NIAGARA MOHAWK POWER CORPORATION
SYRACUSE, N.Y.

NINE MILE POINT AQUATIC ECOLOGY SUMMARY
(1973-1981)

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CHAPTER 1.0

INTRODUCTION

Comprehensive aquatic studies were conducted in the Nine Mile Point vicinity during the years 1973 through 1978. During these six years, the major trophic levels of the aquatic ecosystem, as well as water quality, were sampled extensively. Sampling of the nekton community and impingement studies were continued through 1981 at Nine Mile Point Unit 1 (Unit 1) and J.A. FitzPatrick (JAF) Power Plant.

This 9-year data base has been used to monitor the aquatic ecosystem during the operation of Unit 1 and JAF. The data are summarized in this report as the preoperational condition for evaluating the potential impact of the operation of Nine Mile Point Unit 2 (Unit 2). Entrainment, impingement, and the effect of thermal discharges are the main concerns to aquatic biota from power plant operations.

Chapter 2.0 of this report discusses the general aquatic ecology of the Nine Mile Point vicinity and the potential involvement of the Unit 2 intake and discharge system within this environment. Chapter 3.0 describes the methods and materials used throughout the study.

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CHAPTER 2.0

BIOLOGICAL STUDIES

2.1 AQUATIC ECOLOGY

2.1.1 Phytoplankton

Phytoplankton are microscopic aquatic plants that utilize solar energy to convert inorganic matter to organic matter. This primary activity provides food for planktonic benthic invertebrates and constitutes the organic base of the Lake Ontario food web.

The abundance, distribution, and productivity of the phytoplankton community in the Nine Mile Point vicinity have been examined through the use of data collected between 1973 and 1978. Detailed descriptions of the station locations, frequency of sampling, and methodologies employed are presented in Section 3.1.1.

Table 2.1.1-1 lists the genera identified during this survey period. A total of 187 genera from seven divisions were identified. The species assemblage remained consistent throughout the study period and was similar to that described in previous studies(1-4). Among the dominant taxa are Scenedesmus, Oocystis, and Coelastrum, which Ogawa(5) reported to exist throughout the lake. Davis(6) reviewed the early phytoplankton studies on Lake Ontario (as far back as the 1930s), and most of the abundant species identified since 1973 in the Nine Mile Point vicinity were also abundant during the earlier years covered by his review.

The temporal distribution of phytoplankton is determined by such biotic and abiotic factors as light intensity, turbidity, temperature, concentrations of organic and inorganic nutrients, interspecific competition, and grazing pressure. These factors combine

TABLE 2.1.1-1

PHYTOPLANKTON SPECIES INVENTORY
NINE MILE POINT VICINITY - 1973-1978

Taxon

CYANOPHYTA
- Coccogoneae
  - Chroococcales
    - *Agmenellum* sp.
    - [a]*Anacystis* sp.
    - *Aphanocapsa* sp.
    - *Aphanothece* sp.
    - *Chroococcus* sp.
    - *Coelosphaerium* sp.
    - *Dactylococcopsis* sp.
    - *Gloeocapsa* sp.
    - *Gloeothece* sp.
    - [a]*Gomphosphaeria* sp.
    - *Marsoniella* sp.
    - *Merismopedia* (*Agmenellum*) sp.
    - *Rabdoderma* sp.
    - *Synechoccus* sp.
  - Chamaesiphonales
    - *Chamaesiphon* sp.
- Hormogonae
  - Oscillatoriales
    - *Lyngbya* sp.
    - [a]*Oscillatoria* sp.
    - *Phormidium* sp.
    - *Rhaphidiopsis* sp.
  - Nostocales
    - [a]*Anabaena* sp.
    - [a]*Aphanizomenon* sp.
    - *Nostoc* sp.
  - Scytonematales
    - *Plectonema* sp.
  - Stigeonematales
    - *Stigonema* sp.

CHLOROPHYTA
- Chlorophyceae
  - Volvocales
    - *Carteria* sp.
    - *Chlamydomonas* sp.
    - *Eudorina* sp.

Taxon

    - *Gonium* sp.
    - *Pandorina* sp.
    - *Pedinopera* sp.
    - *Pedinomonas* sp.
    - *Phacotus* sp.
    - *Pleodorina* sp.
    - *Lobomonas* sp.
    - *Polytoma* sp.
    - *Gyromitus* sp.
    - *Polytomella* sp.
    - *Scourfieldia* sp.
    - *Spermatozoopsis* sp.
    - *Volvox* sp.
  - Tetrasporales
    - *Apiocystis* sp.
    - *Asterococcus* sp.
    - *Dispora* sp.
    - *Elakotothrix* sp.
    - *Gloeocystis* sp.
    - *Schizochlamys* sp.
    - *Sphaerocystis* sp.
    - *Stylosphaeridium* sp.
    - *Tetraspora* sp.
  - Ulotrichales
    - *Geminella* sp.
    - *Gloeolita* sp.
    - *Ulothrix* sp.
    - *Uronema* sp.
  - Microsporales
    - *Microspora* sp.
  - Cylindrocapsales
    - *Cylindrocapsa* sp.
  - Chaetophorales
    - *Chaetophora* sp.
    - *Stigeoclonium*
  - Cladophorales
    - *Cladophora* sp.
    - *Rhizoclonium* sp.
  - Oedogoniales
    - *Oedogonium* sp.

TABLE 2.1.1-1 (Cont)

Taxon	Taxon
Zygnematales	*Scenedesmus* sp.
Mougeotia sp.	*Schroederia* sp.
Spirogyra sp.	*Selenastrum* sp.
Zygnema sp.	*Sphaerocystis* sp.
Desmidiales	*Tetradesmus* sp.
Closterium sp.	*Tetraedron* sp.
Cosmarium sp.	*Tetrastrum* sp.
Spondylosium sp.	*Treubaria* sp.
Staurastrum sp.	*Trochiscia* sp.
Chlorococcales	*Coranastrum* sp.
Actinastrum sp.	*Paramastix* sp.
Ankistrodesmus sp.	*Westella* sp.
Ankyra sp.	
Botryococcus sp.	EUGLENOPHYTA
Characium sp.	Euglenophyceae
Chlorococcum sp.	Euglenales
Chlorella sp.	*Euglena* sp.
Chlorococcum sp.	*Phacus* sp.
Chodatella sp.	*Trachelomonas* sp.
Closteriopsis sp.	*Lepocinclis* sp.
Coelastrum sp.	
Crucigenia sp.	CHRYSOPHYTA
Dactylococcus sp.	Xanthophyceae
Desmatractum sp.	Heterococcales
Dicellula sp.	*Perionella* sp.
Dictyosphaerium sp.	Chrysophyceae
Didymocystis sp.	Chrysomonodales
Dimorphococcus sp.	*Aulomonas* sp.
Echinosphaerella sp.	*Dinobryon* sp.
Errerella sp.	*Epipyxis* sp.
Franceia sp.	*Mallomonas* sp.
Gloeoactinium sp.	*Chrysochromulina* sp.
Golenkinia sp.	*Chromulina* sp.
Kirchneriella sp.	*Chrysosphaerella* sp.
Micractinium sp.	*Kephyrion* sp.
Nephrocytium sp.	*Pseudokephyrion* sp.
Ocystis sp.	*Stelexomonas* sp.
Paradoxia sp.	*Stylobryon* sp.
Pediastrum sp.	*Synura* sp.
Planktosphaeria sp.	Rhizochrysidales
Poleydriopsis sp.	*Chrysarachnion* sp.
Pseudochlorella sp.	*Lagynion* sp.
Quadrigula sp.	*Rhizochrysis* sp.
Radiococcus sp.	*Stipitococcus* sp.

TABLE 2.1.1-1 (Cont)

Taxon

Chrysosphaerales
- *Chrysamoeba* sp.
- *Chrysococcus* sp.

Ochromondales
- *Ochromonas* sp.
- *Uroglena* sp.
- *Codonosiga* sp.
- *Bicoeca* sp.

Craspedomonadales
- *Codonosigopsis* sp.

Monadales
- *Monosiga* sp.
- *Monas* sp.
- *Bodo* sp.

Isochrysidales
- *Erkenia* sp.

Bacillariophyceae

Centrales
- *Actinocyclus* sp.
- *Bacteriastrum* sp.
- *Coscinodiscus* sp.
- *Cyclotella* sp.
- *Melosira* sp.
- *Rhizosolenia* sp.
- *Skeletonema* sp.
- *Stephanodiscus* sp.

Pennales
- *Amphora* sp.
- *Achnanthes* sp.
- *Amphiprora* sp.
- *Asterionella* sp.
- *Cocconeis* sp.
- *Cymatopleura* sp.
- *Cymbella* sp.
- *Diatoma* sp.
- *Eunotia* sp.
- *Fragilaria* sp.

Taxon

- *Gomphonema* sp.
- *Gyrosigma* sp.
- *Meridion* sp.
- *Navicula* sp.
- *Nitzschia* sp.
- *Pinnularia* sp.
- *Rhoicosphenia* sp.
- *Surirella* sp.
- *Synedra* sp.
- *Tabellaria* sp.

RHODOPHYTA

Nemalionales
- *Batrachospermun* sp.

CRYPTOPHYTA

Cryptophyceae

Cryptomonadales
- *Chroomonas* sp.
- *Cryptomonas* sp.
- *Katablepharis* sp.
- *Rhodomonas* sp.
- *Sennia parvula*
- *Cryptaulax* sp.
- *Monomastix* sp.
- *Chilomonas* sp.

PYRROPHYTA

Dinophyceae

Gymnodiniales
- *Gymnodinium* sp.
- *Gyrodinium* sp.

Peridiniales
- *Ceratium hirundinella*
- *Glenodinium* sp.
- *Peridinium* sp.

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[a]Species which occurred each year from 1973-1978

to produce the seasonal patterns in species composition, abundance, and primary activity observed in temperate waters. On Lake Ontario, upwelling of cold, deep waters also influences phytoplankton, primarily through the influx of nutrients. The monthly abundances of total phytoplankton from 1973-1978 are presented in Figure 2.1.1-1. The lower abundances exhibited in 1973 and 1974 relative to the other years could be partially attributed to a change in analysis technique in 1975. Only the larger forms of the Chrysophyceae and none of the Cryptophyta were enumerated in 1973 and 1974. Phytoplankton abundance generally cycled two to four times each year; maximum abundances generally occurred during the summer. A plankton population succession typical of the six study years is shown in Figure 2.1.1-2. Bacillariophyta (diatoms) bloomed in the spring, then declined until late fall when they again became abundant. Green algae were generally most abundant during the summer; blue-green algae, during late summer and early fall. These trends are characteristic of the study area[1-4].

Since chlorophyll a is common to all phytoplankton taxa, it is regularly used as an indicator of phytoplankton standing crop[7]. The mean monthly chlorophyll a concentrations in the NMP vicinity from 1973 through 1978 are presented in Figure 2.1.1-3. Generally, values were higher during the spring and summer than during the fall, but within each year the number of peaks varied. Chlorophyll a was chosen for examination of long-term trends because the techniques used to collect and analyze the data did not change significantly over the six-year duration of the program; consequently, the trends exhibited should be related to changes in the community standing crop rather than to methodology.

The long-term trends, as indicated by chlorophyll a concentrations, indicated a cyclic pattern, with low values occurring during 1975 and 1978 and highest values during 1974 (Figure 2.1.1-4). The

FIGURE 2.1.1-1

MONTHLY ABUNDANCE OF TOTAL PHYTOPLANKTON

Nine Mile Point Vicinity - 1973-1978

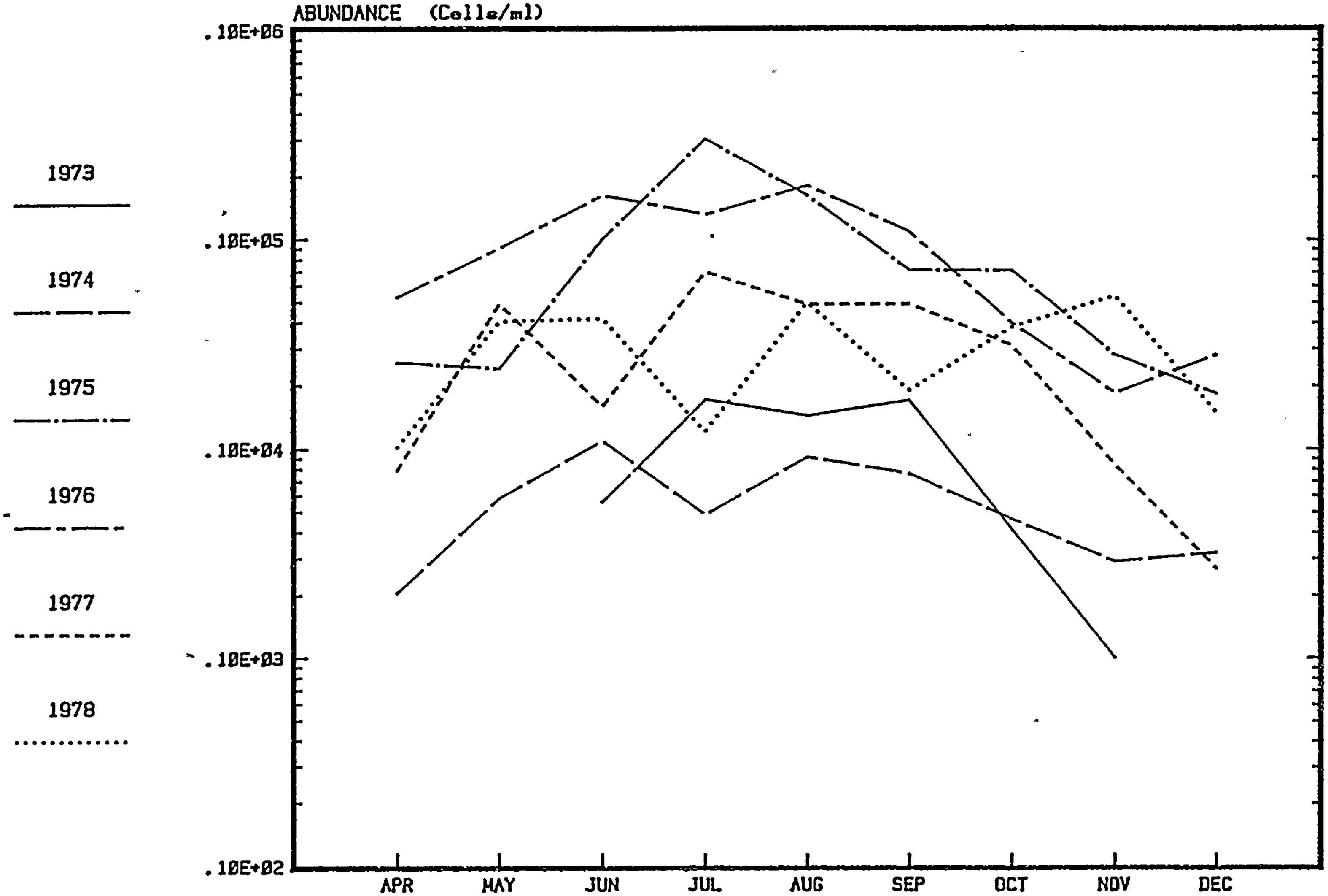


FIGURE 2.1.1-2

PHYTOPLANKTON COMMUNITY SUCCESSION

Nine Mile Point Vicinity -1978

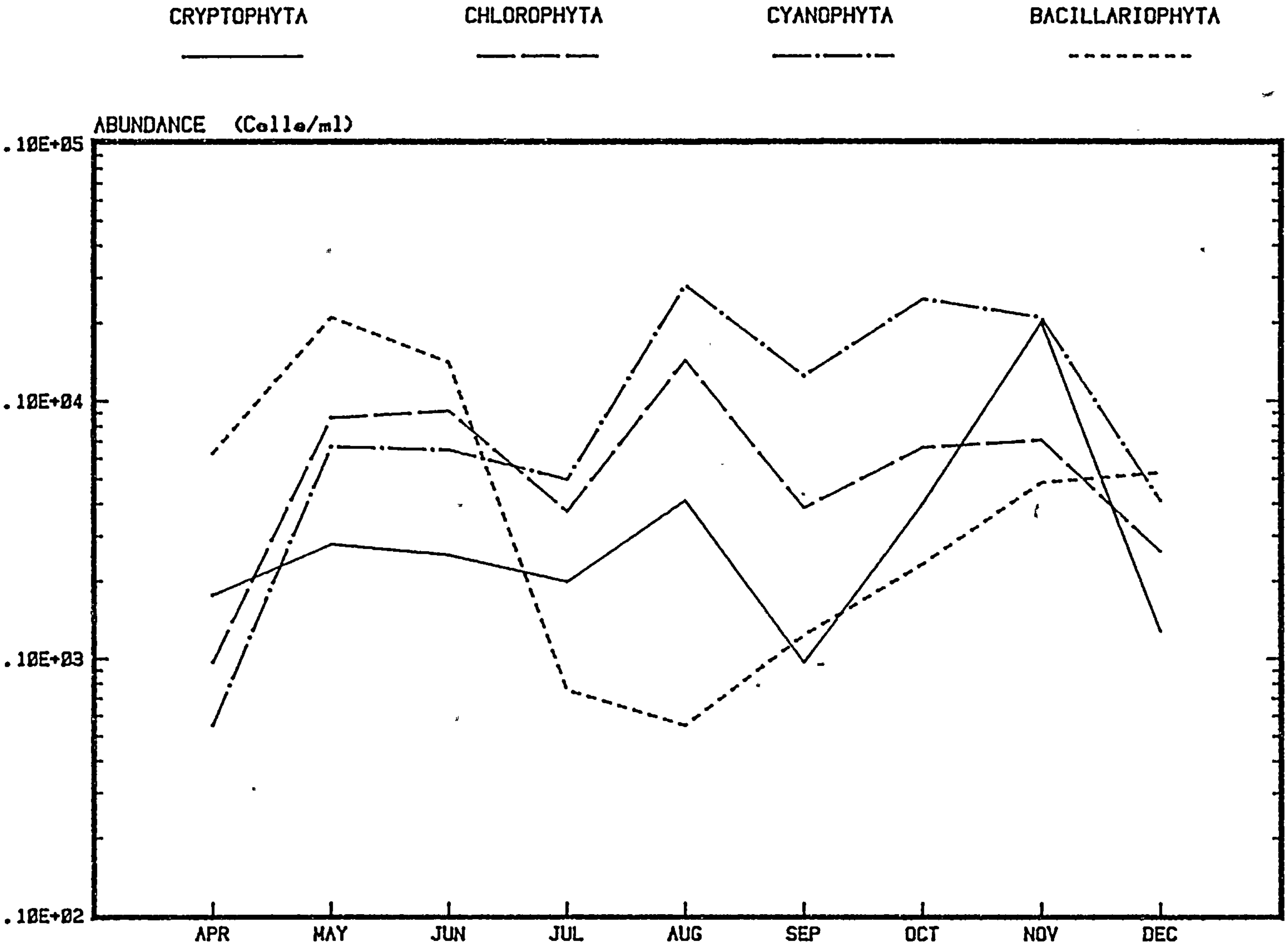


FIGURE 2.1.1-3

MEAN CHLOROPHYLL a VALUES RECORDED

Nine Mile Point Vicinity - 1973 - 1978

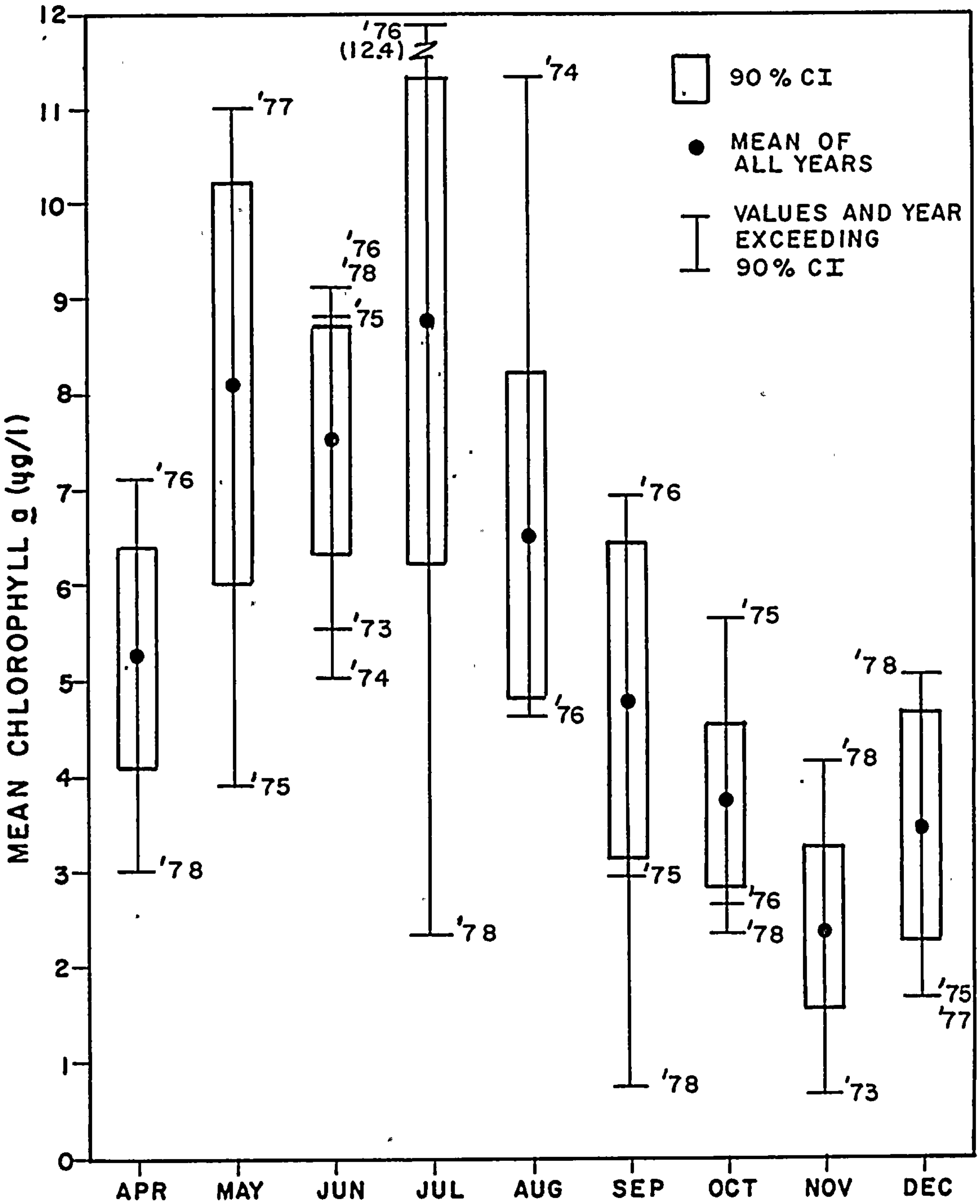
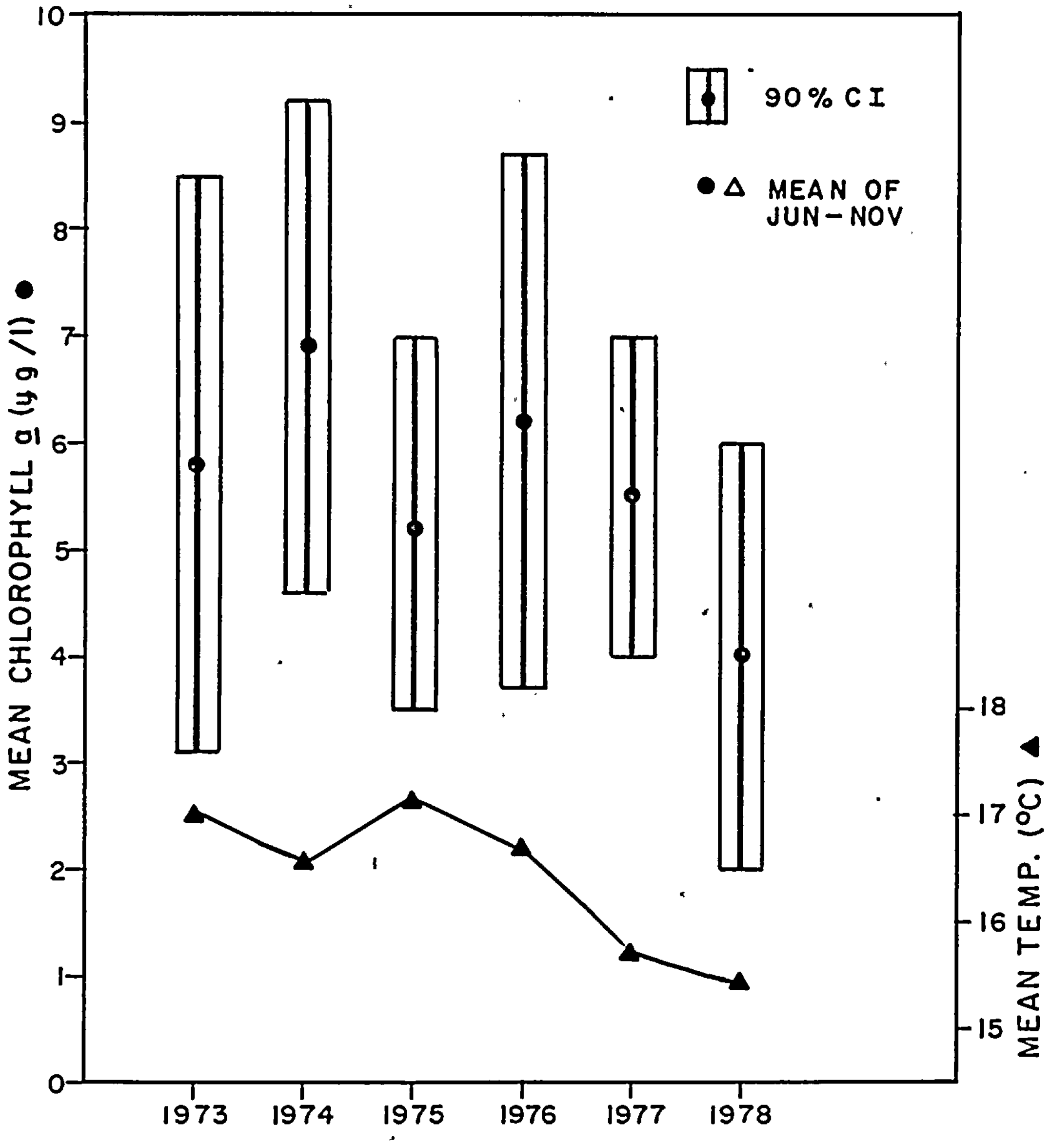


FIGURE 2.1.1-4

YEARLY MEAN CHLOROPHYLL a AND TEMPERATURE VALUES

Nine Mile Point Vicinity—1973-1978



remaining three years (1973, 1976, and 1977) demonstrated intermediate values. While the overall trend, based on the mean values, indicates a reduction in phytoplankton standing crop (as chlorophyll a), the large variance of the mean attributable to the wide seasonal variability (Figure 2.1.1-3) precludes demonstration of any significance between the yearly means.

There are many water quality parameters that have been shown to affect the phytoplankton standing crop; one of them, temperature, is commonly used to explain distributional patterns. Annual temperature cycles, in combination with annual light cycles, have been reported as being responsible for the gross seasonal changes in phytoplankton communities[8]. Figure 2.1.1-4 indicates no consistent relationship between water temperature and chlorophyll a concentrations for the NMP vicinity.

Analysis of spatial distribution showed that chlorophyll a concentrations were generally lower offshore than onshore (Table 2.1.1-2). This observation is supported by the results of other researchers on Lake Ontario[9]. Longshore trends indicated a generally higher phytoplankton standing crop at NMPW compared to other transects, which is attributed to the influence of the Oswego River, which affects NMPW more than the other stations[10,11].

In conclusion, the phytoplankton community in the Nine Mile Point vicinity is similar to that of other shoal areas in Lake Ontario with regard to species composition and seasonal succession. Local trends in phytoplankton abundance and distribution are largely related to natural phenomena. Similar species and similar seasonal patterns were observed each year, and no apparent changes have occurred in the phytoplankton community during the six-year study period.

TABLE 2.1.1-2

YEARLY MEAN[a] OF CHLOROPHYLL a

NINE MILE POINT VICINITY - 1973-1978

	Transect[b]				Contour[c]			
Year	NMPW	NMPP	FITZ	NMPE	10	20	40	60
1973	6.7	5.5	4.9	6.1	6.5	5.9	6.2	4.6
1974	7.2	5.8	6.1	6.3	6.6	6.6	6.2	6.0
1975	5.1	4.5	4.7	4.8	5.1	5.0	4.6	4.3
1976	7.0	6.2	6.3	6.6	6.8	6.6	6.6	6.1
1977	5.9	5.6	6.1	5.0	5.8	5.7	5.7	5.4
1978	5.1	4.6	4.1	4.0	5.1	5.0	4.5	3.2

[a] 1973 Jun-Nov; 1974-1978 Apr-Dec; μg/l
[b] Mean of all depth contours
[c] Mean of all transects

2.1.2 Microzooplankton

Lake zooplankton are separated into two groups based on size, with microzooplankton ranging from 76 to 571 μm and macrozooplankton larger than 571 μm. Microzooplankton have generally poor locomotive abilities, and their movement is largely dictated by water movements. Some species are carnivorous, feeding on smaller zooplankton; others consume detritus, bacteria, or phytoplankton[12]. They serve as a link between primary producers and higher trophic levels. The annual cycle of microzooplankton abundance and species composition in lakes is determined by a number of biotic and abiotic factors, such as temperature, light, food availability, predation, and hydrodynamics.

A total of 51 genera were identified from the microzooplankton sampling program conducted from 1973 to 1978 (Table 2.1.2-1). Four phyla - Protozoa, Coelenterata, Aschelminthes, and Arthropoda - contain all of the microzooplankton taxa identified; among these, rotifers, copepods, and cladocerans were the major components of the community. Rotifers were the most numerous taxa. Many of the same or similar species occurred each year, and the common genera near Nine Mile Point were also reported to be common in Lake Ontario and the Great Lakes in general[6,13,14]. These are the rotifers *Polyarthra*, *Keratella*, *Synchaeta*; and *Asplanchna*; the cladocerans *Daphnia*, *Bosmina*, and *Diaphanosoma*; and the copepods *Diacyclops*, *Tropocyclops*, and *Acanthocyclops*. The brackish water copepod *Eurytemora affinis* which has invaded all of the Great Lakes was also identified.

This section discusses the three major taxa present in the NMP vicinity: rotifers, cladocerans, and copepods.

The maximum microzooplankton total abundance occurred in June or July during each year, with secondary peaks either in the spring

TABLE 2.1.2-1

MICROZOOPLANKTON SPECIES INVENTORY
NINE MILE POINT VICINITY - 1973-1978

Taxon

- PROTOZOA
  - Mastigophora
  - Ciliophora
  - Sarcodina
    - *Difflugia* sp.
  - Suctoria
    - *Acineta* sp.
    - *Tokophrya* sp.
    - *Thecacineta* sp.
    - *Paracineta* sp.
    - *Staurophrya* sp.
  - Ciliata
    - *Codonella* sp.
    - Vorticellidae
      - *Vorticella* sp.
    - Epistylidae
      - *Epistylis* sp.
    - Gymnostomata
    - Protozoa unid
- COELENTERATA
  - *Hydra* sp.
- ASCHELMINTHES
  - Rotifera
    - Bdelloidea
    - Monogononta
      - [a]Brachionidae
        - *Brachionus* sp.
        - *Euchlanis* sp.
        - *Kellicottia* sp.
        - *Keratella* sp.
        - *Lepadella* sp.
        - *Notholca* sp.
        - *Platyias* sp.
      - Lecanidae
        - *Lecane* sp.
        - *Monostyla* sp.
      - Notommatidae
        - *Cephalodella* sp.
      - Trichocercidae
        - [a]*Trichocerca* sp.
      - Gastropidae
        - *Ascomorpha* sp.
        - *Chromogaster* sp.
      - [a]Asplanchnidae
        - [a]*Asplanchna* sp.
      - Synchaetidae
        - [a]*Pleosoma* sp.
        - [a]*Polyarthra* sp.
        - [a]*Synchaeta* sp.
      - Hexarthridae
        - *Hexarthra* sp.
      - Testudinellidae
        - *Filinia* sp.
        - *Testudinella* sp.
      - Conochilidae
        - *Conochiloides* sp.
        - *Conochilus* sp.
      - Collothecaceae
        - *Collotheca* sp.
- Nematoda
  - Nematoda unid
- ARTHROPODA
  - Crustacea
    - Cladocera
      - Holopedidae
        - *Holopedium* sp.
      - Daphnidae
        - [a]*Ceriodaphnia* sp.
        - [a]*Daphnia* sp.
      - Bosminidae
        - [b]*Bosmina* sp.
      - Chydoridae
        - *Alona* sp.
        - [a]*Chydorus* sp.
      - Leptodoridae
        - *Leptodora* sp.
      - Sididae
        - *Diaphanosoma* sp.

TABLE 2.1.2-1 (Cont)

Taxon
Copepoda
Copepoda nauplii
Calanoida unid
[a]*Eurytemora* sp.
[a]*Diaptomus* sp.
Limnocalanus macrarus
Cyclopoida
Acanthocyclops sp.
[a]*Cyclops* sp.
[a]*Diacyclops* sp.

[a]Genera which occurred each year from 1974-1978.
[b]Identified during 1974-1976, probably present during 1977-1978, but identification was only to family level.

or fall, depending on the year (Figure 2.1.2-1). A seasonal microzooplankton succession typical of the six study years is shown in Figure 2.1.2-2. Rotifers were typically the dominant group except during the fall and early winter when copepods or cladocerans sometimes dominated.

Microzooplankton abundances were typically lower at offshore stations than at nearshore stations (Table 2.1.2-2).. A similar trend was descried by Patalas[15] and Czaika[16] for Lake Ontario. No consistent longshore trends were evident for the major groups, i.e., over several years no one transect showed either higher or lower abundance than any other (Table 2.1.2-1).

The microzooplankton community observed each year was similar, with variations between years caused by a general reduction of all components of the community rather than reduction of a specific component (Figure 2.1.2-3). The mean microzooplankton abundance (indicative of the standing crop) increased throughout the first four study years (1973-1976) but dropped significantly in 1977 and 1978 (Figure 2.1.2-3). This corresponds to a general reduction in water temperature (increased cloud cover, less solar input), which may have affected the microzooplankton standing crop by causing a reduction in their reproduction and/or by affecting the quality or quantity of their primary food source, the phytoplankton.

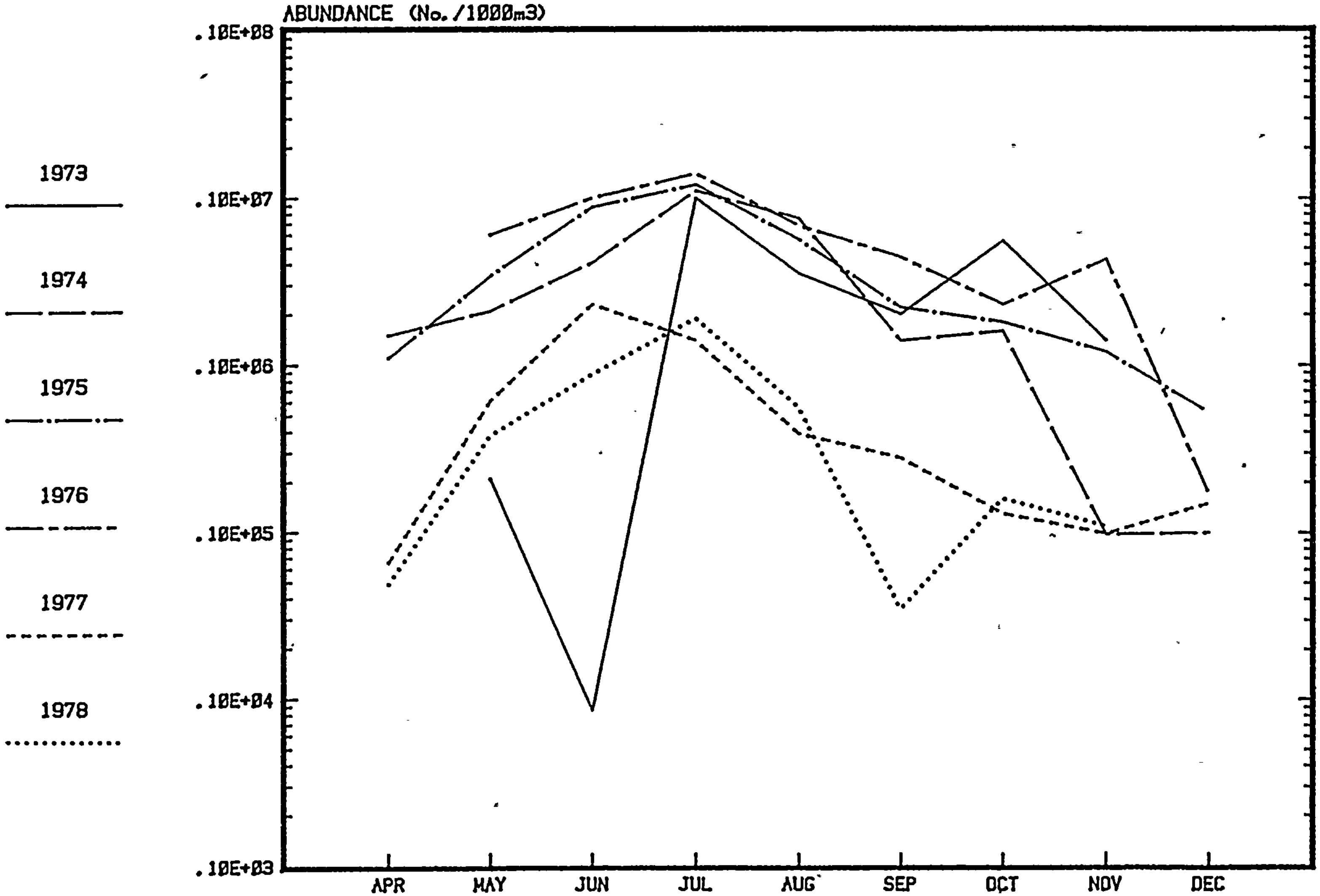
2.1.3 Macrozooplankton

Macrozooplankton, defined as invertebrate animal plankton larger than 571 μm, are important in the diet of planktivorous fish and fish larvae. Since macrozooplankton consume pelagic and benthic organisms of lower trophic levels, they are influential in both

FIGURE 2.1.2-1

SEASONAL SUCCESSION OF TOTAL MICROZOOPLANKTON

Nine Mile Point Vicinity - 1973-1978



FIGU[illegible].1.2-2

SEASONAL SUCCESSION OF SELECTED MICROZOO TAXA

Nine-Mile Point Vicinity - 1975

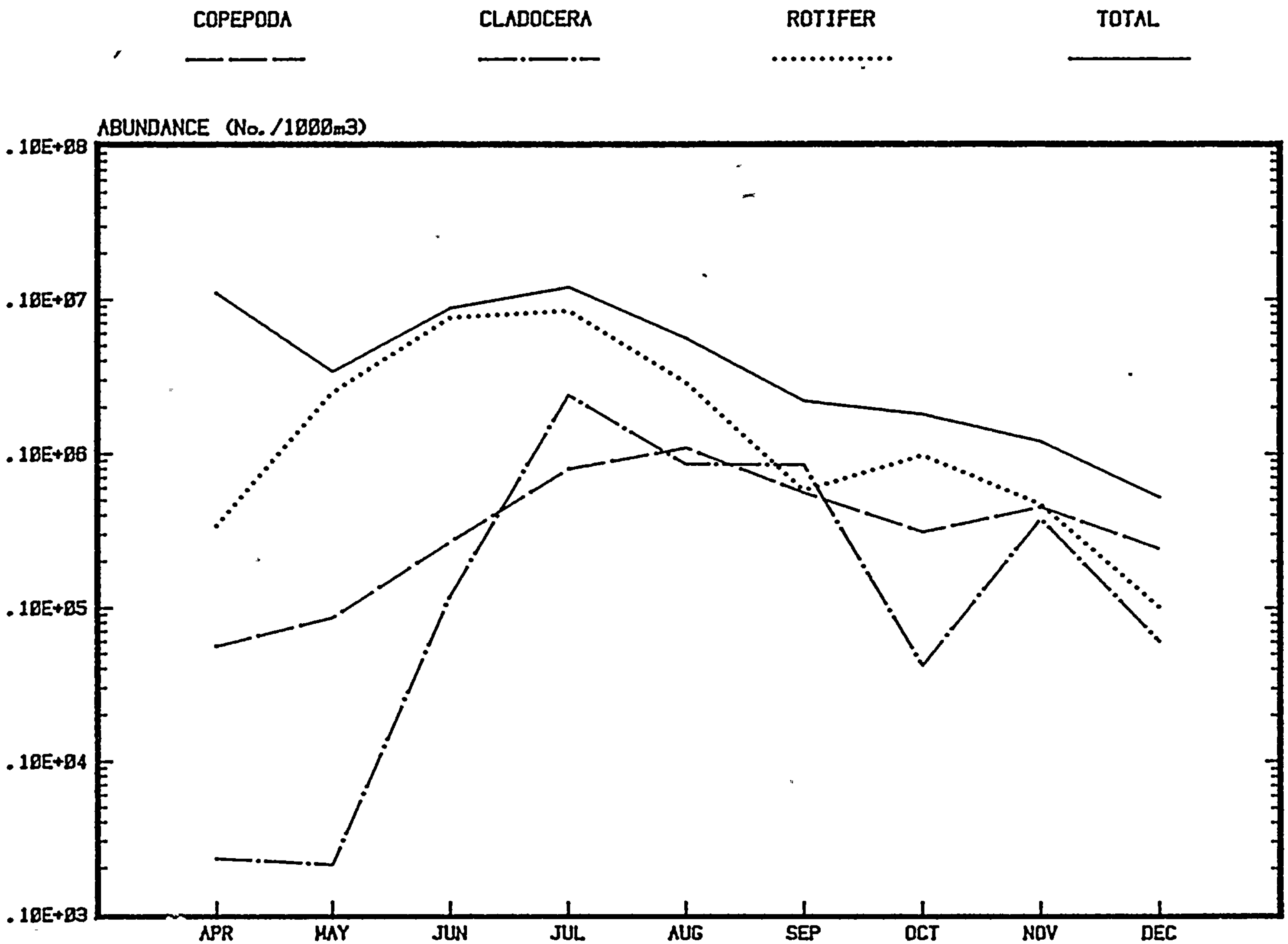


TABLE 2.1.2-2

YEARLY MEAN ABUNDANCE OF SELECTED MICROZOOPLANKTON TAXA BY TRANSECT AND DEPTH CONTOUR

NINE MILE POINT VICINITY - 1973-1978

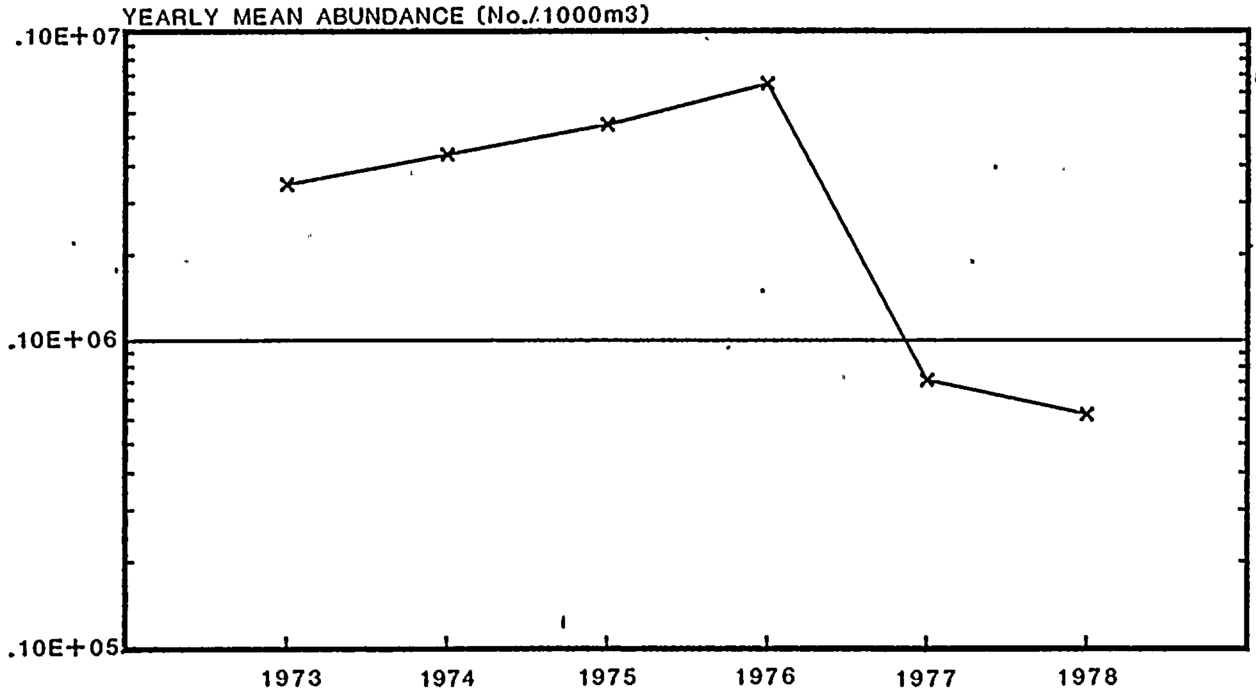
		Transect[a]				Depth Contour (ft)[b]			
Year	Group	NMPW	NMPP	FITZ	NMPE	10	20	40	60
1973	Rotifera	$2.0x10^5$	$2.1x10^5$	$2.6x10^5$	$1.7x10^5$	$3.0x10^5$	$2.2x10^5$	$1.7x10^5$	$1.5x10^5$
	Cladocera	$1.2x10^5$	$1.2x10^5$	$1.0x10^5$	$1.2x10^5$	$1.6x10^5$	$1.4x10^5$	$8.7x10^4$	$7.6x10^4$
	Copepoda	$6.4x10^4$	$1.2x10^5$	$7.3x10^4$	$5.4x10^4$	$1.3x10^5$	$6.1x10^4$	$5.9x10^4$	$6.5x10^4$
	Total	$3.8x10^5$	$4.6x10^5$	$4.3x10^5$	$3.9x10^5$	$5.8x10^5$	$4.3x10^5$	$3.2x10^5$	$2.9x10^5$
1974	Rotifera	$3.0x10^5$	$2.6x10^5$	$3.1x10^5$	$4.4x10^5$	$4.2x10^5$	$4.1x10^5$	$2.8x10^5$	$1.9x10^5$
	Cladocera	$5.7x10^4$	$3.5x10^4$	$4.6x10^4$	$8.6x10^4$	$6.6x10^4$	$5.8x10^4$	$5.8x10^4$	$3.6x10^4$
	Copepoda	$3.5x10^4$	$4.1x10^4$	$4.2x10^4$	$4.8x10^4$	$5.2x10^4$	$4.4x10^4$	$3.8x10^4$	$3.0x10^4$
	Total	$4.0x10^5$	$3.5x10^5$	$4.2x10^5$	$6.0x10^5$	$5.6x10^5$	$5.3x10^5$	$3.9x10^5$	$2.6x10^5$
1975	Rotifera	$3.6x10^5$	$4.5x10^5$	$3.5x10^5$	$4.0x10^5$	$4.2x10^5$	$4.4x10^5$	$3.9x10^5$	$3.1x10^5$
	Cladocera	$7.3x10^4$	$8.6x10^4$	$6.5x10^4$	$4.9x10^4$	$6.2x10^4$	$8.4x10^4$	$6.9x10^4$	$5.8x10^4$
	Copepoda	$4.7x10^4$	$5.3x10^4$	$4.7x10^4$	$4.9x10^4$	$4.8x10^4$	$5.1x10^4$	$5.0x10^4$	$4.5x10^4$
	Total	$5.1x10^5$	$6.4x10^5$	$5.1x10^5$	$5.6x10^5$	$5.9x10^5$	$6.2x10^5$	$5.6x10^5$	$4.5x10^5$
1976	Rotifera	$3.1x10^5$	$3.2x10^5$	$3.1x10^5$	$4.3x10^5$	$3.9x10^5$	$4.2x10^5$	$2.8x10^5$	$2.8x10^5$
	Cladocera	$9.3x10^4$	$1.3x10^5$	$1.1x10^5$	$1.2x10^5$	$1.4x10^5$	$1.4x10^5$	$9.8x10^4$	$8.0x10^4$
	Copepoda	$1.0x10^4$	$1.2x10^5$	$1.4x10^5$	$1.2x10^5$	$1.1x10^5$	$1.2x10^5$	$1.2x10^5$	$1.2x10^5$
	Total	$5.2x10^5$	$5.9x10^5$	$5.8x10^5$	$7.1x10^5$	$6.9x10^5$	$7.1x10^5$	$5.2x10^5$	$5.0x10^5$
1977	Rotifera	$5.0x10^4$	$4.9x10^4$	$4.4x10^4$	$3.7x10^4$	$6.5x10^4$	$4.8x10^4$	$4.1x10^4$	$2.7x10^4$
	Cladocera	$4.2x10^3$	$3.1x10^3$	$4.4x10^3$	$6.2x10^3$	$5.0x10^3$	$4.3x10^3$	$4.6x10^3$	$3.4x10^3$
	Copepoda	$9.4x10^3$	$8.9x10^3$	$9.3x10^3$	$1.4x10^4$	$8.3x10^3$	$9.4x10^3$	$1.2x10^4$	$1.2x10^4$
	Total	$6.4x10^4$	$6.1x10^4$	$5.8x10^4$	$5.7x10^4$	$7.9x10^4$	$6.3x10^4$	$5.6x10^4$	$4.2x10^4$
1978	Total	$4.8x10^4$	$4.9x10^4$	$5.3x10^4$	$5.4x10^4$	$5.3x10^4$	$5.1x10^4$	$5.0x10^4$	$4.9x10^4$

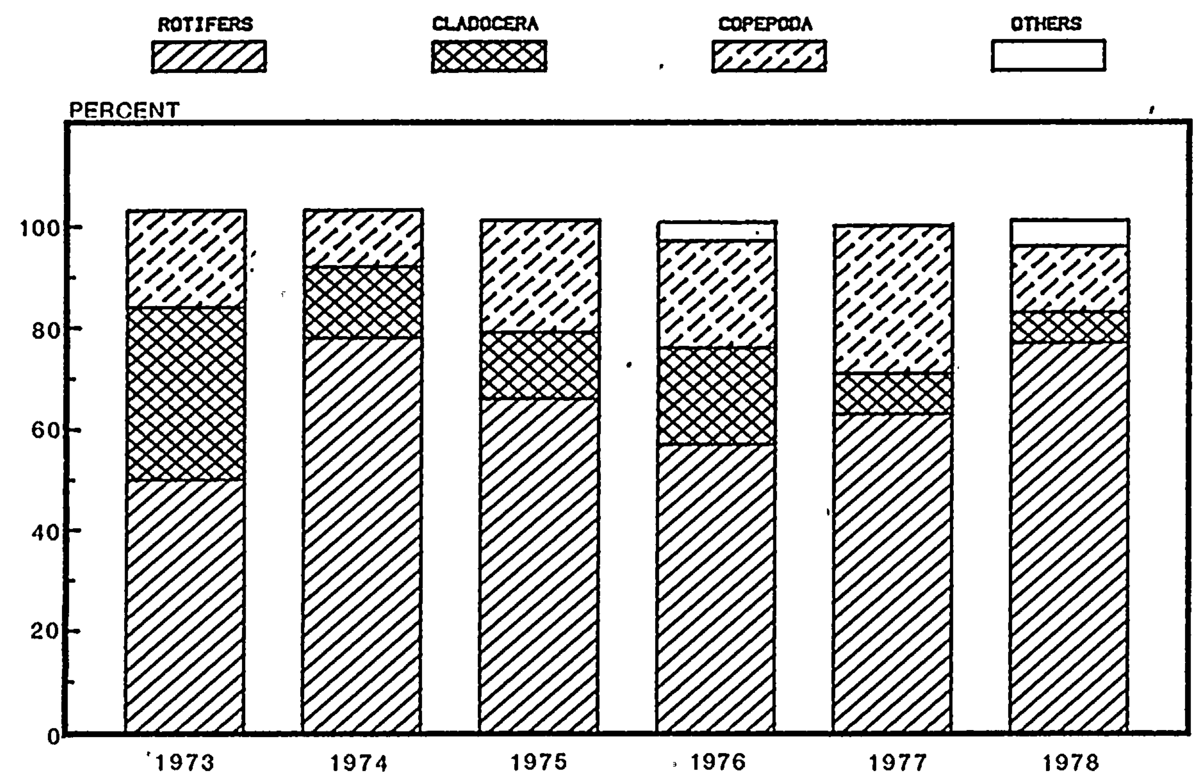
[a] Mean of all depth contours within each transect
[b] Mean of all transects within each depth contour

FIGURE 2.1.2-3

ABUNDANCE AND PERCENT COMPOSITION OF MICROZOO

Nine Mile Point Vicinity - 1973-1978





lower and higher trophic levels. The community structure and temporal/spatial distribution of macrozooplankton in the Nine Mile Point vicinity were investigated during the 1973 through 1978 study period.

