1978-1979 ANNUAL REPORT
BAILLY NUCLEAR-1 SITE
ENCOMPASSING
APRIL 1978 - MARCH 1979

JUNE 1979

Prepared for

NORTHERN INDIANA
PUBLIC SERVICE COMPANY
5265 Hohman Avenue
Hammond, Indiana 46325

by

TEXAS INSTRUMENTS INCORPORATED
ECOLOGICAL SERVICES

P.O. Box 225621
Dallas, Texas 75265

579066

7907130044

1978-1979 ANNUAL REPORT BAILLY NUCLEAR-1 SITE
ENCOMPASSING APRIL 1978-MARCH 1979

June 1979

7907130044

Prepared for

NORTHERN INDIANA PUBLIC SERVICE COMPANY
5265 Hohman Avenue
Hammond, Indiana 46325

Prepared by

TEXAS INSTRUMENTS INCORPORATED
ECOLOGICAL SERVICES
P.O. Box 225621
Dallas, Texas 75265

579067

SUMMARY AND CONCLUSIONS

Terrestrial

The summer sampling program was accomplished on schedule during July 1978. Sampling included analysis of foliar effects, vegetation analysis, mammal observations, roadside surveys (mammals and birds), reptile and amphibian surveys, invertebrate surveys, and soil sample analysis.

Vegetation and Soils. Vegetation sampling results were consistent with past years. Revegetation in the beachgrass community continued to improve in the area which was burned in 1976. Other sampling locations showed little change other than normal plant succession.

Foliar conditions of white pine appeared to be improving, and the large cottonwood that appeared stressed during 1977 seemed healthy in July 1978. Herbicide application to vegetation along the transmission right-of-way during July 1978 caused defoliation of numerous broad-leafed plants and severely restricted the growth of blackberry plants adjacent to the sampling plots. Additionally, woody species were cut and allowed to remain in the transmission right-of-way, and several trees were cut along the southern bounda , of the maple forest.

Soil conductivity levels were well below potential stress levels, although the foredune samples had higher conductivity levels in May 1978 than in previous years.

Mammals. Seventeen species of mammals were reported from the Bailly Study Area during 1978. Small mammal trapping results throughout the year were most comparable to those of 1977, with significant increases in catches from May to October. Capture rates were low during May, with no captures in the beachgrass or immature oak sampling locales at that time. These data indicated that small mammals in sampling locations away from the lakefront, although low, apparently were not drastically affected by the severe winter of 1977-78.

Generally, larger mammals were as well-distributed on the site during 1978 as during past years. Although few sightings were recorded, signs indicated

substantial large mammal activity in most sampling locales. The gray squirrel, however, was not sighted during 1978, and only two observations of the muskrat occurred. The gray squirrel apparently is rare on the site, but the muskrat appears to be declining from a larger population in the past.

Birds. During 1978 a total of 130 species of birds was reported from the Bailly Study Area. This number is comparable to those of past years.

During October, waterfowl, especially ducks, were common on most of the major water bodies, and gulls were abundant near the Bailly discharge canal and along the lakefront. During each season, the numbers of individuals of the more commonly sighted passerine species generally were up slightly from the previous year. Warblers were the most abundant group of passerines observed during May sampling, while blackbirds were the most numerous group during October. No new bird species were sighted.

Amphibians and Reptiles. Thirteen species (eight amphibians and five reptiles) were reported from the Bailly Study Area during 1978. During May, 11 species were observed, while only 6 species were observed during July. Frogs were the most numerous amphibian group, while turtles were the most abundant reptile group. Reptiles were generally more scarce during 1978 than during past years.

Invertebrates. Conditions for sampling insects at the Bailly Study Area in July 1978 were improved substantially from the previous year, although defoliation in the transmission corridor may have affected sweepnet captures from that location. With re-establishment of the pool in sampling location 2 and sufficient standing water in the wet woods of Cowles Bog, the full complement of samples was taken; and, most importantly for the sampling results, weather conditions prior to and during sampling were more typical for the season than during the previous year. The number of insect families observed (140) was comparable to those observed in summers of 1975 and 1976 and considerably more than collected during the dry, cool sampling period of 1977. Five insect families were newly recorded.

579069

Aquatic

Aquatic sampling was conducted during April, June, August, and November 1978 and January 1979. Phytoplankton, periphyton, zooplankton, benthos, macrophytes, fishery, water quality, and sediment particle size samples were collected and analyzed.

Aquatic Flora. Mean phytoplankton density was higher, although not significantly higher at $p \leq 0.05$, in Lake Michigan in 1978 than in any previous year (i.e., 1974, 1975, 1976 or 1977). Phytoplankton biovolume followed the changes in density, although not at the same fast rate, implying species compositional change from early years in the study. Blue-green algae continued to be numerically dominant in fall 1978 sampling.

Mean phytoplankton densities in the interdunal ponds were comparable to those recorded for previous years, with no apparent consistent change in density over time. The biovolume peak observed in August 1977 was higher than any other mean value (with the exception of a June 1976 value caused by a "clump" of algal cells in one sample). The high 1978 biovolume occurred in April.

Comparing dominant algal forms with dominant forms from previous years indicated annual continuity, although considerable variability was evident among less common forms. Eutrophication indices denote a change in Lake Michigan flora to more tolerant forms; however, no major changes in eutrophication indices were observed in the interdunal ponds.

Phytoplankton chlorophyll a and productivity levels mirror biovolume fluctuations, particularly in the interdunal ponds, although there was no exact correspondence of biovolume with the other two parameters. Successional changes throughout the sampling year and between years affect chlorophyll and productivity values.

As in previous years, 1978 periphyton data revealed similar abundance and distributional patterns. Periphyton distribution was affected by the presence of heated water and nutrients. The presence of the thermointolerant taxon Rhoicosphenia curvata defined the effective extent of plume influence. The genera Eunotia and Pinnularia, which were collected primarily in the interdunal ponds, may be considered eurytopic or eutrophic indicators.

Zooplankton. Changes observed in the zooplankton community over the past five years were due primarily to periodic occurrences of uncommon species, principally of cladocerans and copepods. Seasonal density distributions in 1978, compared with previous years, indicated essentially unimodal patterns from year to year. Density maxima were higher in 1978 than any previous year of this study. Seasonal succession patterns in 1978 Lake Michigan zooplankton similar to previous years are displayed by the dominance of diaptomid copepods in the spring, bosminid cladocerans in the summer and cyclopoid copepodids in November. As in previous years, the relatively stable community structure in the lake suggests only negligible influence of plant operation on Lake Michigan's major zooplankton components.

Zooplankton communities in the ponds over the past five years reflect the more unstable conditions prevalent within this system; densities have been variable since 1974. Periods of peak bosminid occurrence have decreased compared to previous years; concurrently, cyclopoid copepods and chydorid cladocerans have steadily increased in percent composition since 1974, while calanoid copepod percent composition has declined noticeably over the same period. Such trends are described in the literature as indiciative of increased eutrophication. As in previous years, 1978 pond zooplankton abundance was significantly higher than that recorded in the lake; generally, abundance peaked in November (ponds only) and in August in Cowles Bog.

The degree to which plant operation may influence pond community dynamics cannot be assessed. However, trends similar to those described above have been found in the literature, suggesting that the major community component shifts may be a natural limnological process.

Benthos. Benthic density in Lake Michigan increased from April through August as in previous years but did not show the general decline in November. Depth-related density variations were also observed in 1978 in that density generally increased with depth. Little or no difference in seasonal density distribution was indicated between near-field and far-field stations although densities at Station 10 (discharge) were considerably lower than at other stations. Overall density pattern during 1978 was very similar to that observed in 1976. A seasonal succession pattern in the lake was characterized by an April dominance of

tubificids with chironomids and tubificids co-dominant in June and August. Tubificids alone were dominant in November. The basic community components and successional patterns of 1978 were consistent with those of previous years. A trend of declining relative abundance of amphipods was continued in 1978. Data indicated that while plant operation may exert a negative influence in the immediate vicinity of the discharge, no discernible deleterious effects of plant operation on Lake Michigan outside the area of the discharge are obvious.

Density of benthos in nearshore ponds was characterized by an April to August decline with a subsequent increase in November. Cowles Bog generally displayed the highest densities within this pond system. The steady decline of benthic densities in the pond system since 1975, most pronounced in the bog and Pond B, was not continued during 1978. Total densities have been relatively similar since 1976. Pond benthic fauna during 1977 was dominated throughout the year by tubificid worms, which was not the case during 1978. Tubificids were not dominant or even second most numerous during 1978. Chironomids were dominant during April, bivalves in June, and naidids in November.

A comparison of 1978 data with that of previous years indicates 1977 was atypical with diminishing dominance of naidids and their replacement by tubificids, whose growth and colonization can be attributed to increased clay deposits.

Aquatic Macrophytes. Composition of aquatic macrophyte communities sampled in June 1978 was generally similar to that of previous years. The dominant and/or common species were bullhead lily, bladderwort, watermilfoil and pondweed. Areas along the edges of Ponds B and C and throughout Cowles Bog were characterized, as in previous years, by a predominance of emergent species. Some factor other than natural variation may be influencing the dominant macrophyte species in Pond B since the dominant macrophyte in the pond has usually been different each year of the study.

Fisheries. The 1978 yield in fisheries sampling was distributed among 12 species. Alewife was dominant in gill net samples, while spottail shiner was dominant in samples collected by beach seine. Electrofishing in Pond B yielded 22 black bullheads. Ichthyoplankton collections were comprised of alewife and cyprinid eggs and alewife and percid (yellow perch or johnny darter) larvae. All species collected in 1978 have been reported in previous collections, and

no major change in fish species composition was found in samples from the Bailly Study Area. Spawning in the area apparently is confined primarily to alewives and cyprinids. Condition of the collected fish was normal, and no external parasites were noted on salmonids collected during 1978. No potential disruption of rare or endangered species was noted.

Water Quality. Water quality values in both Lake Michigan and the interdunal ponds were similar to those from previous years. Virtually all values in Lake Michigan were well within applicable Indiana Stream Pollution Control Board (ISPCB) standards. One exception was pH, which was slightly more alkaline than ISPCB standards for Lake Michigan, but was well within normal tolerance limits for resident biota. There was more variability of water quality values in the near-shore ponds than in Lake Michigan, as was the case in previous years. Highest variability and concentrations were generally in ash settling ponds. Pond B values were lower than those of the ash ponds but appeared to reflect some seepage from the ash ponds, as Pond C concentrations were generally lower than those of Pond B. A trend of increasing sulfate concentrations since 1974 was noted in Pond B. Although some indication of increasing sulfate levels was also observed in the ash settling ponds, the relationship between concentrations in the two ponds is not clear. Silica levels in Lake Michigan have been observed to be decreasing slightly over time, a condition also noted in other portions of Lake Michigan.

An examination of 1978 phytoplankton data indicates that this depletion may be one factor in the shift from a diatom-dominant fall population to a green/blue-green dominant fall population. In general, observations of silica, phosphorus, and nitrogen indicate that the nutrient levels of southern Lake Michigan waters are comparable, with the exception of silica, with previous years; even with the lower silica levels, the lake should support a diverse aquatic community.

Trace elements in both water and sediment, and indicators of industrial or organic contamination were monitored only in the ash settling and interdunal ponds. Trace element surveys revealed no consistent trends, but rather constant fluctuations of all values. The observed high and low values, considering the scattered nature of the high values, may indicate a normal pond cycle. High iron levels in all the ponds observed during 1976 and 1977 were not observed during 1978.

579072

Total and fecal coliform levels in the ponds were also examined and values found quite variable. Highest values in natural ponds were found during August 1978 and appear correlated with warm-water temperatures. Biochemical oxygen demand, total organic carbon, and chemical oxygen demand levels were reasonably low, with variations during the study apparently seasonally related. The remaining parameters (hexane soluble materials, phenols, and methylene blue active substances) were below or, in the case of phenols in April, slightly above detection limits.

From the composite data, it appears that the biota and chemical parameters in the NIPSCo Bailly Study Area show natural variability from year to year.

With the exception of Pond B, into which some seepage may be occurring, and Station 10, which is influenced by the discharge, there is no indication that Bailly Station operation has a significant effect on the biota or water quality.

TABLE OF CONTENTS

579074

TABLE OF CONTENTS (CONTD)

579075

TABLE OF CONTENTS (CONTD)

TABLE OF CONTENTS (CONTD)

APPENDIXES

579077

ILLUSTRATIONS

ILLUSTRATIONS (CONTD)

579079

ILLUSTRATIONS (CONTD)

579080

TABLES

579081

TABLES (CONTD)

TABLES (CONTD)

579083

TABLES (CONTD)

TABLES (CONTD)

579085

TABLES (CONTD)

SECTION 1
TERRESTRIAL ECOLOGY

1.1 INTRODUCTION AND STATUS

The objectives of the fifth annual report are as stated in the first annual report, i.e., to outline existing environmental conditions and to determine changes in the terrestrial biota of the Bailly site as related to construction and operation of the NIPSCo Bailly Nuclear-1 plant (TI 1975). The 11 established sampling locations in the primary study area (Figure 1.1-1), bounded on the north by Lake Michigan, on the east by Dune Acres Road, on the south by Route 12, and on the west by the NIPSCo access road, were surveyed for biological parameters listed in Table 1.1-1. Dates of all sampling traips and data collected on those trips are listed in this table. All sampling stations are located in Figure 1.1-1, with the exception of the roadside counts (Figure 1.3-1) and the aquatic bird survey (Figure 1.4-1).

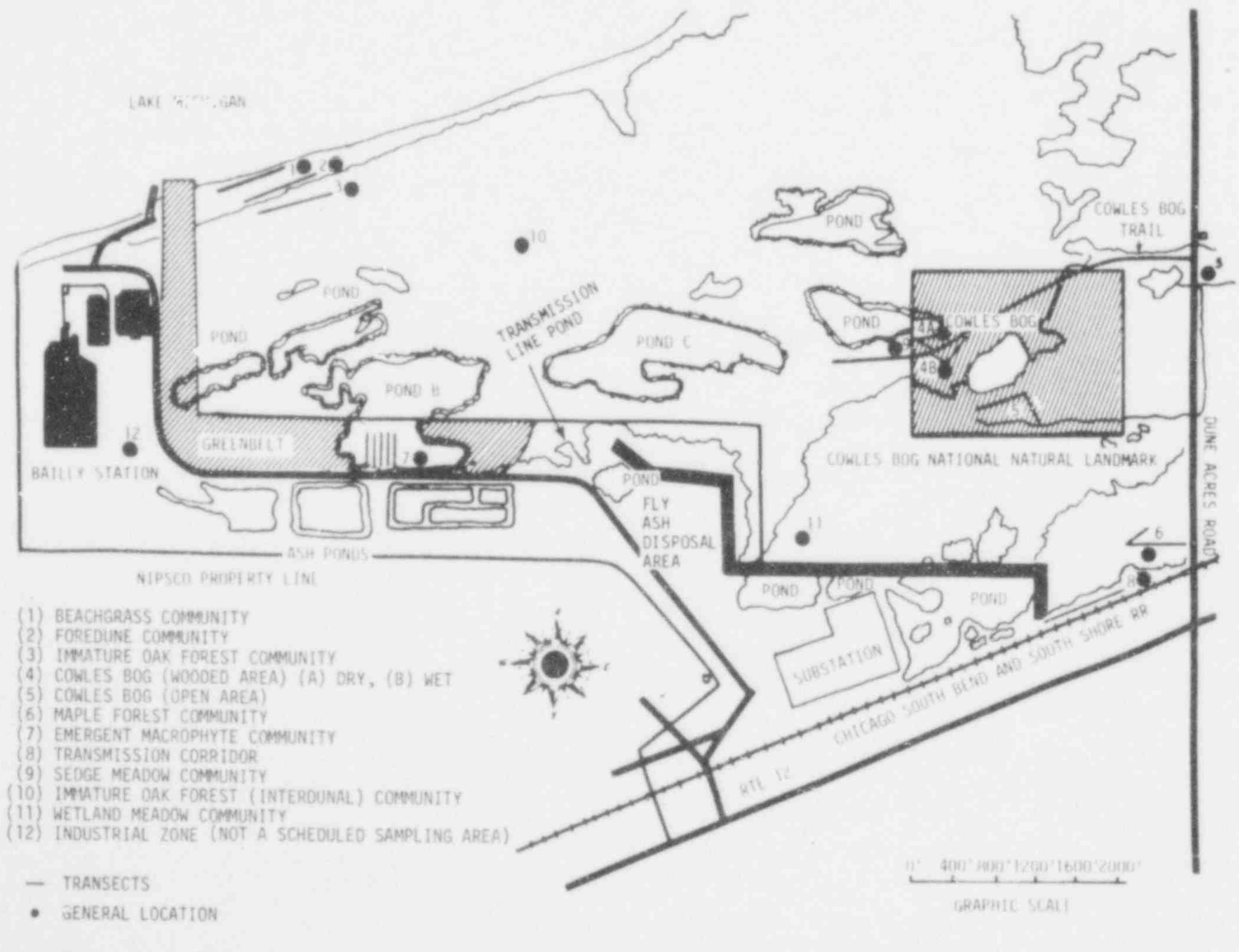


Figure 1.1-1. Terrestrial Sampling Locations, Bailly Study Area, 1978

Table 1.1-1

Terrestrial Ecology Sampling Schedule and Personnel for the Spring, Summer, Fall and Winter Seasons of 1978†

Sampling Activity	Sampling Location	Spring May 8-26	Summer July 9-29	Fall Oct 9-27
1. Vegetation and soils				
a. Vegetation analysis				
• Quantitative	1-8		x	
• Qualitative	9-11		x	
b. Foliar effects	1-11	x	x	x
c. Soil conductivity analysis	1-6, 8-10	x	x	x
2. Mammals				
a. Small mammal trapping	1,3,4,6,8	x		x
b. Large mammal observations	1-11	x	x	x
c. Roadside counts (rabbits)	22-mi route*	x	x	
3. Avifauna				
a. Transect counts	1, 3-6, 8, Cowles Bog Trail	x		x
b. Roadside counts (pheasants and doves)	22-mi route	x	x	
c. Aquatic bird survey	A-J**	x		x
4. Reptiles and amphibians	1-8	x	x	
5. Entomology	1-8		x	
PERSONNEL		Roy Greer	Roy Greer Tom Manthey Audrey James	Roy Greer

*See Figure 1.3-1.

**See Figure 1.4-1.

†No winter sampling scheduled (1978).

579088

1.2 VEGETATION AND SOILS

1.2.1 INTRODUCTION AND METHODS. The general botanical history of the Bailly Study Area was described, vegetation types and land-use categories were mapped, and distinguishing characteristics of each mapped division were discussed in the first annual report (TI 1975). Sampling methodologies used in 1978 for vegetation, foliar effects, and soils were identical to those used previously and follow the procedures defined in the Standard Operating Procedures for the Northern Indiana Public Service Company Bailly Station Nuclear I (TI 1978). Sampling was conducted at the 11 established locations (Figure 1.1-1), and resulting data are presented in Tables 1.2-1 through 1.2-16 and Figure 1.2-1. The entire vegetational stratigraphy (i.e., herbaceous, shrubs, trees) in each permanent sampling plot was quantitatively and qualitatively sampled in July 1978. These sampling data were used to characterize present floral conditions, with emphasis again placed on the dominant and important species. These data also were compared with that collected in September 1974 and July 1975, 1976, and 1977 to better describe community dynamics and to indicate differences and similarities in vegetation over the five years.

Tables 1.2-1, 1.2-2, and 1.2-3 present data by sampling location that indicate some of the vegetational changes occurring during the 5-year monitoring program. The mean percentages of vegetation and litter cover of ground surface in the herbaceous stratum of each sampling location during the monitoring period are shown on Table 1.1-1. The distribution by sampling location of herbaceous stratum taxa having an importance value of 20 or greater during 1978 sampling is shown on Table 1.2-2; differences between the important herbaceous species in 1978 and those of past years also are shown on the table. Changes in dominance, rank, and number of tree-class individuals from 1974 to 1978 in applicable sampling locations (2, 3, 4A, 4B, and 6) are shown on Table 1.2-3. An annotated list of plant species observed in the Bailly Study Area during the five-year monitoring period is presented in Appendix A.

1.2.2 QUANTITATIVE ANALYSIS

1.2.2.1 Beachgrass Community. The beachgrass community sampling location was on the Indiana National Lakeshore property adjacent to Lake Michigan, approximately 1/4 mile east of the existing Bailly plume area (Figure 1.1-1).

Table 1.2-1

Mean Percentage of Ground Surface Covered by Vegetation and Litter in the Herbaceous Stratum by Sampling Location, Bailly Study Area, during Summer Samplings from 1974* to 1978

Sampling Location	Community Name	Vegetation					Litter					Total				
		1974	1975	1976	1977	1978	1974	1975	1976	1977	1978	1974	1975	1976	1977	1978
01	Beachgrass	29	43	14	39	42	43	51	48	29	45	72	94	63	68	87
02	Foredune	23	30	17	22	38	36	36	36	25	14	60	66	53	48	56
03	Immature Oak Forest	11	10	21	8	29	68	75	63	56	61	79	85	85	64	89
04A	Cowles Bog (Wooded-Dry)	14	12	33	[illegible]	46	72	82	**	60	44	86	94	**	92	90
04B	Cowles Bog (Wooded-Wet)	17	12	64	26	66	82	65	**	34	22	100	78	**	61	88
05	Cowles Bog (Open)	51	51	53	48	51	42	32	**	44	30	93	83	**	93	81
06	Maple Forest	3	5	22	11	23	74	80	67	81	50	78	86	90	92	73
08	Transmission Corridor	53	52	70	74	85	45	48	29	25	15	98	100	100	99	100

*1974 sampling occurred in September; all other samplings in July.

**Not available from data.

Table 1.2-2

Distribution of Principal Herbaceous Stratum Taxa (Importance Value ≥20) on the Bailly Study Area during the 5-Year Monitoring Period, with Importance Values for July 1978

Taxa	Sampling Location* 1	2	3	4A	4B	5	6	8
Acer rubrum							**+	
Ammophilia breviligulata	300	**+						
Andropogon gerardii								95
Andropogon scoparius		127						
Calamovilfa longifolia		26						
Carex pennsylvanica			73	96	**+	**		**
Celastrus scandens		23*						
Circea alpina							**+	
Geranium maculatum							**	
Impatiens bifora					29	61	43	
Leersia oryzoides					30	60		41
Lemna minor					39			
Lindera benzoin							24	
Maianthemum canadense					**			
Osmunda cinnamomea					**+			
Parthenocissus quinquefolia					**+		27+	
Phragmites communis						**		
Pilea pumila					**	29		
Poa sp.			26+			**		
Polygonum sagittatum						38+		
Prunus serotina							75	
Pteridium aqualinum			52					
Rhus radicans		**+	**+					
Rosa blanda							**+	
Rubus flagellaris								29
Solidago sp.		23			**			
Stachys palustris						27+		
Symplocarpus foetidus					25+			
Thalictrum polygamum							**	
Thelyptris palustris								26+
Typha latifolia						43		
Urtica urens					31+			
Vaccinium pennsylvanicum				92				
Total species	1	4	3	2	5	6	4	4
Importance value	300	199	151	188	154	258	169	191
Percent of total importance	100.0	66.3	50.3	62.7	51.3	86.0	56.3	63.7

*Refer to Figure 1.1-1.
**Taxa were observed with an importance value ≥ 20 during previous July samplings.
+Change in status from 1977 samplings.

POOR ORIGINAL

579091

Table 1.2-3

Changes in Dominance, Rank, and Number of Individuals in the Tree Class for Sampling Locations 2, 3, 4A, 4B, and 6, Bailly Study Area, May 1974 to July 1978

Species	Location	May 1974 Dominance*	May 1974 Rank*	July 1978 Dominance	July 1978 Rank	1974-1978 Individuals Lost	1974-1978 Individuals Gained	1974-1978 Change in Dominance
Foredune Community	2							
Pinus banksiana		1.0	2	1.5	3	0	0	+0.5
Populus deltoides		1.0	3	1.9	2	0	0	+0.9
Quercus velutina		0.4	4	0.6	4	0	0	+0.2
Tilia americana		2.9	1	3.1	1	0	0	+0.2
Total		5.3		7.1		0	0	1.8
Immature Oak Forest Community	3							
Quercus alba		0.3	2	0.3	2	0	0	—
Quercus velutina		32.9	1	38.2	1	1	13	+5.3
Total		33.2		38.5		1	13	5.3
Cowles Bog (Wooded-Dry)	4A							
Lindera benzoin**		--	—	0.4	4	0	1	+0.4
Prunus serotina		1.0	3	2.6	2	0	1	+1.6
Quercus alba		2.0	2	2.1	3	0	2	+0.1
Quercus velutina		79.0	1	94.4	1	0	14	+15.4
Total		82.0		99.5		0	18	17.5
Cowles Bog (Wooded-Wet)	4B							
Acer rubrum		24.4	1	29.0	1	1	4	+4.6
Betula lutea		3.9	3	5.0	3	0	0	+1.1
Nyssa sylvatica**		—	—	1.1	6	0	2	+1.1
Prunus serotina		0.9	5	1.1	6	0	0	+0.2
Salix nigra		16.3	2	5.6	2	4	4	-10.7
Sassafras albidum		3.0	4	3.0	5	1	0	—
Ulmus rubra**		—	—	0.7	4	0	1	+0.7
Total		48.5		45.5		6	11	-3.0
Maple Forest	6							
Acer rubrum		51.4	1	63.3	1	3	5	+11.9
Crataegus sp.		0.6	6	1.1	5	0	0	+ 0.5
Prunus serotina		13.4	3	16.8	2	0	0	+ 3.4
Quercus alba		1.4	4	1.7	4	0	0	+ 0.3
Robina pseudoacacia		9.7	2	9.7	3	1	1	—
Sassafras albidum		1.4	5	1.7	4	0	0	+ 0.3
Total		77.9		94.3		3	6	+16.4

*Dominance is expressed as the basal area in square feet per acre and rank is based on importance values.
**Species not present in May 1974.

As before (July 1974-1977), American beachgrass (Ammophila breviligulata) was the only species observed within sampling plots (Table 1.2-4). The density of this species doubled from the 1977 sampling. The greatest increases occurred in the plots that burned in 1976 and in the plots that were located in a swale area where additional available moisture may have favored increased growth. Litter cover in the burned plots increased to a mean of 39 percent compared with none for the 1976 and 1977 samplings and about 60 percent prior to the fire.

The increases in density, dominance, and litter cover in this sampling location (Tables 1.2-1 and 1.2-4) seem to indicate at least a short-term stabilization of the beach sands in the community. Flowering stalks, which are indicators of mature stands of beachgrass (Laing 1954), were not observed in or near the sampling plots, but were observed in an active dunal area between the NIPSCo boundary fence and the discharge channel.

Table 1.2-4

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in Beachgrass Community, Location 1, Bailly Study Area, July 1978

	Total Observations	Total Dominance	Density*	Relative Density	Dominance*	Relative Dominance	Frequency	Relative* Frequency	Importance* Value
Ammophila breviligelata	1,870	442	756,789	100	19,247	100	10	100	300
Total			756,789						

*Density is expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

1.2.2.2 Foredune Community. Importance values indicate that this community remained similar to the 1977 sampling, although a slight shift in the rank of several of the important species (importance value greater than 20) has occurred. Little bluestem (Andropogon scoparius), sand reedgrass (Calamovilfa longifolia), goldenrod (Solidago sp.), and bittersweet (Celastrus scandens) were the most important herbaceous class species in 1978 (Tables 1.2-2 and 1.2-5), accounting for 66.3 percent of the total importance in the foredune community. A general trend of increased density and dominance for most species in the sampling location indicated normal dune succession, has occurred during the monitoring period (TI 1975-1978).

Table 1.2-5

Density, Dominance, Frequency, and Importance Values for Vegetation Samples in the Foredune Community, Location 2, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance* Value
Herbs							
Ammophila breviligulata	3,238	0.5	44	0.2	30	4.8	5.5
Andropogon scoparius	475,118	74.4	6,706	36.9	100	16.1	127.4
Asclepias tuberosa	405	0.1	44	0.2	10	1.6	1.9
Calamovilfa longifolia	47,755	7.5	1,263	7.0	70	11.3	25.8
Celastrus scandens	3,642	0.6	3,179	17.5	30	4.8	22.9
Compositae I	2,024	0.3	348	1.9	20	3.2	5.4
Dicot I	405	0.1	tr	tr	10	1.6	1.7
Draba sp.	2,428	0.4	tr	tr	20	3.2	3.6
Euphorbia corollata	3,642	0.6	523	2.9	20	3.2	6.7
Hamamelis virginiana	405	0.1	131	0.7	10	1.6	2.4
Kuhnia sp.	405	0.1	87	0.5	10	1.6	2.2
Lithospermum carolinense	31,162	4.9	523	2.9	40	6.5	14.3
Panicum huachucae	3,238	0.5	87	0.5	10	1.6	2.6
Parthenocissus quinquefolia	405	0.1	348	1.9	10	1.6	3.6
Quercus velutina	405	0.1	44	0.2	10	1.6	1.9
Rhus radicans	16,593	2.6	1,611	8.9	50	8.1	19.6
Rosa blanda	3,238	0.5	174	1.0	10	1.6	3.1
Rudbeckia hirta	1,214	0.2	87	0.5	10	1.6	2.3
Salix sp.	2,024	0.3	218	1.2	10	1.6	3.1
Smilicina racemosa	3,238	0.5	87	0.5	10	1.6	2.6
Solidago graminifolia	3,642	0.6	1,176	6.5	10	1.6	8.7
Solidago sp.	30,353	4.7	1,002	5.5	80	12.9	23.1
Tradescantia virginiana	405	0.1	87	0.5	10	1.6	2.2
Verbascum thapsus	809	0.1	87	0.5	20	3.2	3.8
Vitis sp.	2,833	0.4	305	1.7	10	1.6	3.7
Total	639,026						
Shrubs**							
Quercus velutina	121	60	270	88.5	10	50.0	198.5
Tilia americana	81	40	35	11.5	10	50.0	101.5
Total	202						
Trees							
Pinus banksiana	8	20	1.5	21.1	20	33.3	74.4
Populus deltoides	4	10	1.9	26.8	10	16.7	53.5
Quercus velutina	4	10	0.6	8.5	10	16.7	35.2
Tilia americana	24	60	3.1	43.7	20	33.3	137.0
Total	40						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

**Dominance, Relative Dominance, and Importance Values for shrub species are corrected from those appearing in the July-September 1978 quarterly report (TI 1978).

tr = trace

Shrub- and tree-class species in the foredune remained similar to previous samplings. In the tree class, the continued dominance of basswood (Tilia americana) was due primarily to a relatively high density in the sampling plots rather than a greater growth rate. The growth rate of cottonwood (Populus deltoides), which is recognized as the principal tree species to initially invade Michigan dunes (Shelford 1963, Curtis 1971), far exceeded that of other trees (Table 1.2-5). Between July 1977 and July 1978 little tree stand growth was recognized in this community with a total tree basal area increase of 0.2 square feet per acre; this represented 11 percent of total growth during the monitoring program.

1.2.2.3 Immature Oak Forest Community. Sedge (Carex sp.), bluegrass (Poa sp.), and bracken fern (Pteridium aquilinum) continued to show distinct year to year changes in importance value in this community. These fluctuations, as well as those of other more common species in the community, appeared to be within the normal patterns described by Olson (1958) and Curtis (1971).

Red maple (Acer rubrum) and flowering dogwood (Cornus florida) were observed for the first time in this community (Table 1.2-6). These two species generally are associated with later successional stages in the Bailly Study Area [e.g., Cowles Bog (dry-wooded) and red maple communities]. Seedlings of red maple and flowering dogwood, as well as those of bluegrass, are reported to be relatively shade-tolerant and sensitive to low available moisture (Fowells 1965, Whitford and Whitford 1978).

Witch hazel remained more important than sassafras (Sassafras albidum) and black oak (Quercus velutina) in the shrub class (Table 1.2-6). Four black oaks reached tree class size between July 1977 and July 1978, contributing to the total basal area increase of 2.5 square feet per acre. Dominance change in the community during the monitoring program has been little, with only the foredune community showing less change. The growth changes in the tree stratum that have been observed during the past five years were attributed mostly to the introduction of these four black oaks and nine others since 1974 (Table 1.1-3). A relatively slow individual rate of growth, as apparent in this community, is reported as common in stands that occur on poorer sites (Fowells 1965).

579095

Table 1.2-6

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in the Immature Oak Forest Community, Location 3, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance* Value
Herbs							
Acer rubrum	2,428	0.7	44	0.4	20	2.9	4.0
Bryophyta**	-	-	827	7.3	10	1.5	-
Carex pennsylvanica	183,329	52.7	1,132	10.0	70	10.3	73.0
Chenopodium standleyanum	2,024	0.6	tr	tr	10	1.5	2.1
Cornus florida	405	0.1	44	0.4	10	1.5	2.0
Dicot II	405	0.1	44	0.4	10	1.5	2.0
Draba sp.	2,024	0.6	tr	tr	20	2.9	3.5
Euphorbia corollata	3,642	1.0	87	0.8	20	2.9	4.7
Graminae I	17,402	5.0	131	1.2	10	1.5	7.7
Hamamelis virginiana	4,047	1.2	305	2.7	50	7.4	11.3
Helianthus microcephalus	405	0.1	44	0.4	10	1.5	2.0
Krigia sp.	405	0.1	44	0.4	10	1.5	2.0
Monarda fistulosa	1,214	0.3	tr	tr	10	1.5	1.8
Panicum hauchucae	4,452	1.3	44	0.4	30	4.4	6.1
Poa sp.	75,274	21.7	348	3.1	10	1.5	26.3
Pteridium aquilinum	6,475	1.9	4,834	42.8	50	7.4	52.1
Rhus radicans	8,903	2.6	1,089	9.7	50	7.4	19.7
Rosa blanda	6,475	1.9	174	1.5	20	2.9	6.3
Sassafras albidum	5,261	1.5	1,045	9.3	50	7.4	18.2
Smilax rotundifolia	809	0.2	131	1.2	20	2.9	4.3
Smilician stellata	6,880	2.0	392	3.5	70	10.3	15.8
Solidago sp.	7,285	2.1	261	2.3	60	8.8	13.2
Taraxacum officinale	405	0.1	44	0.4	10	1.5	2.0
Tradescantia virginiana	3,238	0.9	87	0.8	30	4.4	6.1
Vaccinium pennsylvanicum	2,024	0.6	131	1.2	10	1.5	3.3
Viola sp.	2,428	0.7	tr	tr	10	1.5	2.2
Total	347,639						
Shrubs***							
Hamamelis virginiana	1,376	65.4	8530	55.1	60	40.0	160.5
Quercus velutina	283	13.5	960	6.2	30	20.0	39.7
Sassafras albidum	445	21.2	6000	38.8	60	40.0	100.0
Total	2,104						
Trees							
Quercus alba	4	2.3	0.3	0.8	10	9.1	12.2
Quercus velutina	168	97.7	38.2	99.2	100	90.9	287.8
Total	172						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

**Calculations for dominance, relative dominance, frequency, and relative frequency only.

***Dominance values for shrubs are corrected from those appearing in the July-September quarterly report (TI 1978).

tr = trace

POOR ORIGINAL

579096

1.2.2.4 Cowles Bog (Wooded-Dry). Pennsylvania sedge (Carex pennsylvanica) and lowbush blueberry (Vaccinium pennsylvanicum) continued to dominate the herb class in this sampling location (Table 1.2-7). The status of these species remained essentially unchanged: together they accounted for 87 percent of the density and 72 percent of the cover (dominance). Catbriar (Smilax rotundifolia), which was present in 1975 but not in 1976 and 1977 sampling, was third in importance followed by starry false Solomon's seal (Smilicina stellata) and black cherry (Prunus serotina). Ash (Fraxinus sp.) and witchhazel were observed for the first time in the herb class. Witchhazel is a common associate of the immature oak forest but ash has not been observed as a common species in similar types on the study area.

Sassafras was observed for the first time in the shrub class. An increase in dominance of this stratum reflected the addition of sassafras as well as several red maple and black cherry into the shrub class. In the tree stratum, one black cherry and two white oak reached tree class size, while one black oak was lost through normal tree fall. These changes contributed to substantial increase in importance of white oak but did not affect the species' rank in the tree stratum (Table 1.2-3). The second greatest increase in basal area of the communities sampled has occurred in this location (Table 1.2-3). This large increase probably resulted from the relatively larger mean basal areas of the established individuals, excellent growing conditions, and introduction of 18 new individuals into the tree class during the monitoring period. Black oak accounted for nearly all of the stand increase (88 percent).

1.2.2.5 Cowles Bog (Wooded-Wet). Rice cutgrass (Leersia oryzoides), small stinging nettle (Urtica urens), jewelweed, and skunk cabbage (Symplocarpus foetidus) were the four most important terrestrial herb class species in this location during 1978 sampling (Table 1.2-8). Small stinging nettle, although previously recorded (TI 1977), was not positively identified until 1978. Duckweed (Lemna minor), with the highest importance value in the herb stratum, increased in importance from the 1977 sampling, probably due to near normal water level in the sampling area. Although there have been significant fluctuations in the status of the more important herb class species (Table 1.1-2), total density and dominance values have generally increased during the monitoring period (Tables 1.2-8 and 1.2-3). The greatest species diversity in the herbaceous

Table 1.2-7

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in Cowles Bog (Wooded-Dry) Community, Location 4A, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance* Value
Herbs							
Acer rubrum	578	0.1	497	2.7	14	2.5	5.3
Carex pennsylvanica	298,898	70.4	2,796	15.4	57	10.3	96.1
Dicotolydonae sp.	578	0.1	tr	tr	14	2.5	2.6
Fraxinus sp.	578	0.1	tr	tr	14	2.5	2.6
Hamamelis virginiana	1,734	0.4	tr	tr	14	2.5	2.9
Lithospermum carolinense	3,469	0.8	tr	tr	14	2.5	3.3
Poa sp.	8,672	2.0	tr	tr	43	7.7	9.7
Prunus serotina	10,985	2.6	1,119	6.2	43	7.7	16.5
Quercus velutina	1,734	0.4	311	1.7	43	7.7	9.8
Rosa blanda	5,781	1.4	249	1.4	43	7.7	10.5
Rubus allegheniensis	578	0.1	124	0.7	14	2.5	3.3
Sassafras albidum	578	0.1	62	0.3	14	2.5	2.9
Smilax rotundifolia	2,891	0.7	2,051	11.3	43	7.7	19.7
Smilicina stellata	13,875	3.3	621	3.4	57	10.3	17.0
Solidago sp.	1,156	0.3	tr	tr	14	2.5	2.8
Tephrosia virginiana	1,156	0.3	tr	tr	14	2.5	2.8
Vaccinium pennsylvanicum	71,111	16.8	10,315	56.8	100	18.0	91.6
Total	424,352						
Shrubs							
Acer rubrum	347	30.0	96	23.9	57	32.2	86.1
Prunus serotina	463	40.0	196	48.9	57	32.2	121.1
Quercus velutina	289	25.0	100	24.9	43	24.3	74.2
Sassafras albidum	58	5.0	9	2.2	20	11.3	18.5
Total	1,157						
Trees							
Lindera benzoin	6	3.0	0.4	0.4	14	8.9	12.3
Prunus serotina	17	8.4	2.6	2.6	14	8.9	19.9
Quercus alba	23	11.4	2.1	2.1	29	18.5	32.0
Quercus velutina	156	77.2	94.4	94.9	100	63.7	235.8
Total	202						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

tr = trace

Table 1.2-8

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in Cowles Bog (Wooded-Wet) Community, Location 4B, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance Value*
Herbs							
Betula lutea	578	0.1	373	1.2	14	2.3	3.6
Carex sp.	60,127	9.2	808	2.7	29	4.7	16.6
Cornus stolonifera	4,047	0.6	746	2.5	57	9.3	12.4
Cystopteris fragilis	4,625	0.7	62	0.2	14	2.3	3.2
Galium aparine	578	0.1	62	0.2	14	2.3	2.6
Geum canadense	7,516	1.2	1[illegible]4	0.4	14	2.3	3.9
Impatiens biflora	55,501	8.5	1,988	6.6	88	14.3	29.4
Labiatae	29,485	4.5	1,367	4.5	29	4.7	13.7
Leersia oryzoides	104,643	16.0	2,858	9.5	29	4.7	30.2
Lemna minor	208,130	31.9	1,429	4.7	14	2.3	38.9
Maianthemum canadense	42,204	6.5	870	2.9	14	2.3	11.7
Onoclea sensiblis	38,735	5.9	2,361	7.8	14	2.3	16.0
Osmunda cinnamomea	22,547	3.5	3,107	10.3	29	4.7	18.5
Panicu.. sp.	4,047	0.6	tr	tr	29	4.7	5.3
Parthenocissus quinquefolia	578	0.1	373	1.2	14	2.3	3.6
Polygonum arifolium	13,297	2.0	994	3.3	14	2.3	7.6
Rhus vernix	578	0.1	62	0.2	14	2.3	2.6
Salix nigra	578	0.1	tr	tr	14	2.3	2.4
Solanum dulcamara	578	0.1	62	0.2	14	2.3	2.6
Symplocarpus foetidus	16,187	2.5	3,915	13.0	57	9.3	24.8
Ulmus rubra	2,313	0.4	62	0.2	14	2.3	2.9
Urtica dioca	5,203	0.8	373	1.2	43	7.0	9.0
Urtica urens	21,969	3.4	7,643	25.4	14	2.3	31.1
Urtica sp.	6,938	1.1	497	1.6	14	2.3	5.0
Viola sp.	1,734	0.3	tr	tr	14	2.3	2.6
Total	652,717						
Shrubs							
Acer rubrum	176	5.1	653	11.3	43	17.6	34.0
Alnus incana	58	2.5	174	3.0	29	11.8	17.3
Cornus stolonifera	867	38.5	1,871	32.3	57	23.3	94.1
Lindera benzoin	752	33.4	2,306	39.8	29	11.8	85.0
Rhus radicans	58	2.5	174	3.0	29	11.8	17.3
Rhus vernix	231	10.3	479	8.3	29	11.8	30.4
Salix nigra	58	7.7	131	2.3	29	11.8	21.8
Total	2,140						
Trees							
Acer rubrum	110	55.6	29.0	58.9	86	43.2	157.7
Betula lutea	35	17.7	5.0	10.2	43	21.6	49.5
Nyssa sylvatica	12	6.1	1.1	2.2	14	7.0	15.3
Prunus serotina	6	3.0	1.1	2.2	14	7.0	12.2
Salix nigra	6	3.0	5.6	11.4	14	7.0	21.4
Sassafras albidum	23	11.6	3.0	6.[illegible]	14	7.0	24.7
Ulmus rubra	6	3.0	4.4	8.9	14	7.0	18.9
Total	198						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

tr = trace

stratum of the communities sampled, consistently a characteristic of the transmission corridor, occurred in the wet woods in 1978. This reflected a change in the transmission corridor rather than in the wet woods: the wet woods exhibited near usual herbaceous species diversity but the transmission corridor exhibited less due primarily to herbicide application along the corridor prior to the July 1978 sampling.

Shrubs remained about the same as in previous sampling periods with red ozier dogwood (Cornus stolonifera) and spicebush (Lindera benzoin) the more important species. The introduction of poison ivy (Rhus radicans) and the increase in density of red ozier dogwood, spicebush, and poison sumac (Rhus vernix) accounted for much of the increase in dominance. The increase in shrub species is indicative of the trend noted in the wet woods during the monitoring period: between 1974 and 1978, four new shrub species were introduced and one species was lost.

Except for black willow (Salix nigra), the status of the tree class species in the wet woods remained similar to previous sampling years. The loss of four black willows, which occurred in a single sampling plot, accounted for the 58-percent decrease in tree growth during the monitoring period (Table 1.2-3). Two of the black willows were leaning during the 1977 sampling (TI 1978), and the other had fallen since then. Additional change in the tree stratum of the wet woods was the gain of one slippery elm (Ulmus rubra) and one red maple.

1.2.2.6 Cowles Bog (Open). Rice cutgrass and jewelweed with almost identical importance values (60.1 and 61.9 respectively, Table 1.2-9), were the most important herb class species in 1978 sampling. These were followed by cattail, arrow-leaved tearthumb (Polygonum sagittatum), and clearweed (Pilea pumila). Hedge-nettle (Stachys palustris) increased significantly in importance, primarily because of an increase in its dominance.

Some fluctuation of those species designated important in this location has occurred during the monitoring period (Table 1.2-2), but the vegetation ground cover values appear to be more consistent than those of other types (Table 1.2-1). Between 1976 and 1978, arrow-leaved tearthumb increased in the plots both in density and dominance. These increases were reflected in the significantly larger 1978 importance value (up from 5 to 37). Although reported as common in swampy woods and grassy swales of the dunes area (Peattie 1930), this species apparently

Table 1.2-9

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in Cowles Bog (Open) Community, Location 5, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance* Value
Herbs							
Bidens sp.	2,024	0.1	tr	tr	20	3.6	3.8
Convolvulus sepium	7,689	0.7	522	1.7	10	1.8	4.2
Cuscuta gronavii	8,094	0.8	44	0.1	40	7.1	8.0
Cystopteris fragalis	405	<0.1	tr	tr	10	1.8	1.8
Eupatorium purpureum	4,452	0.4	609	2.0	10	1.8	4.2
Impatiens biflora	331,354	30.8	5,003	16.1	80	14.3	61.2
Leerzia oryzoides	342,376	31.8	4,916	15.8	70	12.5	60.1
Pilea pumila	168,760	15.7	1,436	4.6	50	8.9	29.2
Polygonum sagittatum	45,326	4.2	7,091	22.9	60	10.7	37.8
Rosa sp.	9,308	0.9	653	2.1	10	1.8	4.8
Solanum carolinense	4,452	0.4	348	1.1	10	1.8	3.3
Stachys palustris	25,901	2.4	5,307	17.1	40	7.1	26.6
Typha latifolia	107,246	10.0	4,698	15.1	100	17.9	43.0
Urtica sp.	17,402	1.6	305	1.0	30	5.4	8.0
Zizia aurea	2,428	0.2	87	0.3	20	3.6	4.1
Total	1,077,717						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

tr = trace

POOR ORIGINAL

5704?4

is not common in swampy woods of the Bailly Study Area: it has not been observed in sampling plots of wet woods community in the past two years but was reported as an incidental species prior to then (TI 1976).

Litter cover values appeared to fluctuate slightly more than vegetation cover values in the open bog (Table 1.2-1), primarily because of water level fluctuations in the sampling plots. No shrubs or trees were reported for this type.

1.2.2.7 Maple Forest Community. In 1978, black cherry remained the most important herb class species in this location, followed by jewelweed, virginia creeper (Parthenocissus quinquefolia), and spicebush (Table 1.2-10). As during 1977, enchanters nightshade (Circea alpina), pale rose (Rosa pallida), and red maple were equal in importance, each with importance values near 18. In general, this understory was similar to that of the maple-beech forests described by Stearns and Kobriger (1975) and Curtis (1971). The floors of the maple-beech forests were typified by subdued light intensity and sparse understory except in openings caused by disturbance. In the openings, species with little shade tolerance, including black cherry, occurred in dense patches, and vegetative ground cover (dominance) reached 100 percent in many instances.

The increase in importance of black cherry in the shrub class reflected an increase of three individuals of this species and a loss of one red maple. The status of the tree species remained the same as during the 1977 sampling with red maple as the dominant species. Between 1977 and 1978 sampling, two red maples and one black locust (Robinia pseudoacacia) were lost through normal treefall.

High tree seedling mortality was apparent in this community during the monitoring period (TI 1975-1978). It is comparable to a similar stand predominated by sugar maple (Acer sarrharum) in Wisconsin, where mortality between seedling and shrub stages was greater than 97 percent (Curtis 1971). In the Bailly Study Area red maple community, red maple, red osier dogwood, and black cherry seedling to shrub density ratios of less than 0.03 substantiates a similar mortality pattern. Red maple, however, remained the most important tree species followed by black locust (Robinia pseudoacacia) and black cherry. During the past five years, red maple and black cherry accounted for 93 percent of the growth in this community (Table 1.2-3).

Table 1.2-10

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in Maple Forest Community, Location 6, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance* Value
Herbs							
Acer rubrum	5,666	6.1	44	0.5	50	11.9	18.5
Corex sp.	3,238	3.5	tr	tr	10	2.4	5.9
Circaea alpina	10,522	11.3	392	4.3	10	2.4	18.0
Cornus florida	3,238	3.5	44	0.5	30	7.1	11.1
Galium aparine	405	0.4	tr	tr	10	2.4	2.8
Geum canadense	7,689	8.3	783	8.5	10	2.4	19.2
Glecoma hederacea	2,428	2.6	tr	tr	20	4.8	7.4
Impatiens biflora	14,569	15.7	1,436	15.6	50	11.9	43.2
Lindera benzoin	5,666	6.1	1,001	10.9	30	7.1	24.1
Parthenocissus quinquefolia	11,736	12.6	653	7.1	30	7.1	26.8
Prunus serotina	19,830	21.3	3,828	41.7	50	11.9	74.9
Quercus velutina	405	0.4	tr	tr	10	2.4	2.8
Rosa blanda	4,452	4.8	566	6.2	30	7.1	18.1
Sanicula trifoliata	405	0.4	tr	tr	10	2.4	2.8
Smilax herbacea	405	0.4	tr	tr	10	2.4	2.8
Smilicina racemosa	1,214	1.3	131	1.4	30	7.1	9.8
Urtica dioca	405	0.4	174	1.9	10	2.4	4.7
Zizia aurea	809	0.9	131	1.4	20	4.8	7.1
Total	93,082						
Shrubs							
Acer rubrum	160	21.0	2,523	29.9	60	54.5	105.4
Cornus florida	40	5.3	174	2.1	20	18.2	25.6
Prunus serotina	561	73.7	5,742	68.0	30	27.3	169.0
Total	761						
Trees**							
Acer rubrum	202	72.7	62.79	66.6	80	44.4	183.7
Crataegus crus-galli	8	2.9	1.1	1.2	10	5.6	9.7
Prunus serotina	24	8.6	16.8	17.8	20	11.1	37.5
Quercus alba	8	2.9	1.7	1.8	10	5.6	10.3
Robinia pseudo-acacia	30	10.10	10.2	10.8	50	27.8	48.7
Sassafras albidum	8	2.9	1.7	1.8	10	5.6	10.3
Total	278						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

**Values for Acer rubrum and Robinia pseudo-acacia are corrected from those appearing in the July-September 1978 quarterly report (TI 1978).

tr = trace

579103

1.2.2.8 Emergent Macrophyte Community. Samples from pond B in July 1978 yielded two species (Table 1.2-11). Bullhead lily (*Nuphar variegatum*) remained the most important species while the second species, pondweed (*Potamogeton* sp.), increased in importance over the 1977 sampling. The status of common shoreline emergent species appeared to be similar to that of previous years.

A further discussion of the aquatic macrophyte community is in Section 2.4.

1.2.2.9 Transmission Corridor. Several weeks prior to the July 1978 sampling, the transmission corridor was treated with herbicide (see subsection 1.2.4) and several shrubs and trees were cut along the edge of the corridor. As indicated, this line maintenance affected the character of the sampling plots. The herbicide inhibited growth of broad-leaf (Dicot) species but had little or no apparent adverse effects on narrow-leaf (Monocot) species. The selective nature of the herbicide was apparent from the significant increase in importance of big bluestem (*Andropogon gerardi*) and rice cutgrass (Table 1.2-12). In addition, these species showed little or no visible stress, while most broad-leaf species exhibited various degrees of leaf necrosis. Thirteen species observed in the 1977 sampling, 12 of them broadleaf taxa, did not occur in the 1978 sampling. The treatment apparently also accounted for a 28 percent loss of diversity compared to the 1977 sampling.

1.2.3 QUALITATIVE ANALYSIS

1.2.3.1 Sedge Meadow Community. During the July 1978 sampling, 19 taxa, representing 38 percent of the common species in past samplings, were observed in this community (Table 1.2-13). Daisy fleabane (*Erigeron strigosus*), horse mint (*Monarda punctata*), and goat's rue (*Tephrosia virginiana*), were among the common species of 1977 that were not observed in the current sampling. Canadian anemone (*Anemone canadense*), not observed in previous sampling, was recorded for July 1978. The other species previously recorded in the location but not recorded in 1978 were absent or uncommon in 1977. Such differences in presence/absence are attributed to natural fluctuations in populations of these predominantly annual plants.

579104

Table 1.2-11

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in Emergent Macrophyte Community, Location 7, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance* Value
Nuphar variegatum	9,066	90.3	768	92.8	0.28	77.8	260.9
Potamogeton sp.	971	9.7	60	7.2	0.08	22.2	39.1
Total	10,037						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

Table 1.2-12

Density, Dominance, Frequency, and Importance Values for Vegetation Sampled in Transmission Corridor, Location 8, Bailly Study Area, July 1978

Scientific Name	Density*	Relative Density	Dominance*	Relative Dominance	Frequency*	Relative Frequency	Importance* Value
Herbs							
Achillea millefolium	2,024	0.1	131	0.3	20	3.5	3.9
Andropogon gerardi	686,776	47.6	14,616	35.3	70	12.3	95.2
Apocynum medium	1,214	0.1	348	0.8	10	1.8	2.7
Carex sp.	61,514	4.3	261	0.6	10	1.8	6.7
Circium arvense	1,619	0.1	218	0.5	20	3.5	4.1
Dicotyledonae	809	0.1	87	0.2	10	1.8	2.1
Fragaria virginiana	809	0.1	44	0.1	10	1.8	2.0
Helianthus giganteus	1,214	0.1	261	0.6	10	1.8	2.5
Iris versicolor	21,449	1.5	1,131	2.7	10	1.8	6.0
Lactuca canadensis	405	<0.1	44	0.1	10	1.8	1.9
Leersia oryzoides	307,977	21.3	5,046	12.2	40	7.0	40.5
Oenothera muricata	405	<0.1	348	0.8	10	1.8	2.6
Onoclea sensiblis	12,950	0.9	1,523	3.7	30	5.3	9.9
Panicum clandestinum	15,783	1.1	435	1.1	30	5.3	7.5
Parthenocissus quinquefolia	3,642	0.3	261	0.6	10	1.8	2.7
Poa sp.	25,496	1.8	392	0.9	20	3.5	6.2
Polygonum sagittatum	809	0.1	44	0.1	10	1.8	2.0
Pycarthemum virginianum	7,285	0.5	5,568	13.5	20	3.5	17.5
Rubus flagellaris	53,016	3.7	3,915	9.5	90	15.8	29.0
Rudbeckia hirta	3,238	0.2	174	0.4	20	3.5	4.1
Solidago graminifolia	98,342	6.8	1,001	2.4	20	3.5	12.7
Solidago sp.	4,452	0.3	522	1.3	30	5.3	6.9
Thelypterus palustris	123,434	8.5	4,350	10.5	40	7.0	26.0
Tradescantia virginiana	4,856	0.3	131	0.3	10	1.8	2.4
Zizia aurea	4,452	0.3	522	1.3	10	1.8	3.4
Total	1,443,970						

*Density expressed as number of individuals per acre, dominance as areal coverage in square feet per acre, and frequency as percent of sample plots in which a species occurred. Importance value is the sum of the three relative values.

Table 1.2-13

Vegetational Taxa Observed in Sedge Meadow Community, Location 9, Bailly Study Area, July 1978

Scientific Name	Common Name
Acer rubrum	Red maple
Anemone canadensis	Canadian anemone
Carex sp.	Sedge
Euphorbia corollata	Flowering spurge
Hamamelis virginiana	Witch-hazel
Hieracium sp.	Hawkweed
Monarda fistulosa	Wild bergamot
Panicum sp.	Panic grass
Pinus banksiana	Jack pine
Poa sp.	Bluegrass
Prunus serotina	Black cherry
Pteridium aquilinum	Bracken fern
Quercus velutina	Black oak
Rosa blanda	Pale rose
Sassafras albidum	Sassafras
Smilacina stellata	Starry-false-Solomon's seal
Tradescantia virginiana	Spiderwort
Vaccinium pennsylvanicum	Lowbush blueberry
Vitis sp.	Wild grape

1.2.3.2 Immature Oak Forest (Interdunal) Community. During the July 1978 sampling, 27 taxa were observed in this location. These species represented 47 percent of all the taxa observed in this type during the monitoring period. Three taxa observed in the 1977 sampling (Table 1.2-14) — Lupine (Lupinus perennis), wild lily-of-the-valley (Maianthemum canadense), and beardtongue (Penstemon hirsutus) — were not observed during July 1978.

1.2.3.3 Wet Meadow Community. Seventy-five percent (15 taxa) of the representative taxa in the wet meadow were observed during the 1978 sampling. Several species not recorded for the 1977 sampling were observed during July 1978. All of the species (Table 1.2-15) are common for this type and occurred throughout the dunes area (Peattie 1930).

1.2.4 FOLIAR EFFECTS. Foliar effects previously noted along the NIPSCo access road appeared to be diminishing. The large cottonwood that exhibited foliar damage in 1977 (TI 1977) appeared healthy during July 1978, and the white pines (Pinus strobus) that incurred foliar damage during 1976 (TI September 1977a) appeared to be recovering, although needle browning was still observed on old needles.

Table 1.2-14

Vegetational Taxa Observed in Immature Oak Forest (Interdunal) Community, Location 10, Bailly Study Area, July 1978

Scientific Name	Common Name
Andropogon scoparius	Little bluestem
Apocynum medium	Dogbane
Artemisia campestris	Wormwood
Carex sp.	Sedge
Erigeron strigosus	Daisy fleabane
Euphorbia corollata	Flowering spurge
Hamamelis virginiana	Witch-hazel
Helianthus divericatus	Woodland sunflower
Hieracium sp.	Hawkweed
Monarda fistulosa	Wild bergamot
Opuntia compressa	Prickly-pear
Panicum sp.	Panic grass
Parthenocissus quinquefolia	Virginia creeper
Pinus banksiana	Jack pine
Poa sp.	Bluegrass
Prunus serotina	Black cherry
Pteridium aquilinum	Bracken fern
Quercus velutina	Black oak
Rosa blanda	Pale rose
Rubus sp.	Blackberry
Sassafras albidum	Sassafras
Smilacina stellata	Starry-false-Solomon's-seal
Solidago sp.	Goldenrod
Tephrosia virginiana	Goat's rue
Tradescantia virginiana	Spiderwort
Vaccinium pennsylvanicum	Lowbush blueberry
Vitis sp.	Wild grape

Table 1.2-15

Vegetational Taxa Observed in Wetland Meadow Community, Location 11, Bailiy Study Area, July 1978

Scientific Name	Common Name
Andropogon gerardii	Big bluestem
Cephalanthus occidentalis	Button bush
Impatiens biflora	Jewelweed
Leersia oryzoides	Cutgrass
Rhus vernix	Poison sumac
Rhus radicans	Posson ivy
Salix sp.	Willow
Salix nigra	Blackwillow
Sambucus canadensis	Elderberry
Solanum dulcamara	Nightshade
Solanum carolinense	Horsenettle
Spirea alba	Meadow-sweet
Spirea tomentosa	Steeple bush
Typha latifolia	Cattail
Urtica dioca	Stinging nettle

579107

Recent stress was observed along the South Shore and South Bend Railroad and Northern Indiana Public Service Company right-of-way area (sampling location 8, Figure 1.1-1). This stress was associated with selective brush removal and herbicide treatments. Selective brush removal occurred beneath and adjacent to the NIPSCo transmission line. Beneath the transmission line, several black cherry saplings were cut and felled into one of the sampling plots. Adjacent to the transmission line, along the eastern edge of the maple woods (sampling location 6), several trees and understory brush were removed.

The stress related to herbicide treatment was apparent on broadleaf (Dicot) species in the transmission corridor. Both NIPSCo and South Shore and South Bend Railroad use herbicide for vegetation control along their respective rights-of-way. The South Shore and South Bend Railroad has used herbicide annually for treatment of its right-of-way (beginning prior to 1974). The railroad has applied a variety of selective and nonselective herbicides by broadcast and spot treatment methods (Personal communication with G.K. Clem, Manager-Engineering, South Shore and South Bend Railroad, Michigan City, Indiana).

During early July 1978, Amdon-Ten K pellets were used for broadcast treatment of the NIPSCo right-of-way. This herbicide was developed as a selective brush and broadleaf weed-control agent (Personal communication with Dr. J.B. Grumbles, Dow Chemicals, Dallas, TX). Applied as recommended, Amdon-Ten K is safe for wildlife and enhances a ground cover composed of grasses. Under normal application and weather conditions, effectiveness of the herbicides used near or in the sampling plots lasts from 12 to 18 months. On this basis future vegetation sampling should reflect the 1978 treatment by showing an increasing importance of grass species.

1.2.5 SOIL CONDUCTIVITY. Electrical conductivity (soil salinity) values (Table 1.2-16) were generally greater than those for 1977, but were within the maximum and minimum mean values recorded between 1974-1978. As in previous years, May salinity levels were generally higher than those for July and October. Sampling locations with dry, well-drained sandy soils (types 1, 2, 3, and 10) had generally higher conductivity values in 1978 than in previous years, but the remaining locations, with wet, poorly-drained organic soils had conductivity levels similar to previous years.

579108

Table 1.2-16

Average Soil Conductivity (µmhos/cm) Values from 10 Locations, Bailly Study Area, May, July and October 1978

Sampling Location	May	Jul	Oct
Beachgrass (01)	228.6	148.5	125
Foredune (02)	754.5	196.0	150
Immature Oak Forest (03)	242.3	137.4	160
Cowles Bog (Wooded-Dry) (4a)	300.5	209.6	79
Cowles Bog (Wooded-Wet) (4b)	389.6	267.1	483
Cowles Bog (Open (5)*	418.0	368.6	695
Maple Forest (6)	631.1	339.3	410
Transmission Corridor (8)	387.4	189.4	237
Sedge Meadow (9)	250.2	152.4	71
Immature Oak Forest (Interdunal) (10)	377.3	164.9	336

*Soils and conductivity values in Cowles Bog (5) and Wet Meadow (11) are similar.

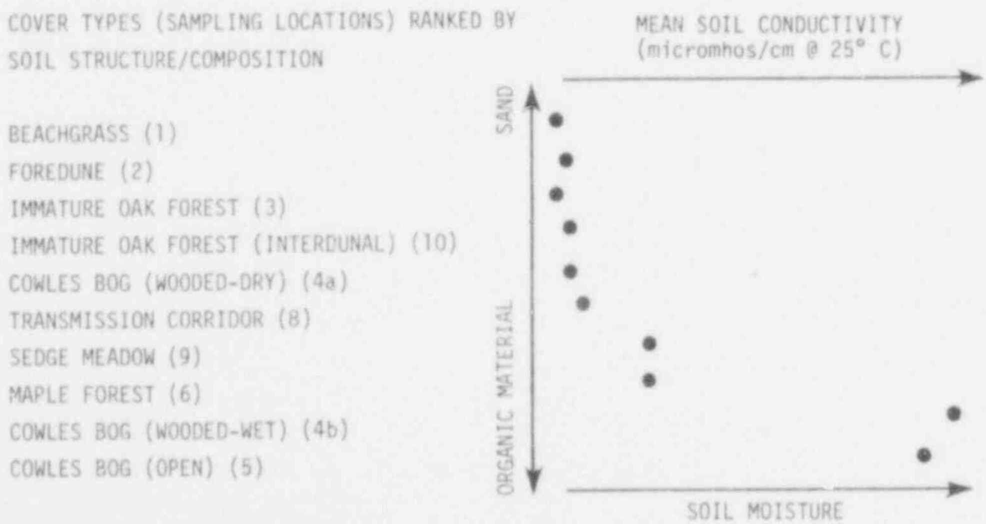
The apparent conductivity patterns for the Bailly Study Area are consistent with principles of soil/salinity relationships presented by FAO/UNESCo (1973) and Black (1954). Naturally occurring soluble salts tend to move with water and may be carried by precipitation or runoff into topographically lower areas. Ridges or hilltops in an area often are drier and have greater leaching of the soil due to runoff characteristics while moist areas or lowland basins receive runoff waters high in soluble salts from the upland areas. This process of outward movement of salts is called leaching.

Soluble salt concentrations in the surface soil vary seasonally and are closely related to the precipitation-evaporation characteristics of a site. After periods of considerable precipitation, salts may be leached from the site and during dry periods, evaporation of soil moisture draws salts to the surface where accumulation results. The evaporation characteristics, in turn, are influenced by soil structure and composition. Sites in the Bailly Study Area with high percentage of sand and low percentage of organic material generally are subject to greater leaching and less surface accumulation of salts from evaporation than soils with more organic material.

579109

Vegetation cover types in an area are often correlated with soil, drainage and salt accumulation patterns. This is well illustrated by the vegetation cover types within the study area (Figure 1.2-1). For example, the beachgrass, foredune, immature oak forest, and immature oak forest (interdunal) cover types occur on dry, well-drained sandy soils and have lower soluble salt concentrations than other cover types. Similarly, the Cowles Bog (wooded wet) and Cowles Bog (open) cover types occur on wet, poorly-drained organic soils having the highest soluble salt concentrations. The remaining types represent areas with intermediate soil characteristics and correspondingly intermediate conductivity values.

The effects of salts on vegetation are often evaluated on the basis of electrical conductivity of an aqueous solution (e.g., soil, irrigation, or rainwater). Salt solutions with electrical conductivity values of 0 to 2,000 micromhos/cm at 25° usually have negligible effects on plants; values from 2,000 to 4,000 may restrict the yield of salt-sensitive crops; values from 4,000 to 8,000 restrict the yield of many plant species, and at values over 8,000 micromhos/cm only salt-tolerant species yield satisfactorily (Richards 1954). As shown in Table 1.2-16, the highest mean electrical conductivity value encountered was 754.5 micromhos/cm in the Foredune cover type. This is still far below salinity levels that might be harmful to crop or native plant species. From the existing data collected to date, it does not appear that natural salinity levels reach sufficient concentrations to create serious soil salinity problems.



579110

Figure 1.2-1. Relationship of Vegetation Types, Mean Soil Conductivity, Soil Structure/Composition, and Soil Moisture for Sample Plots in the Bailly Study Area

1.3 MAMMALS

1.3.1 INTRODUCTION AND METHODS. The sampling techniques, locations (Figure 1.1-1), and intensity used to survey mammals during 1978 were consistent with those of previous years (TI 1975). Small mammal trapping data were collected during May and October, while data for larger mammals were collected in in May, July, and October. The road route survey for cottontail rabbits was run in May and July, as shown in Figure 1.3-1. An annotated checklist indicating common and scientific names of the species reported during 1978 is presented in Appendix B. Small mammal live-trapping data along assessment lines in five sampling locations are presented in Table 1.3-1. Larger mammal sightings and signs are summarized in Table 1.3-2. Figure 1.3-2 shows the numbers of mammal species encountered in each sampling location and each sampling period.

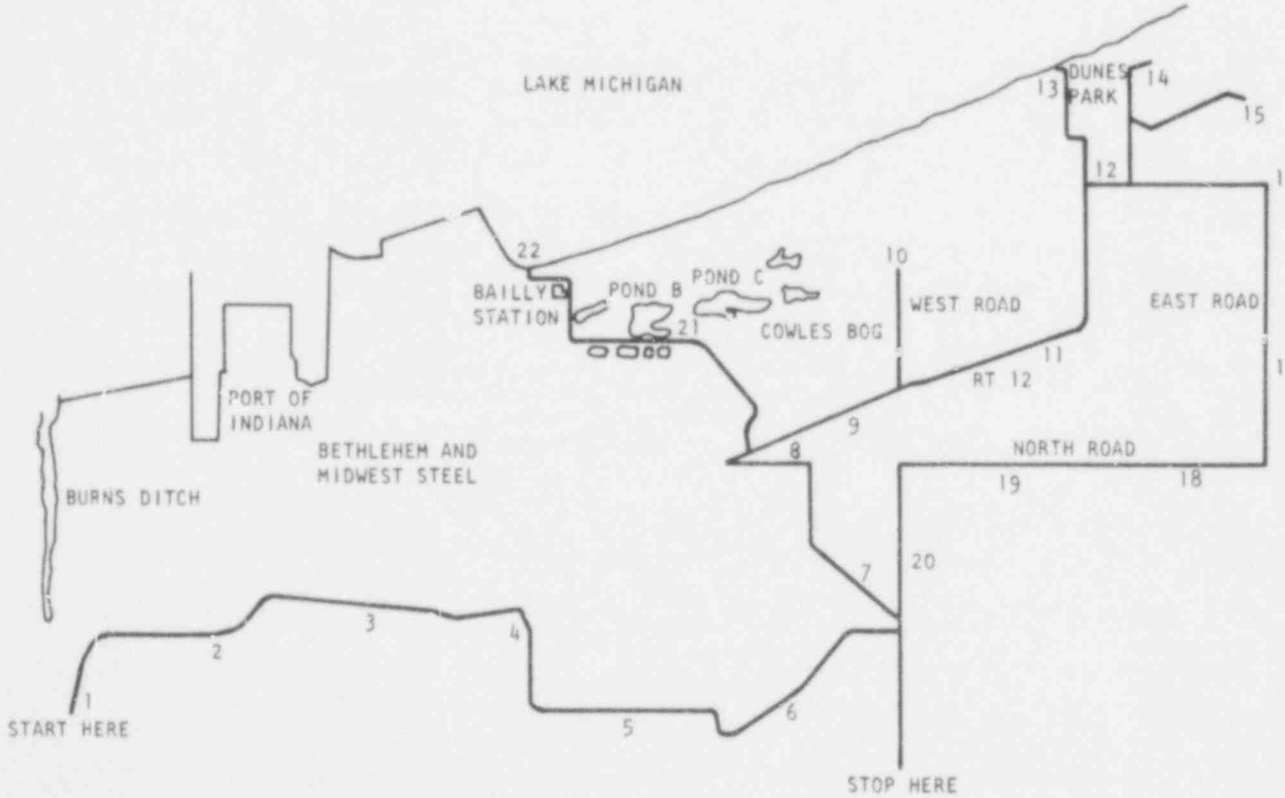


Figure 1.3-1. Twenty-Two Mile Road Route in the Vicinity of NIPSCo Bailly Study Area

579111

Table 1.3-1

Numbers of Small Mammals Captured per 100 Trapnights in Five Sampling Locations at the Bailly Study Area, May (M) and October (O), 1978

	Sampling Locations									
	Beachgrass		Immature Oak Forest		Cowles Bog(w)		Maple Forest		Transmission Corridor	
Species	M	O	M	O	M	O	M	O	M	O
Short-tailed shrew		0.3		0.3		0.7		3.0	0.3	7.3
Masked shrew									0.3	
Eastern chipmunk				0.3	1.0	0.3		1.7		0.3
Southern flying squirrel					0.3					
Red squirrel						0.3		1.0		
White-footed mouse		0.7		1.3	0.3	1.3	2.3	6.7		1.7
Meadow vole		1.7							0.7	3.0
Meadow jumping mouse		1.3							0.3	2.3
Number/100 trapnight	0	4.0	0	1.9	1.6	2.6	2.3	12.4	1.6	14.6
Number of species	0	4	0	3	3	4	1	4	4	5
Total species	4		3		5		4		6	

Table 1.3-2

Number or Signs (x) of Mammals Reported from Eight Sampling Locations at the Bailly Study Area, May (M), July (J), October (O), 1978

	Sampling Location																							
	Beachgrass			Foredune			Immature Oak Forest			Cowles Bog (Wooded)			Cowles Bog (Open)			Maple Forest			Emergent Macrophyte			Transmission Corridor		
Species	M	J	O	M	J	O	M	J	O	M	J	O	M	J	O	M	J	O	M	J	O	M	J	O
Opossum	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x					x
Eastern mole										x	x	x		x	x		x						x	
Eastern cottontail rabbit		x	x		x	x		x			x		1	x								1	1	
Eastern chipmunk							4	1	3	27	10	10				3	2	2						2
Woodchuck								x		x	x		1	x										
Fox squirrel							1		1	8	2	3				1		1						
Red squirrel							2		1	2	1	2				2		2						
Muskrat																				1	x			
Striped skunk					1																			
Raccoon	x	x	x	x	x	x	x	x	x	x	2	2		x	x	x	x	x	1	x	x	x		x
Long-tailed weasel*																								
White-tailed deer	x	x	x	x	x	x	x	x	x	x	1	x	x	x	x	x	x	x		x	x	x	x	x
No. of Species	3	4	4	3	5	4	6	6	6	7	9	7	4	6	4	6	5	6	2	3	3	3	3	4

*Road 'ill just off the immediate study area during July.

POOR ORIGINAL

579112

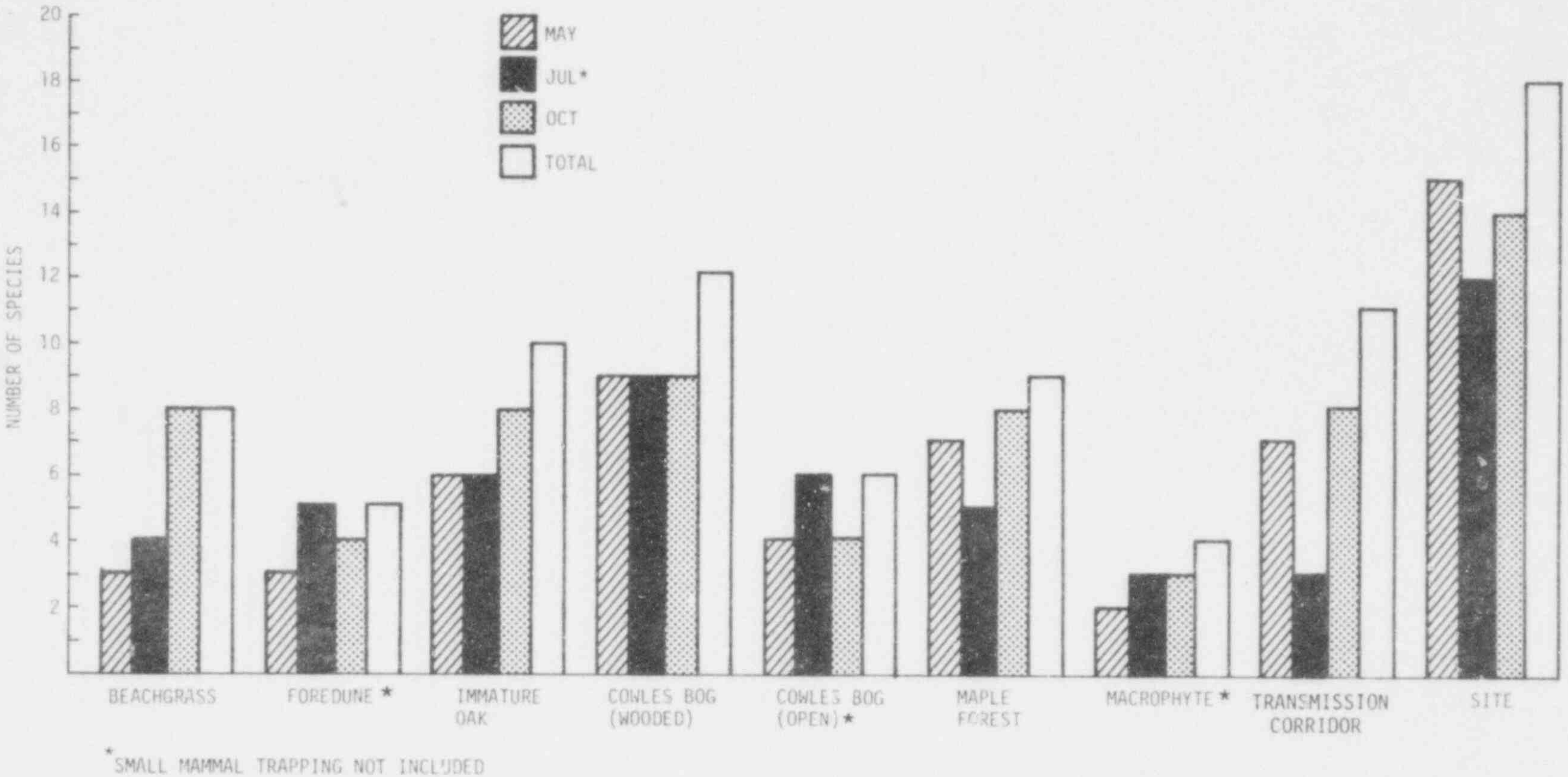


Figure 1.3-2. Numbers of Mammal Species Encountered on the Bailly Study Area during 1978

5791113

1.3.2 RESULTS AND DISCUSSION

1.3.2.1 Beachgrass Community. The 1978 mammal trapping results in this community were most comparable to those of 1977, with notable increases in captures from May to October. No small mammals were captured during May, while at least one individual of each of four species was captured during October. Results in other years of the monitoring period also indicate pronounced changes in trapping success and/or fluctuations in small mammal populations from season to season and year to year. Several factors may be involved. Meadow voles (*Microtus pennsylvanicus*) become virtually untrapable during certain months due primarily to excess food availability (Krebs et al. 1969). Other species (e.g., chipmunks) decrease activity or become dormant during prolonged hot or cold periods (Condrin 1936). The most important factor probably is winter dieoff, attributable to food scarcity from snow or ice accumulation and expiration due to extreme cold. Compensatory reproductive capabilities in turn enable population increases during moderate weather and when foods are readily available. Such extreme fluctuations in small mammal populations are not uncommon (Smith 1966).

Signs were reported for four species of larger mammals along the narrow beachgrass community during 1978 (Table 1.3-2). All except the eastern cottontail rabbit (*Sylvilagus floridanus*) were reported during the three sampling periods. This community is used extensively by larger mammals as a migration corridor to and from the Lake Michigan lakefront.

1.3.2.2 Foredune Community. As in past years, small mammal trapping was not conducted in the foredune. Five species of mammals, including the only striped skunk (*Mephitis mephitis*) sighted on the study area, were reported from this transitional community in 1978. The striped skunk is predominately carnivorous, feeding on whatever animal life is most plentiful (Martin et al. 1951); eggs of ground-nesting birds are a favorite food.

1.3.2.3 Immature Oak Forest. Three species of small mammals were captured during 1978 in this locale (Table 1.3-1). Captures per 100 trap-nights were lower (1.9) than those of 1977 (5.6). The reduced number of captures in lakefront locales, possibly reflecting low population levels, was believed to be caused by the extreme weather conditions during winter 1977-78.

579114

The eastern chipmunk (Tamias striatus) was the most commonly sighted species during 1978 in the immature oak forest (Table 1.3-2). Fox squirrels (Sciurus niger), the most abundant tree squirrel throughout Indiana (Muniford 1969), were sighted during May and October, as were red squirrels (Tamiasciurus hudsonicus). The red squirrel, unlike the fox squirrel, is distributed in suitable habitat only in the northern third of Indiana (Mumford 1969). Tracks were reported for the raccoon (Procyon lotor), opossum (Didelphis marsupialis), and white-tailed deer (Odocoileus virginianus) during each sampling period.

1.3.2.4 Cowles Bog (Wooded). Live-trapping in the wooded bog in 1978 produced five species of small mammals (Table 1.3-1). The white-footed mouse (Peromyscus leucopus) and eastern chipmunk, both common woodland inhabitants, were taken during May and October, while the others were captured in only one period. The southern flying squirrel (Glaucomy volans) captured during May in the wooded bog was the only 1978 sighting of the species on the study area. Flying squirrels, although rarely sighted during the day, are probably fairly abundant in the wooded bog. Mumford (1969) noted that this species is most abundant in mature and over-mature hardwood stands such as those found in the Indiana State forests.

Two of the trapped mammals and seven others were sighted or reported from tracks or signs in the wooded bog (Table 1.3-2). Four of these were encountered during each sampling period. The 12 mammal species reported in this sampling locale represented two-thirds of those found on the site (Figure 1.3-2).

Gray squirrels (Sciurus carolinensis), seen in past years at least once or twice in Cowles Bog woods, have always been uncommon on the study area. No sightings were made during 1978, perhaps indicating that the trend of decreasing populations noted in the northern third of Indiana during the mid-60's (Mumford 1969) is continuing.

1.3.2.5 Cowles Bog (Open). Six mammal species were reported from the open bog in 1978 (Table 1.3-2). Two, the eastern cottontail rabbit and woodchuck (Marmota monax), were sighted, while the others were reported from tracks, scats, or other visible signs. The dike running along the southern boundary of the open bog was the location of many of the observations.

579115

1.3.2.6 Maple Forest. The white-footed mouse was the only small mammal captured during May 1978 in the maple forest (Table 1.3-1). October trapping yielded three additional species, as well as an overall increase of approximately 10 individuals per 100 trap-nights. The second highest overall abundance (number per 100 trap-nights) of small mammals on the site occurred in this locale during October.

Five other species of mammals were sighted or reported by signs or tracks from the maple forest (Table 1.3-2); the fox squirrel was the only one sighted.

1.3.2.7 Emergent Macrophyte Community. The muskrat (Ondatra zibethica) and raccoon were sighted in this locale and tracks of the opossum and white-tailed deer were observed (Table 1.3-2). Both the raccoon and muskrat are common inhabitants of the macrophyte community. While the muskrat spends most of the time in or near water, good raccoon habitat, as noted on the Jasper-Pulaski Wildlife Area in northern Indiana (Lehman 1977), includes a mixture of timber and wetlands. Muskrat numbers have declined on the Bailly Study Area during the past two years, although there is no apparent reason.

1.3.2.8 Transmission Corridor. The greatest number of small mammal species captured on the Bailly Study Area during 1978 (6) was taken in this locale (Table 1.3-1). Three species, the short-tailed shrew (Blarina brevicauda), meadow vole, and meadow jumping mouse (Zapus hudsonicus), were trapped during May and October. Following trends on the site, each was captured more frequently in October. Captures of the short-tailed shrew, a voracious little species that consumes approximately its weight in food each day (Barbre 1975), increased during October (22 captures versus one in May). Those of the meadow vole and meadow jumping mouse increased more moderately. Peak population levels, activity periods, or trapping susceptibility of the meadow jumping mouse reportedly are greatest during August (Rybak et al. 1975).

An eastern chipmunk was also captured in this locale during October. Chipmunks are rarely seen out of nonforested habitat. It is doubtful that the NIPSCo right-of-way represents a barrier for chipmunks, since right-of-ways as wide as 100 meters apparently do not inhibit movements of smaller mammals (e.g., white-footed mice and short-tailed shrews)(Schreiber and Graves 1977).

579116

Additionally, two chipmunk sightings were recorded along the transmission corridor during October. Cottontails were observed during May and July, while surface runways of the eastern mole (<u>Scalopus aquaticus</u>) were distributed along much of the transmission corridor during all three sampling periods. The eastern mole constructs two types of runways, surface (approximately 2 to 5 centimeters deep) and underground [approximately 10 to 40 centimeters deep (Harvey 1976)]. Surface runways were visible in other sampling locales on the Bailly site.

1.3.2.9 <u>Road Route</u>. The May and July 1978 road route surveys for cottontail rabbits produced fewer sightings than past surveys, except that of April 1975 (Table 1.3-3). As in past surveys, the majority of the sightings occurred within the first ten stops.

Table 1.3-3

Cottontail Rabbit Sightings along a 22-Mile Road Route near the Bailly Study Area, 1974-1978

	Month of Observation									
Stop	Jun 1974	Aug 1974	Apr 1975	Jul 1975	May 1976	Jul 1976	May 1977	Jul 1977	May 1978	Jul 1978
1										
2						2				
3										
4					4	2	3	3		1
5	1			1	2	6		3	3	
6	4	1		2	1	2	7	4	2	2
7	5	2	1	3	3	7		1	1	
8	4	1			1		3			
9	2			1		1				
10						5				1
11		3	1	1		2				
12	2	1	2	1	1		3			
13			2					1		
14						1				
15										1
16	3	1		2						
17	1	1							1	
18	1	2		3	1	2	1			2
19	1	1			1	4	1			
20				2	1					
21				3						
22										
Total	24	13	6	19	15	34	18	12	7	7
Observations/Mile	1.1	0.6	0.3	[illegible]	0.7	1.5	0.8	0.6	0.4	0.4

Extreme 1977-78 winter weather conditions may have been responsible for the noticeable reduction in rabbits, although, as we have reported in the past,

cottontail population fluctuations are not unusual. Low numbers of cottontails were also reported during 1978 by other investigators using the roadside survey census method (Ill. Natur. Hist. Survey 1979).

1.3.2.10 Yearly Comparisons. For the past five years mammal populations on the Bailly Study Area have been monitored at an approximately equal level of effort. Some of the more important trends are included in the following discussion.

Small mammal populations on the Bailly Study Area generally fluctuate more within a year than from year to year. October trapping has generally produced greater catches than May trapping, probably indicating an overall post-winter recovery of small mammal numbers (populations). Peak populations may occur between May and October or during late fall (November or early December). It is unlikely that any small mammal population would peak much later than December.

Both small and larger mammal utilization of the study area appears to have remained fairly constant, except for decreases in muskrat numbers from aquatic habitat and the apparent absence of gray squirrels from forested habitat. Cottontail rabbit populations also appear to be experiencing a decline.

1.3.2.11 Disease and Parasites. No noteworthy occurrences of diseases were encountered during 1978 sampling. A previous report (TI 1975) described sources and vectors of mammalian disease.

1.4 AVIFAUNA (BIRDS)

1.4.1 INTRODUCTION AND METHODOLOGY. The objectives of the avifauna study have been previously stated, as have the methods (TI 1975). Birds were observed during May, July, and October 1978. Transect counts in sampling locations 1, 3, 4, 5, 6, 8, and along Cowles Bog trail (Figure 1.1-1) were accomplished during May and October (Tables 1.4-1 through 1.4-4). Roadside surveys (Figure 1.3-1) for Ring-necked Pheasant (Phasianus colchicus) and Mourning Dove (Zenaida macroura) were run during May and July (Table 1.4-5). Birds inhabiting aquatic areas (Figure 1.4-1) were censused during May and October and the results of these surveys given in Table 1.4-6. A checklist of all species observed in 1978 and reported since 1974 and an annotated checklist of 1978 species occurrences on the study area are presented in Appendix C.

579118

Table 1.4-1

Numbers of Birds per 100 Acres Calculated for the Beachgrass and Immature Oak Communities on the Bailly Study Area, 1978

	Sampling Locations							
	Beachgrass				Immature Oak			
	May		Oct		May		Oct	
Species	a*	b*	a	b	a	b	a	b
Eastern Phoebe					116			
Willow Flycatcher					58			
Blue Jay					58	116		
Common Crow							116	
Gray Catbird					58			
Philadelphia Vireo						58		
Magnolia Warbler					116			
Black-throated Green Warbler					58	58		
Blackburnian Warbler					58			
Chestnut-sided Warbler					58			
Scarlet Tanager						58		
Rose-breasted Grosbeak						58		
Dark-eyed Junco			279					116
No. of Species	0	0	1	0	8	5	1	1
Total Species	0		1		11		2	

*Transects.

1.4.2 RESULTS AND DISCUSSION

1.4.2.1 Beachgrass Community. The Dark-eyed Junco (*Junco hyemalis*) was the only species reported from transect surveys along the beachgrass community in 1978 (Table 1.4-1). The Barn Swallow (*Hirundo rustica*) was the only other species that occurred commonly in this locale. Both are commonly observed over other open habitats on the Bailly Study Area.

1.4.2.2 Immature Oak Forest Community. Eleven of the 13 species of birds reported in this community in 1978 were sighted during May and the other 2 were seen during October. The Blue Jay (*Cyanocitta cristata*) and Common Crow (*Corbus brachyrhynchos*) are considered permanent residents, while the others are seasonal residents or migrants.

579119

Large numbers of migrating songbirds (passerines) enter and exit Indiana by way of the forested communities that border the southern shoreline of Lake Michigan. Some, as noted by numerous dead birds occasionally found along the beachfront, expire during the migratory journey. Songbirds generally have a 50 percent chance of surviving one year, with mortality greatest during migration or periods of severe weather (Robbins 1978).

1.4.2.3 Cowles Bog (Wooded). Transect surveys during May and October 1978 revealed 18 species of birds in the wooded bog (Table 1.4-2). Fifteen species were sighted during May, and four species were sighted during October, with the Wood Thrush (*Hylocichla mustelina*) the species observed during both periods. Wood Thrushes were abundant in the wooded bog during 1978, as indicated by Cowles Bog trail data as well (Table 1.4-3). Six species of warblers were sighted during May; all are migrants or summer residents.

The diversity of habitat (dry, wet, open, forested) in a community such as the wooded bog strongly influences the number of species present (Galli et al. 1976).

Table 1.4-2

Numbers of Birds per 100 Acres Calculated for the Cowles Bog (Wooded and Open) Community on the Bailly Study Area, 1978

	Sampling Locations							
	Cowles Bog (Wooded)				Cowles Bog (Open)			
	May		Oct		May		Oct	
Species	a*	b*	a	b	a	b	a	b
Mallard		58						58
Wood Duck							58	
Red-headed Woodpecker						58		
Blue Jay				116				
Black-capped Chickadee		58						
Long-billed Marsh Wren					58			
Short-billed Marsh Wren	58				116			
Gray Catbird		58				58		
American Robin			58					
Wood Thrush	116		58					
Veery					58			
Starling						58		
Golden-crowned Kinglet				116				
White-eyed Vireo	58	58						
Philadelphia Vireo		58						
Warbling Vireo		58						
Golden-winged Warbler	58							
Yellow-rumped Warbler	58						174	174
Yellow Warbler						174		
Magnolia Warbler		116						
Mourning Warbler	58							
Canada Warbler	58	58						
American Redstart	58	116						
Red-winged Blackbird		116				174	522	174
Common Grackle								290
Brown-headed Cowbird								58
American Goldfinch						58		
Dark-eyed Junco							116	58
Swamp Sparrow					58			
White-throated Sparrow			58	58				
No. of Species	8	10	3	3	4	6	4	6
Total Species	15		5		10		7	

*Transects.

1.4.2.4 Cowles Bog (Open). Sixteen species of birds were reported along transects in the open bog during 1978 (Table 1.4-2). Ten species were observed during May, while seven species were noted during October. The Red-winged Blackbird (Agelaius phoeniceus) was observed during both months. It was also one of the most abundant species during May and October. Redwings nested by the hundreds in the cattail marsh in the open bog during May, and roosted by the thousands in the cattails during October. Of the 34 million terrestrial birds that are estimated to breed in Indiana, nearly 10 percent (3 million) are Red-winged Blackbirds (Webster 1966).

1.4.2.5 Cowles Bog Trail. The trail through the wooded bog traverses some of the most productive habitat for wildlife on the Bailly Study Area. The diversity of habitat accounts for the species represented. The 1978 May and October surveys along the eight sections of Cowles Bog trail accounted for 36 bird species (Table 1.4-3). Twenty-nine species were sighted during May and 8 species were sighted during October. The Gray Catbird (Dumetella carolinensis) was observed along all eight transects during May. Other common species included the Blue Jay, Wood Thrush, American Redstart (Setophaga ruticilla), and Red-winged Blackbird. These species were also common along transects in Cowles Bog (wooded).

1.4.2.6 Maple Forest Community. Twelve bird species, nine during May and four during October, were observed in the maple forest (Table 1.4-4). The Blue Jay was sighted during May and October. Birds inhabiting the maple forest were those typically associated with other forest habitats on the Bailly Study Area.

1.4.2.7 Transmission Corridor. Only six birds were noted in 1978 in this location, four in May and two in October (Table 1.4-4). Unlike forested habitats on the Bailly Study Area, the transmission corridor contains primarily grasses and other low herbaceous vegetation, with comparatively little stratification. The lack of significant stratification limits the kind of roosting, nesting, and other spaces so that fewer species utilize this locale.

1.4.2.8 Road Route Census. The road route census was conducted during May and July 1978 (Table 1.4-5) along the 22-mile route shown in Figure 1.3-1. The census is conducted primarily to monitor trends in two of Indiana's important game birds, the Ring-necked Pheasant and Mourning Dove.

Table 1.4-3

Numbers of Birds per 100 Acres for Each Transect along Cowles Bog Trail on the Bailly Study Area, May (M) and October (O), 1978

	375-Ft Transects															
	1		2		3		4		5		6		7		8	
Species	M	O	M	O	M	O	M	O	M	O	M	O	M	O	M	O
Mallard							116		116							
Yellow-billed Cuckoo			58													
Common Nighthawk									58							
Common Flicker															58	
Eastern Kingbird											58					
Blue Jay	116	58					58				58					58
White-breasted Nutnatch								58								
Brown Creeper		58														
Tufted Titmouse										116						
Shortbilled Marsh Wren	116				58								58			
Gray Catbird	116		116		58		116		116		58		58		116	
Brown Thrasher							58		58							
American Robin	174				58				58		58					
Wood Thrush	58		58	58	116		116	58				58			58	
Swainson's Thrush															58	
Gray-cheeked Thrush							58									
Veery			58			58					116				58	
Ruby-crowned Kinglet												116				
White-eyed Vireo	58															
Yellow-throated Vireo	58															
Red-dyed Vireo			58		58		58									
Warbling Vireo											58		58		58	
Magnolia Warbler	116												58			
Bay-breasted Warbler			116												58	
Nashville Warbler											58					
Wilson Warbler											58		58			
Hooded Warbler	116															
Canada Warbler	116		58										58		174	
American Redstart			116				58				58		58		116	
Red-winged Blackbird	232	116		58					58							58
Common Grackle		58	58										58			
Brown-headed Cowbird	116															
Scarlet Tanager											58					
Rufous-sided Towhee											58					
White-throated Sparrow				58				58						116		
Fox Sparrow				58												
No. of Species	12	4	9	4	5	1	8	3	6	1	11	2	8	1	9	2
Total Species (36)	14		12		6		10		7		13		9		11	

Table 1.4-4

Numbers of Birds per 100 Acres for the Maple Forest and Transmission Corridor on the Bailly Study Area, May and October 1978

	Maple Forest				Transmission Corridor			
	May		October		May		October	
Species	a*	b*	a	b	a	b	a	b
Mallard					58			
Hairy Woodpecker	58							
Blue Jay		58	116					
Brown Creeper				58				
American Robin			58		58			
Veery		116						
White-eyed Vireo		58						
Philadelphia Vireo	58							
Blackburnian Warbler	116							
Canada Warbler	58							
American Redstart	174	58						
Red-winged Blackbird						58		
Rosebreasted Grosbeak	58							
Dark-eyed Junco							58	
Field Sparrow							58	
Tree Sparrow					58	58		
White-throated Sparrow				58				
No. of Species	6	4	2	2	3	2	2	0
Total Species	9		4		4		2	

*Transects.

The Ring-necked Pheasant was not observed during May and July along the 22-mile road route. Pheasants have always been uncommon in the study area, with generally only one or two sightings per survey. Mourning Dove observations were also down slightly from past years. Only 2 and 10 sightings were made during May and July respectively.

The species counted in most numbers during both surveys was the Ring-billed Gull (Larus delawarensis). Gulls and other shore and wading birds congregate on the lake and beach near the Bailly discharge canal, which is near one of the stops on the road route.

The most frequently sighted species during May was the Common Grackle (Quiscalus quiscula), observed on 18 stops. The Mourning Dove was the most frequently sighted species during July.

Table 1.4-5

Number of Observations and Number of Stops Recorded for Each Species along the 22-Mile Road Route Conducted in the Vicinity of Bailly Study Area, 1978

Species	May No. of Observations	May Stops Observed	July No. of Observations	July Stops Observed
Great Blue Heron	1	1	2	2
American Kestrel			2	2
Least Sandpiper			1	1
Killdeer	2	2		
Herring Gull	15	1	18	1
Ring-Billed Gull	185	2	123	1
Bonaparte's Gull	6	1		
Ruddy Turnstone	14	1		
Rock Dove			4	2
Mourning Dove*	2	2	10	7
Yellow-billed Cuckoo	1	1		
Chimney Swift	2	1	1	1
Belted Kingfisher	1	1		
Common Flicker	3	3	5	3
Red-headed Woodpecker			1	1
Hairy Woodpecker	1	1	1	1
Downy Woodpecker	2	2		
Cliff Swallow			3	1
Tree Swallow	4	2	12	4
Barn Swallow	4	1	3	2
Bank Swallow			7	1
Blue Jay	9	8	9	6
Common Crow	1	1	8	5
Carolina Wren	1	1		
Gray Catbird	13	7	3	3
Brown Thrasher	1	1		
American Robin	33	16	10	6
Veery	4	4	4	3
Starling	16	5		
Philadelphia Vireo	1	1		
Red-eyed Vireo	1	1		
Warbling Vireo	5	3		
Blackburnian Wa[illegible]er	1	1		
Yellow Warbler	4	3		
Canada Warbler	2	2		
Magnolia Warbler	2	2		
Common Yellowthroat	1	1		
American Redstart	1	1	2	1
House Sparrow	13	5	17	5
Red-winged Blackbird	18	6	13	6
Rusty Blackbird			14	4
Common Grackle	31	18	8	4
Brown-headed Cowbird			1	1
Cardinal	8	5	1	1
Rose-breasted Grosbeak	10	6	1	1
Indigo Bunting	1	1		
American Goldfinch	2	2		
Rufous-sided Towhee	1	1		
Chipping Sparrow	1	1		
Song Sparrow	4	4	1	1
Tree Sparrow	7	3	5	2
No. of Species	43		30	

*Game species.

579124

Data collected during 1978 along the road route was similar to past years in both numbers of species and numbers of individuals observed.

1.4.2.9 Aquatic Sampling Locations. Since May 1977 comparative surveys for aquatic birds have been made during May and October at 10 aquatic locations (Figure 1.4-1) on the Bailly Study Area. During each survey, period maximum counts of aquatic birds are made for each location. Table 1.4-6 presents 1978 aquatic survey data.

Sampling locations with the greatest numbers of species and individuals were B, C, and J (Table 1.4-6). Ponds B and C were utilized heaviest by waterfowl during October. The Bailly discharge area (J) contained greater numbers of shore birds during May, although the difference between May and October usage was not so great as noted on the ponds. Most of the birds assembled during May and October were migrants, although small numbers of some of the species do breed in the area. As many as 100,000 dabbling ducks [e.g., Mallard (Anas platyrhynchos), Wood Duck (Aix sponsa)] and 75,000 diving ducks [e.g., Ring-necked Duck (Aythya collaris)] migrate through an area encompassing northcentral Indiana (Bellrose 1968).

As in past surveys, the Mallard was generally the most frequent and abundant waterfowl species sighted on the study area, possibly because Indiana is about midway between the principal breeding and wintering grounds of the species (Bellrose and Crompton 1970). The Ring-billed Gull was the most abundant species counted in 1978, and practically all of these sighted occurred along the lakefront. A maximum count of 210 individuals was tallied during May surveys, while a maximum of 51 individuals was observed during October aquatic bird surveys; a greater number (123), however, was observed in the same location during the October road route survey (Table 1.4-5).

The species of gulls that occur on the Bailly Study Area are primarily fish eaters and scavengers (Martin el al. 1951). Desirable fish (game species) constitute a minor part of their diet and the service they render in scavenging marine and other detritus is considerable.

579125

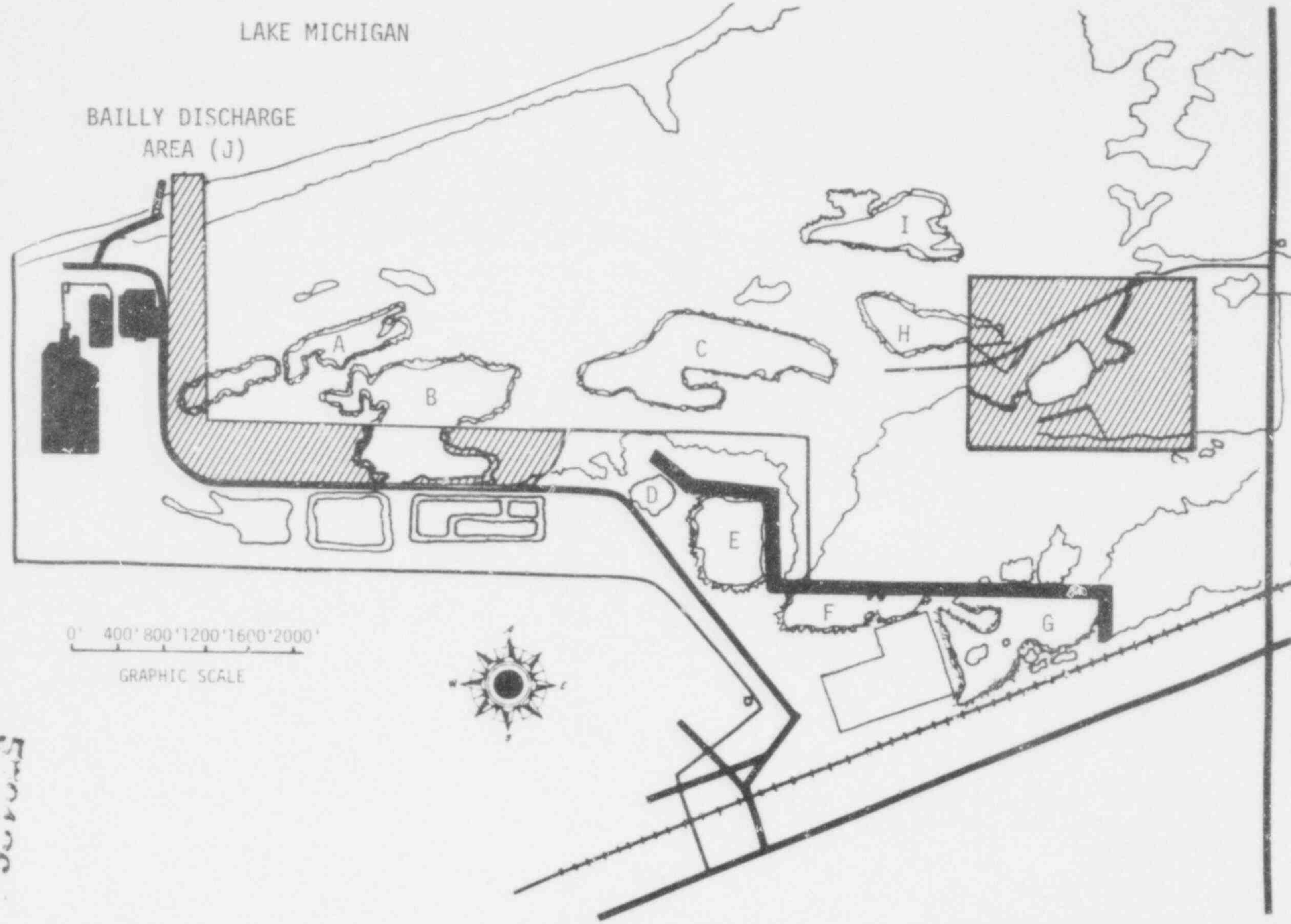


Figure 1.4-1. Major Aquatic Habitats (A through J) Utilized by Water Birds on the Bailly Study Area, 1978

Table 1.4-6

Maximum Numbers of Aquatic and Shore Birds Observed during Aquatic Bird Surveys from 10 Sampling Locations on the Bailly Study Area, May (M) and October (O), 1978

	Aquatic Sampling Locations																			
	A		B		C		D		E		F		G		H		I		J	
Species	M	O	M	O	M	O	M	O	M	O	M	O	M	O	M	O	M	O	M	O
Horned Grebe				2																
Pied-billed Grebe	2	1	2	3									3	2						
Double-crested Cormorant																				1
Great Blue Heron																			1	
Great Egret			1																	
Green Heron			2				1		1				7				1			
Black-crowned Night Heron							1													
Least Bittern					1															
Canada Goose						1														
Mallard	1		2	2	3	76	2			4			3	9	2		2	1		
Black Duck						10														
Gadwall						13														
Pintail				21																
Green-winged Teal						39														
Blue-winged Teal						12														
American Wigeon				56																
Northern Shoveler										1										
Wood Duck										7						2				
Ring-necked Duck						18														
Common Merganser								1												
Sora													1							
Common Gallinule													2							
American Coot				9		20			3	2		4	12	18						
Killdeer																				2
Ruddy Turnstone																			6	20
Herring Gull																			34	13
Ring-billed gull																			210	51
Bonaparte's Gull																			37	3
Common Tern																			2	
Belted Kingfisher	2		1	1	2								1							
No. Species (29)	3		9		10		4		5		1		7		2		2		8	

579129

1.4.2.10 Annual Bird Comparisons (1974-1978). Few changes in species or numbers have occurred from the onset of the studies on the Bailly Study Area.

