1,48	No Test
Apparent Color	31.51 ^{**}	4,40	143.97 ^{**}	1,40	$u_2=u_4=u_5=u_6 \neq u_{5-3}$
True Color	75.25 ^{**}	5,48	115.31 ^{**}	1,48	$u_2=u_4=u_5=u_6 \neq u_{5-3} \neq u_{5-6}$
Total Suspended Solids	199.40 ^{**}	2,24	0.07	1,24	$u_5 \neq u_9 \neq u_{10}$

^a Student-Newman-Keuls Test at P<0.05.

^b Subscripts indicate site.

* P<0.05.

** P<0.001.

Appendix B. Results of analyses of variance on chemical variables of Weso Lake surface samples with sampling day and year as factors. Only samples collected during the stratified period of each year (May through September) were used in the comparisons.

Variable	Calculated F Value	
	Month (d.f.=4,12)	Year (d.f.=1,3)
Secchi	134.61**	1659.43**
Temperature	421.11**	54.86*
pH	43.22**	6.15
Conductivity	58.41**	1271.51**
Alkalinity	2.56	4.20
Total Hardness	10.80**	15.00*
Ca Hardness	5.00*	0.09
Reactive Phosphorus	30.55**	245.38**
Total Phosphorus	12.21**	862.97**
NH ₄ -N	1.00	1.11
NO ₂₋₃ -N	6.00*	0
Total Kjeldahl-N	9.43*	33.42*
Chloride	398.92**	4908.37**
Apparent Color	16.33**	4760.54**
True Color	187.67**	6269.43**

* $P < 0.05$.

** $P < 0.001$.

Appendix C. Results of "two sample t-tests" comparing yearly means of chemical variables in Weso Lake for sites 5-3, 5-6, and 7. Only samples collected during the stratified period of each year (May through September) were used in the comparisons.

Variable	Site 5-3 t (d.f.=9)	Site 5-6 t (d.f.=9)	Site 7 t (d.f.=9)
Temperature	-0.34	-0.41	-0.36
pH	0.61	0.06	-1.04
Conductivity	-6.22**	-4.34*	1.57
Alkalinity	-1.77	-2.34	--
Total Hardness	-0.27	1.92	-0.51
Ca Hardness	0.34	1.21	1.40
Dissolved Oxygen	0.34	--	-1.47
COD	1.15	-0.22	--
BOD	-1.14	-0.26	--
Reactive Phosphorus	7.32**	1.58	3.42*
Total Phosphorus	2.21	1.25	1.54
NH ₄ -N	1.39	-0.51	0.60
NO ₂₋₃ -N	--	--	--
Total Kjeldahl-N	0.92	0.31	3.01*
Chloride	-5.87**	-3.76*	1.53
Apparent Color	1.93	--	--
True Color	5.75**	2.33	4.24*
Total Suspended Solids	1.03	-2.05	--

* $P < 0.05$.

** $P < 0.001$.

Appendix D. Water quality data for Weso Lake.

Date/Site	Depth m	Secchi m	Temperature °C	pH	Cond. umhos cm ⁻¹	Alkalinity	Total Hardness	Ca Hardness	DO	COD	BOD ₅	Reactive P	Total P	NH ₄ -N	NO ₂ -NO ₃ N	TKN	Cl ⁻	Apparent Color pt-co units	True Color pt-co units	Silica	TSS
V-26-79																					
1	0	.75	18	5.35	25	3	12	6	---	---	---	.008	.030	.12	.01	.72	<1.0	238	223	---	---
2	0	.80	19	5.41	26	3	12	6	---	---	---	.003	.030	.17	.01	1.00	<1.0	228	216	---	---
3	0	.75	18	5.47	25	2	11	6	---	---	---	.005	.080	.18	.01	1.00	<1.0	245	227	---	---
4	0	.80	18	5.44	26	3	12	6	---	---	---	.011	.050	.01	.01	1.32	<1.0	236	219	---	---
5	0	.75	19	5.54	25	2	11	6	7.5	44	1.8	.007	.050	.08	<.01	.84	<1.0	242	224	---	2.0
6	0	.75	18	5.52	24	2	10	6	---	---	---	.015	.050	.06	<.01	1.36	<1.0	232	218	---	---
5-3	3	---	6	5.42	27	4	12	7	.5	79	.6	.017	.040	.10	<.01	.91	<1.0	308	236	---	8.5
5-6	6	---	6	5.78	34	6	18	9	0	64	.9	.038	.126	.45	.01	1.65	<1.0	---	386	---	27.0
7	0	---	18	4.66	32	0	11	8	6.9	---	---	.032	.330	.42	<.02	2.76	2.1	---	239	---	---
11	1	---	16	5.45	26	3	11	6	6.1	---	---	.006	.030	.14	<.01	.86	<1.0	---	---	---	---
12	2	---	8	5.59	25	3	11	6	1.8	---	---	.010	.030	.21	<.01	.82	<1.0	---	---	---	---
13	4	---	6	5.68	29	4	12	8	0	---	---	.014	.040	.37	.01	.96	<1.0	---	---	---	---
14	6	---	6	5.78	34	6	18	9	0	---	---	.038	.126	.45	.01	1.65	<1.0	---	---	---	---
VI-24-79																					
1	0	.70	22	5.57	28	4	10	4	---	---	---	<.002	.060	.18	<.02	1.72	<1.0	224	214	---	---
2	0	.75	21	5.46	26	3	10	5	---	---	---	<.002	.080	.03	<.02	1.28	<1.0	216	209	---	---
3	0	.70	22	5.61	24	4	9	5	---	---	---	<.002	.030	.16	<.02	.80	<1.0	218	204	---	---
4	0	.70	22	5.46	24	3	9	6	---	---	---	<.002	.070	.08	<.02	.92	<1.0	220	212	---	---
5	0	.75	22	5.42	23	4	9	6	5.8	47	1.4	.007	.060	.04	<.02	1.20	<1.0	226	216	---	2.0
6	0	.70	22	5.43	24	3	10	5	---	---	---	<.002	.070	.10	<.02	1.12	<1.0	222	214	---	---
5-3	3	---	10	5.34	25	3	12	6	0	49	.8	.018	.060	.04	<.02	.86	<1.0	292	224	---	5.5
5-6	6	---	5	5.77	31	8	14	8	0	52	1.6	.164	.170	.40	<.02	1.32	<1.0	---	394	---	25.0
7	0	---	23	4.39	36	0	9	5	6.2	---	---	.005	.250	.10	<.02	2.60	1.2	---	228	---	---
11	1	---	20	4.99	26	2	9	6	5.0	---	---	.016	.100	.09	<.02	1.60	<1.0	---	---	---	---
12	2	---	13	5.32	26	3	11	6	.2	---	---	---	.040	.14	<.02	1.04	<1.0	---	---	---	---
13	4	---	12	5.54	28	5	12	8	0	---	---	.014	.070	.20	<.02	.68	1.1	---	---	---	---
14	6	---	5	5.77	31	8	14	8	0	---	---	.164	.170	.40	<.02	1.32	<1.0	---	---	---	---

ALL DATA mg l⁻¹ UNLESS NOTED

Appendix D continued. Water quality data for Weso Lake.

Date/Site	Depth m	Secchi m	Temperature °C	pH	Cond. umhos cm ⁻¹	Alkalinity	Total Hardness	Ca Hardness	DO	COD	BOD ₅	Reactive P	Total P	NH ₄ -N	NO ₂ -NO ₃ N	TKN	Cl ⁻	Apparent Color pt-co units	True Color pt-co units	Silica	TSS
VII-21-79																					
1	0	.60	26	5.86	29	4	12	8	---	---	---	.030	.050	<.02	<.02	.90	1.8	212	196	---	4.0
2	0	.65	25	5.70	26	4	13	8	---	---	---	.030	.065	<.02	<.02	.90	1.6	204	186	---	5.0
3	0	.60	26	5.81	24	3	12	8	---	---	---	.015	.050	.08	<.02	.86	1.5	216	200	---	1.5
4	0	.60	25	5.75	24	4	12	8	---	---	---	.020	.050	.06	<.02	.86	1.4	209	192	---	2.5
5	0	.60	26	5.70	26	3	13	8	5.5	53	1.5	.025	.050	.02	<.02	.88	1.5	214	196	---	1.0
6	0	.60	26	5.72	25	4	13	8	---	---	---	.025	.060	.04	<.02	1.00	1.4	219	205	---	3.0
5-3	3	---	8	5.83	28	5	13	8	0	48	1.3	.025	.065	.41	<.02	.63	1.1	284	218	---	6.0
5-6	6	---	6	5.89	35	11	14	9	0	59	1.1	.200	.270	.82	<.02	1.88	1.5	---	378	---	20.0
7	0	---	27	4.31	54	0	10	6	4.9	---	---	.070	---	<.02	<.02	---	13.2	---	220	---	---
11	1	---	27	5.59	24	3	12	8	3.8	---	---	.030	.080	<.02	<.02	1.12	1.1	---	---	---	2.0
12	2	---	14	5.36	26	3	12	8	.4	---	---	.050	.055	.02	<.02	.70	1.4	---	---	---	3.0
13	4	---	7	5.76	32	8	11	5	0	---	---	.090	.185	.32	<.02	1.48	1.4	---	---	---	18.0
14	6	---	6	5.89	35	11	14	9	0	---	---	.200	.270	.82	<.02	1.88	1.5	---	---	---	20.0
VIII-11-79																					
1	0	.80	26	5.80	24	4	12	8	---	---	---	.010	.040	<.02	<.02	1.24	<1.0	200	180	---	2.0
2	0	.90	25	5.76	23	4	11	8	---	---	---	.010	.050	<.02	<.02	1.32	<1.0	205	183	---	4.0
3	0	.80	26	5.83	22	4	12	8	---	---	---	.010	.020	<.02	<.02	.80	<1.0	190	180	---	1.5
4	0	.80	26	5.72	23	4	11	8	---	---	---	.010	.030	<.02	<.02	1.12	<1.0	205	172	---	3.0
5	0	.85	26	5.77	22	4	11	8	5.8	57	2.8	.010	.040	<.02	<.02	1.04	<1.0	200	175	---	4.0
6	0	.80	26	5.78	22	4	12	8	---	---	---	.010	.020	.02	<.02	.72	<1.0	195	176	---	2.0
5-3	3	---	9	5.61	27	4	12	8	0	58	1.1	.030	.026	.04	<.02	1.07	<1.0	268	208	---	16.0
5-6	6	---	6	5.94	33	14	13	10	0	67	1.3	.140	.350	.72	<.02	2.48	<1.0	---	365	---	26.0
7	0	---	27	4.42	48	0	11	7	5.9	---	---	.050	.920	<.02	<.02	5.60	8.8	---	209	---	---
11	1	---	23	5.64	23	4	12	7	4.0	---	---	.010	.036	<.02	<.02	.76	<1.0	---	---	---	3.0
12	2	---	16	5.42	25	4	12	8	.1	---	---	.020	.024	<.02	<.02	.76	<1.0	---	---	---	3.5
13	4	---	7	5.49	26	8	12	9	0	---	---	.030	.020	<.02	<.02	.68	<1.0	---	---	---	4.0
14	6	---	6	5.94	33	14	13	10	0	---	---	.140	.350	.72	<.02	2.48	<1.0	---	---	---	26.0

ALL DATA mg l⁻¹ UNLESS NOTED

Appendix D continued. Water quality data for Weso Lake.

Date/Site	Depth m	Secchi m	Temperature °C	pH	Cond. umhos cm ⁻¹	Alkalinity	Total Hardness	Ca Hardness	DO	COD	BOD ₅	Reactive P	Total P	NH ₄ -N	NO ₂ -NO ₃ N	TKN	Cl ⁻	Apparent Color pt-co units	True Color pt-co units	Silica	TSS
IX-09-79																					
1	-	----	19	5.93	25	6	11	7	5.1	---	---	.030	.080	.08	<.02	.72	1.2	174	130	---	----
2	0	1.10	19	5.93	25	6	11	7	5.1	---	---	.030	.080	.08	<.02	.72	1.2	174	130	---	----
3	-	----	18	5.91	25	5	11	7	---	---	---	.025	.075	.10	<.02	.88	1.3	172	132	---	----
4	0	1.00	18	5.91	25	5	11	7	---	---	---	.025	.075	.10	<.02	.88	1.3	172	132	---	----
5	0	1.05	19	5.84	24	6	11	7	5.4	46	1.5	.030	.070	.10	<.02	.92	1.4	168	138	---	2.0
6	0	1.00	18	5.86	24	6	10	8	---	---	---	.035	.070	.08	<.02	.84	1.4	170	136	---	----
5-3	3	----	11	5.68	28	6	11	6	0	61	.6	.020	.080	.14	<.02	.95	1.2	214	182	---	13.5
5-6	6	----	6	5.97	34	10	14	8	0	63	1.1	.137	.186	.81	<.02	1.79	1.9	---	338	---	22.0
7	0	----	18	4.65	38	0	7	5	5.4	---	---	.050	.050	.04	<.02	3.20	11.8	---	120	---	----
11	1	----	16	5.72	23	5	11	6	5.0	---	---	.025	.060	.08	<.02	.92	1.5	158	147	---	----
12	2	----	13	5.74	23	5	11	6	.6	---	---	.020	.060	.03	<.02	.88	1.4	166	142	---	----
13	4	----	7	5.82	30	7	12	7	0	---	---	.040	.090	.10	<.02	1.25	1.2	---	---	---	----
14	6	----	6	5.97	34	10	14	8	0	---	---	.137	.186	.81	<.02	1.79	1.9	---	---	---	----
X-20-79																					
2	0	.90	11	5.84	22	3	12	7	---	---	---	<.020	.030	<.02	<.01	.64	1.6	190	160	---	----
5	0	.90	11	5.00	23	2	12	7	7.0	41	.9	.008	.055	.50	.01	1.28	1.6	190	158	---	2.0
5-3	3	----	9	5.82	25	3	12	7	4.0	46	1.3	.003	.035	.02	<.01	.95	1.7	238	206	---	2.0
5-6	6	----	6	5.97	36	10	14	8	0	68	1.6	.131	.178	1.45	<.01	2.36	1.3	---	354	---	23.0
XI-16-79																					
2	0	----	4	5.33	52	3	14	8	---	---	---	.010	.080	.24	.10	1.28	2.1	224	195	---	----
5	0	----	4	5.89	37	4	13	7	5.4	33	1.9	.015	.060	.08	.04	1.12	2.3	250	224	---	4.0
5-3	3	----	4	5.82	35	4	13	6	5.2	36	1.2	.011	.056	.09	.02	.81	1.9	286	232	---	5.0
5-6	6	----	4	5.77	36	5	13	6	4.9	31	1.4	.015	.056	.13	.02	.82	1.6	---	336	---	5.5

ALL DATA mg l⁻¹ UNLESS NOTED

Appendix D continued. Water quality data for Weso Lake.

Date/Site	Depth m	Secchi m	Temperature °C	pH	Cond. umhos cm ⁻¹	Alkalinity	Total Hardness	Ca Hardness	DO	COD	BOD ₅	Reactive P	Total P	NH ₄ -N	NO ₂ -NO ₃ N	TKN	Cl ⁻	Apparent Color pt-co units	True Color pt-co units	Silica	TSS
I-05-80																					
2	0	----	1	5.65	36	5	11	6	5.8	44	1.5	.012	.100	.18	.03	2.00	2.0	220	215	---	----
5	0	----	1	5.58	43	4	11	7	5.8	43	1.8	.012	.060	.24	.03	1.36	2.1	220	205	---	2.0
5-3	3	----	2	5.54	36	4	11	7	4.1	45	1.4	.012	.056	.27	.03	1.41	2.0	262	224	---	4.5
5-6	6	----	4	5.82	35	8	12	8	1.4	46	1.1	.012	.070	.30	.03	1.54	1.9	---	328	---	12.0
II-09-80																					
2	0	----	0	5.74	37	5	14	8	5.0	49	1.7	.022	.060	.15	.13	1.12	3.5	206	195	4.9	----
5	0	----	0	5.72	36	5	12	8	4.8	46	1.4	.015	.060	.23	.11	1.20	3.2	208	197	5.0	3.0
5-3	3	----	3	5.77	37	5	12	8	2.3	45	1.1	.025	.068	.18	.10	1.24	3.4	254	215	---	5.0
5-6	6	----	4	5.82	39	10	12	9	0	48	1.0	.030	.075	.35	.12	1.48	3.1	---	318	---	17.5
IV-27-80																					
2	0	.80	21	5.54	29	4	10	5	7.1	--	---	<.005	.120	<.02	<.02	----	2.9	145	138	5.4	----
5	0	.80	21	5.53	31	4	10	6	8.3	45	.8	<.005	.060	<.02	<.02	1.10	2.9	187	147	5.3	4.0
5-3	3	----	8	5.58	32	4	9	5	.1	58	1.2	.005	.045	<.02	<.02	.58	2.5	205	172	4.7	7.5
5-6	6	----	6	5.87	37	10	9	6	0	71	1.9	.030	.115	.14	<.02	1.04	2.4	415	250	7.8	21.0
V-24-80																					
2	0	1.10	27	5.99	31	6	12	6	7.0	43	---	.005	.005	.08	<.02	1.70	2.7	114	113	3.8	----
4	0	1.00	28	5.95	32	6	11	5	---	---	---	.005	.020	.06	<.02	.88	2.6	124	120	3.2	----
5	0	1.05	28	6.00	30	5	12	6	6.7	47	2.2	.005	.020	.14	.02	.84	2.9	130	110	3.7	2.0
6	0	1.00	28	6.04	30	5	10	6	---	---	---	.005	.025	.08	<.02	.76	2.8	118	116	3.6	----
5-3	3	----	6	5.56	32	6	12	8	0	51	.7	.005	.030	.08	<.02	.88	2.5	230	160	4.9	6.0
5-6	6	----	5	6.13	54	19	10	9	0	92	1.1	.175	.320	1.34	<.02	2.80	2.4	615	365	3.5	28.5
7	0	----	28	4.50	44	0	12	6	6.9	65	---	.005	.020	.08	<.02	.68	4.0	445	120	2.8	----
11	1	----	24	5.90	30	5	10	7	4.9	---	---	.005	.030	.14	<.02	.80	2.8	125	120	---	----
12	2	----	11	5.61	30	7	12	7	1.7	---	---	.005	.030	.08	<.02	.76	2.5	185	160	---	----
13	4	----	5	5.63	32	8	12	7	0	---	---	.005	.035	.06	<.02	.88	2.5	255	160	---	----
14	6	----	5	6.13	54	19	10	9	0	---	---	.175	.320	1.34	<.02	2.80	2.4	615	365	---	----

ALL DATA mg l⁻¹ UNLESS NOTED

Appendix D continued. Water quality data for Weso Lake.

Date/Site	Depth m	Secchi m	Temperature °C	pH	Cond. umhos cm ⁻¹	Alkalinity	Total Hardness	Ca Hardness	DO	COD	BOD ₅	Reactive P	Total P	NH ₄ -N	NO ₂ -NO ₃ N	TKN	Cl ⁻	Apparent Color pt-co units	True Color pt-co units	Silica	TSS
VI-22-80																					
2	0	1.25	23	5.53	27	3 10	7	6.4	36	---	---	.005	.025	.02	<.02	.72	2.4	117	95	<1.0	----
4	0	1.20	22	5.52	28	4 10	8	---	---	---	---	.005	.030	.02	<.02	.98	2.6	118	98	<1.0	----
5	0	1.20	22	5.59	28	4 11	7	6.6	40	1.4	---	.005	.030	.02	<.02	.92	2.2	120	100	<1.0	1.0
6	0	1.20	22	5.56	27	4 11	7	---	---	---	---	.005	.025	.15	<.02	.86	2.4	122	100	<1.0	----
5-3	3	-----	8	5.62	31	5 10	6	0	46	1.2	---	.005	.050	<.02	<.02	.96	1.9	260	160	4.6	6.3
5-6	6	-----	5	5.97	37	10 12	6	0	51	.8	---	.025	.075	.36	<.02	1.24	2.0	420	261	4.0	28.0
7	0	-----	24	4.76	27	2 8	4	6.7	68	---	---	.005	.240	.02	<.02	1.48	2.8	---	112	1.0	----
11	1	-----	21	5.57	28	4 11	6	6.5	---	---	---	.005	.030	.02	<.02	.72	2.4	---	---	---	----
12	2	-----	14	5.60	29	4 11	7	.6	---	---	---	.005	.025	.05	<.02	.92	2.0	---	---	---	----
13	4	-----	11	5.72	32	6 12	7	0	---	---	---	.005	.065	.15	<.02	1.18	1.8	---	---	---	----
14	6	-----	5	5.97	37	10 12	6	0	---	---	---	.025	.075	.36	<.02	1.24	2.0	---	---	---	----
VII-20-80																					
2	0	1.35	26	5.61	29	4 11	6	6.9	--	---	---	<.005	.010	.03	<.01	.36	3.0	92	72	2.8	----
4	0	1.30	25	5.55	28	4 10	6	---	--	---	---	<.005	.010	.08	<.01	.32	3.2	94	70	2.6	----
5	0	1.25	25	5.57	26	4 11	6	6.8	61	.7	---	<.005	.012	.10	<.01	.40	3.1	92	72	3.1	1.0
6	0	1.30	25	5.60	27	4 11	5	---	--	---	---	<.005	.012	.06	<.01	.44	3.0	96	74	3.3	----
5-3	3	-----	10	5.66	34	5 13	7	0	63	1.3	---	<.005	.019	.08	<.01	.48	2.4	218	152	4.8	6.0
5-6	6	-----	7	5.56	46	17 14	9	0	48	2.4	---	.095	.154	.93	<.01	1.08	2.4	515	240	8.4	29.3
7	0	-----	26	4.64	28	0 12	6	6.6	40	---	---	.005	.029	.11	<.01	.68	3.0	---	82	2.6	----
11	1	-----	24	5.58	26	4 11	6	6.2	--	---	---	<.005	.012	.08	<.01	.40	2.9	92	72	---	----
12	2	-----	19	5.60	27	4 13	7	.3	---	---	---	.010	.020	.18	<.01	.53	2.7	157	120	---	----
13	4	-----	7	5.69	30	6 14	9	0	---	---	---	.005	.013	.06	<.01	.57	2.4	249	165	---	----
14	6	-----	7	5.56	46	17 14	9	0	---	---	---	.095	.154	.93	<.01	1.08	2.4	515	240	---	----

ALL DATA mg l⁻¹ UNLESS NOTED

Appendix D continued. Water quality data for Weso Lake.