A total of 26 genera from the phyla Coelenterata, Platyhelminthes, Aschelminthes, Mollusca, Annelida, and Arthropoda were represented, with the arthropod classes Insecta and Crustacea contributing the greatest number of genera (Table 2.1.3-1). The macrozooplankton community in the Nine Mile Point vicinity is composed of three numerically dominant groups: cladocerans, copepods, and amphipods. The most abundant cladocerans recorded were Daphnia retrocurva, D. galeata mendotae, Leptodora kindtii, and Holopedium gibberum; the dominant copepods were Diaptomus sicilis, D. oregonensis, Limnocalanus macrurus, and calanoid copepodites (juveniles). Amphipods, which were abundant at night, were dominated by Gammarus fasciatus[17-22].

The seasonal pattern of total macrozooplankton density (abundance) reflected the combined seasonal patterns of the dominant groups and species listed above and was essentially unimodal, with peak numbers (~1-2 x 10^5 organisms/1000 m^3) occurring in late summer. Numerous smaller peaks and depressions in abundance were superimposed on the main seasonal pattern, reflecting temporal variability caused by both natural factors and the seasonal succession of various taxa[10,11]. Copepods were dominant during the early spring, with cladocerans generally dominating the community during the remainder of the sampling season. Amphipods reached their seasonal peak during the late summer or fall[10,11]. This basic pattern was undoubtedly influenced by seasonal changes in temperature and food availability and probably by grazing pressure from planktivorous fish and fish larvae and raptorial zooplankters (e.g., L. kindtii). Other groups important in seasonal succession included Diptera and Hydroida.

TABLE 2.1.3-1

SPECIES INVENTORY OF MACROZOOPLANKTON
NINE MILE POINT VICINITY - 1973-1978

Taxon

- CNIDARIA(COELENTERATA)
  - Hydrozoa
    - Hydroida (Athecata)
      - Clavidae
        - *Cordylophora* sp.
      - Hydridae
        - *Hydra* sp.
- PLATYHELMINTHES
  - Turbellaria
- ASCHELMINTHES
  - [a]Nematoda
- MOLLUSCA
  - Gastropoda
  - Bivalvia (Pelecypoda)
- ANNELIDA
  - Polychaeta
    - Sabellida
      - Sabellidae
        - *Manayunkia* sp.
  - Oligochaeta
  - Hirudinea
      - Naididae UID
- ARTHROPODA
  - Arachnida
    - [a]Hydracarina (Acarina)
  - Insecta
    - Odonata
    - Ephemeroptera
    - Hemiptera
    - Tricoptera
    - Diptera
      - Dipteran larvae
      - Dipteran pupae
      - Culicidae (Chaoboridae)
        - *Chaoborus* sp.
      - Simuliidae
      - Chironomidae (Tendipedidae)
    - Coleoptera
    - Lepidoptera
    - Neuroptera
      - *Climacia* sp.
  - Crustacea
    - Cladocera
      - *Eurycercus* sp.
      - *Daphnia* sp.
      - *Diaphanosoma* sp.
      - *Ceriodaphnia* sp.
      - *Helopedium* sp.
      - [a]*Leptodora* sp.
      - *Ilyocryptus* sp.
      - *Polyphemus* sp.
      - *Sica* sp.
      - Bosminidae UID
    - Copepoda
    - Calanoida
      - *Diaptomus* sp.
      - *Epischura* sp.
      - *Eurytemura affinis*
      - *Limnocalanus* sp.
      - Calanoida immature
    - Cyclopoida
      - *Cyclops* sp.
      - *Tropocyclops* sp.
    - Harpacticoida
    - Branchiura
      - Argulidae
        - *Argulus* sp.
    - Isopoda
    - Amphipoda
      - Gammaridae
        - *Crangonyx* sp.
        - *Gammarus* sp.
      - Haustoriidae
        - *Pontoporeia* sp.
      - Talltridae
        - *Hyalella* sp.
    - Mysidacea
      - Mysidae
        - *Mysis* sp.
    - [a]Ostracoda (Podocopa)

---

[a]Taxon which occurred each year from 1973-1978.

Quantitative evaluation of the macrozooplankton community is extremely difficult because of the nature of the species involved and their normal temporal and spatial cycles. Macrozooplankton includes three groups of organisms whose existence can be classified as holoplanktonic (spending their entire life cycle as plankton), meroplanktonic (spending part of their life cycle as plankton), or tycoplanktonic (primarily benthic but swept into the water column by water currents). Many of the collected macrozooplankton (Cordylophora sp., Hydra sp., Gammarus sp., Pontoporeia sp.) are meroplanktonic, and their respective distribution and abundance reflect diel and seasonal behavior patterns.

Quantitative estimates are further affected by retention of specific organisms by the sampling gear. Only the larger copepods (Diaptomus sp. and Cyclops sp.) and cladocerans (Daphnia sp. and Leptodora sp.) are retained in the 571 μm mesh, and even many of the young of these species are not quantitatively retained by the net. To evaluate the trends over the six-year study period, three dominant taxa (Leptodora sp., Amphipoda [primarily Gammarus sp.], and Diptera) will be discussed.

L. kindtii, the only species of the genus Leptodora, is a common freshwater cladoceran in the temperate zone of North America. A typical annual cycle begins with the hatching of overwintering eggs which mature as females within a few days. These and subsequent generations reproduce parthenogenetically through midsummer peak(s) in abundance. Males begin to appear in late summer/early fall as overall abundance levels decrease. Sexual reproduction then results in the production of overwintering eggs[23].

Leptodora is one of the few predaceous cladocerans; mature individuals (>6 mm in length) consume other cladocerans and copepods,

while smaller individuals presumably feed on bacteria, algae, and detritus particles.

In the Nine Mile Point vicinity, L. kindtii was more abundant at night than during the day, and abundance increased with depth in the water column[10,11], indicating that this species, like many zooplankters, migrates vertically in the water column at night. Abundance generally decreased as distance from shore increased; concentrations were greater on the average toward the western end of the study area. However, differences in abundance among stations varied from date to date and were significant on the average for only a few stations[10,11].

Seasonally, Leptodora concentrations increased from May through August or September and then decreased through December; the pattern was unimodal during all years of study (Figure 2.1.3-1).

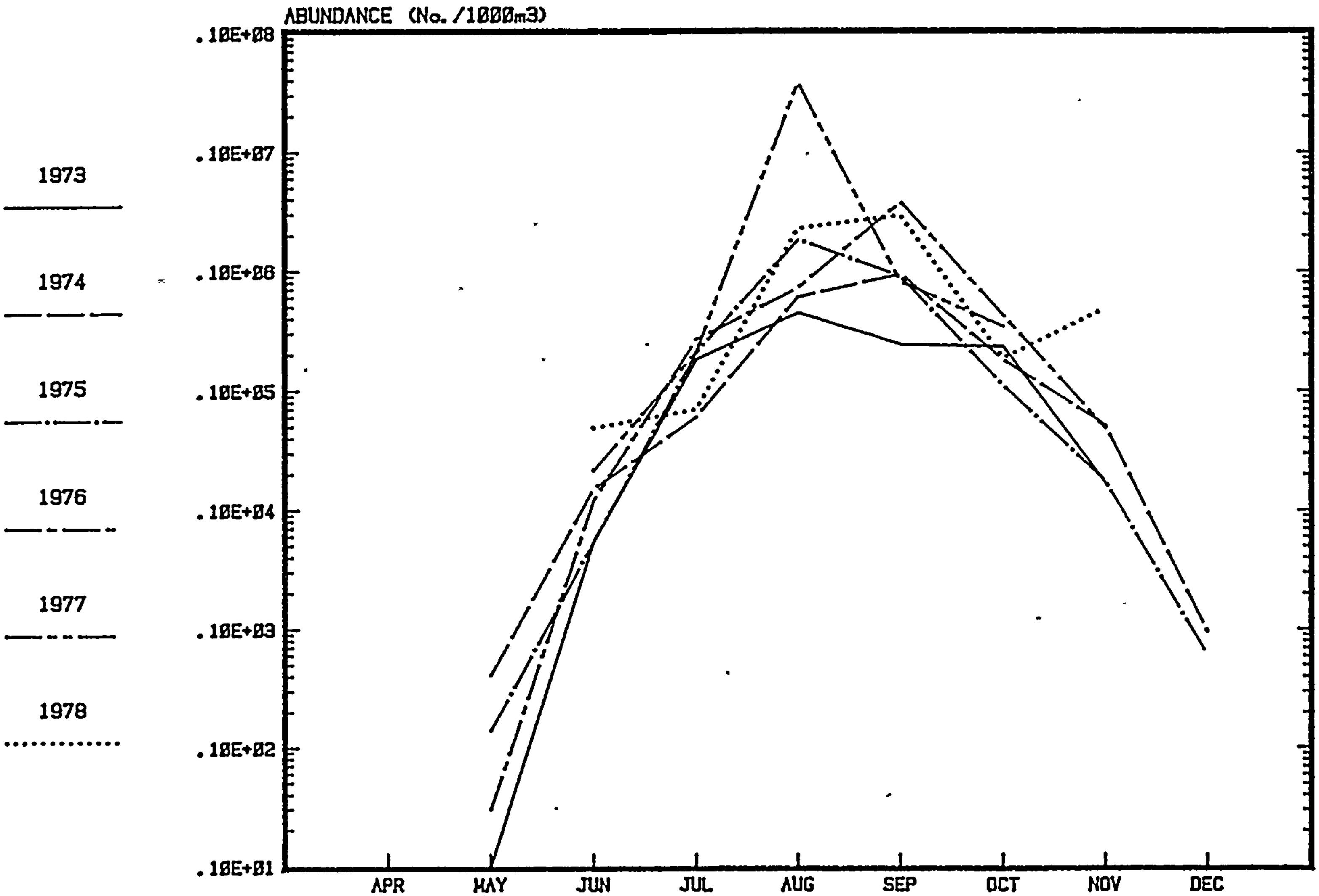
G. fasciatus is a widely distributed species of freshwater amphipod ranging from the Mississippi River to the Atlantic coast and from the Great Lakes/St. Lawrence River to the northeastern shores of the Gulf of Mexico. Although this amphipod is primarily epibenthic and prefers areas of vegetation, it is a relatively strong swimmer capable of active movement in the water column[24]. G. fasciatus is omnivorous and consumes nonliving and living plant and animal matter. Specific food limitation is therefore unlikely to be a problem for this species.

Reproduction is sexual and occurs from spring through fall; a variable number of individual broods are produced by each mature female. Individual growth and reproduction rates increase with temperature, but size at maturity and brood size (which is directly related to the size of the female) decrease concomitantly.

FIGURE 2.1.3-1

SEASONAL SUCCESSION OF LEPTODORA KINDTII

Nine Mile Point Vicinity - 1973-1978



In the Nine Mile Point vicinity of Lake Ontario, *G. fasciatus* was consistently more abundant at night than during the day; diurnal differences were statistically significant when tested [10,11]. Abundance increased with depth in the water column; increases were statistically significant for some transects. These two findings indicate that near-bottom and epibenthic populations migrate vertically at night. *G. fasciatus* densities tended to increase from west to east in the study area and from offshore to nearshore.

The east/west trend was probably the result of natural differences in sediment type: the relatively unconsolidated sediments toward the western end of the study area support higher densities of epibenthic *Gammarus* than the stones and cobbles of the western and central portions.

Seasonally, *Gammarus* were recorded from April to December, with peak daylight concentrations during July or August. However, concentrations in the water column varied considerably beween months and depth contours, reflecting the primarily epibenthic nature of this species and its preference for near-bottom waters during the day.

Aquatic dipterans represent the larval and pupal forms of flies and gnats. As indicated earlier (Table 2.1.3-1), the dipteran group is highly diverse: more genera were identified than in any other taxonomic group. In general, aquatic dipterans are most abundant during the warmer months of the year. Dipterans are consumed by fish; as predators, they consume other zooplankton.

Dipteran abundance was significantly greater at night than during the day and in mid-depth and bottom waters than in surface waters[10,11]. Concentrations also decreased significantly as

water depth (distance from shore) increased. As observed for Gammarus, dipterans were generally more abundant toward the eastern end of the study area.

Seasonal patterns of dipteran abundance were variable among both years and depth contours. In general, the pattern was unimodal, with maxima during April, May, June, July, August, or September, and copepods and amphipods contributing substantial numbers during early spring and late summer/fall, respectively.

On a long-term basis (1973 through 1978), Gammarus and dipteran concentrations in the water column consistently decreased from year to year at all depth contours; by 1977 Gammarus had essentially disappeared from the water column during the day (Figure 2.1.3-2). However, Gammarus abundance in benthic collections showed no consistent changes during the same time period (Section 2.1.5). Concentrations of Leptodora consistently increased as Gammarus declined.

The increase in Leptodora concentrations possibly reflects a reduction in grazing pressure caused by locally reduced fish stocks (see Section 2.1.6). Possibly, local environmental changes were selective against Gammarus, but benthic data show no consistent reductions in Gammarus abundance. With reference to overall abundance of macrozooplankton, these data do not support any consistent, long-term changes attributable to power plant operation.

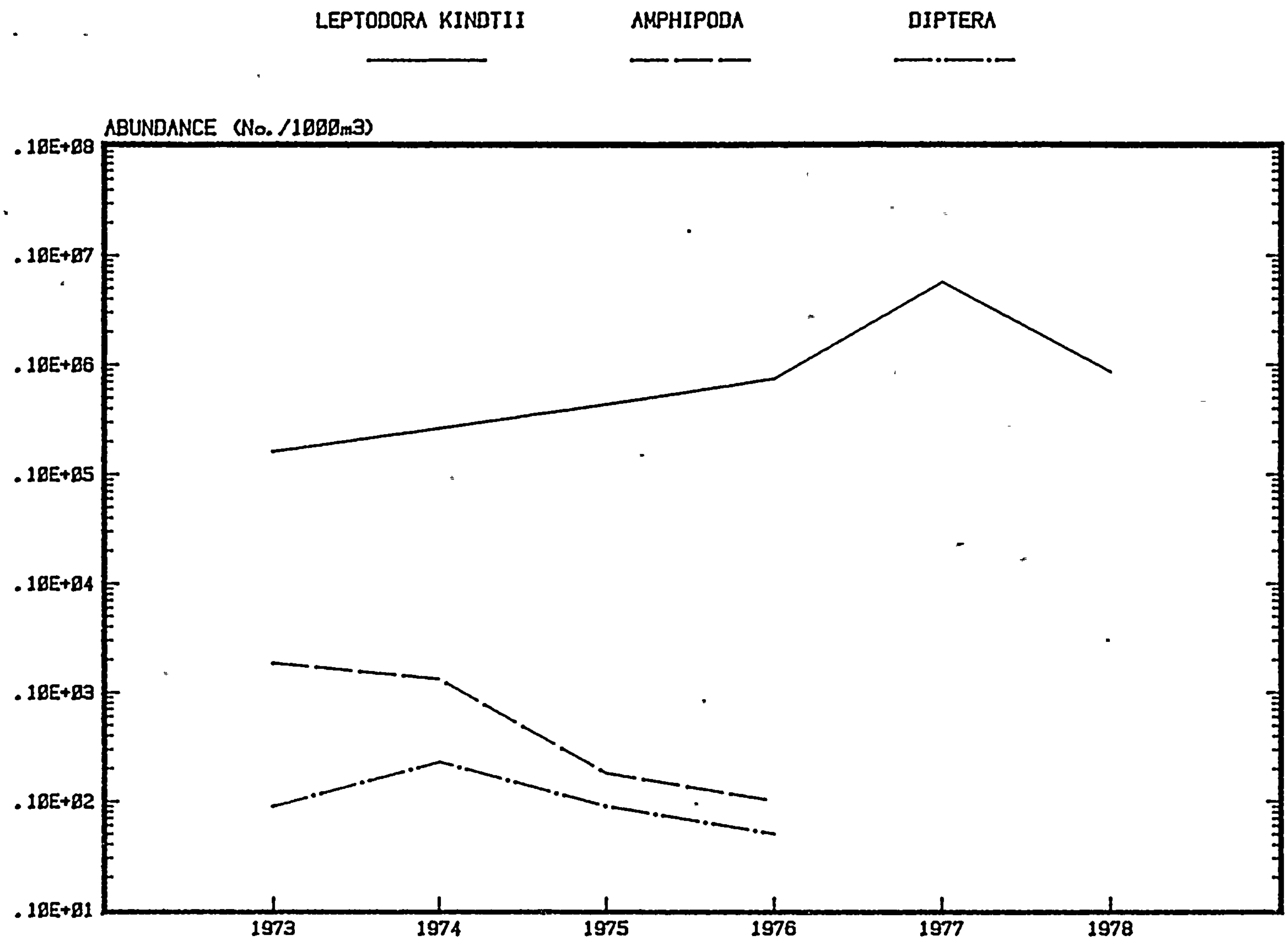
2.1.4 Ichthyoplankton

Ichthyoplankton are the vertebrate portion of the macrozooplankton collection, and include eggs, larvae, and juvenile fish. Fish larvae and juveniles feed primarily on small invertebrates and algae. Thus, the availability of these food items at this critical

FIGURE [illegible].3-2

MEAN OF SELECTED MACROZOOPLANKTON

Nine Mile Point Vicinity - 1973-1978



Mean of samples from May through November.

life stage is an important factor in fish recruitment. Consequently, ichthyoplankton abundance can affect both planktonic and benthic communities. In turn, ichthyoplankton are preyed upon by larger carnivores.

The species composition and spatial/temporal distribution of ichthyoplankton in the Nine Mile Point area were investigated from 1973 to 1978. A total of 31 species of ichthyoplankton (eggs and/or larvae) were identified (Table 2.1.4-1). Eleven, including the bluegill, smallmouth bass, white bass, and walleye, were rarely recorded in the study area. Eleven of the 31 species were present during at least five of the six years studied. The dominant species in the area throughout the study period were alewife, rainbow smelt, and, to a lesser degree, threespine stickleback and yellow perch.

Alewife spawning takes place after adults migrate from deep water to gravelly or sandy shallow areas; in Lake Ontario, the inshore migration begins sometime in April. Spawning takes place primarily at night, and adults then immediately leave inshore waters[25]. Broadcast at random, the eggs are demersal and essentially nonadhesive. Hatching takes place in three to six days at water temperatures of between approximately 16 and 22°C; development proceeds rapidly thereafter[25]. Studies in Lake Michigan indicate that the first feeding of alewife larvae occurs when individuals are approximately 6 mm in length; the diet is primarily copepods (Diacyclops), with greater percentages of cladocerans and rotifers consumed as length increases[26].

The rainbow smelt migrate inshore to spawn in streams or near the lake's shore; evidence exists that some offshore spawning takes place over gravel shoals. Spawning, which occurs primarily at night, has been reported at water temperatures of approximately 9-18°C; peak spawning activity seldom persists for more than a

TABLE 2.1.4-1

SPECIES INVENTORY OF ICHTHYOPLANKTON
NINE MILE POINT VICINITY - 1973-1978

Family	Common Name	Scientific Name	1973	1974	1975	1976	1977	1978
Catostomidae	White sucker	Catostomus commersoni	X				X	
Centrarchidae	Bluegill	Lepomis macrochirus			X			X
	Pumpkinseed	Lepomis gibbosus	X	X				
	Smallmouth Bass	Micropterus dolomieui		X				
	UID Sunfish	Lepomis sp.	X			X	X	X
	-	UID Centrarchidae			X			
Clupeidae	Alewife	Alosa pseudoharengus	X	X	X	X	X	X
	Gizzard shad	Dorosoma cepedianum		X[a]	X[a]	X[a]	X	X
	Tessellated darter	Etheostoma olmstedi						X
	UID Herring	Clupeidae					X	X
Cottidae	Mottled sculpin	Cottus bairdi	X	X	X	X		
	UID Sculpin	Cottidae					X	X
Cyprinidae	Bluntnose minnow	Pimephales notatus			X			
	Carp	Cyprinus carpio	X	X	X	X	X	X
	Common shiner	Notropis cornutus	X	X	X[a]			
	Emerald shiner	Notropis atherinoides	X		X	X	X	
	Fathead minnow	Pimephales promelas			X			
	Goldfish	Carassius auratus	X	X			X	X
	Spottail shiner	Notropis hudsonius	X		X			X
	UID Shiner	Notropis sp.	X	X	X	X		
	-	UID Cyprinidae			X	X	X	X
Gadidae	Burbot	Lota lota		X	X	X	X	X
Gasterosteidae	Threespined stickleback	Gasterosteus aculeatus	X		X	X	X	X
Osmeridae	Rainbow smelt	Osmerus mordax	X	X	X	X	X	X
Percichthyidae	White bass	Morone chrysops	X					
	White perch	Morone americana	X	X	X	X	X	X
	-	Morone sp.					X	X
Percidae	-	Etheostoma sp.			X			
	Johnny darter	Etheostoma nigrum	X	X	X	X	X	
	Logperch	Percina caprodes	X				X	
	Yellow perch	Perca flavescens	X	X	X	X	X	X
	Walleye	Stizostedion vitreum		X[a]			X	
Percopsidae	Trout-perch	Perocopsis omiscomaycus		X	X	X	X	X
Salmonidae	Cisco/Lake herring	Coregonus artedii		X	X	X	X	X
		Coregonus sp.			X			
Sciaenidae	Freshwater drum	Aplodinotus grunniens					X	X

[a]Identified from eggs only

week. Eggs are demersal, adhesive, and hatch in two to three weeks, after which growth is fairly rapid[25].

Unlike the carnivorous adults, rainbow smelt larvae are omnivorous. According to studies in Minnesota lakes, first feeding may occur prior to yolk-sac absorption when the diet is composed of copepod nauplii, cyclopoid copepods, and diatoms. In addition, post-larvae consume green algae and add larger items to their diet - such as calanoid copepods and cladocerans - as their size increases[27].

Both the threespine stickleback and yellow perch prefer shallow waters. The latter spawns during spring, usually near rooted aquatic vegetation to which the egg masses can adhere. The stickleback spawns later in shallow water, preferably over a sandy bottom. A nest builder, this species guards newly hatched fish until they can take care of themselves [25].

The seasonal pattern of ichthyoplankton involved the succession of three groups of species: the early spring group composed of burbot (Lota lota) and Coregonus sp.; the spring group dominated by rainbow smelt (Osmerus mordax); and the late spring/summer group dominated by alewife. Peak concentrations of eggs and larve coincided with the occurrence of the late spring/summer group and consisted primarily of alewife larvae [17-22].

Analyses of selected dominant taxa (alewife and rainbow smelt) indicated that alewife eggs were most abundant in bottom samples collected from nearshore waters at night. Rainbow smelt eggs were rarely collected in the study area and occurred primarily in surface waters [17-22].

The larvae of rainbow smelt and alewife, predominantly post-yolk-sac phase, were more abundant at night than during the day. Alewife

larvae were more abundant in surface waters; rainbow smelt larvae were more abundant in mid-depth and bottom waters. There was no consistent east/west pattern in the distribution of alewife or rainbow smelt larvae [17-22].

Spatial variability for both the alewife and the rainbow smelt was minimal between the 6-m, 12-m, and offshore contours (Figures 2.1.4-1 and 2.1.4-2). Seasonal distribution of alewife and smelt remained similar in each of the six years, with peak abundances in June and July, respectively.

The yearly mean larval concentration reported in the NMP vicinity from May through November increased throughout the study period (Figure 2.1.4-3). Except for a slight decrease in smelt larval abundance in 1975, both the alewife and smelt larvae showed increasing abundances from 1974 through 1978 [17-22]. Thus, based on the maintenance of a diverse species inventory and an increasing stock of the two dominant larval species, the operation of the generating stations has no observable impact on the ichthyoplankton community.

2.1.5 Benthic Organisms

Periphyton and invertebrate populations inhabit the Lake Ontario bottom, residing either on (epifaunal/epifloral) or within (infaunal) the substratum. These populations include producers as well as primary and secondary consumers in the Lake Ontario food web, and in turn become food for higher trophic levels. As prey for the higher trophic levels, they provide essential support for the fish populations of the lake. Consequently, data on macrobenthos are useful to indicate general lake conditions.

In Lake Ontario, seasonal environmental changes influence the deposition of bottom sediments. This in turn affects the spatial

FIGURE 2.1.4-1

MONTHLY MEAN ABUNDANCE OF ALEWIFE

Nine Mile Point Vicinity - 1974-1978

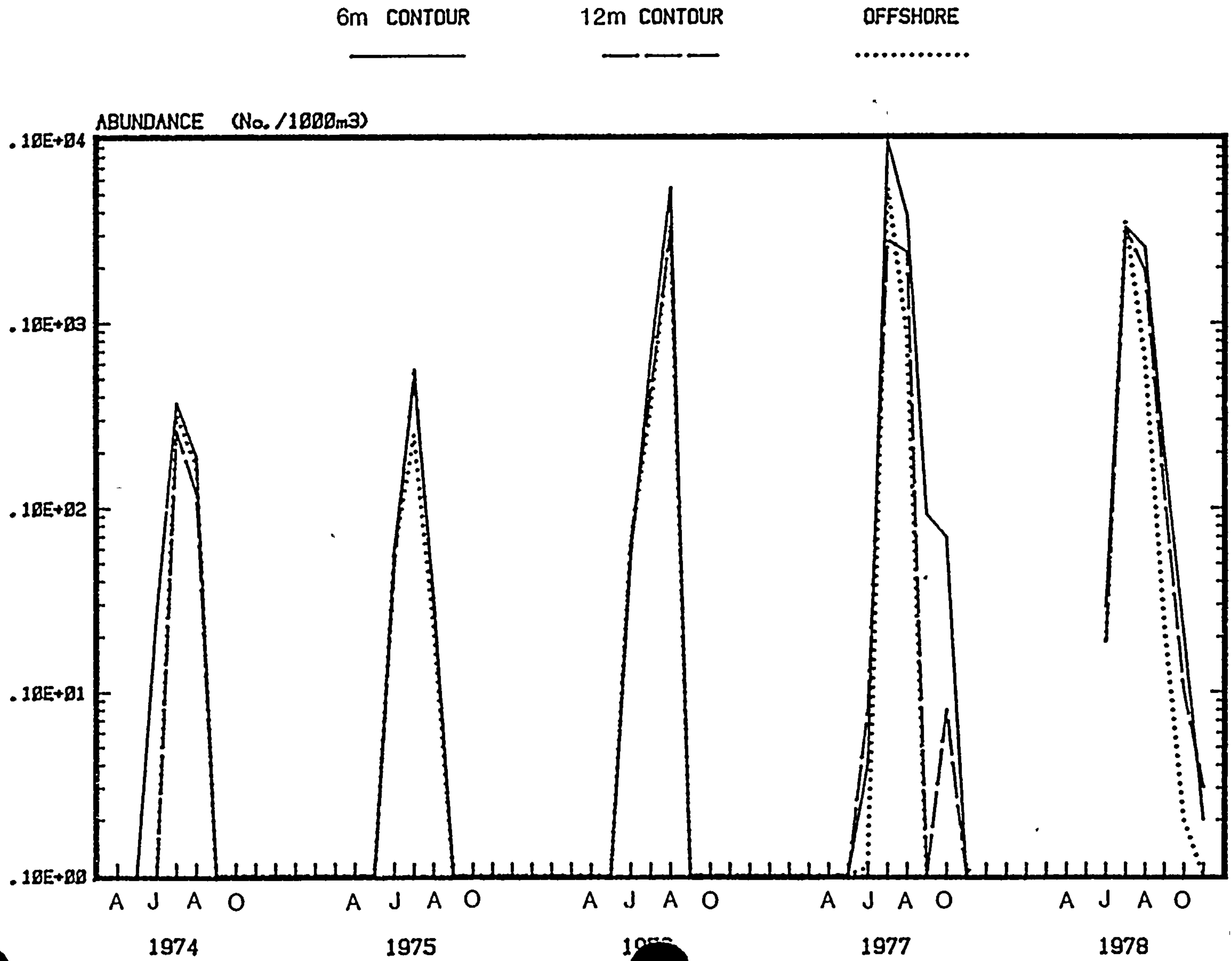


FIGURE 2.1.4-2

MONTHLY MEAN ABUNDANCE OF RAINBOW SMELT

Nine Mile Point Vicinity - 1974-1978

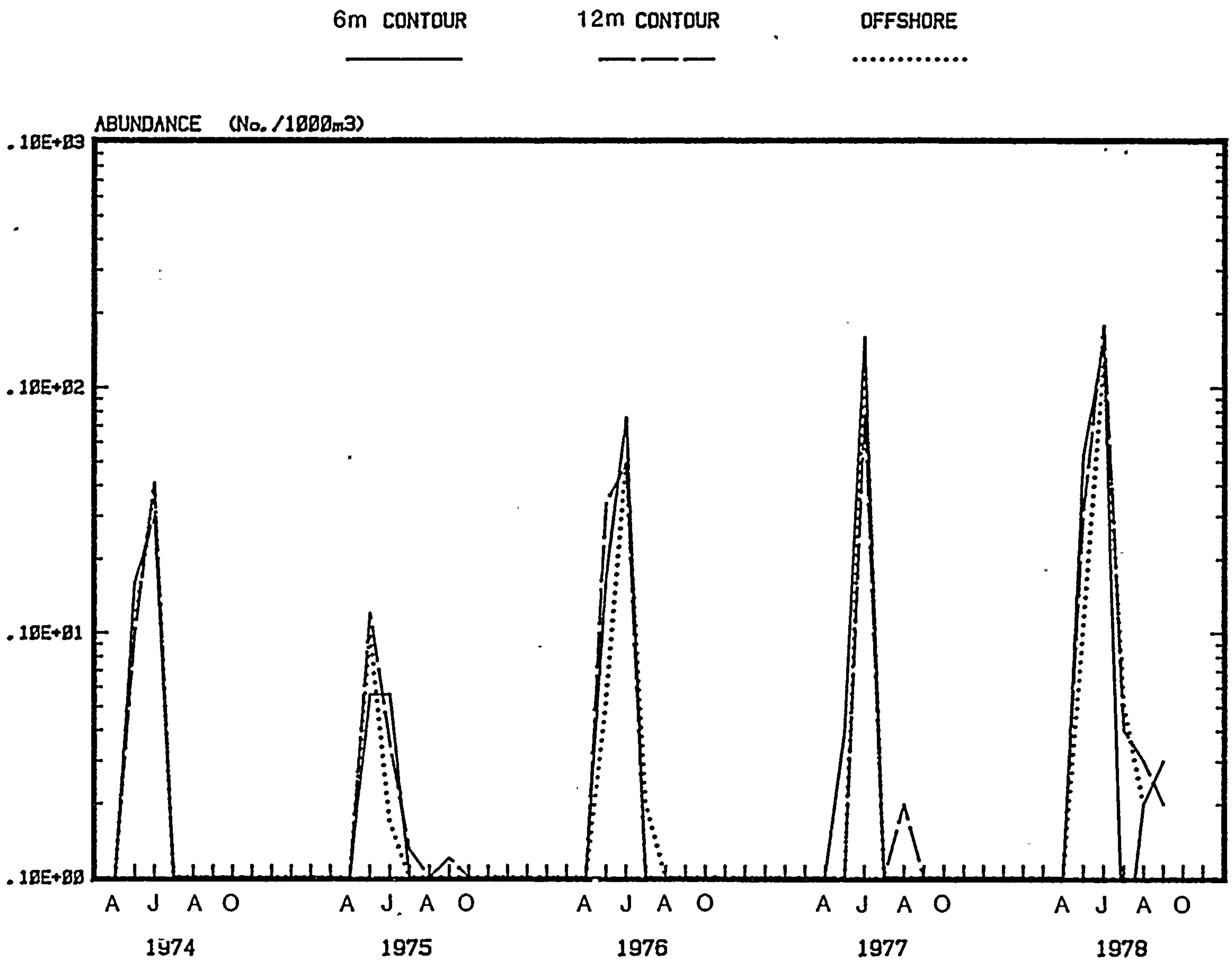
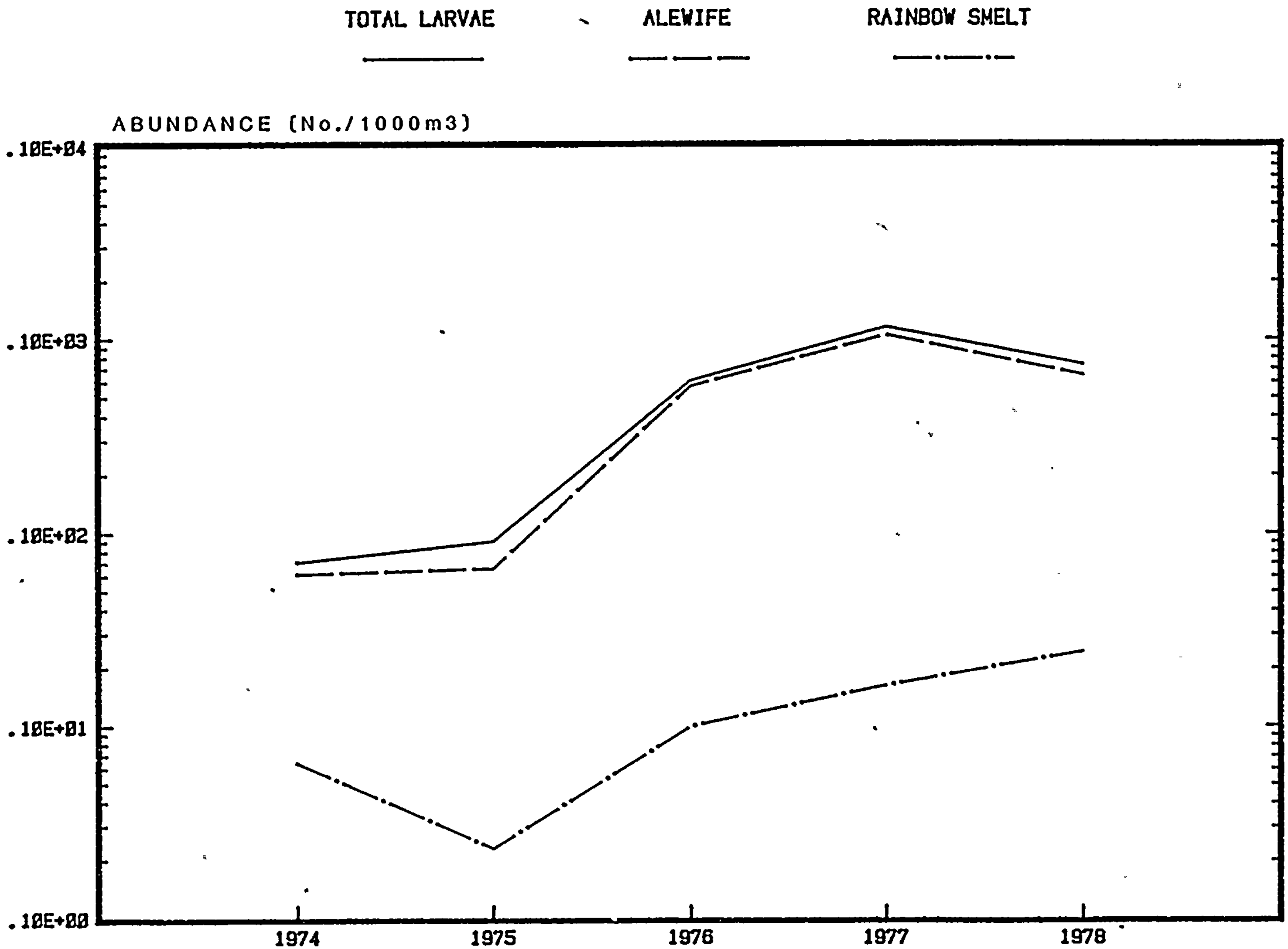


FIGURE 2.1.4-3

MEAN ABUNDANCE OF SELECTED ICHTHYOPLANKTON

Nine Mile Point Vicinity - 1974-1978



Mean of samples from through November.

distribution of infaunal and epifaunal organisms that have specific substrate requirements for burrowing or feeding activities. Literature has also shown that distribution of macrobenthos will occur according to substrate composition[28,29]. The bottom in the study area is characteristically bedrock with varying amounts of rubble and sand and silt. Sand and silt typically represented less than 10% of the bottom substrate of the NMPW and NMPP transects while it often represented 80-90% of the substrate at the NMPE and FITZ transects[22].

A cumulative macroinvertebrate species inventory for the period 1973 to 1978 (Table 2.1.5-1) showed the large diversity of benthic invertebrates. The greatest diversity (largest number of genera) was among the oligochaete worms and dipteran larvae. The studies do not indicate a decrease in benthic taxa over the six-year period.

The major taxa identified throughout the studies were Amphipoda, Platyhelminthes, Nematoda, Gastropoda, Pelecypoda, Diptera, Polychaeta, and Oligochaeta. Some taxa were represented by numerous genera (Diptera, with 44 genera), while others were represented by a limited number (Polychaeta, with a single genus). Although the number of genera differed widely between the taxa Diptera and Polychaeta, total abundances (No./m^2) over the duration of the study were similar.

The amphipoda identified in the samples were predominantly of the two genera Gammarus sp. and Pontoporeia sp. Gammarus sp. typically occupied the shallow depth contours, while Pontoporeia sp. increased in density with depth[20]. As previously mentioned, the Polychaeta were represented by a single genus, Manayunkia sp., which seemed to prefer the shallow water stations along the 3, 6, and 9-m (10, 20, and 30-ft) depth contours[20]. Oligochaeta abundances were dominated by Stylodrilus sp. and Nais sp. in shallow

TABLE 2.1.5-1

OCCURRENCE OF MACROINVERTEBRATES
IN BENTHIC COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

Taxon

COELENTERATA
- Hydrozoa
  - [a]*Cordylophora* sp.
  - *Hydra* sp.

RHYNCHOCOELA

PLATYHELMINTHES
- [a]Turbellaria

NEMERTEA
- *Prostoma* sp.
- *Nemertea* sp.

ASCHELMINTHES
- [a]Nematoda
  - Chromadoroidea
    - *Anonchus* sp.
  - Enoplida
    - *Alaimus* sp.
  - Dorylaimida
    - Dorylaimidae
      - *Dorylaimus* sp.
  - Rhabditida
    - Rhabditidae
      - *Butlerius* sp.
  - Bastianiidae

MOLLUSCA
- Gastropoda
  - Valvatidae
    - [a]*Valvata* sp.
  - Bulimidae
    - [a]*Amnicola* sp.
    - *Bithinia* sp.
  - Pleuroceridae
    - [a]*Goniobasis* sp.
    - *Pleurocera* sp.
  - Physidae
    - [a]*Physa* sp.
  - Lyminaeidae
    - [a]*Lymnaea* sp.
  - Planorbidae
    - [a]*Gyraulus* sp.
    - [a]*Helisoma* sp.
    - *Campeloma* sp.
  - Ancylidae
    - [a]*Ferrissia* sp.
    - *Laevaplex* sp.
- Bivalvia (Pelecypoda)
  - Margaritifaridae
    - *Adadonta* sp.
  - Unionidae
    - *Ellipto* sp.
    - *Lampsilis* sp.
  - Sphaeriidae
    - *Musculium* sp.
    - [a]*Pisidium* sp.
    - [a]*Sphaerium* sp.

ANNELIDA
- Polychaeta
  - Sabellidae
    - [a]*Manayunkia* sp.
- Oligochaeta
  - Lumbriculidae
    - *Stylodrilus* sp.
  - [a]Tubificidae
    - *Aulodrilus* sp.
    - *Ilyodrilus* sp.
    - *Limnodrilus* sp.
    - *Peloscolex* sp.
    - *Potamothrix* sp.
    - *Tubifex* sp.
  - Enchytraeidae
  - [a]Naididae
    - *Arcteonais* sp.
    - *Chaetogaster* sp.

TABLE 2.1.5-1 (Cont)

Taxon

Nais sp.
Ophidonais sp.
Paranais sp.
Piguetiella sp.
Pristina sp.
Specaria sp.
Stylaria sp.
Uncinais sp.
Vejdovskyella sp.
Hirudinea
Glossiphoniidae
Helobdella sp.
Piscicolidae
Piscicola sp.

ARTHROPODA
Acari (Hydracarina)
Limnesiidae
Limnesia sp.
Hygrobatidae
Hygrobates sp.
Unionicolidae
Huitfeldtia sp.
Koenikia sp.
Neumania sp.
Unionicola spp.
Pionidae
Forelia sp.
Piona sp.
Lebertiidae
Lebertia sp.
Torrenticolidae
Torrenticola spp.

INSECTA
[a]Ephemeroptera
Caenis sp.
Heptageniidae
Stenonema sp.
Baetidae
Hemiptera
[a]Trichoptera
Psychomyiidae
[a]Hydroptilidae

Taxon

Agraylea sp.
Leptoceridae
[a]*Arthriposodes* sp.
Leptocerus sp.
Oecetis sp.
Hydropsychidae
Hydropsyche sp.
Cheumatopsyche sp.
Diptera
Tendipedidae
Ablabesmyia sp.
Calopsectra sp.
[a]*Chironomus* sp.
Cladotanytarsus sp.
Coelotanypus sp.
[a]*Cricotopus* sp.
[a]*Cryptochironomus* sp.
Cryptocladopelma sp.
Demircryptochironomus sp.
[a]*Dicrotendipes* sp.
Endochironomus sp.
Eukiefferella sp.
Glyptotendipes sp.
[a]*Heterotrissocladius* sp.
Hydrobaenus sp.
Kiefferules sp.
[a]*Micropsectra* sp.
[a]*Microtendipes* sp.
Nannocladius sp.
Orthocladius sp.
Parachironomus sp.
Paracladopeltma sp.
Paralauterborniella sp.
Paratendipes sp.
Pentaneura sp.
[a]*Phaenopsectra* sp.
[a]*Polypedilum* sp.
Potthastia sp.
[a]*Procladius* sp.
Psectrocladius sp.
Pseudochironomus sp.
Rheotanytarsus sp.
[a]*Stictochironomus* sp.
Tanypus sp.

TABLE 2.1.5-1 (Cont)

Taxon
Trissocladius sp.
Xenochironomus sp.
Einfeldia sp.
Tanytarsus sp.
Paratanytarsus sp.
Trichocladius sp.
Anatopynis sp.
Cardiocladius sp.
Harnischia sp.
Ceratopogonidae
Empididae
Stratiomyidea
Chironomidae
Leidoptera
Neuroptera
Sisyridae
Climacia sp.
Crustacea
Isopoda
Asellidae
Erichsonella sp.
Asellus sp.
Amphipoda
Gammaridae
Crangonyx sp.

[a]Taxon which occurred each year from 1973-1978.

waters and Limnodrilus sp. and Potamothrix sp. in deep waters[18-20]. Johnson and Matheson[31] and Thut[32] described a similar distribution in their studies.

Gastrodopa distribution was also related to depth. Goniobasis sp. and Physa sp. showed a preference for shallow depths, while the genus Valvata sp. exhibited higher abundances at greater depths. Amnicola sp. appeared slightly more ubiquitous in its distribution across all depths[18-20]. Pelecypoda distribution has been related to specific substrate requirements[20]. In general, greater abundances of Pisidium sp. and Sphaerium sp. were found further offshore, associated with localized areas of available sand or silt.