Grebes have occurred in about equal numbers and at the same locations. Generally, waterfowl numbers and species have fluctuated little, although two species, the Black Duck (*Anas rubripes*) and Wood Duck, appear to be decreasing in numbers slightly. Hawks and owls have never been common on the study area. Wading birds remained in the reduced state noted during 1977. Numbers of individuals of commonly sighted passerine species were up slightly from 1977 results.

1.5 AMPHIBIANS AND REPTILES

1.5.1 INTRODUCTION AND METHODOLOGY. Herpetofauna were sampled during May and July 1978. Moderate temperatures during the May sampling periods accounted for a substantial amount of chorus activity. The intensity and sampling locations were identical to 1975.

Sampling locations (1-8) are noted in Figure 1.1-1. The results of surveys within these locations are reported in Table 1.5-1 and Appendix D. No attempt was made to calculate abundance, since most sightings occurred away from established transects.

1.5.2 RESULTS AND DISCUSSION

1.5.2.1 Lakefront Communities. The blue racer (*Coluber constrictor*) was the only species observed in the three lakefront communities in 1978 (Table 1.5-1). The large (1 meter) individual observed appeared to be searching for food. Small mammals, an important item in the diet of larger racers, were scarce in these communities during May 1978 (see subsection 1.3.2.1).

1.5.2.2 Cowles Bog (Wooded). Six species of herpetiles were observed in the wooded bog, five during May and two during July (Table 1.4-1). Cricket frogs (*Acris crepitans*) and gray treefrogs (*Hyla versicolor*) were abundant, with chorus activity noted from numerous locations. Most of the gray treefrog calling came from high in the forest canopy. The gray treefrog is the only arboreal amphibian in Indiana (Minton 1966).

579128

Table 1.5-1

Relative Abundance of Amphibians and Reptiles Observed in Eight Sampling Locations at the Bailly Study Area, May (M) and July (J), 1978

	Sampling Locations*															
	Beachgrass		Foredune		Oak Forest		Cowles Bog (W)		Cowles Bog (O)		Maple Forest		Emergent Macrophyte		Transmission Corridor	
Species	M	J	M	J	M	J	M	J	M	J	M	J	M	J	M	J
Amphibians																
Red-backed salamander							C									
American toad																U
Cricket frog							A		A				A			
Spring peeper									A		C					
Gray treefrog							A		C							
Bull frog													C	C		
Green frog							U	C	U			U		U		
Wood frog							C									
Reptiles																
Painted turtle													A	A		
Northern water snake													C	U		
Blue racer	U															
Eastern hognose snake											U					
Eastern garter snake								U								
Total (13)	1		0		0		5		4		3		5		1	

*A = Numerous individuals observed, C = Several observations, U = Only one or two observations.

579 129

Green frogs (Rana clamitans), which were observed during both surveys, appeared considerably less abundant in the wooded bog than during past years. This species overwinters in the larval stage (tadpoles), transforming into the adult stage in the spring. Low water levels in the wooded bog, combined with cold temperatures during winter 1977-78, possibly killed a number of green frog larvae.

1.5.1.3 Cowles Bog (Open). Large choruses (50+ individuals) of cricket frogs and spring peepers (Hyla cruicifer) were heard in the open bog during May 1978. A small chorus of gray treefrogs and an occasional green frog were also heard.

Rainfall plays an important roll in anuran emergence and chorus activity. Species such as the green frog are capable of emergence during periods of warm rainfall when air temperatures are as low as 40°F (Martof 1953). It is quite possible that peak emergence preceded May sampling.

1.5.2.4 Maple Forest. The spring peeper was the only species commonly observed in the maple forest. Peepers become quite obscure when they are not calling. and although undoubtedly present during July, none were sighted. One eastern hognose snake (Heterodon platyrhinos) was observed along the floor of the maple forest community. The hognose has not been previously reported from the maple forest; it is also uncommon in other habitats on the site.

1.5.2.5 Emergent Macrophyte Community. Three of the five species of herpetiles observed in this sampling location occurred during both May and July (Table 1.5-1). Cricket frogs were abundant during May. Painted turtles (Chrysemys picta) were observed sunning on above-water structures during both sampling periods. Habitat within the macrophyte community is excellent for painted turtles since they are quiet water turtles that feed on all sorts of plant and animal material (Cochran and Goin 1970). The northern water snake (Natrix sipedon) was another fairly common inhabitant of the macrophyte community. This community has through the years produced consistently equal numbers of species and individuals.

1.5.2.6 Transmission Corridor. The American toad (Bufo americanus) was the only species encountered along the transmission corridor during 1978. Toads are almost exclusively insectivorus, with ants and beetles making up 70 to 80 percent of their diet (Clark 1974).

1.5.2.7 Annual Comparisons. The changes in amphibian and reptile populations on the Bailly Study Area have been generally subtle. Each year there appear to be fewer individuals of many of the reptile species (especially snakes and lizards), although few of the reptile species present have ever been observed to be common.

1.6 INVERTEBRATES

1.6.1 INTRODUCTION AND SAMPLING REGIME. Entomological sampling in 1978 on the Bailly Study Area comprised 26 samples from established vegetative and aquatic locations and reconnaissance over the entire site, especially to determine butterfly activity and presence and extent of pest activity. The number of samples taken represented the secluded complement: sweepnet and litter samples from locations 1, 2, 3, 4A, 4B, 6, and 8; dipnet samples from locations 2, 4B, 5, 6, 7, and 8; and lighttrap samples from 1, 2, 3, 4B, 6, and 8 (Figure 1.1-1). Sampling methods are described in the Standard Operating Procedure for the Northern Indiana Public Service Company's Bailly Station Nuclear 1 (TI 1978) and the 1974-1975 annual report (TI 1975).

Sampling conditions on the study area in general were good. Two aquatic locations not sampled during the previous summer, 2 and 4B, again contained sufficient water for sampling. The level of standing water in location 4B, the wet woods of Cowles Bog, is maintained naturally and typically fluctuates with the season and amount of precipitation; the low level of last summer (1977) reflected the drought conditions prevalent in the area during spring 1977. The cattail/shallow pool habitat of location 2, on the other hand, is maintained partially by drainage shunted into the location. The area was drained in summer 1977 to allow construction of a fence around the Bailly plant, but the viable condition of the vegetation and advanced recovery of the arthropod community a year later indicated disturbance of the habitat was only temporary and probably did not impact the site's entomological fauna.

Besides the more normal rainfall that preceded 1978 entomological sampling, a second factor contributing to good sampling conditions was the stability of atmospheric conditions during the sampling period. Daily temperatures were more typical of July than during 1977 sampling, when a record low temperature occurred, and most days were fair rather than cloudy and windy as in 1977. The

coolest sampling temperatures in 1978 (approximately 14 to 17°C) occurred while lighttrapping locations 4B, 6, and 8. These temperatures apparently affected the activity of some insect groups but apparently not that of moths, which are captured most effectively at lighttraps.

1.6.2 RESULTS AND DISCUSSION. Entomological taxa identified during July 1978 sampling on the Bailly site are listed on Table 1.6-1. The number of insect families observed (140) was comparable to those observed in summers of 1975 and 1976 and considerably more (by two dozen) than collected in 1977. Composition and abundance varied somewhat from previous sampling periods, reflecting characteristic population fluctuations and emergence patterns. Entomological taxa recorded during the five-year study are in Appendix E.

Five insect families were newly observed on the site in 1978: termites (Isoptera:Rhinotermitidae), giant silkworm moths (Lepidoptera:Saturniidae), reticulated beetles (Coleoptera:Cupeidae), velvet ants (Hymenoptera:Mutillidae), and mydas flies (Diptera:Mydidae).

The termites, which were clustered in the foredune feeding on the vegetation sampling plot stakes, were the eastern subterranean termite, Reticulitermes flavipes. Subterranean species nest in soil and either tunnel to wood or construct earthern tubes to wood not in contact with soil. They are the only kind of termite likely to be found in the region. Species that attack dry wood such as furniture and utility poles (drywood and powderpost termites) and those with need for high moisture content as in tree roots and damp logs (dampwood termites) are restricted east of the Great Plains to the southern states.

Two giant silkworm moths were observed: the polyphemus moth (Antheraea polyphemus), a large (125-mm wingspread) yellowish brown moth with an eyespot in each hindwing and the io moth (Automeris io), a smaller (75-mm wingspread), brighter yellow-brown species, also with hindwing eyespots. The polyphemus was seen in two locations: the immature oak community at the lighttrap and the dry woods of Cowles Bog on leaf litter. The caterpillar of this common species, which ranges to the westernmost states, feeds on several trees, including oak, hickory, elm, and birch. The io was swept from vegetation in the maple woods. The io is a common species also, but it ranges westward only to the Great Plains. The larva, a highly spiny green caterpillar, is a general feeder.

POOR ORIGINAL

Table 1.6-1

Checklist of Entomological Taxa Collected in the Bailly Study Area, July 1978

	Sampling Stations								
	1	2	3	4A	4B	5	6	7	8
Taxa	Beachgrass	Foredune	Immature Oak	Cowles Bog Dry Woods	Cowles Bog Wet Woods	Dunes Creek	Maple Woods	Pond B	Transmission Corridor
Protura (proturans)				X					
Collembola (springtails)									
Poduridae			X	X	X		X		
Isotomidae	X	X	X	X	X		X		X
Entomobryidae	X			X					X
Ephemeroptera (mayflies)									
Caenidae									
Caenis spp.								X	X
Baetidae									
Cloeon sp.		X							
Odonata (dragonflies, damsel flies)									
Aeshnidae (dragonflies)									
Aeschna sp.							X		
Anax junius								X	
Libellulidae (dragonflies)									
Erythemis sp.		X						X	
Libellula sp.								X	
Pachydiplax longipennis								X	
Plathemis lydia									X
Sympetrum vicinium		X						X	X
Lestidae (damselflies)									
Lestes rectangularis				X					
Coenagrionidae (damselflies)		X						X	X
Enallagma sp.		X							
Ischnura spp.								X	
Orthoptera (grasshoppers, katydids, roaches, etc.)									
Acrididae (grasshoppers)		X		X					X
Dissosteira carolina (Carolina grasshopper)									X
Tettigoniidae (katydids)		X					X		X
Gryllidae (crickets)									
Oecanthus sp.					X				
Phasmatidae (walkingsticks)									
Diapheromera femorata			X						
Mantidae (mantids)		X							
Blattidae (roaches)									
Parcoblatta virginica		X							
Dermaptera (earwigs)									
Foriculidae					X				
Isoptera (termites)									
Rhinotermitidae		X							
Plecoptera (stoneflies)									
Perlidae									
Perlesta placida		X							
Pscocoptera (psocids)									
Pseudocaeciliidae	X			X	X				
Psocidae		X							
Thysanoptera (thrips)									
Thripidae	X								
Hemiptera (bugs)									
Corixidae (waterboatmen)									
Sigara spp.		X		X	X				
Trichocorixa spp.		X							X
Notonectidae (backswimmers)									
Notonecta spp.		X			X				
Pleidae (pleid water bugs)									
Plea striola		X						X	X
Belostomatidae (giant water bugs)									
Belostoma sp.						X			
Gerridae (water striders)									
Gerris sp.							X		X
Trepobates sp.		X							X
Veliidae (broadshouldered water striders)								X	
Mesoveliidae (water treaders)									
Mesovelia sp.	X	X						X	
Reduviidae (assasin bugs)							X		
Zelus sp.				X					
Phymatidae (ambush bugs)									
Phymata sp.	X								X
Tingidae (lace bugs)									
Corythuca arcuata				X					
C. marmorata		X							
Lygaeidae (seed bugs)									
Cymus sp.	X								
Geocoris sp.					X				
Ischnodemus falicus									X
Miridae (leaf bugs)			X		X				
Lygus lineolaris (tarnished plant bug)				X					
Sixeonotus sp.									X
Trigonotylus ruficornis									X
T. tarsalis				X	X				X
Pentatomidae (stink bugs)									
Cosmopepla bimaculata			X						
Mormidea lugens				X	X				
Solubea sp.									X
Homoptera (hoppers, aphids, etc.)									
Membracidae (treehoppers)									
Cyrtolobus spp.		X	X	X					
Cicadellidae (leafhoppers)	X			X	X		X		
Chlorotettix sp.		X	X						X
Commellus sp.		X							

579133

Table 1.6-1 (Contd)

	Sampling Stations								
	1	2	3	4A	4B	5	6	7	8
Taxa	Beachgrass	Foredune	Immature Oak	Cowles Bog Dry Woods	Cowles Bog Wet Woods	Dunes Creek	Maple Woods	Pond B	Transmission Corridor
Homoptera (Contd)									
Empoasca sp.	X	X							X
Erythroneura sp.		X							
Texamia sp.		X		X					
Graphocephala sp.		X	X						
Gyponana sp.		X							
Idiocerus sp.					X				
Macrosteles divisa	X	X							
Mesamia sp.			X						
Paraphlepsius sp.		X							
Polyamia sp.	X	X							
Cercopidae (spittlebugs)		X	X	X	X		X		X
Delphacidae (delphacid planthoppers)	X	X							X
Cixiidae (cixiid planthoppers)		X							
Achilidae (achilid planthoppers)		X		X	X				
Acanaloniidae (acanaloniid planthoppers)		X							
Psyllidae (jumping plantlice)	X								X
Aphididae (aphids)		X		X	X				
Coleoptera (beetles)									
Cupedidae (recticulated beetles)									
Cupes concolor			X						
Cicindellidae (tiger beetle)					X				
Cicindella dorsalis	X								
Cicindella sexguttata									X
Carabidae (ground beetles)					X				X
Lema pumila			X						
Platynus sp.	X								
Pterostichus sp.	X								
Tachys sp.							X		
Haliplidae (crawling water beetle)									
Haliplus sp.						X			X
Dytiscidae (predaceous diving beetle)									
Hydroporus consimilis						X		X	X
H. niger						X			
Hygrotus sp.						X			X
Ilybius sp.									X
Hydrophilidae (water scavenger beetles)									
Berosus sp.									X
Helophorus sp.			X						
Hydrobius sp.					X				
Hydrochara obtusata		X							
Paracymus sp.						X			X
Tropisternus sp.		X						X	
Staphylinidae (rove beetles)	X	X		X	X				X
Conosomus sp.							X		
Falagria sp.							X		
Ptiliidae (featherwinged beetles)									
Ptinella sp.				X	X				
Pselaphidae (shortwinged mold beetles)			X						
Cantharidae (soldier beetles)				X					
Cantharis rectus				X	X				
Lampyridae (fireflies)									
Ellychnia corrusca	X								
Photinus sp.		X							
Cleridae (checkered beetles)									
Phyllobaenus pallipennis			X						
Elateridae (click beetles)									
Hemicrepidus sp.							X		X
Limonius interstitialis							X		
Buprestidae (metallic woodborers)									
Acmaeodera pulchella		X							
Helodidae (marsh beetles)									
Cyphon sp.		X		X	X				
Prionocyphon sp.	X								
Scrites sp.	X	X	X						
Phalacridae (shining fungus beetles)									
Olibrus sp.									X
Nitidulidae (sap beetles)									
Brachypterus sp.							X		X
Lathridiidae (minute brown scavenger beetles)									
Corticaria sp.									X
Erotylidae (pleasing fungus beetles)									
Megalodacne fasciata		X							
Coccinellidae (lady beetles)			X						
Coleomegilla fuscilabris	X								X
Cycloneda snaguinea	X								
Hippodamia convergens	X								
Hippodamia glacialis									X
Hippodamia tridecimpunctata		X							
Hyperaspis undulata	X								
Anthicidae (antlike flower beetles)									
Notoxus sp.		X							
Euglenidae (antlike leaf beetles)									
Emelinus sp.				X					
Pedilidae (false antlike flower beetles)	X	X							
Mordellidae (tumbling flower beetles)									
Mordella spp.		X		X					
Alleculidae (combclawed beetles)									
Hymenorus sp.		X							
Isomera sericea		X	X						

579134

Table 1.6-1 (Contd)

Taxa	1 Beachgrass	2 Foredune	3 Immature Oak	4A Cowles Bog Dry Woods	4B Cowles Bog Wet Woods	5 Dunes Creek	6 Maple Woods	7 Pond B	8 Transmission Corridor
	Sampling Stations								
Coleoptera (Contd)									
Tenebrionidae (darkling beetles)	X								
Uloma imberbis		X							
Xylopinus saperdioides	X	X							
Melandryidae (false drakling beetles)									
Symphora sp.	X	X	X						
Scarabeidae (scarabs)									
Ataenius spp.	X	X							
Geotrupes sp.	X								
Onthophagus orpheus	X								
Phyllophaga sp.	X	X							
Cerambycidae (longhorned beetles)									
Psenocerus supernotatus		X							
Chrysomelidae (leaf beetles)			X						
Altica sp.	X								
Anoplitis inaequalis					X				
Chalmisus sp.			X						
Chrysodina sp.				X					
Colaspsis		X							
Cryptocephalus sp.							X		
Diachus sp.		X							
Dibolia sp.							X		
Disonycha sp.		X							
Lema collaris		X							
Nodonota sp.				X	X				
Pachybrachis sp.							X		
Anthribidae (fungus weevils)									X
Curculionidae (weevils)	X	X	X	X	X	X	X	X	X
Apion sp.									X
Calendra sp.	X								
Scolytidae (bark beetles)	X								
Neuroptera (antlions, dohsonflies, etc.)									
Corydalidae (dobsonflius, fishflies)					X	X		X	
Chrysopidae (green lacewings)		X	X	X					X
Hemerobiidae (brown lacewings)				X	X				
Myrmeleontidae (antlions)	X	X							
Mecoptera (scorpionflies)									
Bittacidae (hangingflies)									
Bittacus sp.							X		
Trichoptera (caddisflies)									
Phi ,ganeidae									
Banksiola selina			X						
Oligostomis sp.							X		
Limnephilidae									X
Athripsodes sp.		X							
Lepidoptera (butterflies, moths)									
Papilionidae (swallowtail butterflies)									
Papilio polyxenes (black swallowtail)	X	X							
Pieridae (whites, sulfurs)									
Colias philodice (common sulfur)	X	X							
Pieris rapae (imported cabbageworm)	X	X	X						X
Danaidae (milkweed butterflies)									
Danaus plexippus (monarch)	X	X							
Nymphalidae (brushfooted butterflies)									
Junonia coenia (buckeye)				X					
Limenitis archippus (viceroy)									X
Phyciodes tharos (pearl cresent)				X					
Polygonia interrogationis (question mark)									X
Speyeria cybele (great spangled frittilary)		X		X					
Vanessa atalanta (red admiral)									X
Satyridae (satyr butterflies)									
Euptychia cymela (little wood satyr)				X					
Lethe eurydice (eyed brown)				X					X
Lethe portlandia (pearly eye)				X					
Lycaenidae (blues, coppers, hairstreaks)									
Everes comyntas (eastern tailed blue)							X		
Lycaenopsis argiolus (spring azure)				X	X				
Satyrium caryaevorous (hickory hairstreak)				X					
Saturniidae (giant silkworm moths)									
Antheraea polyphemus (polyphemus moth)			X	X					
Automeris io (io moth)							X		
Arctiidae (tiger moths)									
Halisodota tesselaris (pale tussock moth)		X							
Noctuidae (owlet moths, underwings)									
Apatela sp.	X								
Epizeuxis aemula			X						
Phosphila miselioides			X						
Zale sp.			X						
Geometridae (geometrid moths)									
Epimecis sp.					X				
Lygris diversilineata (grapevine looper)			X		X		X		
Scopula inboundata							X		
Tetracis crocallata		X							
Pyralidae (pyralid moths)									
Herculia himonialis			X						
Nymphula sp.								X	
Paraponyx sp.								X	
Tortricidae (tortricid moths)									
Archies parallela									X
Micromoths	X	X	X	X	X		X		X

579135 science services division

Table 1.6-1 (Contd)

Taxa	1 Beachgrass	2 Foredune	3 Immature Oak	4A Cowles Bog Dry Woods	4B Cowles Bog Wet Woods	5 Dunes Creek	6 Maple Woods	7 Pond B	8 Transmission Corridor
	Sampling Stations								
Diptera (flies)									
Tipulidae (crane flies)		X		X	X		X		X
Ptychopteridae (phantom crane flies)									
Bittacomorpha clavipes				X		X	X		X
Psychodidae (moth flies)		X				X			X
Chaoboridae (phantom midges)				X	X		X		X
Chironomidae (midges)	X	X	X	X	X	X	X	X	X
Dixidae (dixid midges)				X					
Culicidae (mosquitoes)	X	X	X	X	X		X		X
Mycetophilidae (fungus gnats)					X		X		
Sciaridae (darkwinged fungus gnats)	X	X	X	X			X		
Cecidiomyiidae (gall midges)	X	X		X			X		
Cera*opogonidae (biting midges)	X	X		X	X	X	X		X
Stratiomyiidae (soldier flies)		X		X				X	
Pedicella sp.				X					
Ptecticus sp.			X						
Tabanidae (deer flies, horse flies)									
Chrysops vittatus	X		X	X					
Therevidae (stilleto flies)				X					
Asilidae (robber flies)									
Efferia albibaris	X								
Leptogaster annulatus			X						
Rhagionidae (snipe flies)								X	
Mydidae (mydas flies)									
Mydas clavatus	X								
Phoridae (humpbacked flies)					X		X		
Empididae (dance flies)									
Chelopoda sp.		X			X				
Hybos sp.		X	X	X			X		
Tachypeza sp.			X	X			X		
Dolichopodidae (longlegged flies)									
Argyra sp.		X							
Chrysotus spp.	X	X		X	X				
Dolichopus sp.	X	X		X	X				
Gymnopternus sp.					X				
Sciapus sp.		X							
Thinophilus sp.					X				
Tephritidae (fruit flies)				X					
Sepsidae (black scavenger flies)									
Sepsis sp.									X
Lauxaniidae (lauxaniid flies)									
Camptoprosopella sp.	X	X							X
Homoneura sp.	X								
Minettia sp.	X								X
Sapromyza sp.			X	X	X		X		
Piophilidae (skipper flies)		X		X					
Sphaeroceridae (dung flies)		X					X		
Drosophilidae (vinegar flies)									
Chymomyza sp.		X	X						
Chloropidae (chloropic flies)									
Chlorops sp.									X
Diplotoxa sp.	X								
Hippelates spp.	X	X			X				X
Merumyza sp.									X
Agromyzidae (leafminer flies)									X
Clusiidae (clusiid flies)		X							
Anthomyzidae (anthomyzid flies)									X
Calliphoridae (blow flies)									
Muscidae (muscid flies)	X	X	X	X	X		X		X
Tachinidae (tachinid flies)					X				
Hymenoptera (bees, wasps, ichneumons, etc.)									
Tenthredinidae (sawflies)					X				
Braconidae (braconids)		X	X	X			X		
Ichneumonidae (ichneumons)	X	X	X	X	X		X		X
Eulophidae (eulophids)				X					X
Pteromalidae (pteromalids)					X				
Scelionidae (scelionids)	X								
Eurytomidae (eurytomids)									X
Evaniidae (ensign wasps)				X					
Mutillidae (velvet ants)	X								
Formicidae (ants)	X	X	X	X	X		X		X
Sphecidae (mud daubers)									X
Halictidae (sweat bees)		X							
Apidae									
Apis mellifera (honey bee)		X	X	X					X
Amphipoda (scuds)		X				X	X	X	X
Chelonethida (pseudoscorpions)			X	X	X				
Phalangida (harvestmen)		X	X	X	X		X		
Acari (mites)	X	X	X	X	X		X		X
Dermacentor variabilis (American dog tick)	X								
Araneida (spiders)	X	X	X	X	X		X		X
Isopoda (isopods)						X			
Diplopoda (millipedes)			X	X	X		X		

POOR ORIGINAL

579136

One of the five known species of reticulated beetles in eastern United States, Cupes concolor, was observed in the immature oak forest at the lighttrap. This primitive beetle is dark-colored, elongate (7 mm), and irregularly sculptured on the surface. Reticulated beetles are little collected, although perhaps not because of rarity but because their habitats are overlooked (Arnett 1968). The larvae are woodborers in pine and oak and the adults often remain under bark or in wood as well.

Velvet ants are actually wasps with a common name that describes the females, which are wingless and antlike and covered with a dense pubescence (Borror et al. 1976). The group is large — about 470 North American species, mostly distributed in the south and west and primarily in dry habitats. Appropriately, the single individual observed on the site was in the beachgrass sampling location. Most species are external parasites of the larvae and pupae of various bees and wasps; others attack certain beetles and flies.

The mydas fly observed on the site was Mydas clavatus, a widespread species in the United States. A single individual was observed on the sand along the beachgrass-beach interface. Mydas flies are large (about 25 mm) black species, sometimes with a distinct orange-gold second abdominal segment. Both larvae and adults of this group apparently are predaceous, although little is known about their prey. The larvae live in decaying wood, perhaps feeding on beetle larvae (Peterson 1960).

Butterfly activity in July 1978 was good as in previous summers and comprised essentially the same species in the same locations. The imported cabbageworm (Pieris rapae) was observed most commonly in open areas (beachgrass, foredune, and transmission locations), as was the common sulfur (Colias philodice) and monarch (Danaus plexippus). The open-wooded areas harbored satyrs, blues, and hairstreaks particularly, while the several species of brushfooted butterflies observed appeared evenly distributed among the wooded and wood/field ecotonal areas. The most commonly observed blue was the spring azure (Lycaenopsis giolus), found in Cowles Bog (wooded) areas; the most common satyr was the eyed brown (Lethe eurydice), which was active in the dry woods of Cowles Bog and along the maple forest/transmission corridor edge; and the most frequently sighted brushfooted species was the great spangled frittilary (Speyeria cybele) found in the dry woods of Cowles Bog and along the foredune.

Hairstreaks, represented by the hickory hairstreak (Satyrium caryaevorous), were observed for the first time on the site and were especially abundant in the interdunal areas. Hairstreaks are medium-sized species (about 25-mm wingspread), often bluish or brownish in color and generally characterized by a hair-like tail on each hindwing and narrow bands on the undersides of both pairs of wings. Larvae of the hickory hairstreak apparently feed on hickory, black ash, and hawthorn (Erlich and Erlich 1961), of which the latter is the likely host on the site.

The other obvious variation in the abundance of butterflies in 1978 compared with 1977 was the prominence of the imported cabbageworm again rather than its congenor, the southern cabbageworm (Pieris protodice). As indicated in the 1977-1978 annual report (TI 1978), the southern cabbageworm, recorded then for the first time on the site, was considerably more abundant in July 1977 than the imported cabbageworm. Although the July 1977 sampling period undoubtedly coincided with an emergence of the protodice summer brood, while the other July sampling periods did not, the consistent presence and general abundance of rapae indicate it probably is the more established and abundant species on the site.

Pest activity during the 1978 sampling period was limited to biting insects — deer flies and mosquitoes. Tent caterpillars that had occupied black cherry at the southern edge of the maple woods were not observed in 1978. Their absence, although possibly caused by a cyclic population decline (the number of webs noted in 1977 was less than in 1975 and 1976), could have been linked to the removal of several trees from the location.

1.6.2.1 Beachgrass Community. Both the number and composition of insect families collected from the beachgrass location in July 1978 were essentially comparable to those of past July sampling periods. As in 1976, delphacid planthoppers were the most abundant group in the sweepnet sample. They were collected in fewer numbers in sweepnet samples from other locations (foredune and transmission corridor in 1978), as has been the trend in past years. These collections and those of previous years indicate planthoppers are found over the site in suitable herbaceous habitats but apparently are most abundant on the beachgrass vegetation.

579138

Other prominent insect groups in the 1978 beachgrass sweepnet sample were leafhoppers, longlegged flies, midges, and false antlike flower beetles. The beetles, which were collected also from the foredune, and in the past were collected from these locations and the transmission corridor as well, have not been observed previously in such abundance. Apparently they inhabit all nonwoody locations on the site but are most abundant in the beachgrass/foredune area. Food habits of these dark, 5- to 12-mm cylindrical beetles are unknown, but sandy areas, including dunes, are reported habitats (Arnett 1968). Their attraction to light, as exhibited at the beachgrass and foredune lighttraps, also is reported.

Of the other prominent insect groups in the 1978 beachgrass sweepnet sample, only leafhoppers seem to be more abundant in the beachgrass area than in other sampling locations. They generally are represented there by fewer species, however, as might be expected in a monoculture-like habitat. In the adjacent foredune area, where vegetation is more diverse, the abundance of the group is somewhat less but more species are represented; similar numbers of species have been observed in the other sampling locations but abundance is less than in either the beachgrass or the foredune. The most frequently collected species in the beachgrass area is Macrosteles divisa, a small (about 4 mm) greenish yellow and black leafhopper that is common throughout the United States (DeLong 1948).

Longlegged flies consistently are a prominent component of the beachgrass insect fauna and that of all other sampling locations except perhaps the transmission corridor, where they have been collected somewhat less frequently. As with the plant-feeding leafhoppers, more species of these predaceous flies occur in sampling locations with greater varieties of vegetation. Although too little is known of these species' precise feeding habits to implicate prey specificity as the only factor in such distribution, the greater variety of prey associated with the more diverse vegetation could be an influence. The prominence of the group on the site as a whole probably is related to the extent and distribution of water, since the group generally is adapted to moist and wet habitats (Curran 1934; Cole 1969).

The most abundant groups in the 1978 beachgrass lighttrap sample were midges, as expected, and formicine ants. Formicine ants have been collected at least once at all other lighttrap locations in the past, but abundance similar to

that at the beachgrass, foredune, and immature oak forest 1978 lighttraps has not been noted. This species, whose winged forms seem to be strongly attracted to light, apparently was nesting on the beach side of the site since none was noted at lighttraps beyond the interdunal areas.

A conspicuous component of the lighttrap sample was a number of scarab beetles in the genus Ataenius. These small (3 to 5 mm), were observed in similar abundance in summer 1974. They likely occur over the site, although none has been collected from the immature oak and maple forests, but, like most of the groups just mentioned, appear to be most abundant in the beachgrass area. The 1978 beachgrass lighttrap also attracted more May beetles (Phyllophaga spp.) than other lighttraps. These large (15 to 20 mm), light-attracted species are herbivorous scarabs. They are consistently observed at lighttraps over the site although rarely in large numbers. As mentioned previously, their larvae (white grubs) are associated with roots of grasses, particularly lawn varieties, so that populations in residential areas may be larger than those of areas similar to the Bailly site.

Significantly more spiders were collected from the beachgrass in the 1978 sample. More than half of them were long-jawed spiders, a group frequently inhabiting fields or meadows adjacent to water. Arthropods extracted from the litter and soil sample were, as usual, comparatively few in number.

The robber fly Efferia albibaris was again observed on the Lake Michigan beach but not in abundance. Insect presence on the beach comparable to the clusters of western corn rootworms and convergent lady beetles of 1977 and blow fly larvae of 1976 was not observed in 1978. An increase in western corn rootworm abundance apparently was typical in the northern one-fourth of Indiana at that time (Meyer 1977). The blow fly larvae, as reported, were associated with beached decaying fish, which were fewer in number during 1978 sampling.

1.6.2.2 Foredune Community. The sweepnet sample from the foredune contained the greatest number of insect families in the 1978 samples. In the past, this number generally has been second highest, surpassed by that collected from vegetation in the transmission corridor. Both the foredune and transmission corridor contain a variety of grasses, forbs, and low shrubs, and since sweepnet samples

primarily reflect insect habitation in the herbaceous stratum, somewhat larger numbers of insect families in these samples might be expected. The smaller variety collected from the transmission corridor vegetation in 1978 quite possibly was related to herbicide usage, as discussed in subsection 1.6.2.8.

Five insect groups were represented by 20 or more individuals in the sweepnet sample: midges, muscid flies, leafhoppers, aphids, and longlegged flies. The abundance of muscid flies, most frequently the horse fly (Musca domestica), generally is greatest in the foredune and transmission corridor, although they occur over the site. Aphids, which often cluster to suck fluids from plant stems and leaves, also occur over the site; they have been collected in comparatively large numbers from all sampling locations except the beachgrass.

As in previous sampling periods, a variety of beetles was included in the foredune sweepnet sample. Most are general feeders that may be found on a number of different plants, while a few are either host-specific or at least show some host preference. Lema collaris, collected consistently here and from the transmission corridor, is a leaf beetle particularly associated with spiderwort. Two beetles newly recorded from the foredune were Xylopinus saperdiodes, a medium-sized (12 to 16 millimeter) black darkling beetle that lives under oak bark, and Psenocerus supernotatus, a small (approximately 5 millimeter) long-horned beetle that breeds in a variety of trees and shrubs (Knull 1946), of which only sumac (Rhus aromatica) is recorded in the location. Xylopinus also is recorded from the adjacent immature oak forest.

Most of the abundant groups at the 1978 foredune lighttrap were the same as those at the beachgrass lighttrap: midges, Ataenius, formicine ants, and mosquitoes. Next to the scarabs, the most common beetle groups at the trap were combclawed beetles and marsh beetles. Combclawed beetles, which have been collected previously in the foredune, immature oak forest, and the dry woods of Cowles Bog, also were collected again in the immature oak forest. One species, Hymenorus niger, collected only in the foredune, was newly recorded on the site; it is an elongate small (6 mm) blackish, pubescent beetle typically found on dead branches of oak (Dillon and Dillon 1961).

579141

Marsh beetles were collected in nearly all locations where they had been recorded previously, indicating a consistent distribution over the site. Three genera, Prionocyphon, Cyphon, and Scrites, were present and, as in the past, the latter was most abundant in the foredune and Cyphon most abundant in the wet woods of Cowles Bog; Prioncyphon, recorded from the beachgrass and wooded area of Cowles Bog, is more abundant in the bog. Another genus, Elodes, was collected previously in the bog, indicating this likely habitat probably supports the greatest diversity of these minute (2-3 mm), oval to round, brownish to black beetles. A single individual of Megalodacne fasciata represented the first observation of the species on the site and only the second observation of a pleasing fungus beetle. Despite a large size (approximately 12 millimeters) and colorful appearance (black and red), this species is rarely seen since it inhabits decaying wood and other fungus-rich habitats.

Litter from the foredune contained only a few more individuals than that from the beachgrass and fewer groups. The groups were rove beetles, isotomid springtails, ants, and soil mites. The foredune litter and soil sample, with one exception (TI 1977), has contained greater numbers of individuals than that from the beachgrass and fewer than those from other sampling locations. It generally also contains a somewhat greater variety of taxa than found in the beachgrass sample. Apparently the combined litter and soil stratification is less complex in the beachgrass and foredunes than in other sampling locations on the site.

As mentioned previously, a new small pool formed next to the cattail area at the base of the foredune inside the Bailly site fence. Many of the same taxa collected from the old pool were present in 1978 although only toad bugs and soldier fly larvae were seen there last year following drainage of the area. One of the abundant taxa was the water scavenger beetle Tropisternus lateralis. The only other beetle collected, Hydrochara obtusata, also a hydrophilid, was not abundant. Predaceous diving beetles were notably absent since this area previously produced the only significant populations of Laccophilus spp. on the site. Also absent were water scorpions, although these species also were not collected in other known habitats on the site. Other hemipteran groups, water boatmen, backswimmers, water treaders, and water striders were present as before. The most abundant odonates in the sample were coenagrionid damselflies.

579142

1.6.2.3 Immature Oak Forest Community. Midges were by far the most abundant group in the 1978 sweepnet sample from these woods. Ants were the second most abundant group, followed by dance flies, spittlebugs, and spiders. Most of the other 35 groups were not abundant, represented by fewer than 5 individuals.

The abundance of midges, ants, and spittlebugs in understory vegetation in the immature oak forest is documented by past samples, in which one or more has been either the most abundant or second or third most abundant group. Dance flies or other dipteran groups comprising generally minute species associated with decaying materials consistently are a significant component of the sweepnet sample. Apparently dance flies are predators or scavengers in such communities (Borror et al. 1976); they are so-named because the adults sometimes swarm, flying in up and down movements.

Several Cosmopepla bimaculata, mostly larvae, were again swept from this location. This small (approximately 6 millimeter) black and red stink bug has been consistently present in the oak forest and once was recorded from the maple forest. Like most stink bugs, it is herbivorous and apparently is a general feeder that will utilize oak as well as several other trees (Furth 1974).

The lighttrap (and the trappers) in this woods attracted an abundance of mosquitoes as had occurred under suitable weather conditions in past summers. Midges, of course, were abundant, as were formicine ants.

Two moths associated with oak were identified at the lighttrap: Herculia himonialis, a pyralid moth, and Phosphila miseliodes, a noctuid; the latter is associated with Smilax also. Both species are widespread and common in eastern and most western United States. The most abundant moth at the trap was the noctuid Epizeuxis aemula, a species associated with fallen leaves; it also is common and distributed over most of this country. None of these moths was identified at other sampling locations.

Litter and soil from the oak forest contained the single shortwinged mold beetle observed on the site in 1978. This group of minute (less than 3 mm) beetles has been observed in all wooded sampling locations on the site and is apparently restricted to these habitats. These species apparently feed on mites (Dillon and Dillon 1961).

579143

Also present in the oak forest litter were larvae of case-bearing leaf beetles, likely a species of Chalmisus, which has been observed in the location in the adult stage. Other groups included pseudoscorpions and millipedes. The same millipedes were found in all wooded sampling locations in 1978. Previously this group, which generally inhabits damp places, was recorded only from the maple forest. Pseudoscorpions have been recorded from each wooded location at least once in the past, and this year were observed again in all but the maple woods.

1.6.2.4 Cowles Bog (Wooded).

1.6.2.4.1 Dry. The sweepnet sample from the high side of Cowles Bog woods contained the greatest number of individuals of the 1978 sweepnet samples. Midges, mosquitoes, biting midges, and ants were the most abundant groups, each represented by more than 25 individuals. Among the next most numerous individuals were crane flies, phantom midges, longlegged flies, and darkwinged fungus gnats. The most abundant beetle, as in the past, was the soldier beetle Cantharis rectus. Ichneumons were, next to ants, the most abundant of several hymenopteran groups in the sample.

These observations generally were consistent with those of other summer sampling periods, with the exception of spittlebugs not being among the most abundant groups. Several spittlebugs were in the sample, however, and once again their presence over the site was documented by capture in all sweepnet samples except that from the beachgrass. They consistently are most abundant in samples from wooded areas, and for the first time were twice as numerous in the maple woods sample, indicating a prevalence in wooded habitats on the site and approximately equal abundance in each locations.

The litter and soil sample from the dry woods also contained the greatest number of individuals of that sampling category. Among the groups present were pseudoscorpions, millipedes, rove beetles, featherwinged beetles, and a proturan. Rove beetles, as usual, were collected over the site, and featherwinged beetles again were collected only in the wet and dry woods of Cowles Bog. The proturan represented only the second observation of the group on the site. These obscure species are infrequently collected and apparently rare as well (Borror and White 1970).

579144

1.6.2.4.2 Wet. The sweepnet sample from the lower part of Cowles Bog woods contained as many midges as that from the dry woods. The only other group of similar abundance was aphids. Of somewhat lesser prominence were mosquitoes, dance flies, and longlegged flies. Among the Arachnida in the sample, spiders and harvestmen were equally represented, whereas the general ratio in other sweepnet samples was 2 spiders to one harvestman. In the past, harvestmen have been collected in most numbers from here and the maple forest, possibly indicating a preference for moist woodland habitats. The dipnet sample from the wet woods contained only midges in abundance. Typical of past sampling periods, the midge numbers were greater than collected from other aquatic habitats. The other taxa in the sample were mosquitoes, predaceous diving beetles, scuds, fishflies, and water boatmen — each represented by either one or two individuals.

As mentioned previously, lighttrap activity in this location was affected by coolness. Among the comparatively few individuals attracted to the trap were mosquitoes and midges in greatest numbers and single representatives of gall midges, crane flies, and longlegged flies. Several moths were attracted to the light; the most abundant was the grapevine looper, Lygris diversilineata, a consistent visitor to lighttraps in this location. The cool temperatures during both the 1977 and 1978 lighttrapping in this location appear to be the only reason for fewer observations in those years than in the three previous years. Arthropods in the litter and soil sample from the wet woods were similar to those collected in past samples, including featherwinged beetles, as mentioned above.

The deer fly Chrysops vitattus was again abundant on the Cowles Bog trail. It seemed to exhibit greatest activity patterns during cloud cover and/or high relative humidity.

1.6.2.5 Dunes Creek. A variety of aquatic beetles was in the 1978 dipnet sample from Dunes Creek. The most abundant, as usual, was the predaceous diving beetle, Hydroporus consimilus. Hydroporus niger was also present again, along with Hygrotus sp., the hydrophilids Paracymus and Helophorus, and the crawling water beetle, Haliplus. Several fishfly larvae and water boatmen were in the sample as well as a single backswimmer and giant water bug. As usual, the sample contained phantom crane fly larvae, but their abundance was greater than observed previously.

Dragonfly and damselfly larvae, although never abundant in Dunes Creek samples, have not been collected during the past two years. These groups also are collected infrequently from the aquatic sampling location in Cowles Bog, but are well represented in the three other aquatic locations. The single whirligig beetle noted here in 1976, along with the individual collected at the same time in the foredune pool, represented the only observations of this group in sampling locations. The greatest number of whirligigs noted during the monitoring period was in 1975 in one of the ash settling ponds along the NIPSCo access road. Apparently the group is not established in most, if any, of the site's water bodies.

1.6.2.6 Maple Woods. The 1978 sweepnet sample from the maple woods contained the fewest insect families as well as comparatively few individuals. Spittlebugs and mosquitoes, equally represented, were the only abundant groups present and leafhoppers were the only other group represented by more than 10 individuals. Among other taxa present, and typically so, were scorpionflies, leaf beetles, click beetles, and lauxaniid flies.

In addition to the perennially abundant scuds, the dipnet sample from the small maple woods tributary to Dunes Creek contained water striders, midges, and a phryganeid caddisfly. The caddisfly, Oligostomis ocelligera, lives in long cases constructed of narrow strips of leaf arranged in a spiral. This species in one of the few phryganeids that live only in lotic waters; it probably is restricted on the site to this tributary since the other water bodies, including Dunes Creek, are either ponds or slow streams.

Conspicuous among the comparatively few individuals appearing at the maple woods lighttrap were the grapevine looper, apparently a common species in all wooded habitats on the site, and another geometrid moth, Scopula imboundata. The latter, a common eastern species, is a general feeder often assoicated with cherry (Forbes 1948), which is an important plant in the maple woods. Other prominent groups at the lighttrap were midges, mosquitoes, phantom midges, and gall midges.

The litter and soil sample, like that from the foredune, contained comparatively few individuals. The primary difference in comparative numbers of individuals in this and most instances is the difference in numbers of mites, especially soil mites. Among the groups represented in the sample were millipedes, ground beetles, and ants.

1.6.2.7 Emergent Macrophyte - Pond B. As in 1977, caenid mayflies were the most abundant group in the dipnet sample from this location. Late instars of the aeshnid dragonfly Anax junius were collected for the third consecutive year. Numbers of early instar aeshnid dragonflies were not observed as in 1977, although eggs could well have been present during this somewhat earlier sampling period. Coenagrionid damselflies were again abundant in the sample as were midges. Aquatic pyralid moths, typically present in the pond, were collected in greater numbers than previously. One group, snipe flies, which comprises a few aquatic species, was newly recorded from the habitat.

1.6.2.8 Transmission Corridor. The variety of taxa observed in the 1978 sweepnet samples from the transmission corridor was approximately equivalent to that observed in 1977 and did not approach the greater numbers recorded in 1976 and 1975 as did those of most other sampling locations. This likely was caused by additional herbicide usage along the transmission/railway right of way (see subsection 1.2.4), although, of course, the sampling regime does not permit that conclusion.

As in May 1975 and July 1976, the seed bug Ischnodemus falicus was the most abundant insect in the sweepnet sample. The plant bug, Trigonotylus tarsalis, which was considerably more abundant than I. falicus in the 1977 sample, was nearly as abundant as the seed bug in this sample. A congenor of tarsalis, T. ruficornis, was present in fewer numbers as in 1977. Aphids, jumping plantlice, anthomyzid flies, and chloropid flies were the other insect groups prominent in the sample. These groups also are typically associated with the habitat.

The dipnet sample from the channel adjacent to part of the transmission corridor showed little variation from previous samples. It contained predaceous diving beetles, caenid mayflies, midges, and aquatic mites in abundance. Crawling water beetles, pleid water bugs, and water striders also were prominent components of the sample. Present in few numbers, as before, were water scavenger beetles, libellulid dragonflies, and coenagrionid damselflies. A single limnephilid caddisfly was collected.

The number of soil and litter inhabitants extracted from the ground sample was not equivalent to those of 1976 and 1977 samples but this was a general observation among the 1978 samples. The groups extracted were typical and, as mentioned

previously, except for soil mites, were present in approximately equivalent numbers. Ground beetle larvae were again more abundant in this ground sample than others.

1.7 TERRESTRIAL REFERENCES CITED

Arbib, R. 1977. The blue list for 1978. Amer. Birds 31:1087-1094.

Arnett, R.H. 1968. The beetles of the United States. Amer. Entomol. Institute, Ann Arbor, MI. 1112 p.

Barbre, M.R. 1975. Common shrews of Indiana. Outdoor Indiana 40:25-26.

Bellrose, F.C. 1968. Waterfowl migration corridors east of the Rocky Mountains in the United States. Ill. Natur. Hist. Sur. Bio. Note No. 61, 24 p.

Bellrose, F.C. and R.D. Crompton. 1970. Migration behavior of Mallards and Black Ducks determined from banding. Ill. Natur. Hist. Sur. Bull. 30:167-234.

Black, C.A., D.D. Evans, J.L. White, L.E. Ensminger, and F.E. Clark. 1965. Methods of soil analysis: part 2. Amer. Soc. of Agron., Madison, WI. 771-1572.

Borror, D.J., D.M. DeLong, and C.A. Triplehorn. 1976. An introduction to the study of insects. Holt, Rinehart and Winston. N.Y. 852 p.

Borror, D.J. and R.E. White. 1970. A field guide to the insects of America. Houghton Mifflin Co., Boston. 404 p.

Clark, R.D. 1974. Food habits of toad genus Rufo, Amphibia: Bufonidae. Amer. Midl. Natur. 91:140-147.

Cochran, D.M. and C.J. Goin. 1970. Reptiles and amphibians. G.P. Putman Sons, N.Y., N.Y. 359 p.

Cole, F.R. 1969. The flies of western North America. Univ. Calif. Press, Berkeley. 693 p.

Condrin, J.M. 1936. Observation on the seasonal and reproductive activities of the eastern chipmunk. Jour. Mammals. 17:231-234.

Curran, C.H. 1934. The families and genera of North American Diptera. Publ. by the author, New York. 521 p.

Curtis, J.T. 1971. The vegetation of Wisconsin: an ordination of plant communities. Univ. Wis. Press, Madison, WI.

DeLong, D.M. 1948. The leafhoppers, or Cicadellidae, of Illinois. Ill. Nat. Hist. Surv. Bull. 24:97-376.

579168

Dillon, E.S., and L.S. Dillon. 1961. A manual of common beetles of eastern North America. Row, Peterson and Company, Evanston, IL. 884 p.

Ehrlich, P.R., and A.H. Ehrlich. 1961. How to know the butterflies. Wm. C. Brown Co., Dubuque, Iowa. 262 p.

FAO/UNESCo. 1973. Irrigation/drainage and salinity. Camelot Press Ltd, London.

Forbes, W.T.M. 1948. Lepidoptera of New York and neighboring states, Part II. Cornell Agr. Exp. Sta. Mem. 274. 263 p.

Fowells, H. A. 1965. Silvics of forest trees of the United States. Agric. Handbook No. 271, U.S. Govt. Printing Office, Washington, D.C. 762 p.

Furth, D.G. 1974. The stink bugs of Ohio (Hemiptera:Pentatomidae). Ohio Biol. Surv. Bull. 5, new series. 60 p.

Galli, A.F., C.F. Leck, and R.T.T. Forman. 1976. Avian distribution patterns in four islands of diferent sizes in central New Jersey. AWK. 93:356-364.

Hardin, K.I. and K.E. Evans. 1977. Cavity nesting bird habitat in the oak-hickory forests - a review. USDA Forest Service, Gen. Tech. Rpt NC-2. 23 p.

Harvey, M.J. 1976. Home range, movement, and diel activity of the eastern mole (Scalopus aquat) Amer. Midl. Natur. 95:436-445.

Illinois Natural History Survey. 1979. Trends in cottontail abundances. Jan 1979, No. 183.

Knull, J.N. 1947. The long-horned beetles of Ohio (Coleoptera:Cerambycidae). Ohio Biol. Surv. Bull. 7:133-354.

Krebs, C.J., B.L. Keller, and R.H. Tamarin. 1969. Microtus population biology: demographic changes in fluctuating population of M. ochrogaster and M. pennsylvanica in southeastern Indiana. Ecol. 50:587.

Laing, C.C. 1954. Ecological life history of the Ammophila breviligulata community or Lake Michigan dunes. Ph.D. dissertation, Dept. Botany, Univ. Chicago, Chicago, Ill.

Lehman, L.E. 1977. Population ecology of the raccoon on the Jasper-Paluski Wildlife Study Area. Pittman Robertson Bull. 9. 97 pp.

Martin, A.C., H.S. Zim and A.L. Nelson. 1951. American wildlife and plants, A guide to wildlife food habits. Dover Pub. N.Y. 500 p.

Martof, B. 1953. Home range and movement of the green frog (Rana clamitans) Ecol. 34:529-543.

Meyer, R.W. 1977. Insects and other arthropods of economic importance in Indiana during 1976. Ind. Acad. Sci. 87:231-23.

579149

Minton, S.A. 1966. Amphibians and reptiles. In: Natural features of Indiana. Ind. Acad. of Sci. 597 p.

Mumford, R.E. 1969. Distribution of the mammals of Indiana. Ind. Acad. of Sci.

Olson, J.S. 1958. Rates of succession and soil changes on southern Lake Michigan sand dunes. Bot. Gaz. 119(3):125-170.

Peattie, D.C. 1930. Flora of the Ind: na dunes. Field Museum Nat. Hist, Chicago, Ill. 432 p.

Richards, L.A. (Ed.). 1954. Diagnosis and improvement of saline and alkali soils. USDA Handbook No. U.S. Government Printing Office, Washington, D.C. 153 p.

Robbins, C.S. 1978. Census techniques for forest birds. In: Proceedings of workshop for management of the southern forests nongame birds. For. Ser. Tech. Rpt. SE 14:142-163.

Rybak, E.J., E.J. Neufarth and S.H. Vessey. 1975. Distribution of the jumping mouse, (Zapus hudsonicus), in Ohio: A twenty year update. Ohio Jour. Sci. 75:184-187.

Schreiber, R.K. and J.H. Graves. 1977. Powerline corridors as possible barriers to the movements of small mammals. Amer. Midl. Natur. 97:504-508.

Shelford. 1963. The ecology of North America. Univ. Illinois press, Urbana, Ill. 610 p.

Smith, R.L. 1966. Ecology and field biology. Harper and Row. 686 p.

Stearns, F. and N. Kobriger. 1975. Environmental status of the Lake Michigan region: 10, vegetation of the Lake Michigan drainage basin. Natl. Tech. Inf. Serv., U.S. Dept. Commerce, Springfield, Va.

Texas Instruments Incorporated. 1975. 1974-1975 annual rpt, Bailly Nuclear-1 Site, encompassing April 1974-February 1975.

Texas Instruments Incorporated. 1976. 1975-1976 annual rpt, Bailly Nuclear-1 Site, encompassing March 1975-February 1976.

Texas Instruments Incorporated. 1977. 1976-1977 annual rpt, Bailly Nuclear-1 Site, encompassing March 1976-March 1977.

Texas Instruments Incorporated. 1978. 1977-1978 annual rpt, Bailly Nuclear-1 Site, encompassing March 1977-March 1978.

Texas Instruments Incorporated. 1978. Summer quarterly rpt, Bailly Nuclear-1 Site encompassing July-September 1978.

Texas Instruments Incorporated. 1978. Standard Operating Procedures, Quality Control and Quality Assurance Manual (Terrestrial). Prepared for Northern Indiana Public Service Company.

579150

Van Camp, L.F. and C.J. Henny. 1975. The Screech Owl: its life history and population ecology in northern Ohio. USDI N. Amer. Fauna. No. 71. 65 p.

Webster, J.D. 1966. The birds. In: Natural features of Indiana. Ind. Acad. Sci. 597 p.

Whitford, P.C. and P.B. Whitford. 1978. Effects of trees on ground cover in old-field succession. Am. Midl. Natur. 99(2)435-444.

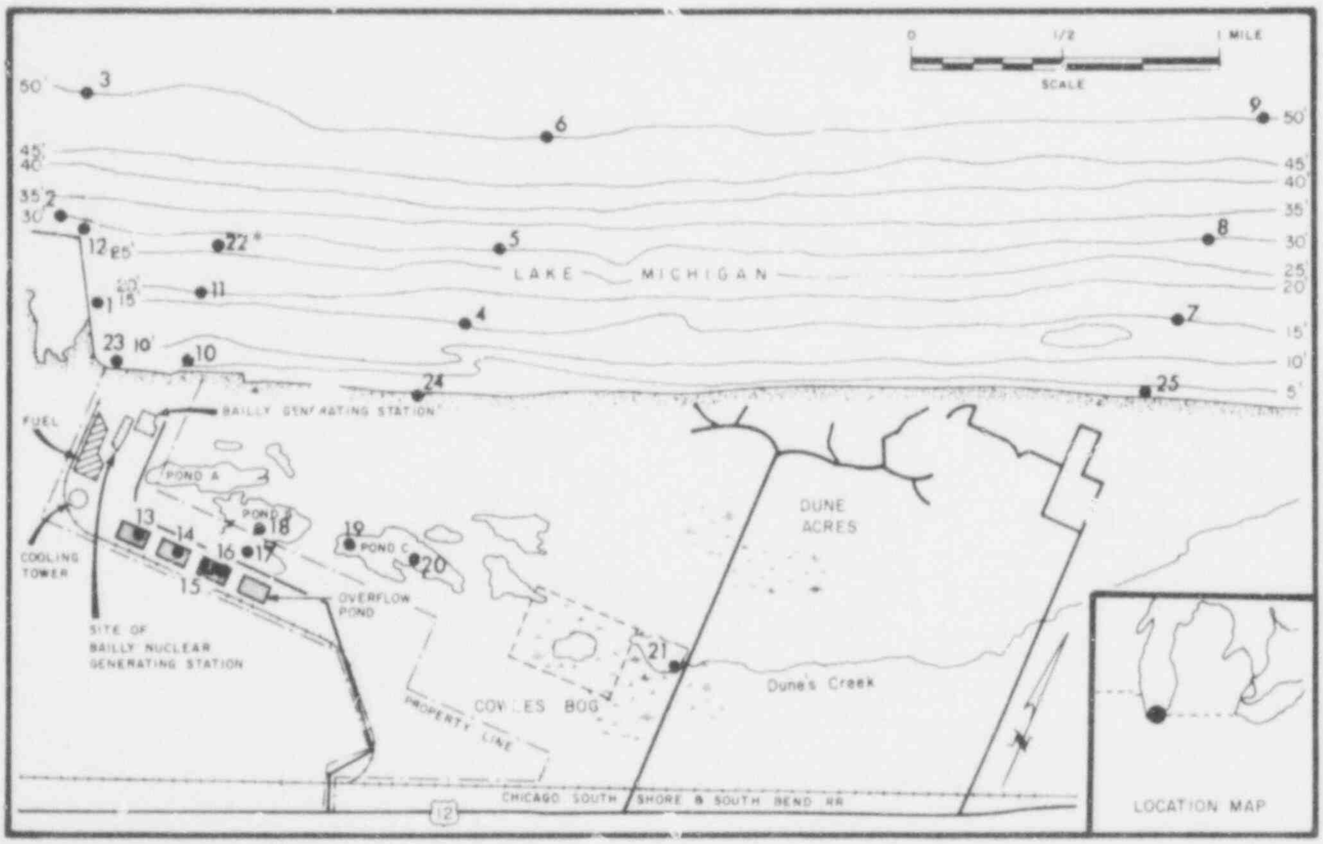
Wright and Wright. 1970. Handbook of frogs and toads. Cornell Univ. Press, Ithaca. 640 p.

579151

SECTION 2
AQUATIC ECOLOGY

2.0 INTRODUCTION AND STATUS

Sampling during the 1978-79 sampling year (April 1978-March 1979) was scheduled for April, June, August, and November 1978 and January 1979 at the stations shown in Figure 2.0-1 and as scheduled in Table 2.0-1. Samples were collected on the dates and by the personnel shown in Table 2.0-2.



*Station 22 is a "floating" station located on the plume center line, 1,000 feet from the discharge.

Figure 2.0-1. Aquatic Sampling Stations in Vicinity of NIPSCo Bailly Nuclear-1 Plant Site (Bailly Study Area)

579152

Table 2.0-1

Aquatic Ecology Sampling Frequency, NIPSCo Bailly Study Area, April 1978-March 1°

Parameter	Sampling Stations	1978 Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1979 Jan	Feb	Mar
Phytoplankton													
Identification, enumeration	1-10, 17-21	X		X		X			X				
Productivity	1-10, 17-21	X		X		X			X				
Chlorophyll a	1-10, 17-21	X		X		X			X				
Zooplankton													
Identification, enumeration	1-10, 17-21	X		X		X			X				
Periphyton													
Identification, enumeration	1,10,11,12,25,17,19,21	X		X		X			X				
Chlorophyll a	1,10,11,12,25,17,19,21	X		X		X			X				
Benthos	1-10, 17-21	X		X		X			X				
Fish (gill netting)	4,7	X		X		X			X				
Fish (beach seining)	23,24,25	X		X		X			X				
Fish (electrofishing)	18	X				X							
Fish food habits	4,7,23,24,25	← 300 fish per year →											
Ichthyoplankton	1-10*	X		X		**			X				
Water quality													
General water quality	1-22	X		X		X			X				
Aquatic nutrients	1-22	X		X		X			X				
Trace elements	13-21	X		X		X			X				
Indicators of industrial and organic contamination	13-21	X		X		X			X				
Sediments, trace elements	13-20	X				X			X		X		
Sediments, particle sizing	1-10, 17-21					X							
Aquatic macrophytes	17-21			X									

*1-10 with zooplankton; 4 and 7 also collected with pump.

**With zooplankton hauls.

579153

Table 2.0-2

Scheduled Dates and Purposes of All Aquatic Field Trips

Date	Personnel	Parameters Sampled
April 10-23 1978	Paul Meier Frank Crawford Steve DuBois	Phytoplankton, zooplankton, periphyton, benthos, fish, ichthyoplankton, water quality
June 12-18 1978	Frank Crawford Paul Meier Dave Schiappa	Phytoplankton, zooplankton, periphyton, benthos, fish, ichthyoplankton, water quality, aquatic macrophytes
August 22-26 1978	Frank Crawford Paul Meier Steve DuBois Bill Galloway	Phytoplankton, zooplankton, periphyton, benthos, fish, ichthyoplankton, water quality, sediments
November 15-27 1978	Frank Crawford Sid Soleum Steve DuBois	Phytoplankton, zooplankton, periphyton, benthos, fish, ichthyoplankton, water quality, sediments
January 18 1979	Frank Crawford Glen Rasmussen	Sediments for trace element analysis

579154

2.1 AQUATIC FLORA

2.1.1 METHODOLOGY. Duplicate 2-liter samples were collected utilizing a 6-liter Van Dorn bottle at Lake Michigan stations 1 through 10 and interdunal pond stations 17 through 21 (Figure 2.0-1). Samples were collected quarterly during the months of April, June, August, and November 1978. All samples were collected 1 meter below the surface. Prior to sampling, each 2-liter sample container was prepared with 20 milliliters of acid-Lugol's solution, a narcotizing settling agent. After sampling, each container was supplemented with buffered formalin to a final concentration of 4 percent and 3 to 5 drops of liquid detergent to facilitate sedimentation. Before processing, each sample was allowed to settle for 48 hours, at which point 1800 milliliters of supernatant was siphoned off with a membrane-covered siphon. The remaining 200 milliliters was spun on a laboratory centrifuge at 2000 rpm for 15 minutes to further concentrate the organisms. The supernatant was then filtered off and the "bead" of phytoplankton transferred to 12-dram vials.

In the laboratory, concentrated phytoplankton samples (10 milliliters) were thoroughly mixed, and three subsamples were placed in Palmer cells. The algae in 12 fields (four per subsample) were identified, enumerated, and measured at 400X magnification. In certain instances scarcity of organisms in a sample necessitated extending the total field count to 24 fields. Biovolume (microliters per liter) was determined by attributing to the algae geometric shapes best suiting their morphology and calculating their appropriate volumes (Nauwerck 1963; Rodhe, Vollenweider, and Nauwerck 1958; Strickland 1960). Instead of developing an average volume/species based on a few representative organisms, dimensions of each organism enumerated were measured.

Phytoplankton productivity samples were taken at the same locations and at the same frequency as samples collected for identification, enumeration, and biovolume measurements. Duplicate samples were collected from 1 meter below the surface at each station using a 6-liter Van Dorn bottle. After all samples were collected, each was strained through a 333-micron mesh nitex net to remove zooplankters and detrital materials that could be labeled by the carbon-14 material. The strained water of each sample was placed into a 2-liter flask to which four 1-milliliter ampoules of 10 μCi $NaH^{14}CO_3$ were added and thoroughly mixed. Time-zero samples consisting of one 0.5-milliliter subsample per sample were measured

579155

and placed into scintillation vials along with one drop of 6N sodium hydroxide. One 50-milliliter subsample per sample was removed and strained through Whatman GF/C filters at minimum vacuum pressure (<50 millimeter Hg differential across the filter) and the filters placed in scintillation vials to provide an estimate of background counts. Duplicate clear and darkened 300-milliliter BOD bottles were filled with the remaining sample. When all samples were prepared, they were suspended 1 meter below the surface at their stations for 4 hours. Following incubation, the bottles were retrieved and the contents of each preserved by adding 12 milliliters of buffered formaldehyde. Subsamples of 50 milliliters were removed from each bottle, filtered as previously described, and each was placed in a scintillation vial with enough tissue solubilizer to cover the filter pad. Activity counts were made using a liquid scintillation counter.

Phytoplankton productivity in milligrams of carbon fixed per liter was calculated for each replicate sample from the scintillation counts using the formula:

$$\text{mg carbon fixed}/\ell = (\text{counting rate}/\text{total activity}) \times (\text{total sample volume}/\text{subsample volume}) \times \text{alkalinity (mg}/\ell) \times 0.95 \times 12 \times 1.064$$

where:

Total activity = amount of potentially available carbon-14 at time zero

Counting rate = clear bottle minus darkened bottle counts

Total sample volume = 300 milliliters

Subsample volume = 50 milliliters

1.064 = correction for the isotope effect

Phytoplankton chlorophyll a samples were collected from the same water sample from which regular phytoplankton samples were extracted (stations 1 through 10 and 17 through 21). To prepare phytoplankton samples for analysis, a measured volume of water was filtered through a 0.45-micron filter pad stabilized with magnesium carbonate. The filter pad was then frozen for shipment to the central laboratory, where it was extracted for 24 hours with acetone, ground for 30 seconds with a tissue grinder, centrifuged, and measured on a narrow-band spectrophotometer at 665- and 750-millimicron wavelengths before and after sample

acidification. Periphyton samples were similarly processed, except that scrapings from natural (as available) or artificial substrates were used. All concentrations were calculated using the equation:

$$\text{Chlorophyll } \underline{a} \text{ (µg per sample)} = (D_b - D_a)\ [R/(R-1)]\ (V/\ell)\ (10^3/a_c)$$

which equals

$$11.9 \times [2.43\ (D_b - D_a)]\ (V/\ell)$$

for these samples, were:

D_a = optical density of sample after acidification = $D_{665} - D_{750}$ (acidified)

D_b = optical density of sample before acidification = $D_{665} - D_{750}$ (unacidified)

a_c = specific absorption coefficient for chlorophyll a (in grams per centimeter)

V = volume of solvent used to extract the sample (milliliters)

ℓ = path length (centimeters)

R = D_b/D_a for pure chlorophyll a = 84 according to Talling and Driver (1963)

579157

To convert to micrograms per liter or micrograms per square centimeter, the above chlorophyll a value was divided by number of liters filtered or number of square centimeters scraped.

During this survey, periphyton samples were collected at five stations (1, 10, 11, 12, and 25) in Lake Michigan and at three pond stations (17, 19, and 21). Pond samples were collected using a modification of an artificial substrate sampler described by Patrick, Hohn, and Wallace (1954) and Hohn and Hellerman (1963). This sampler suspends two racks of five glass slides each, with a surface area of 37.5 square centimeters per slide, just below the surface as a substrate for periphyton colonization. Colonization generally takes place in 2 to 4 weeks; thus the "incubation" time per sampler was one month. Qualitative lake samples were scraped from natural substrates found at each sampling station. When samples were collected, the slides (both sides) and substrate scrapings were placed

into 8-dram vials and preserved with 6-3-1* solution. Two replicate slides were quantitatively analyzed per sample, although all slides were scraped and the scraping saved for reference. Counts were made as described for the regular phytoplankton samples. Biovolume estimates were also generated for these data in the manner described for phytoplankton.

2.1.2 RESULTS. Results for numerical abundance, biovolume, chlorophyll a, and productivity have been included in relevant quarterly reports (TI 1978b, 1978c, 1979a, 1979b). Tables 2.1-1 through 2.1-5 and Figures 2.1-1 through 2.1-19 summarize that data and provide comparisons with previous years' data.

2.1.3 DISCUSSION

2.1.3.1 Phytoplankton Density and Biovolume. In 1978, as in the previous sampling years (1974-1977), a multitude of phytoplankton taxa were collected in the vicinity of the NIPSCo Bailly Study ea (Table 2.1-1). This table shows species occurrence for Lake Michigan stations 1 through 6 and 10, lake stations 7 through 9, and pond stations 17 through 21. Table 2.1-2 shows the taxa collected during each of the five years (1974-1978). A total of 168 taxa (including unidentified forms) were collected in Lake Michigan and nearshore interdunal ponds in 1978, and to date a total of 325 taxa has been collected in five years of study. Mean numerical abundance and biovolume of total phytoplankton by station are listed in Table 2.1-3. Figures 2.1-1 and 2.1-2 summarize lake and pond changes in density and biovolume April 1974 through November 1978.

Density peaks are evident in Lake Michigan data (Figure 2.1-1) in June, August, and October 1974; June 1975; November 1976; November 1977; June and November 1978. Biovolume peaks indicated a bimodal annual change, with primary peaks in spring and fall (April and November). The large difference in magnitude of the fall 1978 density and biovolume peaks is due to predominance of small coccoid and filamentous blue-green algae. In the ponds (Figure 2.1-2) density and biovolume peaks more nearly coincided until August 1977, when large Cladophora in Pond C caused biovolume to greatly exceed cell density. In April 1978, large desmids and diatoms caused the same disparity while the inverse (high cell densities with low biovolume) occurred in August 1978 due to a bloom of blue-green algae.

---

*6 water: 3 ethanol: 1 formalin.

579158

Table 2.1-1

Phytoplankton Occurrence, NIPSCo Bailly Study Area, 1978

TAXA	SPR 12345	SUM 12345	FAL 12345
UNIDENTIFIED ALGAE			
UNIDENTIFIED ALGAE (LPIL)	2	12345	1234
CYANOPHYTA			
CHROOCOCCACEAE			
CHROOCOCCUS LIMNETICUS			2
CHROOCOCCUS (LPIL)			1
AGMENELLUM (LPIL)		2 5	1
MICROCYSTIS (LPIL)	1	12 45	12
GOMPHOSPHAERIA LACUSTRIS	12		12
GOMPHOSPHAERIA APONINA			12
GOMPHOSPHAERIA NAEGELIANUM			12
GOMPHOSPHAERIA (LPIL)	2	34	1
APHANOTHECE (LPIL)	1	12 5	12
CHAMAESIPHONACEAE			
CHAMAESIPHON (LPIL)		3	
OSCILLATORIACEAE			
OSCILLATORIA (LPIL)	1 45	12345	1 3
LYNGBYA (LPIL)		12 5	
OSCILLATORIACEAE (LPIL)		1 3	
NOSTOCACEAE			
ANABAENA CIRCINALIS			2
ANABAENA (LPIL)		1 34	1
APHANIZOMENON FLOS-AQUAE		12	1
CYANOPHYTA (LPIL)		23	3
CHLOROPHYTA			
VOLVOCALES			
CARTERIA (LPIL)	1 4		
CHLAMYDOMONAS (LPIL)	12345	1234	12
EUDORINA (LPIL)	1		
GONIUM (LPIL)	2	4	
RADIOFILUM (LPIL)		4	
VOLVOCALES (LPIL)	4	1 3	4
TETRASPORALES			
GLOEOCYSTIS (LPIL)		123	2
ELAKATOTHRIX VIRIDIS			1
ELAKATOTHRIX (LPIL)		2	1 3
CHLOROCOCCALES			
SPHAEROCYSTIS SCHROETERI		1 4	3
SPHAEROCYSTIS (LPIL)		12345	1
ANKISTRODESMUS CONVOLUTUS	12	1 3	
ANKISTRODESMUS FALCATUS	12 4	12 5	1 4
ANKISTRODESMUS (LPIL)		1	4

TAXA	SPR 12345	SUM 12345	FAL 12345
CHLORELLA (LPIL)	23 5		
CLOSTERIOPSIS LONGISSIMA			3
CLOSTERIOPSIS (LPIL)	4	345	
KIRSCHNERIELLA LUNARIS		3	
OOCYSTIS (LPIL)	3	1234	123 5
QUADRIGULA CHODATII		1	
GOLENKINIA (LPIL)	3	2	
MICRACTINIUM PUSILLUM			1
MICRACTINIUM (LPIL)	1	1	
DICTYOSPHAERIUM PULCHELLUM			1
DICTYOSPHAERIUM (LPIL)	2	1	
SCENEDESMUS ACUMINATUS		12	
SCENEDESMUS ACUTUS	3		
SCENEDESMUS DENTICULATUS		4	
SCENEDESMUS QUADRICAUDA	3	3	1 3
SCENEDESMUS ECORNIS	123	1 34	1
SCENEDESMUS SPINOSUS		3	3
SCENEDESMUS (LPIL)		12345	3
PEDIASTRUM DUPLEX		3	
PEDIASTRUM TETRAS		4	
PEDIASTRUM BORYANUM			1
TETRAEDRON CAUDATUM		4	
TETRAEDRON MUTICUM		2 5	
TETRAEDRON MINIMUM		4	
TETRAEDRON TRIGONUM	3		
SCHROEDERIA (LPIL)	12		
CRUCIGENIA QUADRATA		1	
CRUCIGENIA RECTANGULARIS		5	
TETRASTRUM (LPIL)			1
COELASTRUM MICROPORUM		34	2
CHODATELLA CILIATA			2
CHLOROCOCCALES (LPIL)		12345	234
ULOTRICHALES			
ULOTHRIX (LPIL)		1	
MICROSPORA (LPIL)			1
ULOTRICHALES (LPIL)		1	
OEDOGONIALES			
OEDOGONIUM (LPIL)	1 5	3 5	12 4
ZYGNEMATALES			
MOUGEOTIA (LPIL)	1 34		1 3
CLOSTERIUM MONILIFERUM	3	2	
CLOSTERIUM (LPIL)	234		

Table 2.1-1 (Contd)

TAXA	SPR 12345	SUM 12345	FAL 12345
COSMARIUM (LPIL)		1 4	2
HYALOTHECA (LPIL)		3	
STAURASTRUM PARADOXUM		4	2
STAURASTRUM JOHNSONII		4	
STAURASTRUM (LPIL)	3	234	1
GONATOZYGON PILOSUMM	4		
CHLOROPHYTA (LPIL)		12 4	2
EUGLENOPHYTA			
EUGLENALES			
EUGLENA (LPIL)	345	5	
TRACHELOMONAS (LPIL)	3 5	4	
XANTHOPHYTA			
HETEROCOCCALES			
PERONIELLA (LPIL)			1
HETEROTRICHALES			
TRIBONEMA (LPIL)		1	
RHIZOCHLORIDALES			
STIPITOCOCCUS (LPIL)		12	
CHRYSOPHYTA			
CHRYSOMONADALES			
MALLAMONAS (LPIL)	1		
CHRYSOCOCCUS (LPIL)	3	5	
SYNURA (LPIL)	1		
DINOBRYON SERTULARIA	1234	2	3
DINOBRYON DIVERGENS		12	3
DINOBRYON PEDIFORME		1	
DINOBRYON CYLINDRICUM	1	2	
DINOBRYON SOCIALE	12	12	1 4
DINOBRYON (LPIL)	12345	1	34
CHROMULINA (LPIL)	5		
PSEUDOKEPHYRION (LPIL)	1	1	
KEPHYRION (LPIL)		1	
CHRYSOCHROMULINA PARVA	2	12 4	2
CHRYSOCHROMULINA (LPIL)	12		
CHRYSOMONADALES (LPIL)		12345	4
ISOCHRYSIDALES			
ISOCHRYSIDALES (LPIL)	3		
MONOSIGALES			
MONOSIGA (LPIL)		12	3
STELEXOMONAS DICHOTOMA	12		2
MONOSIGALES (LPIL)		1	

TAXA	SPR 12345	SUM 12345	FAL 12345
	4		
CHRYSOPHYTA (LPIL)		1	
BACILLARIOPHYTA-CENTRIC			
EUPODISCALES			
MELOSIRA ITALICA		1	
MELOSIRA ISLANDICA	12	12	
MELOSIRA (LPIL)	12	5	1 3 5
CYCLOTELLA CASPIA	1		
CYCLOTELLA (LPIL)	1	1	1
STEPHANODISCUS BINDERANA	1		2
STEPHANODISCUS ASTRAEA	12		12
STEPHANODISCUS (LPIL)	12	1	
SKELETONEMA COSTATUM	2		
SKELETONEMA POTAMUS		2	
SKELETONEMA (LPIL)	12		
EUPODISCALES (LPIL)	12	12345	1
RHIZOSOLENIALES			
RHIZOSOLENIA ERIENSIS	12	12	1
BACILLARIOPHYTA-PENNATE			
FRAGILARIALES			
ASTERIONELLA FORMOSA	12	1234	12
DIATOMA TENUE	12	12 5	
FRAGILARIA CROTONENSIS	12 4	12	12
FRAGILARIA CAPUCINA	1234		
FRAGILARIA VAUCHERIAE			123
FRAGILARIA (LPIL)	1 34	12345	1 4
MERIDION CIRCULARE	5		
MERIDION (LPIL)	2		
SYNEDRA ULNA	12 5	12	
SYNEDRA (LPIL)	12345	1234	45
TABELLARIA FENESTRATA		1	
TABELLARIA FLOCCULOSA	12 4	12	123
TABELLARIA (LPIL)		1	
FRAGILARIALES (LPIL)		1 5	3
EUNOTIALES			
EUNOTIA (LPIL)	5	3 5	
ACHNANTHALES			
ACHNANTHES (LPIL)	345	234	4
COCCONEIS (LPIL)	3	2 4	1
NAVICULALES			
AMPHIPLEURA PELLUCIDA	1		
GYROSIGMA (LPIL)			

Table 2.1-1 (Contd)

TAXA	SPR 12345	SUM 12345	FAL 12345
NAVICULA (LPIL)	123 5	345	45
PINNULARIA (LPIL)	3	5	
GOMPHONEMA TRUNCATUM	5		
GOMPHONEMA ACUMINATUM			3
GOMPHONEMA (LPIL)	1 5	1 5	3 5
CYMBELLA (LPIL)	1	4	
NAVICULALES (LPIL)		12 5	
EPITHEMIALES			
RHOPOLODIA GIBBA	45	4	
RHOPOLODIA (LPIL)	4		
BACILLARIALES			
HANTZSCHIA (LPIL)		4	
NITZSCHIA ACICULARIS	1 4	12 4	1 4
NITZSCHIA HOLSATICA	1		
NITZSCHIA LINEARIS	1		
NITZCHIA (LPIL)	123 5	123 5	12 5
SURIRELLALES			
CYMTOPLEURA SOLEA	12		
SURIRELLA (LPIL)		1 3	
BACILLARIOPHYTA-PENNATE (LPIL)	123	12345	2 45
PYRRHOPHYTA-DINOPHYCEAE			
GYMNODINIALES			
GYMNODINIUM (LPIL)	1 4	1	4
PERIDINIALES			
PERIDINIUM GATUNENSE		34	
PERIDINIUM INCONSPICUUM		12 4	
PERIDINIUM CINCTUM		1	
PERIDINIUM (LPIL)	1 34	1 4	
CERATIUM HIRUNDINELLA		12	
CRYPTOPHYTA			
CRYPTOMONODALES			
CRYPTOMONAS MARSSONII	5	1 3	1 34
CRYPTOMONAS OVATA	4	1 3	45
CRYPTOMONAS (LPIL)	12345	12345	12345
RHODOMONAS MINUTA	12345	1234	1234
RHODOMONAS LENS		12	
RHODOMONAS (LPIL)		12	2
CHROOMONAS (LPIL)	12345	1234	
CYANOMONAS (LPIL)		2	
CRYPTOMONADALES (LPIL)	2	12 5	

Legend

SPR = April Sampling
SUM = June and August Sampling
FAL = November Sampling

Location 1 = Near-field stations 1-6 and 10
Location 2 = Far-field stations 7-9
Location 3 = Pond B
Location 4 = Pond C
Location 5 = Cowles Bog

Table 2.1-2

Annual Occurrence of Phytoplankton in Lake Michigan and Nearshore Ponds from 1974 through 1978, NIPSCo Bailly Study Area

Taxa	Year 1 Lake Michigan	Year 1 Ponds	Year 2 Lake Michigan	Year 2 Ponds	Year 3 Lake Michigan	Year 3 Ponds	Year 4 Lake Michigan	Year 4 Ponds	Year 5 Lake Michigan	Year 5 Ponds
Cyanophyta										
Unidentified Cyanophyta	Sp F W	S F W	Sp*	Sp		S			S	S
Chroococcaceae										
Unidentified Chroococcaceae	S F* W	Sp* S* F	Sp F*	Sp	S F	S F		S		
Agmenellum sp.	S F		Sp S	S*	S*	S	S F		S F	S*
Aphanocapsa sp.	F*	S*	Sp	S	S		Sp			
Aphanothece sp.							S F		Sp* S* F*	S*
Chroococus sp.	S* F W	S F	Sp F	Sp	Sp S F	Sp	Sp S F		F	
C. prescotti	S									
C. limneticus									F	
Coelosphaerium sp.	S F* W*	F*	Sp S F		S					
Dactylococcopsis sp.	S		Sp				F			
Gloeothece sp.				F*						
Gomphosphaeria sp.			S F		F		S*		Sp* F	
G. naegolianum		S					F		F	S
G. aponina							F		F*	
G. lacustris							S F		Sp F*	
Microcystis sp.		F	Sp S F*	Sp* F	Sp S* F*	Sp S* F	Sp S F	F	Sp S* F*	S*
Rhabdoderma sp.	F									
Chamaesiphonaceae										
Chamaesiphon										S
Pleurocapsaceae										
Unidentified Pleurocapsaceae					S					
Oscillatoriaceae										
Unidentified Oscillatoriaceae	S F W*	S	Sp* S* F						S	S
Oscillatoria sp.	Sp* S* F W*	W*	Sp* S* F	S F	Sp* S* F	Sp S* F*	Sp* S* F	Sp S F	Sp* S* F	Sp S*
O. amphibia							S			
O. princeps								S		
Phormidium sp.					S	S*				
Lyngbya sp.						S*		F	S	S*
Nostocaceae										
Unidentified Nostocaceae	S		Sp* S F	Sp				S*		
Anabaena sp.	S* F		Sp F	Sp F	S F	S	Sp S* F	S* F	S F	S
A. circinalis			S* F							
A. flos-aquae								F	S* F	
Aphanizomenon								S*		
Cylindrospermum sp.						S*				
Nodularia sp.				Sp						
Raphidiopsis sp.		S								
Chlorophyta										
Unidentified Chlorophyta	Sp S* F W	S* W	Sp S*	S* F	Sp S* F	Sp S*			S F	
Chaetophorales										
Unidentified Chaetophorales			S		Sp S	S	S			
Chlorosarcina sp.	F									
Pseudendocloniopsis sp.			S							
Chlorococcales										
Unidentified Chlorococcales	Sp S* F W	Sp S* F* W	Sp S F	Sp S F	S F	Sp S*	Sp S F	Sp* S F	S F	S F
Actinastrum sp.							F			
Ankistrodesmus sp.	S F W	Sp* S F	Sp* S* F	Sp S	S F	Sp S	Sp S F	Sp S	S	F
A. convolutus					Sp S F	Sp S	S	S	Sp S	S
A. falcatus	Sp	F	Sp	Sp	Sp S F	Sp S	Sp S	S	Sp S F	Sp S F
A. spiralis		F		S		Sp				

*Dominant taxa

Sp = spring, S = summer, F = fall, W = winter

POOR ORIGINAL

579162

Table 2.1-2 (Contd)

Taxa	Year 1 Lake Michigan	Year 1 Ponds	Year 2 Lake Michigan	Year 2 Ponds	Year 3 Lake Michigan	Year 3 Ponds	Year 4 Lake Michigan	Year 4 Ponds	Year 5 Lake Michigan	Year 5 Ponds
Chlorophyta (Contd)										
Chlorococcales (Contd)										
Chodatella sp.	Sp S F		S F	S*	S	F	S			
C. ciliata							S		F	
C. citriformis							S			
C. quadriseta							S			
Chlorella									Sp	Sp
Closteriopsis sp.		S	Sp S F		F		Sp S			
C. longissima	Sp									
Coelastrum sp.	F	S* F*	Sp F	Sp F*	S	S	Sp S	S		
C. microporum	Sp* S	S* F	F	S						
C. cambricum							S	S	F	S*
Crucigenia sp.	Sp F	Sp F		Sp	S					
C. crucifera		S F								
C. quadrata	W						S F		S	
C. tetrapedia					S		S F			
C. rectangularis								S		S
Desmotractum								S		
Dictyosphaerium sp.	S W		Sp S*		S F		S		Sp S	
D. ehrenbergianum					S					
D. pulchellum	F		Sp		S F		S F		F	
Didymocystis							Sp			
Franceia sp.			S							
Golenkinia sp.			Sp							
G. radiata			Sp							
Golenkiniopsis sp.			S							
Kirschneriella sp.	S F	S F	Sp*	Sp	S	Sp S F		Sp*		
K. lunaris						Sp				
K. obesa	S	S	S F	F	F	Sp				
Micractinium sp.	Sp	F	Sp S							
M. pusillum							S		F	
Myrmecia							S			
Nephrocytium sp.							F	S		
Oocytis sp.	F	Sp S F	Sp S* F	S F	S F	Sp S				
O. gloeocystiformis	S									
Ourococcus	S									
Pediastrum sp.	S	Sp* S F	Sp F	Sp						
P. boryanum	F			Sp S F	S		S F	S	F	
P. duplex	F	Sp* S* F	F	F		Sp S	S	S F		S
P. simplex	F									
P. tetras		S F		Sp			S	S		
Pseudochlorella							S F			
Quadrigula sp.	F W		S	S	S F					
Q. chodatii									S	
Scenedesmus sp.	S F W	Sp* S* F* W*	Sp* S* F*	Sp* S* F*	Sp S F	Sp S	S F	Sp S	S	S F
S. acuminatus	S	S* F*		S F			S	S F	S	
S. acutus	F	F*			S		S F	F		Sp
S. arcuatus		S* F		S		S		S		
S. columnatus			S							
S. circumfusus							S			
S. denticulatus							F	S		S
S. dimorphus	Sp			S						
S. ecornis		S	F	F	S	S	S F	Sp* S F	Sp S F	Sp S
S. intermedius			S			Sp	S	S		
S. opoliensis		S					S			
S. quadricauda	Sp S F	S* F	Sp S F	Sp* S* F	S F	Sp S F	S F	Sp* S F	F	Sp S F*

579163

Table 2.1-2 (Contd)

Taxa	Year 1 Lake Michigan	Year 1 Ponds	Year 2 Lake Michigan	Year 2 Ponds	Year 3 Lake Michigan	Year 3 Ponds	Year 4 Lake Michigan	Year 4 Ponds	Year 5 Lake Michigan	Year 5 Ponds
Chlorophyta (Contd)										
Chlorococcales (Contd)										
S. spinosus	S	S F	S			Sp	S	Sp		S F
Schroederia sp.	F			F	S	S		S	Sp	
Selenastrum sp.			Sp					S		
S. gracile		S F								
S. minutum								S		
Sorastrum sp.		F								
Sphaerocystis sp.			S	S F	S	S	F	S*	S F	S
S. schroeteri	S F							S*	S	S F*
Tetraedron sp.	S F									
T. caudatum										S
T. muticum										S
T. trigonum							S			Sp
T. minimum	F		F	S	S F	S F	S	S F		S
Tetrastrum sp.	W		Sp		S	S			S	
Treubaria sp.			F							
Westella sp.							S			
Oedogoniales										
Oedogonium sp.	F		Sp	F			S F	S	Sp F	Sp S
O. undulatum			F					S		
Bulbochaete sp.										
Cladophorales										
Cladophora sp.								S		
Tetrasporales										
Unidentified Tetrasporales	S F W	S* F	Sp S	Sp S	S		S	S		
Asterococcus sp.		S								
Elakatothrix sp.	F					S		S	S F	F
E. viridis	Sp								F	
Gloeocystis sp.		S F	Sp S F	S F	Sp S F	S	Sp S F	Sp S F	S F	S
G. gigas	F									
G. gelatinosa							F			
Ulotrichales										
Unidentified Ulotrichales	S F W	S F	Sp F		F				S	
Microspora sp.									F	
Ulothrix sp.									S	
Radiofilum sp.										S
Volvocales										
Unidentified Volvocales	F	Sp S F W	Sp	Sp S	Sp S F	Sp S* F	Sp S F	Sp* S F	S	Sp S
Carteria sp.		F						S F	Sp	Sp
Chlamydomonas sp.	F	F		Sp S F	Sp S F	Sp S F	Sp S	Sn S F	Sp S F	Sp S
Eudorina sp.								S	Sp	
Gonium sp.									Sp	S
Pandorina sp.			Sp				S			
Pedinomonas sp.							Sp			
Spermatozoopsis sp.					S	S	Sp			
Volvox sp.								S*		
Zygnematales										
Unidentified Zygnematales	F	Sp S F								
Arthrodesmus sp.		S	Sp	Sp						
Closterium sp.	F	S* F	F	S F		S	S	S	Sp	Sn
C. gracile								S		
C. kuetzingii								S	S	Sp
C. setaceum							F	S		
Cosmarium cosmetum								S		
Cosmarium sp.	Sp S F	S F	S F	Sp S	S F	Sp S		S		

Table 2.1-2 (Contd)

Taxa	Year 1 Lake Michigan	Year 1 Ponds	Year 2 Lake Michigan	Year 2 Ponds	Year 3 Lake Michigan	Year 3 Ponds	Year 4 Lake Michigan	Year 4 Ponds	Year 5 Lake Michigan	Year 5 Ponds
Chlorophyta (Contd)										
Zygnematales (Contd)										
Desmidium sp.				F		S*				
D. aptogonium		S								
D. baileyi		S								
D. swartzi				S						
Euastrum sp.								S		
Gonatocygon sp.				S						
G. pilosum								S		Sp
Hyalotheca sp.				S						S
H. mucosa								S		
Micrasterias sp.								S		
M. ehrenbergii								S		
M. truncata								S*		
Mougeotia sp.	S*	S* F	F	Sp S F	S	Sp S !	S	Sp* S F	Sp F	Sp F*
Pleurotaenium sp.	W	S W								
Spirogyra sp.		Sp* S F		Sp F		S*	S	S*		
Spondylosium sp.				Sp				F		
Staurastrum sp.	S F W	S F W		Sp F		S*		F	S F	Sp S*
S. arctiscon								S		
S. dickiei								S		
S. megaganthum								S		
S. paradoxum								S		S
S. radians								S		
Staurastrum "J"								S*		
S. johnsonii										S*
S. gralatorium						S				
S. longiradiatum				S		S				
S. ophiura				S					F	S
S. tetracerum				S		S				
Euglenophyta										
Unidentified Euglenophyta		S								
Euglenales										
Unidentified Euglenales	S F	S F		F	Sp	Sp				
Euglena sp.	F	F		Sp S F		Sp S			Sp* S	Sp S
E. acus		S								
E. spirogyra								S*		
Lepocinclis sp.		F				S		S		
Phacus sp.		F	Sp	F	S	S		Sp S		
Trachelomas sp.	Sp	F	Sp		S	S		Sp S F		Sp S
Xanthophyta										
Unidentified Xanthophyta	F W									
Rhizochloridales										
Unidentified Rhizochloridales	S									
Stipitococcus sp.	S F		Sp S		Sp		S		S	
Bumilleriopsis sp.		Sp*								
Heterococcales										
Unidentified Heterococcales	F	F					S			
Ophiocytium sp.		S								
Peroniella sp.								S*	F	
Heterotrichales										
Tribonema sp.							S			
T. affine							S			
Chloramoebales										
Unidentified Chloramoebales					Sp	Sp				

579165

Table 2.1-2 (Contd)

Taxa	Year 1 Lake Michigan	Year 1 Ponds	Year 2 Lake Michigan	Year 2 Ponds	Year 3 Lake Michigan	Year 3 Ponds	Year 4 Lake Michigan	Year 4 Ponds	Year 5 Lake Michigan	Year 5 Ponds
Chrysophyta										
Unidentified Chrysophyta	Sp S F W	Sp S* F	Sp S	Sp S			Sp S F	Sp S	S	
Chrysomonadales										
Unidentified Chrysomonadales	S F W	S* F W*	Sp S* F*	Sp* S* F*	Sp S F	Sp S F	Sp S F	Sp* F	S	S F
Aulomonas sp.					Sp					
Chromulina sp.					S	S*		Sp		Sp
Chrysochromulina sp.			Sp*	Sp	Sp	Sp	Sp		Sp S F	S
Chrysococcus sp.		F W	Sp S	Sp S* F		Sp F	Sp S	Sp* S		Sp S
Cyclonexis sp.			Sp* F	Sp F	Sp		S			
Dinobryon sp.	S* F W	F W*	Sp* S* F	Sp* S	Sp S F	Sp* S F	Sp*	Sp* F	Sp* S	Sp* F
D. bavarium						Sp				
D. cylindricum	S	F			Sp				Sp S	
D. divergens	S F		S F		Sp F	Sp F	S F		S	F*
D. pediforme									S	
D. sertularia	Sp			S F	Sp	Sp F	Sp	Sp F	Sp* S	Sp* F*
D. sociale	S F	F	F		Sp S	Sp*		Sp* F	Sp* S F	F*
Kephryion sp.			Sp				S	Sp	S	
Mallomonas sp.	F	F	Sp S F		Sp F	F	Sp S F	Sp* S	Sp	
Synura sp.		Sp F							Sp	
Ochromonas sp.							Sp	Sp		
Pseudokephyrion sp.							Sp	F	Sp S	
Stylobryon					S	Sp				
Monosigales										
Stelexomonas dichotoma	W		Sp				Sp F		Sp F	
Monosiga			S				F			
Chrysocapsales										
Chryocapsa sp.	F							Sp*		
Isochrysidales										
Unidentified Isochrysidales							S			Sp
Rhizochrysidales										
Unidentified Rhizochrysidales	S F	Sp F			Sp S F	F				
Chrysopyxis sp.	F									
Lagynion sp.		S						S		
Salpingorhiza sp.					F		S			
Hyalocylix sp.							S			
Stylococcus sp.							S			
Bacillariophyta										
Centrales										
Unidentified Centrales	S W		Sp S	S	S		S F	S F		S
Attheya zachariasi	F									
Coscinodiscus							S			
Cyclotella sp.	Sp* S* F W*	Sp S F	Sp* S F*	Sp	Sp S F*	S F	Sp S F	Sp S	Sp S F	
C. chaetoceras			Sp							
C. glomerata			Sp							
Melosira sp.	Sp S F W	F	Sp S F	S*	Sp* S*		Sp S F	S	Sp F	S* F*
M. islandica							Sp		Sp* S	
M. varians				S			S	S		
M. italica								Sp*	S	
Skeletonema potamos	F		Sp F		Sp		S F		Sp S	
Rhizosolenia eriensis	Sp* F W		Sp		Sp S F		Sp F		Sp S F	
R. longiseta	S									
R. sp.	S W		Sp*		Sp S					
Stephanodiscus sp.	S F W	S F	S* F	Sp S			Sp S* F		Sp S	
S. astraea			Sp				Sp S F		Sp* F	

Taxa	Year 1 Lake Michigan	Year 1 Ponds	Year 2 Lake Michigan	Year 2 Ponds	Year 3 Lake Michigan	Year 3 Ponds	Year 4 Lake Michigan	Year 4 Ponds	Year 5 Lake Michigan	Year 5 Ponds
Bacillariophyta (Contd)										
Centrales (Contd)										
S. binderana	W*		Sp* S F				S F		Sp F	
S. hantzschii							F			
S. niagarae							F			
Pennales										
Unidentified Pennales	Sp S F W	Sp S F W	Sp* S* F	Sp* S* F*	Sp S F	Sp S F*		Sp*		Sp S F
Achnanthes sp.	Sp	Sp S F		Sp F	Sp	Sp F	S	Sp S F	S	Sp S F
Amphora sp.						S	F			
Amphipura sp.					F		Sp			
A. ornata							F			
Amphipleura pellucida			F						Sp	
Asterionella sp.					S					
A. formosa	Sp S* F* W*	F	Sp* S F		Sp* S* F*	Sp F	Sp* S F	Sp	Sp* S F	S
Cocconeis sp.		F						F	S F	Sp S
Cymatopleura sp.	F		F				S			
C. solea	F						Sp S F		Sp	
Cymbella sp.	Sp F	Sp* S F W		F			S	S	Sp	S
Diatoma sp.			Sp S		S		S	S		
D. tenue			Sp S F	Sp	Sp* S*	S	Sp S F		Sp S	S
D. tenue v. elongatum			Sp S	Sp	Sp					
D. vulgare		F			Sp* S					
Eunotia sp.		Sp S F W*	Sp	Sp F*				Sp* S		Sp S
Fragilaria sp.	Sp S F* W	S* F	Sp S F	Sp F*	Sp S F	S F*	Sp S F	Sp S F	Sp S* F*	Sp S F
F. capucina		F					F		Sp	Sp
F. crotonensis	Sp S* F* W	F	Sp* S F*	F	Sp* S* F*	F	Sp* S F	Sp F	Sp* S F*	Sp
F. vaucheria						F			F*	F
Frustulia sp.				F						
Gomphonema sp.	Sp S F	Sp S F W		Sp* S* F*		F		Sp S F	Sp S	Sp S F
G. acuminatum				Sp F						F
G. acuminatum v. coronata		F								
G. truncatum										Sp
Gyrosigma or Pleurosigma							S	S F		
Gyrosigma										S
Meridion circulare								Sp	Sp	
Hannaea arcus		Sp								
Hantzschia										S
Navicula sp.	Sp			S		Sp	S F		Sp	Sp S* F
Nitzschia sp.	F W		Sp F	S	Sp S F	Sp	Sp S F	Sp S	Sp S F	Sp S F
N. acicularis	Sp S F W		F	Sp* S*	Sp S	Sp	Sp F	Sp F	Sp S F	Sp S F
N. closterium					S					
N. linearis									Sp	
N. longissima					Sp					
N. holsatica	F		Sp				Sp	Sp	Sp	
Pinnularia sp.	W	F					F			Sp* S
Rhoicosphenia sp.			S							
R. curvata	F		Sp	Sp	S					
Rhopalodia								F		Sp
R. gibba										Sp S
Stauroneis sp.		S*		F						
Surirella spiralis	F									
Surirella sp.	W								S	S
Synedra sp.	Sp* S F W	Sp* S F W	Sp* S* F	Sp S F	Sp* S F	Sp F*	Sp* S F	Sp S F	Sp S	Sp S F
S. acus							Sp			
S. ulna	F		S				Sp S F		Sp S	Sp*
S. ulna v. chasaena	F									

Table 2.1-2 (Contd)

Taxa	Year 1 Lake Michigan	Year 1 Ponds	Year 2 Lake Michigan	Year 2 Ponds	Year 3 Lake Michigan	Year 3 Ponds	Year 4 Lake Michigan	Year 4 Ponds	Year 5 Lake Michigan	Year 5 Ponds
Bacillariophyta (Contd)										
Pennales (Contd)										
Tabellaria sp.	W		F				Sp* S*	S	S	
T. fenestrata					Sp S	Sp	S		S	
T. flocculosa	S* F* W*	Sp* S F	Sp* S* F*	Sp F	Sp S F*	F	Sp* S* F		Sp S F*	Sp F*
Unidentified Fragilariaceae			Sp		Sp F	Sp	Sp S F	Sp S F	S	S F
Unidentified Achnanthales						F				
Unidentified Naviculales					Sp	Sp F	Sp F	Sp S	S	S
Cryptophyta										
Unidentified Cryptophyta	Sp F W	S F*								
Cryptomonadales										
Unidentified Cryptomonadales	S F* W	S* F* W*	Sp S F	Sp* S F*	Sp S	Sp S	S F	Sp [illegible] F	Sp S	S
Chroomonas sp.	F*	F*	Sp S F	S F*	S	Sp S F	Sp S F	Sp [illegible] F	Sp S	Sp S
Cryptomonas sp.	S* F* W	Sp* S* F W*	Sp S F*	Sp* F*	Sp S* F*	Sp* S* F*	Sp S F		Sp S F	Sp S* F*
C. marssonii							F	F	S F	Sp S F
C. ovata	Sp								S	Sp S* F
C. reflexa								F		
Rhodomonas sp.	S* F W	Sp S*	Sp* S F*	Sp* S* F*	Sp* S* F*	Sp S* F*			S F	
R. lacustris	S* F*	S F	Sp*	Sp	Sp	Sp				
R. lens							S	S		
R. minuta							S	S* F	Sp S F	Sp S F*
Cyanomonas									S	
Pyrrophyta										
Unidentified [illegible]	W	S* W	Sp				S	Sp		
Gymnodiniales										
Unidentified [illegible]	S	F								
Gymnodinium	F	S F		F	S	Sp S	Sp S	F	Sp S	Sp F
Peridiniales										
Unidentified P[illegible]	S F	S F W	Sp	Sp	Sp S*	Sp S	S	Sp		
Ceratium sp					S*					
C. [illegible]	S F	S					S	S*	S*	
Gle[illegible]inium		S*	Sp	Sp* S						
Gonyaulax s[illegible]		F		F		S				
Peridinium s[illegible]					S	S F*	Sp S*	Sp* S F	Sp S	Sp* S*
P. gymnodinium							S	S		
P. inconspicuum							S	S	S	S
P. gatunense									S	S*
Unidentified Algae			Sp S F	F	Sp					

Table 2.1-3

Mean Phytoplankton Density (No./mℓ) and Biovolume (μℓ/ℓ) by Station for 1978

Station		Apr	Jun	Aug	Nov
1	D*	3,433.8	4,913.3	2,168.3	47,656.0
	B	4.76	2.44	1.12	7.18
2	D	5,436.6	1,112.8	6,876.9	26,548.3
	B	6.47	0.45	0.24	3.82
3	D	1,994.2	2,822.0	594.0	69,049.1
	B	2.13	2.08	0.58	2.47
4	D	5,614.6	7,498.3	4,251.2	28,074.3
	B	5.34	1.48	2.3	1.25
5	D	10,733.0	4,942.7	934.0	19,416.2
	B	6.38	1.46	0.20	0.94
6	D	1,534.9	8,670.6	2,402.2	26,574.3
	B	1.91	4.71	2.02	1.17
7	D	3,827.1	12,733.8	717.5	17,020.3
	B	3.69	4.85	0.26	4.09
8	D	11,367.3	3,887.4	7,280.8	148,133.3
	B	6.37	1.18	1.77	7.21
9	D	7,235.5	7,781.8	404.4	21,609.8
	B	12.9	1.36	0.20	2.41
10	D	2,756.5	3,177.6	592.4	28,981.3
	B	2.82	0.86	5.82	4.0
17	D	6,990.7	1,935.9	13,546.6	10,924.9
	B	11.17	0.26	2.6	2.12
18	D	9,540.7	2,477.2	2,753.3	4,249.9
	B	25.32	0.52	0.87	2.23
19	D	3,628.5	981.1	23,219.2	1,700.4
	B	2.41	2.41	1.94	0.60
20	D	9,938.8	2,542.5	11,895.4	1,510.8
	B	6.33	1.23	1.67	0.40
21	D	547.8	25,344.8	40,847.6	256.4
	B	30.59	14.79	2.01	0.30

*D = Density; B = Biovolume

579169

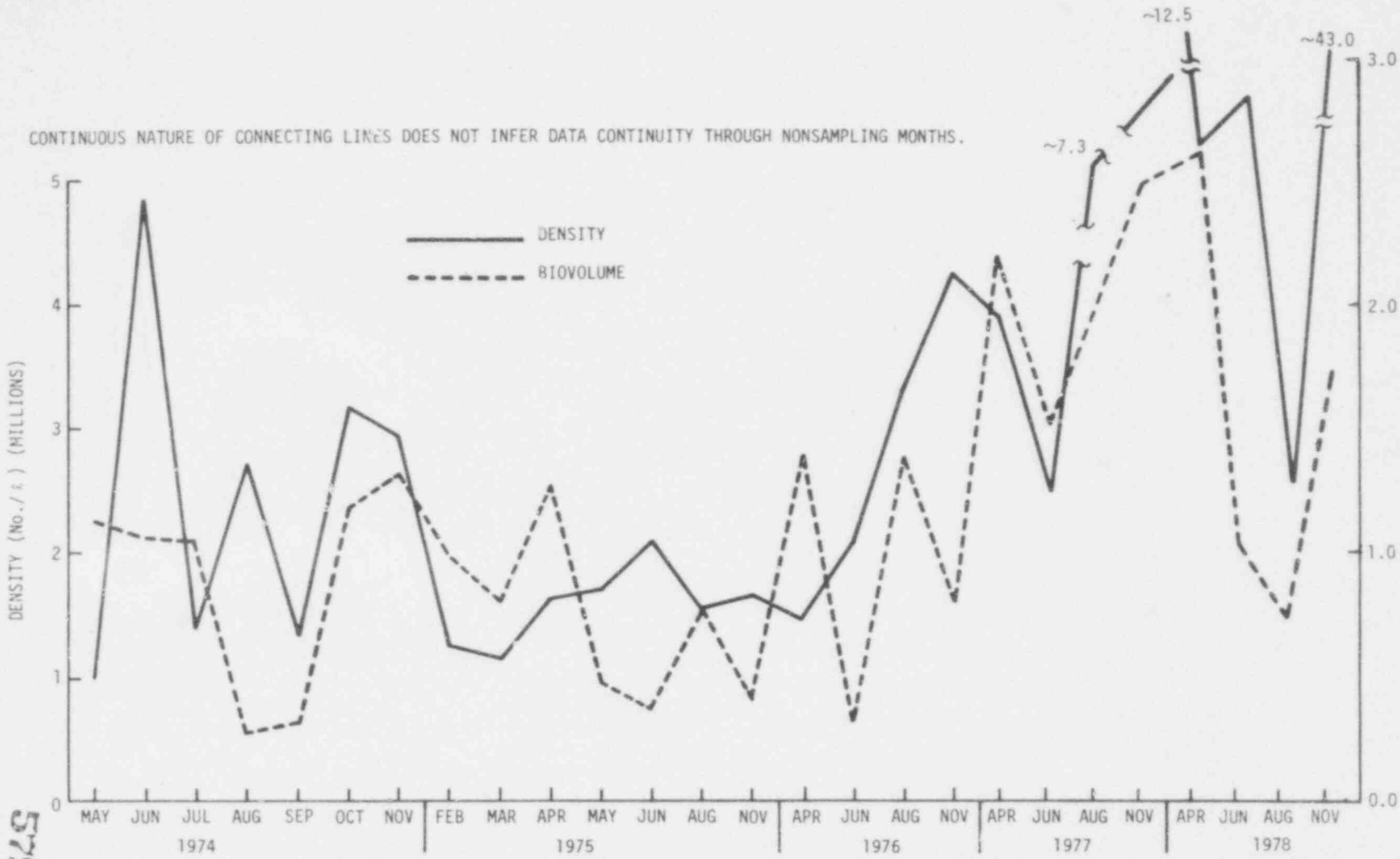


Figure 2.1-1. Mean Phytoplankton Density (No./ℓ) and Biovolume (μℓ/ℓ) for Lake Michigan in the NIPSCo Bailly Study Area, May 1974-November 1978r 19

579170

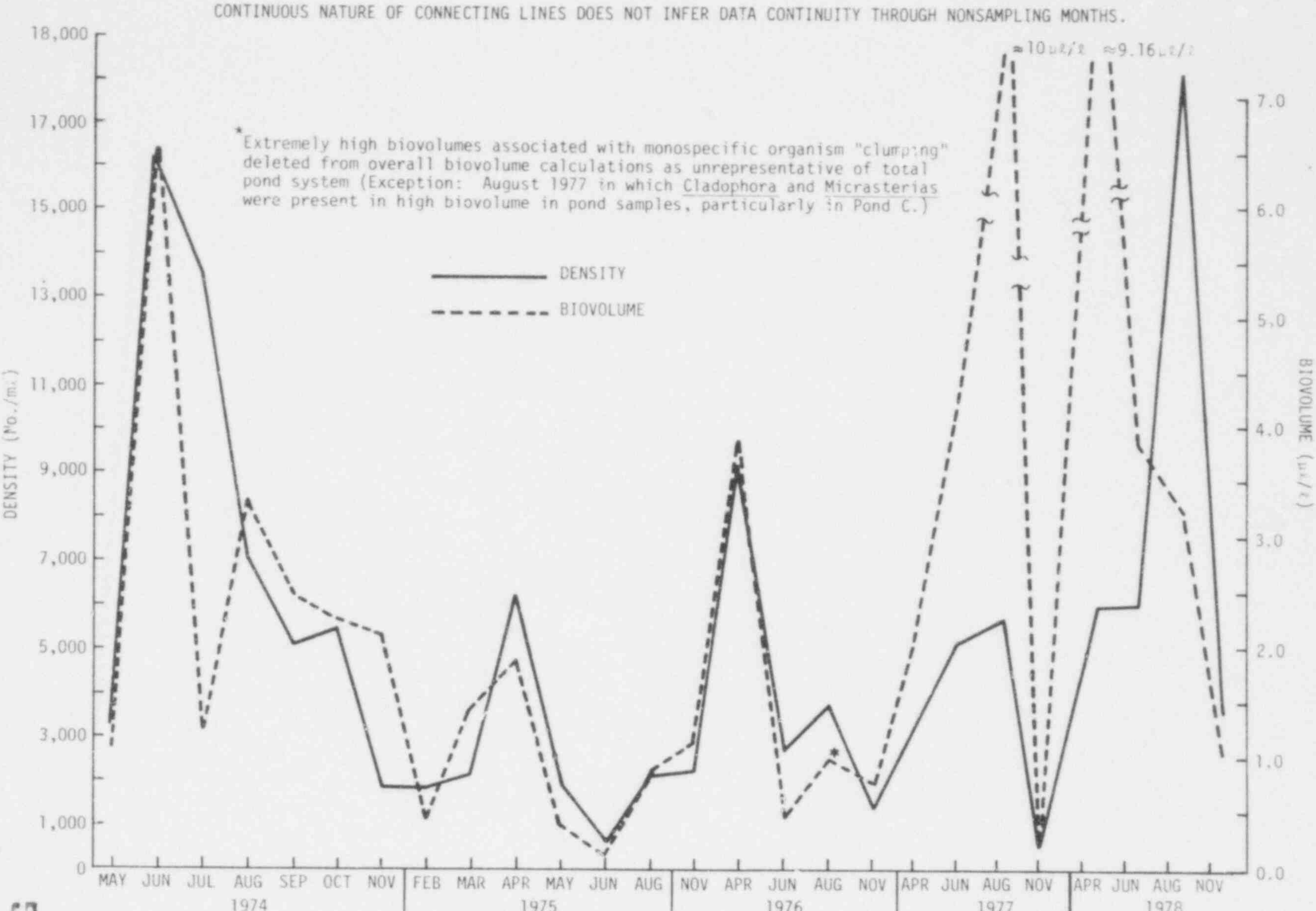


Figure 2.1-2. Mean Phytoplankton Density (No./mℓ) and Biovolume (µℓ/ℓ) for Nearshore Ponds in the NIPSCo Bailly Study Area, May 1974-November 1978

579171

Average densities at each depth contour within Lake Michigan indicate small differences among the 15-, 30-, and 50-ft depth contours from 1975 through 1978 (Figure 2.1-3). The only major difference was the deep-water transect (50 ft) which did not show an autumn pulse in 1976. Phytoplankton density increased through time, marked by autumn pulses of increasing magnitude in 1976, 1977, and 1978.