Date/Site	Depth m	Secchi m	Temperature °C	pH	Cond. umhos cm ⁻¹	Alkalinity	Total Hardness	Ca Hardness	DO	COD	BOD ₅	Reactive P	Total P	NH ₄ -N	NO ₂ -NO ₃ N	TKN	Cl ⁻	Apparent Color pt-co units	True Color pt-co units	Silica	TSS
VIII-10-80																					
2	0	1.35	25	5.39	35	4	11	6	6.8	--	---	<.005	.030	.06	<.02	.80	3.2	105	85	---	---
4	0	1.40	24	5.35	33	6	11	5	---	--	---	<.005	.020	.12	<.02	.74	3.2	110	85	3.2	---
5	0	1.40	24	5.40	31	4	10	6	6.8	42	.6	<.005	.010	.08	<.02	.68	3.1	105	85	3.0	2.0
6	0	1.40	24	5.43	32	4	10	6	---	--	---	<.005	.015	.06	<.02	.78	3.0	105	85	3.1	---
5-3	3	---	8	5.10	34	6	12	6	0	54	1.2	<.005	.020	.06	<.02	.88	2.4	255	168	4.7	7.5
5-6	6	---	6	5.53	47	16	12	8	0	63	.9	.045	.090	.66	<.02	2.00	2.5	590	330	4.5	23.0
7	0	---	24	4.42	30	0	8	3	6.2	---	---	<.005	.140	.06	<.02	2.36	3.7	---	120	3.0	---
11	1	---	23	5.42	33	4	11	6	6.4	---	---	<.005	.030	.08	<.02	.70	3.2	112	98	---	---
12	2	---	14	5.28	30	6	12	5	4.2	---	---	<.005	.010	.14	<.02	.76	3.4	118	100	---	---
13	4	---	7	5.25	37	8	14	7	0	---	---	<.005	.030	.06	<.02	1.20	2.6	342	217	---	---
14	6	---	6	5.53	47	16	12	8	0	---	---	.045	.090	.66	<.02	2.00	2.5	590	330	---	---
IX-13-80																					
2	0	1.20	19	5.68	38	3	12	8	5.7	52	---	.002	.055	.02	<.01	1.10	4.3	159	109	3.3	---
4	0	1.25	18	5.58	36	3	13	7	---	---	---	.002	.040	.02	<.01	.84	4.6	146	110	3.4	---
5	0	1.30	19	5.55	36	3	13	8	5.7	40	1.3	.002	.035	.02	<.01	.76	4.4	133	113	3.5	2.0
6	0	1.25	18	5.61	38	4	11	8	---	---	---	.002	.035	.02	<.01	.88	4.3	135	112	3.5	---
5-3	3	---	15	5.53	36	5	14	7	.3	43	1.0	.002	.030	.02	<.01	.70	3.1	228	150	4.1	11.0
5-6	6	---	7	6.12	55	12	14	8	0	60	1.2	.032	.080	.42	<.02	1.44	3.7	---	352	4.5	31.5
7	0	---	18	4.59	38	0	11	6	5.8	---	---	.005	.025	.05	<.01	.94	4.6	---	105	3.1	---
11	1	---	18	5.59	36	3	12	7	5.6	---	---	.002	.035	.02	<.01	.78	4.0	---	---	---	---
12	2	---	18	5.64	37	3	13	8	5.6	---	---	.002	.025	.18	<.01	.84	3.2	---	---	---	---
13	4	---	10	5.82	42	8	14	8	0	---	---	.002	.045	.15	<.01	1.12	3.4	---	---	---	---
14	6	---	7	6.12	55	12	14	8	0	---	---	.032	.080	.42	<.02	1.44	3.7	---	---	---	---

ALL DATA mg l⁻¹ UNLESS NOTED

Appendix E. Dominant phytoplankton cell numbers in Weso Lake for May 26, 1979.

Dominant Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.		1		1		
<u>Ankistrodesmus</u> sp.	2	1	6	3	3	10
<u>Botryococcus</u> sp.						
<u>Chlamydomonas</u> sp.	72	107	69	158	176	218
<u>Closteriopsis</u> sp.	2		1	1		
<u>Closterium</u> sp.						
<u>Cosmarium</u> spp.	2	2	1	1	4	3
<u>Crucigenia</u> sp.		4			3	
<u>Dictyosphaerium</u> sp.						
<u>Euastrum</u> sp.					1	
<u>Haematococcus</u> sp.			1		1	1
<u>Microasterias</u> spp.						
<u>Oocystis</u> sp.	3	7	3		7	6
<u>Pediastrum</u> spp.			3			
<u>Scenedesmus</u> sp.	3		3	8		
<u>Schroederia</u> sp.	1					1
<u>Sphaerocystis</u> sp.	17	56	11	45	30	48
<u>Staurastrum</u> sp.	1	2	1		1	
Unidentified unicellular sp.	26	23	9	37	28	19
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> spp.		1				
<u>Actinella</u> sp.						
<u>Asterionella</u> sp.	15	9	16	22		48
<u>Chrysosphaerella</u> sp.						
<u>Cocconeis</u> sp.						3
<u>Cymbella</u> spp.	1		1			1
<u>Dinobryon</u> sp.	20	10	4	31	24	32
<u>Eunotia</u> spp.	3	4	4	1	2	4
<u>Frustulia</u> sp.	2	4	1	1	2	1
<u>Gyrosigma</u> sp.	2					1
<u>Hantzschia</u> sp.						1
<u>Melosira</u> spp.	234	368	370	467	364	877
<u>Navicula</u> spp.						
<u>Naidium</u> sp.	1				1	
<u>Nitzschia</u> spp.		1				
Pennales Order	2	2	1	1	1	4
<u>Pinnularia</u> spp.	2	3	1	3		1
<u>Stauroneis</u> sp.	1					
<u>Stephanodiscus</u> sp.		1		1		
<u>Synura</u> sp.						
<u>Tabellaria</u> spp.	2	4	2	3	2	4
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.	4	10	11	6	13	16
<u>Aphanocapsa</u> sp.		44		32	77	
<u>Dactylococcopsis</u> spp.						
Cryptophycophyta (cryptomonads)						
<u>Cryptomonas</u> spp.	646	492	371	1649	1879	2402
Pyrrhophycophyta (dinoflagellates)						
<u>Peridinium</u> sp.	2	2	1	1	2	6
Euglenophycophyta (euglenoids)						
<u>Phacus</u> sp.						
<u>Tracnelemonas</u> sp.						
Total number of taxa	25	24	23	21	21	23
Total number of genera	23	22	21	19	19	21
Total taxa number	1066	1158	891	2472	2621	3707
Unidentified (bacterial cells?)	14	18	11		15	

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for June 24, 1979.

Dominant Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.		1	1	1	1	1
<u>Ankistrodesmus</u> sp.		39	7	5	7	10
<u>Rotryococcus</u> sp.						
<u>Chlamydomonas</u> sp.	37	28	56	36	30	31
<u>Closterionopsis</u> sp.	2		1	1	1	1
<u>Closterium</u> sp.						
<u>Cosmarium</u> spp.	2		4		2	
<u>Crucigenia</u> sp.	3	11	20	20	20	3
<u>Dictyosphaerium</u> sp.						
<u>Euastrum</u> sp.		1		1		
<u>Haematococcus</u> sp.						
<u>Micrasterias</u> spp.						
<u>Oocystis</u> sp.	16	57	77	64	66	71
<u>Pediastrum</u> spp.		7		3		3
<u>Scenedesmus</u> sp.	3	5	4		10	6
<u>Schroederia</u> sp.	3	2			3	1
<u>Sphaerocystis</u> sp.	619	531	421	313	457	465
<u>Staurastrum</u> sp.	2	1	2	3	2	2
Unidentified unicellular sp.	185	68	111	88	80	77
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> spp.				2		
<u>Actinella</u> sp.						
<u>Asterionella</u> sp.	6	4	3	5	10	6
<u>Chrysosphaerella</u> sp.						
<u>Cocconeis</u> sp.						
<u>Cymbella</u> spp.				1		1
<u>Dinobryon</u> sp.	3	4	4	8	15	23
<u>Eunotia</u> spp.	5	2	4	1	1	1
<u>Frustulia</u> sp.	2	1	3	2	2	1
<u>Gyrosigma</u> sp.						
<u>Hantzschia</u> sp.						
<u>Melosira</u> spp.	224	147	156	180	236	218
<u>Navicula</u> spp.						
<u>Neidium</u> sp.						
<u>Nitzschia</u> spp.						
<u>Pennales</u> Order	1		2	1	2	1
<u>Pinnularia</u> spp.			1	1		1
<u>Stauroneis</u> sp.					1	
<u>Stephanodiscus</u> sp.	1					
<u>Synura</u> sp.						
<u>Tabellaria</u> spp.	2	1	4	1	1	1
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.			21	30	10	
<u>Aphanocapsa</u> sp.	181	134	67	42	127	101
<u>Dactylococcopsis</u> spp.						
Cryptophycophyta (cryptomonads)						
<u>Cryptomonas</u> spp.	321	160	191	215	267	203
Pyrrhophycophyta (dinoflagellates)						
<u>Peridinium</u> sp.	2	1		1	6	14
Euglenophycophyta (euglenoids)						
<u>Phacus</u> sp.						
<u>Trachelomonas</u> sp.						
Total number of taxa	21	21	22	25	24	24
Total number of genera	19	20	20	23	22	22
Total taxa number	1620	1205	1160	1025	1357	1242
Unidentified (bacterial cells?)	40	13				

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for July 21, 1979.

Dominant Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.	21	23	21	16	13	17
<u>Ankistrodesmus</u> sp.	6	6	4	4	1	2
<u>Rotyrococcus</u> sp.						
<u>Chlamydomonas</u> sp.	10	20	13	20	20	26
<u>Olosterionopsis</u> sp.		1	1		1	
<u>Olosterium</u> sp.						
<u>Cosmarium</u> spp.	1				1	1
<u>Crucigenia</u> sp.	4		4	15	7	4
<u>Dictyosphaerium</u> sp.	17			23	34	
<u>Euastrum</u> sp.						
<u>Haematococcus</u> sp.				1		1
<u>Micrasterias</u> spp.						
<u>Oocystis</u> sp.	27	23	18	21	21	7
<u>Pediastrum</u> spp.	4		8	8	4	7
<u>Scenedesmus</u> sp.	12		8	4	4	4
<u>Schroederia</u> sp.	18	26	23	32	20	12
<u>Sphaerocystis</u> sp.	1175	1266	1529	1415	1273	1417
<u>Staurastrum</u> sp.	1	9	3	6	4	4
Unidentified unicellular sp.	11	14	42	148	38	57
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> spp.	1					
<u>Actinella</u> sp.		1			1	
<u>Asterionella</u> sp.	148	86	129	62	128	98
<u>Chrysosphaerella</u> sp.		14				
<u>Cocconeis</u> sp.						
<u>Cymbella</u> spp.	1		1	1	1	1
<u>Dinobryon</u> sp.	59	18	15	46	16	11
<u>Eunotia</u> spp.	2	7	4	2	1	4
<u>Frustulia</u> sp.	5	2	1	2	1	
<u>Gyrosigma</u> sp.						
<u>Hantzschia</u> sp.						
<u>Melosira</u> spp.	375	452	379	300	459	407
<u>Navicula</u> spp.						
<u>Neidium</u> sp.				1		1
<u>Nitzschia</u> spp.		1				1
Pennales Order	3	1	2	3	2	2
<u>Pinnularia</u> spp.	3	2	2	2	1	2
<u>Stauroneis</u> sp.				1		
<u>Stephanodiscus</u> sp.						
<u>Synura</u> sp.						
<u>Tabellaria</u> spp.	4	1	2	1	1	3
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.	10	18	10	4	13	7
<u>Aphanocapsa</u> sp.						
<u>Dactylococcopsis</u> spp.		5	2		4	
Cryptophycophyta (cryptomonads)						
<u>Cryptomonas</u> spp.	46	64	95	62	94	197
Pyrrhophycophyta (dinoflagellates)						
<u>Peridinium</u> sp.	30	107	43	30	47	53
Euglenophycophyta (euglenoids)						
<u>Phacus</u> sp.						
<u>Trachelomonas</u> sp.						
Total number of taxa	26	24	25	27	28	26
Total number of genera	24	22	23	25	26	24
Total taxa number	1994	2167	2359	2230	2210	2346
Unidentified (bacterial cells?)	57	12		19	18	31

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for August 11, 1979.

Dominant Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.	28	18	30	20	24	23
<u>Ankistrodesmus</u> sp.		4	7	4	9	5
<u>Betryococcus</u> sp.	143			69	36	
<u>Chlamydomonas</u> sp.	9	13	4	13	12	8
<u>Closterionopsis</u> sp.	1		1		1	
<u>Closterium</u> sp.						
<u>Cosmarium</u> spp.	3		4	7	4	12
<u>Crucigerina</u> sp.	11	10	12	11	13	20
<u>Dictyosphaerium</u> sp.	18			13	20	
<u>Euastrum</u> sp.						1
<u>Haematococcus</u> sp.		2		1	1	
<u>Microasterias</u> spp.						
<u>Oocystis</u> sp.	9	11	4	8		12
<u>Pediastrum</u> spp.	9	4	7	13	3	3
<u>Scenedesmus</u> sp.		8	4		7	
<u>Schroederia</u> sp.	13	8	12	12	6	5
<u>Sphaerocystis</u> sp.	538	492	637	704	466	546
<u>Staurastrum</u> sp.	8	2	5	5	2	
Unidentified unicellular sp.	22	26	39	38	23	26
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> spp.						
<u>Actinella</u> sp.						
<u>Asterionella</u> sp.	26	15	26	21	20	26
<u>Chrysosphaerella</u> sp.	28	48	43	133		18
<u>Cocconeis</u> sp.						
<u>Cymbella</u> spp.	2	2	1	1		1
<u>Dinobryon</u> sp.	73	72	74	85	79	57
<u>Eunotia</u> spp.	5	3	2	5	6	3
<u>Frustulia</u> sp.	2	2	3	2	2	5
<u>Gyrosigma</u> sp.			1			
<u>Hantzschia</u> sp.	1					
<u>Melosira</u> spp.	1222	1225	1030	1159	996	736
<u>Navicula</u> spp.						
<u>Neidium</u> sp.					1	1
<u>Nitzschia</u> spp.						
Pennales Order	5	3	3	2	2	4
<u>Pinnularia</u> spp.	2	2	2	2	2	2
<u>Stauroneis</u> sp.				1		
<u>Stephanodiscus</u> sp.		1		1		
<u>Synura</u> sp.	57	95			54	
<u>Tabellaria</u> spp.	6	2	3	2	5	5
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.	17	14		11	6	6
<u>Aphanocapsa</u> sp.				133		
<u>Dactylococcopsis</u> spp.	2	6		4		6
Cryptophycophyta (cryptomonads)						
<u>Cryptomonas</u> spp.	28	37	31	24	27	39
Pyrrhophycophyta (dinoflagellates)						
<u>Peridinium</u> sp.	39	147	39	51	57	26
Euglenophycophyta (euglenoids)						
<u>Ehancus</u> sp.						
<u>Trachelomonas</u> sp.						
Total number of taxa	29	28	26	31	28	26
Total number of genera	27	26	24	29	26	24
Total taxa number	2327	2272	2024	2555	1884	1596
Unidentified (bacterial cells?)	17		40			23

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for September 9, 1979.

Dominant Taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Chlorophycophyta (green)						
<i>Arthrodesmus</i> spp.	2	1	2	1	1	2
<i>Ankistrodesmus</i> sp.	2	2	5	4	2	2
<i>Botryococcus</i> sp.	1132	952	1322	1075	1015	938
<i>Chlamydomonas</i> sp.	26	17	31	21	33	24
<i>Closteriopsis</i> sp.						
<i>Closterium</i> sp.	1					
<i>Cosmarium</i> spp.	3	3	3	2	3	2
<i>Crucigenia</i> sp.	12	12	8	9	12	9
<i>Dictyosphaerium</i> sp.		16		12	20	
<i>Euastrum</i> sp.				1		
<i>Haematococcus</i> sp.	1					1
<i>Microasterias</i> spp.						
<i>Oocystis</i> sp.	6		4		8	4
<i>Pediastrum</i> spp.	8	8	13	10	4	9
<i>Scenedesmus</i> sp.						
<i>Schroederia</i> sp.		2		2	1	
<i>Sphaerocystis</i> sp.	76	97	82	92	89	42
<i>Staurastrum</i> sp.		1		1		1
Unidentified unicellular sp.	20	22	19	16	15	9
Chrysophycophyta (yellow-green)						
<i>Achnanthes</i> spp.		1				
<i>Actinella</i> sp.				1		
<i>Asterionella</i> sp.	29	51	48	38	20	16
<i>Chrysosphaerella</i> sp.	116	97	138	126	153	46
<i>Cocconeis</i> sp.						
<i>Cymbella</i> spp.	1	1	2			
<i>Dinobryon</i> sp.	22	18	25	16	8	9
<i>Eunotia</i> spp.	12	8	23	9	6	11
<i>Frustulia</i> sp.	6	7	7	5	2	2
<i>Gyrosigma</i> sp.			1			
<i>Hantzschia</i> sp.		2		1		
<i>Melosira</i> spp.	222	490	75	246	312	44
<i>Navicula</i> spp.						
<i>Neidium</i> sp.	1		1			
<i>Nitzschia</i> spp.						
Pennales Order	2	3	7	3	3	2
<i>Pinnularia</i> spp.	3	2	2	2	2	2
<i>Stauroneis</i> sp.			1			
<i>Stephanodiscus</i> sp.			1			1
<i>Synura</i> sp.	208	49	254	94	229	204
<i>Tabellaria</i> spp.	6	14	8	8	1	1
Cyanochloronta (blue-green)						
<i>Anabaena</i> spp.		8		10	14	11
<i>Aphanocapsa</i> sp.						
<i>Dactylococcopsis</i> spp.	6		4			
Cryptophycophyta (cryptomonads)						
<i>Cryptomonas</i> spp.	386	279	486	309	327	267
Fyrrhophycophyta (dinoflagellates)						
<i>Peridinium</i> sp.	26	18	32	34	36	30
Euglenophycophyta (euglenoids)						
<i>Ehancus</i> sp.						
<i>Trachelomonas</i> sp.						
Total number of taxa	27	28	28	28	25	26
Total number of genera	25	26	26	26	23	24
Total taxa number	2335	2181	2604	2148	2316	1689
Unidentified (bacterial cells?)	18	15	16	22	15	27

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for October 20, 1979.

Dominant Taxa	Site 2	Site 5
Chlorophycophyta (green)		
<u>Arthrodesmus</u> spp.		
<u>Ankistrodesmus</u> sp.	2	2
<u>Botryococcus</u> sp.		
<u>Chlamydomonas</u> sp.	32	26
<u>Closteriopsis</u> sp.		
<u>Closterium</u> sp.		
<u>Cosmarium</u> spp.	1	1
<u>Crucigenia</u> sp.	9	13
<u>Dictyosphaerium</u> sp.		22
<u>Euastrum</u> sp.		
<u>Haematococcus</u> sp.		
<u>Micrasterias</u> spp.		
<u>Oocystis</u> sp.	4	
<u>Pediastrum</u> spp.		
<u>Scenedesmus</u> sp.		
<u>Schroederia</u> sp.		
<u>Sphaerocystis</u> sp.	105	80
<u>Staurastrum</u> sp.		1
Unidentified unicellular sp.	46	38
Chrysophycophyta (yellow-green)		
<u>Achnanthes</u> spp.		
<u>Actinella</u> sp.		1
<u>Asterionella</u> sp.	1	2
<u>Chrysosphaerella</u> sp.		
<u>Cocconeis</u> sp.		
<u>Cymbella</u> spp.		1
<u>Dinobryon</u> sp.	47	16
<u>Eunotia</u> spp.	7	20
<u>Frustulia</u> sp.	1	1
<u>Gyrosigma</u> sp.		
<u>Hantzschia</u> sp.	1	
<u>Melosira</u> spp.	129	179
<u>Navicula</u> spp.		
<u>Neidium</u> sp.		
<u>Nitzschia</u> spp.		
<u>Pennales</u> Order	2	2
<u>Pinnularia</u> spp.	2	2
<u>Stauroneis</u> sp.		
<u>Stephanodiscus</u> sp.	1	
<u>Synura</u> sp.		
<u>Tabellaria</u> spp.	2	2
Cyanochloronta (blue-green)		
<u>Anabaena</u> spp.	36	32
<u>Aphanocarsa</u> sp.		
<u>Dactylococcopsis</u> spp.		
Cryptophycophyta (cryptomonads)		
<u>Cryptomonas</u> spp.	169	666
Pyrrophycophyta (dinoflagellates)		
<u>Peridinium</u> sp.		
Euglenophycophyta (euglenoids)		
<u>Phacus</u> sp.		
<u>Trachelomonas</u> sp.		
Total number of taxa	19	20
Total number of genera	17	18
Total taxa number	597	1107
Unidentified (bacterial cells?)	18	11

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for November 16, 1979.

Dominant Taxa	Site 2	Site 5
Chlorophycophyta (green)		
<u>Arthrodesmus</u> spp.		
<u>Ankistrodesmus</u> sp.		
<u>Botryococcus</u> sp.		
<u>Chlamydomonas</u> sp.	26	28
<u>Closteriopsis</u> sp.		
<u>Closterium</u> sp.		
<u>Cosmarium</u> spp.		
<u>Crucigenia</u> sp.		
<u>Dictyosphaerium</u> sp.		
<u>Euastrum</u> sp.		
<u>Haematococcus</u> sp.		
<u>Microsterias</u> sp.		
<u>Oocystis</u> sp.		
<u>Pediastrum</u> spp.		
<u>Scenedesmus</u> sp.		
<u>Schroederia</u> sp.		
<u>Sphaerocystis</u> sp.		
<u>Staurastrum</u> sp.		1
Unidentified unicellular sp.	4	3
Chrysophycophyta (yellow-green)		
<u>Achnanthes</u> spp.		
<u>Actinella</u> sp.		
<u>Asterionella</u> sp.	11	
<u>Chrysosphaerella</u> sp.		
<u>Cocconeis</u> sp.		
<u>Cymbella</u> spp.		
<u>Dinobryon</u> sp.		
<u>Eunotia</u> spp.	56	1
<u>Frustulia</u> sp.	9	1
<u>Gyrosigma</u> sp.		
<u>Hantzschia</u> sp.		
<u>Melosira</u> spp.	48	31
<u>Navicula</u> spp.		
<u>Neidium</u> sp.	2	
<u>Nitzschia</u> spp.	2	
Pennales Order	17	1
<u>Pinnularia</u> spp.	9	1
<u>Stauroneis</u> sp.	2	
<u>Stephanodiscus</u> sp.		
<u>Synura</u> sp.		
<u>Tabellaria</u> spp.	19	
Cyanochloronta (blue-green)		
<u>Anabaena</u> spp.		
<u>Aphanocarsa</u> sp.		
<u>Dactylococcopsis</u> spp.		
Cryptophycophyta (cryptomonads)		
<u>Cryptomonas</u> spp.	119	132
Pyrrhophycophyta (dinoflagellates)		
<u>Peridinium</u> sp.		
Euglenophycophyta (euglenoids)		
<u>Phacus</u> sp.		
<u>Trachelomonas</u> sp.		
Total number of taxa	13	9
Total number of genera	11	7
Total taxa number	324	199
Unidentified (bacterial cells?)		17

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for January 5, 1980.

Dominant Taxa	Site 2	Site 5
Chlorophycophyta (green)		
<u>Arthrodesmus</u> spp.		
<u>Ankistrodesmus</u> sp.		
<u>Botryococcus</u> sp.		
<u>Chlamydomonas</u> sp.	6	4
<u>Closterionopsis</u> sp.		
<u>Closterium</u> sp.		
<u>Cosmarium</u> spp.		
<u>Crucigenia</u> sp.		
<u>Dictyosphaerium</u> sp.		
<u>Euastrum</u> sp.		
<u>Haematococcus</u> sp.	1	1
<u>Microasterias</u> spp.		
<u>Cocystis</u> sp.		
<u>Pediastrum</u> spp.		
<u>Scenedesmus</u> sp.		
<u>Schroederia</u> sp.		
<u>Sphaerocystis</u> sp.		
<u>Staurastrum</u> sp.		
Unidentified unicellular sp.	7	6
Chrysophycophyta (yellow-green)		
<u>Achnanthes</u> spp.	1	1
<u>Actinella</u> sp.		
<u>Asterionella</u> sp.		
<u>Chrysosphaerella</u> sp.		
<u>Cocconeis</u> sp.		
<u>Cymbella</u> spp.		
<u>Dinobryon</u> sp.		
<u>Eunotia</u> spp.	1	
<u>Frustulia</u> sp.	1	
<u>Gyrosigma</u> sp.		
<u>Hantzschia</u> sp.		
<u>Melosira</u> spp.	15	1
<u>Navicula</u> spp.		
<u>Neidium</u> sp.		
<u>Nitzschia</u> spp.		
Pennales Order	1	1
<u>Pinnularia</u> spp.	1	
<u>Stauroneis</u> sp.		
<u>Stephanodiscus</u> sp.	1	
<u>Synura</u> sp.		
<u>Tabellaria</u> spp.	2	
Cyanochloronta (blue-green)		
<u>Anabaena</u> spp.		
<u>Apharocapsa</u> sp.		
<u>Dactyococcopsis</u> spp.		
Cryptophycophyta (cryptomonads)		
<u>Cryptomonas</u> spp.	222	365
Pyrrhophycophyta (dinoflagellates)		
<u>Peridinium</u> sp.		
Euglenophycophyta (euglenoids)		
<u>Phacus</u> sp.		
<u>Trachelomonas</u> sp.		
Total number of taxa	12	7
Total number of genera	10	5
Total taxa number	259	379
Unidentified (bacterial cells?)		