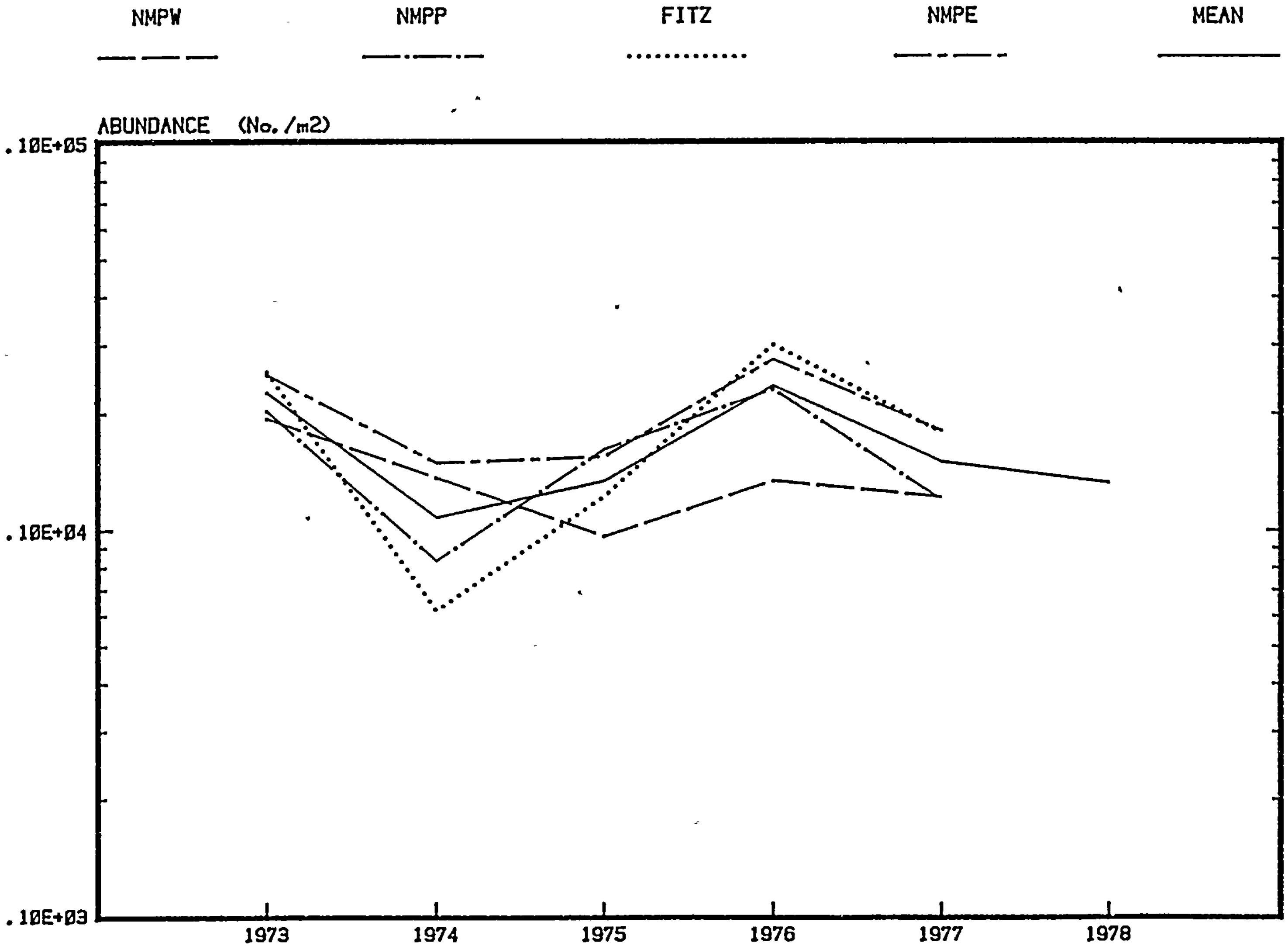
Spatial variability between transects differed by taxon. Amphipoda and Platyhelminthes abundances (Figures 2.1.5-1 and 2.1.5-2) were similar for each transect each year, while Nematoda (Figure 2.1.5-3), Gastropoda (Figure 2.1.5-4), and Pelecypoda (Figure 2.1.5-5) abundances were consistently highest and lowest at the NMPE and NMPP transects, respectively. Diptera (Figure 2.1.5-6), Polychaeta (Figure 2.1.5-7), and Oligochaeta (Figure 2.1.5-8) showed variable spatial distribution over the six-year study. The increased abundances, particularly of Nematoda, Gastropoda, and Pelecypoda, at the easternmost transect (NMPE), probably relate to the predominantly soft substrate, which is more suitable than the hard substrate characteristic of the NMPP transect for supporting the infaunal forms[22] These benthic dynamics indicate viable and persistent communities, with no trend toward anomalous declines or increases in densities.

Seasonally, benthos abundances peaked generally in the summer period (June or August collections), but occasionally in the spring. This

FIGURE 2.1.5-1

MEAN ABUNDANCE OF AMPHIPODA

Nine Mile Point Vicinity - 1973-1978

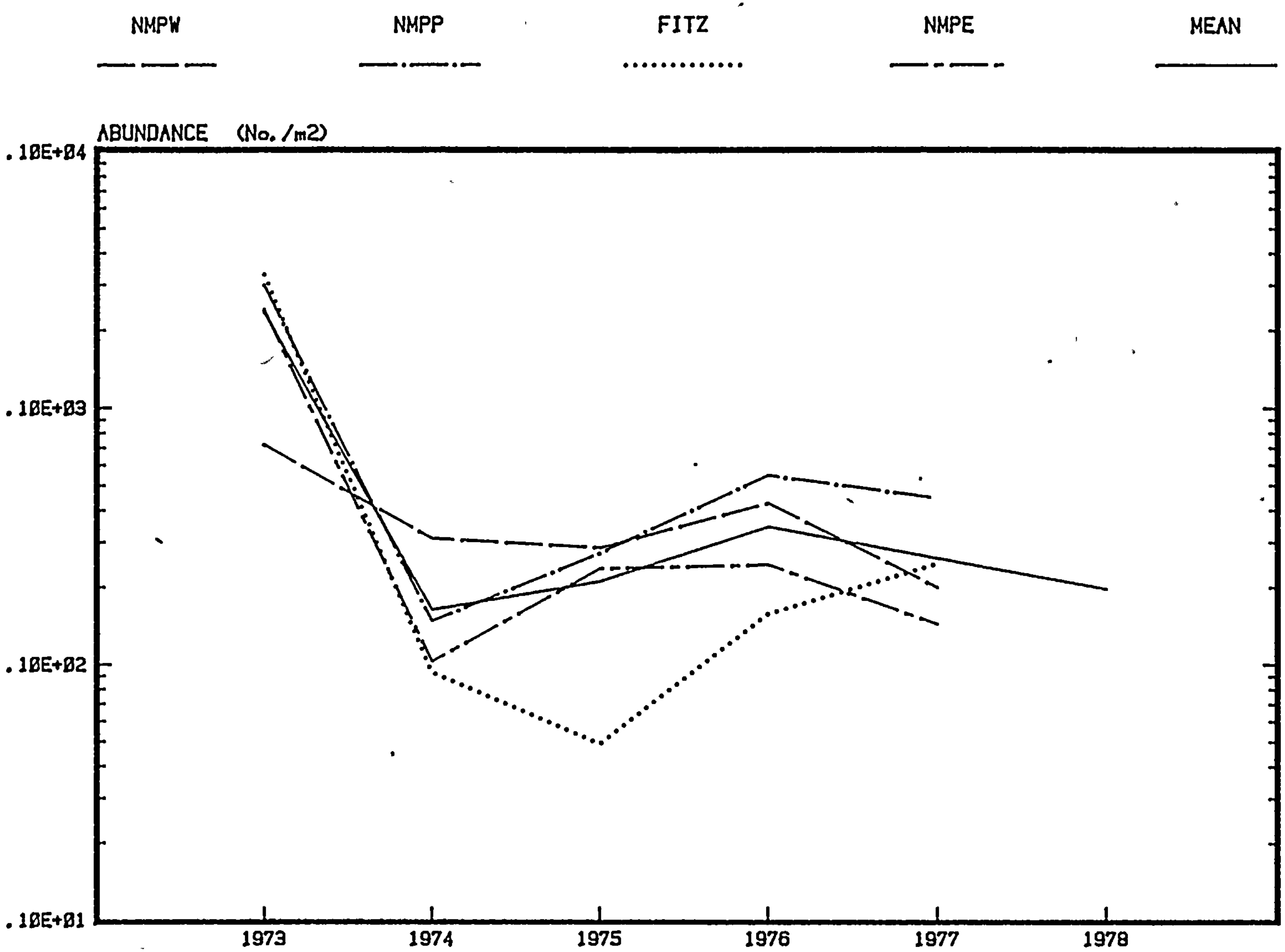


Mean of Jun. Aug. and Oct s s: mean of all contours.

FIGURE 2.1.5-2

MEAN ABUNDANCE OF PLATYHELMINTHES

Nine Mile Point Vicinity - 1973-1978

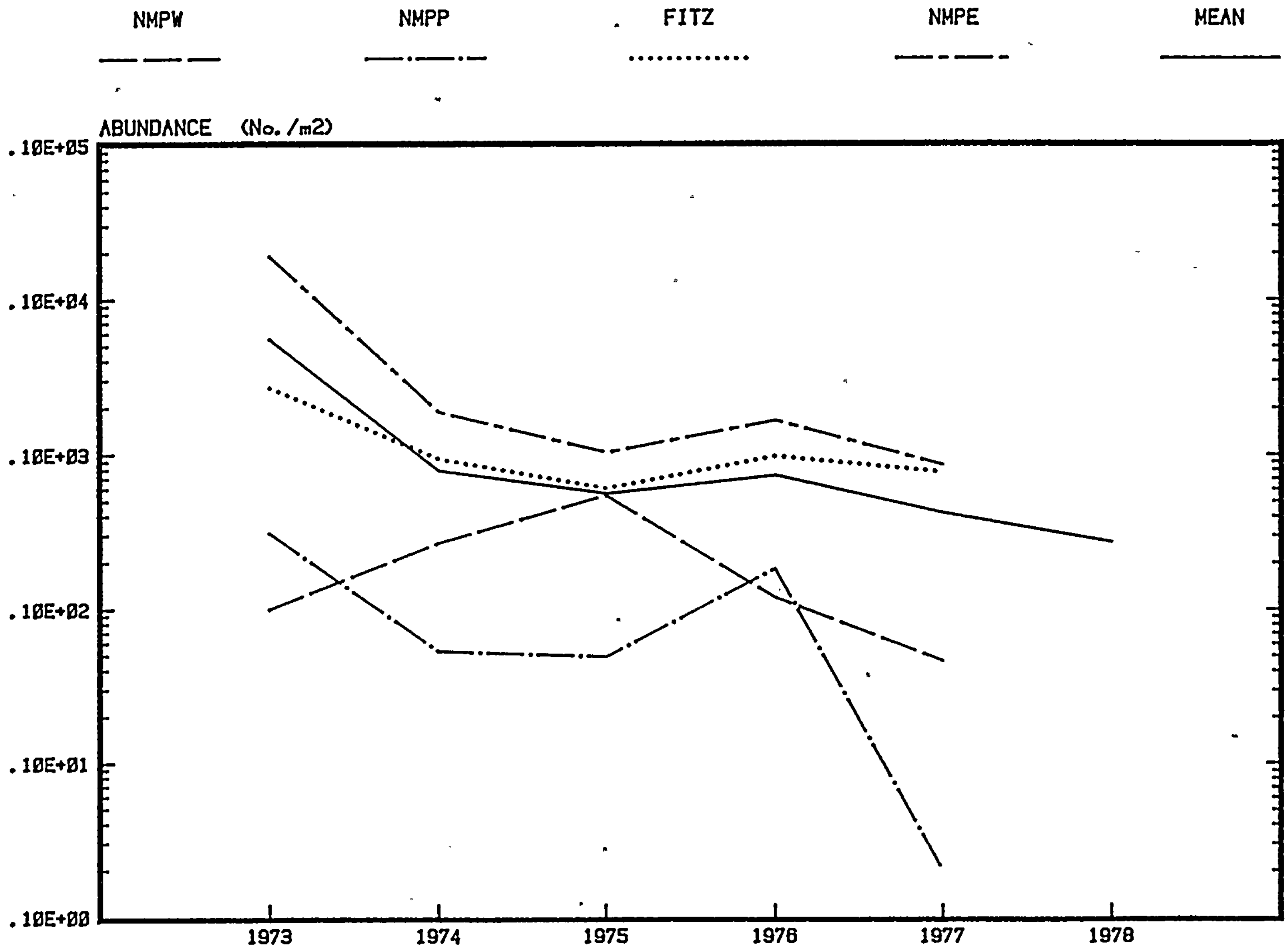


Mean of Jun, Aug, and Oct samples; mean of all contours.

FIGURE 2.1.5-3

MEAN ABUNDANCE OF NEMATODA

Nine Mile Point Vicinity - 1973-1978

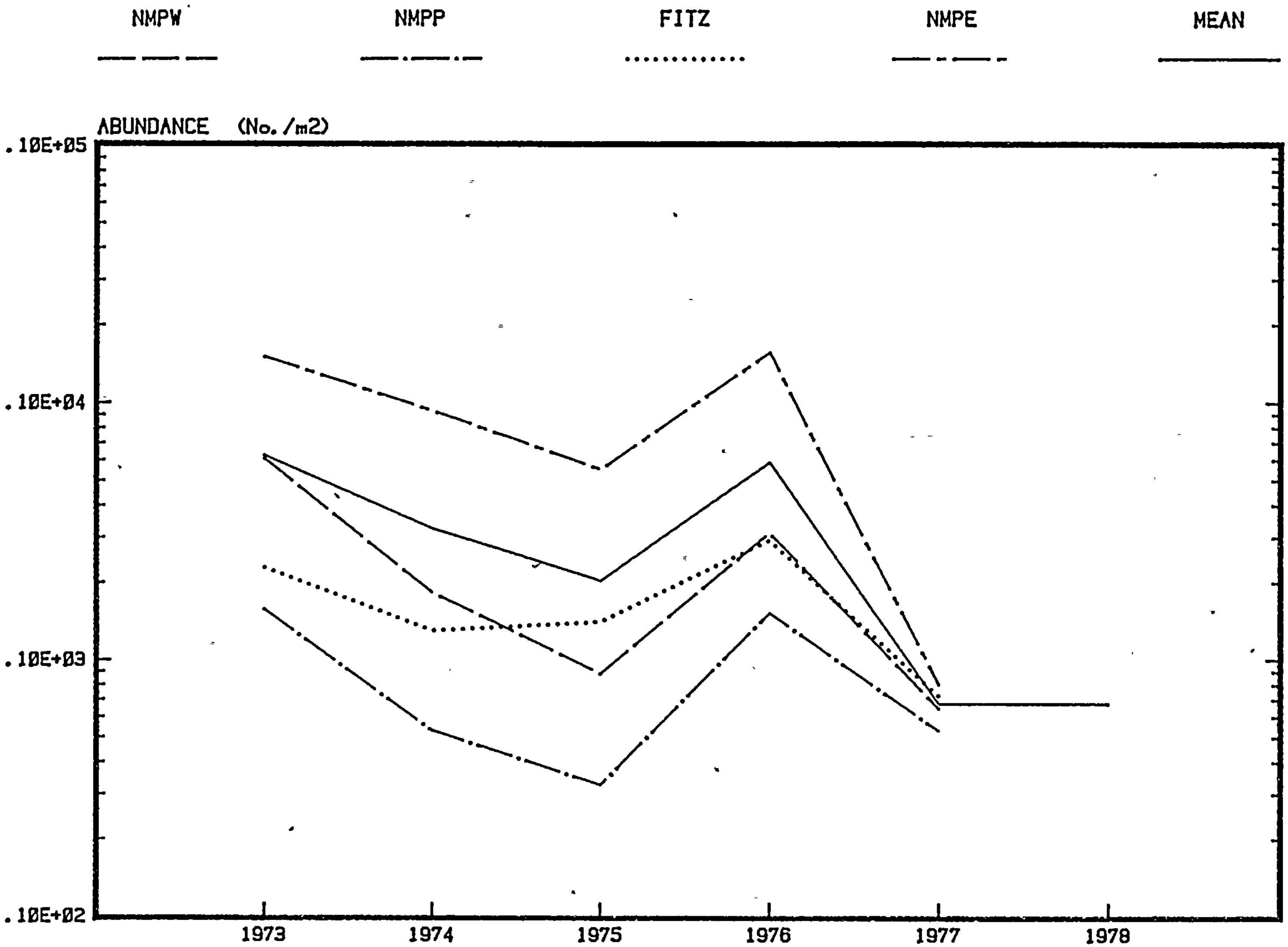


Mean of Jun, Aug, and Oct s[illegible]s; mean of all contours.

FIGURE 2.1.5-4

MEAN ABUNDANCE OF GASTROPODA

Nine Mile Point Vicinity - 1973-1978

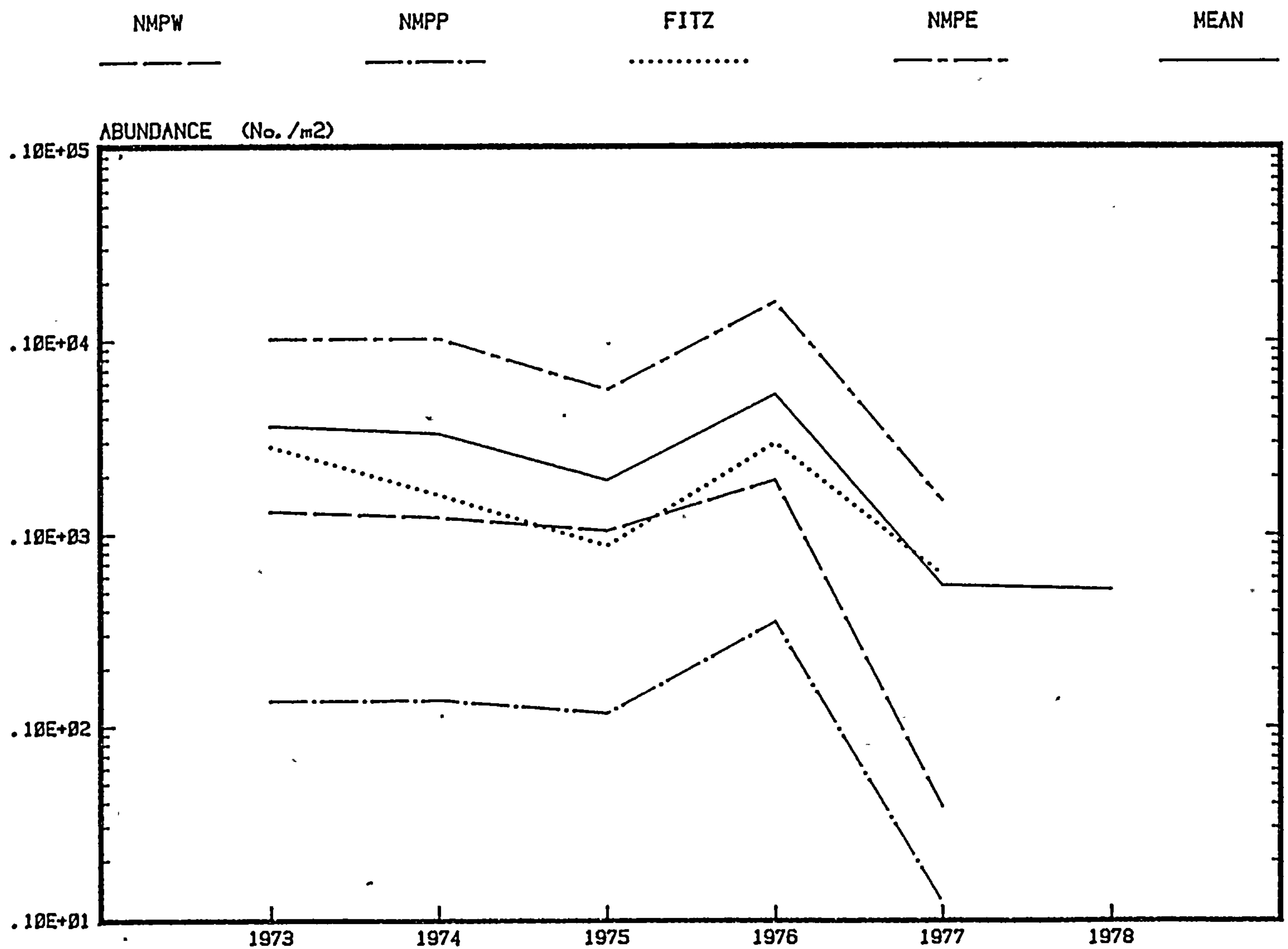


Mean of Jun. Aug. and Oct samples; mean of all contours.

FIGURE 2.1.5-5

MEAN ABUNDANCE OF PELECYPODA

Nine Mile Point Vicinity - 1973-1978

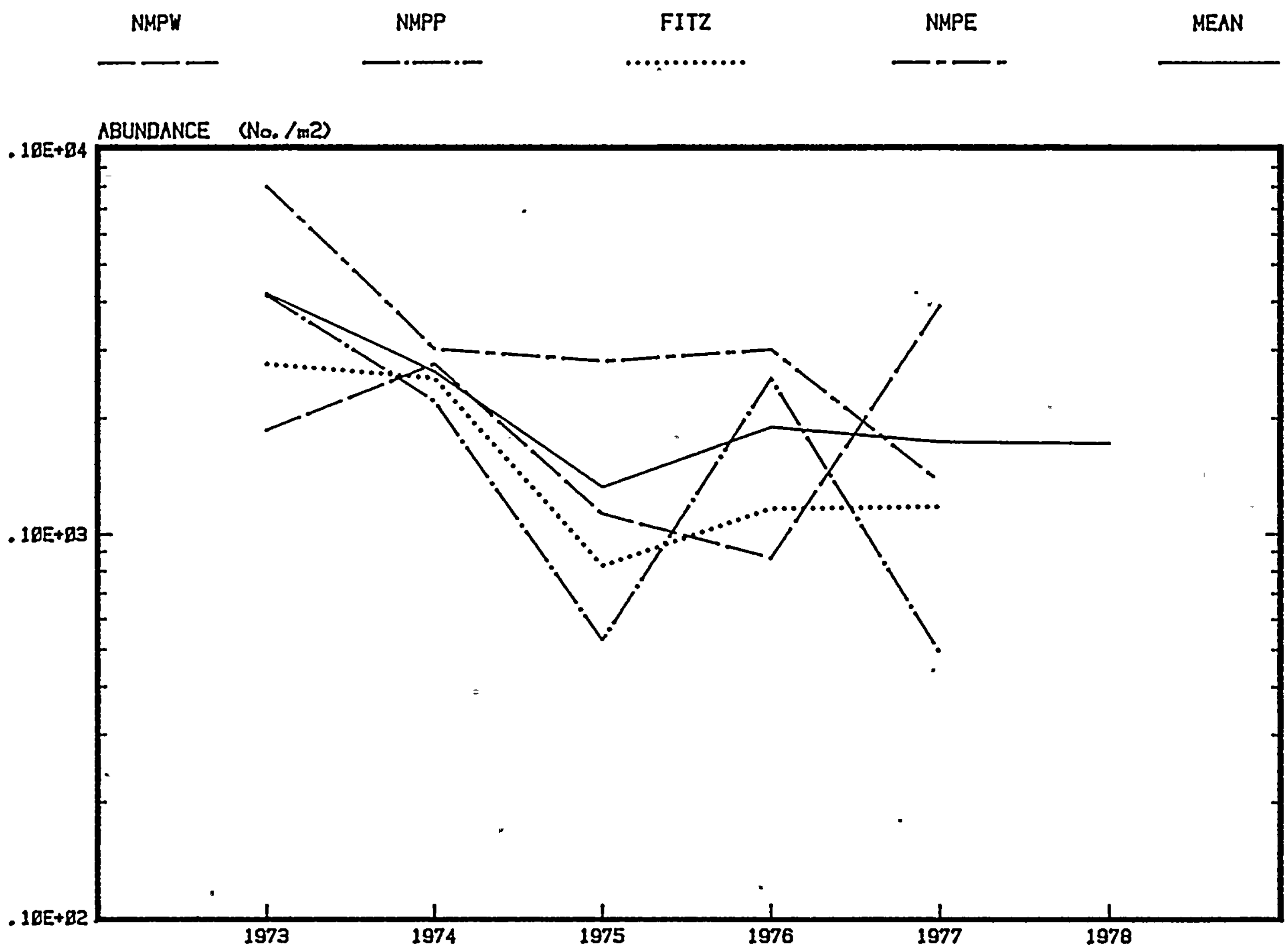


Mean of Jun. Aug. and Oct a[illegible]es; mean of all contours.

FIGURE 2.1.5-6

MEAN ABUNDANCE OF DIPTERA

Nine Mile Point Vicinity - 1973-1978

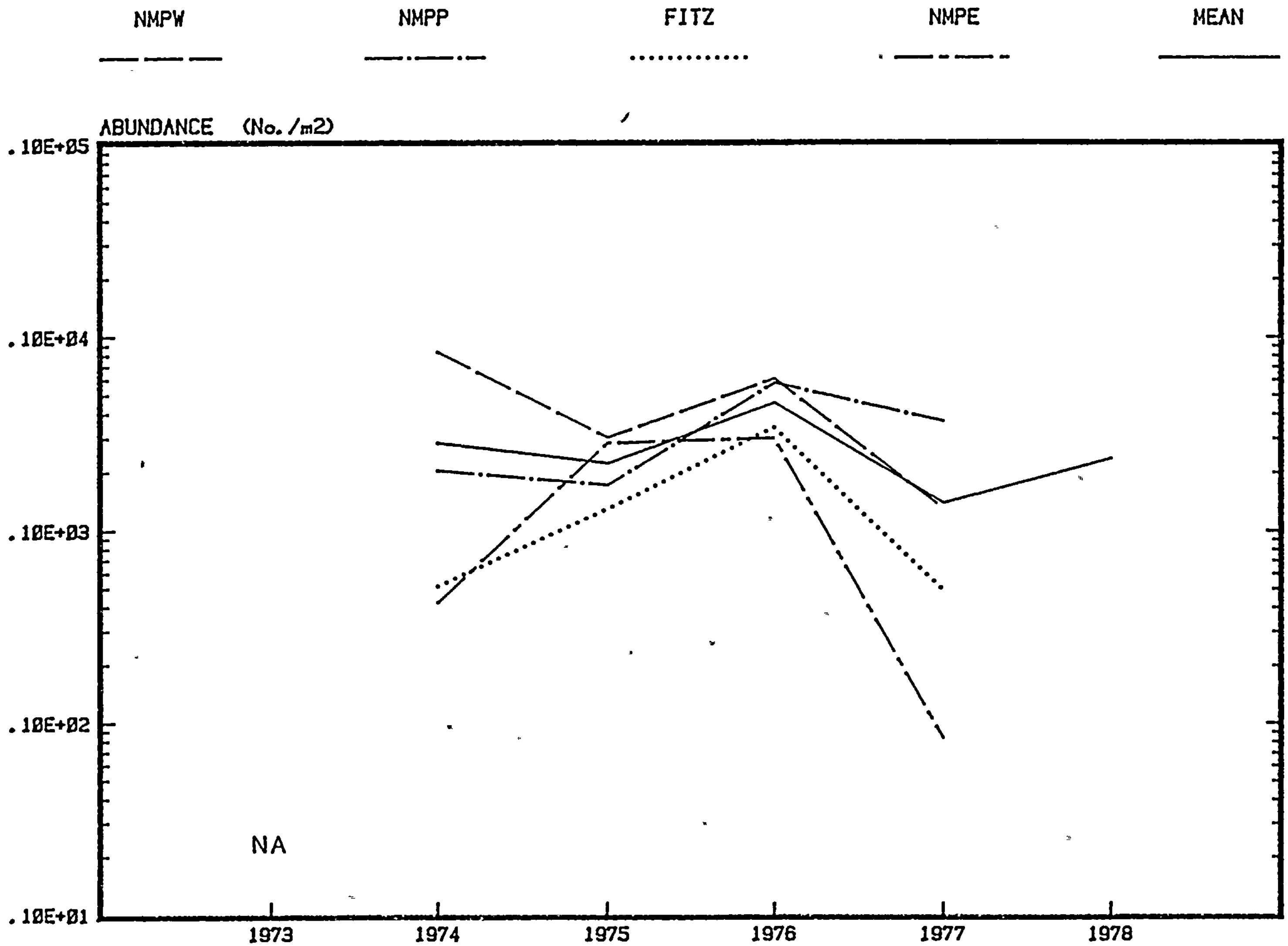


Mean of Jun, Aug, and Oct samples; mean of all contours.

FIGURE 2.1.5-7

MEAN ABUNDANCE OF POLYCHAETA

Nine Mile Point Vicinity - 1973-1978

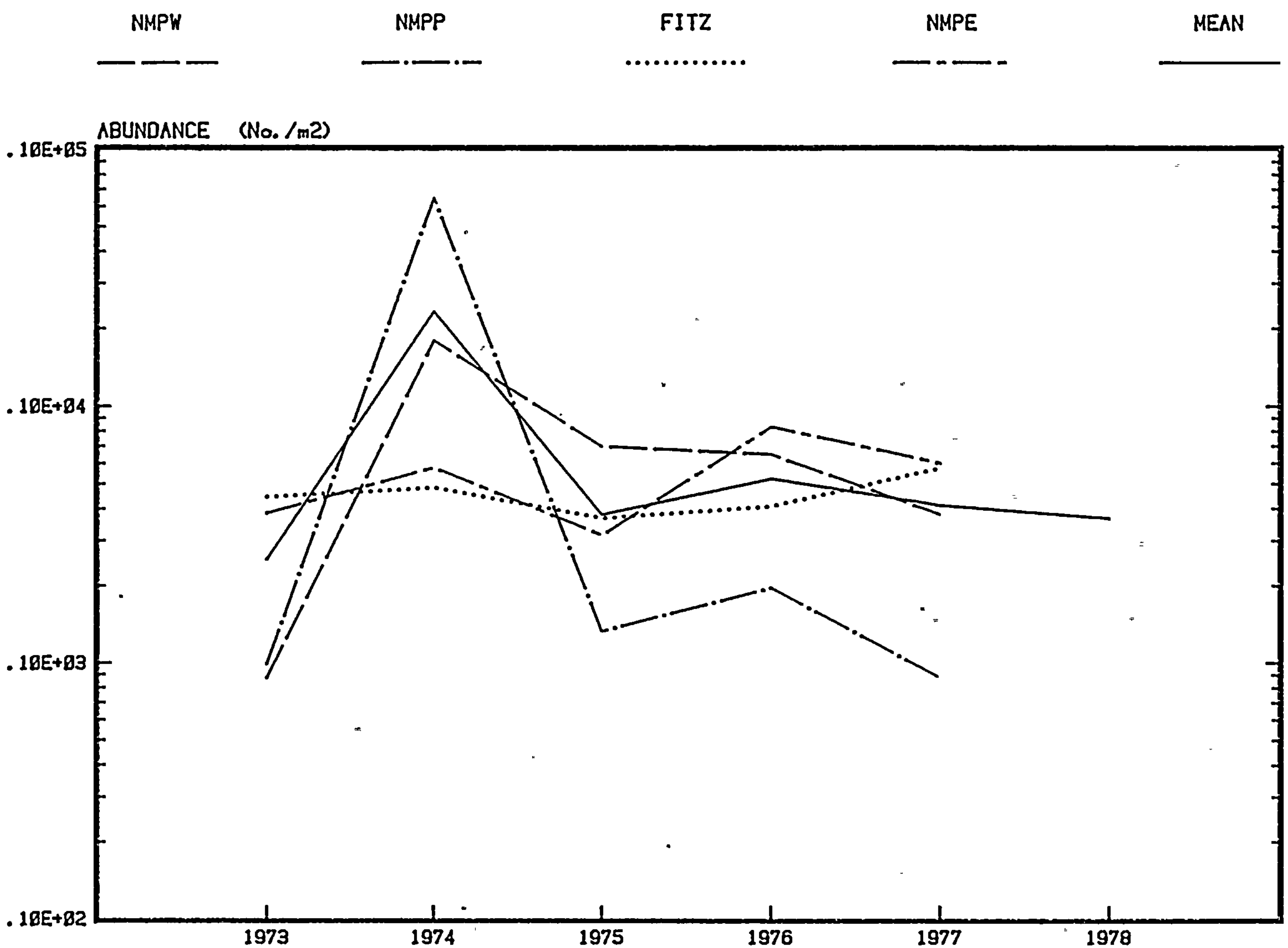


Mean of Jun. Aug. and Oct sa[illegible] mean of all contours.

FIGURE 2.1.5-8

MEAN ABUNDANCE OF OLIGOCHAETA

Nine Mile Point Vicinity - 1973-1978



Mean of Jun, Aug, and Oct samples; mean of all contours.

pattern was correlated to the presence of actively growing Cladophora, which provide food and refuge for many invertebrate populations.

Taxon-specific long-term (1973-1978) trends were demonstrated. Except for an increased abundance in 1974, Oligochaeta abundances remained similar throughout the study period. Amphipoda abundances also remained constant. Gastropoda, Nematoda, Diptera, and Platyhelminthes varied, but demonstrated no singular trend or population shift. Mean Pelecypoda abundance decreased throughout the study; the most radical change, however, occurred at the NMPP transect and was most likely attributable to the loss of suitable habitat for this infaunal taxon. The bottom substrate (predominantly bedrock) at the NMPP transect was not capable of supporting the burrowing Pelecypoda.

Sampling of the periphyton community was conducted from 1973 through 1978. Species assemblages attached to glass or plexiglass substrates located near the surface and at the bottom were identified and enumerated. Complete collection and analysis methodology is presented in Section 3.1.5.

The periphyton species inventory (Table 2.1.5-2) is large, indicating a diverse and viable assemblage of periphytic algae in the Nine Mile Point vicinity. The periphyton community was composed primarily of diatoms in the spring, green and/or blue-green algae during the warm months, and diatoms again in the fall. While not identified and enumerated, protozoa, primarily ciliates and suctorians, were commonly associated with the periphyton community, particularly at the greater depths where light intensity was lower.

The pattern of algal succession was similar for both the phytoperiphyton and the phytoplankton communities and typical of conditions in temperate water bodies[8]. The presence of a relatively large

TABLE 2.1.5-2

OCCURRENCE OF PERIPHYTON IN ARTIFICIAL SUBSTRATE COLLECTIONS
NINE MILE POINT VICINITY - 1974, 1976-1978

Taxon

- CHLOROPHYTA
  - Chlorophyceae
    - Volvocales
      - [a]Carteria sp.
      - Chlamydomonas sp.
      - [a]Eudorina sp.
      - Pandorina sp.
    - Tetrasporales
      - Chaetopeltis sp.
      - Chlorangiogloea sp.
      - Cylindrocapsa sp.
      - Elakotothrix sp.
      - Gloecystis sp.
      - Stylosphaeridium sp.
      - Tetraspora sp.
    - Chlorococcales
      - Actinastrum sp.
      - Ankistrodesmus sp.
      - Ankyra sp.
      - Botryococcus sp.
      - Characium sp.
      - Chlorococcum sp.
      - Chlorella sp.
      - Chodatella (Lagerheimia) sp.
      - Closteriopsis sp.
      - Coelastrum sp.
      - Crucigenia sp.
      - Dictyosphaerium sp.
      - Didymocystis sp.
      - Echinosphaerella sp.
      - Elakatothrix sp.
      - Franceia sp.
      - Gloeoactinium sp.
      - Golenkinia sp.
      - Hydrodictyon sp.
      - Kirchneriella sp.
      - Micractinium sp.
      - Nephrocytium sp.
      - Oocystis sp.
      - Pediastrum sp.

Taxon

- Chlorococcales (Cont)
  - Phacotus sp.
  - Planktosphaeria sp.
  - Quadrigula sp.
  - Scenedesmus sp.
  - Schroederia sp.
  - Selenastrum sp.
  - Sorastrum sp.
  - Sphaerocystis sp.
  - Tetradesmus sp.
  - Tetraedron sp.
  - Tetrastum sp.
  - Treubaria sp.
  - Westella sp.
- Ulotrichales
  - Geminella sp.
  - Microspora sp.
  - Schizomeris sp.
  - Stichococcus sp.
  - Ulothrix sp.
- Chaetophorales
  - Chaetophora sp.
  - Gongrosira sp.
  - Draparnaldia sp.
  - Leptosira sp.
  - Protoderma sp.
  - Pseudulvella sp.
  - Stigeoclonium sp.
  - Ulvella sp.
- Oedogoniales
  - Bulbochaeta sp.
  - Oedogonium sp.
- Cladoporales
  - Cladophora sp.
  - Rhizoclonium sp.
- Zygnematales
  - Closterium sp.
  - Cosmarium sp.
  - Mougeotia sp.
  - Mougeotiopsis sp.

TABLE 2.1.5-2 (Cont)

Taxon

Zygnematales (Cont)
- *Strogonium* sp.
- *Spirogyra* sp.
- *Spondylosium* sp.
- *Staurastrum* sp.

EUGLENOPHYTA
- Euglenophyceae
  - Euglenales
    - *Euglena* sp.
    - *Lepocinclis* sp.
    - *Phacus* sp.
    - *Trachelomonas* sp.

CHRYSOPHYTA
- Xanthophyceae (Chrysophyceae)
  - *Characiopsis* sp.
  - *Chrysochromulina* sp.
  - *Chrysococcus* sp.
  - *Codosiga* sp.
  - *Chrysocapsa* sp.
  - *Diceras* sp.
  - *Dinobyron* sp.
  - *Distephanum* sp.
  - *Isochrysidales* sp.
  - *Kephyrion* sp.
  - *Lagynion* sp.
  - *Mallamonas* sp.
  - *Monosiga* sp.
  - *Peroniella* sp.
  - *Rhizochrysis* sp.
  - *Stelexomonas* sp.
  - *Stipitococcus* sp.
  - *Synura* sp.
  - *Tribonema* sp.

BACILLARIOPHYTA
- Centrales
  - *Bacteriastrum* sp.
  - *Coscinodiscus* sp.
  - *Cyclotella* sp.
  - *Melosira* sp.
  - *Skeletonema* sp.
  - *Stephanodiscus* sp.
- Pennates
  - *Achnanthes* sp.
  - *Amphiprora* sp.

Taxon

Pennates (Cont)
- *Amphora* sp.
- *Asterionella* sp.
- *Cocconeis* sp.
- *Cymatopleura* sp.
- *Cymbella* sp.
- *Cymtopleura* sp.
- *Diatoma* sp.
- *Diploneis* sp.
- *Epithemia* sp.
- *Eunotia* sp.
- *Fragilaria* sp.
- *Gomphonema* sp.
- *Gyrosigma* sp.
- *Meridion* sp.
- *Navicula* sp.
- *Nitzschia* sp.
- *Pinnularia* sp.
- *Pleurosigma* sp.
- *Rhoicosphenia* sp.
- *Surirella* sp.
- *Synedra* sp.
- *Tabellaria* sp.

PYRRHOPHYTA
- Dinophyceae
  - *Ceratium* sp.
  - *Glenodinium* sp.
  - *Gymnodinium* sp.
  - *Peridinium* sp.

CRYPTOPHYTA
- Cryptophyceae
  - *Chroomonas* sp.
  - *Cryptomonas* sp.
  - *Rhodomonas* sp.

CYANOPHYTA
- Myxophyceae
  - *Agmenellem* sp.
  - *Anabaena* sp.
  - *Anabaenopsis* sp.
  - *Anacystis* sp.
  - *Aphanizomenon* sp.
  - *Aphanocapsa* sp.
  - *Aphanothece* sp.
  - *Calothrix* sp.

TABLE 2.1.5-2 (Cont)

Taxon	Taxon
Myxophyceae (Cont)	Myxophyceae (Cont)
Chamaesiphon sp.	*Microcystis* sp.
Chroococcus sp.	*Oscillatoria* sp.
Coelosphaerium sp.	*Phormidium* sp.
Entophysalis sp.	*Pleurocapsa* sp.
Gloeocapsa sp.	*Polycystis* sp.
Gomphosphaeria sp.	*Pseudoanabaena* sp.
Lyngbya sp.	*Spirulina* sp.
Merisimopedia sp.	*Stichosiphon* sp.

blue-green algal component is consistent with reports of increasing eutrophication of Lake Ontario, particularly in the nearshore waters[30]. Numerical densities were greater near the surface than on the bottom, probably because of lower siltation and higher light levels near the surface. Temperature and light intensity have been cited as the most important factors affecting production[16].

Seasonal growth patterns of the bottom periphyton community indicated peak biomass during July or August, depending on water temperature and depth. Bottom periphyton biomass and chlorophyll a values decreased as the depth contours increased, but no consistent pattern was discernible among the four transects tested[17,22].

The species composition and standing crop (biomass and chlorophyll) of the bottom periphyton have remained relatively constant over the six-year study period. No consistent trends were observed among years for bottom periphyton. An increased biomass on surface substrates during 1975, 1976, and 1977 at the NMPP and FITZ transects may have resulted from either the thermal discharge or increased light penetration at these stations[10,11].

The various groups of periphyton showed some spatial variability among the transects; however, the seasonal fluctuations far exceeded the spatial variability and were typical of those described in other long-term studies[33]. Thus, the periphyton community was composed of a diverse assemblage of organisms with a dynamic seasonal distribution that was much more extensive than the spatial distributions observed.

2.1.6 Fish

The fish community of Lake Ontario has undergone major changes, beginning before 1850 and continuing to the present. The community

can be described as unstable and dominated by exotic species which were accidentally or purposefully introduced. The commercially important deep-water assemblage of salmonids has been lost and many other species are greatly reduced in abundance. Pesticides have entered the lake and have been identified in a number of commercially and recreationally important species. In recent years, large numbers of salmonids have been stocked in the lake to prey upon the abundant alewives and produce a sport fishery.

Table 2.1.6-1 lists 82 species collected from Lake Ontario during aquatic surveillance programs conducted from 1972 to 1981. Christie[34] presented a list of fishes of Lake Ontario that included extinct species as well as species of uncertain status. Most of the common species listed by Christie also occur in Table 2.1.6-1, but many rare species or species of uncertain status have not been observed in the Nine Mile Point vicinity. The relative abundance and distribution of the important species and the occurrence of endangered and threatened species will be discussed in detail in subsequent sections.

Sampling and analysis procedures utilized during these studies are presented in Section 3.1.6.

Life Histories of Important Species

The following information represents a summary of the results of site-specific life history studies made on the five dominant species: alewife, rainbow smelt, yellow perch, white perch, and smallmouth bass. Limited data were obtained on spottail shiner, threespine stickleback, brown trout, and coho salmon because few specimens of these species were collected. This summary will concentrate on the relative abundance and temporal and spatial distribution of the aforementioned species in the vicinity of Nine Mile Point.

TABLE 2.1.6-1

LIST OF FISHES COLLECTED FROM LAKE AND IMPINGEMENT SAMPLING
NINE MILE POINT NUCLEAR STATION UNIT 1,
JAMES A. FITZPATRICK NUCLEAR POWER PLANT, AND OSWEGO STEAM STATION - 1972-1981

Common Name	Scientific Name	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Alewife	Alosa pseudoharengus[a,b]	x	x	x	x	x	x	x	x	x	x
American eel	Anguilla rostrata	x	x	x	x	x	x	x	x	x	x
Banded killifish	Fundulus diaphanus		x		x	x		x			
Black bullhead	Ictalurus melas		x				x	x			
Black crappie	Pomoxis nigromaculatus		x	x	x	x	x	x	x	x	x
Bloater	Coregonus hoyi										x
Bluegill	Lepomis macrochirus	x	x	x	x	x	x	x	x	x	x
Bluntnose minnow	Pimephales notatus		x	x		x	x				
Bowfin	Amia calva		x	x	x	x	x		x		
Brassy minnow	Hybognathus hankinsoni						x				
Bridal shiner	Notropis bifrenatus				x						
Brook silverside	Labidesthes sicculus			x	x						
Brook stickleback	Culaea inconstans		x	x	x	x	x	x	x	x	x
Brook trout	Salvelinus fontinalis				x	x					
Brown bullhead	Ictalurus nebulosus	x	x	x	x	x	x	x	x	x	x
Brown trout	Salmo trutta[a,b]		x	x	x	x	x	x	x	x	x
Burbot	Lota lota		x	x	x	x	x	x	x	x	x
Carp	Cyprinus carpio[a]	x	x	x	x	x	x	x	x	x	
Central mudminnow	Umbra limi		x	x	x	x	x	x	x	x	x
Chain pickerel	Esox niger										x
Channel catfish	Ictalurus punctatus		x	x	x	x	x			x	x
Chinook salmon	Oncorhynchus tshawytscha[a]		x	x	x	x	x	x	x		x
Cisco	Coregonus artedii	x	x	x	x	x	x	x	x		x
Coho salmon	Oncorhynchus kisutch[a,b]		x	x	x	x	x	x			
Common shiner	Notropis cornutus	x	x						x		x
	Coregonus sp.									x	
Creek chub	Semotilus atromaculatus		x	x	x	x	x				
Dwarf longnose sucker	Catostomus catostomus				x						
Emerald shiner	Notropis atherinoides	x	x	x	x	x	x	x	x	x	x
Fathead minnow	Pimephales promelas			x	x	x	x	x	x		
Freshwater drum	Aplodinotus grunniens	x	x	x	x	x	x	x	x	x	
Gizzard shad	Dorosoma cepedianum[a]	x	x	x	x	x	x	x	x	x	x
Golden shiner	Notemigonus crysoleucas	x	x	x	x	x	x	x	x	x	x
Goldfish	Carassius auratus[a]	x	x	x	x	x	x	x	x		x
Johnny darter	Etheostoma nigrum[c]	x	x	x	x	x	x		x	x	x
Lake chub	Couesius plumbeus	x	x	x	x	x	x	x	x	x	x
Lake chubsucker	Erimyzon sucetta				x						
Lake trout	Salvelinus namaycush			x	x	x	x				x
Lake whitefish	Coregonus clupeaformis					x					
Largemouth bass	Micropterus salmoides			x	x	x	x	x	x	x	x

TABLE 2.1.6-1 (Cont)

Common Name	Scientific Name	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Logperch	Percina caprodes	x	x	x	x	x	x		x	x	x
Longnose dace	Rhinichthys cataractae	x	x	x	x	x	x	x	x		x
Longnose gar	Lepisosteus osseus		x	x	x	x					
Madtoms	Noturus sp.										x
Minnows	Cyprinidae							x	x	x	
Mosquito fish	Gambusia affinis[a]			x							
Mottled sculpin	Cottus bairdi	x	x	x	x	x	x				
Northern hogsucker	Hypentelium nigricans			x	x	x	x				
Northern pike	Esox lucius	x	x	x	x	x	x	x	x	x	x
Pearl dace	Semotilus margarita			x		x					
Pirate perch	Aphredoderus sayanus			x					x		
Pugnose minnow	Notropis emiliae					x					
Pumpkinseed	Lepomis gibbosus	x	x	x	x	x	x	x	x	x	x
Rainbow smelt	Osmerus mordax[a,b]	x	x	x	x	x	x	x	x	x	x
Rainbow trout	Salmo gairdneri[a]			x	x	x	x	x	x	x	x
Redfin pickerel	Esox americanus americanus			x	x	x					x
Redfin shiner	Notropis umbratilus				x						
Rock bass	Ambloplites rupestris	x	x	x	x	x	x	x	x	x	x
Salmon	Oncorhynchus sp.							x			
Sauger	Stizostedion canadense	x									
Sculpin	Cottidae							x	x	x	x
Sea lamprey	Petromyzon marinus	x	x	x	x	x	x	x	x	x	x
Shorthead redhorse	Moxostoma macrolepidotum		x	x	x			x		x	
Silvery minnow	Hybognathus nuchalis				x	x					
Smallmouth bass	Micropterus dolomieui[b]	x	x	x	x	x	x	x	x	x	x
Splake	Salvelinus fontinalis x S. namaycush				x	x	x				
Spottail shiner	Notropis hudsonius	x	x	x	x	x	x	x	x	x	x
Stonecat	Noturus flavus		x	x	x	x	x	x	x	x	x
Sunfishes	Lepomis sp.							x			
Tadpole madtom	Noturus gyrinus				x	x	x				
Temperate bass	Percichthyidae										x
Tessellated darter	Etheostoma olmstedi[c]		x					x			
Threespine stickleback	Gasterosteus aculeatus[b]	x	x	x	x	x	x	x	x	x	x
Trout	Salvelinus sp.							x	x	x	
Trout-perch	Percopsis omiscomaycus	x	x	x	x	x	x	x	x	x	x
Walleye	Stizostedion vitreum vitreum	x	x	x	x	x	x	x	x		x
White bass	Morone chrysops	x	x	x	x	x	x	x	x	x	x
White crappie	Pomoxis annularis					x					x
White perch	Morone americana[a,b]	x	x	x	x	x	x	x	x	x	x
White sucker	Catostomus commersoni	x	x	x	x	x	x	x	x	x	x
Yellow bass	Morone mississippiensis		x	x							
Yellow perch	Perca flavescens[b]	x	x	x	x	x	x	x	x	x	x

[a]Recent additions to the Lake Ontario fish fauna; some may not be persisting.
[b]Important species.
[c]Taxonomic status of these species is unknown.

2.0-47b

Alewife (*Alosa pseudoharengus*) The alewife is an anadromous species that spends most of its adult life in marine waters and returns to fresh water to spawn. If occurs from New Foundland to North Carolina[25], and is landlocked in many lakes along its range, including Lake Ontario.

In Lake Ontario, adult alewives reside in the open lake and migrate inshore during the spring and summer to spawn in streams or in nearshore shallow water areas with sand and gravel bottoms. During the spring spawning season, alewives move inshore in greatest numbers at night; a decrease in alewife abundance in the spawning areas during the day indicates the occurrence of short diurnal migrations near the spawning grounds.

