NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT
UNIT 1

316(a) Demonstration Submission

NPDES Permit NY 0001015

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SUMMARY OF FINDINGS

This document has been prepared to demonstrate that Niagara Mohawk Power Corporation (NMPC) Nine Mile Point Nuclear Station Unit 1 thermal discharge has not resulted in any appreciable harm to the aquatic community and that therefore operation of Nine Mile 1 with the present discharge assures that protection and propagation of "a balanced, indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge has been made.*" The demonstration follows the guidelines provided in the draft "316(a) Technical Guidance Thermal Discharges" (guidance manual), dated September 30, 1974.

Nine Mile Point Nuclear Station Unit 1 is located on the south shore of Lake Ontario eight miles east of Oswego. The Station has an electrical capacity of 610 MWe. The Stations cooling water discharge consists of a maximum of 268,000 gpm flow with a 17.4°C (31.2°F) temperature rise, at capacity operation. The circulating water intake is located in 24 ft of water about 850 ft from shore, and the discharge is located in approximately 17 ft of water, 335 ft from shore.

Plant operating information since its initial commercial operation in December 1969 exhibits seasonal fluctuations in generating capacity with minimum output during the spring and maximum output during the fall. The resultant discharge zone (as defined by the area heated more than 2°C, more than 30% of the time) encompasses approximately 160 acres of surface area and a volume of 350 acre-ft. The discharge plume is in compliance with applicable water quality standards as specified in 6NYCRR 704.6.

The aquatic ecology of the Lake Ontario area near Nine Mile Point has been under study since 1963. Baseline studies have demonstrated that the lake community in this vicinity is comprised of aquatic populations that spatially and temporally are similar to the littoral zone community of Lake Ontario as a whole. Results of surveys of each trophic level including planktonic, benthonic, and nektonic are presented and discussed herein. All populations are characteristic of temperate lakes although the upper trophic level at Nine Mile Point and in Lake Ontario as a whole is dominated by the alewife, a forage fish and member of the herring family.

A list of representative important species which were selected for the Nine Mile Point area by the Environmental Protection Agency (letter of August 11, 1975) is used as a focus in the demonstration. The representative important species were selected because of their abundance in the Nine Mile Point area, and because of their trophic level relationships. In addition, salmonids (coho salmon and

*As required by 40 CFR 122.9(b)(1)

brown trout) were included as a result of the intensive New York State and Canadian stocking programs in Lake Ontario, and their limited representation in the Nine Mile Point area. Information on the life history of the representative important species and their thermal preferenda and tolerance limits is discussed herein.

Evidence is presented which indicates that the aquatic community as a whole is intact, and hence, that no apreciable harm has resulted from station operation. The specific phenomena suggested for evaluation of "appreciable harm" in the guidance manual under the definitions are addressed where data allow. Potential thermal discharge impacts impact of the plume on representative species, shut-down of the station in winter, and attraction of fish by the discharge flow are discussed as potential impacts of plant operation. The effects of pressure changes in the plume or reduced dissolved oxygen are shown to be insignificant on the basis of physical and chemical data evaluated relative to published sensitivities of the species to these effects.

Aesthetic impacts through physical appearance, or taste and odor are discussed. Chemical analyses of water samples from the Nine Mile Point vicinity and observations by members of sampling crews indicate no adverse aesthetic impact as a result of plant operation. Alewife die-offs in Lake Ontario are a matter of historical record, and occur on an annual cycle. The resultant decaying carcasses produc aesthetic problems throughout Lake Ontario. The alewife die-offs have not been associated with operation of the Nine Mile 1 discharge. The alga Cladophora has an annual growth and die-off cycle in the littoral zone which results in large amounts of decaying matter along the shore, creating health and aesthetic problems. This die off occurs regardless of plant operation.

The trophic structure of the lake in the vicinity of Nine Mile Point remains similar to the rest of Lake Ontario. Potential nuisance taxa include the introduced fish species (alewife, rainbow smelt, white perch, and gizzard shad) and certain phytoplankton species (algae) which, when they occur in bloom proportions, could cause an aesthetic or a physical nuisance. Introduced species compete with indigenous populations for the same resources resulting in severe environmental stress. Gizzard shad abundance is reported to be increasing in the Great Lakes and the shad reportedly prefer areas of thermal plumes. Gizzard shad abundance, however, has not reached high levels either in Lake Ontario as a whole or at Nine Mile Point.

Life cycle information for the representative important species based on available data from the Nine Mile Point area is discussed in depth. Nine Mile Point fish populations were evaluated for fecundity, time of scale annulus formation, time of spawning, feeding, sex ratio, and age and growth by year class and sex. Fish egg and larval abundance and distribution are discussed for those species whose eggs and larvae were present in sufficient quantity in ichthyoplankton samples namely; alewife, rainbow smelt, white perch, and yellow perch. All normal phases of life cycle activity are observed in the vicinity of Nine Mile Point. Comparison of the available life cycle information collected at Nine Mile Point with other naturally occurring populations are made to demonstrate that the populations at Nine Mile Point exhibited normal patterns.

Statistical comparison of the abundance of the predominant representative important species were made among years encompassing pre-operational and post-operational years, and between areas influenced by the thermal discharge and areas not within the influence of the thermal discharge. Taking into consideration normally observed population fluctuations, only the yellow perch is found to exhibit population changes among years. The reduction in yellow perch abundance has occurred lake-wide and is attributed to trophic level competition.

A fish species index of diversity was calculated for the sampling transects located in the vicinity of Oswego and Nine Mile Point for the years 1973 and 1974. The index was statistically evaluated for transect differences to indicate disruption of distributional trends as a result of the thermal discharge of Nine Mile Unit 1. No significant differences are observed.

This demonstration and information already submitted in support of 316a alternative thermal effluent limitations is adequate to conclude that the operation of the present Nine Mile Point Unit 1 discharge has resulted in no appreciable harm since the community as a whole is intact. Hence continued operation of this discharge will assure the protection and propagation of the community at Nine Mile Point.