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for February 9, 1980.

Dominant Taxa	Site 2	Site 5
Chlorophycophyta (green)		
<u>Arthrodesmus</u> spp.		1
<u>Ankistrodesmus</u> sp.		
<u>Botryococcus</u> sp.		
<u>Chlamydomonas</u> sp.	6	4
<u>Closteriopsis</u> sp.		
<u>Closterium</u> sp.		
<u>Cosmarium</u> spp.	1	
<u>Crucigenia</u> sp.		
<u>Dictyosphaerium</u> sp.		
<u>Euastrum</u> sp.		
<u>Haematococcus</u> sp.	2	1
<u>Microsterias</u> spp.		
<u>Oocystis</u> sp.		
<u>Pediastrum</u> spp.		
<u>Scenedesmus</u> sp.		
<u>Schroederia</u> sp.		
<u>Sphaerocystis</u> sp.		
<u>Staurastrum</u> sp.		
Unidentified unicellular sp.	2	4
Chrysophycophyta (yellow-green)		
<u>Achnanthes</u> spp.		1
<u>Actinella</u> sp.		
<u>Asterionella</u> sp.		2
<u>Chrysosphaerella</u> sp.		
<u>Cocconeis</u> sp.		
<u>Cymbella</u> spp.		
<u>Dinobryon</u> sp.		
<u>Eunotia</u> spp.	1	4
<u>Frustulia</u> sp.		1
<u>Gyrosigma</u> sp.		
<u>Hantzschia</u> sp.		
<u>Melosira</u> spp.	1	26
<u>Navicula</u> spp.		
<u>Neidium</u> sp.		1
<u>Nitzschia</u> spp.		1
Pennales Order	1	3
<u>Pinnularia</u> spp.		1
<u>Stauroneis</u> sp.		
<u>Stephanodiscus</u> sp.		
<u>Synura</u> sp.		
<u>Tabellaria</u> spp.		2
Cyanochloronta (blue-green)		
<u>Anabaena</u> spp.		
<u>Aphanocapsa</u> sp.		
<u>Dactylococcopsis</u> spp.		
Cryptophycophyta (cryptomonads)		
<u>Cryptomonas</u> spp.	316	138
Pyrrhophycophyta (dinoflagellates)		
<u>Peridinium</u> sp.		
Euglenophycophyta (euglenoids)		
<u>Phacus</u> sp.		
<u>Trachelomonas</u> sp.		
Total number of taxa	8	15
Total number of genera	6	13
Total taxa number	330	190
Unidentified (bacterial cells?)		

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for April 27, 1980.

Dominant Taxa	Site 2	Site 5
<u>Chlorophycophyta (green)</u>		
<u>Arthrodesmus</u> spp.		
<u>Ankistrodesmus</u> sp.		
<u>Botryococcus</u> sp.		
<u>Chlamydomonas</u> sp.	85	106
<u>Closterionopsis</u> sp.		
<u>Closterium</u> sp.		
<u>Cosmarium</u> spp.		
<u>Crucigeria</u> sp.		
<u>Dictyosphaerium</u> sp.		
<u>Euastrum</u> sp.		
<u>Haematococcus</u> sp.	1	
<u>Microasterias</u> spp.		
<u>Oocystis</u> sp.	7	4
<u>Pediastrum</u> spp.		
<u>Scenedesmus</u> sp.		
<u>Schroederia</u> sp.		
<u>Sphaerocystis</u> sp.	32	18
<u>Staurastrum</u> sp.	1	
Unidentified unicellular sp.	73	56
<u>Chrysophycophyta (yellow-green)</u>		
<u>Achnanthes</u> spp.		
<u>Actinella</u> sp.		
<u>Asterionella</u> sp.	14	25
<u>Chrysosphaerella</u> sp.		
<u>Cocconeis</u> sp.		
<u>Cymbella</u> spp.		
<u>Dinobryon</u> sp.	5	2
<u>Eunotia</u> spp.	1	3
<u>Frustulia</u> sp.	1	2
<u>Gyrosigma</u> sp.		
<u>Hantzschia</u> sp.		
<u>Melosira</u> spp.	431	407
<u>Navicula</u> spp.		
<u>Neidium</u> sp.		
<u>Nitzschia</u> spp.		
<u>Pennales</u> Order	2	3
<u>Pinnularia</u> spp.	1	
<u>Stauroneis</u> sp.		
<u>Stephanodiscus</u> sp.		
<u>Synura</u> sp.		
<u>Tabellaria</u> spp.	2	1
<u>Cyanochloronta (blue-green)</u>		
<u>Anabaena</u> spp.	17	22
<u>Aphanocapsa</u> sp.		
<u>Dactylococcopsis</u> spp.		
<u>Cryptophycophyta (cryptomonads)</u>		
<u>Cryptomonas</u> spp.	649	756
<u>Pyrrhophycophyta (dinoflagellates)</u>		
<u>Peridinium</u> sp.	1	1
<u>Euglenophycophyta (euglenoids)</u>		
<u>Phacus</u> sp.		1
<u>Trachelomonas</u> sp.		
Total number of taxa	17	15
Total number of genera	15	13
Total taxa number	1323	1407
Unidentified (bacterial cells?)		

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for May 24, 1980.

Dominant Taxa	Site 2	Site 4	Site 5	Site 6	Site 5-2	Site 5-3	Site 5-4	Site 5-6
Chlorophycophyta (green)								
<i>Arthrodesmus</i> spp.				1	2	1		
<i>Ankistrodesmus</i> sp.	11	13	1	8	16	2		
<i>Potryococcus</i> sp.								
<i>Chlamydomonas</i> sp.	51	27	39	46	418	360	146	15
<i>Closteriopsis</i> sp.			2		2			
<i>Closterium</i> sp.								
<i>Cosmarium</i> spp.	1	3	4		4			
<i>Crucigenia</i> sp.		8		9	13	4	8	
<i>Dictyosphaerium</i> sp.								
<i>Euastrum</i> sp.			1	1				
<i>Haematococcus</i> sp.	1	1				1	2	
<i>Microsterias</i> spp.								
<i>Oocystis</i> sp.	30	42	15	13	46	9	4	
<i>Pediastrum</i> spp.								
<i>Scenedesmus</i> sp.		5		9	26			
<i>Schroederia</i> sp.	2		1		3			
<i>Sphaerocystis</i> sp.	26	89	65	18	124	14	8	
<i>Staurastrum</i> sp.	1	1		1	6	1		
Unidentified unicellular sp.	183	318	386	266	433	239	147	169
Chrysophycophyta (yellow-green)								
<i>Achnanthes</i> spp.								
<i>Actinella</i> sp.								
<i>Asterionella</i> sp.	9			7	233	2	18	34
<i>Chrysosphaerella</i> sp.								
<i>Cocconeis</i> sp.			1					
<i>Cymbella</i> spp.								1
<i>Dinobryon</i> sp.	44	145	278	135	64	2	9	
<i>Eunotia</i> spp.	1	1	1	1	8	12	2	10
<i>Frustulia</i> sp.	3	4	1	1	12	9	1	11
<i>Gyrosigma</i> sp.								
<i>Hantzschia</i> sp.								
<i>Melosira</i> spp.	1281	1687	1782	1278	3684	386	318	334
<i>Navicula</i> spp.								
<i>Neidium</i> sp.	1			1			1	
<i>Nitzschia</i> spp.								
<i>Pennales</i> Order		3	1	3	4	3	1	4
<i>Pinnularia</i> spp.	1	1	1	1	3	1		1
<i>Stauroneis</i> sp.								
<i>Stephanodiscus</i> sp.								
<i>Synura</i> sp.								
<i>Tabellaria</i> spp.	1	1	1	1	4	2	2	5
Cyanochloronta (blue-green)								
<i>Anabaena</i> spp.	17		19	8	28			
<i>Aphanocapsa</i> sp.			56		122			
<i>Dactylococcopsis</i> spp.								
Cryptophycophyta (cryptomonads)								
<i>Cryptomonas</i> spp.	156	80	93	82	867	692	346	16
Pyrrhophycophyta (dinoflagellates)								
<i>Peridinium</i> sp.	3	3	4	1	3			
Euglenophycophyta (euglenoids)								
<i>Phacus</i> sp.					4			1
<i>Trachelomonas</i> sp.						7		
Total number of taxa	20	19	21	22	25	19	15	12
Total number of genera	19	17	19	20	23	17	13	10
Total taxa number	1823	2432	2752	1831	6129	1747	1013	601
Unidentified (bacterial cells?)	26	16			42	144	41650	331

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for June 22, 1980.

Dominant Taxa	Site 2	Site 4	Site 5	Site 6	Site 5-2	Site 5-3	Site 5-4	Site 5-6
Chlorophycophyta (green)								
<u>Arthrodesmus</u> spp.	7	7	14	9	37	2		1
<u>Ankistrodesmus</u> sp.	9	5	7	7	12	10		
<u>Botryococcus</u> sp.								
<u>Chlamydomonas</u> sp.	20	14	16	18	126	50	36	
<u>Closterionopsis</u> sp.	2		1	1	4			
<u>Closterium</u> sp.		1		1				
<u>Cosmarium</u> spp.	9	3	6	4	12	4		
<u>Crucigenia</u> sp.	9	14	16	12	23			
<u>Dictyosphaerium</u> sp.								
<u>Euastrum</u> sp.			1					
<u>Haematococcus</u> sp.	3	1	1	2	8	4	4	1
<u>Microasterias</u> spp.								
<u>Oocystis</u> sp.	21	30	22	26	59	8	17	
<u>Pediastrum</u> spp.	5		8	4	65			
<u>Scenedesmus</u> sp.	9	14	4	12	33			
<u>Schroederia</u> sp.	10	11	12	12	12	2		
<u>Sphaerocystis</u> sp.	437	701	488	563	1315	81	17	76
<u>Staurastrum</u> sp.	2	8	6	5	134	6	2	1
Unidentified unicellular sp.	382	728	592	584	1112	484	272	214
Chrysophycophyta (yellow-green)								
<u>Achnanthes</u> spp.						2		
<u>Actinella</u> sp.				1				
<u>Asterionella</u> sp.	13	13		10	102	10	2	1
<u>Chrysosphaerella</u> sp.								
<u>Cocconeis</u> sp.								
<u>Cymbella</u> spp.	1				4		2	
<u>Dinobryon</u> sp.	2	15	22	17	12	8	17	9
<u>Eunotia</u> spp.	1	1	1	2	4	2	2	1
<u>Frustulia</u> sp.	1	3		2	16			
<u>Gyrosigma</u> sp.								
<u>Hantzschia</u> sp.								
<u>Melosira</u> spp.	358	654	430	504	18475	4324	3805	2638
<u>Navicula</u> spp.								
<u>Neidium</u> sp.	1	1						
<u>Nitzschia</u> spp.								
Pennales Order	2	2	1	2	12		2	1
<u>Pinnularia</u> spp.		1		1	4			1
<u>Stauroneis</u> sp.								
<u>Stephanodiscus</u> sp.								
<u>Synura</u> sp.								
<u>Tabellaria</u> spp.	2	1	1	2	4	2	2	1
Cyanochloronta (blue-green)								
<u>Anabaena</u> spp.		9	16	10	33	50		9
<u>Aphanocarsa</u> sp.	229		76	124	305			
<u>Dactylococcopsis</u> spp.								
Cryptophycophyta (cryptomonads)								
<u>Cryptomonas</u> spp.	99	61	106	94	615	156	127	24
Pyrrhophycophyta (dinoflagellates)								
<u>Peridinium</u> sp.	25	18	23	24	4	2		1
Euglenophycophyta (euglenoids)								
<u>Phacus</u> sp.					4			1
<u>Tracheomonas</u> sp.						2		
Total number of taxa	26	25	24	28	28	21	15	16
Total number of genera	24	23	22	26	26	20	13	14
Total taxa number	1659	2316	1870	2053	22546	5211	4309	2980
Unidentified (bacterial cells?)		18	8	12	179	451	52147	590

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for July 20, 1980.

Dominant Taxa	Site 2	Site 4	Site 5	Site 6	Site 5-2	Site 5-3	Site 5-4	Site 5-6
Chlorophycophyta (green)								
<i>Arthrodesmus</i> spp.	14	12	6	9	95	68	9	1
<i>Ankistrodesmus</i> sp.	24	21	21	17	9	32		
<i>Rotyrococcus</i> sp.								
<i>Chlamydomonas</i> sp.	37	50	40	31	20	35	20	
<i>Closterionopsis</i> sp.								
<i>Closterium</i> sp.								
<i>Cosmarium</i> spp.	2			1	4	10		
<i>Crucigenia</i> sp.	10	20	13	15	16	9		
<i>Dictyosphaerium</i> sp.	52	32	44	60	237	40		
<i>Euastrum</i> sp.				1				
<i>Haematococcus</i> sp.	1	2	1	2	20	1		1
<i>Microasterias</i> spp.								
<i>Oocystis</i> sp.	38	30	13	15	9	4		
<i>Pediastrum</i> spp.	5		4	4				
<i>Scenedesmus</i> sp.		15	4		18			
<i>Schroederia</i> sp.	12	10	4	4	9			
<i>Sphaerocystis</i> sp.	4460	4637	6366	5388	5506	1174	25	42
<i>Staurastrum</i> sp.	1	2	1	1	1	7	1	1
Unidentified unicellular sp.	203	293	283	306	277	165	200	283
Chrysophycophyta (yellow-green)								
<i>Achnanthes</i> spp.								
<i>Actinella</i> sp.	1		1					
<i>Asterionella</i> sp.	1	15	29	23	32	12	2	10
<i>Chrysosphaerella</i> sp.	28	62	13					
<i>Cocconeis</i> sp.								
<i>Cymbella</i> spp.	1		1	1		1		
<i>Dinobryon</i> sp.	6	10	10	10	7			
<i>Eunotia</i> spp.	7	6	8	5	7	1	1	5
<i>Frustulia</i> sp.	5	5	2	1	3	2	1	3
<i>Gyrosigma</i> sp.								
<i>Hantzschia</i> sp.	1							
<i>Melosira</i> spp.	91	76	114	97	321	1920	827	933
<i>Navicula</i> spp.								
<i>Neidium</i> sp.	1					1	1	
<i>Nitzschia</i> spp.	1							
Pennales Order	2	1	3	2	2	1	1	2
<i>Pinnularia</i> spp.	2	1	1	1	2	1	1	
<i>Stauroneis</i> sp.								
<i>Stephanodiscus</i> sp.								
<i>Synura</i> sp.								
<i>Tabellaria</i> spp.	4	4	1	3	1	2		4
Cyanochloronta (blue-green)								
<i>Anabaena</i> spp.	5	16		13	7			
<i>Aphanocapsa</i> sp.					132			
<i>Dactylococcopsis</i> spp.		7	4	4	9	9		
Cryptophycophyta (cryptomonads)								
<i>Cryptomonas</i> spp.	109	87	101	95	107	558	274	7
Pyrrophycophyta (dinoflagellates)								
<i>Peridinium</i> sp.	8	43	40	40	3	1	1	1
Euglenophycophyta (euglenoids)								
<i>Phacus</i> sp.					2	1		1
<i>Trachelomonas</i> sp.								
Total number of taxa	30	25	27	27	27	24	14	14
Total number of genera	28	23	25	25	25	22	12	12
Total taxa number	5132	5457	7128	6149	6856	4055	1364	1294
Unidentified (bacterial cells?)	14	22	69	37		462	123951	633

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for August 10, 1980.

Dominant Taxa	Site 2	Site 4	Site 5	Site 6	Site 5-2	Site 5-3	Site 5-4	Site 5-6
Chlorophycophyta (green)								
<u>Arthrodesmus</u> spp.	2	4	5	5	15	11	3	1
<u>Ankistrodesmus</u> sp.	24	9	5	6	89	16		
<u>Betryococcus</u> sp.	148		82	114				
<u>Chlamydomonas</u> sp.	30	18	26	15	12	24	4	
<u>Closteriopsis</u> sp.	1		1	1				
<u>Closterium</u> sp.								
<u>Cosmarium</u> spp.	4	5	4	2	15	6	4	1
<u>Crucigenia</u> sp.	31		16	15	10	12		
<u>Dictyosphaerium</u> sp.	40	30	14	18	108	29		
<u>Euastrum</u> sp.				1				
<u>Haematococcus</u> sp.		1		3	1	1		1
<u>Microasterias</u> spp.			1	1				
<u>Cocystis</u> sp.	10	4		11	5	8		
<u>Pediastrum</u> spp.	10		5	11	15	8		
<u>Scenedesmus</u> sp.			2		27	4	7	
<u>Schroederia</u> sp.	1	2		2	1			
<u>Sphaerocystis</u> sp.	349	207	349	234	1928	3274	1836	158
<u>Staurastrum</u> sp.	1	1		1				
Unidentified unicellular sp.	113	168	188	153	226	162	131	193
Chrysophycophyta (yellow-green)								
<u>Achnanthes</u> spp.								
<u>Actinella</u> sp.								
<u>Asterionella</u> sp.	17	8		4	36	12	2	4
<u>Chrysosphaerella</u> sp.	59	117	451	169	15			
<u>Cocconeis</u> sp.								
<u>Cymbella</u> spp.	1				1			
<u>Dinobryon</u> sp.	10	11	53	22	18			
<u>Eunotia</u> spp.	2	1	1	1	1	1	3	1
<u>Frustulia</u> sp.		1	1	1	3	3	1	1
<u>Gyrodigma</u> sp.								
<u>Hantzschia</u> sp.								
<u>Melosira</u> spp.	114	126	113	98	302	224	116	133
<u>Navicula</u> spp.								
<u>Neidium</u> sp.								1
<u>Nitzschia</u> spp.					1			
Fennales Order		1	1	1	1	2	2	1
<u>Pinnularia</u> spp.	1	1			1			1
<u>Stauroneis</u> sp.					1			
<u>Stephanodiscus</u> sp.								
<u>Synura</u> sp.	28	73	74	196				
<u>Tabellaria</u> spp.	2	2	4	2	1	1	1	1
Cyanochloronta (blue-green)								
<u>Anabaena</u> spp.	10		29	10	10		92	67
<u>Aphanocapsa</u> sp.						232		
<u>Dactylococcopsis</u> spp.	5		7	2	15			
Cryptophycophyta (cryptomonads)								
<u>Cryptomonas</u> spp.	75	97	146	93	69	526	265	27
Pyrrhophycophyta (dinoflagellates)								
<u>Peridinium</u> sp.	30	13	21	16	5	2	1	2
Euglenophycophyta (euglenoids)								
<u>Phacus</u> sp.						1	1	2
<u>Trachelemonas</u> sp.								
Total number of taxa	27	23	25	30	29	22	16	17
Total number of genera	26	21	23	28	27	20	14	15
Total taxa number	1118	900	1599	1208	2932	4559	2469	595
Unidentified (bacterial cells?)	12	5				764	83826	274

ALL DATA IN cells ml⁻¹

Appendix E continued. Dominant phytoplankton cell numbers in Weso Lake for September 13, 1980.

Dominant Taxa	Site 2	Site 4	Site 5	Site 6	Site 5-2	Site 5-3	Site 5-4	Site 5-6
Chlorophycophyta (green)								
<u>Arthrodesmus</u> spp.	1	2	2	1	1	1	1	1
<u>Ankistrodesmus</u> sp.	6	4	2	5	2	4	2	
<u>Botryococcus</u> sp.	1864	1669	1751	1923	78			
<u>Chlamydomonas</u> sp.	28	18	28	32	8		6	
<u>Closteriopsis</u> sp.								
<u>Closterium</u> sp.								
<u>Cosmarium</u> spp.	6	3	3	4	3	1	2	1
<u>Crucigenia</u> sp.	23	18	13	22	17	9		
<u>Dictyosphaerium</u> sp.	29	41	34	23	36			
<u>Euastrum</u> sp.					1			
<u>Haematococcus</u> sp.	3	1	2	3	1	1		1
<u>Micrasterias</u> spp.								
<u>Oocystis</u> sp.			4	6		4		
<u>Pediastrum</u> spp.	18	6	8	10	8	4		
<u>Scenedesmus</u> sp.					6	18	4	
<u>Schroederia</u> sp.	3	5	1			1		
<u>Sphaerocystis</u> sp.	47		55		83	43	93	37
<u>Staurastrum</u> sp.	1	1	1	1	2			
Unidentified unicellular sp.	137	146	169	171	70	45	61	174
Chrysophycophyta (yellow-green)								
<u>Achnanthes</u> spp.		1				1		
<u>Actinella</u> sp.				1				
<u>Asterionella</u> sp.	164	206	312	238	200	325	46	67
<u>Chrysosphaerella</u> sp.	146	125	133	164	52	14		
<u>Cocconeis</u> sp.								
<u>Cymbella</u> spp.								
<u>Dinobryon</u> sp.	16	12	13	17	7	9		
<u>Eunotia</u> spp.	1	1	1	1	1	1	4	1
<u>Frustulia</u> sp.	1	1	1	1	2	1	1	1
<u>Gyrosigma</u> sp.								
<u>Hantzschia</u> sp.								
<u>Melosira</u> spp.	233	242	282	276	319	350	224	267
<u>Navicula</u> spp.								
<u>Neidium</u> sp.	1			1			1	
<u>Nitzschia</u> spp.		1						
<u>Pennales</u> Order	1	2	1	1		4	2	1
<u>Pinnularia</u> spp.						1	1	1
<u>Stauroneis</u> sp.								
<u>Stephanodiscus</u> sp.								
<u>Synura</u> sp.	240	256	223	219	17			
<u>Tabellaria</u> spp.	1	2	2	2	1	1	1	1
Cyanochloronta (blue-green)								
<u>Anabaena</u> spp.	22	16	13	21	8		38	52
<u>Aphanocapsa</u> sp.		84	212		104	450		
<u>Dactylococcopsis</u> spp.		4	4		8			
Cryptophycophyta (cryptomonads)								
<u>Cryptomonas</u> spp.	122	214	534	432	130	200	168	34
Pyrrhophycophyta (dinoflagellates)								
<u>Peridinium</u> sp.	159	102	22	46	3	1	1	1
Euglenophycophyta (euglenoids)								
<u>Phacus</u> sp.					1	1	1	2
<u>Trachelomonas</u> sp.					3	4		
Total number of taxa	26	28	28	26	29	26	19	16
Total number of genera	24	26	26	24	28	24	17	14
Total taxa number	3273	3183	3826	3621	1172	1494	657	642
Unidentified (bacterial cells?)	38	36	21	17		175	76422	344

ALL DATA IN cells ml⁻¹

Appendix F. Chlorophyll data for Weso Lake.