A summary of the average density trends for all Lake Michigan stations is shown in Figure 2.1-4. The Lake Michigan average densities also show a general increase through time, with prominent temporary increases in the autumn of 1977 and 1978 due to blooms of coccoid blue-green algae. A similar increase in blue-green algae for Lake Michigan has been attributed to depletion of silica in the epilimnion (Schelske 1977); water quality data show that silica depletion has been ongoing in Lake Michigan (see Figure 2.6-7) and thus the fall increases in density of bluegreen algae may not represent any change in the trophic status of Lake Michigan since biovolume has not increased significantly. Within the interdunal ponds (Figure 2.1-4), density continued to change without apparent consistent trends.

Phytoplankton biovolume values for Lake Michigan and the interdunal ponds (Figure 2.1-5) have changed very little through time (including 1978). This indicates that the identified density changes have not resulted in concomitant biovolume changes and suggests that the density of smaller but more numerous green and blue-green algal forms is increasing. No association with plant operational influence is suspected since the operational mode of the Bailly plant did not change during this time period.

Density and biovolume for depth contours averaged over four years are presented in Figures 2.1-6 and 2.1-7.

There are no apparent density differences due to distance from shore. Overall average density in August is decreased relative to the 1977 summary, reflecting

579172

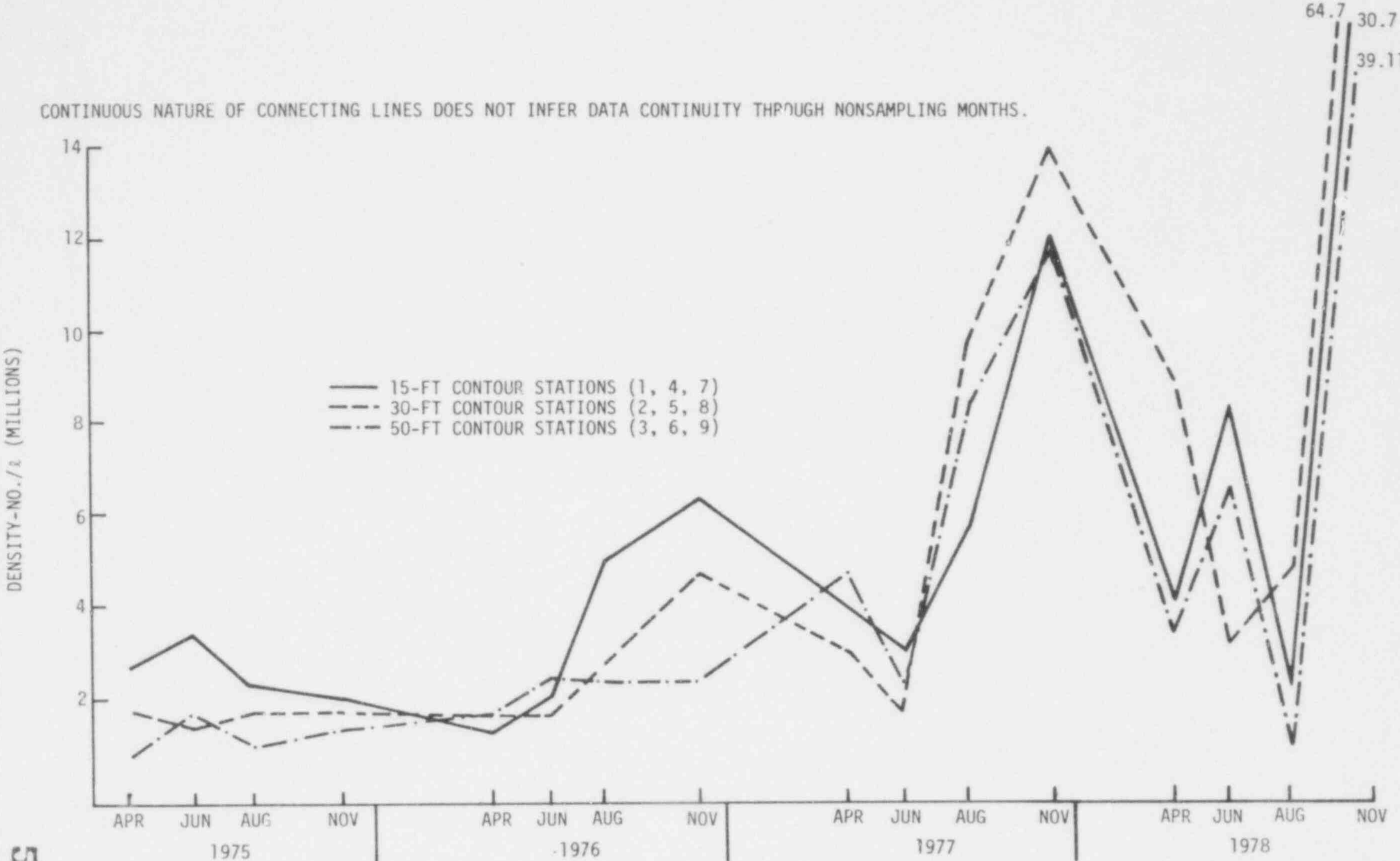
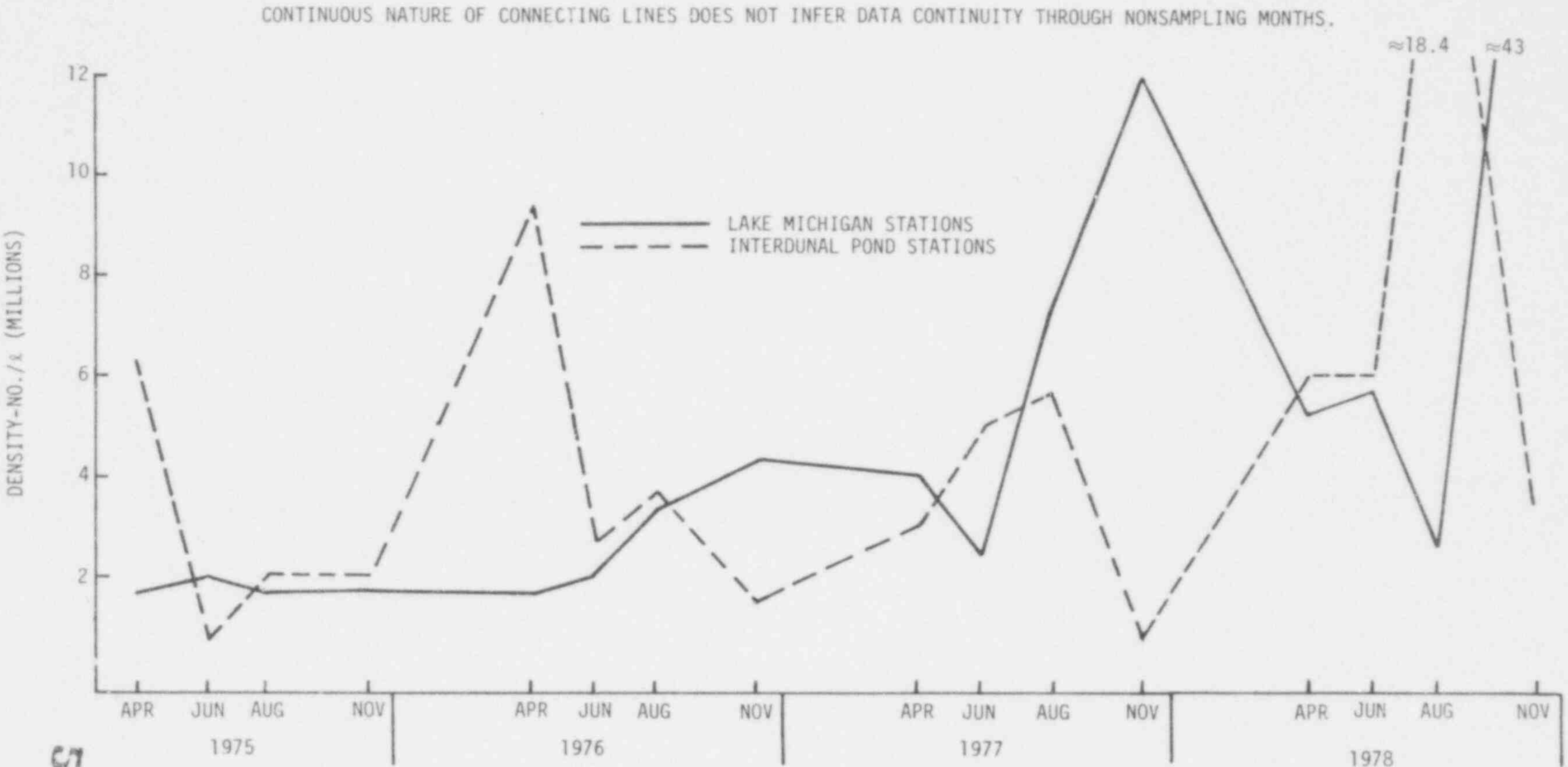


Figure 2.1-3. Phytoplankton Density (No./ℓ), Lake Michigan Stations (1975-1978)

5791 73



579174

Figure 2.1-4. Phytoplankton Density (No./ℓ), Lake Michigan Stations and Interdunal Pond Stations (1975-1978)

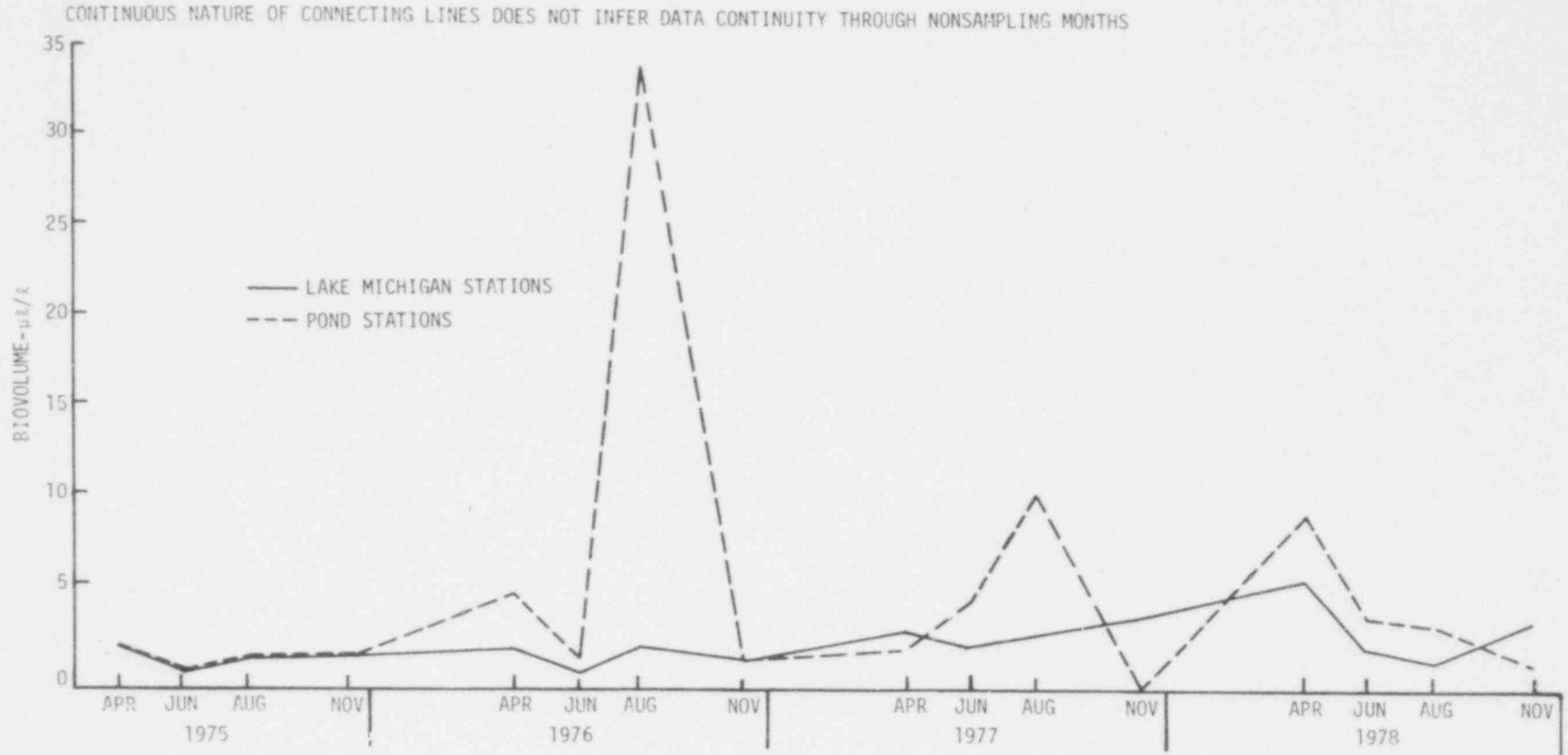


Figure 2.1-5. Phytoplankton Biovolume (μℓ/ℓ), Lake Michigan Stations and Interdunal Pond Stations (1975-1978)

7912175

CONTINUOUS NATURE OF CONNECTING LINES DOES NOT INFER DATA CONTINUITY THROUGH NONSAMPLING MONTHS

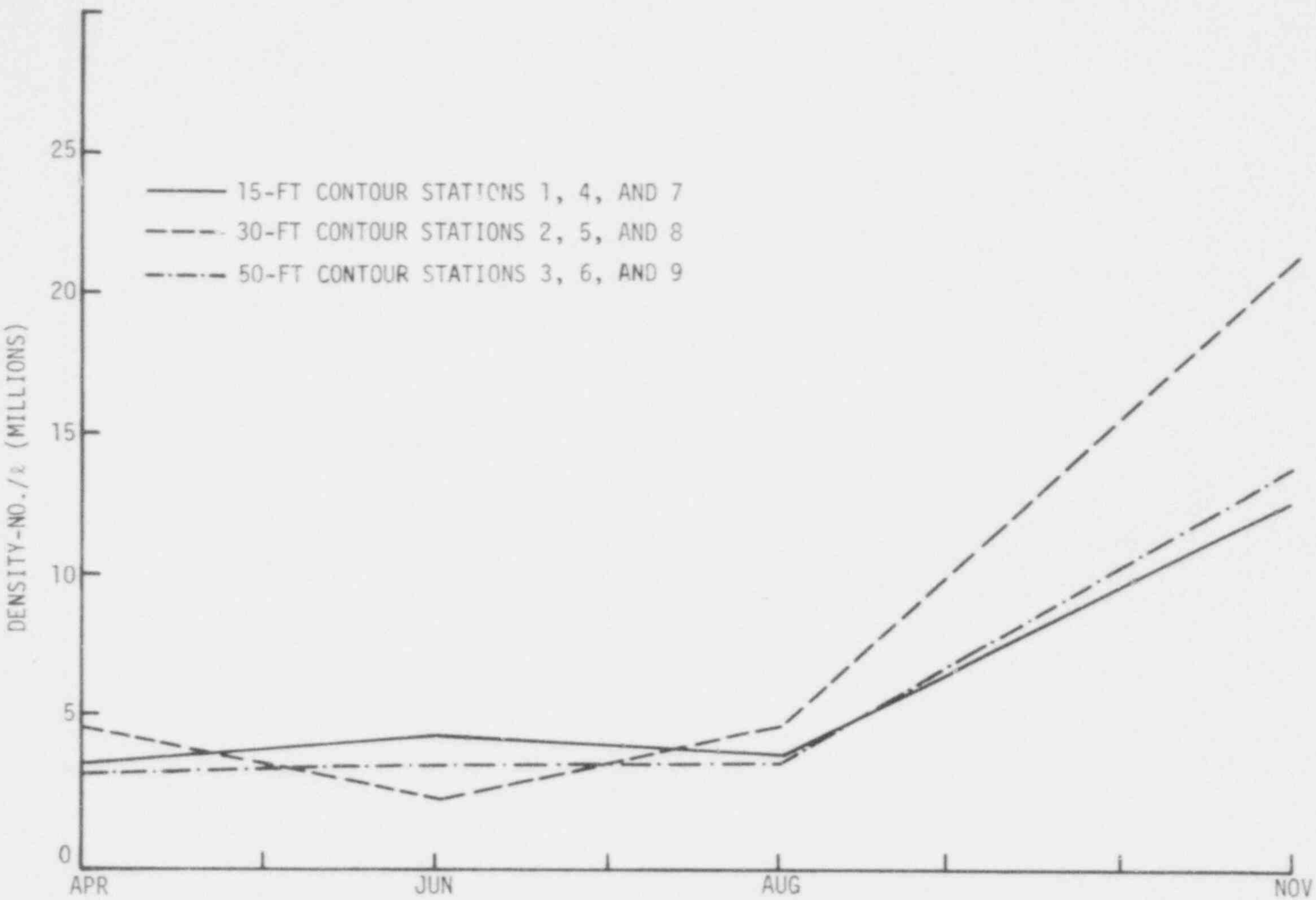


Figure 2.1-6. Phytoplankton Density (No./ℓ) at Lake Michigan Stations Summed over 1975-1978

slightly decreased density of blue-green algae in August 1978. The four-year summary (Figure 2.1-6) indicates an overall density increase in November.

Phytoplankton biovolume (Figures 2.1-7 and 2.1-8) reflects the limiting effect of available nutrients. While densities fluctuated greatly with changes in cell size of dominant species, the total average phytoplankton biomass from 1975 to 1978 (Figure 2.1-7) showed only slight fall and spring increases. The spring increase may be attributed in part to replenishment of epilimnion nutrients during winter mixing. During stratification (summer and fall), mixing takes place to 10 meters (Figure 2.6-3) and nearshore transects (15 ft and 30 ft) support more biovolume than the 50-ft stations.

This annual cycle is seen in Figure 2.1-8, where slight peaks are apparent each April, and somewhat larger peaks in the fall of 1977 and 1978. Stations along the nearshore contour (1, 4, 7) yielded higher biovolume concentrations during late summer and fall than the stations along the 50-ft contour.

Density patterns within individual nearshore ponds are shown in Figure 2.1-9, while mean seasonal densities across ponds and years are shown in Figure 2.1-10. Ponds B and C showed highest densities in April and August, while Cowles Bog peaks occurred in August. Overall densities averaged across years were highest in April and August (Figure 2.1-10).

Phytoplankton biovolume in the ponds was relatively constant. Peaks recorded in ponds B and C during 1976 and 1977 (Figure 2.1-11) were the result of algal clumps which did not disperse homogeneously. These individual results are reflected in the five-year summary (Figure 2.1-12) as biovolume peaked for ponds B and C in August, even though high densities for these stations occurred in April (Figure 2.1-13). The high average August cell density shown for Cowles Bog (Figure 2.1-13) was largely small blue-green algae, contributing to a low average August biovolume (Figure 2.1-12).

579177

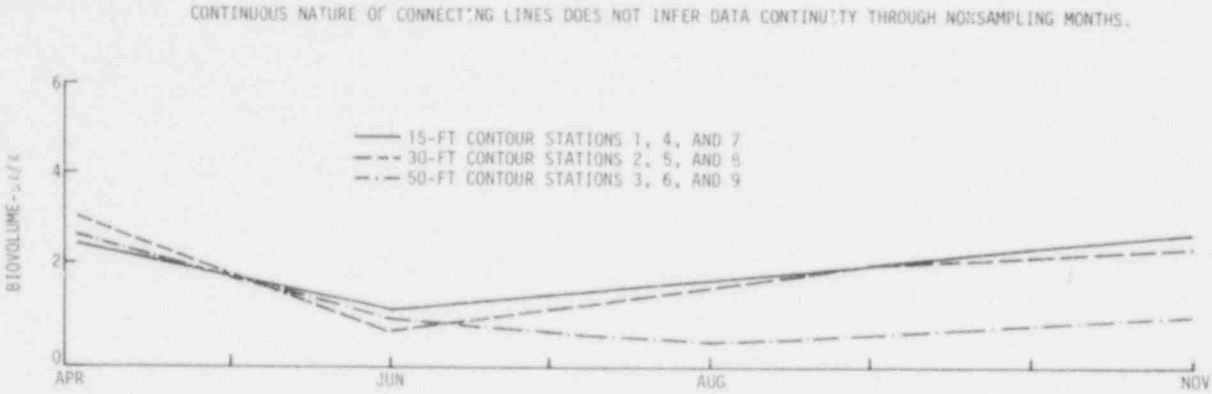


Figure 2.1-7. Mean Phytoplankton Biovolume (μℓ/ℓ) at Lake Michigan Stations Summed over 1975-1978

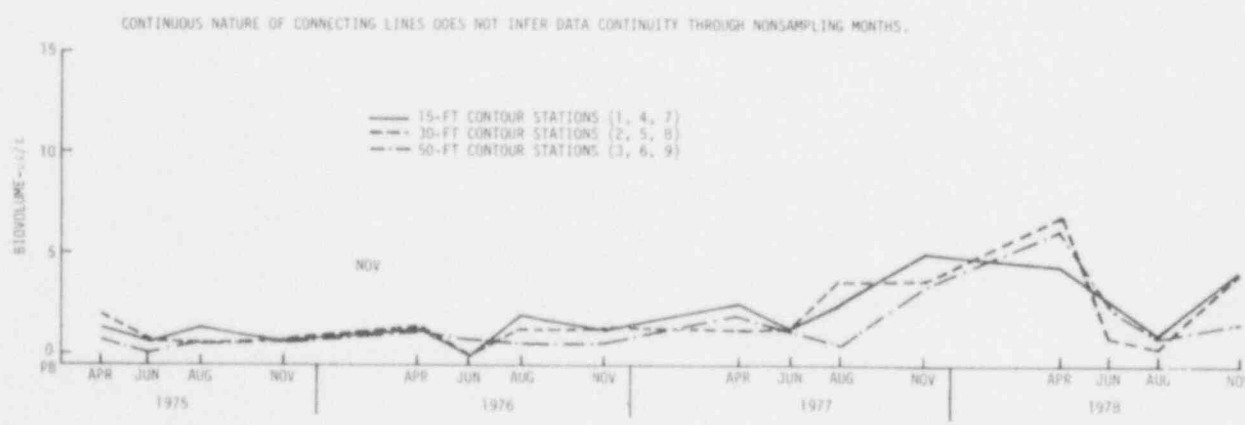


Figure 2.1-8. Phytoplankton Biovolume (μℓ/ℓ), Lake Michigan (1975-1978)

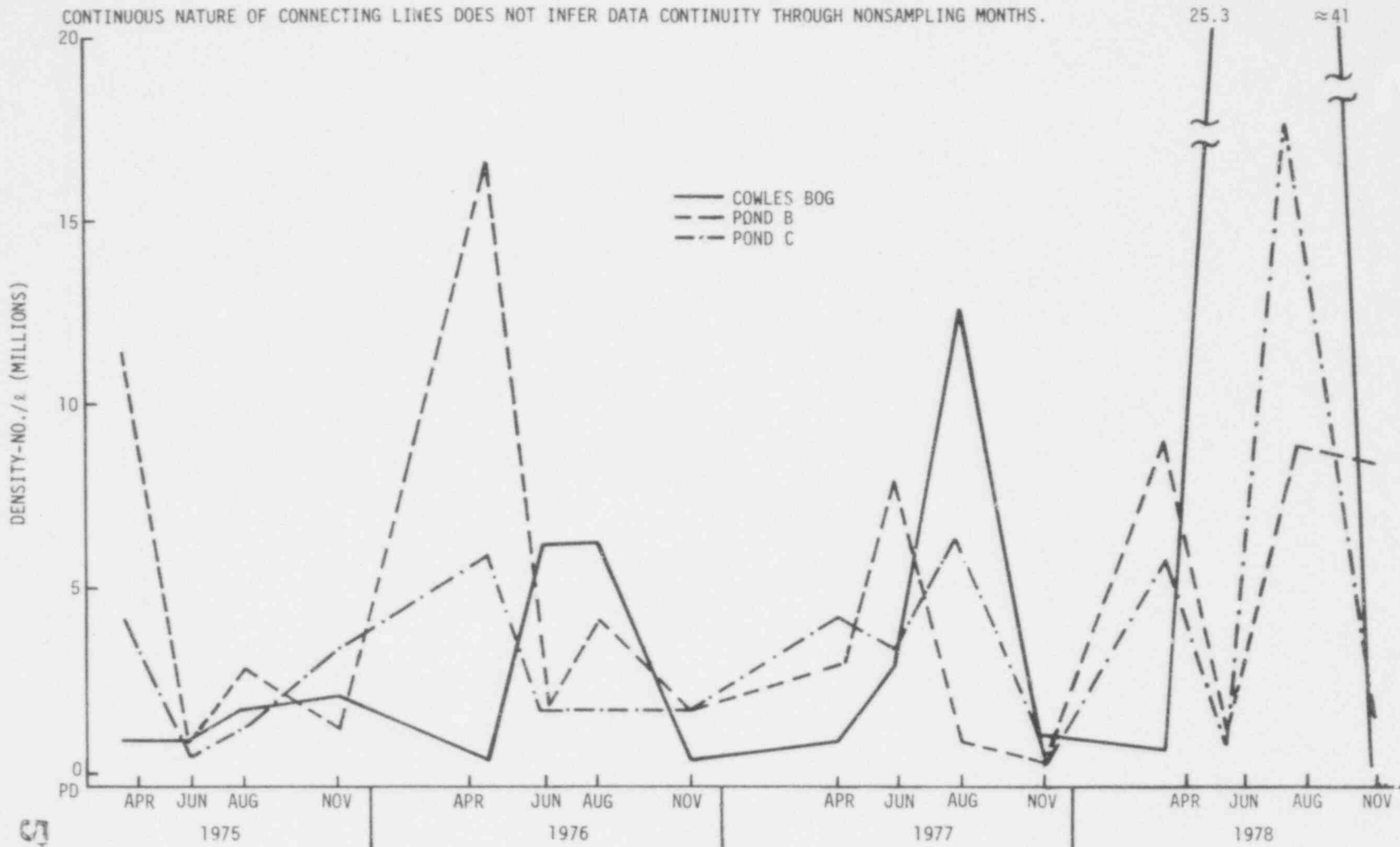


Figure 2.1-9. Phytoplankton Density (No./ℓ), Interdunal Ponds (1975-1978)

579179

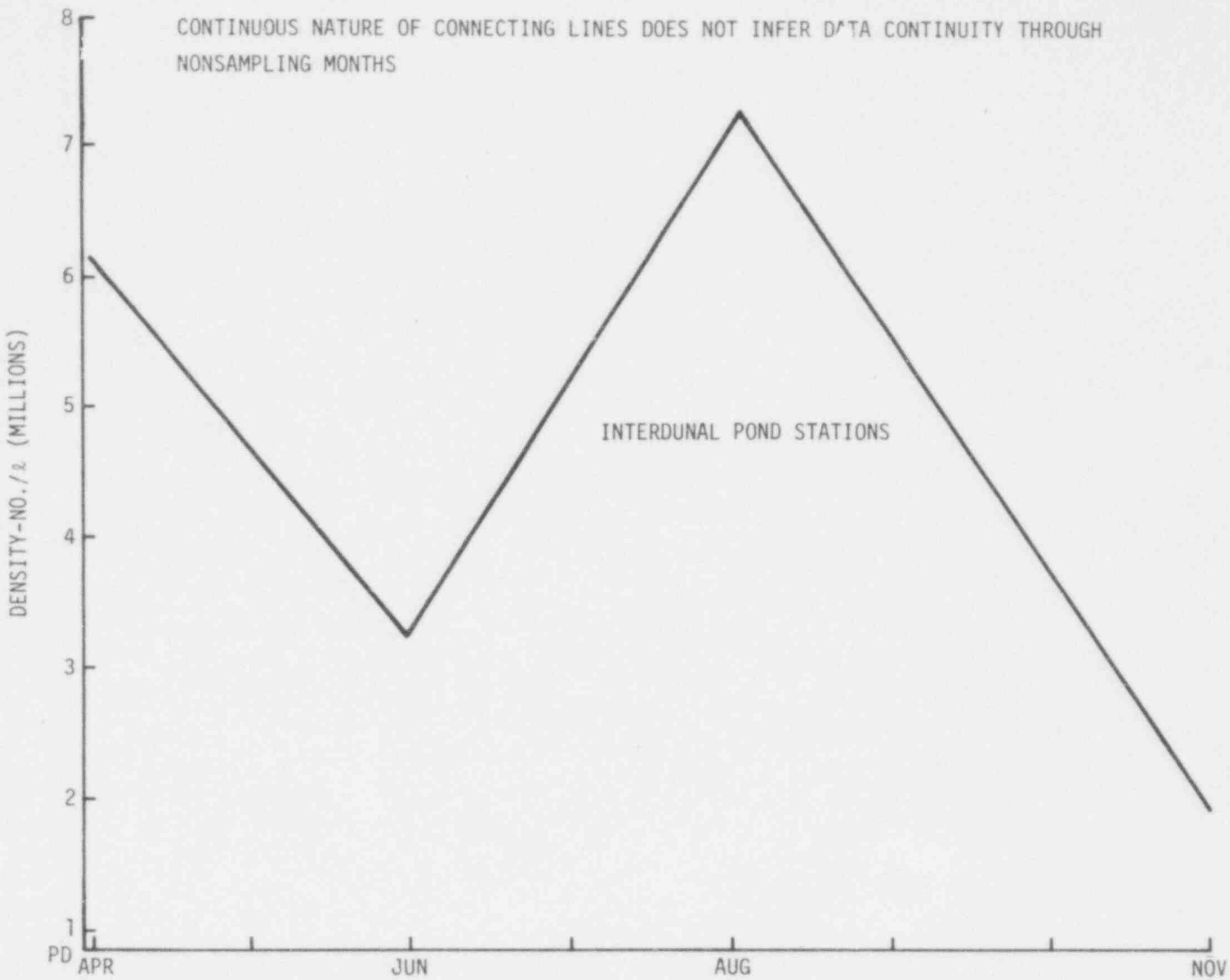


Figure 2.1-10. Mean Phytoplankton Density (No./ℓ) of Interdunal Pond Samples Summed over 1975-1978 (e.g., April data equals mean value for April 1975, 1976, 1977, and 1978)

0879180

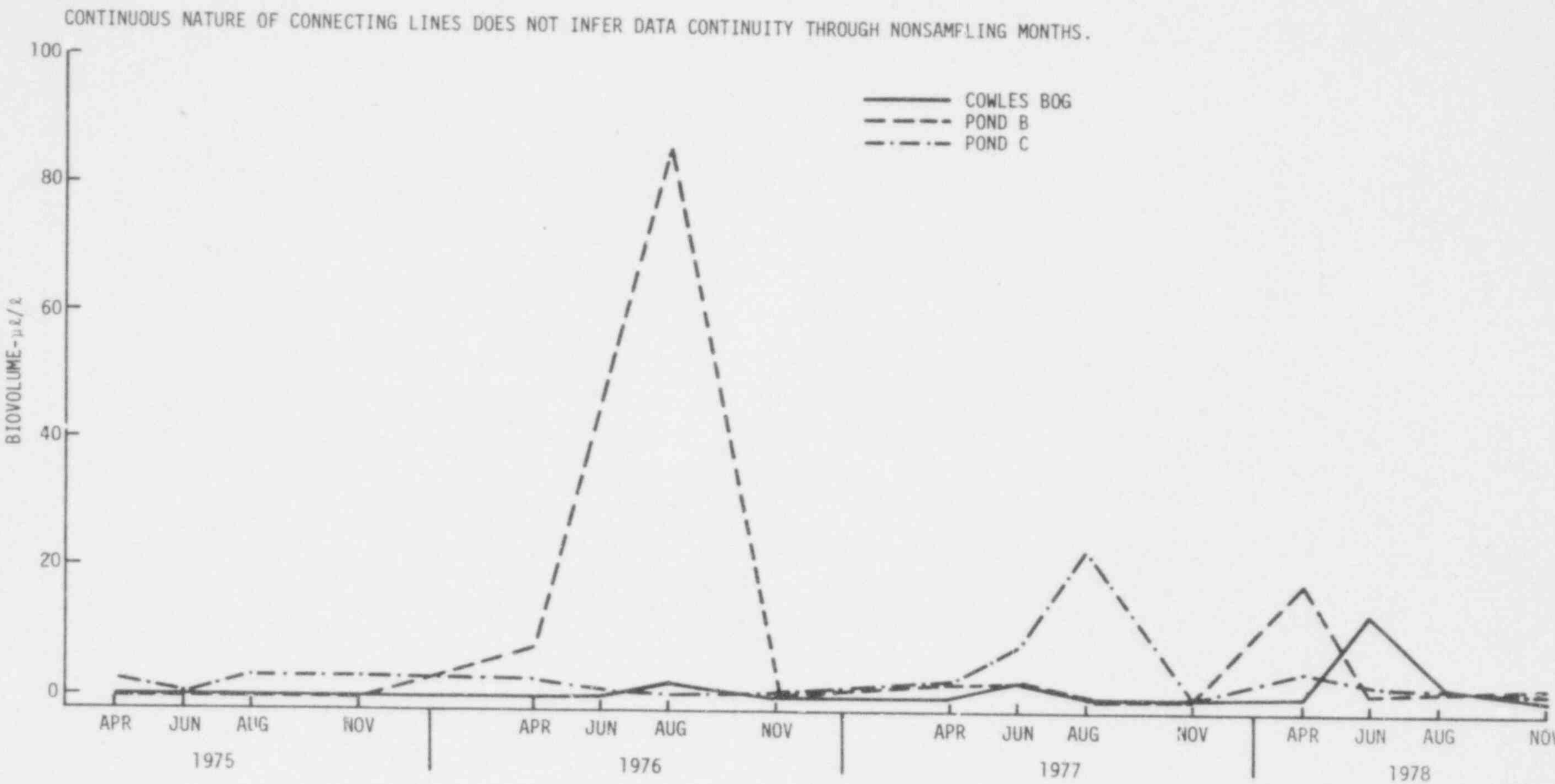


Figure 2.1-11. Phytoplankton Biovolume (µℓ/ℓ), Interdunal Ponds (1975-1978)

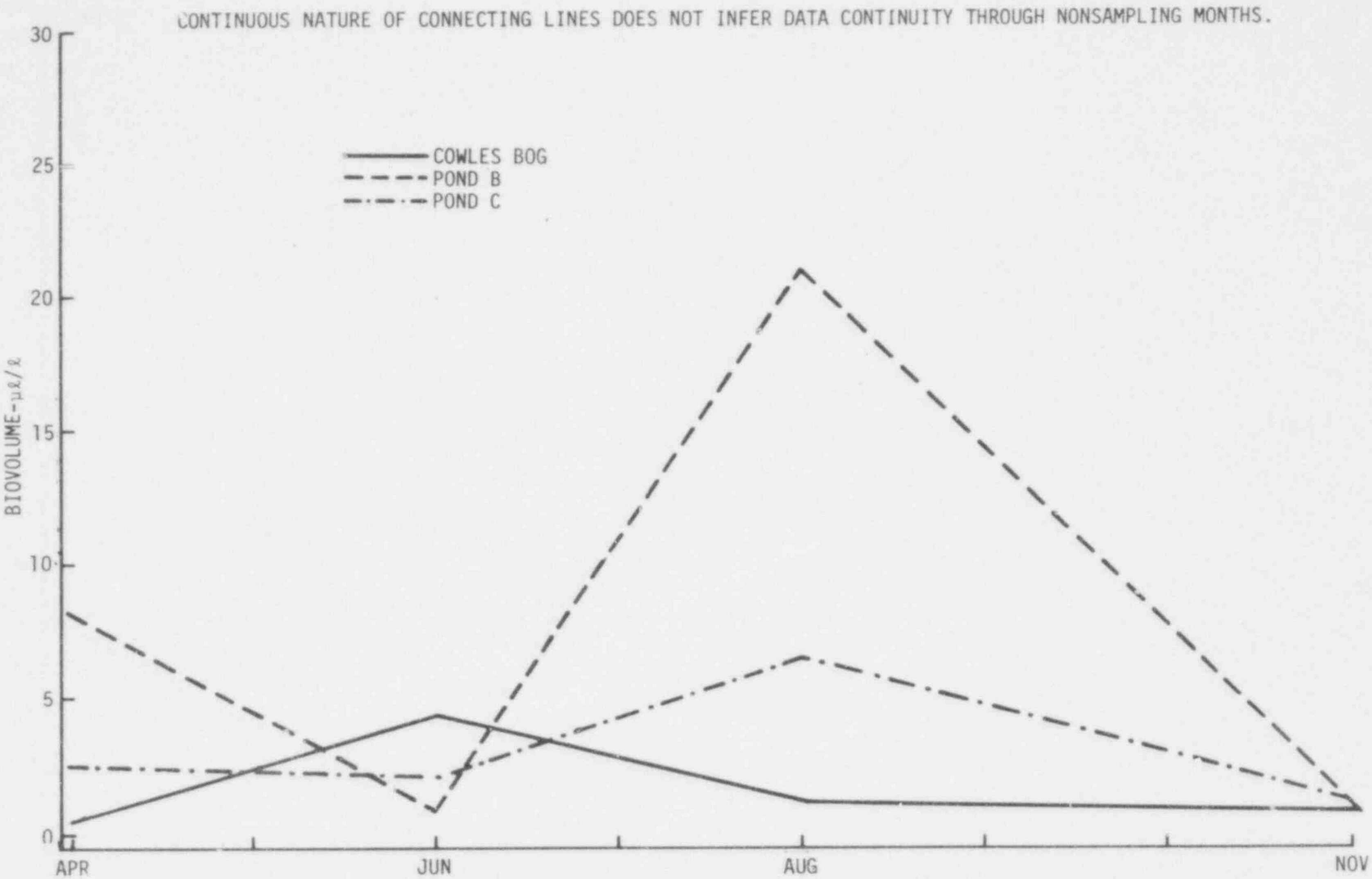


Figure 2.1-12. Mean Phytoplankton Biovolume (μℓ/ℓ) of Interdunal Ponds Summed over 1975-1978 (e.g., 8.6 μℓ/ℓ value for Pond B in April equals mean value of 1975, 1976, 1977, and 1978)

'CONTINUOUS NATURE OF CONNECTING LINES DOES NOT INFER DATA CONTINUITY THROUGH NONSAMPLING MONTHS.

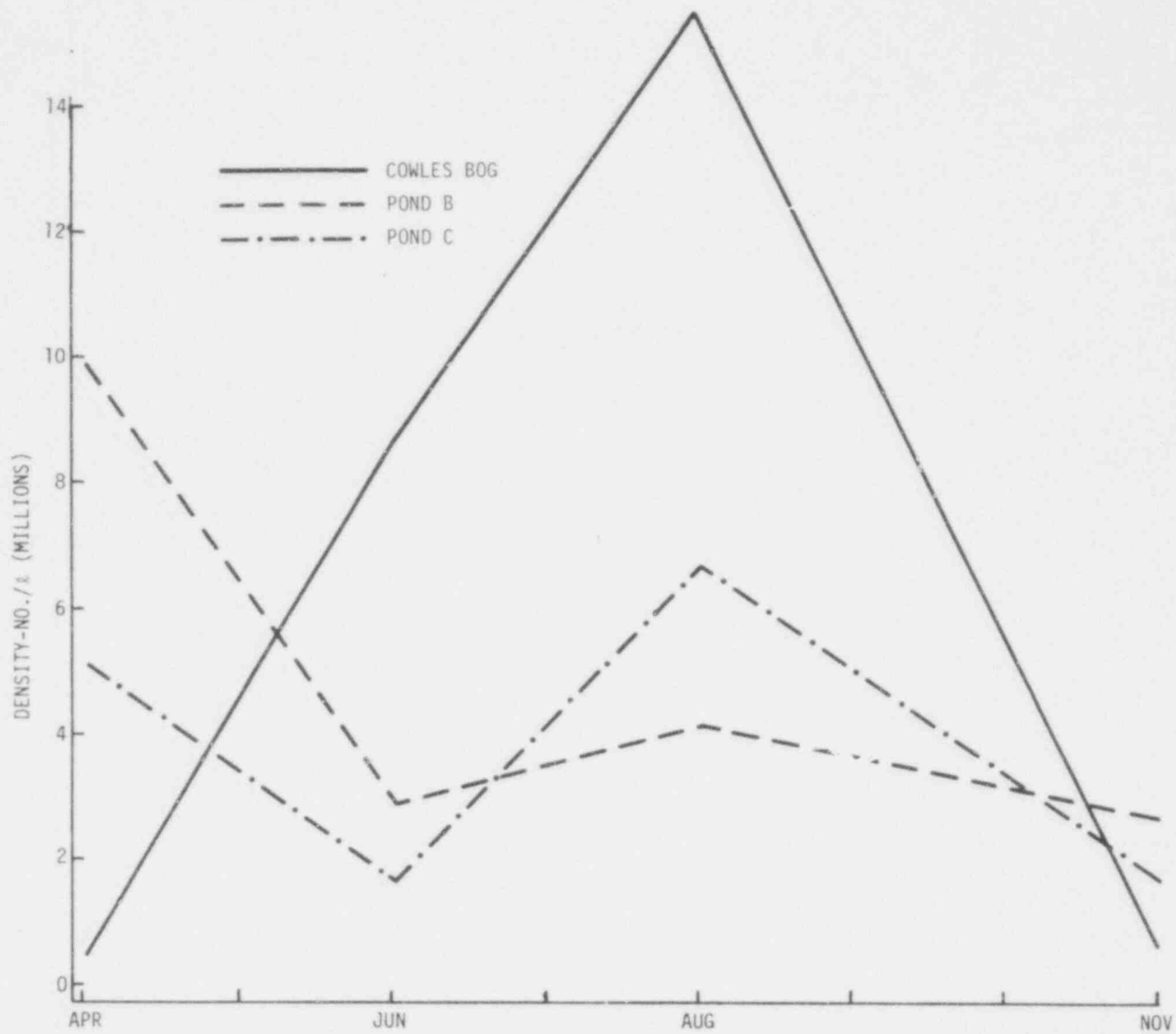


Figure 2.1-13. Mean Phytoplankton Density (No./ℓ) of Interdunal Ponds Summed over 1975-1978 (e.g., 5 μℓ/ℓ value for Pond B in April equals mean value of 1975, 1976, 1977, and 1978)

The data collected during five years of study may be used to follow changes in the trophic state of Lake Michigan and the nearshore ponds. Nygaard (1949) has proposed that the ratio:

$$\frac{\text{Myxophyceae} + \text{Chlorococcales} + \text{Centrales} + \text{Euglenineae}}{\text{Desmidiaceae}}$$

may be used to generate a compound quotient. Nygaard stated that a compound quotient less than one indicates oligotrophy. Patrick (1973, cited in Cairns and Dickson 1973) indicates that a quotient greater than one indicates eutrophy. Prescott (1968) indicates that a quotient greater than three equals eutrophy; a quotient ranging from one to three should be the indicator of mesotrophy.

While Lake Michigan remains in the mesotrophic range, the increasing autumnal pulses of blue-green algae indicate that the Nygaard index for the lake is increasing. This change may reflect results of competition for nutrients rather than a change in trophic status.

The nearshore ponds would continue to be judged eutrophic by the Nygaard index, based on the dominance of Myxophyceae and Chlorococcales. This is at variance with the character of periphyton diatoms. While Euglenoids were present in both ponds and Cowles Bog during the spring, and were present in Pond C and Cowles Bog during June, the Euglenineae quotient (Euglenineae/Myxophyceae + Chlorococcales) (Nygaard 1949) approached saprotrophy only during spring in Cowles Bog. Chlorococcoid green algae and Myxophyceae were dominant in Cowles Bog as well as ponds B and C during June and August. During November, Chlorococcoid green algae dominated the ponds while Cryptomonads were prominent in Cowles Bog.

Genera tolerant of organic pollution decreased in abundance during 1978. Palmer (1969) synthesized indices of tolerance for various genera from reports in the literature. Genera with high Palmer indices such as Oscillatoria, Chlamydomonas, and Synedra had densities during August 1978 of less than 50 cells per milliliter, and thus are not included in the calculation of the Lake Michigan Palmer index for August.

799184

Lake Michigan		Nearshore Ponds	
Genera	Palmer Index	Genera	Palmer Index
Microcystis	1	Microcystis	1
		Oscillatoria	
		Scenedesmus	
		Melosira	
Total	1	Total	11

These totals are similar to those found in 1976 (lake = 1, ponds = 16), and much lower than the limit of evidence for high "organic loading." It is instructive to consider the Palmer indices for samples taken during June. During June 1978, the following pollution-tolerant genera were present in excess of 50 cells per milliliter.

Lake Michigan		Nearshore Ponds	
Genera	Palmer Index	Genera	Palmer Index
Oscillatoria	5	Oscillatoria	5
Microcystis	1	Microcystis	1
Scenedesmus (acuminatus)	4	Scenedesmus (quadricauda)	4
Cyclotella (eupodiscales)	1	Navicula	3
Synedra	2	Nitzschia	3
Total	13	Total	16

While these totals are somewhat below the limits of evidence for high organic loading, it is significant that the taxon <u>Skeletonema potamus</u> was also present at the westerly lake stations, and had a mean density in excess of 50 cells per milliliter during June 1978. This diatom has been associated with waters having high levels of available nutrients (Weber 1970) and with increases in certain salts (Hasle and Evensen 1976; Stoermer et al. 1974).

2.1.3.2 <u>Phytoplankton Chlorophyll *a* and Productivity.</u> Chlorophyll *a* and productivity levels have been plotted for sampling years 1-5 in Figures 2.1-14 and 2.1-15. Chlorophyll *a* values for Lake Michigan correlate generally with biovolumes. In November 1977 and April 1978, large diatoms and Chrysophyceae dominated lake biovolume, and chlorophyll *a* values did not reflect the large increase in biomass. The ratio of biomass to chlorophyll *a* has been found to vary

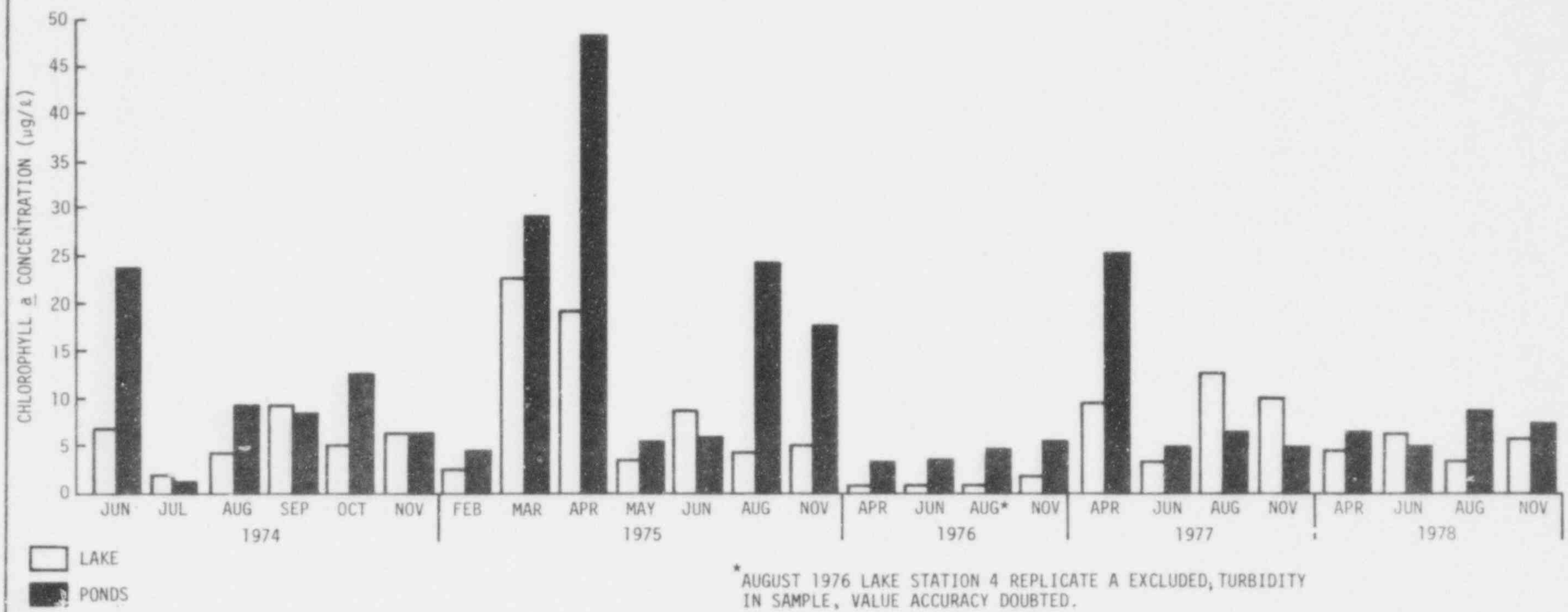


Figure 2.1-14. Phytoplankton Chlorophyll a Concentrations (µg/ℓ) Recorded from Lake Michigan and Pond Sampling Stations in the NIPSCo Bailly Study Area, June 1974-November 1978

579186

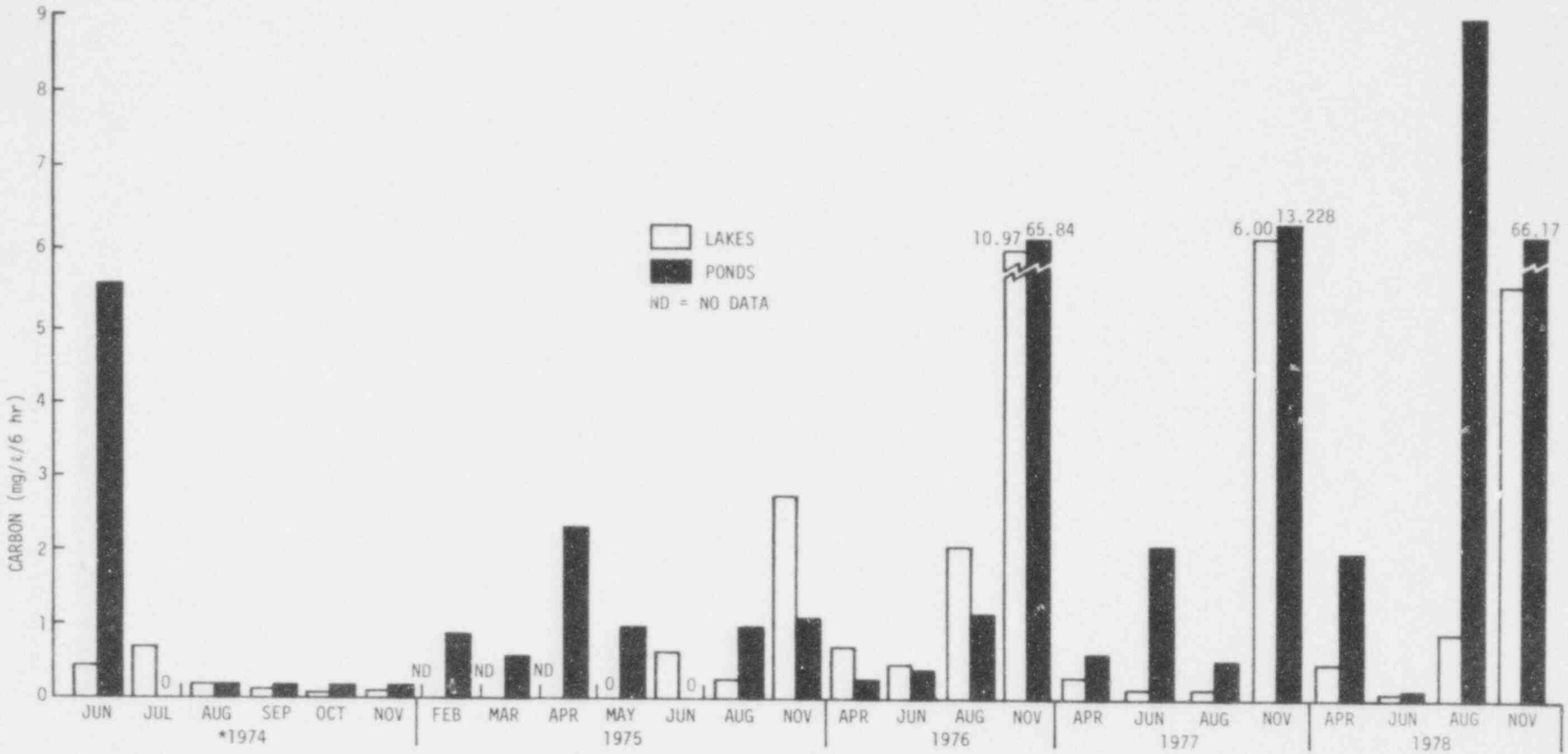


Figure 2.1-15. Phytoplankton Productivity Levels Recorded from Lake Michigan and Interdunal Pond Sampling Stations in the NIPSCo Bailly Study Area, June 1974-November 1978

579187

directly with cell size amongst diatoms and to be highest in the Chrysophyceae (Parsons et al. 1961). Chlorophyll a values for the ponds more nearly follow biovolume fluctuations, since the relative abundance of the Bacillariophyceae and Chrysophyceae during spring and fall is about half that in the lake, and green algae (Chrysophyceae) yield more chlorophyll a per unit biovolume. The notable deviations, in August 1977 and April 1978, coincide with large contributions to total biovolume by dinoflagellates. Productivity values during 1978 roughly followed phytoplankton density and biovolume values, with deviations caused by seasonal changes in dominant species. Highly productive chlorococcoid green algae (Malone 1971; Mullen, Sloan and Eppley 1966; Strickland 1972) yielded high carbon fixation rates in ponds B and C during August and November, while Cowles Bog exhibited low productivity. Large diatoms dominating Lake Michigan biovolume during April and June fixed less carbon than the chlorococcoid green algae and blue-green algae, which succeeded them in August and November.

2.1.3.3 Phytoplankton Statistical Analysis

2.1.3.3.1 Methodology. The following statistical methodology was applied not only to phytoplankton density and biovolume but also to zooplankton density and benthos density. For all samples, the procedure of Analysis of Variance (ANOVA) was used to determine differences between factors of interest. Significant effects were further analyzed using Newman-Keuls multiple range tests (Winer 1971). The analysis was performed on log-transformed data. Zero values were adjusted to the minimum detectable levels. These levels were: zooplankton density (1), benthos density (1), phytoplankton density (19), and phytoplankton biomass (0.01).

Two ANOVA models were used. The first compared data from the 1978 sampling season only. The second considered data from 1975, 1976, and 1977 as well.* Month and year effects were considered to be random while station effects were treated as fixed, the effects tested, and the error terms used are shown on the following page.

---

*1974 data were not considered for phytoplankton, zooplankton, or benthos with the remaining data because of the lack of April data in that year.

1978 Only	1975-1978
Month	Year
Station	Month
Station 10 vs rest	Station
Row linear	Year x month
Row quadratic	Year x station
Column	Month x station
Row linear x column	Month x station x year
Row quadratic x column	Replication (residual)
Station x month	
Replication (residual)	

The two factors, year x station and month x station, were tested. When one proved nonsignificant, it was possible to use the other as the denominator for the F-test of station effects.

2.1.3.3.2 ANOVA Results and Discussion. ANOVA results are shown in Table 2.1-4. For Lake Michigan, monthly densities and biovolume were significantly different within 1978; among years, only biovolume was significantly different. The significant year-month interaction of density and biovolume reflects the non-parallel changes in density and biovolume during like months in different years. Station densities were not significantly different when averaged over years, but significant station biovolume differences were observed.

Newman-Keuls results for the lake station effects indicate the average biovolume at Station 1 was significantly higher than the average biovolume at Station 3. Biovolume at all other lake stations was similar.

The monthly densities for the ponds were significantly different during 1978 (Table 2.1-4 and Figure 2.1-9). Comparison of yearly mean densities and biovolume yielded no significant differences for the ponds. Although no differences were observed in the means, differences did occur in the time of year (month) when peak values were observed and where (station) peak values occurred as indicated by the significant year x month, month x station, and year x month x station interactions.

579189

Table 2.1-4

1978 NIPSCo ANOVA Results

	Phytoplankton Density			Phytoplankton Biovolume		
	Degrees of Freedom	Sum of Squares	F-Value	Degrees of Freedom	Sum of Squares	F-Value
			1978 Single Year			
Lake Stations						
Month	3	97.8583	24.96*	3	34.0780	9.77*
Station	9	10.4626	1.21	9	8.1724	0.58
10 vs rest	1	2.3501	2.457	1	0.0605	0.04
Row (linear)	1	0.6404	0.67	1	0.5404	0.35
Row (quadratic)	1	1.792	1.87	1	0.0016	0.01
Column	2	1.8355	0.96	2	1.1948	0.38
Row linear x column	2	0.7179	0.37	2	1.2000	0.39
Row quadratic x column	2	3.1267	1.63	2	5.1752	1.67
Month x station	27	25.9393	0.747	27	41.9[illegible]32	1.34
Residual (replicate)	40	52.2752		40	46.4908	
Pond and Bog Stations						
Month	3	17.1188	6.44*	3	20.3068	2.46
Station	4	4.7163	0.38	4	0.5557	0.05
Ponds vs bog	1	0.7357	0.24	1	0.0902	0.03
Pond B	1	0.9422	0.30	1	0.1021	0.03
Pond C	1	0.7248	0.23	1	0.0001	0.01
B vs C	1	2.3136	0.[illegible]	1	0.3634	0.12
Month x station	12	37.4872	3.53*	12	35.2337	1.07
Residual	20	17.7089		20	54.9273	
			1975-1978 Multiyear Comparisons			
Lake Stations						
Year	3	101.568	3.11	3	77.1935	5.73*
Month	3	38.2850	1.17	3	49.4006	3.67
Year x month	0	97.9896	10.08*	9	40.3810	5.25*
Station	9	15.3954	1.86	9	15.3484	2.42*
Year x station	27	32.3616	1.12	27	14.4564	0.47
Month x station	27	24.8808	0.86	27	23.6662	0.78
Year x month x station	81	87.0055	0.99	81	91.3421	1.38
Residual	150	162.0275		150	128.3056	
Pond and Bog Stations						
Year	3	15.1141	1.46	3	25.5974	1.09
Month	3	36.8308	3.56	3	49.6286	2.12
Year x Month	9	31.0544	5.55*	9	70.1761	5.15*
Station	4	7.3908	0.44	4	14.7347	0.76
Year x station	12	7.1900	0.55	12	23.0592	1.08
Month x station	12	50.4353	3.84*	12	58.5016	2.74*
Year x month x station	36	39.9469	1.76*	36	64.1287	3.22
Residual	75	46.6401		75		

*Significant at ≤0.05

2.1.3.4 Periphyton Numerical Abundance and Composition. Most of the material discussed in the previous subsections (particularly 2.1.3.1) deal solely with phytoplankton studies. Any periphytic algae mentioned are mainly tychoplanktonic (i.e., forms of the littoral community occurring accidentally in the plankton) and usually are not important components of the phytoplankton. The diatom Tabellaria flocculosa (fenestrata/flocculosa complex) is the only organism encountered in

both habitats in significant numbers. Examples of algae which are usually strictly periphytic are the genera Chamaesiphon, Cladophora, Stigeoclonium, and Navicula. These genera and all other taxa collected on artificial and natural substrate by season in the NIPSCo Bailly Station Vicinity are summarized in Table 2.1-5. Dominant taxa (≥ 4 percent of either density or biovolume) are designated by an asterisk.

As samples were collected from natural and artificial substrates during sampling year 5 (1978), abundance and biovolume data appear somewhat biased from station to station inasmuch as natural substrates are exposed year-round and artificial substrates are exposed for only four weeks. Table 2.1-5 is therefore based only on relative abundance data to obviate bias. The reader is referred to Texas Instruments quarterly reports 16-19 (TI 1978b, 1979a, 1979b) for numerical abundance data. Several minor changes occurred in periphyton distribution during 1978:

(1) Calothrix sp., Mougeotia sp., and Fragilaria vaucheriae were found in the plume. Other dominant plume taxa were as in 1977; Lyngbya dominated biovolume throughout the year. Oscillatoria, Cyclotella spp., Stephanodiscus astraea, Diatoma vulgare, D. tenue, Fragilaria crotonensis, Nitzschia spp., and Navicula were also present in 1978.

(2) Lyngbya and Oscillatoria continued to dominate lake stations outside the plume area. Calothrix and Ulothrix were identified as components of periphyton during the spring and summer. Diatoma vulgare and Rhoicosphenia curvata were again present at non-plume stations. Achnanthes minutissima, Gomphonema olivaceum, Fragilaria vaucheria, and Stigeoclonium were also important in the lake periphyton.

(3) Diatoms (Achnanthes minutissima, Gomphonema acuminatum) dominated density and biovolume at pond stations during spring, but were succeeded by green and blue-green algae during summer and fall.

(4) In previous years, Rhoicosphenia curvata has been present only outside the thermal plume. In November 1978, R. curvata increased its relative abundance at stations 1 and 12 to 66 percent and 77 percent of the total diatom population. At this time, it also comprised 30 percent of the diatom population in the plume. Thus, the thermal effect seems inhibitory but not exclusive to this diatom.

579191

(5) Eunotia and Pinnularia continue to be represented by numerous species in the ponds. Most species occurred at Station 19 in Pond C during summer and fall. The species present are characteristic of waters of low mineral and nutrient content (Patrick and Reimer 1966).

Table 2.1-5

A Comparison of Periphyton Occurrence in the NIPSCo Bailly Study Area, Sampling Years 2, 3, 4, and 5

Taxa	Year 2 (1975) Lake Michigan	Year 2 (1975) Ponds	Year 3 (1976) Lake Michigan	Year 3 (1976) Ponds	Year 4 (1977) Lake Michigan	Year 4 (1977) Ponds	Year 5 (1978) Lake Michigan	Year 5 (1978) Ponds
Cyanophyta								
Chamaesiphonsales								
Unidentified Chamaesiphonaceae			S*					
Chamaesiphon sp.	S				S			
Chroococcales								
Agmenellam sp.					S F			
Aphanothece							F	F
Chlorogloea sp.					F			
Chroococcus sp.		S				S		F
Dactylococcopsis sp.				F				
Merismopedia sp.	S							
Microcystis sp.			S F	Sp* S F			F	F
Unidentified Chroococcales	S	Sp				Sp		
Pleurocapsaceae								
Chroococcopsis							Sp	
Pleurocapsa							Sp	
Dermocarpales								
Unidentified Dermocarpaceae			F					
Oscillatoriales								
Lyngbya sp.	S F*		S* F*	S* F	F*	Sp* S*	Sp* S* F*	Sp S F*
L. epiphytica					S		Sp	
L. limnetica					S			
L. martensiana					S		Sp*	
Oscillatoria sp.	S* F*	S* F*	Sp* S* F*	S* F*	Sp S* F*	S*	Sp* S* F*	Sp
O. amoena					S			
O. amphibia					S			
O. splendida					S* F			
Phormidium sp.	S*	S*	Sp* S*					
Symploca sp.	Sp*							
Unidentified Oscillatoriales	Sp S*	Sp*						
Rivulariales								
Calothrix sp.			F		S F*		Sp* S	
Unidentified Rivulariales	Sp							
Nostocaceae								
Anabaena sp.					S F	S		Sp F
Aphanizomenon flos-aquae					S			
Nostoc sp.						Sp		
Chamaesiphanales								
Chamaesiphon sp.					S* F			
Chlorophyta								
Chlorococcales								
Ankistrodesmus sp.	S		S	S	S			
A. convolutus			Sp S					
A. falcatus						S F	Sp	Sp
Characium ambiguum								S
Coelastrum sp.		S		S*		F		
Crucigenia apiculata					S			
Desmatractum sp.					S			
Kischneriella sp.				Sp	Sp			
K. lunaris						S		
K. obesa					S			

Table 2.1-5 (Contd)

Taxa	Year 2 (1975) Lake Michigan			Year 2 (1975) Ponds			Year 3 (1976) Lake Michigan			Year 3 (1976) Ponds			Year 4 (1977) Lake Michigan			Year 4 (1977) Ponds			Year 5 (1978) Lake Michigan			Year 5 (1978) Ponds		
Chlorophyta (Contd)																								
Chlorococcales (Contd)																								
Micractinium pusillum																			Sp					
Nephrocytium sp.											S													
Oocystis sp.																								
Pediastrum boryanum															F		S					Sp		
Pediastrum tetras				Sp								F		S								Sp		
Quadrigula sp.										Sp											F			
Scenedesmus sp.		S		Sp	S		Sp	S		Sp	S	F			F	Sp		F						
S. acuminatus														S		Sp	S							
S. acutus					S*																			
S. arcuatus																						Sp	S	
S. bicaudatus																	S							
S. carinatus																	S							
S. dimorphus				Sp																		Sp		
S. ecornis																								
S. quadricauda		S			S			S						S			S			S	F			
S. spinosus														S		Sp*	S	F		S			S	
Selenastrum												F		S	F	Sp*	S	F				Sp		
Sorastrum																						Sp		
Tetraedron sp.																								F
T. minimum												F									F			
Tetrastrum staurogoniaformis										Sp							S							
Unidentified Chlorococcales				Sp									Sp			Sp		F*						
Cladophorales																								
Cladophora sp.		S*	F*					S*	F*		S*													
Rhizoclonium sp.																				S	F			
Chaetophorales																	S		Sp					
Chaetophora																								
Chaetosphaeridium globosum																						Sp		
Stigeoclonium sp.	Sp*	S*						S	F								S							
Unidentified Chaetophorales			F*																		F			
Coleochaete									F		S	F			F									
M. herzogii								S																F
M. islandica							Sp	S		Sp	S		Sp	S	F		S	F	Sp	S	F			F
M. italica							Sp	S	F	Sp	S	F	Sp	S	F	Sp			Sp	S	F	Sp	S	F
M. varians							Sp	S			S		Sp		F	Sp*				S		Sp	S	
Stephanodiscus sp.	Sp	S	F					S					Sp	S	F	Sp			Sp	S				
S. astraea	Sp	S	F	Sp			Sp	S	F	Sp			Sp	S	F	Sp		F	Sp	S				
S. binderana								S																
S. hantzchii								S			S		Sp*		F	Sp				S				
S. invisitatus														S										
S. niagarae															F					S				
Unidentified Centrales	Sp	S	F					S			S		Sp	S	F	Sp					F			F
Pennales																								
Achnanthes sp.	Sp*	S	F*	Sp*	S*	F*	Sp	S	F	Sp*	S*	F*		S*	F*	Sp	S*	F	Sp	S	F	Sp	S	F
A. affinis																	S							
A. clevei								S									S							

579193

POOR ORIGINAL

POOR ORIGINAL

Table 2.1-5 (Contd)

Taxa	Year 2 (1975)						Year 3 (1976)						Year 4 (1977)						Year 5 (1978)					
	Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan			Ponds		
Chlorophyta (Contd)																								
Pennales (Contd)																								
Achnanthes exigua		S		Sp	S	F*					S	F					S*	F					S	F
A. hauckiana										Sp				S	F									
A. hungarica				Sp							S	F						F					S	F
A. hustedi										Sp														
A. lanceolata			F	Sp*	S*		Sp	S	F	Sp	S*	F			F		S	F					S	F
A. linearis	Sp	S*	F	Sp	S*		Sp	S	F*	Sp	S	F		S*	F*		S*	F	Sp*	S	F		S	
A. microcephala		S					Sp			Sp														F
A. minutissima	Sp	S*	F	Sp*	S*		Sp	S			S	F		S	F*	Sp*	S*	F*		S*	F	Sp*	S*	F
Amphipleura sp.										Sp													S	
A. pellucida					S									S	F	Sp		F	Sp	S		Sp		
A. rutilans															F									
Amphiphora ornata																				S				F
Amphora sp.		S					Sp				S			S			S		Sp					F
A. coffeaformis							Sp		F															
A. lybica										Sp		F												
A. ovalis		S	F				Sp		F					S	F			F	Sp	S	F		S	
A. perpusilla														S							F			
Anomoeneis sp.		S			S	F									F	Sp		F						
A. serians		S			S*							F					S	F			F		S	F
A. vitrea		S		Sp	S8					Sp	S*	F				Sp	S*	F			F	Sp	S*	F
Asterionella formosa	Sp	S					Sp	S					Sp		F			F	Sp	S	F			
Bacillaria paradoxa							Sp																	
Caloneis sp.			F			F	Sp							S										
C. bacillum															F		S							
C. ventricosa																	S				F			
Cocconeis sp.		S	F	Sp				S	F	Sp			Sp	S		Sp	S				F		S	F
C. disculus																			Sp					
C. pediculus		S	F					S	F					S						S	F			F
C. placentula		S		Sp	S			S	F			F		S	F		S	F		S	F	Sp	S	F
Cymatopleura sp.														S										
C. elliptica															F					S				
C. solea														S	F					S				
Cymbella sp.	Sp	S	F	Sp	S*	F		S	F	Sp	S	F	Sp	S	F*	Sp	S		Sp		F	Sp	S	F
C. affinis		S	F						F		S				F*			F	Sp	S				
C. amphioxys										Sp														
C. aspera																						Sp		
C. caespitosa		S																						
C. cistula															F						F			
C. lunata																								F
C. microcephala							Sp			Sp		F		S*	F	Sp		F			F	Sp		F
C. minuta																		F	Sp	S	F		S	F
C. naviculiformis		S																F				Sp		
C. prostrata	Sp	S*	F			F	Sp	S	F	Sp		F	Sp	S	F				Sp	S	F			F
C. sinuata				Sp																				
C. sphaerophora					S																			
C. tumida														S										
C. turgida					S		Sp			Sp						Sp	S							
C. ventricosa		S		Sp	S	F		S		Sp	S	F		S		Sp	S							
C. ventricosa var minuta														S										

579194

Table 2.1-5 (Contd)

Taxa	Year 2 (1974) Lake Michigan			Year 2 (1974) Ponds			Year 3 (1976) Lake Michigan			Year 3 (1976) Ponds			Year 4 (1977) Lake Michigan			Year 4 (1977) Ponds			Year 5 (1978) Lake Michigan			Year 5 (1978) Ponds		
Chlorophyta (Contd)																								
Pennales (Contd)																								
Diatoma sp.	Sp*	S*	F*	Sp	S	F	Sp	S					Sp	S*	F*	Sp								
D. anceps														S*			S*			S				
D. hiemela							Sp	S																
D. tenue		S			S		Sp	S*	F		S	F	Sp	S	F	Sp	S		Sp	S*	F	Sp	S	F
D. tenue v. elongatum		S			S		Sp																	
D. tenue v. tenue	Sp	S																						
D. vulgare	Sp	S	F*	Sp		F	Sp*	S	F	Sp		F	Sp*	S	F*	Sp	S	F	Sp	S	F		S	F
D. vulgare v. ovales			F																					
Denticula sp.										Sp		F					S	F				Sp	S	F
D. tenuis																								F
Oedogoniales																								
Bulbochaete sp.																		F*						
Oedogonium sp.				Sp*	S*					Sp*	S*	F*				Sp*	S*	F*				Sp	S	F
O. undulatum					S						S													
Tetrasporales																								
Elakatothrix sp.		S																						
Gloeocystis sp.										Sp	S			S		Sp								F
Sphaerocystis sp.		S																						
Unidentified Tetrasporales		S												S										
Trentephonliales																								
Unidentified Trentephonliaceae												F												
Ulotrichales																								
Cylindrocapsa geminella																	S							
Gominella																								F
Hormidium sp.							Sp*																	
Microspora sp.					S																			
Ulothrix sp.	Sp*	S*	F					S	F		S*		Sp		F*				Sp	S	F	Sp		
U. tenerrima														S										
U. verrucosa														S										
U. zonata								S*			S*								Sp*		F	Sp		
Uronema sp.		S																						
Unidentified Ulotrichaeles	Sp*						Sp	S*					Sp											
Volvocales																								
Chlamydomonas sp.												F		S				F						
Spermatozoopis sp.								S																
Unidentified Volvocales		S				F	Sp	S	F			F					S							
Zygnematales																								
Closterium sp.										Sp						Sp								
C. moniliferum																	S							
Cosmarium sp.				Sp								F		S			S						S	
Desmidium sp.					S																			
Euastrum sp.																	S							
Mougeotia sp.		S		Sp*	S	F				Sp*	S*	F	S		F*	Sp*	S	F*			F	Sp		F
Pleurotaenium sp.				Sp*																				
Spirogyra sp.					S						S*					Sp	S							
Staurastrum sp.											S												S	
Unidentified Desmidiaceae					S																			
Unidentified Zygnematales					S																			
Unidentified Chlorophyta	Sp	S	F	Sp*	S		Sp	S*			S*					Sp								

POOR ORIGINAL

science services division

579195

Table 2.1-5 (Contd)

Taxa	Year 2 (1975) Lake Michigan	Year 2 (1975) Ponds	Year 3 (1976) Lake Michigan	Year 3 (1976) Ponds	Year 4 (1977) Lake Michigan	Year 4 (1977) Ponds	Year 5 (1978) Lake Michigan	Year 5 (1978) Ponds
Euglenophyta								
Unidentified Euglenaceae				Sp				
Trachelomonas sp.						S		Sp
Euglena sp.		S						
Xanthophyta								
Heterotrichales								
Unidentified Tribonemataceae		S						
Chrysophyta								
Chrysomonadales								
Chrysococcus sp.	S				Sp		Sp	Sp
Derepyxis sp.				F				
Dinobryon sp.		F			Sp F	Sp F		
D. divergens					S			
D. sertularia						F		
Epipyxis utriculus						F?		Sp
Unidentified Chrysomonadales	Sp	Sp F*	Sp		F	F		
Unidentified Rhizochrysidales			Sp					
Unidentified Chrysophyta		Sp						
Unidentified Chromulinales					Sp	Sp		
Unidentified Chrysocapsales					Sp			
Bacillariophyta								
Centrales								
Actinocyclus normanii							S	
Cosinodiscus lacustris					S		Sp	
Cosinodiscus sp.		S					Sp	
Cyclotella sp.	Sp S F	Sp F	Sp S F	Sp S F	Sp S F	Sp	S F	S
C. atomus			S F		S		S	
C. bodanica							S F	
C. comensis			F*					
C. comta					F		Sp S F	
C. glomerata					S		Sp	
C. kutzingiana	S		S F	S	Sp S F	F	Sp* S F	
C. meneghiniana		S	S F	S F	S F	S F	S F	Sp S
C. ocellata	S F		S F		S		S	
C. perpusilla					S			
C. prostrata			S					
C. pseudestelligera			Sp					
C. stelligera			S		Sp	Sp	S	
C. striata			Sp					
Melosira sp.	S F	Sp S F*	S	S	Sp S	S F		
M. ambigua			S		S			
M. binderana			S					
M. granulata					S		Sp S	
Diploneis sp.	F				S		S	
D. smithii	S				F			
Epithemia sp.						S		
E. reichetti					S			F
E. turgida								S* F
Eunotia sp.	Sp S F	Sp* S F		Sp S* F	S	Sp S* F*	F	Sp S
E. curvata		Sp S F		Sp S F		Sp S F		Sp S F
E. diodon						S		

579196

POOR ORIGINAL

Table 2.1-5 (Contd)

Taxa	Year 2 (1975) Lake Michigan			Year 2 (1975) Ponds			Year 3 (1976) Lake Michigan			Year 3 (1976) Ponds			Year 4 (1977) Lake Michigan			Year 4 (1977) Ponds			Year 5 (1978) Lake Michigan			Year 5 (1978) Ponds		
Bacillariophyta (Contd)																								
Centrales (Contd)																								
Epithemia diadon																	S							
E. elegans					S					Sp														
E. exigua					S						S													
E. fallax					S																			
E. flexuosa					S		Sp			Sp						Sp		F					S	F
E. flexuosa v. eurycephala					S																			
E. gracilis																		F						
E. hexaglyphis					S																		S	F
E. incisa					S		Sp			Sp	S												S	F
E. major												F						F					S	F
E. naegelii				Sp	S													F						F
E. pectinalis		S			S*	F					S	F					S	F*				Sp	S	
E. praerupta					S											Sp								
E. rhomboides																		F						
E. septentrionalis					S																			
E. tenella											S					Sp	S							
E. valida																Sp								
E. vanheurkii		S			S			S			S	F												
Fragilaria sp.	Sp*	S	F	Sp*	S	F	Sp	S		Sp	S	F*	Sp	S	F	Sp*	S*	F*	Sp	S	F		S	F
F. brevistriata								S		Sp	S*			S								Sp		
F. capucina				Sp									Sp	S		So					F	Sp	S	F
F. capucina v. mesolepta					S		Sp			Sp	S	F												
F. constricta											S													
F. construens		S	F	Sp			Sp	S		Sp					F				Sp					
F. crotonensis	Sp	S	F	Sp	S	F*	Sp	S	F	Sp	S	F*	Sp	S	F*	Sp*	S	F*	Sp*	S	F	Sp	S	F
F. minutissima							Sp																	
F. pinnata							Sp	S	F	Sp		F	Sp	S					Sp	S		Sp	S	
F. vaucheriae	Sp*	S*	F*		S	F*	Sp*	S*	F*	Sp*	S*	F	Sp*	S*	F*	Sp*	S	F*	Sp*	S*	F*	Sp	S	F
Frustulia sp.											S						S							
F. rhomboides v. crassinerica					S																			
F. rhomboides v. saxonica					S																			
F. rhomboides				Sp		F					S*	F				Sp	S	F*					S	F
Gomphonema sp.	Sp	S	F	Sp	S	F	Sp	S*	F	Sp	S*	F	Sp*	S	F	Sp	S*	F*	Sp	S		Sp*	S	F
G. acuminatum				Sp	S					Sp	S					Sp	S	F		S		Sp		F
G. acuminatum v. coronatum	Sp			Sp	S																			
G. affine																		F				Sp*		
G. angustatum		S		Sp	S		Sp	S		Sp	S	F*			F	Sp*		F	Sp			Sp*		F
G. constrictum												F				Sp	S	F						
G. gracile					S																			
G. instabilis																	S	F	Sp					F
G. intricatum			F							Sp							S					Sp		
G. lanceolatum								S	F		S											Sp		
G. longiceps		S	F		S	F				Sp	S	F				Sp								
G. longiceps v. subclavata					S	F																		
G. montanum																	S							
G. olivaceoides																				S				
G. olivaceum	Sp*	S	F			F	Sp	S	F	Sp	S		Sp*	S	F	Sp			Sp	S	F		S	F
G. parvulum	Sp	S		Sp				S			S			S	F		S		Sp	S	F	Sp	S	F

575197

Table 2.1-5 (Contd)

Taxa	Year 2 (1975)						Year 3 (1976)						Year 4 (1977)						Year 5 (1978)					
	Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan			Ponds		
Bacillariophyta (Contd)																								
Centrales (contd)																								
Gomphonema subclavatum																			Sp					
G. subtile																	S							
G. truncatum																		F					S	
Gomphoneis hurculeana																					F			
Gyrosigma sp.		S	F		S															S			S	
G. sciotense								S							F									
Meridion sp.		S																						
M. circulare				Sp	S											Sp	S		Sp			Sp	S	F
Navicula sp.	Sp	S	F	Sp	S	F	Sp	S	F	Sp	S	F	Sp	S	F	Sp	S	F	Sp	S	F		S	F
N. accomoda		S	F		S																			
N. anglica										Sp														
N. bacillum																Sp				S				
N. capitata							Sp			Sp	S						S	F				Sp		F
N. capitata v. capitata	Sp																							
N. costulata		S																						
N. cryptocephala			F	Sp			Sp	S	F	Sp	S	F		S								Sp		F
N. cryptocephala v. veneta								S			S													
N. cuspidata										Sp						Sp							S	F
N. dystrophica																	S							
N. elginensis																		F					S	F
N. exigua														S						S				
N. gotilandica											S													
N. graciloides			F			F							Sp	S	F	Sp								F
N. halophila					S															S				
N. hambergii		S													F				Sp		F			
N. heufleri										Sp						Sp							S	
N. integra														S										
N. laevissima										Sp	S													
N. lanceolata							Sp																	
N. lafens		S																						
N. luzonensis		S																						
N. maculata					S																			
N. minisculus		S																						
N. minuta																					F			
N. mutica																		F						
N. navicula										Sp														
N. notha										Sp										S			S	
N. obdurata												F												
N. platystoma														S	F						F			
N. pseudoreinhardii																					F			
N. punctulatae																Sp								
N. pupula		S			S	F			F	Sp	S	F		S		Sp	S	F		S		Sp	S	F
N. radiosa		S	F		S	F		S	F	Sp	S						S	F			F			F
N. radiosa v. tennella		S			S																			
N. rhyncocephala					S																			
N. salinarium								S						S	F					[illegible]				
N. species "S"														S*										
N. subhamulata																				S				
N. tripunctata							Sp	S	F			F		S					Sp	S	F			

570198

Table 2.1-5 (Contd)

Taxa	Year 2 (1975) Lake Michigan			Year 2 Ponds			Year 3 (1976) Lake Michigan			Year 3 Ponds			Year 4 (1977) Lake Michigan			Year 4 Ponds			Year 5 (1978) Lake Michigan			Year 5 Ponds		
Bacillariophyta (Contd)																								
Centrales (Contd)																								
Navicula viridula								S						S										
Neidium sp.	Sp	S*	F		S	F																		
N. affine				Sp		F																	S	
N. apiculatum														S*										
N. dubium														S										
N. iridis						F					S						S						S	F
N. kozlowii																	S							
Nitzchia sp.	Sp	S*	F	Sp	S	F	Sp	S	F	Sp	S	F*	Sp	S*	F	Sp	S	F	Sp	S	F	Sp	S	F
N. acicularis	Sp	S								Sp			Sp			Sp		F	Sp		F			F
N. acuta											S	F												
N. affinis							Sp			Sp														
N. amphibia				Sp		F		S		Sp	S	F				Sp	S	F		S			S	F
N. amphioxys														S										
N. angularis							Sp																	
N. augustata							Sp	S	F										Sp	S	F			
N. balatonis													Sp											
N. dissidua			F																					
N. dissipata	Sp*	S	F			F	Sp*	S	F	Sp	S		Sp	S	F				Sp	S	F		S	F
N. filiformis																Sp								
N. fonticola		S	F			F	Sp	S	F				Sp	S					Sp	S	F	Sp		F
N. frustulum					S						S	F							Sp			Sp		F
N. gracilis							Sp		F	Sp			Sp						Sp				S	
N. hantzschia						F																		
N. ignorata																	S							
N. kutzingiana							Sp	S	F	Sp		F				Sp			Sp	S				F
N. lanceolata		S											Sp				S							F
N. linearis			F					S	F	Sp				S	F					S				
N. microcephala														S										
N. obtusa																		F						
N. palea		S	F*	Sp	S	F	Sp	S	F	Sp	S	F		S*	F*	Sp	S	F*	Sp	S	F			F
N. palaceae									F					S										
N. recta															F								S	F
N. romana							Sp		F		F													
N. scalaris															F									
N. sigma							Sp							S					Sp					
N. sigmoidea								S			S	F												
N. thermalis					S				F					S										
N. tryblionella															F									
Opephora martyi							Sp		F	Sp	S													
Pinnularia sp.				Sp	S			S			S								Sp			Sp		F
P. abaujensis					S													F						F
P. acrosphaeria																							S	F
P. appendiculata						F																		
P. biceps					S																			
P. borealis																		F					S	F
P. braunii																	S							F
P. brevicostata											S													
P. gentilis					S																			
P. legumen																								F

Table 2.1-5 (Contd)

Taxa	Year 2 (1975)						Year 3 (1976)						Year 4 (1977)						Year 5 (1978)					
	Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan			Ponds		
Bacillariophyta (Contd)																								
Centrales (Contd)																								
Pinnularia major																	S							
P. major v. pulche a					S																			
P. microstauron					S												S	F					S	
P. modosa					S																			
P. obscura					S																			
P. streptoraphe					S																			
P. subcapitata					S						S	F				Sp	S	F						
P. substomatophora												F						F						
P. sudetica					S																			
P. viridis					S	F										Sp	S		Sp				S	
Plagsotropis																			Sp					
Rhoicosphenia curvata	Sp	S*	F*		S	F	Sp	S*	F*		S	F	Sp	S*	F	Sp	S		Sp	S	F*		S	F
Rhopalodia gibba					S											Sp	S	F					S	F
Rhopalodia sp.													.				S							
Stauroneis sp.					S		Sp	S								Sp								
S. anceps												F		S			S							F
S. fluminea																		F						
S. phoenocenteron				Sp	S						S													F
S. kriegeri										Sp														
Surirella sp.	Sp							S					Sp	S	F									
S. augustata								S	F					S	F					S				F
S. ovata							Sp							S						S				
Synedra sp.		S		Sp	S	F	Sp	S		Sp*	S	F*	Sp	S	F*	Sp	S	F*	Sp	S		Sp	S	F
S. acus															F			F	Sp					
S. amphicephala									F				Sp	S		Sp	S							F
S. capitata												F						F	Sp					
S. capucina														S			S							
S. cyclopum										Sp						Sp	S							
S. delicatissima					S						S							F	Sp				S	
S. fasciculata										Sp														
S. fasciculata v. tabulata					S																			
S. fasciculata v. truncata					S																			
S. gaillonii																								F
S. incisa													Sp			Sp								
S. parasitica														S										
S. pulchella					S	F																		
S. radians					S		Sp			Sp		F*	Sp*	S		Sp*		F	Sp			Sp		
S. rumpens					S		Sp				S		Sp	S		Sp			Sp					
S. tenera											S													
S. filiformis											S		Sp											
Synedra ulna					S		Sp			Sp	S	F*		S		Sp	S	F	Sp	S	F	Sp	S	F
Skeletonema sp.					S																			F
Tabellaria sp.		S			S						S		Sp	S		Sp	S							
T. fenestra			F			F	Sp	S		Sp*	S		Sp	S	F	Sp	S	F	Sp	S			S	
T. flocculosa	Sp	S	F	Sp*	S	F*		S	F	Sp*	S*	F	Sp	S*	F	Sp*	S	F	Sp	S	F	Sp	S	F
Unidentified Achnanthales								S																
Unidentified Epithemiales											S													
Unidentified Fragilariales		S			S		Sp			Sp	S		Sp	S	F	Sp	S	F*						F
Unidentified Naviculales							Sp	S	F	Sp	S	F	Sp	S	F	Sp	S							F
Unidentified Pennales	Sp	S	F*	Sp*	S	F*	Sp*	S	F	Sp	S*	F	Sp	S	F	Sp		F*			F			F

579200

Table 2.1-5 (Contd)

Taxa	Year 2 (1975) Lake Michigan	Year 2 (1975) Ponds	Year 3 (1976) Lake Michigan	Year 3 (1976) Ponds	Year 4 (1977) Lake Michigan	Year 4 (1977) Ponds	Year 5 (1978) Lake Michigan	Year 5 (1978) Ponds
Cryptophyta								
Cryptomondales								
Cryptomonas sp.					S			
Rhodomonas sp.		F	Sp S F	S F		F		
R. minuta					S		Sp	
Unidentified Cryptomondales	S					F		
Pyrrophyta								
Unidentified Peridinales				Sp				
Ceratium hirundinella								F
Peridinium sp.						S		
P. inconspicuum							Sp	
Rhodophyta								
Bangiophyceae								
Bangiales			S					
Unidentified Algae				Sp	S F	F		

*Dominant taxa.

Sp = April
S = June and/or August
F = November

(6) While a few taxa have been reported for the first time in 1978, the dominant taxa reported in Lake Michigan and the nearshore ponds have retained a stable annual repetition of occurrence. The diatom taxa which dominated the pond periphyton during spring 1978 were eurytrophic species.

2.1.3.5 Periphyton Chlorophyll a. Figure 2.1-16 shows that periphyton chlorophyll a values in Lake Michigan were higher than in past years during the spring, but reached an August peak lower than in past years. Periphyton biovolume during the same months roughly corresponded with Lake Michigan chlorophyll a values; pond chlorophyll a values were again lowest in August, as was pond periphyton biovolume. Chlorophyll a values were higher in April and November in the ponds, but did not correspond with biovolume changes. The pond chlorophyll a levels continue to show an early spring periphyton growth pulse. The low summer pond chlorophyll a concentrations reflect their distrophic status during this season.

2.1.3.6 Periphyton Statistical Analysis. Owing to the heterogeneity of sampling techniques (natural and artificial substrates) necessitated by existing conditions during the sampling year, statistical comparisons between data cells were deemed invalid. Qualitative comparisons involving relative abundance and dominant taxa were discussed previously. Comparisons have also been made using a similarity index (Odum 1971), which is calculated as follows:

$$S = \frac{2C}{A + B}$$

where

S = Similarity index

A = Number of species in sample A

B = Number of species in sample B

C = Number of species common to both samples

The limits of the similarity index are 0 and 1, where 0 indicates complete dissimilarity and 1 equals equivalence.

The following comparisons were made:

5792C2

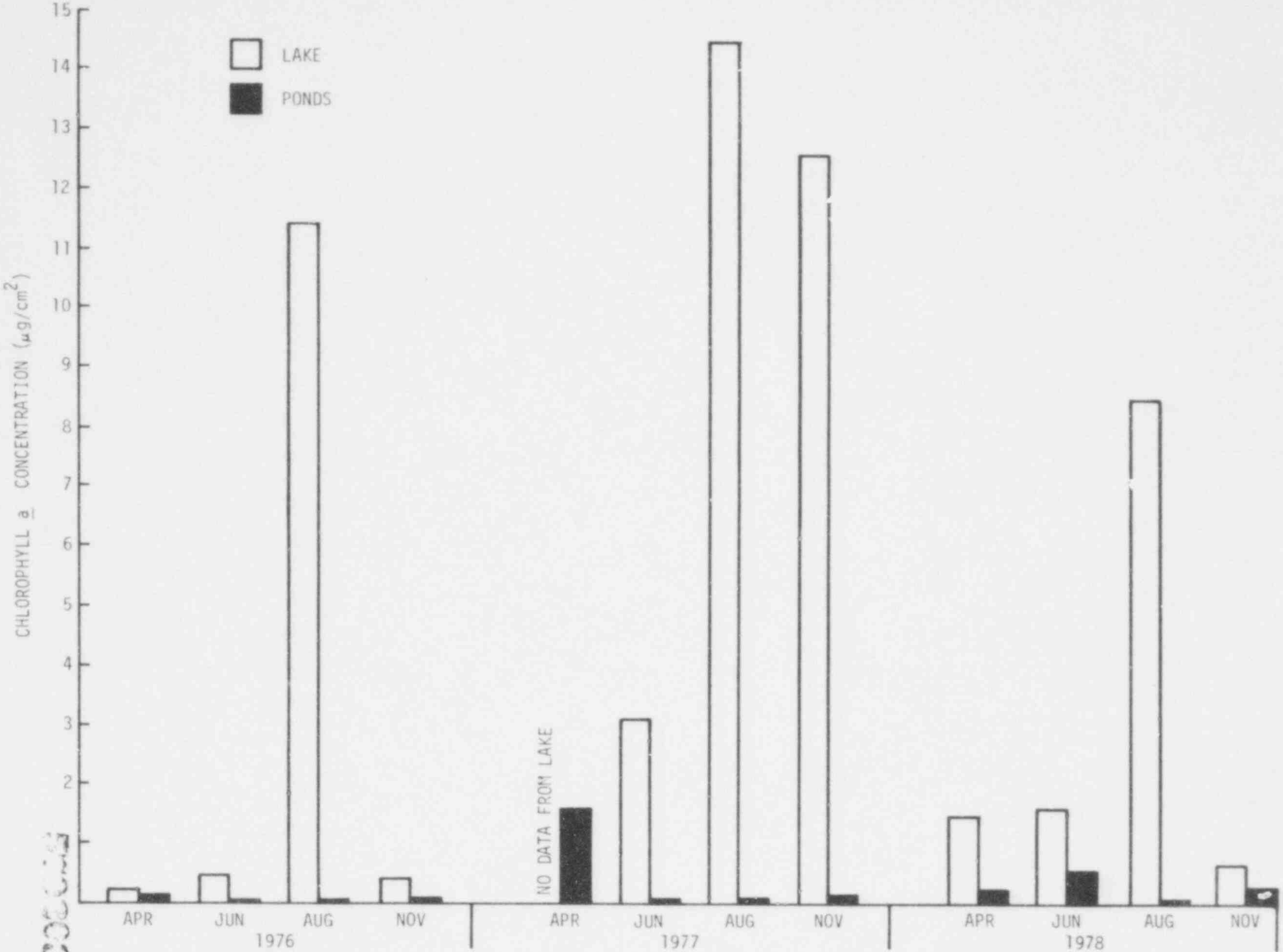


Figure 2.1-16. Periphyton Chlorophyll a Concentrations (μg/cm^2) Recorded from Lake Michigan and Interdunal Pond Stations, 1976-1978

Lake Michigan	
1977 vs 1978	0.657
Ponds	
1977 vs 1978	0.626
Lake Michigan versus Ponds	
1978	0.638

A functional dividing line between similarity and dissimilarity has been set at 0.7 in past analyses. On this basis, Lake Michigan periphyton composition was marginally dissimilar between 1977 and 1978. Pond periphyton composition was dissimilar between 1977 and 1978. The periphyton flora of Lake Michigan and the ponds were also dissimilar during 1978. The hypothetical dividing line between similarity and dissimilarity is 0.50; however, the dissimilarity of the periphyton community composition was determined by the arbitrary dividing line set at 0.7.

579204

2.2 ZOOPLANKTON

2.2.1 INTRODUCTION. The present survey represents the fifth year of baseline data accumulation designed to determine and document existing ecological conditions at the site and immediate vicinity at the Bailly Generating Station in order to assess any possible alteratiors in the zooplankton community.

As early as the late 1800s, information describing this component of the Lake Michigan ecosystem was being compiled. In recent years, the quantity and quality of this work has increased. Since 1966, synoptic sampling in Lake Michigan has intensified, producing much information on zooplankton distribution and abundance (Robertson 1966; Beeton 1970; Roth and Stewart 1973; Watson 1974; Beeton, Torke, Brooks, and Bowers 1975; Gannon 1974; and Evans and Stewart 1977). Much additional information describing zooplankton population dynamics and regulatory mechanisms affecting community structure in Lake Michigan has also been published (McNaught 1966, Norden 1968, Wells 1970, Patalas 1972, and Gannon 1972).

The following subsections present data describing seasonal and annual fluctuations in zooplankton abundance, percent composition, and species occurrence. Spatial distribution is also described for zooplankton at ten Lake Michigan stations (1-10) and five stations (17-21) located in nearshore, interdunal ponds (Pond B, Pond C and Cowles Bog).

2.2.2 METHODOLOGY. Zooplankton were sampled regularly once during April, June, August, and November 1978 at each of ten lake stations and at each of five stations in three ponds (Table 2.0-1). Lake samples were collected by the vertical haul of a No. 25 mesh, 0.5-meter-diameter plankton net (Texas Instruments 1975), and pond samples were collected with a 6-liter Van Dorn sampler. During 1978, a total of 240 zooplankton samples were collected.

All samples were processed as previously described (Texas Instruments 1975). In sum, four replicate samples per station were transferred from the net or the Van Dorn bottle to 1-liter polyethylene bottles, narcotized with a Lugol's rose bengal dye solution, and subsequently fixed with buffered formalin.

A minimum of 200 organisms (EPA 1973) was enumerated as representative of the sample. If 200 organisms were encountered midway through analysis of a subsample,

the remaining subsample was completed. If zooplankton in a sample were sparse, the entire sample was analyzed.

Reference keys and pertinent literature used in establishing field and laboratory procedures and taxa identifications included Wilson (1932), Pennak (1953, 1963, 1978), Usinger (1956), Edmondson (1959), Brooks (1957), and UNESCO (1968).

Statistical analyses were performed on zooplankton data according to the methodology presented in subsection 2.1.3.3.

2.2.3 RESULTS AND DISCUSSION

2.2.3.1 Introduction. The data presented and discussed in this report represent parameters chosen to characterize the zooplankton community in the vicinity of the Bailly study area of Lake Michigan from April 1978 to November 1978. A checklist of zooplankton occurrences seasonally during 1978 and annually from 1974 through 1978, as well as figurative and tabular data characterizing seasonal variations in the relative numerical abundance of zooplankton, appears in Tables 2.2-1 through 2.2-4 and Figures 2.2-1 through 2.2-8.

2.2.3.2 Zooplankton Occurrence. Through the three seasons (spring, April; summer, June and August; and fall, November) of 1978, 50 taxa were identified from Lake Michigan and 69 from the interdunal ponds (Table 2.2-1). Previous years (1974-1977) yielded 69, 55, 49, and 44 taxa, respectively, for Lake Michigan stations (Table 2.2-2). The interdunal ponds (Pond B, Pond C, and Cowles Bog) yielded 96, 93, 87, and 57 taxa, respectively for years 1974 through 1977 (Table 2.2-2). During 1978, the most temporally and spatially ubiquitous organisms were the bosminid cladocerans and immature (copepodid) copepods. Other taxa occurring regularly throughout 1978 were Chydous sp., several species of Diaptomus, Daphnia galeata mendotae, and Cyclops bicuspidatus thomasi at the lake stations and Nematoda, Chydorus sp., Cyclops vernalis, harpacticoid copepods, and ostracods in the ponds. As in previous years, basic habitat differences between lake and pond stations were manifest in the respective community structures. Certain littoral species of Macrothicidae cladocerans were strictly limited to the shallow, enclosed habitats of the pond stations. Also more prevalent in the weedy, shallower, pond habitats were the various chydorid cladocerans. The large limnetic copepod Limnocalanus macrurus was again most prevalent in the deeper, more open waters characteristic of the lake stations.