I. INTRODUCTION

A. BACKGROUND

On May 22, 1974, the staff for Region II of the U. S. Environmental Protection Agency (EPA) issued a draft National Pollutant Discharge Elimination System (NPDES) permit for the Nine Mile Point Nuclear Station - Unit 1 (Nine Mile 1) (NY 0001015) in accordance with the provisions of the Federal Water Pollution Control Act (FWPCA). On June 28, 1974, Niagara Mohawk Power Corporation (NMPC) requested that the Regional Administrator impose alternative thermal effluent limitations to those described in the draft permit pursuant to Section 316(a) of the FWPCA. Niagara Mohawk provided documentary evidence in support of its request on August 2, 1974. On February 24, 1975, NMPC was issued the final NPDES Permit for Nine Mile 1. The final permit did not include the requested alternative thermal effluent limitations.

The Final Effluent Guidelines and Standards (40 CFR 423) do not require closed cycle cooling for Nine Mile 1. The final NPDES permit (condition 11 (a) (1) on page 6 of 21) cites the New York Criteria Governing Thermal Discharges as the limiting regulation with respect to the thermal discharge of Nine Mile 1. This document will demonstrate that the subject permit condition is more stringent than necessary to assure the protection and propagation of the balanced indigenous population in and on the receiving water body, Lake Ontario. This document further supports the position of NMPC that the existing mode of discharge assures the necessary protection and propagation.

In a memorandum transmitted with the final permit, and in discussions with NMPC, the technical staff of Region II indicated that the previous information submitted (August 2, 1974) in support of the request for alternative thermal effluent limitations was insufficient. In response, Niagara Mohawk has prepared this document supplementing its original Section 316(a) submittal in areas identified by the Region II staff.

On June 30, 1975, NMPC submitted to the EPA its recommendations for the selection of Representative Important Species at Nine Mile Point and Oswego. On August 11, 1975, the Regional Administrator forwarded a copy of the designated list of Representative Important Species for the Nine Mile Point locality of Lake Ontario (see Table I-1).

The content of this document generally follows the procedures presented in the draft document entitled "316(a) Technical Guidance-Thermal Discharges" (the guidance manual) published September 30 1974 by the Water Planning Division of the EPA and the guidance provided by the Region II staff in their memorandum and during the technical

TABLE I-1

LIST OF REPRESENTATIVE SPECIES FOR LAKE ONTARIO
(Oswego 5, Oswego 6, Nine Mile Point 1, FitzPatrick)

Macroalgae

*Cladophora - habitat former

Macroinvertebrates

Gammarus sp. - lower trophic level food source

Fish

Clupeidae
Alewife - forage, community dominant

Salmonidae
Coho salmon
Brown trout - major predator species, thermally sensitive

Osmeridae
Rainbow smelt - forage

Gasterosteidae
Threespine stickleback - forage

Centrarchidae
Smallmouth bass - sport species

Percidae
Yellow perch - sport species, thermally sensitive

* Nine Mile Point Only.

meetings. The information contained herein includes some of the previously submitted data as well as new information. Niagara Mohawk believes that its original conclusions are verified and reinforced by this supplemental submission.

B. DEMONSTRATION APPROACH AND RATIONALE

Nine Mile 1 began operation in December 1969. Monitoring of the preoperational and postoperational aquatic communities has been conducted from 1963 to the present allowing an assessment of plant-induced impacts. This document includes the information required for a Type I demonstration as outlined in the guidance manual.

In the case of Nine Mile 1, the discharge of heated effluent into Lake Ontario has occurred for a sufficient period of time and sufficient postoperational data have been collected by Niagara Mohawk to allow evaluation of the effects of the discharge. In addition, the waters of Lake Ontario in the vicinity of Nine Mile 1 were not despoiled prior to or after commencement of the discharge of heated effluent from Nine Mile 1, hence assessment of any appreciable harm resulting from that effluent is possible.

As stated in the guidance manual, the rationale and approach for demonstration of no prior appreciable harm do not require demonstration "that every species which would occur under optimal conditions is present, as long as it demonstrates that the community as a whole, and all major components thereof are intact" (page 26). The guidance manual (page 23) cites seven specific points to be considered in evaluating "appreciable harm." These are:

1. Substantial increase in abundance or distribution of any nuisance species or heat tolerant community not representative of the highest community development achievable in receiving waters of comparable quality.

2. Substantial decrease of formerly indigenous species, other than nuisance species.

3. Changes in community structure to resemble a simpler successional stage than is natural for the locality and season in question.

4. Unaesthetic appearance, odor or taste of the waters.

5. Elimination of an established or potential economic or recreational use of the waters.

6. Reduction of the successful completion of life cycles of indigenous species, including those of migratory species.

7. Substantial reduction of community heterogeneity or trophic structure.

Each of these points is discussed in this demonstration.

The ultimate question raised by the guidance manual is whether or not there has been prior appreciable harm to the balanced indigenous community in the vicinity of Nine Mile Point. It is presumed in this question that there was a balanced indigenous community present in the vicinity of the generating station before its operation. This, however, does not appear to be the case for Lake Ontario.

The biological communities of Lake Ontario have been subjected to various disturbances over the past 150 years coincident with a rapid and large increase in the human population around the lake. Concomitant with this, exotic species invaded and established themselves within the lake. These exotics include members from every trophic level that has been studied for a prolonged period. Examples include the zooplankter, Eurytemora affinis and several species of fish such as the alewife, white perch, rainbow smelt, gizzard shad, carp, coho and chinook salmon, and rainbow and brown trout (Christie, 1973; and Scott and Crossman, 1973).

The invasion of new habitats by exotic species is a natural phenomena that continues to occur (May, 1966). However, the introductions that have occurred in Lake Ontario have resulted in significant changes in the community structure in the last 100 years (Christie, 1973, 1974 and Scott and Crossman, 1973). For instance, the most frequently collected fishes in the vicinity of Nine Mile Point, i.e., the alewife, rainbow smelt, and white perch, are all introduced. And seven species are reported to have become extinct or reduced in numbers since 1900; these species are the lake trout, shortnose cisco, bloater, kiyi, burbot, blue pike, and fourhorn sculpin (Christie, 1973).

Thus, although evidence of no prior appreciable harm will be evaluated in this demonstration based on the populations present in Lake Ontario and near the site, assessment based on a balanced indigenous community is not possible since the Lake Ontario community is not in a balanced state being composed of numerous introduced species.

C. FORMAT OF THE DOCUMENTATION

This document provides the specific information required for a Type I demonstration.