Date	Site	Chl <u>a</u>	Chl <u>b</u>	Chl <u>c</u>	Pheophytin	Chl <u>a</u> - Pheophytin	663B/663A
← ug l⁻¹ →							
V-26-79	1	4.18	0.95	2.18	----	----	----
	2	3.81	0.89	2.23	----	----	----
	3	4.72	1.31	2.39	----	----	----
	4	3.29	0.74	2.73	----	----	----
	5	7.37	0.53	2.48	----	----	----
	6	6.72	0	0.04	----	----	----
VI-24-79	1	3.91	0.75	0.83	----	----	----
	2	2.81	0.26	0.39	----	----	----
	3	2.06	0.27	0.90	----	----	----
	4	2.59	0.24	1.35	----	----	----
	5	5.96	0.95	2.54	----	----	----
	6	7.42	0.88	3.98	----	----	----
VII-21-79	1	6.72	0	0.80	----	----	----
	2	10.09	0.42	4.10	----	----	----
	3	5.94	0.61	3.26	----	----	----
	4	7.49	2.08	5.14	----	----	----
	5	6.98	0.68	2.66	----	----	----
	6	7.87	1.48	3.90	----	----	----
VIII-11-79	1	8.79	1.12	4.32	----	----	----
	2	13.97	1.79	8.48	----	----	----
	3	5.48	1.49	1.03	----	----	----
	4	6.14	0.22	0	----	----	----
	5	10.49	0.44	4.27	----	----	----
	6	4.67	1.14	1.39	----	----	----
IX-09-79	1	8.86	0.82	1.85	----	----	----
	2	9.12	0.33	0.65	----	----	----
	3	13.13	0.70	2.18	----	----	----
	4	10.48	1.26	2.67	----	----	----
	5	12.08	1.42	3.58	----	----	----
	6	9.86	1.99	4.78	----	----	----
X-20-79	2	5.36	2.15	1.79	----	----	----
	5	9.99	1.11	2.64	----	----	----
XI-16-79	2	2.15	0.73	0	----	----	----
	5	4.23	0	0	----	----	----

Appendix F continued. Chlorophyll data for Weso Lake.

Date	Site	Chl <u>a</u>	Chl <u>b</u>	Chl <u>c</u>	Pheophytin	Chl <u>a</u> - Pheophytin	663B/663A
		←————— ug l ⁻¹ —————→					
I-05-80	2	6.09	0.38	2.04	----	----	----
	5	3.25	0.75	1.62	----	----	----
II-09-80	2	1.73	3.93	0	----	----	----
	5	2.97	0	7.63	----	----	----
IV-27-80	2	2.31	0.16	0	0	3.06	2.22
	5	2.72	0	5.96	0.03	2.50	1.69
V-24-80	2	3.20	1.53	1.15	0.75	2.89	1.56
	4	3.72	0.23	0	0.56	3.37	1.60
	5	4.38	0.50	0.44	0.81	3.90	1.58
	6	3.09	0.28	0.73	1.10	2.43	1.48
	5-2	16.49	2.39	6.03	13.72	8.71	1.27
	5-3	14.16	4.05	4.51	2.44	13.01	1.59
	5-4	24.23	39.64	0	35.09	7.23	1.12
	5-6	11.80	4.33	2.76	15.35	3.10	1.12
VI-22-80	2	4.35	1.41	2.02	3.53	2.39	1.28
	4	5.41	1.41	4.07	4.70	2.76	1.26
	5	4.90	0.73	0.51	3.08	3.11	1.35
	6	5.70	2.88	8.43	7.05	1.86	1.15
	5-2	13.60	2.66	3.85	13.43	5.84	1.21
	5-3	15.98	10.11	0	14.88	8.02	1.25
	5-4	26.32	40.93	0	33.42	10.67	1.17
	5-6	10.76	11.37	0	17.72	1.36	1.05
VII-20-80	2	9.17	0.95	6.16	7.57	4.76	1.27
	4	14.73	3.17	8.67	12.14	7.82	1.27
	5	14.21	3.33	6.97	10.89	8.04	1.30
	6	10.69	2.60	4.30	6.93	6.78	1.35
	5-2	11.41	4.19	6.17	12.33	4.51	1.19
	5-3	32.95	35.89	0	22.53	23.09	1.35
	5-4	39.86	43.81	0	36.37	22.58	1.27
	5-6	16.63	15.73	0	27.37	1.96	1.05

Appendix F continued. Chlorophyll data for Weso Lake.

Date	Site	Chl <u>a</u>	Chl <u>b</u>	Chl <u>c</u>	Pheophytin	Chl <u>a</u> - Pheophytin	663B/663A
← ug l⁻¹ →							
VIII-10-80	2	5.00	0.48	2.25	4.08	2.61	1.27
	4	7.42	0.97	3.31	3.31	5.51	1.44
	5	6.46	0.98	1.43	2.38	5.10	1.48
	6	7.05	3.60	2.96	4.01	5.01	1.39
	5-2	7.10	1.30	4.21	3.63	5.04	1.41
	5-3	39.64	42.19	0	38.62	20.94	1.25
	5-4	38.35	45.84	0.25	40.08	19.21	1.23
	5-6	21.10	24.63	17.67	31.31	5.52	1.10
IX-13-80	2	48.25	0.89	25.57	9.48	42.36	1.57
	4	38.05	0	25.79	1.29	36.22	1.68
	5	19.93	1.07	8.04	0	22.27	1.86
	6	22.50	1.37	12.02	0	26.20	1.92
	5-2	5.70	0.43	2.33	0	7.00	2.03
	5-3	29.39	23.90	0	18.94	20.42	1.36
	5-4	35.83	42.97	0	39.64	16.59	1.21
	5-6	18.38	20.01	0	28.70	3.31	1.07

Appendix G. Results of analyses of variance on phytoplankton density, number of taxa, and biomass of Weso Lake surface samples with sampling day and year as factors. Only samples collected during the stratified period of each year (May through September) were used in the comparisons.

Variable	Calculated F Value	
	Month (d.f.=4,12)	Year (d.f.=1,3)
Total Organisms		
Density	35.60**	62.39*
Taxa	31.16**	0.01
Chlorophycophyta		
Density	11.17**	24.19*
Taxa	0.64	0.68
Cyanochloronta		
Density	1.96	0.01
Taxa	0.45	0.61
Chrysophycophyta		
Density	42.93**	0.56
Taxa	5.51*	24.94**
Cryptophycophyta		
Density	2.50	0.28
Taxa	No Test	No Test
Phyrrhophycophyta		
Density	24.59**	0.39
Taxa	No Test	No Test
Chlorophyll <u>a</u>	18.70**	8.70

* P<0.05.

** P<0.001.

Appendix H. Dominant algal aufwuchs cell numbers on
Sphagnum spp. in Weso Lake.

Dominant Taxa	V-26-79		VI-23-79		VII-21-79	
	Site 7	Site 8	Site 7	Site 8	Site 7	Site 8
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.	1		2	2	2	2
<u>Bambusina</u> sp.						
<u>Closterium</u> sp.	1	1		2		
<u>Cosmarium</u> spp.		2	2	2		5
<u>Cylindrocapsa</u> sp.	1	1	5		24	11
<u>Euastrum</u> spp.				2	3	
<u>Micrasterias</u> spp.						
<u>Netrium</u> sp.				2	3	3
<u>Oedogonium</u> spp.	11					16
<u>Staurostrum</u> sp.	2	1	2	4	3	2
<u>Tetmemorus</u> sp.				2	2	
Unidentified spp.	746	330	80	325	923	884
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> sp.			2	1		2
<u>Actinella</u> sp.						
<u>Anomoeneis</u> spp.					5	21
<u>Asterionella</u> sp.						39
<u>Cocconeis</u> sp.			2	1		1
<u>Cyclotella</u> sp.						2
<u>Cymbella</u> spp.						
<u>Diatoma</u> sp.	1	1				
<u>Eunotia</u> spp.	3171	1918	4368	3747	4904	1650
<u>Fragilaria</u> spp.			1		1	1
<u>Frustulia</u> spp.	20	8	178	144	461	425
<u>Hantzschia</u> sp.			2			2
<u>Melosira</u> spp.	373	202	136	141	490	447
<u>Navicula</u> spp.	522	32	294	110	686	810
<u>Neidium</u> spp.					2	2
<u>Nitzschia</u> spp.			2		7	379
<u>Pennales</u> Order	278	116	120	101	236	257
<u>Pinnularia</u> spp.	373	222	496	319	2221	798
<u>Stauroneis</u> sp.						
<u>Stephanodiscus</u> sp.					1	
<u>Tabellaria</u> spp.	21	8	25	17	14	6
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.	376	267	1607	1756	7896	6732
<u>Aphanocapsa</u> spp.	221			158		
<u>Hapalosiphon</u> sp.						971
<u>Merismopedia</u> sp.			226			
<u>Microchaete</u> spp.					106	485
<u>Nostoc</u> spp.	55	56			2632	998
<u>Oscillatoria</u> sp.	22				68	
<u>Spirulina</u> sp.				2	2	
Unidentified spp.		69	106	106		523
Total number of taxa	18	16	20	21	24	27
Total number of genera	16	13	17	18	22	24
Total taxa number	6195	3234	7656	6944	20692	15473

ALL DATA IN cells mg^{-1} Sphagnum spp. dry weight

Appendix H continued. Dominant algal aufwuchs cell numbers on Sphagnum spp. in Weso Lake.

Dominant Taxa	VIII-11-79		IX-09-79		Site 7	Site 8
	Site 7	Site 8	Site 7	Site 8		
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.	2	2		3		
<u>Bambusina</u> sp.	8					
<u>Closterium</u> sp.	2		5			
<u>Cosmarium</u> spp.		2	2	6		
<u>Cylindrocystis</u> sp.	25	14	20	32		
<u>Euastrum</u> spp.	2					
<u>Micrasterias</u> spp.				3		
<u>Netrium</u> sp.	4	2	5	3		
<u>Oedogonium</u> spp.	46			65		
<u>Staurastrum</u> sp.	2	2	5	6		
<u>Tetmemorus</u> sp.	2			3		
Unidentified spp.	318	211	780	483		
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> sp.	4	2	1	3		
<u>Actinella</u> sp.						
<u>Anomoeneis</u> spp.	12	9	10			
<u>Asterionella</u> sp.				244		
<u>Cocconeis</u> sp.	2	2		2		
<u>Cyclotella</u> sp.		3	5			
<u>Cymbella</u> spp.		2		94		
<u>Diatoma</u> sp.						
<u>Eunotia</u> spp.	3462	1833	3128	3186		
<u>Fragilaria</u> spp.	2			1		
<u>Frustulia</u> spp.	308	145	1355	2776		
<u>Hantzschia</u> sp.				218		
<u>Melosira</u> spp.	88	179	482	2190		
<u>Navicula</u> spp.	1285	645	395	2515		
<u>Neidium</u> spp.			15	3		
<u>Nitzschia</u> spp.	14	30		648		
Pennales Order	459	269	282	851		
<u>Pinnularia</u> spp.	1294	1115	1107	601		
<u>Stauroneis</u> sp.						
<u>Stephanodiscus</u> sp.		1		1		
<u>Tabellaria</u> spp.	8	9	610	1007		
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.	867	1426	1473	889		
<u>Aphanocapsa</u> spp.		27		147		
<u>Hapalosiphon</u> sp.				1599		
<u>Merismopedia</u> sp.						
<u>Microchaete</u> spp.	249		122	745		
<u>Nostoc</u> spp.	1241	450	254	74		
<u>Oscillatoria</u> sp.			51	71		
<u>Spirulina</u> sp.	2					
Unidentified spp.	75		71	153		
Total number of taxa	27	23	22	32		
Total number of genera	24	21	19	29		
Total taxa number	9783	6380	16178	18622		

ALL DATA IN cells mg^{-1} Sphagnum spp. dry weight

Appendix H continued. Dominant algal aufwuchs cell numbers on Sphagnum spp. in Weso Lake.

Dominant Taxa	V-25-80		VI-22-80		Site 7	Site 8
	Site 7	Site 8	Site 7	Site 8		
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.	1	2		1		
<u>Famulusina</u> sp.						
<u>Closterium</u> sp.	1	2	2	1		
<u>Cosmarium</u> spp.		41	3	10		
<u>Cylindrocapsa</u> sp.	4	105	3	20		
<u>Euastrum</u> spp.			2			
<u>Micrasterias</u> spp.			2	1		
<u>Netrium</u> sp.	1	11	2	3		
<u>Oedogonium</u> spp.	8	15	59	21		
<u>Staurastrum</u> sp.	1	4	2	1		
<u>Tetmemorus</u> sp.		2				
Unidentified spp.	487	6675	534	1137		
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> sp.	1	3	2	1		
<u>Actinella</u> sp.				1		
<u>Anomoeneis</u> spp.			6	22		
<u>Asterionella</u> sp.	4	15		10		
<u>Cocconeis</u> sp.	2	2	2	1		
<u>Cyclotella</u> sp.	8		14			
<u>Cymbella</u> spp.	4	63		16		
<u>Diatoma</u> sp.		1				
<u>Eunotia</u> spp.	2221	3431	2047	704		
<u>Fragilaria</u> spp.				1		
<u>Frustulia</u> spp.	8	1061	158	108		
<u>Hantzschia</u> sp.	3	15		77		
<u>Melosira</u> spp.	156	1248	343	1055		
<u>Navicula</u> spp.	753	3227	2662	904		
<u>Neidium</u> spp.		2	2			
<u>Nitzschia</u> spp.		592	108	1144		
<u>Pennales</u> Order	75	587	192	208		
<u>Pinnularia</u> spp.	443	749	1563	272		
<u>Stauroneis</u> sp.						
<u>Stephanodiscus</u> sp.			1			
<u>Tabellaria</u> spp.	5	100	4	27		
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.	8845	6736	15470	8865		
<u>Aphanocapsa</u> spp.	256					
<u>Hapalosiphon</u> sp.	54	899	2244	208		
<u>Merismopedia</u> sp.	19					
<u>Microchaete</u> spp.	345	915	2037	521		
<u>Nostoc</u> spp.	6433	1078	1801	568		
<u>Oscillatoria</u> sp.		63	92	107		
<u>Spirulina</u> sp.		2				
Unidentified spp.	482			104		
Total number of taxa	27	30	28	31		
Total number of genera	24	28	26	28		
Total taxa number	20620	27646	29357	16119		

ALL DATA IN cells mg^{-1} Sphagnum spp. dry weight

Appendix H continued. Dominant algal aufwuchs cell numbers of Sphagnum spp. in Weso Lake.

Dominant Taxa	VII-20-80		VIII-09-80		IX-13-80	
	Site 7	Site 8	Site 7	Site 8	Site 7	Site 8
Chlorophycophyta (green)						
<u>Arthrodesmus</u> spp.	1	2	2	1	2	3
<u>Bambusina</u> sp.			11			
<u>Closterium</u> sp.	1		2	1	2	2
<u>Cosmarium</u> spp.	1	2	2	8	2	4
<u>Cylindrocystis</u> sp.		5	21	44	23	52
<u>Euastrum</u> spp.				1		2
<u>Microasterias</u> spp.				1	1	
<u>Netrium</u> sp.		3	7	10	5	4
<u>Oedogonium</u> spp.	17	12	255	58	26	34
<u>Staurastrum</u> sp.	1	2	4	3	6	6
<u>Tetmemorus</u> sp.		2		1		1
Unidentified spp.	382	900	475	522	894	514
Chrysophycophyta (yellow-green)						
<u>Achnanthes</u> sp.	2		3	1	2	2
<u>Actinella</u> sp.			4	1		
<u>Anomoeneis</u> spp.	25	11	199	30	215	
<u>Asterionella</u> sp.	4	11	16			43
<u>Cocconeis</u> sp.	1		2		3	
<u>Cyclotella</u> sp.		2		4	4	
<u>Cymbella</u> spp.		26	121	16	288	63
<u>Diatoma</u> sp.						
<u>Eunotia</u> spp.	2219	1081	2586	950	3478	1864
<u>Fragilaria</u> spp.		1		1		1
<u>Frustulia</u> spp.	94	216	1012	407	1376	958
<u>Hantzschia</u> sp.	36	77	40	158	112	173
<u>Melosira</u> spp.	17	539	2975	951	1642	1267
<u>Navicula</u> spp.	2450	714	1351	1209	1476	1538
<u>Neidium</u> spp.			2		3	2
<u>Nitzschia</u> spp.	112	480	982	765	1074	867
Pennales Order	327	196	564	255	746	384
<u>Pinnularia</u> spp.	2007	693	484	756	1432	1012
<u>Stauroneis</u> sp.	1		4			
<u>Stephanodiscus</u> sp.			1		1	
<u>Tabellaria</u> spp.	6	14	113	173	592	810
Cyanochloronta (blue-green)						
<u>Anabaena</u> spp.	600	5459	1759	426	2447	484
<u>Aphanocapsa</u> spp.	276			685		134
<u>Hapalosiphon</u> sp.	4412	345	1833	745	813	1269
<u>Meristopedia</u> sp.						
<u>Microchaete</u> spp.	323	277	246	640	83	432
<u>Nostoc</u> spp.	354	690	450	69	125	347
<u>Oscillatoria</u> sp.	177	40	91	79	38	56
<u>Spirulina</u> sp.			2			
Unidentified spp.		138	91		84	112
Total number of taxa	26	28	34	32	31	31
Total number of genera	24	25	31	30	28	28
Total taxa number	13846	11938	15710	8971	16995	12440

ALL DATA IN cells μg^{-1} Sphagnum spp. dry weight

Appendix I. Percentage error (D) for mean total invertebrate numbers (no. m^{-2}) collected with a 252- cm^2 Ekman grab, Weso Lake, assuming a negative binomial distribution (Elliott 1977).

Year/Site	N	Mean	SD	K ^a	D ^b	No. of Samples Required for D=20%
May-September 1979						
Site 1	16	4980	5113	0.89	26.5	28
Site 2	16	1137	898	1.54	20.4	16
Site 3	16	1432	874	2.63	15.5	10
Site 4	16	374	340	1.15	23.3	22
May-September 1980						
Site 1	16	12958	8347	2.35	16.3	11
Site 2	16	1508	584	6.63	9.7	4
Site 3	16	2997	995	9.04	8.3	3
Site 4	16	1096	945	1.28	22.1	20

^a K from negative binomial distribution was estimated from total invertebrate counts.

^b D is the percentage error expressed as $(SE)(100)/\bar{x}$.

Appendix J. Percentage error (D) for mean total invertebrate biomass (g m^{-2}) collected with a 252-cm^2 Ekman grab, Weso Lake, assuming a negative binomial distribution (Elliott 1977).

Year/Site	N	Mean	SD	K ^a	D ^b	No. of Samples Required for D=20%
May-September 1979						
Site 1	16	4.056	4.214	1.12	26.7	28
Site 2	16	5.335	3.288	5.07	15.5	10
Site 3	16	4.445	2.459	12.10	13.9	8
Site 4	16	0.730	0.605	-1.40	20.2	16
May-September 1980						
Site 1	16	9.418	4.752	6.63	12.7	6
Site 2	16	8.773	5.446	3.60	15.6	10
Site 3	16	7.293	2.868	56.49	9.8	4
Site 4	16	1.809	1.469	8.99	20.4	17

^a K from negative binomial distribution was estimated from total invertebrate biomass.

^b D is the percentage error expressed as $(\text{SE})(100)/\bar{x}$.

Appendix K. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE V-25-79 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	1032	386	0.802	0.380
Tanypodinae	989	357	0.762	0.320
Ladona	43	50	3.702	4.396
Limnephilidae (Unk. sp.)	43	61	0.312	0.440
Sphaerium	54	41	0.095	0.076
Oligochaeta	1548	447	0.246	0.102

Percent Composition

			Taxa	No.	Wt.
Total	No. m^{-2}	SD	Chironomidae	54	27
			Chaoborus	0	0
Total	$g\ m^{-2}$	SD	Oligochaeta	42	4
			Other	4	69

DATE V-25-79 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	731	222	7.126	2.030
Chaoborus	452	200	0.746	0.443
Oligochaeta	129	127	0.047	0.064

Percent Composition

			Taxa	No.	Wt.
Total	No. m^{-2}	SD	Chironomidae	56	90
			Chaoborus	34	9
Total	$g\ m^{-2}$	SD	Oligochaeta	10	1
			Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE V-25-79 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	978	180	5.572	0.462
Chaoborus	1161	320	1.718	0.145

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	2139	SD 487	Chironomidae	46	76
				Chaoborus	54	24
Total	$g\ m^{-2}$	7.290	SD 0.500	Oligochaeta	0	0
				Other	0	0

DATE V-25-79 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chaoborus	806	387	1.406	0.735

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	806	SD 387	Chironomidae	0	0
				Chaoborus	100	100
Total	$g\ m^{-2}$	1.406	SD 0.735	Oligochaeta	0	0
				Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VI-23-79 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	6472	3862	0.885	0.458
Tanypodinae	559	346	0.209	0.162
Ladona	22	43	0.354	0.708
Polycentropus	22	43	0.159	0.319
Donacia	75	150	1.536	3.073
Sphaerium	172	93	0.248	0.049
Oligochaeta	3859	2757	0.386	0.359
Nematoda	140	118	0.060	0.055

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	11321	SD 6696	Chironomidae	62	29
				Chaoborus	0	0
Total	$g m^{-2}$	3.837	SD 3.450	Oligochaeta	34	10
				Other	4	61

DATE VI-23-79 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	409	268	3.896	3.248
Chaoborus	204	152	0.496	0.460
Sphaerium	11	22	0.006	0.011
Oligochaeta	11	22	0.005	0.009

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	635	SD 423	Chironomidae	64	88
				Chaoborus	32	12
Total	$g m^{-2}$	4.403	SD 3.363	Oligochaeta	2	0
				Other	2	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VI-23-79 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	871	393	2.890	0.886
Tanypodinae	11	22	0.014	0.028
Chaoborus	871	399	1.830	0.714

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>1753</u>	SD	<u>777</u>	
		Chironomidae	50	61
		Chaoborus	50	39
		Oligochaeta	0	0
		Other	0	0
Total $g m^{-2}$	<u>4.734</u>	SD	<u>1.456</u>	

DATE VI-23-79 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chaoborus	366	74	0.836	0.166

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>366</u>	SD	<u>75</u>	
		Chironomidae	0	0
		Chaoborus	100	100
		Oligochaeta	0	0
		Other	0	0
Total $g m^{-2}$	<u>0.836</u>	SD	<u>0.166</u>	

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VII-20-79 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	1204	864	2.023	2.005
Tanypodinae	355	220	0.283	0.147
Chaoborus	22	25	0.063	0.075
Sphaerium	32	22	0.066	0.076
Oligochaeta	1473	1358	0.223	0.163
Nematoda	11	22	0.004	0.009

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>3097</u>	SD	<u>2088</u>	
Total $g m^{-2}$	<u>2.662</u>	SD	<u>2.120</u>	
		Chironomidae	50	87
		Chaoborus	1	2
		Oligochaeta	48	8
		Other	1	3

DATE VII-20-79 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	409	247	3.225	1.973
Chaoborus	376	64	0.595	0.164

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>785</u>	SD	<u>305</u>	
Total $g m^{-2}$	<u>3.820</u>	SD	<u>2.062</u>	
		Chironomidae	52	84
		Chaoborus	48	16
		Oligochaeta	0	0
		Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VII-20-79 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	1075	403	3.625	1.012
<u>Chaoborus</u>	473	246	1.044	0.514