579206

Table 2.2-1

Zooplankton Occurrence in Lake Michigan and Interdunal Ponds during 1978

NET (LAKE) & BOTTLE (POND)

LAKE (1,2) PONDS (3,4,5)

LS	TAXA	SPR 12345	SUM 12345	FAL 12345
0	CNIDARIA (TOTAL)			
0	HYDROZOA			
19	HYDRA (LPIL)	1 34	34	3
1	HYDRA (LPIL)			34
0	NEMATODA (TOTAL)			
1	NEMATODA (LPIL)	12345	12345	12345
0	OLIGOCHAETA (TOTAL)			
0	NAIDIDAE			
1	CHAETOGASTER (LPIL)	1 4	34	34
1	NAIDIDAE (LPIL)	12 4	12345	12 45
0	TUBIFICIDAE			
1	TUBIFICIDAE (LPIL)	5		
0	GASTROPODA (TOTAL)			
2	GASTROPODA (LPIL)	4	4	
0	BIVALVIA (TOTAL)			
2	BIVALVIA (LPIL)	1 4		5
0	ARACHNIDA (TOTAL)			
0	PROSTIGMATA			
1	HYDRACARINA (LPIL)		1 4	
19	HYDRACARINA (LPIL)	2 4	345	
0	CLADOCERA (TOTAL)			
0	BOSMINIDAE			
1	BOSMINIDAE (LPIL)	12345	12345	12345
0	CHYDORIDAE			
1	ALONA RECTANGULA	4	1 345	345
1	ALONA AFFINIS	1	34	5
1	ALONA QUADRANGULARIS	4	3 5	3 5
1	ALONA INTERMEDIA	1 4	3	
1	ALONA GUTTATA			3 5
1	ALONA (LPIL)	1	1 4	345
1	CAMPTOCERCUS RECTIROSTRIS	4	34	4
1	CHYDORUS (LPIL)	1234	12345	12345
1	KURZIA LATISSIMA	4	45	4
1	EURYCERCUS LAMELLATUS	1	1	12
1	ALONELLA (LPIL)	4		
1	GRAPTOLEBERIS TESTUDINARIA	45	34	4
1	LEYDIGIA QUADRANGULARIS		4	12
1	OXYURELLA TENUICAUDIS		5	5
1	PLEUROXUS DENTICULATUS	34	345	345
1	PLEUROXUS PROCURVUS	4	345	
6	CHYDORIDAE (LPIL)		4	
1	CHYDORIDAE (LPIL)			345
0	DAPHNIDAE			
1	DAPHNIA AMBIGUA	1	123	
1	DAPHNIA GALEATA MENDOTAE	12	12	12345
1	DAPHNIA RETROCURVA		12345	123
1	DAPHNIA PULEX		2	1
1	DAPHNIA PARVULA	1		
6	DAPHNIA (LPIL)	12	12	1
1	DAPHNIA (LPIL)	1	1	1 3
1	SIMOCEPHALUS VETULUS			3 5
1	SIMOCEPHALUS SERRULATUS			4
1	SIMOCEPHALUS (LPIL)	4	345	34
1	CERIODAPHNIA (LPIL)	4	12345	345
0	HOLOPEDIDAE			
1	HOLOPEDIUM GIBBERUM		12	2
0	LEPTODORIDAE			
1	LEPTODORA KINDTII		1234	
2	LEPTODORA KINDTII	1		
0	MACROTHRICIDAE			
1	ILYOCRYPTUS SORDIDUS		34	4
1	ILYCRYPTUS SPINIFER		4	
1	ILYOCRYPTUS (LPIL)			1
1	MACROTHRIX ROSEA		4	
1	BUNOPS SERRICAUDATA		4	
0	SIDIDAE			
1	SIDA CRYSTALLINA		3	1
1	DIAPHANOSOMA (LPIL)	4	1 34	2
0	OSTRACODA (TOTAL)			
19	OSTRACODA (LPIL)	1 345	345	345
0	COPEPODA (TOTAL)			
0	CALANOIDA (TOTAL)			
1	DIAPTOMUS OREGONENSIS	12		1234
1	DIAPTOMUS ASHLANDI	12 4	12	123
1	DIAPTOMUS PALLIDUS		34	
1	DIAPTOMUS SICILIS	12	12	12
1	DIAPTOMUS MINUTUS	12	12	123
1	EURYTEMORA AFFINIS		1 3	12
1	LIMNOCALANUS MACRURUS	12	123	1
1	EPISCHURA LACUSTRIS		12	12
14	CALANOIDA (LPIL)	1234	12345	1234
0	CYCLOPOIDA (TOTAL)			
1	CYCLOPS BICUSPIDATUS THOMASI	12 4	12345	1234

579207

Table 2.2-1 (Contd)

NET (LAKE) & BOTTLE (POND)

LAKE (1,2) PONDS (3,4,5)

LS	TAXA	SPR 12345	SUM 12345	FAL 12345
1	CYCLOPS VARICANS RUBELLUS		4	
1	CYCLOPS VERNALIS	1 34	12345	12345
1	CYCLOPS (LPIL)			3
1	EUCYCLOPS AGILIS	3 5	2345	345
1	EUCYCLOPS PRIONOPHORUS		1	
1	EUCYCLOPS SPERATUS		1 345	345
1	MACROCYCLOPS ALBIDUS	5	345	1 345
1	MESOCYCLOPS EDAX	1 4	3	1
1	MESOCYCLOPS LEUKARTI		45	
1	PARACYCLOPS FIMBRIATUS POPPEI			1 5
1	TROPOCYCLOPS PRASINUS MEXICANA		12	12 5
14	CYCLOPOIDA (LPIL)	12345	12345	12345
1	CYCLOPOIDA (LPIL)	1	1	
0	HARPACTICOIDA (TOTAL)			
14	HARPACTICOIDA (LPIL)	12 45	12 5	5
1	HARPACTICOIDA (LPIL)	12345	12 45	345
0	AMPHIPODA (TOTAL)			
0	GAMMARIDAE (TOTAL)			
1	GAMMARIDAE (LPIL)	1		5
0	HAUSTORIIDAE			
1	PONTOPOREIA AFFINIS	1		
0	HYALELLIDAE			
1	HYALELLA AZTECA		5	
0	CRUSTACEA LARVAE (TOTAL)			
0	EPHEMEROPTERA (TOTAL)			
0	BAETIDAE			
13	BAETIDAE (LPIL)	4	3	
0	CAENIDAE			
13	CAENIDAE (LPIL)	4	34	
13	EPHEMEROPTERA (LPIL)		34	
0	ODONATA (TOTAL)			
0	COENAGRIONIDAE			
13	COENAGRIONIDAE (LPIL)	4		
0	DIPTERA NEMATOCERA (TOTAL)			
0	CHIRONOMIDAE			
2	CHIRONOMIDAE (LPIL)	1234	1 345	1 345
2	DIPTERA NEMATOCERA (LPIL)		4	5
0	TARDIGRADA (TOTAL)			
1	TARDIGRADA (LPIL)	1	2	

Legend:

LS = Life stage
- 0 = Summary level
- 1 = Adult
- 2 - Larva
- 6 = Immature
- 13 = Nymph
- 14 = Copepodid
- 19 = Undetermined
- 20 = Mixed

Spring = April sampling
Summer = June and August sampling
Fall = November sampling

Location 1 = Near-field stations 1-6 and 10
Location 2 = Far-field stations 7-9
Location 3 = Pond B
Location 4 = Pond C
Location 5 = Cowles Bog

579808

Table 2.2-2

Annual Occurrence of Zooplankton in Lake Michigan and Nearshore Ponds from 1974 through 1976, NIPSCo Bailly Study Area

	1974		1975		1976		1977		1978	
	Lake Michigan[1]	Ponds[2]	Lake Michigan[1]	Ponds	Lake Michigan[1]	Ponds	Lake Michigan[1]	Ponds	Lake Michigan	Ponds
Coelenterata										
Hydrozoa	S	S	Sp	Sp	S					
Hydra sp.	Sp	S F W	Sp S	Sp S F	Sp	F	Sp F		Sp	Sp S F
Hydra americana								S		
Rotatoria	Sp									
Bivalvia										
Sphaerium sp.				S						
Planaridae						Sp				
Nematoda	Sp	S F W	Sp S F	Sp S F	Sp S	Sp* S F	Sp S F	Sp S F	Sp* S F	Sp S F
Ectoprocta (Statoblast)	Sp	W								
Annelida	Sp		Sp			S				
Naididae										
Naididae (unidentified)	Sp	S W	Sp S	Sp S F	Sp S	Sp S F	Sp S F	Sp S F		
Chaetogaster sp.	F	W		Sp		Sp S			Sp	Sp S F
Tubificidae					Sp					Sp
Crustacea (unidentified)				Sp						
Cladocera (unidentified)	S F	S F	Sp S	Sp S						
Bosminidae										
Bosminidae (unidentified)		W	Sp S F	Sp S F	Sp* S* F*	Sp* S* F*	Sp S* F	Sp S* F	Sp S* F*	Sp S* F
Eubosmina sp.	F	F								
Bosmina longirostris	Sp S F	S F W		S						
B. sp.		W								
Chydoridae										
Chydoridae (unidentified)		F		F	S	F				S F
Acroperus harpae		S		S		S F				
Alona affinis	S F	S F W	Sp	S F	S	Sp S F	S	Sp S F	Sp	S F
A. costata	S F	S F W	Sp S	Sp S F	S	Sp S F	S	S		
A. guttata	F	F		S F		S F		S F		F
A. quadrangularis				S		F				Sp S F
A. rectangula		F W		S F	S	Sp S F*	S	Sp S F	S	Sp S F*
A. intermedia							S		Sp	Sp S
A. sp.	S F	S F W	Sp S F	Sp S F	Sp S	Sp S F	Sp	S	Sp S	S F
Alonella sp.						S				Sp
Camptocercus rectirostris		S F	Sp S	Sp S F		Sp S F	S	S F		Sp S F
Chydorus sphaericus	S	S W			Sp					
C. sp.	S F	S F	Sp S F	Sp S F	Sp S	Sp* S* F*	Sp S F	Sp* S* F*	Sp S F	Sp* S* F*
Eurycercus lamellatus	Sp S F		S F		Sp S	S F	Sp S		Sp S F	
Graptoleberis testudinaria		S				S F		S F		Sp S F
Kurzia latissima		S		S		S F		S F		Sp S F
Leydigia quadrangularis		W		S		S F			F	S
Oxyurella tenuicaudis				S						S F
Pleuroxus denticulatus	S	S F W		Sp S F		Sp S F		Sp S F		Sp S F
P. procurvus	S	F		S		S		S		Sp S
Daphnidae										
Ceriodaphnia pulchella	S F	S F		S						
C. quadrangula		F	S							
C. reticulata		F						S		
C. sp.	F	F	S	Sp S	S	S*	S	S F	S	Sp S* F
Daphnia sp.	Sp S F	S F W	Sp S F	Sp S F	Sp S F		Sp S	Sp	Sp S F	F
D. ambigua	F	F	Sp F	Sp	S F	S		S	Sp S	S
D. galeata	Sp S	W			S	S				
D. galeata mendotae	F	F	Sp S F	Sp S F	F		S F		Sp S F	F
D. longiremis			Sp	S F	S F	S				
D. parvula	Sp					S			Sp	
D. pulex			S						S F	
D. retrocurva	Sp S F	S F W	Sp S F	Sp S F	Sp S F*	S F	S F	S	S* F	S F
D. schodleri			Sp							
Moina brachiata			S							
M. sp.							S			
Moinodaphnia maclepyii							S			
Scapholeberis sp.	S	S								
S. kin[illegible]i					S	S				
S. au[illegible]	S									
Simocephalus expinosus		W		S F		Sp				
S. serrulatus	F	S F	S	Sp S F		S F		Sp S		F
S. vetulus		W		Sp S F		S F				F
S. sp.		S		F		F		Sp S F		Sp S F

*All Bosminidae family now lumped in Bosminidae; no genus level distinction made.

POOR ORIGINAL

579209

Table 2.2-2 (Contd)

	1974						1975						1976						1977						1978					
	Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan			Ponds			Lake Michigan[1]			Ponds			Lake Michigan			Ponds		
Cyclopoida							Sp																		Sp	S				
Cyclopoid copepodids		S	F	S	F	W	Sp	S	F	Sp	S	F	Sp*	S*	F*	Sp*	S*	F*	Sp	S*	F*	Sp*	S*	F*	Sp*	S*	F*	Sp*	S*	F*
Cyclopoidae										Sp																				
Cyclops bicuspidatus thomasi	Sp	S	F	S	F	W	Sp	S	F	Sp	S	F	Sp*	S	F*	Sp	S	F	Sp*	S	F	Sp		F	Sp*	S*	F	Sp	S	F
C. exilis					F	W																								
C. nearcticus											S																			
C. varicans rubellus																	S												S	
C. varicans			F								S					Sp														
C. venustoides										Sp																				
C. vernalis	Sp	S	F	S		W	Sp	S		Sp	S	F	Sp	S	F	Sp	S	F		S		Sp	S	F	Sp	S	F	Sp	S	F
C. sp.	Sp	S	F	S	F	W	Sp			Sp	S						S													F
Ectocyclops phaleratus												F																		
Eucyclops agilis				S		W			F		S	F	Sp			Sp	S	F					S	F		S		Sp	S	F
E. prionophus				S		W				Sp	S						S	F		S			S	F		S			S	F
E. speratus				S		W				Sp	S	F					S	F					S			S			S	F
E. sp.						W					S																			
Macrocyclops sp.										Sp																				
M. albidus		S		S		W				Sp	S	F					S	F					S	F			F	Sp	S	F
M. distinctus						W																								
Mesocyclops sp.											S																			
M. edax		S	F	S	F					Sp	S												S		Sp		F	Sp	S	
M. leuckarti											S					Sp	S												S	
Orthocyclops modestus										Sp							S						S							
Paracyclops fimbriatus poppei						W				Sp		F					S										F			F
Tropocyclops sp.						W																	S							
T. prasinus			F	S	F	W	Sp	S	F		S	F	Sp	S	F*	Sp	S	F												
T. prasinus mexicanus																	S		Sp	S	F		S	F		S	F			F
Harpacticoida	Sp	S		S	F	W	Sp	S	F	Sp	S	F	Sp	S		Sp*	S	F	Sp	S	F	Sp*	S	F	Sp	S		Sp*	S	F
Ostracoda			F	S	F	W	Sp	S		Sp	S	F	Sp	S		Sp*	S*	F		S	F	Sp	S*	F	Sp			Sp*	S	F
Decapoda				S																										
Amphipoda				S																										
Gammaridae	Sp												Sp												Sp					F
Gammarus sp.								S			S																			
Talitridae																														
Hyallela azteca						W										Sp	S												S	
Haustoridae																														
Pontoporeia affinis													Sp												Sp					
Isopoda										Sp																				
Asellidae																														
Asellus sp.						W																								
Arachnida																														
Hydracarina sp.	Sp	F		S		W	Sp			Sp	S	F	Sp	S		Sp	S			S			S		Sp	S		Sp	S	
Insecta				S						Sp																				
Ephemeroptera																														
Ephemeroptera (nymph)				S	F					Sp	S	F					S						S						S	
Baetidae				S	F												S						S					Sp	S	
Caenidae						W											S	F				Sp	S	F				Sp	S	
Caenis sp.																Sp	S													
Hemiptera											S																			
Corixidae (nymph)																	S						S							
Diptera				S						Sp	S					Sp													S	F
Diptera (larvae)						W					S	F																		
Chironomidae																		F												
Chironomidae (larvae)	Sp	S	F	S	F	W	Sp	S		Sp	S			S		Sp	S*			S		Sp	S	F	Sp	S	F	Sp	S	F
Odonata						W																								
Coenagrionidae																Sp												Sp		
Collembola											S																			
Smynthuridae (unidentified)																Sp														
Trichoptera (larvae)																	S													
Homoptera (larvae)																	S													
Coleoptera																		F												
Tardigrada								S					Sp				S						S		Sp	S				
Gastropoda																Sp							S					Sp	S	
Bivalvia																									Sp			Sp		F

*Dominant taxa.
[1]No winter samples collected in Lake Michigan.
[2]No spring samples collected in nearshore ponds during 1974.
Sp = spring (April); S = summer (June, August); F = fall (October or November); W = winter (February or March)

POOR ORIGINAL

579 10

Table 2.2-2 (Contd)

	1974 Lake Michigan[1]	1974 Ponds[2]	1975 Lake Michigan[1]	1975 Ponds	1976 Lake Michigan[1]	1976 Ponds	1977 Lake Michigan[1]	1977 Ponds	1978 Lake Michigan	1978 Ponds
Holopedidae										
Holopedium gibberum	Sp S F	S F W	Sp S F	Sp F	S	S	Sp S F		S F	
Leptodoridae										
Leptodora kindtii	Sp S F	F	Sp S		S	S	S	S	S	S
Macrothricidae										
Macrothricidae (unidentified)		S		S		S				
Streblocerus semicaudatus						Sp				
S. pygmaeus		S								
Ilyocryptus sordidus		S	S	Sp S F		S	S			S F
I. spinifer		F					S	S		S
I. acutifrons							S			
I. sp.		S					Sp		F	
Macrothrix laticornis				S						
M. rosea				S				S		S
M. sp.		S		S		S		S		
Bunops serricaudata						S		S		S
Polyphemidae										
Polyphemus pediculus	S F	S	S	S			S			
Sididae										
Diaphanosoma brachyurum	S F	S F	S	Sp	S	S		S		
D. leuchtenbirgianum			S F	S F		S*				
D. sp.			S	S	S F	S F	S F	Sp S	Sp	Sp S F
Latona sp.	F									
L. setifera	F				S					
Latonopsis sp.	F									
Sida crystallina	F	S F		Sp			S		F	S
Copepoda										
Calanoida (unidentified)	S	S								
Calanoid copepodids	F	F W	Sp S F	Sp S F	Sp* S* F*	Sp* S* F	Sp* S* F*	Sp S F	Sp* S* F*	Sp S F
Centropagidae										
Limnocalanus macrurus	S		Sp F		Sp		Sp	Sp	Sp S F	S
Osphranticum labronectum	Sp F					S				
Diaptomidae										
Diaptomus ashlandi	S F	F W	Sp S F	Sp S F	Sp* S F*	Sp* S F	Sp* S F	Sp F	Sp* S F	Sp F
D. birgei	Sp									
D. clavipoides		S								
D. leptopus				S						
D. minutus	Sp S F	S F	Sp S F	Sp S F	Sp* S F	Sp S	Sp S F	Sp	Sp* S F	F
D. oregonensis	S F	S F W	Sp S F	Sp S F	Sp S F	Sp S F	Sp S F	Sp S	Sp F*	F
D. pallidus	S F	S W		Sp S F		S F		S F		S
D. pygmaeus		S		S						
D. reighardi	S	S		S						
D. siciloides			Sp S F	Sp	Sp					
D. sicilis	S F	W	Sp S	Sp S F	Sp* S F	Sp	Sp F	Sp	Sp* S F	
D. sp.	Sp S F	S F W	Sp	Sp S F	S F					
Pseudocalanidae										
Senecella calanoides		F								
Temoridae										
Epischura lacustris	S F	S F	S F	F	S F	S	S F		S F	
E. nevadensis	Sp S F	F	S							
E. sp	Sp	F								
Eurytemora affinis	Sp S F		Sp S F	Sp S F	S F		S F		S F	S
E. sp.	Sp									

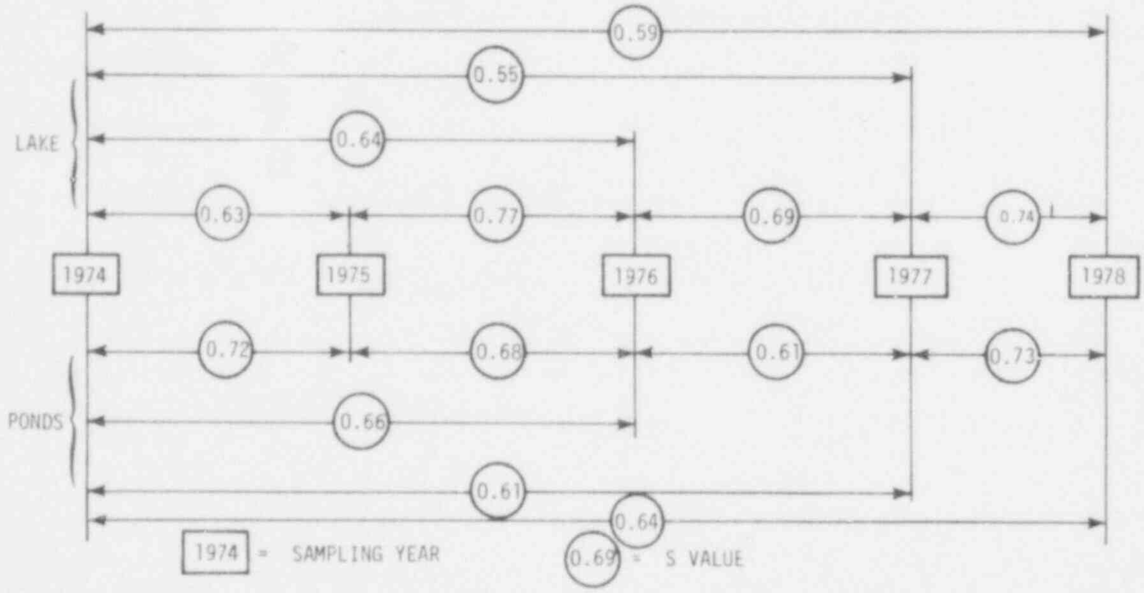
POOR ORIGINAL

579711

The Index of Similarity (Odum 1971) is useful in comparing one community with another, either spatially or temporally; it makes maximum use of information contained in species occurrence data by comparing the number of taxa in community A (A) with the number of taxa in community B (B) and the number of taxa common to both (C) by the following relationship:

$$S \text{ (similarity)} = \frac{2C}{A + B}$$

The index ranges from 0 to 1, and any value greater than 0.5 indicates that the two communities were more similar than dissimilar. A comparison of Lake Michigan and nearshore pond zooplankton communities of 1974 through 1978 yielded the following result:



The data suggest that the zooplankton communities are similar from year to year, but the degree of similarity fluctuates somewhat. The trend of decreasing similarity of the lake zooplankton community from 1974 to 1977 was reversed in 1978 owing to increased number of taxa collected during 1978. The variation observed in the zooplankton communities are due primarily to the variable nature of collecting low abundance species, principally cladocerans and copepods. Many of the less abundant taxa collected intermittently are species associated with the bottom substrates and therefore are not collected in abundance with plankton sampling techniques. No shifts in major community components are apparent from 1974 to 1978.

579212

2.2.3.3 Numerical Abundance. Zooplankton abundance in Lake Michigan reflected similar seasonal patterns between near-field stations (1-6 and 10) and far-field stations (7-9) (Table 2.2-3). Zooplankton densities peaked in August with bosminid cladocerans the most numerous. Density values ranged from a low of $256/m^3$ at Station 2 in April to a high of $214,722/m^3$ at Station 7 in August. This range is considerably higher than observed for previous years; previously the maximum observed density was $138,010/m^3$ in 1974 (Texas Instruments 1975). Densities during 1978 were generally higher at the inshore stations and lowest offshore, a continuation of a trend that was observed in 1976 and 1977 (Figure 2.2-1).

Table 2.2-3

Zooplankton Density (No./m^3) for Lake Michigan Stations 1-10 and Interdunal Pond Stations 17-21, NIPSCo Bailly Study Area, April, June, August, and November 1978

	Station	Apr	Jun	Aug	Nov
Lake Michigan Stations (No./m^3)	1	366	12674	52381	84786
	2	256	20786	66962	43811
	3	550	7863	39433	25650
	4	675	5855	58924	55459
	5	549	7289	52012	31279
	6	485	5658	64538	29604
	7	1277	8561	214722	22784
	8	727	7377	41972	19636
	9	505	6592	19748	20672
	10	928	3127	38377	29235
	Near-field $\bar{x}$ 1-6,10	544	9036	53232	42832
	Far-field $\bar{x}$ 7-9	836	7510	92147	21031
Pond Stations (No./ℓ)	17	2.1	305.2	95.2	937.0
	18	1.0	414.2	509.8	137.0
	19	25.8	323.8	468.5	495.1
	20	22.7	299.5	593.4	785.9
	Cowles Bog 21	51.8	105.4	354.1	19.1
	Pond B $\bar{x}$ 17-18	1.6	359.7	302.5	537.0
	Pond C $\bar{x}$ 19-20	24.3	311.6	531.0	640.4

579213

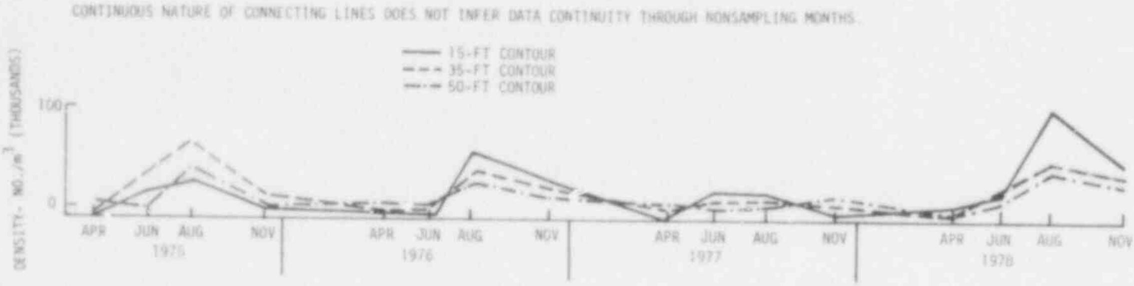


Figure 2.2-1. Zooplankton Density (No./m^3), Lake Michigan Stations (1975-1978)

As in previous years, pond densities were significantly higher than lake zooplankton density (Table 2.2-3, Figure 2.2-2). Values ranged from a low of 1.0/liter (1,000/m^3) in April at Station 18 to a high of 937/liter (937,000/m^3) at Station 17 in November. Densities in the ponds generally peaked in November; Cowles Bog densities, however, peaked in August (Figure 2.2-3). Densities in Cowles Bog were much lower than those observed in Ponds B or C as in previous years, except during August when densities in Cowles Bog generally peaked (Figure 2.2-3).

Comparison of 1978 seasonal density distribution patterns in Lake Michigan with previous years indicates that peak density occurrences and intensity vary annually (Figure 2.2-2) although seasonal patterns remain essentially unimodal from year to year. During the first three years of study and in 1978, density peaks (mean lake density) occurred in August, while 1977 peak zooplankton abundance occurred in June. Density levels of annual maxima (lake mean) steadily declined from 1974 through 1977 but increased considerably in 1978. Density levels during the April and June (nonpeak periods) have remained comparable from year to year with significantly higher densities in August and November of 1978 (Figure 2.2-2). The data in Figure 2.2-2 suggest a seasonal pattern characterized by a steady increase in density from April to August with a subsequent decline in November. This trend is similar to that described for adjacent areas within Lake Michigan (Roth and Stewart 1973).

579214

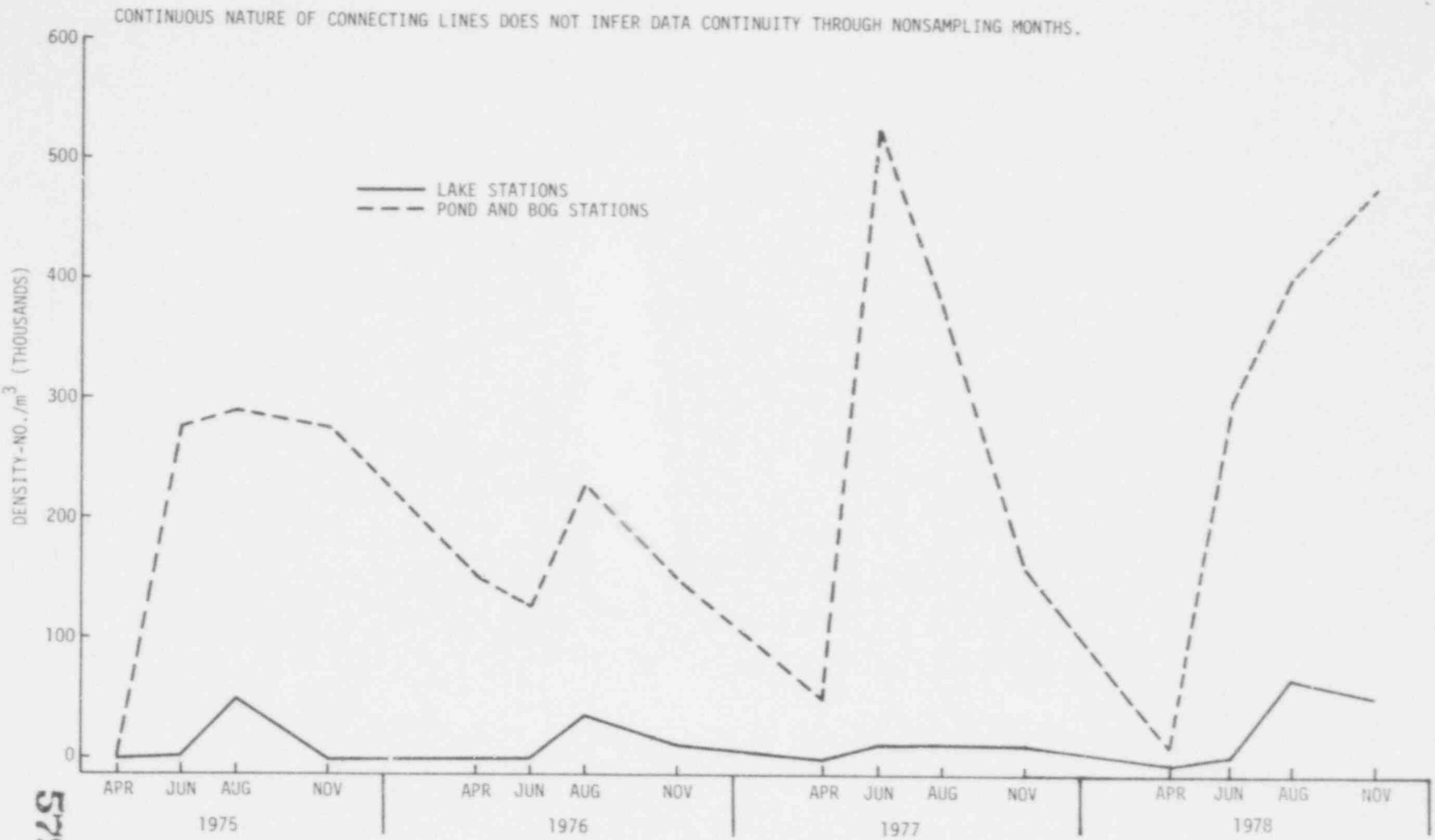


Figure 2.2-2. Zooplankton Density (No./m^3), Lake Michigan versus Pond Stations (1975-1978)

579215

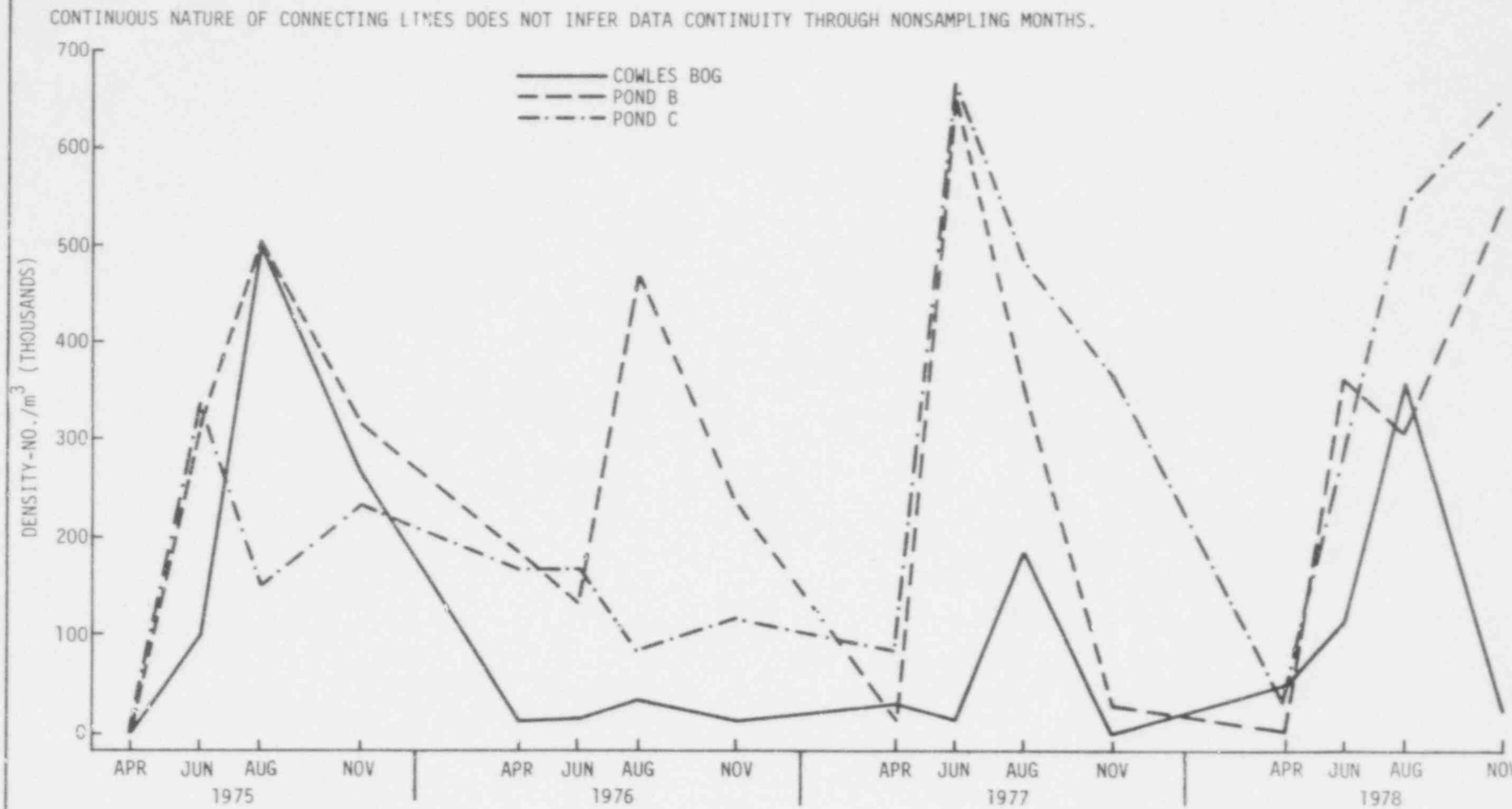


Figure 2.2-3. Zooplankton Density (No./m^3), Interdunal Ponds (1975-1978)

In terms of the ponds, temporal density variations of maxima and minima reflected much greater annual fluctuation (Figure 2.2-3). Data collapsed over the past three surveys (Figure 2.2-4) indicate a seasonal pattern as densities increased from April to June with relatively high densities through November.

2.2.3.4 Percent Composition. Defining community structure and monitoring temporal variations in the community are essential in characterizing the ecosystem. Figures 2.2-5 and 2.2-6 indicate temporal changes in relative (percent) abundance of the major taxa in Lake Michigan and nearshore ponds during this and previous studies in the Bailly study area. Table 2.2-4 presents relative abundance (percent) values for the major taxa during 1978.

Zooplankton seasonal succession in Lake Michigan during 1978 displayed a similar pattern to previous years with diaptomid copepods, bosminid cladocerans, and cyclopoid copepodids the most numerous organisms. Diaptomid copepods (54 percent) dominated the spring 1978 fauna followed by cyclopoid copepodids (46 percent) in June, bosminid cladocerans (66 percent) in August, and bosminid cladocerans and cyclopoid copepodids in November (25 and 31 percent, respectively). Calanoid copepodids (13 percent) were also abundant during November (Table 2.2-4).

The pond zooplankton community also exhibited salient seasonal fluctuations in community structure. Cyclopoid copepodids dominated April and August and were followed by bosminid cladocerans in June and chydorid cladocerans in November (Table 2.2-4; Figure 2.2-6). The chydorid cladocerans were the second most numerous group in August and were dominant in November, comprising 73 percent of the total density.

Compared with previous years, Lake Michigan 1978 zooplankton community dynamics were similar to seasonal succession patterns observed earlier during 1974, 1975, and 1977 (Figure 2.2-5), further isolating the 1976 sampling year as atypical by exhibiting high relative abundance of cyclopoid copepodids and relatively lower abundance of bosminid cladocerans during August. The seasonal succession pattern observed for 1974, 1975, 1977, and 1978 of this survey has been described previously for southern Lake Michigan by Roth and Stewart (1973).

5792 7

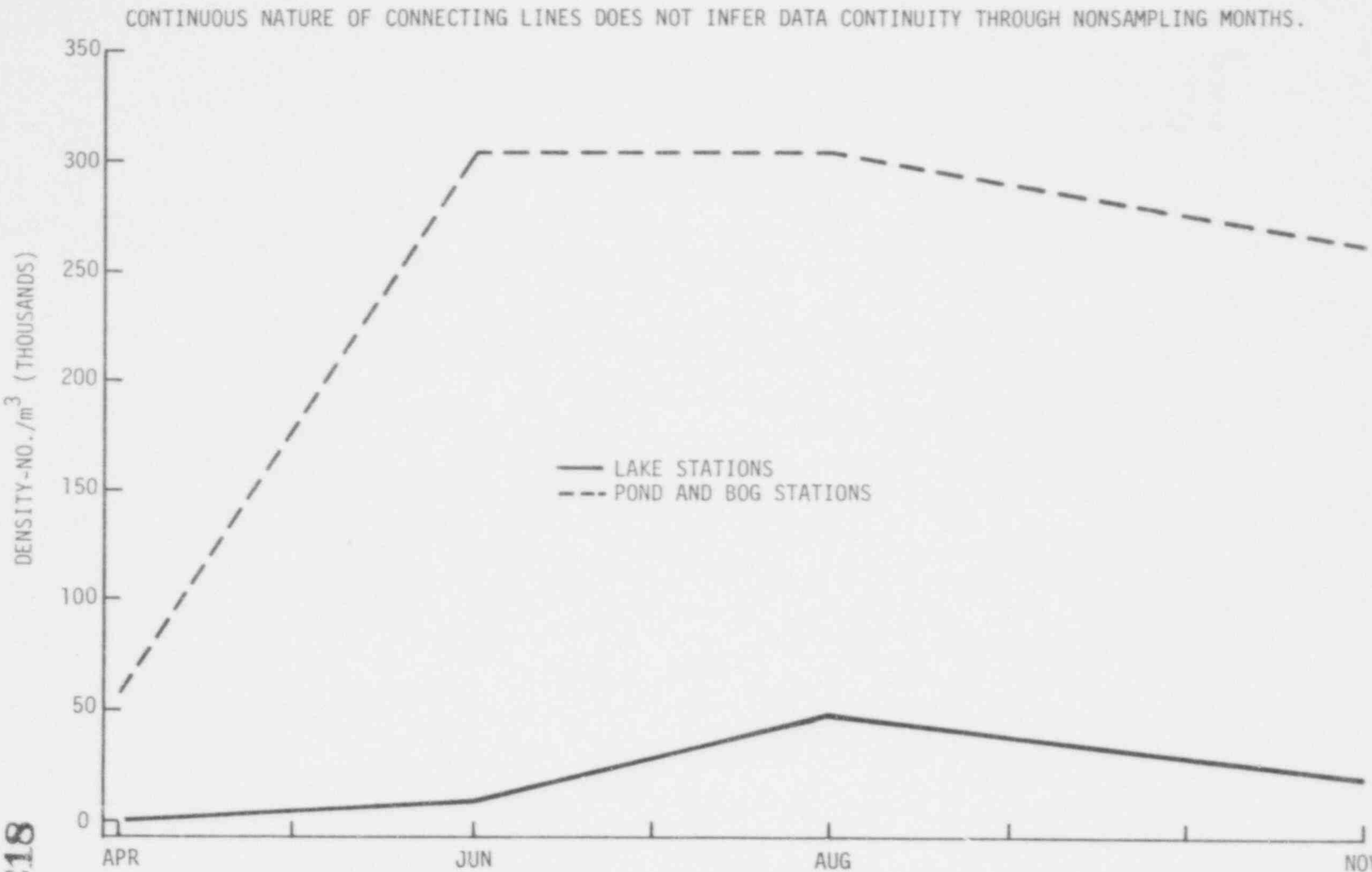
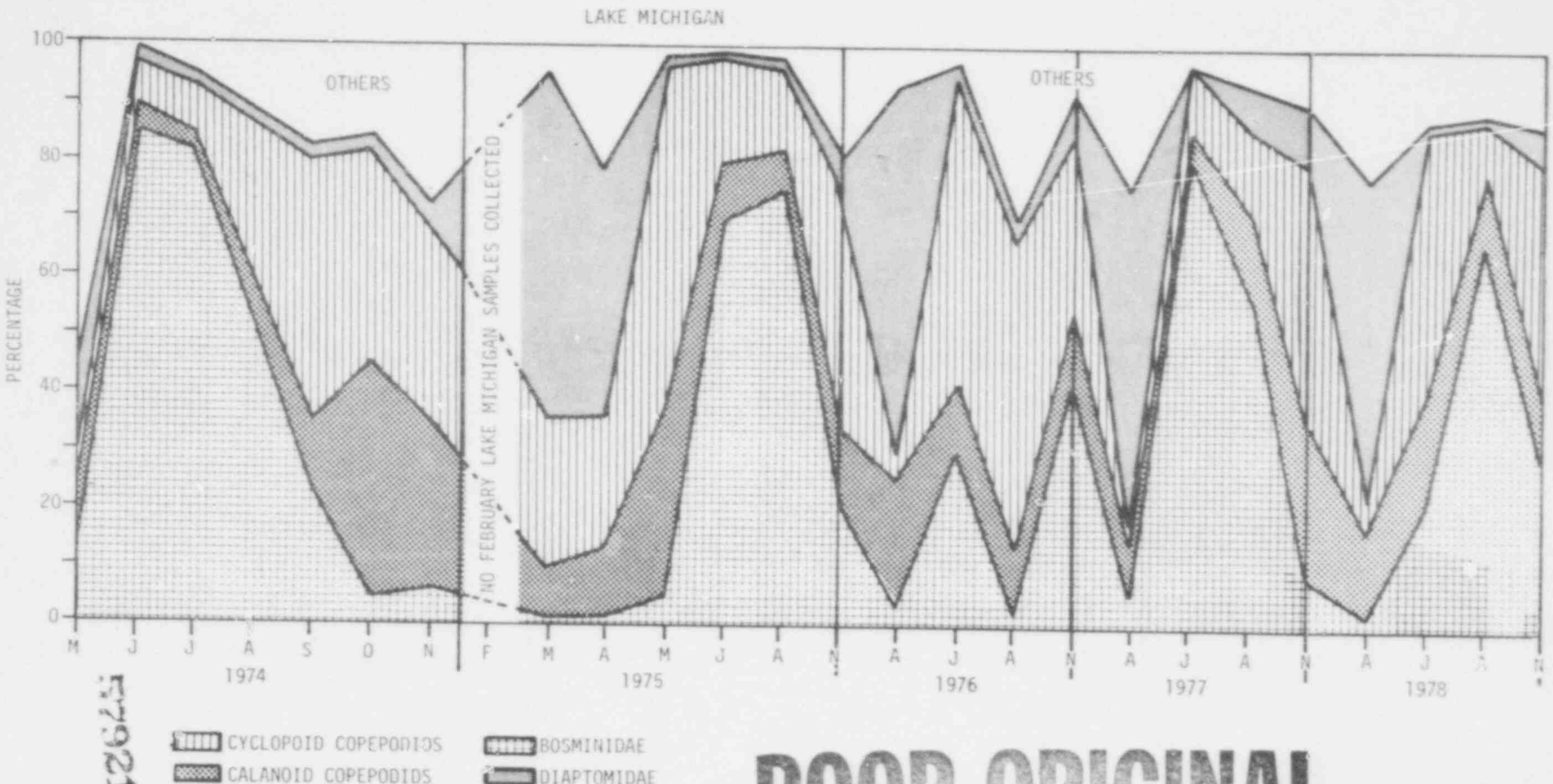


Figure 2.2-4. Average Zooplankton Density (No./m^3), Lake Michigan versus Interdunal Ponds Summed over 1975-1978

579218



POOR ORIGINAL

5779219

Figure 2.2-5. Percentage Composition of Important Zooplankton Forms in Lake Michigan in the NIPSCo Bailly Study Area, 1974-1978

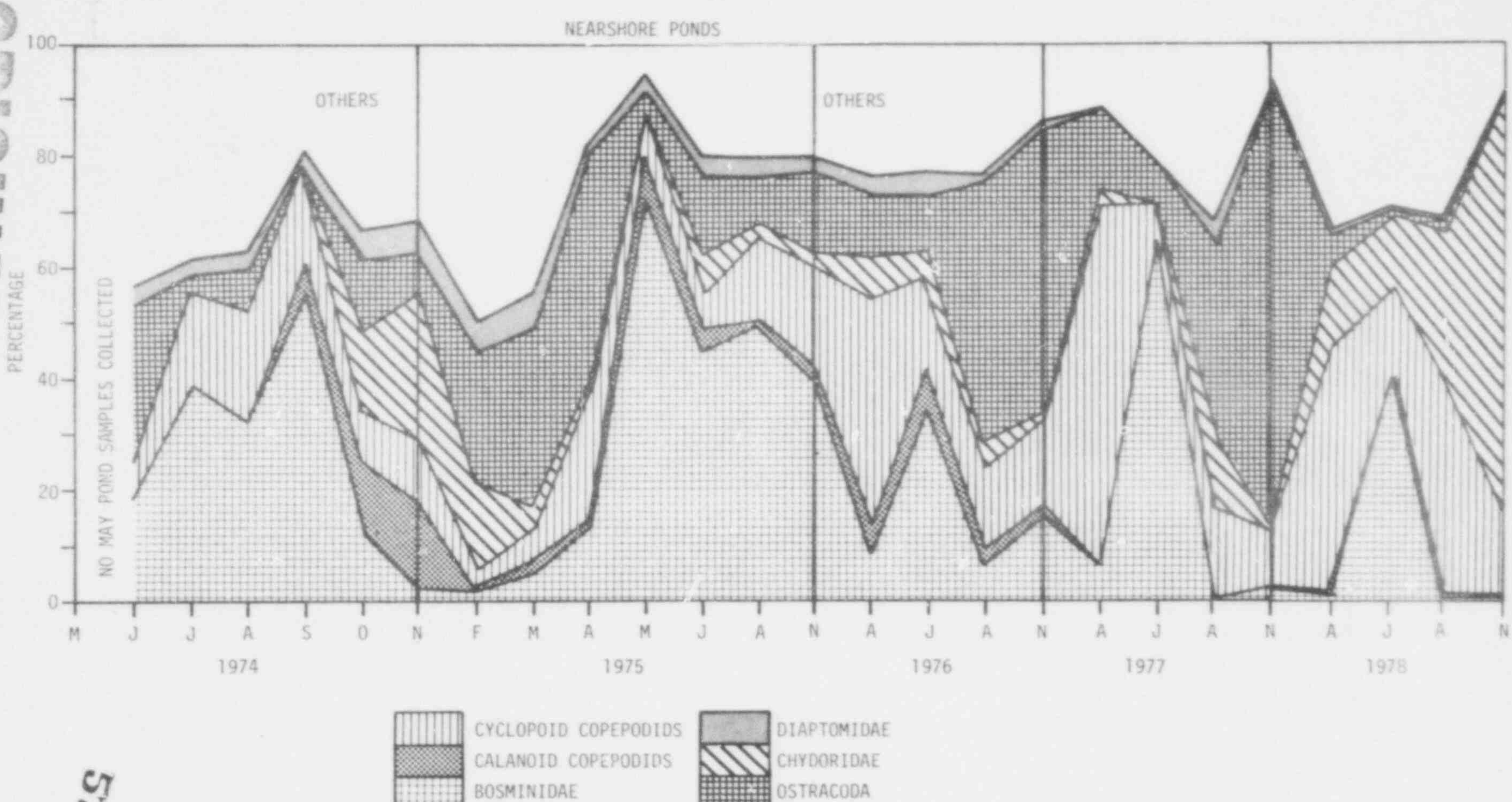


Figure 2.2-6. Percentage Composition of Important Zooplankton Forms in Interdunal Ponds in the NIPSCo Bailly Study Area, 1974-1978

Table 2.2-4

Percent Composition of Major Zooplankton Forms in Lake Michigan and Interdunal Ponds, NIPSCo Bailly Study Area, A , June, August, and November 1978

Taxon	Apr Lake	Apr Ponds	Jun Lake	Jun Ponds	Aug Lake	Aug Ponds	Nov Lake	Nov Ponds
..ydoridae	<1	15	2	13	<1	21	<1	73
Bosminidae	2	3	22	42	66	1	25	1
Cyclopoid Copepodids	6	41	46	12	11	42	31	14
Calanoid Copepodids	13	<1	18	1	10	<1	13	<1
Diaptomidae	54	<1	1	1	1	0	17	<1
Ostracoda	<1	7	0	1	0	5	0	2
Total %	75	66	89	70*	88	69	86	90
No. Taxa	33	37	25	40	27	46	30	44

*Ceriodaphnia sp. comprised 21% of pond density in June.

Seasonal succession patterns in the nearshore ponds may be indicative of changes in the trophic condition within these ponds. Comparisons of seasonal succession patterns over the past five years (Figure 2.2-6) indicate several significant trends. Periods of peak bosminid dominance have decreased since 1976, no longer lasting until August as observed in 1974 and 1975. Concurrently, cyclopoid copepods and chydorid cladocerans have steadily increased in perc nt composition since 1974 with the cyclopoids most prevalent prior to bosminid peaks and the chydorids occurring most heavily after the bosminids' short summer peak. Calanoid copepod percent composition has diminished noticeably from 1974 as well. Gliwicz (1969) noted that smaller species are more abundant in Polish lakes since they feed on smaller food particles that are more prevalent in eutrophic conditions. The general trend in the nearshore ponds indicated increasing numbers of smaller forms, most notably the chydorid cladocerans. Gannon (1972) indicates that Chydorus sphaericus often appears as a common plankter in eutrophic waters accompanying blue-green algal blooms. It should be emphasized, however, that while shifts in species composition of crustacean zooplankton may be indicative of changes in the degree of eutrophy, similar shifts in species composition, and especially size-related shifts, can also be attributable to size-selective fish predation. Gannon (1972) states that it would be difficult to separate shifts in species composition due to size-selective predation or eutrophication.

579221

The more stable community structure observed in the lake suggests, as in previous years, that plant operation has a negligible influence on the major zooplankton components in Lake Michigan. Zooplankton community dynamics in the nearshore ponds indicates that shifts in major community components are occurring that may reflect increased eutrophication and/or fish predation. The degree (if any) to which plant operation is influencing this trend cannot be assessed at this time; however, similar trends observed in the literature suggest that this phenomenon is more related to natural limnological processes than plant operation.

2.2.3.5 Trophic Relationships. Although other factors are often influential, food availability is important in regulating zooplankton community structure. In general, much information regarding the trophic interrelationships of zooplankton can be gained by observing those of the phytoplankton; normally, zooplankton abundance depends almost entirely on phytoplankton levels and reacts accordingly, but the system can exist only when the zooplankton abundance is free to fluctuate greatly and is not rigorously limited by predation (O'Brien and deNoyelles 1974). In a study by Lane and McNaught (1970) involving a mathematical analysis of Lake Michigan zooplankton niches, food was considered the dominant factor in niche separation. While temperature controls crustacean growth and hatching rates (Elster 1954; Eichhorn 1957; as cited in Patalas 1972), food availability affects the fertility of females (Edmondson 1965; Comita and Anderson 1959; as cited in Patalas 1972).

Trends described earlier for Lake Michigan zooplankton in which densities have decreased during the 1975-1977 period may be closely related to phytoplankton community dynamics rather than interactions from higher trophic levels. Figure 2.2-7 presents zooplankton and phytoplankton densities from 1975 through 1978 which indicate a steady increase in phytoplankton density concomitant with declining zooplankton abundance; however, zooplankton and phytoplankton abundance increased in 1978, indicating factors other than total phytoplankton abundance are influencing zooplankton abundance. Levels of blue-green algae increased steadily from 1974 through 1978 accounting for the major portion of the phytoplankton community during peak periods (see Phytoplankton, subsection 2.1.3.1). Blue-greens are generally considered undesirable as a food source for invertebrates, especially cladocerans (Arnold 1971), but apparently there is sufficient phytoplankton to support high densities of zooplankton since 1978 zooplankton densities are higher than any previous year of the Bailly study.

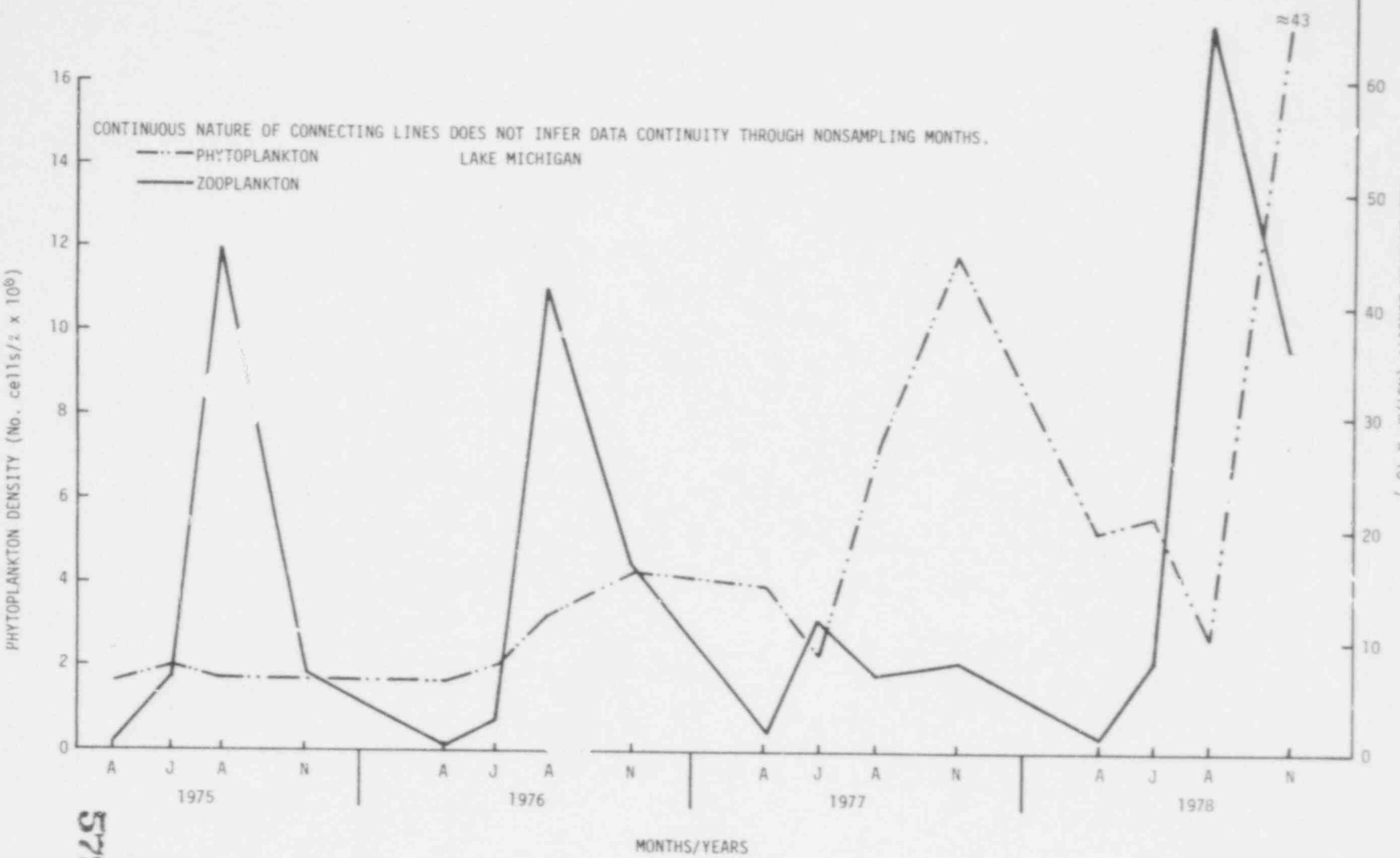


Figure 2.2-7. Comparison of Phytoplankton Density (No./ℓ x 10^6) and Zooplankton Density (No./m^3 x 10^3) within Lake Michigan from 1975-1978

579223

While size-selective predation on zooplankton by alewives has been indicated for Lake Michigan (Gannon 1974), predatory pressure from tertiary trophic levels does not appear to be a major mechanism affecting zooplankton community dynamics in this area. In general, no major size-related shifts in zooplankton community have been observed during the five years of study.

Phytoplankton-zooplankton relationships in the ponds during 1977 were more direct in that zooplankton density generally followed the pattern established by the phytoplankton (Figure 2.2-8). It appears that this was not entirely true during 1978 although zooplankton community dynamics were more closely related to phenomena occurring in lower trophic levels than to any major predatory stress higher in the food chain. Zooplankton community dynamics in Lake Michigan near the Bailly Study Area apparently are influenced by factors other than those shown in the phytoplankton surveys, although probably not owing to predatory stress higher in the food chain since organism size-related shifts have not been observed.

2.2.3.6 Statistical Analysis

2.2.3.6.1 Lake Michigan. Total zooplankton densities of Lake Michigan were subjected to an analysis of variance. To stabilize variance, the data values were logarithmically transformed. Months (seasons) were considered as random effects, stations as fixed effects. A complete description of statistical analysis methodology is presented in Section 2.1, Phytoplankton. The summary analysis of variance can be tabulated as follows, with significant F-statistics marked with an asterisk ($\alpha = >0.05$).

1978 ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Month	3	487.3190	1455.04*
Stations (1-10)	7	8.2906	1.00
Stations (1-9 vs 10)	1	0.6383	0.69
Stations (1-9)	1		
Row (linear) (contour)	1	5.3726	5.85*
Row (quadratic) (contour)	2	0.0765	0.08
Column	2	0.4624	0.25
Row L x column	2	1.3726	0.75
Row Q x column	2	0.3681	0.20
Month station	27	24.8096	8.20*
Replication	120	13.4517	

1975-1978 Across Years ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Years	3	145.7090	1.17
Month	3	1831.6113	14.71*
Year x month	9	373.6590	551.48*
Station	9	11.9826	1.50
Year x station	27	48.7523	2.38*
Month x station	27	23.9610	1.17
Year x month x station	81	61.5483	10.09*
Replication	480	36.1361	

579224

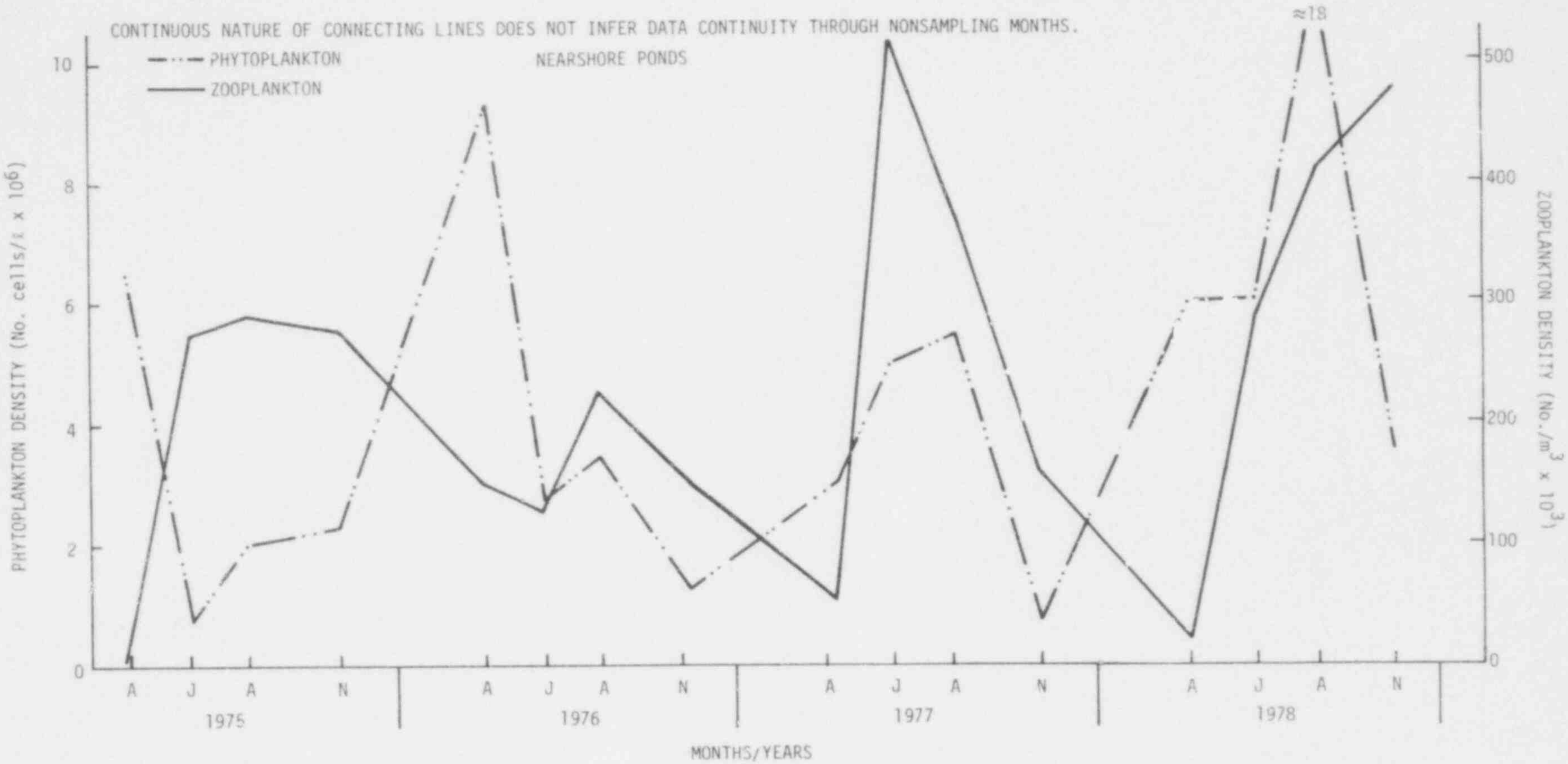


Figure 2.2-8. Comparison of Phytoplankton Density (No./ℓ x 1( ) and Zooplankton Density (No./m^3 x 10^3) within the Interdunal Ponds from 1975-1978

579225

As one would expect, the seasonal effect (months) for 1978 data was significant, with August density highest and April the lowest. Generally, stations 1-10 were fairly uniform in terms of density distribution with no significant differences in mean density (α = >0.05). The contour (15 ft, 30 ft and 50 ft) means were significantly different with the highest densities along the 15-ft depth contour and lowest densities along the 50-ft depth contour.

The significant month x station factor indicates the spatial pattern of densities was not uniform across all months. Although August usually exhibited the highest densities, stations 1 and 9 had higher densities during November. Generally all other spatial relationships were uniform throughout 1978.

Across-year comparisons of zooplankton data indicate that while no significant year-to-year differences were observed, seasonal (monthly) variations were significant as observed in the 1978 ANOVA (α = >0.05). Year x month, year x station, and year x month x station interactions were also significant. indicating changes in the spatial pattern of zooplankton density across months and years. Although changes in spatial distributions occurred throughout the four-year period when averaged over time, the densities at each station were not different, nor were the yearly means different. This indicates natural variation in abundance but no apparent overall change in zooplankton abundance.

2.2.3.6.2 Ponds and Bog. Analysis of variance was performed also on total zooplankton densities in the ponds and bogs, and the data values were logarithmically transformed to help stabilize variances. In the analysis of variance, months (seasons) were considered as random effects; stations as fixed. The station sum of squares was partitioned with orthogonal contrasts for specific tests. The summary analysis of variance can be tabulated as follows, with significant F-statistics marked with an asterisk:

1978 ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Month	3	175.7252	161.60*
Station	4	21.1505	0.82
Ponds vs bog	1	5.8746	0.91
Pond B	1	0.1561	0.02
Pond C	1	0.0580	0.01
Pond B vs Pond C	1	15.0617	2.33
Month x station	12	77.5558	17.83*
Replication	60	21.7478	

579226

1975-1978 Across Years ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Year	3	245.5091	0.68
Month	3	885.6640	2.46
Year x month	9	1080.0821	697.22*
Station	4	104.4386	4.41*
Year x station	12	71.0101	1.96
Month x station	12	55.4565	1.53
Year x month x station	36	108.8048	7.14*
Replication	240	101.6216	

Seasonal (monthly) effects were found to be significant for zooplankton density within the ponds, as one would expect. Mean zooplankton densities for 1978 for all stations were found to be not significantly different. Monthly density differences combined with lower densities in Cowles Bog resulted in significant station x month interactions.

Comparisons across years for zooplankton pond density revealed that while annual density differences were not statistically different, year x month and year x station interactions were significant. Station x month x year interactions were also significant, indicating fluctuations in the station seasonal density pattern during the past four years. Cowles Bog had significantly lower densities when averaged over the four-year period (station factor significant).

579227

2.3 BENTHOS

2.3.1 INTRODUCTION. Benthic studies of the open waters of the Great Lakes have largely emphasized numerical distribution in relation to sediment characteristics and depth and the significance of particular organisms as indicators of water quality (Eggleton 1937, Powers and Alley 1967, Mozley and Garcia 1972, Mozley and Alley 1973, and Mozley and Winnell 1975). A recent study by Mozley (1975) describes benthic community responses to power plant effluents in the Great Lakes. In addition, several studies have been conducted which concentrated upon specific major taxa groups such as amphipods (Alley 1964, Kidd 1970, and Mozley and Garcia 1972), molluscs (Hensen and Herrington 1965) and oligochaetes (Stimpson et al 1975). Several studies describing species association of benthic macroinvertebrates in the Great Lakes have also been conducted (Cook and Powers 1964, Hiltunen 1967, Brinkhurst et al 1968, and Johnson and Brinkhurst 1971).

This survey of the benthic community was designed to characterize the spatial and temporal variation in composition and abundance in the vicinity of the Bailly Study Area. This report contains the results of the fifth year of continuous monitoring effort, 1978, and also draws comparisons among the study years 1974-1978. A general discussion of certain groups as they function as organic pollution indicators is also provided for comparison with data collected in this study.

2.3.2 METHODOLOGY. Benthic macroinvertebrate samples were scheduled to be collected at 10 lake stations (1-10) and 5 pond stations (17-21) during April, June, August, and November 1978. All samples were collected as scheduled. Sediment size analysis at all benthos lake and pond stations was scheduled and conducted during August 1978.

Lake station samples consisted of duplicate quantitative samples collected with a 9-inch by 9-inch Ponar grab sampler. This particular sampler was chosen for its ability to sample a variety of substrates. The Ekman grab is better for sampling fine substrates, but the Ponar grab is more effective on firm substrate samples (Hudson 1970, Howmiller 1971, and Lewis 1972) such as are found in Lake Michigan.

579228

Ponar grab samples were taken at each station until duplicate valid samples were collected. A valid grab haul was defined as one containing substrate within the completely closed jaws of the sampler. Invalid haul contents were discarded. Replicate samples were placed in separate containers, labeled, and preserved to a final concentration of 4 percent buffered formalin. Rose-bengal dye (0.5 percent solution) was added as a stain to aid in rapid detection of the organisms during separating processes.

Each sample was washed through a No. 30 U.S. standard sieve and examined, using white enamel pans and 10X illuminated magnifying lenses. The brightly stained organisms were easily distinguished in the sediment-laden samples. Specimens were sorted by taxon, enumerated, and placed in appropriately labeled vials containing 70 percent ethanol. Specimens were examined using dissection and compound microscopes; principal reference keys used in identification included: Johannsen (1934, 1935, 1937); Ross (1944), Burks (1953), Wiggins (1977); Pennak (1953, 1978); Usinger (1956); Roback (1957); Ward and Whipple (1959); Edmunds et al (1976); and Brinkhurst and Jamieson (1971). These references were supplemented as necessary with specific monographs.

Benthic samples were collected in the ponds with a 9-inch by 9-inch Ekman dredge. This grab was chosen because of its ability to sample areas where the sediment is primarily silt or muck (APHA 1971). Pond samples were collected, preserved, and analyzed in the same manner as the lake samples.

Substrate sediment analysis was performed on regular benthic samples from Lake Michigan and the ponds during August 1978. Five random subsamples were taken from each sample and strained through a National Bureau of Standards sieve series (No. 5, 10, 18, 35, 60, 120, and 230). The fractions passing through the No. 230 screen were caught in an enamel pan, dried at 110°C, and weighed and the percentage composition calculated. Particle sizes were classified according to Wentworth scale as follows:

Sediment Size (mm)	Scale
≥4	Pebble
2	Granule
1	Very coarse sand
0.500	Coarse sand
0.250	Medium sand
0.125	Fine sand
0.063	Silt
<0.063	Clay

579229

2.3.3 RESULTS AND DISCUSSION

2.3.3.1 Numerical Abundance. Numerical abundance (No./m^2) (Table 2.3-1) in Lake Michigan exhibited a temporal distribution pattern unlike that observed in previous years. Values for April and June overall were relatively constant; however, increases were noted at all stations on the 15-foot and 30-foot contour lines while total densities at the 50-foot contour stations and Station 10 were markedly reduced from April to June. August densities generally were higher than those observed in June with exceptions being noted at stations 6, 7, 8, and 10. Whereas densities in previous years declined in November, November sampling yielded the highest densities of the 1978 sampling program. Densities were particularly large at the 50-foot contour stations where a maximum value of 32,356/m^2 at Station 6 was observed. The increasing density with increasing depth phenomenon observed in previous years (TI 1975, 1976, 1977, 1978) and also documented by other authors (Mozley and Garcia 1972, Ayers and Seible 1973, and Stimpson et al 1975) was again observed (Figure 2.3-1). A comparison of near-field stations (1 to 6 and 10) with far-field stations (7 to 9) indicates that mean densities were generally higher at the near-field stations with the exception of the June sampling period when densities were approximately equal (Table 2.3-1). As in the past, Station 10 (discharge) exhibited low density values with a zero value being observed in August. The general comparability of numerical abundance within depth contours for each sampling period at stations outside the immediate discharge area and the low densities observed at Station 10 (discharge) suggest that plant operation effects in terms of total abundance are confined to the immediate vicinity of the discharge.

As with previous data, the nearshore ponds in 1978 generally yielded much higher average densities than observed in the lake (Table 2.3-1, Figure 2.3-2), although differences in sampling gear (Ponar vs Ekman grab) preclude a strict comparison between lake and pond densities. Densities generally decreased from April to June, declined again in August and increased in November (considering all stations as a whole). Cowles Bog displayed the highest densities throughout the nearshore pond area during the April and June study periods, while Pond C exhibited the highest values in August and November. Values ranged from a low of 0.0/m^2 at Station 17 during August to a maximum of 14,471/m^2 at Station 21 in June (Table 2.3-1). Perhaps the most significant pattern occurring within

579 290

Table 2.3-1

Numerical Abundance (No./m^2) of Benthic Invertebrates in the NIPSCo Bailly Study Area, April-November 1978

	Station		Apr	Jun	Aug	Nov
Lake Stations (No./m^2)		1	279	1,192	7,481	885
		2	500	1,135	1,596	1,904
		3	1,212	577	5,183	11,654
		4	327	414	731	1,683
		5	471	962	1,942	769
		6	11,462	4,125	3,817	32,356
		7	192	1,788	817	856
		8	519	981	548	1,538
		9	1,846	202	3,365	4,952
		10	490	29	0	164
	Near-field	$\bar{x}$ 1-6,10	1,747	943	2,964	7,059
	Far-field	$\bar{x}$ 7,9	853	990	1,577	2,449
Pond Stations (No./m^2)		17	606	1,625	0	4,336
		18	11,337	1,240	1,144	5,567
		19	3,002	827	4,423	7,923
		20	10,077	7,433	1,500	6,490
	Cowles Bog	21	14,471	4,500	885	3,058
	Pond B	$\bar{x}$ 17-18	5,971	1,433	572	4,952
	Pond C	$\bar{x}$ 19-20	6,543	4,130	2,962	7,207

the ponds is the continued low total density relative to 1975 (Figure 2.3-2). This phenomenon is most pronounced in Cowles Bog and Pond B (Figure 2.3-3). It has been noted in the literature concerning benthic communities in the Great Lakes region that maximum seasonal abundances of nearshore benthos vary from year to year with fivefold changes not uncommon (Mozley 1975). However, this phenomenon may reflect changes in the physical and/or chemical environment of these ponds.

2.3.3.2 Species Composition. Determining the temporal and spatial variations in benthic species composition can provide information concerning the effects of subtle environmental changes not always discernible by instantaneous physico-chemical testing. The April Lake Michigan sampling period was dominated primarily by tubificid worms (Table 2.3-2; Figure 2.3-4). Chironomids and tubificids dominated in June; however, the amphipod *Pontoporeia affinis* (Tables 2.3-3 and 2.3-4) was also abundant during this period. The August benthic fauna was dominated primarily by tubificids and chironomids and was succeeded in November

578231

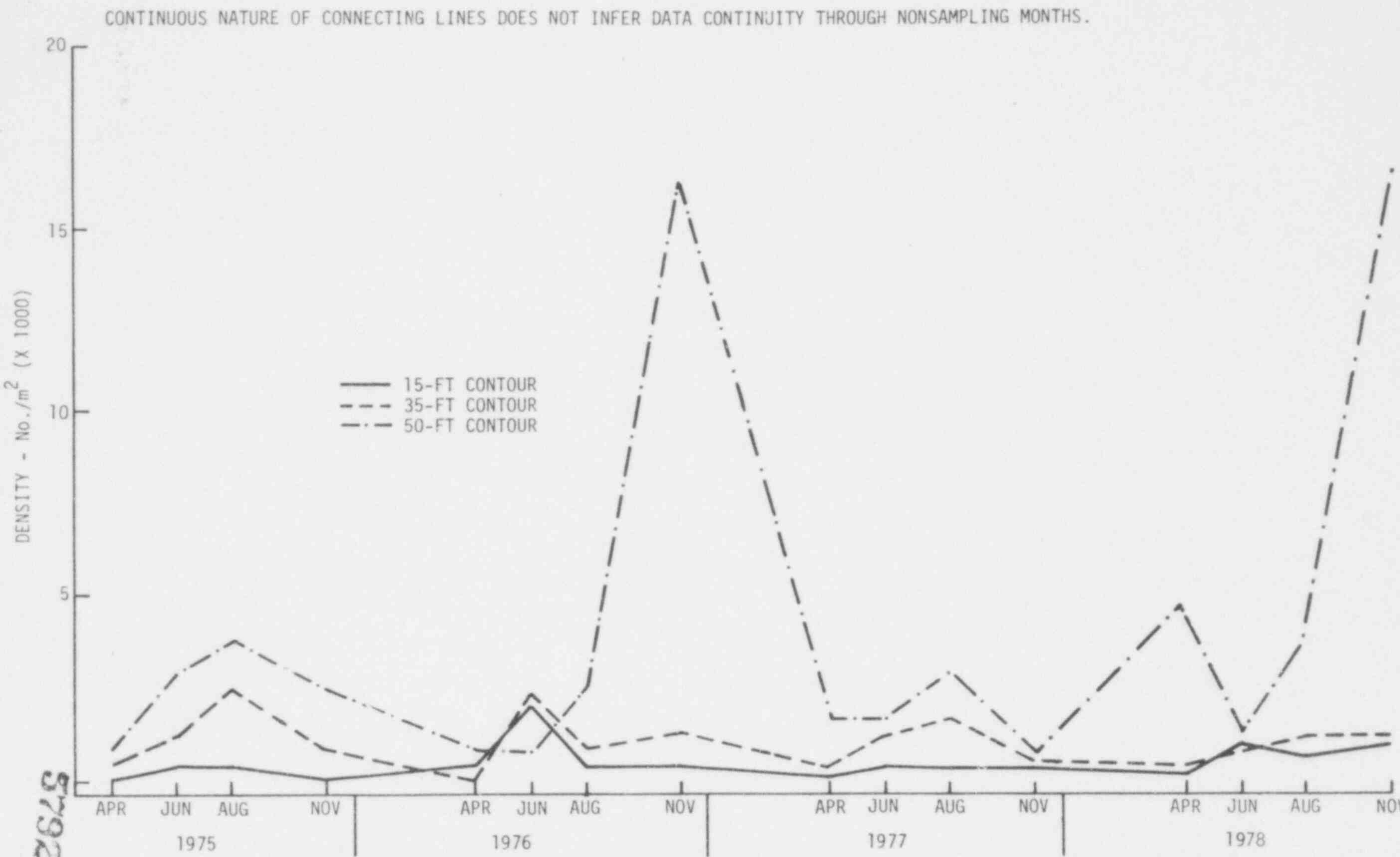


Figure 2.3-1. Benthos Density (No./m^2), Lake Michigan Stations (1975-1978)

CONTINUOUS NATURE OF CONNECTING LINES DOES NOT INFER DATA CONTINUITY THROUGH NONSAMPLING MONTHS.

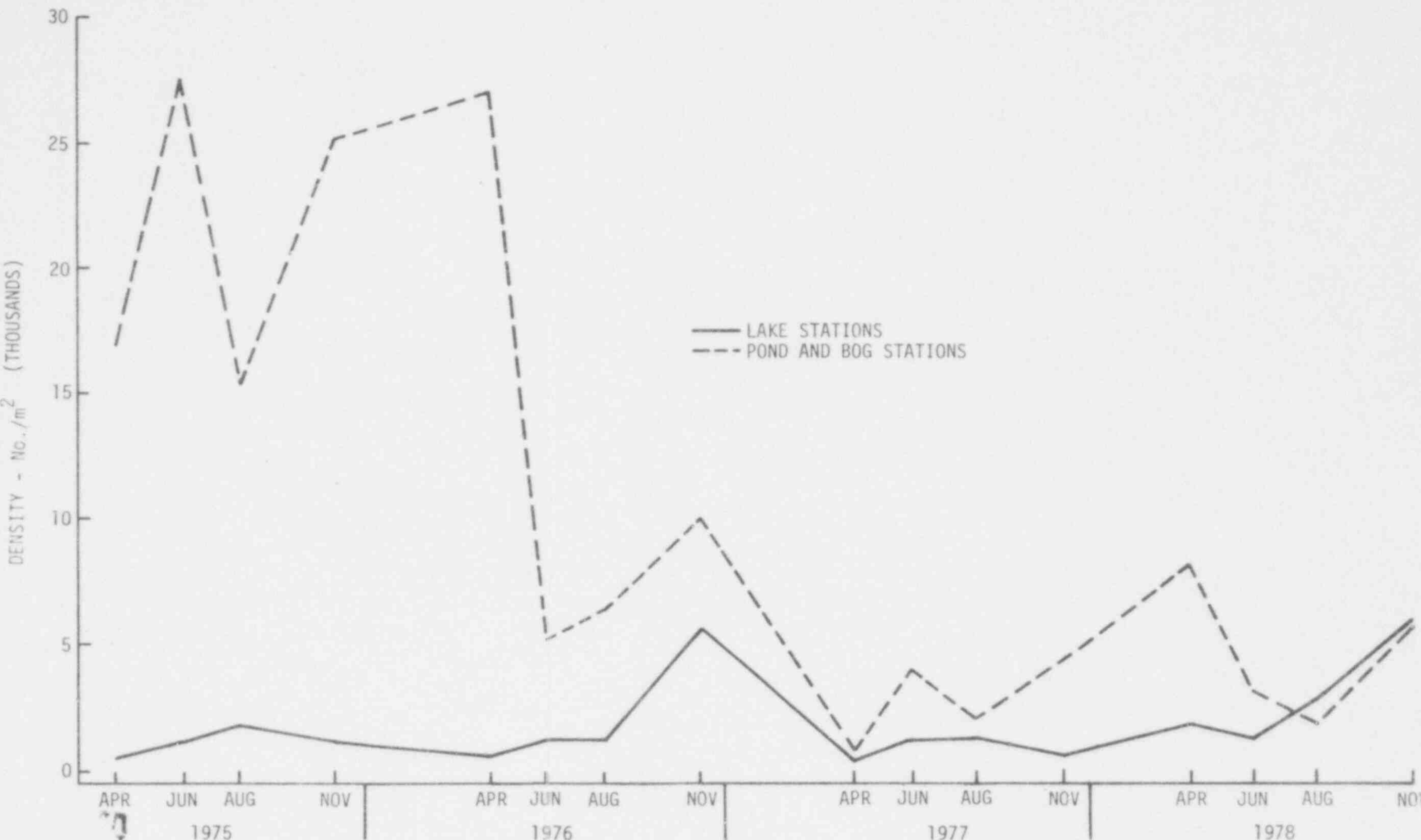


Figure 2.3-2. Benthos Density (No./m^2), Lake Michigan versus Interdunal Ponds (1975-1978)

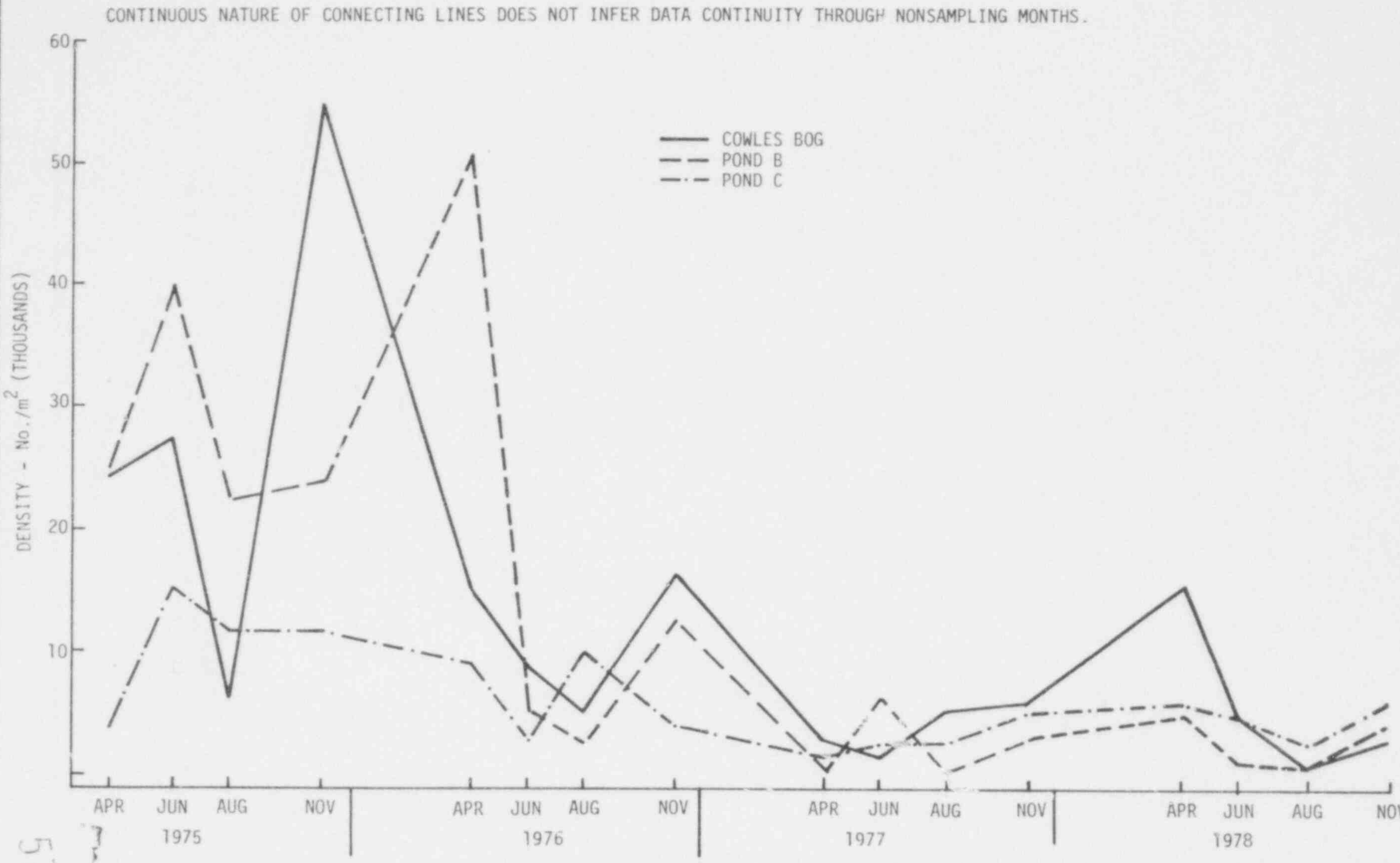
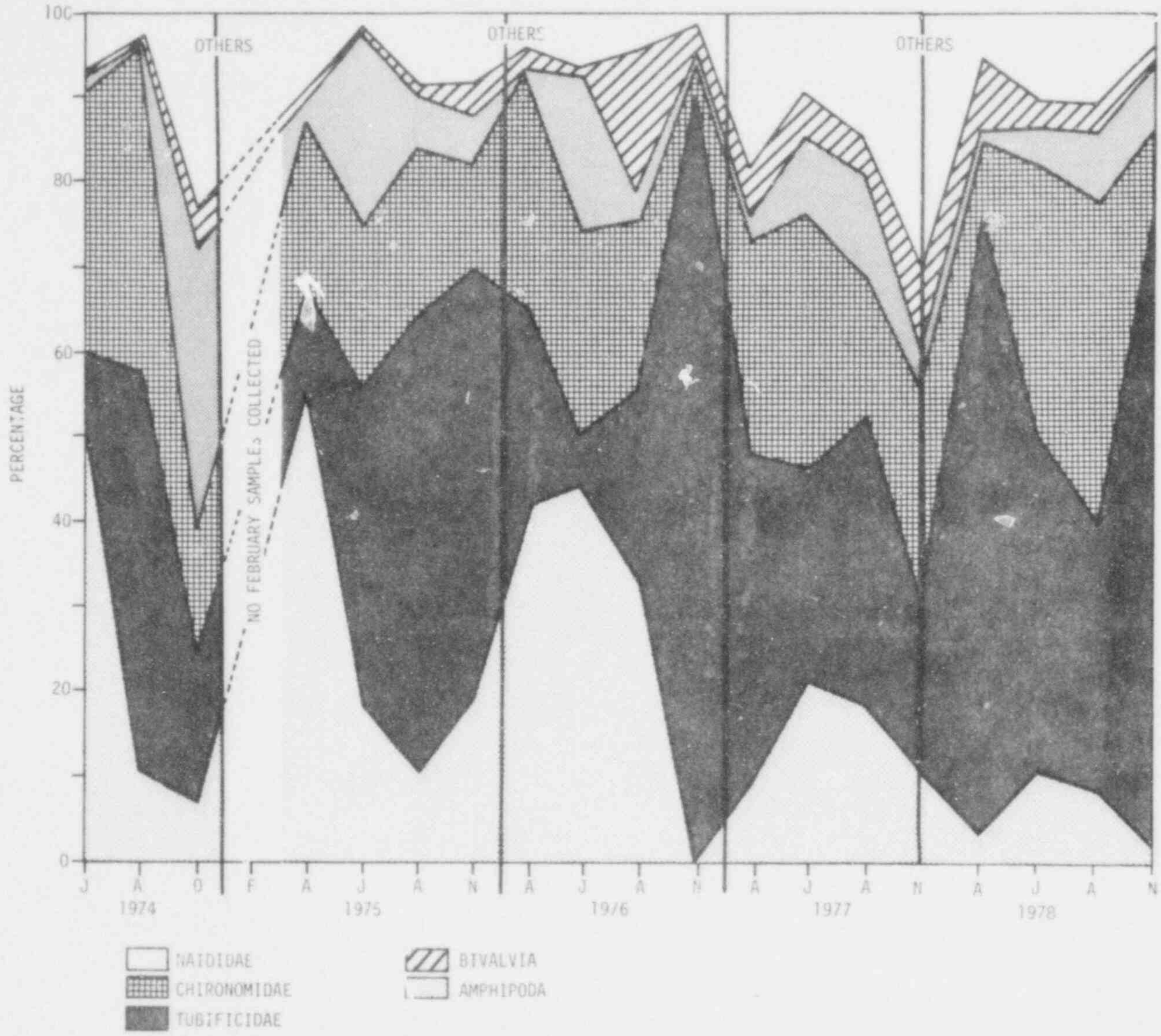


Figure 2.3-3. Benthos Density (No./m^2), Interdunal Ponds (1975-1978)

579 234



POOR ORIGINAL

Figure 2.3-4. Percentage Composition of Important Benthic Organisms in Lake Michigan in the NIPSCo Bailly Study Area

Table 2.3-2

Percent Composition of Major Benthic Organisms in Lake Michigan and Interdunal Ponds in NIPSCo Bailly Study Area, April-November 1978

	Taxon	Apr	Jun	Aug	Nov
Lake Stations (1-10)	Amphipoda	3.5	10.7	8.9	2.2
	Tubificidae	72.5	39.2	31.0	74.9
	Chironomidae	8.5	32.4	38.2	8.8
	Naididae	1.2	3.4	7.9	7.5
	Bivalvia	8.4	4.0	3.5	2.1
	Total %	94.1	89.7	89.5	95.5
	No. Taxa	18	21	25	20
Pond Stations (17-21)	Naididae	5.4	17.4	39.8	35.8
	Tubificidae	14.8	6.6	13.1	9.1
	Amphipoda	0.1	0.0	0.2	6.7
	Chironomidae	40.1	31.2	21.9	27.6
	Bivalvia	20.8	35.5	6.0	4.2
	Total %	81.2	90.7	81.0	83.4
	No. Taxa	33	30	26	53

by tubificids. Other subdominants during August and November were amphipods (Pontoporeia affinis), naidids and bivalves. The predominant chironomids throughout the study were Cryptochironomus sp., Chironomus sp., Cricotopus sp., and Procladius sp. (Table 2.3-3). Tubificid relative abundance was greater in April and November 1978 than was observed in the corresponding time periods for 1977. Pontoporeia affinis also displayed declining relative abundance values between 1977 and 1978. Other community components remained fairly constant from 1977 to 1978 in this area of Lake Michigan (Table 2.3-4).

The predominance of the amphipod Pontoporeia affinis in the lake has been described previously by several authors. In a comparative survey of the Lake Michigan benthos (Robertson and Alley 1966), the structure of this community was compared with a prior description by Eggleton (1936, 1937). Both surveys indicated the abundance of Pontoporeia affinis and oligochaetes.

In another survey by Mozley and Garcia (1972) Pontoporeia affinis was the dominant organism, occurring in greater densities at deeper stations. The occurrence of tubificids as a dominant taxon is also consistent with trends described in the literature, as Mozley (1975) indicates that tubificids are the most numerous whenever the substrate is primarily silt or sand (as in southeastern Lake Michigan).

579 236

Table 2.3-3

Comparison of Benthic Organisms in Lake Michigan and Nearshore Ponds in the NIPSCo Bailly Study Area during the First 5 Years of Sampling

	1974		1975		1976		1977		1978	
	Lake Michigan[1]	Ponds[2]	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds
Coelenterata (Hydroids)										
Hydra sp.	S F	S F W	Sp S F	Sp F	Sp S F	S F	Sp F	F	F	S F
Cordylophora lacustris									F	
Turbellaria (Flatworms)										
Dugesia sp.		W								
Unid. Turbellaria		W	S	Sp S F	F	Sp S F				
Nematoda (Roundworms)	S F	F* W*	S* F	Sp S* F	S F	Sp S F	Sp S F	Sp S F	Sp S F	Sp S F
Nemertea		W					S		Sp F	S
Bryozoa (Moss animalcules)					F					
Lophopodidae										
Lophopodella sp.	F									
Plumatellidae				S						
Cristatellidae										F
Cristatella sp.	F*		S							
Unid. Statoblast					S					
Annelidae (Segmented worms)			S		S					
Oligochaeta (Aquatic earthworms)		W	Sp							
Naididae										
Unid. Naididae	S F*	S* F*	S* F*	Sp S* F*	S* F	S* F*	Sp S F	Sp S* F	Sp S F	Sp S F
Aulophorus sp.		S								
Chaetogaster sp.	S	S F W*	S	Sp* S F*	S	Sp S F			S	S F
Nais sp.		W*	Sp	Sp*		Sp*			S	
Pristina sp.		S F W		Sp S F		Sp				
Stylaria lacustris	S									
Lumbricidae				Sp S		Sp		Sp	S	
Lumbriculidae		W		S F				Sp* S F		
Tubificidae										
Unid. Tubificidae	S* F*	S* W*	Sp* S* F*	Sp* S* F*	Sp* S* F*	Sp* S* F*	Sp* S* F*	Sp* S* F*	Sp S F	Sp S F
Peloscolex sp.			S							
Erpobdellidae					F	S				
Hirudinea (Leeches)					S				S F	
Glossiphonidae										
Glossiphonia sp.		W		Sp F						F
*Helobdelia stagnalis**	S	S	Sp S F	S	S F	Sp S F	Sp S F	S	Sp S F	F
Helobdella sp.*	F	F W		Sp	Sp S	S	Sp S	F	F	
Unid. Glossiphonidae		W		S F						Sp
Piscicolidae										
Piscicola sp.	S			Sp S						
Erpobdellidae										
Erpobdella sp.							S	Sp S		Sp S
Cladocera		W		Sp						
Leptodoridae										
Leptodora kindtii	S F	S			S		F			
Bosminidae										
Unid. Bosminidae**				F						
Bosmina sp.**	F*		Sp							
Chydoridae		F			S					
Chydorus sp.			S							
Eurycercus sp.			S F							
E. lamellatus	S						S			
Daphnidae	F	F								
Daphnia sp.	F	W	Sp F	Sp S F			Sp S F*	F		
Simocephalus sp.		S								
Holopedidae										
Holopedium sp.	F									
H. gibberum			F				F			
Macrothricidae										
Ilyocryptus sp.	S	S W								
Sididae										
Unid. Sididae			S	S						
Latona setifera	S									
Copepoda				Sp S F						
Cyclopoida		W								
Cyclops sp.		S F	Sp S F	Sp* S F	Sp	Sp S F	F			
Calanoida		W	Sp S	Sp	Sp		Sp			
Unid. Calanoida										
Diaptomus sp.	F	S F								
Harpacticoida	S F	S F* W		Sp S F	S		Sp			

*Probably the same species
**All *Bosmina* and *Eubosmina* species now classified under Bosminidae

POOR ORIGINAL

579 237

Table 2.3-3 (Contd)

	1974		1975		1976		1977		1978	
	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds
Isopoda										
Asellus sp.		W		Sp	S	Sp F		Sp S		Sp F
A. intermedius		S								
Lirceus sp.										
Mysidae										
Mysis relicta	F				Sp				F	
Amphipoda										
Talitridae										
Hyallela azteca		S F W	S*	Sp S* F			S	Sp S F		Sp S F
Haustoriidae										
Pontoporeia affinis	S* F	S F	Sp* S F*		Sp* S* F	Sp S F*	Sp* S* F*	S	Sp S F	F
Gammaridae										
Gammarus sp.				Sp S	Sp S	S				
G. fasciatus								F	S F	
Ostracoda (Seed shrimp)		F* W		Sp S F	F	Sp F				
Hydracarina (Water mites)	S* F	S F W	Sp S F	Sp S F	Sp S	Sp S F		Sp S	S	Sp S F
Unid. Arachnida					S				Sp	
Collembola (Springtails)										
Entombryidae	S									
Entombrya sp.					S				Sp	
Ephemeroptera (Mayflies)		W		Sp						F
Baetis sp.				F						F
Caenis sp.		S* F* W		Sp* S F*	F	Sp* S* F*		Sp S F		Sp S F
Neocloeon sp.		S								
Odonata (Dragon flies, damselflies)										
Unid. Odonata				Sp S F	S	S				F
Aeschnidae										
Aeschna sp.		S				S				
Libellulidae										
Unid. Libellulidae		W		Sp F						S
Celithemis sp.				Sp						
Cordulia sp.		F								
Epicordulia sp.		F								
Erythemis sp.				F						
Helocordulia sp.		S								
Ladona sp.								F		
Leucorrhinia sp.				Sp				Sp S F		Sp S F
Libellula sp.				Sp		S F				
Miathyria sp.		S				Sp				
Pachydiplax sp.				Sp						F
Plathemis sp.				F						
Polydia								Sp S F		
Sympetrum sp.						Sp				
Tarnetrum sp.				Sp						
Coenagrionidae										
Unid. Coenagrionidae		S F W		Sp S F*		Sp S F		Sp S F		Sp S F
Coenagrion sp.						F				
Enallagma sp.		F W		Sp						Sp
Ischnura sp.				Sp				F		
Lestes sp.						S				
Cordulegasteridae Unid.		S W								
Hemiptera (Bugs)										
Belostomatidae										
Belostoma sp.										
Corixidae		S		S						
Pleidae		W		Sp F						
Plea striola		S				F				
Tenogobia sp.		S								
Neuroptera					S					
Climacia sp.					S					
Corydalidae										
Chauliodes sp.										
Trichoptera (Caddis flies)										
Unid. Trichoptera		W								
Hydroptilidae		F								
Agraylea sp.		F				Sp F		F		
Hydroptila sp.				F						
Orthotrichia sp.		F								F
Oxyethira sp.		S F W		Sp S F*		Sp S F				
Paraponyx sp.				Sp						
Leptoceridae				S						S
Leptocella sp.				F						Sp S F
Mystacides sp.		F								
Oecetis sp.		S F W		Sp S		Sp S F		S F		F
Polycentropus sp.		W		Sp			S			
										F
										F

POOR ORIGINAL

579 233

Table 2.3-3 (Contd)

	1974		1975		1976		1977		1978	
	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds
Limnephilidae										F
Limnephilus sp.					Sp	S				
Pycnopsyche sp.						Sp				
Phryganeidae										
Banksiola selina (formerly *Agrypnia* sp.)				Sp		Sp		Sp		F
Agrypnia vestita						Sp				
Phryganea sp.		W		Sp						
Banksiola croteni (formerly *Phryganea A.*)						Sp S F		Sp S F		Sp
Psychomyiidae										
Neureclipsis		F				S				
Rhyacophilidae				S						
Rhyacophila sp.				S						
Beraeidae										
Unid. Beraeidae		S								
Lepidoptera (Aquatic caterpillar)										
Unid. Lepidoptera						F				Sp S
Unid. Pyralididae		S				S				
Coleoptera (Beetles)										
Chrysomelidae	S			S						
Curculionidae		F		Sp		F				
Dermestidae			Sp							
Dytiscidae				S F		S				S
Agabus sp.						S				
Elmidae	S									
Haliplidae				Sp S F						
Haliplus sp.				F		S				Sp
Helodidae				Sp						
Hydrophilidae				Sp S						
Berosus sp.								S		
Diptera (Flies, mosquitoes, midges)										
Culicidae										
Chaoborus sp.	S	S F W	Sp	Sp F		S F		S		
Tendipedidae (Chironomidae)										
Ablabesmyia sp.	F	S* F* W*		Sp* S* F		Sp S F		Sp		Sp S F
Analopynia sp.	F									
Brillia sp.		W		Sp						
Calopsectra sp.		S*								
C. varela		S*								
Cardiocladius sp.	S									
Chironomus sp.	S* F	S F* W*	Sp* S* F*	Sp* S F	Sp* S* F	Sp S F*	Sp S F	Sp S F*	Sp S F	Sp S F
Coelotanypus sp.	F		S	S				S		
Corynoneura sp.		W		Sp S					S	Sp
Cricotopus sp.	F	S W	S	Sp S F		Sp S F	S	Sp S F	Sp S	Sp S F
Cryptochironomus sp.	S F	F W	Sp* S* F	Sp S	Sp* S* F*	S	Sp* S* F*	S F	Sp S F	S F
Diamesa sp.		S		Sp						
Dicrotendipes sp.		S F* W		Sp S F		Sp S F		Sp S F	S	Sp S F
Einfeldia sp.		F								
Endochironomus sp.		W		F		S		S F		S F
Eukieferiella sp.		W								
Glyptotendipes sp.	S	S		Sp		Sp S	S	Sp		S
Harnischia sp.	S*	S F	S	Sp S			Sp S	Sp	S	S
Heterotrissocladius sp.	S	S	Sp		Sp				Sp S	Sp S F
Kiefferulus sp.		W		Sp						
Lauterborniella sp.		F								
Metriocnemus sp.	S	S								F
Micropsectra sp.			S	S*				Sp	S	F
Microtendipes sp.	F	F W				S F	F	Sp F		
Monodiamesa sp.			Sp S		Sp S		S		Sp S	S
Nilotanypus sp.										
Orthocladius sp.	S	S		Sp						
Parachironomus sp.			S F	Sp S F			Sp S F	S		Sp S
Paracladopelma sp.										
Paralauterborniella sp.	S									
Paratendipes sp.				Sp		F*				
Pentaneura sp.				S						
Phaenopsectra sp.		W		Sp		Sp			S	
Polypedilum sp.	S	S F W	S	Sp S	S	Sp S F	S	S	S	Sp S F
Potthastia sp.			Sp						Sp F	
Procladius sp.	S F	S* F* W*	Sp S F	Sp* S* F*	Sp S F	Sp S F	Sp S F	Sp S F	Sp S F	Sp S F
Prodiamesa sp.	F									

POOR ORIGINAL

579 239

Table 2.3-3 (Contd)

	1974		1975		1976		1977		1978	
	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds	Lake Michigan	Ponds
<u>Psectrocladius</u> sp.	S	S F W	S	Sp S		Sp S F	S	F	S	Sp S F
<u>Psectrotanypus</u> sp.		F						S		
<u>Pseudochironomus</u> sp.								S		F
<u>Rheotanytarsus</u> sp.		F*								
<u>Tanypus</u> sp.		F		Sp		Sp	F	S		F
<u>Tanytarsus</u> sp.	S	F W*	Sp F	Sp* S* F*	F	Sp* S* F*	S	Sp S F		Sp S F
<u>Tendipedini</u> sp.	S	F								
<u>Tendipes</u> sp.	F	W	Sp							
<u>Tribelos</u> sp.		S W						S		Sp
<u>Trichocladius</u> sp.	S									
<u>Trissocladius</u> sp.			S		F					
<u>Smittia</u> sp.		W								
<u>Stenochironomus</u> sp.		W		Sp						
Unid. Chironomidae		S F	Sp S	Sp S F*	S	Sp S	S	S	S	Sp S
Unid. Tanypodinae			Sp						S	Sp S F
Ceratopogonidae										
<u>Allvaudomyia</u> sp.		S W*		Sp* S* F*		Sp S* F	S F	Sp S F		
<u>Palpomyia</u> sp.		S F*								
Dolichopodidae				Sp						
Ephydridae										
<u>Ephyadra</u> sp.										S
Unid. Ephydridae				Sp S						
<u>Notophila</u> sp.				Sp						
Sciomyzidae										
<u>Sepedon</u> sp.										S
Stratiomyiidae										
<u>Euparyphus</u> sp.				Sp S F		S	Sp			
<u>Ptecticus</u> sp.								Sp		
Tabanidae										
<u>Chrysops</u> sp.		S W		Sp F		Sp S		F		Sp
Tipulidae										
<u>Polymeda</u> sp.		F		S		F		F		Sp
<u>Tipula</u> sp.						F				
<u>Trimicra</u> sp.						F				
Unid. Diptera		W		Sp S						
Gastropoda (Unid.)				Sp S F						S
Lymnaedidae										
<u>Lymnaea</u> sp.		W	S	Sp S F	F	Sp F	S F	S F	Sp	Sp
Ancylidae										
<u>Ferrisia</u> sp.		S F W		Sp S		S F				
Amnicolidae										
<u>Amnicola</u> sp.	S F		S	Sp S	S F		S F		Sp S F	
Physidae										
<u>Physa</u> sp.	F	S F W		Sp S	Sp S	S F	S	Sp S F		
Planorbidae										
<u>Gyraulus</u> sp.	S	S F W		Sp S F	S F	Sp S F		S* F		Sp S F
<u>Helisoma</u> sp.		S F W		Sp F		S* F		Sp S* F		Sp S F
<u>Promentus</u> sp.		F W		Sp S						F
Valvatidae										
<u>Valvata</u> sp.			S		F		S	Sp	Sp S F	
Viviparidae										
Unid. Viviparidae					S					
Bivalvia (Unid.)										S
Sphaeriidae										
<u>Pisidium</u> sp.	S F	S* F	Sp S F	Sp S			Sp S F	Sp S* F	Sp S F	Sp S
<u>Sphaerium</u> sp.	S F	S* F* W	Sp S F	Sp* S* F*	Sp S* F	Sp S* F*	Sp S F	Sp* S F	Sp S F	Sp S F
Unidentified Invertebrate Eggs			S* F*	Sp* S F	S					
Unidentified Invertebrates			S F							
Fish Eggs			S*	S						
Fish Larvae			S	S						
Annelidae Egg				Sp						

No samples in Lake Michigan February 1975
Station 21 dry; no samples taken August 1977
*Dominant taxa
Sp = spring (April); S = summer (June, August); F = fall (October or November); W = winter (February or March)

POOR ORIGINAL

579 240

Table 2.3-4

Benthos Occurrence (Presence/Absence) in Lake Michigan during 1978

LS	TAXA	SPR 12	SUM 12	FAL 12
0	CNIDARIA (TOTAL)			
0	HYDROZOA			
1	HYDRA (LPIL)			12
11	CORDYLOPHORA LACUSTRIS			1
0	NEMERTINA (TOTAL)			
1	NEMERTINA (LPIL)	1		12
0	NEMATODA (TOTAL)			
1	NEMATODA (LPIL)	12	12	12
0	OLIGOCHAETA (TOTAL)			
0	NAIDIDAE			
1	CHAETOGASTER (LPIL)		12	
1	NAIS (LPIL)		1	
1	STYLARIA (LPIL)		12	
1	NAIDIDAE (LPIL)	12	12	12
0	TUBIFICIDAE			
1	TUBIFICIDAE (LPIL)	12	12	12
0	HIRUDINEA (TOTAL)			
0	GLOSSIPHONIIDAE			
1	HELOBDELLA STAGNALIS	12	12	12
1	HELOBDELLA (LPIL)			12
6	HIRUDINEA (LPIL)		12	
1	HIRUDINEA (LPIL)		1	
5	HIRUDINEA (LPIL)			12
0	GASTROPODA (TOTAL)			
0	LYMNAEIDAE			
1	LYMNAEA (LPIL)	2		
0	HYDROBIIDAE (=AMNICOLIDAE)			
1	AMNICOLA (LPIL)	12	12	12
0	VALVATIDAE			
1	VALVATA (LPIL)	2	2	2
0	BIVALVIA (TOTAL)			
0	SPHAERIIDAE			
1	SPHAERIUM (LPIL)	12	12	12
1	PISIDIUM (LPIL)	12	12	12
1	SPHAERIIDAE (LPIL)	1		
0	ARACHNIDA (TOTAL)			
0	SOLPUGIDA			
0	PROSTIGMATA			
1	HYDRACARINA (LPIL)		1	
0	MYSIDACEA (TOTAL)			
0	MYSIDAE			
1	MYSIS RELICTA			12
0	ISOPODA (TOTAL)			
0	ASELLIDAE			
1	LIRCEUS (LPIL)		2	
0	AMPHIPODA (TOTAL)			
0	GAMMARIDAE (TOTAL)			
1	GAMMARUS FASCIATUS		1	1
0	HAUSTORIIDAE			
1	PONTOPOREIA AFFINIS	12	12	12
0	COLLEMBOLA (TOTAL)			
0	ENTOMOBRYIDAE			
1	ENTOMOBRYA (LPIL)	2		
0	DIPTERA NEMATOCERA (TOTAL)			
0	CERATOPOGONIDAE			
2	CERATOPOGONIDAE (LPIL)		1	
0	CHIRONOMIDAE			
2	CHIRONOMUS (LPIL)	12	12	12
2	CRYPTOCHIRONOMUS (LPIL)	12	12	12
2	CRICOTOPUS (LPIL)	12	1	
2	DICROTENDIPES (LPIL)		12	
2	POLYPEDILUM (LPIL)		12	
2	PROCLADIUS (LPIL)	1	12	1
2	CORYNONEURA (LPIL)		1	
2	HARNISCHIA (LPIL)		12	
2	PHAENOPSECTRA (LPIL)		1	
2	PSECTROCLADIUS (LPIL)		12	
2	MICROPSECTRA (LPIL)		2	
2	PARACLADOPELMA (LPIL)		12	
2	POTTHASTIA	12		2
2	HETEROTRISSOCLADIUS	2	12	
2	MONODIAMESA (LPIL)	12	12	
3	CHIRONOMIDAE (LPIL)		12	
2	CHIRONOMIDAE (LPIL)			

LS = Life Stage
0 = Summary Level
1 = Adult
2 = Larva
3 = Pupae
5 = Immature

Spr = April Sampling
Sum = June and August Sampling
Fal = November Sampling

Location 1 = Near-field Stations 1-6 and 10
Location 2 = Far-field Stations 7-9

579 241

The nearshore pond benthic fauna was dominated throughout the year by tubificid and naidid worms, chironomids and bivalves (Table 2.3-2). The prevalent chironomids in the ponds during 1978 were Chironomus sp., Cryptochironomus sp., Dicrotendipes sp., Procladius sp., and Tanytarsus sp. (Table 2.3-3 and Table 2.3-5). The dominant bivalves during the study were as in previous years, Pisidium sp. and Sphaerium sp.