Chapter I presents the demonstration approach and rationale and the basis for using Demonstration Type 1 as defined in the guidance manual.

Chapter II presents a description of Nine Mile 1 and its associated thermal discharge structure. Included in this chapter are a description of the monthly plant load, the flow rates and temperature limitations specified by the Environmental Technical Specifications of the AEC(NRC) operating license, and the records of all plant shutdowns which resulted in the complete stoppage of heated effluent flow during the last five years.

Chapter III presents a detailed description of the thermal plume resulting from Nine Mile 1 based on thermal surveys conducted at the site. The discharge zone, as defined in the guidance manual, is discussed. In addition, the existing thermal plume is discussed relative to New York Criteria Governing Thermal Discharges. Water quality correspondence between Niagara Mohawk and any regulatory agency other than the EPA which indicate possible harmful effects resulting from the existing discharge during the last five years are discussed.

Chapter IV presents a description, based on site-specific investigations, of the communities by trophic level found in the vicinity of Nine Mile Point. Information is also provided on biological communities found in similar areas in Lake Ontario that are not influenced by thermal discharges. The information presented in this chapter is based on data previously submitted to the EPA (QLM, 1972, 1973, 1974).

Chapter V presents a discussion of the life histories of certain species found at Nine Mile Point. The representative important species selected by the EPA and transmitted to Niagara Mohawk by letter dated August 11, 1975 are included in this discussion. The basis for selection of each species is discussed and data on the characteristics of each species are provided. Rare and endangered species of Lake Ontario are described.

Chapter VI presents a discussion of the effects of the thermal discharge from Nine Mile 1. With the data collected since 1963 at the site, it is demonstrated in this chapter that the biological community is intact and that no appreciable harm to the biological community has resulted from operation of Nine Mile 1.

II. THE STATION

A. INTRODUCTION

The purpose of this station description is to familiarize the reader with engineering design features of the station and the operating history.

The Nine Mile Point Nuclear Station Unit 1 is powered by a single boiling water reactor, manufactured by the General Electric Company, which generates steam at 1000 psig to drive the turbine-generator. The reactor has a rating of 1850 MWt, corresponding to a net electrical output of 610 MWe.

The turbine-generator is a tandem unit with a high-pressure section on the same shaft with three low-pressure sections and the electric generator. Steam is exhausted from the turbine to the main condenser, where it is condensed and returned via the regenerative feed-water heaters.

The reactor core, which contains 532 fuel assemblies, is refueled annually, with about 25 percent or 133 fuel assemblies replaced during each refueling period. The assemblies now in use were manufactured by General Electric Corporation.

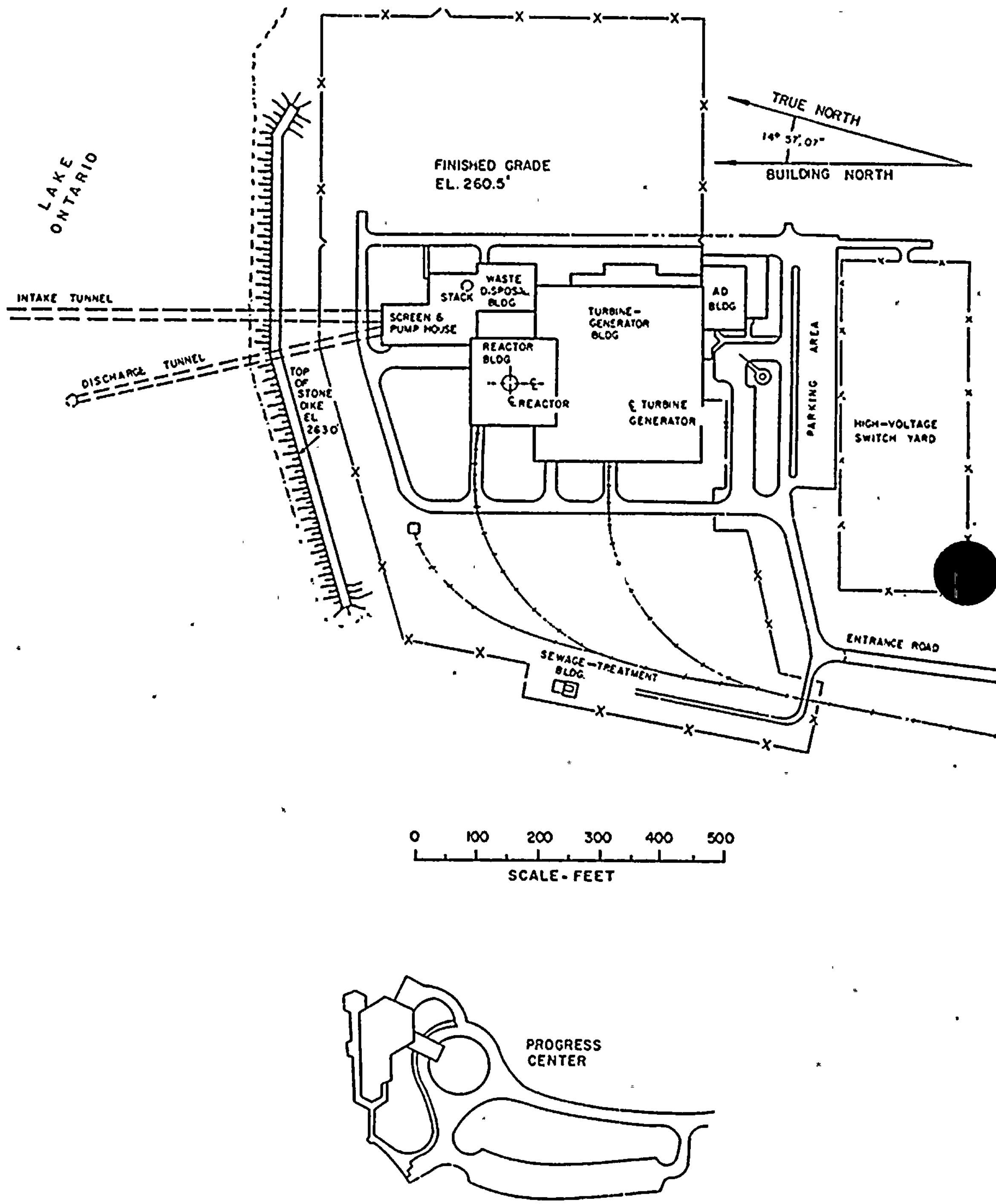
The station was designed by Niagara Mohawk Power Corporation and constructed by Stone and Webster Engineering Corporation. The Station has been in commercial operation since December, 1969. The station plot plan is illustrated in Figure II-1.