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	1548	SD 623	
Total	$g m^{-2}$	4.669	SD 1.342	
		Chironomidae	69	78
		Chaoborus	31	22
		Oligochaeta	0	0
		Other	0	0

DATE VII-20-79 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
<u>Chaoborus</u>	118	73	0.304	0.227

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	118	SD 73	
Total	$g m^{-2}$	0.304	SD 0.227	
		Chironomidae	0	0
		Chaoborus	100	100
		Oligochaeta	0	0
		Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VIII-10-79 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	645	1090	2.174	3.274
Tanypodinae	204	220	0.267	0.261
Ladona	11	22	1.132	2.264
Sphaerium	54	41	0.078	0.074
Oligochaeta	871	1229	0.157	0.270
Nematoda	11	22	0.004	0.008

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	1796	SD 2591	Chironomidae	47	64
				Chaoborus	0	0
Total	$g\ m^{-2}$	3.812	SD 6.055	Oligochaeta	49	4
				Other	4	32

DATE VIII-10-79 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	366	295	4.339	3.871
Chaoborus	1451	1255	0.859	0.574

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	1817	SD 1533	Chironomidae	20	83
				Chaoborus	80	17
Total	$g\ m^{-2}$	5.198	SD 4.423	Oligochaeta	0	0
				Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VIII-10-79 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	118	64	0.832	0.156
Chaoborus	172	105	0.256	0.114

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	290	SD	162
Total	$g\ m^{-2}$	1.088	SD	0.249
		Chironomidae	41	76
		Chaoborus	59	24
		Oligochaeta	0	0
		Other	0	0

DATE VIII-10-79 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chaoborus	183	200	0.367	0.426
Nematoda	22	25	0.007	0.010

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	205	SD	206
Total	$g\ m^{-2}$	0.374	SD	0.423
		Chironomidae	0	0
		Chaoborus	89	98
		Oligochaeta	0	0
		Other	11	2

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE IX-08-79 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	247	124	0.176	0.290
Tanypodinae	538	102	0.789	0.555
Ceratopogonidae	11	22	0.003	0.006
Caenis	11	22	0.003	0.005
Cordulia	11	22	0.410	0.819
Libellulidae (Unk. sp.)	11	22	0.074	0.149
Polycentropus	11	22	0.015	0.030
Sphaerium	54	54	0.102	0.149
Oligochaeta	1527	611	0.225	0.152

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	2421	SD 723	Chironomidae	32	54
				Chaoborus	0	0
Total	$g\ m^{-2}$	1.797	SD 1.666	Oligochaeta	63	13
				Other	5	33

DATE IX-08-79 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	581	206	6.352	2.073
Chaoborus	323	82	0.255	0.076

Percent Composition

				Taxa	No.	Wt.
Total	No. m^{-2}	904	SD 202	Chironomidae	64	96
				Chaoborus	36	4
Total	$g\ m^{-2}$	6.607	SD 2.035	Oligochaeta	0	0
				Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE IX-08-79 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	817	0	2.678	0.220
<u>Chaoborus</u>	860	316	1.042	0.370

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	1677	SD 316	
Total	$g\ m^{-2}$	3.720	SD 0.458	
		Chironomidae	49	72
		Chaoborus	51	28
		Oligochaeta	0	0
		Other	0	0

DATE IX-08-79 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
<u>Chaoborus</u>	226	162	0.377	0.302

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	226	SD 162	
Total	$g\ m^{-2}$	0.377	SD 0.302	
		Chironomidae	0	0
		Chaoborus	100	100
		Oligochaeta	0	0
		Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE V-24-80 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	3419	1848	2.047	0.856
Tanypodinae	1387	398	1.055	0.405
Ceratopogonidae	22	25	0.027	0.038
Libellulidae (Unk. sp.)	11	22	0.199	0.398
Ladona	43	86	3.080	6.159
Polycentropus	86	78	0.528	0.515
Donacia	22	25	0.825	1.607
Caenis	86	35	0.101	0.060
Sphaerium	710	102	1.330	1.147
Oligochaeta	1774	779	0.218	0.090
Nematoda	43	35	0.025	0.017

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	7603	Chironomidae	63	33
SD	2677	Chaoborus	0	0
Total $g m^{-2}$	9.435	Oligochaeta	23	2
SD	6.609	Other	14	65

DATE V-24-80 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	1043	547	10.389	2.395
Tanypodinae	151	159	0.259	0.343
Chaoborus	430	145	0.545	0.199
Oligochaeta	237	147	0.053	0.055

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	1861	Chironomidae	64	95
SD	777	Chaoborus	23	5
Total $g m^{-2}$	11.246	Oligochaeta	13	0
SD	7.666	Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE V-24-80 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	1161	153	7.787	1.618
Tanypodinae	11	22	0.003	0.007
Chaoborus	2483	520	2.904	0.478

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	3655	SD 635	
		Chironomidae	32	73
		Chaoborus	68	27
		Oligochaeta	0	0
		Other	0	0
Total	$g\ m^{-2}$	10.694	SD 1.882	

DATE V-24-80 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chaoborus	2473	513	3.692	0.806
Nematoda	11	22	0.008	0.016

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	2484	SD 510	
		Chironomidae	0	0
		Chaoborus	100	100
		Oligochaeta	0	0
		Other	0	0
Total	$g\ m^{-2}$	3.700	SD 0.802	

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VI-21-80 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	13320	3991	4.803	2.012
Tanypodinae	2053	228	1.301	0.126
Ceratopogonidae	11	22	0.007	0.013
Leucorrhinia	11	22	0.475	0.095
Ladona	22	25	2.161	2.500
Donacia	22	43	0.154	0.309
Caenis	86	35	0.154	0.103
Sphaerium	462	128	1.067	0.410
Oligochaeta	3601	540	0.515	0.177
Nematoda	32	41	0.007	0.009

Percent Composition

			Taxa	No.	Wt.
Total No. m^{-2}	19620	SD 4295	Chironomidae	79	57
			Chaoborus	0	0
Total $g\ m^{-2}$	10.644	SD 1.471	Oligochaeta	18	5
			Other	3	38

DATE VI-21-80 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	968	376	10.224	3.792
Tanypodinae	75	54	0.014	0.010
Chaoborus	430	306	0.631	0.644
Oligochaeta	32	41	0.016	0.019

Percent Composition

			Taxa	No.	Wt.
Total No. m^{-2}	1505	SD 520	Chironomidae	69	94
			Chaoborus	29	6
Total $g\ m^{-2}$	10.885	SD 3.756	Oligochaeta	2	0
			Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VI-21-80 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	$\overline{\text{No } m^{-2}}$	SD	$\overline{g \text{ } m^{-2}}$	SD
Chironominae	1204	342	5.587	0.573
Chaoborus	2064	122	3.371	0.106

Percent Composition

		Taxa	No.	Wt.
Total	$\overline{\text{No. } m^{-2}}$	3268	SD	440
Total	$\overline{g \text{ } m^{-2}}$	8.958	SD	0.673
Chironomidae	37			62
Chaoborus	63			38
Oligochaeta	0			0
Other	0			0

DATE VI-21-80 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	$\overline{\text{No } m^{-2}}$	SD	$\overline{g \text{ } m^{-2}}$	SD
Chaoborus	1215	275	2.450	0.596

Percent Composition

		Taxa	No.	Wt.
Total	$\overline{\text{No. } m^{-2}}$	1215	SD	275
Total	$\overline{g \text{ } m^{-2}}$	2.450	SD	0.596
Chironomidae	0			0
Chaoborus	100			100
Oligochaeta	0			0
Other	0			0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VII-19-80 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	5021	1308	9.284	3.893
Tanypodinae	1634	637	0.929	0.455
Ceratopogonidae	11	22	0.009	0.018
Cordulia	97	138	0.642	0.838
Libellulidae (Unk. sp.)	97	41	0.115	0.072
Oecetis	32	22	0.065	0.099
Oxyethira	11	22	0.001	0.002
Polycentropus	43	35	0.053	0.038
Caenis	11	22	0.007	0.014
Sphaerium	624	257	0.954	0.675
Ferrissia	11	22	0.002	0.003
Oligochaeta	4762	2797	0.675	0.391
Nematoda	43	35	0.059	0.076

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	12397	SD 4809	
Total	$g\ m^{-2}$	12.795	SD 4.463	
		Chironomidae	54	80
		Chaoborus	0	0
		Oligochaeta	38	5
		Other	8	15

DATE VII-19-80 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	409	307	4.615	3.831
Chaoborus	634	108	1.169	0.130
Oligochaeta	86	35	0.028	0.005

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	1129	SD 359	
Total	$g\ m^{-2}$	5.812	SD 3.940	
		Chironomidae	36	80
		Chaoborus	56	20
		Oligochaeta	8	0
		Other	0	0

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VII-19-80 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	774	241	3.107	0.438
Chaoborus	892	89	1.438	0.107

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	1666	SD	154
Total	$g\ m^{-2}$	4.545	SD	0.348
		Chironomidae	46	68
		Chaoborus	54	32
		Oligochaeta	0	0
		Other	0	0

DATE VII-19-80 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chaoborus	387	61	0.644	0.377
Nematoda	11	22	0.007	0.014

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	398	SD	41
Total	$g\ m^{-2}$	0.651	SD	0.379
		Chironomidae	0	0
		Chaoborus	97	99
		Oligochaeta	0	0
		Other	3	1

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VIII-09-80 SITE 1 DEPTH 1 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	1043	583	2.542	0.852
Tanypodinae	2096	865	1.386	0.482
Leucorrhinia	11	22	0.058	0.116
Libellulidae (Unk. sp.)	32	22	0.304	0.392
Oecetis	32	41	0.012	0.015
Oxyethira	11	22	0.008	0.015
Fabria	11	22	0.009	0.017
Chaoborus	11	22	0.020	0.040
Sphaerium	290	54	0.304	0.077
Ferrissia	11	22	0.004	0.007
Oligochaeta	1054	338	0.133	0.091
Nematoda	118	154	0.025	0.021

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>4720</u>	SD	<u>2045</u>	
Total $g\ m^{-2}$	<u>4.805</u>	SD	<u>1.252</u>	
		Chironomidae	67	82
		Chaoborus	0	0
		Oligochaeta	11	3
		Other	22	15

DATE VIII-09-80 SITE 2 DEPTH 2 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	495	124	3.796	1.038
Tanypodinae	151	82	0.133	0.054
Ceratopogonidae	11	22	0.006	0.013
Libellulidae (Unk. sp.)	65	129	1.276	2.552
Leucorrhinia	11	22	0.423	0.845
Ladona	11	22	1.170	2.341
Chaoborus	108	90	0.132	0.127
Sphaerium	22	25	0.018	0.020
Oligochaeta	667	466	0.195	0.105

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>1541</u>	SD	<u>588</u>	
Total $g\ m^{-2}$	<u>7.149</u>	SD	<u>5.529</u>	
		Chironomidae	42	55
		Chaoborus	7	2
		Oligochaeta	43	3
		Other	8	40

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE VIII-09-80 SITE 3 DEPTH 4 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	849	142	3.873	0.629
Chaoborus	2537	913	1.097	0.273
Nematoda	11	22	0.004	0.008

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	3397	SD 1040	
Total	$g\ m^{-2}$	4.974	SD 0.812	
		Chironomidae	25	78
		Chaoborus	75	22
		Oligochaeta	0	0
		Other	0	0

DATE VIII-09-80 SITE 4 DEPTH 6 m NO. OF GRABS 4

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chaoborus	280	163	0.428	0.179
Nematoda	11	22	0.009	0.017

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	291	SD 154	
Total	$g\ m^{-2}$	0.437	SD 0.170	
		Chironomidae	0	0
		Chaoborus	96	98
		Oligochaeta	0	0
		Other	4	2

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE IX-12-80 SITE 1 DEPTH 1 m NO. OF GRABS 2

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	710	395	1.550	0.964
Tanypodinae	1096	213	1.042	0.068
Leucorrhinia	43	61	0.880	1.244
Libellulidae (Unk. sp.)	64	30	0.785	0.052
Ceratopogonidae	22	30	0.011	0.015
Polycentropus	43	61	0.053	0.075
Caenis	22	30	0.009	0.013
Sphaerium	129	61	0.170	0.015
Oligochaeta	946	243	0.142	0.068
Nematoda	22	30	0.129	0.182

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>3097</u>	SD	<u>669</u>	
		Chironomidae	58	56
		Chaoborus	0	0
		Oligochaeta	31	3
		Other	11	41
Total $g m^{-2}$	<u>4.771</u>	SD	<u>2.560</u>	

DATE IX-12-80 SITE 2 DEPTH 2 m NO. OF GRABS 2

Taxa	No m^{-2}	SD	$g m^{-2}$	SD
Chironominae	688	426	7.352	4.233
Tanypodinae	86	61	0.112	0.012
Chaoborus	494	152	0.648	0.138
Oligochaeta	129	182	0.038	0.053

Percent Composition

		Taxa	No.	Wt.
Total No. m^{-2}	<u>1397</u>	SD	<u>821</u>	
		Chironomidae	56	92
		Chaoborus	35	8
		Oligochaeta	9	0
		Other	0	0
Total $g m^{-2}$	<u>8.150</u>	SD	<u>4.437</u>	

Appendix K continued. Number and biomass m^{-2} of dominant benthic macroinvertebrates in Weso Lake.

DATE IX-12-80 SITE 3 DEPTH 4 m NO. OF GRABS 2

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chironominae	1032	547	5.016	2.058
Chaoborus	2064	486	2.488	0.431

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	3096	SD	1034
Total	$g\ m^{-2}$	7.504	SD	1.628
Chironomidae	33	67		
Chaoborus	67	33		
Oligochaeta	0	0		
Other	0	0		

DATE IX-12-80 SITE 4 DEPTH 6 m NO. OF GRABS 2

Taxa	No m^{-2}	SD	$g\ m^{-2}$	SD
Chaoborus	236	91	0.382	0.155

Percent Composition

		Taxa	No.	Wt.
Total	No. m^{-2}	236	SD	91
Total	$g\ m^{-2}$	0.382	SD	0.155
Chironomidae	0	0		
Chaoborus	100	100		
Oligochaeta	0	0		
Other	0	0		

Appendix L. Results of analyses of variance on benthic macroinvertebrate density, biomass, and number of taxa in Weso Lake with site, sampling date, and year as factors.

Variable	Calculated F Value		
	Year (d.f.=1,12)	Month (d.f.=3,12)	Site (d.f.=3,36)
Total Organisms			
Density	104.68**	16.15**	235.43**
Biomass	1.61**	0.21	3.42**
Taxa	48.20**	1.43	358.52**
Oligochaeta			
Density	44.58**	1.25	541.85**
Biomass	119.10**	1.00	185.60**
Ceratopogonidae			
Density	2.78	0.36	1.59
Biomass	2.60	0.59	1.57
<u>Chaoborus</u>			
Density	7.23*	6.86**	338.85**
Biomass	0.98	1.02	170.97**
Chironominae			
Density	65.11**	20.45**	1227.90**
Biomass	4.48	2.04	170.50**
Tanypodinae			
Density	82.25**	3.42*	441.77**
Biomass	42.59**	2.78	538.05**
Odonata			
Density	4.66	0.82	28.73**
Biomass	4.51	0.89	17.58**
Trichoptera			
Density	7.25*	8.72**	11.14**
Biomass	2.22	9.47**	12.19**
Ephemeroptera			
Density	317.50**	17.25**	317.50**
Biomass	263.21**	22.56**	263.21**
Coleoptera			
Density	0.40	2.87*	2.95
Biomass	0.82	2.83	2.84
Mollusca			
Density	27.04**	1.01	359.61**
Biomass	20.68**	4.66*	231.99**
Nematoda			
Density	1.92	1.24	38.08**
Biomass	2.26	0.85	27.44**

*

* P<0.05.

** P<0.001.

Appendix M. Results of analyses of variance on chemical variables of Weso Lake water samples collected at sites 11 through 14 with site and year as factors. Pooled samples from the stratified period of each year (May through September) were used in the comparisons.

Variable	Calculated F Value		Multiple Comparisons for Site Differences ^{ab}
	Site (d.f.=3,32)	Year (d.f.=1,32)	
Temperature	62.13 ^{**}	1.58	$u_{14} \neq u_{13} \neq u_{12} = u_{11}$
pH	6.06 [*]	0.34	$u_{14} \neq u_{13} = u_{12} = u_{11}$
Conductivity	25.37 ^{**}	42.99 ^{**}	$u_{14} \neq u_{13} \neq u_{12} = u_{11}$
Alkalinity	37.99 ^{**}	8.82 [*]	$u_{14} \neq u_{13} \neq u_{12} = u_{11}$
Total Hardness	8.16 ^{**}	0	$u_{14} \quad u_{13} \quad u_{12} \quad u_{11}$
Ca Hardness	6.48 [*]	0.36	$u_{14} \quad u_{13} \quad u_{12} \quad u_{11}$
Dissolved Oxygen	71.14 ^{**}	6.28 [*]	$u_{14} = u_{13} \neq u_{12} \neq u_{11}$
Reactive Phosphorus	18.62 ^{**}	8.88 [*]	$u_{14} \neq u_{13} = u_{12} = u_{11}$
Total Phosphorus	15.78 ^{**}	6.18 [*]	$u_{14} \neq u_{13} = u_{12} = u_{11}$
NO ₂₋₃ -N	0.67	2.00	No Test
NH ₄ -N	28.24 ^{**}	0.05	$u_{14} \neq u_{13} = u_{12} = u_{11}$
Total Kjeldahl-N	15.38 ^{**}	1.63	$u_{14} \neq u_{13} = u_{12} = u_{11}$
Chloride	0.11	92.04 ^{**}	No Test

^a Student-Newman-Keuls Test at P<0.05.

^b Subscripts indicate site.

* P<0.05.

** P<0.001.

Appendix N. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for May 25, 1979.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda												
Insecta												
Collembola	X ^d		X		X		X		X		X	
Coleoptera												
Donacia sp.												
Cyrrinus sp.												
Malipilus sp.	7	.047					2	.014	1	.007	1	.001
Hydrophilidae sp.												
Hydroporus sp.												
Iaccophilus sp.												
Tropisternus sp.												
SUBTOTAL: Coleoptera	Mean No		2	SD	4	N=3	Mean No	1	SD	1	N=3	
	Mean Wt	.016	SD	.027	N=3		Mean Wt	.007	SD	.006	N=3	
Diptera												
Ceratopogonidae spp.	5	.001	6	Tr ^e	2	Tr			5	.001	24	.004
Chironomidae spp.	269	.071	233	.044	311	.041	172	.033	273	.053	704	.058
Chrysops sp.												
Culex sp.											1	.001
Melius sp.												
Sepedon sp.												
SUBTOTAL: Diptera	Mean No	275	SD	37	N=3		Mean No	393	SD	296	N=3	
	Mean Wt	.052	SD	.017	N=3		Mean Wt	.050	SD	.016	N=3	
Ephemeroptera												
Callibaetis sp.												
Caenis sp.	13	.032	9	.018	11	.021	44	.098	32	.068	6	.017
SUBTOTAL: Ephemeroptera	Mean No	11	SD	2	N=3		Mean No	27	SD	19	N=3	
	Mean Wt	.024	SD	.007	N=3		Mean Wt	.061	SD	.041	N=3	
Hemiptera												
Belostoma sp.												
Corixidae spp.	4	.037										
Gerris sp.												
Hydrometra sp.												
Notonecta sp.												
Plea sp.	1	.001	4	.006					1	.002		
Ranatra sp.												
Trepobates sp.			4	.004					2	.002	4	.007
SUBTOTAL: Hemiptera	Mean No	4	SD	4	N=3		Mean No	2	SD	2	N=3	
	Mean Wt	.016	SD	.020	N=3		Mean Wt	.004	SD	.004	N=3	
Odonata												
Anisoptera												
Aeschna spp.							1	.413	1	.613	1	.642
Anax spp.							1	.063				
Basiaeschna sp.												
Boyeria sp.	1	Tr	1	Tr					1	Tr	5	.001
Cordulia sp.							1	.158				
Gomphus sp.												
Ladona sp.												
Leucorrhinia spp.	5	.054	20	.087	34	.027	1	.002	2	.011	14	.078
Libellulidae ^c							2	.034				
Tetragoneuria sp.												
Zygoptera												
Coenagrionidae ^c												
Chromagrion sp.												
Enallagma spp.	3	.067	2	.049			3	.075	7	.094	5	.072
Ischnura sp.					1	.034					1	.013
Lestes sp.			1	.001	1	.005	3	.011	1	.004	5	.002
Nehalennia sp.			1	.007							3	.035
SUBTOTAL: Odonata	Mean No	23	SD	14	N=3		Mean No	19	SD	13	N=3	
	Mean Wt	.111	SD	.040	N=3		Mean Wt	.774	SD	.063	N=3	
Megaloptera												
Chauliodes sp.												
Sialis sp.												
SUBTOTAL: Megaloptera	Mean No		SD		N=3		Mean No		SD		N=3	
	Mean Wt		SD		N=3		Mean Wt		SD		N=3	
Neuroptera												
Sisyra spp.	4	.004	3	.006	1	Tr						
SUBTOTAL: Neuroptera	Mean No	3	SD	2	N=3		Mean No		SD		N=3	
	Mean Wt	.004	SD	.002	N=3		Mean Wt		SD		N=3	

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for May 25, 1979.

TAXA	SITE					
	9-1 No	9-1 Wt	9-2 No	9-2 Wt	9-3 No	9-3 Wt
Lepidoptera						
<u>Parargyractis</u> sp.						
<u>Synclita</u> spp.						
SUBTOTAL: Lepidoptera	Mean No	Mean Wt	SD	SD	N=3	N=3
Trichoptera						
<u>Banksiola</u> sp.	3	.019				
<u>Ceraclea</u> sp.						
<u>Fabria</u> sp.						
<u>Glyptopsyche</u> sp.	1	.070	1	.032	1	.044
<u>Limnephilus</u> spp.					1	.053
<u>Limnophilidae</u> ^c						
<u>Oecetis</u> spp.	1	.001			90	.128
<u>Oxyethira</u> sp.					68	.088
<u>Nemotaulius</u> sp.						
<u>Nycticonylax</u> sp.						
<u>Platycentropus</u> sp.			2	.010	1	.003
<u>Polycentropus</u> sp.					5	.022
<u>Ptilostomis</u> spp.					8	.036
<u>Triaenodes</u> sp.						
SUBTOTAL: Trichoptera	Mean No	Mean Wt	SD	SD	N=3	N=3
Crustacea						
Amphipoda						
<u>Gammarus</u> sp.						
SUBTOTAL: Amphipoda	Mean No	Mean Wt	SD	SD	N=3	N=3
Decapoda						
<u>Cambarus</u> sp.						
SUBTOTAL: Decapoda	Mean No	Mean Wt	SD	SD	N=3	N=3
Arachnoidea						
Hydracarina	X		X			
Mollusca						
Gastropoda						
<u>Helisoma</u> sp.					1	.004
<u>Ferrissia</u> sp.					4	.137
<u>Lymnaea</u> sp.						
Pelecypoda						
<u>Sphaerium</u> sp.	1	.001	5	.015	36	.105
SUBTOTAL: Mollusca	Mean No	Mean Wt	SD	SD	N=3	N=3
Annelida						
Oligochaeta	82	.011	45	.005	41	.006
SUBTOTAL: Oligochaeta	Mean No	Mean Wt	SD	SD	N=3	N=3
Hirudinea						
<u>Erpobdella</u> sp.						
<u>Macrobdella</u> sp.						
Nematoda						
Porifera						
<u>Spongilla</u> sp.	X		X		X	
TOTAL: All Organisms	Mean No	Mean Wt	SD	SD	N=3	N=3
	379	.281	37	.140	588	1.224
					SD	SD
					283	.103
					N=3	N=3

^a Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for June 23, 1979.