Alewife in Lake Michigan occupy all depth contours as well as all vertical depths, depending on life stage and time of year[35]. The inshore spawning migration of adults was reported to occur as early as 11 March. By 15 April, the largest concentration of adults was observed in the shallow areas of Lake Michigan[35]. In the Bay of Quinte, Lake Ontario, the inshore migration of alewife reached a maximum in late June and ended in late July[36]. The inshore movement of adult alewife in the NMP vicinity was observed to take place during April[18]. Like the adults, juvenile alewife initiated their inshore movements in the spring; they tended to group in shallow areas at dark and to remain at depths of 2 to 3 m (6 to 10 ft) during daylight hours.

Gill net sampling at four transects in the vicinity of Nine Mile Point provides a basis for examining the trend in relative abundance of alewife from 1973 through 1981[17-22,37-39]. Table 2.1.6-2 summarizes these data.

TABLE 2.1.6-2

ANNUAL MEAN CATCH PER EFFORT[a] FOR ALEWIFE
IN BOTTOM GILL NET COLLECTIONS
NINE MILE POINT VICINITY - 1973-1981

Year	5-m Contour				9-m Contour				12-m Contour				18-m Contour			
	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE
1973[b]	30	103	40	58	18	41	34	37	11	21	20	22	5	8	16	14
1974	96	268	154	108	40	116	133	98	76	137	216	101	52	39	87	98
1975	19	7	12	29	11	5	5	6	23	24	111	16	10	13	13	12
1976	49	25	17	35	-	-	-	-	22	37	30	17	-	-	-	-
1977	7	8	11	13	3	7	6	10	4	6	8	8	1	1	2	6
1978	8	10	7	9	3	3	1	3	2	2	2	2	1	1	2	1
1979[c]	NS	NS	NS	NS	15	12	25	12	NS	NS	NS	NS	NS	NS	NS	NS
1980[c]	NS	NS	NS	NS	39	36	41	35	NS	NS	NS	NS	NS	NS	NS	NS
1981[c]	NS	NS	NS	NS	138	138	107	143	NS	NS	NS	NS	NS	NS	NS	NS

[a]Catch per 12-hour net set; mean of all samples collected Apr-Dec.
[b]Sampling June through November.
[c]Sampled at 9-m contour only.
NS - Not sampled.

There was a decline in alewife abundance at Nine Mile Point after a peak in 1974. This decrease is reported to be a lakewide phenomenon as a result of heavy alewife mortality during the winter of 1974-1975. Abundances picked up slightly in 1976 but were followed by another massive alewife dieoff during the winter of 1976-1977[40]. Gill net catches from 1980 and 1981 indicate that the population has recovered.

The bottom gill nets indicate that alewife are least abundant at the 18-m contour, which suggests that the alewife remains inshore of this depth during its spring/early summer spawning period.

Coefficient of maturity values calculated from specimens collected in 1973 and 1974 indicate that gonadal development peaked in mid-June for males and in early July for females in both years. Additional sampling in 1976 further supported these findings[17,18,20].

Fecundity data for alewives were collected in 1974 and 1976. In 1974 the total number of mature eggs ranged from 7364 to 36,574 with a mean of 21,378 for a sample of 38 alewives[18]. A sample of 19 fish in 1976 had a mean fecundity of mature eggs of 18,263[20]. A range in total egg production of 11,147 to 22,407 eggs per female was reported for alewives of similar size in Lake Michigan[41]. Since only mature eggs are spawned during a season, total egg count may overestimate the actual fecundity of freshwater alewives. Fecundity of alewives does not seem correlated with age, fish weight, ovary weight, or fish length[18].

Growth rate of alewife is characterized as rapid during the first two years of life. After the first and second years, alewife were 54 and 67%, respectively, of the length achieved after six years. Growth rates of male and female alewives were similar for age groups I and II, after which females exhibited a relatively faster growth rate.

Alewives are size-selective zooplankton feeders, preferring large cladocerans and calanoid and cyclopoid copepods[42]. Information on the feeding habits of alewives in the vicinity of Nine Mile Point is not currently available. All of the food items reported for alewives are abundant in the Nine Mile Point area.

Rainbow Smelt (Osmerus mordax) The original range of the rainbow smelt in eastern North America was the Atlantic coastal drainage from New Jersey to Labrador. Whether the smelt is native to Lake Ontario is uncertain; Hubbs and Lagler[43] believe that it is, whereas Scott and Crossman[25] do not. In either case, the first report of rainbow smelt taken from Lake Ontario was in 1931 by Mason[44] although they now occur in all of the Great Lakes and in many Canadian and United States lakes. The smelt is an anadromous species, leaving the sea or large lakes in spring to spawn in freshwater streams or along the lake shore.

The majority of adult rainbow smelt from the Nine Mile Point area were collected by surface and bottom gill nets[17,22,37-39]. Few were collected by trawl and seine nets. The very low abundance of this species in seine collections may indicate that there is no spawning in the littoral area near Nine Mile Point. Scott and Crossman[25] reported that rainbow smelt in the Great Lakes spawn in streams or, under adverse weather conditions, in the offshore areas on gravel shoals.

The bottom gill nets fished consistently from 1973 to 1981 indicate peaks in abundance in 1974 and 1981, with low abundances in 1975 and 1980 (Table 2.1.6-3). The peaks in 1974 and 1981 coincide with the peaks in alewife abundance during this nine-year period. There is no consistent pattern in the catch rate between depth contours or transects.

TABLE 2.1.6-3

ANNUAL MEAN CATCH PER EFFORT[a] FOR RAINBOW SMELT
IN BOTTOM GILL NET COLLECTIONS
NINE MILE POINT VICINITY - 1973-1981

Year	5-m Contour				9-m Contour				12-m Contour				18-m Contour			
	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE
1973[b]	1	d	d	d	1	1	1	2	1	1	1	1	1	1	2	1
1974	5	5	11	20	5	2	18	8	9	3	10	28	10	6	17	65
1975	d	0	1	d	0	d	d	d	d	d	1	1	1	1	2	1
1976	1	1	1	2	-	-	-	-	4	10	10	2	-	-	-	-
1977	3	3	1	2	3	1	4	3	2	2	5	5	3	3	5	2
1978	d	1	3	2	1	1	2	3	1	1	4	3	1	1	3	2
1979[c]	NS	NS	NS	NS	1	1	3	2	NS	NS	NS	NS	NS	NS	NS	NS
1980[c]	NS	NS	NS	NS	1	d	1	2	NS	NS	NS	NS	NS	NS	NS	NS
1981[c]	NS	NS	NS	NS	8	10	8	10	NS	NS	NS	NS	NS	NS	NS	NS

[a]Catch per 12-hour net set; mean of all samples collected Apr-Dec.
[b]Sampling Jun through Nov.
[c]Sampled at 9-m contour only.
[d]<1 fish per 12-hour set
NS - Not sampled.

Adult rainbow smelt migrate from deep offshore waters to the nearshore area in late winter/early spring in preparation for spawning in tributary streams and along the lake shore[25]. Coefficient of maturity values were calculated for samples collected in 1973, 1974,. and 1976. The values for females indicate a yearly peak in maturity in late April, which corresponds to the reported time of spawning and the first occurrence of eggs in samples from Nine Mile Point.

The fecundity of rainbow smelt was investigated in 1974 and 1976. In 1974 the mean number of eggs per female was 17,002[18]. This is the lowest average egg production of the Great Lakes populations that have been studied. In a larger sample of rainbow smelt collected in 1976[20] the mean number of eggs per female was greater than in 1974 (18,962) but still less than values reported for Lake Huron and Lake Michigan[10].

Male and female rainbow smelt grew quickly in their early years, slowing down with age. Both sexes exhibited similar growth rates during the first year of life, after which females grew significantly faster than males. This characteristic has been observed for female rainbow smelt in other waters as well. The growth of rainbow smelt from the Nine Mile Point vicinity is greater than or similar to that of smelt collected from other areas in the vicinity of Lake Ontario[10,11].

Smelt are carnivorous and prey upon a variety of organisms, including insects, oligochaetes, crustaceans, and other fish. They are in turn preyed upon by lake trout, walleye, perch, and salmon. The common invertebrate organisms observed in smelt stomachs were dipterans, primarily Chaoborus, copepods, and cladocerans, all of which are abundant in the Nine Mile Point area.

Yellow perch (Perca flavescens) Yellow perch are able to tolerate a wide variety of environmental conditions and are a commercially valuable species in the Great Lakes and elsewhere. They are generally found in water less than 9.2 m and aggregate in schools of 50-200 individuals of approximately the same size[25].

Gill net sampling in the Nine Mile Point vicinity indicated peaks in abundance of yellow perch in 1974 and 1981 and particularly low abundance in 1977, except for the 5-m depth contour (Table 2.1.6-4). The 5- and 9-m depth stations showed the greatest abundance of yellow perch, which reflects their preference for shallow water. There was no consistent pattern in the abundance of yellow perch among all transects and all depth contours, but the highest abundances recorded during the studies were at the shallow depth contour (5 m) along the NMPP and FITZ transects (Table 2.1.6-4). This is in agreement with studies conducted by Everest[45], which reported yellow perch concentrations in the vicinity of the Hearn Generating Station thermal plume in northwestern Lake Ontario. The absence of yellow perch in the surface waters associated with the surface NMP and FITZ plume suggests that those present in the area were responding to some other stimuli, i.e., physical structure, current, food, etc.

The majority of yellow perch collected from the vicinity of Nine Mile Point in 1973, 1974, and 1975 were obtained in bottom gill nets[17-19]. Yellow perch collected in 1974 were abundant in bottom gill nets during both day and night, and did not exhibit the diel vertical migration reported by Scott and Crossman[25]. Yellow perch were abundant in the vicinity of NMP and FITZ in July-August 1973 (highest catch per effort) and in July-September 1974 and 1975. The timing of yellow perch abundance in the study area does not coincide with the timing of their reproductive behavior (April). This suggests that spawning does not take place in the area.

TABLE 2.1.6-4

ANNUAL MEAN CATCH PER EFFORT[a] FOR YELLOW PERCH
IN BOTTOM GILL NET COLLECTIONS
NINE MILE POINT VICINITY - 1973-1981

Year	5-m Contour				9-m Contour				12-m Contour				18-m Contour			
	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE
1973[b]	4	12	15	3	2	3	4	3	1	2	3	d	d	d	1	1
1974	7	16	19	8	2	4	11	7	3	4	5	4	2	3	5	4
1975	5	7	6	2	2	1	1	d	1	d	2	1	1	2	2	3
1976	2	3	5	3	-	-	-	-	2	2	8	2	-	-	-	-
1977[c]	2	3	3	4	1	d	1	1	d	d	1	1	d	d	d	d
1978	3	3	4	4	1	1	1	1	1	d	d	1	d	d	1	d
1979[c]	NS	NS	NS	NS	4	1	3	7	NS	NS	NS	NS	NS	NS	NS	NS
1980[c]	NS	NS	NS	NS	2	2	3	3	NS	NS	NS	NS	NS	NS	NS	NS
1981[c]	NS	NS	NS	NS	7	5	3	4	NS	NS	NS	NS	NS	NS	NS	NS

[a]Catch per 12-hour net set, mean of all samples collected Apr-Dec.
[b]Sampling Jun-Nov.
[c]Sampled at 9-m contour only.
[d]<1 fish per 12-hour net set.
NS - Not sampled.

Between 1972 and 1976, 4107 yellow perch were tagged in the vicinity of Nine Mile Point to determine the distribution and movements of this species[46]. Returns showed regular seasonal movements between the Nine Mile Point area and the eastern end of Lake Ontario. During fall, yellow perch moved eastward from Nine Mile Point and concentrated in the area of Sandy Pond where they overwintered and probably spawned the following spring. In spring they moved westward along the south shore of the lake and were recaptured in the Nine Mile Point area in greatest numbers from June through October.

Coefficient of maturity values calculated for samples taken in 1974 (the year of most intensive sampling) show gonadal development peaked during the first two weeks of April when water temperatures were 0.7-6.2°C (33.3-43.2°F). The ovaries had total egg counts ranging from 4840 eggs to 50,000 eggs, with a mean of 25,077 eggs[18].

The growth patterns for male and female yellow perch are similar; females appeared to be larger than males, but the differences in annual mean calculated lengths were not statistically significant. The growth rate of both male and female yellow perch from the Nine Mile Point vicinity is characterized as being rapid through the fourth year of life, after which it slows[10,11].

Back-calculated growth of male and female yellow perch show that female yellow perch growth for the first three years of life has been similar for the past nine years. Females that spawned between 1966 and 1968 exhibited a progressively slower growth rate after age 4, while those that spawned in 1969 showed an increased rate. Male yellow perch appear to have grown uniformly from 1968 to 1972. No 1973 year class fish were collected during 1974 because of the selectivity of gill nets for larger fish[10,11].

The yellow perch larvae feed on zooplankton and insect larvae, and as they grow to a length of 5.0 to 7.5 cm, their diet changes to larger zooplankton, insects, crayfish, snails, and small fish, including their own species[47]. Stomach contents of adult yellow perch analyzed in 1974 and 1975 indicated that perch consumed mostly fishes and decapods[18,19]. Dipterans were the only insects recovered from the stomachs; fish eggs, Gammarus, and oligochaetes were also found. Adult sculpins were also preferred food items[19,20]. These results agreed with those reported by Scott and Crossman[25].

White Perch (*Morone americana*). White perch are a common brackish-water species in the northeastern coastal area of North America. Not a native of the Great Lakes, this species presumably gained access to Lake Ontario via the Oswego River from Hudson River populations moving northward and westward through the Mohawk River and Erie Barge Canal[25,48].

Gill net sampling from 1973 through 1981 showed a peak in abundance in 1974 and substantially lower abundance in the following years (Table 2.1.6-5). White perch were generally more abundant at the 5- and 9-m stations than at the deeper stations. White perch were abundant in the east side of the study area, particularly in 1973 and 1974 when overall abundance was high. White perch were more abundant near the bottom than at the surface throughout a diel cycle. Night collections were larger during summer than in the spring and fall, but day collections did not show a seasonal pattern.

White perch coefficient of maturity values (based on samples collected in 1974) peaked in mid-May. The water temperature at this time varied from 5.5 to 13.0°C (41.9 to 55.4°F), averaging 10.8°C (51.4°F) on the surface and 7.2°C (45.0°F) on the bottom. In 1974

TABLE 2.1.6-5

ANNUAL MEAN CATCH PER EFFORT[a] FOR WHITE PERCH
IN BOTTOM GILL NET COLLECTIONS
NINE MILE POINT VICINITY - 1973-1981

Year	5-m Contour				9-m Contour				12-m Contour				18-m Contour			
	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE
1973[b]	3	7	12	24	1	2	5	12	d	1	1	5	d	d	1	1
1974	14	14	33	34	2	7	10	24	1	2	6	13	1	2	3	9
1975	5	4	3	5	1	2	3	6	1	1	2	3	d	1	1	2
1976	7	10	3	8	-	-	-	-	d	1	1	1	-	-	-	-
1977	4	10	6	10	2	2	3	3	1	2	3	4	d	1	2	2
1978	2	7	3	6	1	1	1	1	d	1	d	d	d	d	d	d
1979[c]	NS	NS	NS	NS	4	2	1	1	NS	NS	NS	NS	NS	NS	NS	NS
1980[c]	NS	NS	NS	NS	1	2	1	1	NS	NS	NS	NS	NS	NS	NS	NS
1981[c]	NS	NS	NS	NS	1	2	1	1	NS	NS	NS	NS	NS	NS	NS	NS

[a] Catch per 12-hour net set; mean of all samples collected Apr-Dec.
[b] Sampling Jun-Nov.
[c] Sampled at 9-m contour only.
[d] <1 fish per 12-hour net set.
NS - Not sampled.

the first white perch larvae were collected on 22 May, which confirms the time of spawning as mid-May[18].

The fecundity of mature female white perch was determined by examining the ovaries of fish collected in 1974 and 1977. In 1974 there was an average of 117,789 eggs per female for fish ranging in length from 192 to 249 mm. In 1977 the fish sampled had a larger range of lengths, 141 to 320 mm, and there was an average of 105,239 eggs per female[18,21].

The growth curves for male and female white perch had approximately the same form; however, females appeared larger after the second and subsequent years of life. The faster growth of female white perch has been reported in Lake Ontario and throughout the range of the species[49-52]. The maximum growth of Nine Mile Point white perch occurred during the first two years of life. At the end of the first and second years, white perch were 25 and 48%, respectively, of the length attained after 10 years[10,11].

The white perch diet changes with growth, from a predominance of microzooplankton, to aquatic insect larvae, and then to fish, including yellow perch, smelt, johnny darters, and other white perch[53,54]. The white perch analyzed had consumed a larger variety of food items during the spring than the fall; amphipods were most frequently consumed in the spring, and they were the dominant food item during the fall. Stomachs of white perch larger than 21.1 cm in total length contained primarily fish (alewives) during both seasons[10,11].

Smallmouth bass (*Micropterus dolomieui*) Smallmouth bass are distributed in North America from southern Canada to Alabama and west to Oklahoma[43]. It is an important sport fish and piscivore in the nearshore waters of Lake Ontario.

In the Nine Mile Point area, smallmouth bass were collected almost exclusively with bottom gill nets. The sampling from 1973 to 1981 indicates a trend of decreasing abundance through 1979, with increasing abundances recorded for 1980 and 1981 (Table 2.1.6-6). Compared to other abundant species, the catch rate of smallmouth bass has always been quite low, although they were found in the nearshore area and in impingement collections. Catches at the 5-, 9-, and 12-m contours were consistently greater than at the 18-m contour, which reflects the nearshore distribution of this species. There was no consistent pattern in the catch rate when transects were compared. Gill net catches were consistently higher during the summer than during spring and fall[20].

Spawning occurs in streams or shallow bays from May through July, usually over a period of 6-10 days. Spawning activities commence when temperature is in the range of 12.8-20.0°C (55.0-68.0°F); egg deposition occurs primarily at 16.1-18.3°C (61.0-65.0°F). The male builds a nest on a gravel or rocky bottom, usually near the protection of rocks or dense vegetation. The number of eggs, which are demersal and adhesive and are attached to stones in the nest, varies with the size of the female, ranging from 5000-14,000[25].

Fecundity data obtained in the NMP vicinity indicated an average of 8516 and 8163 eggs per female in 1973[17] and 1977[21], respectively. Coefficient of maturity values calculated for specimens collected in 1973 and 1976 indicate that gonadal development in females appeared to peak in the first half of June. Coefficient of maturity values for males were relatively consistent from April through the first of July[10,11].

The diet of smallmouth bass varies with age. Young bass prey upon plankton and immature insects, whereas adult bass include crayfish and a variety of fish in their diet. Rather than ingesting a wide

TABLE 2.1.6-6

ANNUAL MEAN CATCH PER EFFORT[a] FOR SMALLMOUTH BASS
IN BOTTOM GILL NET COLLECTIONS
NINE MILE POINT VICINITY - 1973-1981

Year	5-m Contour				9-m Contour				12-m Contour				18-m Contour			
	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE
1973[b]	1.75	3.40	1.61	3.23	0.30	1.14	1.33	0.97	0.70	0.85	2.23	0.58	0.17	0.22	0.06	0.06
1974	1.38	3.00	1.60	2.10	1.34	1.68	2.15	0.73	1.07	1.16	1.41	0.59	0.17	0.12	0	0.06
1975	1.22	2.18	0.99	2.30	1.22	1.62	2.48	0.89	1.29	1.87	2.69	1.46	0.16	0.73	0.07	0.92
1976	0.22	1.63	0.50	0.92	-	-	-	-	1.01	0.53	0.29	0.48	-	-	-	-
1977	0.13	0.28	0.27	0.17	0.14	0.20	0.10	0.07	0.10	0.10	0.10	0.10	0.03	0.10	0.05	0
1978	0.06	0.18	0.03	0.15	0.07	0.06	0.15	0.15	0.09	0.12	0.09	0.12	0.05	0	0.05	0.06
1979[c]	NS	NS	NS	NS	0.08	0.08	0.15	0.08	NS	NS	NS	NS	NS	NS	NS	NS
1980[c]	NS	NS	NS	NS	0.12	0.62	0.38	0.12	NS	NS	NS	NS	NS	NS	NS	NS
1981[c]	NS	NS	NS	NS	0.5	0.25	2.0	0.5	NS	NS	NS	NS	NS	NS	NS	NS

[a] Catch per 12-hour net set; mean of all samples collected Apr-Dec.
[b] Sampling Jun-Nov.
[c] Sampled at 9-m contour only.
NS - Not sampled.

variety of organisms from their habitat, large bass limit their feeding to two types of prey: small fishes and decapod crustaceans.

Spottail shiner (*Notropis hudsonius*) The spottail shiner occurs in North America from Canada south to Georgia and west to Iowa and Missouri in the United States. It is most abundant in large bodies of water.

The total numbers of spottail shiners collected at Nine Mile Point by various fishery gear from 1973-1981 are presented in Table 2.1.6-7. Spottails were most abundant in collections made with gear fished on the bottom, indicating their preference for this habitat. The largest numbers were collected in 1975 and 1976 but these years also represented the highest amount of effort (Section 3.1.7). Catch/effort data indicate a predominance of spottails to the east of Nine Mile Point, with the greatest abundance at the FITZ transect[20].

Spawning reportedly occurs over sandy substrates[25], which are not found in the area around Nine Mile Point but do exist toward the east[20]. The absence of eggs and very small numbers of larvae collected suggests that Nine Mile Point is not a preferred spawning or nursery area for this species.

Threespine stickleback (*Gasterosteus aculeatus*) The threespine stickleback is widely distributed in fresh and marine waters of North America. It ranges from Chesapeake Bay north to the Hudson Bay region. Although threespine stickleback are relatively abundant in impingement samples, they are not collected in large numbers with the fishing gear employed at Nine Mile Point; therefore, there are very limited life history data available for the NMP vicinity.

The total numbers of threespine stickleback collected by various fishery gear at Nine Mile Point from 1973 through 1981 are

TABLE 2.1.6-7

TOTAL NUMBER OF SPOTTAIL SHINER
COLLECTED BY VARIOUS FISHING GEAR
NINE MILE POINT VICINITY - 1973-1981

Year	Seine	Surface Trawl	Bottom Trawl	Surface Gill Net	Bottom Gill Net
	Sampling Gear				
1973	470	5	99	180	2,363
1974	14	4	13	50	5,377
1975	51	0	43	147	8,652
1976	30	NS	1364	17	8,112
1977	18	NS	21	NS	6,602
1978	192	NS	12	NS	5,777
1979	NS	NS	NS	NS	692
1980	NS	NS	NS	NS	767
1981	NS	NS	NS	NS	817

NS - Not sampled.

presented in Table 2.1.6-8. The greatest numbers of stickleback were collected in 1976 and 1978; however, there was no discernible trend in abundance over the years of sampling[20].

No data are available on the time of spawning or the fecundity of the threespine sticklebacks in the vicinity of Nine Mile Point. Their eggs and larvae were among the ichthyoplankton collections in 1975, but were few in number. Eggs were not collected in either 1973 or 1974, and very few larvae were found in 1973 collections.

Coho Salmon (*Oncorhyncus kisutch*) The coho salmon is an anadromous species which occurs naturally in the Pacific Ocean and in rivers that drain northwestern North America. Attempts to establish the coho salmon in the Great Lakes were unsuccessful until the 1960s[25]. NYSDEC annually stocks coho salmon in New York State tributary streams of Lake Ontario.

The total numbers of coho salmon collected at Nine Mile Point in various fishery gear from 1973 through 1981 are presented in Table 2.1.6-9. Coho salmon were most abundant in 1975; however, there is no discernible trend in abundance over the years of study. The zero catch since 1977 is attributable to reduced sampling effort.

The spawning runs of the coho in the Great Lakes takes place from September to early October, although actual time of the spawning occurs from October to January, depending upon the run[25]. Swift-running tributaries with gravel bottoms are selected as the spawning site. Populations of salmon in the Lake Ontario area are maintained through stocking of hatchery-reared fingerlings.

The number of eggs deposited by the female varies with the size of the female, location, and year. The adults die shortly after they

TABLE 2.1.6-8

TOTAL NUMBER OF THREESPINE STICKLEBACK
COLLECTED BY VARIOUS FISHING GEAR
NINE MILE POINT VICINITY - 1973-1981

	Sampling Gear				
Year	Seine	Surface Trawl	Bottom Trawl	Surface Gill Net	Bottom Gill Net
1973	23	50	5	0	0
1974	6	16	5	0	2
1975	65	46	48	0	1
1976	446	NS	213	0	0
1977	6	NS	62	NS	1
1978	72	NS	894	NS	3
1979	NS	NS	NS	NS	0
1980	NS	NS	NS	NS	0
1981	NS	NS	NS	NS	0

NS - Not sampled.

TABLE 2.1.6-9

TOTAL NUMBER OF COHO SALMON
COLLECTED BY VARIOUS FISHING GEAR
NINE MILE POINT VICINITY - 1973-1981

	Sampling Gear				
Year	Seine	Surface Trawl	Bottom Trawl	Surface Gill Net	Bottom Gill Net
1973	0	0	0	0	0
1974	0	0	0	10	3
1975	12	0	0	31	14
1976	20	NS	0	8	13
1977	0	NS	0	NS	9
1978	0	NS	0	NS	0
1979	NS	NS	NS	NS	0
1980	NS	NS	NS	NS	0
1981	NS	NS	NS	NS	0

NS - Not sampled.

spawn, and eggs hatch during the early spring in 35-50 days, depending upon the water temperature. The yolk sac is absorbed by the alevins during a 2-3 week period, while the eggs remain on the gravelly stream bottom. When fry emerge, which may occur from March to July, some individuals will migrate to the sea or open lake, although most remain in freshwater streams or tributaries for a one-year period.

No data are available on the time of spawning or the fecundity of coho salmon in the vicinity of Nine Mile Point. Lake Ontario stocks of the coho salmon first introduced in 1968-1969 are currently being maintained through extensive stocking programs. At present no information is available on any natural reproduction by the introduced fish. Coho are riverine spawners and would not be expected to spawn in the Nine Mile Point vicinity.

Because of the scarcity of coho salmon in the study area, age and growth of that species were not analyzed.

In fresh water, young cohos feed upon aquatic insects and oligochaetes. Schools of salmon migrate to the ocean or lake during the spring of the year following emergence. The majority of the migratory population spends about 18 months in the lake or at sea, and returns to spawn at age 3 or age 4 during the fall[25]. Large coho salmon prey primarily upon rainbow smelt and alewives. Information on coho salmon feeding in the Nine Mile Point vicinity is not available at present.

<u>Brown trout</u> (<u>Salmo</u> <u>trutta</u>) The total numbers of brown trout collected at Nine Mile Point by various fishery gear from 1973 through 1981 are presented in Table 2.1.6-10. Yearly abundance of brown trout is a reflection of the sampling effort and stocking rate. There is no obvious trend in the abundance of brown trout

TABLE 2.1.6-10

TOTAL NUMBER OF BROWN TROUT
COLLECTED BY VARIOUS FISHING GEAR
NINE MILE POINT VICINITY - 1973-1981

	Sampling Gear				
Year	Seine	Surface Trawl	Bottom Trawl	Surface Gill Net	Bottom Gill Net
1973	0	0	0	21	10
1974	0	0	0	60	15
1975	0	0	0	116	66
1976	5	NS	1	19	113
1977	8	NS	1	NS	50
1978	11	NS	1	NS	117
1979	NS	NS	NS	NS	4
1980	NS	NS	NS	NS	6
1981	NS	NS	NS	NS	14

NS - Not sampled.

over the years of study. The low abundances in 1979-1981 are the result of reduced sampling effort.

Brown trout usually spawn during late autumn/early winter; in one study, Mansell[55] noted that brown trout spawned during mid-October through early November in Ontario Province when water temperatures ranged from 6.7-8.9°C (44.1-48.0°F). Spawning usually takes place in the shallow headwaters of streams over a gravel bottom, although Eddy and Surber[56] observed that many trout spawned on rocky reefs along the shore of Lake Superior. The number of eggs deposited by a spawning female brown trout is proportional to her size: the larger females deposit more eggs.

No data are available on the fecundity or time of spawning of brown trout in the vicinity of Nine Mile Point, and no eggs or larvae have been collected.

Existing and Planned Man-Induced Manipulations Affecting Fish Population

There are a number of factors that may significantly affect the aquatic biota of Lake Ontario through trophic interactions. Past species composition changes are attributed to the destabilizing influence of overfishing. Commercial fishing is now greatly reduced from past levels, but in conjunction with other factors it apparently has produced some irreversible effects. Although these changes have been occurring over a long period of time, there is no indication that the fish community has stabilized. A number of exotic species have been so successful that they now dominate the fish community.

The reintroduction of salmonids has produced a highly successful sport fishery and should help control alewife abundance, which has

sometimes been a problem. Ecological succession in the fish community of Lake Ontario has been altered by man. The water quality of Lake Ontario is generally good and apparently adequate to support the original fish stocks if they were still abundant. There are, however, localized areas of pollution; the discovery of concentrations of mirex in fish indicates that water quality may be influencing the fish community in unknown ways.

Based on the long-term trends established over the nine years of study presented in the preceding sections, power plants represent a minor influence on the lake aquatic community. Thermal discharges are a highly localized effect that may affect localized seasonal fish distribution but no consistent species-specific distribution was identified with the thermal discharges. Direct mortality as a result of impingement and entrainment has had no appreciable effect on the fish populations as demonstrated by long-term abundance. Naturally occurring seasonal and yearly cycles account for most of the variability observed in the monitored aquatic communities.

Endangered Species

Table 2.1.6-11 provides a list of the fish species classified by the NYSDEC as endangered or threatened. Only three species (longjaw cisco, shortnose sturgeon, and blue pike) reported at one time in New York State or the Great Lakes were listed by the U.S. Fish and Wildlife Service as endangered or threatened. These three were also present on the New York State list. Of the 15 species listed on the N.Y. State list, eight are located in areas outside of Lake Ontario. While the remaining seven species have been reported from Lake Ontario by various researchers over the years, either their behavior or low numbers have precluded their occurrence from the nine-year lake sampling program or the impingement sampling at Unit 1 or the JAF plant.

TABLE 2.1.6-11

LIST OF NEW YORK STATE
ENDANGERED AND THREATENED FISH SPECIES*

Common Name	Scientific Name	Reported presence in the site vicinity
ENDANGERED		
Longjaw cisco[a]	Coregonus alpenae	NO
Blue pike[a]	Stizostedion vitreum glaucum	YES
Shortnose sturgeon[a]	Acipenser brevirostrum	NO
Round whitefish	Prosopium cylindraceum	YES
Pugnose shiner	Notropis anogenus	NO
Eastern sand darter	Ammocrypta pellucida	NO
Bluebreast darter	Etheostoma camurum	NO
Gilt darter	Percina evides	NO
Spoonhead sculpin	Cottus ricei	YES
Deepwater sculpin	Myoxocephalus thompsoni	NO
THREATENED		
Lake sturgeon	Acipenser fulvescens	YES
Mooneye	Hiodon tergisus	YES
Lake chubsucker	Erimyzon sucetta	YES
Mud sunfish	Acantharchus pomotis	NO
Longear sunfish	Lepomis megalotis	YES

*Source: New York State Register; February 9, 1983 p. 7-9.

[a]Listed by the U.S. Fish and Wildlife Service as an endangered or threatened species (Federal Register, 2-25-83).

NOTE: All fish species listed by the U.S. Fish and Wildlife Service as endangered or threatened and at one time reported in New York or the Great Lakes are included in the N.Y. State list.

The literature on the general biology of the endangered species in Lake Ontario and the fishery sampling at Nine Mile Point indicate that this area is not of unique importance to these species. A recovery of the populations now in low abundance may be possible in the future for some species. The biological requirements of these species are such that the effects of power plant operation at Nine Mile Point would not prevent the recovery of these species if other conditions were favorable.

Commercial and Sport Fisheries of Lake Ontario

Commercial and sport fishing in Lake Ontario has undergone major changes with the reduction in abundance (and, in some cases, extinction) of many important species and the introduction of exotic game species(34). The species composition changes have shifted the emphasis of the commercial fishery from one that relied on relatively small numbers of large, valuable fish to a fishery that captures large numbers of small, lower value fish.

The formerly important commercial species which have been greatly reduced in abundance include the lake trout, blackfin cisco, shortnose cisco, bloater, kiyi, lake herring, lake whitefish, blue pike, white bass, and northern pike. The native species important in the commercial fishery include American eel, yellow perch, catfish, and bullheads. Other species which contribute to the commercial fishery include the white perch, carp, and rainbow smelt.

The important species in the sport fishery are less well defined than commercial species, but many species are probably taken at various times and locations around the lake. Centrarchids, especially the smallmouth bass, as well as yellow perch, catfish, bullheads, and white perch are taken by sport fishermen over a broad area. Rainbow trout, northern pike, and muskellunge are important

in restricted areas. Walleye, an abundant and popular sport fish in the 1950s, decreased in abundance after 1959 and is only now returning to its previous levels.

Recently, large numbers of salmonids, including lake trout, splake, coho salmon, chinook salmon, Atlantic salmon, steelhead trout, and brown trout have been stocked in the lake to take advantage of the food base provided by the alewife and to create recreational fisheries. The coho, chinook, and brown trout have survived well and an important sport fishery on these species has developed. New York State has recently constructed a large hatchery for salmon production on the Salmon River and large numbers of coho, chinook, and steelhead trout will be stocked in the future.

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2.2 POTENTIAL INTAKE IMPACTS

The intake sytem for Nine Mile Point Unit 2 consists of two hexagonal intake structures located at lake bottom contour, el 68.43 m (224.5 ft). The west intake will be approximately 290 m (950 ft) offshore and the east intake, approximately 320 m (1050 ft) offshore. The two intakes will be approximately 120 m (400 ft) apart and located on the same bottom contour. Each intake structure will have six intake openings 2.3 m (7.5 ft) wide by 0.9 m (3 ft) high. The total area of the 12 openings is designed to provide a combined maximum intake velocity of 0.15 m/s (0.5 fps). During normal plant operation, an average of 3380 l/s (53,600 gpm) of lake water will be withdrawn from Lake Ontario and utilized mostly as cooling water.

The flow enters the onshore screenwell, passes through the trash racks, and approaches the vertical traveling screens. The screens are angled to the flow with a fish bypass and return system located at the downstream end of the screens. Under average operating conditions, approximately 27% of the total intake flow is returned to the lake via this system.

The circulation and subsequent entrainment of ambient water into the intake exposes some organisms from each biotic group to plant effects. Since Unit 2 utilizes a closed-cycle cooling system, only the organisms diverted by the fish collection system will survive entrainment into the power plant's intake. The estimated impacts of entrainment on each of the major biotic groups are discussed in subsequent sections.

2.2.1 Phytoplankton

The impact of entrainment cropping on the phytoplankton community is different for Unit 2 than it is for either Nine Mile Point Unit 1

or the James A. FitzPatrick plant. Since Unit 2 will utilize a closed-cycle cooling system, the entrained flow rate is substantially smaller; however, 100% mortality of all entrained organisms is assumed. This provides a conservative estimate because some survival of organisms entrained in the bypass flow is anticipated.

The evaluation of the impact of entrainment cropping is based on projected water flow into Unit 2, general water circulation in Lake Ontario, and reproduction times for plankton populations in lakes. Since Unit 2 will withdraw considerably less water from Lake Ontario than either Unit 1 or JAF (approximately 18 and 14% of the latter plants' flows, respectively), its effect on the phytoplankton portion of the aquatic community will most likely be immeasurable, particularly since no substantial impacts from the operation of either Unit 1 or JAF have been noted[1-3].

The general circulation patterns in Lake Ontario have been documented and were reviewed by LMS[4]. While the predominant currents in Lake Ontario are alongshore, onshore and offshore currents also occur. Mean alongshore currents averaged 9 cm/s (0.3 fps), while onshore and offshore currents averaged 3 and 6 cm/s (0.09 and 0.2 fps), respectively. Therefore, no parcel of water will be subject to entrainment for any length of time and no portion of the plankton community will be continuously cropped.

Based on marine data, it can be assumed that typical growth rates for phytoplankton species in lakes range from 0.15-4.1 doublings/day, with most values near one doubling/day[5]. At one doubling/day, if one-half the population is entrained in a day, which is considerably higher than expected, the remaining population would replace the number entrained in one day; at four doublings/day, approximately 6 hrs would be required for comparable production.

This is a simplified approach, since it considers neither species interactions nor the fact that all phytoplankton do not grow at the same rate. Consequently, the change in relative proportions of species cannot be predicted. However, it is a reasonable approach since no major shifts in community composition of the phytoplankton have been seen from the operation of Unit 1 and JAF [1-3,6-8].

If a waterbody segment is assumed to extend just east of Nine Mile Point and west of the Oswego Steam Station (OSS), as described in LMS[4], the cropping resulting from either Unit 2 alone or Unit 2 in conjunction with the other plants located within this segment (JAF, Unit 1, and OSS) can be examined. This segment contains approximately 9.6×10^9 m^3 (3.4×10^{11} ft^3) of water. The daily water intake for Unit 2 is approximately 2.9×10^5 m^3/day (1.0×10^7 ft^3/day) or 0.0033% of the volume of the waterbody segment per day. In one year's time, Unit 2 would withdraw only 1% of the volume of the segment if the segment were not being naturally flushed by lake circulation and dispersion. When the turnover time of organisms in the waterbody segment is considered, the effect of entrainment cropping becomes negligible.

Data collected in the Nine Mile Point vicinity, as reported in Section 2.1, have indicated no long-term changes in the abundance or species composition of the plankton community attributable to the operation of the existing stations. The influence of Unit 2 is projected to be minimal because of its use of closed-cycle cooling. On an annual basis, the plant will withdraw less than 1% of the volume of the surrounding water body for cooling; this small withdrawal rate, coupled with the potential for regeneration, leads to the conclusion that Unit 2 will have negligible impact on the phytoplankton community.

2.2.2 Microzooplankton

As indicated in Section 2.1.2, seasonal abundance and species composition have been similar for microzooplankton for the last six years. No major shifts in this community have been noted. In addition, analysis of spatial trends has revealed no consistent patterns in the abundance of zooplankters. Temporal patterns have far outweighed any differences in abundance among stations.

Based on the same rationale developed for phytoplankton in Section 2.2.1, the impact on microzooplankton will be small and probably not distinguishable from natural variability.

2.2.3 Macrozooplankton

To assess the projected impact of macrozooplankton entrainment by Unit 2, impact on Gammarus fasciatus, an amphipod selected as a Representative Important Species in the Nine Mile Point vicinity[4,9] (Section 2.1.3) is discussed. While numerically more abundant in the benthic collections, this epibenthic organism will be subject to entrainment when present in the water column. Therefore, for discussion purposes, Gammarus is classified as a macrozooplankton.

To assess the impact of plant entrainment on this species, estimates were made of the total number entrained into the plant. These estimates were compared to the calculated standing stock of Gammarus in the lake in the vicinity of the plant. Since Unit 2 will have closed-cycle cooling, 100% mortality through the plant was assumed. Data collected during the 1976 JAF plant entrainment studies[1] were used to estimate the numbers entrained per unit volume.

The total number of Gammarus entrained by the JAF plant was calculated from the monthly entrainment abundance (Table 2.2.3-1) and

TABLE 2.2.3-1

MEAN[a] ABUNDANCE OF *GAMMARUS FASCIATUS* IN ENTRAINMENT COLLECTIONS

JAMES A. FITZPATRICK NUCLEAR POWER PLANT - 1976-1977

Date	Abundance (No./1000 m^3)
14 Jan 1976	9,675
18 Feb	541
17 Mar	264
14 Apr	357
12 May	153
16 Jun	330
14 Jul	246
18 Aug	377
8 Sep	147
6 Oct	287
3 Nov	301
15 Dec	252
1 Jan 1977	281
2 Feb	465
7 Mar	194

[a]Mean of four daily intake collections taken at two depths from January through September 1976 and mean of two daily intake collections taken at two depths from October 1976 through March 1977.
Source: 10

plant circulating water flow data. Two-month totals for the number of Gammarus entrained were computed (three months were computed for the period January to March 1977) to coincide with the standing stock estimates (see below). Projections of the number of total organisms entrained at Unit 2 during the two-month periods (based on the 1976 JAF entrainment data) were made for both projected mean and maximum plant flow conditions and are presented in Table 2.2.3-2. The maximum flow results represent a worst case condition, with the plant pumping at its maximum rate every day during the period.

To evaluate the effects of entrainment on the Gammarus community, estimates were made of the number of Gammarus present in the lake during the entrainment studies. Results of both the macrozooplankton lake collections and the benthic collections were examined for use in estimating the standing stock since G. fasciatus is present in both plankton and benthic collections(2). Since both data sets showed maximum abundance of Gammarus in August 1976, that month's data were selected to compare the number of Gammarus in the water column with those found on the bottom. The maximum observed abundance in the water column during 1976 was 9.2 organisms/m^3 in a bottom night collection (sample collected approximately 1 m above the lake bottom) on 18 August along the 6.1-m (20-ft) contour. The mean benthic abundance of Gammarus observed along this contour in August collections was 2999 organisms/m^2 of bottom area. Even if one assumed that the maximum observed concentration was actually distributed equally throughout the water column, it would represent only 56 organisms (9.2 organisms/m^3 x 6.1 m depth). This number represents approximately 1.9% of the observed mean benthic abundance of Gammarus. This example indicates that the main portion of the Gammarus community is benthic; therefore, standing stock estimates were made from the benthic abundance data. The estimates are

TABLE 2.2.3-2

PROJECTED TOTAL ENTRAINED, TOTAL IN WATERBODY SEGMENT AND PERCENT CROPPING OF GAMMARUS FASCIATUS
NINE MILE POINT UNIT 2

Sampling Period	Projected Volume[1] (m^3) Mean ($x10^6$)	Projected Volume[1] (m^3) Max. ($x10^6$)	Estimated Entrainment Abundance[2] (No./m^3)	Estimated Entrainment (No.) Mean ($x10^6$)	Estimated Entrainment (No.) Max. ($x10^6$)	Estimated Standing Crop[2] ($x10^7$)	Estimated Percent Cropping Mean	Estimated Percent Cropping Max.
Jan-Feb	16.468	17.825	2.740	45.12	48.84	864.9	0.52	0.56
Mar-Apr	17.490	18.137	0.272	4.76	4.93	269.8	0.18	0.18
May-Jun	18.178	18.178	0.242	4.40	4.40	601.3	0.07	0.07
Jul-Aug	18.178	19.300	0.312	5.67	6.02	1840.5	0.03	0.03
Sep-Oct	18.147	18.147	0.217	3.94	3.94	1459.9	0.03	0.03
Nov-Dec	18.128	18.128	0.276	5.00	5.00	1459.9	0.03	0.03

(1) Source: 11
(2) Source: 10

conservatively low in that they do not include the percentage of the population in the water column.

The estimates of standing stock were made for each seasonal set of benthic collections; for purposes of impact assessment, each population was assumed to be independent in terms of the effect of entrainment cropping during each period (Table 2.2.3-2). That is, it was assumed that the population does not undergo extensive immigration or emigration and that natural reproductive cycles take place during this period. Since no benthic collections were made outside the April-October period, November-December standing stocks were estimated from the October data and both 1976 and 1977 winter (January-February 1976 and January-March 1977) estimates were taken as the mean of the early spring and late fall estimates.

Standing stock was estimated for the area bounded by the benthic collections in the longshore direction (approximately 5.6 km [3.5 mi]) and to the 19.8-m (65-ft) depth in the lake. The total benthic area contained in the segment is approximately 6.8×10^6 m^2 (1680 acres).

Table 2.2.3-2 gives the results of two cropping calculations, one for each of the plant flow conditions evaluated. Estimated percent cropping during either projected mean or maximum plant flow conditions was less than 0.2% of the population throughout each sampling period, except during January-February (Table 2.2.3-2). At this time, the increase in the estimated percent cropping resulted from the high January entrainment abundance. Since similarly high abundances were not detected during either the summer period of naturally high lake abundance or the following winter period, it is probable that the January 1976 estimate was an anomaly in the data, not representative of actual entrainment cropping during the month.

The results of the Gammarus entrainment cropping analysis clearly indicate that the numbers of Gammarus removed by entrainment at Unit 2 represent an extremely small percentage of the local population and that such mortalities would have a negligible effect on the population.

2.2.4 Ichthyoplankton

To assess the projected impact of plant entrainment on the ichthyoplankton community, data collected during entrainment studies at Unit 1 and JAF have been utilized in conjunction with the results of the aquatic ecology studies presented in Section 2.1.4.

This analysis utilizes the data collected during 1976 since that was the first year that both Unit 1 and JAF were fully operational; data collected during other years are discussed qualitatively. The techniques used to collect these data are described in Section 3.1.4. For the cropping estimates, 100% mortality of entrapped organisms is assumed.

2.2.4.1 Species Present

Nearly all species identified from the lake collections (Section 2.1.4) were also found during entrainment sampling at either Unit 1 or JAF, and their temporal occurrence in the entrainment collections coincided with their occurrence in the lake[1-3,6-8]. During the early spring, burbot and Coregonus sp. were present, followed by rainbow smelt during midspring and alewife during the late spring/summer period. Peak concentrations of eggs and larvae in the lake occurred during the late spring/ summer period, dominated by alewives (Section 2.1.4); peak entrainment also occurred during this period. As with the lake collections, the most abundant species in entrainment collections were alewife and rainbow smelt[1-3,6-8].

Rainbow smelt and alewife are the only two Representative Important Species of fish[9,10] collected in sufficient numbers during ichthyoplankton entrainment surveys to allow impact assessment.

2.2.4.2 Estimated Entrainment of Selected Species

The projected total numbers of alewife eggs and alewife and rainbow smelt larvae entrained at Unit 2 were computed from the day/night abundance data amassed during the regular 1976 entrainment sampling program at Unit 1 and JAF. During the summer of 1977, JAF was shut down for refueling, and only limited analyses were conducted on 1978 data. The Unit 1 and JAF data are considered to be representative of the intake abundance that will occur at Unit 2 since all the intakes are at approximately the same depth contour. Since 100% mortality is assumed for the Unit 2 closed-cycle cooling system, no adjustment has been made for the fish diversion system flow. This flow normally represents 27% of the total flow withdrawn and would not be expected to incur 100% mortality to organisms entrained in it. However, since no studies have been made, the conservative approach, assumption of 100% mortality, has been taken.

The concentrations of eggs and larvae collected at the intake forebays were averaged to give a mean concentration per sample date (Table 2.2.4-1). This mean concentration by date was considered representative of the weekly abundance. Incubation time for alewife eggs is approximately six days at the water temperature in Lake Ontario during peak spawning activity[12]. Weekly cropping estimates can therefore be viewed as independent losses to the annual egg production. Rainbow smelt egg incubation time was reported to be 19 days at 9-10°C (48-50°F) for a population in the Miramichi River, New Brunswick[12]. Thus, contiguous weekly cropping estimates for rainbow smelt may not be independent estimates of losses, but rather may be replicate estimates of the loss from a fixed group of cohorts.

TABLE 2.2.4-1

MEAN ABUNDANCE* OF EGGS AND LARVAE FOR RAINBOW SMELT AND ALEWIFE IN ENTRAINMENT COLLECTIONS

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND NINE MILE POINT UNIT 1 - 1976

	Eggs				Larvae			
	Rainbow Smelt		Alewife		Rainbow Smelt		Alewife	
Date	NMP1	FITZ	NMP1	FITZ	NMP1	FITZ	NMP1	FITZ
14 Apr	0	0	0	0	0	2	0	0
28 Apr	145	834	0	0	0	0	0	0
5 May	50	177	0	0	6	0	0	0
12 May	25	41	0	0	0	1	0	22
19 May	1	0	0	0	8	6	0	7
26 May	4	9	0	0	0	4	0	7
2 Jun	7	2	2	0	6	6	0	0
9 Jun	38	0	3	0	2	21	0	0
16 Jun	0	0	18	9	1	5	0	0
23 Jun	0	0	1026	3060	0	0	0	6
30 Jun	0	0	34412	8057	0	0	4	71
7 Jul			4421	9807	1	1	13	15
14 Jul			791	3786	4	7	54	137
21 Jul			1393	1435	0	2	8	20
28 Jul			481	80	0	0	14	300
4 Aug			270	867	1	0	481	2524
11 Aug			68	562	3	1	115	527
18 Aug			0	0	4	1	372	612
25 Aug			0	0	20	0	135	438
1 Sep			0	0	0	1	116	32
8 Sep			0	0	0	0	4	2
22 Sep			0	0	0	1	12	9
6 Oct			0	0	0	0	1	2
20 Oct			0	0	0	0	1	2

*Mean of all samples on each sampling date; number of organisms/1000 m^3.
Source: 1

The estimated weekly entrainment concentrations are then multiplied by projected weekly plant flows to produce a projected weekly entrainment total. The projected weekly entrainment for alewife eggs and larvae is presented in Tables 2.2.4-2 and 2.2.4-3. Table 2.2.4-4 shows similar data for rainbow smelt larvae. The greatest projected entrainment is for alewife eggs, while the least is for rainbow smelt larvae.