B. PLANT WATER USE

Cooling water for the main condenser, auxiliary systems, reactor-shutdown heat removal, and the primary cooling system is withdrawn from Lake Ontario and returned after use. The only net water consumption is that due to evaporation of water, water in disposed "solids" or radwaste solutions, and water due to minor leaks. Although an exact determination of this loss cannot be made, the maximum loss is estimated to be 10 gpm. This loss does not include evaporation from the lake surface due to the heated discharge.

No chemicals or inhibitors are added to the circulating or service water systems. The silt content of the lake water has been sufficient to prevent attachment of biological growth in the cooling system. Chemicals are used in the makeup-water treatment system, analytical sampling system, and the decontamination system. Chemical discharges from these systems are diluted below detection limits and below possible impact levels as described in Section 3.6 of the AEC Final Environmental Statement for the station issued in January 1974.

FIGURE II-1



NINE MILE POINT NUCLEAR STATION UNIT 1
PLOT PLAN

The City of Oswego supplies 3300 gpd for domestic-water use. Most of this water is returned to Lake Ontario after treatment. The water usage for the Station is shown in Figure II-2.

C. COOLING WATER SYSTEM

The Station uses once-through cooling to dissipate waste heat from the main condensers and auxiliary cooling systems. The circulating water for the Station is drawn from Lake Ontario into a submerged inlet, circulated through the condensers, and returned to the lake through a submerged discharge structure. The intake and discharge tunnels run under the lake bed to the screenwell and pumphouse on shore. Figure II-3 shows the location of the intake and discharge structures in Lake Ontario.

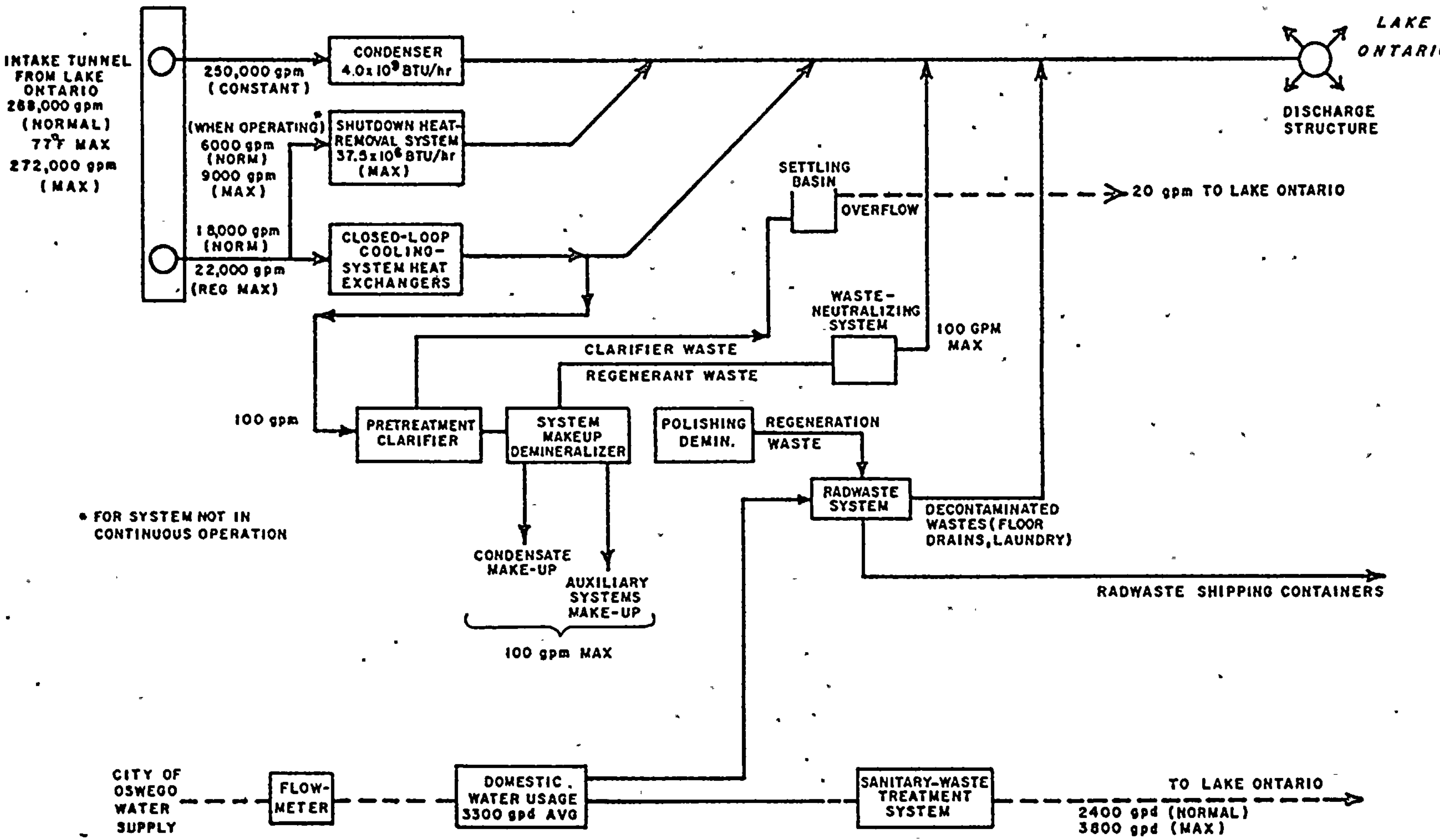
At maximum power output, the Station requires a total flow of 268,000 gpm; 250,000 gpm are for the main condenser and 18,000 gpm are for service-water requirements. The main condenser will raise the cooling water temperature a maximum of 32°F corresponding to a heat rejection rate of 4.0×10^9 BTU/hr. The service-water temperature will be raised about 20°F. The temperature rise for the total flow is 31.2°F. The temperature of the intake water varies with the season normally ranging from 32° to 77°F.