TAXA	SITE									
	9-1		9-2		9-3		10-1		10-2	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda										
Insecta										
Collembola			X ^d		X				X	
Coleoptera										X
<u>Donacia</u> sp.										
<u>Gyrinus</u> sp.										
<u>Halophilus</u> sp.			2	.016			8	.064	2	.012
Hydrophilidae sp.										
<u>Hydroporus</u> sp.										
<u>Laccophilus</u> sp.										
<u>Tropisternus</u> sp.										
SUBTOTAL: Coleoptera	Mean No	1	SD	1	N=3		Mean No	4	SD	3
	Mean Wt	.005	SD	.009	N=3		Mean Wt	.031	SD	.028
Diptera										
Ceratopogonidae spp.			13	.004	9	.003			6	.001
Chironomidae spp.	268	.084	397	.116	370	.108	169	.061	368	.111
<u>Chrysops</u> sp.										
<u>Culex</u> sp.										
<u>Helius</u> sp.										
<u>Sepedon</u> sp.										
SUBTOTAL: Diptera	Mean No	352	SD	75	N=3		Mean No	217	SD	140
	Mean Wt	.105	SD	.019	N=3		Mean Wt	.069	SD	.039
Ephemeroptera										
<u>Callibaetis</u> sp.										
<u>Caenis</u> sp.	13	.035	36	.073	9	.017	15	.038	53	.124
SUBTOTAL: Ephemeroptera	Mean No	19	SD	15	N=3		Mean No	30	SD	20
	Mean Wt	.042	SD	.028	N=3		Mean Wt	.073	SD	.046
Hemiptera										
Belostoma sp.										
Corixidae spp.	3	.005	2	.001						
Gerris sp.										
Hydrometra sp.	1	Tr	1	.002						
Notonecta sp.										
Plea sp.	3	.005	8	.013	4	.006	2	.003	1	.001
Ranatra sp.										
Trepobates sp.			1	.004					10	.021
SUBTOTAL: Hemiptera	Mean No	8	SD	4	N=3		Mean No	5	SD	5
	Mean Wt	.012	SD	.008	N=3		Mean Wt	.013	SD	.010
Odonata										
Anisoptera										
<u>Aeschna</u> spp.					1	.004				
<u>Anax</u> spp.										
<u>Basiaeschna</u> sp.										
<u>Boyeria</u> sp.									3	.002
<u>Cordulia</u> sp.										
<u>Gomphus</u> sp.										
<u>Iadona</u> sp.										
<u>Leucorrhinia</u> spp.	16	.017	34	.196	17	.039	1	.001	1	.066
Libellulidae ^c									1	.139
<u>Tetragoneuria</u> sp.							2	.170		
Zygoptera										
Coenagrionidae ^c										
<u>Chromagrion</u> sp.										
<u>Enallagma</u> spp.	1	.025	1	.029			2	.032	11	.236
<u>Ischnura</u> sp.					2	.060				
<u>Lestes</u> sp.			1	.001			3	.064	3	.070
<u>Nehalennia</u> sp.										
SUBTOTAL: Odonata	Mean No	24	SD	10	N=3		Mean No	13	SD	5
	Mean Wt	.124	SD	.094	N=3		Mean Wt	.399	SD	.247
Megaloptera										
<u>Chauliodes</u> sp.										
<u>Sialis</u> sp.										
SUBTOTAL: Megaloptera	Mean No		SD		N=3		Mean No		SD	
	Mean Wt		SD		N=3		Mean Wt		SD	
Neuroptera										
<u>Sisyra</u> spp.	6	.006	8	.022	7	.013				
SUBTOTAL: Neuroptera	Mean No	3	SD	2	N=3		Mean No		SD	
	Mean Wt	.004	SD	.002	N=3		Mean Wt		SD	

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for June 23, 1979.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera												
<u>Parargyractis</u> sp.									1	.008	1	.009
<u>Synclita</u> spp.												
SUBTOTAL:Lepidoptera	Mean No		SD		N=3		Mean No		1	SD	1	N=3
	Mean Wt		SD		N=3		Mean Wt	.006	SD	.005	N=3	
Trichoptera												
<u>Banksiola</u> sp.					5	.035						
<u>Ceraclea</u> sp.	16	.104										
<u>Fabria</u> sp.												
<u>Glyptopsysche</u> sp.							1	.058	6	.388	2	.161
<u>Limnephilus</u> spp.												
<u>Limniphilidae</u> ^c					2	.005	17	.037	55	.118	20	.040
<u>Oecetis</u> spp.	1	.002					1	.001				
<u>Oxyethira</u> sp.	13	.004	7	.002								
<u>Nemotaulius</u> sp.									1	.003	1	.003
<u>Nyctiophylax</u> sp.												
<u>Platycentropus</u> sp.					1	.006	3	.022	12	.084	4	.028
<u>Polycentropus</u> sp.	6	.050	6	.044								
<u>Ptilostomis</u> spp.					4	.005	2	.003				
<u>Triadenodes</u> sp.			3	.002								
SUBTOTAL:Trichoptera	Mean No	21	SD	13	N=3		Mean No	42	SD	28	N=3	
	Mean Wt	.087	SD	.063	N=3		Mean Wt	.315	SD	.247	N=3	
Crustacea												
Amphipoda												
<u>Gammarus</u> sp.												
SUBTOTAL:Amphipoda	Mean No		SD		N=3		Mean No		SD		N=3	
	Mean Wt		SD		N=3		Mean Wt		SD		N=3	
Decapoda												
<u>Cambarus</u> sp.												
SUBTOTAL:Decapoda	Mean No		SD		N=3		Mean No		SD		N=3	
	Mean Wt		SD		N=3		Mean Wt		SD		N=3	
Arachnoidea												
Hydracarina					X		X		X		X	
Mollusca												
Gastropoda												
<u>Helisoma</u> sp.			2	.002			1	.002				
<u>Ferrissia</u> sp.					6	.088						
<u>Lymnaea</u> sp.												
Pelecypoda												
<u>Sphaerium</u> sp.	6	.011	1	.004			24	.070	20	.081	12	.126
SUBTOTAL:Mollusca	Mean No	5	SD	2	N=3		Mean No	19	SD	7	N=3	
	Mean Wt	.035	SD	.046	N=3		Mean Wt	.093	SD	.029	N=3	
Annelida												
Oligochaeta	66	.011	161	.029	86	.019	40	.002	140	.008	22	.005
SUBTOTAL:Oligochaeta	Mean No	104	SD	50	N=3		Mean No	67	SD	64	N=3	
	Mean Wt	.020	SD	.010	N=3		Mean Wt	.005	SD	.003	N=3	
Hirudinea												
<u>Erpobdella</u> sp.												
<u>Macrobdella</u> sp.												
Nematoda												
Porifera												
<u>Spongilla</u> sp.	X		X		X							
TOTAL:All Organisms	Mean No	541	SD	134	N=3		Mean No	398	SD	261	N=3	
	Mean Wt	.444	SD	.104	N=3		Mean Wt	1.004	SD	.440	N=3	

^a Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for July 20, 1979.

TAXA	SITE									
	9-1		9-2		9-3		10-1		10-2	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda										
Insecta										
Collembola	X ^d		X		X		X		X	
Coleoptera										
Donacia sp.										
Cyrrinus sp.										
Halophilus sp.					1	.007	4	.024		
Hydrophilidae sp.										
Hydroporus sp.			1	.012						
Laccophilus sp.								1	.004	
Tropisternus sp.										3 .010
SUBTOTAL: Coleoptera	Mean No	1	SD	1	N=3		Mean No	3	SD	2
	Mean Wt	.006	SD	.006	N=3		Mean Wt	.014	SD	.010
Diptera										
Ceratopogonidae spp.	10	.005	11	.008	33	.004	6	.002	6	.004
Chironomidae spp.	114	.097	580	.142	374	.196	414	.146	271	.109
Chrysops sp.								1	.013	
Culex sp.										
Helius sp.										
Sepedon sp.										
SUBTOTAL: Diptera	Mean No	374	SD	235	N=3		Mean No	390	SD	100
	Mean Wt	.151	SD	.049	N=3		Mean Wt	.151	SD	.027
Ephemeroptera										
Callibaetis sp.										
Caenis sp.	2	.003	51	.106	6	.013	8	.023	11	.022
SUBTOTAL: Ephemeroptera	Mean No	20	SD	27	N=3		Mean No	9	SD	2
	Mean Wt	.041	SD	.057	N=3		Mean Wt	.022	SD	.001
Hemiptera										
Belostoma sp.										
Corixidae spp.					1	.001	1	.001		
Gerris sp.			1	.032			1	.008		
Hydrometra sp.			4	.004	5	.004			1	Tr ^e
Notonecta sp.										1 .036
Plea sp.	1	.001	8	.009	5	.004	6	.007		1 Tr
Ranatra sp.					1	.032				
Trepobates sp.										2 .002
SUBTOTAL: Hemiptera	Mean No	9	SD	7	N=3		Mean No	4	SD	4
	Mean Wt	.029	SD	.024	N=3		Mean Wt	.018	SD	.019
Odonata										
Anisoptera										
Aeschna spp.			2	.035	1	.062	1	.033	3	.036
Anax spp.	2	.044					2	.035		
Basiaeschna sp.										1 .011
Boyeria sp.								1	.014	
Cordulia sp.							1	.240	1	.184
Gomphus sp.										
Iadona sp.								3	.106	
Leucorrhinia spp.	5	.161	38	1.179	21	1.053	9	.158	17	.658
Libellulidae ^c			4	.032	3	.006	2	.011	1	.031
Tetragoneuria sp.							1	.086		1 .091
Zygoptera										
Coenagrionidae ^c					13	.007	17	.008	3	.001
Chromagrion sp.								4	.036	1 .009
Enallagma spp.			1	.001	2	.003	5	.014	3	.008
Ischnura sp.										3 .010
Lestes sp.			4	.158			1	.047		
Mehallenia sp.	1	Tr					21	.002	2	Tr
SUBTOTAL: Odonata	Mean No	32	SD	22	N=3		Mean No	50	SD	11
	Mean Wt	.914	SD	.628	N=3		Mean Wt	.850	SD	.221
Megaloptera										
Chauliodes sp.			2	.016			2	.008		
Sialis sp.							1	.001		1 Tr
SUBTOTAL: Megaloptera	Mean No	1	SD	1	N=3		Mean No	1	SD	2
	Mean Wt	.005	SD	.009	N=3		Mean Wt	.003	SD	.005
Neuroptera										
Sisyra spp.	18	.022	1	.001	13	.019	1	.001		
SUBTOTAL: Neuroptera	Mean No	11	SD	9	N=3		Mean No	Tr	SD	--
	Mean Wt	.014	SD	.012	N=3		Mean Wt	Tr	SD	--

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for July 20, 1979.

TAXA	SITE									
	9-1		9-2		9-3		10-1		10-2	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera										
<u>Parargyractis</u> sp.							48	.014	2	.001
<u>Synclita</u> spp.									1	Tr
SUBTOTAL: Lepidoptera	Mean No		SD		N=3		Mean No	17	SD	27
	Mean Wt		SD		N=3		Mean Wt	.005	SD	.011
Trichoptera										
<u>Banksiola</u> sp.	1	.016								
<u>Ceraclea</u> sp.										
<u>Fabria</u> sp.										
<u>Glyphopsyche</u> sp.									2	.230
<u>Limnephilus</u> spp.							2	Tr		
<u>Limnephilidae</u> *							1	.003	3	.012
<u>Oecetis</u> spp.			1	.002						
<u>Oxyethira</u> sp.					2	Tr				
<u>Nemotaulius</u> sp.										
<u>Nyctiophylax</u> sp.										
<u>Platycentropus</u> sp.									1	.007
<u>Polycentropus</u> sp.			1	.009					1	Tr
<u>Ptilostomis</u> spp.			1	Tr			1	Tr		
<u>Triaenodes</u> sp.			2	.013	2	.016	1	.087		
SUBTOTAL: Trichoptera	Mean No		3	SD	2	N=3	Mean No	6	SD	1
	Mean Wt	.019	SD	.004	N=3		Mean Wt	.107	SD	.124
Crustacea										
Amphipoda										
<u>Gammarus</u> sp.										
SUBTOTAL: Amphipoda	Mean No		SD		N=3		Mean No		SD	N=3
	Mean Wt		SD		N=3		Mean Wt		SD	N=3
Decapoda										
<u>Cambarus</u> sp.										
SUBTOTAL: Decapoda	Mean No		SD		N=3		Mean No		SD	N=3
	Mean Wt		SD		N=3		Mean Wt		SD	N=3
Arachnoidea										
Hydracarina	X		X		X		X			
Mollusca										
Gastropoda										
<u>Helisoma</u> sp.										1 .004
<u>Ferrissia</u> sp.										8 .040
<u>Lymnaea</u> sp.	2	.008	26	.079	22	.067	6	.018	2	.004
Pelecypoda										
<u>Sphaerium</u> sp.			1	.004			75	.133	42	.090
SUBTOTAL: Mollusca	Mean No	17	SD	13	N=3		Mean No	56	SD	22
	Mean Wt	.053	SD	.040	N=3		Mean Wt	.152	SD	.058
Annelida										
Oligochaeta	117	.028	213	.065	125	.037	14	.007	34	.032
SUBTOTAL: Oligochaeta	Mean No	152	SD	53	N=3		Mean No	23	SD	10
	Mean Wt	.043	SD	.019	N=3		Mean Wt	.016	SD	.014
Hirudinea										
<u>Erpobdella</u> sp.										
<u>Macrobdella</u> sp.										
Nematoda										
Porifera										
<u>Spongilla</u> sp.	X		X		X					
TOTAL: All Organisms	Mean No	620	SD	240	N=3		Mean No	559	SD	126
	Mean Wt	1.275	SD	.739	N=3		Mean Wt	1.388	SD	.283

* Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for August 10, 1979.

TAXA	SITE											
	9-1 No ^a	Wt ^b	9-2 No	Wt	9-3 No	Wt	10-1 No	Wt	10-2 No	Wt	10-3 No	Wt
Arthropoda												
Insecta												
Collembola	X ^d		X		X		X		X		X	
Coleoptera												
<u>Donacia</u> sp.												
<u>Gyrinus</u> sp.												
<u>Halophilus</u> sp.			2	.022	1	.002	1	.002				
Hydrophilidae sp.												
<u>Hydroporus</u> sp.									3	.023		
<u>Laccophilus</u> sp.												
<u>Tropisternus</u> sp.												
SUBTOTAL: Coleoptera	Mean No	1	SD	1	N=3		Mean No	1	SD	2	N=3	
	Mean Wt	.008	SD	.012	N=3		Mean Wt	.008	SD	.013	N=3	
Diptera												
Ceratopogonidae spp.	3	Tr	6	.001	24	.002	1	Tr ^e	13	.002	33	.004
Chironomidae spp.	41	.023	75	.045	112	.042	161	.060	312	.049	491	.119
<u>Chrysops</u> sp.												
<u>Culex</u> sp.												
<u>Helius</u> sp.												
<u>Sepedon</u> sp.												
SUBTOTAL: Diptera	Mean No	87	SD	46	N=3		Mean No	337	SD	181	N=3	
	Mean Wt	.038	SD	.013	N=3		Mean Wt	.078	SD	.040	N=3	
Ephemeroptera												
<u>Callibaetis</u> sp.												
<u>Caenis</u> sp.	2	.004	12	.011			8	.005	9	.003	40	.010
SUBTOTAL: Ephemeroptera	Mean No	5	SD	6	N=3		Mean No	19	SD	18	N=3	
	Mean Wt	.005	SD	.006	N=3		Mean Wt	.006	SD	.004	N=3	
Hemiptera												
<u>Belostoma</u> sp.												
Corixidae spp.			1	.028					1	.005		
<u>Gerris</u> sp.							1	.010				
<u>Hydrometra</u> sp.					2	.004			1	.001	2	Tr
<u>Notonecta</u> sp.												
<u>Plea</u> sp.			14	.010	3	.004	6	.006				
<u>Ranatra</u> sp.												
<u>Trepobates</u> sp.			1	.002			2	.003	4	.008	4	.003
SUBTOTAL: Hemiptera	Mean No	7	SD	8	N=3		Mean No	7	SD	2	N=3	
	Mean Wt	.017	SD	.022	N=3		Mean Wt	.012	SD	.008	N=3	
Odonata												
Anisoptera												
<u>Aeschna</u> spp.	1	.046	2	.096			1	.035				
<u>Anax</u> spp.					1	.050						
<u>Basiaeschna</u> sp.												
<u>Boyeria</u> sp.												
<u>Cordulia</u> sp.									1	.362		
<u>Gomphus</u> sp.												
<u>Iadona</u> sp.			1	.010	1	.003	2	.092	1	.058		
<u>Leucorrhinia</u> spp.	3	.084	36	.429	6	.105	18	.014	16	.420	20	.670
Libellulidae ^c	1	.046	3	.031	1	.038	2	.009	1	.008		
<u>Tetragoneuria</u> sp.							1	.121				
Zygoptera												
Coenagrionidae ^c	1	.001	6	.004			29	.017	2	.002	13	.010
<u>Chromagrion</u> sp.									8	.027	18	.074
<u>Enallagma</u> spp.	2	.005					24	.037	5	.009	8	.011
<u>Ischnura</u> sp.			1	.022							1	.019
<u>Lestes</u> sp.							1	Tr				
<u>Nehaliera</u> sp.	2	Tr	8	.004	1	.001	35	.004	9	.001	34	.004
SUBTOTAL: Odonata	Mean No	26	SD	27	N=3		Mean No	83	SD	36	N=3	
	Mean Wt	.326	SD	.235	N=3		Mean Wt	.669	SD	.297	N=3	
Megaloptera												
<u>Chauliodes</u> sp.			1	.016	1	.001	5	.009			2	.013
<u>Sialis</u> sp.												
SUBTOTAL: Megaloptera	Mean No	1	SD	1	N=3		Mean No	2	SD	2	N=3	
	Mean Wt	.006	SD	.009	N=3		Mean Wt	.007	SD	.007	N=3	
Neuroptera												
<u>Sisyra</u> spp.	8	.009	1	.003	11	.011						
SUBTOTAL: Neuroptera	Mean No	7	SD	5	N=3		Mean No		SD		N=3	
	Mean Wt	.008	SD	.004	N=3		Mean Wt		SD		N=3	

Appendix N continued, Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for August 10, 1979.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera												
<u>Parargyractis</u> sp.												
<u>Synclita</u> spp.	1	Tr	2	.001			12	.009			6	.006
SUBTOTAL: Lepidoptera	Mean No	1	SD	1	N=3		Mean No	6	SD	6	N=3	
	Mean Wt	Tr	SD	--	N=3		Mean Wt	.005	SD	.004	N=3	
Trichoptera												
<u>Banksiola</u> sp.												
<u>Ceraclea</u> sp.	1	.018			1	.011						
<u>Fabria</u> sp.												
<u>Glyphopsyche</u> sp.											3	.149
<u>Limnephilus</u> spp.									1	.079	1	.074
<u>Limnephilidae</u> ^c			4	.001								
<u>Oecetis</u> spp.							27	.006	11	.001	29	.004
<u>Oxyethira</u> sp.	2	.001	5	.002	8	.003			1	Tr		
<u>Nemotaulius</u> sp.											1	.001
<u>Nyctiophylax</u> sp.												
<u>Platycentropus</u> sp.												
<u>Polycentropus</u> sp.			3	.008	3	Tr	3	.001	2	Tr	21	.001
<u>Ptilostomis</u> spp.							2	.003	1	Tr	3	Tr
<u>Triadenodes</u> sp.												
SUBTOTAL: Trichoptera	Mean No	9	SD	5	N=3		Mean No	35	SD	21	N=3	
	Mean Wt	.015	SD	.005	N=3		Mean Wt	.107	SD	.112	N=3	
Crustacea												
Amphipoda												
<u>Gammarus</u> sp.									2	.010		
SUBTOTAL: Amphipoda	Mean No		SD		N=3		Mean No	1	SD	1	N=3	
	Mean Wt		SD		N=3		Mean Wt	.003	SD	.006	N=3	
Decapoda												
<u>Cambarus</u> sp.									1	.211		
SUBTOTAL: Decapoda	Mean No		SD		N=3		Mean No	Tr	SD	--	N=3	
	Mean Wt		SD		N=3		Mean Wt	.070	SD	.122	N=3	
Arachnoidea												
<u>Hydracarina</u>			X		X							
Mollusca												
Gastropoda												
<u>Helisoma</u> sp.												
<u>Ferrissia</u> sp.	3	.003	1	.002	1	.001	1	.002	12	.010	15	.014
<u>Lymnaea</u> sp.	1	.013	12	.088	4	.027	5	.046	5	.033	10	.070
Pelecypoda												
<u>Sphaerium</u> sp.							56	.112	48	.188	35	.251
SUBTOTAL: Mollusca	Mean No	7	SD	5	N=3		Mean No	62	SD	2	N=3	
	Mean Wt	.044	SD	.039	N=3		Mean Wt	.243	SD	.088	N=3	
Annelida												
Oligochaeta												
	44	.005	56	.008	63	.012	31	.042	28	.010	27	.006
SUBTOTAL: Oligochaeta	Mean No	54	SD	10	N=3		Mean No	29	SD	2	N=3	
	Mean Wt	.008	SD	.004	N=3		Mean Wt	.020	SD	.019	N=3	
Hirudinea												
<u>Erpobdella</u> sp.												
<u>Macrobdella</u> sp.												
Nematoda												
Porifera												
<u>Spongilla</u> sp.	X		X		X							
TOTAL: All Organisms	Mean No	205	SD	77	N=3		Mean No	582	SD	205	N=3	
	Mean Wt	.475	SD	.321	N=3		Mean Wt	1.228	SD	.504	N=3	

^a Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for September 8, 1979.