2.2.4.3 Cropping Estimates for Eggs

The estimated total number of alewife eggs entrained per week under projected mean flow conditions was compared with the estimated total present in the adjacent segment of the lake during the same week and with fecundity of spawning adults. The area of the lake chosen for comparison was a waterbody segment bounded by the extent of sampling (i.e., larval tows). This segment covered approximately 5.6 km (3.5 mi) of shoreline and extended outward to the 33.5-m (110-ft) depth contour, which is approximately 1.6 km (1 mi) offshore.

The estimate of lake standing crop in the segment is based on the collections made with towed plankton nets and therefore represents the abundance of eggs in the water column at the time of sampling. Alewife eggs are demersal and can be sampled by plankton nets only for a short time immediately after being spawned in the water column. Most of the eggs present in the area of interest at any given time would be on the bottom; therefore, estimates based on towed net samples alone would grossly underestimate the total present.

Only some of the benthic samples from Nine Mile Point were analyzed for fish egg abundance by species. Although the data were not quantified, significantly more alewife eggs were reported in the benthic samples than in the concurrent plankton collections.

TABLE 2.2.4-2

PROJECTED TOTAL ENTRAINED AND PERCENT CROPPING OF ALEWIFE EGGS AT NINE MILE POINT UNIT 2

Sampling Period	Unit 2 Projected Flow[1] ($m^3 \times 10^6$)	1976 Entrainment (No./m^3)		Projected Unit 2 Entrainment ($\times 10^6$) Based On		Estimated Total in Water Segment ($\times 10^6$)	Estimated Percent Cropping Based On	
		Unit 1	JAF	Unit 1	JAF		Unit 1	JAF
Jun 6-12	2.084	0.0025	0.0	0.005	0.0	9.1	0.06	0.00
Jun 13-19	2.084	0.018	0.009	0.038	0.019	190.8	0.02	0.01
Jun 20-26	2.084	1.026	3.060	2.138	6.377	23,943.9	0.01	0.03
Jun 27-Jul 3	2.084	34.412	8.057	71.715	16.791	9,100.1	0.79	0.18
Jul 4-10	2.084	4.421	9.807	9.213	20.438	197,257.5	<0.01	0.01
Jul 11-17	2.084	0.791	3.786	1.648	7.890	332,552.4	<0.01	<0.01
Jul 18-24	2.084	1.393	1.435	1.999	2.991	149,800.3	<0.01	<0.01
Jul 25-31	2.084	0.481	0.080	1.002	0.167	62,646.2	<0.01	<0.01
Aug 1- 7	2.083	0.270	0.867	0.562	1.806	10,317.8	<0.01	0.02
Aug 8-14	2.083	0.068	0.562	0.142	1.171	443.4	0.03	0.26
Aug 15-21	2.083	0.0	0.0	0.0	0.0	0	0.0	0.0
Total (Jun 6-Aug 21)				88.462	57.650			
Mean (Jun 6-Aug 21)				8.042	5.241	71,508.3	0.01	0.01

(1) Source: 11

TABLE 2.2.4-3

PROJECTED TOTAL ENTRAINED AND PERCENT CROPPING
OF ALEWIFE LARVAE AT NINE MILE POINT UNIT 2

Sampling Period	Unit 2 Projected Flow[1] ($m^3 \times 10^6$)	1976 Entrainment (No./m^3)		Projected Unit 2 Entrainment ($\times 10^6$) Based On		Estimated Total in Water Segment ($\times 10^6$)	Estimated Percent Cropping Based On	
		Unit 1	JAF	Unit 1	JAF		Unit 1	JAF
Jun 13-19	2.084	0.0	0.0	0.0	0.0	0.14	0.0	0.0
Jun 20-26	2.084	0.0	0.006	0.0	0.012	0.85	0.0	1.41
Jul 27-Jun 3	2.084	0.004	0.071	0.008	0.148	3.61	0.22	4.10
Jul 4-10	2.084	0.013	0.015	0.027	0.031	14.54	0.19	0.21
Jul 11-17	2.084	0.054	0.137	0.113	0.286	17.57	0.64	1.63
Jul 18-24	2.084	0.008	0.020	0.017	0.042	32.74	0.05	0.13
Jul 25-31	2.084	0.014	0.300	0.029	0.625	30.38	0.10	2.06
Aug 1- 7	2.083	0.481	2.524	1.002	5.257	320.64	3.13	1.64
Aug 8-14	2.083	0.015	0.527	0.031	1.098	133.84	0.02	0.82
Aug 15-21	2.083	0.372	0.612	0.775	1.275	160.90	0.48	0.79
Aug 22-28	2.083	0.135	0.438	0.281	0.912	36.59	0.77	2.49
Aug 29-Sep 4	2.082	0.116	0.032	0.242	0.067	60.77	0.40	0.11
Sep 5-11	2.081	0.004	0.002	0.008	0.004	1.18	0.68	0.34
Sep 12-18	2.081	0.008	0.005	0.017	0.010	7.03	0.22	0.14
Sep 19-25	2.081	0.012	0.009	0.025	0.019	NS		
Sep 26-Oct 2	2.081	0.006	0.006	0.012	0.012	NS		
Oct 3- 9	2.079	0.001	0.003	0.002	0.006	NS		
Oct 10-16	2.079	0.001	0.002	0.002	0.004	NS		
Oct 17-23	2.079	0.001	0.002	0.002	0.004	NS		
Total (Jun 13-Oct 23)				2.593	9.812			
Mean (Aug 1-Sep 4)				0.466	1.722	142.55	0.33	1.21

[1] Source: 11

KEY: NS = Not sampled.

TABLE 2.2.4-4

PROJECTED TOTAL ENTRAINED AND PERCENT CROPPING OF RAINBOW SMELT LARVAE AT NINE MILE POINT UNIT 2

Sampling Period	Unit 2 Projected Flow[1] ($m^3 \times 10^6$)	1976 Entrainment ($No./m^3$) Unit 1	1976 Entrainment ($No./m^3$) JAF	Projected Unit 2 Entrainment ($\times 10^6$) Based On NMP1	Projected Unit 2 Entrainment ($\times 10^6$) Based On JAF	Estimated Total in Water Segment ($\times 10^6$)	Estimated Percent Cropping Based On Unit 1	Estimated Percent Cropping Based On JAF
May 2- 8	2.083	0.006	0	0.012	0	NS	-	-
May 9-15	2.083	0	0.001	0	0.002	NS	-	-
May 16-22	2.083	0.008	0.006	0.017	0.035	NS	-	-
May 23-29	2.083	0	0.004	0	0.008	NS	-	-
Nay 30-Jun 5	2.084	0.006	0.006	0.012	0.012	9.46	0.13	0.13
Jun 6-12	2.084	0.002	0.021	0.004	0.044	2.23	0.18	1.97
Jun 13-19	2.084	0.001	0.005	0.002	0.010	3.04	0.07	0.33
Jun 20-26	2.084	0	0	0	0	2.84	0	0
Jun 27-Jul 3	2.084	0	0	0	0	0.35	0	0
Jul 4-10	2.084	0.001	0.001	0.002	0.002	2.30	0.09	0.09
Jul 11-17	2.084	0.004	0.007	0.008	0.015	3.00	0.27	0.50
Jul 18-24	2.084	0	0.002	0	0.004	1.12	0	0.36
Jul 25-31	2.084	0	0	0	0	0.11	0	0
Aug 1- 7	2.083	0.001	0	0.002	0	0.97	0.21	0
Aug 8-14	2.083	0.003	0.001	0.006	0.002	0.54	1.11	0.37
Aug 15-21	2.083	0.004	0.001	0.008	0.002	0.45	1.78	0.44
Aug 22-28	2.083	0.020	0.000	0.042	0	0.42	10.0	0
Aug 29-Sep 4	2.082	0	0.001	0	0.002	0.13	0	1.5
Sep 5-11	2.081	0	0	0	0	0	0	0
Sep 12-18	2.081	0	0.001	0	0.002	0.43	0	0.46
Sep 19-25	2.081	0	0.001	0	0.002	NS	-	-
Total (May 2-Sep 25)				0.115	0.142			
Mean (May 30-Jul 17)				0.004	0.012	3.32	0.12	0.36

(1) Source: 11

KEY: NS = Not sampled.

Studies in Lake Michigan in the vicinity of the Zion and Waukegan Generating Stations included both net sampling and benthic sampling of alewife eggs with a suction pump(13). Two transects were sampled intensively with the pump during the period of peak alewife spawning, revealing large numbers of eggs present on the bottom. The Lake Michigan data(13) indicate that only 0.43% of the total eggs present were in the water column for the dates with concurrent sampling.

In Table 2.2.4-2 the total number of eggs present in the waterbody segment was thus computed by adjusting the mean concentration (No./1000 m^3) from night tows for each depth contour range (e.g., 0-9, 9-15, 15-21, 21-27, and 27-33 m [0-30, 30-50, 50-70, 70-90, and 90-110 ft]) by the factor 0.0043 and then multiplying by the volume for that depth range in the segment. The totals for each depth range were summed to produce a waterbody segment total from the stratified estimates.

Table 2.2.4-2 shows that the percentages of the weekly standing crops of alewife eggs removed by entrainment are extremely low. The overall seasonal cropping rates, based on Unit 1 and JAF data, are both 0.01%.

Since rainbow smelt eggs are demersal and adhesive, and spawning in the Great lakes occurs on stream bottoms or, under adverse weather conditions, in the offshore areas on gravel shoals (Section 2.1.4), these eggs are not usually subject to entrainment. Because the eggs are attached to the bottom, plankton tows or entrainment collections are not representative of the actual numbers available.

To attain a better concept of the entrainment egg abundances, the estimated total number of alewife and rainbow smelt eggs entrained was compared with the average fecundity of these species in Lake Ontario.

The average total number of eggs per female by size group is presented in Tables 2.2.4-5 and 2.2.4-6. The fecundity data for the control and experimental sites and for the different size groups were combined to produce a mean total number of eggs per female for each species. For alewife, the mean total number of eggs was 26,272 and for rainbow smelt, 24,288.

The estimated total number of eggs entrained for each species was divided by the mean number of total eggs per female to determine the average number of females required to produce the total eggs lost to entrainment. The results of these calculations indicate that the entrainment rate for Unit 2, based on the Unit 1 or JAF results, is equivalent to the fecundity of 2200 to 3400 alewives and about 23 to 91 smelt, a small fraction of the population estimates (Section 2.2.6).

2.2.4.4 Cropping Estimates for Larvae

Plant cropping estimates for alewife and rainbow smelt larvae were based on the same waterbody segment described for eggs and also on an estimate of the lakewide larval standing crops of these species from night collections. A lakewide cropping estimate was developed because alewife and rainbow smelt are distributed throughout the lake and apparently use the entire shoreline for spawning. Fishery and impingement sampling at widely spaced locations on Lake Ontario on both the United States and Canadian sides has shown these species to be abundant at all locations. CDM/Limnetics[14] summarized entrainment and impingement studies at power plants on Lake Michigan and found all life stages of alewife and rainbow smelt to be widely distributed in that lake. Wells[15] studied the distribution of fish fry along the shores of central and southern Lake Michigan and found alewife larvae distributed throughout this area (approximately two-thirds of Lake Michigan). Alewife larvae were more abundant

TABLE 2.2.4-5

FECUNDITY OF ALEWIFE

NINE MILE POINT VICINITY - JUNE-JULY 1976

I. Control Site[a]

Age	Number of Fish	Total Length (mm) Mean	Total Length (mm) Range	Total Eggs/Ovary Mean	Total Eggs/Ovary Standard Deviation	Mature Eggs/Ovary Mean	Mature Eggs/Ovary Standard Deviation
II	15	156	145 - 170	23435	7309	12052	3243
III	15	157	129 - 179	28779	8199	14329	3776
IV	15	170	157 - 181	27211	6713	15333	2905
V	6	168	156 - 180	26914	6662	13750	3114

II. Experimental Site[b]

Age	Number of Fish	Total Length (mm) Mean	Total Length (mm) Range	Total Eggs/Ovary Mean	Total Eggs/Ovary Standard Deviation	Mature Eggs/Ovary Mean	Mature Eggs/Ovary Standard Deviation
II	15	157	129 - 168	21756	5889	11763	2840
III	15	152	130 - 172	24653	8253	13547	4216
IV	15	166	137 - 180	27333	8367	14740	3917
V	11	167	137 - 184	30097	9144	16429	4469

[a] Bottom Gill Net: NMPW, NMPE
Surface Gill Net: NMPW, NMPE

[b] Bottom Gill Net: NMPP, FITZ
Surface Gill Net: NMPP, FITZ

TABLE 2.2.4-6

FECUNDITY OF RAINBOW SMELT

NINE MILE POINT VICINITY - APRIL-MAY 1976

I. Control Site[a]

Age	Number of Fish	Total Length (mm) Mean	Total Length (mm) Range	Total Eggs/Ovary Mean	Total Eggs/Ovary Standard Deviation
II	7	144	137 - 154	9041	1688
III	15	153	142 - 172	11764	3558
IV	14	168	145 - 209	16261	6398
V	12	207	163 - 248	36895	20105
VI	5	231	211 - 264	55477	20241

II. Experimental Site[b]

Age	Number of Fish	Total Length (mm) Mean	Total Length (mm) Range	Total Eggs/Ovary Mean	Total Eggs/Ovary Standard Deviation
II	10	145	133 - 162	10049	1876
III	15	157	137 - 215	13949	7092
IV	16	165	146 - 193	15614	4408
V	15	209	158 - 250	33490	15030
VI	3	224	222 228	40344	4885

[a]Bottom Gill Net: NMPW, NMPE
Surface Gill Net: NMPW, NMPE
Bottom Trawl: NMPW, NMPE

[b]Bottom Gill Net: NMPP
Surface Gill Net: NMPP, FITZ
Bottom Trawl: NMPP/FITZ

on the east shore than the west shore, but this difference was probably caused by upwellings on the west shore which carried larvae out of the study area. Rainbow smelt larvae were less abundant than alewife larvae, but they were also distributed throughout the study area.

Because the larval stage lasts more than one week, both weekly cropping estimates and total entrainment are compared with an average standing crop during the peak of larval abundance. This approach is conservative because the actual population present in the waterbody segment throughout the larval period is greater than the number present during the peak abundance period. Furthermore, an additional conservative factor was added to the estimate because larvae living in the deeper portions of the lake were not accounted for in the computation of cropping rate.

The weekly cropping estimates for alewife larvae in the waterbody segment of interest ranged from 0 to approximately 4% (Table 2.2.4-3). Weekly cropping estimates for rainbow smelt larvae ranged from 0 to 10% (Table 2.2.4-4). While these estimates cannot be summed to produce a seasonal cropping percentage, they do indicate the projected rate of loss of larvae for weekly time units in the vicinity of Unit 2.

During their period of maximum abundance in the vicinity of Nine Mile Point (1 August to 4 September), alewife larvae had a mean weekly abundance of 143×10^6. Cropping percentages based on total alewife larvae entrained in 1976 were approximately 0.3 and 1.2% based on Unit 1 and JAF data, respectively (Table 2.2.4-3). Rainbow smelt larvae had a mean weekly abundance of 3×10^6 during the period of peak abundance (30 May to 17 July) in the vicinity of Nine Mile Point. Annual cropping percentages of approximately

0.1 and 0.4% based on Unit 1 and JAF data, respectively, were obtained from the estimated total number entrained during 1976 (Table 2.2.4-4). The conservative nature of this calculation should be emphasized in that the standing stock estimates do not account for the immigration and emigration of larvae to and from the waterbody segment.

A lakewide standing crop estimate of alewife larvae was computed from the mean abundance of larvae during the period of peak abundance (143×10^6) at Nine Mile Point and the ratio of the waterbody segment shoreline length (5.6 km [3.5 mi]) to the total shoreline length for Lake Ontario (1371 km [857 mi.])[16].

An estimated total of 3.5×10^{10} alewife larvae were present in Lake Ontario in an area around the entire perimeter of the lake and extending outward to the 33-m (110-ft) depth contour. Lakewide cropping estimates are based on the projected number of larvae entrained by all units at the Nine Mile Point site, i.e., by JAF, Unit 1, and Unit 2 combined. A similar calculation was performed for rainbow smelt larvae, and a lakewide estimate of 8.1×10^8 larvae was obtained. Entrainment estimates for alewife and rainbow smelt larvae at Unit 1 and JAF were taken from LMS[10].

Lakewide cropping estimates for alewife and rainbow smelt larvae are low for both Unit 2 alone and JAF and Units 1 and 2 combined (Table 2.2.4-7). The contribution of Unit 2 to larval cropping in Lake Ontario will be practically immeasurable.

2.2.4.5 Impact of Egg and Larval Cropping

Considering the demersal nature of the eggs of both alewife and rainbow smelt, a low percentage of cropping (less than 1%) of eggs is indicated. The egg cropping estimate, in terms of the number of

TABLE 2.2.4-7

ESTIMATED LAKEWIDE CROPPING OF ALEWIFE AND RAINBOW SMELT LARVAE

JAMES A. FITZPATRICK POWER PLANT AND NINE MILE POINT UNITS 1 AND 2

I. Alewife

Total Number Entrained ($X 10^6$)			Lakewide	Percentage Cropped		
UNIT 2	FITZ AND UNIT 1	FITZ, UNIT 1 AND 2	(Total $X 10^6$)	UNIT 2	FITZ AND UNIT 1	FITZ, UNIT 1 AND 2
6*	83	88	34,905	0.02	0.24	0.25

II. Rainbow Smelt

Total Number Entrained ($X 10^4$)			Lakewide	Percentage Cropped		
UNIT 2	FITZ AND UNIT 1	FITZ, UNIT 1 AND 2	(Total $X 10^4$)	UNIT 2	FITZ AND UNIT 1	FITZ, UNIT 1 AND 2
11*	191	202	81,149	0.01	0.24	0.25

*Total entrained by UNIT 2 based on mean of FITZ and UNIT 1 data (see Tables 2.2.4-3 and 2.2.4-4).

average mature females required to produce the eggs lost (2200 to 3400 alewife and 23 to 91 smelt), indicates that this loss represents only a small fraction of the spawning potential of these populations, which certainly have the ability to offset the small egg losses.

Waterbody segment cropping of larvae, based on an average maximum standing crop and conservative estimates of the population size, produced percentages cropped ranging up to 10%. The most important factor, which would reduce the cropping percentage substantially, is the inclusion of the larvae that were not accounted for in the average standing crop. The total actually present would certainly be greater than the average. In addition, only those larvae inside the 33-m (110-ft) depth contour were included. The assumption of 100% plant mortality also increases the estimated cropping over what actually occurs.

The projection of plant cropping on a lakewide larval population basis is a rough estimate, because it is based on an average standing crop for only a small portion of the total potential spawning area. The actual larval population density would be expected to vary significantly from place to place along the shoreline. However, the lakewide cropping estimates provide a rough estimate for the lake as a whole, which is an important perspective for impact assessment. These estimates are low (0.02%) and conservative because the same factors that affected the standing crop estimate for the waterbody segment apply to the lakewide estimate.

In Section 2.2.6 the lakewide abundance of alewife, as determined from Yankee trawl data, is given as 2.3×10^9 (adjusted). When this is compared with the lakewide abundance of larvae estimated in this section (3.5×10^{10}), it is apparent that the number of

larvae in the lake is grossly underestimated. It would be expected that a much greater number of larvae would be produced if the lakewide abundance of older age groups were reasonably accurate. If larval abundance has been underestimated, as suggested here, the larval cropping percentages would actually be much lower.

The combined cropping of eggs and larvae of alewife and rainbow smelt by JAF and Units 1 and 2 will remove an extremely small percentage of the reproductive potential of these populations, and the impact of Unit 2 alone will be immeasurable since projected cropping is more than an order of magnitude lower than cropping by the existing plants, whose effects have been undetectable.

2.2.5 Benthos

The degree to which the Unit 2 intake system interacts with the adjacent invertebrate communities is a function not only of flow rate and design characteristics of the plant but also of the nature of the organisms themselves. Of significance is the life history of each taxon under consideration. Some benthic forms, for example, pass their entire lives closely associated with the bottom, moving within (infauna) or upon (epifauna) the lake bottom. Others make transient use of the water column for breeding, feeding, active swimming, or drifting with water currents. Benthic species that utilize the water column are susceptible to power plant entrainment. During these life stages, their degree of susceptibility depends mainly upon their pelagic movement (near the surface, on the bottom, or throughout the entire water column) and swimming ability.

In considering intake system impacts, both direct and indirect effects are evaluated. The former include entrainment of all life stages. Indirect effects may occur via attraction of nektonic predators to the intake area. If either type of interaction occurs,

it is likely to be discernible near the existing Unit 1 intake where long-term monitoring at near- and farfield stations has continued over a six-year study period.

The resiliency of benthic populations has been documented in several studies of benthic estuarine communities[17], marine communities[18], and freshwater communities[19].

Similar studies[20-24] conducted in the vicinity of power generating stations indicate that, in general, the intake areas for each of the sites studied contain benthic communities that would be considered "typical" or unaltered for the ecosystem under consideration. The common conclusion is that the major potential for impact would arise from the discharge of warm water, and the significance of this impact is dependent upon a number of site-specific factors (see Section 2.3.2).

As shown in Section 2.1.5, the benthic organisms near the intake of Unit 1 have undergone a variety of natural changes since the initial sampling in 1968 and during the six years of intensive study. The key factors involved in these fluctuations, however, were natural environmental changes over time, climate, substrate nature, and organic content of the sediment. Similar benthic variability has been documented in a 16-year study of the lower York River Estuary, where Boesch et al.[25] found that few common benthic species were persistent and most were either irruptive, annuals, or euryhaline opportunists responding to habitat change. The data base described in Section 2.1.5 indicates typical benthic patterns over time and does not suggest adverse processes that were identifiable with the operation of the Unit 1 intake system.

Because the large data base shows no impact on the benthic communities from the operation of the Unit 1 intake, it is reasonable

to expect no impact from the withdrawal of a lesser amount of water for Unit 2.

2.2.6 Fish

The impingement sampling data for Unit 1 and the JAF plant provide a basis for estimating the total annual impingement by species at the Unit 2 intake. Because a fish diversion and return system was incorporated into the Unit 2 intake, only a fraction of the fish entrapped in the offshore intake will be impinged. The major portion of these fish will be returned to the lake. The studies of fish protection systems for Unit 2 and ongoing studies on a similar system at the OSS Unit 6 provide estimates of survival subsequent to passage through the diversion system. This information was used to estimate the mortality expected for selected species at Unit 2. A description of the diversion system is provided in NMPC-EROLS[11].

The impingement rate for Unit 2 was estimated by the extrapolation of the impingement rates of Unit 1 to Unit 2 by the ratio of the plant flows. This method assumes that the impingement rate is directly proportional to plant flow rate.

The Unit 1 impingement data were selected as the primary bases for extrapolation because there are nine years of continuous sampling as opposed to only six years at JAF. The trend in both fishery and impingement sampling has indicated cyclic trends in abundance of some species. Because the Unit 1 data cover a longer time than the JAF data, they better reflect the changing abundances of these species in the Nine Mile Point vicinity. In addition, the Unit 2 intake design is similar to that of Unit 1, but differs substantially from the JAF design.

The impingement rate of some abundant fishes has been somewhat higher at JAF than at Unit 1; however, there is no consistent pattern in month by month comparisons except for rainbow smelt. A large number of potential factors could account for this difference, but how they may interact to control the impingement rate at the two plants is unknown at present. Because the Unit 2 intake is located between the Unit 1 and JAF intakes, its impingement rate (adjusted for flow differences) may fall between the other two. However, because the initial extrapolation is not based on a knowledge of the factors influencing impingement, this refinement is not justified.

Because it is impossible to predict when plant outages will occur, the estimated impingement rate for Unit 2 assumes that the plant will operate all days of the year. This assumption will therefore produce an estimated total annual mortality greater than the actual one. The difference between the two will depend on the duration and seasonal occurrences of unit downtime. An extended period of downtime in early spring would have the most pronounced effect on the annual total because the spring peaks in alewife and rainbow smelt impingement would be eliminated.

The Unit 2 intake structure will incorporate a diversion system to return entrapped fish to the lake. This system was designed by Stone and Webster Engineering Corporation (SWEC), which conducted laboratory tests of diversion efficiency and survival of alewife after passage through the system. These tests indicated an overall test mortality rate of 11.8% and a control mortality of 7.8%[26]. Preliminary studies conducted by LMS on the OSS Unit 6 diversion system, similar in design to the Unit 2 diversion system, have demonstrated substantially lower alewife survival following passage

through the system. The results of the Oswego studies indicate alewife survivals between 2 and 34%, with an estimated yearly survival rate of 9.6%[27]. The rainbow smelt, white perch, and spottail shiner estimated yearly survival rates were 13.1, 41.1, and 85.1%, respectively. The major game fish (brown trout, smallmouth bass, lake trout) collected from the system all demonstrated greater than 95% survival.

Since the LMS studies are being conducted on an operating system (as opposed to the SWEC studies, which were conducted on a laboratory scale), the results from the LMS Oswego studies will be used for this assessment. These results are believed to be conservative (effects are overestimated) because no adjustments were made for control or handling mortality.

Table 2.2.6-1 contains the estimated monthly impingement and estimated yearly total impingement for selected species at Unit 1. Table 2.2.6-2 provides an estimate of Unit 2 entrapment (obtained by multiplying the Unit 1 total by 0.20, the ratio of Unit 2 to Unit 1 design plant flows) and mortality (obtained by multiplying the number entrapped by the mortality observed from the Oswego diversion system).

The estimated mortality is low for all species except alewife,and when the alewife total is compared with the annual impingement rates at other Lake Ontario power plants, the mortality at Unit 2 is seen to be a small contribution. The effects of impingement cropping at power plants on Lake Ontario were evaluated in the 316(b) demonstration for the JAF plant[10]. That evaluation is presented here in slightly modified form to show the relative magnitude of impingement effects at Unit 2.

TABLE 2.2.6-1

ESTIMATED MEAN MONTHLY* AND TOTAL YEARLY IMPINGEMENT
FOR SELECTED SPECIES
NINE MILE POINT UNIT 1

Species	Yearly Total	January	February	March	April	May	June	July	August	September	October	November	December
Alewife	1,261,910	1,301	284	60,504	631,964	399,278	44,670	28,440	33,618	9,778	20,049	17,050	14,974
Rainbow smelt	79,939	13,988	5,377	6,957	11,981	10,798	1,571	357	536	1,435	962	3,698	22,279
White perch	6,666	1,099	628	1,613	918	221	44	37	166	377	116	583	863
Yellow perch	2,817	579	198	102	128	912	42	113	78	36	77	202	350
Smallmouth bass	223	35	26	11	5	24	30	13	15	7	13	16	28
Coho salmon	<6	<1	0	<1	<1	<1	0	<1	<1	0	0	0	0
Threespine stickleback	45,589	1,253	2,071	4,872	20,044	14,645	1,171	961	2	33	34	95	106
Brown trout	12	2	0	<1	0	<1	1	3	1	<1	0	1	1
Spottail shiner	3,298	300	112	231	260	1,252	268	185	107	84	51	136	312

*Mean estimated impingement based on monthly collection from 1973 through 1981.
Sources: 1-3,6-8,28-30

TABLE 2.2.6-2

ESTIMATED TOTAL ENTRAPMENT AND MORTALITY
FOR SELECTED SPECIES
NINE MILE POINT UNIT 2

Species	Annual Total Unit 1	Annual Total Entrapment Unit 2[1]	Annual Total Mortality Unit 2[2]
Alewife	1,261,910	252,382	228,153
Rainbow smelt	79,939	15,988	13,590
White perch	6,666	1,333	785
Yellow perch	2,817	563	28
Smallmouth bass	223	45	2
Coho salmon	6	1	<1
Threespine stickleback	45,589	9,118	456
Brown trout	12	2	<1

(1) Obtained by multiplying Unit 1 total by 0.20, the ratio of design plant flows.

(2) Obtained by multiplying Unit 2 total by the estimated mortality rate in the fish diversion system based on the OSS Unit 6 diversion results.

The impact of removing a number of fish from a population can be addressed in many different ways. In this analysis, the removal of fish is related to such measures of population size as (1) lake standing stock estimates, (2) commercial fishing removals, (3) stocking statistics for the species, and (4) exploitation rates based on tagging studies.

In 1976, the New York State Department of Environmental Conservation (NYSDEC)[31] conducted a forage fish stock estimate for the demersal portion of the alewife and rainbow smelt populations in the New York waters of Lake Ontario, which was divided into four sectors: (1) the Eastern Outlet Basin Sector, extending from Stony Point Light north to the Cape Vincent Laboratory; (2) the Oswego Sector, centered approximately at Oswego, NY, and extending east to the eastern shore and approximately the same distance west; (3) the Rochester Sector, centered on Rochester, NY, and extending from Sodus Bay to approximately Thirty Mile Point; and (4) the Wilson-Olcott Sector, extending from Thirty Mile Point to just west of the Niagara River. Within each sector, replicate trawls were conducted at the following depths: 5, 7, 10, 12, 15, 17, 20, 25, 30, 35, 40, and 50 fathoms; in addition, sector acreage estimates were made for each depth sampled. A 12-m (39-ft) headrope Yankee trawl was used, with the following fishing dimensions: 6.4 m (21 ft) for the sweep and 2.1 m (7 ft) for the maximum vertical opening. A standard 10-min tow covered approximately 0.49 ha (1.2 acres) of bottom[31]. Trawl catches for each sector were separated into two or three depth strata and average catch rates were calculated for each stratum. The NYSDEC developed the standing stock estimates by expanding the average catch per tow to total fish per stratum (average catch x stratum acreage/1.2). The average weight of each species was then expanded to a total weight per depth stratum, and summations were made for the depth strata and sector to give a total biomass[31].

For this analysis, the biomass values were converted to numbers of fish by dividing the biomass by the average weight of the fish caught by NYSDEC. This was done for the Oswego Sector alone and for the total estimate for the four sectors combined, which represent 18% of the total New York State surface acreage of the lake. The standing stock estimates were divided by 0.18 for extrapolation to the total New York State lake area.

Storr(32) has conducted mark-recapture experiments along the southern shore of Lake Ontario since 1972, marking and recapturing fish from North Sandy Pond on the eastern shore to Oswego. Tag returns were also obtained by giving a one dollar reward to commercial and sport fishermen. In addition, as part of the impingement monitoring programs at JAF and Unit 1, impinged fish were examined for tags.

A total of 20,897 fish representing 26 species were tagged and released in the program through 1976, and 1517 tags were returned. All fish tagged during 1972 and 1973 were tagged in the immediate Nine Mile Point vicinity, while from 1974 on, fish were tagged at four locations in the study area. During 1974, approximately 83% of the fish tagged were released in the Nine Mile Point vicinity where they would be exposed to potential impingement at the Nine Mile Point plant. While no breakdown of the percentage of fish tagged at each location is available for the 1975 or 1976 data, the percentages can be assumed to be similar to 1974 since the major tagging effort was again in the Nine Mile Point vicinity.

Storr(32) has shown that of all the species studied, only yellow perch demonstrate a true migratory pattern, a movement toward the eastern end of the lake during winter with spawning in the spring in North Sandy Pond. The other species appear to move back and forth along the shore with little predictability. Rock bass, pumpkinseed,

yellow perch, and brown bullhead ranged long distances, up to 112 km (70 mi), while smallmouth bass appeared to be territorial, generally remaining in a small area near the shoreline. White perch were observed to move moderately long distances, ranging 32 km (20 mi) east and west of Nine Mile Point.

The data presented by Storr[32] are used in several ways: (1) to estimate a species domain, (2) to estimate annual mortality, and (3) to approximate a power plant exploitation rate. In the analysis of the tag return data from impingement collections, reference is made to Unit 1 since this plant has been in operation since the beginning of the tagging program and impingement collections have been examined for tag returns. The analyses of impingement cropping are presented separately for the important species below.

2.2.6.1 Alewife

The NYSDEC data were used as described above and the resulting alewife standing stock estimates are presented in Table 2.2.6-3. These estimates are only for the near-bottom waters where the trawl fished and are based on the assumption of 100% trawl efficiency. Edsall et al.[33], in an analysis of the standing stock of alewives in Lake Michigan, concluded that only 3% of the fish (80-139 mm [3-5.5 in.] long) taken in gill nets fished from surface to bottom in 26 fathoms were in the lower 12 m (40 ft) of water. They therefore used a factor of 10 to expand standing stock estimates, based on the assumption that only 10% of the fish were in the lower 1.2-2.4 m (4-8 ft) of the water column where the trawl fishes. In the results presented, the alewife standing stock is estimated with and without the factor of 10 to show bottom-trawled standing stocks and the full water column estimate (adjusted standing stock).

This analysis is open to two possible sources of error in addition to fish distribution in the water column and the assumption of 100%

TABLE 2.2.6-3

STANDING STOCK ESTIMATES FOR ALEWIFE AND RAINBOW SMELT IN THE NYSDEC OSWEGO SECTOR, ALL OF NEW YORK STATE'S WATER TO 110 m (360 ft) AND THE TOTAL U.S. LAKE AREA[1]

Species	Location	Number Impinged at Unit 1	Estimated Mortality at Unit 2	Standing Stock	Adjusted Standing Stock[2]	Percent Cropped at Unit 1		Percent Cropped at Unit 2	
						Standing Stock	Adjusted Standing Stock	Standing Stock	Adjusted Standing Stock
Alewife	Oswego Sector	1,261,910	228,153	122,998,300	1,229,983,000	1.03	0.10	0.20	0.019
	New York State Waters to 110 m (360 ft)[3]			226,083,000	2,260,830,000	0.56	0.06	0.10	0.010
	Lake-wide (U.S. Only)[4]			1,256,021,000	12,560,210,000	0.10	0.01	0.02	0.002
Rainbow smelt	Oswego Sector	79,939	13,590	11,703,510	117,035,100	0.68	0.07	0.12	0.012
	New York State Waters to 110 m (360 ft)[3]			17,902,650	179,026,500	0.44	0.04	0.08	0.008
	Lake-Wide (U.S. Only)[4]			99,459,000	994,590,000	0.08	0.01	0.01	0.001

(1) Data from Reference 31.

(2) Standing stock from bottom trawl collections multiplied by 10 for upper water column fish.

(3) Represents 18 percent of U.S. lake surface area.

(4) Extrapolated to 100 percent of U.S. lake surface area.

gear efficiency. First, the NYSDEC estimates extended only to the 110-m (360-ft) depth contour. Since the NYSDEC estimates represent 18% of the total New York State lake area, the standing stock estimates were divided by 0.18 for extrapolation to the total New York State lake area. This may result in an error if the total population estimate of the alewife is not uniformly distributed from shore to midlake.

Second, the average weight of the alewives collected by the NYSDEC was 27.2 g (0.06 lb), while the average weight of impinged fish was 18.0 g (0.04 lb), indicating that a greater percentage of younger fish were present in impingement collections than were sampled by the trawl. The trawling program conducted by the NYSDEC either did not collect young fish (young-of-the-year and yearlings) or natural mortality of these ages had occurred by the time of the trawling, and the average weight reflects the true average weight/individual of the remaining stock. The NYSDEC trawling program was conducted between 18 October and 12 November 1976, late enough in the year so that mortality of young fish could have occurred, whereas impingement collections were conducted throughout the year. Thus, the NYSDEC stock estimate may not be representative of the populations affected by impingement; however, no stock estimates are available for other times of the year.

The former hypothesis, that the NYSDEC simply did not collect young fish, is supported by several observations. Smith[34] stated that young alewives reside in the water column off the bottom for at least the first year of life. The NYSDEC stated that many targets were observed with hydroacoustic equipment in the upper water column at the time of the surveys in the Rochester area. Wells[35] found alewives in the water column throughout the year in Lake Michigan. It appears, therefore, that the trawling conducted by NYSDEC would result in an underestimate of the true standing stock since a large

portion of the population would be above the bottom waters sampled by the trawl. This is additional evidence supporting the use of the multiplier to estimate total standing stock from bottom trawls. The evidence on alewife distribution in the water column, the weight differential between impinged and netted fish, and the assumption of 100% gear efficiency all support the use of the stock adjustment. The adjusted stocks are still considered conservative estimates of the true standing stock.

The estimated yearly impingement mortality at Unit 2 was divided by the NYSDEC standing stock estimates to determine alewife impingement cropping. The cropping effect of Unit 2 (0.20%) is extremely small for the Oswego sector and other designated areas of the U.S. waters of Lake Ontario (Table 2.2.6-3). The cropping estimates for Unit 1 are included in this table to contrast Unit 2 with a once-through cooling system that does not incorporate a fish diversion system. For the preceding reasons, these estimates of cropping are considered conservative.

2.2.6.2 Rainbow Smelt

The NYSDEC forage fish standing stock estimate included an estimate of the rainbow smelt stock. The standing stock data derived in this section were calculated in the same manner as the alewife data. The results, therefore, may be subject to the same conservative error as the alewife results. As with alewife, the rainbow smelt mortality at Unit 2 was estimated to represent 0.12%, an extremely small percentage of the estimated standing stock in the Oswego sector and other designated areas of the U.S. waters of Lake Ontario (Table 2.2.6-3).

2.2.6:3 White Perch

Storr[32] tagged a total of 1421 white perch in the Nine Mile Point vicinity from 1972 to 1976, of which 488 were tagged in 1976. Only one tagged white perch was recovered in the JAF plant impingement collections (April 1977), with no tag returns observed at the Nine Mile Point plant. Since annual mortality rates for tagged white perch were not computed, it is impossible to determine the total number of tags available at the time of the recovery in 1977. But with an assumed 50% mortality rate and only those fish tagged during 1976 considered, an exploitation rate of 0.82% would result after adjustment for impingement sampling frequency. The lack of any tagged fish in the Unit 1 impingement studies, which have been ongoing since 1973, indicates that impingement cropping of white perch is negligible.

A total of 20,525 kg (45,249 lb) of white perch were harvested by commercial fishermen from New York State waters of Lake Ontario during 1976[36]. If an average weight of 32.4 g/fish (0.07 lb/ fish) (from 1976 impingement data at the JAF plant[1]) is assumed, a total of 633,487 fish were harvested. The average Unit 1 impingement during the period 1973 through 1981 amounted to 6666 fish. Thus, impingement was 1.0% of commercial fishing exploitation. The Unit 2 mortality rate is projected to be 0.12% of the commercial catch in 1976. The available data indicate that impingement cropping is minimal when compared with available fish in the area or commercial fishing pressure.

2.2.6.4 Yellow Perch

An exploitation rate was calculated based on the number of tagged fish recovered in impingement collections compared to the number of tagged fish available in the lake. Although yellow perch tagging

began in 1972, no tagged yellow perch were recovered in impingement collections at either the JAF plant or Unit 1 prior to 1976. During 1976, two tagged fish were recovered at Unit 1 and one at the JAF plant. Since sampling at both plants took place on 43% of the days during 1976, the total estimated number of returns is calculated to be five fish and two fish at Unit 1 and the JAF plant, respectively.

An estimated 1232 tagged yellow perch were available in 1976. The seven-fish impingement estimate for Unit 1 and the JAF plant combined then represents an exploitation rate of 0.57% of the available tagged yellow perch. When compared to an average exploitation rate of 7.41%[32], based on other fishing efforts (total tag returns), the impact of impingement is negligible. Based on the total number of yellow perch impinged during 1976 (3695) and the New York State commercial catch of 23,841 kg (52,560 lb)[36] (which represents 478,000 fish, based on an average weight of 49.8 g/fish [0.11 lb/fish]), impingement at Unit 1 and the JAF plant during 1976 represented 0.77% of the commercial harvest. Compared to other sources of mortality, impingement at Unit 1 and the JAF plant is insignificant. The Unit 2 impingement, based on 1976 statistics, would represent less than 0.01% of the commercial harvest.

2.2.6.5 Smallmouth Bass

Storr[32] has tagged 126 smallmouth bass since 1972 but none were collected from the traveling screens at Unit 1 or the JAF plant through December 1981. Since the majority of these fish were tagged and released in the immediate vicinity of the two intakes, the lack of any recoveries in impingement collections would indicate that the plants do not have a significant effect on the local smallmouth bass population.

No commercial catch statistics are available for smallmouth bass, so comparisons to commercial harvest were not possible; however, Storr

had 19 tags returned of the total of 126 smallmouth bass tagged. For the most part, these tags were returned by commercial and sport fishermen, and an exploitation rate of 15.1% can thus be attributed to commercial and sport fishing combined. Therefore, based on the lack of any tag returns in impingement collections, cropping by the power plants would be at least an order of magnitude less than that by fishing mortality.

2.2.6.6 Coho Salmon

Coho salmon do not occur naturally in Lake Ontario, but are stocked by various state and Federal agencies. Thus, the only population size data available are from stocking statistics. Impingement at Unit 1 and the JAF plant and estimated impingement at Unit 2 are therefore compared to stocking conducted by NYSDEC.

The estimated total impingement of coho salmon from 1976 through 1981 at Unit 1 and the JAF plant was 10 fish[1-3,6-8,28-30]. NYSDEC stocked approximately 1,753,000 coho from 1975 through 1980[37]. The 10 fish impinged at the two plants represent an insignificant portion of the fish stocked during this period and the fish return system on Unit 2 will return any salmon inadvertently entrapped in its cooling water flow.

2.2.6.7 Threespine Stickleback

Since no standing stock or tagging data are available for threespine stickleback, impingement cropping rates cannot be calculated. However, the large cycles of population abundances exhibited by this species, noted in Section 2.1.4 and indicated in the impingement data, demonstrate that the population is regulated by some other factors (weather, predation, fecundity, or inherent behavior) that far override the localized effect of impingement cropping.

2.2.6.8 Brown Trout

The brown trout is not native to North America but was introduced into New York during the 19th century. Recently, Lake Ontario stocks have been maintained by New York and Canadian stocking programs. Therefore, cropping at Unit 1, the JAF plant, and Unit 2 is compared to New York State stocking statistics.

An estimated 256 brown trout were impinged from 1976 through 1981 at Unit 1 and the JAF plant[1-3,6-8,28-30]. NYSDEC stocked 1,881,000 brown trout from 1975 through 1980[37], and impingement cropping therefore represents less than 0.02% of the stocked fish. Unit 2 represents a small addition to this estimated cropping.

2.2.6.9 Endangered Species

The species currently listed by the NYSDEC and U.S. Fish and Wildlife Service as endangered or threatened are presented and discussed in Section 2.1.6 of this report. None of these species have been collected in impingement at Unit 1 or the JAF plant nor are any anticipated to be collected at Unit 2.

2.2.6.10 Summary of Impingement Impact

The preceding analyses indicate that the total annual mortality at Unit 2 is expected to be low for all species. This mortality, relative to various measures of abundance in the vicinity of Nine Mile Point, indicates that plant effects will be insignificant at the population level. Previous analyses[9,10,38] have indicated that the impingement cropping caused by the operation of three major power plants at the eastern end of Lake Ontario has a minimal effect on fish populations. Because the cropping at Unit 2 is an extremely small increment of mortality, the conclusions of the previous

analyses are not changed when Unit 2 mortality is added to the existing effect. This is also true for the conclusions of an analysis of lakewide effects of cropping that included all operating power plants on Lake Ontario[10].

2.2.7 References

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2.3 POTENTIAL DISCHARGE IMPACTS

The Unit 2 discharge structure is a submerged diffuser located in approximately 10.7 m (35 ft) of water. Its two ports are angled slightly upward to minimize plume contact with the bottom, which causes scouring. The plume is predicted to be diluted 3:1 with ambient lake water in the first 6 m and 6:1 in 11 m. In the worst case, surface temperature rises are expected to be less than 1.7°C (3°F).

As the water exits from the discharge ports at high velocity, surrounding lake water is drawn into the stream and is mixed with the discharge water. Organisms with limited motility present in the nearfield vicinity of the discharge are subject to entrainment into the discharge plume. Actively swimming organisms will also be entrained if they do not or cannot resist the flow.

Plume entrainment can result in a broad spectrum of time/temperature exposures. Because of the complex hydraulics associated with the mixing of the jet and the surrounding water, it is difficult to define the thermal regime that a plume-entrained organism might experience. If an organism were entrained next to the discharge nozzle and entered the core of the jet, it would theoretically experience the time/temperature relationship of a water particle exiting from the discharge ports. This would represent the worst situation for a plume-entrained organism since the temperature increase and exposure time are both maximized. An organism encountering the periphery of the plume would experience a smaller temperature increase for a shorter time.

2.3.1 Benthos

Interactions between benthic organisms and the intake system were discussed in Section 2.2.5; some of these concepts are germane to

the interactions between benthos and the discharge. Potential sources for impacts caused by the cooling water discharge include: temperature-induced mortality of sessile organisms, plume entrainment of semi-planktonic forms, and scouring of the bottom habitat. Of significance, therefore, is the life mode of each species, particularly the degree to which the organism utilizes the water column for dispersal, breeding, larval development, or feeding.

The meroplanktonic forms, including the Representative Important Species Gammarus, are discussed under zooplankton (Section 2.3.2.2). Other similar forms include certain insect groups (dipterans, tricopterans, and ephemeropterans), which are terrestrial as adults but metamorphose in the aquatic medium. Abundance of the aquatic phase of these insects is prone to considerable fluctuation as a result of variability in the terrestrial environment.

For the most part, benthic organisms remain closely associated with the lake substrate and, as evidenced by temperature patterns near the bottom, are not usually subjected to thermal elevations resulting from the plume. This occurs because the plume is buoyant, except on sporadic occasions during winter months. In addition, many benthic species - for example, annelids and snails - burrow into and live in the sediments, which act as a buffer against temperature change. Studies at other power plants have shown that plume-induced elevations in water temperature near the substrate are not transmitted through the sediment[1].

Another potential source of impact on benthos could occur through scouring of sediments by a high-velocity bottom diffuser and, to a lesser extent, through redepositing of these particles in quiescent areas. Studies at JAF concluded that the high-velocity jet discharge created some scour near the center of the diffuser[2]. The scouring in the vicinity of the discharge caused substrate particles to be transported from an area approximately 15 m (49 ft) from the

center of the diffuser and extending up to 55 m (180 ft) lakeward. This scouring process probably displaced part of the benthic community (e.g., Valvata, Amnicola, Sphaerium, and various oligochaete species) occupying an area less than 500 by 100 m (164 x 328 ft) adjacent to the discharge ports. However, this phenomenon is clearly localized and of negligible effect in relation to benthic production in the Nine Mile Point vicinity[2]. Design characteristics of the Unit 2 discharge structure are expected to result in a greatly reduced scouring effect, since the flow rate is much smaller (about 13% of the JAF flows).

Based on the analysis of six years of benthic data (Section 2.1.5) collected near the Unit 1 discharge and at a control transect, no measurable effect was demonstrated on either species assemblages or abundances as a result of Unit 1 operation. For each group of organisms studied, the population changes between years usually followed parallel patterns in nearfield and control areas. Since there was no discernible impact detected at Unit 1, none would be expected at Unit 2, which has a lower potential for causing impact.

2.3.2 Plankton

2.3.2.1 Phytoplankton

Within the immediate vicinity of the plume, some reduction in phytoplankton standing stock may be noted since the discharge waters will be devoid (or nearly so) of viable phytoplankton (100% mortality through the closed cooling system is assumed). As a result of the mixing of discharge waters with lake water and the patchy nature of planktonic populations, this localized reduction will probably not be observable in the discharge area of the lake.

The effect the discharge will have on phytoplankton entrained into the plume will most likely be an alteration in metabolic processes

observable as a change in primary productivity. A localized reduction in standing stock may occur as a combination of entrained subsurface water, which generally has lower levels of phytoplankton than the surface waters, and the discharge water (devoid of phytoplankton) is carried up in the buoyant plume.

Studies to determine the effect of plume entrainment on phytoplankton were conducted at JAF from 1976 through 1979[3-6]. During the first year, phytoplankton productivity in the plume (as measured by ^{14}C uptake after 4 hrs of incubation) was consistently higher than that measured outside the plume. Results following a 7-hr incubation were more variable, particularly for the night samples, and some inhibition was noted. Recycling of carbon was cited as a possible cause of the observed results[2,3]. The phytoplankton plume entrainment studies conducted during 1977-1979 did not show the consistent increased productivity that was observed during 1976[4-6]. During these later studies the 4-hr incubation period was omitted, so the results are not entirely comparable to the 1976 data. With the exception of a few samples each year that showed either significant stimulation or inhibition when compared to the intake sample, most values fell near unity, indicating little or no effect of plume entrainment on the phytoplankton. The data for 1979[6] were collected only from January to March so the greater number of samples exhibiting stimulation is probably a seasonal response of the cold-water phytoplankton species to the warmer temperatures in the plume during this time of year. This finding was expected, and similar observations have been made at a number of other power plants[7].