The circulating water system is designed with a system of gates located in the screenhouse which allow reversal of flow through the intake-discharge tunnels and lake structures, and allow intake water to be tempered with a percentage of recirculated warm discharge water. Flow reversal is effected to correct intake icing. Tempering is achieved by partially opening a gate connecting the intake and discharge bays. The gate is periodically adjusted to maintain the condenser inlet temperature near 45°F when lake ambient temperature is cooler than 45°F.

1. Intake Structure

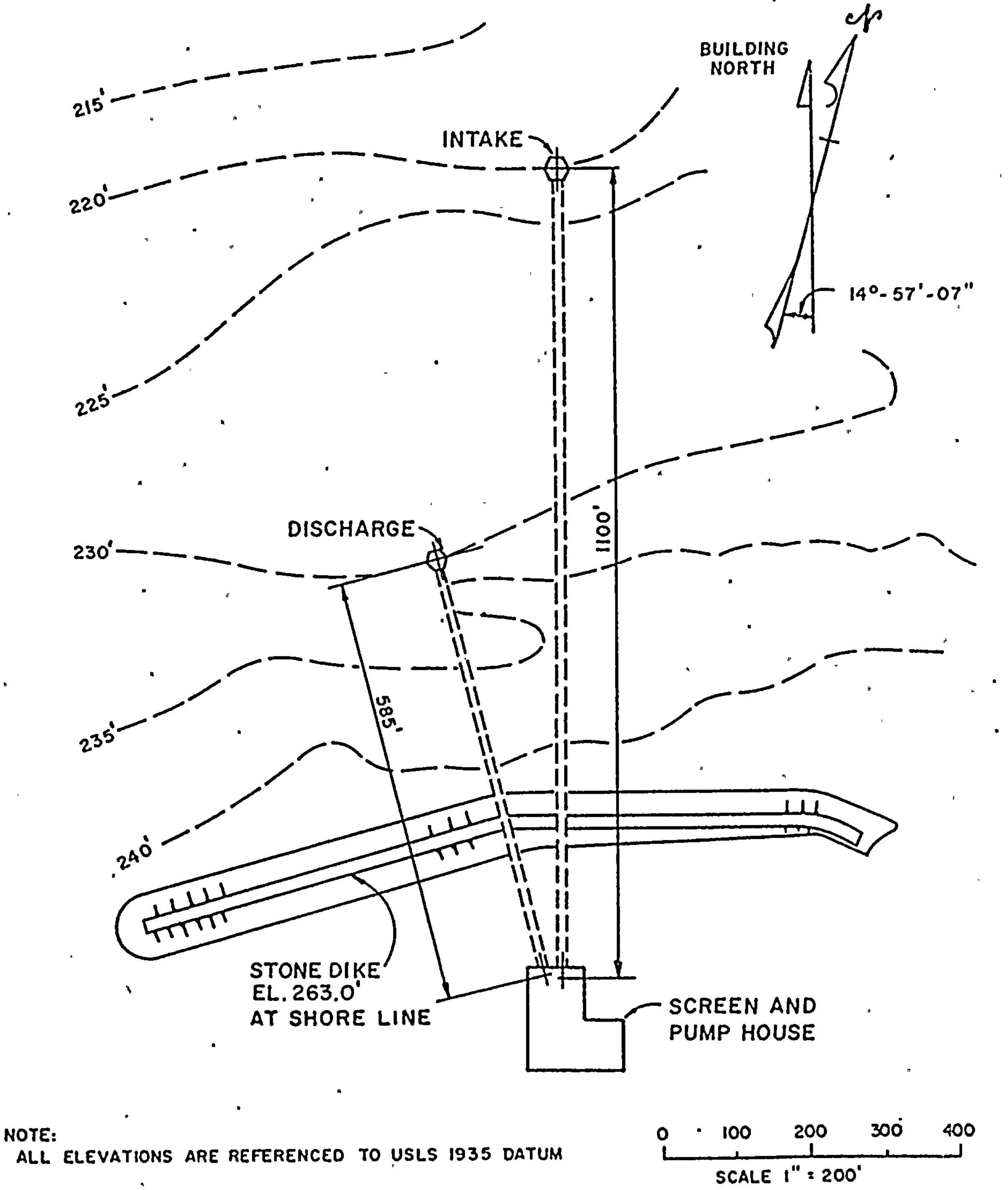
Cooling water is taken from Lake Ontario into a hexagonal intake structure located in a water depth of approximately 18 ft about 850 ft from the existing shoreline. The six water inlets, each 5 ft high by 10 ft long, are guarded by galvanized steel racks to prevent the entrance of unmanageable flotsam into the water system. This design provides for water to be drawn equally from all directions with a minimum of disturbance and no vortex at the surface. When the Station is at maximum output, the water velocity at the intake is about 2 fps. Figure II-4 shows structural details of the intake.

From the intake structure, the water flows at 8 fps maximum velocity through a concrete-lined tunnel (see Figure II-5) with approximately a 78 square foot cross section (10-ft diameter) to the screenwell and pump house adjacent to the turbine building. From three separate