TAXA	SITE									
	9-1		9-2		9-3		10-1		10-2	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda										
Insecta										
Collembola			X ^d		X		X		X	
Coleoptera										
<u>Donacia</u> sp.							8	.084		
<u>Gyrinus</u> sp.										
<u>Haliphus</u> sp.			3	.011	4	.013	1	.005	1	.002
Hydrophilidae sp.										
Hydroporus sp.										
<u>Laccophilus</u> sp.										
<u>Tropisternus</u> sp.										
SUBTOTAL: Coleoptera	Mean No	2	SD	2	N=3		Mean No	3	SD	5
	Mean Wt	.009	SD	.008	N=3		Mean Wt	.030	SD	.051
Diptera										
Ceratopogonidae spp.	1	Tr ^e	7	.002	15	.002	8	.003	5	.001
Chironomidae spp.	71	.020	113	.042	290	.073	525	.082	111	.018
<u>Chrysops</u> sp.										
<u>Culex</u> sp.										
<u>Helius</u> sp.										2
<u>Sepedon</u> sp.			1	Tr						.007
SUBTOTAL: Diptera	Mean No	166	SD	123	N=3		Mean No	319	SD	209
	Mean Wt	.046	SD	.028	N=3		Mean Wt	.057	SD	.034
Ephemeroptera										
<u>Callibaetis</u> sp.										
<u>Gaenis</u> sp.	30	.012	80	.030	106	.038	102	.038	121	.037
SUBTOTAL: Ephemeroptera	Mean No	72	SD	39	N=3		Mean No	120	SD	18
	Mean Wt	.027	SD	.013	N=3		Mean Wt	.041	SD	.007
Hemiptera										
<u>Belostoma</u> sp.										
Corixidae spp.	1	.015	1	.008						
<u>Gerris</u> sp.										
<u>Hydrometra</u> sp.	1	Tr	1	.001	1	Tr				
<u>Notonecta</u> sp.										
<u>Plea</u> sp.	1	.001	14	.020	26	.032	12	.019	1	.001
<u>Ranatra</u> sp.										2
<u>Trepobates</u> sp.									2	.005
SUBTOTAL: Hemiptera	Mean No	15	SD	12	N=3		Mean No	6	SD	6
	Mean Wt	.026	SD	.008	N=3		Mean Wt	.009	SD	.009
Odonata										
Anisoptera										
<u>Aeschna</u> spp.	1	.090			1	.071	1	.064		
<u>Anax</u> spp.										1
<u>Basiaeschna</u> sp.										1.162
<u>Boyeria</u> sp.							1	.001		
<u>Cordulia</u> sp.									1	.293
<u>Gomphus</u> sp.										
<u>Iadona</u> sp.							3	.007		
<u>Leucorrhinia</u> spp.	11	.209	37	.335	93	.555	12	.022	6	.078
Libellulidae ^c	2	.023	4	.064	4	.053	3	.017		
<u>Tetragoneuria</u> sp.			3	.125						1
Zygoptera										
Coenagrionidae ^c	3	.004	19	.017	29	.035	27	.034	28	.032
<u>Chromagrion</u> sp.							3	.022	8	.046
<u>Enallagma</u> spp.	4	.019	9	.028	55	.182	15	.053	16	.050
<u>Ischnura</u> sp.					2	.014				26
<u>Lestes</u> sp.										.089
<u>Nehalennia</u> sp.			5	.001	6	.002	4	.001	6	.001
SUBTOTAL: Odonata	Mean No	96	SD	86	N=3		Mean No	84	SD	30
	Mean Wt	.610	SD	.285	N=3		Mean Wt	.765	SD	.714
Megaloptera										
<u>Chauliodes</u> sp.	1	.013					3	.017		
<u>Sialis</u> sp.										
SUBTOTAL: Megaloptera	Mean No	Tr	SD	--	N=3		Mean No	1	SD	2
	Mean Wt	.004	SD	.008	N=3		Mean Wt	.006	SD	.010
Neuroptera										
<u>Sisyra</u> spp.	24	.028	1	.001	20	.021				
SUBTOTAL: Neuroptera	Mean No	15	SD	12	N=3		Mean No		SD	N=3
	Mean Wt	.017	SD	.014	N=3		Mean Wt		SD	N=3

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for September 8, 1979.

TAXA	SITE									
	9-1		9-2		9-3		10-1		10-2	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera										
<u>Paragyrractis</u> sp.			1	Tr			1	.052		1 .009
<u>Synclita</u> spp.									9	.037
SUBTOTAL:Lepidoptera	Mean No	Tr	SD	--	N=3		Mean No	4	SD	6 N=3
	Mean Wt	Tr	SD	--	N=3		Mean Wt	.033	SD	.029 N=3
Trichoptera										
<u>Banksiola</u> sp.							1	.008	8	.028
<u>Ceraclea</u> sp.										
<u>Fabria</u> sp.			2	.001	9	.006	7	.001	3	.001
<u>Glyptopsyche</u> sp.										
<u>Limnephilus</u> spp.										
<u>Limniphilidae</u>	5	.001	16	.006	21	.006	6	.001	14	.003
<u>Oecetis</u> spp.							109	.038	70	.013
<u>Oxyethira</u> sp.	29	.009	7	.002	143	.050	10	.003	5	.001
<u>Nemotaulius</u> sp.	2	.014	35	.119	34	.089	1	.002	4	.005
<u>Nyctiophylax</u> sp.										
<u>Platycentropus</u> sp.										
<u>Polycentropus</u> sp.	14	.007	42	.016	55	.019	12	.002	14	.003
<u>Ptilostomis</u> spp.	1	Tr	3	.004	8	.011	2	.001	9	.010
<u>Triatodes</u> spp.										
SUBTOTAL:Trichoptera	Mean No	142	SD	114	N=3		Mean No	176	SD	68 N=3
	Mean Wt	.120	SD	.079	N=3		Mean Wt	.082	SD	.037 N=3
Crustacea										
Amphipoda										
<u>Gammarus</u> sp.									2	.017
SUBTOTAL:Amphipoda	Mean No		SD		N=3		Mean No	1	SD	1 N=3
	Mean Wt		SD		N=3		Mean Wt	.006	SD	.010 N=3
Decapoda										
<u>Cambarus</u> sp.									1	.283
SUBTOTAL:Decapoda	Mean No		SD		N=3		Mean No	1	SD	1 N=3
	Mean Wt		SD		N=3		Mean Wt	.179	SD	.155 N=3
Arachnoidea										
Hydracarina			X		X		X			
Mollusca										
Gastropoda										
<u>Helisoma</u> sp.										
<u>Ferrissia</u> sp.	10	.008	12	.010	16	.014	7	.008	21	.018
<u>Lymnaea</u> sp.	10	.007	36	.043	131	.102	22	.050	12	.047
Pelecypoda										
<u>Sphaerium</u> sp.			1	.011			48	.232	12	.039
SUBTOTAL:Mollusca	Mean No	72	SD	66	N=3		Mean No	64	SD	17 N=3
	Mean Wt	.065	SD	.050	N=3		Mean Wt	.186	SD	.096 N=3
Annelida										
Oligochaeta	82	.014	75	.010	320	.044	24	.009	11	.001
SUBTOTAL:Oligochaeta	Mean No	159	SD	139	N=3		Mean No	19	SD	7 N=3
	Mean Wt	.023	SD	.019	N=3		Mean Wt	.004	SD	.004 N=3
Hirudinea										
<u>Erpobdella</u> sp.										
<u>Macrobdella</u> sp.										
Nematoda										
Porifera										
<u>Spongilla</u> sp.	X		X		X					
TOTAL:All Organisms	Mean No	739	SD	573	N=3		Mean No	798	SD	269 N=3
	Mean Wt	.947	SD	.470	N=3		Mean Wt	1.398	SD	.744 N=3

* Number of organisms per collection.

* Wet weight in grams per collection.

* Early instars.

* X = Present.

* Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for May 24, 1980.

TAXA	SITE											
	9-1 No ^a	Wt ^b	9-2 No	Wt	9-3 No	Wt	10-1 No	Wt	10-2 No	Wt	10-3 No	Wt
Arthropoda												
Insecta												
Collembola	X ^d		X		X		X		X		X	
Coleoptera												
Donacia sp.												
Gyrinus sp.			1	.018								
Haliplus sp.	1	.009	7	.048	2	.013						
Hydrophilidae sp.			1	.004	2	.006						
Hydroporus sp.												
Iaccophilus sp.												
Tropisternus sp.												
SUBTOTAL: Coleoptera	Mean No	5	SD	4	N=3		Mean No	Tr ^e	SD	--	N=3	
	Mean Wt	.033	SD	.032	N=3		Mean Wt	.003	SD	.005	N=3	
Diptera												
Ceratopogonidae spp.	8	.002	3	Tr	3	.001			1	Tr	3	.002
Chironomidae spp.	146	.188	124	.135	135	.184	123	.080	152	.096	159	.084
Chrysops sp.												
Culex sp.												
Helius sp.												
Sepsid sp.												
SUBTOTAL: Diptera	Mean No	140	SD	14	N=3		Mean No	146	SD	20	N=3	
	Mean Wt	.170	SD	.030	N=3		Mean Wt	.088	SD	.008	N=3	
Ephemeroptera												
Callibaetis sp.												
Caenis sp.	6	.011	4	.005	2	.002	8	.014			5	.006
SUBTOTAL: Ephemeroptera	Mean No	4	SD	2	N=3		Mean No	4	SD	4	N=3	
	Mean Wt	.006	SD	.005	N=3		Mean Wt	.007	SD	.007	N=3	
Hemiptera												
Belostoma sp.												
Corixidae spp.			1	.026								
Gerris sp.												
Hydrometra sp.												
Notonecta sp.												
Plea sp.	1	.002	1	.001	1	.002					1	.002
Ranatra sp.												
Trepobates sp.												
SUBTOTAL: Hemiptera	Mean No	1	SD	1	N=3		Mean No	Tr	SD	--	N=3	
	Mean Wt	.010	SD	.014	N=3		Mean Wt	.001	SD	.001	N=3	
Odonata												
Anisoptera												
Aeschna spp.	2	.468	3	.613					2	.471		
Anax spp.												
Basiaeschna sp.												
Boyeria sp.			1	Tr	2	.001						
Cordulia sp.												
Gomphus sp.												
Ladona sp.									2	.062	6	.786
Leucorrhinia spp.	1	.002	1	.002					3	.009	1	.050
Libellulidae ^c											2	.050
Tetragoneuria sp.												
Zygoptera												
Coenagrionidae ^c									1	.003		
Chromagrion sp.												
Enallagma spp.	3	.024	3	.043	1	.014	1	.012	8	.100	4	.034
Ischnura sp.	3	.084			3	.095			1	.030		
Lestes sp.			1	.001								
Nehalennia sp.												
SUBTOTAL: Odonata	Mean No	8	SD	2	N=3		Mean No	10	SD	8	N=3	
	Mean Wt	.450	SD	.297	N=3		Mean Wt	.536	SD	.470	N=3	
Megaloptera												
Chauliodes sp.												
Sialis sp.												
SUBTOTAL: Megaloptera	Mean No		SD		N=3		Mean No		SD		N=3	
	Mean Wt		SD		N=3		Mean Wt		SD		N=3	
Neuroptera												
Sisyra spp.	11	.008			7	.010						
SUBTOTAL: Neuroptera	Mean No	6	SD	6	N=3		Mean No		SD		N=3	
	Mean Wt	.006	SD	.005	N=3		Mean Wt		SD		N=3	

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for May 24, 1980.

TAXA	SITE									
	9-1		9-2		9-3		10-1		10-2	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
<u>Lepidoptera</u>										
<u>Parargyractis</u> sp.										
<u>Synclita</u> spp.										
SUBTOTAL:Lepidoptera	Mean No		SD		N=3		Mean No		SD	N=3
	Mean Wt		SD		N=3		Mean Wt		SD	N=3
<u>Trichoptera</u>										
<u>Banksiola</u> sp.										1 .029
<u>Ceraclea</u> sp.	14	.192			43	.698				
<u>Fabria</u> sp.										
<u>Glyphopsyche</u> sp.									4 .167	6 .382
<u>Limnephilus</u> spp.										
<u>Limniphilidae</u> *										
<u>Oecetis</u> spp.							18	.030	35	.038
<u>Oxyethira</u> sp.										61 .047
<u>Nemotaulius</u> sp.									1 .014	1 .021
<u>Nyctiophylax</u> sp.										
<u>Platycentropus</u> sp.	1	.102	1	.109					1 .096	
<u>Polycentropus</u> sp.	22	.052	4	.013	4	.014			11 .028	10 .022
<u>Ptilostomis</u> sp.										
<u>Triaenodes</u> sp.										
SUBTOTAL:Trichoptera	Mean No		30 SD		22 N=3		Mean No		50 SD	31 N=3
	Mean Wt		.464 SD		.241 N=3		Mean Wt		.292 SD	.240 N=3
<u>Crustacea</u>										
<u>Amphipoda</u>										
<u>Gammarus</u> sp.										2 .081
SUBTOTAL:Amphipoda	Mean No		SD		N=3		Mean No		SD	N=3
	Mean Wt		SD		N=3		Mean Wt		SD	N=3
<u>Decapoda</u>										
<u>Cambarus</u> sp.										
SUBTOTAL:Decapoda	Mean No		SD		N=3		Mean No		SD	N=3
	Mean Wt		SD		N=3		Mean Wt		SD	N=3
<u>Arachnoidea</u>										
<u>Hydracarina</u>	X		X				X			
<u>Mollusca</u>										
<u>Gastropoda</u>										
<u>Helisoma</u> sp.										
<u>Ferrissia</u> sp.	3	.012	2	.036	3	.012				
<u>Lymnaea</u> sp.										
<u>Pelecypoda</u>										
<u>Sphaerium</u> sp.							90	.341	92	.247
SUBTOTAL:Mollusca	Mean No		3 SD		1 N=3		Mean No		91 SD	1 N=3
	Mean Wt		.020 SD		.014 N=3		Mean Wt		.365 SD	.131 N=3
<u>Annelida</u>										
<u>Oligochaeta</u>	176	.018	222	.028	180	.023	75	.018	33	.008
SUBTOTAL:Oligochaeta	Mean No		193 SD		25 N=3		Mean No		41 SD	30 N=3
	Mean Wt		.023 SD		.005 N=3		Mean Wt		.023 SD	.019 N=3
<u>Hirudinea</u>										
<u>Erpobdella</u> sp.										
<u>Macrobdella</u> sp.										
<u>Nematoda</u>										
<u>Porifera</u>							2	.001		
<u>Spongilla</u> sp.	X		X		X					
TOTAL:All Organisms	Mean No		390 SD		9 N=3		Mean No		343 SD	26 N=3
	Mean Wt		1.182 SD		.101 N=3		Mean Wt		1.342 SD	.829 N=3

* Number of organisms per collection.

* Wet weight in grams per collection.

* Early instars.

* X = Present.

* Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for June 21, 1980.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda												
Insecta												
Collembola	X ^d		X		X		X				X	
Coleoptera												
<u>Donacia</u> sp.					1	.006						
<u>Gyrinus</u> sp.												
<u>Halipius</u> sp.	1	.003	2	.020							1	.008
Hydrophilidae sp.											1	.001
Hydroporus sp.												
<u>Iaccophilus</u> sp.												
<u>Tropisternus</u> sp.												
SUBTOTAL: Coleoptera	Mean No	1	SD	1	N=3		Mean No	1	SD	1	N=3	
	Mean Wt	.010	SD	.009	N=3		Mean Wt	.003	SD	.005	N=3	
Diptera												
Ceratopogonidae spp.	13	.006	14	.006	16	.008	23	.012	11	.006	6	.004
Chironomidae spp.	314	.116	213	.079	228	.084	691	.225	98	.030	110	.045
Chrysops sp.											1	.007
<u>Culex</u> sp.												
<u>Helius</u> sp.												
<u>Sepedon</u> sp.												
SUBTOTAL: Diptera	Mean No	266	SD	54	N=3		Mean No	313	SD	347	N=3	
	Mean Wt	.099	SD	.019	N=3		Mean Wt	.110	SD	.111	N=3	
Ephemeroptera												
<u>Callibaetis</u> sp.	3	.001	4	.007								
<u>Caenis</u> sp.	6	.012	7	.019	1	.003	10	.022			1	.004
SUBTOTAL: Ephemeroptera	Mean No	7	SD	5	N=3		Mean No	4	SD	6	N=3	
	Mean Wt	.014	SD	.012	N=3		Mean Wt	.009	SD	.012	N=3	
Hemiptera												
<u>Belostoma</u> sp.												
Corixidae spp.	1	.004	3	.017			1	.002				
<u>Gerris</u> sp.												
<u>Hydrometra</u> sp.	2	.004			3	.005						
<u>Notonecta</u> sp.												
<u>Plea</u> sp.					1	.002						
<u>Ranatra</u> sp.												
<u>Trepobates</u> sp.												
SUBTOTAL: Hemiptera	Mean No	3	SD	1	N=3		Mean No	Tr ^e	SD	--	N=3	
	Mean Wt	.010	SD	.006	N=3		Mean Wt	.001	SD	.001	N=3	
Odonata												
Anisoptera												
<u>Aeschna</u> spp.	1	.010	4	.042	1	.011	4	.022	2	.013	2	.511
<u>Anax</u> spp.											1	.291
<u>Basiaeschna</u> sp.												
<u>Boyeria</u> sp.												
<u>Cordulia</u> sp.												
<u>Gomphus</u> sp.							1	.178				
<u>Iadona</u> sp.											1	.082
<u>Leucorrhinia</u> spp.	6	.141	3	.023	4	.159	7	.082	2	.021	3	.053
Libellulidae ^c									2	.066		
<u>Tetragoneuria</u> sp.									1	.044		
Zygoptera												
Coenagrionidae ^c												
<u>Chromagrion</u> sp.							1	.011			1	.005
<u>Enallagma</u> spp.	2	.040	3	.072	2	.048	2	.044	4	.066	2	.027
<u>Ischnura</u> sp.					1	.018						
<u>Lestes</u> sp.							2	.002				
<u>Nehaliera</u> sp.									1	.018		
SUBTOTAL: Odonata	Mean No	9	SD	1	N=3		Mean No	13	SD	4	N=3	
	Mean Wt	.188	SD	.050	N=3		Mean Wt	.512	SD	.399	N=3	
Megaloptera												
<u>Chauliodes</u> sp.												
<u>Sialis</u> sp.							1	Tr				
SUBTOTAL: Megaloptera	Mean No		SD		N=3		Mean No	Tr	SD	--	N=3	
	Mean Wt		SD		N=3		Mean Wt	Tr	SD	--	N=3	
Neuroptera												
<u>Sisyra</u> spp.	50	.073	1	.002	1	.003						
SUBTOTAL: Neuroptera	Mean No	17	SD	28	N=3		Mean No		SD		N=3	
	Mean Wt	.026	SD	.041	N=3		Mean Wt		SD		N=3	

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for June 21, 1980.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera												
<u>Parargyractis</u> sp.			1	.007	1	.068						
<u>Synclita</u> spp.												
SUBTOTAL: Lepidoptera	Mean No	1	SD	1	N=3		Mean No		SD		N=3	
	Mean Wt	.025	SD	.037	N=3		Mean Wt		SD		N=3	
Trichoptera												
<u>Banksiola</u> sp.												
<u>Ceraclea</u> sp.												
<u>Fabria</u> sp.												
<u>Glyphopsyche</u> sp.											1	.108
<u>Limnephilus</u> spp.												
<u>Limnophilidae</u> ^c												
<u>Oecetis</u> spp.	1	.004	2	.003	1	.003	5	.010	1	.002	6	.014
<u>Oxyethira</u> sp.					2	.001						
<u>Nemotaulius</u> sp.												
<u>Nyctiophylax</u> sp.												
<u>Platycentropus</u> sp.							2	.200				
<u>Polycentropus</u> sp.	14	.119	2	.013	5	.028	1	.007	1	.009	1	.006
<u>Ptilostomis</u> spp.												
<u>Triaenodes</u> sp.					15	.030	4	.013				
SUBTOTAL: Trichoptera	Mean No	15	SD	4	N=3		Mean No	6	SD	3	N=3	
	Mean Wt	.071	SD	.045	N=3		Mean Wt	.119	SD	.103	N=3	
Crustacea												
Amphipoda												
<u>Gammarus</u> sp.							1	.001	12	.035	6	.006
SUBTOTAL: Amphipoda	Mean No		SD		N=3		Mean No	6	SD	6	N=3	
	Mean Wt		SD		N=3		Mean Wt	.014	SD	.018	N=3	
Decapoda												
<u>Cambarus</u> sp.									1	.032	1	.021
SUBTOTAL: Decapoda	Mean No		SD		N=3		Mean No	1	SD	1	N=3	
	Mean Wt		SD		N=3		Mean Wt	.018	SD	.016	N=3	
Arachnoidea												
<u>Hydracarina</u>	X		X		X		X					
Mollusca												
Gastropoda												
<u>Helisoma</u> sp.												
<u>Ferriissia</u> sp.			1	.002	3	.015					2	.008
<u>Lymnaea</u> sp.					3	.005						
Pelecypoda												
<u>Sphaerium</u> sp.							168	.669	44	.137	95	.406
SUBTOTAL: Mollusca	Mean No	2	SD	3	N=3		Mean No	133	SD	51	N=3	
	Mean Wt	.007	SD	.011	N=3		Mean Wt	.408	SD	.268	N=3	
Annelida												
<u>Oligochaeta</u>	669	.148	365	.073	205	.040	301	.069	60	.026	121	.059
SUBTOTAL: Oligochaeta	Mean No	413	SD	236	N=3		Mean No	161	SD	125	N=3	
	Mean Wt	.087	SD	.055	N=3		Mean Wt	.051	SD	.022	N=3	
Hirudinea												
<u>Erpobdella</u> sp.												
<u>Macrobdella</u> sp.												
Nematoda									1	Tr	1	Tr
Porifera												
<u>Spongilla</u> sp.	X		X		X							
TOTAL: All Organisms	Mean No	734	SD	311	N=3		Mean No	638	SD	534	N=3	
	Mean Wt	.537	SD	.134	N=3		Mean Wt	1.245	SD	.642	N=3	

^a Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for July 19, 1980.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda												
Insecta												
Collembola	X ^d		X		X		X		X			
Coleoptera												
<i>Donacia</i> sp.												
<i>Gyrinus</i> sp.												
<i>Halipus</i> sp.	4	.008	2	.004					1	.004	1	.010
Hydrophilidae sp.									1	.001		
<i>Hydroporus</i> sp.											1	.008
<i>Laccophilus</i> sp.												
<i>Tropisternus</i> sp.												
SUBTOTAL: Coleoptera	Mean No	2	SD	2	N=3		Mean No	1	SD	1	N=3	
	Mean Wt	.004	SD	.004	N=3		Mean Wt	.007	SD	.009	N=3	
Diptera												
Ceratopogonidae spp.	2	Tr ^e			2	Tr	2	Tr	3	.002	5	.002
Chironomidae spp.	105	.053	311	.111	213	.070	131	.077	136	.025	137	.048
Chrysops sp.									1	.002		
<i>Culex</i> sp.												
<i>Helius</i> sp.	1	.002							3	.001	1	Tr
<i>Sepedon</i> sp.												
SUBTOTAL: Diptera	Mean No	211	SD	102	N=3		Mean No	140	SD	6	N=3	
	Mean Wt	.079	SD	.029	N=3		Mean Wt	.052	SD	.024	N=3	
Ephemeroptera												
<i>Callibaetis</i> sp.	2	.002	4	.007	3	.002					1	.001
<i>Caenis</i> sp.	5	.009	14	.025	4	.005	8	.009	4	.002	8	.002
SUBTOTAL: Ephemeroptera	Mean No	11	SD	6	N=3		Mean No	7	SD	3	N=3	
	Mean Wt	.017	SD	.013	N=3		Mean Wt	.005	SD	.004	N=3	
Hemiptera												
<i>Belostoma</i> sp.												
Corixidae spp.					1	.001						
<i>Gerris</i> sp.												
<i>Hydrometra</i> sp.	1	.002	3	.003	5	.006						
<i>Notonecta</i> sp.												
<i>Plea</i> sp.			2	.002	5	.003	6	.006			1	.001
<i>Ranatra</i> sp.			1	.039	1	.024						
<i>Trepobates</i> sp.												
SUBTOTAL: Hemiptera	Mean No	6	SD	5	N=3		Mean No	2	SD	3	N=3	
	Mean Wt	.026	SD	.022	N=3		Mean Wt	.002	SD	.003	N=3	
Odonata												
Anisoptera												
<i>Aeschna</i> spp.	2	.079			1	.022			1	.031	1	.044
<i>Anax</i> spp.			1	.012					1	.017		
<i>Basiaeschna</i> sp.											1	.318
<i>Boyeria</i> sp.	2	.012					1	.002	1	.003	1	.002
<i>Cordulia</i> sp.												
<i>Gomphus</i> sp.												
<i>Iadona</i> sp.							2	.152	1	.125		
<i>Leucorrhinia</i> spp.	14	.427	38	1.656	42	1.014	2	.007	8	.461	8	.421
Libellulidae ^c	9	.027	5	.004	9	.018	6	.013			5	.004
<i>Tetragoneuria</i> sp.												
Zygoptera												
Coenagrionidae ^c					17	.010	1	.001			1	.001
<i>Chromagrion</i> sp.											1	.001
<i>Enallagma</i> spp.					21	.044	5	.018			2	.012
<i>Ischnura</i> sp.							1	.017			2	.032
<i>Lestes</i> sp.			1	.022								
<i>Nehalennia</i> sp.	2	.002	4	.001			1	Tr				
SUBTOTAL: Odonata	Mean No	56	SD	31	N=3		Mean No	18	SD	5	N=3	
	Mean Wt	1.117	SD	.575	N=3		Mean Wt	.561	SD	.320	N=3	
Megaloptera												
<i>Chauliodes</i> sp.					2	.013						
<i>Sialis</i> sp.							2	.003				
SUBTOTAL: Megaloptera	Mean No	1	SD	1	N=3		Mean No	1	SD	1	N=3	
	Mean Wt	.004	SD	.008	N=3		Mean Wt	.001	SD	.002	N=3	
Neuroptera												
<i>Sisyra</i> spp.	4	.006										
SUBTOTAL: Neuroptera	Mean No	1	SD	2	N=3		Mean No		SD		N=3	
	Mean Wt	.002	SD	.003	N=3		Mean Wt		SD		N=3	

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for July 19, 1980.