In the worst case, the initial discharge temperature rise at Unit 2 will be approximately 15.6°C (28.0°F); however, this temperature differential will be diluted to 5.2°C (9.4°F) within 6 m (20 ft) and to 2.6°C (4.7°F) within 11 m (35 ft). These temperature differentials are not sufficient to cause significant alteration to the

phytoplankton community in light of the rapid dilution of the plume with ambient lake water. Depending upon season or ambient temperatures, individual species may be either stimulated or inhibited, but the overall effect will be small and, in light of the small volume discharged by Unit 2, probably immeasurable.

2.3.2.2 Zooplankton

As discussed for the phytoplankton, a localized reduction in zooplankton standing crop near the discharge may be expected due to the mixing of lake water with discharge water that is devoid of viable zooplankton. Depending on the degree of mixing, this reduction would be difficult to measure because of the patchy nature of the planktonic community. Species living in the deeper water layers may be displaced in the immediate vicinity of the discharge due to turbulent mixing. Species such as Gammarus, which use both the bottom substrate and the water column, may be displaced slightly because of bottom scour but this is expected to be minimal at Unit 2.

Studies conducted by LMS and TI at JAF[3-6] to determine the effects of plume entrainment on zooplankton survival indicated little or no effect. In general the survival of zooplankton collected in the intake and subjected to plume simulation studies in the laboratory and those collected at the 1.1 and 1.7°C (2 and 3°F) isotherms in the lake was within the range observed for intake organisms. This indicates that the greatest mortality was probably a result of collection and handling procedures.

Markowski[8] observed no effects on zooplankton as a result of the thermal discharges of several power generating stations located on marine waters. Whitehouse[9] found no significant effect on the composition, abundance, or seasonal fluctuations of resident zooplankton populations in a cooling pond receiving the thermal

discharge from a small generating station. WAPORA, Inc.[10] evaluated the thermal discharge of four power stations along the Ohio River and concluded that the zooplankton populations were not altered as a result of the thermal discharges. Davies and Jensen[11], in an extensive survey at three power plants situated on different types of water bodies, concluded that there was no lasting or permanent effect on resident populations of zooplankton in the receiving waters.

Specific studies on Gammarus sp., the only invertebrate among the Representative Important species for Unit 2, also indicate a small potential impact by the Unit 2 discharge. NYU studied zooplankton plume entrainment by drifting Gammarus spp., the dominant zooplankton group in the vicinity of the Indian Point plant, through the thermal plume for a one-hour exposure period[12]. They observed 100% survival on two separate occasions following the exposure to the elevated plume temperatures and to the additional stress of chlorine. In laboratory thermal tolerance studies, Sprague[13] determined the ultimate 24- and 48-hr Lethal Temperature for 50% of the test organisms (LT50s) for G. fasciatus to be 34.6°C (94.3°F) and 33°C (91.4°F), respectively. Thibault and Couture[14] found the ultimate 24-hr LT50 for G. fasciatus to be 33.8°C (92.8°F), similar to Sprague's results. When acclimated to 10 and 20°C (50 and 68°F), the 24-hr LT50s for G. fasciatus were approximately 31 (87.8°F) and 32°C (89.6°F)[12]. As shown by these results, thermal tolerance in Gammarus is related to acclimation temperature.

As a result of the rapid dilution of the thermal plume, Gammarus will not be exposed to lethal temperatures for the extended periods that organisms were in the laboratory. In those cases where Gammarus is entrained into the plume near the discharge port, exposure to potentially lethal temperatures is possible, but only for a short time. The maximum ambient temperature in the NMP vicinity of Lake Ontario is estimated to be 25.6°C (78°F). With a

maximum discharge temperature rise of 15.6°C (28°F), exposure to a maximum of 41.2°C (106°F) is possible; however, the duration will be on the order of seconds. In a study by New York University Medical Center[15] Gammarus from the Hudson River were exposed to ΔTs ranging from 0-19°C (0-34.2°F) for 10 min when ambient conditions were 22°C (71.6°F). At a ΔT of 15°C (26.8°F), survival after 24 hrs was the same as for controls; at a ΔT of 17°C (30.6°F), survival was still not significantly different from control survival. At a ΔT of 19°C (34.2°F), on the other hand, mortality was 100% after 24 hrs. Based on these studies, even if Gammarus is entrained near the discharge port during high ambient temperatures, survival is expected to be high.

2.3.2.3 Ichthyoplankton

As stated for both phytoplankton and zooplankton, blowdown from the closed-cycle cooling system will be devoid of viable fish larvae. This will create a localized reduction in ichthyoplankton abundance, but will be a localized phenomenon that probably will not be observable above natural variation.

Laboratory studies simulating the temperature effects of plant entrainment may be used for evaluating plume entrainment of larvae and early life stages of fish. The time/temperature exposures incurred during passage through the entire cooling system are considerably more severe than the worst case of time/temperature exposures in the Unit 2 plume; therefore, these studies provide a conservative estimate.

The effects of plume entrainment on ichthyoplankton were studied at JAF during 1976, 1977, and 1978 by laboratory simulation of the time/temperature regime to which larvae would be exposed in the plume[3-5]. Because of initial high mortality in the intake samples, apparently due to the collection process, and very low

numbers of larvae available for testing, no conclusions could be drawn from these data. On a few occasions, live larvae were obtained and survived the simulation process, demonstrating that larvae can survive plume entrainment.

Because few data are available on the representative species, data from a few closely related species are included to provide a general picture of the effect of thermal shock on early life stages of fish.

Barker et al.(16) exposed rainbow smelt larvae acclimated to 13°C (55.4°F) to abrupt temperature changes for durations of 5, 30, and 60 min, after which they were observed for 24 hrs. The LT50s for the three exposure periods were >30.6 <32.4°C (>87.1 <90.3°F), >28.8 <30.8°C (>83.8 <87.4°F), and >26.8 <28.8°C (>80.2 <83.8°F), respectively. Schubel et al.(17) exposed larvae of blueback herring (Alosa aestivalis), American shad (Alosa sapidissima), and striped bass (Morone saxatilis) to time/temperature histories typical of currently operating power plants at acclimation temperatures of 20°C (68°F). In this study, eggs and larvae were exposed to temperature increases and subsequent decreases, representing plant passage and thermal decay in the plume. As with Barker et al.(16), their time/temperature combinations were longer than those predicted for Unit 2. For eggs of the three selected species, Schubel et al.(17) found no significant increase in mortality for temperature increases of 10°C (17.9°F) for 20-min exposure. Eggs of striped bass survived temperature increases of 15°C (26.8°F) for 3-min, but eggs of the other two species exhibited a significant increase in mortality (percentage not stated) for the same temperature increase and exposure.

Similar results were found for larvae, in that no significant increase in mortality occurred for increased temperatures of 10°C (17.9°F) for 20-min exposures for striped bass and blueback herring.

There was a small but statistically significant increase in mortality of 3% for American shad. For a 3-min exposure to a 15°C (26.8°F) increase there was no significant increase in mortality for blueback herring. For striped bass and shad the increase in mortality was less than 50%.

Chadwick(18) obtained high survival of striped bass larvae after exposure to 10°C (17.9°F) temperature shocks for up to 6 min at acclimation temperatures of 15.5 and 21.1°C (56.0 and 70.0°F). Temperature increases that brought the maximum to 32°C (89.6°F) or above resulted in significant mortality, regardless of exposure time for this species.

The foregoing results from laboratory studies indicate that the worst case of plume entrainment at Unit 2 is far less severe than the time/temperature regimes for which there was substantial survival for a variety of species. These studies exposed eggs and larvae to temperature increases for a minimum of 3 min. At JAF an organism entrained exactly at the point of discharge is at a temperature 5°C (8.9°F) above ambient in less than 2 sec for the worst case condition. This duration would be even less at Unit 2. In general, the cited studies found that a 10°C (17.9°F) increase did not affect survival, while a 15°C (26.8°F) increase resulted in less than 50% mortality. Since these studies were done for exposure periods that were substantially longer than comparable exposure at Unit 2, it is expected that plume entrainment at Unit 2 will have a minimal effect on survival of eggs and larvae.

This conclusion is further supported by the aquatic ecology studies conducted for Unit 1 and JAF from 1972 to 1978, which showed no measurable reductions in ichthyoplankton numbers or alterations in temporal patterns in the thermally influenced area as compared to the control areas. Based on this six-year data base and the relatively small volume being discharged by Unit 2, plume entrainment is expected to have a minimal impact on the ichthyoplankton community.

2.3.3 Nekton

The response of an organism to temperature can be divided into two zones: the zone of tolerance and the zone of resistance. An organism may live indefinitely in the zone of tolerance because the temperature level does not exceed the upper (or lower) incipient lethal temperature (UILT) for that species. The UILT depends on acclimation temperature and, according to Coutant, is defined as that temperature which when a fish is brought rapidly to it from a different temperature will kill a stated fraction of the population (generally 50%) with an indefinitely prolonged exposure[19]. The lower incipient lethal level is correspondingly defined. The higher the acclimation temperature, the higher the UILT, until the ultimate UILT is reached. At this level, an increase in acclimation temperature will not raise the incipient lethal level.

In the zone of resistance, an organism's survival is time-dependent. At temperatures well above the UILT, resistance time is short, while at temperatures close to the UILT, resistance times are greater. A temperature can ultimately be reached that produces death instantaneously.

Another important concept related to the thermal responses of fish is the Critical Thermal Maximum (CTM), which is the temperature, determined in controlled laboratory studies, at which locomotor activity becomes disorganized and the fish loses its ability to escape from potentially dangerous conditions. The point of equilibrium loss is of particular importance in evaluating the effects of exposure to thermal plumes in the natural environment (the CTM is also dependent on acclimation temperature).

While standard thermal bioassays provide a fairly precise demarcation of lethal temperature, they do not permit evaluation of sublethal effects on behavior. For example, Coutant[19] has shown

that exposure to sublethal temperatures resulted in increased predation on juvenile salmonids in controlled laboratory experiments. Increases in predation rate occurred at thermal elevations well below those causing equilibrium loss visible to the experimenter.

Fish can also respond behaviorally to temperature changes by avoiding or gravitating to the change. For example, when presented with a temperature gradient in the laboratory, fish will show a preference for a particular temperature regime while avoiding others, the response being related to acclimation temperature and season. Preferred and avoidance temperatures are important in assessing thermal plume effects because they permit an evaluation of fish behavior in relation to the thermal gradient of the plume.

Over the years there has been a considerable amount of experimentation done to determine the thermal tolerances of fish using laboratory studies; however, care must be taken in extrapolation. In nature, fish respond to many abiotic and biotic factors, while in the laboratory conditions are simplified and, to a large extent, controlled. Therefore, predictions of fish behavior from laboratory results must be made with care.

2.3.3.1 Lethal Thermal Effects

The evaluation of potential effects is based on thermal data for each species, field data collected in the vicinity of Nine Mile Point, and literature concerning the effect of thermal discharges. Appendix A contains a tabulation of thermal data for selected Lake Ontario fish species. Data on other Great Lakes species are presented to show representative analysis of thermal effects. Thermal data of Otto et al.[20] are particularly useful because they are based on specimens from the Great Lakes and provide thermal characteristics relative to an acclimation temperature in each case.

Fish can interact with the thermal plume in two ways: they can swim voluntarily into the plume or they can be entrained into it. The temperature distributions in the Unit 1 or JAF plume provide a very sharp gradient of temperature as a result of the rapid dilution produced by the high-velocity discharge. Because of the high velocity and rapid dilution, the likelihood of a fish's intentionally experiencing the full temperature increase by swimming into the plume is remote. Only those few fish entrained into the plume near the discharge ports will experience the highest temperatures, and the exposure period will be on the order of only a few seconds.

Otto et al.[20] studied the swimming ability of yellow perch, rainbow smelt, and other species from Lake Michigan. The maximum sustained swimming speeds (speeds which a fish can maintain for up to 45 min) over a range of acclimation temperatures from 5 to 20°C (41 to 68°F) were 14-28 cm/s (0.5-1.0 fps) for yellow perch and 34-45 cm/s (1.1-1.5 fps) for rainbow smelt. Their ranges of sustained swim speeds probably encompass the capabilities of the other important species.

The predicted velocity of water exiting from the discharge ports is approximately 140 cm/s (4.6 fps) at a distance of 10.7 m (35 ft) from the ports. Over this same distance dilution of the discharge water has reduced the temperature increase from 15.6°C (27.9°F) to approximately 2.4°C (4.3°F) above ambient. It is clear from a comparison of discharge velocities and maximum sustained swim speeds that it is impossible for any of the important species to swim against the discharge flow and maintain themselves in the hottest portion of the plume. Therefore, the evaluation of lethal effects resulting from voluntary exposure to the plume should be based on the temperatures that exist in the area of the velocity field where a fish could theoretically maintain itself.

Studies indicated that most of the important species could maintain themselves in water with a 30 cm/s (1.0 fps) velocity during the

summer months when their swimming ability is at a maximum, particularly specimens larger than those tested. Temperature increases of 1.5°C (2.7°F) above ambient are expected in this area. UILT levels for the selected important species (Table 2.3.3-1) at low to moderate ambient lake temperatures are well above temperatures in the 30 cm/s (1.0 fps) area of the plume. Summer lethal thresholds (UILT levels based on the highest acclimation temperatures) for smallmouth bass, yellow perch, white perch, and spottail shiner are above the plume temperatures under consideration (Table 2.3.3-2). Although the lethal thresholds for the threespine stickleback are lower than for the species discussed above, it does not appear that the 1.5°C (2.7°F) above ambient will cause mortality, based on the available data. At acclimation temperatures of 19 and 20°C (66.2 and 68°F), lethal thresholds were 25.8 (78.4°F) and 27.2°C (81°F), respectively[21,22].

Behavioral characteristics of other selected species will tend to keep them away from the discharge area during the period of warm ambient temperatures. Brown trout, coho salmon, and rainbow smelt are cold water species which normally leave the warm surface waters of the lake during the summer months to reside in the cool waters of the lake depths, and are thus removed from potential exposure to lethal temperatures.

Adult alewives are less tolerant of high temperatures than young-of-the-year and move to the cool depths of Lake Ontario following spawning in the spring[3]. While the UILT level may be exceeded for adult alewives during the summer, young-of-the-year can apparently tolerate these conditions.

Another behavioral characteristic that reduces the potential for adverse interaction between the fish populations and the thermal plume is avoidance. It has been demonstrated in the laboratory that fish will avoid potentially harmful temperatures. In nature this is

TABLE 2.3.3-1

A SUMMARY OF UPPER INCIPIENT LETHAL TEMPERATURES FOR FISH[a]

Species	Acclimation Temperature (°C)				
	5	10	15	20	25
Alewife (Adult)	-	23.3	23.8	24.5	-
Alewife[b] (Young-of-the-Year)		26.3	-	30.3	32.1
Bloater[b]	22.6	23.8	24.8	26.6	27.0
Brook trout[c]	23.7	24.4	25.0	25.3	25.3
Chinook salmon[b]	21.5	24.3	25.0	25.1	-
Cisco[c]	21.6	24.3	-	26.6	26.0
Coho salmon[d]	21.3	22.5	23.1	23.9	-
Emerald shiner[e]	23.2	26.7	28.9	30.7	30.7
Fathead minnow[f]	-	28.2	-	31.7	33.2
Golden shiner[g]	-	29.3	30.5	31.8	32.2
Largemouth bass	-	-	-	32.5	34.5
Rainbow trout (Yearling)	23.4	24.7	25.7	25.7	-
Slimy sculpin	18.5	22.5	23.5	-	-
Yellow perch	22.2	24.7	27.7	29.8	31.2

[a] Reference 20
[b] Reference 23
[c] Reference 24
[d] Reference 25
[e] Reference 26
[f] Reference 27
[g] Reference 28

TABLE 2.3.3-2

SUMMER LETHAL THRESHOLD TEMPERATURES FOR IMPORTANT SPECIES

Species	Summer Lethal Threshold (°C)*
Alewife	23.0-32.2
Brown trout	23.5-25.0
Coho salmon	24.0-25.0
Rainbow smelt	21.5-28.5
Smallmouth bass	36.0
Threespine stickleback	25.8-33.0
Yellow perch	29.0-30.0
White perch	34.7
Spottail shiner	30.8

*Upper lethal threshold temperatures based on the highest acclimation temperatures presented in Appendix A.

confirmed by seasonal changes in distribution of most species. Table 2.3.3-3 lists laboratory-determined avoidance temperatures for some Lake Michigan fishes[20]. Table 2.3.3-4 gives the CTM related to acclimation temperature. There is a trend through the range of acclimation temperatures available that shows the avoidance temperature to be below the CTM and below or nearly equal to the UILT. The CTMs are substantially greater than the UILT.

The one exception to this is yellow perch. Based on the data at hand, this species may not avoid potentially lethal temperatures at acclimation temperatures of 5, 10, and 15°C (41, 50, and 59°F). The data in Tables 2.3.3-2, 2.3.3-3, and 2.3.3-4 show that at acclimation temperatures from 5-15°C (41-59°F) the UILT is lower than the avoidance temperature and the CTM at 10 and 15°C (50 and 59°F)is lower than the avoidance temperature at those acclimation levels. However, if ambient lake conditions are 15°C (59°F) and fish are exposed to the full temperature rise of 15.6°C (27.9°F), the exposure temperature will be 30.6°C (87.1°F). While this temperature is nearly identical to the CTM, it has already been concluded that because of the exit velocities there is practically no chance of organisms' being exposed to the maximum discharge temperatures.

A second mode of contact of fish with the thermal plume is through entrainment with the surrounding water mass.

Analyzing plume entrainment of juvenile and adult fish is more complex than it is for eggs and larvae because these life stages have the ability to resist entrainment into the plume or to leave the plume if they encounter unsuitable temperatures. The velocity component of the discharge will help entrained organisms escape potentially harmful temperatures because the plume momentum carries organisms away from the warmest temperatures. It has already been concluded that the fish will be unable to maintain themselves in an area where the velocity is greater than 30 cm/s (1.0 fps) and that

TABLE 2.3.3-3

AVOIDANCE TEMPERATURES OF FISH AS DETERMINED IN A CHOICE APPARATUS[a]

Species	Acclimation Temperature (°C)				
	5	10	15	20	25
Brook trout	20.0	22.0	21.5	24.0	-
Brown trout	-	21.5	-	-	-
Chinook salmon	20.0	21.5	23.5	-	-
Coho salmon	19.5	22.0	24.5	23.5	-
Lake trout	17.5	18.0	22.0	-	-
Rainbow smelt	10.5	16.0	-	-	-
Rainbow trout	20.5	21.5	23.5	24.5	-
Slimy sculpin	15.0	19.0	23.0	-	-
Yellow perch	26.0	30.0	31.0	31.0	33.0

[a]Reference 20

TABLE 2.3.3-4

A SUMMARY OF CRITICAL THERMAL MAXIMA FOR FISH ACCLIMATED TO CONSTANT TEMPERATURES[a]

Species	Acclimation Temperature (°C)					
	5	10	15	20	25	30
Alewife (Adult)	24.7	28.7	29.9	31.9	32.8	-
Alewife (Young-of-the-Year)	24.7	26.7	29.5	31.9	34.3	36.7
Brook trout (Yearling)	27.5	28.8	30.0	-	-	-
Brown trout (Yearling)	-	27.8	-	-	-	-
Chinook salmon (Yearling)	26.4	28.5	29.5	30.2	-	-
Coho salmon (Yearling)	26.1	27.3	28.2	29.9	-	-
Fathead minnow	28.5	31.9	32.7	35.7	36.7	38.5
Golden shiner	27.9	30.3	33.0	35.0	37.6	39.0
Lake trout (Yearling)	26.3	25.9	27.9	-	-	-
Longnose dace	28.4	30.5	31.4	33.9	35.4	36.7
Rainbow smelt	23.5	24.4	-	-	-	-
Rainbow trout (Yearling)	27.9	28.4	29.7	31.1	-	-
Slimy sculpin	23.4	25.0	27.1	29.4	-	-
Spottail shiner	27.7	30.2	31.2	33.3	35.5	37.7
White sucker	27.8	28.7	30.5	32.9	-	-
Yellow perch (Adult)	26.6	29.3	31.6	33.8	35.4	-
Yellow perch (Young-of-the-Year)	27.5	28.6	30.3	32.6	35.1	-

[a]Reference 20

the temperature rise in this area is approximately 1.5°C (2.7°F) above ambient. Thus the exposure period for organisms entrained near the discharge ports and subject to higher temperatures will be of short duration, probably less than 1 min.

Since little temperature tolerance information exists for short exposure times, CTM data will be used as an indication of survival for plume-entrained nekton. CTMs, as pointed out previously, are determined by exposing a fish to gradually increasing temperatures until there is an equilibrium loss. The situation at Unit 2 is reversed; once entrained in the plume, the fish will be exposed to an abrupt temperature increase followed by a decline to ambient conditions. The CTMs in Table 2.3.3-4 can be used as a conservative indication of the temperature increase that a species can survive for short exposure periods.

The maximum temperature rise of 15.6°C (27.9°F) will be at or near the CTM for a few species at 10-15°C (50-59°F) acclimation. At a water temperature of 20°C (68°F), it is expected that the salmonids and rainbow smelt would have migrated from the area and only the warm water species will be present. At ambient temperatures of 20°C (68°F) and greater, with the maximum ΔT of 15.6°C (27.9°F), the CTMs of all the species in Table 2.3.3-4 are exceeded. However, at a ΔT of 10°C (18°F) the only Representative Important Species whose CTM is exceeded are coho salmon, at 20°C (68°F) ambient, and alewife, at 25°C (77°F) ambient. As discussed previously, these species will have left the area by the time these ambient temperatures have been reached. Limited data on spottail shiner (Appendix A) indicate that a ΔT of 15.6°C (27.9°F) at 20°C (68°F) acclimation may be harmful while a ΔT of 10°C (18°F) is not. There are no data for white perch or threespine stickleback.

While the above analysis suggests that some mortality may occur for the worst-case condition, particularly at 20 and 25°C (68-77°F)

acclimation temperatures, it should be emphasized again that the thermal limits used in this analysis are based on durations that far exceed the conditions that exist for plume entrainment. At Unit 2, the worst-case condition occurs at 25°C (77°F) acclimation, which is the maximum intake temperature recorded in 1976 at the JAF plant. In the plume, entrained organisms experience temperatures more than 10°C (18°F) above ambient for less than 1 sec. It takes another second to traverse to the 7.5°C (13.5°F) isotherm. Beyond this point, plume-related mortality is not expected.

In summary, it appears that fish will avoid lethal areas of the plume and that any plume-entrained mortality will be minimal, if it occurs at all, because of the short exposure time to the warmest plume temperatures.

2.3.3.2 Sublethal Thermal Effects

Sublethal effects may manifest themselves as changes in the behavior or physiology of the organism. The former involve almost immediate responses by fish, while the latter require an extended period of exposure to increased water temperatures. Some examples of physiological effects are alterations in the reproductive cycle, changes in growth, and changes in feeding patterns. Alterations to the reproductive cycle could be manifested as delays in spawning or reduced numbers of eggs. Changes in growth and feeding could affect one another and both could precipitate changes in the reproductive cycle.

Sublethal effects involving a physiological response are precluded because of the exclusionary effect of the high plume velocity. The time required for a fish to acclimate to a change in water temperature is days or weeks, depending on the magnitude of change. Based on maximum sustained swim speeds, fish can maintain themselves only

on the periphery of the plume and then only for short periods of time.

The potential for a sublethal effect caused by a brief exposure to an elevated temperature, such as would occur in the worst-case entrainment situation, has not been studied exclusively. The results of Hoss et al.[29] indicated no persistent effects on oxygen consumption or growth rate for thermally shocked fish larvae.

The ecological studies conducted in the vicinity of Nine Mile Point and Oswego provide a base for assessing the effect of thermal effluents on the fish community in the Nine Mile Point vicinity. Studies were conducted from 1969 through 1978 and included analyses of abundance and taxonomic composition, fecundity and time of spawning, annulus formation as an indirect measure of growth, and feeding patterns. The overall results of this work are described briefly below. More detailed analyses are presented in Section 2.1.6.

Work conducted by Storr[30] indicates the extent of movement of fish in the Nine Mile Point vicinity. Almost 10,000 individuals of 22 species of fish were tagged from 1972 to 1974. Tag returns were obtained primarily from anglers, so there was a differential rate of return depending on the popularity of a species and the relative ease of capture for each species. Yellow perch and smallmouth bass, two important species, were among those whose tags were returned in greatest numbers.

The continuous dispersal of fish from the tagging area suggests that there may not be long-term residence in the vicinity of the discharge. Tagged fish were recovered from a wide area, indicating an approximate 112-km (70-mi) range of movement around Nine Mile Point. There was a general pattern of movement to the east of Nine Mile Point during the summer and fall and to the west in the spring.

Storr's findings are supported by the results of the ecological studies that found that normal onshore-offshore seasonal migrations are unaffected by the presence of thermal discharges.

In general, no alterations in the fish community have been detected. There have been some cycles demonstrated in the long-term data base. Alewife abundances in the Nine Mile Point vicinity peaked during the early 1970s, declined during the late 1970s, and are showing a rebound to previous high abundances during the early 1980s. Threespine stickleback also ave some wide variation in abundances over the duration of the study (Section 2.1.6).

Analyses to ascertain the effect of Unit 1 and JAF on reproduction showed that reproductive activity proceeds normally near the existing discharges and is similar to that in other habitats for the same species[2-6]. Time of annulus formation was analyzed for rainbow smelt, yellow perch, alewife, and smallmouth bass[3-5, 31-33]. The results indicated no detectable impacts on the time of annulus formation using the same species. Studies on feeding preferences showed that feeding patterns of these fish have not been altered by the operation of the plants[3-5, 31-33]. In conclusion, the data indicate that operation of existing plants has not measurably affected the fish populations of Lake Ontario and the relatively small addition of heat by Unit 2 is not expected to have a significant impact.

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CHAPTER 3.0

METHODS AND MATERIALS

3.1 BIOLOGICAL PROGRAMS

The data base of the preoperational monitoring program at Unit 2 accrued mainly from studies of the Nine Mile Point vicinity conducted by LMS from 1972-1977*[1-4] and by TI during 1977-1981[5-8]. Other studies in the immediate vicinity of the study area have been conducted by the Lake Ontario Environmental Laboratory (LOTEL)[9], McNaught and Fenlon[10], McNaught and Buzzard[11], and Storr[12].

The objective of the aquatic ecology monitoring programs was to determine the taxonomic composition of the biota and characterize the temporal/spatial abundance distribution of major groups and selected species in the Nine Mile Point vicinity of Lake Ontario. The biotic groups studied included phytoplankton, microzooplankton, macrozooplankton, ichthyoplankton, benthic invertebrates, periphyton, and nekton (fish).

Other variables were monitored for some biota to obtain additional information on the ecology of the area. For example, primary productivity, chlorophyll a and phaeopigments, and biovolume were measured as part of the phytoplankton study; length-frequency or developmental stage was determined for ichthyoplankton; and data on reproduction, age, growth, and food habits were obtained for fish. Supporting data (e.g. water temperature, light intensity, sediment characteristics) were obtained as necessary to aid in interpretation of the biological data.

*First three months of 1977 - entrainment and impingement only.

Finally, entrainment and impingement studies conducted at Unit 1 and the JAF plant provided information necessary to estimate intake effects for Unit 2.

3.1.1 Phytoplankton

3.1.1.1 Field Methods

Lake Studies

Plankton studies were initiated in 1963 and 1964 by Mirza and Storr[13]. Samples were collected with a 23-cm (9-in.) plankton net by means of timed tows at transects corresponding to NMPW and NMPE (6.1-m [20-ft] depth) and at a station 3.2 km (2 mi) offshore.

A summary of the field procedures used to collect phytoplankton in the Nine Mile Point vicinity of Lake Ontario from 1973 to 1978 is provided in Table 3.1.1-1, and includes stations, frequency, and techniques. Details of the program are found in LMS[1-4] and TI[5,6].

Phytoplankton samples were collected in the Nine Mile Point vicinity along four transects (NMPE, NMPP, NMPW, and FITZ) approximately 4.0 km (2.5 mi) along the lake shore at four depth contours (3, 6, 12, and 18 m [10, 20, 40 and 60 ft]), as depicted in Figure 3.1.1-1. These sampling locations, established in 1973, were used throughout the program without further modification.

The frequency of sample collection varied from every two to every four weeks, depending on year and season. During 1973-1975, samples were taken twice a month during the summer; all other sampling was conducted on a monthly basis.

TABLE 3.1.1-1

SUMMARY OF FIELD MATERIALS AND METHODS FOR PHYTOPLANKTON COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

		Field Methods			Sample Treatment			
Year	Stations	Sampling Frequency	Collection Method and Depth	Replicates	Taxonomy, Biovolume & Enumeration	Chlorophyll a and Phaeophytin	Primary Productivity	Water Quality
1973	3,6,12, and 18-m depth contours along 4 transects NMPW, NMPP, FITZ, NMPE	Chlorophyll a monthly except twice monthly JUL-AUG, NS-DEC. Net - APR-SEP monthly except twice monthly during JUL & AUG. Whole water - JUN-NOV frequency as above	Whole water & chlorophyll a - 0.5 m below surface by filling a polyethylene container Net - 20-liter of surface water (0.5 m below surface) through 28 μm mesh Wisconsin net	Not collected	1-liter samples preserved with 5% formaldehyde (buffered)	1-liter bottle stored on ice (in opaque black plastic bags)	Not conducted	
1974	Same as during 1973	^{14}C primary productivity and chlorophyll a - 2 times- May, 1/month- JUN-DEC, NS-NOV Whole water monthly - APR & SEP-DEC, twice-monthly-MAY-AUG	PVC Van Dorn water bottle 0.5 m below surface for enumeration and taxonomy & chlorophyll a; 1 m below surface for ^{14}C productivity and chlorophyll a	-	1-liter sample preserved with Lugol's solution or Weber's solution (after 28 June)	Same as during 1973.	Procedures of Vollenweider et al. [14] and APHA [15]. 2 light, 1 dark bottle; 1 sample for TIC; 4-hr incubation in situ at collection depth (1 m). Inoculated with 1 μCi ^{14}C as $NaH^{14}CO_3$	Temperature, light penetration at 1 m intervals in conjunction with ^{14}C

TABLE 3.1.1-1 (Cont)

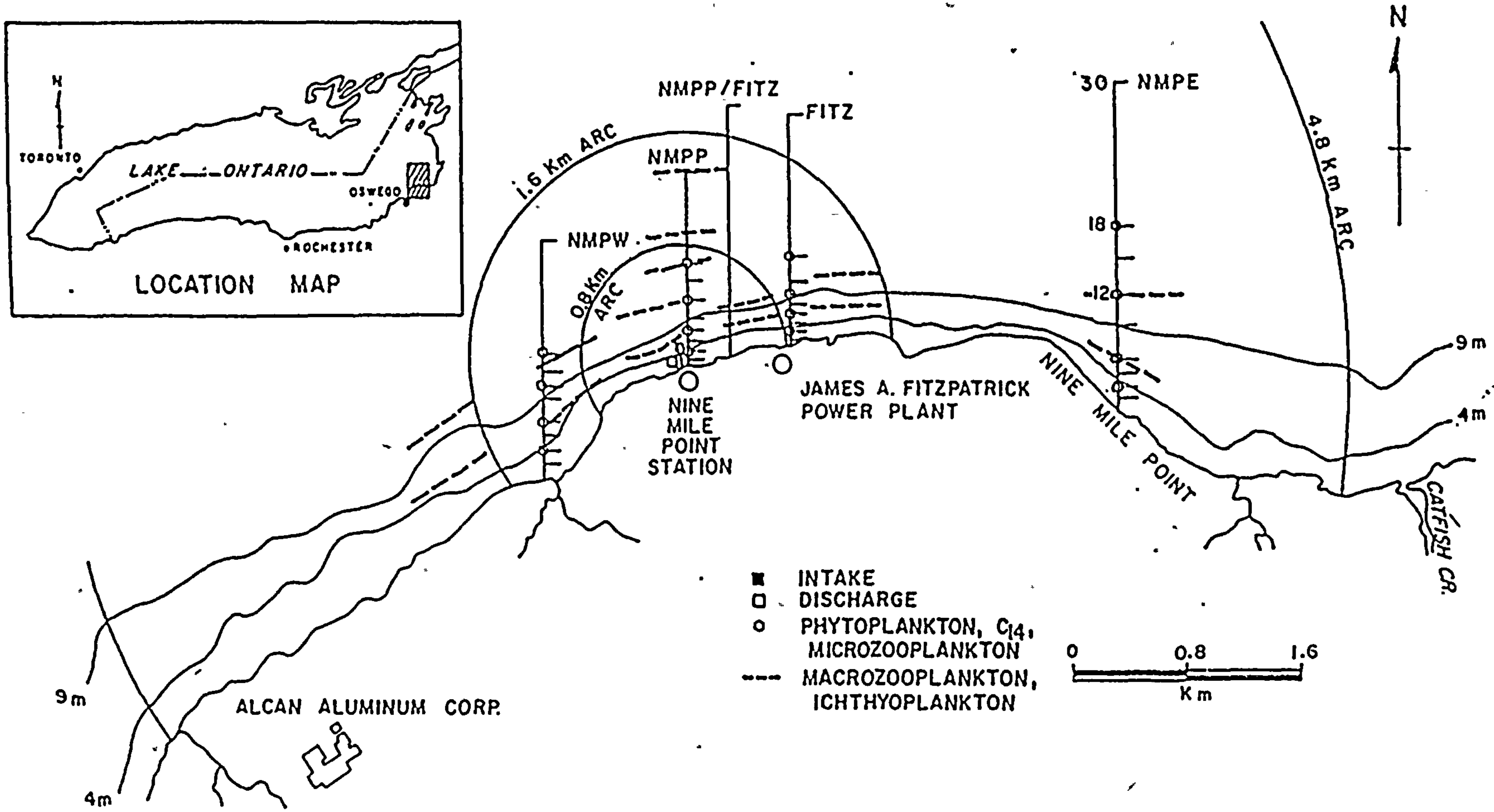
Year	Stations	Sampling Frequency	Field Methods: Collection Method and Depth	Field Methods: Replicates	Sample Treatment: Taxonomy, Biovolume & Enumeration	Sample Treatment: Chlorophyll a and Phaeophytin	Sample Treatment: Primary Productivity	Sample Treatment: Water Quality
1975	Same as during 1973-1974	Chlorophyll a and enumeration and taxonomy- monthly APR, SEP, DEC twice monthly- MAY-AUG ^{14}C Primary Productivity monthly - APR-DEC	PVC Van Dorn water bottle surface (50%) all stations, 3 depths composited for enumeration and chlorophyll a; 3 depths separate for ^{14}C and chlorophyll a	2-composited immediately after collection and prior to splitting for various treatments	1-liter sample preserved with Lugol's solution	2-liter bottle treated as during 1973-1974	Same as during 1974	Temperature at surface and at bottom as well as 50% (surface), 25% and 1% light levels at NMPE Light penetration-50,25, & 1% levels at NMPE
1976	Same as during 1973-1975	Monthly APR-DEC all samples collected during day	PVC Van Dorn water bottle; just below surface; also 50, 25, and 1% light transmittance levels at NMPE-12 m	Same as during 1975	350 ml subsample preserved with Lugol's solution(15)	2 1-liter bottles-treated as during 1973-1975	Same as during 1974-1975 except incubated in laboratory at 1000 f.c. Transported immediately in dark box.	Same as during 1975
1977	Same as during 1973-1976	Monthly APR-DEC	Same as during 1976	Same as during 1975-1976	2-3.8-liter subsamples preserved with acid Lugol's	Same as during 1973-1976	Same as during 1976.	Same as during 1975-1976
1973	Same as during 1973-1977	Monthly APR-DEC	Same as during 1976-1977	Same as during 1975-1977	Same as during 1977	Same as during 1973-1977	Same as during 1976-1977, except incubated at 200 f.c.	Light penetration temperature, 1 100-ml sample collected at each location for alkalinity; two samples at each 6-m contour for background primary productivity

NS - No sample.
f.c. - Foot candles.

FIGURE 3.1.1-1

PLANKTON SAMPLING STATIONS

NINE MILE POINT VICINITY - 1973-1978



3.1.1.2 Laboratory Methods

Lake Studies

A summary of the laboratory methods used to analyze phytoplankton samples in the Nine Mile Point vicinity from 1973 through 1978 is presented in Table 3.1.1-2. Details of these procedures are presented in the annual reports(1-6).

Identification and Enumeration To facilitate analysis, the preserved whole water samples were concentrated by allowing the phytoplankton to settle. The phytoplankton present in two subsamples were then enumerated and identified to the lowest possible taxonomic level.

Phytoplankton abundance was calculated using equations described in the annual reports(3,4).

Biovolume was estimated by calculating an average cell volume for individuals of a species(16). In order to facilitate these estimates, each species was represented by a specific geometric shape (e.g., cylinders and spheres), and a minimum of 20 individuals per species per sampling date was measured. Biovolume was expressed as mg/m^3 unpreserved weight, assuming a specific gravity of 1.0 for algal cells.

Photosynthetic Pigments Samples for pigment analysis were filtered onto either 0.45 μm pore size membrane filters (1973) or glass fiber filters (1974-1978) with subsequent extraction in acetone. Spectrophotometric measurements of the extract were made on either a Spectronic 20 or a Beckman Model 26 spectrophotometer. Phaeopigment concentrations were obtained by acidifying the acetone extract with dilute HCl and determining the absorbance at 663 nm. Chlorophyll a

TABLE 3.1.1-2

SUMMARY OF LABORATORY MATERIALS AND METHODS FOR PHYTOPLANKTON COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

Year	Chlorophyll a	^{14}C Primary Productivity	Enumeration and Taxonomy	Biovolume
1973	0.5 liter filtered through Millipore (0.45 μm) filter Analyzed according to Golterman[17] and APHA[15]	Not analyzed in 1973	5-day settling period in acid-cleaned separatory funnel Duplicate aliquots counted and identified in a Palmer-Maloney counting chamber at 200x mag. 3-10 mm strips analyzed, counted as either cells or clumps/l	Not analyzed during 1973
1974	2 1-liter whole water samples filtered through separate Whatman GF/C glass fiber filters. Analyzed according to Golterman[17] and APHA[15].	Inoculated with 1 ml $NaH^{14}CO_3$ (1μCi/ml). Inoculated and incubated in situ at 1 m. At termination, filtered through 0.45-μm membrane filters, placed in vial with fluor and read on Teledyne Liquid Scintillation Counter - Model 360.	Concentration by 7-day settling period in acid-cleaned separatory funnels Two 0.1-ml subsamples of concentrate analyzed in Palmer-Maloney nanoplankton counting chamber; 200x magnification; 3 strips the width of a Whipple grid 10 mm long analyzed from each subsample enumeration as cells/ml, except for Aphanizomenon and Oscillatoria (filaments/ml)	Not analyzed during 1974
1975	Same as during 1974	Inoculated in field, laboratory methods same as during 1974.	Two 10-50 ml aliquots (depending on density) were placed in settling tubes for at least 24 hr. Analysis according to Utermohl method[18, 19] A maximum of 300 units (single cells, filaments, or colonies) enumerated as cells/ml	Minimum 20 measurements/dominant species/date, standard geometric shapes assumed; biovolume expressed as mg/m^3 unpreserved weight (sp. grav. assumed = 1.0 for algal cells)[16]

(1 of 2)

TABLE 3.1.1-2 (Cont)

Year	Chlorophyll a	^{14}C Primary Productivity	Enumeration and Taxonomy	Biovolume
1976	Same as during 1974-1975	Incubated at ambient lake temp. at constant 1000 f.c. for 4 hrs Laboratory methods same as during 1974-1975	Same as during 1975	Same as during 1975
1977	500-2000 ml filtered through Whatman GF/A at ~15 psi, $MgCO_3$ added, frozen until analysis. Used Beckman Model 26 spec. only read 665 & 750 nm	Inoculated with $5\mu Ci\ ^{14}C$ in form of $NaH^{14}CO_3$ incubated at lake surface temp. and 200 f.c. for 4 hr at end-fixed with 1 ml neutral full strength formalin, filtered through membrane filters placed into scintillation vial - added fluor and used Beckman LS-250 scintillation counter	Settled in glass settling chamber 24 hr with 1 drop dishwashing detergent. Drew off supernatant leaving ~200 ml centrifuged at 2000 rpm for 12 min.; drew off supernatant leaving 10 ml. Enumeration and ID of 2 subsamples at 400x on Palmer-Maloney cell using 10 random fields/aliquot	Not analyzed in 1977
1978	Same as during 1977	Same as 1977, but used Beckman LS-100 scintillation counter	Same as during 1977	Not analyzed in 1978

f.c. - Foot candles

(2 of 2)

and phaeopigments were calculated according to the methods described by Golterman[17].

Primary Production The ^{14}C labeled samples were analyzed according to the Millipore filtration-liquid scintillation technique, similar to that described by Vollenweider[14].

After correction for background radiation, ^{14}C-uptake/unit volume/unit time was calculated for light and dark bottles. Primary production (generally considered to approximate net production using the ^{14}C-uptake method) was calculated by subtracting ^{14}C-uptake in the dark bottle from the mean of ^{14}C-uptake in the light bottle.

From 1974 through 1976, total inorganic carbon was determined by titration according to the method described by Golterman[17]. During 1977 and 1978, alkalinity was measured[15] and available inorganic carbon was calculated from these measurements.

Entrainment Studies Laboratory analyses of entrainment samples were generally the same as those described for lake studies for corresponding years of study (Table 3.1.1-2).

3.1.2 Microzooplankton

3.1.2.1 Field Methods

Lake Studies

A summary of the field and laboratory procedures used to study microzooplankton in the Nine Mile Point vicinity from 1973 through 1978 is provided in Table 3.1.2-1. A more detailed description of the program is found in the annual reports[1-6].

TABLE 3.1.2-1

SUMMARY OF FIELD AND LABORATORY MATERIALS AND METHODS FOR MICROZOOPLANKTON COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

Year	Stations	Sampling Frequency	Field Methods: Collection Method and Depth	Field Methods: Replicates	Preser-vative	Laboratory Methods
1973	3,6,12,18 m depth contours at 4 transects NMPW,NMPP,FITZ and NMPE	MAY-DEC	Double 12 cm diameter Wisconsin-type plankton net with 76-μm mesh netting vertical tows - bottom-surface - double nets beginning in JUN single net - APR-MAY	JUN to end of year-2 reps.	5% buffered formalin	2 1-ml aliquots of a well-mixed sample in a Sedgwick-Rafter counting chamber; 3 strips 0.5 cm in width were analyzed. Identified to lowest possible taxon. Level of ID rotifers-genus, except _Keratella_ to species; cladocerans-genus, except _Leptodora kindtii_; copepods-adults or nauplii; selected protozoa-order or genus
1974	Same as during 1973	Monthly APR, SEP-DEC; twice monthly MAY-AUG	Same as during 1973 except only double nets used.	2	0.06% neo-synephrine followed by 5% buffered formalin	Same as during 1973, except 10-20 strips the width of a Whipple grid and the length of the Sedgwick-Rafter cell were analyzed. Level of ID same as during 1973-plus juveniles for copepods.

TABLE 3.1.2-1 (Cont)

Year	Stations	Sampling Frequency	Field Methods: Collection Method and Depth	Field Methods: Replicates	Preservative	Laboratory Methods
1975	Same as during 1973-1974	Same as during 1974	Clarke-Bumpus-76 μm mesh net; oblique tow-bottom to surface, 2-4 min. duration; meter readings before and after each tow.	No replicates	5% buffered formalin	Samples were split into 2 equal fractions with a Folsom plankton splitter. 2 1-ml fractions analyzed using Sedgwick-Rafter counting chamber - 100x magnification, minimum of 10 horizontal strips as defined by a Whipple grid. Minimum 200 organisms enumerated; ID to species level whenever possible.
1976	Same as during 1973-1975	Monthly MAY-DEC with phytoplankton	Same as during 1975 except tows 2-4 min.	2-taken simultaneously	6% conc. neosynephrine ~30 min. later-adjusted to 5% buffered formalin.	Same as during 1975
1977	Same as during 1973-1976	Monthly APR-DEC	12 cm Wisconsin net; Length:mouth = 3.1; oblique tow-2 nets simultaneously; flowmeter towed alongside boat to measure towing speed 2-4 min tows, 1-1.5 m/sec	2-composited before lab processing	Rose bengal stain/acid Lugol's then formalin (buffered) to 10%	2 subsamples analyzed; Sedgwick-Rafter cell-100x magnification; 5 Whipple strips/chamber-3 Sedgwick-Rafter chambers/subsample; minimum 200 organisms
1978	Same as during 1973-1977	Same as during 1977	Same as during 1977	Same as during 1977	Same as during 1977	Same as during 1977

(2 of 2)

Microzooplankton samples were collected in the Nine Mile Point vicinity along four transects (NMPW, NMPP, FITZ, and NMPE) encompassing approximately 4.0 km (2.5 mi) at four depth contours (3, 6, 12, and 18-m [10, 20, 40, and 60-ft]), as depicted in Figure 3.1.1-1. The same sampling locations were used throughout the program without modification. The frequency with which samples were collected varied from two to four weeks, depending on year and season. From 1973 to 1975 samples were taken twice monthly during the summer; all other sampling was conducted on a monthly basis. All surveys were conducted during the day. Samples were collected with 76 μm mesh nets towed vertically or obliquely through the water column. Either a Wisconsin-type net or Clarke-Bumpus quantitative plankton sampler was used, both with mouth diameters of approximately 12 cm (9 in.).

Entrainment Studies

For the microzooplankton entrainment program at the Unit 1 and JAF plants, samples were generally collected from the intake forebay, discharge bay, and sometimes (1976-1979) the discharge areas in the lake, and analyzed for viability and/or abundance and species composition. The methods used and frequency of sampling are summarized in Table 3.1.2-2. As in the lake, microzooplankton were collected on a 76 μm mesh for all years of study. Collection techniques were designed to minimize collection-induced mortality.

3.1.2.2 Laboratory Methods

Lake Studies

The following procedure was used for analyses for enumeration and taxonomy. A 1-ml (0.3-oz) aliquot of a measured, well-mixed sample was pipetted into a Sedgwick-Rafter cell and all organisms in a specified number of horizontal strips the length of the cell were

TABLE 3.1.2-2

SUMMARY OF METHODS AND MATERIALS FOR MICROZOOPLANKTON ENTRAINMENT COLLECTIONS
NINE MILE POINT AND JAMES A FITZPATRICK NUCLEAR GENERATING STATIONS - 1973-1979

Year	Stations	Sampling Frequency	Collection Method	Analysis
1973	Intake forebay, discharge aftbay. (NMP1)	1-2/month JUL-DEC	Bucket collection of 20-50 liters of surface water; sieved through 76 µm net; sieved material resuspended in 50 ml of filtered water	Immediate counts of dead organisms in two 1-ml aliquots; examination for motility at 100x. Sealed counting chamber returned to laboratory for taxonomy and enumeration of all organisms.
1974	Same as during 1973	2/month; day and night JAN-DEC	Special sampling gear: drum containing 76 µm plankton net.	Same as during 1973
1975	No collections	-	-	-
1976	Intake forebay, discharge aftbay, +3°F mixing zone, +2°F area (JAF)	2/month; day and night APR-DEC	Centrifugal pump/ 76 µm mesh net suspended in water. Volume sampled varied with organism concentation; surface (0.5 m) samples.	Samples incubated 8-10 hours prior to viability analysis; discharge samples diluted to ambient temperature with filtered intake water. Simulation samples: intake samples mixed with filtered discharge water to +3°F and +2°F. Viability analysis: The same during 1974 except one 1-ml aliquot analyzed.
1977	Same as during 1976	Same as during 1976	Same as during 1976 except samples from 1.5 m depth	Same as during 1976 except identification to major group level only.
1978	Same as during 1976-1977	2/month; day and night JAN-DEC	Same as during 1977	Same as during 1977
1979	Same as during 1976-1978	2/month; day and night JAN-MAR	Same as during 1977-1978	Same as during 1977-1978

counted and identified. The number of strips and the number of 1-ml (0.3-oz) aliquots that were analyzed are indicated in Table 3.1.2-1.

Entrainment Studies

The methods used for identification and enumeration of microzooplankton in entrainment samples were basically the same as those applied to lake samples (Table 3.1.2-2). However, dead organisms in unpreserved samples were counted and identified immediately after collection or incubation. These numbers were then compared to the total count after preservation to determine the plant-induced mortality[4-6].

3.1.3 Macrozooplankton

3.1.3.1 Field Methods

Lake Studies

Macrozooplankton sampling was conducted at the same 15 stations in the Nine Mile Point vicinity from 1973 through 1978 (Table 3.1.3-1). The stations were located at the 6 and 12-m (20 and 40-ft) depth contours east and west of the Unit 1 plant and at the 18, 24, and 30-m (60, 80, and 100-ft) depth contours directly offshore. The stations were arranged to permit samples to be obtained within concentric arcs 4.8, 1.6, and 0.8 km (3, 1, and 0.5 mi) from the plant (Figure 3.1.1-1).