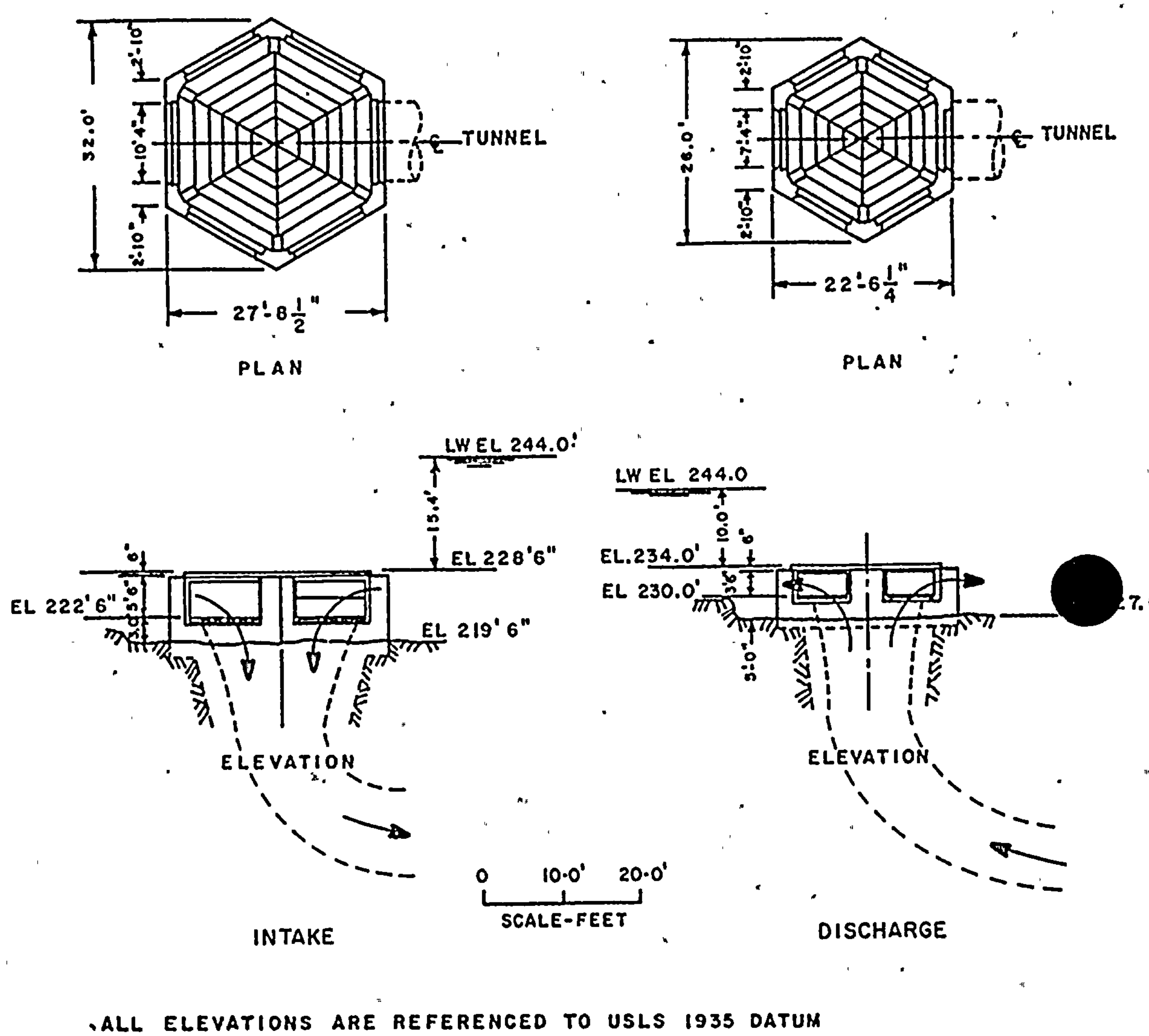
STATION WATER USAGE

FIGURE 1

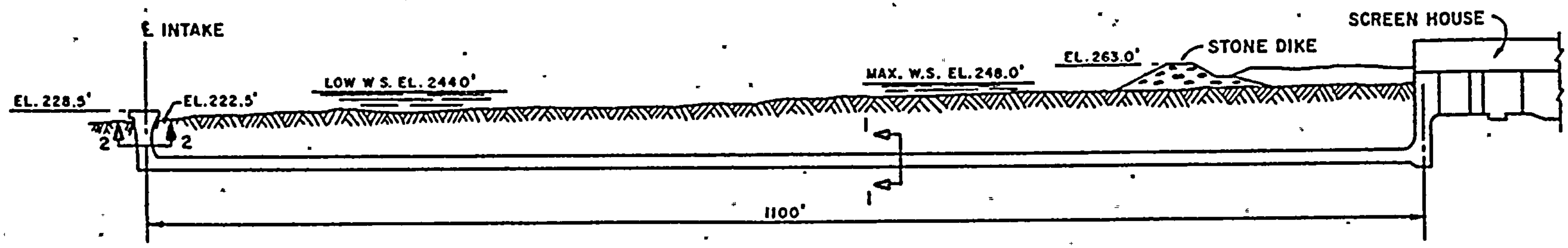


INTAKE AND DISCHARGE STRUCTURE LOCATIONS

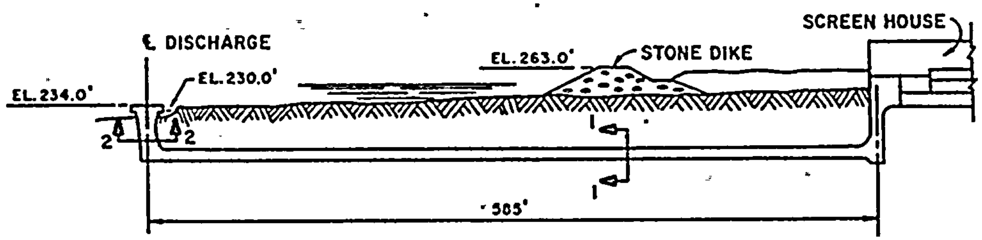
FIGURE II-4



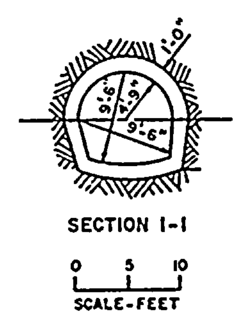
DETAILS OF INTAKE AND DISCHARGE STRUCTURES

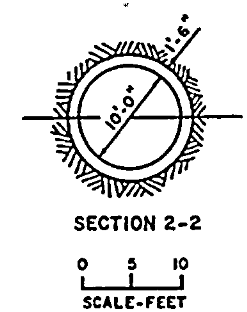


INTAKE TUNNEL (LOOKING EAST)



DISCHARGE TUNNEL (LOOKING EAST)





NOTES:

ALL ELEVATIONS ARE REFERENCED TO USLS 1935 DATUM

0 100 200

SCALE-FEET
EXCEPT WHERE SHOWN

INTAKE AND DISCHARGE TUNNELS

FIGURE II-5

interconnected bays in the screenwell, two circulating pumps (total capacity 250,000 gpm) take the water through trash racks and travelling screens and thence to the condenser.

Plant service-water is supplied by two 22,000-gpm pumps (normally run at 18,000 gpm). Also located in the pump house are two 2500-gpm, 125-psig vertical turbine fire pumps. A sketch of the screenwell is shown in Figure II-6.