TAXA	SITE									
	9-1		9-2		9-3		10-1		10-2	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera										
<u>Parargyractis</u> sp.	1	.007	2	.001						
<u>Synchlita</u> spp.										
SUBTOTAL:Lepidoptera	Mean No	1	SD	1	N=3		Mean No	SD	N=3	
	Mean Wt	.003	SD	.004	N=3		Mean Wt	SD	N=3	
Trichoptera										
<u>Banksiola</u> sp.										
<u>Ceraclea</u> sp.	5	.043					1	Tr		
<u>Fabria</u> sp.							1	.009		
<u>Glyphopsyche</u> sp.										
<u>Limnephilus</u> spp.										
<u>Limnophilidae</u> ^c										
<u>Oecetis</u> spp.									2	.002
<u>Oxyethira</u> sp.	4	.002	7	.002	7	.002	2	.001	2	.001
<u>Nemotaulius</u> sp.										
<u>Nyctiophylax</u> sp.										
<u>Platycentropus</u> sp.										
<u>Polycentropus</u> sp.	7	.014	13	.014	3	.009				
<u>Ptilostomis</u> spp.			1	Tr						
<u>Triadenodes</u> sp.										
SUBTOTAL:Trichoptera	Mean No	16	SD	6	N=3		Mean No	3	SD	1
	Mean Wt	.029	SD	.026	N=3		Mean Wt	.004	SD	.005
Crustacea										
Amphipoda										
<u>Gammarus</u> sp.									8	.017
									6	.012
SUBTOTAL:Amphipoda	Mean No		SD		N=3		Mean No	5	SD	4
	Mean Wt		SD		N=3		Mean Wt	.010	SD	.009
Decapoda										
<u>Cambarus</u> sp.										
SUBTOTAL:Decapoda	Mean No		SD		N=3		Mean No		SD	
	Mean Wt		SD		N=3		Mean Wt		SD	
Arachnoidea										
Hydracarina	X		X		X					
Mollusca										
Gastropoda										
<u>Helisoma</u> sp.									1	Tr
<u>Ferussia</u> sp.	3	.002	10	.013	9	.012			1	.015
<u>Lymnaea</u> sp.	9	.069	18	.195	26	.187	4	.047		
Pelecypoda										
<u>Sphaerium</u> sp.					2	.014	130	.806	53	.272
									76	.451
SUBTOTAL:Mollusca	Mean No	26	SD	13	N=3		Mean No	89	SD	41
	Mean Wt	.164	SD	.080	N=3		Mean Wt	.535	SD	.289
Annelida										
Oligochaeta	36	.010	50	.008	55	.009	87	.033	40	.029
									50	.024
SUBTOTAL:Oligochaeta	Mean No	47	SD	10	N=3		Mean No	59	SD	25
	Mean Wt	.009	SD	.001	N=3		Mean Wt	.029	SD	.004
Hirudinea										
<u>Erpobdella</u> sp.										
<u>Macrobdella</u> sp.										
Nematoda										
Porifera										
<u>Spongilla</u> sp.	X		X		X					
TOTAL:All Organisms	Mean No	378	SD	141	N=3		Mean No	325	SD	65
	Mean Wt	1.454	SD	.672	N=3		Mean Wt	1.206	SD	.202

^a Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for August 9, 1980.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda												
Insecta												
Collembola	X ^d		X		X		X				X	
Coleoptera												
<u>Donacia</u> sp.												
<u>Gyrinus</u> sp.												
<u>Haliphus</u> sp.	3	.014	1	.002							1	.002
Hydrophilidae sp.											1	.087
Hydroporus sp.									1	.006	1	.038
Laccophilus sp.												
Tropisternus sp.												
SUBTOTAL: Coleoptera	Mean No	1	SD	2	N=3		Mean No	1	SD	2	N=3	
	Mean Wt	.005	SD	.008	N=3		Mean Wt	.045	SD	.072	N=3	
Diptera												
Ceratopogonidae spp.	22	.005	6	.001	13	.004	5	.002	8	.002	1	.001
Chironomidae spp.	310	.080	415	.140	239	.059	231	.153	69	.025	64	.020
Chrysops sp.							1	.034				
Culex sp.												
Helius sp.												
Sepsid sp.												
SUBTOTAL: Diptera	Mean No	335	SD	84	N=3		Mean No	126	SD	96	N=3	
	Mean Wt	.097	SD	.040	N=3		Mean Wt	.079	SD	.096	N=3	
Ephemeroptera												
Callibaetis sp.	1	.001	3	.010	3	.007	3	.007				
Caenis sp.	3	.004	6	.008	4	.003	9	.008	5	.009	7	.010
SUBTOTAL: Ephemeroptera	Mean No	7	SD	2	N=3		Mean No	8	SD	4	N=3	
	Mean Wt	.011	SD	.006	N=3		Mean Wt	.011	SD	.003	N=3	
Hemiptera												
Belostoma sp.												
Corixidae spp.							1	.007				
Gerris sp.												
Hydrometra sp.												
Notonecta sp.					1	.016						
Plea sp.	3	.003	4	.004	5	.008	2	.003				
Ranatra sp.												
Trepobates sp.												
SUBTOTAL: Hemiptera	Mean No	4	SD	2	N=3		Mean No	1	SD	2	N=3	
	Mean Wt	.010	SD	.012	N=3		Mean Wt	.003	SD	.006	N=3	
Odonata												
Anisoptera												
Aeschna spp.			1	.072	1	.051	1	.052	5	.773	6	.290
Anax spp.												
Basiaeschna sp.												
Boyeria sp.												
Cordulia sp.												
Gomphus sp.							1	Tr ^e			2	.005
Iadon sp.							2	.076	6	.741		
Leucorrhinia spp.	20	.431	16	.396	50	.980	3	.023	3	.173	2	.136
Libellulidae ^c	5	.032	5	.022	3	.031	12	.025	11	.033	3	.007
Tetragoneuria sp.			1	.028	1	.033	2	.144				
Zygoptera												
Coenagrionidae ^c	5	.007	9	.012	22	.014	1	.001			3	.002
Chromagrion sp.									1	.016		
Enallagma spp.	4	.020	1	.004	39	.06	1	.001			2	.006
Ischnura sp.												
Lestes sp.							1	.005				
Nehalienia sp.	1	Tr	1	Tr					1	Tr		
SUBTOTAL: Odonata	Mean No	62	SD	47	N=3		Mean No	23	SD	5	N=3	
	Mean Wt	.733	SD	.384	N=3		Mean Wt	.836	SD	.781	N=3	
Megaloptera												
Chauliodes sp.												
Sialis sp.							4	.039			3	.009
SUBTOTAL: Megaloptera	Mean No		SD		N=3		Mean No	2	SD	2	N=3	
	Mean Wt		SD		N=3		Mean Wt	.016	SD	.020	N=3	
Neuroptera												
Sisyra spp.												
SUBTOTAL: Neuroptera	Mean No		SD		N=3		Mean No		SD		N=3	
	Mean Wt		SD		N=3		Mean Wt		SD		N=3	

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for August 9, 1980.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera											2	.002
<u>Parargyractis</u> sp.												
<u>Synclita</u> spp.												
SUBTOTAL: Lepidoptera	Mean No		SD		N=3		Mean No		1	SD	1	N=3
	Mean Wt		SD		N=3		Mean Wt	.001	SD	.001	N=3	
Trichoptera									1	.003		
<u>Banksiola</u> sp.												
<u>Ceraclea</u> sp.												
<u>Fabria</u> sp.												
<u>Glyphopsyche</u> sp.												
<u>Limnephilus</u> spp.			3	.001							1	Tr
<u>Limnophilidae</u> ^c							5	.001	1	Tr		
<u>Oecetis</u> spp.					2	.001						
<u>Oxyethira</u> sp.	4	.001	3	.002								
<u>Nemotaulius</u> sp.												
<u>Nyctiophylax</u> sp.												
<u>Platycentropus</u> sp.			5	.002	4	.002						
<u>Polycentropus</u> sp.	12	.008	1	Tr					1	.001	5	.003
<u>Ptilostomis</u> spp.												
<u>Triadenodes</u> sp.												
SUBTOTAL: Trichoptera	Mean No	11	SD	5	N=3		Mean No	5	SD	2	N=3	
	Mean Wt	.006	SD	.003	N=3		Mean Wt	.003	SD	.002	N=3	
Crustacea												
Amphipoda									3	.019	7	.032
<u>Gammarus</u> sp.												
SUBTOTAL: Amphipoda	Mean No		SD		N=3		Mean No	3	SD	4	N=3	
	Mean Wt		SD		N=3		Mean Wt	.017	SD	.016	N=3	
Decapoda												
<u>Cambarus</u> sp.												
SUBTOTAL: Decapoda	Mean No		SD		N=3		Mean No		SD		N=3	
	Mean Wt		SD		N=3		Mean Wt		SD		N=3	
Arachnoidea												
Hydracarina	X		X		X				X			
Mollusca												
Gastropoda												
<u>Helisoma</u> sp.			6	.040								
<u>Ferriassia</u> sp.	13	.011	25	.013	5	.032	1	.001			1	.001
<u>Lymnaea</u> sp.	9	.031	36	.030	11	.010	6	.065	1	.004	3	.004
Pelecypoda												
<u>Sphaerium</u> sp.	1	.012			2	.052	61	.333	96	.602	63	.310
SUBTOTAL: Mollusca	Mean No	36	SD	27	N=3		Mean No	77	SD	17	N=3	
	Mean Wt	.077	SD	.021	N=3		Mean Wt	.440	SD	.150	N=3	
Annelida												
Oligochaeta	49	.005	21	.003	58	.008	38	.006	44	.063	19	.021
SUBTOTAL: Oligochaeta	Mean No	43	SD	19	N=3		Mean No	35	SD	14	N=3	
	Mean Wt	.005	SD	.002	N=3		Mean Wt	.181	SD	.158	N=3	
Nemertea												
<u>Probdella</u> sp.									3	.162		
<u>Macrobdella</u> sp.											1	.292
Nematoda												
Porifera												
<u>Spongilla</u> sp.	X		X		X							
TOTAL: All Organisms	Mean No	499	SD	61	N=3		Mean No	282	SD	98	N=3	
	Mean Wt	.944	SD	.381	N=3		Mean Wt	1.632	SD	.878	N=3	

^a Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for September 12, 1980.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No ^a	Wt ^b	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Arthropoda												
Insecta												
Collembola	X ^d		X		X				X			
Coleoptera												
<u>Donacia</u> sp.												
<u>Gyrinus</u> sp.												
<u>Haliphus</u> sp.	2	.008	1	.003					3	.010		
Hydrophilidae sp.												
Hydroporus sp.												
<u>Laccophilus</u> sp.												
<u>Tropisternus</u> sp.												
SUBTOTAL: Coleoptera	Mean No	1 SD	1 SD	N=3	Mean No	1 SD	2 N=3					
	Mean Wt	.004 SD	.004 SD	N=3	Mean Wt	.003 SD	.006 N=3					
Diptera												
Ceratopogonidae spp.	32	.005	4	.001	1	.001	13	.001	41	.006	28	.006
Chironomidae spp.	276	.076	218	.081	183	.046	411	.082	306	.050	265	.043
<u>Chrysops</u> sp.												
<u>Culex</u> sp.												
<u>Helius</u> sp.	1	Tr ^e										
<u>Sepedon</u> sp.												
SUBTOTAL: Diptera	Mean No	238 SD	64 SD	N=3	Mean No	355 SD	66 N=3					
	Mean Wt	.070 SD	.020 SD	N=3	Mean Wt	.063 SD	.018 N=3					
Ephemeroptera												
<u>Callibaetis</u> sp.	2	.002	3	.007	1	.001						
<u>Gaenis</u> sp.	9	.002	17	.006	27	.009	24	.004	29	.009	41	.014
SUBTOTAL: Ephemeroptera	Mean No	20 SD	8 SD	N=3	Mean No	31 SD	9 N=3					
	Mean Wt	.009 SD	.004 SD	N=3	Mean Wt	.009 SD	.005 N=3					
Hemiptera												
<u>Belostoma</u> sp.					1	.013						
Corixidae spp.	1	.005	2	.017								
<u>Gerris</u> sp.												
<u>Hydrometra</u> sp.	1	.001	2	.001	1	Tr						
<u>Notonecta</u> sp.												
<u>Plea</u> sp.	1	.001	5	.006	8	.013			2	.002	1	.001
<u>Ranatra</u> sp.												
<u>Trepobates</u> sp.												
SUBTOTAL: Hemiptera	Mean No	7 SD	4 SD	N=3	Mean No	1 SD	1 N=3					
	Mean Wt	.019 SD	.010 SD	N=3	Mean Wt	.001 SD	.001 N=3					
Odonata												
Anisoptera												
<u>Aeschna</u> spp.	1	.064	2	.180					2	.127	1	.073
<u>Anax</u> spp.									4	.066	2	1.123
<u>Basiaeschna</u> sp.												
<u>Boyeria</u> sp.							2	.001				
<u>Cordulia</u> sp.												
<u>Gomphus</u> sp.												
<u>Ladona</u> sp.									3	.008	2	.005
<u>Leucorrhinia</u> spp.	23	.427	26	.253	14	.084	18	.214	3	.035	6	.010
Libellulidae ^c	4	.045	5	.057	5	.023	6	.013	2	.014	4	.007
<u>Tetragoneuria</u> sp.			1	.167					1	.042	3	.504
Zygoptera												
Coenagrionidae ^c	3	.004	8	.007	21	.026	26	.033	9	.010	12	.013
<u>Chromagrion</u> sp.							1	.006				
<u>Enallagma</u> spp.	5	.020	2	.006	40	.13	13	.052	4	.013	7	.024
<u>Ischnura</u> sp.											1	.007
<u>Lestes</u> sp.							1	.005				
<u>Nehalennia</u> sp.	1	Tr			1	.001			1	Tr		
SUBTOTAL: Odonata	Mean No	54 SD	24 SD	N=3	Mean No	45 SD	20 N=3					
	Mean Wt	.498 SD	.209 SD	N=3	Mean Wt	.802 SD	.835 N=3					
Megaloptera												
<u>Chauliodes</u> sp.	2	.025										
<u>Sialis</u> sp.							4	.019				
SUBTOTAL: Megaloptera	Mean No	1 SD	1 SD	N=3	Mean No	1 SD	2 N=3					
	Mean Wt	.008 SD	.014 SD	N=3	Mean Wt	.006 SD	.011 N=3					
Neuroptera												
<u>Sisyra</u> spp.	5	.006	1	.001	3	.003						
SUBTOTAL: Neuroptera	Mean No	3 SD	2 SD	N=3	Mean No	SD	N=3					
	Mean Wt	.003 SD	.002 SD	N=3	Mean Wt	SD	N=3					

Appendix N continued. Dominant aquatic macroinvertebrate aufwuchs numbers and biomass in Weso Lake for September 12, 1980.

TAXA	SITE											
	9-1		9-2		9-3		10-1		10-2		10-3	
	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
Lepidoptera												
Parargyractis sp.												
Synclita spp.			2	.001								
SUBTOTAL: Lepidoptera	Mean No		1	SD	1	N=3	Mean No		SD		N=3	
	Mean Wt		Tr	SD	--	N=3	Mean Wt		SD		N=3	
Trichoptera												
Banksiola sp.												
Ceraclea sp.												
Fabria sp.			1	Tr	4	.001	3	.001	3	.003	2	.001
Glyphopsyche sp.												
Limnephilus spp.												
Limniphilidae ^c	7	.001	22	.005	26	.006	3	.001	7	.001	12	.004
Oecetis spp.							22	.008	15	.003	31	.011
Oxyethira sp.	6	.002	2	.001	1	.001	4	.002				
Nemotaulius sp.	4	.028	19	.064	16	.042	2	.003	2	.003	9	.016
Nyctiorhylax sp.												
Platycentropus sp.												
Polycentropus sp.	17	.008	26	.009	30	.009	7	.002	3	.002	16	.007
Ptilostomis spp.			2	.004	3	.011	4	.002	6	.004	8	.043
Triaenodes sp.												
SUBTOTAL: Trichoptera	Mean No		62	SD	25	N=3	Mean No		53	SD	22	N=3
	Mean Wt		.064	SD	.023	N=3	Mean Wt		.038	SD	.038	N=3
Crustacea												
Amphipoda												
Gammarus sp.									7	.036	8	.067
SUBTOTAL: Amphipoda	Mean No			SD		N=3	Mean No		5	SD	4	N=3
	Mean Wt			SD		N=3	Mean Wt		.034	SD	.034	N=3
Decapoda												
Cambarus sp.												
SUBTOTAL: Decapoda	Mean No			SD		N=3	Mean No			SD		N=3
	Mean Wt			SD		N=3	Mean Wt			SD		N=3
Arachnoidea												
Hydracarina	X		X		X							
Mollusca												
Gastropoda												
Helisoma sp.									1	.007		
Ferrissia sp.	12	.010	21	.018	5	.004	7	.008	3	.004	6	.008
Lymnaea sp.	9	.006	39	.045	70	.054	15	.034	11	.047	19	.050
Pelecypoda												
Sphaerium sp.					2	.021	47	.214	66	.216	52	.248
SUBTOTAL: Mollusca	Mean No		56	SD	23	N=3	Mean No		76	SD	6	N=3
	Mean Wt		.053	SD	.033	N=3	Mean Wt		.278	SD	.025	N=3
Annelida												
Oligochaeta	76	.013	58	.008	114	.015	32	.012	12	.001	35	.003
SUBTOTAL: Oligochaeta	Mean No		83	SD	29	N=3	Mean No		26	SD	12	N=3
	Mean Wt		.012	SD	.004	N=3	Mean Wt		.005	SD	.006	N=3
Hirudinea												
Erpobdella sp.												
Macrobdella sp.												
Nematoda												
Porifera												
Spongilla sp.	X		X		X							
TOTAL: All Organisms	Mean No		526	SD	46	N=3	Mean No		594	SD	63	N=3
	Mean Wt		.740	SD	.218	N=3	Mean Wt		1.239	SD	.907	N=3

^a Number of organisms per collection.

^b Wet weight in grams per collection.

^c Early instars.

^d X = Present.

^e Tr = Trace (<.001g).

Appendix O. Results of analyses of variance of dominant macroinvertebrate aufwuchs density, biomass, and number of taxa in Weso Lake with site, sampling date, and year as factors.

Variable	Calculated F Value		
	Year (d.f.=1,4)	Month (d.f.=4,16)	Site (d.f.=1,4)
Total Organisms			
Density	.62	3.20*	.02
Biomass	.08	4.63*	.92
Taxa	98.58**	136.41**	94.51**
Total Organisms (excluding Mollusca)			
Density	1.71	3.43*	.82
Biomass	.78	7.51*	.19
Taxa	.60	18.48**	2.16
Diptera			
Density	1.21	.86	.23
Biomass	.52	4.18*	.91
Taxa	.55	1.12	.22
Ephemeroptera			
Density	9.68*	14.46**	.48
Biomass	13.12*	2.62	.01
Taxa	.40	1.22	1.18
Odonata			
Density	5.57	18.24**	.02
Biomass	.28	2.10	2.37
Taxa	.01	10.27**	24.84*
Trichoptera			
Density	5.94	27.38**	15.38*
Biomass	3.53	23.05**	.67
Taxa	145.21**	11.19**	5.12
Mollusca			
Density	46.68*	12.38**	34.91*
Biomass	90.37**	6.31*	34.33*
Taxa	.21	6.19*	9.15*
Oligochaeta			
Density	1.77	8.42**	659.55**
Biomass	14.03*	5.08*	39.87*
Taxa	No Test	No Test	No Test

* P<0.05.

** P<0.001.

Appendix P. Fish survey data for Weso Lake. Weights expressed in grams.

Dates: VI-14-1979 through VI-21-1979

Method of Capture: Funnel Traps

Total Hours Set: 168

Species	Total Number	Fish/24 hr	Total Weight	Percent of Grand Total Number	Percent of Grand Total Weight
Black Bullhead	63	9.0	3411	69.23	71.48
Pumpkinseed	16	2.2	910	17.58	19.07
Green Sunfish	9	1.3	408	9.89	8.55
Black Crappie	2	0.3	39	2.20	0.82
Central Mudminnow	1	0.1	4	1.10	0.08
Grand Total	91	12.9	4772	100.00	100.00

Dates: VI-14-1979 through VI-21-1979

Method of Capture: Hook-and-Line

Total Effort: 12.5 hr

Species	Total Number	Fish/24 hr	Total Weight	Percent of Grand Total Number	Percent of Grand Total Weight
Black Crappie	40	3.2	4483	100.00	100.00
Grand Total	40	3.2	4483	100.00	100.00

Dates: VIII-07-1979 through VIII-11-1979

Method of Capture: Funnel Traps

Total Hours Set: 96

Species	Total Number	Fish/24 hr	Total Weight	Percent of Grand Total Number	Percent of Grand Total Weight
Black Bullhead	10	2.5	411	52.63	43.91
Pumpkinseed	6	1.5	373	31.58	39.85
Green Sunfish	3	0.8	152	15.79	16.24
Grand Total	19	4.8	936	100.00	100.00

Appendix P continued. Fish survey data for Weso Lake.
Weights expressed in grams.

Dates: VI-21-1980 through VI-25-1980

Method of Capture: Funnel Traps

Total Hours Set: 96

Species	Total Number	Fish/24 hr	Total Weight	Percent of Grand Total Number	Percent of Grand Total Weight
Pumpkinseed	15	3.8	528	78.95	64.23
Green Sunfish	4	1.0	294	21.05	35.77
Grand Total	19	4.8	822	100.00	100.00

Dates: VI-21-1980 through VI-25-1980

Method of Capture: Hook-and-Line

Total Effort: 9 hr

Species	Total Number	Fish/24 hr	Total Weight	Percent of Grand Total Number	Percent of Grand Total Weight
Black Crappie	34	3.7	2747	100.00	100.00
Grand Total	34	3.7	2747	100.00	100.00

Dates: VIII-09-1980 through VIII-10-1980

Method of Capture: Minnow traps

Total Hours Set: 24

Species	Total Number	Fish/24 hr	Total Weight	Percent of Grand Total Number	Percent of Grand Total Weight
Black Bullhead	55	55	-- ^a	57.29	--
Pumpkinseed	41	41	-- ^a	42.71	--
Grand Total	96	96	--	100.00	--

^a Young-of-the-year; no weights taken.