Samples were collected weekly from April through December with a 1.0-m (3.3-ft) mouth diameter Hensen-type plankton net of 571 μm mesh from just below the surface, at mid-depth, and near the bottom. A single TSK flowmeter was mounted in the net mouth to permit the volume of water sampled to be calculated.

TABLE 3.1.3-1

SUMMARY OF FIELD AND LABORATORY MATERIALS AND METHODS FOR MACROZOOPLANKTON COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

Year	Stations	Depths	Sampling Frequency	Gear	Preservative	Analysis
1973	15: Nine Mile Point vicinity 0.8-W-6, 0.8-E-6, 0.8-W-12, 0.8-E-12, 0.8-P-18, 1.6-W-6, 1.6-E-6, 1.6-W-12, 1.6-E-12, 1.6-P-18, 4.8-W-6, 4.8-E-6, 4.8-W-12, 4.8-E-12, 4.8-P-30	Surface Mid-depth Bottom (Mid and bottom tows oblique)	Weekly; day and night late JUN-early SEP; day only on other dates APR-DEC	1.0-m Hensen net 571-μm mesh, TSK flow meter, 5-min tow duration	Formalin	Enumeration, identification of major groups and selected species.
1974	Same as during 1973	Surface Mid-depth Bottom	Same as 1973, but day and night late JUN-mid-SEP	Same as during 1973	5-8% buffered formalin	Same as during 1973, but for selected major groups and species.
1975	Same as during 1973-1974	Same as during 1974	Same as during 1974	Same as during 1973-1974	5% buffered formalin	Same as during 1974, but one survey per month analyzed.
1976	Same as during 1973-1975	Same as during 1974-1975	Same as during 1974-1975	Same as during 1973-1975	Same as during 1975	Same as during 1975, but only Gammarus, Pontoporeia, and Mysis counted and identified.
1977	Same as during 1973-1976	Same as during 1976, but three depths composited prior to analysis	Same as during 1974-1976	Same as during 1973-1976	Unreported	Same as during 1976, but only day samples analyzed and identification to lowest taxonomic level possible.
1978	Same as during 1973-1977	Same as during 1977	Monthly	Same as during 1973-1977	Unreported	Same as during 1977

Entrainment Studies

Macrozooplankton entrainment studies were conducted from 1973 through 1976 at Unit 1 and from 1975 through 1979 at the JAF plant. Details were presented by LMS[1-4] and TI[5,6].

The basic program at Unit 1 consisted of sample collection at the intake and discharge to determine organism density and viability at both locations (Table 3.1.3-2).

The study at the JAF plant was similar to that at Unit 1; however, density measurements were obtained only at the intake, and viability analyses were limited to a dominant organism, the amphipod Gammarus. In addition to investigation of plant entrainment effects on viability, laboratory simulations of plume entrainment were conducted and samples in the discharge plume were obtained to investigate the effects of plume entrainment on Gammarus viability (Table 3.1.3-3).

Samples were collected with 0.5-m (1.6-ft) mouth diameter conical plankton nets of 571 μm mesh or a 0.05 m^3/s (13 gal/s) centrifugal water pump with a 571 μm mesh screen (net). A single TSK or digital flowmeter was used to monitor flow through the plankton nets, and the pump was calibrated prior to use to determine volume sampled per unit time.

Plume entrainment was simulated by adding filtered discharge water (at discharge temperature) to intake collections and then ambient temperature intake water at rates that approximated temperature decay in the plume (to +1.1°C and 1.7°C [+2°F and +3°F]). Temperature decay (to 1.1°C [+2°F]) was also simulated for all discharge samples collected after June 1976.

TABLE 3.1.3-2

SUMMARY OF FIELD AND LABORATORY MATERIALS AND METHODS FOR MACROZOOPLANKTON ENTRAINMENT COLLECTIONS
NINE MILE POINT AND JAMES A. FITZPATRICK GENERATING STATIONS - 1973-1978

Year	Stations	Depths	Sampling Frequency	Gear	Analysis
1973	Intake, Bay 1 Bay 2 Discharge	Surface Mid-depth Mid-depth	Weekly; day and night JUL-OCT, DEC	0.5-m mouth dia. conical net; 4:1 open area to mouth ratio; 571 μm mesh; single TSK flowmeter; 15 min. and 60 min. collections.	Enumeration, identification of major groups and selected species.
1974	Same as during 1973	Same as during 1973	Twice monthly; day and night JAN-DEC	Same as during 1973, but all collections were 5 min.	Viability (live/dead) for selected taxa; enumeration, identification of selected major groups and species.
1975	Same as during 1974, but Disch. omitted and Intake at JAF added	Same as during 1973-1974 (NMP1) Surface and Mid-depth (JAF)	Same as during 1974, but APR-OCT (NMP1) OCT-DEC (JAF)	Same as during 1974, but all collections were 30 min.	Enumeration, identification of selected major groups and species. One survey/month analyzed.
1976	Same as during 1975. (For viability program, see Table 3.1.3-3)	Same as during 1975	Weekly MAY-SEP; twice monthly JAN-MAY and SEP-DEC; day and night APR-OCT (NMP1) JAN-DEC (JAF)	Same as during 1975	Identification and enumeration of *Gammarus* only in JAF collections; one survey/month analyzed. (For viability program see Table 3.1.3-3)
1977	No program				
1978	No program				

TABLE 3.1.3-3

SUMMARY OF FIELD AND LABORATORY MATERIALS AND METHODS FOR MACROZOOPLANKTON AND ICHTHYOPLANKTON VIABILITY STUDY JAMES A. FITZPATRICK GENERATING STATION- 1976-1979

Stations	Dates	Sampling Frequency	Gear	Analysis
Intake (4,6 m) Discharge (2 m)	APR-DEC 1976 JAN-DEC 1977 JAN-DEC 1978	1-2 times/month; day and night for ichthyoplankton; Night only for macrozooplankton	Intake and discharge plume: 0.5-m conical nets of 571-μm mesh; single flowmeters; 5-15 min. collections	<u>Gammarus</u> analyzed during 1976; ichthyoplankton analyzed by species and life stage during 1976, 1977, and 1978., and 1978.
Discharge Plume (Surface)			Discharge: 0.05 m^3/s centrifugal pump/571-μm mesh; 5 min. collections	Live/dead determined for: 1) cross-plant, 2) simulated plume entrainment, 3) actual discharge plume.
Intake, discharge, 2° and 3°FΔT	JAN-MAR	2/month;day and night; ichthyoplankton	Drift nets	Same as during 1978

3.1.3.2 Laboratory Methods

Lake Studies

After fish larvae and eggs were sorted and removed from the ichthyoplankton samples, macrozooplankton from the same samples were counted and identified. Details were presented by LMS[1-4] and TI[5,6]. Several subsampling schemes were used, with the choice dependent on organism density.

Entrainment Studies

Viability was estimated on the basis of motility; samples were examined as soon as possible following collection. Analyses to determine macrozooplankton density were as described for lake samples.

3.1.4 Benthos

3.1.4.1 Field Methods

Benthos surveys were conducted in the Nine Mile Point vicinity from 1968-1978. Storr[20] reported the results of four years of sampling in the area (1968-1972); his studies were concerned mainly with sampling beds of the filamentous alga *Cladophora* and determining the abundance of benthic organisms, especially gammarid amphipods, associated with those beds.

The 1973-1978 surveys are summarized in Table 3.1.4-1. Benthic macroinvertebrate samples were collected along four transects perpendicular to the shoreline (Figure 3.1.4-1). From 1973 through 1975, when *Cladophora* beds were present, samples were collected in non-*Cladophora* and *Cladophora* areas, if possible, at the 3-m (10-ft) depth contours.

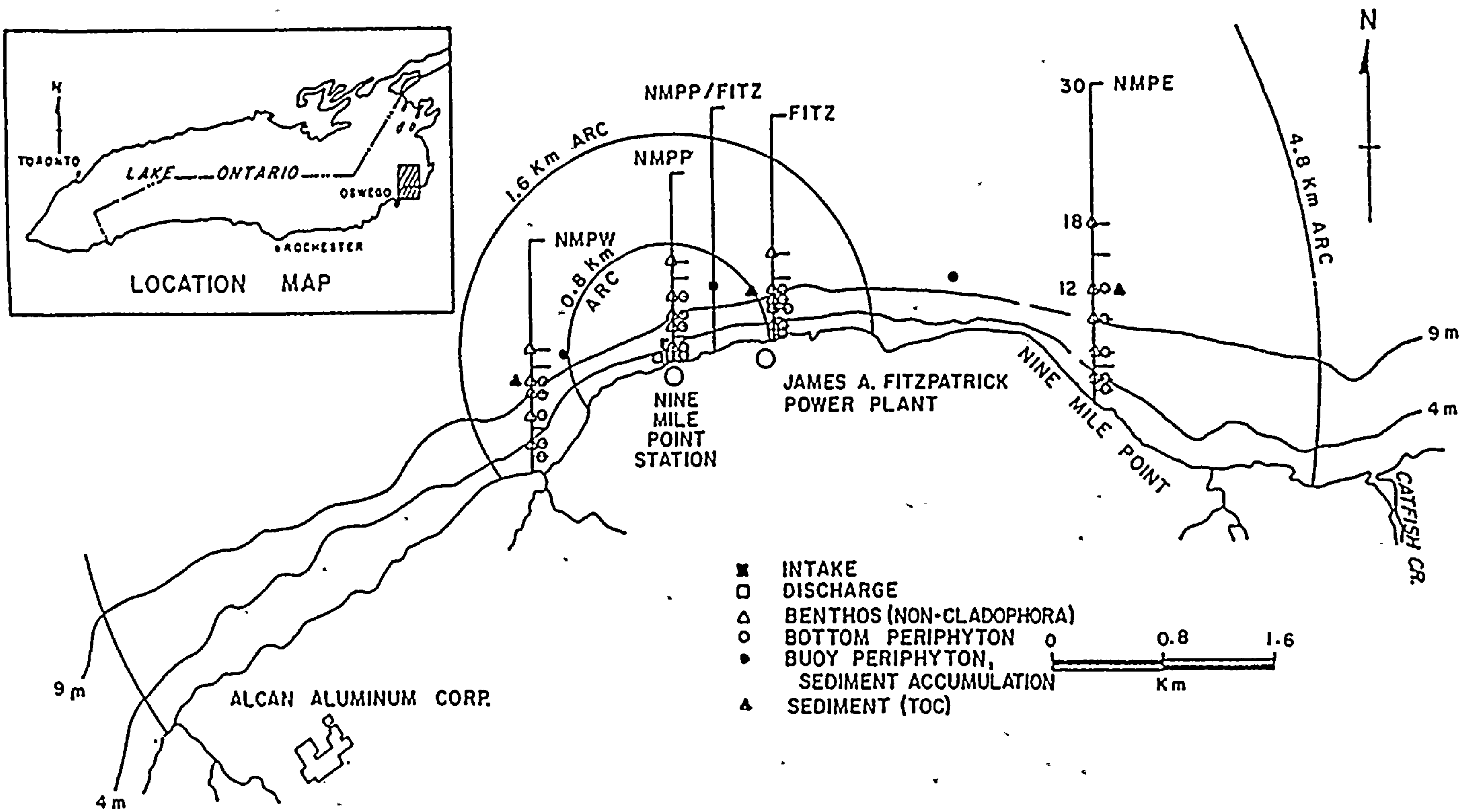
TABLE 3.1.4-1

SUMMARY OF FIELD AND LABORATORY MATERIALS AND METHODS FOR MACROBENTHOS
NINE MILE POINT VICINITY - 1973-1978

Year	Collection Method	Preservative	Sediment	Laboratory Analysis
1973	Diver-operated pump; 0.39 m diameter ring	7% formalin or ice and menthol	Visual observation	Sieved through 420 μm screen; preserved in 70% ethanol and Phloxine-B; Abundance and biomass (wet weight).
1974	Same as during 1973 except 0.50 m diameter ring (0.196 m^2)	Ice and menthol	Same as during 1973; plus samples for lab analysis	Same as 1973 plus sediment analysis (chemistry)
1975	Same as during 1974	Same as during 1974	Same as during 1973-1974	Same as 1973-1974 plus sediment grain size analysis
1976	Same as during 1974-1975	Same as during 1974-1975	Same as during 1973-1975	Same as 1973-1975 except sediment chemistry limited to determination of organic carbon
1977	Self-contained diver-operated pump (0.166 m^2)	Sieved through 590 μm mesh; buffered formalin	None	Sieved through 500 μm screen; preserved in 70% ethanol. Abundance and biomass (wet weight).
1978	Same as during 1977	Same as during 1977	None	Same as during 1977

FIGURE 3.1.4-1

BENTHOS SAMPLING STATIONS
NINE MILE POINT VICINITY 1973-1978



3.0-18

Benthos samples were collected with a diver-operated pump. A metal ring was used to define the bounds of the sampling area at each station. Following the June 1973 survey, all benthos samples were chilled on ice. The organisms were anesthetized with menthol and returned to the laboratory for analysis preparation..

Sediment analyses were carried out as part of the 1973-1976 benthos studies. These involved visual analyses by divers; definitions applied are shown in Table 3.1.4-2. During 1974, chemical analyses were performed on the silt-sand sediment type and supernatant (September survey). During 1975 and 1976, grain size analyses and sediment accumulation experiments were conducted (at buoy periphyton sites); organic carbon concentration in the sediments at selected sites was measured during 1976.

3.1.4.2 Laboratory Methods

Analysis preparation involved sieving, to separate organisms and sediment, followed by preservation (70% ethanol) of the material on the sieve. A 420 μm sieve was used from 1973-1976; a 500 μm sieve was employed during 1977 and 1978. A stain, Phloxine-B, was added to the preservative from 1973-1976 to aid in organism recognition (21).

Organisms were identified to the lowest feasible taxonomic level using a dissecting microscope or, for diptera larvae and oligochaetes, slide mounts and a light microscope. Subsampling generally was not required.

Biomass estimates were based on wet weight, measured on a Mettler balance after washing and removal of interstitial water by blotting or by drying 30 min over desiccant.

TABLE 3.1.4-2

DEFINITIONS OF SUBSTRATE TYPE
NINE MILE POINT VICINITY - 1973-1976

Type		Observation
Bedrock	=	Large flat rock
Boulder	=	256 mm rounded rock
Rubble	=	64 to 256 mm - mixture of flat and rounded rock of cobblestone size
Gravel	=	2 to 64 mm rock
Mixed Rock	=	Bedrock predominant with pieces of rubble between
Sand & Silt Over Bedrock	=	Mask of sand less than 5 cm over bedrock
Sand & Silt	=	Sand deeper than 5 cm

3.1.5 Periphyton

3.1.5.1 Field Methods

Bottom Periphyton

Bottom periphyton studies were carried out in the Nine Mile Point vicinity from 1973-1978. Field procedures for each year are summarized in Table 3.1.5-1. Four transects (NMPW, NMPP, FITZ, and NMPE) were established perpendicular to the shoreline in the vicinity of Unit 1. Each transect was the same as defined for benthic sampling (Section 3.1.4.1). Sampling locations were established at the 2, 3, 6, 10, and 12-m (7, 10, 20, 30, and 40-ft) depth contours.

The duration of these studies varied among years, but generally samples representative of spring, summer, and fall conditions were obtained. Exposure periods also varied among years; four-week exposures were common to 1975-1978 programs and were used for some periods during earlier years.

In 1973 glass slides were used as the substrates. The artificial substrates used from 1974-1978 were doubled Plexiglas plates. On each collection date, scuba divers collected the exposed substrates and replaced them with cleaned plates. Exposed substrates were returned to the laboratory for analysis preparation.

Buoy Periphyton

Buoy periphyton studies were conducted from 1973-1978; a summary of these studies is presented in Table 3.1.5-2. Three stations were used for buoy periphyton collections: NMPE, NMPP, and NMPW. Each buoy was anchored at the 12-m (40-ft) depth contour (Figure 3.1.4-1). A structure extended below each buoy to a depth of 5 m (16 ft), and

TABLE 3.1.5-1

SUMMARY OF FIELD METHODS AND MATERIALS FOR BOTTOM PERIPHYTON COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

Year	Stations	Duration	Exposure Periods	Substrate	Analysis
1973	20:4 Transects (NMPW, NMPP, FITZ, NMPE) by 5 depth contours (2,3,6,10, 12 m)	JUL-OCT	2-16 wks	8 glass slides; diver retrieval	Taxonomy and abundance; dry weight and ash weight; chlorophyll a
1974	Same as during 1973	MAY-NOV	2-4 wks	Double Plexiglas plates; diver retrieval	Same as during 1973
1975	Same as during 1973-1974	MAY-DEC	4 wks	Same as during 1974	Same as during 1973-1974
1976	Same as during 1973-1975	APR-DEC	4 wks	Same as during 1974-1975	Same as during 1973-1975 except chlorophyll a not analyzed
1977	Same as during 1973-1976	MAY-DEC	4 wks	Same as during 1974-1976	Same as during 1976
1978	Same as during 1973-1977	APR-DEC	4 wks	Same as during 1974-1977	Same as during 1977

TABLE 3.1.5-2

SUMMARY OF FIELD METHODS AND MATERIALS FOR BUOY PERIPHYTON COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

Year	Stations	Duration	Exposure Periods	Substrate	Analysis
1973	NMPE, NMPP, NMPW all at 12-m depth contour	AUG-NOV	2-16 wks	Glass slides; styrofoam blocks; diver retrieval	Taxonomy and abundance; dry weight and ash weight; chlorophyll a
1974	Same as during 1973	MAY-NOV	2-4 wks	Plexiglas plates; diver retrieval	Same as during 1973
1975	Same as during 1973-1974	MAY-DEC	4 wks	Same as during 1974	Same as during 1973-1974
1976	Same as during 1973-1975	APR-DEC	4 wks	Same as during 1974-1975	Same as during 1973-1975 except chlorophyll a not analyzed
1977	NMPW, NMPP, FITZ all at 12-m depth contour	MAY-SEP	4 wks	Same as during 1974-1976 except some samples retrieved by winch	Same as during 1976
1978	Same as during 1977	MAY-SEP	4 wks	Same as during 1977	Same as during 1977

samples were collected from the 1, 2, 4, 5-m (3, 7, 13, and 16-ft) depths (Figure 3.1.5-1). The same sampling locations were used from 1973-1976. In 1977 and 1978, the transects used were NMPW, NMPP, and FITZ (Figure 3.1.4-1).

In 1973, glass slides and polystyrene blocks were used as the substrates. From 1974-1978 doubled Plexiglas plates were used. On each collection date, scuba divers retrieved the exposed substrates and replaced them with clean ones. Exposed substrates were returned to the laboratory for analysis.

3.1.5.2 Laboratory Methods

Methods of periphyton analysis were essentially the same for bottom and buoy collections and were basically similar among the years of study. Details were presented in annual reports[1-6].

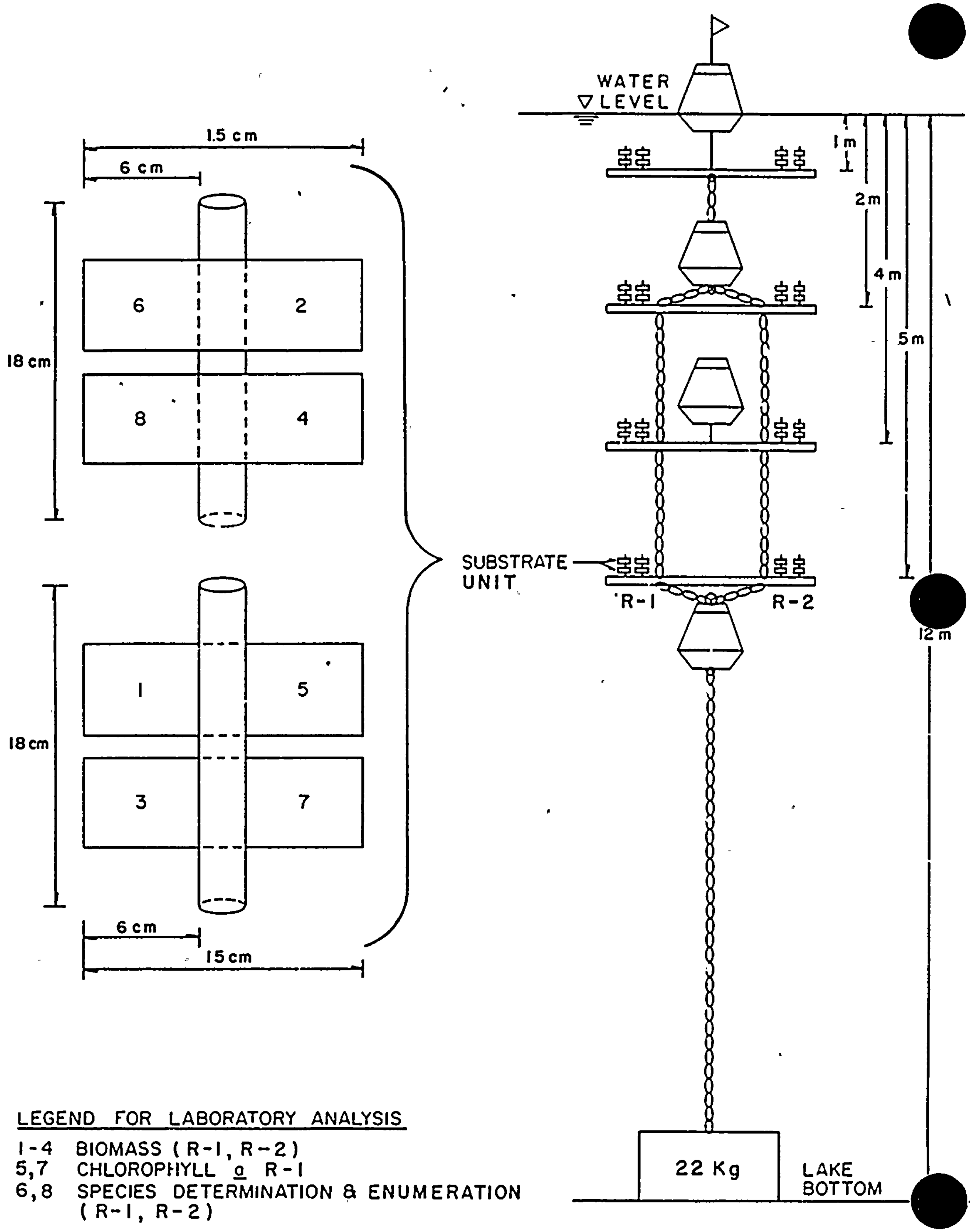
Taxonomy and Abundance

Material was scraped from glass slides or sections of Plexiglas plates, agitated to break up algal films and clumps, and preserved in 5% formalin. Basically the same procedure was followed for polystyrene substrates except that the surfaces of the blocks were sliced off and homogenized in a blender at low speed to separate the substrate from sample material.

A Palmer-Maloney and/or Sedgwick Rafter counting chamber and light microscope were used for analyses. Counts were expressed as clumps, algal cells, and organisms (for zooperiphyton) per square decimeter or centimeter. Taxonomic identifications were to the lowest feasible level.

FIGURE 3.1.5-1

BUOY PERIPHYTON SAMPLING APPARATUS



Biomass

Biomass determinations used either entire glass slides or scrapings from sections of Plexiglas plates. In both cases, samples were dried in a hot air oven, cooled, weighed, ashed in a muffle furnace for 30 min, cooled, and reweighed. Dry weight, ash weight, or ash-free dry weight were computed as appropropriate for the two drying techniques.

Chlorophyll *a*

The trichromatic method was used for chlorophyll *a* analyses during 1973 through 1975[22].

3.1.6 Ichthyoplankton

3.1.6.1 Field Methods

Lake Studies

Following a preliminary survey during the late summer/early fall of 1972, ichthyoplankton samples were collected at the same stations in the Nine Mile Point vicinity from 1973 through 1978 (Table 3.1.6-1). The stations were located at the 6 and 12-m (20 and 40-ft) depth contours east and west of Unit 1 and at the 18, 24, and 30-m (60, 80, and 100-ft) depth contours directly offshore from the plant. The stations were arranged to permit samples to be obtained within concentric arcs 4.8, 1.6, and 0.8 km (2, 1, and 0.5 mi) from the power plant (Figure 3.1.1-1).

Samples were collected weekly at all stations from April through December during all years of study except 1973 when sampling was conducted from May through December and 1977 and 1978 when sampling

TABLE 3.1.6-1

SUMMARY OF FIELD AND LABORATORY MATERIALS AND METHODS FOR ICHTHYOPLANKTON COLLECTIONS
NINE MILE POINT VICINITY - 1973-1978

Year	Stations	Depths	Sampling Frequency	Gear	Preservative	Analysis
1972	7: Oswego vicinity 6: Mexico Bay (Preliminary survey)	Surface Mid-depth	1/mo; day and night (OCT); evening (SEP) SEP-OCT	Hensen-type net, 1-m mouth dia. 571 μm mesh, single TSK flowmeter; 10-15 min. tow.	10% formalin	Enumeration, identification of major species.
1973	15: Nine Mile Point vicinity 0.8-W-6,0.8-E-6, 0.8-W-12,0.8-E-12, 0.8-P-18,1.6-W-6, 1.6-E-6,1.6-W-12, 1.6-E-12,1.6-P-18, 4.8-W-6,4.8-E-6, 4.8-W-12,4.8-E-12, 4.8-P-30	Surface Mid-depth Bottom (Mid and bottom tows oblique)	Weekly; day and night late JUN-early SEP; day only on other dates MAY-DEC	Same as during 1972, but 5 min. tows	Same as during 1972	Enumeration of eggs and larvae; identification of larvae to species where possible; length of larvae.
1974	Same as during 1973	Surface Mid-depth Bottom	Same as during 1973, but day and night late JUN-mid-SEP APR-DEC	Same as during 1973	5-8% buffered formalin	Same as during 1973; in addition, eggs identified to species where possible.
1975	Same as during 1973-1974	Same as during 1974	Same as during 1974	Same as during 1973-1974	5% buffered formalin	Same as during 1974; in addition, larvae identified according to life stage.
1976	Same as during 1973-1975	Same as during 1974-1975	Same as during 1974-1975	Same as during 1973-1975	Same as during 1975	Same as during 1975
1977	Same as during 1973-1976	Same as during 1974-1976	Same as during 1974-1976, but 2/mo. in DEC	Same as during 1973-1976	Unreported	Same as during 1975-1976, but juveniles omitted and measuring for length omitted.
1978	Same as during 1973-1977	Same as during 1974-1977	Same as during 1977	Same as during 1973-1977	Unreported	Same as during 1977

was conducted only twice during December. The samples were collected with a 1.0-m (3.3 ft) mouth diameter Hensen-type plankton net of 571 μm mesh from just below the surface, at mid-depth, and near the bottom. A single TSK flowmeter was mounted in the net mouth to permit the volume of water sampled to be computed.

Entrainment Studies

Ichthyoplankton entrainment studies were conducted from 1973 through 1978 at Unit 1 and from 1975 through 1979 at JAF. Details were presented by LMS[1-4] and TI[5-7].

The basic program at Unit 1 consisted of sample collection at the intake and discharge to determine organism density at these locations and changes in viability after plant entrainment. Samples were collected at least twice per month during the day and at night. Discharge collections were omitted after 1974 (Table 3.1.6-2).

The entrainment study at JAF was similar to that at Unit 1. In addition to investigating organism density and plant entrainment effects on viability, laboratory simulations of plume entrainment were conducted and samples from the discharge plume were obtained to investigate the effects of plume entrainment on ichthyoplankton viability.

Samples were collected with 0.5-m (1.6-ft) mouth diameter conical plankton nets of 571 μm mesh or a 0.05 m^3/s (13 gal/s) centrifugal water pump with a 571 μm mesh screen (net). A single TSK flowmeter was used to monitor flow through the plankton nets, or the pump was calibrated prior to use to determine volume sampled per unit time.

Plume entrainment was simulated by adding filtered discharge water (at discharge temperature) to intake collections and then ambient

TABLE 3.1.6-2

SUMMARY OF FIELD AND LABORATORY MATERIALS AND METHODS FOR ICHTHYOPLANKTON ENTRAINMENT COLLECTIONS
NINE MILE POINT AND JAMES A. FITZPATRICK GENERATING STATION - 1973-1979

Year	Stations	Depths	Sampling Frequency	Gear	Analysis
1973	Intake, Bay 1 Bay 2 Discharge	Surface Mid-depth Mid-depth	Weekly; day and night JUL-OCT, DEC	0.5-m mouth dia. conical net; 4:1 open area to mouth ratio; 571 μm mesh; single TSK flowmeter; 15 min. and 60 min. collections.	Viability (live/dead), enumeration, identification, "lengthing" of fish larvae, enumeration of fish eggs.
1974	Same as during 1973	Same as during 1973	Twice monthly; day and night JAN-DEC	Same as during 1973, but 5 min. collections	Viability (live/dead), enumeration, identification of fish larvae; enumeration and identification of fish eggs
1975	Same as during 1973-1974, but Disch. omitted and Intake at JAF added	Same as during 1973-1974 (NMP1) Surface and Mid-depth (JAF)	Same as during 1974 APR-OCT (NMP1) OCT-DEC (JAF)	Same as during 1974, but 30 min. collections.	Enumeration, identification of fish larvae and eggs
1976	Same as during 1975. (For viability program, see Table 3.1.3-3)	Same as during 1975	Weekly MAY-SEP; twice monthly JAN-MAY and SEP-DEC; day and night APR-OCT (NMP1) JAN-DEC (JAF)	Same as during 1975	Enumeration, identification of fish larvae and eggs; larval life stages identification (For viability program, see Table 3.1.3-3)
1977	Same as during 1976, but Intake, Bay 2 (NMP1)	Same as during 1975-1976	Twice monthly; day (NMP1); day and night (JAF) APR-OCT (NMP1) JAN-DEC (JAF)	Same as during 1975-1976, but 15-30 min. collections (NMP1); 5-15 min. collections (JAF)	Same as during 1976
1978	Same as during 1977	Same as during 1975-1977	Same as during 1977	Same as during 1977	Same as during 1975-1977
1979	Intake (JAF)	4 and 6-m	2/month; day and night, JAN-MAR	Same as during 1977-1978	Enumeration; identification

temperature intake water at rates that approximate temperature decay in the plume [to +1.1°C and +1.7°C (+2°F and +3°F)]. Temperature decay [to +1.1°C (+2°F)] was also simulated for all discharge samples collected after June 1976.

3.1.6.2 Laboratory Methods

Lake Studies

After sorting and transfer to 70% alcohol, ichthyoplankton were counted, identified, and measured for total length. All fish larvae were identified to species where possible from 1973 on; fish eggs were identified to species where possible from 1974 on; larvae were identified according to life stage (prolarvae, postlarvae, juveniles) from 1975 on. Details of analysis were presented by LMS[1-4] and TI[5-7].

Entrainment Studies

Viability was estimated on the basis of motility; samples were examined as soon as possible following collection. Methods and procedures for identification by species and life stage, enumeration, and length measurements were as for lake studies.

3.1.7 Fish

3.1.7.1 Field Methods

Lake Studies

Early in the design-construction phase of Unit 1, Dr. Storr assessed Lake Ontario fish populations near the Nine Mile Point area. Abundance and distribution of fish stocks were determined by fathometric surveys and by gill net collections[23-37]. Additional

studies were conducted to determine the food preferences of yellow perch[38,39] and other fishes[40-45]. Storr's work provides a description of the fish communities prior to full-scale operation of the power station.

LMS (QLM prior to 1975) conducted additional studies on the distribution and abundance of fishes in the Nine Mile Point area from 1972 to 1977[1-4,46,47]. TI conducted additional studies from 1977 to 1981[5-8]. Fish populations were sampled periodically by surface and bottom trawling, surface, bottom, and mid-depth gill netting, and beach seining. Anatomical and meristic data from these fish were used to determine population characteristics, i.e., length-weight relationship, condition factors, length-frequency distributions, coefficients of maturity, and sex ratios for selected species.

The gear used to sample fishes in the vicinity of Nine Mile Point from 1972 through 1981 are listed in Table 3.1.7-1 which also gives the dimensions for each gear type. Trawl runs (Otter and Yankee) were made parallel to shore along the selected depth contour for 15 min in an east to west direction at each sampling site. Gill nets were set parallel to shore at the specified depth contours. Trap nets were set at sunset and retrieved shortly after sunrise on each sampling date. All fishes collected with each type of gear were preserved in 10% buffered formalin for later processing. Fish collected for food habit studies were injected in the body cavity and the stomach (through the pharynx) with 10% formalin.

Table 3.1.7-2 summarizes the sampling schedule, including sampling location and frequency for the period from 1972 through 1981. The basic program was to sample fishes with a variety of gear from four

TABLE 3.1.7-1

SAMPLING GEAR USED DURING FISH COLLECTIONS
NINE MILE POINT VICINITY - 1972-1981

Gear	Year	Dimensions
Otter Trawl	1972 - 1978	7-m long; 5-cm stretched mesh in wing and body, 3.8-cm stretched mesh liner; net equipped with floats for surface trawling.
Yankee Trawl (Three-quarter standard)	1976 and 1977	8.9-cm stretched mesh in wings, 6.4-cm stretched mesh in body, 1.3-cm strecthed mesh in cod end
Gill Net (Experimental)	1972 - 1981	46-m long, 2.4-m deep (1.8-m deep in 1972 only). 6 panels each 7.6-m long; each panel had a different mesh: 1.3, 2.5, 3.8, 5.1 and 6.4-cm bar mesh. From Apr through Oct 1973 nets were made of monofilament; from Nov 1973 to end of 1981 nets were made of nylon multifilament.
Trap Net (Box trap)	1977-1978	0.9 x 0.9 x 1.8-m aluminum pipe frame box covered with 0.6-cm nylon bar mesh, a 15-m center lead, and two 7.6-m wings.
Beach Seine	1972 and 1973	30-m long, 2.4-m deep, 2.4-m deep pocket; 1.3-cm stretched mesh in wings and pocket.
	1974 - 1978	15-m long, 2.4-m deep, 2.4-m deep pocket; 1.3-cm stretched mesh in wings and pocket; 0.6-cm stretched mesh used in 1978.
	1975 (only)	61-m long, 2.4-m deep, 2.4-m deep pocket; 1.3-cm stretched mesh in wings and pocket. Fished at special sites only (see text).

TABLE 3.1.7-2

SUMMARY OF FIELD MATERIALS AND METHODS FOR FISH COLLECTIONS
NINE MILE POINT VICINITY - 1972-1981

Year	Gear	Frequency	Transect	Depth Contour m (ft)	Sample Depth	Comments
1972	Otter trawl	Monthly (D&N) Apr, Oct	NMPW, NMPP	6, 12 (20, 40)	Surface & bottom	Floats were attached to trawl for surface sampling. Bottom trawls were made with net slightly above bottom to avoid net fouling.
	Gill net	Monthly (D) Sep, Oct	NMPW, NMPP	5, 9, 12 (15, 30, 40)	Mid-depth at 5 m; surface & bottom at 9 and 12 m	
	Beach seine	Monthly (D) Sep	-	-	Shoreline to 2.5 m	
1973	Otter trawl	Monthly (D&N) Mar-May, Dec	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Surface & bottom	Trawling at NMPP crossed the FITZ transect eliminating the need for trawling at the FITZ transect (comments for 1972 apply)
	Gill net	Semi-monthly (D&N)-Jun-Dec	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 30, 40, 60)	Bottom at 5 m; surface and bottom at 9, 12 & 18 m	Nets set for 48 hours and harvested every 12 hours at dawn and dusk approximately
	Beach seine	Semi-monthly (D) Jun-Nov	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m at end of each transect	
1974	Otter trawl	Semi-monthly (D&N) Apr-Nov	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Surface and bottom	Comments for 1972 & 1973 apply
	Gill net	Apr, May and Jul - 3 samples; Jun - 4 samples; Aug-Nov - 2 samples; Dec - 1 sample (D&N for all months)	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 30, 40, 60)	Bottom at 5 m; Surface and bottom at 9, 12 and 18 ft	Comments for 1973 apply.
	Beach seine	Semi-monthly Apr-Nov, 1 sample in Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m at end of each transect	

(1 of 3)

TABLE 3.1.7-2 (Cont)

Year	Gear	Frequency	Transect	Depth Contour m (ft)	Sample Depth	Comments
1975	Otter trawl	Apr, Aug, Sep - 3 samples; May, Jun, Jul, Oct - 2 samples; Nov - 4 samples; Dec - 1 sample (D&N for all months)	NMPW, NMPP NMPE	6, 12, 18 (20, 40, 60)	Surface and bottom	Comments from 1972 and 1973 apply.
	Gill net	Apr & Dec - 1 sample; Semi-monthly May - Nov (D&N)	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 30, 40, 60)	Surface at 5 m; Surface and bottom at 9, 12 and 18 m	Comments for 1974 apply.
	Beach seine	Apr, Jul, Oct, Nov, Dec - 1 sample; May & Jun - 2 samples; Aug & Sep - 3 samples	NMPW, NMPP, FITZ	-	Shoreline to 2.5 m at end of each transect	See text for special seine sampling program in 1975.
1976	Otter trawl	Semi-monthly (D&N) Apr-Dec (12 and 20 m contours at NMPE from Apr-Jun only)	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Bottom	Comments for 1972 and 1973 apply.
	Yankee trawl	Semi-monthly (D&N) Jun-Dec	NMPE	12, 18 (40, 60)	Bottom	See text for trawl comparison study in 1976.
	Gill net	Semi-monthly (D&N), Apr-Dec	NMPW, NMPP, FITZ, NMPE	5, 9, 12, 18 (15, 30, 40, 60)	Bottom only at 5, 9 and 18 m; surface and bottom at 12 m	Comments for 1973 apply; Surface at 12 m contour was a night collection only and bottom net was for day collection only
	Beach seine	Semi-monthly (D) Apr-Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m at end of each transect	

(2 of 3)

TABLE 3.1.7-2 (Cont)

Year	Gear	Frequency	Transect	Depth Contour m (ft)	Sample Depth	Comments
1977	Otter trawl	Semi-monthly (D&N) Apr-Dec	NMPW, NMPP, NMPE	6, 12, 18 (20, 40, 60)	Bottom	Comments for 1972 and 1973 apply.
	Yankee trawl	Semi-monthly (D&N) Apr-Dec	NMPE	12, 18 (40, 60)	NA	
	Gill net	Semi-monthly (D&N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	5, 6, 9, 12, 18 (15, 20, 30, 40, 60)	Bottom	Comments for 1973 apply. No sampling at 6-m contour for NMPP.
	Beach seine	Semi-monthly (D) Apr-Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m at end of each transect	
	Trap net	Semi-monthly (N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	6 (20)	Bottom	
1978	Otter trawl	Semi-monthly (D&N) Apr-Dec	NMPW, NMPP, NMPE/FITZ	6, 12, 18 (20, 40, 60)	Bottom	Comments for 1972 and 1973 apply.
	Gill net	Semi-monthly (D&N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	5, 6, 9, 12, 18 (15, 20, 30, 40, 60)	Bottom	Comments for 1973 apply. No sampling at 6-m contour for NMPP.
	Beach seine	Semi-monthly (D) Apr-Dec	NMPW, NMPP, FITZ, NMPE	-	Shoreline to 2.5 m at end of each transect	
	Trap net	Semi-monthly (N) Apr-Dec	NMPW, NMPP, FITZ, NMPE	6 (20)	Bottom	
1979	Gill net	Semi-monthly (N) Apr-Aug Monthly (N) Sep-Dec	NMPW, NMPP, FITZ, NMPE	9 (30)	Bottom	
1980	Gill net	Same as during 1979	Same as during 1979	Same as during 1979	Same as during 1979	
1981	Gill net	Same as during 1979-1980	Same as during 1979-1980	Same as during 1979-1980	Same as during 1979-1980	

KEY: NA = Not available
D = day sampling
N = night sampling

transects distributed around Unit 1 and JAF. Figure 3.1.7-1 indicates the transects sampled from 1969 through 1971 and Figure 3.1.7-2 gives the transects sampled from 1972 through 1981.

In addition to the fishery sampling program summarized in Tables 3.1.7-1 and 3.1.7-2, special sampling was conducted during a number of years. From 1973 through 1978 special gill net sampling was employed to obtain specimens for food habit studies. From 1973 through 1975 these gill nets were fished on the bottom at the 5- and 10-m (15- and 30-ft) contours at all transects. In 1976 and 1978 they were fished only at the 5-m (15-ft) contour of each transect. From 1973 through 1975 the gill nets were harvested every 4 hrs and in 1976 and 1977 they were harvested every 2 hrs.

In 1975 a special seine sampling program was conducted at 10 sites from April through December. Two sites were located at the end of transect NMPW and eight sites were distributed along the shore east of Nine Mile Point to the mouth of the Salmon River (Figure 3.1.7-3). This program employed both a 61-m (200 ft) beach seine of 1.3 cm (0.5 in.) stretched mesh in the wings and the bag or the 15-m (50-ft) seine described in Table 3.1.7-1. The purpose of this program was to collect as large a number and variety of species as possible, particularly young-of-the-year.

From 1972 through 1978, fishes were sampled in a consistent manner from year to year with few changes in the program. The reduced sampling program after 1978 reflects changes in the Unit 1 and JAF technical specifications.

The principal problem encountered was weather severe enough to prevent sampling on a scheduled date; however, missed samples were generally obtained at the earliest possible date thereafter.

FIGURE 3.1.7-1

SAMPLING TRANSECTS FOR FISH COLLECTIONS
NINE MILE POINT VICINITY—1969-1971

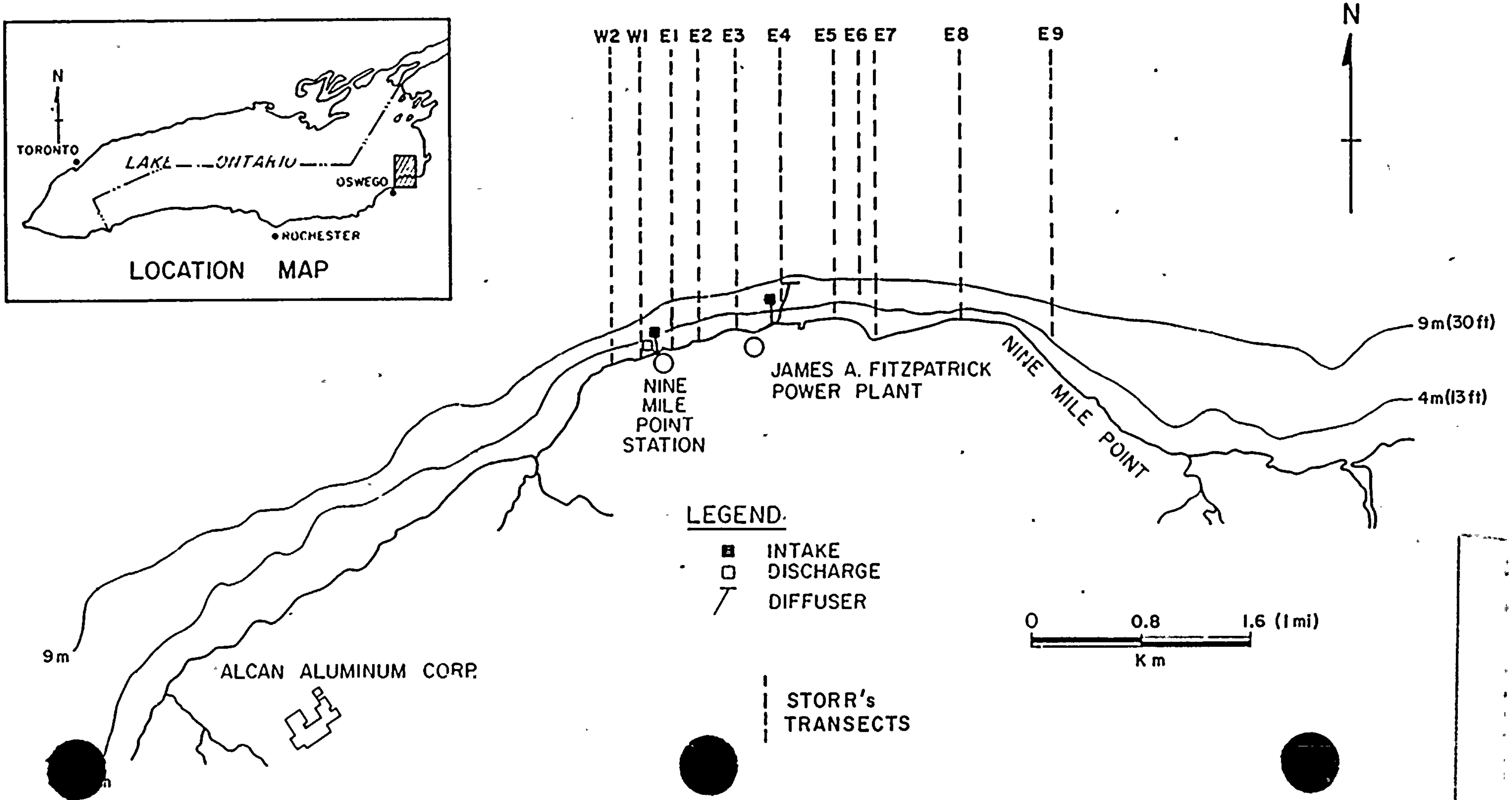


FIGURE 3.1.7-2

SAMPLING TRANSECTS FOR FISH COLLECTIONS
NINE MILE POINT VICINITY—1972-1981

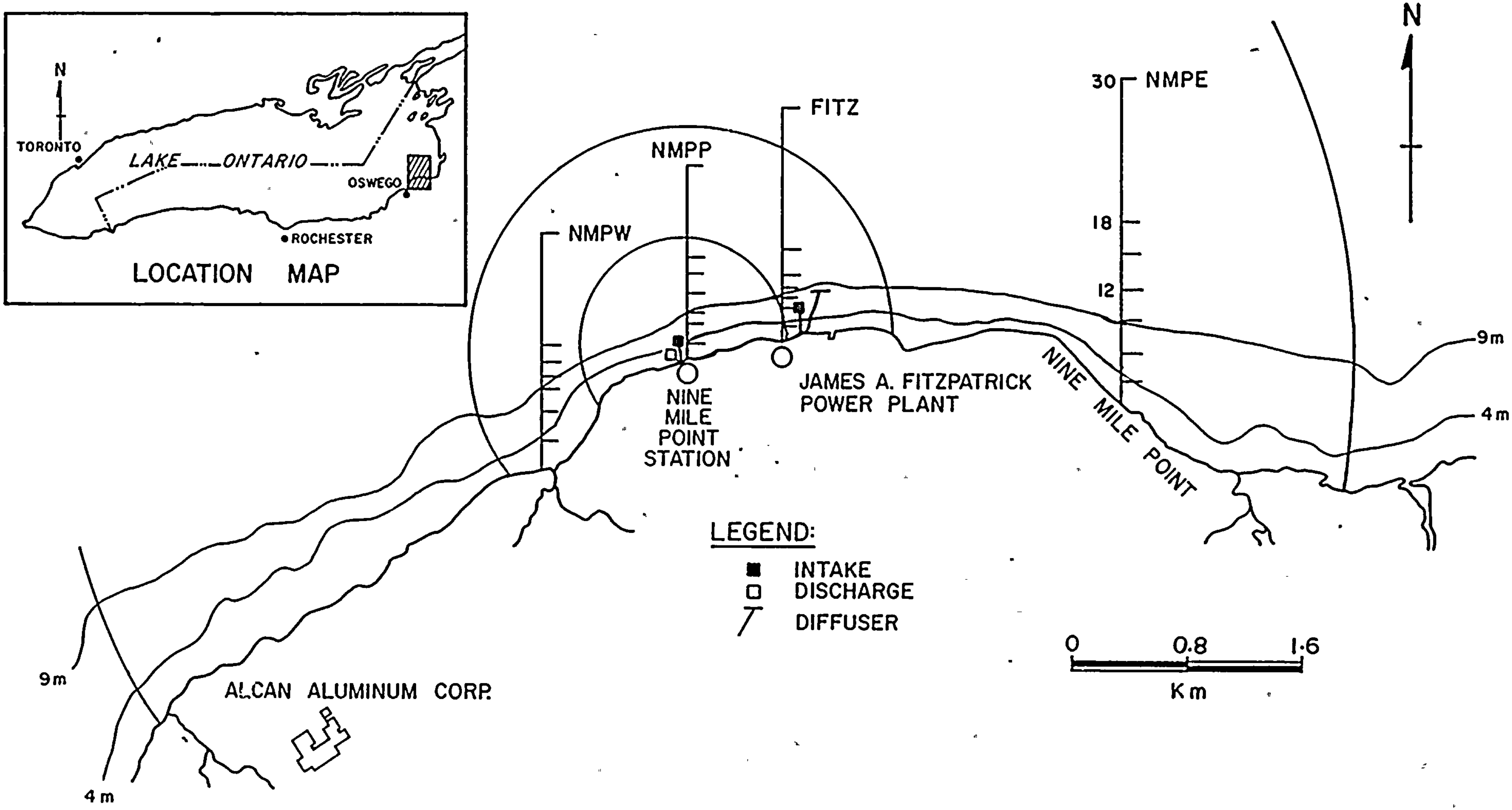
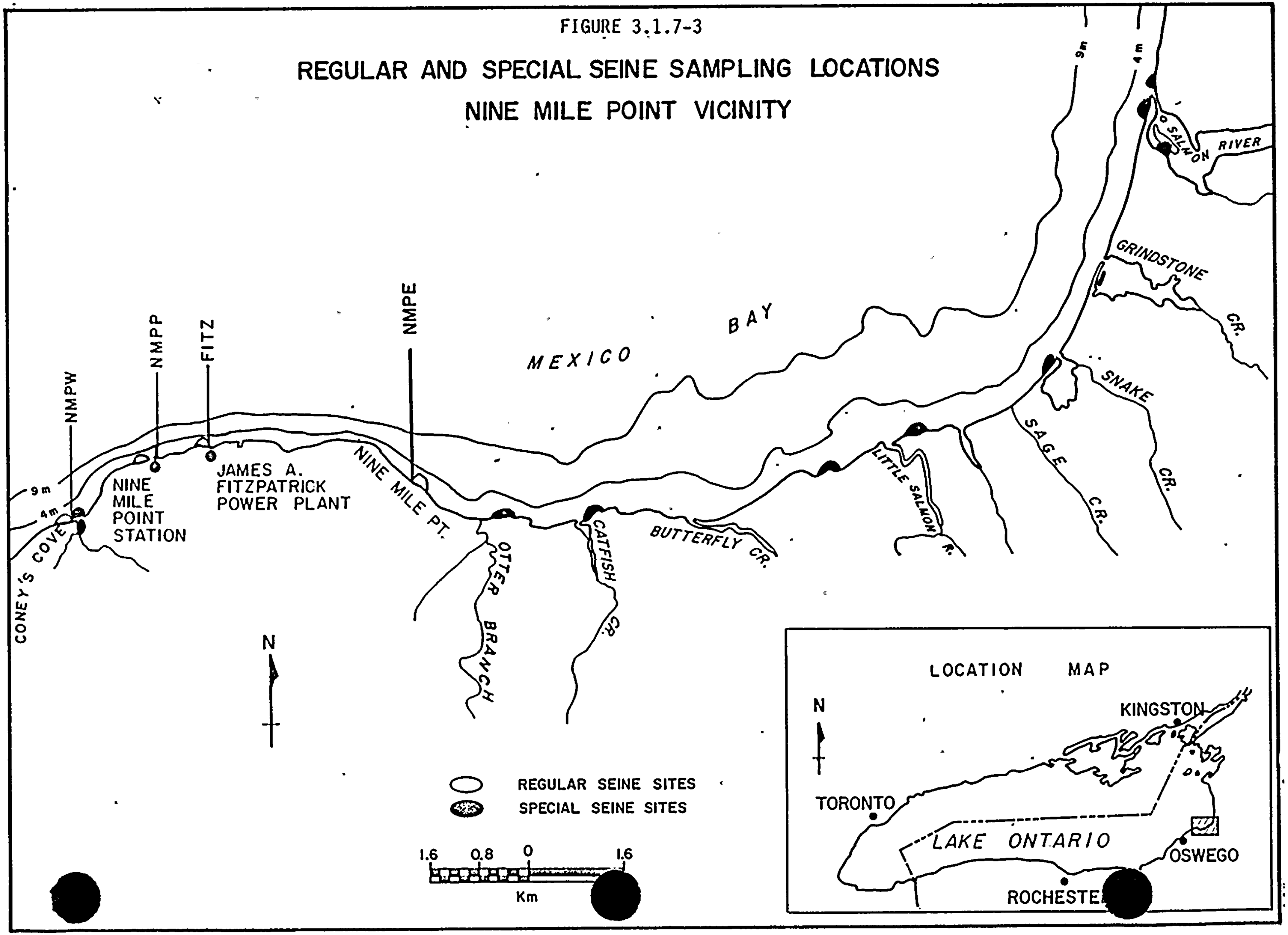


FIGURE 3.1.7-3

REGULAR AND SPECIAL SEINE SAMPLING LOCATIONS NINE MILE POINT VICINITY



3.0-37

Impingement Studies

Impinged fishes were sampled at Unit 1 from 1973 through 1981 and at JAF from September 1975 through 1981. The gear used to collect fish and the sampling frequency are summarized in Table 3.1.7-3. Before each 24-hr sampling period the bar racks and traveling screens were cleaned to remove accumulated fish so that each collection represented exactly 24 hrs of impingement.