Annual trends observed in the ponds (Figure 2.3-5) reflect the variable percent composition that has been characteristic of the pond and bog stations since the onset of field sampling in 1974. Naidid worms displayed a much larger contribution to percent composition in 1978 than was observed in 1977. This naidid increase was concomittant with a marked decrease in Tubificidae relative abundance. Chironomids and bivalves also generally exhibited higher relative abundance in 1978 than in 1977.

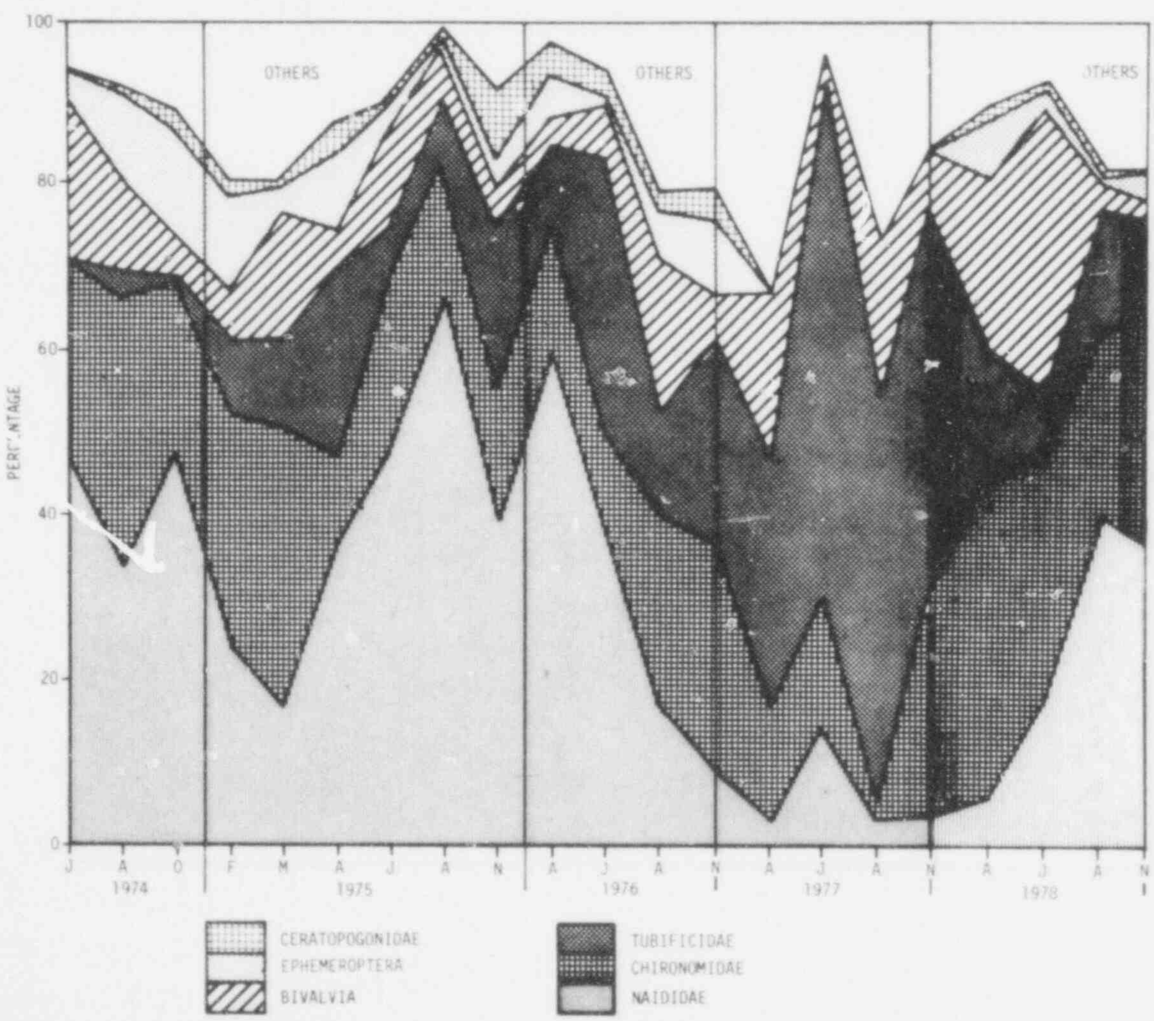


Figure 2.3-5. Percentage Composition of Important Benthic Organisms of the Interdunal Ponds in the NIPSCo Bailly Study Area, 1974-1978

579 242

Table 2.3-5

Benthos Occurrence (Presence/Absence) in Nearshore Ponds during 1978

LS	TAXA	SPR 234	SUM 234	FAL 234
0	CNIDARIA (TOTAL)			
0	HYDROZOA			
1	HYDRA (LPIL)		2	234
0	NEMERTINA (TOTAL)			
1	NEMERTINA (LPIL)		2	
0	NEMATODA (TOTAL)			
1	NEMATODA (LPIL)	234	34	234
0	OLIGOCHAETA (TOTAL)			
0	NAIDIDAE			
1	CHAETOGASTER (LPIL)		234	234
1	NAIDIDAE (LPIL)	234	234	234
0	TUBIFICIDAE			
1	TUBIFICIDAE (LPIL)	234	234	234
0	HIRUDINEA (TOTAL)			
C	GLOSSIPHONIIDAE			
1	HELOBDELLA STAGNALIS			2
1	GLOSSIPHONIA (LPIL)			3
1	GLOSSIPHONIIDAE (LPIL)	3		
0	ERPOBDELLIDAE			
1	ERPOBDELLA (LPIL)	4	4	
0	GASTROPODA (TOTAL)			
0	LYMNAEIDAE			
1	LYMNAEA (LPIL)	4		
0	PHYSIDAE			
1	PHYSA (LPIL)		234	34
0	PLANORBIDAE			
1	GYRAULUS (LPIL)	234	34	234
1	HELISOMA (LPIL)	3	34	34
1	PROMENETUS			4
1	GASTROPODA (LPIL)		3	
0	BIVALVIA (TOTAL)			
0	SPHAERIIDAE			
1	SPHAERIUM (LPIL)	34	234	34
1	PISIDIUM (LPIL)	4	4	
6	BIVALVIA (LPIL)		2	
0	ARACHNIDA (TOTAL)			
0	PROSTIGMATA			
1	HYDRACARINA (LPIL)	2	3	34
0	ISOPODA (TOTAL)			
0	ASELLIDAE			
1	ASELLUS (LPIL)	4		4
1	LIRCEUS (LPIL)			4
0	AMPHIPODA (TOTAL)			
0	HAUSTORIIDAE			
1	PONTOPOREIA AFFINIS			2
0	HYALELLIDAE			
1	HYALELLA AZTECA	23		2 4
1	HYALELLA (LPIL)		4	3
0	EPHEMEROPTERA (TOTAL)			
0	BAETIDAE			
10	BAETIS (LPIL)			3
0	CAENIDAE			
10	CAENIS (LPIL)	23	23	23
10	EPHEMEROPTERA (LPIL)			2
0	ODONATA (TOTAL)			
0	LIBELLULIDAE			
10	PACHYDIPLAX LONGIPENNIS			3
10	LEUCORRHINIA (LPIL)	3	3	3
10	LIBELLULIDAE (LPIL)		2	
0	COENAGRIONIDAE			
10	ENALLAGMA (LPIL)	3		
10	COENAGRIONIDAE (LPIL)	23	34	34
10	ODONATA (LPIL)			2
0	HEMIPTERA (TOTAL)			
0	BELOSTOMATIDAE			
10	BELOSTOMA (LPIL)		4	
0	COLEOPTERA ADEPHAGA (TOTAL)			
0	HALIPLIDAE			
2	HALIPLUS (LPIL)	3		
0	DYTISCIDAE			
1	DYTISCIDAE (LPIL)		4	
0	NEUROPTERA (TOTAL)			
0	CORYDALIDAE			
2	CHAULIODES			4
0	TRICHOPTERA (TOTAL)			
0	HYDROPSYCHIDAE			
2	POTAMYIA (LPIL)			3
0	HYDROPTILIDAE			
2	ORTHOTRICHIA (LPIL)			23
3	ORTHOTRICHIA (LPIL)			2
0	PHRYGANEIDAE			
2	BANKSIOLA SELINA			3
2	BANKSIOLA CROTCHI	3		
0	LIMNEPHILIDAE			

579 243

Table 2.3-5 (Contd)

LS	TAXA	SPR 234	SUM 234	FAL 234
2	LIMNEPHILIDAE (LPIL)			4
0	LEPTOCERIDAE			
2	OECETIS (LPIL)			3
2	TRIAENODES (LPIL)			2
2	NECTOPSYCHE (=LEPTOCELLA)(LPIL)	2	2	2
2	LEPTOCERIDAE (LPIL)		3	
0	LEPIDOPTERA MICROLEPIDOPTERA (TOTAL			
2	LEPIDOPTERA MICROLEPIDOPTERA (LPIL)	2	4	
0	DIPTERA NEMATOCERA (TOTAL)			
0	TIPULIDAE			
2	POLYMEDA (LPIL)	4		
0	CERATOPOGONIDAE			
2	CERATOPOGONIDAE (LPIL)	234	234	3
0	CHIRONOMIDAE			
2	CHIRONOMUS (LPIL)	23	234	234
2	METRIOCNEMUS (LPIL)			4
2	CRYPTOCHIRONOMUS (LPIL)		2	3
2	CRICOTOPUS (LPIL)	23	23	23
2	TANYTARSUS (LPIL)	23	234	234
2	DICROTENDIPES (LPIL)	234	234	23
2	POLYPEDILUM (LPIL)	23	234	234
2	ABLABESMYIA (LPIL)	234	23	234
2	PROCLADIUS (LPIL)	23	234	234
2	CORYNONEURA (LPIL)	23		
2	PARACHIRONOMUS (LPIL)	23	3	
2	PSEUDOCHIRONOMUS (LPIL)			3
2	GLYPTOTENDIPES (LPIL)		3	
2	HARNISCHIA (LPIL)		4	
2	TRIBELOS (LPIL)	3		
2	TANYPUS (LPIL)			3
2	PSECTROCLADIUS (LPIL)	23	234	2
2	MICROPSECTRA (LPIL)			3
2	PARACLADOPELMA (LPIL)			2
2	HETEROTRISSOCLADIUS	23	2	2
2	ENDOCHIRONOMUS (LPIL)		3	23
2	MONODIAMESA (LPIL)		2	
2	NILOTANYPUS (LPIL)		3	3
3	CHIRONOMIDAE (LPIL)	23	23	
0	DIPTERA BRACHYCERA (TOTAL)			
0	TABANIDAE			
2	CHRYSOPS (LPIL)	4		

LS	TAXA	SPR 234	SUM 234	FAL 234
0	DIPTERA CYCLORRHAPHA (TOTAL)			
0	SCIOMYZIDAE			
2	SEPEDON (LPIL)		4	
0	EPHYDRIDAE			
3	EPHYDRA (LPIL)		4	
0	ECTOPROCTA (TOTAL)			
0	PLUMATELLIDAE			
11	FREDERICELLA SULTANA			2
0	CRISTATELLIDAE			
8	CRISTATELLA (LPIL)			3

LS = Life Stage
0 = Summary Level
1 = Adult
2 = Larva
3 = Pupae
10 = Nymph

Spr = April Sampling
Sum = June and August Sampling
Fal = November Sampling

Location 2 = Pond B (stations 17, 18)
Location 3 = Pond C (stations 19, 20)
Location 4 = Cowles Bog (Station 21)

579 244

2.3.3.3 Zonation

2.3.3.3.1 Physical Zonation (Sediment Analysis). A description of substrate composition is essential to identify accurately the distributional mechanisms of the benthic community inhabiting a particular area. The Wentworth particle sizing analysis conducted during August 1978 indicated that the predominant size fraction throughout the lake sediments was in the 0.063 to 0.5 millimeter (silt, very fine sand and fine sand) range (Table 2.3-6), which compares favorably with the predominant fraction described in the three previous years' surveys and in the literature (Hough 1935). In terms of depth distribution, the shallow (15-foot) and mid-depth (30-foot) stations were dominated by silt to fine sand (0.063 to 0.5 millimeter) while the deepest (50-foot) stations were composed predominantly of a very fine sand/silt/clay mixture. A comparison of previous years' data (Figure 2.3-6) indicates that the lake substratum is relatively stable through time as the major sediment components (fine-very fine sand) have persisted with only moderate annual variations in percent composition.

In the ponds, substrate type was composed of much finer material, predominantly clay (<0.063 millimeter) mixed with very fine sand. Very coarse sand/gravel substrates were also major components of each station in the ponds (Table 2.3-6). This was also the case in the four previous survey years. In comparison with Lake Michigan, the nearshore ponds are more variable over time in terms of substrate composition (Figure 2.3-5). Greatest annual variability exists within the coarser components (gravel-very coarse sand). This latter trend was evident in both ponds and Cowles Bog.

2.3.3.3.2 Faunal Zonation. Benthic faunal distribution at the lake stations was closely related to both physical zonation (sediment characterization) and depth. The 50-foot contour represented by stations 3, 6 and 9 generally exhibited the highest density values in the study area during 1978, as it did in previous years. Sediment composition along this contour also displayed the highest percentages of very fine sand, silt and clay, a substrate condition particularly conducive to colonization and growth of dense Tubificidae and Chironomidae populations. Although shallow-water stations along the 15-foot contour also exhibit finely divided substrate characteristics, it is probable that wave action precludes the establishment of dense populations at this depth

Table 2.3-6

Benthic Particle Size Analysis in the NIPSCo Bailly Study Area, August 1978

Location	Station	>4 mm Gravel NBS No. 5*	2-4 mm Very Coarse Sand NBS No. 10	1-2 mm Coarse Sand NBS No. 15	0.5-1 mm Medium Sand NBS No. 35	0.25-0.5 mm Fine Sand NBS No. 60	0.125-0.25 mm Very Fine Sand NBS No. 160	0.063-0.125 mm Silt NBS No. 230	<0.063 mm Clay NBS No. 230
Lake	1	0.00	0.10	0.09	0.89	11.66	68.99	6.71	11.55
	2	0.00	0.00	0.10	0.24	23.91	62.55	8.30	4.90
	3	0.33	0.00	0.06	0.56	8.57	72.62	12.76	5.11
	4	0.25	0.44	0.71	0.17	9.03	71.02	11.79	6.59
	5	2.55	0.31	0.48	0.98	9.05	69.77	14.12	2.74
	6	0.00	0.19	0.65	0.66	6.39	53.40	21.95	16.77
	7	0.47	0.68	0.45	0.78	2.89	65.71	25.59	3.44
	8	93.22	2.63	0.79	0.42	0.52	0.33	0.00	2.29
	9	0.40	0.09	0.22	0.31	2.62	28.35	58.69	9.32
	10	26.61	12.26	12.71	27.22	21.74	2.03	0.16	1.23
	x̄ Lake	12.38	1.67	1.63	3.22	9.64	49.48	16.01	6.39
Shallow	1,4,7	0.24	0.41	0.42	0.61	7.86	68.57	14.70	7.19
Mid-Lake	2,5,8	31.92	0.98	0.46	0.55	11.16	44.22	7.47	3.31
Deep Lake	3,6,9	0.24	0.09	0.31	0.51	5.86	51.46	31.13	10.40
Pond	17**	20.92	0.45	1.95	2.21	7.88	23.39	7.90	35.30
	18**	24.96	0.23	0.74	3.16	8.80	18.59	8.55	31.97
	19**	35.12	2.05	2.38	0.30	1.88	1.87	2.14	54.26
	20**	12.37	0.07	0.51	2.33	11.94	25.21	3.93	43.64
	21**	19.32	4.09	7.02	10.67	8.55	7.29	3.70	39.35
	x̄ Pond	22.54	1.38	2.52	3.73	7.81	15.27	5.24	40.90

*National Bureau of Standards Screen Size No. 5.

**Samples contained large amounts of organic material which collected in the No. 5 sieve. This material was not counted as part of the sediment analysis.

POOR ORIGINAL

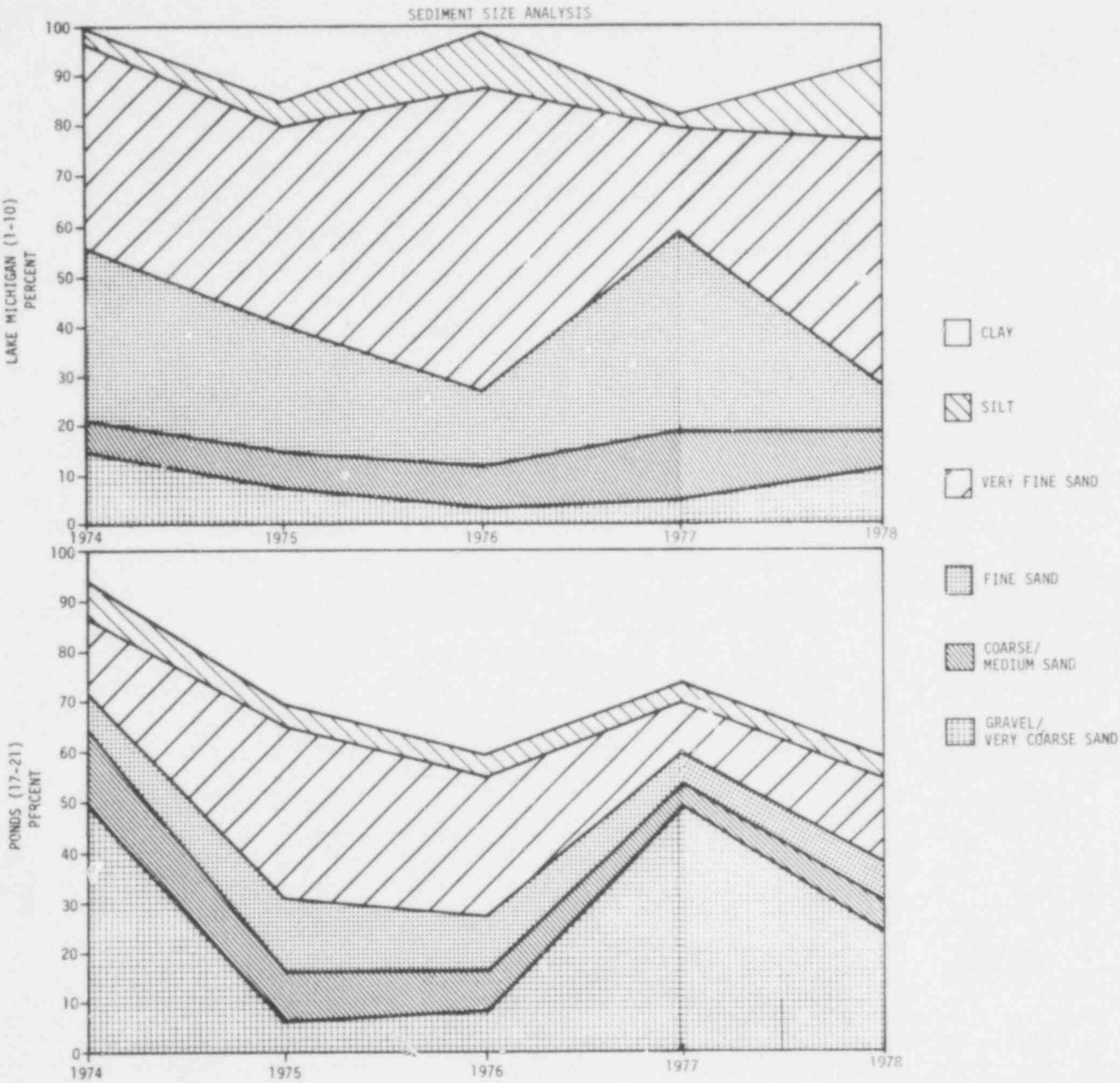


Figure 2.3-6. Sediment Grain Size Distribution, Lake Michigan and Interdunal Ponds, NIPSCo Bailly Study Area, 1974-1978

range in most instances. The stability of benthic faunal density distribution patterns during 1974-1978 can be attributed to relatively stable substrate composition at the various depth contours.

Distinct faunal zonation patterns among the ponds are not readily discernible. Similarities in substrate composition among the ponds have led to the establishment of relatively similar distributions of benthic invertebrates in each of the ponds.

2.3.3.4 Benthic Indicator Organisms. Biological indicators of environmental conditions are shown to be of great value in monitoring subtle changes in the aquatic ecosystem. To compare these data with some standard, Table 2.3-7 was prepared from several sources (Borror and Delong 1971, Pennak 1953, Usinger 1971, EPA 1973). The table is designed to elucidate the trophic positions, habitats, and tolerances of some of the benthic organisms described in tne vicinity of Bailly Generating Station.

The tolerance indications presented in Table 2.3-7 are those of EPA (1973), and caution should be taken in applying and interpreting this technique in describing environmental conditions based on this indicator-organism scheme. (This scheme is simply based on an organism's tolerance or intolerance to organic contamination based on descriptions found in the literature.) The three classifications used in this system are:

- Tolerant, meaning frequently associated with higher levels of organic contamination
- Facultative, meaning a wide range of tolerance frequently associated with moderate levels of organic contamination
- Intolerant, meaning not found even at moderate levels of organic contamination and generally intolerant of moderate reductions in dissolved oxygen (EPA 1973)

This technique is limited in that it can only provide positive evidence of clean water, and then only when intolerant forms are collected (EPA 1973). In addition, the presence or absence of an organism may reflect qualities of the physical environment other than contamination, including current or substrate type. Describing the faunal zonation with respect to substrate composition has hopefully eliminated this problem.

Table 2.3-7

Food, Habitats, and Tolerance Limits of Common Groups of Benthic Invertebrates

Classification	Common Name	Adult Description	Adult Food	Immature Description	Immature Food	Habitat	Tolerance
Hydrozoa	Hydra	Radially symmetrical; main body is elongated cylinder with circlet of tentacles on digital end and pedal disk on proximal end	Carnivore, feeding on metazoans including cladocerans, copepods, insects, and annelids	Bud on side of adult	Same as adults	Sessile on rock and debris	F
Turbellaria	Flatworms	Elongate with exterior end differentiated to resemble "head"; eyespot usually present on exterior end	Usually living on dead or crushed animal matter including protozoans, rotifers, nematodes	Similar to adults	Same as adults	Under objects or in debris	F
Nematoda	Roundworms	< 1 cm long; body slightly tapered and round with terminal mouth; posterior end tapers to five points	Detritus feeders and herbivorous and carnivorous; carnivores prey on protozoans, oligochaetes, rotifers, and other nematodes	Eggs; immature form similar to adult	Same as adults	In sand, mud, debris, or vegetation	F
Bryozoa	Bryozoans	Unit of organisms more or less cylindrical zooid or polypide similar to hydra		Bud (statoblast) released to operate new color		Colonies occur on underside of logs and stones or on twigs and other objects where light is dim	T F I
Oligochaeta	Aquatic Earthworms	Segmented worms with length ranging from 1-30 mm. Prostomium projects in roof-like fashion above mouth; most segments have chitinoid setae arranged in bundles	Bacteria	Cocoons; similar to adults	Same as adults	Common in mud and debris or in masses of filamentous algae	T F

Table 2.3-7 (Contd)

Classification	Common Name	Adult Description	Adult Food	Immature Description	Immature Food	Habitat	Tolerance
Hemiptera	Bugs	Terrestrial and semiaquatic; mouth parts greatly modified to form jointed piercing sucking beak; anterine wings leathery at base and membranes apical	Predaceous on small terrestrial and aquatic insects	Eggs hatch to nymphs similar to adult	Omnivorous and carnivorous on protozoans, algae and other aquatic invertebrates	Adults terrestrial, semi-aquatic, and aquatic (on beach areas); nymphs aquatic around rock and vegetation	T
Trichoptera	Caddisflies	Head with long, thicklike antennae, mandibles; vestigial; two pairs of wings held roof-like over body and covered with hairlike setae	Feeding not common	Eggs hatch to larvae with head and thorax heavily scelerotized, abdomen soft; most build protective cases	Omnivorous and carnivorous feeding on algae, higher plants, crustaceans, annelids, and insect larvae	Adults terrestrial near lakes and streams; larvae under stones in debris and vegetation	F I
Lepidoptera	Aquatic Caterpillars (butterflies and moths)	Terrestrial butterflies and moths; body and wings covered with scales; long antennae	Feed on plants	Eggs hatch to larvae having long slender body with blood gills; mandibles are large; flattened; teeth arranged in flat plane	Feed on algae and diatoms	Adults terrestrial; found along stems on brush or trees	F
Coleoptera	Beetles	Terrestrial and aquatic; small to large; forewings modified into leathery elytra	Carnivorous and herbivorous	Eggs hatch to larvae having well developed head and three well developed legs on thoracic segments	Carnivorous and herbivorous	Around stems and vegetation	T F I

579 250

POOR ORIGINAL

Table 2.3-7 (Contd)

Classification	Common Name	Adult Description	Adult Food	Immature Description	Immature Food	Habitat	Tolerance
Polychaeta	—	Head 3-5 mm long bears two large lateral lophophorelike structures having long tentacles; paired eyes near midline.					
Hirudinea	Leeches	Segmented; dorso-ventrally flattened body having oral and caudal sucker; usually one or more eyespots	Parasites on fish or crustaceans or snails, chironomids, and oligochaetes	Cocoons; similar to adults	Same as adults	In warm protected shallows where plants, stones, and debris afford concealment	T F
Cladocera	Water Fleas	0.2-3.0 mm long with thoracic and abdominal region covered by carapace; head has large compound eyes	Bacteria, algae, protozoa, and organic detritus	Eggs carried by adult; young similar to adult	Same as adults	Littoral and limnetic and in aquatic vegetation	F
Copepoda	—	Elongated body 0.3-3.2 mm and divided into head thorax and abdomen head fused with first two segments of thorax; five pairs of appendages	Protozoans algae, and organic debris	Eggs hatch to to nauplius forms; metamorphosis development	Similar to adults and in some instances parasitic on fish	Limnetic; bottom debris and sand	F
Ostracoda	Seed Shrimp	Body 1-3 mm long covered by opaque bivalve shell	Bacteria, molds algae, and fine detritus	Eggs hatch to to nauplius; metamorphosis development	Similar to adults	In algae, decaying vegetation, rooted aquatics, mud and gravel where there is little current	F T
Isopoda	Aquatic Sow Bug	Body 5-20 mm long and strongly flattened dorsoventrally; six pairs of abdomen appendages	Scavengers feeding on live-dead animals and plants	Eggs hatch to to forms similar to adults	Similar to adults	Hide under rocks, vegetation, and detris	T F I

579 2

Table 2.3-7 (Contd)

Classification	Common Name	Adult Description	Adult Food	Immature Description	Immature Food	Habitat	Tolerance
Amphipoda	Scuds	Body 5-20 mm long, laterally compressed, and consisting of cephalothoracic segments, 6-segmented abdomen, and small terminal telson	Omniverous scavengers	Eggs hatch to forms similar to adult	Similar to adults	Hide under rocks, vegetation, and debris	F
Hydracarina	Water Mites	Appear to be minute spiders	Carnivorous feeding on worms and small insects	Eggs hatch to larval forms	Parasitic on other aquatic insects such as plecopterans, odonates, dipterans, and hemipteran immature forms;	On algae, decaying vegetation, and rooted aquatics	I
				Nymph similar to adult	same as adults		
Ephemeroptera	Mayflies	Medium-sized terrestrial insects with delicate many-veined, transparent wing; held vertically when at rest	None	Eggs hatch to have elongated bodies, larvae head; well developed mandibulate mouth parts, stout legs; larvae, compound eyes and large lateral or dorsal gills on abdominal segments	—	Adult terrestrial, usually clinging to vegetation; nymph in water under stones and in vegetation; may burrow in mud or debris	F I
Odonata	Dragonflies and Damselflies	Medium-large insects having long slender abdomen and two pairs of long, narrow, net-veined wings; head mobile and bearing large compound eyes	Predaceous on mosquitoes, gnats, and other pests	Eggs hatch to aquatic nymphs; body robust or rough and bears spines; large labium	Predaceous on other aquatic insects and small fish	Adults terrestrial nymphs aquatic on submerged vegetation and on rocks in sand or silt	F I

POOR ORIGINAL

579 252

The identified organisms — most of which are Chironomidae, Tubificidae, or Naididae — are listed by the EPA (EPA 1973) as tolerant or faculative and are so classified here. These organisms reflected the broadest representation in the ponds during this survey and are indicative of a more nutrient-rich state in the ponds than in the lake. Certain other taxa (i.e., Hydracarina, Hyellela azteca, and some of the Ephemeroptera) are forms termed facultative to intolerant of pollution.

Many of the forms just described are present in both the lake and ponds. It is therefore thought that the lake can be classified as relatively oligotrophic (based on numbers of organisms intolerant to pollution), while the ponds contain greater loads of decomposable organic material. Water quality data and data from other flora and fauna further substantiate this description.

The benthic data from this study indicate that, although the area in the vicinity of Station 10 (discharge) may be adversely affected by the discharge through scouring, the Bailly Generating Station does not contribute significantly to eutrophication in this area.

2.3.3.5 Benthic Statistical Analysis

2.3.3.5.1 Lake Michigan. Total benthic macroinvertebrate densities of Lake Michigan were subjected to an analysis of variance. In order to stabilize variance, the data values were logarithmically transformed. Months (seasons) were considered as random effects and stations as fixed effects. A complete description of statistical analysis methodology is presented in subsection 2.1.3.3, Phytoplankton. The summary analysis appears on the following page and is tabulated with significant F-statistics marked with an asterisk ($\alpha = >0.05$).

Across-year comparisons reflected the relatively stable temporal density distribution described previously, as no significant differences among years were observed. Significant differences were observed among the 1975-1978 mean densities at each of the stations. Newman Keul's multiple range test results illustrate which stations are significantly different. A horizontal bar drawn beneath the station numbers, as shown below, indicates those stations that are not statistically different from one another:

Lake Station Numbers: 10 9 7 4 1 2 8 5 3 6

Group Similarities:

Density Distribution: lowest ———————— highest

1978 ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Months	3	18.1	7.10*
Stations (1-10)	9	154.9	5.49*
Stations (10 vs 1-9)	1	107.1	34.20*
Stations			
Row (linear contour)	1	27.6	8.80*
Row (quadratic contour)	1	2.7	0.37
Column	2	6.8	1.08
Row x column	4	10.8	0.86
Station x month	27	84.6	3.68*
Replication	40	34.0	—

1975-1978 Across-Year ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Years	3	92.5	3.01
Month	3	128.7	4.20*
Station	9	359.4	6.00*
Years x month	9	92.0	10.16*
Years x station	27	282.9	1.84*
Month x station	27	179.7	1.17
Month x station x year	81	462.3	5.67*
Replication	160	161.0	—

*α = >0.05

Months and stations were a significant source of variation during 1978. For most stations, November densities were higher than in other months; and, in most months, Station 10 reflected significantly lower density. Significant differences were not observed among stations 1 through 9; however, densities generally increased with depth (significant row effect). The significant station x month interaction indicates spatial patterns of density were different from month to month.

2.3.3.5.2 Ponds and Bog. Analysis of variance was performed on total benthos density. The data values were logarithmically transformed to help stabilize variances. In the analysis of variance, months (seasons) were considered random effects and stations were considered fixed.

The summary analysis-of-variance table for benthos density appears below with significant (α = >0.05) F-statistics marked with an asterisk:

1978 ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Months	3	49.4	23.23*
Stations (17-21)	4	41.7	2.15
Pond B (17 vs 18)	1	21.96	4.52
Pond C (19 vs 20)	1	1.42	0.29
Pond B vs Pond C	1	13.98	2.88
Ponds vs Bog	1	4.3	0.89
Station x month	12	58.27	6.85*
Replication	20	14.18	—

1975-1978 Across-Year ANOVA Results

Source of Variation	Degrees of Freedom	Sum of Squares	F-Value
Years	3	135.6	9.89*
Month	3	31.7	2.31
Station	4	31.3	2.78*
Years x month	9	41.2	6.61*
Years x station	12	33.9	1.19
Month x station	12	33.5	1.17
Month x station x year	36	85.7	3.44*
Replication	80	55.4	—

Results from 1978 data analysis indicate that only seasonal density variations were a significant source of variation. No significant spatial differences between stations were observed. Significant interactions resulted from low densities at Station 17 relative to the other stations. Cross-year comparisons reflected the dynamic nature of this system as annual population fluctuations were a significant source of variation. Densities in the ponds were generally uniform from 1976 through 1978 with the 1975 densities significantly higher.

Year x month and month x station x year interactions were also found significant; however, seasonal (month) across years was not a significant source of variation. Stations were significantly different with the density at Station 17 significantly lower than the density at Station 21.

Pond Stations Numbers: 17 19 20 18 21

Group Similarities:

Density Distribution: lowest ——— highest

579 256

2.4 AQUATIC MACROPHYTES

2.4.1 INTRODUCTION. One of the indicators of change in water quality within an aquatic ecosystem is a change in the aquatic plant community. Changes in both the micro (phytoplankton and periphyton) and macro (aquatic macrophyte) forms are observable. Considerably more information has been generated on environmental tolerances of the microforms, but there also exists a growing data base on tolerances of the larger aquatic macrophytes. With this data base in mind, a study of the submerged and floating macrophytes was conducted in Pond B, Pond C, and Cowles Bog in the NIPSCo Bailly Study Area during 1978.

2.4.2 METHODOLOGY. During the 1978 sampling, aquatic macrophytes were collected at all pond sampling locations. Pond B samples were taken in the vicinity of stations 17 and 18, Pond C in the vicinity of stations 19 and 20, and Cowles Bog in the vicinity of Station 21. At each of these locations, representative specimens were collected using a 9-inch by 9-inch dredge at five randomly selected points along a 250-foot transect. The transects were as close as possible to those of 1975, 1976, and 1977. Extent of coverage was estimated qualitatively and quantitatively. Qualitative data were described in the following terms:

- Scattered individuals (or patches)
- Uncommon (or relatively uncommon)
- Common (or common in certain areas)
- Very common
- Dominant

Extent of coverage was estimated also in terms of grams dry weight per 81 square inches of sampler. With this sampling technique, comparisons will be available for future use. Table 2.4-1 presents the results.

2.4.3 RESULTS AND DISCUSSION. Summer 1978 macrophyte composition was similar to that of previous years. Some of the less common forms were missed because of the quantitative sampling technique employed in 1978. However, sampling yielded the same dominant and/or common species as in previous years — bullhead lily (Nuphar sp.), bladderwort (Utricularia sp.), pondweed (Potamogeton

sp.), and watermilfoil (Myriophyllum sp.) (Table 2.4-1). As in previous years, the area in and around Cowles Bog was characterized by a predominance of emergent species.

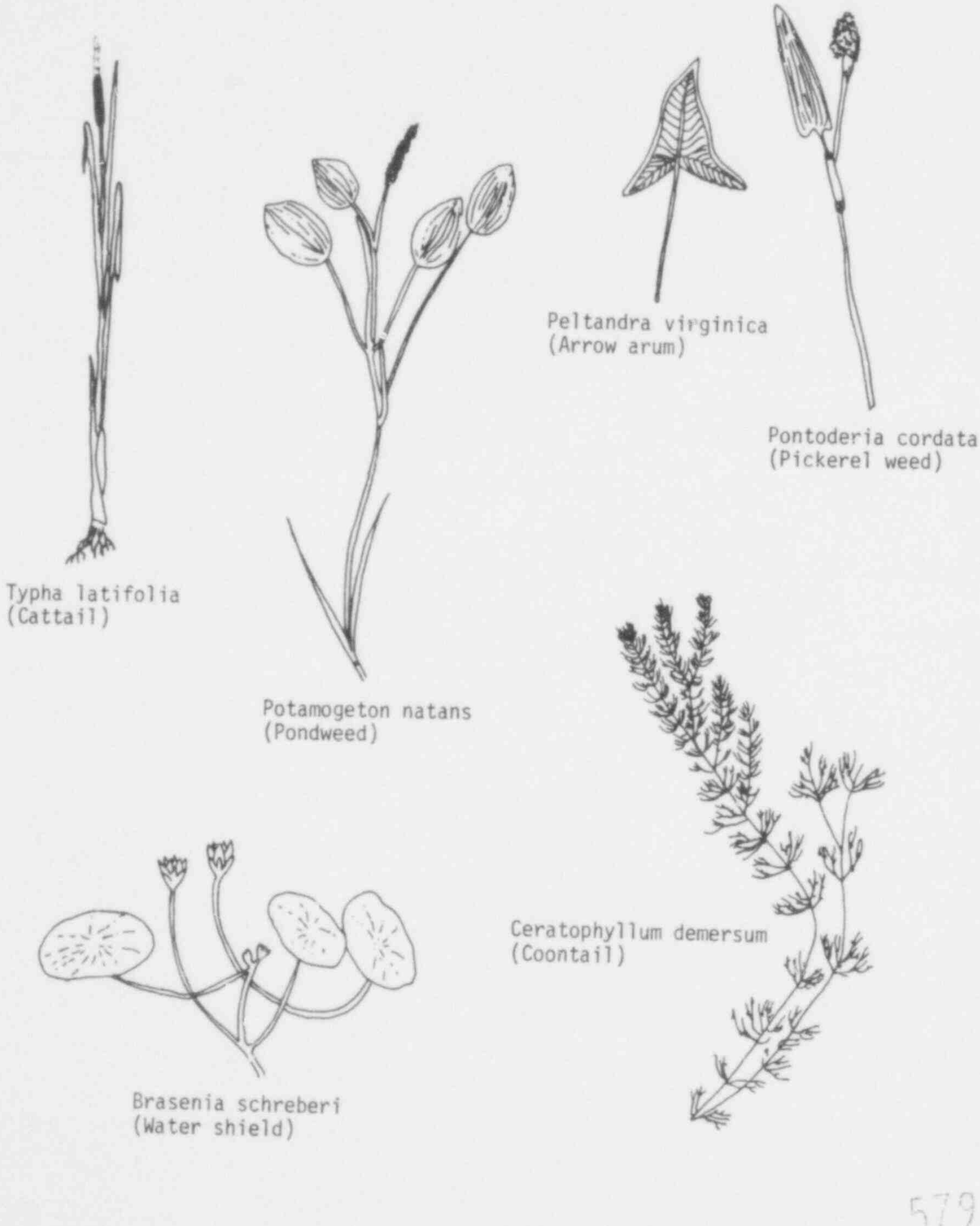
Table 2.4-1

Macrophyte Composition, Bailly Study Area, June 1978

Location	Common Name	Scientific Name	Relative Abundance	Density (gm/81 in.^{2})
Pond B	Smartweed	Polygonum pennsylvanicum	Uncommon	3.5
	Pickerel weed	Pontederia cordata	Scattered specimens	1.5
	Pondweed	Potamogeton natans	Very common	30.1
	Watermilfoil	Myriophyllum sp.	Dominant	60.5
	Bullhead lily	Nuphar sp.	Dominant	45.0
	Duckweed	Lemna minor	Common	0.02
Pond C	Bladderwort	Utricularia vulgaris	Dominant	384.5
	Bullhead lily	Nuphar sp.	Dominant	270.7
	Smartweed	Polygonum pennsylvanicum	Uncommon	3.5
	Pickerel weed	Pontederia cordata	Scattered specimens	1.5
	Duckweed	Lemna minor	Common	0.07
Cowles Bog	Watermilfoil	Myriophyllum sp.	Common	6.0
	Duckweed	Lemna minor	Very common	1.0
	Coontail	Ceratophyllum diversum	Common	5.0
	Cattail	Typha latifolia	Dominant	60.0
	Bladderwort	Utricularia vulgaris	Dominant	42.0
	Bullhead lily	Nuphar sp.	Common	5.0
	Arrow arum	Peltandra virginica	Scattered specimens	0.6

Diagrams of some of the common macrophytes counted or seen within the ponds are shown in Figure 2.4-1, and a key to the common nearshore pond flora is provided in Table 2.4-2.

579 258



579 259

Figure 2.4-1. Some Common Macrophytes Found in Pond Areas in Vicinity of Bailly Study Area (after Hutchinson 1975)

Table 2.4-2
A Generalized Key to the Common Nearshore Pond Macrophyte Flora
Collected in the Bailly Study Area

A. Free floating, without roots or with roots pendant in water.

I. At surface, upper part of plant ordinarily dry.

Lemnaceae – Lemna minor (duckweed)

II. Below surface, plant entirely submerged, floating at mid-depths.

a. Leaves capillary with traps (utricularids)

Lentibulariaceae – Utricularia (bladderwort)

b. Leaves capillary in whorls, without traps, roots absent but stems sometimes become buried (ceratophyllids).

Ceratophyllaceae – Ceratophyllum (coontail)

B. Rooted in sediment (rhizophytes)

I. Part of vegetative structure emerging above water for most of year.

a. Elongate emergent stems with long cylindrical or narrow flat leaves.

Sparaganiaeae	Sparganium (bur-reed)
Cyperaceae	Carex (sedge) Dulichium arundinaceum (3-way sedge) Eleocharis (spike rush) Scirpus (bulrush)
Typhaceae	Typha (cattail)

b. Leaf-bearing stem emerging well above water with air leaves that are usually lanceolate, elliptical, or compound above water.

Polygonaceae	Polygonum (smartweed)
Haloragaceae	Proserpinaca (mermaid-weed)

c. Foliose, petiole extending above water so that the leaf rather than the whole shoot is emergent; flower stalk or inflorescence ordinarily emerges above water; emergent leaf cordate, sagittate, or lanceolate.

Pontederiaceae	Pontederia cordata (pickerel weed)
Araceae	Peltandra virginica (arrow arum)

II. Leaves, or at least some of them, floating but not usually emergent.

a. Floating leaves cordate, circular, or elongate-oblong.

Nymphaeaceae	Nymphaea (water lily) Nuphar (water lily)
Cabombaceae	Brasenia (water-shield)

b. Floating leaves lanceolate

Potamogetonaceae Potamogeton (pondweed)

III. Plant, except flower or inflorescence, submerged, perennially or during most of the growing season.

a. Vittate, long stems or creeping rhizomes with long flexible branches.

(1) Small leaves

Hydrocharitaceae Elodea (waterweed)

(2) Leaves negriophyllord, greatly divided

Haloragidaceae Myriophyllum (milfoil)

579 260

b. Stem very short, leaves in a rosette.

Hydrocharitaceae Vallisneria (eelgrass)

2.5 FISHERIES STUDIES

2.5.1 INTRODUCTION. The fish community comprises one of the more important components of the Lake Michigan aquatic system both from an ecological and public viewpoint. Fish represent the higher consumer levels in the aquatic ecosystem and provide the basis for the sport and commercial fishing industries. Additionally, fish are excellent indicators of aquatic environmental quality, since changes in environmental conditions often effect changes in the resident fish community. Typically, fish communities inhabiting a disturbed portion of a water body may differ in some respects (i.e., species composition, growth rates and condition, incidence of parasitism/disease) from the fish community in an undisturbed area with similar habitat.

The objective of the fisheries portion of the ongoing NIPSCo Bailly Generating Station study is to obtain baseline data on the fish community in potentially disturbed (experimental) and undisturbed (control) nearshore areas of Lake Michigan in the vicinity of an existing fossil-fueled electric generating plant and a planned nuclear-fueled electric generating plant. These baseline data are being used to evaluate changes, if any, in the Lake Michigan nearshore fish community within and outside an area potentially affected by the combined thermal discharges of these two plants, as well as fish community changes in a natural pond (Pond B) potentially affected by water seepage from existing ash-settling basins. This subsection represents the fifth in a series of fishery study reports characterizing the ecology of the nearshore Lake Michigan fishery in the study area and the fish community inhabiting Pond B.

Adult and juvenile fish samples were collected in Lake Michigan and Pond B during April, June, August, and November 1978 to determine species occurrence, composition and spatial/temporal distribution, as well as condition and degree of external parasitic infestation. Additionally, food habits were determined for a number of important species (spottail shiner, salmonids [salmon and brown trout combined], alewife, yellow perch, gizzard shad, and carp). Similar determinations (except food habits) were performed on fish samples collected in Pond B. Fish eggs and larvae samples were collected in Lake Michigan to evaluate the extent and temporal/spatial distribution of spawning both within and

579 261

outside the potentially thermally affected areas. Subsequently, these data were compared with the extant fishery data base (Texas Instruments 1975, 1976c, 1977, and 1978a) in order to discern possible changes, if any, in the resident fish community.

2.5.2 METHODOLOGY. Adult and juvenile fish samples were collected in near-shore Lake Michigan control and experimental stations with experimental gill nets and beach seine; Pond B samples were collected by backpack electrofishing. All captured fish were identified, counted, weighed (grams), and measured for total length (millimeters), and examined for external parasites. Young-of-the-year fish and smaller species were immediately preserved and later taken to the laboratory for length and weight measurements while larger fish were processed in the field.

2.5.2.1 Experimental Gill Nets. The experimental gill nets were 91.4 meters (300 feet) long, 3.0 meters (10 feet) deep and contained six 15.2-meter (50-foot) panels, ranging from 25.4 to 88.9 millimeters (1.0 to 3.5 inches) square mesh measured from knot to knot. Gill nets were set perpendicular to the shore across the 4.6-meter (15-foot) depth contour at stations 4 and 7 (Figure 2.0-1) during each sampling month. Generally, the nets were set in late afternoon and retrieved the following morning. The nets were anchored at each end with concrete blocks attached to the lead-lines and buoyed with polyethylene floats attached to the floatlines.

2.5.2.2 Beach Seine. Shore-zone samples were collected during daylight at stations 23, 24, and 25 (Figure 2.0-1) during each sampling month with a 15.2-meter (50-foot) long, 1.2-meter (4-foot) deep beach seine having 3.1-millimeter (0.125-inch) square mesh webbing. Samples were taken by wading to a depth of 0.9 meter (3 feet), drawing the seine parallel to the shoreline, and hauling both ends of the net simultaneously shoreward. Caution was exercised to ensure that the net was stretched its entire length and that the leadline was hauled slightly ahead of the floatline. Following net retrieval, samples were concentrated in the center of the seine, removed, and immediately preserved in 10-percent buffered formalin.

579 262

2.5.2.3 Electrofishing Unit. A Coffelt Model BP-2 backpack electrofishing unit was used to collect duplicate electrofishing samples in April and August at pond stations 17 and 18 (Figure 2.0-1). The duplicate samples were of 5-minute duration each. The fish collected during each sample were bagged separately and immediately preserved in 10-percent buffered formalin.

2.5.2.4 Benthic Pump. Ichthyoplankton samples were taken immediately above the substrate using a Gorman-Rupp water pump with reinforced neoprene intake and discharge hoses during daylight at stations 4 and 7 in April, June, and November 1978. The stream of water from the pump was directed into a conical hoop net with 80-micron mesh size netting, suspended in the water column. Fish eggs and larvae contained in the volume of water strained in 15 minutes (3.41 cubic meters) constituted a single sample, and four samples were collected at each station. Fish egg and larvae samples were stained with Lugol's iodine and rose bengal solutions and preserved in 4-percent buffered formalin. Fish eggs and larvae were removed from the samples and identified and enumerated under magnification using standard freshwater identification keys and other relevant literature.

2.5.2.5 Hoop Net. Zooplankton samples (Section 2.2) netted during daylight at stations 1 through 10 also were examined for fish eggs and larvae during each sampling month. Fish eggs and larvae were removed from each sample and identified and enumerated.

2.5.2.6 Food Habits. Food habits of 50 individuals (25 juveniles and 25 adults) of each selected species (alewife, yellow perch, spottail shiner, carp, gizzard shad, and all salmonids [salmon and trout combined]) were determined from fish collected by gill net and beach seine. Smaller fish were injected with buffered formalin to halt gastric digestion and preserved whole; only the stomachs of larger fish were preserved.

Stomach contents were teased out into a petri dish and the food items identified to the lowest practical taxon and enumerated. Quantitative data were used to determine each taxon's frequency of occurrence and percentage with respect to total number of organisms counted. Qualitative estimates of stomach fullness

579 263

and degree of digestion were also recorded for each fish examined. To more accurately represent each food item's importance, percent estimated importance (Importance Index) was determined by multiplying the individual percentage volume of each food item by the percent fullness of each individual stomach; thus, a food organism representing 60 percent of the volume in a stomach would be rated at 42 percent in a 70 percent full stomach (i.e., 0.60 x 0.70 = 0.420). The percent estimated importance values of all food items encountered in each species were added together, and each food item's importance was expressed as a percentage of the total food values in all stomachs.

2.5.2.7 Data Analysis. Catch per unit effort (C/f) was the principal criterion used to determine spatial and temporal distribution patterns of fish and was defined for gill net catches as the number of fish collected in a single overnight gill net set and for beach seines as the number of fish collected per seine haul. Catch per unit effort was tabulated for each species and an average value calculated for various time periods (i.e., month, year, study to date) and for each sampling location.

Condition factors (Lagler 1956) were calculated for individual fish using the equation

$$K = \frac{W \times 10^5}{L^3}$$

where

K = condition factor

W = weight in grams

L = length in millimeters

Additionally, monthly and yearly averages were calculated for each species.

Densities (number per cubic meter) of each ichthyoplankton taxon collected by zooplankton hoop net and epibenthic pump were calculated for each sample using the following equation:

$$\text{Density of eggs or larvae of taxa} = \frac{x}{f} \cdot \frac{s}{v}$$

579 264

where

x = number of eggs or larvae of taxa within aliquot analyzed

f = total volume of aliquot

s = volume of sample

v = total volume of lake water sampled

Mean densities of eggs and/or larvae of individual taxa were calculated for each set of four replicate samples collected at each station using the following equation:

$$\text{Mean density of eggs or larvae of taxa at a specific location} = \frac{(d_1 + d_2 + d_3 \ldots d_x)}{r_x}$$

where

d = density of eggs or larvae of taxa in an individual replicate

r = number of replicates

2.5.3 RESULTS AND DISCUSSION

2.5.3.1 Species Composition. Twelve species were identified from the 3353 fish collected in the Bailly Study Area during 1978 (Table 2.5-1). In general, the species composition observed in 1978 samples was similar to the composition observed in 1977 catches; however, some differences were noted. Although carp, white sucker and shorthead redhorse were collected in low numbers during 1977, these species were not taken during 1978. Conversely, rainbow smelt and channel catfish were collected during 1978 but not during 1977.

Alewife was the dominant fish (72.1%) collected by gill net at Lake Michigan stations during 1978, and spottail shiner (93.3%) comprised the majority of the beach seine catch. Other abundant species taken by these gear included lake trout, yellow perch, coho salmon, and brown trout. Black bullhead was the only fish species collected in Pond B during the 1978 study period.

Table 2.5-1

Common and Scientific Names of Fish Collected in Bailly Study Area, 1974-1978

Name* Common	Name* Scientific	May 1974-Feb 1975	Mar 1975-Feb 1976	Mar 1976-Feb 1977	Mar 1977-Feb 1978	Mar 1978-Feb 1979
Herrings	Clupeidae					
Alewife	Alosa pseudoharengus	X	X	X	X	X
Gizzard shad	Dorosoma cepedianum	X	-	X	X	X
Trouts and Salmon	Salmonidae					
Brown trout	Salmo trutta	X	X	X	X	X
Steelhead trout	S. gairdneri	X	X	-	X	X
Lake trout	Salvelinus namaycush	X	X	X	X	X
Chinook salmon	Onchorhyncus tshawytscha	X	X	X	X	X
Coho salmon	O. kisutch	X	X	X	X	X
Lake whitefish	Coregonus clupeiformis	X	-	-	-	-
Smelts	Osmeridae					
Rainbow smelt	Osmerus mordax	X	-	X	-	X
Mudminnows	Umbridae					
Central mudminnow**	Umbra limi	X	-	-	-	-
Minnows and Carps	Cyprinidae					
Emerald shiner	Notropis antherinoides	X	X	-	-	-
Spottail shiner	N. hudsonius	X	X	X	X	X
Carp	Cyprinus carpio	X	X	X	X	-
Suckers	Catostomidae					
White sucker	Catostomus commersoni	-	X	-	X	-
Shorthead redhorse	Moxostoma macrolepidotum	-	-	-	X	-
Freshwater catfish	Ictaluridae					
Channel catfish	Ictalurus punctatus	-	X	-	-	X
Black bullhead	I. melas	X	X	X	X	X
Sunfish	Centrarchidae					
Bluegill***	Lepomis macrochirus	-	X	X	-	-
Green sunfish**	L. cyanellus	X	-	-	-	-
Rock bass	Ambloplites rupestris	-	X	-	-	-
Perch	Percidae					
Yellow perch	Perca flavescens	X	X	X	X	X

*American Fishery Society. 1970. Spec. Pub. No. 6, 3rd ed.

**Taken only in nearshore ponds.

***Taken in nearshore pond and in Lake Michigan.

2.5.3.2 Gill Net Sampling. Gill net sampling accounted for 799 of the 3353 fish collected during 1978 in the study area (Table 2.5-2). Alewife was the dominant species collected, followed by lake trout, yellow perch, coho salmon, and brown trout. During 1977, yellow perch was the dominant species collected, followed in abundance by chinook salmon, alewife and lake trout. This apparent shift in species composition was due primarily to larger catches of alewives and lake trout during 1978 than during 1977. Typically, apparent shifts in species composition during previous study years (1974-1977) were related to fluctuations in alewife and salmonid populations. State and federal fish stocking programs largely govern the size of salmonid populations in the study area, while alewife population levels may still be adjusting, following their relatively recent (1949) invasion of Lake Michigan and the salmonid introductions designed to curb their population levels

Table 2.5-2

Number and Percent Composition of Fish Collected by Gill Net, Bailly Study Area, 1974-1978

	1974		1975		1976		1977		1978	
Common Name	No.	%	No.	%	No.	%	No.	%	No.	%
Alewife	68	17.9	285	54.8	123	66.8	18	15.0	576	72.1
Brown trout	11	2.9	9	1.7	7	3.8	2	1.7	23	2.9
Carp	4	1.1	4	0.8	3	1.6	5	4.2	–	–
Channel catfish	–	–	2	0.4	–	–	–	–	1	0.1
Chinook salmon	14	3.7	2	0.4	2	1.1	29	24.2	14	1.8
Coho salmon	2	0.5	47	9.0	1	0.5	8	6.7	23	2.9
Gizzard shad	1	0.3	–	–	1	0.5	1	0.8	2	0.2
Lake trout	134	35.3	53	10.2	5	2.7	16	13.3	110	13.8
Lake whitefish	1	0.3	–	–	–	–	–	–	–	–
Rainbow smelt	1	<0.1	–	–	1	0.5	–	–	6	0.7
Rock bass	–	–	1	0.2	–	–	–	–	–	–
Shorthead redhorse	–	–	–	–	–	–	2	1.7	–	–
Steelhead trout	37	9.7	3	0.6	–	–	1	0.8	8	1.0
White sucker	–	–	2	0.4	–	–	1	0.8	–	–
Yellow perch	108	28.4	112	21.5	41	22.3	37	30.8	36	4.5
Total	381	–	520	–	184	–	120	–	799	–

The total gill net catch (all species combined) was higher during 1978 than during previous years (1974-1977) (Table 2.5-3). Gill net catches were highest in April and lowest in June. Higher spring gill net catches were also noted during 1975, 1976, and 1977, and probably were a result of inshore spawning activities of some species (yellow perch, alewife) and nearshore movements of salmon and trout.

Table 2.5-3

Spatial and Temporal Distribution of Total Catch (All Species Combined) Collected by Gill Net, Bailly Study Area, 1974-1978

Date	Station 4 Catch	Station 7 Catch	Total Catch	Total Samples	C/f
1974					
May 26	9	46	55	2	27.5
Jun	15	7	22	2	11.0
Jul	79	34	113	2	56.5
Aug	3	6	9	2	4.5
Oct 4	24	48	72	2	36.0
Oct 24	41	20	61	2	30.5
Nov 18	37	12	49	2	24.5
Total fish	208	173	381		
Total samples	7	7		14	
C/f	29.7	24.7			27.2
1975					
Mar	*	*	*	0	*
Apr 17	150	134	284	2	142.0
May 22	13	16	29	2	14.5
Jun 18	35	19	54	2	27.0
Aug 8	26	30	56	2	28.0
Nov 3	59	38	97	2	48.5
Total fish	283	237	520		
Total samples	5	5		10	
C/f	56.6	47.4			52.0
1976					
Apr 7	82	42	124	2	62.0
Jun 6	5	9	14	2	7.0
Aug 12	9	28	37	2	18.5
Nov 19	7	2	9	2	4.5
Total fish	103	81	184		
Total samples	4	4		8	
C/f	25.8	20.3			23.0
1977					
Apr 14	35	33	68	2	34.0
Jun 11	7	4	11	2	5.5
Aug 26	21	17	38	2	19.0
Nov 23	1	2	3	2	1.5
Total fish	64	56	120		
Total samples	4	4		8	
C/f	16.0	14.0			15.0
1978					
Apr 23	308	255	563	2	281.5
Jun 17	43	26	69	2	34.5
Aug 21	67	12	79	2	39.5
Nov 19	45	43	88	2	44.0
Total fish	463	336	799		
Total samples	4	4		8	
C/f	115.8	84.0			99.9
1974-1978					
Total fish	1121	883	2004		
Total samples	24	24		48	
C/f	46.7	36.8			41.8

*No sample.

Spatial distribution during 1978 (Table 2.5-3) was characterized by higher catch-per-unit-effort (115.8) at the warm-water station (Station 4) than at the down lake control station, Station 7 (84.0). Previous years data and 1974-1978 catch-per-unit-effort (C/f) values were also higher at Station 4, indicating that fish prefer this area over the area at Station 7.

2.5.3.3 Beach Seine Sampling. Beach seine sampling during 1978 produced 2532 fish comprising five species (Table 2.5-4). Spottail shiners and alewives were the dominant species collected; one species, rainbow smelt, was previously unreported in beach seine samples. Numbers of fish collected by beach seine during 1978 were considerably higher than the numbers collected during 1977 but lower than total catches for 1974 and 1976. Previously, species composition, although not strictly comparable because of reduced sampling frequency in 1975, had shifted from a shore-zone community dominated by alewife and spottail shiner during 1974, 1975 and 1976 to a community dominated primarily by spottail shiner and yellow perch during 1977. The return to a spottail shiner and alewife-dominated community during 1978 was due primarily to substantial increases in the catch for these two species and was probably not related to Bailly Generating Station operation or Bailly Nuclear-1 construction activities.

Table 2.5-4

Number and Percent Composition of Fish Collected by Beach Seine, Bailly Study Area, 1974-1978

	1974		1975		1976		1977		1978	
	No.	%	No.	%	No.	%	No.	%	No.	%
Alewife	1762	84.0	1232	32.2	2033	51.2	1	0.4	140	5.5
Bluegill	–	–	1	0.1	6	0.2	–	–	–	–
Brown trout	12	0.6	–	–	–	–	–	–	–	–
Chinook salmon	10	0.5	5	0.1	–	–	3	1.2	7	0.3
Emerald shiner	1	<0.1	3	0.1	–	–	–	–	–	–
Gizzard shad	4	0.2	–	–	–	–	–	–	–	–
Spottail shiner	282	13.5	2563	67.0	1928	48.6	220	89.8	2361	93.3
Steelhead trout	1	<0.1	–	–	–	–	–	–	–	–
White Sucker	–	–	–	–	–	–	1	0.4	–	–
Yellow perch	19	0.9	21	0.5	–	–	20	8.2	16	0.6
Rainbow smelt	–	–	–	–	–	–	–	–	8	0.3
Total	2091	–	3825	–	3967	–	245	–	2532	–

579 269

Beach seine catches were highest during June (775.3) and were dominated by subadult fish. Highest beach seine catches during previous years (1974-1976) occurred during August and were dominated by young-of-the-year fish. Zero or extremely low seine catches have occurred during April sampling since 1975; this trend continued during April 1978.

Spatial distribution of total catch (all species combined) during 1978 was characterized by high catches at Station 24 (experimental or warm-water station) and low catches at Station 23 (control station) (Table 2.5-5). During most of the previous years (1974-1977), yearly catch values were usually higher at Station 24. However, higher catches usually varied by sample date from Station 24 to 25, indicating that fish may prefer the area of one beach seine station over the other during certain times of the year.

2.5.3.4 Electrofishing. Electrofishing in Pond B during 1978 produced 22 black bullhead (Table 2.5-6), the species that dominated each of the previous years collections except during 1974, when qualitative dip net samples documented the presence of central mudminnow and green sunfish. The 22 black bullhead collected during 1978 ranged from 86 to 125 millimeters in total length, and had a mean condition factor of K = 1.25 (Table 2.5-16, subsection 2.5.4.1.4). Previous data have shown that the black bullhead is common and in apparent good health in this pond (TI 1977).

2.5.3.5 Ichthyoplankton. Alewife and cyprinid (probably carp) eggs and alewife and percid (yellow perch or johnny darter) larvae were the only fish eggs and larvae identified from Bailly area ichthyoplankton net samples collected during 1978 (Tables 2.5-7 through 2.5-10). Alewife eggs and larvae have been the dominant ichthyoplankton collected during previous years, but this was the first year that Cyprinidae eggs have been identified from Bailly area ichthyoplankton net samples. Alewife egg densities in 1978, an indication of alewife spawning in the Bailly area, were slightly higher than 1974, 1975, and 1977 concentrations but were lower than densities found in 1976 samples (Table 2.5-7). Alewife eggs were collected only in June 1978, a month when peak egg densities were collected during previous years; concentrations were higher at stations 1, 2, and 7 than at other sampling locations.

Table 2.5-5

Spatial and Temporal Distribution of Total Catch (All Species Combined) Collected by Beach Seine, Bailly Study Area, 1974-1978

Date	Station 23 Catch	Station 24 Catch	Station 25 Catch	Total Catch	Total Samples	C/f
1974						
May 24	8	82	0	90	3	30.0
Jun 28	0	14	0	14	3	4.7
Jul	2	77	461	540	3	180.0
Aug 26	1	738	102	841	3	280.3
Sep 21	0	0	10	10	3	3.3
Nov 7	233	20	0	253	3	84.3
Nov 7	329	14	0	343	3	114.3
Total fish	573	945	573	2091		
Total samples	7	7	7		21	
C/f	81.9	135.0	81.9			99.6
1975						
Mar 27	0	0	0	0	3	0.0
Apr 17	1	0	0	1	3	0.3
May 15	102	0	50	152	3	50.7
Jun 13	214	595	12	821	3	273.7
Aug 8	497	991	1363	2851	3	950.3
Nov 2	0	0	0	0	3	0.0
Total fish	814	1586	1425	3825		
Total samples	6	6	6		18	
C/f	135.7	264.3	237.5			212.5
1976						
Apr 10	1	0	0	1	3	0.3
Jun 8	7	1596	31	1634	3	544.7
Aug 11	0	638	1698	2331	3	77[illegible].0
Nov 16	0	1	0	1	3	[illegible]
Total fish	8	2235	1724	3967		
Total samples	4	4	4		12	
C/f	2.0	558.8	431.0			330.6
1977						
Apr	0	0	0	0	3	0.0
Jun 10	2	19	2	23	3	7.7
Aug 26	8	39	172	219	3	73.0
Nov 20	0	1	2	3	3	1.0
Total fish	10	59	176	245		
Total samples	4	4	4		12	
C/f	2.5	14.8	44.0			20.4
1978						
Apr 18	0	0	0	0	3	0.0
Jun 16	32	2276	18	2326	3	775.3
Aug 18	8	47	87	142	3	47.3
Nov 18	0	64	0	64	3	21.3
Total fish	40	2387	105	2532		
Total samples	4	4	4		12	
C/f	10.0	596.8	26.3			211.0
1974-1978						
Total fish	1445	7212	4003	12660		
Total samples	25	25	25		75	
C/f	57.8	288.5	160.1			168.8

579 271

Table 2.5-6

Number and Percent Composition of Fish Collected by Electrofishing, Bailly Study Area, 1974-1978

	1974*		1975		1976		1977		1978	
Common Name	No.	%	No.	%	No.	%	No.	%	No.	%
Black bullhead	1	3.6	10	90.9	42	100	2	100	22	100
Bluegill	-	-	1	0.1	-	-	-	-	-	-
Central mudminnow	1	3.6	-	-	-	-	-	-	-	-
Green sunfish	26	92.9	-	-	-	-	-	-	-	-
Total	28		11		42		2		22	

*Qualitative dip net samples taken in September; electrofishing produced no fish.

Alewife larvae were collected only during June 1978; concentrations were highest at stations 1, 2, and 10 (Table 2.5-8). Alewife larval densities were lower in 1978 than during previous years and although densities were somewhat higher at several sampling locations, actual numbers indicate the similar usage of these sampling locations as a nursery area. Based on the presented data (1974-1978), no consistent yearly differences in egg or larval concentrations were evident between sampling stations. No eggs or larvae were collected in nearshore ponds.

The effect of the warm-water discharge on the nearshore spawning and nursery areas in the Bailly vicinity was further determined by sampling fish eggs and larvae with an epibenthic pump during April, June, and November at a warm-water station (Station 4) and a control station (Station 7). No fish eggs or larvae were collected with the epibenthic pump during 1978 (Tables 2.5-9 and 2.5-10). Based on the presented data (1974-1978), no consistent yearly differences in egg and larvae concentrations were shown between the two sampling locations.

Incidental ichthyoplankton observations from Ponar dredge samples are shown in Table 2.5-11. Although all samples did not yield eggs, those which did, yielded from 19 to approximately 1,435 eggs per square meter. The vertically hauled zooplankton net yielded fewer eggs, indicating net samples may underestimate egg density in the Bailly area of Lake Michigan.

Table 2.5-7

Mean Densities* of Fish Eggs Collected by Vertical Net Tows, Bailly Study Area, 1974-1978

		1974							1975							1976				1977				1978		
Station	Taxon	May	Jun	Jul	Aug	Sep	Oct	Nov	Feb	Mar	Apr	May	Jun	Aug	Nov	Apr	Jun	Aug	Nov	Apr	Jun	Aug	Nov	Apr	Jun	Aug	Nov
1	Alewife	-	-		-	-	-	-	-	-	-	-	2.23	-	-	-	2.80	-	-	-	0.13	-	-	-	12.22	-	-
2	Alewife	-	-	-	-	-	-	-	-	-	-	-	0.28	-	-	-	0.30	-	-	-	-	-	-	-	2.89	-	-
	Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-
3	Alewife	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	5.00	-	-	-	1.57	-	-	-	0.55	-	-
4	Alewife	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	381.00	-	-	-	0.14	-	-	-	0.21	-	-
	Unidentified	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gizzard shad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.70	-	-	-	-	-	-	-	-	-
5	Alewife	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.60	-	-	-	0.11	-	-	-	1.73	-	-
	Gizzard shad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-	-	-	-	-	-
	Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-
6	Alewife	-	-	0.01	-	-	-	-	-	-	-	-	0.17	-	-	-	0.40	-	-	-	0.02	-	-	-	0.48	-	-
7	Alewife	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.10	-	-	-	-	-	-	-	7.50	-	-
	Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-
8	Alewife	-	0.27	-	-	-	-	-	-	-	-	-	0.14	-	-	-	0.20	-	-	-	0.11	-	-	-	0.92	-	-
	Gizzard shad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-
9	Alewife	-	-	-	-	-	-	-	-	-	-	-	0.25	-	-	-	0.90	-	-	-	1.80	-	-	-	1.49	-	-
	Smelt	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	Alewife	-	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-	4.50	-	-	-	3.12	-	-	-	1.50	-	-
	Unidentified	0.10	-	-	-	-	-	-	-	-	-	-	-	-	0.51	-	-	-	-	-	-	-	-	-	-	-	-
	Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.17	-	-

*Mean number per cubic meter.

POOR ORIGINAL

1579 273

Table 2.5-8

Mean Densities* of Fish Larvae Collected by Vertical Net Tows, Bailly Study Area, 1974-1978

		1974							1975							1976				1977				1978			
Station	Taxon	May	Jun	Jul	Aug	Sep	Oct	Nov	Feb	Mar	Apr	May	Jun	Aug	Nov	Apr	Jun	Aug	Nov	Apr	Jun	Aug	Nov	Apr	Jun	Aug	Nov
1	Alewife	-	0.04	0.19	-	-	-	-	-	-	-	-	0.56	-	-	-	9.80	-	-	-	0.21	-	-	-	0.07	-	-
	Darter sp.	-	-	-	-	-	-	-	-	-	0.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Alewife	-	-	0.01	-	-	-	-	-	-	-	-	0.70	-	-	-	-	-	-	-	0.18	-	-	-	0.18	-	-
3	Alewife	0.02	0.09	0.02	-	-	-	-	-	-	-	-	1.34	-	-	-	-	-	-	-	0.06	-	-	-	0.04	-	-
4	Alewife	-	0.04	0.15	-	-	-	-	-	-	-	-	-	-	-	-	9.00	0.07	-	-	0.11	-	-	-	-	-	-
5	Alewife	-	0.14	0.01	-	-	-	-	-	-	-	-	1.53	-	-	-	-	0.07	-	-	0.10	-	-	-	0.04	-	-
	Unidentified	-	-	-	-	-	-	-	-	-	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Percid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-	0.04	-	-
6	Alewife	-	0.04	-	-	-	-	-	-	-	-	-	1.09	-	-	-	0.01	-	-	-	0.10	-	-	-	-	-	-
7	Alewife	-	0.07	0.19	-	-	-	-	-	-	-	-	-	-	-	-	2.20	-	-	-	0.07	-	-	-	-	-	-
8	Alewife	-	0.01	0.03	-	-	-	-	-	-	-	-	0.42	-	-	-	0.20	0.07	-	-	0.18	-	-	-	0.04	-	-
	Smelt	-	-	-	-	-	-	-	-	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Alewife	-	0.07	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	-	0.02	-	-
	Deep-water sculpin	-	-	-	-	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	Alewife	-	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-	0.40	-	-	-	-	-	-	-	0.08	-	-
	Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.12	-	-	-	-	-	-

*Mean number per cubic meter.

POOR ORIGINAL

579 274

Table 2.5-9

Mean Densities* of Fish Eggs Collected by Benthic Pump, Bailly Study Area, 1974-1978

Station	Taxon	1974				1975					1976						1978		
		May**	Jun	Jul	Nov	Apr	May	Jun	Jul	Nov	Apr	Jun	Nov	Apr	Jun	Nov	Apr	Jun	Nov
4	Alewife	0.31	-	-	-	-	-	-	0.51	-	-	-	-	-	0.29	-	-	-	-
7	Alewife	0.14	-	-	-	-	-	-	4.25	-	-	0.90	-	-	0.07	-	-	-	-
	Unidentified	-	-	-	-	-	-	-	11.22	-	-	-	-	-	-	-	-	-	-
10	Alewife	-	-	-	-	-	-	27.27	-	-	-	18.50	-	-	-	-	-	-	-
	Unidentified	-	-	-	-	-	2.00	0.76	-	-	-	-	-	-	-	-	-	-	-

Note: see footnotes below

Table 2.5-10

Mean Densities* of Fish Larvae Collected by Benthic Pump, Bailly Study Area, 1974-1978

Station	Taxon	1974				1975					1976			1977			1978		
		May**	Jun	Jul	Nov	Apr	May	Jun	Jul	Nov	Apr	Jun	Nov	Apr	Jun	Nov	Apr	Jun	Nov
4	Alewife	0.01	-	-	-	-	-	0.76	-	-	-	-	-	-	-	-	-	-	-
	Unidentified	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Alewife	-	-	-	-	-	-	1.78	0.25	-	-	-	-	-	0.22	-	-	-	-
	Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-
10	No catch																		

*Mean number per cubic meter.

**Data collected with 0.5-meter (1.6-foot) epibenthic sled having net with 333-micron mesh aperture. Station 10 not sampled with this gear.

***Epibenthic pump replaced by hoop net at Station 10 during 1977.

579 275

Table 2.5-11

Incidental Ichthyoplankton Observations from Ponar Grab Samples

Station	Species	Life Stage	Number	Number/m^2
1B	Alewife	Eggs	6	115
2A	Alewife	Eggs	≈75	≈1,435
2B	Alewife	Eggs	≈75	≈1,435
3A	Alewife	Eggs	8	153
3B	Alewife	Eggs	≈50	≈957
5A	Alewife	Eggs	≈40	≈765
5B	Alewife	Eggs	≈25-30	≈478-574
6B	Alewife	Eggs	1	19
7A	Alewife	Eggs	2	38
7B	Alewife	Eggs	2	38
8A	Alewife	Eggs	10	191
8B	Alewife	Eggs	≈25	≈478
9A	Alewife	Eggs	1	19
9B	Alewife	Eggs	6	115
10A	Alewife	Eggs	≈60	≈1,148
	Cyprinidae	Eggs	1	19
10B	Alewife	Eggs	≈25	≈478
	Cyprinidae	Eggs	9	172

2.5.4 SPECIES DISCUSSION. The following species discussion addresses fish community, spatial and temporal distribution, reproduction in the study area, and condition and external parasitism for each species collected during 1978. Food habits will also be discussed for selected species (alewife, carp, gizzard shad, salmonids [salmon and trout], spottail shiner, and yellow perch).

2.5.4.1 Alewife.

2.5.4.1.1 Introduction. The alewife is a small exotic fish that has become established in all five of the Laurentian Great Lakes (Scott and Crossman 1973). Its invasion of Lake Michigan was first detected in May 1949 when a single adult was taken in a gill net set off South Manitou Island (Miller 1957). Since that time, it has become the most abundant and widely distributed species in the lake, occupying all areas of the lake and its tributaries, estuaries, and bays during different seasons of the year (Smith 1968). The alewife has a strong competitive advantage over other planktivorous species because of its efficient filter-feeding behavior and its characteristic of forming dense schools (Smith

1968). Because dense schools of alewives occupy different portions of the lake during different seasons of the year, they can influence all other fish species (Smith 1968).

2.5.4.1.2 Spatial and Temporal Distribution. Gill net catches of alewife were highest during April and lowest during August and November 1978 (Table 2.5-2). Gill net catches of alewife in April and June of 1978 were higher at Station 4 (warm-water station) than at Station 7 (control or unaffected station). Gill net catches during previous years showed no consistent yearly preference for area (station), and overall catch rates (1974-1978) for the two gill net stations were similar (23.5 = Station 4 versus 20.7 = Station 7). Alewife catches were much higher during 1978 than in previous years, and a temporal (time-related) pattern of higher alewife catches during spring than during summer and fall was evident in the 1978 catch data as in each of the previous years. Mean lengths and weights of alewife (Table 2.5-12) were similar for fish collected at the two gill net stations, when numbers permitted comparison (April, June); all fish collected were adults. Several authors (Norden 1968, Wells 1968, and Brown 1972) reported that alewife overwinter in deep water and initiate shoreward spawning migrations led by larger fish during March, with peak abundance in nearshore areas occurring in late April and May. After spawning, alewife gradually move back to the deeper water.

Beach seine catches of alewife were higher during 1978 than the previous year (1977) but much lower than observed during 1974-1976 (Table 2.5-13). Alewife catches were similar during 1978 at Station 24 (warm-water station), and control Station 25. Overall catch records (1974-1978) show that greater numbers of alewife (usually young-of-the-year fish) were collected at Station 25 (C/f = 103.8) and beach seine catches decreased in a westward direction to a low at Station 23 (C/f = 42.3).

2.5.4.1.3 Food Habits. Adult alewife collected in the Bailly vicinity during 1978 fed on a variety of food organisms (Table 2.5-14). Zooplankton was found in a high percentage of the stomachs containing food items, indicating that alewife probably fed primarily in open water. Bosminidae, a small cladoceran, and unidentifiable copepods, were the most important food items by frequency of occurrence and percent by number. Based on the importance index (subsection 2.5.2.6), unidentifiable zooplankton was the most important food item followed by Bosminidae and unidentifiable copepods.

Alewife in previous years (1974-1976) also fed primarily on zooplankton (TI 1975, 1976a, 1977, 1978a); however, Webb and McComish (1974) and Rhodes et al (1974) reported that fish eggs and larval alewife were important food items of Lake Michigan alewife during late summer and early fall.

Juvenile alewife fed primarily on zooplankton, primarily cladocerans and copepods (Table 2.5-15).

Table 2.5-12

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Alewives Collected by Gill Net, Bailly Study Area, 1974-1978

Date	Station 4			Station 7			Total Catch	Total Samples	C/f
	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE			
1974									
May 26	4	200.5 ± 12.9	53.0 ± 11.4	44	204.3 ± 9.9	63.5 ± 9.7	48	2	24.0
Jun	7	192.7 ± 31.9	75.9 ± 58.6	4	189.6 ± 31.5	37.0 ± 11.7	11	2	5.5
Jul	6	162.7 ± 66.9	46.5 ± 15.2	2	207.5 ± 10.6	40.0 ± 4.2	8	2	4.0
Aug	0	-	-	0	-	-	0	2	0.0
Oct 4	1	190.0 ± 0.0	61.0 ± 0.0	0	-	-	1	2	0.5
Oct 24	0	-	-	0	-	-	0	2	0.0
Nov 8	0	-	-	0	-	-	0	2	0.0
Total fish	18			50			68		
Total samples	7			7				14	
C/f	2.6			7.14					4.9
1975									
Mar	*			*			*	0	*
Apr 17	117	202.8 ± 10.0	66.3 ± 8.2	116	202.2 ± 7.5	67.9 ± 4.4	233	2	116.5
May 22	9	203.0 ± 11.9	63.7 ± 13.0	14	207.9 ± 14.8	65.1 ± 13.0	23	2	11.5
Jun 18	11	202.2 ± 19.0	53.6 ± 12.4	6	194.6 ± 14.3	46.2 ± 8.6	17	2	8.5
Aug 8	6	196.1 ± 10.3	51.0 ± 12.3	3	180.0 ± 30.0	39.0 ± 21.9	9	2	4.5
Nov 3	3	203.0 ± 3.0	62.0 ± 9.2	0	0	0	3	2	1.5
Total fish	146			139			285		
Total samples	5			5				10	
C/f	29.2			27.8					28.5
1976									
Apr 7	76	202.[illegible] ± 1.0	64.0 ± 1.2	37	205.1 ± 1.2	68.9 ± 1.0	113	2	56.5
Jun 6	2	207.5 ± 2.5	55.5 ± 4.5	8	194.0 ± 8.8	52.3 ± 6.9	10	2	5.0
Aug 12	0	-	-	0	-	-	0	2	0.0
Nov 19	0	-	-	0	-	-	0	2	0.0
Total fish	78			45			123		
Total samples	4			4				8	
C/f	19.5			11.3					15.4
1977									
Apr 14	9	214.6 ± 7.63	65.3 ± 6.2[illegible]	6	210.8 ± 11.02	56.3 ± 9.63	15	2	7.5
Jun 11	1	208.0 ± 0	57.[illegible] ± 0	2	198.0 ± 9.00	86.5 ± 3.50	3	2	1.5
Aug 26	0	-	-	0	-	-	0	2	0
Nov 23	0	-	-	0	-	-	0	2	0
Total fish	10			8			18		
Total samples	4			4				8	
C/f	2.5			2.0					2.3
1978									
Apr 23	283	203.1 ± 1.01	69.1 ± 0.85	246	203.3 ± 1.09	68.8 ± 0.93	529	2	264.5
Jun 17	30	201.0 ± 2.14	66.2 ± 1.62	16	199.4 ± 3.36	67 6 ± 2.89	46	2	23.0
Aug 21	0	-	-		-	-	0	2	0.0
Nov 19	0	-	-	1	197.0 ± 0.0	6 .0 ± 0.0	1	2	0.5
Total fish	313			263			576		
Total samples	4			4				8	
C/f	78.3			65.8					72.0
1974-1978									
Total fish	565			497			1062		
Total samples	24			24				48	
C/f	23.5			20.7					22.1

*No sample

5?9 278

POOR ORIGINAL

Table 2.5-13

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Alewives Collected by Beach Seine in Bailly Study Area, 1974-1978

Date	Station 23			Station 24			Station 25					
	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE	Total Catch	Total Samples	C/f
1974												
May 24	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 28	0	--	--	2	161.0 ± 12.7	39.00 ± 1.84	0	--	--	2	3	0.7
Jul	0	--	--	8	20.8 ± 1.6	0.1 ± *	461	25.4 ± 2.1	0.1 ± *	469	3	156.3
Aug 26	1	25.0 ± 0.0	0.15 ± 0.00	665	34.2 ± 6.9	0.28 ± 0.27	36	32.2 ± 9.1	0.36 ± 0.53	702	3	[illegible]
Sep 21	0	--	--	0	--	--	0	--	--	0	3	[illegible]
Nov 7	233	57.9 ± 6.9	1.73 ± 0.58	17	46.4 ± 5.4	0.90 ± 0.32	0	--	--	250	3	83.3
Nov 7	326	54.0 ± 8.9	1.46 ± 0.79	13	44.5 ± 7.6	0.82 ± 0.42	0	--	--	339	3	113
Total fish	560			705			497			1762		
Total samples	7			7			7				21	
C/f	80.0			100.7			71.0					83.9
1975												
Mar 27	0	--	--	0	--	--	0	--	--	0	3	0.0
Apr 17	0	--	--	0	--	--	0	--	--	0	3	0.0
May 19	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 13	0	--	--	0	--	--	0	--	--	0	3	0.0
Aug 8	497	22.5 ± 3.3	0.10 ± *	401	29.8 ± 3.3	0.21 ± 0.09	334	50.2 ± 2.2	1.09 ± 0.23	1232	3	410.7
Nov 12	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	497			401			334			1232		
Total samples	6			6			6				18	
C/f	82.8			66.8			55.7					68.4
1976												
Apr 10	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 8	0	--	--	82	81.0 ± 0.8	3.10 ± 0.10	0	--	--	82	3	27.3
Aug 11	0	--	--	259	27.6 ± 0.4	0.16 ± *	1692	26.6 ± 0.5	0.22 ± *	1951	3	650.3
Nov 16	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	0			341			1692			2033		
Total samples	4			4			4				12	
C/f	0.0			85.3			423.0					169.4
1977												
April	0	--	--	0	--	--	0	--	--	0	3	0
Jun 10	0	--	--	0	--	--	0	--	--	0	3	0
Aug 26	0	--	--	0	--	--	0	--	--	0	3	0
Nov 20	0	--	--	1	55 ± 0	1.2 ± 0	0	--	--	1	3	0.3
Total fish	0			1			0			1		
Total samples	4			4			4				12	
C/f	0			0.3			0					0.1
1978												
Apr 23	0	--	--	0	--	--	0	--	--	0	3	0
Jun 16	0	--	--	5	133.8 ± 22.4	22.1 ± 7.83	0	--	--	5	3	1.7
Aug 18	0	--	--	0	--	--	71	45.6 ± 0.89	0.71 ± 0.04	71	3	23.7
Nov 18	0	--	--	64	50.5 ± 1.13	1.23 ± 0.11	0	--	--	0	3	
Total fish	0			69			71			140		
Total samples	4			4			4				12	
C/f	0			17.2			17.8					11.7
1974-1978												
Total fish	1057			1517			2594			5168		
Total samples	25			25			25				75	
C/f	42.3			60.7			103.8					68.9

POOR ORIGINAL

579 279

Table 2.5-14

Food Habits of Adult Alewife

Length Range - 172-212 millimeters
Stomachs Examined - 25
Stomachs Empty - 7

Food Items	Frequency of Occurrence (%)	Percent by Number (%)	Importance Index (%)
Zooplankton	88.8	99.8	90.7
Copepoda (unid.)	61.1	29.3	12.5
Calanoida (adult)	33.3	16.2	8.4
Cyclopoida (adult)	44.4	16.4	8.9
Cladocera (unid.)	33.3	0.7	0.1
Cladocera (Ep)	22.2	0.1	
Bosminidae (adult)	55.5	33.9	15.6
Daphnidae (adult)	22.2	2.7	1.8
Chydoridae (adult)	22.2	0.5	
Zooplankton (unid.)	22.2		43.4
Diptera (adult	5.5	T*	2.0
Chironomidae (larvae)	11.1	T	
Chironomidae (pupae)	5.5	T	
Invertebrate (eggs)	5.5	0.1	0.3
Filamentous algae	11.1		0.2
Plant material (terrestrial)	5.5		0.6
Digested material	44.4		6.2
Sand grains	5.5		

*T = trace.

Table 2.5-15

Food Habits of Juvenile Alewife

Length Range - 43-82 millimeters
Stomachs Examined - 25
Stomachs Empty - 0

Food Item	Frequency of Occurrence (%)	Percent by Number	Importance Index (%)
Cladocera	100.0	64.4	69.6
Daphnidae (adult)	96.0	47.3	59.2
Chydoridae (adult)	96.0	8.2	7.7
Bosminidae (adult)	96.0	8.9	2.7
Copepoda	100.0	35.6	27.3
Calanoida (adult)	92.0	13.5	10.6
Cyclopoida (adult)	80.0	4.5	1.5
Harpacticoida (adult)	12.0		
Copepoda (unid.)	100.0	17.6	15.2
Amphipoda remains	4.0		
Chironomidae remains	4.0		
Plant material (terrestrial)	4.0		
Digested material	92.0		3.1
Sand grains	44.0		

The presence of zooplankton in a high percentage of stomachs indicated that juvenile alewife fed in open water while the occurrence of sand grains indicates that juvenile alewife also fed on or near the bottom. Cladocerans, especially Daphnidae, were the most important food item by number and were ranked as the most important food item based on the importance index. Calanoid copepods and unidentifiable copepods were the second most important food item.

2.5.4.1.4 Condition and Parasitism. Condition factors for alewife collected during 1978 were higher than those collected during 1974 and 1977, and only slightly lower than those observed during 1975 and 1976 (Table 2.5-16). Yearly condition factors were similar to or fell within the ranges reported by Liston and Tack (1973). No obvious external parasites were noted on alewife collected during 1978. Parasites that have been known to infest alewife have been previously discussed by Texas Instruments (1975).

2.5.4.2 Yellow Perch

2.5.4.2.1 Introduction. The yellow perch, a percid, is commonly found in all of the Great Lakes (Hubbs and Lagler 1958). In Lake Michigan, it inhabits the shallow and intermediate depths and is near bottom during most of the year and at mid-levels in summer (Wells 1968).

2.5.4.2.2 Spatial and Temporal Distribution. Yellow perch were collected in greater abundance at Station 4 (warm-water station) than at Station 7 (control station) and were most abundant in the Bailly area in August (Table 2.5-17). Year-to-date (1974-1978) catch rates (C/f) were higher at Station 4; 1976 was the only year with higher catches at Station 7 than at Station 4, indicating that yellow perch may prefer the area of one gill net station over the other. High catches in August also were observed during 1978, a year when sampling frequency corresponded to that in 1976 and 1977. Thirty-four of the thirty-six yellow perch collected were adult fish. The other two fish were subadults. When comparable data were available, no discernible difference between lengths and weights of yellow perch collected at the two sampling locations was noted (Table 2.5-17).

Table 2.5-16

Condition Factors Calculated by Month of Fish Collected in NIPSCo Bailly Study Area, April-November 1977, Plus Values Obtained from Relevant Literature

Species	Apr	Jun	Aug	Nov	$\bar{x}$ 1978	$\bar{x}$ 1977	$\bar{x}$ 1976	$\bar{x}$ 1975	$\bar{x}$ 1974	Literature Source
Alewife	0.821	0.812	0.669	0.796	0.783	0.690	0.834	0.800	0.708	0.700-0.861 (Liston and Tack 1973)
Gizzard shad	—	—	1.111	1.280	1.195	1.519	1.058	—	1.113	1.2193 (Jude et al 1973)
Chinook salmon	1.201	1.148	1.036	—	1.128	1.002	1.115	1.151	1.171	1.3462 (Jude et al 1973)
Coho salmon	1.150	1.245	—	1.050	1.295	0.884	1.010	0.926	1.085	1.0535 (Jude et al 1973)
Brown trout	1.493	2.035	1.211	1.379	1.408	1.354	1.267	1.336	1.327	1.26 (Carlander 1969) — 1.2621 (Jude et al 1973)
Lake trout	1.221	1.224	0.877	0.967	0.904	0.983	0.932	0.97[illegible]	1.022	0.950-1.151 (Liston and Tack 1973)
Carp	—	—	—	—	—	1.503	1.489	1.349	1.564	1.2[illegible]0 (Carlander 1969)
Spottail shiner	—	0.828	0.882	—	0.845	0.762	0.795	0.870	0.809	0.826-0.941 (Liston and Tack 1973)
Black bullhead	1.241	—	1.345	—	1.255	1.062	1.384	1.213	1.248	1.11-1.66 (Carlander 1969)
Yellow perch	—	1.582	1.016	—	1.092	0.989	1.099	1.063	1.075	1.0485-1.359 (Jude et al 1973)
White sucker	—	—	—	—	—	0.997	—	—	—	
Shorthead redhorse	—	—	—	—	—	1.419	—	—	—	
Steelhead	1.211	1.501	0.895	—	1.162	1.457	[illegible]	0.942	1.115	

POOR ORIGINAL

579 282

Table 2.5-17

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Yellow Perch Collected by Gill Net, Bailly Study Area, 1974-1978

Date	Station 4 Catch	x̄ Length ± SE	x̄ Weight ± SE	Station 7 Catch	x̄ Length ± SE	x̄ Weight ± SE	Total Catch	Total Samples	C/f
1974									
May 26	0	--	--	1	191.0 ± 0.0	68.0 ± 0.0	1	2	0.5
Jun	7	190.7 ± 45.4	112.6 ± 79.5	1	185.0 ± 0.0	64.0 ± 0.0	8	2	4.0
Jul	69	200.3 ± 18.9	93.6 ± 40.5	28	205.5 ± 23.9	99.6 ± 60.2	97	2	48.5
Aug	0	--	--	0	--	--	0	2	0.0
Oct 4	0	--	--	0	--	--	0	2	0.0
Oct 24	0	--	--	0	--	--	0	2	0.0
Nov 8	2	205.8 ± 6.3	97.0 ± 14.8	0	--	--	2	2	1.0
Total fish	78			30			108		
Total samples	7			7				14	
C/f	11.1			4.3					7.7
1975									
Mar	*	--	--	*	--	--	*	*	*
Apr 17	0	--	--	0	--	--	0	2	0.0
May 22	0	--	--	1	195.0 ± 0.0	80.0 ± 0.0	1	2	0.5
Jun 18	21	186.4 ± 10.7	75.4 ± 15.1	12	193.5 ± 5.3	75.6 ± 5.3	33	2	16.5
Aug 8	16	211.0 ± 22.6	98.1 ± 55.4	23	206.8 ± 12.1	92.8 ± 21.1	39	2	19.5
Nov 3	23	201.9 ± 15.6	92.8 ± 21.0	16	209.4 ± 11.7	95.3 ± 17.7	39	2	19.5
Total fish	60			52			112		
Total samples	5			5				10	
C/f	12.0			10.4					11.2
1976									
Apr 7	0	--	--	0	--	--	0	2	0.0
Jun 6	2	215.0 ± 10.0	92.0 ± 18.0	1	201.0 ± 0.0	85.0 ± 0.0	3	2	1.5
Aug 12	8	208.4 ± 4.4	105.4 ± 9.1	27	200.4 ± 1.7	90.5 ± 3.6	35	2	17.5
Nov 19	3	217.3 ± 20.0	116.7 ± 35.5	0	--	--	3	2	1.5
Total fish	13			28			41		
Total samples	4			4				8	
C/f	3.3			7.0					5.1
1977									
Apr 14	2	188.5 ± 2.12	67.0 ± 11.31	0	--	--	2	2	1.0
Jun 11	6	206.0 ± 5.50	96.0 ± 7.00	2	211.5 ± 0.50	58.5 ± 5.50	8	2	4.0
Aug 26	18	212.4 ± 3.71	101.2 ± 6.80	9	211.7 ± 4.65	105.8 ± 6.00	27	2	13.5
Nov 23	0	--	--	0	--	--	0	2	0
Total fish	26			11			37		
Total samples	4			4				8	
C/f	6.5			2.8					4.6
1978									
Apr 23	0	--	--	0	--	--	0	2	0.0
Jun 17	1	197.0 ± 0.0	91.0 ± 0.0	0	--	--	1	2	0.5
Aug 19, 21	35	204.0 ± 5.66	98.2 ± 9.70	0	--	--	35	2	17.5
Nov 19	0	--	--	0	--	--	0	2	0.0
Total fish	36			0			36		
Total samples	4			4				8	
C/f									4.5
1974-1978									
Total catch	213			121			334		
Total samples	24			24				48	
C/f	8.9			5.0					7.0

*No sample.

POOR ORIGINAL

579 283

The first catch of subadult yellow perch by beach seine occurred during June sampling at stations 24 and 25 (Table 2.5-18). Young-of-the-year (47-57 mm) and subadult (73-83 mm) yellow perch were collected by beach seine during August 1978 at stations 24 and 25. Young-of-the-year perch were not collected during 1976 but were collected in similar numbers at these same two stations in August 1974, 1975, and 1977.

2.5.4.2.3 Food Habits. Adult yellow perch examined during 1978 fed exclusively on fish (Table 2.5-19). The primary food during other years was fish although other food categories were encountered (TI 1975, 1976a, 1977, 1978a).

Juvenile yellow perch stomachs examined during 1978 were essentially empty (Table 2.5-20). Only digested material and sand grains were found in the stomachs examined. During previous years, zooplankton was the predominant food item; however, fish were usually a prominent food item in the diet (TI 1975, 1976a, 1978a).

2.5.4.2.4 Condition and Parasitism. The condition factor (1978) for yellow perch collected during 1978 was slightly higher than those of fish collected during 1974, 1975, and 1977 and slightly lower than observed during 1976 (Table 2.5-16). Slight differences in yearly condition factors were probably due to the different lengths, weights, and life stages of perch collected (Tables 2.5-17 and 2.5-18), rather than effects caused by operation of Bailly Generating Station or construction activities for the Bailly Nuclear-1 facility.

No obvious external parasites were noted on yellow perch during 1978. Parasitic infestations of yellow perch have been discussed previously (TI 1975).

2.5.4.3 <u>Spottail Shiner</u>

2.5.4.3.1 Introduction. The spottail shiner is a small cyprinid that belongs to the group of fish collectively referred to as minnows. Spottail shiners inhabit all of the Great Lakes, where they can be found close to the bottom in nearshore water (Hubbs and Lagler 1958; Wells and House 1974). In Lake Michigan, they are most abundant in the southeastern portion of the lake and in Green Bay (unpublished data cited by Wells and House 1974).

Table 2.5-18

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Yellow Perch Collected by Beach Seine, Bailly Study Area, 1974-1978

Date	Station 23			Station 24			Station 25			Total Catch	Total Samples	C/f
	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE			
1974												
May 24	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 28	0	--	--	0	--	--	0	--	--	0	3	0.0
Jul	0	--	--	0	--	--	0	--	--	0	3	0.0
Aug 26	0	--	--	11	48.3 ± 3.3	1.09 ± 0.21	8	48.2 ± 2.8	1.02 ± 0.19	19	3	
Sep 21	0	--	--	0	--	--	0	--	--	0	3	0.0
Nov 7	0	--	--	0	--	--	0	--	--	0	3	0.0
Nov 7	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	0			11			8			19		
Total samples	7			7			7				21	
C/f	0.0			1.6			1.4					0.9
1975												
Mar 27	0	--	--	0	--	--	0	--	--	0	3	0.0
Apr 17	0	--	--	0	--	--	0	--	-	0	3	0.0
May 19	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 13	0	--	--	0	--	--	0	--	--	0	3	0.0
Aug 8	0	--	--	6	23.7 ± 6.4	1.11 ± 0.16	15	48.5 ± 4.9	1.10 ± 0.20	21	3	7.0
Nov 2	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	0			6			15			21		
Total samples	6			6			6				18	
C/f	0.0			1.0			2.5					1.2
1976												
Apr 10	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 8	0	--	--	0	--	--	0	--	--	0	3	0.0
Aug 11	0	--	--	0	--	--	0	--	--	0	3	0.0
Nov 16	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	0			0			0			0		
Total samples	4			4			4				12	
C/f	0.0			0.0			0.0					0.0
1977												
Apr	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 10	0	--	--	0	--	--	0	--	--	0	3	0.0
Aug 26	0	--	--	9	67.0 ± 2.97	2.9 ± 0.36	11	62.1 ± 3.59	2.4 ± 0.33	20	3	6.7
Nov 20	0		--	0	--	--	0	--	--	0	3	0.0
Total fish	0			9			11			20		
Total samples	4			4			4				12	
C/f	0			2.3			2.8					1.7
1978												
Apr 18	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 16	0	--	--	5	80.2 ± 4.79	5.8 ± 1.08	1	86.0 ± 0.0	10.6 ± 0.0	6	3	2.0
Aug 18	0	--	--	1	57.0 ± 0.0	1.9 ± 0.0	9	62.0 ± 5.17	2.6 ± 0.63	10	3	3.3
Nov 18	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	0			6			10			16		
Total samples	4			4			4				12	
C/f	0			1.5			2.5					1.3
1974-1978												
Total fish	0			32			44			76		
Total samples	25			25			25				50	
C/f	0.0			1.3			1.8					1.5

Table 2.5-19

Food Habits of Adult Yellow Perch

Length Range - 149-309 millimeters
Stomachs Examined - 24
Stomachs Empty - 3

Food Items	Frequency of Occurrence (%)	Percent by Number (%)	Importance Index (%)
Fish	95.2	100.0	99.6
Rainbow smelt	4.8	8.3	6.0
Fish (unidentifiable)	42.8	52.7	48.8
Fish (postlarvae)	33.3		29.2
Fish remains	47.6		15.6
Digested material	9.5		0.4

Table 2.5-20

Food Habits of Juvenile Yellow Perch

Length Range - 75-96 millimeters
Stomachs Examined - 5
Stomachs Empty - 4

Food Items	Frequency of Occurrence (%)	Percent by Number (%)	Importance Index (%)
Digested material	100.0		100.0
Sand grains	100.0		

2.5.4.3.2 Spatial and Temporal Distribution. Spottail shiners were collected only by beach seine and were found in greatest abundance at warm-water Station 24 (Table 2.5-19). Most spottail shiners were collected during June. Total catch (C/f) for spottail shiners during 1978 was higher than observed during pervious years (1974-1977). Catches of spottail shiner during most of the previous years (1974, 1975, 1976) and overall catch rates (1974-1978) were higher at the warm-water station (Station 24), indicating that these fish may prefer the warm-water area. Spottails collected during June and August 1978 were primarily subadult or adult fish (Table 2.5-21). During previous years subadult and adult fish were collected during spring or early summer and smaller (young-of-the-year or subadult) fish were collected during late summer. Wells (1968) reported that spottail shiners in southeastern Lake Michigan were confined to depths of 12.8 meters (42 feet) in early spring and fall and to depths of 31.1 to 45.7 meters (102 to 150 feet) in winter. This behavior in the Bailly area would preclude the capture of spottail shiner during these times of year. Wells (1968) also reported that during summer, spottails were usually restricted to depths less than 12.8 meters (42 feet).

2.5.4.3.3 Food Habits. Only 13 of the 25 juvenile spottail shiner stomachs examined during 1978 contained food. The most important food items in stomachs containing food, based on frequency of occurrence, percent by number, and the importance index, were cladocerans and copepods (Table 2.5-22). During previous years, spottail shiners fed on fish eggs, insects, and plant material (TI 1976a, 1977). Scott and Crossman (1973) reported that juvenile spottail shiners feed primarily on zooplankton (cladocerans, copepods, rotifers) and algae, while adult fish feed on zooplankton, insect nymphs and larvae, molluscs, and fish eggs and larvae.

2.5.4.3.4 Condition and Parasitism. The condition of spottail shiner collected during 1978 was similar to the condition of fish collected during previous years (Table 2.5-16).

No obvious external parasites were noted on spottails collected during 1978 but external parasites found during other years (1974-1976) and possible parasites have been previously discussed by TI (1975, 1976a, 1977).