2. Discharge Structure

The discharge tunnel, 10 ft in diameter, about 78 square ft in cross section and designed for a flow velocity of about 8 fps, takes the heated water from the screenwell to the discharge structure located about 335 ft off-shore. The top of the hexagonal discharge structure (Figure II-4), which has six ports 3 ft high by 7 ft 4 inches wide, is about 4 ft above the lake bottom and is about 8-1/2 ft below the lowest expected lake level.

The transit time of water through the cooling system is about six minutes, of which 14 seconds is for passage through the condenser. From the condensers to the exit at the discharge structure, travel time is about two minutes. The effluent at the exit has an initial velocity of approximately 4 fps. The profile of the circulating system is shown in Figure II-5.

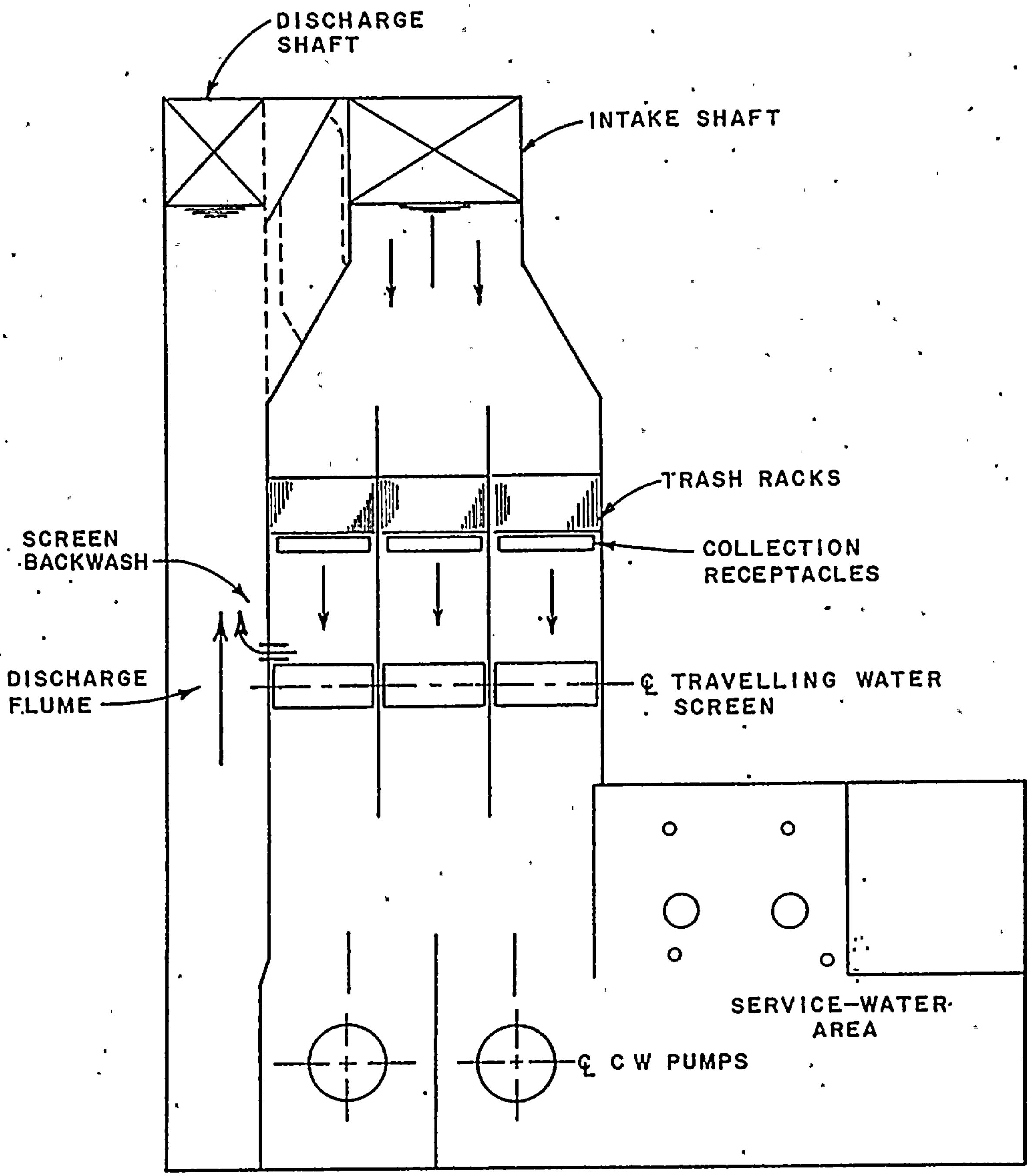
3. Permit Limits

The Nine Mile 1 circulating water system operates in compliance with the U.S. Atomic Energy Commission Facility Operating License No. DPR-63 and Appendix B thereto (Environmental Technical Specifications). The limiting thermal conditions are appended to this document (Appendix B) and include descriptions of the basis for the limitations. In summary, the maximum temperature rise across the main condenser is limited to 32°F. The discharge temperature elevation over lake ambient is limited to 50°F when lake ambient temperature is between 32°F and 50°F, except during reverse flow operations. During flow reversal the discharge temperature shall not exceed lake ambient temperature by more than 70°F during the first hour, 60°F for the second hour and 50°F thereafter. The maximum change in discharge temperature shall not exceed 18°F in any hour except during forced shutdowns or flow reversal.

In addition to these limitations the station operates in compliance with limits set in the final NPDES permit with the exception of certain contested conditions whose effectiveness has b een stayed. The thermal limits in affect at this time are:

The discharge temperature shall not exceed 44.5°C (112°F).

FIGURE II-6



SKETCH OF SCREENWELLS

The discharge-intake temperature* difference shall not exceed 17.8°C (32°F).

The net rate of addition of heat to receiving water shall not exceed 1.06 Billion Kilocalories/hr (4.20 Billion BTU/hr).

D. PLANT OPERATING HISTORY

1. Records of Shutdowns

The EPA guidance manual requests a list of plant shutdown dates. Nine Mile 1 went into commercial operation on December 14, 1969. The station records of shutdowns and scrams are summarized in Tables II-1 through II-5. Each shutdown or scram resulted in a discontinuance of the thermal discharge except for service water cooling flow. The annual refueling shutdowns in spring result in substantial plant capacity reductions.