When impingement rate was high (more than 20,000 fish in a 24-hr period), daily sampling was conducted until the rate dropped below 20,000 fish/day. The fish collected during the additional sampling were identified and enumerated only.

All fish were identified to the species level and enumerated at the collection site except when the traveling screens were continuously washed because of large Cladophora accumulation or large numbers of impinged fish. During these periods the following sampling scheme was instituted:

No. Fish Impinged/hr	Sampling Duration at the Fish Basket
Less than 2,000	1 hr
2,000 - 8,000	15 min
8,000 - 40,000	3 min
More than 40,000	1 min

The samples were preserved in 10% buffered formalin and returned to the laboratory for analysis and species verification.

In most cases the collections were made from all three traveling screens. However, if one or two of the screens were not in operation, the numbers of fish collected were extrapolated, assuming

TABLE 3.1.7-3

SUMMARY OF METHODS FOR IMPINGEMENT COLLECTIONS
NINE MILE POINT AND JAMES A. FITZPATRICK NUCLEAR GENERATING STATIONS -- 1973-1981

I. NINE MILE POINT UNIT 1

Year	Gear	Frequency of Sampling	Days of Sampling	Comments
1973	0.64-cm mesh basket at sluiceway discharge	1 day per week from APR through DEC; JAN 3 dates for a total of 25 hours; FEB 2 dates for a total of 28 hours; MAR 3 dates for 24 hours on each date	APR-DEC 1200 hours on Wednesday to 1200 hours on Thursday; JAN 1/2, 1/16, 1/29; FEB 2/12, 2/28; MAR same as APR-DEC except one date not sampled	-
1974-1978	Same as during 1973 except 0.95-cm mesh collection basket during 1977	3 days per week	Monday, Wednesday and Friday of each week, JAN-DEC	Samples on Monday and Friday were for 24 hours. On Wednesday samples were collected every hour over a 24 hour period. Sampling began at 1000 hours on each day and ended at 1000 hours on the following day
1979	Same as during 1978	3 days per week JAN-MAR 4-20 days per month APR-DEC	Same as during 1978	Same as during 1978
1980	Same as during 1978-1979	4-20 days per month JAN-DEC	Randomly selected	Composite 24-hr samples
1981	Same as during 1978-1980	Same as during 1980	Same as during 1980	Same as during 1980

(1 of 2)

TABLE 3.1.7-3 (Cont.)

II. JAMES A. FITZPATRICK NUCLEAR POWER PLANT

Year	Gear	Frequency of Sampling	Days of Sampling	Comments
SEPT 1975-1978	0.64-cm mesh basket at sluice-way discharge	3 days per week	Monday, Wednesday & Friday of each week	Samples on Monday and Friday were for 24 hours. Sampling began at 1000 hours on Mondays and Fridays and ended at 1000 hours on the following day. In 1976 Wednesday samples were collected every hour over a 24-hour period. In 1977 and 1978 2 samples corresponding to daylight and darkness were collected every Wednesday.
1979		3 days per week (D/N) JAN-MAY 4-6 days per month JUN-DEC	Same as during 1978	
1980	Same as during 1978-1979	4-20 days per month JAN-DEC	Randomly selected	Composite 24-hr samples
1981	Same as during 1978-1980	Same as during 1980	Same as during 1980	Same as during 1980

uniform impingement among screens. Similarly, during the continuous wash sampling program when subsampling was necessary, the numbers of fish impinged were extrapolated according to the hourly rate. These adjustments are incorporated into the estimates of the total annual number impinged.

3.1.7.2 Laboratory Methods

Fish were identified to the species level and enumerated where possible. Total length and weight were determined for all individuals (up to 40) per net catch. For gill nets, which were set for 48 hrs and harvested every 12 hrs, each harvest was considered a net catch. From 1972 through 1976 the sex and gonadal development of each fish (up to 40 individuals for abundant species) were determined, while in 1977 and 1978 these characteristics were determined for only three key species (white perch, yellow perch, and smallmouth bass).

For fishes collected in 1972, condition factor ($K = W \times 10^5/L^3$, where W = weight in grams, L = length in millimeters) and coefficient of maturity were determined for all species collected in substantial abundance. The studies were expanded from years 1973 through 1976 to include age and growth, fecundity, coefficient of maturity, and food habits of five important species: alewife (Alosa pseudoharengus), rainbow smelt (Osmerus mordax), white perch (Morone americana), yellow perch (Perca flavescens), and smallmouth bass (Micropterus dolomieui). In 1977 and 1978, these same studies were conducted for white perch and smallmouth bass only. In addition, fecundity was determined for alewife and rainbow smelt in 1977. The techniques used for these studies are discussed below and apply to work done from 1973 through 1978.

Age and Growth

Age and growth were determined for the selected species as follows: Alewife scales were removed from the left side of the fish below the lateral line at the level of the vent[48]. Rainbow smelt scales were taken from a mid-lateral posterior position approximately even with the adipose fin on the left side[49]. White perch scales were taken from the left side midway between the lateral line and dorsal fin, between the spiny and soft-rayed dorsal fins[50]. Yellow perch scales were taken from immediately behind the left pectoral fin[51]. Smallmouth bass scales were removed from the area near the tip of the left pectoral fin[52]. Scales were washed with a solution of liquid detergent and water and mounted between glass microscope slides. A Bausch and Lomb tri-simplex projector was used to facilitate counting and measuring of annuli.

The body length-scale relationship (L/Sc) for all sizes and age classes of fish was determined in order to select the proper method of back-calculating growth[53,54]. Regression techniques were used to determine the L/Sc relationship or line of best fit to the body length-scale length data. A Bartlett's test of homogeneity of variances ($\alpha = .05$) was conducted prior to the ANOVA on the regression. Tests of significance of a linear regression and deviation from linearity were made at $\alpha = .05$.

All fish were considered to have been born on 1 January. Therefore, fish caught between 1 January and the current year's annulus formation were aged as the number of annuli plus one year. After annulus formation for the current year, the age of the fish was equal to the number of annuli.

Fecundity

During the spring spawning season (April through June), gonads were collected from gravid females of the selected species for estimating fecundity. Up to 40 females for all age classes for each species were collected where possible from 1973 through 1976. In 1977 and 1978, 25 females per species were collected where possible. Females of several different sizes were used so results would not be biased toward larger or smaller fish. After removal from the fish, the ovaries were preserved in modified Gilson's fluid.

Fecundity, defined as the number of ripening ova in a female prior to spawning[55], was determined using a gravimetric (for yellow perch, white perch, and smallmouth bass) or volumetric (for rainbow smelt and alewife) procedure. The eggs within a subsample removed from the middle of the ovary were counted (both immature and mature eggs were counted for alewife and white perch). This number was then multiplied by a factor representing the ratio of total gonad volume (or weight) to subsample volume (or weight).

Coefficient of Maturity Gonads (ovaries or testes) were excised from fish chosen at random from each collection for each of the five selected species and weighed to the nearest 0.01 g. Coefficient of maturity was determined by the following formula:

$$\text{Coefficient of maturity} = \frac{\text{Gonad wt}}{\text{Fish wt} - \text{Gonad wt}} \times 100$$

Approximate spawning time was determined by graphing the seasonal change in the coefficient of maturity[54].

Food Habit Studies Fish for stomach-contents analysis were captured in gill nets at sampling stations along the 5 and 10-m

(15 and 30-ft) contours. The number of specimens available for analysis was dependent upon the success of sampling. Where possible, the analyses were done by size groups to determine how food habits change with growth.

Stomach contents were identified to the lowest practical taxon and enumerated. Quantitative data were used to determined each taxon's frequency and percentage with respect to total number of organisms counted. Qualitative estimates of stomach fullness and degree of digestion were also recorded for each fish examined. To represent each food item's importance more accurately, food items were "weighted" by multiplying the individual percentage volume of each food item by the percent stomach fullness of each individual stomach. Thus, a food organism representing 50% of the volume in a stomach would be rated 37.5% in a 75% full stomach (i.e., 0.50 x 0.75 = 0.375).

3.1.8 Data Analysis Procedures and Statistical Methods

Data analysis procedures included some methodologies conducted in the field or laboratory in conjunction with routine data accumulation. Those procedures are explained in individual sections earlier in this chapter.

Data for each biotic group and for water quality were presented in the annual reports in either graphic or tabular form but do not necessarily represent all the data analyzed. When a single year or event was representative of several, a representative unit may be shown and reference made to the total data set. The taxonomic level for data interpretation varied with sampling program (e.g., fish at species level, phytoplankton at class level).

Data were compared within and between sampling programs wherever such comparisons were biologically meaningful; parameters monitored in the water quality program were also discussed in relation to biotic groups where appropriate.

Various statistical tests were conducted, using both original and replicate samples wherever possible, to increase the sensitivity of the test and to determine levels of significance for spatial/temporal distribution patterns.

The statistical tests used are described and referenced in detail in the annual reports[1-8]. The tests used included Bartlett's test for homogeneity of variance, T-tests, paired T-tests, least significant difference test, analysis of variance, analysis of covariance, Student-Newman-Keuls procedure, and simple linear regresssion.

Specific tests were chosen after each individual data base was reviewed to ensure correct application of the statistic being used. For example, to analyze the impingement data collected in 1975, parametric techniques, following the method of Steel and Torrie[56] and Sokal and Rohlf[57], were used because of the large sample sizes and the high sensitivity of the tests. The analysis of variance and the correlation analysis techniques were used whenever their application was meaningful; an $\alpha = .05$ was chosen for the significance level for all correlations. Statistical techniques for stratified sampling and the optimum allocation procedures were applied to the impingement data analyzed.

To facilitate handling the extensive data base, cluster analyses were used where applicable[58]. Two measures of association have been used with Nine Mile Point data: Gower's similarity coefficent[59] for quantitative data and the Per Cent Similarity (PS) measure given by Haedrich[60].

The clustering strategy chosen was the group average, also known as the unweighted pair-group average[59]. This strategy has proved generally satisfactory in many ecological studies and, since it gives only moderately sharp clustering (i.e., it is a relatively conservative strategy), it has the advantage of being relatively immune to misclassification and is generally not group-size dependent[61].

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3.2 CHEMICAL PROGRAMS

3.2.1 Field Sampling

A number of comprehensive studies of the water quality in Lake Ontario were undertaken during the late 1960s. These surveys were performed under the auspices of several state, national, and international agencies and include IJC[1], Weiler and Chawla[2], and Chau et al.[3]. A review of these water quality surveys, along with a review of surveys conducted in the subject area during 1970-1972, was included in a report by Quirk, Lawler & Matusky Engineers (QLM)[4] to Niagara Mohawk. Several other studies were conducted in the area during 1968-1972 by Storr[5] and concerned nitrate and phosphate concentrations.

Since 1970, LMS and TI have been surveying the water chemistry of the nearshore waters and sediments in the general area of Oswego and Nine Mile Point. The early (1970-1972) studies are summarized in the 1974 QLM report[4]. Details of the 1973-1980 water quality sampling programs are given below.

1973

Water quality sampling conducted during 1973 in the Nine Mile Point vicinity included weekly field measurements, bimonthly (twice per month) collections in conjunction with biological sampling, and monthly collections for extensive water quality analyses. Special studies were conducted to characterize the bottom sediment and storm drain and sanitary effluent. The specific locations of lake sampling stations are shown in Figure 3.2.1-1 and described in Table 3.2.1-1. The water quality parameters measured are presented in Table 3.2.1-2.

FIGURE 3.2.1-1

WATER SAMPLING STATIONS

Nine Mile Point

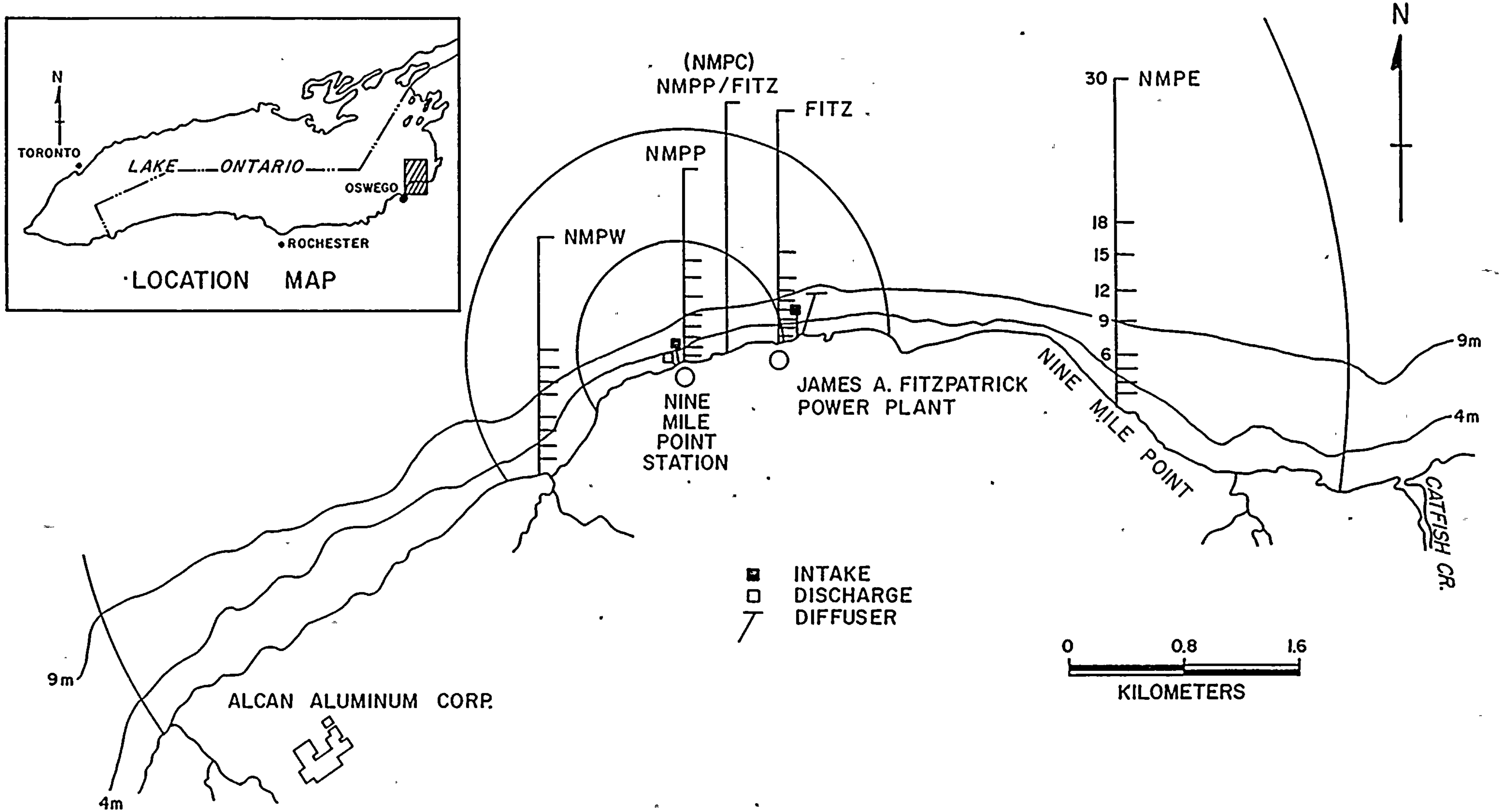

TABLE 3.2.1-1

WATER QUALITY SAMPLING LOCATIONS ON LAKE ONTARIO

NMPW	Nine Mile Point West Transect
NMPC (NMPP/FITZ)	Nine Mile Point Center Transect
FITZ	J.A. FitzPatrick Power Plant
NMPE	Nine Mile Point East Transect
NMPP	Nine Mile Point Power Plant
NMPI	Nine Mile Point Intake
NMPD	Nine Mile Point Discharge
OSWP	In Front of Oswego Steam Station
OSWI	Oswego Steam Station Intake
OSWD	Oswego Steam Station Discharge

NOTE: At each sampling site along a given transect, a sample was collected 0.5 m (1.5 ft) below the surface and 0.5 m (1.5 ft) off the bottom.

TABLE 3.2.1-2

WATER QUALITY PARAMETERS MEASURED IN THE MONTHLY AND BIMONTHLY SAMPLING PROGRAMS
NINE MILE POINT VICINITY

Parameter	1973		1974		1975		1976		1977-1978		1979-1980
	Mo	Bi	Mo	Bi	Mo	Bi	Mo	Bi	Mo	Bi	Bi
pH	X	X	X	X	X	X	X	X	X	X	
Temperature	X	X	X	X	X	X	X	X	X	X	X
Specific Conductance	X	X	X	X	X	X	X	X	X	X	
Turbidity	X	X	X	X	X	X	X	X	X	X	
Color	X		X		X		X		X		
Alkalinity	X		X		X		X		X		
Carbon dioxide		X		X		X		X		X	
Dissolved oxygen	X	X	X	X	X	X	X	X	X	X	X
Biological oxygen demand	X	X	X	X	X	X	X	X	X	X	
Chemical oxygen demand	X	X	X	X	X	X	X	X	X	X	
Chlorophyll a		X		X		X		X			
Total solids	X	X	X	X	X	X	X	X	X	X	
Total dissolved solids	X		X		X		X		X		
Total suspended solids	X	X	X	X	X	X	X	X	X	X	
Total volatile solids	X		X		X		X		X		
Settleable solids	X				X		X				
Total coliforms	X		X		X		X		X		
Fecal coliforms	X		X		X		X		X		
Phenols	X		X		X		X		X		
Surfactants	X		X		X		X		X		
Nitrate nitrogen	X	X	X	X	X	X	X	X	X	X	
Ammonia nitrogen	X		X	X	X	X	X	X	X	X	
Total Kjeldahl nitrogen	X	X	X	X	X	X	X	X	X	X	
Orthophosphate	X	X	X	X	X	X	X	X	X	X	
Total phosphorus	X	X	X	X	X	X	X	X	X	X	
Silicate	X	X	X	X	X	X	X	X	X	X	
Sulfate	X		X		X	X	X		X		
Aluminum	X		X		X		X		X		
Arsenic	X		X		X		X		X		
Barium	X		X		X		X		X		
Beryllium	X		X		X		X		X		
Cadmium	X		X		X		X		X		
Calcium	X		X		X	X	X		X		
Chloride	X		X		X		X		X		
Chromium	X		X		X	X	X		X		
Copper	X		X		X		X		X		
Cyanide	X		X		X		X		X		
Fluoride	X		X		X		X		X		
Iron	X		X		X		X		X		
Lead	X		X		X		X		X		
Magnesium	X		X		X		X		X		
Manganese	X		X		X		X		X		
Mercury	X		X		X		X		X		
Nickel	X		X		X		X		X		
Potassium	X		X		X		X		X		
Silver	X		X		X		X		X		
Sodium	X		X		X	X	X		X		
Vanadium	X		X		X		X		X		
Zinc	X		X		X		X		X		
Total organic carbon			X				X				
Selenium	X		X				X		X		
Organic nitrogen	X		X		X		X		X		
Radiological	X		X		X		X		X		
Carbon chloroform extract									X		

Mo - Monthly.
Bi - Bimonthly.

Weekly temperature surveys were conducted from April through November at the NMPC, NMPE, and NMPW transects at the 6, 12, 15, 18, and 30-m (20, 40, 50, 60 and 100-ft) depth contours (Figure 3.2.1-1). Bimonthly chemistry collections were made from June through December at the same three transects, but only at the 6 and 18-m (20 and 60-ft) depth contours. Monthly collections were made from March through November at the Unit 1 intake and discharge and at the NMPC transect at the 6 and 14-m (20 and 45-ft) contours.

The Unit 1 sanitary sewage treatment plant effluent was monitored monthly from August through November 1973. A separate 1.2-m (4-ft) storm drain located at the edge of the lake on the west side of Unit 1 was also sampled monthly from August through November. Additional sampling was conducted in the Oswego vicinity[4].

1974

The 1974 water quality sampling program was similar to the 1973 program (Tables 3.2.1-2 and 3.2.1-3). The analyses were designed to supplement the 1973 study and to determine which parameters should continue to be monitored.

Thermal profiles were conducted weekly during 1974 at the 15 and 30-m (50 and 100-ft) depth contours at NMPW, NMPP/FITZ (formerly NMPC), and NMPE (Figure 3.2.1-1). Bimonthly monitoring of 17 parameters was conducted at the 6 and 18-m (20 and 60-ft) contours at the NMPW, NMPP/FITZ, and NMPE transects and monthly for 48 parameters at NMPP/FITZ at the 6 and 14-m (20 and 45-ft) contours and at the Unit 1 intake and discharge. Specific parameters were monitored in-plant either weekly (temperature and dissolved oxygen in conjunction with the impingement sampling program) or monthly (water quality sampling program) at Unit 1 and monthly at the Nine Mile Point sanitary sewage treatment plant[6].

1975

Temperature measurements were taken weekly from April through December 1975 at the 30-m (100-ft) contour at three transects: NMPW, NMPP/FITZ, and NMPE (Figure 3.2.1-1).

Surface and bottom water quality samples were taken bimonthly along three transects (NMPW, NMPP/FITZ, NMPE) at three depth contours (6, 12, and 18 m [20, 40, and 60 ft]) from April through December. In December, weather conditions limited the usual bimonthly sampling efforts to a single collection. The 1975 bimonthly water quality sampling program included a 12-m [40-ft] depth contour station at each transect; this had not been a part of the 1974 program.

Surface and bottom water quality sampling was conducted monthly at the 6 and 14-m (20 and 45-ft) depth contours along the NMPP/FITZ transect only. Samples were collected approximately 30 days apart from April through December.

Sediment samples were collected once per year at the 6 and 12-m (20 and 40-ft) depth contours along NMPW, NMPP, FITZ, and NMPE transects(7).

1976

Three water quality sampling programs were conducted during 1976: the NMP monthly water quality program, the JAF monthly water quality program, and the JAF twice-monthly water quality program(8).

The NMP water quality program consisted of monthly surface sampling at the 6 and 12-m (20 and 40-ft) depth contours of three transects (NMPW, NMPP/FITZ, and NMPE). For the JAF monthly water quality program, surface and bottom samples were collected at the 6 and 14-m

(20 and 45-ft) depth contours along the NMPP/FITZ transect, while for the twice-monthly program, surface samples only were collected at the 6 and 18-m (20 and 60-ft) depth contours along three transects (NMPW, NMPP/FITZ, and NMPE). Selenium and total organic carbon were added to the list of parameters measured in the JAF monthly water quality program in 1976 (Table 3.2.1-2).

Temperature was measured for the 1976 thermal profile programs approximately weekly at the 30-m (100-ft) contour of three transects (NMPW, NMPP/FITZ, and NMPE). Temperature measurements were also made in conjunction with each of the biological sampling programs[8].

1977 and 1978

The water quality programs for these years were essentially the same as the 1976 program[9,10]. Locations and frequencies remained the same; some parameters were added and some deleted (Tables 3.2.1-2 abd 3.2.1-3).

1979 and 1980

For these two years, the water quality program was designed to provide environmental information (dissolved oxygen and water temperature) in the vicinity of the gill net sampling locations. Water samples were collected from the bottom at the 9-m (30-ft) contour of the NMPW, NMPP, FITZ, and NMPE transects. Collections were made twice per month from April through August and once per month from September through December[11,12].

3.2.2 Laboratory Procedures

From 1973 through 1980, most temperature measurements were made with a Martek Mark II multiprobe analyzer or Y.S.I. Model 57 DO

TABLE 3.2.1-3

SAMPLING LOCATIONS USED IN THE MONTHLY AND BIOMONTHY
WATER QUALITY PROGRAMS
NINE MILE POINT VICINITY: 1973-1980

Station	Depth Contour (m)	1973	1974	1975	1976	1977	1978	1979	1980
Monthly									
NMPI	Intake	X	X						
NMPI	Discharge	X	X						
NMPC	6 (20 ft)	X							
	14 (45 ft)	X							
NMPP/FITZ	6 (20 ft)		X	X	X	X	X		
	12 (40 ft)				X	X	X		
	14 (45 ft)		X	X	X	X	X		
NMPW	6 (20 ft)				X	X	X		
	12 (40 ft)				X	X	X		
NMPE	6 (20 ft)				X	X	X		
	12 (40 ft)				X	X	X		
Bimonthly									
NMPE	6 (20 ft)	X	X	X	X	X	X		
	9 (30 ft)							X	X
	12 (40 ft)			X					
	18 (60 ft)	X	X	X	X	X	X		
NMPW	6 (20 ft)	X	X	X	X	X	X		
	9 (30 ft)							X	X
	12 (40 ft)			X					
	18 (60 ft)	X	X	X	X	X	X		
NMPC	6 (20 ft)	X							
	12 (40 ft)								
	18 (60 ft)	X							
NMPP/FITZ	6 (20 ft)		X	X	X	X	X		
	12 (40 ft)			X					
	18 (60 ft)		X	X	X	X	X		
NMPP	9 (30 ft)							X	X
FITZ	9 (30 ft)							X	X

meter, in which cases pH, DO, and specific conductivity were also measured. On occasion, thermal stratification measurements were made with a Montedoro Whitney Model TF-20 thermistor or a GM model OC-1/S bathythermograph.

For the bimonthly and monthly water collections, samples were taken with a 4- or 9-liter (1- or 2-gal) PVC Van Dorn sampler and were dispensed into 4-liter (1-gal) polyethylene bottles for immediate transport to the laboratory; sterile 300-ml (0.3-qt) Pyrex BOD bottles were used for bacteriological and DO analyses. Free CO_2 was determined in the field by titration.

Bottom sediment collections were performed by scuba divers. The samples were placed in ice chests and returned to the laboratory for analysis. Effluent samples of the sewage treatment plant were 24-hr composites of the oxidation pond influent and effluent. Sampling at the 1.2-m (4-ft) storm drains was carried out by grab samples taken every 6 hrs for 24 hrs.

The EPA has promulgated mandatory guidelines establishing test procedures for the analysis of pollutants[13,14]. All analyses conformed either to these guidelines or, by permission of the EPA Region II laboratory, to current standard methods[15-17]. The orthotolidine field measurement technique for total chlorine residual was used at Nine Mile Point. Details of specific analytical procedures are available in the annual reports[4,6-12].

3.2.3 Data Analysis Procedures and Statistical Methods

Data reduction procedures are included in the annual reports[4,6-12]. Concentrations of most water quality parameters were usually displayed graphically or in tables, and visual comparisons were made between stations. In some instances, analysis of variance was

conducted to test for possible differences among dates of collection, stations, and sample depth means. Biologically significant water quality parameters received special attention to aid in interpreting certain biological patterns.

3.2.4 References Cited

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17. American Society for Testing and Materials (ASTM). 1972. Annual book of standards. Part 23. Water, atmospheric analysis.

3.3 THERMAL PROGRAMS

Temperature measurements have been conducted at the Nine Mile Point site since 1969. Temperature profiles were conducted at the site by Stone & Webster Engineering Corp. in 1969 and 1970 as part of the design studies for JAF and Unit 2. During 1970, Dr. J.F. Storr commenced routine monitoring of the Unit 1 thermal plume. During 1972, discussions with the NRC staff led to an ETS (issued for Unit 1) requiring aquatic studies and thermal monitoring for the site. A similar ETS is part of the JAF operating license. These ETSs (and their revisions) for the two licenses (Unit 1 and JAF) are the basis for most of the thermal and aquatic ecology studies conducted at the site. From 1973 through 1978, temperature measurements to determine the movement and timing of natural lake thermal stratification were taken weekly from April through December. These data, describing thermal structure at the site, fulfilled requirements of the Unit 1 and JAF operating license ETSs.

In the fall of 1975 the JAF plant went into commercial operation. As required by the ETS, triaxial thermal plume and dye measurements were made in 1976 and 1977.

The sections below provide further details of the thermal monitoring conducted in the Nine Mile Point vicinity.

3.3.1 Measurements of Vertical Temperature Profiles

Each year from 1973 through 1978 weekly surveys were conducted from April through December at various water depths at three transects: directly off Unit 1 (NMPP), east of the plant (NMPE), and west of the plant (NMPW). The east or west transects act as controls, depending on the ambient lake current, while the plant transect is

at the Unit 1 outfall. The study area includes the existing Unit 1 plume and the area potentially affected by Unit 2. Some data were also collected near the Oswego Plant, 11 km (7 mi) west of Nine Mile Point.

Temperature measurements were made at 1-m (3-ft) intervals to define the seasonal progression of thermal stratification at the 30-m (100-ft) depth contour from 1973 through 1978, and at the 15-m (50-ft) depth contour in 1973 and 1974. Measurements were made with a Martek Mark II multiprobe analyzer, a Montedoro Whitney Model TF-20 thermistor, or a GM Model OC-1/S bathythermograph. Temperatures were also measured with most biological collections and water quality sampling; these data are consistent with the Unit 1 and JAF plume survey data. The profile data were evaluated to identify when and where thermal stratification existed in the lake. Stratification is defined as a vertical temperature gradient in excess of 1°C/m (1.8°F/3.3 ft).

3.3.2 Nine Mile Point Unit 1 Plume Surveys

The Unit 1 plume surveys were conducted by Dr. J.F. Storr[1-6]. The area surveyed varied among dates in response to the Unit 1 thermal configuration. The western boundary was commonly 1 km (0.6 mi) west of Unit 1 while the eastern boundary of the surveyed area occasionally extended 1 km (0.6 mi) east of the JAF plant.

Instrumentation used in the surveys consisted of four thermistors spaced to measure the temperature at desired depths below the lake surface. The thermistor "string" was attached to a weighted line suspended from the side of the boat, with the topmost detector within the upper 0.3 m (1 ft) of water as the boat followed the transect course.

Four Rustrak recorders, Model 2133, and four Gulton Industries thermistor probes, Model 133, were used in each survey. In combination, the recording range is 0-40°C (32-104°F), accuracy is ± 0.5% of the scale, and response time is 90% in 5 sec. A Taylor precision thermometer (mercury) with an accuracy of ± 0.1°C (0.18°F) was used to calibrate the recorders before each thermal run. Later, the recorders were rechecked at ambient temperatures on the lake and in the discharge plume. Periodic checks of equipment were made throughout the study.

Temperature at the four detector depths was continuously recorded by a four-pen strip chart recorder. As the preselected transect was followed, the recorder chart was marked when the traverse intersected another transect as sighted against a shoreline marker. Temperatures recorded at this time were plotted later as depth and isothermal points for that particular grid location. The course along each transect was maintained and temperatures were recorded until the temperature was within about 0.5°C (1°F) of ambient.

To allow the determination and reproduction of boat location in the water, shoreline markers, in the form of triangular arrays of poles, were installed to form a base for each lakeward transect. The arrays were spaced at approximately 305-m (1000-ft) intervals along the entire site shoreline. While one pair of poles was used to traverse a course along a 45 degree angle to the shore, a pair of poles at each shore base of successive transects was used to mark boat position along the course. Runs were made at speeds generally between 0.3 and 1.0 m/s (1 and 3 fps). Meteorological data were recorded during each survey.

A complete survey was performed each day. Daily surveys were plotted as triaxial isotherm contours at 0.5°C (1°F) or 1.0°C (1.8°F) intervals on a grid map of the survey area. Ambient temperatures,

meteorological conditions, and plant operating parameters are listed on each map.

3.3.3 J.A. FitzPatrick (JAF) Plume Surveys

The JAF plume surveys, which included dye and temperature measurements, were conducted by Aquatec, Inc., under the direction of Stone & Webster Engineering Corp.[7]. The study area included the JAF plume, the Unit 1 plume, and farfield ambient monitoring locations. The data acquisition system used in the surveys included a data logger that records on magnetic tape. This system was used to collect data in two sampling modes during the JAF hydrothermal surveys. In the first mode, horizontal sampling, the tracking boat traveled along a transect while water was pumped at a constant rate from selected depth(s) and passed through the fluorometer cell(s) where its dye content was continuously measured. Water temperature was measured with a thermistor probe near the pump intake. In the second mode, vertical sampling, the boat remained stationary at a buoy and a hose was raised from the bottom to the surface at a constant rate while the sample was continuously pumped through the sensing units.

On those surveys when dye was used, Rhodamine WT dye was injected into the JAF circulating water system upstream of the center circulating water pump in the screenhouse, using an FMI positive displacement fluid metering pump. The weight of the dye was recorded each hour as a check on the rate of dye release.

Circulating water intake and discharge dye concentrations were measured at the intake and discharge shafts inside the pump house. Measurements of dye scale readings and temperature, used for dye correction, were recorded on analog strip chart recorders. Background fluorescence was determined before each survey.

Following the survey, the dye concentrations were converted to equivalent temperature rises, neglecting atmospheric heat exchange and plotted as a calculated "thermal plume."

Temperature measurements were converted to temperature rise by subtracting an ambient surface temperature for each survey. The resulting triaxial plume was then compared with the calculated "thermal plumes," based on dye results, for surveys that included the dye release.

3.3.4 References Cited

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7 Aquatec, Inc. James A. FitzPatrick Nuclear Power Plant, second operational hydrothermal survey, August 19 & 20, 1976. Power Authority of the State of New York. Prepared for Stone & Webster Engineering Corporation. Aquatec, Incorporated, South Burlington, VT, 1976.

APPENDIX

THERMAL LIMITS FOR SELECTED SPECIES

FISH THERMAL LIMITS

SPECIES: Alewife (*Alosa pseudoharengus*)

I. Lethal threshold:	Acclimation	Larvae	Juvenile	Adult	Data Source
	Temperature (°C)				
Upper	9		23		3
	10		2	20	3
	14-15	~31			9
	15			23	3
	20			23	3
	16.2		30-31		5
	10		26.5	23.5	8
	15			23.5	8
	20		30.3	24.5	8
	25		32.1		8
Lower	21			6-8	8
	15			<6	8
	10			<6	8
	5			<6	8

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]	26			9

III. Reproduction:	Optimum	Range	Months	Data Source
Migration Spawning		15.6-27.7		4
		13-16		2
Incubation and hatch		15.5-22 for 6 to 2 days		1
		17.2*		6
		20.8*		9

*maximum hatching success

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	5.5-20			21.3	7
	NA	26.3 (larvae & early juveniles)			9
	7-11 (May)			21	8
	10-11 (Jun)			19	8
	10-18 (Aug-Sep)		24-25	16	8
	24-25		25		8
	5-9 (Nov)		21	16	8
	1-4 (Dec-Jan)		19 (Dec)	11-12	8

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.

Data sources:

1. Rounsefell and Stringer 1943
2. Threinen 1958
3. Graham 1956
4. U.S. Dept. of Interior 1970
5. Stanley and Colby 1971 cited in Kellogg 1982.
6. Edsall 1970
7. Reutter and Herdendorf 1974
8. Otto et al. 1976
9. Kellogg 1982

FISH THERMAL LIMITS

SPECIES: Brown trout (<u>Salmo trutta</u>)

I. Lethal threshold:	Acclimation	Temperature (°C) Larvae	Juvenile	Adult	Data Source
Upper	14-18			25	3
	5-6		22.5		3
	20		23		3
	26			26	3
Lower	10		29		8
	20		30		8

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]			18.3-23.9	2
			8-17	4
			12	5

III. Reproduction:	Optimum	Range	Months	Data Source
Migration				
Spawning		6.7-8.9	Oct-Nov	1
Incubation	7.3 for 64 days			
and hatch	10.0 for 41 days			6

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	12		11.7		9
	15		15.5		9
	18		17.9		9
	21		18.8		9
	23		18.5		9
Final preferendum	NA			12.4-17.6	7
Final preferendum	NA		14.3-17.8		9

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.

Data sources:

1. Mansell 1966
2. Brynildson et al. 1963
3. Klein 1962
4. Brett 1970
5. Swift 1961
6. Bardach et al. 1972
7. Tait 1956, cited in Ferguson 1958
8. Lee and Rinne 1980
9. Cherry et al. 1977

FISH THERMAL LIMITS

SPECIES: Coho salmon (Oncorhynchus kisutch)

I. Lethal threshold:	Temperature (°C) Acclimation	Larvae	Juvenile	Adult	Data Source
Upper	5		23		1
	10		24		1
	15		24		1
	20		25		1
	23		25		1
Lower	5		0.2		1
	10		2		1
	15		3		1
	20		5		1
	23		6		1

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]		15 (5-17)		2 4

III. Reproduction:	Optimum	Range	Months	Data Source
Migration		7-16	Fall	3
Spawning				
Incubation and hatch				

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	(5.5-20)		11.4		5

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.

Data sources:
1. Brett 1952
2. Great Lakes Research Laboratory 1973
3. Burrows 1963
4. Averett 1968
5. Reutter and Herdendorf 1974

FISH THERMAL LIMITS

SPECIES: Rainbow smelt (*Osmerus mordax*)

I. Lethal threshold:	Acclimation	Temperature (°C) Larvae	Juvenile	Adult	Data Source
Upper	10.2-15			21.5-28.5	1
	13	>-30.6<32.4 (5 min exposure)			7
	13	>-28.8<30.8 (30 min exposure)			7
	13	>-26.8<28.8 (60 min exposure)			7
Lower					

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]				

III. Reproduction:	Optimum	Range	Months	Data Source
Migration			March-April	5
Spawning		8.9-18.3		2
Incubation		11-15	June	4
and hatch		6-10 for 29 to 19 days		3

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	NA			7.2	6
	NA			6-14	8

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.
NA - Not available.

Data sources:

1. Huntsman and Sparks 1924 cited in Brown 1974.
2. Scott and Crossman 1973
3. McKenzie 1964
4. Sheri and Power 1968
5. QLM 1975
6. Hart and Ferguson 1966
7. Barker et al. 1981
8. Wells 1968

FISH THERMAL LIMITS

SPECIES: Smallmouth bass (Micropterus dolomieui)

I. Lethal threshold:	Acclimation	Temperature (°C) Larvae	Juvenile	Adult	Data Source
Upper	NA	38			9
	UUILT[c]		35		15
Lower	15	4	2		3,9
	18		4		3
	22		7		3
	26		10		3

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]	28-29(2)	26(3) [<20<32]		2,3 14

III. Reproduction:	Optimum	Range	Months	Data Source
Migration				
Spawning	17-18(5)	13(8)-21(7)	May-July(8)	5,7,8
	16.1-18.3	12.8-20.0		11
Incubation and hatch			May-July	

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	15		20.2		15
	18		25.5		15
	24		28.2		15
	30		30.9		15
	Summer			21-27	6
	Winter			>8*	1
	NA			20-30**	10
	Winter		18.0	12-13	12
	Spring		19-24	15-16	12
	Summer		31.0	30.0	12
	Fall		24-27	21-23	12
	Fall (20.0-5.5)		26.6		13
Final preferenda					
	NA		30.3-31.5		15
	NA		28.0		4
	NA		31.0		12

*Life stage unknown
**Avoidance

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.
[c]Ultimate upper incipient lethal temperature.
NA - Not available.

Data sources:

1. Munther 1968
2. Peek 1965
3. Horning and Pearson 1973
4. Fry 1950, cited in Ferguson 1958
5. Breder and Rosen 1966
6. Emig 1966
7. Hubbs and Baily 1938
8. Surber 1943
9. Larimore and Duever 1968
10. Cherry et al. 1975
11. Scott and Crossman 1973
12. Barans and Tubb 1973
13. Reutter and Herdendorf 1974
14. Wrenn 1980
15. Cherry et al. 1977

FISH THERMAL LIMITS

SPECIES: Spottail shiner (Notropis hudsonius)

I. Lethal threshold:	Temperature (°C) Acclimation	Larvae	Juvenile	Adult	Data Source
Upper	11.1			1.1	1
	7.2			30.6	1
Lower					

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]				

III. Reproduction:	Optimum	Range	Months	Data Source
Migration				
Spawning			May-August	3,4
Incubation and hatch				

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	15			14	2
	Winter (<5.5)			10.2	5
	Spring (5.5-20.0)			14.3	5

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.
NA - Not available.

Data sources:
1. Trembley 1961 for LD 50
2. Meldrim and Gift 1971
3. Peer 1961
4. Carlander 1969
5. Reutter and Herdendorf 1974
6. Reutter and Herdendorf 1976

FISH THERMAL LIMITS

SPECIES: Threespine stickleback (*Gasterosteus aculeatus*)

I. Lethal threshold:	Acclimation	Temperature (°C) Larvae	Juvenile	Adult	Data Source
Upper	19			25.8	1
	10			25.7	2
	20			27.2	2
				31.7-33	3
Lower					

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]			<37.1	3

III. Reproduction:	Optimum	Range	Months	Data Source
Migration			Jun-Jul (generally)	5
Spawning				
Incubation and hatch		19 for 7 days		4

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.

Data sources:

1. Blahm and Parente 1970
2. Jordon and Garside 1972
3. Altman and Dittmer 1966
4. Breder and Rosen 1966
5. Scott and Crossman 1973

FISH THERMAL LIMITS

SPECIES: White perch (*Morone americana*)

I. Lethal threshold:	Temperature (°C) Acclimation	Larvae	Juvenile	Adult	Data Source
Upper	1.1			6.6	1*
	24.8			34.7	1*
Lower					

*Minimum avoidance temperature

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
Optimum and [range[b]]			23.9	1

III. Reproduction:	Optimum	Range	Months	Data Source
Migration				
Spawning		11-15	May-Jun	3
		10-15	Mar-May[c]	5
Incubation and hatch		15-20 for 4.5-1.2 days	Mar-May	2

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	6		15.2-16.9		4
	12		19-21.4		4
	18		22-24.7		4
	24		26.3-30		4
	30		29.3-31		4
	33		30-32.6		4
Final preferenda			31.6-32.4		4
	NA		(North Carolina) 29.3-30.6 (Maryland) 29.2-29.6 (New Jersey)		

[a]As reported or net growth (growth in weight minus weight of mortality).
[b]As reported or to 50% of optimum if data permit.
[c]Patuxent Estuary, Maryland.

Data sources:

1. Meldrim and Gift 1971
2. Scott and Crossman 1973
3. Sheri and Power 1968
4. Hall et al. 1978
5. Mansuetti 1961

FISH THERMAL LIMITS

SPECIES: Yellow perch (*Perca flavescens*)

I. Lethal threshold:	Acclimation	Larvae	Juvenile	Adult	Data Source
		Temperature (°C)			
Upper	5			21.3	1
	9-18			13-22	12
	18	3-28[c]			15
	10			25	1
	22-24			29-30	2
	25			29.7	3
	UUILT		26		19
Lower	25		4		1
	18	9.8			15

II. Growth[a]	Larvae	Juvenile	Adult	Data Source
		28		16
Optimum and		22		18
[range[b]]			13-20	5

III. Reproduction:	Optimum	Range	Months	Data Source
Migration				
Spawning	12(11)	7.2-12.8(9)		9,11
	8(11)	8.9-18.6(Lab)		14
		5-10(10)	March-June(11)	10,11
Incubation	10.1-18[d]	3.7-21[e]		15
and hatch		7-22.9[f]		15

IV. Preferred:	Acclimation	Larvae	Juvenile	Adult	Data Source
	NA			13	17
	5			11	4
	10		19.3	17.0	4
	10			16	17
	15		23.0	20.0	4
	15			19	17
	20		23.1	20.5	4
	NA			10-29	7
	20			20	17
	20		24	18-24	8
	Winter		10-13	7-12	7
	Winter			14.1	13
	Spring		18.0	13-16	7
	Summer		25-27	27.0	7
Final preferenda	Winter			25-30	17
	Spring			21	17
	Summer			17-18	17
	NA		21.4-22.2		19
	NA		24.2	21.0	4
	24			18-24	8

[a] As reported or net growth (growth in weight minus weight of mortality).
[b] As reported or to 50% of optimum if data permit.
[c] Range tolerated for 24 hrs.
[d] For production of swim-up larvae.
[e] TL_{50} for early stage.
[f] TL_{50} for later stage.
[g] Ultimate upper incipient lethal temperature

Data sources:

1. Hart 1947
2. Black 1953
3. Brett 1956
4. Ferguson 1958
5. Coble 1966
6. Weatherley 1963
7. Barans and Tubb 1973
8. McCauley and Read 1973
9. Breder and Rosen 1966
10. QLM 1975
11. Jones et al. 1973
12. Everest 1973
13. Reutter and Herdendorf 1974
14. Hokanson 1977
15. Hokansen and Kleiner 1974
16. McCormick 1976
17. McCauley 1977
18. Huh et al. 1976
19. Cherry et al. 1977

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