Table 2.5-21

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Spottail Shiners Collected by Beach Seine, Bailly Study Area, 1974-1978

Date	Station 23 Catch	Station 23 x̄ Length ± SE	Station 23 x̄ Weight ± SE	Station 24 Catch	Station 24 x̄ Length ± SE	Station 24 x̄ Weight ± SE	Station 25 Catch	Station 25 x̄ Length ± SE	Station 25 x̄ Weight ± SE	Total Catch	Total Samples	C/f
1974												
May 24	0	--	--	78	54.3 ± 11.8	1.33 ± 1.32	0	--	--	78	3	26.0
Jun 26	0	--	--	1	125 ± 0.0	22.70 ± 0.00	0	--	--	1	3	0.3
Jul	2	18.0 ± 2.8	0.10 ± 0.00	69	20.0 ± 1.6	0.1 ± 0.00	0	--	--	71	3	23.7
Aug 26	0	--	--	62	44.9 ± 13.5	0.89 ± 0.11	58	54.9 ± 23.7	2.26 ± 2.36	120	3	40.0
Sep 21	0	--	--	0	--	--	10	30.1 ± 1.1	0.29 ± 0.07	10	3	3.3
Nov 7	0	--	--	2	31.5 ± 2 1	0.29 ± 0.03	0	--	--	2	3	0.7
Nov 7	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	2			212			68			282		
Total samples	7			7			7				21	
C/f	0.3			30.3			9.7					13.4
1975												
Mar 27	0	--	--	0	--	--	0	--	--	0	3	0.0
Apr 17	0	--	--	0	--	--	0	--	--	0	3	0.0
May 19	101	42.9 ± 11.8	0.89 ± 1.58	0	--	--	50	46.3 ± 9.4	0.99 ± 0.62	151	3	50.3
Jun 13	210	55.1 ± 5.6	1.57 ± 0.60	594	51.4 ± 6.5	1.23 ± 0.40	10	60.8 ± 24.3	2.70 ± 3.20	814	3	271.3
Aug 8	0	--	--	584	32.4 ± 8.7	0.40 ± 0.30	1014	28.0 ± 9.0	0.21 ± 0.30	1598	3	532.7
Nov 2	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	311			1178			1074			2563		
Total samples	6			6			6				18	
C/f	51.8			196.3			179.0					142.4
1976												
Apr 10	1	40.0 ± 0.0	0.50 ± 0.00	0	--	--	0	--	--	1	3	0.3
Jun 8	7	55.6 ± 3.3	1.60 ± 0.3	1508	56.0 ± 0.7	1.40 ± 0.10	31	54.7 ± 1.3	1.50 ± 0.10	1546	3	515.3
Aug 11	0	--	--	379	29.8 ± 0.9	0.45 ± *	1	21.0 ± 0.0	0.16 ± 0.00	380	3	126.7
Nov 16	0	--	--	1	24.0 ± 0	0.08 ± 0	0	--	--	1	3	0.3
Total fish	9			1887			32			1928		
Total samples	4			4			4				12	
C/f	2.3			471.8			8.0					160.7
1977												
Apr	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 10	0	--	--	18	51.5 ± 1.53	1.08 ± 0.12	1	86.0 ± 0.0	6.0 ± 0.0	19	3	6.3
Aug 26	8	33.3 ± 2.6	0.3 ± 0.6	30	40.9 ± 1.75	0.81 ± 0.16	161	27.1 ± 0.56	0.18 ± 0.01	199	3	66.3
Nov 20	0	--	--	0	--	--	2	60.0 ± 21.20	2.29 ± 2.14	2	3	0.7
Total fish	8			48			164			220		
Total samples	4			4			4				12	
C/f	2.0			12.0			41.0					18.3
1978												
Apr 18	0	--	--	0	--	--	0	--	--	0	3	0.0
Jun 16	32	53.3 ± 1.39	1.4 ± 0.11	2260	58.8 ± 0.71	1.7 ± 0.07	16	82.1 ± 4.15	5.6 ± 0.79	2308	3	769.3
Aug 18	0	--	--	46	61.3 ± 1.0	2.1 ± 0.09	7	62.0 ± 5.17	1.7 ± 0.32	53	3	17.7
Nov 18	0	--	--	0	--	--	0	--	--	0	3	0.0
Total fish	32			2306			23			2361		
Total samples	4			4			4				12	
C/f	8.0			576.5			4.0					196.7
1974-1978												
Total fish	362			5631			1361			7354		
Total samples	25			25			25				75	
C/f	14.5			225.2			54.4					98.0

579 288

Table 2.5-22

Food Habits of Juvenile Spottail Shiners

Length Range - 35-65 millimeters
Stomachs Examined - 25
Stomachs Empty - 12

Food Item	Frequency of Occurrence (%)	Percent by Number (%)	Importance Index (%)
Cladocera	76.9	62.8	41.8
Chydoridae (adult)	69.2	16.3	19.4
Daphnidae (adult)	46.1	5.2	4.7
Daphnidae (unid.)	7.7	8.4	6.7
Bosminidae (adult)	15.4	0.7	
Cladocera (unid.)	53.8	32.2	11.0
Copepoda	23.1	36.3	43.0
Calanoida (adult)	23.1	11.5	10.3
Cyclopoida (adult)	7.7	0.2	
Copepoda (adult)	15.4	24.5	32.7
Chironomidae (larvae)	15.4	0.5	8.3
Chironomidae (larval remains)	7.7		2.2
Chironomidae (pupae)	15.4		1.5
Invertebrate eggs	7.7	0.5	
Digested material	7.7		3.2
Sand grains	46.1		

2.5.4.4 Salmonidae (Salmon and Trout)

2.5.4.4.1 Introduction. The salmonid species collected during this investigation included the lake trout, steelhead trout, brown trout, and chinook and coho salmon. Generally, these fish occur throughout the Great Lakes (Scott and Crossman 1973) where they are highly prized and avidly sought by sport fishermen. All of the salmonids collected during this study except lake trout are exotic species which have been introduced into the waters of the Great Lakes; the lake trout populations in the lakes are also maintained at this time by stocking.

All salmonid populations are maintained through stocking programs initiated by various governmental agencies of the lake states and provinces. Within the Indiana waters of Lake Michigan, these fish are stocked solely by the Indiana Department of Natural Resources (DNR). The Indiana DNR began its stocking program in 1967 when the Bureau of Sport Fisheries and Wildlife provided 87,000 lake trout for stocking off the Bethlehem Steel pier within the entrance channel of the Port of Indiana [personal communication, Bob Koch, Indiana DNR (1976];

since that initial planting, the DNR has increased the number of lake trout planted and has broadened its program by stocking trout at several other locations. Lake trout were stocked in response to their rapid decline and near extinction in the 1950s because of predation by sea lamprey followed by complete failure of natural reproduction (Smith 1968). Koch (personal communication) states that, even now, natural reproduction of lake trout is not confirmed anywhere in Lake Michigan. Stocking of lake trout was followed by plantings of steelhead trout in 1968, coho and chinook salmon in 1970, and brown trout in 1971. All of these salmonids have been planted as fingerlings in the east branch of the Little Calumet River where they remain for varying periods of time, depending on the species, before migrating to the lake. This was probably the source of many of the salmonids collected during the Bailly study. Once in the lake, however, they are largely unavailable to capture in nearshore nets since they inhabit the open lake of various depths. When mature, these fish return and congregate in large schools at the mouth of their natal streams before "running" upstream to spawn. At this time, they are vulnerable to capture by net in the nearshore water.

Spawning runs generally occur from early fall to late winter, depending on the strain or race of the stocked fish. Natural reproduction does occur, but only in streams and for some species only on a limited basis (Koch, personal communication). Koch (personal communication) has stated that there has been no evidence that any of these species spawn in the Indiana waters of Lake Michigan, but there has been evidence of limited natural reproduction by coho and chinook salmon and steelhead trout in the east branch of the Little Calumet River and in Trail Creek; additionally, he has stated that there is evidence of successful natural reproduction by brown trout spawning in the east branch.

Since there is only limited natural reproduction of these fish, their abundance in the study area is governed largely by the number of each species stocked by the DNR and their survival and return rates. The latter range from 1 to 6 percent, depending on the species stocked and the year of stocking (Koch, personal communication). However, strict computation of abundance in the study area based on these percentages is often misleading, since faster-maturing male salmonids return before slower-maturing females stocked during the same year; therefore, any fluctuation in yearly relative abundances presented for these

species in the following discussions should be reviewed in the light of these factors. Specific spawning activities for all of the salmonids except lake trout have been deleted, since these species spawn in streams and would not likely be affected by the construction or operation of the Bailly Nuclear-1 plant.

2.5.4.4.2 Spatial and Temporal Distribution. Salmonids were collected in greatest abundance by gill net during November 1978. Salmonids were more abundant at Station 4 (Tables 2.5-23 through 2.5-27). Overall (1974-1978) and yearly salmonid catches were usually higher at Station 4 (warm-water station) or were similar for the two stations, as noted in previous years. High catches of lake trout, the most numerous salmonid in the study area, usually occurred during the cooler fall months. Higher catches of other salmonids usually occurred during spring and summer.

Juvenile chinook salmon were collected by beach seine at Station 24 in June 1974, stations 23 and 25 in June 1975 and 1977, and at stations 24 and 25 in 1978. Mean total lengths of fish collected during 1978 (110.4 mm) were larger than fish collected during previous years (TI 1977, 1978), possibly indicating an earlier stocking date or an improved growth rate.

2.5.4.4.3 Food Habits. Seven lake trout, seven brown trout, five coho salmon, three chinook salmon, and three rainbow trout (steelhead) stomachs were examined to determine the food habits of adult salmonids collected in the Bailly area during 1978. Adult salmonids fed exclusively on fish, some of which were identified as adult alewife (Table 2.5-28). Few juvenile salmonids were collected during 1977; but based on the stomach contents of the seven juvenile chinook salmon examined, insects were the primary food item in the diet (Table 2.5-29). Data presented for fish collected during 1978 were consistent with previously collected data (TI 1976a, 1977, 1978).

2.5.4.4.4 Condition and Parasitism. Mean condition factors for coho salmon and brown trout collected during 1978 were higher than condition factors of fish collected during previous years, while condition factors observed for lake trout were lower than in previous years (Table 2.5-16). Chinook salmon and steelhead condition factors were similar to or slightly lower than condition factors of fish collected during previous years. No external parasites were observed on salmonids collected during 1978.

Table 2.5-23

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Chinook Salmon Collected by Gill Net, Bailly Study Area, 1974-1978

	Station 4			Station 7					
Date	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE	Total Catch	Total Samples	C/f
1974									
May 26	0	-	-	0	-	-	0	2	0.0
Jun	0	-	-	0	-	-	0	2	0.0
Jul	0	-	-	2	955.0 ± 11.3	10457.0 ± 1500.5	2	2	1.0
Aug	3	880.0 ± 50.0	8791 ± 1052.0	6	916.2 ± 51.1	10074.0 ± 3207.0	9	2	4.5
Oct 4	1	900.0 ± 0.0	9194.0 ± 0.0	2	717.0 ± 68.6	4483.0 ± 883.2	3	2	1.5
Oct 24	0	-	-	0	-	-	0	2	0.5
Nov 8	0	-	-	0	-	-	0	2	0.5
Total fish	4			10			14		
Total samples	7			7				14	
C/f	0.6			1.4					1.0
1975									
Mar	*	-	-	*	-	-	*	*	*
Apr 17	0	-	-	0	-	-	0	2	0.0
May 22	0	-	-	0	-	-	0	2	0.0
Jun 18	0	-	-	0	-	-	0	2	0.0
Aug 8	0	-	-	2	869.0 ± 1.4	8207.0 ± 1040.8	2	2	1.0
Nov 3	0	-	-	0	-	-	0	2	0.0
Total fish	0			2			2		
Total samples	5			5				10	
C/f	0.0			0.4					0.2
1976									
Apr 7	2	776.0 ± 1[illegible].0	5603.0 ± 1547.0	0	-	-	2	2	1.0
Jun 6	0	-	-	0	-	-	0	2	0.0
Aug 12	0	-	-	0	-	-	0	2	0.0
Nov 19	0	-	-	0	-	-	0	2	0.0
Total fish	2			0			2		
Total samples	4			4				8	
C/f	0.5			0.0					0.3
1977									
Apr 14	18	556.6 ± 163.63	2204.2 ± 1792.78	9	627.8 ± 129.73	2842.6 ± 1980.55	27	2	13.5
Jun 11	0	-	-	0	-	-	0	2	0.0
Aug 26	1	745 ± 0.0	4717.4 ± 0.0	1	715 ± 0.0	4536 ± 0.0	2	2	1.0
Nov 23	0	-	-	0	-	-	0	2	0.0
Total fish	19			10			29		
Total samples	4			4				8	
C/f	4.8			2.5					3.6
1978									
Apr 23	7	602.7 ± 91.40	3411.3 ± 1012.15	0	-	-	7	2	3.5
Jun 17	0	-	-	0	-	-	0	2	0.0
Aug 19, 21	5	861.6 ± 26.10	6537.6 ± 488.97	2	758.0 ± 24.0	4721.5 ± 272.5	7	2	3.5
Nov 19	0	-	-	0	-	-	0	2	0.0
Total fish	12			2			14		
Total samples	4			4				8	
C/f	3.0			0.5					1.8
1974-1978									
Total fish	37			24			61		
Total samples	24			24				48	
C/f	1.5			1.0					1.3

*No sample.

POOR ORIGINAL

579 222

Table 2.5-24

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Lake Trout Collected by Gill Net, Bailly Study Area, 1974-1978

Date	Station 4			Station 7			Total Catch	Total Samples	C/f
	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE			
1974									
May 26	1	741.0 ± 0.0	4500 ± 0.0	0	-	-	1	2	0.5
Jun	0	-	-	0	-	-	0	2	0.0
Jul	0	-	-	2	688.5 ± 77.1	3693.0 ± 1180.8	2	2	1.0
Aug	0	-	-	0	-	-	0		0.0
Oct 4	21	678.0 ± 43.7	3185.0 ± 679.0	40	679.0 ± 59.2	3385.0 ± 1156.0	61	2	0.0
Oct 24	35	694.0 ± 56.6	3430.0 ± 56 6	13	659.0 ± 37.0	3071.0 ± 461.0	48	2	24.0
Nov 8	18	659.0 ± 61.9	2761.0 ± 696.1	4	675.0 ± 31.6	3028.0 ± 412.8	22	2	11.0
Total fish	75			59			134		
Total samples	7			7				14	
C/f	10.7			8.4					9.6
1975									
Mar	*	-	-	*	-	-	*	*	*
Apr 17	0	-	-	1	691.0 ± 0.0	4047.0 ± 0.0	1	2	0.5
May 22	2	674.0 ± 14.1	3353.5 ± 20.5	0	-	-	2	2	; 0
Jun 18	2	736.5 ± 37.5	4287.5 ± 340.1	0	-	-	2	2	1.0
Aug 8	0	-	-	0	-	-	0	2	0.0
Nov 3	28	674.3 ± 65.1	3012.8 ± 1032.4	20	689.1 ± 55.3	3256.5 ± 289.3	48	2	24.0
Total fish	32			21			53		
Total samples	5			5				10	
C/f	6.4			4.2					5.3
1976									
Apr 7	0	-	-	0	-	-	0	2	0.0
Jun 6	0	-	-	0	-	-	0	2	0.0
Aug 12	0	-	-	0	-	-	0	2	0.0
Nov 19	3	589.7 ± 95.6	2018.7 ± 848.0	2	751.0 ± 127.3	4160.0 ± 2440.9	5	2	2.5
Total fish	3			2			5		
Total samples	4			4				8	
C/f	0.8			0.5					0.6
1977									
Apr 14	4	658.0 ± 34.92	2837.3 ± 417.13	11	669.5 ± 66.11	3236.5 ± 957.22	15	2	7.5
Jun 11	0	-	-	0.0	-	-	0	2	0.0
Aug 26	0	-	-	0.0	-	-	0	2	0.0
Nov 23	1	728.0 ± 0.0	3541.0 ± 0.0	0.0	-	-	1	2	0.5
Total fish	5			11			16		
Total samples	4			4				8	
C/f	1.3			2.8					2.0
1978									
Apr 23	2	592.0 ± 5.00	2531.0 ± 34.0	0	-	-	2	2	1.0
Jun 17	6	643.7 ± 31.33	3447.3 ± 562.87	0	-	-	6	2	3.0
Aug 19, 21	11	681.8 ± 14.84	2868.4 ± 221.30	8	638.3 ± 17.93	2326.8 ± 256.50	19	2	9.5
Nov 19	41	679.9 ± 8.87	3100.0 ± 120.67	42	686.6 ± 9.12	3129.3 ± 144.57	83	2	41.5
Total fish	60			50			110		
Total sample	4			4				8	
C/f	15.4			12.5					13.8
1974-1978									
Total fish	175			70			318		
Total samples	24			24				48	
C/f	7.3			2.9					6.6

*No sample.

POOR ORIGINAL

579 293

Table 2.5-25

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Brown Trout Collected by Gill Net, Bailly Study Area, 1974-1978

Date	Station 4 Catch	Station 4 $\bar{x}$ Length ± SE	Station 4 $\bar{x}$ Weight ± SE	Station 7 Catch	Station 7 $\bar{x}$ Length ± SE	Station 7 $\bar{x}$ Weight ± SE	Total Catch	Total Samples	C/f
1974									
May 26	2	498.0 ± 9.9	1910.5 ± 99.7	0			2	2	1.0
Jun	1	595.0 ± 0.0	3545.0 ± 0.0	2	504.5 ± 7.8	2042.5 ± 160.5	3	2	1.5
Jul	1	508.0 ± 0.0	1896.0 ± 0.0	0	-	-	1	2	0.5
Aug	0	-	-	0	-	-	0	2	0.0
Oct 4	0	-	-	0	-	-	0	2	0.0
Oct 24	3	603.0 ± 160.7	3431.0 ± 2188.0	0	-	-	3	2	1.5
Nov 18	0	-	-	2	474.0 ± 157.7	2023.0 ± 1260.0	2	2	1.0
Total fish	7			4			11		
Total samples	7			7				14	
C/f	1.0			0.6					0.8
1975									
Mar	*	-	-	*	-	-	*	0	*
Apr 17	2	325.8 ± 7.1	436.5 ± 62.9	2	382.5 ± 219.9	1139.5 ± 1430.4	4	2	2.0
May 22	0	-	-	0	-	-	0	2	0.0
Jun 18	0	-	-	0	-	-	0	2	0.0
Aug 18	0	-	-	2	600.0 ± 127.3	3290.0 ± 2194.1	2	2	1.0
Nov 13	1	420.0 ± 0.0	772.5 ± 0.0	2	395.0 ± 127.3	847.0 ± 664.5	3	2	1.5
Total fish	3			6			9		
Total samples	5			5				10	
C/f	0.6			1.2					0.9
1976									
Apr 7	4	491.5 ± 39.8	1593.3 ± 395.5	2	479.0 ± 52.0	1471.5 ± 537.5	6	2	3.0
Jun 6	0	-	-	0	-	-	0	2	0.0
Aug 12	1	704.0 ± 0.0	4981.0 ± 0.0	0	-	-	1	2	0.5
Nov 19	0	-	-	0	-	-	0	2	0.0
Total fish	5			2			7		
Total samples	4			4				8	
C/f	1.3			0.5					0.9
1977									
Apr 14	1	755.0 ± 0.0	4217.0 ± 0.0	0	-	-	1	2	0.5
Jun 11	0	-	-	0	-	-	0	2	0.0
Aug 26	0	-	-	1	592.0 ± 0.0	3583.0 ± 0.0	1	2	0.5
Nov 23	0	-	-	0	-	-	0	2	0.0
Total fish	1			1			2		
Total samples	4			4				8	
C/f	0.3			0.3					0.3
1978									
Apr 23	6	536.5 ± 23.36	2323.2 ± 254.0	3	429.0 ± 25.51	1210.7 ± 170.49	9	2	4.5
Jun 17	1	432.0 ± 0.0	1678.0 ± 0.0	1	555.0 ± 0.0	3402.0 ± 0.0	2	2	1.0
Aug 19, 21	8	463.8 ± 43.81	1489.5 ± 415.98	2	476.0 ± 89.0	1248.5 ± 567.50	10	2	5.0
Nov 19	2	437.5 ± 30.50	1154.5 ± 158.50	0	-	-	2	2	1.0
Total fish	17			6			23		
Total samples	4			4				8	
C/f	4.3			1.5					2.9
1974-1978									
Total fish	33			19			52		
Total samples	24			24				48	
C/f	1.4			0.8					1.1

*No sample.

579 294

Table 2.5-26

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Steelhead Trout Collected by Gill Net, Bailly Study Area, 1974-1978

	Station 4			Station 7					
Date	Catch	x̄ Length ± SE	x̄ Weight ± SE	Catch	x̄ Length ± SE	x̄ Weight ± SE	Total Catch	Total Samples	C/f
1974									
May 26	2	536.5 ± 41.7	1556.5 ± 440.5	1	191.0 ± 0.0	68.0 ± 0.0	3	2	1.5
Jun	0	-	-	0	-	-	0	2	0.0
Aug	3	773.0 ± 14.7	5065.7 ± 614.0	0	-	-	3	2	1.5
Oct 4	0	-	-	0	-	-	0	2	0.0
Oct 24	2	388.0 ± 16.9	679.0 ± 120.2	6	385.0 ± 15.3	-	8	2	4.0
Nov 18	17	406.0 ± 27.6	702.0 ± 118.3	6	385.0 ± 15.7	-	23	2	11.5
Total fish	24			13			37		
Total samples	7			7				14	
C/f	3.4			1.9					2.6
1975									
Mar	*	-	-	*	-	-	*	*	*
Apr 17	0	-	-	0	-	-	0	2	0.0
May 22	0	-	-	0	-	-	0	2	0.0
Jun 18	0	-	-	0	-	-	0	2	0.0
Aug 18	0	-	-	0	-	-	0	2	0.0
Nov 13	3	350.3 ± 62.2	381.4 ± 112.5	0	-	-	3	2	1.5
Total fish	3			0			3		
Total samples	5			5				10	
C/f	0.6			0.0					0.3
1976									
Apr 7	0	-	-	0	-	-	0	2	0.0
Jun 6	0	-	-	0	-	-	0	2	0.0
Aug 12	0	-	-	0	-	-	0	2	0.0
Nov 19	0	-	-	0	-	-	0	2	0.0
Total fish	0			0			0		
Total samples	4			4				8	
C/f	0.0			0.0					0.0
1977									
Apr 14	0.0	-	-	0.0	-	-	0	2	0.0
Jun 11	0.0	-	-	0.0	-	-	0	2	0.0
Aug 26	0.0	-	-	0.0	-	-	0	2	0.0
Nov 23	0.0	-	-	1	491.0 ± 0.0	1725.0 ± 0.0	1	2	0.5
Total fish	0.0			1			1		
Total samples	4			4				8	
C/f	0.0			0.3					0.1
1978									
Apr 23	1	469.0 ± 0.0	1249.0 ± 0.0	0	-	-	1	2	0.5
Jun 17	3	610.3 ± 79.32	3386.7 ± 813.78	0	-	-	3	2	1.5
Aug 19, 21	4	703.0 ± 25.08	3121.35 ± 567.50	0	-	-	4	2	2.0
Nov 19	0	-	-	0	-	-	0	2	0.0
Total fish	8			0			8		
Total samples	4			4				8	
C/f	2.0			0					1.0
1974-1978									
Total fish	35			14			49		
Total samples	24			24				48	
C/f	1.5			0.6					1.0

*No sample.

POOR ORIGINAL

579 295

Table 2.5-27

Catch per Unit Effort (C/f) and Mean Lengths and Weights of Coho Salmon Collected by Gill Net, Bailly Study Area, 1974-1978

Date	Station 4 Catch	Station 4 $\bar{x}$ Length ± SE	Station 4 $\bar{x}$ Weight ± SE	Station 7 Catch	Station 7 $\bar{x}$ Length ± SE	Station 7 $\bar{x}$ Weight ± SE	Total Catch	Total Samples	C/f
1974									
May 26	0	-	-	0	-	-	0	2	0.0
Jun	0	-	-	0	-	-	0	2	0.0
Jul	0	-	-	0	-	-	0	2	0.0
Aug	0	-	-	0	-	-	0	2	0.0
Oct 4	0	-	-	1	640.0 ± 0.0	2833.0 ± 0.0	1	2	0.5
Oct 24	1	745.0 ± 0.0	5037.0 ± 0.0	0	-	-	1	7	0.5
Nov 8	0	-	-	0	-	-	0	2	0.0
Total fish	1			1			2		
Total samples	7			7				14	
C/f	0.1			0.1					0.1
1975									
Mar	*	-	-	*	-	-	*	*	*
Apr 17	31	450.1 ± 135.8	1154.1 ± 828.2	14	462.9 ± 20.4	883.3 ± 112.8	45	2	22.5
May 22	1	379.0 ± 0.0	496.0 ± 0.^	0	-	-	1	2	0.5
Jun 18	0	-	-	0	-	-	0	2	0.0
Aug 8	0	-	-	0	-	-	0	2	0.0
Nov 3	1	698.0 ± 0.0	3098.0 ± 0.0	0	-	-	1	2	0.5
Total fish	33			14			47		
Total samples	5			5				10	
C/f	6.6			2.8					4.7
1976									
Apr 7	0	-	-	1	428.0 ± 0.0	792.0 ± 0.0	1	2	0.5
Jun 6	0	-	-	0	-	-	0	2	0.0
Aug 12	0	-	-	0	-	-	0	2	0.0
Nov 19	0	-	-	0	-	-	0	2	0.0
Total fish	0			1			1		
Total samples	4			4				8	
C/f	0.0			0.3					0.1
1977									
Apr 14	1	411 ± 0.0	538 ± 0.0	7	499.1 ± 42.08	1023.0 ± 105.04	8	2	4.0
Jun 11	0	-	-	0	-	-	0	2	0.0
Aug 26	0	-	-	0	-	-	0	2	0.0
Nov 23	0	-	-	0	-	-	0	2	0.0
Total fish	1			7			8		
Total samples	4			4				8	
C/f	0.3			1.8					1.0
1978									
Apr 23	8	488.5 ± 9.70	1390.4 ± 66.30	3	470.7 ± 22.92	1112.3 ± 112.00	11	2	5.5
Jun 17	2	520.5 ± 37.50	1746.5 ± 385.50	9	576.8 ± 9.17	2424.2 ± 130.04	11	2	5.5
Aug 19, 21	0	-	-	0	-	-	0	2	0.0
Nov 19	1	305.0 ± 0.0	298.0 ± 0.0	0	-	-	1	2	0.5
Total fish	11			12			23		
Total samples	4			4				8	
C/f	2.8			3.0					2.9
1974-1978									
Total fish	46			35			81		
Total samples	24			24				48	
C/f	1.9			1.5					1.7

*No sample.

Table 2.5-28

Food Habits of Adult Salmoni(s

Length Range - 305-857 millimeters
Stomachs Examined - 24
Stomachs Empty - 8

Food Items	Frequency of Occurrence (%)	Percent by Number (%)	Relative Volume (%)
Fish	75.0	100.0	98.0
Alewife	37.5	63.2	78.1
Fish (unid.)	37.5	36.8	14.7
Fish remains	31.2		5.2
Digested material	25.0		2.0
Sand grains	6.2		

Table 2.5-29

Food Habits of Juvenile Salmonids

Length Range - 104-118 millimeters
Stomachs Examined - 7
Stomachs Empty - 0

Food Items	Frequency of Occurrence (%)	Percent by Number (%)	Importance Index (%)
Insecta	85.7	97.5	63.8
Insecta (adult)	71.4	34.2	24.3
Insecta (adult remains)	14.3		5.3
Diptera (adult)	14.3	2.4	3.0
Chironomidae (pupae)	57.1	29.3	3.0
Chironomidae (pupae remains)	28.6		
Coleoptera (unid.)	28.6	4.9	12.7
Staphylinidae (adult)	14.3	2.4	1.8
Hydrophilidae (adult)	14.3	2.4	1.8
Arachnida (adult)	42.9	7.3	
Corixidae (adults)	28.6	4.9	3.3
Corixidae (nymph)	28.6	4.9	3.0
Corixidae remains	14.3		1.2
Trichoptera (adult)	14.3	2.4	4.4
Veliidae (adult)	14.3	2.4	
Aquatic insect remains	14.3		
Amphipoda	14.3	2.4	
Fish remains	28.6		11.0
Cycloid scales	14.3		
Plant material (seed)	28.6		
Digested material	85.7		25.2
sand grains	42.9		

2.5.4.4.5 Other Species. Other species collected in the Bailly vicinity by gill net included rainbow smelt (one at Station 4 in April and two at Station 4 in August), channel catfish and gizzard shad (one each at Station 4 in August) and gizzard shad (one at Station 4 in November). Eight rainbow smelt were collected by beach seine at Station 23 during August. All fish collected by gill nets were adults; fish collected by beach seine were young-of-the-year.

The only gizzard shad gastrointestinal tract examined contained only a few food items (percent fullness ~1%). Bosminidae (a small cladoceran) was the most important food item by number (Table 2.5-30). Digested material was rated as the primary food item based on the importance index.

Table 2.5-30

Food Habits of Adult Gizzard Shad

Length Range – 565 millimeters
Stomachs Examined – 1
Stomachs Empty – 0

Food Items	of Occurrence (%)	by Number (%)	Importance Index (%)
Copepoda (adult)	100.0	17.8	
Bosminidae (adult)	100.0	76.8	
Daphnidae (adult)	100.0	5.4	
Digested material	100.0		100.0
Sand grains	100.0		

Rainbow smelt ranged from 35 to 265 mm total length and had a mean condition factor of K = 0.566. The only channel catfish captured was 386 mm total length and had a condition factor of K = 0.770. Condition factors of gizzard shad are presented in Table 2.5-16.

No obvious external parasites were observed on rainbow smelt, channel catfish, or gizzard shad collected during 1978.

2.5.5 COMMERCIAL AND SPORT FISHING. Commercial and sport fishermen are active in the Bailly Generating Station vicinity. Texas Instruments (1975, 1976a) reported that three commercial fishermen used the Bailly area in 1974 and 1975, fishing primarily for yellow perch. There was only one commercial operation in the Bailly area in 1976 and 1977; information was not available for 1978; past commercial fishing records for the Indiana water of Lake Michigan indicated that

yellow perch was the dominant species taken (Table 2.5-31). This single commercial fishing operation was conducted from Burns Ditch by a single gill net tug, the STELLA POLARIS, owned by the Westerman Brothers. The Westermans indicate that they do not fish in the Bailly study area because of probable interference with sport fishermen and that they set their nets at varying depths and locations, depending on the time of year but that they do not set nets within the 15.2-meter (50-foot) depth contour. Thus, their fishing operation is excluded from the Bailly Study Area.

Table 2.5-31

Lake Michigan Commercial Fishery* Reported Catch in Pounds (1970-1978)

Species	1970	1971	1972	1973	1974	1975	1976	1977	1978
Lake trout	8,079	25,790	13,903	8,400	8,003	12,929	5,651	1,541	405
Brown trout	-	-	-	9	72	53	29	87	69
Steelhead	-	-	-	-	13	-	-	-	-
Coho	3,227	5,083	1,157	218	12	1,050	116	1,036	1,679
Chinook	-	-	-	9	4	29	-	64	59
Chubs	74,390	28,489	38,262	35,668	4,401	910	1,641	1,244	8,619
Whitefish	3,816	22,636	999	868	111	172	155	600	890
Suckers	31,698	208,984	17,659	12,255	8,013	8,269	4,041	2,183	3,511
Yellow perch	205,764	333,850	340,607	257,883	176,338	153,799	176,286	155,810	91,988
Smelt	239	43,642	9,466	**	16,418	7,852	5,463	1,363	3,770
Total production	334,600	784,855	428,373	352,000	213,385	185,063	193,382	156,439	111,341

*Indiana Dept. Nat. Resources (1979).

**Error on printout.

Fishing in the Bailly vicinity and in all the nearshore Indiana waters of Lake Michigan is a highly popular sport. Texas Instruments field crews have observed many boats trolling in the Bailly study area and in the vicinity of the Bailly Generating Station discharge. Other fishermen have been observed along the flume structure, where bow hunting for carp and hook-and-line fishing for carp, salmonids and catfish are popular. The Indiana water of Lake Michigan has seven access sites with boat-launching ramps; three are located along Burns Ditch, two are in Michigan City, one is in Gary, and one is in East Chicago. Also, the Port of Indiana was recently opened to shoreline fishing on a limited basis. Sport fishermen from these areas primarily fish for salmonids (coho and chinook salmon and lake, steelhead, and brown trout), yellow perch, and smallmouth bass. The total sport catch from Indiana waters of Lake Michigan in 1975 was 83.8 percent coho salmon, 5.0 percent chinook salmon, 4.0 percent yellow perch, 3.9 percent lake trout, 2.1 percent steelhead trout, 1.0 percent brown trout, and 0.2 percent smallmouth bass (Koch, 1975).

2.5.6 POTENTIAL DISRUPTION OF RARE AND ENDANGERED SPECIES. Fish considered to be endangered or threatened in Indiana are listed in Table 2.5-32. Specimens denoted with an asterisk were listed by J.L. Janisch, fisheries staff specialist, Indiana Department of Natural Resources. Those specimens bearing two asterisks also were listed by Janisch and are recognized by Miller (1972) as well. Those specimens having three asterisks were not noted by Janisch but are considered rare or endangered in Lake Michigan by Miller (1972).

Table 2.5-32

Rare, Endangered, or Threatened Fish Species in Indiana

Eastern sand darter*	Ammocrypta pellucida
Spring cavefish*	Chologaster agassizi
Northern cavefish**	Amblyopsis spelaea
Southern cavefish**	Typhlichthys subterreaneus
Silverband shiner*	Notropis shumardi
Ribbon shiner*	Notropis fumeus
Popeye shiner*	Notropis ariommus
Crystal darter*	Ammocrypta asprella
Stargazing darter*	Percina uranidea
Gilt darter*	Percina evides
Spotted darter*	Etheostoma maculatum
Harlequin darter*	Etheostoma histrio
Tippecanoe darter*	Ethoestoma tippecanoe
Spottail darter*	Etheostoma squamiceps
Redside dace*	Clinostomus elongatus
Rosefin shiner*	Notropis ardens
Swamp darter*	Etheostoma swaini
Blue sucker**	Cycleptus elongatus
Ohio River muskellunge**	Esox masquinongy ohioensis
Bluebreast darter*	Etheostoma camurum
Variegated darter*	Etheostoma variatum
Lake sturgeon**	Acipenser fulvescens
Longjaw cisco**	Coregonus alpenae
Kiyi***	Coregonus kiyi
Shortjaw cisco***	Coregonus zenithicus
Blackfin cisco***	Coregonus nigripinnis
Shortnose cisco***	Coregonus reighardi

*According to Janisch 1976 (see text)
**According to Janisch (1976) and Miller (1972)
***Rare and endangered in Lake Michigan (Miller 1972)

Neither were any of the species identified by Janisch as endemic to Indiana collected in studies conducted at the Bailly Generating Station, nor were they considered indigenous to Indiana waters of Lake Michigan. Of the known endangered species in Lake Michigan but not on the Indiana list, only lake sturgeon have been collected in impingement studies at Lake Michigan power plants; however, none were found to be either impinged or entrained at the Bailly Generating Station during TI 316(b) study (1976c) or collected in gill nets or beach seines. The five coregonid species listed are deep-water forms and are not expected in the shallow waters of the Bailly Generating Station vicinity.

579 301

2.6 WATER QUALITY

2.6.1 INTRODUCTION. As discussed in previous annual reports, the Great Lakes have been a focal point of scientific interest since the 1800's because, as stated by Beeton (1970), they represent "the most important single factor for the settlement, growth and development of the mid-continent of North America." Multiple-purpose use of the lake waters has created a number of problems since the 1800's including collapse of fisheries, changes in species composition of primary and secondary trophic level organisms, and changes in water quality.

With the realization that change was occurring came the establishment of water quality standards for Lake Michigan and other lakes. These standards will be used as the reference base herein. Criteria for Lake Michigan and other water bodies in Indiana are listed in Table 2.6-1

In the present study, Lake Michigan water quality was characterized through the analyses of five major groups of parameters, as listed in Table 2.6-2.

Samples were collected during five months over the period April 1977 through January 1978. Data derived from these samples will be compared with data collected during the previous survey years and with the Lake Michigan water quality standards (as outlined in Table 2.6-1).

2.6.2 METHODOLOGY. All water quality samples in the Bailly Station vicinity were taken in duplicate using a 6.1-liter Van Dorn sampler (for water samples), a J-Z sterile water sampler (for bacteria samples), and an Ekman dredge (for sediment samples). Samples from the ash settling basins (stations 13 through 16), the natural ponds (stations 17 through 20), and Cowles Bog (Station 21) were collected at mid-depth (sediment samples from the substrate). Lake Michigan samples from locations along the 15-foot contour (stations 1, 4, 7, and 10) were collected from 1 meter below the surface. Lake samples along the 30-foot contour (stations 2, 5, and 8) were collected 1 meter below the surface and 1 meter above the bottom, while lake samples along the 50-foot contour were collected 1 meter below the surface, at mid-depth, and 1 meter above the bottom. Samples at stations 11, 12, and 22 were taken from 1 meter below the surface.

579 302

Table 2.6-1

Water Quality Values Defined by the Indiana Stream Pollution Control Board, or USEPA and Applicable to Lake Michigan in the NIPSCo Bailly Study Area

General Water Quality	Units	Indiana, USPHS or EPA Levels
Alkalinity	mg/ℓ	30-500 range, whatever is of natural origin**
Calcium	mg/ℓ	No limits defined
Chlorides	mg/ℓ	20 single values, 15 monthly average*
Chlorine	mg/ℓ	.002 mg/ℓ**
Conductivity	μmhos	<800-1200 micromhos/cm (at 25°C)*
Color	APHA units	15 single value maximum, 5 monthly average*
Dissolved oxygen	mg/ℓ	Not ≤7 mg/ℓ*
Fluorides	mg/	Not to exceed 1.0 at any time*
Hardness	mg/	0-5000 range, natural origin**
Magnesium	mg/	No limits defined
Odor	odor units pos-neg	Single value 8 — daily avg 4*
pH	pH units	7.5-8.5*
Potassium	mg/ℓ	No limits defined**
Sodium	mg/ℓ	No limits defined**
Total dissolved solids	mg/ℓ	172 (Lake Michigan monthly avg) 200 daily max*
Total suspended solids	mg/ℓ	Should not reduce the depth of the compensation for photosynthesis by more than 10%.
Sulfate	mg/ℓ	50-single value; 26-monthly average*
Water temperature	°C	3°F above existing 1000 ft from discharge or 45° (Jan-Mar) 55° (Apr) 60° (May) 70° (Jun) 80° (Jul-Sep) 65° (Oct) 60° (Nov) 50° (Dec), whichever is lower*
Turbidity	FTU	None other than natural origin*
Aquatic Nutrient		
Ammonia	mg/ℓ	0.05 single value, 0.02 monthly average*
Nitrates	mg/ℓ	10 mg/ℓ***
Nitrites	mg/ℓ	No limits defined**
Organic nitrogen	mg/ℓ	No limits defined**
Orthophosphate	mg/ℓ	No limits defined — presumably less than total P.
Total phosphorus	mg/ℓ	0.04 single value, 0.03 monthly average*
Silicates	mg/ℓ	No limits defined
Trace Elements		
Arsenic, total	mg/ℓ	Not to exceed 0.05 at any time*
Cadmium, total	mg/ℓ	Not to exceed 0.01 at any time*
Chromium, hexavalent	mg/ℓ	Not to exceed 0.05 at any time*
Chromium, total	mg/ℓ	Not to exceed 0.05 at any time*
Copper, total	mg/ℓ	1.0**
Iron, soluble	mg/ℓ	.30 single value; .15 monthly average*
Iron, total	mg/ℓ	0.3 domestic supply; 1.0 freshwater aquatic life**
Lead, total	mg/ℓ	Not to exceed 0.05 at any time*
Manganese, total	mg/ℓ	0.05**
Mercury, total	mg/ℓ	Not to exceed 0.0005 at any time*
Nickel, total	mg/ℓ	1/50 96 hr TL_{50} - ≈.5-2 mg/ℓ***
Selenium, total	mg/ℓ	Not to exceed 0.01 at any time*
Vanadium, total	mg/ℓ	No limits defined**
Zinc, total	mg/ℓ	5**
Indicators of Industrial and Organic Contamination		
Bacteria, fecal coliform	#/100 mℓ	20/100 (Lake Michigan open water 200/100 mℓ at beaches based on geometric mean of 5 samples*
Bacteria, total coliform	#/100 m	No limits defined**
Biochemical oxygen demand	mg/ℓ	No prescribed limits
Chemical oxygen demand	mg/ℓ	No prescribed limits
Cyanide	mg/ℓ	Not to exceed .01 at any time*
Hexane, soluble material	mg/ℓ	No limits defined
Phenols	mg/ℓ	.003 single value; .001 monthly average*
Methylene blue active substances	mg/ℓ	No limits defined
Total organic carbon	mg/ℓ	No prescribed limits**

*Indiana Regulation SPC 4R-2 (1978)
**EPA Water Quality Criteria Data Book (1976)
***EPA National Interim Primary Drinking Water Regulations Implementation (1978)

579 303

Table 2.6-2

Water Quality Parameters Measured in the Vicinity of the NIPSCo Bailly Study Area

Parameter	Station	Method	Accuracy
AQUATIC			
Water Chemistry and Bacteriology			
General Water Quality			
Alkalinity, total	1-21	Titration	1% at 100 mg/ℓ
Calcium, soluble	1-21 exc 12	Atomic absorption	±0.05 mg/ℓ
Chloride, total		Auto analysis	2/3% at 5 mg/ℓ
Chloride, total	1-21 exc 12	Titration	
Conductance, specific		Conductivity bridge	5% at 50 µmhos
Oxygen, dissolved	1-21	Winkler and polarographic	±0.1 mg/ℓ
Oxygen, saturation	1-21	Calculation	N/A
Odor, threshold	1-21 exc 12	Threshold	N/A
Magnesium, soluble	1-21 exc 12	Atomic absorption	±0.004 mg/ℓ
Hardness	1-21 exc 12	Titration	2.9% at 232 mg/ℓ
pH	1-21	Electrode	±0.1 pH
Potassium, soluble	1-21 exc 12	Atomic absorption	±0.005 mg/ℓ
Sodium, soluble	1-21 exc 12	Atomic absorption	±0.005 mg/ℓ
Dissolved solids, total	1-21 exc 12	Gravimetric	4% at 100 mg/ℓ
Suspended solids, total	1-21 exc 12	Gravimetric	4% at 100 mg/ℓ
Sulfate	1-21 exc 12	Colorimetric	3% at 100 mg/ℓ
Temperature	1-21	Thermometer	±0.1°C
Turbidity	1-21	Nephelometric	N/A
Color, true	1-21 exc 12	Standard filters	N/A
Fluoride, soluble	1-21 exc 12	Distillation	8% at 800 µg/ℓ
Aquatic Nutrients			
Ammonia, soluble	1-21	Auto analysis	0.31% at 8 µgat/ℓN
Nitrate, soluble	1-21	Auto analysis	0.59% at 2.5 µgat/ℓN
Nitrite, soluble	1-21	Auto analysis	0.59% at 2.5 µgat/ℓN
Organic nitrogen, total	1-21	Auto analysis	1.25% at 50 mg/ℓN
Orthophosphate, soluble	1-21	Auto analysis	1.98% at 2 µgat/ℓP
Phosphorus, total	1-21	Auto analysis	0.89% at 30 mg/ℓP
Silica, soluble	1-21	Auto analysis	0.36% at 5 mg/ℓSiO_2
Trace Elements			
Cadmium, total	13-21	Atomic absorption	±0.005 mg/ℓ
Chromium, soluble hexavalent	13-21	Auto analysis	±0.14% at 0.10 mg/ℓ
Chromium, total	13-21	Atomic absorption	±0.002 mg/ℓ
Copper, total	13-21	Atomic absorption	±0.03 mg/ℓ
Iron, soluble	13-21	Atomic absorption	±0.05 mg/ℓ
Manganese, total	13-21	Atomic absorption	±0.01 mg/ℓ
Mercury, total	13-21	Atomic absorption	±0.0002 mg/ℓ
Nickel, total	13-21	Atomic absorption	±0.05 mg/ℓ
Zinc, total	13-21	Atomic absorption	±0.01 mg/ℓ
Lead	13-21	Atomic absorption	±0.01 mg/ℓ
Indicators of Industrial and Organic Contamination			
Bacteria, fecal coliform	13-21	Membrane filter	N/A
Bacteria, total coliform	13-21	Membrane filter	N/A
Biochemical Oxygen Demand	13-21	Winkler and polarographic	±0.1 mg/ℓ
Hexane-soluble materials	13-21	Hexane extraction	N/A
Organic Carbon, total	13-21	Combustion - IR	N/A
Phenols	13-21	Chloroform extraction	±0.0001 mg/ℓ
Methylene Blue-Active Substance	13-21	Spectrophotometric	±0.02 mg/ℓ
Cyanide	13-21	Cyanide distillation	±0.005 mg/ℓ
Chemical Oxygen Demand	13-21	Titration	±0.1 mg/ℓ
Sediment			
Cadmium, total	13-20	Atomic absorption	±0.005 mg/ℓ
Chromium, total	13-20	Atomic absorption	±0.07 mg/ℓ
Copper, total	13-20	Atomic absorption	±0.03 mg/ℓ
Iron, total	13-20	Atomic absorption	±0.05 mg/ℓ
Lead, total	13-20	Atomic absorption	±0.06 mg/ℓ
Manganese, total	13-20	Atomic absorption	±0.01 mg/ℓ
Mercury, total	13-20	Atomic absorption (flameless)	±0.0002 µg/ℓ
Nickel, total	13-20	Atomic absorption	±0.05 mg/ℓ
Selenium, total	13-20	Atomic absorption	±0.0003 mg/ℓ
Vanadium, total	13-20	Atomic absorption	±0.002 mg/ℓ
Zinc, total	13-20	Atomic absorption	±0.01 mg/ℓ
Phosphorus, total	13-20	Auto analysis	±1.98% at 2 µgat/ℓ

579 304

POOR ORIGINAL

All samples were preserved and processed following Standard Methods (APHA 1975 and EPA 1973) techniques. Table 2.6-2 lists the sample locations, method and accuracy of individual analyses performed during the study.

2.6.3 RESULTS. Results of monthly analyses for the 1978-1979 survey in the Bailly Station vicinity have been presented in previous quarterly reports (TI 1978b, 1978c, 1979a, 1979b). These parameters are presented by month in the following five classes:

- General water quality parameters
- Aquatic nutrients
- Trace elements
- Indicators of industrial and organic pollution
- Sediments

2.6.4 DISCUSSION

2.6.4.1 General Water Quality Parameters. Water temperature, one of the easiest and most commonly measured parameters in natural waters, is known to have significant effects on aquatic organisms. Mean monthly temperatures for Lake Michigan, the Bailly Station discharge, and the nearshore ponds are presented in Figure 2.6-1. Lake Michigan temperatures normally peak in July or August, with the highest temperature recorded being 22°C in July 1974 and August 1978. August temperatures over the period 1974-1977 varied only 1°C. Discharge temperatures ranged from 0 to 18°F above ambient Lake Michigan temperatures. A 316(a)(b) study conducted in 1976 (TI 1976b) indicated a mean discharge ΔT of 7.9°C. Thermal stratification was observed in August 1978, when an approximately 8°C ΔT was recorded between the 30-foot (9.14-meter) and 60-foot (18.2-meter) depth. No thermal stratification was observed during the remainder of the 1978 sampling period.

During 1978, the interdunal ponds and Cowles Bog reached maximum temperatures in August with a range from 26 to 27.5°C. Minimum temperatures were recorded in November 1978, ranging from 9 to 10°C. Although temperatures are measured only quarterly (monthly in 1974 and early in 1975), pond temperatures no doubt fluctuate daily because of their ability to gain or lose heat more rapidly than larger water bodies such as Lake Michigan. Year 5 (1978) results were similar

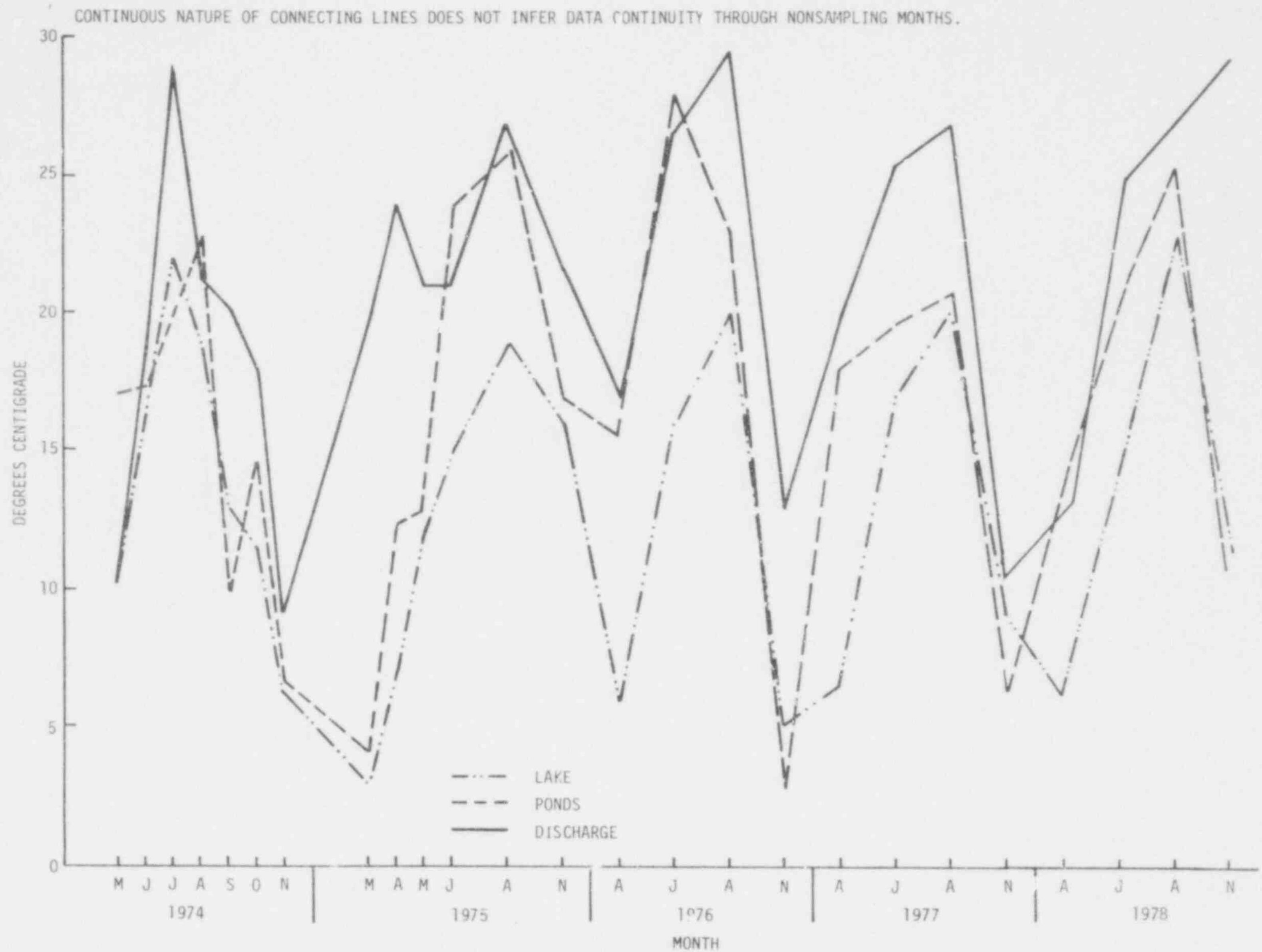


Figure 2.6-1. Temperatures Measured at Lake Michigan Control Station 9S, Discharge Station 10S, and Mean Pond Temperature for Stations 17S-21S

to those of years 1 through 4; i.e., the temperature of the smaller water bodies was generally higher than the lake (excluding discharge temperatures). Ponds warmed sooner in the spring and cooled sooner in the fall. Based on the higher surface-to-volume ratios of the ponds, these changes were not unexpected.

Oxygen content is equally as important to the aquatic community structure as temperature. Water low in dissolved oxygen can harm fish and other aquatic life. An absence of dissolved oxygen brought on by the accumulation of oxidizable material may result in anaerobic conditions, especially near the sediment layers of the bottom. Oxygen content may be modified by such factors as temperature, phytoplankton composition, sunlight, nutrients, and decomposable organic matter (Reid 1961). Solubility of oxygen increases with decreasing temperature and vice-versa. Indiana standards call for not less than 7 milligrams per liter of oxygen for Lake Michigan (Indiana Reg. SPC 4R-2).

Oxygen content in Lake Michigan in the vicinity of Bailly Station during 1978 ranged from 8.1 to 11.8 milligrams per liter and 81 to more than 100 percent saturation. Percentage saturation levels averaged in excess of 95 percent. Oxygen levels in the interdunal ponds during 1978 were highly variable, ranging from a low of 4.6 milligrams per liter in Cowles Bog (Station 21) in November to 15.0 milligrams per liter in June also in Cowles Bog. Percent saturation values over the same period ranged from 41 to 175 percent. Observed levels in the interdunal ponds (stations 17-21) were, with the exception of the marginal 4.6 milligrams per liter value at Station 21 in November, ample for the protection of indigenous aquatic populations.

Acidity or alkalinity of the water, as reflected by pH, is also important. Maximum productivity generally occurs between pH 6.0 to 8.0, and Indiana standards set a range of 7.5 to 8.5. The parameter pH, which is expressed mathematically as $\log_{10} \frac{1}{H+}$, is regulated by the buffering capacity of the water, a capacity generally controlled by carbonate and bicarbonate ions, although iron compounds and silica are also important (Garrels 1965). The pH is altered by such factors as productivity and influx of external acidic or alkaline ions, and fluctuates through the day as CO_2 is utilized or produced. In 1978, pH in Lake Michigan ranged from 7.1 to 8.7, a range exceeding the standard.

579 307

In 1976, the pH in Lake Michigan varied from 7.3 to 8.3, a range also exceeding the standard while during 1975 pH ranged from 6.4 to 8.2; the 1974 pH range was 6.4 to 8.4. As discussed by the EPA (1976), normal surface water pH ranges from 6.0 to 9.0. Tolerance limits for most organisms fall between 5.0 and 9.0 (when pH is the only factor considered [EPA 1976]), and McKee and Wolf (1963) state that 90 percent of the waters supporting good fish populations have ranges of 6.7 to 8.3. On these bases, the pH range described in the Bailly vicinity is normal and should not cause any problems for indigenous species.

The pH in the discharge was similar to the open-lake values, indicating that plant operation apparently does not affect pH. Pond values were lower (i.e., more acid) than lake values, as in 1974 and 1976 but not in 1975, when values were similar. Values were particularly lower in the settling ponds, probably the result of ash addition to these ponds. pH values as low as 3.9 were recorded in the settling ponds in 1978. Values as low as 3.0 were recorded in 1977, 3.6 in 1976, 2.8 in 1975, and 3.5 in 1974. The pH at Station 21 (Cowles Bog) was generally higher than expected for a bog area, with values ranging from 7.0 to 7.8 (similar values were recorded in previous years); this is probably due to the location of the station at the edge rather than center of the bog. Bog waters are generally characterized as being brown in color, high in nutrients and organic material, lower in pH, and with little or no oxygen in deeper areas (Reid 1961). These conditions generally exist at Cowles Bog, although the bog is also quite shallow and apparently does not become anoxic except perhaps under the ice in winter. The conditions observed during 1978 were similar to previous years' data for the interdunal ponds in the Bailly Station vicinity.

Alkalinity is the measure of the ability of a solution to neutralize hydrogen ions and is generally expressed as an equivalent amount of calcium carbonate ($CaCO_3$). This measure is the effect of a combination of substances comprising primarily carbonates, bicarbonates, and hydroxides (McKee and Wolf 1963). Mean quarterly alkalinity values in the lake ranged from 62 to 119 milligrams per liter, well within acceptable standards and comparable to past data. Alkalinity values for control Station 9S in Lake Michigan, plus values for the nearshore ponds, are shown in Figure 2.6-2. Alkalinity values at the discharge station were similar to lake values. These concentrations are similar to 1977, 1976,

579 308

CONTINUOUS NATURE OF CONNECTING LINES DOES NOT INFER DATA CONTINUITY THROUGH NONSAMPLING MONTHS.

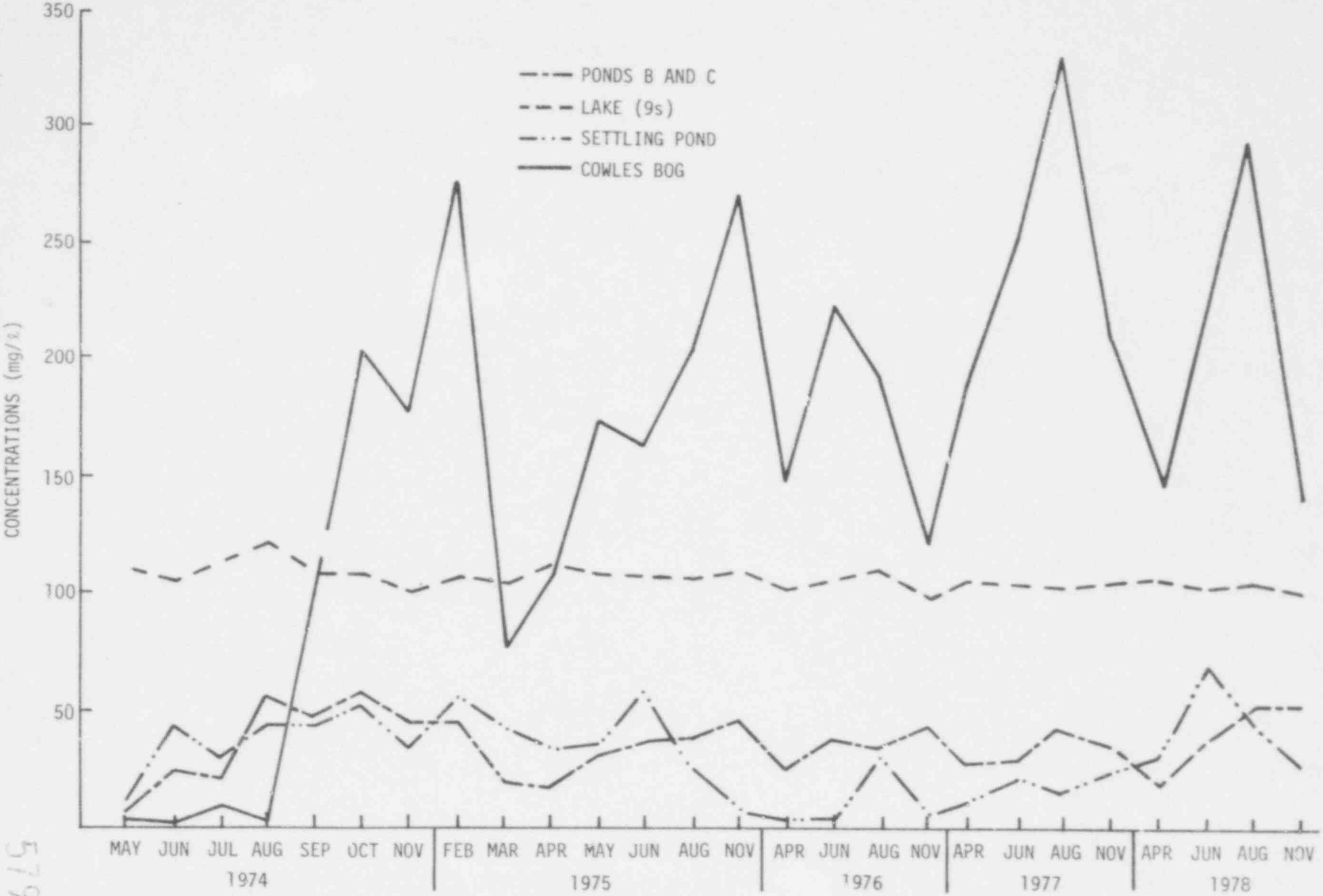


Figure 2.6-2. Alkalinity Values as Recorded at Lake Michigan Station 9S, Settling Ponds 13-16, Ponds B and C, and Cowles Bog

579 309

1975, and 1974; the observed alkalinity levels are adequate for the maintenance of moderate buffering capacity and should keep pH within acceptable ranges.

Alkalinity in the nearshore ponds exhibited much wider variability, and all ponds except Cowles Bog exhibited generally low alkalinity (mean values less than 50 milligrams per liter, some below detection limits), an indication of low buffering capacity. Cowles Bog levels fluctuated widely from a low of 145 milligrams per liter in November 1978 to a high of 287 milligrams per liter in August. Similarly wide ranges were observed in past years and appear to be an annual occurrence, although the August 1977 peak was the highest observed to date. Observation of this and other water quality parameters indicates that the Cowles Bog area may be influenced or maintained by runoff. Because of this, the Cowles Bog area is potentially sensitive and will be closely monitored in the future.

The remaining parameters used as indicators of general water quality are often considered interrelated in their contribution to the chemical environment of water. Turbidity and color, suspended and dissolved solids, hardness, calcium, magnesium, potassium, sodium, sulfates, conductivity, chlorides and fluorides, and odor will be discussed in groups.

Turbidity is the property of water that causes light to be scattered and absorbed rather than transmitted in straight lines. The presence of suspended solids such as silt, finely divided organic material, bacteria, and plankton determines turbidity levels. Color is derived partly from dissolved solids and partly from suspended particulate material. Turbidity in Lake Michigan ranged from less than 0.1 to 51, while color levels remained at 1 Platinum-Cobalt unit throughout the year. Values for turbidity were relatively constant throughout 1978 in both the open lake and discharge waters, continuing a trend established in the period 1974 through 1977, and within ISPCB standards. High turbidities in the bottom sample at Station 9 may have been the result of sediment disturbance by the sample bottle. As expected, turbidity and color in the nearshore ponds were generally higher than in the lake; possible sources of both turbidity and color include organic growth and decomposition or contributions of material from outside sources. Dramatically high color levels were observed in Cowles Bog (e.g., 350 Pt-Co units in August and November) probably

579 310

the result of high levels of organic material. Color observed in the lake generally indicates "clear" water; the EPA (1973) has described waters below 45 APHA units as desirable for photosynthetic activity and lakes with levels of 0 to 5 units as highly transparent.

In natural waters, suspended solids normally consist of silt and clay from erosion, particulate organic detritus, bacteria, and plankton, while dissolved solids consist of carbonates, sulfates, chlorides, phosphates, and nitrates in combination with metallic cations such as calcium, sodium, potassium, and magnesium. Suspended and dissolved solids are important in the ecosystem, where the suspended solids, which include bacteria and phytoplankton, may be used by secondary consumers, and where the bacteria and phytoplankton can assimilate the dissolved solids in the form of nutrients and/or osmotic balancers.

Suspended solids levels recorded in the Bailly Study Area were low (less than 1.0 to 180.8 milligrams per liter with most of the values being less than 5 milligrams per liter) in the open lake and discharge, indicative of the low turbidity and color values in the lake. The 1978 data are similar to the 1974-1977 levels. Contribution by runoff to suspended solids levels was not apparent during any of the years. The nearshore ponds exhibited varying levels of suspended solids throughout 1978, indicating man-related influences (ash particles suspended in settling pond water) or natural particulate matter addition from rainfall and subsequent runoff. It should be noted that natural pond (stations 17-21) levels were low, probably as a result of absorption or filtering of runoff by pond vegetation. This was also observed in data from previous years.

Lake Michigan dissolved solids ranged from 52 to 1083 milligrams per liter. Values were generally similar to those observed during 1974, 1975, 1976, and 1977 (Figure 2.6-3). Extremely high dissolved solid values found in June samples were suspected to be the result of contaminated bottles. These data were not utilized. Variations in concentrations of dissolved solids probably resulted from runoff and changes in water circulation patterns near the shore. Nearshore ponds exhibited a highly variable pattern in dissolved solids (Figure 2.6-4), probably owing to such natural processes as dilution and runoff, evaporative concentration, and assimilation of elements in biological metabolism.

579 311

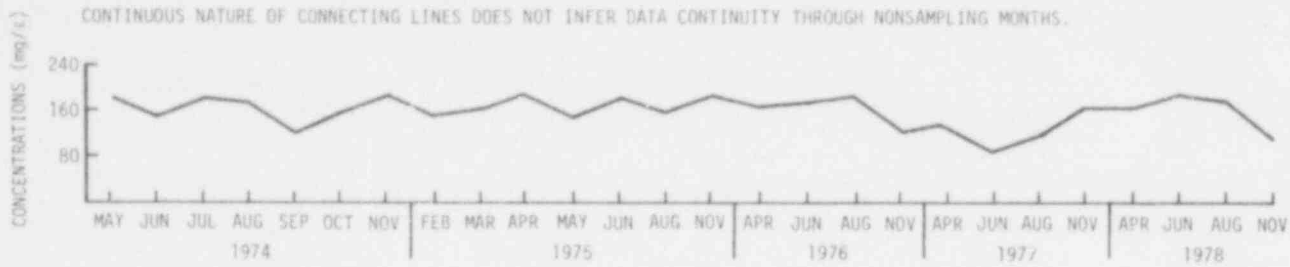


Figure 2-6.3 Total Dissolved Solids Concentrations (mg/ℓ) Observed in Lake Michigan in the NIPSCo Bailly Study Area, 1974-1978

Many factors affect conductance. Concentrations of dissolved solids are notably important, and there is usually a high correlation between conductance and calcium and magnesium ion levels, because the two elements are the most abundant ions in fresh water. Lake Michigan conductance values during 1978 ranged from 242 to 310 micromhos, while 1977 values fluctuated from 240 to 325 micromhos. Ranges of lake conductance values in previous years were 225 to 411 micromhos in 1976, 182 to 340 micromhos in 1975, and 160 to 340 micromhos in 1974. Values for all four years fell well within ISPCB standards of ≤800-1200 micromhos. Conductance values in the ash settling ponds, Pond B and Cowles Bog were generally higher than in the lake; Pond C yielded lower conductance than the other ponds and conductance similar to the lake. The conductance value fluctuations observed in the ponds are not unusual for shallow bodies of water, which reflect environmental changes quicker than larger bodies of water. Conductance was particularly high in the ash settling (stations 13-16) ponds and Pond B. Values in the ash settling ponds appear to be related to coal-ash addition; seepage into Pond B from the ash ponds is speculated but unproved at this time.

Calcium, magnesium, potassium, sodium, and sulfate comprises a group which is important to the chemical nature of the water and which plays a role in determining hardness of waters. They are considered together because of their solubility and because they do not generally form complexes readily (except for calcium, which may precipitate under alkaline conditions, and sulfates, which because they are oxidation products, react somewhat differently). Concentrations of calcium, magnesium, potassium, and sodium, fluctuated slightly during 1978, a trend of values similar to 1974 through 1977. High sulfate values (higher than ISPCB standards) were found during April at all pond stations except

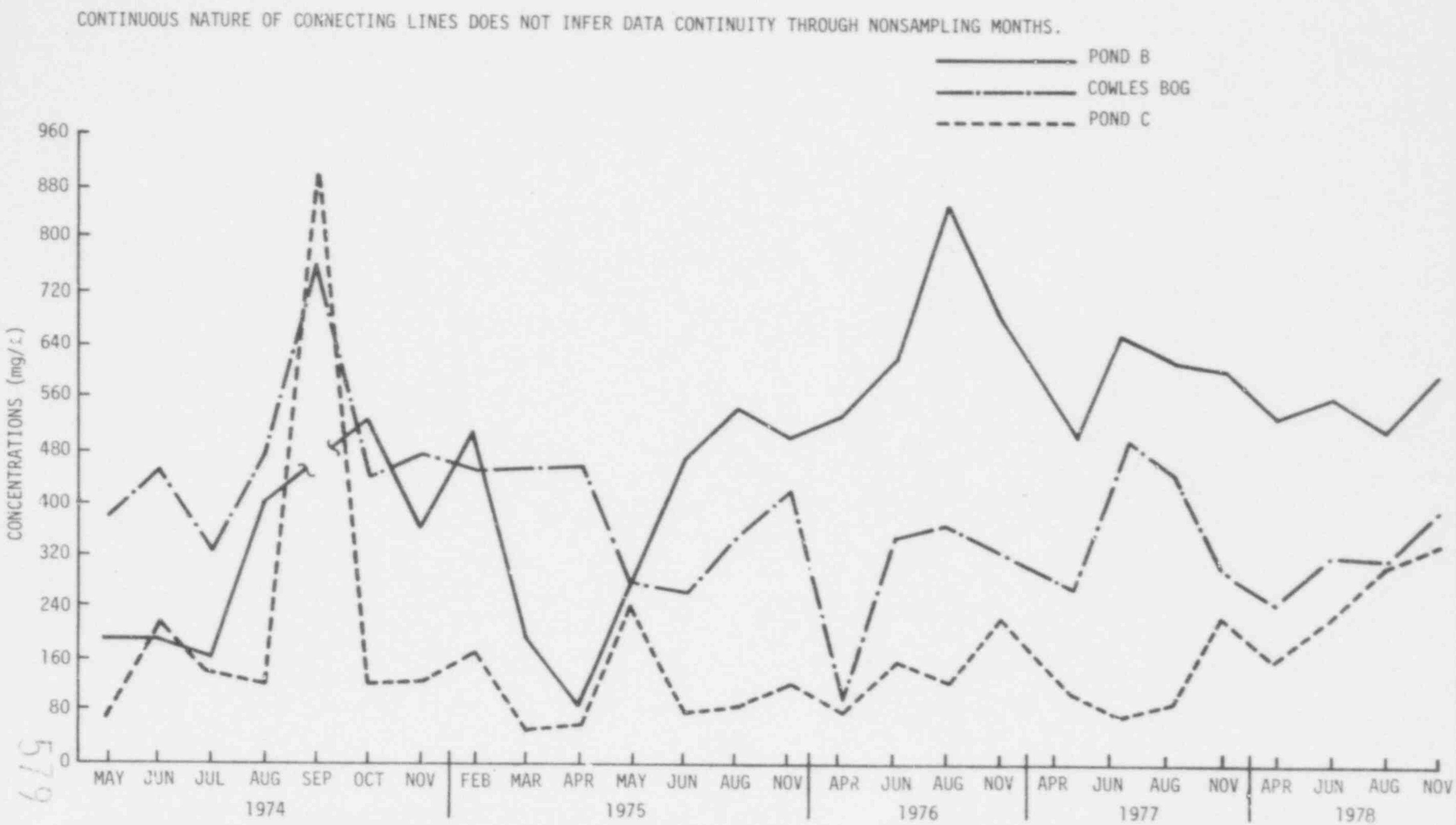


Figure 2.6-4. Total Dissolved Solids Concentration (mg/ℓ) from Interdunal Pond Samples, NIPSCo Bailly Study Area, 1974-1978

579 313

Station 13 (higher than previous years). The levels of sulfate in Pond C and Cowles Bog were reduced to near Lake Michigan levels during the remainder of the year. No exact explanation is evident and high levels may simply be the result of increased spring runoff. There are no defined ISPCB standards for any of the above parameters except sulfate. All of the above are found in what are considered to be acceptable concentrations in lake and discharge samples. Their concentrations in Lake Michigan appear to be indicative of water of good environmental quality. Results for all nearshore ponds revealed higher concentrations of calcium, magnesium, potassium, and sulfates than in Lake Michigan, although levels in Pond C and Cowles Bog were periodically as low as lake values.

Since the beginning of the study in May 1974, a trend of increasing sulfate concentrations has been observed in Pond B. An attempt was made to relate concentrations in Pond B to concentrations in the ash settling ponds, particularly ash ponds 2 and 3 (stations 14 and 15), which are located directly across the Bailly station access road from Pond B. Although a trend of increasing sulfate concentrations was observed in the ash ponds as well as in Pond B, the relationship between the ash ponds and Pond B is not totally clear, as shown in Figure 2.6-5.

Hardness is affected by a variety of ions, primarily calcium and magnesium, mainly because of the ability of these ions to remain in solution at high concentrations. Since relatively small fluctuations (10 to 20 percent) in calcium and magnesium concentrations were observed in the lake, the result was relatively constant hardness for 1978, as in previous years. Hardness fluctuated more in the nearshore ponds than in Lake Michigan, as expected based on wide variability in ionic concentrations. For example, June 1978 calcium values ranged from a low 23.1 milligrams per liter in Pond C to 112 milligrams per liter in Pond B. Variability was similar in other months.

Chlorides, chlorine, and fluorides were found at low concentrations in both Lake Michigan and the interdunal ponds. Chloride levels have averaged 10 ± 2 milligrams per liter in Lake Michigan since program initiation in May 1974. Values in the interdunal and ash ponds have been only slightly different and were relatively similar to Lake Michigan levels in 1978. Chlorine levels have

579 314

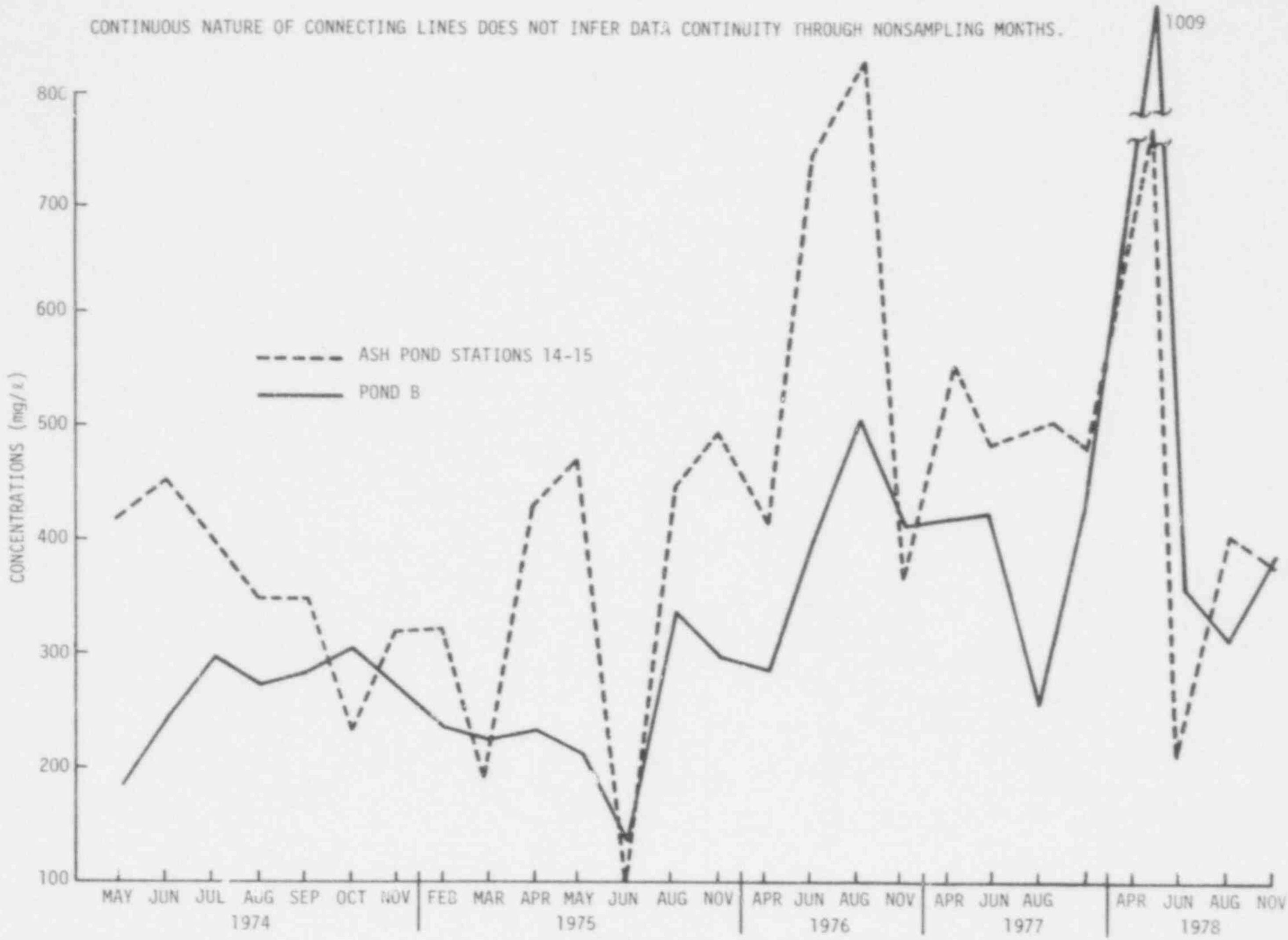


Figure 2.6-5. Sulfate Concentrations Recorded in Pond B and Ash Settling Ponds Stations 14 and 15, NIPSCo Bailly Study Area, 1974-1978

averaged 10 ± 2 milligrams per liter in Lake Michigan since program initiation in May 1974. Values in the interdunal and ash ponds have been only slightly different and were relatively similar to Lake Michigan levels in 1978. Chlorine levels have remained at or below limits of detectability (≤0.01 milligrams per liter) in both the lake and the ponds throughout the study, while fluoride levels have remained at approximately 2 milligrams per liter or less and during 1978 were less than 0.5 milligrams per liter in all samples.

Odor, the last general water quality parameter to be considered, is restricted by Indiana standards to being less than 8 units for a single value or a daily average of 4 units. The method for obtaining these values is to dilute the original sample with odor-free water and smell it. A value of 4 indicates a sample having a detectable odor after dilution to one fourth of its original concentration. This was done for samples from the Bailly vicinity, with values being reported as positive (mean value 4 or greater or single value(s) of 8 or greater) or negative (no detectable odor). Results for 1978 were identical to previous years' results. Lake samples had virtually no odor and were reported as negative in all cases. All settling pond samples were negative, but all natural pond samples had detectable odors exceeding ISPCB standards, undoubtedtly due to decomposition of organic material. This is natural for most small pond systems, except for relatively rare sand-bottom oligotrophic ponds, and was expected in the nearshore ponds.

2.6.4.2 Aquatic Nutrients. Nineteen elements have been reported as being essential nutrients for aquatic plants: boron, carbon, calcium, chlorine, cobalt, copper, iron, hydrogen, potassium, magnesium, manganese, molybdenum, nitrogen, sodium, oxygen, phosphorus, sulfur, vanadium, and zinc (AWWA 1970). In this group the less common are as essential for plant growth as are the more common elements — carbon, hydrogen, oxygen, nitrogen, and phosphorus. The major nutrients considered in the Bailly N-1 study were phosphorus (orthophosphate and total phosphorus), nitrogen (ammonia nitrogen, nitrate, nitrite, and organic nitrogen), and silica. Studies by FWPCA (1968) have shown that ammonia, total phosphorus, and silica are not heavily concentrated in the nearshore areas of southern Lake Michigan. The potential effect of additions of these elements, particularly phosphorus and nitrogen, is as follows (from Schelske 1971):

579 316

- Increase in plankton biomass
- Decreasing water transparency
- Changing water color (apparent)
- Oxygen depletion in the hypolimnion
- Changes in species composition

These effects are generally considered undesirable, as they change the ecosystem, reduce recreational opportunities, increase costs for water treatment, and reduce or destroy aesthetic values. Conclusions from studies of Lake Michigan (Schelske 1971) are that 1) silica depletion will become an increasingly serious problem (values of less than 0.1 milligram per liter were reported as early as 1969 in southern Lake Michigan by Schelske 1971); 2) phosphorus additions have caused an increased demand by diatoms for available soluble silica supplies; and 3) because of the conditions 1 and 2, Schelske predicted a possible shift from diatom-dominant populations to increasing green- and blue-green-dominant populations. An examination of the 1978 phytoplankton data from the vicinity of Bailly Station shows that such a shift may indeed be occuring. While diatoms remain the biovolume dominant, green and blue-green algae dominated the density in June, August, and November 1978.

Silica (SiO_2) is a common component of natural waters. Silica is important, since diatoms incorporate silica into their frustules during reproduction. Unlike many other minerals, silica does not appear important in the composition of animal or plant protoplasm.

As mentioned, silica concentration has decreased in Lake Michigan since the early 1900's, and silica is now found primarily offshore away from the productive nearshore zone. The downward trend in silicates in Lake Michigan is shown in Figure 2.6-6. In the vicinity of Bailly Station, silica concentrations during 1978 ranged from 0.05 to 0.55 milligram per liter; 1974 through 1977 data yielded similar ranges, although mean values did fluctuate by month, as shown in Figure 2.6-7.

Silica was found at considerably higher levels in the interdunal ponds than in Lake Michigan (Figure 2.6-8). Values in Ponds B and C tended to be lower in spring, a period of known diatom abundance, and higher in the summer. Values within Cowles Bog were erratic, ranging from 1.57 to 22.1 milligrams per liter.

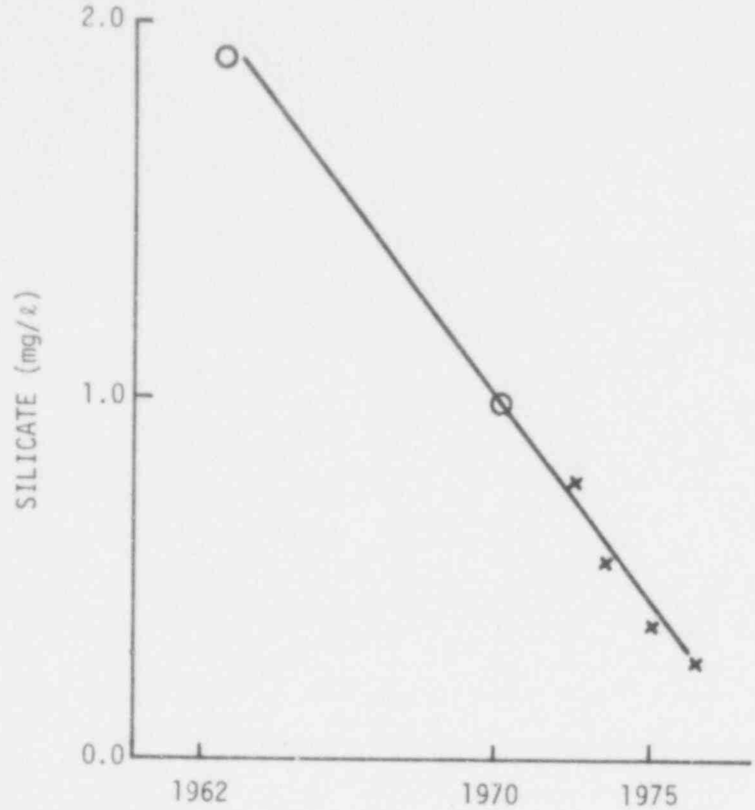


Figure 2.6-6. The Downward Trend in Silicate Concentrations (mg/ℓ) in Lake Michigan during the Period 1962-1975 (From Verdium, 1977 — data compiled from 1962 data of Risley and Fuller [1965], 1970 data of Schelske and Roth [1973] and 1971-1975 data collected by NALCO Environmental Sciences for Commonwealth Edison Company)

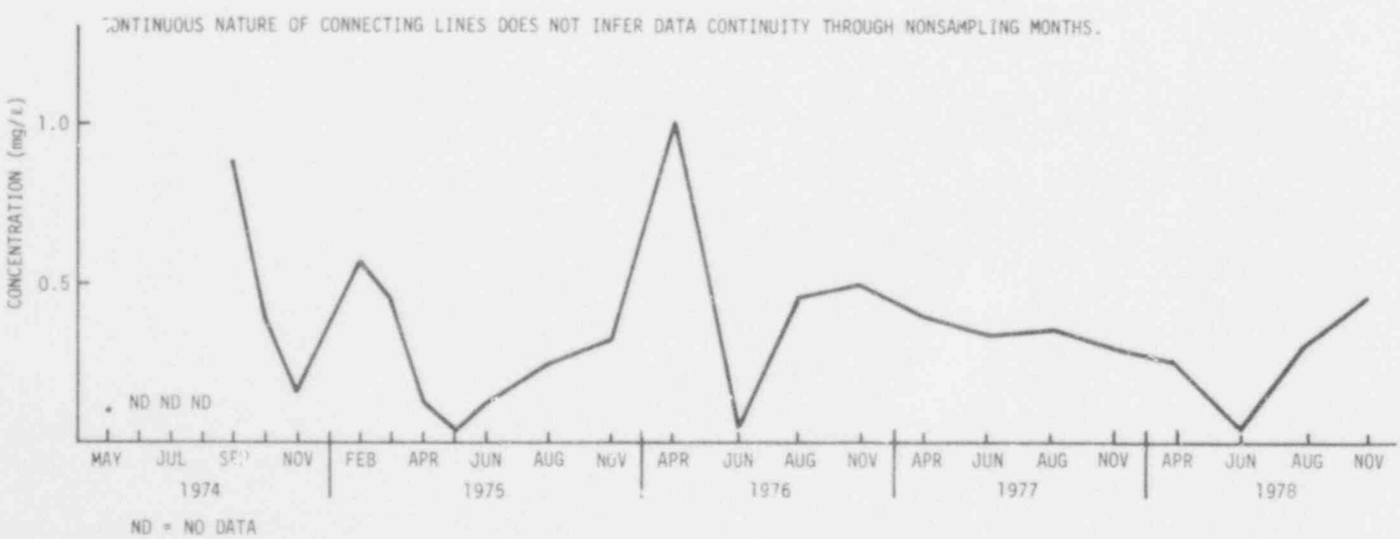


Figure 2.6-7. Mean Silica Concentrations (mg/ℓ) at Lake Michigan Stations in the NIPSCo Bailly Study Area, 1974-1978

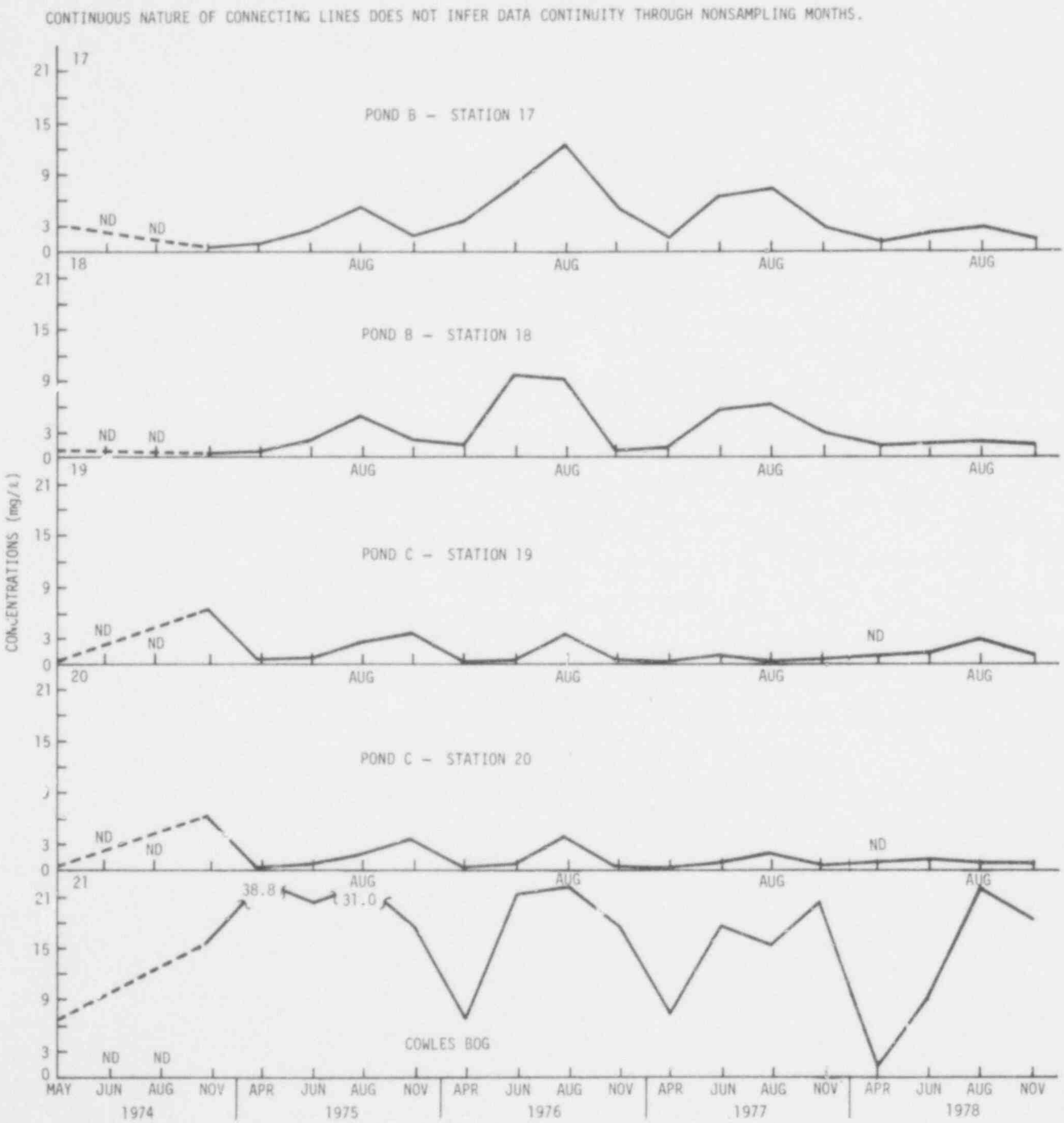


Figure 2.6-8. Silica Concentrations (mg/ℓ) over the Period May 1974-November 1978, Interdunal Ponds, NIPSCo Bailly Study Area

Phosphorus occurs in many forms in aquatic ecosystems. The fully oxidized state, phosphate, is the principal form in naturally occurring phosphorus compounds. Orthophosphate (PO_4^{-3}) is generally the least abundant nutrient in natural waters, although it is the active component involved in growth of green aquatic plants. Considering the principal forms of phosphorus, dissolved orthophosphate makes up only 0.21 percent of the total, while particulate phosphorus represents 98.5 percent of the total. Concentrations of orthophosphate and total phosphorus in Lake Michigan during 1978 ranged from <0.002 to 0.310 milligram per liter and <0.002 to 0.540 milligram per liter respectively. The high orthophosphate and total phosphorus values were apparently caused by sample bottle contamination (see Appendix Table G-7). Other values (those not believed contaminated) were comparable to the 1977 and 1976 Lake Michigan levels.

A possible source of the high concentrations is Burns Ditch, which is relatively close to Station 2 and which is one of the major sources of phosphorus input to Lake Michigan (Table 2.6-3). Because of the random distribution and occurrence of the higher phosphorus levels at the Bailly site, concentrations do not appear to be related to plant operations.

Phosphorus (orthophosphate and total) loadings in the nearshore ponds were generally similar as a group to those in the lake. Concentration varied from <0.002 to 0.500 milligram per liter for orthophosphate and <0.002 to 0.632 milligram per liter for total phosphorus. Ranges for previous years were similar as shown for phosphates in Figure 2.6-9. Values were high in Ponds B and C in the initial month of study (April), but decreased to lower and fairly constant levels thereafter. Levels in Cowles Bog were much more variable; peak in phosphorus each year were recorded in June or August.

The remaining major nutrient measured in the Bailly Station study was nitrogen, which exists in several forms in the aquatic ecosystem, including dissolved nitrogen gas (N_2), ammonia nitrogen (NH_4^+), nitrate salts (NO_3^-), nitrite (NO_2^-), ions, and organic nitrogen compounds (primarily attributable to the presence of aquatic life). The community structure of the aquatic ecosystem can be influenced by the concentration of the above forms, which are commonly made available to the aquatic ecosystem through biological processes (such as nitrogen release, denitrification, nitrification, and nitrogen fixation). Most of the nitrogen other than gaseous N_2 is in the form of organic nitrogen (Sauchelli 1964, as

Table 2.6-3

Contributions of Total Soluble (PO_4)[a] and Silica to Lake Michigan by 19 Tributaries (1963-1964). Data from Ayers (1970)

	Mean flow cfs	Mean concentrations mg/l		Loading lbs/day	
		Total soluble PO_4	SiO_2	Total soluble PO_4	SiO_2
Boardman	186	C.20	7.5	275	10328
Manistique	845	0.04	5.8	182	26400
Manitowoc	83	0.62	5.7	277	2550
Sheboygan	132	0.40	3.9	285	2780
Milwaukee	191	0.61	2.8	628	2880
Burns Ditch	150	1.8	10.	1456	8090
St. Joseph	2060	0.24	6.4	2670	71000
Kalamazoo	1140	0.21	5.9	1290	36300
Grand	1900	0.52	5.3	5330	54300
Muskegon	1731	0.06	5.6	560	52300
Pere Marquette	570	0.03	7.8	92	24000
Fox	4420	0.28	9.4	6670	224000
Oconto	790	0.17	9.2	724	39200
Peshtigo	890	0.08	9.8	384	47000
Menominee	3250	0.11	4.4	1930	77100
Ford	337	0.04	7.0	73	12700
Escanaba	1017	0.06	7.0	329	38400
Rapid	80	1.59	3.1	686	1340
Whitefish	227	0.18	5.7	220	6980
Sums				24,061[b]	737,648[b]

a. PO_4 values should be divided by 3 to convert concentrations to phosphate as phosphorus.

b. Ayers has corrected the sums to account for ungaged drainage and for mean flows that were smaller in 1963-64 than the long-term mean flows. The combined correction increases the sums by a factor of 1.3.

200-300 mg/m^3 NO_3-N and 10 mg/m^3 PO_4-P and greater concentrations during the winter are sufficient to cause phytoplankton problems. Because nutrients flow into most lakes throughout the year, another way of looking at the problem is in terms of loading on an annual basis. Vollenweider has developed a loading scale for phosphorus and nitrogen from data for European lakes based on the average depth of a lake. The utility of the loading scales depends on many factors other than average depth, including depth of photic zone, residence time of water in the lake, and rates of mixing in relation to the surface area of the lake. In other words, any process that tends to maintain phosphorus in the system from year to year will decrease the permissible or dangerous loadings.

CONTINUOUS NATURE OF CONNECTING LINES DOES NOT INFER DATA CONTINUITY THROUGH NONSAMPLING MONTHS.

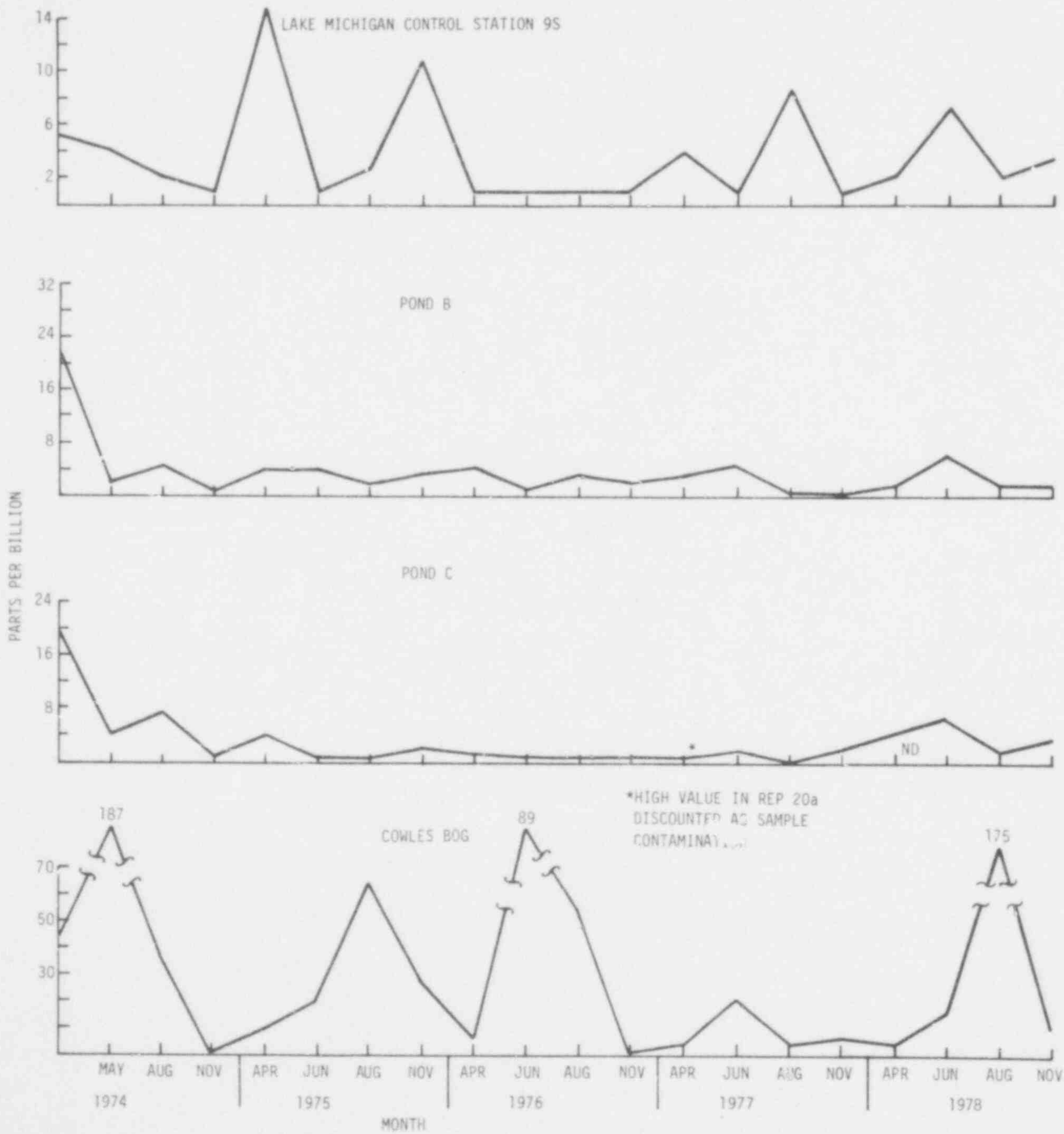


Figure 2.6-9. Orthophosphate Concentrations (parts per billion) from Lake Michigan Control Station 9S and Interdunal Ponds, 1974-1978

recorded from AWWA 1970). Inorganic nitrogen forms seldom exceed concentrations of a few milligrams per liter in surface waters, although they may reach 100 parts per million in ground waters. The concentrations of nitrogen in the water varies widely in the U.S., ranging from 0.1 to 3 milligrams per liter. ISPCB or U.S. EPA standards permit the following maximum levels:

Ammonia — 0.05 milligram per liter
Nitrates plus nitrites — 10 milligrams per liter
Total organic nitrogen — no limits set

Of the nitrogen found in nature, organic nitrogen, as mentioned, is the predominant form, followed closely by nitrate nitrogen (Hutchinson 1957). This is particularly true in the summer because of rapid incorporation of organic nitrogen by green plant tissue and because of the more complete nitrification occurring at this time.

Ammonia nitrogen concentrations in Lake Michigan were similar in April and June, decreased in August, and then increased in November (Table 2.6-4). Somewhat similar trends were observed in past years. Values for ammonia exceeded ISPCB standards only during November 1978 at stations near the plant discharge; values exceeded ISPCB standards in portions of all previous years; power plant operation has seemed to have little apparent relationship to these excessive values. Significantly fewer ammonia values were in excess of state standards during 1978 than during 1977 when standards were exceeded during all months sampled.

During all five years, ammonia values were high at many pond stations, in some cases exceeding standards several fold. These levels were due primarily to microbial activity on detritus and possibly the introduction of ammonia from external sources. The excessive values in the ponds were probably of natural origin, as from decomposition products.

No extremely detrimental concentrations of ammonia were observed during 1978, 1977, or 1975 sampling periods in the nearshore ponds. During September 1974 a 1.66-milligram per liter value was recorded at Station 20 while a 1.54-milligram per liter value was recorded at Station 17 in November 1976. Both values are in excess of the 0.29 to 0.41-milligram per liter levels noted by Ball (1967) as being lethal to lake trout and yellow perch (neither of which are

Table 2.6-4

Concentrations of Ammonia, Nitrate, Nitrite, and Organic Nitrogen Recorded at Lake Michigan Control Station 9S and Interdunal Pond Stations 17-21, May 1974-November 1978

		Location							
		Ammonia		Nitrate		Nitrite		Organic Nitrogen	
Year	Month	9S	Pond	9S	Pond	9S	Pond	9S	Pond
1974	May	0.06	0.15	0.03	1.90	0.006	0.008	0.10	0.31
	Jun	0.02	0.06	0.18	0.02	0.006	0.006	0.31	1.22
	Jul	0.004	0.53	0.16	0.02	0.005	0.004	0.16	1.82
	Aug	0.004	0.11	1.45	0.04	0.007	0.004	0.34	1.24
	Sep	0.04	0.49	0.17	0.01	0.005	0.004	0.23	0.98
	Oct	0.03	1.22	0.10	0.01	0.004	0.006	0.11	1.45
	Nov	0.05	0.81	0.26	0.05	0.005	0.004	0.18	1.16
1975	Feb	0.10	0.66	0.27	0.006	0.004	0.007	0.15	0.77
	Mar	0.05	0.12	0.29	0.006	0.003	0.004	0.05	0.48
	Apr	0.03	0.058	0.27	0.03	0.004	0.002	0.09	0.41
	May	0.07	0.060	0.31	<0.04	0.008	0.004	0.20	0.46
	Jun	0.04	0.049	0.23	<0.04	0.006	0.002	0.13	0.60
	Aug	0.02	0.054	0.18	0.04	0.005	0.002	0.17	0.56
	Nov	0.008	0.089	0.13	0.05*	0.004	0.005	0.12	0.67
1976	Apr	0.03	0.112	0.26	0.37	0.004	0.003	0.17	0.28
	Jun	0.02	0.430	0.18	<0.04	0.004	0.002	0.05	0.36
	Aug	0.01	0.213	0.18	<0.04	0.007	0.002	0.13	0.30
	Nov	0.05	0.572	0.14	0.35	0.005	0.005	0.07	<0.04
1977	Apr	0.02	0.206	0.26	0.06	0.002	0.003	0.18	0.32
	Jun	0.04	0.293	0.24	0.11	0.002	0.007	0.14	0.54
	Aug	0.01	0.061	0.14	0.01	<0.002	0.002	0.11	0.27
	Nov	0.07	0.078	0.21	0.04	0.003	0.002	0.19	0.37
1978	Apr	0.04	0.042	0.25	0.166**	0.003	0.002**	0.71	0.90
	Jun	0.02	0.100	0.95	0.103**	0.003	0.009	0.44	0.76
	Aug	0.01	0.013	0.15	<0.040	<0.002	0.005	0.23	0.59
	Nov	0.04	0.177	0.16	0.060	0.003	0.004	0.31	0.91

*Sample contamination in three samples; these values were deleted in calculation.
**Sample values below detection not used in calculation.

thought to be found in Pond B) in 2 to 7 days (LD_{50} or 50 percent death in 2-7 days). Other species (e.g., green sunfish or bluntnose minnow which could potentially be in the pond) would not have been as susceptible to these concentrations (Henderson et al 1960, Hemens 1966, Summerfelt and Lewis 1967) but probably would have moved from the zone. Because of the wind-mixing potential of these shallow ponds, it is unlikely that toxic levels of ammonia were reached, and no dead fish have been noted during sample collection.

579 324

This same nitrogen load that controlled ammonia levels undoubtedly also affected nitrate and nitrite loadings, total levels of which must be below 10 milligrams per liter by U.S. EPA standards. Levels in the lakes and ponds never exceeded this value during the four years. Although nitrate values in Lake Michigan were higher than normal during November 1975, with concentrations at Station 5 of 2.80 milligrams per liter and at Station 6 of 2.80 and 3.40 milligrams per liter, levels during 1976 and 1977 never exceeded 0.3 milligram per liter; 1978 values were similarly low and usually below 0.2 milligram per liter. Concentrations in the interdunal ponds were usually lower. Concentrations from comparable months (insofar as data were available) of 1974-1978 are shown in Figure 2.6-10.

With the exception of a relatively few higher values, nitrate levels in Lake Michigan and the ponds were stable. Average levels in Cowles Bog were the lowest observed in the study, often below the 0.04 milligram per liter detection limit.

Nitrites occur in very minute quantities in unpolluted waters (Reid 1961); appreciable quantities of nitrite are characteristic of sewage contamination. Seasonal variation in nitrites generally followed nitrate concentrations. Since all green plants require nitrate, the amount of nitrite, which is converted to nitrate by nitrifying bacteria such as Nitrobacter, is often quite low at the end of the growing season. This appeared to be the case in the Bailly study, where levels less than or equal to 5 micrograms per liter were reported by the end of the growing season. Concentrations of nitrite in the ponds were generally lower than in Lake Michigan, with the exception of several of the ash settling ponds which may receive some nitrite addition via sanctuary wastes.

Organic nitrogen is formed and degraded primarily by biological action. The commonly recognized forms of organic nitrogen are proteins and their derivatives — purines, pyrimidines, and urea (AWWA 1970). The concentration of organic nitrogen can be expected to vary seasonally in natural waters such as Lake Michigan.

Total organic nitrogen is a valuable indicator of the productivity of a body of water. Lake Michigan organic nitrogen values in the vicinity of Bailly Station ranged from 0.09 to 0.74 milligram per liter during 1978. Values for

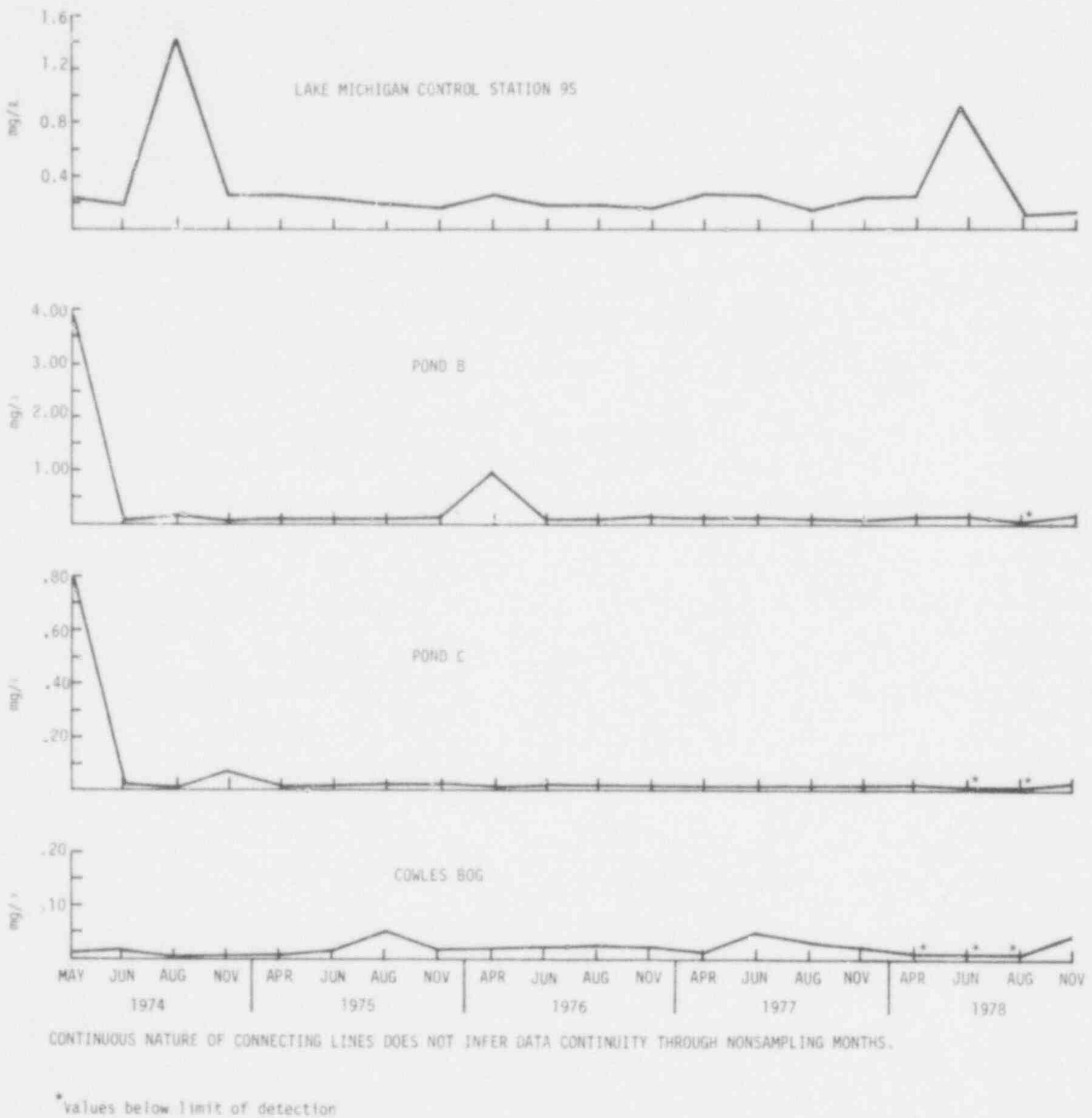


Figure 2.6-10. Nitrate Nitrogen Concentrations (mg/ℓ) at Lake Michigan Control Station 9S and Interdunal Ponds, 1974-1978

579 326

previous years were in the same range. Values in the ponds exhibited individual ranges from <0.03 to 1.49 milligrams per liter. Values from the ponds in previous years were similar. The interdunal ponds, especially Cowles Bog, exhibited generally higher concentrations and greater fluctuations than Lake Michigan. The previous years' studies revealed similar trends. The relatively low organic nitrogen concentrations in the lake were substantiated by low phytoplankton productivity results, while higher organic nitrogen concentrations in the ponds indicated a higher productivity, as substantiated by results of concurrent phytoplankton analysis.

Observations of the concentrations of the above described aquatic nutrients revealed that the waters of southern Lake Michigan in the study area are environmentally of excellent quality and can support diverse aquatic communities; the nearshore ponds are somewhat more enriched (with the exception of silica) but should, and do, support a diverse communtiy.

2.6.4.3 Trace Elements in Water. Trace elements are as essential to plant growth as are the more common compounds such as nitrates, phosphates, and silicates. However, just as with the nutrients, an overabundance of a trace element can cause problems to the indigenous flora and fauna. For example, copper is important for algal growth at low concentrations but at higher concentrations inhibits algal growth. Mercury can become concentrated in fish and other animal tissues and is linked to poisoning and reduced reproduction. Cadmium, lead, and zinc are known toxic metals to which some plants (such as *Typha latifolia*, broad-leafed cattail) can develop a tolerance (McNaughton et al 1974), thus preventing devoid areas in the vicinity of known concentrations of these elements. Copper, nickel, and zinc have been shown to be toxic to some fish species by investigators including Renwoldt et al (1971) and Doudoroff and Katz (1953).

With this background and other literature in mind, water quality standards for the great majority of these elements have been proposed. For the State of Indiana, these have been presented in Table 2.6-1. Data collected in the Bailly Station vicinity will be compared with these standards.

During the period April 1976 through March 1979, in Lake Michigan, samples for trace element analysis were not scheduled for collection. During 1974, cadmium

579 321

concentrations were reported in excess of limits in seven of 42 samples collected in Lake Michigan during October. This is the only known excessive occurrence. During 1975 and 1976, many of the trace element concentrations were at or below analytical detection limits, an indication of water of good quality for existing biota.

The trace element survey in the nearshore ponds revealed no trends, but constant fluctuations of all values. Cadmium, manganese, and nickel were found in concentrations greater than ISPCB limits during 1978. Mercury, which had been found at greater than U.S. EPA recommended levels in 1974 and 1975, was not found to exceed these levels in 1976, 1977, or 1978 samples. Table 2.6-5 shows those elements in excess by month for the 1978 collections. Tables 2.6-6, 2.6-7, 2.6-8, and 2.6-9 show excessive values for 1977, 1976, 1975, and 1974, respectively. The other element showing values above limits during past years was iron. During 1978 iron levels were below maximum standards. The source of this element is thought to be airborne input from nearby steel producing facilities. Cadmium, lead, and manganese were found in all ponds during 1978 in at least one of the quarterly samples. Coal-ash deposition is thought to be the cause for the levels in the ash ponds; subsequent seepage to Pond B is speculated but unproved as the source of manganese in Pond B.

Table 2.6-5

Trace Element Concentrations Exceeding Indiana Standards as Recorded in the NIPSCo Bailly Study Area, April 1978-March 1979

Element	Stations* 1-10	Ash Ponds	Pond B	Pond C	Cowles Bog
Cadmium		Apr, Nov, Aug	Jun		
Chromium					
Copper					
Iron					
Lead					
Manganese		Apr, Nov			
Mercury					
Nickel		Nov			
Zinc					
No. of values in excess		6	1	0	0

*No samples collected at these stations

Table 2.6-6

Trace Element Concentrations Exceeding Indiana Standards as Recorded in the NIPSCo Bailly Study Area, April 1977-March 1978

Element	Stations* 1-10	Ash Ponds	Pond B	Pond C	Cowles Bog
Cadmium		Apr, Jun Aug, Nov			
Chromium		Jun, Nov			Jun
Copper					
Iron		Apr, Jun Aug, Nov	Aug, Nov	Nov	Apr, Jun Aug, Nov
Lead		Aug			
Manganese		Apr, Jun Nov	Nov		
Mercury					
Nickel					
Zinc					
No. of values in excess		14	3	1	5

*No samples required at these stations

Table 2.6-7

Trace Element Concentrations Exceeding Indiana Standards as Recorded in the NIPSCo Bailly Study Area, January 1976-March 1977

Element	Stations* 1-10	Ash Ponds	Pond B	Pond C	Cowles Bog
Cadmium		Apr, Jun Aug, Nov	Apr		
Iron		Apr, Jun	Apr, Aug	Jun, Aug	Jun, Aug
Manganese		Apr, Jun Aug, Nov	Apr Nov		
Chromium, Hexavalent		Aug			
Chromium, Total		Aug			
Nickel					
No. of months x No. of occurrences		14	6	2	2

*Not sampled for these elements in 1976

579 329

Table 2.6-8

Trace Element Concentrations Exceeding Indiana Standards as Recorded in the NIPSCo Bailly Study Area, April 1975-March 1976

Element	Stations* 1-10	Ash Ponds	Pond B	Pond C	Cowles Bog
Mercury		Mar, Jun	Jun	Nov	May
Cadmium		Mar, Apr May, Aug Nov			
Iron		Mar, May Aug, Nov	Mar, Jun	May, Apr Jun	Mar, Jun Nov
Manganese		Mar, Apr May, Jun Aug, Nov	Mar, Apr May, Aug Nov	Apr, May Nov	Apr, May Nov
Chromium		Nov			
No. of months x No. of occurrences		18	8	7	7

*None

Table 2.6-9

Trace Element Concentrations Exceeding Indiana Standards as Recorded in the NIPSCo Bailly Study Area, May 1974-February 1975

Element	Stations 1-10	Ash Ponds	Pond B	Pond C	Cowles Bog
Mercury		May, Jun Jul, Aug Nov, Feb	May, Jun Nov, Feb	May, Jun Nov, Feb	Jun, Feb
Cadmium	Oct	May, Jun Jul, Aug Sep, Oct Nov	Aug		
Iron		May, Jun Jul, Oct Feb	Jul, Aug Sep, Oct Feb	Jun, Jul Aug, Sep Oct, Feb	Jun, Jul Aug, Feb
Manganese		May, Jun Jul, Aug Sep, Oct Feb	May, Jun Jul, Aug Sep, Oct Feb	Jun, Jul Aug, Sep Oct, Feb	May, Jun Jul, Aug Sep, Oct Feb
Chromium		May, Nov	Nov	Nov	May, Jun Jul
No. of months x No. of occurrences	1	27	18	17	16

579 330

Iron has received particular attention. Although lethal levels are estimated by Shaw and Gruskin (1967) as 100 milligrams per liter (for Daphnia magna) and the observed concentrations did not approach this level, concentrations approaching 20 milligrams per liter were observed in November 1977 in both Pond B and Cowles Bog, as well as within the ash ponds. Although ash pond water may be leaching into Pond B and carrying iron with it, the source of the iron in the more distant Cowles Bog is less clear, particularly since Pond C iron concentrations were low. Probable sources for the element are being searched for at this time. These high iron concentrations did not recur in 1978 with no direct source being resolved.

Because of the scattered nature of excess values, the observed high and low values may be a normal pond cycle. The increases are possibly due to changes in solubility or to additions from external sources (possibly airborne pollutants from nearby manufacturing facilities). Decreases may occur through dilution by rainfall or through uptake by the aquatic flora or sediments. The dramatically lower iron levels found during 1978 are not understood at this time in relation to previous years' data.

Whatever the source of excess trace elements in the ponds, the indigenous pond populations have suffered no apparent ill effects. As mentioned in other sections, productivity in the ponds is higher than in the lake, and species composition is varied.

2.6.4.4 Indicators of Industrial and Organic Contamination. As with the other parameters studied in the Bailly Station vicinity, indicators of industrial and organic contamination are represented by several parameters: fecal and total coliform bacteria, chemical and biochemical oxygen demand (COD and BOD), total organic carbon (TOC), cyanides, phenols, hexane-soluble materials, and methylene blue active substance. All have limits prescribed in Indiana or U.S. EPA standards, as listed in Table 2.6-1. These standards will be used for comparison to all data presented.

Fecal and total coliform bacteria are a measure of a system's contamination by coliform bacteria and provide an index of contamination by warm-blooded animals. The coliform bacteria are a group of 17 bacterial forms, only four of which are fecal in origin. The remainder are natural soil or water organisms. Levels

prescribed for Lake Michigan are 20 per 100 milliliters of fecal coliform bacteria in open water and 200 per 100 milliliters at beaches, based on a geometric mean of five samples. No specific limits for total coliform levels are available.

Considerable variability existed in fecal and total coliform levels during 1978. During April all settling ponds, interdunal ponds and Cowles Bog had fecal coliforms <1 per 100 milliliter. Highest fecal coliforms were found during August in Pond B and Cowles Bog, 30,750 and 23,250 cells per 100 milliliters respectively. Although very high, these values do not specifically exceed allowable limits as there are none specific to these waters. The source of the coliform bacteria is not known but is not attributed to operation of the power plant. Relatively high total coliform bacteria were present in the natural ponds and Cowles Bog during all sampling periods. Total coliforms were high in the ash settling ponds during June and August only. As in previous years of study highest bacterial levels were associated with highest water temperatures in August.

Biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total organic carbon (TOC) are all methods used for determination of total organic contaminants. Measuring TOC is a direct determination of contaminating pollutants in the water (APHA 1971). BOD and COD are both "methods for measuring organic contaminants based on determinations of the equivalence of oxidizing agents which can react with organic substances" (APHA 1971). While not direct measures of organic contamination, these methods are widely used, and a rationale for data interpretation has been developed. Allowable limits for these three parameters have not been established.

The natural ponds yielded somewhat higher BOD, TOC, and COD concentrations than did the settling ponds. Overall, BODs were generally low, with the highest value reported, 37 milligrams per liter, in Cowles Bog during June. COD and TOC measurements were also highest in Cowles Bog. Cowles Bog generally behaved differently from the other ponds because of differences in nutrient input, productivity, and amounts of decomposable organic matter present. During 1974, 1975, 1976, and 1977, the interdunal ponds (especially the Cowles Bog area) also revealed higher BOD, TOC, and COD levels than the settling ponds. In general, these three measurements indicate that the nearshore ponds have reasonably low

579 332

levels of organic loading, with the variations during the study apparently seasonally related to macrophyton growth and runoff patterns.

These remaining parameters, hexane-soluble materials (oil and grease), phenols, and methylene blue active substances (surfactants), were also analyzed as indicators of contamination. Phenols and methylene blue active substances (MBAS) are both low-level parameters (Indiana standards are 0.001 milligram per liter for phenols). MBAS levels were never above detection limit 0.02 and phenols were detected at concentrations above detectability limits only in April 1978. As these compounds were found only in April and at very low concentrations, it is not considered noteworthy. Hexane-soluble materials (oils and greases) have no assigned standard in Indiana regulation SPC-4R-2. The ponds were generally low in hexane-soluble materials. The highest value (73.6 milligrams per liter) was observed at pond station 14 during April 1978. The source of the material is unknown, but levels had dropped to below detectability by June and remained so during the rest of the year.

2.6.4.5 Trace Elements in Sediments. Trace elements often collect in sediments at much higher concentrations than in the water column. Much of the material becomes tied to clay-micelles, to *Sphagnum* in bogs, and to detritus, effectively removing it from the system except under specific conditions of low oxygen tension. When such conditions occur and the oxidation/reduction potential changes, iron, manganese, and silica concentrations often rise in the interstitial waters (Sullivan 1967), and mineral recycling begins at the sediment-water interface. When lake or pond waters turn over, this hypolimnetic concentration is mixed throughout the water column, providing a basis for the primary productivity and for all levels that depend on that primary production.

During sampling year 5, sediment samples in the NIPSCo Bailly Station vicinity were collected during April, August, and November 1978 and January 1979. Samples were collected and processed according to an EPA procedure in which a weighed portion of settled, wet, dredge material was added to a fixed volume of water and shaken under controlled conditions. After shaking, the samples were settled and the supernatant decanted and analyzed. Results were expressed in milligrams of constituent per kilogram of sediment (equivalent to parts per million).

579 333

Sediment elements analyzed were cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium, zinc, and total phosphorus. These elements were chosen for their importance as nutrients to the phytoplankton and, in the case of metals like mercury, because of their potential danger in human consumption of fish.

Values for all ranged from low to moderately high. Concentrations of many elements were at or below analytic detection limits. For example, mercury was below detection limits except during January 1979 when levels were only slightly elevated. Selenium was below detectable levels at most stations during the entire year. Only at stations 14, 15, 16, and 17 during November and stations 17, 18, and 19 during January were detectable levels found.

Cadmium was low in all months in the natural ponds but present in concentrations up to 0.045 milligram per liter in the ash settling ponds; very similar to 1977 levels.

Chromium, copper, and nickel were also found in low concentrations, with the highest concentrations generally occurring during November. Average concentrations of copper at each station revealed values below allowable maximum levels even for water samples, much less sediment.

Vanadium and manganese, both important trace elements for phytoplankton, were present during 1978. Vanadium was present during August, November, and January at low levels, while manganese was present in all four months at levels up to 77 milligrams per kilogram (Station 19). Levels of manganese were higher than previous years. In general the values in the interdunal ponds are thought to be due to allochthonous airborne additions, but the high manganese levels are difficult to explain. It does appear that wastes from the Bailly Station had any effect on manganese levels, based on the low observed levels in the ash ponds.

Zinc concentrations were similar to those found in 1977. No standards for zinc have been promulgated for sediment samples, but allowable water concentrations are 5 milligrams per liter and this level was not exceeded.

Phosphorus and iron are commonly reported together in sediment analyses. Phosphorus values were moderate at most stations, with a range of 0.003 to 0.876 milligram per kilogram reported; many values for total phosphorus were below

applicable standards for water. (Again, no standards for sediments have been promulgated.) Iron was found in concentrations ranging from <0.003 milligram per kilogram to 43.8 milligrams per kilogram. Iron was also found to be in excess in water samples from all ponds, as discussed previously, though more frequently in the ash ponds. Airborne particulates may be the source of this material.

Lead values were highly variable. Levels ranged from below detection limits to 0.087 milligram per kilogram. Highest values were recorded in the ash ponds. None of this material appears to have been released into the water column.

From the composite data, it appears that from 1974 through 1978:

- Cadmium, mercury, and phosphorus appear tied to ash deposition or atmospheric particulate fallout. Iron and manganese values also appear tied to atmospheric deposition although the high manganese and iron values in 1978 are unexplained.

- There is a tendency for a general decrease in most trace elements with the onset of winter.

- Copper and lead values fluctuate erratically in the environment (possibly chromium and manganese also).

- Sediment selenium values probably reflect background levels and are influenced little or not at all by the existing Bailly station plant or other facilities in the area.

579 335

2.7. AQUATIC REFERENCES CITED

Alley. W.P. 1964. Ecology of the burrowing benthos amphipod Pontoporeia affinis in Lake Michigan. Spec. Rpt. No. 36. Great Lakes Res. Div., Univ. Michigan, Ann Arbor, Mich. 131 p.

American Water Works Association. 1970. Chemistry of nitrogen and phosphorus in water. J. Amer. Water. Wks. Assoc. 51:127-139.

American Public Health Association. 1971. Standard methods for the examination of water and wastewater. 13th Edition. APHA, AWWA, WPCF. Washington, D.C.

American Public Health Association. 1975. Standard methods for the examination of water and wastewater, 14th Edition. APHA, AWWA, WPCF. Washington, D.C.

Arnold. D.E. 1971. Ingestion, assimilation, survival, and reproduction by Daphnia pulex fed several species of blue-green algae. Limnol and Oceanogr. 16(6): 906-920.

Ayers, John C. and E. Seibel. 1973. Cook plant preoperational studies 1972. Benton Harbor Plant Limnological Studies, Part XIII. Special Rpt. No. 44. Great Lakes Res. Div., Univ. Michigan, Ann Arbor, Mich.

Ball, I.R. 1967. The relative susceptibilities of some species of freshwater fish to poisons. I. Ammonia. Water Res. 1:767-775.

Beeton, A.M. 1970. Statement on pollution and eutrophication of the Great Lakes. Special Rpt. No. 11. Delivered to the U.S. Senate subcommittee on Air and Water Pollution of the Committee on Public Works, May 1970.

Beeton, A.M., B.G. Torke, A.S. Brooks, and J.A. Bowers. 1975. Influence of energy-related effluents on Great Lakes zooplankton. Proc. of the 2nd conf. on the Great Lakes. Prepared by Argonne National Laboratory for the Interagency Committee on Marine Science and Engineering of the Federal Council for Sciences and Technology. p. 432-437.

Borror, D.J. and D.M. DeLong. 1971. An introduction to the study of insects. Holt, Rinehart and Winston, N.Y. 319 p.

Brinkhurst, R.O., A.L. Hamilton and H.B. Herrington. 1968. Components of the bottom fauna of the St. Lawrence Great Lakes. Great Lakes Inst., Univ. Toronto Publ. No. 33, 49 p.

Brinkhurst, R. O. and B. G. M. Jamieson. 1971. Aquatic oligochaeta of the world. University of Toronto Press, Toronto. 860 p.

579 336

Brooks, John L. 1957. The systematics of North American Daphnia. Memoirs of the Connecticut Acad, of Arts & Sci.; 13. Yale Univ. Press, New Haven.

Brown, E.H., Jr. 1972. Population biology of alewives, Alosa pseudoharengus, in Lake Michigan, 1949-70. J. Fish. Res. Bd. Canada 29:477-500.

Burks, B. 1953. The mayflies, or Ephemeroptera, of Illinois. Ill. Nat. Hist. Surv. Bull 26(1):1-216.

Comita, G.W. and G.C. Anderson. 1959. The seasonal development of a population of Diaptomus ashlandi Marsh and related phytoplankton cycles in Lake Washington. Limnol. Oceanogr. 4:37-52.

Cook, G.W. and R.E. Powers. 1964. The benthic fauna of Lake Michigan as affected by the St. Joseph River. Proc. 7th Conf. Great Lakes Res., Great Lakes Res. Div., Univ. Michigan. 68-76.

Doudoroff, P. and M Katz. 1953. Critical review of literature on the toxicity of industrial wastes and their components to fish. II. The metals, as salts. Sewage and Ind. Wastes, 25(7):802-839.

Edmondson, W.T. 1965. Reproductive rates of planktonic rotifera as related to food and temperature in nature. Ecolo. Monagr. 35: 61-111.

Edmondson, W.T. (ed). 1959. Freshwater biology. 2nd Ed.. John Wiley and Sons, Inc., N.Y.

Edmunds, G. F., S. L. Jensen, and L. Berner. 1976. The mayflies of North and Central America. University of Minnesota Press, Minneapolis. 330 p.

Eggleton, F.E 36. The deep-water bottom fauna of Lake Michigan. Papers Mich. Aca Sci., 21:599-612.

Eggleton, F.E. 1937. Productivity of the profundal benthic zone in Lake Michigan. Papers Mich. Acad. Sci. Arts and Letters, 22:593-611.

Eichhorn, R. 1957. Zur populationsdynamik der Calaniden Copepoden in Titisee und Feldsee. Arch. Hydrobid. Suppl. 24:186-246.

Elster, J.H. 1954. Über die populationsdynamik von Eudiaptomus gracilis Sars und Heterocope borealis Fischer in Bodensee-Obersee. Arch. Hydrobiol. Suppl. 20: 546-614.

Environmental Protection Agency. 1971. Water qaulity criteria data book. Vol. 3. Effects of chemicals on aquatic life. 526 p.

______________. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. Edited by C.E. Weber. Nat. Env. Res. Center, Cincinnati, Ohio, 45268.

579 337

Evans, Marlene S and John A. Stewart. 1977. Epibenthic and benthic microcurstaceans (copepods, cladocerans, ostracods) from a nearshore area in southern Lake Michigan. Limnol. and Oceanogr. 22(b):1059-1067.

Federal Water Pollution Control Adminstration. 1968. Physical and chemical quality conditions, Lake Michigan Basin - FWPCA, Great Lakes Reg. Chicago Ill. 81 p + errata.

Gannon, J.E. 1972. Effects of eutrophication and fish predation on recent changes in zooplankton crustacea species composition in Lake Michigan. Trans. Amer. Micros. Soc., 91(1):82-84.

Gannon, J.E. 1974. The crustacean zooplankton of Green Bay, Lake Michigan. Proc. 17th Conf. Great Lakes Res. 1974: 28-51.

Garrels, R.M. 1965. Silica: role in buffering of natural waters. Sci. 2 Apr. 1965: p. 69.

Gliwicz, Z.M. 1969. Studies on the feeding of pelagic zooplankton in lakes with varying trophy. Ekol Polska. 17A:663-708.

Hasle and Evensen. 1976. Brackish water and freshwater species of the diatom genus Skeletonema II. Skeletonema potamos. Comb. Nov. J. Phycol. 12:73-82.

Hemens, J. 1966. The toxicity of ammonia solutions to the mosquito fish (Gambusia affinis, Baird and Girard). J. Proc. Inst. Sewage Purif. 3:265-271.

Henderson, C., Q.H. Pickering, and C.M. Tarzwell. 1960. The toxicity of organic phosphorus and chlorinated hydrocarbon insecticides to fish. In: Biological problems in water pollution (C.M. Tarzwell, comp.), Cincinnati, Ohio. Robt. A. Taft San, Eng. Center, Tech, Rpt. W60-3:76-88.

Henson, E.B. and H.B. Herrington. 1965. Sphaeriidae (Mollusca:Pelecypoda) of Lake Huron and Michigan in the vicinity of the Straits of Mackinac. Proc. 8th Conf. Great Lakes Res., Great Lakes Res. Div., Univ. Michigan, 77-95.

Hicks, Charles R. Fundamental concepts in the design of experiments, Holt, Rinehart and Winston, 2nd Ed. 1973.

Hiltunen, Jarl K. 1967. Some oligochaetes from Lake Michigan. Trans. Amer. Microsc. Soc. 86(4):433-454.

Howmiller, R. 1971. A comparison of the effectiveness of the Ekman and Ponar grabs. Trans. Amer. Fish. Soc. 100:560-564.

Hubbs, C.L. and K.E. Lagler. 1958. Fishes of the Great Lakes region. Univ. Michigan Press, Ann Arbor, Mich. XV + 213 p.

579 338

Hudson, P. 1970. Quantitative sampling with three benthic dredges. Trans. Amer. Fish. Soc. 99:603-607.

Hutchinson, G.E. 1957. A treatise on limnology. Vol. 1. Geography, Physics and Chemistry, John Wiley & Sons Inc. N.Y.

Hutchinson, G.E. 1975. A treatise on limnology. Vol. 3. Limnological Botany. John Wiley & Sons Inc. N.Y.

Indiana Stream Pollution Control Board. 1972. Regulation SPC4R, Lake Michigan and Contiguous Harbors.

_____________________________________. 1973. Regulation SPC-IR3, Water quality standards for waters of Indiana.

Johannsen, O. 1934, 1935, and 1937. Aquatic Diptera. Entomol. Reprint Specialists. Los Angeles, Calif.

Johnson, M.G. and R.O. Brinkhurst. 1971. Benthic community metabolism in Bay of Quinte and Lake Ontario. J. Fish. Res. Bd. Canada 28:1715-1725.

Kidd, Charles C. 1970. Pontoporeia affinis (Crustacea, Amphipoda) as a monitor of radionuclides released to Lake Michigan. Benton Harbor Power Plant Limnological Studies. Part IV. Spec. Rpt. No. 44. Great Lakes Res. Div., Univ. Michigan, Ann Arbor, Mich.

Koch, R.A. 1973. A creel census of the Indiana waters of Lake Michigan, 1970-72.

Koch, R.A. 1975. Personal communication from Indiana Department of Natural Resources.

Koch, R.A. 1975. A creel census of the Indiana waters of Lake Michigan, 1975. Tech. Rpt., Indiana Department of Natural Resources.

Lagler, K.F. 1956. Freshwater fishery biology. Wm. C. Brown Co. Debugue. 421 p.

Lane, Patricia A. and D.C. McNaught. 1970. A mathematical analysis of the niches of Lake Micigan zooplankton. Proc. 13th Conf. Great Lakes Res. 47-57. Internat. Assoc. Great Lakes Res.

Lewis. P. 1972. Evaluation of bottom grabs for macroinvertebrates. EPA, Qual. Contr. Newslet. 15:11. Cincinnati, Ohio.

Liston, C.R. and P.I. Tack. 1973. A study of the effects of installing and operating a large pumped storage project on the shores of Lake Michigan near Ludington, Michigan. Mich. State Dept. of Fish. and Wildlife. 113 p.

Mason, W., Jr. 1973. An introduction to the identification of Chironomidae larvae. Anal. Qual. Contr. Lab. EPA, Cincinnati, Ohio.

McKee, J.E. and H.W. wolf. (eds.) 1963. Water quality criteria. 2nd Ed. Sacramento, Calif., State Water Quality Control Board, Resources Agency of California, Publ. No. 3-A, 548 p.

579 339

McNaught, Donald C. 1966. Depth control by planktonic cladocerans in Lake Michigan. Publ. No. 15, Great Lakes Res. Div., Univ. Michigan, Ann Arbor, Mich.

McNaught, D.C. and M. Buzzard. 1973. Changes in zooplankton populations in Lake Ontario (1939-1970). Proc. 16th Conf. Great Lakes Res: 78-86.

McNaughton, S.J., T.C. Folson, T. Lee, F. Park, C. Prico, D. Roeder, J. Schmitz, and C. Stockwell. 1974. Heavy metal tolerance in Typha latifolia without the evolution of tolerant races. Ecol. 55:1163-1165.

Miller, R.R. 1957. Origin and dispersal of alewife, Alosa pseudohrengus, and the gizzard shad, Dorosoma cepedranum, in the Great Lakes. Trans. Am. Fish. Soc. 86:97-111.

Miller, R.R. 1972. Threatened freshwater fishes of the United States. Trans. Amer. Fish. Soc. 101(2):239-252.

Mozley, S.C. 1975. Benthic community responses to energy-related effluents in the Great Lakes. In: Proc. of the 2nd Fed. Conf. Great Lakes. Interagency Committee on Marine Science and Engineering of the Federal Council for Science and Technology. Argonne Natl. Lab.

Mozley, S. C. and W. P. Alley. 1973. Distribution of benthic invertebrates in the south end of Lake Michigan. In: International Association Great Lakes Research, Proceedings 16th Conference, Great Lakes Research. 87-96.

Mozley, S. C. and L. C. Garcia. 1972. Benthic macrofauna in the coastal zone of southeastern Lake Michigan. Proceedings 15th Conference, Great Lakes Research. 102-131.

Mozley, S. C. and M. H. Winnell. 1975. Macrozoobenthic species assemblages of southeastern Lake Michigan, U.S.A. Verhandlunzen Internationale Vereinlgung fur Theoretische und Ungewandte Limnologie. 19:922-931.

Nauwerck, A. 1963. Die beziehungen zwischen zooplankton und phytoplankton im See Erkn. Symb. Bot. Upsal. 17(5):1-163.

Norden, C.R. 1968. Morphology and food habits of the larval alewife, Alosa pseudoharengus (Wilson), in Lake Michigan. Proc. 11th Conf. Great Lakes Res. 1968. p. 103-110. Intl. Assoc. Great Lakes Res.

O'Brien, W.J. and F. deNoyelles Jr. 1974. Relationship between nutrient concentration, phytoplankton density, and zooplankton density in nutrient-enriched experimental ponds. Hydrobiologia 44:1 105-125.

Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Company, Philadelphia. p. 144.

579 340

Parsons, T. R., K. Stephens, and J. D. H. Strickland. 1961. On the chemical composition of eleven species of marine phytoplankters. J. Fish. Res. Bd. Canada 18(b): 1001-1008.

Patalas, K. 1972. Crustacean zooplankton and the eutrophication of St. Lawrence Great Lakes, J. Fish. Res. Bd. Canada 29:1451-1462.

Patrick, R. 1971. The effects of increasing light and temperature on the structure of fiatom communities. Limnol. Oceanogr. 16(2):405-421.

Patrick, R., M.H. Hohn, and J.H. Wallace. 1954. A new method for determining the pattern of the diatom flora. Bull. Philadelphia Acad. Nat. Sci. 259:1.

Pennak, R.W. 1953. Freshwater invertebrates of the United States. The Ronald Press Co., New York.

Pennak, R.W. 1963. Species identification of the fresh-water cyclopoid copepoda of the United States. Trans. Amer. Micros. Soc. 82(4):353-359.

Pennak, R. W. 1978. Freshwater invertebrates of the United States. 2nd Ed. John Wiley & Sons, New York. 803 p.

Powers, C.F. and W.P. Alley. 1967. Some preliminary observations on the depth distribution of the macrobenthos in Lake Michigan, p. 112-125. In: J.C. Ayers and D.C. Chandler, [eds.] Studies on the environment and eutrophication of Lake Michigan, Great Lakes Res. Div., Spec. Rpt. No. 30, Univ. Michigan, Ann Arbor, Mich. 415 p.

Reid, G.K. 1961. Ecology of inland waters and estuaries. Reinhold Books in the Biological Sciences, N.Y. xvi + 375 p.

Renwoldt, R., G. Bira, and E. Newman. 1971. Acute toxicity of copper, nickel, and zinc ions to some Hudson River fish species. Env. Cont. and Tech. 6(5):445-448.

Risley, C., Jr. and F.D. Fuller. 1965. Chemical characteristics of Lake Michigan Pub. No. 13. Great Lakes Res. Div., Univ. Michigan, Ann Arbor, Mich. 168-174.

Rhodes, R.J., D.A. Webb, and T.S. McComish. 1974. Proc. 17th Conf. Great Lakes Res., 593-595.

Roback, S. 1957. The immature tendipedids of the Philadelphia area. Mon. Acad, Nat. Sci. Philadelphia, Pa.

579 341

Robertson, Andrew. 1966. The distribution of calnoid copepods in the Great Lakes. Publ. No. 15, Great Lakes Res. Div., Univ. Mich., Ann Arbor, Mich.

Robertson, A. and W.P. Alley. 1966. A comparative study of Lake Michigan macrobenthos. Limnol. and Oceanogr. 11(4):576-583.

Rodhe, W., R.A. Vollenweider, and A. Nauwerck. 1958. The primary production and standing crop of zooplankton. In: Perspectives in Marine Biology (edited by A.A. Buzzati-Traverso), 299-322. Univ. Calif. Press.

Ross. H. 1944. The caddis flies, or Trichoptera, of Illinois. Ill. Nat. Hist. Surv. Bull 23(1):1-236.

Roth, James C. and John A Stewart. 1973. Nearshore zooplankton of southeastern Lake Michigan, 1972. Proc. 16th Conf. Great Lakes Res. 10:132-142. Intl. Assoc. Great Lakes Res.

Schelske, C.L. 1971. Nutrient inputs and their relationship to accelerated eutrophication in Lake Michigan. From: Biological effects in the hydrobiological cycle, E.J. Monke (ed.). 1971, Proc. of the 3rd Int. Symp. for Hydrology Professors, Purdue Univ., Dept. Agri. Eng. 59-81.

Schelske, C. L. 1977. Trophic status and nutrient loading for Lake Michigan. Michigan University, Great Lakes Research Div. EPA Publ. No. 600/3-77-086.

Schelske, C.L. and E.F. Stoermer. 1972. Phosphorus, Silica and Eutrophication in Lake Michigan. In: G.E. Likens, Ed., Nutrients and Eutrophication. Amer. Soc. Limnol. and Oceanogr. Spec. Symposia Vol. 1.

Schelske, C.L., and J.C. Roth. 1973. Limnological survey of Lakes Michigan, Superior, Huron, and Erie. Publication No. 17. Great lakes Res. Div., Ann Arbor, Michigan 108 p.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Bd. Can. Bull. 184:966 p.

Shaw, R.H.R. and B. Gruskin, 1967. The toxicity of metal ions to aquatic organisms. Arch. Biochm. Giophys. 67(2):447-452.

Smith, S.H. 1968. Species succession and fishery exploitation in the Great Lakes. J. Fish. Res. Bd. Canada 25:667-693.

Stimpson, K. S., J. R. Brice, M. T. Barbour, and P. Hone. 1975. Distribution and abundance of inshore oligochaetes in Lake Michigan. Trans. Amer. Micros. Soc. 94(3):384-394.

Stoermer, E. F., M. M. Bowman, J. C. Kingston, and A. L. Schaedel. 1974. Phytoplankton composition and abundance in Lake Ontario during IFYGL, University of Michigan Great Lakes Research Div., University of Michigan Publ. Spec. Rpt. S3:1-373.

579 342

Strickland, J.D.H. 1960. Measuring the production of marine phytoplankton. Fish. Res. Bd. Canada. Bull. 122:1-172.

Summerfelt, R.C. and W.M. Lewis. 1967. Repulsation of green sunfish by certain chemicals. J. Water Pollution Contr. Fed. 39(12):2030-2038.

Talling, J.F., and D. Driver. 1963. Some problems in the estimation of chlorophyll a. Proc. Conf. of Prim. Prod. Meas., Marine and Freshwater, Hawaii. 1961. U.S.AEC TID-7633:142-146.

Texas Instruments Incorporated. 1975. 1974-1975 annual report, Bailly Nuclear-1 site, encompassing May 1974-February 1975. Prepared for Northern Indiana Public Service Company.

______________________________. 1976. 1975-1976 annual report, Bailly Nuclear-1 site encompassing March 1975-February 1976. Prepared for Northern Indiana Public Service Company.

______________________________. 1976. 316(a) Demonstration Bailly Station Units 7 and 8. September 30, 1976.

______________________________. 1976. 316(b) Demonstration Bailly Station Units 7 and 8. Dec. 30, 1976.

______________________________. 1977. 1976-1977 annual report, Bailly Nuclear-1 site, encompassing April 1976 through February 1977. Prepared for Northern Indiana Public Service Company.

______________________________. 1978. 1977-1978 annual report, Bailly Nuclear-1 site, encompassing April 1977 through February 1978. Prepared for Northern Indiana Public Service Company.

______________________________. 1978 Spring 1978 quarterly report, Bailly Nuclear-1 site, encompassing April-June 1978. August 1978.

______________________________. 1978. Summer 1978 quarterly report, Bailly Nuclear-1 site, encompassing July-September 1978. November 1978.

______________________________. 1979. Fall 1978 quarterly report, Bailly Nuclear-1 site, encompassing October-December 1978. February 1979.

______________________________. 1979. Winter 1979 quarterly report, Bailly Nuclear-1 site, encompassing January-March 1979. May 1979.

UNESCO. 1968. Monographs on oceanographic methodology 2. Zooplankton sampling. United Nations Educational, Scientific and Cultural Organization. Paris, France.

Usinger, R. 1956. Aquatic insects of California. Univ. Calif. Press, Berkeley, Calif.

579 343

Verduin, J. 1977. Testimony of Dr. Jacob Verduin, Ph.D. on impact of Zion and Waukegan power plant operation on phytoplankton and periphyton in the Zion and Waukegan area of Lake Michigan. For Commonwealth Edison Company, May 1977.

Ward, H.B. and G.C. Whipple. 1959. Freshwater biology. 2nd Ed. W. T. Edmondson (ed.). John Wiley & Sons, Inc., New York.

Watson, N.H.F. 1974. Zooplankton of the St. Lawrence Great Lake - species composition, distribution, and abundance. J. Fish. Res. Bd. Canada. 31:783-794.

Webb, D.A. and T.S. McComish. 1974. Food habits of adult alewives in Lake Michigan near Michigan City, Indiana, in 1971 and 1972. Proc. Indiana Acad. of Sci. 83:179-184.

Weber, C. 1970. A new freshwater centric diatom Microsiphona potamus gen. et sp. Nov. J. Phycol. 6:149-153.

Wells, L. 1968. Seasonal depth distribution of fish in southeastern Lake Michigan. Limnol. Oceanogr. 15:556-565.

Wells, LaRue and Robert House. 1974. Life history of the spottail shiner (Notropis hudsonius) in southeastern Lake Michigan, the Kalamazoo River, and Western Lake Erie. Bur. of Sport Fisheries and Wildl., Res. Rpt. 78. 10 p.

Wiggins, G. B. 1977. Larvae of the North American caddisfly genera (Trichoptera). University of Toronto Press, Toronto. 401 p.

Wilson, C. B. 1932. The copepods of the Woods Hole region, Massachusetts. Bull. U. S. Nat. Mus. 158:1-135.

579 344

APPENDIX A

CHECKLIST OF PLANT SPECIES OBSERVED
IN THE BAILLY STUDY AREA, JULY 1978

579 345

Table A-1

Checklist of Plant Species Observed in the Bailly Study Area, July 1978

Scientific Name	Common Name	Sampling Locations* 1	2	3	4A	4B	5	6	7	8	9	10	11
Aceracaea	Maple family												
Acer rubrum	Red maple			X	X	X		X			X		
Acer saccharinum	Silver maple										—	—	
Aizoaceae	Carpetweed family												
Mollugo verticillata	Carpetweed		—							—			
Alismaceae	Water-plantain family								—				
Alisma plantago-aquatica	Water plantain								X				
Sagittaria gramina	Arrowhead												
Anacardiaceae	Cashew family												
Rhus copallina	Winged sumac				—							—	
Rhus glabra	Smooth sumac												
Rhus radicans	Poison ivy		X	X		X						X	X
Rhus typhina	Hairy sumac												
Rhus vernix	Poison sumac					X						X	X
Annonaceae	Custard-apple family												
Asimina triloba	Pawpaw			—									
Apocyanaceae	Dogbane family												
Apocynum androsaemifolium	Dogbane												
Apocynum medium	Dogbane									X	—	X	—
Araceae	Arum family												
Peltandra virginica	Arrow arum												
Symplocarpus foetidus	Skunk cabbage					X							
Asclepiadaceae	Milkweed family												
Asclepias incarnata	Swamp milkweed						(X)	—					
Asclepias purpurascens	Purpleweed												
Asclepias tuberosa	Butterfly-weed		X										
Asclepias verticillata	Whorled mildweed									—	—	=	
Balsaminaceae	Touch-me-not family												
Impatiens biflora	Jewelweed					X	X	X					X
Betulaceae	Birch family									—			
Alnus incana	Speckled alder					X							
Betula lutea	Yellow birch					X							
Berberidaceae	Barberry family									—	—		
Podophyllum peltatum	Mayapple												
Boraginaceae	Forget-me-not family			—									
Lithospermum carolinense	Gmelin's puccoon		X		X								
Lithospermum croceum	Hairy puccoon											—	
Cactaceae	Cactus family		—										
Opuntia compressa	Prickly pear											X	X
Campanulaceae	Harebell family												
Campanula rotundifolia	Harebell												
Caprifoliaceae	Honeysuckle family										—	—	
Diervilla lonicera	Northern bush-honeysuckle												
Lonicera dioca	Climbing honeysuckle												
Sambucus canadensis	Elderberry					—							
Viburnum acerifolium	Maple-leaved viburnum												— X
Viburnum dentatum	Arrowwood							-		—			
Viburnum lentago	Nannyberry							=					
Caryophyllaceae	Pink family												
Arenaria sp.	Sand wort												
Lychnis alba	Evening lychnis												
Silene cucubatus	Bladder champion												
Silene noctiflora	Night-flowering catchfly				—								
Celastraceae	Staff-tree family												
Celastrus scandens	Bittersweet		X										
Chenopodiaceae	Goosefoot family												
Chenopodium albidum	Goosefoot												
Chenopodium standleyanum				X	—	—					—		
Commelinaceae	Spiderwort family												
Tradescantia virginiana	Spiderwort		X	X						X	X	X	
Compositae	Sunflower family												
Achillea millefolium	Yarrow									X			
Amborsia artemisiifolia	Common ragweed									—			
Ambrosia psilostachya	Ragweed												
Antennaria sp.	Pussytoes												
Aster dumosus	Bushy aster										—		
Artemisia campestris	Wormwood											—	
Aster linariifolius	Stiff aster											—	—
Aster sp.	Aster											X	

*Delineated on Figure 1.1-1. X indicates occurrence of a taxon within sampling plots.
(X) indicates occurrence of a taxon within a community but not within sampling plots.
— indicates that the taxon was previously encountered in plots but was not observed in July 1978, and species with no marks indicate that the taxon was previously unobserved in the plots.

POOR ORIGINAL

579 346

Table A-1 (Contd)

Scientific Name	Common Name	1	2	3	4A	4B	5	6	7	8	9	10	11
		Sampling Locations*											
Compositae (contd)													
Bidens comosa	Beggar-ticks					—	—			—			
Bidens sp.							X						
Centaurea dubia	Knapweed												
Centaurea jacea													
Chrysanthemum leucanthemum	Ox-eye daisy		—							—			
Cirsium arvense	Canada thistle						—			X			
Conyza canadensis	Horseweed												
Erigeron philadelphicus	Common fleabane												
Erigeron ramosus	Daisy fleabane						—						
Erigeron strigosus	Daisy fleabane											X	
Eupatorium perfoliatum	Purple boneset						X				—	—	
Epatorium purpurem	Joe-pye weed												
Helianthus divicatus	Woodland sunflower										—	X	
Helianthus giganteus	Tall sunflower									X			
Helianthus microcephalus				X									
Helianthus mollis											—		
Helianthus petiolaris	Prairie sunflower									—			
Heiracium canadense	Orange hawkweed									—			
Heiracium sp.	Hawkweed									—	X	X	
Lactuca canadensis				—									
Liatris aspera	Blazing star									—		X	
Krigia biflora	Dwarf dandelion										—		
Krigia virginica	Dwarf dandelion												
Krigia sp.				X									
Kuhnia eupatorioides	False boneset		X										
Rudbeckia hirta	Black-eyed susan		X							X			
Senecio sp.	Ragwort												
Solidago altissima	Tall goldenrod												
Solidago caesia	Blue-stemmed goldenrod									—			
Solidago canadensis	Canada goldenrod		—	—						—			
Solidago graminifolia	Narrow-leaved goldenrod		X							X			
Solidago hispida	Hairy goldenrod												
Solidago ohioensis												—	
Solidago sp.			X	X	X					X	—	X	
Sonchus oleraceus	Sow thistle					—							
Taraxacum officinale	Dandelion			X									
Tragopogon pratensis	Goatsbeard									—			
Veronia missurica	Drummond's ironweed									—			
Convolvulaceae	Morning-glory family												
Convolvulus arvensis	Field bindweed					—				—			
Convolvulus sepium	Hedge bindweed						X			—			
Cuscuta gronovii	Dodder						X						—
Ipomoea purpurea	Morning-glory									—			
Cornaceae	Dogwood family												
Cornus alternifolia	Alternate-leaved dogwood					—							
Cornus amomum	Silky dogwood					—							
Cornus florida	Flowering dogwood												
Cornus stolonifera	Red-osier dogwood				X	X		X					
Cruciferae	Mustard family												
Arabis lyrata	Lyre-leaved rockcress		—	—							—	—	
Barbarea vulgaris	Winter cress												
Cakile edentula	Sea rocket												
Cardamine bulbosa	Spring cress										—	—	
Draba sp.			X	X							—		
Hesperis matronalis	Dame's rocket									—	—		
Lepidium apetalum	Peppergrass									(X)	—		
Lepidium virginicum	Wild peppergrass												
Cyperaceae	Sedge family												
Carex sp.	Sedge			X	—	X	—	X		X	X	X	
Carex muhlenbergia													
Carex pennsylvanica					X								
Eleocharis smallii	Spike rush						(X)						
Scirpus validus	Bull rush						(X)						
Eleagnaceae	Oleaster family												
Ludwigia sphaerocarpa	Loosestrife												
Ericaceae	Heath family												
Arctostaphylos uva-ursi	Bearberry											—	
Gaultheria procumbens	Wintergreen										—	—	
Kalmia sp.	Swamp laurel										—		
Vaccinium pennsylvanicum	Lowbush blueberry			X	X						X	X	
Euphorbiaceae	Spurge family												
Euphorbia corollata	Flowering spurge		X	X						—	X	X	
Euphorbia humistrata	Hairy spreading spurge												

579 347

Table A-1 (Contd)

Scientific Name	Common Name	1	2	3	4A	4B	5	6	7	8	9	10	11
		Sampling Locations*											
Fagaceae	Beech family												
Quercus alba	White oak			X	X			X				—	
Quercus rubra	Red oak												
Quercus velutina	Black oak		X	X	X			X			X	X	
Geraniaceae	Geranium family												
Geranium maculatum	Wild geranium							—					
Geranium robertianum	Herb geranium											—	
Geranium sp.	Geranium		—										
Gramineae	Grass family												
Agropyron trachycaulum	Slender wheatgrass												
Ammophila breviligulata	American beachgrass	X	X										
Andropogon gerardi	Big bluestem									X		—	
Andropogon scoparius	Little bluestem		X									X	
Calamagrostic canadensis	Blue-joint reedgrass			—	—					—			
Calamagrostis sp.	Reed grass		X										
Calamovilfa longifolia	Sand reedgrass		—										
Digitaria sanguinalis	Crabgrass												
Eragrostic pectinacea	Purple lovegrass												
Festuca octoflora	Fescue												
Leersia oryzoides	Rice cutgrass					X	X			X			X
Leersia virginica	Cutgrass												
Leptoloma cognatum	Fall witchgrass					—				—			
Panicum clandestinum	Corn grass									X			
Panicum dicotomum	Panic grass		—									—	
Panicum hauchucae	Panic grass		X	X						—			
Panicum sp.	Panic grass				X						X	X	
Panicum virgatum	Panic grass												
Phragmites communis	Common reed						—					—	
Poa pratensis	Kentucky bluegrass											—	
Poa sp.	Bluegrass		—	X	X		—			X	X	X	
Haloragaceae	Water-milfoil family												
Proserpinaca palustris	Mermaid-weed												
Hamamelidaceae	Witch-hazel family												
Hamamelis virginiana	Witch hazel		X	X	X						X	X	
Iridaceae	Iris family												
Iris versicolor	Iris						—			X			
Sisyrinchium sp.	Blue-eyed grass									—			
Juglundaceae	Butternut family												
Juglans cinerea	Butternut												
Juncaceae	Rush family												
Juncus effusus	Rush									—			
Juncus militaris	Bayonet rush												
Labiatae	Mint family												
Glechoma hederacea	Gill-over-the-ground							X					
Collinsonia canadensis	Horse-balm												
Lycopus americanus	Bugle weed												
Lycopus virginicus	Bugle weed												
Mentha arvensis	Wild mint						—						
Mentha sp.	Mint						—						
Monarda fistulosa	Wild bergamot			X						—	X	X	
Monarda punctata	Horse mint									—	—	—	
Neptea cataria	Cat nip			—		—							
Prunella vulgaris	Self-heal							—					
Pycnanthemum virginianum	Mountain mint									X			
Scutellaria galericulata	Common skullcap												
Stachys ambigua	Hedge-nettle												
Stachys hyssopifolia	Hedge-nettle								—				
Stachys palustris	Hedge-nettle						X						
Stachys tenuifolia	Smooth hedge-nettle												
Teucrium canadense	Germander									—			
Lauraceae	Laurel family												
Lindera benzoin	Spice bush				X	X		X					
Sassafras albidum	Sassafras			X	X	X		X			X	X	
Leguminosae	Legume family												
Apios tuberosa	Ground nut					—							
Lathyrus palustris	Vetchling						—						
Lupinus perennis	Lupine												
Medicago lupulina	Black medic										—	—	
Robinia pseudoacacia	Black locust							X					
Tephrosia virginiana	Goat's rue				X						—	X	
Trifolium dubium													
Trifolium hybridum	Alsike clover												
Vicia sp.	Vetch										—	—	

579 348

Table A-1 (Contd)

Scientific Name	Common Name	1	2	3	4A	4B	5	6	7	8	9	10	11
		Sampling Locations*											
Lemnaceae	Duckweed family												
Lemna minor	Duckweed					X					—		
Lentibulariaceae	Bladderwort family												
Utricularia purpurea	Purple bladderwort												
Liliaceae	Lily family												
Allium canadense	Wild garlic												
Convallaria majalis	Lily-of-the-valley										—		
Lilium superbum	Turk's cap lily					X		—					
Mianthemum canadense	Wild lily-of-the-valley				—							—	
Polygonatum biflorum	Solomon's seal							—			—		
Smilacina racemosa	False Solomon's seal		X	X				X			—	—	
Smilacina stellata	Starry false Solomon's seal		X		X						X	X	
Smilax herbacea	Catbrier			X	X			X					
Smilax rotundifolia	Round-leaf catbrier			—									
Trillium recurvatum	Prairie trillium							—					
Uvularia grandiflora	Large-flowered bellwort												
Lycopodiaceae	Groundpine family												
Lycopodium obscurum	Groundpine										—		
Lythraceae	Loosestrife family												
Decodon verticillatus	Swamp loosestrife					—							
Najadaceae	Pondweed family												
Najas sp.	Naiad												
Potamogenton pulcher	Pondweed								—				
Potamogeton vaseyi	Pondweed								X				
Potamogeton sp.	Pondweed												
Nymphaceae	Water lily family												
Brasenia schreberi	Water shield												
Nelumbo lutea	American lotus												
Nuphar variegatum	Bullhead lily								X				
Nymphea odorata	Fragrant waterlily												
Nyssaceae	Gum family												
Nyssa sylvatica	Black gum				X								
Onagraceae	Evening primrose family												
Circaea alpina	Enchanter's nightshade							X					
Epilobium sp.	Fireweed					—							
Ludwigia sphaerocarpa	False loosestrife												
Oenothera muricata	Northern evening primrose									X			
Osmundaceae	Royal fern family												
Osmunda cinnamonea	Cinnamon fern					—	—						
Osmunda regalis	Royal fern												
Oxalidaceae	Wood-sorrel family												
Oxalis stricta	Wood sorrel												
Phytolaccaceae	Pokeweed family												
Phytolacca americana	Pokeweed									—			
Pinaceae	Pine family												
Larix laricina	American larch												
Pinus banksiana	Jack pine		X								X	X	
Pinus strobus	White pine												
Polemoniaceae	Phlox family												
Phlox bifida													
Phlox divaricata	Blue phlox												
Phlox sp.	Phlox											—	
Polygalaceae	Milkwort family												
Polygala sanguinea	Purple milkwort												
Polygonaceae	Buckwheat family												
Polygonum amphibium	Water smartweed												
Polygonum arifolium	Tear-thumb					X							
Polygonum coccineum	Swamp smartweed												
Polygonum sagittatum	Arrow-leaved tear-thumb					—	X			X			
Polygonum sp.	Smartweed						—						
Rumex acetosella	Sheep sorrel								—				
Rumex crispus	Curly dock									—			
Polypodiaceae	Polypody family												
Cystopteris fragalis	Bladder fern					X	X						
Dennstaedtia punctilobula	Hay-scented fern									—			
Onoclea sensiblis	Sensitive fern					X				X			
Osmunda cinnamomea	Cinnamon fern					X							
Pteridium aquilinum	Bracken fern			—	X						X	X	
Thelypteris palustris	Marsh fern					—	—				—		

579 342

Table A-1 (Contd)

Scientific Name	Common Name	1	2	3	4A	4B	5	6	7	8	9	10	11
		Sampling Locations*											
Pontederiaceae	Pickerel-weed family												
Pontederia cordata	Pickerel-weed												
Primulaceae	Primrose family												
Lysimachia ciliata	Fringed loosestrife												
Lysimachia terrestris	Loosestrife												
Trientalis borealis	Starflower												
Ranunculaceae	Crowfoot [illegible]ily												
Anemone reparia	Thimbleweed												
Anemone canadense	Canada anemone										X		
Aquilegia canadensis	Columbine												
Caltha palustris	Marsh marigold												
Ranunculus abortivus	Kidney leaf buttercup					—							
Ranunculus flabellaris	Yellow water buttercup												
Ranunculus pennsylvanicus	Buttercup												
Ranunculus sceleratus	Cursed buttercup						—		—				
Thalictrum polygonum	Rue												
Rosaceae	Rose family												
Agrimonia gryposepala	Agrimony												
Amelanchier canadensis	Serviceberry												
Amelanchier laevis	Serviceberry			—						—			
Aronia arbutifolia	Red chokecherry												
Crataegus crus-galli	Newcastle thornapple				—			X			—		
Fragaria virginiana	Wild strawberry					—				X			
Geum canadense	White avens					X		X					
Geum virginianum	Avens												
Potentilla canadense	Dwarf cinquefoil							—		—			
Potentilla recta	Cinquefoil												
Potentilla simplex	Common cinquefoil												
Potentilla sp.						—							
Prunus serotina	Black cherry				X	X	—	X			X	X	
Prunus virginiana	Choke cherry		—					—					
Rosa blanda	Wild rose		X	X	X			X			X	X	
Rosa sp.	Rose			—			X				—		
Rubus allegheniensis	Blar[illegible]berry				X					—			
Rubus flagellaris	[illegible]									X	—		
Rubus sp.	[illegible]			—								X	
Spirea alba	Me[illegible]ow-sweet						—						X
Spirea tomentosa	Steeple bush												
Rubiaceae	Bedstraw family												
Cephalanthus occidentalis	Buttonbush												—
Galium aparine	[illegible]edstraw					X	—	X					
Galium trifolium	Fragrant bedstraw						—						
Rutaceae	Rue family												
Ptelea trifoliata	Money tree												
Salicaceae	Willow family												
Populus deltoides	Cottonwood		X										
P[illegible]pulus tremuloides	Quaking aspen												
Salix nigra	Black willow					X							X
Salix sp.			X										X
Santalaceae	Sandalwood family												
Commandra umbellata	Bastard-toadflax			—	—				—	—			
Sarraceniaceae	Pitcher plant family												
Sarracenia purpurea	Pitcher plant												
Saxifragaceae	Saxifrage family												
Ribes americanum	Wild black currant												
Scrophulariaceae	Snapdragon family												
Aureolaria pedicularia	Foxglove											—	
Aureolaria purpurea	Purple aureolaria												
Aureolaria virginica	Do[illegible]y false foxglove												
Linaria canadensis	Blue toad-flax												
Melampyrum lineare	Cow wheat												
Mimulus alatus	Sharp-winged monkey flower												
Penstemon hirsutus	Beardtongue												
Penstemon sp.	Beardtongue									—			
Scutellaria galericulata	Skull cap												
Verbascum thapsus	Mullien		X										
Veronica americana	Penny[illegible]oyal						—						
Solanaceae	Tomato family												
Solanum carolinense	Horse nettle				X	X							X
Solanum dulcamara	Nightshade						—						X
Sparganiaceae	Bur-reed family												
Sparganium sp.	Bur-weed												

579 350

POOR ORIGINAL

Table A-1 (Contd)

Scientific Name	Common Name	1	2	3	4A	4B	5	6	7	8	9	10	11
		Sampling Locations*											
Tiliaceae	Linden family												
Tilia americana	Basswood		—	X									
Typhaceae	Cattail family												
Typha latifolia	Cattail						X	—					X
Ulmaceae													
Ulmus rubra	Slippery elm					X							
Umbelliferae	Parsley family												
Cicuta bulbifera	Waterhemlock												
Pastinaca sativa	Wild parsnip							—		—			
Osmorhiza claytoni	Sweet cicely						X	X		X			
Sanicula trifoliata								X					
Zizia aurea	Golden alexander						X			—			
Urticaeae	Nettle family												
Boehmeria cylindrica	False nettle						—						
Pilea pumila	Clearweed					X	X	X					
Urtica dioca	Stinging nettle												X
Urtica urens	Small stinging nettle					—	—						
Urtica sp.	Nettle					X	X						
Verbenaceae	Vervain family												
Verbena hastata	Blue vervain									—			
Violaceae	Violet family												
Viola pedata	Bird's foot violet			—	—	—							
Viola pubescens	Downy yellow violet												
Viola sp.	Violet				X	X		—			—	—	
Vitaceae	Grape family												
Parthenocissus quinquefolia	Virginia creeper		X			X		X		X	X	X	
Vitis sp.	Grape		X								—	X	—

POOR ORIGINAL

579 351

APPENDIX B

ANNOTATED LIST OF MAMMAL SPECIES REPORTED IN THE BAILLY STUDY AREA, MAY, JULY, AND OCTOBER 1978

579 352

APPENDIX B

ANNOTATED LIST OF MAMMAL SPECIES REPORTED IN THE BAILLY STUDY AREA MAY, JULY, AND OCTOBER 1978

Opossum, Didelphis marsupialis

Tracks were reported from all sampling locations.

Masked shrew, Sorex cinereus

A single masked shrew was captured along the transmission corridor during May.

Short-tailed shrew, Blarina brevicauda

Short-tailed shrews were captured from all trapping locations. The species was most numerous along the transmission corridor during October.

Eastern mole, Scalopus aquaticus

Mole tunneling was observed in the open and wooded bog, maple forest, and transmission sampling locations.

Eastern cottontail rabbit, Sylvilagus floridanus

Cottontails were reported from all sampling locations except the maple forest and emergent macrophyte community.

Eastern chipmunk, Tamias striatus

Chipmunks were sighted and captured in all three wooded sampling locales and along the transmission corridor. The chipmunk appeared more abundant in the wooded bog than in other locations.

Woodchuck, Marmota monax

Woodchuck dens were reported in the immature oak forest and wooded bog. The only sighting took place along the dyke in the open bog.

Southern flying squirrel, Glaucomys volans

An individual was captured in a livetrap in the wooded bog during May.

Fox squirrel, Sciurus niger

Fox squirrel sightings were made in all three wooded sampling locales on the study area. Fox squirrels were most numerous in the wooded bog.

Red squirrel, Tamiasciurus hudsonicus

This small arboreal squirrel was sighted in all three wooded sampling locales and trapped in two [maple forest - Cowles Bog (wooded)] of the three.

Muskrat, Ondatra zibethica

One sighting of this species occurred in the macrophyte sampling location.

White-footed mouse, Peromyscus leucopus

The white-footed mouse was trapped along all five assessment lines. It was the most abundant species captured in forested habitats.

Meadow vole, Microtus pennsylvanicus

Meadow voles were captured only in nonforested trapping locations. October results revealed increases over May.

Meadow jumping mouse, Zapus hudsonicus

Jumping mice were captured in the beachgrass and transmission assessment lines.

Raccoon, Procyon lotor

Tracks of the raccoon were found in all sampling locations, while the most sightings took place in the wooded bog.

Striped skunk, Mephitis mephitis

A skunk sighting occurred in the foredune area during July.

White-tailed deer, Odocoileus virginianus

Deer tracks and/or other signs (e.g. scrapes) were noticed in all sampling locations and during all but one season in 1978 on the Bailly Study Area. An individual was observed during July in the wooded bog.

APPENDIX C

1974-1978 CHECKLIST AND 1978 ANNOTATED LIST
OF BIRD SPECIES OBSERVED IN BAILLY STUDY AREA

APPENDIX C

Table C-1

Checklist of Birds Reported from the Bailly Study Area, 1974-1978

Common Loon
*Horned Grebe
*Pied-billed Grebe
*Double-crested Cormorant
*Great Blue Heron
*Green Heron
*Great Egret
*Black-crowned Night Heron
*Least Bittern
American Bittern
*Canada Goose
Snow Goose
*Mallard
*Black Duck
*Gadwall
*Pintail
*Green-winged Teal
*Blue-winged Teal
*American Wigeon
*Northern Shoveler
*Wood Duck
Redhead
*Ring-necked Duck
Greater Scaup
Lesser Scaup
Common Goldeneye
Bufflehead
White-winged Scoter
Ruddy Duck
Hooded Merganser
*Common Merganser
Red-breasted Merganser
*Turkey Vulture
Sharp-shinned Hawk
*Red-tailed Hawk
Red-shouldered Hawk
Rough-legged Hawk
Broadwinged Hawk
Marsh Hawk
*American Kestrel
Bobwhite
*Ring-necked Pheasant
Virginia Rail
*Sora
Yellow Rail
*Common Gallinule
*American Coot
Semipalmated Plover
*Killdeer
Black-bellied Plover
*Ruddy Turnstone
American Woodcock
*Common Snipe
*Spotted Sandpiper
Solitary Sandpiper
Greater Yellowlegs
Lesser Yellowlegs
Pectoral Sandpiper
*Least Sandpiper
Dunlin
Long-billed Dowitcher
Semipalmated Sandpiper
Sanderling
Great Black-backed Gull
*Herring Gull
*Ring-billed Gull
*Bonaparte's Gull
*Common Tern
Caspian Tern
*Rock Dove
*Mourning Dove
*Yellow-billed Cuckoo
*Black-billed Cuckoo
*Screech Owl
Great Horned Owl
Barred Owl
Whip-poor-will
*Common Nighthawk
*Chimney Swift
Ruby-throated Hummingbird
*Belted Kingfisher
*Common Flicker
Red-bellied Woodpecker
*Red-headed Woodpecker
Yellow-bellied Sapsucker
*Hairy Woodpecker
*Downy Woodpecker
*Eastern Kingbird
Great Crested Flycatcher
*Eastern Phoebe
Yellow-bellied Flycatcher
*Acadian Flycatcher
*Willow Flycatcher
Alder Flycatcher
*Least Flycatcher
*Olive-sided Flycatcher
*Eastern Wood Pewee
Horned Lark
*Tree Swallow
*Bank Swallow
Rough-winged Swallow

*Observed in 1978

Table C-1 (Contd)

*Barn Swallow
*Cliff Swallow
Purple Martin
*Blue Jay
*Common Crow
*Black-capped Chicadee
*Tufted Titmouse
*White-breasted Nuthatch
*Red-breasted Nuthatch
*Brown Creeper
*House Wren
Winter Wren
*Carolina Wren
*Long-billed Marsh Wren
*Short-billed Marsh Wren
Mockingbird
*Gray Catbird
*Brown Thrasher
*American Robin
*Wood Thrush
*Hermit Thrush
*Swainson's Thrush
Gray-cheeked Thrush
*Veery
Eastern Bluebird
Blue-gray Gnatcatcher
*Golden-crowned Kinglet
*Ruby-crowned Kinglet
Cedar Waxwing
Northern Shrike
*Starling
*White-eyed Vireo
*Yellow-throated Vireo
Solitary Vireo
*Red-eyed Vireo
*Philadelphia Vireo
*Warbling Vireo
*Black-and-white Warbler
*Golden-winged Warbler
Blue-winged Warbler
*Tennessee Warbler
*Orange-crowned Warbler
*Nashville Warbler
*Northern Parula
*Yellow Warbler
*Magnolia Warbler
*Black-throated Blue Warbler
*Yellow-rumped Warbler
*Black-throated Green Warbler
*Cerulean Warbler
*Blackburnian Warbler
*Chestnut-sided Warbler
*Bay-breasted Warbler
Blackpoll Warbler
*Palm Warbler
*Ovenbird
*Northern Waterthrush
*Louisiana Waterthrush
Kentucky Warbler
Connecticut Warbler
*Mourning Warbler
*Common Yellowthroat
Yellow-breasted Chat
*Hooded Warbler
*Wilson's Warbler
*Canada Warbler
*American Redstart
*House Sparrow
Bobolink
Eastern Meadowlark
*Red-winged Blackbird
Northern Oriole
*Rusty Blackbird
*Common Grackle
*Brown-headed Cowbird
*Scarlet Tanager
*Cardinal
*Rose-breasted Grosbeak
*Indigo Bunting
Purple Finch
*American Goldfinch
*Rufous-sided Towhee
*Savannah Sparrow
Leconte's Sparrow
*Dark-eyed Junco
*Tree Sparrow
*Chipping Sparrow
*Field Sparrow
White-crowned Sparrow
*White-throated Sparrow
*Fox Sparrow
Lincoln's Sparrow
*Swamp Sparrow
*Song Sparrow
Snow Bunting

579 357

APPENDIX C

Table C-2

Annotated List of Bird Species Observed in the Bailly Station Site Vicinity May, July, and October 1978

Horned Grebe, Podiceps auritus (Migrant)

Two individuals were observed on Pond B during October.

Pied-billed Grebe, Podilymbus podiceps (Summer Resident)

Pied-billed Grebes were observed on three ponds (A, B and G) during May and October.

Double-crested Cormorant, Phalacrocorax auritus (Migrant)

One cormorant was sighted on Lake Michigan north of the beachgrass locale feeding in the Bailly outfall. This species is on the 1978 blue list (Arbib 1977).

Great Blue Heron, Ardea herodias, (Summer Resident)

This large wading bird was less common on the study area during 1978 than during previous years. The only sighting came from aquatic sampling location J.

Green Heron, Butorides virescens (Summer Resident)

Individuals of this species were sighted on five ponds during May. Nesting also occurred in the maple community during May. No sightings were reported during October.

Great Egret, Casmerodius albus (Summer Resident)

An individual was observed in the open bog during May.

Black-crowned Night Heron, Nycticorax nycticorax (Summer Resident)

An individual was sighted on Pond D during May.

Least Bittern, Ixyobrychus exilis, (Summer Resident)

An observation of this small wading bird was reported during May in Pond C.

Canada Goose, Branta canadensis (Summer Resident)

An individual was observed leaving Pond C during October.

Mallard, Anas platyrhynchos (Summer Resident)

The Mallard was one of the most abundant and widely distributed ducks inhabiting aquatic areas on the study site.

Black Duck, Anas rubripes (Migrant)

Black Ducks were not reported during May, but were seen on one water body during October. They are rarely as common as Mallards.

Gadwall, Anas strepera (Migrant)

A flock of 13 Gadwalls was sighted on Pond C during October. Gadwall are infrequent visitors of water bodies on the study area.

Pintail, Anas acurta (Migrant)

A flock of 21 Pintail was observed on Pond B during October.

Green-winged Teal, Anas crecca (Migrant)

A rather large flock of 39 birds was observed on Pond D during October.

Blue-winged Teal, Anas discolor (Summer Resident)

Blue-winged Teal were less numerous on the study area than were Green-winged Teal. Twelve individuals were sighted on Pond C.

American Wigeon, Anas americana (Migrant)

One flock composed of 56 individuals inhabited Pond B throughout much of October. The flock was never observed on any of the other water bodies.

Northern Shovler, Anas Clypeata (Migrant)

One sighting was made on Pond E during October.

Wood Duck, Aix sponsa, (Summer Resident)

Wood Ducks were uncommon on the study area during 1978. They are normally more abundant.

Ring-necked Duck, Aythya collaris

One flock of 18 Ring-necked Ducks was observed feeding on Pond C during October.

Common Merganser, Mergus merganser (Migrant)

One Common Merganser was observed on Pond E during October.

Turkey Vulture, Cathartes aura (Summer Resident)

An individual was sighted flying over the study area during May.

Red-tailed Hawk, Buteo jamaicensis (Permanent Resident)

One individual was observed during May.

American Kestrel, Falco sparverius (Permanent Resident)

Two sightings occurred south of the immediate study area during July.

Ring-necked Pheasant, Phasianus colchicus (Permanent Resident)

Several birds were heard during May in the open bog. None were sighted on the road route.

Table C-2 (Contd)

Sora, Porzana carolina (Summer Resident)

A Sora was reported from the shoreline of Pond G during May.

Common Gallinule, Gallinula chloropus (Summer Resident)

Two individuals were noted in Pond G during May.

American Coot, Fulica americana (Summer Resident)

Coots were among the most abundant and widely distributed aquatic species on the site. The greatest numbers occurred in Ponds C and G.

Killdeer, Charadrius vociferus (Summer Resident)

Killdeer occurred along the sandy beach of Lake Michigan during October and along the edge of roads at the Bailly Study Area during May.

Ruddy Turnstone, Arenaria interpres (Migrant)

Six turnstones were sighted along the shoreline of Lake Michigan north of the beachgrass community during May, while a flock of 20 was observed in the same location during October.

Common Snipe, Capella gallinago (Migrant)

Snipe were noted in the open bog during May general observations.

Spotted Sandpiper, Actitis macularia (Summer Resident)

An individual was sighted along the beach area during May.

Least Sandpiper, Calidris minutilla (Summer Resident)

An individual was reported along the road route during July.

Herring Gull, Larus argentatus (Migrant-Winter Resident)

Spring and fall maximum counts for the Lake Michigan beach area were 34 in May and 13 in October.

Ring-billed Gull, Larus delawarensis (Permanent Resident)

A maximum of 210 birds was counted along the beach of Lake Michigan during May.

Bonaparte's Gull, Larus philadelphia (Migrant)

Bonaparte's Gulls were abundant during May, and scarce during Octob

Common Tern, Sterna hirundo (Migrant)

Two Terns were sighted during May flying along the beach of Lake Michigan.

Rock Dove, Columba livia (Permanent Resident)

Rock Dove were most commonly observed during the July road survey.

Table C-2 (Contd)

Mourning Dove, *Zenaida macroura* (Permanent Resident)

Greater numbers of Mourning Dove were sighted during the July roadside survey (10) than during the May survey (2).

Yellow-billed Cuckoo, *Coccyzus americanus* (Summer Resident)

An individual was sighted along Cowles Bog trail in May.

Black-billed Cuckoo, *Coccyzus erythropthalmus* (Summer Resident)

One specimen of this more northern breeding species was sighted during May general observations.

Screech Owl, *Otus asio* (Permanent Resident)

An individual of this small owl species was heard calling at the edge of Cowles Bog in October. The Screech Owl is one of the most noctournal of North American Owls (Van Camp and Henny 1975).

Common Nighthawk, *Chordeiles minor* (Summer Resident)

Numerous individuals of this aerial predator of insects were observed flying over the study area in late May, and an individual was observed along Cowles Bog trail.

Chimney Swift, *Chaetura pelagica* (Summer Resident)

Various numbers were observed hawking for insects over the open bog during May and July.

Belted Kingfisher, *Megaceryle alcyon* (Permanent Resident)

Kingfishers were sighted in both May and October. All sightings were near water.

Common Flicker, *Colaptes auratus* (Permanent Resident)

Flickers were seen sporadically in wooded sampling locations.

Red-headed Woodpecker, *Melanerpes erythrocephalus* (Permanent Resident)

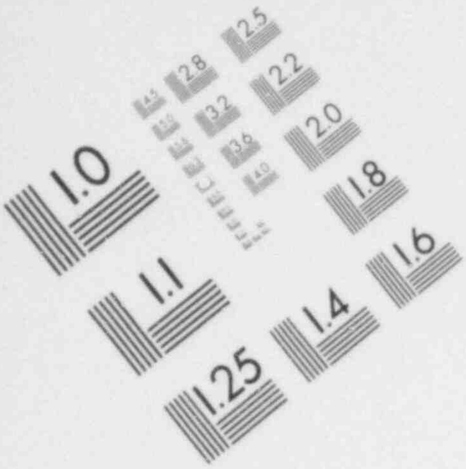
Red-headed Woodpeckers were most common in dead timber in the open bog during May.

Hairy Woodpecker, *Dendrocopos villosus* (Permanent Resident)

This large woodpecker was particularly common on the study area in May. It also was seen in July and October.

Downy Woodpecker, *Dendrocopos pubescens* (Permanent Resident)

This fairly common woodpecker species was recorded from woodlands over the study area. Woodpeckers are generally not destructive to healthy trees, but instead make cavities in trees that have been previously damaged by insects, disease, fires, or storms (Hardin and Evans 1977).



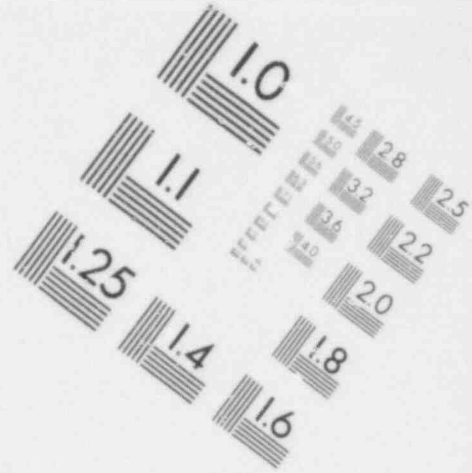
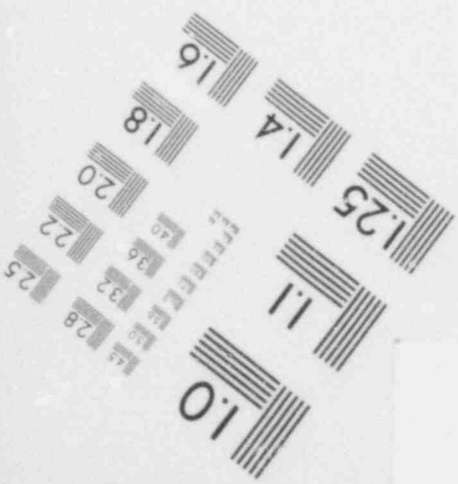


IMAGE EVALUATION TEST TARGET (MT-3)



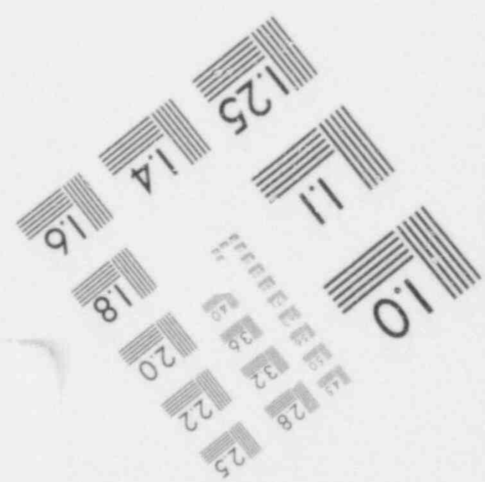


Table C-2 (Contd)

Eastern Kingbird, Tyrannus tyrannus (Summer Resident)

The kingbird was sighted in wet habitats in May, being most numerous around ponds.

Eastern Phoebe, Sayornis phoebe (Summer Resident)

This early-arriving and late-departing summer resident was seen on the study area in May.

Acadian Flycatcher, Empidonax virescens (Summer Resident)

This woodland inhabitant was observed in Cowles Bog (wooded) during May.

Willow Flycatcher, Empidonax traillii (Summer Resident)

Incidental sightings revealed several individuals of this species in the open bog.

Least Flycatcher, Empidonax minimum (Summer Resident)

This smallest of flycatchers was observed on the study area in May, occurring most commonly in edge habitat along Cowles Bog trail.

Eastern Wood Pewee, Contopus virens (Summer Resident)

Observations of this woodland flycatcher were recorded in May, in the wooded bog.

Olive-sided Flycatcher, Nuttallornis borealis (Migrant)

This species was sighted along Cowles Bog trail.

Tree Swallow, Iridoprocne bicolor (Summer Resident)

This species was commonly sighted hunting for insects over several ponds and the beach area in May. Late individuals were observed over these same areas in October.

Bank Swallow, Riparia riparia (Summer Resident)

Bank Swallows were common in and around the same areas tree swallows were observed.

Barn Swallow, Hirundo rustica (Summer Resident)

The greatest numbers of this species occurred during May and October around the beachgrass. Numerous individuals of this and other swallow species were also observed hunting over the open bog.

Cliff Swallow (Petrochelidon pyrrhonota)

Several individuals were observed flying along the beach area during October.

Blue Jay, Cyanocitta cristata (Permanent Resident)

This common permanent resident was observed in all woodlands on the study area.

Common Crow, Corvus brachyrhynchos (Permanent Resident)

Small flocks of this corvid were seen on practically all parts of the study area.

Black-capped Chickadee, Parus atricapillus (Permanent Resident)

Chickadees were less frequent during 1978 than in past years. A few could be counted on most visits to suitable habitat.

Tufted Titmouse, Parus bicolor (Permanent Resident)

A few titmice were observed at all times in woodlands on the study area.

White-breasted Nuthatch, Sitta carolinensis (Permanent Resident)

This nuthatch species was observed most frequently in maple and oak woodlands.

Red-breasted Nuthatch, Sitta canadensis (Migrant-Winter Resident)

An individual was sighted during incidental observations in the wooded bog during May.

Brown Creeper, Certhia familiaris (Migrant-Winter Resident)

Creepers were common in Cowles Bog (wooded) during October.

House Wren, Troglodytes aedon (Summer Resident)

This common summer resident was observed in May.

Carolina Wren, Thyrothorus ludovicianus (Permanent Resident)

An individual was observed on the edge of the maple forest during May.

Long-billed Marsh Wren, Telmatodytes palustris (Summer Resident)

An individual was sighted during May in the edge of the open bog.

Short-billed Marsh Wren, Cistothorus platensis (Summer Resident)

This smaller marsh wren was common in Cowles Bog during May.

Gray Catbird, Dumetella carolinensis (Summer Resident)

Catbirds were most abundant in moist woodlands on the study area during May.

Brown Thrasher, Toxostoma rufum (Summer Resident)

This member of the family Mimidae was observed most commonly on the study area in May, in Cowles Bog (wooded).

American Robin, Turdus migratorius (Summer Resident)

Numerous observations were made of this common woodland thrush.

Table C-2 (Contd)

Wood Thrush, Hylocichla mustelina (Summer Resident)

The wood thrush was common during May and October in Cowles Bog (wooded).

Hermit Thrush, Catharus guttata (Migrant)

Incidental Hermit Thrush observations occurred during May and October in Cowles Bog (wooded).

Swainson's Thrush, Catharus ustulata (Migrant)

A few Swainson's were sighted on the study area in May.

Veery, Catharus fuscescens (Summer Resident)

As in previous years, the Veery bred in the woods along Cowles Bog trail. Several were also noted along the trail in October.

Golden-crowned Kinglet, Regulus satrapa (Migrant-Winter Resident)

The kinglet was uncommon in the immature oak forest in October.

Ruby-crowned Kinglet, Regulus calendula (Migrant)

Two individuals were sighted along Cowles Bog trail during October.

Starling, Sturnus vulgaris (Permanent Resident)

Starlings could usually be observed in the transmission corridor and industrial areas. Large numbers again roosted in cattails in Cowles Bog (open).

White-eyed Vireo, Vireo griseus (Summer Resident)

White-eyed Vireos were commonly observed on the study area in May in wooded locales.

Yellow-throated Vireo, Vireo flavifrons (Summer Resident)

An individual was observed along Cowles Bog trail during May.

Red-eyed Vireo, Vireo olivaceus (Summer Resident)

Red-eyed Vireos, the most common vireo breeding in the region, were observed in wooded locations in May and October.

Philadelphia Vireo, Vireo philadelphia (Migrant)

This species was fairly common in wooded locations during May.

Warbling Vireo, Vireo gilvus (Summer Resident)

Warbling Vireos were also fairly common in wooded locations during May.

Black-and-white Warbler, Minotilta varia (Summer Resident)

A few incidental sightings of black-and-whites were reported in Cowles Bog (wooded) during May.

Table C-2 (Contd)

Golden-winged Warbler, Vermivora chrysoptera (Migrant)

An individual was sighted along Cowles Bog trail during May.

Tennessee Warbler, Vermivora peregrina (Migrant)

A Tennessee Warbler was sighted foraging for invertebrates in black oak trees in sampling location 3 during May.

Orange-crowned Warbler, Vermivora celata (Migrant)

One individual was observed along Cowles Bog trail in October. This was the only warbler observed only in October.

Nashville Warbler, Vermivora ruficapilla (Migrant)

One Nashville was sighted in woodlands along Cowles Bog trail in May.

Northern Parula Parula americana (Migrant)

One parula was seen on the study area in May.

Yellow Warbler, Dendroica petechia (Summer Resident)

Yellow Warblers were fairly common in the open bog during May.

Magnolia Warbler, Dendroica magnolia (Migrant)

The magnolia was commonly observed on the study area in May.

Black-throated Blue Warbler, Dendroica caerulescens (Migrant)

Two individuals were seen along Cowles Bog trail in May.

Yellow-rumped Warbler, Dendroica coronata (Migrant)

The Yellow-rumped Warbler, the most common warbler migrating through the region, was recorded in May and October. They were sighted most frequently in the open bog.

Black-throated Green Warbler, Dendroica virens (Migrant)

Two individuals were noted in the immature oak forest during May.

Cerulean Warbler, Dendroica cerulea (Summer Resident)

An individual was sighted along Cowles Bog trail during May.

Blackburnian Warbler, Dendroica fusca (Migrant)

Blackburnian Warblers were seen in the immature oak and maple sampling locales during May.

Chestnut-sided Warbler, Dendroica pensylvanica (Summer Resident)

An individual was seen in the immature oak woodlands (sampling location 3) during May.

Table C-2 (Contd)

Bay-breasted Warbler, *Dendroica castanea* (Migrant)

Two Bay-breasted Warblers were sighted along Cowles Bog trail during May.

Palm-Warbler, *Dendroica palmarum* (Migrant)

A single individual was observed in open habitat near sampling location 5 during May.

Ovenbird, *Seiurus aurocapillus* (Summer Resident)

One Ovenbird was sighted along Cowles Bog trail in May.

Northern Waterthrush, *Seiurus noveboracensis* (Migrant)

Two sightings occurred in wetter habitats along Cowles Bog trail.

Louisiana Waterthrush, *Seiurus motacilla* (Summer Resident)

A single Louisiana Waterthrush was observed during May in the wooded bog.

Mourning Warbler, *Oporornis philadelphia* (Summer Resident)

An individual of this secretive species was observed in thicket habitat along Cowles Bog trail in May.

Common Yellowthroat, *Geothylpis trichas* (Summer Resident)

The Yellowthroat, a species that commonly nests in marshy habitats, was observed in May.

Hooded Warbler, *Wilsonia citrina* (Migrant)

Two individuals were sighted along Cowles Bog trail in May.

Wilson's Warbler, *Wilsonia pusilla* (Migrant)

Several individuals were observed in May along Cowles Bog trail.

Canada Warbler, *Wilsonia canadensis* (Summer Resident)

Canada Warblers were common in May in Cowles Bog (wooded).

American Redstart, *Setophaga ruticilla* (Summer Resident)

Redstarts were common in forested habitats on the study area during May.

House Sparrow, *Passer domesticus* (Permanent Resident)

This introduced species was most frequent in residential areas along the road route.

Red-winged Blackbird, *Agelaius phoeniceus* (Summer Resident)

Red-winged Balckbirds were abundant on the study area during all sampling periods. Redwings again roosted by the thousands in Cowles Bog (open) in October.

Table C-2 (Contd)

Rusty Blackbird, _Euphagus carolinus_ (Migrant)

A few hundred birds were observed roosting in and around Cowles Bog (open) in October.

Common Grackle, _Quiscalus quiscula_ (Summer Resident)

Grackles were common to abundant on the study area during all sampling seasons. Grackles were among the large number of birds roosting in the open bog during October.

Brown-headed Cowbird, _Molothrus ater_ (Summer Resident)

Cowbirds were commonly observed during May and October, although their number were lower than other blackbird and related species.

Scarlet Tanager, _Piranga olivacea_ (Summer Resident)

Sightings were made in the immature oak forest and in Cowles Bog (wooded).

Cardinal, _Cardinalis cardinalis_ (Permanent Resident)

Although generally common in forested locales, this conspicuous permanent resident was rarely observed during 1978.

Rose-breasted Grosbeak, _Pheucticus ludovicianus_ (Summer Resident)

Grosbeaks were common only during May.

Indigo Bunting, _Passerina cyanea_ (Summer Resident)

An individual was sighted along the road route during May.

American Goldfinch, _Spinus tristis_ (Permanent Resident)

Several small flocks of this small finch were observed in open habitat during May and October

Rufous-sided Towhee, _Pipilo erythrophthalmus_ (Summer Resident)

Towhees were observed in May and October. Woodlands along Cowles Bog trail appeared to be the most favored habitat.

Savannah Sparrow, _Passerculus sandwichensis_ (Summer Resident)

One individual was seen in the border between the wooded and open bog during May.

Dark-eyed Junco, _Junco hyemalis_ (Winter Resident)

Small flocks were common in all open habitats during October.

Tree Sparrow, _Spizella arborea_ (Winter Resident)

Tree sparrows were most common in the transmission corridor and along the edge of the maple forest.

Table C-2 (Contd)

Chipping Sparrow, Spizella passerina (Summer Resident)

An individual was observed during May on the road route survey.

Field Sparrow, Spizella pusilla (Summer Resident)

Field Sparrows were recorded from the transmission corridor during May and October.

White-throated Sparrow, Zonotrichia albicollis (Summer Resident)

This species was common in damp areas in the wooded bog during October.

Fox Sparrow, Passerella iliaca (Migrant)

One Fox Sparrow was sighted along edge habitat in Cowles Bog (wooded).

Swamp Sparrow, Melospiza georgiana (Permanent Resident)

This wetland-inhabiting sparrow was observed in the open bog during May and October.

Song Sparrow, Melospiza melodia (Permanent Resident)

This common sparrow was observed in thicket and brushy habitats over the study area.

580 008

APPENDIX D

ANNOTATED LIST OF AMPHIBIANS AN REPTILE SPECIES OBSERVED AT THE BAILLY STUDY AREA, MAY AND JULY, 1978

APPENDIX D

ANNOTATED LIST OF AMPHIBIANS AND REPTILE SPECIES OBSERVED AT THE BAILLY STUDY AREA, MAY AND JULY 1978

Red-backed salamander, Plethedon cinereus

Individuals o this species were found under logs in Cowles Bog (wooded) during May.

American toad, Bufo americanus

An individual was captured from the transmission corridor during July.

Cricket frog, Acris crepitans

During May, chorus activity was reported from the wooded open bog and emergent macrophyte community.

Spring peeper, Hyla cru ifer

Peepers were reported from two of the eight sampling locations on the study area during May.

Gray treefrog, Hyla versicolor

Gray treefrogs were heard calling from Cowles Bog (wooded and open) sampling locations during May.

Bull frog, Rana catesbeiana

The bull frog was commonly observed during May and July in the aquatic macrophyte sampling location.

Green frog, Rana clamitans

The green frog was much less common in 1978 than during past years on the study area.

Wood frog, Rana sylvatica

Several individuals of this almost exclusively woodland frog were heard calling from Cowles Bog (wooded) during May.

Painted turtle, Chrysemys picta

Painted turtles were observed commonly during May and July from the aquatic macrophyte community.

Northern water snake, Natrix sipedon

The northern water snake was reproted from the aquatic macrophyte sampling location during May and July.

Eastern garter snake, Thamnophis sirtalis

Only one garter snake was observed during 1978. It has in past years been more common.

Blue racer, *Coluber constrictor*

One blue racer was captured during May in the beachgrass sampling locale.

Eastern hognose snake, *Heterodon platyrhinos*

An individual of this species was observed in the maple forest during May.

583 011

APPENDIX E

CHECKLIST OF ENTOMOLOGICAL FAUNA COLLECTED IN THE NIPSCo BAILLY STUDY AREA, 1974-1978

580 012

Table E-1

Checklist of Entomological Fauna Collected in the NIPSCo Bailly Study Area, 1974-1978

Order Protura (proturans)
Order Diplura (diplurans)
Order Collembola (springtails)
- Poduridae
- Onychiuridae
- Isotomidae
- Entomobryidae
- Sminthuridae

Order Ephemeroptera (mayflies)
- Caenidae
  - Caenis spp.
  - Cloeon sp.
- Baetidae
  - Baetis sp.
- Heptageniidae
  - Stenonema sp.
- Ephemeridae
  - Hexagenia sp.

Order Odonata (dragonflies, damselflies)
- Aeshnidae (dragonflies)
  - Aeschna verticalis
  - Anax junius
- Libellulidae (dragonflies)
  - Erythemis sp.
  - Leucorrhinia intacta
  - Libellula sp.
  - Pachydiplax longipennis
  - Plathemis lydia
  - Sympetrum sp.
  - S. vicinium
- Lestidae (damselflies)
  - Lestes rectangularis
- Coenagrionidae (damselflies)
  - Amphiagrion saucium
  - Enallagma spp.
  - Ischnura spp.
  - Nehalennia sp.

Order Orthoptera (grasshoppers, katydids, roaches, etc.)
- Tetrigidae (pygmy grasshoppers)
- Acrididae (grasshoppers)
  - Dissosteira carolina (Carolina grasshopper)
  - Melanoplus spp.
- Tettigoniidae (katydids)
  - Conocephalus sp.
  - Microcentrum sp.
  - Neoconocephalus sp.
  - Scudderia furcata
- Gryllidae (crickets)
  - Gryllus sp.
  - Oecanthus sp.
- Phasmatidae (walkingsticks)
  - Diapheromera femorata
- Mantidae (mantids)
- Blattidae (cockroaches)
  - Parcoblatta virginica

Order Dermaptera (earwigs)
- Forficulidae

Order Isoptera (termites
- Rhinotermitidae

Order Plecoptera (stoneflies)
- Isoperlidae
  - Isoperla sp.
- Perlidae
  - Perlesta placida

Order Psocoptera (psocids)
- Liposcelidae (booklice)
- Pseudocaeciliidae (psocids)
- Polypsocidae (psocids)
- Psocidae (psocids)

Order Thysanoptera (thrips)
- Aeolothripidae
- Thripidae
- Phloeothripidae

Order Hemiptera (bugs)
- Corixidae (waterboatmen)
  - Sigara spp.
  - Trichocorixa sp.
- Notonectidae (backswimmers)
  - Notonecta spp.
- Pleidae (pleid water bugs)
  - Plea striola
- Nepidae (waterscorpions)
  - Nepa apiculata
  - Ranatra sp.
- Gelastocoridae (toad bugs)
- Belostomatidae (giant water bugs)
  - Belostoma sp.
- Gerridae (water spiders)
  - Gerris sp.
  - Trepobates sp.
- Veliidae (broadshouldered water striders)
  - Microvelia sp.
  - Trepobates sp.
- Mesoveliidae (water treaders)
  - Mesovelia sp.
- Hebridae (velvet water bugs)
  - Hebrus sp.
- Miridae (plant bugs)
  - Deraeocoris sp.
  - Eustictus sp.
  - Halticus bracteatus (garden fleahopper)
  - Hyaliodes sp.
  - Lopidea sp.
  - Lygus lineolaris (tarnished plant bug)
  - Neurocolpus sp.
  - Plagiognathus obscurus
  - Poecilocapsus lineatus
  - Sixeonotus sp.
  - Strongylocoris atritibialis
  - Trigonotylus ruficornis
  - T. tarsalis
- Nabidae (damsel bugs)
  - Nabis sp.
- Reduviidae (assassin bugs)
  - Zelus sp.
- Phymatidae (ambush bugs)
  - Phymata sp.
- Tingidae (lace bugs)
  - Corythuca arcuata
  - C. contracta
  - C. marmorata
  - Leptopharsa sp.
- Piesmatidae (ashgray leaf bugs)
  - Piesma cinera
- Lygaeidae (seed bugs)
  - Cymus sp.
  - Eremocoris sp.
  - Geocoris sp.
  - Ischnodemus falicus
  - Ischnorhynchus resedae
  - Lygaeus kalmii
  - Nysius sp.
  - Oedancala sp.
  - Oncopeltus fasciatus
  - Orthaea sp.
  - Phlegyas abbreviatus
- Berytidae (stilt bugs)
  - Jalysus sp.

POOR ORIGINAL

Table E-1 (Contd)

Order Hemiptera (bugs) (Continued)
- Coreidae (coreid bugs)
  - *Euthochtha* sp.
- Pentatomidae (stink bugs)
  - *Acrosternum* sp.
  - *Cosmopepla bimaculata*
  - *Euchistus* sp.
  - *Mormidea lugens*
  - *Peribalus* sp.
  - *Podops* sp.
  - *Solubea* sp.
- Cydnidae (burrower bugs)
  - *Allocoris* sp.
  - *Galgupha* sp.

Order Homoptera (hoppers, aphids)
- Cicadidae (cicadas)
- Membracidae (treehoppers)
  - *Ceresa* sp.
  - *C. bubalus*
  - *Cyrtolobus* sp.
  - *Enchenopa binotata*
  - *Vanduzea* sp.
- Cicadellidae (leafhoppers)
  - *Agallia constricta*
  - *Chlorotettix* sp.
  - *Commellus* sp.
  - *Dikraneura* spp.
  - *Draeculacephala* sp.
  - *Empoasca* sp.
  - *Erythroneura* sp.
  - *Flexamia* sp.
  - *Graphocephala* sp.
  - *Gyponana* sp.
  - *Idiocerus* sp.
  - *Limotettix* sp.
  - *Macrosteles divisa*
  - *Mesamia* sp.
  - *Paraphlepsius* sp.
  - *Polyamia* sp.
- Cercopidae (spittlebugs)
- Delphacidae (delphacid planthoppers)
- Cixiidae (cixiid planthoppers)
- Dictyopharidae (dictyopharid planthoppers)
- Achilidae (achilid planthoppers)
- Flatidae (flatid planthoppers)
- Acanaloniidae (acanaloniid planthoppers)
- Issidae (issid planthoppers)
- Psyllidae (jumping plantlice)
- Aphididae (aphids)

Order Coleoptera (beetles)
- Cupedidae (recticulated beetles)
  - *Cupes concolor*
- Cicindellidae (tiger beetles)
  - *Cicindela dorsalis*
  - *C. hirticollis*
  - *C. repanda*
  - *C. scutellaris*
- Carabidae (ground beetles)
  - *Agonoderus* sp.
  - *Anisodactylus* sp.
  - *Anomoglossus* sp.
  - *Bembidion* sp.
  - *Chlaenius* sp.
  - *Clivinia* sp.
  - *Harpalus* sp.
  - *Lebia pumila*
  - *L. viridis*
  - *Omophron labiatum*
  - *Platynus* sp.
  - *Pterostichus* sp.
  - *Stenocellus* sp.
  - *Stenolophus* sp.
  - *Tachycellus* sp.
  - *Tachys* sp.

Order Coleoptera (beetles) (Continued)
- Haliplidae (crawling water beetles)
  - *Haliplus* sp.
  - *Peltodytes duodecimpunctatus*
  - *P. muticus*
- Dytiscidae (predaceous diving beetles)
  - *Agabus* sp.
  - *Comptotomus* sp.
  - *Desmophachria* sp.
  - *Hydroporus* spp.
  - *H. consimilis*
  - *H. niger*
  - *Hygrotus* sp.
  - *Illybius* sp.
  - *Laccophilus* spp.
  - *Rhantus* sp.
- Gyrinidae (whirling beetles)
  - *Gyrinus* sp.
  - *G. borealis*
- Hydrophilidae (water scavenger beetles)
  - *Anacaena* sp.
  - *Berosus* sp.
  - *Cymbiodyta fimbriata*
  - *Enochrus* sp.
  - *Helophorus* sp.
  - *Hydrobius* sp.
  - *Hydrochara* sp.
  - *Hydrochus* sp.
  - *Paracymus* sp.
  - *Tropisternus* sp.
  - *T. lateralis*
- Ptiliidae (featherwinged beetles)
  - *Ptinella* sp.
  - *Ptinellodes* sp.
- Staphylinidae (rove beetles)
  - *Cyrophaena* sp.
  - *Paederus* sp.
  - *Stenus* sp.
  - *Tachinus* sp.
- Pselaphidae (shortwinged mold beetles)
- Orthoperidae (minute fungus beetles)
  - *Artholips* sp.
- Cantharidae (soldier beetles)
  - *Cantharis* sp.
  - *C. rectus*
  - *Podabrus* spp.
  - *Polemius* sp.
  - *Tytthonyx* sp.
- Lampyridae (fireflies)
  - *Ellychnia corrusca*
  - *Lucidota* sp.
  - *Photinus* sp.
  - *Photuris* sp.
  - *P. pennsylvanica*
  - *Pyractonema* sp.
- Dermestidae (dermestid beetles)
- Malachiidae (softwinged flower beetles)
  - *Attalus* sp.
- Cleridae (checkered beetles)
  - *Enoclerus* sp.
  - *Isohydnocera tabida*
  - *Phyllobaenus pallipennis*
- Elateridae (click beetles)
  - *Athous* sp.
  - *Conoderus vespertinus*
  - *Ctenicera* sp.
  - *Hemicrepidius* sp.
  - *Heteroderes* sp.
  - *Limonius basilaris*
  - *L. interstitialis*
  - *Melanotus* spp.
- Throscidae (throscid beetles)
  - *Aulonothroscus* sp.

POOR ORIGINAL

Table E-1 (Contd)

Order Coleoptera (beetles) (Continued)
- Buprestidae (metallic woodborers)
  - Acmaeodera pulchella
  - Agrilus sp.
  - A. arcuatus
  - Brachys ovatus
  - Taphrocerus sp.
- Ptilodactylidae (ptilodactylid beetles)
  - Ptilodactyla sp.
- Helodidae (marsh beetles)
  - Cyphon sp.
  - Elodes sp.
  - Prioncyphon sp.
  - Scrites sp.
- Elmidae (riffle beetles)
- Cryptophagidae (cryptophagid beetles)
  - Paraxontha sp.
- Languriidae (languriid beetles)
  - Acropteroxys sp.
- Cucujidae (flat bark beetles)
  - Laemopholeus sp.
- Phalacridae (shining fungus beetles)
  - Olibrus sp.
  - Phalacrus sp.
  - Stilbus sp.
- Nitidulidae (sap beetles)
  - Brachypterus sp.
  - C tarcha ampla
- Lath diidae (minute brown scavenger beetles)
  - Corticaria sp.
- Erotylidae (pleasing fungus beetles)
  - Ischyrus quadripunctatus
  - Megalodacne fusciata
- Coccinellidae (lady beetles)
  - Adalia bipunctata (twospotted lady beetle)
  - Chilocoris stigma (twicestabbed lady beetle)
  - Coccinela novemnotata
  - Coleomegilla fuscilabris
  - Cycloneda sanguisga
  - Hippodamia convergens (convergent lady beetle)
  - H. glacialis
  - H. parenthesis
  - H. tridecempunctata (13-spotted lady beetle)
  - Hyperaspis undulata
  - Microweisea sp.
  - Psyllobora viginitimaculata
  - Scymnus sp.
- Anthicidae (antlike flower beetles)
  - Anthicus sp.
  - Notoxus muripennis
- Euglenidae (antlike leaf beetles)
  - Elonus sp.
  - Emelinus sp.
- Pedilidae (false antlike flower beetles)
- Mycetophagidae (hairy fungus beetles)
  - Mycetophagus sp.
- Pyrochroidae (firecolored beetles)
  - Dendroides sp.
- Mordellidae (tumbling flower beetles)
  - Mordella spp.
  - Mordellistena spp.
- Alleculidae (combclawed beetles)
  - Hymenorus sp.
  - Isomira sericea
- Tenebrionidae (darkling beetles)
  - Mercantha contracta
  - Ulcma imberbis
  - Xylopinus saperdioides
- Melandryidae (false darkling beetles)
  - Canifa sp.
  - Symphora sp.
- Ptinidae (spider beetles)
  - Ptinus sp.
- Anobiidae (anobiid beetles)
  - Cryptorama sp.

Order Coleoptera (beetles) (Continued)
- Lucanidae (stag beetles)
  - Pseudolucanus sp.
- Bostrichidae (false powderpost beetles)
  - Lichenophanes sp.
- Scarabeidae (scarabs)
  - Anomala sp.
  - Ataenius sp.
  - Geotrupes sp.
  - Macrodactylus subspinosus (rose center)
  - Maladera castanea (Asiatic garden beetle)
  - Onthophagus janus
  - Phyllophaga spp.
  - Serica sp.
  - Trichiotinus sp.
- Cerambycidae (longhorned beetles)
  - Anoplodera rubica
  - Oberea tripunctata
  - Orthosoma brunneum
  - Parandra brunnea
  - Ps. . cerus supernotatus
  - Psyr. ssa unicolor
  - Saperda vestita
  - Typocerus sp.
- Chrysomelidae (leaf beetles)
  - Acalymma vittata
  - Altica sp.
  - Anisostena sp.
  - Anoplitis inaequalis
  - Babia sp.
  - Calligrapha spp.
  - Cerotoma trifurcata
  - Chaetocnema minuta
  - Chalepus sp.
  - C. scapularis
  - Chalmisus sp.
  - Chrysochus auratus
  - Chrysodina sp.
  - Colaspsis sp.
  - Crepidodera sp.
  - Crioceris duodecimpunctata (spotted asparagus beetle)
  - Cryptocephalus sp.
  - Deloyala guttata
  - Diabrotica undecimpunctata (spotted cucumber beetle)
  - D. virgifera (western corn rootworm)
  - Diachus sp.
  - Dibolia sp.
  - Disonycha pennsylvanica
  - D. latifrons
  - Exema sp.
  - Lema collaris
  - Longitarsus sp.
  - Nodonota sp.
  - Oedionychus sp.
  - Pachybrachis sp.
  - Phaedon viridis
  - Phyllotreta sp.
  - Plagiodera versicolor (imported willow leaf beetle)
  - Plagiometriona clavata
  - Psylliodes sp.
  - Systena frontalis
  - S. marginalis
  - Stenispa sp.
  - Tymnes sp.
- Anthribidae (fungus weevils)
  - Ishnocerus sp.
- Curculionidae (weevils)
  - Apion sp.
  - Calendra sp.
  - Hypera postica (alfalfa weevil)
  - Rhodobaenus sp.
  - Sphenophorus sp.
- Scolytidae (bark beetles)

Order Neuroptera (antlions, lacewings, dobsonflies, etc.)
- Corydalidae (dobsonflies)

Table E-1 (Contd)

Order Neuroptera (Continued)
Sialidae (alderflies)
Chrysopidae (green lacewings)
Hemerobiidae (brown lacewings)
Coniopterygidae (dustywings)
Myrmeleontidae (antlions)
Order Mecoptera (scorpionflies)
Panorpidae (scorpionflies)
Panorpa sp.
Bittacidae (hangingflies)
Bittacus sp.
Order Trichoptera (caddisflies)
Psychomyiidae
Hydropsychidae
Hydroptilidae
Leptoceridae
Athripsodes sp.
Oecetis sp.
Triaenodes sp.
Phryganeidae
Banksiola selina
Oligostomis sp.
Limnephilidae
Athripsodes sp.
Order Lepidoptera (butterflies, moths)
Papilionidae (swallowtail butterflies)
Papilio glaucus (tiger swallowtail)
P. polyxenes (black swallowtail)
Pieridae (whites, sulfurs)
Colias philodice (common sulfur)
Pieris protodice (southern cabbageworm)
P. rapae (imported cabbageworm)
Danaidae (milkweed butterflies)
Danaus plexippus (monarch butterfly)
Nymphalidae (brushfooted butterflies)
Cynthia cardui (painted lady)
Euphydras phaeton (Baltimore)
Junonia coenia (buckeye)
Limenitis archippus (viceroy)
Nymphalis antiopa (mourningcloak butterfly)
Phyciodes tharos (pearl crescent)
Polygonia interrogationis (question mark)
Speyeria cybele (great spangled fritillary)
S. diana (diana)
Vanessa atalanta (red admiral)
Satyridae (satyr butterflies)
Euptychia cymela (little wood satyr)
E. mitchellii (Mitchell's satyr)
Lethe eurydice (eyed brown)
L. portlandia (pearly eye)
Lycaenidae (blues, coppers, hairstreaks)
Everes comyntas (eastern tailed blue)
Lycaenopsis argiolus (spring azure)
Satyrium caryaevorous (hickory hairstreak)
Hesperiidae (skippers)
Epargyreus clarus (silverspotted skipper)
Saturniidae (giant silkworm moths)
Antheraea polyphemus (polyphemus moth)
Automeris io (io moth)
Sphingidae (sphinx moths)
Poanias myops (smalleyed sphinx)
Smerinthus jamaicensis (twinspot sphinx)
Ctenuchidae (ctenuchid moths)
Scepsis fulvicollis (yellowcollared scape moth)
Arctiidae (tiger moths)
Estigmina congrua
Halisodota tesselaris (pale tussock moth)
Haploa confusa
Hypoprepia miniata
H. fucosa
Isia isabella (banded woollybear)
Noctuidae (owlet moths, underwings)
Apatela sp.
Calpe canadensis
Catacola sp.
Epizeuxis sp.

Order Lepidoptera (Continued)
Noctuidae (Continued)
Phosphila miseliodes
Trichoplusia ni (cabbage looper)
Ulolonche culea
Zale sp.
Notodontidae (notodontid moths)
Cerura borealis
Datana ministra (yellownecked caterpillar)
Heterocampa guttivitta (saddled prominent)
Lasiocampidae (tent caterpillar moths)
Malacosoma americana (eastern tent caterpillar)
Geometridae (geometrid moths)
Abbotana clementaria
Bapta vestaliata
Chlorochlamys chloroleucaria (blackberry looper)
Ectropis crepuscularia
Epimecis sp.
Lygris diversilineata (grapevine looper)
Philobia enotata
Sabulodes thisoaria
S. transversata
Scopula imboundata
Tetracis crocallata
Xanthotype coelaria
Limacodidae (slug caterpillar moth)
Euclea penulata
Pyromorphidae (smoky moths)
Pyralidae (pyralid moths)
Desmia funeralis (grape leaffolder)
Herculia himonialis
Nymphula sp.
Pantographa limata (basswood leafroller)
Paraponyx sp.
Tortricidae (tortricid moths)
Archips parallela
Micromoths
Order - Diptera (flies)
Tipulidae (crane flies)
Ptycnopteridae (phantom crane flies)
Bittacomorpha clavipes
Ptychoptera sp.
Psychodidae (moth flies)
Chaoboridae (phantom modges)
Chironomidae (midges)
Bibionidae (March flies)
Bibio sp.
Dixidae (dixid midges)
Simuliidae (black flies)
Culicidae (mosquitoes)
Mycetophilidae (fungus gnats)
Scatopsidae (black scavenger flies)
Sciaridae (darkwinged fungus gnats)
Cecidiomyiidae (gall midges)
Ceratopogonidae (biting midges)
Xylophagidae (xylophagid flies)
Stratiomyiidae (soldier flies)
Cyphomyia sp.
Nemotelus sp.
Pedicella sp.
Petecticus sp.
Tabanidae
Chrysops cincticornis
C. cuclux
C. vittatus
Tabanus spp.
T. trimaculatus
Therevidae (stilleto flies)
Rhagionidae (snipe flies)
Scenopinidae (window flies)
Metatrichia sp.
Mydidae (mydas flies)
Mydas clavatus
Asilidae (robber flies)
Efferia albibaris
Bombyliidae (bee flies)

POOR ORIGINAL

Table E-1 (Contd)

Order of Diptera (flies) (Continued)
- Empididae (dance flies)
  - Chelipoda sp.
  - Tachypeza sp.
- Dolichopodidae (longlegged flies)
  - Argyra sp.
  - Asyndetus sp.
  - Chrysotus spp.
  - Condylostylus sp.
  - Dolichopus sp.
  - Gymnoternus sp.
  - Mesorhaga sp.
  - Pelastoneurus sp.
  - Sciapus sp.
  - Thinophilus sp.
- Lonchopteridae (spearwinged flies)
  - Lonchoptera sp.
- Phoridae (humpbacked flies)
- Pipunculidae (bigheaded flies)
  - Alloneura sp.
  - Pipunculus sp.
- Syrphidae (flower flies)
- Conopidae (thickheaded flies)
- Micropezidae (stiltlegged flies)
- Otitidae (otitid flies)
  - Chaetopsis sp.
  - Eumetopiella sp.
- Platystomatiae (platystomatid flies)
  - Rivellia sp.
- Tephritidae (fruit flies)
- Sepsidae (black scavenger flies)
  - Sepsis sp.
- Sciomyzidae
  - Hoplodictya sp.
  - Tetanocera sp.
- Lauxaniidae (lauxaniid flies)
  - Camptoprosopella sp.
  - Homoneura sp.
  - Minettia sp.
  - Sapromyza sp.
- Chamaemyiidae (chamaemyiid flies)
- Piophilidae (skipper flies)
- Lonchaeidae (lonchaeid flies)
- Sphaeroceridae (dung flies)
  - Leptocera sp.
  - Scatophora sp.
- Ephydridae (shore flies)
  - Dichaeta sp.
  - Pahydra sp.
  - Scatella sp.
  - Scatophila sp.
- Drosophilidae (vinegar flies)
  - Chymomza sp.
  - Drosophila sp.
- Chloropidae (chloropid flies)
  - Cetema sp.
  - Chlorops sp.
  - Crassiseta sp.

Order of Diptera (flies) (Continued)
- Chloropidae (Continued)
  - Diplotoxa sp.
  - Hippelates sp.
  - Meromyza sp.
  - Parectocephala sp.
- Agromyzidae (leafminer flies)
- Clusiidae (clusiid flies)
  - Clusiodes sp.
  - Heteromingia sp.
- Heleomyzidae (heleomyzid flies)
- Anthomyzidae (anthomyzid flies)
- Cuterebridae (rodent bots)
- Anthomyiidae (anthomyiid flies)
- Calliphoridae (blow flies)
  - Lucillia sp.
  - Phaenicia sp.
- Muscidae (muscid flies)
  - Musca domestica (house fly)
- Tachinidae (tachinid flies)

Order Hymenoptera (sawflies, wasps, ants, bees)
- Pamphiliidae (webspinning sawflies)
- Pergidae (pergid sawflies)
  - Acordulecera sp.
- Argidae (argid sawflies)
- Tenthredinidae (sawflies)
- Braconidae (braconids)
- Ichneumonidae (ichneumons)
- Eulophidae (eulophids)
- Eupelmidae (eupelmids)
- Perilampidae (perilampids)
- Torymidae (torymids)
- Pteromalidae (pteromalids)
- Eurytomidae (eurytomids)
- Chalcididae (chalcidids)
- Cynipidae (gall wasps)
- Evaniidae (ensign wasps)
- Prototrupidae (prototrupids)
- Ceraphronidae (ceraphronids)
- Diapriidae (diapriids)
- Scelionidae (scelionids)
- Tiphiidae (tiphiids)
- Formicidae (ants)
- Pompilidae (spider wasps)
- Sphecidae (mid daubers)
- Andrenidae (andrenid bees)
- Halictidae (sweat bees)
- Apidae (bees)
  - Apis mellifera (honey bee)
  - Xylocopa virginica (large carpenter bee)

Order Decapoda (crayfish)

Order Amphipoda (scuds)

Order Chelonethida (pseudoscorpions)

Order Phalangida (harvestmen)

Order Acari (mites)
- Dermacentor variabilis (American dog tick)

Order Araneida (spiders)

Order Isopoda (isopods)

Class Chilopoda (centipedes)

Class Diplopoda (millipedes)

583 018

APPENDIX F

ANNOTATED LIST OF MACROPHYTE TAXA COLLECTED IN NEARSHORE PONDS IN THE BAILLY STUDY AREA, JUNE 1978

APPENDIX F

ANNOTATED LIST OF MACROPHYTE TAXA COLLECTED IN NEARSHORE PONDS IN THE BAILLY STUDY AREA, JUNE 1978

Bullhead or yellow water lily, Nuphar microphyllum

Yellow, tulip-like flowers and broadly oval, bilobed leaf blades characterize this lant. Many birds and animals eat the flowers, seeds, leaves, and rhizomes, the latter being the chief food of muskrats (Prescott 1969). Deer are known to browse on the leaves. The stems (actually petioles) may grow to 12-foot length. The bullhead commonly inhabits eastern United States bays and ponds.

Pickerel weed, Pontederia cordata

The deep-green leaves of this plant are heart or lance-shaped. The purple or bluish flowers grow on a spike rising above the water surface and are very showy. Like the yellow water lily, this plant is also a food for muskrats, and the seeds are consumed by many birds. It appears along soft, mucky shores in the eastern United States.

Coontail or hornwort, Ceratophyllum spp. (probably demersum)

Readily identifiable by the whorls of leaves spaced at intervals along the stem, the coontail does not have true roots, but the stems are sometimes embedded in the substrate, particularly in muddy bottoms. The flowers are small, solitary red cylinders in the axils of the leaves. The plant is only moderately efficient as an aerator, but is eaten by muskrats and birds. C. demersum is found throughout the continental United States. It is characteristic of shallow ponds and slow streams.

Cattail, Typha latifolia

This particular species is common in the United States (found in all states except those in the lower Mississippi Valley — Muenscher 1944). It grows in dense stands in shallow waters and along the edges of ponds and provides excellent cover for birds and other animals. The rhizomes are food for muskrats and beavers.

Water lily, Nymphaea sp.

This species was probably Nymphaea odorata or N. tuberosa. Necessary identifying structures were unavailable at time of collection. Both species have large, showy, white or violet lotus-like blossoms and circular but deeply lobed leaves. Nymphaea often occurs along with Nuphar, as it does in the NIPSCo Bailly N-1 vicinity, but may be more common by itself in soft or acid-water habitats.

Duckweed, Lemna minor

Duckweed is perhaps the most common aquatic macrophyte species in the United States. A "floater" on the surface of the water or entangled in other macrophytes, it is about 1/4 inch in diameter and often forms extensive surface mats in quiet waters or slowly flowing streams. It is

a useful indicator organism of hard-water habitats (Prescott 1969). Use of this plant for nutrient removal in water treatment ponds has been proposed (Harvey and Fox 1973).

Water shield, Brasenia schreberi

This species is a rooted plant with leaves that float on the surface similar to water lilies. B. schreberi is found chiefly in the eastern half of the United States (Muenscher 1944) and is most abundant in ponds and lakes with water of pH less than 7.0 and a bottom of sand or partially decomposed plant remains. It, like Utricularia, provides a point of attachment for periphytic algae.

Sedge, Carex spp.

These taxa, comprising about 1000 species, are grasslike perennials occurring in marshes and along wet shorelines. The taxa are useful as a shoreline builder, as home for birds, and as a food for muskrats and birds.

Pondweed, Potamogeton spp.

This rooted genus is comprised of 90 to 100 species worldwide, of which approximately 40 are indigenous to North America. Pondweeds are found primarily in shallow ponds, lakes, and quiet waters of rivers and streams. The achenes (hard, dry fruits) are a favorite and important wildfowl food. Other plant parts also are eaten by waterfowl, marshbirds, muskrats, and deer. The taxa also provide food, shelter, and shade for fish, zooplankton, and benthic fauna.

Arrow Arum, Peltandra virginica

This stout perennial has a short, erect rootstock and arrow-shaped leaves with three major veins. P. virginica is found mostly in the eastern states in shallow waters and along stream banks. The seeds of this plant are eaten by species such as wood ducks, marshbirds, and shorebirds and to some extent, by muskrats (Correll and Correll 1972).

Smartweed, Polygonum sp.

This taxon is a member of the same family as Rumex (Dock). Like Rumex, the taxon is cosmopolitan, with approximately 320 species identified worldwide. More than 20 species are common in the United States, five of which are amphibious. The taxon is consumed (primarily the seeds) by many songbirds, waterfowl, marshbirds, and small mammals. The stems often are eaten by browsers such as deer. Regions where Polygonum densities are high are often popular congregating areas for waterfowl (Correll and Correll 1972).

Bur reed, Sparganium (chlorocarpum)

This perennial species, tentatively identified as chlorocarpum, is common in temporary ponds and on boggy shores. The most distinguishing characteristic of the genus is the fruiting head, which grows to 1-1/2 inches in diameter and resembles a large, fleshy cocklebur. Waterfowl and marsh birds eat the achenes of the plant, and muskrats and deer eat the whole plant. The primary value of the bur reed is as a cover plant to attract marsh birds and waterfowl (Correll and Correll 1972).

Cutgrass, Leersia virginica

A perennial grass found near the edges of ponds and bogs, this species is distributed over much of the United States but occurs infrequently in the far West. The species provides food for songbirds and small mammals.

Black willow, Salix nigra

This woody plant, like buttonbush and others found near the ponds, is not a true aquatic plant, although it will also grow in areas inundated for a portion of the year, a characteristic it shares with other willows. Like the buttonbush (Cephalanthus occidentalis), it serves a useful role in substrate stabilization and as a home for avifauna.

Rush, Juncus spp.

This genus is represented in the United States by in excess of 30 species. The species are usually perennial, tufted grass-like plants with persistent flowers. The fruit forms a small capsule with numerous small seeds. The genus is common in open, moist areas.

Chara, Chara

Chara, although relatively large in size, is in truth a macro-algal form, with a primary axis, branches and leaves differentiated into nodes and internodes. Branches arise in the axils of leaves and there is usually but a single branch at each node, along with a whorl of 6 to 16 leaves. This genus of the division Chlorophyta (green algae) is relatively common throughout the United States.

Water plantain, Alisma plantago-aquatica

This species is considered a marsh or aquatic perennial herb. Common from April through November in marshes, pond and stream borders, it is identified by the carpels attached to the receptacle in a ring; perfect flowers; paniculate inflorescence; and leaves never sagittate.

CITED LITERATURE

Correll, D.S. and H.B. Correll, 1972. Aquatic and wetland plants of southwestern United States. EPA Pub. 16030 DNL 01/72. XV + 1777 pp.

Harvey, R.M. and J.L. Fox, 1973. Nutrient Removal using Lemna minor. J. Water Poll. Control Fed. 45(9):1928-1938.

Muenscher, W.C., 1944. Aquatic plants of the United States. Comstock Pub. Assoc. Ithaca, N.Y. x + 374 pp.

Prescott, G.W. 1969. How to know the aquatic plants. Wm. C. Brown Co. (Publishers). N.Y.

APPENDIX G

WATER QUALITY

Parameter	Unit	Rep.	1S	2S	2B	3S	3M	3B	4S	5S	5B	6S	6M	6B
Alkalinity, total	mg/ℓ	a	122	122	122	120	122	122	122	110	111	110	111	112
		b	122	122	122	122	122	122	123	110	109	113	111	113
Calcium, soluble	mg/ℓ	a	37.2	36.5	37.2	36.9	36.2	36.5	35.8	36.9	37.5	37.1	38.5	35 [illegible]
		b	37.0	36.4	36.6	35.8	36.4	35.3	36.0	37.5	37.7	38.4	36.3	3[illegible].8
Chloride, total	mg/ℓ	a	10.5	10.4	9.7	10.1	9.8	9.6	11.1	10.7	10.1	10.0	9.9	9.6
		b	10.5	10.3	9.3	10.1	9.8	9.6	10.9	10.8	10.1	10.0	9.7	9.6
Chlorine, total	mg/ℓ	a	<0.01	—	—	—	—	—	—	—	—	—	—	—
		b	<0.01	—	—	—	—	—	—	—	—	—	—	—
Conductance	µmhos	a	270	255	260	242	265	270	260	249	280	270	247	258
		b	270	255	260	242	265	270	260	249	280	270	247	258
Oxygen, dissolved	mg/ℓ	a	11.6	11.6	11.6	11.8	11.7	11.6	11.5	11.9	11.0	11.7	11.7	11.6
		b	11.6	11.6	11.6	11.8	11.7	11.6	11.5	11.9	11.0	11.7	11.7	11.6
Oxygen, % saturation	% sat.	a	96	95	93	97	95	94	94	98	89	95	95	95
		b	96	95	93	97	95	94	94	98	89	95	95	95
Odor, threshold	Pos/Neg	a	Neg	—	—	—	—	—	—	—	—	—	—	—
		b	Neg	—	—	—	—	—	—	—	—	—	—	—
Magnesium, soluble	mg/ℓ	a	10.4	10.1	10.5	9.99	9.91	9.82	9.74	9.87	9.66	9.66	9.70	16.9
		b	10.2	10.1	10.2	9.82	10.3	9.70	9.95	10.1	9.40	9.91	9.28	9.45
Hardness	mg/ℓ	a	132.7	136.3	141.2	138.6	140.2	20[illegible]	161.7	137.4	138.6	145.9	145.1	158.9
		b	132.9	137.4	134.9	138.2	134.1	188.0	150.8	142.4	[illegible]	148.1	145.7	138.8
pH	pH units	a	8.35	8.2	8.2	8.35	8.2	8.2	8.42	8.45	8.4	8.2	8.3	8.4
		b	8.35	8.2	8.2	8.35	8.2	8.2	8.42	8.45	8.4	8.2	8.3	8.4
Potassium, soluble	mg/ℓ	a	1.16	1.18	1.12	1.15	1.11	1.17	1.36	1.28	1.15	1.18	1.11	1.08
		b	1.13	1.1[illegible]	1.27	1.08	1.11	1.17	1.28	1.24	1.20	1.11	1.03	1.08
Sodium, soluble	mg/ℓ	a	5.27	5.20	4.95	5.12	5.07	4.84	5.59	5.46	4.82	4.97	[illegible].65	4.73
		b	5.33	5.35	4.75	5.12	5.05	4.88	5.46	5.27	4.95	5.03	4.60	4.77
Dissolved solids, total	mg/ℓ	a	172	171	155	145	168	141	143	183	178	177	147	125
		b	176	125	176	163	149	103	182	189	174	181	152	172
Suspended solids, total	mg/ℓ	a	7.8	0.6	4.8	4.0	4.0	4.4	3.6	8.8	2.4	1.0	1.8	3.4
		b	2.4	1.6	40.4	5.0	2.2	6.4	4.0	3.2	6.0	3.8	6.4	1.6
Sulfates	mg/ℓ	a	27.7	27.4	27.2	27.2	27.4	27.2	29.3	29.3	28.2	28.7	27.2	29.8
		b	27.7	27.7	26.7	27.2	27.7	26.7	29.3	29.3	28.5	28.0	27.4	30.3
Temperature	°C	a	7.5	7.0	6.0	7.0	6.5	6.5	7.0	7.0	6.5	6.5	6.3	6.3
		b	7.5	7.0	6.0	7.0	6.5	6.5	7.0	7.0	6.5	6.5	6.3	6.3
Turbidity	NTU	a	1.7	0.8	1.4	1.8	1.0	1.3	0.7	0.6	0.4	0.6	0.5	0.4
		b	1.2	0.9	7.5	1.0	0.8	0.7	0.4	0.9	1.6	0.8	0.9	0.4
Color, true	Pt-Co units	a	1	1	1	1	1	1	1	1	1	1	1	1
		b	1	1	1	1	1	1	1	1	1	1	1	1
Fluoride, soluble	mg/ℓ	a	0.12	0.13	0.09	0.11	0.12	0.09	0.05	0.03	0.05	0.07	0.06	0.08
		b	0.12	0.12	0.10	0.10	0.11	0.09	0.05	0.05	0.06	0.04	0.09	0.08

Table G-1

General Water Quality Parameters, NIPSCo Bailly Station Vicinity, April 1978

Station																		
7S	8S	8B	9S	9M	9B	10S	11S	12S	22S	13S	14S	15S	16S	17S	18S	19S	20S	21S
4	123	122	118	112	89	125	129	127	126	55	10	6	44	24	21	20	22	147
2	120	116	113	112	62	127	126	126	[illegible]	57	10	8	44	24	21	21	22	149
7.2	36.5	3[illegible].4	37.8	36.5	38.6	37.9	38.8	39.5	38.[illegible]	51.[illegible]	64.5	63.2	51.2	100.0	93.4	29.2	31.[illegible]	38.0
8.5	36.1	36.6	36.5	36.4	39.4	38.2	39.3	39.4	37.7	51.2	68.4	63.2	5[illegible].6	98.7	38.7	36.1	24.3	37.4
[illegible].0	10.4	9.	10.0	10.0	8.8	10.5	10.7	10.4	11.2	12.2	12.0	12.3	12.9	10.0	10.4	4.1	3.6	6.8
1.0	10.4	9.9	10.0	10.1	8.8	10.7	10.7	10.4	11.2	12.3	12.0	12.3	13.1	10.0	10.4	4.1	3.4	6.8
																		<0.01
																		<0.01
0	262	275	240	[illegible]70	261	260	270	260	275	300	510	600	305	610	560	185	215	240
0	262	275	240	270	261	260	270	260	275	300	510	600	305	610	560	185	215	240
1.2	11.2	11.0	11.7	11.6	11.3	11.4	11.6	11.6	11.4	10.8	10.9	11.0	10.9	12.2	11.8	12.4	13.0	8.6
1.2	11.2	11.0	11.7	11.6	11.3	11.4	11.6	11.6	11.4	10.8	10.9	11.0	10.9	12.2	11.8	12.4	13.0	8.6
92	91	89	95	93	89	106	95	95	101	104	[illegible]	104	105	117	112	119	126	83
92	91	89	95	93	89	106	95	95	101	104	102	104	105	117	112	119	126	83
													Neg	Pos				Pos
													Neg	Pos				Pos
10.1	9.66	9.87	10.8	10.6	10.9	10.7	10.5	10.5	10.1	12.[illegible]	17.0	15.5	12.2	15.8	15.3	8.5	7.0	13.0
9.99	9.78	10.7	10.4	10.6	10.6	10.5	10.6	11.0	10.1	12.5	16.3	15.8	12.7	15.0	16.0	8.5	7.0	13.2
47.7	153.8	132.9	140.4	141.8	168.9	142.2	151.4	152.6	148.7	176.6	240.0	247.7	193.0	311.1	331.0	117.9	105.9	16[illegible].0
44.5	172.5	156.7	165.2	178.4	158.3	138.2	145.1	165.0	168.2	170.7	251.6	254.0	192.4	324.1	313.7	111.8	10[illegible].2	150.8
8.2	8.4	8.35	8.2	8.3	8.2	8.28	8.4	8.4	8.45	7.35	5.9	7.1	7.4	7.5	7.25	7.75	8.3	7.4
8.2	8.4	8.35	8.2	8.3	8.2	8.28	8.4	8.4	8.45	7.35	5.9	7.1	7.4	7.5	7.25	7.75	8.3	7.4
1.42	1.32	1.14	1.17	1.10	1.04	1.28	1.17	1.21	1.46	3.20	7.27	6.67	3.03	12.7	13.3	1.47	1.63	1.47
1.38	1.26	1.13	1.17	1.12	1.[illegible]	1.18	1.18	1.24	1.43	3.27	7.27	6.67	3.03	12.7	13.3	1.47	1.60	1.47
5.35	5.01	4.82	4.86	5.01	4.65	5.65	5.54	5.37	6.01	20.2	24.6	27.2	20.2	17.1	17.1	4.49	3.97	5.83
5.18	5.05	4.88	5.01	5.03	4.80	5.54	5.74	5.54	5.91	20.8	26.5	27.8	22.1	17.4	17.1	4.49	3.85	5.77
49	172	155	151	155	152	178	161	224	113	321	480	481	408	572	530	142	158	188
54	165	157	150	166	156	159	166	149	159	328	451	520	310	542	554	177	143	220
3.4	4.4	5.4	3.0	0.8	180.8	5.2	3.4	1.[illegible]	11.6	1.6	2.8	1.2	<0.1	2.4	45.8	1.4	0.2	2.0
4.2	4.8	2.6	5.0	5.0	165.0	3.2	3.8	1.8	4.0	18.2	8.6	3.0	0.6	2.8	23.4	1.0	1.0	2.6
31.8	31.8	31.1	32.1	32.1	26.7	26.9	30.8	30.0	34.4	29.8	725.1	725.1	698.8	883.4	1015.2	1015.2	1147.1	1199.8
32.9	31.8	31.6	32.4	28.0	26.9	26.9	30.8	30.0	35.5	29.3	751.5	857.0	698.8	988.8	1147.1	1015.2	1199.8	1252.5
7.0	6.5	6.5	6.5	6.0	5.5	12.0	7.0	7.0	10.0	14.0	12.5	13.0	14.0	13.9	13.5	13.9	14.4	14.5
7.0	5.5	6.5	6.5	6.0	5.5	12.0	7.0	7.0	10.0	14.0	12.5	13.0	14.0	13.9	13.5	13.9	14.4	14.5
0.4	0.8	2.2	0.7	0.5	36.0	1.4	0.7	0.4	5.6	1.2	2.8	0.4	0.3	1.5	6.4	0.2	0.2	0.8
0.5	1.6	0.7	1.7	2.1	51.0	1.1	1.4	0.6	1.7	0.3	5.8	3.1	0.4	2.1	4.3	[illegible]	0.5	0.6
1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	25	[illegible]	30	100
1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	30	25	30	120
0.11	0.10	0.10	0.13	0.16	0.13	0.14	0.14	0.13	0.25	0.23	0.32	0.04	0.31	0.39	0.37	0.22	0.24	0.40
0.10	0.12	0.11	0.15	0.15	0.12	0.13	0.13	0.13	0.23	0.29	0.34	0.01	0.32	0.39	0.38	0.21	0.24	0.44

580 026

Parameter	Unit	Rep.	1S	2S	2B	3S	3M	3B	4S	5S	5B	6S	6M	6B
Ammonia, soluble	mg/ℓ	a	0.034	[illegible]	0.022	0.032	0.026	0.023	0.036	0.036	0.027	0.031	0.026	0.024
		b	0.016	0.037	0.016	0.036	0.029	0.014	0.038	0.029	0.036	0.018	0.029	0.018
Nitrate, soluble	mg/ℓ	a	0.26	0.26	0.24	0.25	0.25	0.24	0.28	0.28	0.25	0.26	0.25	0.24
		b	0.26	0.26	0.73	0.25	0.25	0.24	0.28	0.28	0.25	0.25	0.25	0.24
Nitrite, soluble	mg/ℓ	a	0.002	0.002	0.002	0.003	0.002	0.008	[illegible]	0.003	0.003	0.002	0.003	0.002
		b	0.003	0.002	0.002	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.002
Organic nitrogen, total	mg/ℓ	a	0.22	0.20	0.14	0.16	0.44	0.34	0.32	0.38	0.38	0.40	0.34	0.40
		b	0.06	0.34	0.12	0.22	0.22	0.20	0.34	[illegible]	0.42	0.30	0.46	0.32
Orthophosphate, soluble	mg/ℓ	a	0.004	0.009	0.003	0.002	0.002	0.002	0.004	0.004	0.003	0.004	0.002	<0.002
		b	0.003	0.006	0.003	0.002	0.002	0.002	0.004	0.004	0.002	0.004	0.002	<0.002
Phosphorus, total	mg/ℓ	a	0.014	0.014	0.012	0.016	0.018	0.018	0.008	0.012	0.012	0.012	0.022	0.020
		b	0.012	0.016	0.016	0.034	0.016	0.020	0.010	0.016	0.014	0.014	0.020	0.026
Silica, soluble	mg/ℓ	a	0.21	0.23	0.27	0.20	0.22	0.28	0.17	0.12	0.24	0.32	0.25	0.24
		b	0.18	0.20	0.25	0.24	0.29	0.21	0.13	0.13	0.19	0.31	0.27	0.21

Table G-2

Aquatic Nutrient Concentrations, NIPSCo Bailly Station Vicinity, April 1976

7S	8S	8B	9S	9M	9B	10S	11S	12S	22S	13S	14S	15S	16S	17S	18S	19S	20S	21S
0.049	0.038	0.040	0.035	0.038	0.022	0.032	0.032	0.021	0.026	0.034	0.178	0.228	0.028	0.067	0.089	0.018	0.008	0.008
0.045	0.044	0.038	0.039	0.039	0.019	0.036	0.029	0.030	0.017	0.029	0.178	0.236	0.033	0.071	0.091	0.011	0.017	0.010
0.28	0.27	0.25	0.25	0.25	0.23	0.27	0.27	0.26	0.30	0.43	0.46	0.49	0.50	0.48	0.11	0.08	<0.04	<0.04
0.29	0.27	0.25	0.25	0.25	0.23	0.27	0.28	0.26	0.2[illegible]	0.44	0.46	0.49	0.49	0.07	0.09	<0.04	<0.04	<0.04
0.003	0.003	0.002	0.003	0.003	0.00[illegible]	0.002	0.003	0.002	0.003	0.008	0.010	0.008	0.008	0.002	0.002	<0.002	<0.002	<0.002
0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.010	0.012	0.008	0.008	0.002	0.003	<0.002	<0.002	<0.002
0.40	0.46	0.70	0.74	0.74	0.62	0.46	0.38	0.66	0.50	0.46	0.58	0.58	0.44	0.72	1.20	0.72	0.52	1.32
0.38	0.46	0.68	0.68	0.68	0.58	0.68	0.[illegible]	0.38	0.52	0.46	0.72	0.68	0.42	0.94	0.94	0.56	0.54	1.40
<0.002	0.003	0.003	0.003	0.003	0.003	0.00[illegible]	0.007	0.007	0.008	0.007	0.008	0.008	0.004	0.004	0.002	<0.002	<0.002	0.002
<0.002	0.003	0.004	0.003	0.002	0.004	0.007	0.008	0.008	0.007	0.008	0.010	0.007	0.003	0.003	<0.002	<0.002	<0.002	0.002
0.014	0.016	0.034	0.072	0.027	0.019	0.034	0.020	0.020	0.038	0.018	0.066	0.018	0.010	0.024	0.052	0.018	0.020	0.034
0.019	0.040	0.019	0.040	0.018	0.020	0.021	0.024	0.025	0.035	0.042	0.076	0.042	0.012	0.026	0.0[illegible]	0.020	0.020	0.038
0.08	0.15	0.22	0.21	0.21	0.34	0.16	0.18	0.15	0.16	1.87	1.21	1.00	1.42	0.65	0.96	<0.05	<0.05	2.88
0.07	0.15	0.23	0.22	0.21	0.34	0.23	0.17	0.11	0.17	1.29	1.13	0.[illegible]1	0.93	0.65	1.23	<0.05	<0.05	1.57

580 028

Table G-3

Trace Element Concentrations, NIPSCo Bailly Study Area, April 1978

Parameter	Unit	Rep.	13S	14S	15S	16S	17S	18S	19S	20S	21S
Bacteria, fecal coliform	No./100 ml	a	<1	←						→	1
		b	<1	←						→	<1
Bacteria, total coliform	No./100 ml	a	<1	<1	<1	200	2575	2075	1175	1400	1525
		b	50	<1	<1	75	3600	2900	825	1475	1575
Biochemical oxygen demand	mg/ℓ	a	1	←					→	1	[illegible]
		b	1	←					→	1	2
Chemical oxygen demand	mg/ℓ	a	2.6	1.4	2.7	2.4	9.1	8.9	15.8	16.0	38.[illegible]
		b	2.9	1.2	2.0	3.0	9.1	9.0	16.0	16.0	45.0
Hexane soluble materials	mg/ℓ	a	<0.1	<0.1	1.2	0.8	<0.1	1.2	0.8	3.2	7.2
		b	3.6	73.6	2.8	5.2	2.0	1.2	2.4	3.6	24.8
Total organic carbon	mg/ℓ	a	5.1	2.3	3.8	5.2	9.5	7.7	8.5	9.4	20.8
		b	5.5	2.0	5.5	5.2	9.6	7.9	9.2	9.0	20.5
Phenols	mg/ℓ	a	<0.005	<0.005	<0.005	0.006	<0.005	<0.006	0.005	<0.005	0.007
		b	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	0.007
Methylene blue active substances	mg/ℓ	a	<0.02	←						→	<0.02
		b	<0.02	←						→	<0.02

Table G-4

Indicators of Industrial and Organic Contamination, NIPSCo Bailly Study Area, April 1978

			Station								
Parameter	Unit	Rep.	13S	14S	15S	16S	17S	18S	19S	20S	21S
Cadmium, total	mg/ℓ	a	0.007	0.033	0.029	0.013	0.004	0.008	<0.001	<0.001	<0.001
		b	0.011	0.031	0.032	0.013	0.005	0.008	<0.001	<0.001	<0.001
Chromium, hexavalent	mg/ℓ	a	<0.001	←						→	<0.001
		b	<0.001	←						→	<0.001
Chromium, total	mg/ℓ	a	<0.001	←						→	<0.001
		b	<0.001	←						→	<0.001
Copper, total	mg/ℓ	a	0.002	0.084	0.088	0.003	0.002	0.004	<0.001	<0.001	0.005
		b	0.002	0.078	0.088	0.002	0.002	<0.001	<0.001	0.001	0.001
Iron, soluble	mg/ℓ	a	0.112	0.038	0.051	0.123	0.192	0.265	0.074	0.060	0.185
		b	0.088	0.024	0.018	0.140	0.172	0.239	0.082	0.071	0.242
Lead, total	mg/ℓ	a	0.001	0.003	0.007	0.007	0.001	0.003	<0.001	<0.001	<0.001
		b	0.001	0.003	0.007	0.001	0.003	0.003	<0.001	<0.001	<0.001
Manganese, total	mg/ℓ	a	0.002	0.103	0.104	0.012	0.012	0.043	<0.001	<0.001	<0.001
		b	0.029	0.102	0.104	0.016	0.009	0.027	<0.001	<0.001	<0.001
Mercury, total	mg/ℓ	a	<0.0003	←						→	<0.0003
		b	<0.0003	←						→	<0.0003
Nickel, total	mg/ℓ	a	0.017	0.117	0.156	0.025	0.023	0.030	0.001	0.001	0.001
		b	0.020	0.113	0.164	0.027	0.026	0.028	0.001	0.001	0.001
Zinc, total	mg/ℓ	a	0.050	0.775	0.763	0.094	0.063	0.088	0.005	0.003	0.004
		b	0.069	0.825	0.750	0.091	0.069	0.088	0.004	0.004	0.007

*No Lake Michigan (stations 1-12) samples required by contract.

POOR ORIGINAL

Table G-5

Levels of Trace Elements Recorded in Sediment Samples from Nearshore Ponds, NIPSCo Bailly Study Area, April 1978

Parameter (mg/kg)*	Rep.	Station 13	14	15	16	17	18	19	20
Cadmium	a	0.006	0.041	0.040	0.003	0.027	0.003	0.002	0.008
	b	0.011	0.039	0.040	0.011	0.022	0.003	0.002	0.003
Chromium	a	<0.003	<0.003	<0.003	<0.003	<0.01	<0.005	<0.005	<0.006
	b	<0.003	<0.003	<0.003	<0.003	<0.02	<0.004	<0.006	<0.005
Copper	a	0.009	0.077	0.076	<0.003	0.052	0.018	0.015	0.006
	b	0.003	0.072	0.067	<0.003	0.125	0.015	0.018	0.005
Iron	a	0.018	0.043	0.024	0.203	0.760	0.430	0.550	0.720
	b	0.065	0.024	0.049	0.204	1.920	0.470	0.870	0.780
Lead	a	<0.003	0.006	0.003	<0.006	<0.01	<0.005	<0.005	<0.006
	b	<0.003	0.006	0.006	<0.003	<0.02	<0.004	<0.006	<0.005
Manganese	a	0.106	0.198	0.143	0.860	1.220	0.005	0.024	0.[illegible]82
	b	0.108	0.243	0.119	0.830	1.410	0.037	0.024	0.215
Mercury	a	<0.0009	<0.0009	<0.0009	<0.0009	<0.004	<0.001	<0.001	<0.002
	b	<0.0009	<0.0009	<0.0009	<0.001	<0.005	<0.001	<0.002	<0.001
Nickel	a	0.006	0.028	0.049	0.003	0.026	<0.005	<0.005	<0.006
	b	0.009	0.028	0.049	0.045	0.031	<0.004	<0.006	<0.005
Selenium	a	<0.0006	<0.0006	<0.0006	<0.0006	<0.003	<0.0009	<0.0009	<0.001
	b	<0.0006	<0.0006	<0.0006	<0.0006	<0.003	<0.0008	<0.001	<0.001
Vanadium	a	<0.006	<0.006	<0.006	<0.006	<0.03	<0.009	<0.009	<0.01
	b	<0.006	<0.006	<0.006	<0.006	<0.03	<0.008	<0.01	<0.01
Zinc	a	0.192	1.580	1.710	1.098	1.930	0.340	0.242	0.289
	b	0.117	1.580	1.670	0.121	0.780	0.156	0.151	0.280
Total phosphorus	a	0.007	0.005	0.007	0.007	0.011	0.022	0.020	0.018
	b	0.007	0.006	0.005	0.009	0.022	0.024	0.022	0.027
Percent solids	a	18.9	18.7	17.8	21.1	80.6	45.5	48.3	56.8
	b	18.9	19.1	17.7	21.8	84.0	39.2	58.7	49.9

*All results expressed as mg/kg dry weight. Variable minimum detectability limits based on amount sample had to be concentrated prior to analysis.

POOR ORIGINAL

580 030

Parameter	Unit	Rep	1S	2S	2B	3S	3M	3B	4S	5S	5B	6S	6M	6B
Alkalinity, total	mg/ℓ	a	109	108	108	111	110	111	109	110	108	109	108	110
		b	108	108	108	109	110	112	109	109	108	110	109	110
Calcium, soluble	mg/ℓ	a	38.5	35.9	34.6	35.9	35.9	33.3	35.9	35.9	35.9	35.9	35.9	35.9
		b	37.2	35.9	37.2	36.5	35.9	34.6	35.9	36.5	36.5	35.9	36.5	38.5
Chloride, total	mg/ℓ	a	10.8	10.8	10.9	11.0	10.8	10.9	10.8	10.8	10.3	10.8	10.5	10.1
		b	10.9	10.8	10.8	11.0	10.8	10.3	10.6	10.8	10.6	11.4	10.8	10.0
Chlorine, total	mg/ℓ	a	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		b	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Conductance	µmhos	a	290	250	280	300	290	300	310	310	300	300	290	295
		b	290	250	280	300	290	300	310	310	300	300	290	295
Oxygen, dissolved	mg/ℓ	a	10.8	9.1	9.6	9.7	10.8	10.3	9.2	9.7	10.8	9.3	10.7	9.5
		b	10.8	9.1	9.6	9.7	10.8	10.3	9.2	9.7	10.8	9.3	10.7	9.5
Oxygen, % saturation	%sat	a	118	94	95	97	106	99	92	98	105	92	105	91
		b	118	94	95	97	106	99	92	98	105	92	105	91
Odor, threshold	Pos/Neg	a	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
		b	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
Magnesium, soluble	mg/ℓ	a	12.6	12.6	12.4	12.6	12.4	12.4	12.6	12.6	12.6	12.6	12.6	12.6
		b	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Hardness	mg/ℓ	a	136.9	136.5	136.4	135.8	135.3	135.8	136.3	137.7	136.0	137.4	135.4	135.2
		b	137.9	136.2	136.4	136.1	135.5	134.6	136.2	136.6	135.0	136.5	134.7	135.9
pH	pH	a	8.1	8.5	8.5	8.6	8.6	8.5	8.3	8.3	8.3	8.4	8.5	8.4
		b	8.1	8.5	8.5	8.6	8.6	8.5	8.3	8.3	8.3	8.4	8.5	8.4
Potassium, soluble	mg/ℓ	a	1.38	1.38	1.44	1.25	1.25	1.31	1.44	1.25	1.31	1.38	1.25	1.12
		b	1.38	1.25	1.25	1.38	1.31	1.25	1.31	1.38	1.63	2.00	1.50	1.12
Sodium, soluble	mg/ℓ	a	6.79	6.05	6.11	5.92	5.80	5.92	6.05	6.17	5.80	6.17	5.80	5.80
		b	6.05	5.93	6.05	6.05	5.92	5.80	6.05	6.17	5.86	6.42	5.80	5.80
Dissolved solids, total	mg/ℓ	a	2224**	2623**	969**	670**	1597**	978**	1038**	1152**	1103**	1601**	1587**	1227**
		b	212	203	199	207	210	224	231	204	193	198	198	190
Suspended solids, total	mg/ℓ	a	.0.1	4.5	2.2	1.0	1.7	1.7	2.6	1.6	1.4	1.2	1.1	1.4
		b	7.7	2.7	1.7	1.5	2.1	1.1	2.3	1.7	1.4	1.7	0.7	1.1
Sulfates, soluble	mg/ℓ	a	24.4	23.6	23.4	23.3	23.3	23.3	23.3	236	23.3	23.7	22.7	23.0
		b	24.7	23.5	23.3	23.4	23.3	23.0	23.4	24.0	23.1	23.6	22.7	22.7
Temperature	°C	a	20.5	17.0	15.5	16.0	14.9	13.8	16.0	16.5	14.5	15.5	15.0	14.0
		b	20.5	17.0	15.5	16.0	14.9	13.8	16.0	16.5	14.5	15.5	15.0	14.0
Turbidity	NTU	a	1	2	1	2	1	1	2	2	1	1	1	1
		b	3	2	1	1	1	3	2	3	2	1	1	1
Color, true	Pt-Co	a	1	1	1	1	1	1	1	1	1	1	1	1
		b	1	1		1	1	1	1	1	1	1	1	1
Fluoride, soluble	mg/ℓ	a	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		b	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0 15

S = Surface
B = Bottom

*Meter reading off maximum scale reading of 15; meter checked for accuracy and found to be correct.
**Replicate sample bottle contamination suspected; values discarded.

POOR ORIGINAL

580 031

Table G-6

General Water Quality Parameters, NIPSCo Bailly Station Vicinity, June 1978

		Station																
7S	8S	8B	9S	9M	9B	10S	11S	12S	22S	13S	14S	15S	16S	17S	18S	19S	20S	21S
10 09	109 110	108 109	110 102	110 110	110 106	108 109	108 112	101 108	110 110	56 58	67 72	74 74	58 57	38 38	37 36	45 42	45 40	193 193
8.5 8.5	37.8 39.1	38.5 38.5	37.8 37.8	37.1 37.8	37.8 37.1	37.8 38.5	38.5 37.1	38.5 37.8	37.1 37.1	52.6 53.8	74.3 74.4	71.8 69.2	53.8 53.8	109 109	110 112	30.7 29.5	26.9 23.1	51.3 62.8
0.6 0.6	11.0 11.0	11.0 11.0	12.7 11.0	10.6 10.5	9.9 9.9	10.5 10.4	10.6 10.6	10.8 10.8	10.6 10.8	11.7 11.7	10.9 10.9	11.3 11.3	12.3 12.3	11.3 11.5	11.3 11.3	7.4 7.4	7.0 6.8	4.2 4.3
.01 .01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01
00 00	300 300	305 305	299 299	249 249	279 279	275 275	300 300	310 310	285 285	500 500	650 650	590 590	520 520	725 725	700 700	300 300	250 250	420 420
0.2 0.2	9.4 9.4	9.8 9.8	9.4 9.4	8.1 8.1	7.0 7.0	8.6 8.6	10.2 10.2	8.5 8.5	8.4 8.4	9.3 9.3	9.6 9.6	9.7 9.7	9.4 9.4	7.8 7.8	7.5 7.5	10.9 10.9	11.4 11.4	>15.0* >15.0*
02 02	93 93	94 94	94 94	81 81	65 65	102 102	101 101	90 90	99 99	109 109	106 106	108 108	107 107	87 87	82 82	121 121	130 130	>176* >176*
eg eg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Pos Pos	Pos Pos	Pos Pos	Pos Pos	Pos Pos
2.6 2.6	12.6 12.6	12.6 12.6	12.6 12.6	12.6 12.6	12.6 12.6	12.6 12.6	12.6 12.6	12.6 12.6	12.6 12.6	18.2 18.2	29.9 29.7	26.7 26.7	17.9 17.9	20.5 20.4	20.5 20.5	14.1 14.2	12.1 12.1	22.6 25.9
36.3 36.4	137.6 136.8	137.5 137.3	134.9 136.4	136.3 134.4	136.9 136.2	135.9 137.1	135.6 135.3	136.9 137.9	137.2 136.2	187.1 187.7	297.8 294.9	274.4 273.0	192.0 190.4	335.2 327.8	326.6 329.7	120.9 123.5	10[illegible].5 1[illegible].2	221.8 238.5
.7 .7	8.2 8.2	8.0 8.0	8.3 8.3	8.4 8.4	8.2 8.2	8.1 8.1	8.6 8.6	7.1 7.1	8.1 8.1	7.3 7.3	7.2 7.2	8.0 8.0	8.2 8.2	7.4 7.4	7.4 7.4	8.8 8.8	9.2 9.2	7.8 7.8
.25 .25	1.25 1.25	1.25 1.25	3.04 1.14	1.20 1.18	1.14 1.14	1.39 1.27	1.27 1.33	1.39 1.27	1.33 1.52	5.06 4.94	11.3 11.4	10.1 9.9	5.31 5.25	13.3 13.6	13.1 13.1	1.39 1.33	1.20 1.20	0.14 0.10
.05 .05	6.05 6.17	6.17 6.17	6.42 6.05	5.92 5.92	5.67 5.67	5.92 5.92	5.92 5.92	5.92 5.92	5.92 5.92	19. 19.3	12.4 12.4	12.2 12.2	21.5 21.5	15.1 15.4	15.4 15.1	6.79 6.79	5.68 5.68	6.30 7.65
074** 2	1577** 135	1047** 182	1246** 158	997** 134	1210** 172	414** 181	419** 167	156 149	145 146	364 353	480 475	459 429	367 371	617 540	594 602	189 211	176 155	259 339
.8 .2	2.5 0.9	1.7 1.6	1.8 2.3	2.3 0.9	23.0 4.8	14.0 8.5	9.3 6.4	11.0 5.0	6.6 6.1	19.4 919	4.8 2.5	2.4 4.7	4.1 13.1	12.1 9.8	22.2 43.2	30.4 1.9	34.7 5.4	95.2 18.4
3.9 3.4	23.7 24.1	24.0 24.0	22.7 23.0	23.0 22.7	22.3 24.0	25.0 24.8	23.3 22.7	23.7 32.5	34.7 23.8	169 158	227 232	214 220	174 173	312 315	316 318	79.0 79.4	63.2 63.0	9.8 8.1
5.9 5.9	15.5 15.5	13.8 13.8	15.9 15.9	15.9 15.9	12.0 12.0	24.5 24.5	15.5 15.5	18.5 18.5	24.0 24.0	24.0 24.0	21.0 21.0	21.0 21.0	22.0 22.0	21.0 21.0	20.0 20.1	21.0 21.0	22.0 22.0	24.0 24.0
	1 2	2 2	1 1	1 2	1 3	3 2	2 2	2 3	4 4	5 5	2 2	2 2	2 2	3 3	6 8	4 6	3 3	8 10
	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	10 15	10 10	30 40	15 20	160 180
.15 .15	0.15 0.15	0.15 0.15	0.15 0.15	0.14 0.14	0.15 0.14	0.15 0.15	0.15 0.15	0.15 0.15	0.16 0.16	0.16 0.17	0.26 0.26	0.27 0.27	0.25 0.25	0.29 0.29	0.31 0.31	0.20 0.20	0.19 0.19	0.42 0.42

Parameter	Unit	Rep	1S	2S	2B	3S	3M	3B	4S	5S	5B	6S	6M	6B	7S
Ammonia,	mg/ℓ	a	0.034	0.024	0.026	0.031	0.026	0.018	0.032	0.034	0.020	0.020	0.030	0.028	0.034
soluble		b	0.037	0.030	0.032	0.034	0.014	0.032	0.034	0.032	0.020	0.032	0.023	0.030	0.031
Nitrate,	mg/ℓ	a	0.13	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.12	0.13	0.12	0.12	0.12
soluble		b	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.12	0.13	0.12	0.12	0.12
Nitrite,	mg/ℓ	a	0.003	<0.002	<0.002	0.002	<0.002	0.002	0.003	0.003	0.003	0.003	0.004	<0.002	0.003
soluble		b	<0.002	^.002	<0.002	0.002	<0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.003
Organic nitrogen,	mg/ℓ	a	0.53	0.40	0.49	0.49	0.52	0.42	0.42	0.3(	).55	0.44	0.40	0.30	0.46
total		b	0.47	[illegible]	0.42	0.52	0.41	0.38	0.37	0.38	0.40	0.41	0.38	0.39	0.19
Orthophosphate,	mg/ℓ	a	0.005	5.003	0.116*	0.004	0.002	0.142*	0.084*	0.003	<0.002	0.003	0.003	<0.002	0.005
soluble		b	0.004	0.003	0.005	0.004	0.002	0.004	0.004	0.002	0.076*	0.098*	0.002	<0.002	0.004
Phosphorus,	mg/ℓ	a	0.020	0.012	0.135*	0.013	0.011	0.173*	0.113*	0.017	0.005	0.011	0.012	0.007	0.009
total		b	0.017	0.012	0.016	0.013	0.014	0.012	0.015	0.016	0.111*	0.146*	0.012	0.006	0.011
Silica,	mg/ℓ	a	0.08	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.06	0.08	0.06	0.07	0.06
soluble		b	0.11	0.05	0.06	0.06	0.06	0.05	0.06	0.09	0.07	0.08	0.06	0.07	0.08

S = Surface
M - Mid-depth
B = Bottom

*Suspected sample contamination

580 033

Table G-7

Levels of Aquatic Nutrients in Lake Michigan and Pond Samples
Baily Study Area, June 1978

Station

8S	8B	9S	9M	9B	10S	11S	12S	22S	13S	14S	15S	16S	17S	18S	19S	20S	21S
0.036	0.037	0.010	0.024	0.034	0.025	[illegible]	0.073	0.041	0.075	0.360	0.016	0.265	0.265	0.285	0.019	0.005	0.035
0.036	0.039	0.039	0.026	0.052	[illegible]	[illegible]	0.023	0.051	0.081	0.340	0.100	0.163	0.163	0.141	0.019	0.004	0.020
0.12	0.58	0.16	0.15	0.10	0.17	0.11	0.11	0.11	0.19	0.14	0.13	0.18	0.08	0.06	<0.04	<0.04	<0.04
0.12	0.38	1.74	0.10	0.98	0.11	0.11	0.11	0.12	0.18	0.13	0.11	0.26	0.23	0.04	<0.04	<0.04	<0.04
0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.013	0.012	0.014	0.005	0.005	0.006	0.003	[illegible]	0.004
0.003	0.004	0.003	0.003	0.003	0.004	0.005	0.004	0.005	0.011	0.010	0.010	0.027	0.055	0.005	0.002	[illegible]	0.003
0.27	0.26	0.45	0.43	0.36	0.34	0.41	0.38	0.26	0.33	0.31	0.34	0.34	0.58	0.52	0.82	0.70	1.28
0.26	0.44	0.43	0.31	0.38	0.30	0.41	0.42	0.48	0.32	0.44	0.51	0.36	0.54	0.53	0.76	0.62	1.20
0.006	0.005	0.006	0.006	0.008	0.004	0.002	0.310	0.010	0.011	0.008	0.104*	0.008	0.008	0.008	0.008	0.008	0.036
0.005	0.005	0.007	0.006	0.010	0.004	0.006	0.008	0.188*	0.010	0.008	0.009	0.008	0.165*	0.008	0.008	0.008	0.016
0.017	0.013	0.540*	0.021	0.021	0.019	0.017	0.560	0.028	0.012	0.020	0.091*	0.017	0.018	0.019	0.020	0.021	0.050
0.015	0.012	0.011	0.017	0.021	0.018	0.075	0.019	0.185*	0.025	0.018	0.029	0.020	0.164*	0.025	0.021	0.022	0.034
0.10	0.09	0.10	0.06	0.12	0.11	0.10	0.10	0.09	1.09	1.42	1.56	0.91	1.32	1.48	0.56	0.63	10.62
0.10	0.10	0.06	0.07	0.08	0.09	0.06	0.14	0.13	1.11	1.48	1.54	1.13	1.32	1.46	0.48	0.59	11.84

580 034

Table G-8
Trace Elements, Nearshore Ponds, Bailly Study Area, June 1978

Parameter	Units	Rep	Station 13S	14S	15S	16S	17S	18S	19S	20S	21S
Cadmium, total	mg/ℓ	a	<0.001	0.001	<0.001	0.004	0.018	0.014	0.006	0.003	0.004
		b	<0.001	<0.001	<0.001	0.006	0.020	0.015	<0.001	0.003	0.004
Chromium, soluble hexavalent	mg/ℓ	a	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	<0.002
		b	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	<0.002
Chromium, total	mg/ℓ	a	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		b	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, total	mg/ℓ	a	0.003	0.002	0.001	0.002	0.003	0.002	0.004	0.001	<0.001
		b	0.003	0.002	0.001	0.002	0.002	0.002	0.002	0.001	<0.001
Iron, soluble	mg/ℓ	a	0.007	0.006	0.006	0.004	0.006	0.006	0.004	0.015	0.004
		b	0.007	0.009	0.004	0.006	0.005	0.004	0.009	0.006	0.003
Lead, total	mg/ℓ	a	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		b	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese, total	mg/ℓ	a	0.006	0.005	<0.001	0.001	0.003	<0.001	0.002	0.001	0.004
		b	0.006	0.005	<0.001	0.001	<0.001	<0.001	0.001	0.001	<0.001
Mercury, total	mg/ℓ	a	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
		b	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Nickel, total	mg/ℓ	a	0.002	0.011	0.007	0.001	0.006	0.006	<0.001	<0.001	<0.001
		b	0.002	0.011	0.007	0.002	0.007	0.001	<0.001	<0.001	<0.001
Zinc, total	mg/ℓ	a	0.027	0.103	0.052	0.024	0.041	0.055	0.021	0.002	0.006
		b	0.028	0.103	0.062	0.017	0.052	0.083	0.021	0.003	0.015

S = surface

POOR ORIGINAL

Table G-9
Indicators of Industrial and Organic Contamination, Nearshore Ponds, Bailly Study Area, June 1978

Parameter	Unit	Rep	Station 13S	14S	15S	16S	17S	18S	19S	20S	21S
Bacteria, fecal coliform	No./100 mℓ	a	325	<1	<1	25	25	<1	<1	<1	300
		b	<1	<1	<1	<1	225	<1	<1	45	225
Bacteria, total coliform	No./100 mℓ	a	1,925	25	100	6,750	39,750	35	3,375	1,600	162,500
		b	2,925	100	50	3,050	18,250	21,450	2,550	2,175	410,000
Biochemical oxygen demand	mg/ℓ	a	1	1	1	1	3	3	1	1	37
		b	3	1	1	1	1	4	1	1	33
Chemical oxygen demand	mg/ℓ	a	[illegible].1	2.1	2.8	4.3	10.9	11.2	26.5	26.1	72.2
		b	3.1	2.8	3.3	5.2	10.6	10.0	25.0	26.3	77.0
Hexane soluble materials	mg/ℓ	a	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		b	<0.1	<0.1	<0.1	<0.[illegible]	<0.1	<0.1	<0.1	<0.1	<0.1
Total organic carbon	mg/ℓ	a	8.3	5.3	7.3	6.0	7.4	7.3	10.2	9.7	39.3
		b	7.7	6.1	6.4	5.1	6.5	9.9	9.9	10.3	37.8
Phenols	mg/ℓ	a	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
		b	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Methylene - blue-active-substances	mg/ℓ	a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cyanides	mg/ℓ	a	0.006	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006
		b	0.005	0.005	0.006	0.005	0.006	0.006	0.006	0.006	0.006

S = surface

Table G-10
Trace Elements in Sediment Samples from Nearshore Ponds,
Bailly Study Area, August 1978

Parameter	Unit	Rep	Station 13	14	15	16	17	18	19	20
Phosphorus	mg/kg	a	0.005	0.015	0.016	0.027	0.074	0.071	0.079	0.067
		b	0.008	0.013	0.010	0.031	0.070	0.167	0.058	0.094
Cadmium	mg/kg	a	<0.003	0.028	0.045	<0.003	0.013	<0.003	<0.003	<0.003
		b	<0.003	0.031	0.008	<0.003	0.003	<0.003	<0.004	<0.003
Chromium	mg/kg	a	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
		b	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Copper	mg/kg	a	0.017	0.015	0.016	0.021	0.030	0.019	0.034	0.029
		b	0.015	0.016	0.021	0.018	0.021	0.027	0.029	0.031
Iron	mg/kg	a	<0.003	<0.003	0.228	1.352	1.001	0.564	1.150	1.245
		b	0.013	<0.003	1.578	[illegible].322	1.728	3.740	3.119	1.660
Lead	mg/kg	a	<0.014	<0.013	<0.013	<0.013	<0.017	<0.014	<0.019	<0.016
		b	<0.013	<0.013	<0.013	<0.013	<0.015	<0.017	<0.016	<0.016
Manganese	mg/kg	a	0.100	0.228	0.011	0.019	0.037	0.214	0.140	0.079
		b	0.118	0.233	0.026	0.008	0.027	0.264	0.178	0.041
Mercury	mg/kg	a	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
		b	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Nickel	mg/kg	a	0.022	0.048	0.053	0.027	0.047	0.027	0.015	0.035
		b	0.015	0.052	0.058	0.013	0.048	0.033	0.019	0.006
Selenium	mg/kg	a	<0.014	<0.013	<0.013	<0.013	<0.017	<0.014	<0.019	<0.016
		b	<0.013	<0.013	<0.013	<0.013	<0.015	<0.017	<0.016	<0.016
Vanadium	mg/kg	a	<0.005	<0.005	<0.005	<0.005	0.060	0.025	<0.008	<0.006
		b	<0.005	<0.005	<0.005	<0.005	0.033	0.030	<0.006	<0.006
Zinc	mg/kg	a	0.030	0.235	0.332	0.122	0.295	0.011	0.004	0.029
		b	0.031	0.297	0.359	0.094	0.185	0.017	0.010	0.022
Percent solids	%	a	90.7	92.3	89.7	90.3	65.8	59.6	49.1	63.9
		b	90.9	90.1	90.7	92.6	70.2	64.7	52.2	71.5

*Results expressed as mg/kg dry weight. Variable minimum detectability limits based on amount sample had to be concentrated prior to analysis.

Parameter	Unit	Rep	1S	2S	2B	3S	3M	3B	4S	5S	5B	6S	6M	6B	7
Alkalinity, soluble	mg/ℓ	a	112	112	.14	114	114	116	115	115	116	116	112	111	11
		b	112	112	116	114	113	116	117	115	116	116	111	111	11
Calcium, soluble	mg/ℓ	a	35.0	36.3	35.6	35.6	35.6	35.0	33.8	35.0	35.0	35.0	35.0	35.7	35
		b	36.3	36.3	35.6	35.0	35.0	33.8	33.8	35.0	35.0	35.0	35.0	35.7	35
Chloride, total	mg/ℓ	a	8.8	8.9	8.6	8.6	8.7	8.1	8.8	8.6	8.7	8.5	8.8	9.0	8.
		b	8.7	8.6	8.7	8.6	8.7	8.6	8.6	8.7	8.7	8.5	8.8	8.6	8.
Chlorine, total	mg/ℓ	a	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.
		b	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.
Conductance	μmhos	a	270	280	280	280	270	270	230	280	290	280	280	290	28
		b	270	280	280	280	270	270	230	280	290	280	280	290	28
Oxygen, dissolved	mg/ℓ	a	10.0	9.4	10.0	9.4	10.3	10.6	9.4	9.8	10.3	9.4	10.3	10.7	9.
		b	10.0	9.4	10.0	9.4	10.3	10.6	9.4	9.8	10.3	9.4	10.3	10.7	9.
Oxygen, % saturation	mg/ℓ	a	110	101	109	102	103	97	103	106	105	104	106	104	11
		b	110	101	109	102	103	97	103	106	105	104	106	104	11
Odor, threshold	pos/neg	a	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Ne
		b	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Ne
Magnesium, soluble	mg/ℓ	a	11.5	11.2	11.2	11.3	11.3	11.0	11.7	11.3	11.7	11.5	11.3	11.3	11
		b	11.5	11.2	11.2	11.3	11.2	11.0	11.7	11.3	11.3	11.5	11.3	11.3	11
Hardness	mg/ℓ	a	134	133	133	129	134	133	132	133	133	133	134	133	13
		b	134	132	133	132	134	134	132	133	134	134	132	132	13
pH	pH	a	8.4	8.4	8.4	8.4	8.3	8.1	8.3	8.5	8.4	8.2	8.2	8.2	8.
		b	8.4	8.4	8.4	8.4	8.3	8.1	8.3	8.5	8.4	8.2	8.2	8.2	8.
Potassium, soluble	mg/ℓ	a	1.35	1.48	1.23	1.20	1.29	1.17	1.35	1.23	1.32	1.20	1.29	1.72	1.
		b	1.29	1.23	1.29	1.20	1.29	1.63	1.23	1.35	1.41	1.17	1.29	1.26	1.
Sodium, soluble	mg/ℓ	a	5.12	5.12	5.12	5.00	5.12	4.75	5.25	5.12	5.12	5.25	5.00	5.12	5.
		b	5.12	5.12	5.12	5.12	5.12	5.00	5.12	5.25	5.12	5.00	5.12	5.25	5.
Suspended solids, total	mg/ℓ	a	2.4	1.2	0.8	0.6	2.0	8.0	5.0	1.8	3.6	1.0	2.4	3.4	1.
		b	1.8	1.4	2.6	0.8	3.0	10.4	2.8	1.6	4.6	1.8	3.0	3.2	1.
Dissolved solids, total	mg/ℓ	a	350	591	605	630	668	1,083	595	731	765	769	992	442	39
		b	679	573	643	618	891	557	710	632	701	727	609	403	29
Sulfates, soluble	mg/ℓ	a	24.2	24.2	24.1	24.3	24.2	21.8	23.1	22.8	23.4	23.5	24.9	23.1	23.
		b	24.2	24.1	24.5	24.2	24.7	22.3	23.6	24.0	26.1	23.3	23.9	23.5	24.
Temperature	°C	a	20.5	19.5	20.0	20.0	16.0	11.5	20.5	20.0	16.5	21.0	17.0	14.5	22.
		b	20.5	19.5	20.0	20.0	16.0	11.5	20.5	20.0	16.5	21.0	17.0	14.5	22.
Turbidity	NTU	a	0.9	1.1	0.8	0.6	1.1	1.7	1.4	0.9	1.8	1.3	1.1	1.5	0.
		b	1.2	0.7	1.1	1.5	1.4	1.9	1.2	1.0	1.7	0.7	1.4	1.1	0.
Color, true	Pt-Co	a	1	1	1	1	1	1	1	1	1	1	1	1	1
		b	1	1	1	1	1	1	1	1	1	1	1	1	1
Fluoride, soluble	mg/ℓ	a	0.12	0.13	0.13	0.12	0.13	0.11	0.12	0.12	0.13	0.12	0.13	0.11	0.1
		b	0.12	0.13	0.13	0.12	0.12	0.11	0.12	0.11	0.14	0.11	0.12	0.11	0.1

S = Surface
B = Bottom
M = Mid-depth

580 038

Table G-11

General Water Quality Parameters, NIPSCo Bailly Station Vicinity, August 1978

Station 8S	8B	9S	9M	9B	10S	11S	12S	22S	13S	14S	15S	16S	17S	18S	19S	20S	21S
112 112	113 113	112 112	112 112	114 113	112 111	113 112	115 116	115 116	50 50	43 41	34 32	44 41	34 32	47 46	71 70	74 75	287 293
35.0 35.0	35.0 35.0	35.7 35.7	35.7 35.7	35.7 35.7	35.7 35.7	35.0 35.0	36.2 36.2	35.6 36.2	44.4 44.4	83.7 84.2	83.1 82.5	45.0 45.6	72.5 73.8	81.2 72.5	43.8 43.8	31.2 31.2	57.6 56.2
8.6 8.6	9.1 9.0	12.8 8.5	8.9 8.9	8.1 9.1	8.6 8.6	8.7 8.7	9.1 9.1	8.6 8.6	9.4 9.4	9.0 9.0	9.2 9.1	9.5 9.4	9.9 9.9	10.4 10.4	8.8 8.8	8.3 7.4	3.7 3.5
<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 [illegible].01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01
290 290	290 290	280 280	280 280	280 280	280 280	279 270	290 290	270 270	400 400	790 790	750 750	400 400	580 580	600 600	400 400	305 305	440 440
9.7 9.7	9.2 9.2	9.3 9.3	9.6 9.6	10.0 10.0	9.7 9.7	9.7 9.7	8.7 8.7	9.5 9.5	7.5 7.5	8.9 8.9	9.3 9.3	8.3 8.3	6.3 6.3	6.4 6.4	5.3 5.3	10.7 10.7	>15.0 >15 [illegible]
108 108	100 100	106 106	103 103	91 91	120 120	108 108	95 95	116 116	96 96	110 110	113 113	106 106	77 77	79 79	65 65	134 134	>180 >180
Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Neg Neg	Pos Pos	Pos Pos	Pos Pos	Pos Pos	Pos Pos
11.5 11.5	11.5 11.5	11.5 11.5	11.2 11.3	11.5 11.5	11.2 11.2	11.5 11.5	11.5 11.5	11.5 11.5	15.1 15.1	31.5 31.5	30.3 30.3	14.9 14.9	20.2 20.2	20.2 20.2	18.0 17.8	11.5 14.1	26.9 26.9
133 133	133 133	133 133	133 133	133 133	133 133	133 132	133 134	132 133	180 172	386 394	367 363	169 172	259 259	278 278	192 192	149 145	262 267
8.5 8.5	8.4 8.4	8.4 8.4	8.3 8.3	8.0 8.0	8.3 8.3	8.4 8.4	8.4 8.4	8.4 8.4	7.0 7.0	7.5 7.5	7.7 7.7	7.3 7.3	6.7 6.7	7.2 7.2	7.1 7.1	8.0 8.0	7.0 7.0
1.20 1.20	1.29 1.29	6.28 1.17	1.26 1.48	1.20 2.46	1.32 1.29	1.29 1.35	1.41 1.41	1.29 1.29	3.87 3.93	17.8 19.4	17.8 17.2	3.88 3.88	12.0 12.6	11.4 11.2	1.72 1.60	2.83 1.54	0.25 0.22
5.12 5.12	5.12 5.38	5.38 6.25	5.12 5.25	5.50 4.88	5.25 5.25	5.12 5.25	5.88 5.88	5.38 5.38	12.0 12.5	14.8 14.8	14.8 14.8	13.3 13.1	14.5 14.4	14.5 14.8	8.5 8.5	7.00 6.76	6.00 6.00
0.8 0.8	2.6 4.6	1.6 2.0	0.8 1.4	6.8 11.4	0.8 0.8	0.6 2.0	0.2 <0.1	0.8 1.2	0.8 0.2	1.2 0.6	0.8 0.4	0.8 5.4	9.6 42.8	12.4 21.6	3.6 15.8	19.6 4.8	71.4 30.8
329 310	300 260	255 237	233 258	228 216	186 178	189 159	253 239	260 236	358 345	766 779	718 730	326 345	536 530	531 544	297 320	234 214	294 284
24.3 23.1	24.4 23.9	23.5 22.7	22.7 24.3	22.9 22.1	24.7 25.0	24.2 24.1	23.5 23.5	23.4 23.4	136.0 140.0	409.0 418.0	396.0 401.0	149.0 144.0	258.0 263.0	277.0 276.0	168.0 168.0	73.9 74.9	9.0 7.5
21.0 21.0	20.0 20.0	22.0 22.0	19.5 19.5	11.5 11.5	27.0 27.0	20.0 20.0	20.0 20.0	26.0 26.0	29.0 29.0	27.0 27.0	26.0 26.0	29.0 29.0	26.0 26.0	27.0 27.0	27.0 27.0	27.5 27.5	26.0 26.0
0.8 0.7	1.1 0.7	0.9 0.8	0.9 1.5	1.1 1.4	0.8 0.6	0.6 0.9	0.7 1.0	1.0 0.7	2.38 1.9	1.0 1.1	1.3 1.5	4.1 1.9	3.7 2.1	1.7 1.7	1.[illegible] 4.3	1.7 1.7	6.7 6.8
1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	10 10	15 15	50 50	35 35	300 300
0.11 0.11	0.13 0.12	0.10 0.10	0.11 0.11	0.10 0.10	0.13 0.11	0.11 0.10	0.10 0.11	0.09 0.09	0.18 0.18	0.23 0.22	0.22 0.22	0.18 0.19	0.22 0.22	0.22 0.22	0.09 0.08	0.13 0.12	0.30 0.31

580 039

Parameter	Units	Rep	1S	2S	2B	3S	3M	3B	4S	5S	5B	6S	6M	6B	
Ammonia, soluble	mg/ℓ	a	0.012	0.005	0.011	0.002	0.022	0.022	0.005	0.011	0.023	0.007	0.007	0.016	0
		b	0.018	0.008	0.007	0.010	0.018	0.017	0.002	0.008	0.029	0.004	0.009	0.018	0
Nit.ate, soluble	mg/ℓ	a	υ.16	0.16	0.16	0.15	0.17	0.17	0.16	0.16	0.17	0.15	0.17	0.16	0
		b	0.16	0.16	0.16	0.15	0.16	0.17	0.15	0.16	0.17	0.15	0.17	0.16	0
Nitrite, soluble	mg/ℓ	a	0.002	0.002	0.002	0.002	0.003	<0.002	0.002	0.002	0.002	0.002	0.002	0.002	0
		b	0.002	0.002	0.003	0.002	0.003	<0.002	0.002	0.002	0.002	0.002	0.002	0.002	0
Organic nitrogen, total	mg/ℓ	a	0.45	0.30	0.24	0.24	0.30	0.37	0.30	0.13	0.25	0.30	0.17	0.21	0
		b	0.22	0.16	0.13	0.16	0.25	0.20	0.27	0.11	0.33	0.23	0.31	0.19	0
Orthophosphate, soluble	mg/ℓ	a	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.015	0.011	<0.002	0.002	<0.002	0
		b	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	0.002	0.010	<0.002	<0.002	0
Phosphates, total	mg/ℓ	a	0.020	0.019	0.006	0.005	0.014	0.020	0.020	0.006	0.032	0.010	0.014	0.010	0
		b	0.020	0.008	0.009	0.013	0.021	0.016	0.010	0.012	0.016	0.026	0.015	0.019	0
Silica, soluble	mg/ℓ	a	0.22	0.26	0.19	0.27	0.15	0.34	0.24	0.38	0.12	0.26	0.24	0.20	0
		b	0.22	0.23	0.21	0.33	0.11	0.36	0.33	0.20	0.08	0.27	0.19	0.24	0

S = Surface
M = Mid-bottom
B = Bottom

Table G-12

Levels of Aquatic Nutrients, NIPSCo Bailly Station, August 1978

	Station																	
	8S	8B	9S	9M	9B	10S	11S	12S	22S	13S	14S	15S	16S	17S	18S	19S	20S	21S
007	0.020	0.023	0.006	0.014	0.022	0.012	0.050	0.030	0.013	0.036	0.510	0.370	0.055	0.016	0.002	0.016	0.012	0.021
013	0.010	0.043	0.007	0.015	0.021	0.011	0.034	0.024	0.015	0.068	0.480	0.370	0.042	0.044	0.002	0.003	0.011	0.007
4	0.14	0.16	0.14	0.16	0.17	0.16	0.17	0.19	0.17	0.21	0.19	0.17	0.20	<0.04	<0.04	<0.04	<0.04	<0.04
5	0.14	0.17	0.14	0.17	0.17	0.16	0.17	0.19	0.16	0.21	0.20	0.17	0.21	<0.04	<0.04	<0.04	<0.04	<0.04
002	0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	0.003	0.003	0.002	0.002	0.002	0.003	0.002	0.021
002	0.002	0.003	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	0.003	0.003	0.002	0.002	0.002	0.003	0.002	0.014
5	0.28	0.20	0.22	0.09	0.25	0.25	0.43	0.18	0.31	0.15	<0.03	<0.03	0.06	0.17	0.26	0.47	0.52	1.48
32	0.16	0.30	0.23	0.18	0.30	0.28	0.30	0.11	0.28	0.16	<0.03	<0.03	0.04	0.35	0.24	0.43	0.49	1.49
002	0.003	0.002	0.002	0.002	0.002	0.003	0.004	0.004	0.003	0.002	0.003	0.003	0.002	0.002	0.002	0.003	0.002	0.021
003	0.002	0.003	0.002	0.002	0.003	0.003	0.004	0.003	0.003	0.002	0.003	0.003	0.002	0.002	0.002	0.003	0.002	0.014
012	0.011	0.014	0.007	0.008	0.010	0.010	0.006	0.018	0.011	0.007	0.005	0.005	0.008	0.012	0.012	0.016	0.017	0.044
016	0.010	0.011	0.007	0.007	0.011	0.010	0.012	0.011	0.012	0.006	0.005	0.005	0.009	0.016	0.012	0.019	0.019	0.038
34	0.22	0.17	0.21	0.23	0.28	0.28	0.23	0.36	0.24	1.44	2.69	2.16	1.55	2.72	2.17	3.17	0.91	22.0
24	0.22	0.19	0.21	0.22	0.32	0.25	0.23	0.36	0.24	1.46	2.70	2.15	1.57	2.69	2.18	3.16	0.91	22.1

580 041

Table G-13

Trace Elements, Nearshore Ponds, Bailly Study Area, August 1978

Parameter	Unit	Rep	Station 13	14	15	16	17	18	19	20	21
Cadmium, total	mg/ℓ	a	0.006	0.040	0.036	0.008	0.005	<0.001	<0.001	<0.001	<0.001
		b	0.006	0.046	0.036	0.004	0.001	<0.001	<0.001	<0.001	<0.001
Chromium, hexavalent	mg/ℓ	a	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		b	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, total	mg/ℓ	a	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
		b	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Copper, total	mg/ℓ	a	0.004	0.006	0.006	0.003	0.003	0.002	0.003	0.003	0.003
		b	0.003	0.006	0.007	0.003	0.003	0.002	0.003	0.002	0.003
Iron, soluble	mg/ℓ	a	0.020	0.009	0.021	0.029	0.089	0.016	0.018	0.021	0.195
		b	0.089	0.012	0.032	0.036	0.038	0.021	0.039	0.036	0.173
Lead, total	mg/ℓ	a	<0.001	0.005	0.005	0.006	0.007	0.007	0.008	0.007	0.010
		b	0.005	0.005	0.006	0.006	0.007	0.007	0.008	0.007	0.009
Manganese, total	mg/ℓ	a	0.003	0.004	0.015	0.003	0.004	0.003	0.003	0.005	0.005
		b	0.003	0.006	0.050	0.004	0.003	0.003	0.004	0.003	0.003
Mercury, total	mg/ℓ	a	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
		b	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel, total	mg/ℓ	a	0.008	0.132	0.104	0.010	0.021	0.017	0.002	0.003	0.002
		b	0.009	0.126	0.107	0.010	0.021	0.015	0.002	0.002	0.001
Zinc, total	mg/ℓ	a	0.007	0.057	0.113	0.013	0.023	0.009	0.003	0.003	0.003
		b	0.007	0.102	0.207	0.007	0.019	0.007	0.001	0.002	0.002

POOR ORIGINAL

Table G-14

Indicators of Industrial and Organic Contamination, Nearshore Ponds, Bailly Study Area, August 1978

Parameter	Units	Rep	Station 13S	14S	15S	16S	17S	18S	19S	20S	21S
Bacteria, fecal coliform	No./100 mℓ	a	175	0	0	50	30,750	10,350	975	850	21,250
		b	825	0	0	125	9,050	10,900	725	8,650	23,250
Bacteria, total coliform	No./100 mℓ	a	2,[illegible]00	50	150	2,950	36,750	30,750	25,750	33,750	58,000
		b	2,275	100	225	3,500	13,750	32,250	22,750	24,250	35,000
Biochemical oxygen demand	mg/ℓ	a	1	1	1	1	1	1	1	1	9
		b	1	1	1	1	1	1	1	1	8
Chemical oxygen demand	mg/ℓ	a	<2.0	<2.0	<2.0	3.5	4.5	4.0	10.3	12.2	33.8
		b	2.0	<2.0	<2.0	3.0	5.0	4.0	11.7	12.2	34.0
Hexane soluble materials	mg/ℓ	a	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3.6
		b	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Total organic carbon	mg/ℓ	a	3.2	3.3	4.5	7.2	6.3	7.0	16.0	14.4	37.8
		b	3.6	3.7	3.9	3.7	6.6	6.6	16.4	18.0	48.2
Phenols	mg/ℓ	a	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
		b	<0.005	<0.005	<0.005	[illegible]0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Methylene - blue active substances	mg/ℓ	a	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
		b	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

S = surface

Table G-15

Trace Element Concentrations (mg/kg dry weight) in Sediment Samples from Nearshore Ponds, Bailly Study Area, November 197[illegible]*

Parameter	Replicate	13	14	15	16	17	18	19	20
Cadmium	a	0.013	0.009	0.007	0.006	<.013	<.006	0.005	0.004
	b	0.010	0.006	0.007	0.006	0.037	<.007	<.005	<.004
Chromium	a	0.025	0.006	0.008	0.028	0.040	0.013	0.011	0.008
	b	0.006	0.006	0.007	0.016	0.025	0.014	0.011	0.008
Copper	a	0.135	0.006	0.015	0.050	0.255	0.131	0.080	0.053
	b	0.013	0.006	0.018	0.020	0.174	0.103	0.072	0.056
Iron	a	3.40	0.301	0.042	2.14	2.25	0.831	1.29	0.203
	b	0.597	0.192	0.011	2.59	2.06	0.468	1.24	0.804
Lead	a	<.003	<.003	<.004	0.009	<.013	<.006	<.005	<.004
	b	<.003	<.003	<.004	<.003	<.012	0.006	0.011	0.008
Manganese	a	1.49	0.541	0.471	0.[illegible]2	2.64	0.157	0.010	0.069
	b	1.30	0.573	0.616	0.229	1.59	0.227	0.011	0.056
Mercury	a	<.002	<.002	<.002	<.002	<.008	<.004	<.003	<.002
	b	<.002	<.002	<.002	<.002	<.007	<.003	<.003	<.002
Nickel	a	0.195	0.073	0.049	0.040	0.552	0.157	0.064	0.032
	b	0.079	0.082	0.064	0.033	0.287	0.165	0.033	0.016
Selenium	a	<.002	0.002	<.002	0.002	0.008	<.003	<.003	<.002
	b	<.002	<.002	0.003	0.003	0.007	<.003	<.003	<.002
Vanadium	a	<.006	<.006	<.007	<.006	1.20	0.275	0.085	<.008
	b	<.007	<.006	<.007	<.006	0.735	0.337	0.056	<.008
Zinc	a	0.302	0.066	0.011	0.093	0.040	0.046	0.101	0.028
	b	0.076	0.104	0.011	0.164	0.100	0.041	0.039	0.012
Phosphorus	a	0.057	0.016	0.046	0.218	0.283	0.144	0.083	0.061
	b	0.040	0.018	0.036	0.102	0.274	0.110	0.089	0.096
Percent Solids	a	78.6	78.8	66.1	80.4	19.5	36.6	54.7	61.3
	b	76.7	79.1	70.1	78.5	20.6	36.6	44.8	61.4

*Variable minimum detectability limits based on amount sample had to be concentrated prior to analysis.

POOR ORIGINAL

580 044

Parameter	Unit	Replicate	1S	2S	2B	3S	3M	3B	4S	5S	5B	6S	6M	6B	7S
Alkalinity, soluble	mg/ℓ	a	111	110	110	111	110	111	109	109	109	108	109	108	109
		b	112	111	111	109	109	109	109	110	109	109	108	109	109
Calcium, soluble	mg/ℓ	a	31.5	32.6	33.4	32.9	31.3	33.4	31.8	33.9	32.1	33.1	31.3	31.2	31.
		b	32.1	32.1	32.3	33.4	33.1	33.1	32.9	32.9	3.29	33.9	31.0	31.7	30.
Chloride, total	mg/ℓ	a	10.5	9.9	10.1	10.1	10.2	10.0	10.0	10.1	9.9	9.8	9.7	9.8	9.
		b	10.2	10.2	10.1	10.1	10.3	10.1	10.1	10.0	10.1	9.8	9.6	9.8	9.
Chlorine, total	mg/ℓ	a	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.
		b	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.
Conductance	μmhos	a	280	290	280	270	260	280	280	280	270	280	270	280	280
		b	280	290	280	270	260	280	280	280	270	280	270	280	280
Oxygen, dissolved	mg/ℓ	a	10.6	10.6	10.6	10.4	11.1	10.9	10.9	8.4	10.6	10.5	10.4	10.5	10.
		b	10.6	10.6	10.6	10.4	11.1	10.9	10.9	8.4	10.6	10.5	10.4	10.5	10.
Oxygen, saturation	% Sat.	a	95	95	95	94	100	98	98	78	95	95	94	95	94
		b	95	95	95	94	100	98	98	78	95	95	94	95	94
Odor, threshold	Pos/Neg	a	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
		b	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
Magnesium, soluble	mg/ℓ	a	10.1	9.9	9.8	9.8	9.3	9.5	9.4	9.5	9.4	9.5	9.0	8.8	9.
		b	9.8	9.9	9.8	9.4	9.5	9.4	9.5	9.5	9.4	9.6	9.0	9.1	8.
Hardness	mg/ℓ	a	137	137	135	136	135	136	137	137	136	135	135	136	136
		b	138	136	135	135	136	136	137	136	136	135	135	135	136
pH	pH	a	8.4	8.5	8.5	8.5	8.5	8.4	8.4	8.5	8.5	8.5	8.5	8.4	8.
		b	8.4	8.5	8.5	8.5	8.5	8.4	8.4	8.5	8.5	8.5	8.5	8.4	8.
Potassium, soluble	mg/ℓ	a	1.5	1.5	1.5	1.4	1.5	1.6	1.4	1.4	1.4	1.4	1.4	1.4	1.
		b	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.4	1.
Sodium, soluble	mg/ℓ	a	5.3	5.1	5.2	4.8	4.9	5.2	4.9	5.1	4.9	5.0	4.9	5.1	5.
		b	5.6	5.2	4.9	4.9	5.0	5.0	5.0	4.9	4.9	4.9	5.0	5.2	5.
Suspended solids, total	mg/ℓ	a	9.2	0.4	3.6	2.0	4.0	16.2	8.2	3.0	6.0	2.2	2.4	2.2	7.
		b	12.2	2.8	5.8	2.4	3.8	10.4	5.4	5.8	9.4	2.0	1.0	2.8	7.
Dissolved solids, total	mg/ℓ	a	165	170	162	167	161	157	152	150	155	164	161	159	182
		b	171	163	162	163	160	151	158	152	169	154	168	159	186
Sulfates, soluble	mg/ℓ	a	25.8	25.2	25.1	25.2	25.2	25.4	25.4	25.2	25.2	25.2	24.9	25.1	25.
		b	25.8	25.7	25.3	25.2	25.3	25.1	25.2	25.7	25.6	25.1	25.3	25.2	25.
Temperature	°C	a	11.0	11.0	11.0	11.0	11.0	11.0	11.0	12.0	11.0	11.0	11.0	11.0	10.
		b	11.0	11.0	11.0	11.0	11.0	11.0	11.0	12.0	11.0	11.0	11.0	11.0	10.
Turbidity	NTU	a	<0.1	<0.1	0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	0.2	<0.1	<0.
		b	<0.1	0.1	0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.
Color, true	Pt-Co	a	1	1	1	1	1	1	1	1	1	1	1	1	1
		b	1	1	1	1	1	1	1	1	1	1	1	1	1
Fluoride, soluble	mg/ℓ	a	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.24	0.24	0.24	0.23	0.23	0.
		b	0.26	0.24	0.24	0.24	0.24	0.24	0.23	0.24	0.24	0.24	0.23	0.23	0.

*S = surface, B = bottom, M = mid-depth.

Table G-16

General Water Quality Parameters, NIPSCo Bailly Station Vicinity, November 1978

Stations

8S	8B	9S	9M	9B	10S	11S	12S	22S	13S	14S	15S	16S	17S	18S	19S	20S	21S
108	109	106	108	108	112	113	113	116	65	<5	<5	39	37	41	69	76	145
108	108	107	107	107	112	113	114	115	65	<5	<5	39	36	42	70	76	146
35.3	30.5	29.7	29.4	30.2	29.7	29.7	32.3	39.5	47.5	58.2	56.3	51.8	88.5	94.9	44.3	48.1	54.6
30.5	30.7	29.7	30.7	28.1	28.6	28.9	32.6	39.3	47.8	57.2	57.5	52.3	88.0	90.7	44.2	47.7	55.2
9.9	9.7	9.0	9.0	9.1	10.0	10.1	10.0	10.0	9.6	9.6	9.6	9.8	10.7	10.8	9.4	9.7	24.9
9.9	9.8	9.2	9.0	9.1	10.1	10.1	10.0	10.1	9.7	9.6	9.6	9.8	10.7	10.9	9.5	9.7	24.9
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
280	280	260	260	280	290	280	260	280	480	850	560	515	800	750	415	420	520
280	280	260	260	280	290	280	260	280	480	850	560	515	800	750	415	420	520
10.5	10.5	10.7	10.4	10.6	8.8	10.5	10.6	10.0	10.0	9.2	9.8	10.5	9.0	10.1	8.1	8.3	4.6
10.5	10.5	10.7	10.4	10.6	8.8	10.5	10.6	10.0	10.0	9.2	9.8	10.5	9.0	10.1	8.1	8.3	4.6
93	95	96	94	95	113	95	95	123	88	85	92	95	80	89	70	73	41
93	95	96	94	95	113	95	95	123	88	85	92	95	80	89	70	73	41
Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Pos	Pos	Pos	Pos	Pos
Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Pos	Pos	Pos	Pos	Pos
8.8	8.9	9.1	9.0	9.2	9.5	9.6	9.5	9.8	13.7	31.0	29.0	13.8	18.8	19.5	13.8	13.5	22.0
8.8	9.1	8.9	9.0	9.2	9.5	9.6	9.5	9.6	13.7	30.0	29.0	13.8	18.9	19.5	13.8	13.5	22.7
136	136	134	135	134	137	137	135	138	187	323	259	200	346	343	176	182	238
136	135	134	133	134	137	137	136	137	187	324	260	198	346	343	175	183	237
8.5	8.5	8.4	8.4	8.5	8.4	8.4	8.4	8.5	7.4	3.9	4.8	7.5	7.1	7.45	7.35	7.5	7.45
8.5	8.5	8.4	8.4	8.5	8.4	8.4	8.4	8.5	7.4	3.9	4.8	7.5	7.1	7.45	7.35	7.5	7.45
1.3	1.3	1.5	1.5	1.2	1.5	1.4	1.4	1.5	4.9	13.2	12.2	4.8	14.1	14.3	2.4	2.6	2.6
1.3	1.3	1.2	1.4	1.3	1.5	1.4	1.4	1.5	4.9	13.1	12.1	4.8	14.2	14.1	2.5	2.7	2.6
5.1	5.1	4.0	4.0	4.2	4.7	4.8	4.7	4.9	11.5	21.2	22.5	13.0	16.2	15.0	6.8	7.2	13.0
5.1	5.2	4.0	4.1	4.3	4.7	4.8	4.7	4.8	11.2	21.8	21.2	12.8	16.8	15.2	6.9	7.0	12.9
5.2	5.6	3.0	0.4	10.6	12.2	5.2	5.4	27.4	2.0	10.0	9.2	1.2	3.2	3.4	37.1	15.7	2.0
2.8	7.0	1.6	1.8	8.0	13.6	6.4	8.4	18.0	4.8	10.4	4.6	1.8	3.6	5.8	36.0	2.0	0.8
178	196	185	173	159	169	167	167	166	302	537	480	334	615	573	282	276	342
171	187	166	174	155	172	170	173	168	217	532	476	335	603	588	276	276	334
25.2	24.9	23.7	24.1	23.8	26.8	25.7	25.5	26.2	205	392	369	240	385	380	168	159	51
25.1	24.8	23.8	24.0	23.9	27.0	26.0	25.4	26.0	204	400	367	231	391	384	152	159	44
10.0	11.0	11.0	11.0	11.0	29.0	11.0	11.0	27.0	10.0	12.0	12.5	11.0	10.0	10.0	9.0	10.0	10.0
10.0	11.0	11.0	11.0	11.0	29.0	11.0	11.0	27.0	10.0	12.0	12.5	11.0	10.0	10.0	9.0	10.0	10.0
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.3	0.1	0.2
<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	0.2	<0.1	0.1	<0.1	<0.1	0.3	0.1	0.2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	15	25	15	350
1	1	1	1	1	1	1	1	1	1	1	1	1	1	15	25	15	320
0.24	0.24	0.21	0.21	0.22	0.21	0.23	0.24	0.24	0.29	0.18	0.18	0.28	0.34	0.32	0.33	0.24	0.26
0.24	0.24	0.21	0.22	0.21	0.22	0.24	0.24	0.23	0.29	0.17	0.17	0.28	0.34	0.31	0.33	0.23	0.26

580 046

Parameter	Unit	Rep	1s	2s	2b	3s	3m	3b	4s	5s	5b
										Station	
Ammonia	mg/ℓ	a	0.038	0.033	0.040	0.031	0.028	0.050	0.034	0.032	0.0
		b	0.051	0.038	0.040	0.038	0.040	0.039	0.037	0.038	0.0
Nitrate	mg/ℓ	a	0.18	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.1
		b	0.20	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.1
Nitrite	mg/ℓ	a	0.003	0.003	0.004	0.004	0.004	0.007	0.004	0.004	0.0
		b	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.0
Organic nitrogen	mg/ℓ	a	0.38	0.30	0.29	0.42	0.24	0.26	0.23	0.14	0.1
		b	0.46	0.29	0.32	0.26	0.33	0.27	0.16	0.24	0.2
Orthophosphate	mg/ℓ	a	0.005	0.004	0.003	0.002	0.002	0.002	0.004	0.003	0.0
		b	0.006	0.004	0.003	0.002	0.002	0.002	0.004	0.003	0.0
Total phosphate	mg/ℓ	a	0.015	0.002	0.003	0.002	<0.002	0.006	0.002	<0.002	<0.0
		b	0.006	0.004	0.003	<0.002	0.006	0.007	0.002	<0.002	0.0
Silicate	mg/ℓ	a	0.35	0.24	0.14	0.10	0.10	0.43	0.25	0.24	0.2
		b	0.38	0.22	0.11	0.08	0.14	0.23	0.25	0.22	0.

Table G-17

Aquatic Nutrients, Bailly Study Area, November 1978

	Station																					
	6s	6m	6b	7s	8s	8b	9s	9m	9b	10s	11s	12s	22s	13s	14s	15s	16s	17s	18s	19s	20s	21s
37	0.029	0.034	0.035	0.038	0.035	0.034	0.045	0.026	0.029	0.066	0.053	0.047	0.061	0.086	0.340	0.300	0.132	0.150	0.097	0.570	0.052	0.021
48	0.037	0.026	0.038	0.040	0.042	0.034	0.035	0.028	0.036	0.059	0.054	0.052	0.053	0.095	0.340	0.306	0.128	0.158	0.100	0.560	0.045	0.018
9	0.19	0.18	0.18	0.18	0.18	0.18	0.16	0.16	0.16	0.19	0.19	0.19	0.19	0.28	0.30	0.29	0.31	0.07	0.07	0.06	0.03	0.07
9	0.19	0.18	0.18	0.18	0.18	0.18	0.16	0.16	0.19	0.21	0.19	0.21	0.19	0.29	0.31	0.29	0.31	0.07	0.07	0.07	0.02	0.07
05	0.005	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.005	0.005	0.011	0.019	0.019	0.007	0.003	0.004	0.005	0.004	0.004
05	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.002	0.003	0.005	0.003	0.005	0.005	0.011	0.019	0.019	0.007	0.004	0.004	0.004	0.004	0.004
7	0.18	0.30	0.20	0.25	0.28	0.32	0.26	0.49	0.31	0.32	0.64	0.34	0.44	0.52	0.22	0.33	0.47	0.46	1.04	1.10	0.89	1.13
8	0.18	0.28	0.18	0.29	0.25	0.25	0.36	0.49	0.40	0.33	0.65	0.43	0.26	0.36	0.24	0.21	0.33	0.49	0.63	0.98	0.96	1.37
02	0.003	0.002	0.002	0.003	0.002	0.002	0.005	0.002	0.002	0.004	0.002	0.002	0.004	0.009	0.004	<0.002	0.006	<0.002	0.002	0.004	0.003	0.012
02	0.002	0.002	0.002	0.003	0.002	0.008	0.002	0.002	0.008	0.004	0.003	0.002	0.004	0.008	0.004	<0.002	0.006	<0.002	0.002	0.004	0.003	0.012
02	0.003	0.006	0.002	0.005	0.005	0.005	0.005	0.003	0.003	0.005	0.012	0.004	0.003	0.006	0.002	<0.002	<0.002	0.003	0.010	0.009	0.007	0.024
06	0.003	0.005	<0.002	0.005	0.004	0.007	0.002	0.003	0.010	0.004	0.006	0.007	0.003	0.003	<0.002	<0.002	0.008	0.002	0.010	0.008	0.007	0.014
2	0.21	0.26	0.18	0.32	0.24	0.22	0.26	0.49	0.29	0.36	0.26	0.21	0.38	2.22	2.26	3.30	3.16	1.62	0.75	0.78	0.09	17.9
6	0.21	0.26	0.34	0.32	0.28	0.20	0.28	0.55	0.28	0.53	0.25	0.34	0.36	2.22	2.27	3.29	3.14	1.59	0.74	0.78	0.07	17.9

Table G-18

Trace Elements in Water, Interdunal Ponds, Bailly Study Area, November 1978

Parameter	Units	Replicate	13	14	15	16	17	18	19	20	21
Cadmium, total	ml/ℓ	a	0.006	0.080	0.070	0.009	0.001	0.002	<.001	<.001	<.001
		b	0.006	0.086	0.014	0.009	0.001	0.002	<.001	<.001	<.001
Chromium, hexavalent	ml/ℓ	a	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
		b	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Chromium, total	mg/ℓ	a	<.001	0.006	0.001	<.001	<.001	<.001	<.001	<.001	<.001
		b	<.001	0.010	0.001	<.001	<.001	<.001	<.001	<.001	<.001
Copper, total	mg/ℓ	a	<.001	0.308	0.163	<.001	<.001	<.001	<.001	<.001	<.001
		b	<.001	0.296	0.199	<.001	<.001	<.001	<.001	<.001	<.001
Iron, soluble	mg/ℓ	a	0.180	0.185	0.165	0.202	0.173	0.089	0.186	0.144	0.209
		b	0.179	0.217	0.079	0.203	0.167	0.078	0.186	0.138	0.214
Lead, total	mg/ℓ	a	<.001	0.006	0.001	<.001	<.001	<.001	<.001	<.001	<.001
		b	<.001	0.010	0.001	<.001	<.001	<.001	<.001	<.001	<.001
Manganese, total	mg/ℓ	a	0.002	0.263	0.259	0.243	0.028	0.003	0.004	0.002	0.004
		b	0.002	0.292	0.259	0.012	0.014	0.008	0.004	0.002	0.001
Mercury, total	mg/ℓ	a	<.0001	0.0002	0.0002	<.0001	0.0002	0.0002	<.0001	<.0001	<.0001
		b	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Nickel, total	mg/ℓ	a	0.020	0.085	0.072	0.022	0.009	0.008	<.001	<.001	<.001
		b	0.020	0.820	0.072	0.017	0.008	0.008	<.001	<.001	<.001
Zinc, total	mg/ℓ	a	0.030	0.447	0.312	0.046	0.004	0.002	<.001	<.001	<.001
		b	0.030	0.440	0.220	0.032	0.007	0.002	<.001	<.001	<.001
Selenium, total**	mg/ℓ	a	0.0011	0.0017	0.0011	0.0010	0.0013	0.0013	0.0008	0.0008	0.0011
		b	0.0011	0.0015	0.0011	0.0010	0.0013	0.0017	0.0008	0.0008	0.0010
Vanadum, total**	mg/ℓ	a	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
		b	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002

*Variable minimum detectability limits based on amount sample had to be concentrated prior to analysis.
**Not required by contract.

POOR ORIGINAL

580 049

Table G-19

Indicators of Industrial and Organic Contamination, Interdunal Ponds, Bailly Study Area, November 1978

Parameter	Units	Replicate	13	14	15	16	17	18	19	20	21
Bacteria, Fecal Coliform	No./100 mℓ	a	<1	<1	<1	<1	<1	<1	75	<1	25
		b	<1	<1	<1	<1	<1	<1	<1	<1	25
Bacteria, Total Coliform	No./100 mℓ	a	25	<1	<1	<1	425	500	125	<1	325
		b	<1	<1	<1	<1	525	500	200	<1	250
Biochemical Oxygen Demand	mg/ℓ	a	4	7	11	1	2	2	4	2	6
		b	4	5	12	1	2	2	3	3	5
Chemical Oxygen Demand	mg/ℓ	a	4.7	20.3	23.4	5.0	10.1	10.1	26.5	26.4	46.9
		b	4.9	20.4	23.4	4.9	10.1	10.5	26.5	26.4	47.9
Hexane Soluble Materials	mg/ℓ	a	<.1	<.1	<.1	<.1	<.1	<.1	0.6	<.1	<.1
		b	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Total Organic Carbon	mg/ℓ	a	5.9	5.4	11.9	7.3	4.1	10.1	31.6	13.0	36.5
		b	6.2	5.9	14.4	5.9	6.9	10.0	28.0	12.3	28.1
Phenols	mg/ℓ	a	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
		b	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Methylene-blue active substances	mg/ℓ	a	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
		b	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02

POOR ORIGINAL

Table G-20

Trace Element Concentrations (mg/kg dry weight) in Sediment Samples from Nearshore Ponds, Bailly Study Area, January 1978

POOR ORIGINAL

Parameter	Replicate	13	14	15	16	17	18	19	20
Cadmium	a	0.009	0.003	0.003	<.004	<.042	<.080	<.007	<.007
	b	0.006	0.006	0.003	<.004	0.020	<.011	<.029	<.009
Chromium	a	<.003	<.003	<.003	<.004	<.042	<.080	<.027	<.007
	b	<.003	<.003	<.003	<.004	<.020	<.011	<.029	<.009
Copper	a	<.003	<.003	<.003	0.014	0.468	0.399	0.015	0.020
	b	<.003	<.003	<.003	0.007	0.081	0.187	0.258	0.038
Iron	a	0.150	0.085	0.066	0.826	5.8	[illegible].6	0.6[illegible]	1.5
	b	0.112	0.122	0.010	0.507	2.6	[illegible].8	43.8	1.8
Lead	a	0.015	<.003	<.003	<.004	3.9	2.5	0.052	0.054
	b	0.009	<.003	<.003	0.013	0.831	0.330	0.372	0.047
Manganese	a	0.380	0.120	0.076	<.004	5.7	39.7	1.1	0.992
	b	0.212	0.088	0.199	<.003	5.5	0.989	77.0	1.5
Mercury	a	0.0025	0.0025	0.0007	0.0025	0.021	0.024	0.0015	0.003
	b	<.0003	0.0030	<.0003	0.0030	0.0081	0.0066	0.0200	0.004
Nickel	a	<.003	<.003	<.003	<.004	0.127	<.080	<.007	0.014
	b	0.019	0.009	<.003	<.003	<.020	0.022	<.029	<.009
Selenium	a	<.0009	<.0009	<.0010	<.0010	0.025	0.024	<.0022	<.0020
	b	<.0009	<.0009	<.0009	<.0010	0.020	<.0033	0.0020	<.0028
Vanadium	a	0.015	<.003	<.003	<.004	3.9	2.5	0.052	0.054
	b	0.009	<.003	<.003	0.013	0.831	0.330	0.372	0.047
Zinc	a	0.309	0.047	0.023	0.058	0.637	0.878	0.045	0.027
	b	0.121	0.063	0.018	0.017	0.365	0.110	1.5	0.047
Phosphorus	a	0.344	0.098	0.105	<.007	0.468	<.144	0.468	0.443
	b	0.403	0.098	0.116	0.017	0.813	<.022	0.876	0.450
Percent Solids	a	81.1	82.1	78.7	68.6	10.0	4.5	81.1	43.5
	b	79.4	81.1	78.5	77.5	12.3	25.0	20.4	27.9

*Variable minimum detectability limits based on amount sample had to be concentrated prior to analysis.