2. Seasonal Plant Loads

The heat rejection of Nine Mile 1 to Lake Ontario varies with the plant load. The plant capacity factor is defined as the ratio of net electrical power generated to the maximum dependable capacity over the reporting period. Monthly plant capacity factors over the last five years are presented in Table II-6. The periods of low capacity factor in April, May, and June result from annual refueling and maintenance shutdowns. The peak capacity factor for Nine Mile 1 is generally in the late fall or winter.

E. SUMMARY OF STATION DESCRIPTION

Nine Mile 1 is a 610 MWe nuclear station with once-through cooling and submerged offshore intake and discharge structures. The maximum condenser temperature elevation is 32°F and the design condenser flow rate is 250,000 gpm. The normal service water flow rate is 18,000 gpm. The station has been in commercial operation since December 1969 at seasonal capacity factors characterized by spring shutdowns and peak loads in late fall or winter.

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* The temperature of the intake water refers to that temperature which is present after intake water tempering.

TABLE II-1

RECORD OF SHUTDOWNS AND SCRAMS
AFTER INITIAL STEAMING

1969		1970		
Date	Operation	Date	Operation	Hours Off Load
Oct. 5	sc	Jan. 9	sh	
6 to 9	sh	12	sc	
11	sc	19	sc	
12	sc	23	sc	
12 to 18	sh	24	sc	
23	sc	Feb. 8	sc	
26 to		14	sc	
Nov. 2	sh	17	sc	
3	sc	20	sc	
7 to 10	hs	25	sc	
8	sc	Mar. 2	sh	
10	sc	**		
11	sc,sh	July 4	sc	Not on Load
13	sc	20	sc	7.67
21 to		21	sc	5.96
Dec. 7	sh	28	sc	7.25
14	sc	Aug. 8	sc	10.27
15	sc	Oct. 9	sc	228.43
20 to 22	hs	Nov. 14	s sh	41.92
21	sc	Dec. 4	sc	4.00
24	sc	4 to		
30	sc	20	sh	391.75

sc - scram
sh - shutdown
hs - hot standby/s sh scheduled shutdown

** - starting with July 4, 1970, # of hours off load were recorded.

TABLE II-2

RECORD OF SHUTDOWNS AND SCRAMS - 1971

Date	Operation	Hours Off Load
Jan. 13	sc	111.70
24	sc	7.38
Feb. 11	sc	7.13
Apr. 3	s sh	668.90
May -	s sh	657.37
28	sh(hs)	28.20
30	sc	12.08
June 1	sh(hs)	160.55
10	sc	12.15
11	sh(hs)	65.83
13	sc	65.83
July 15	sc (shutting down while bringing down to hs)	84.90
16	sc (while on hs)	84.90
21	sc	12.40
Aug. 18	sc	10.80
29	sc	13.42
30	hs	5.00
Sept 18	sh	931.42
Dec. 31	sc	13.80

sc - scram
sh - shutdown
s sh - scheduled shutdown
hs - hot standby

TABLE II-3

RECORD OF SHUTDOWNS AND SCRAMS - 1972

Date	Operation	Hours Off Load	Hours Reactor Sub-critical
Jan. 11	sh	96.03	
Feb. 28	sc	78.70	
Mar. 4	sc	24.45	
Apr. 1	sh	1791.06	
June 14	sc	0.00	
23	sh	30.78	
26	sh	110.24	
*			
July 1	sh	.82	-
22	sc	6.63	2.30
28	sh	61.87	48.00
Aug. 26	sh	44.10	32.50
Sept 2	sh	32.51	28.42
9	sh	52.98	40.07
21	sh	87.88	72.00
Oct. 7	sh	53.84	22.00
28	sh	34.65	21.00
Nov. 19	sc	122.46	111.87

sc - scram
sh - shutdown
* - began recording reactor subcritical
s sh - scheduled shutdown
hs - hot standby

TABLE II-4

RECORD OF SHUTDOWNS AND SCRAMS - 1973 and 1974

1973

Date	Operation	Hours Generator Off Load	Hours Reactor Subcritical
Feb. 9	sc	151.2	135.2
23	sh	53.0	32.9
Apr. 8	sc	17.1	6.8
11	sh	47.8	24.0
14	sc	-	-
14 to June 12	sh	1517.9	1394.8
12	sh	-	46.0
15	sc	-	4.4
16	Turbine generator shutdown only	8.3	0
July 8	sc	13.90	5.0
Oct. 18	sh	131.35	118.0
Nov. 16	sh	42.30	23.5
17	sh,sc	-	-
20	sc	16.38	5.75
26	sh,2sc	79.87	68.70

1974

Date	Operation	Hours Generator Off Load	Hours Reactor Subcritical
Mar. 30 to June	sh	2,264.7	2,147.6
Oct. 12	sc	41.6	17.4
Dec. 9	sc	16.1	11.2
Dec. 21	sc	261.2	200.5

sc - scram
sh - shutdown

TABLE II-5

RECORD OF SHUTDOWNS AND SCRAMS - 1975

Date	Time	Operation	Hours Unavailable
Dec. 21 to Jan. 5	off 0250 am on 0138 am	-	97.63
12 13	0440 pm 0650 am	sc	14.16
18 19	1057 am 0703 am	sc	20.1
Feb. 3	0051 am 1005 pm	sc	9.2
Feb. 3 to 12	2300 pm 0558 am	sh	211.9
Mar. 8 to 9	0042 am 0310 am	sh	26.5
18	1415 pm 1752 pm	sh	3.6
20 to 21	0045 am 1400 pm	sh	37.3
Apr. 11 to 13	1140 pm 0634 am	sh	42.9
July 27 to 28	0025 am 0247 am	sc	24.37
Sept. 13	0540 am	sh	426.3

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sc - scram
sh - shutdown

TABLE II-6

FIVE YEAR RECORD OF SEASONAL CAPACITY FACTORS[1]

MONTH	1970	1971	1972	1973	1974	1975	Average
January	-	79.3	77.9	94.8	94.9	70.3	83.4
February	-	98.4	89.0	60.8	93.9	56.8	79.8
March	-	100.0	82.6	94.6	77.2	79.2	86.7
April	-	6.4	0.8	30.8	0	83.7	24.3
May	-	1.9	0	0	0	88.5	18.1
June	-	51.3	22.5	27.9	0	86.9	37.7
July	45.8	75.7	75.2	81.9	69.8	-	69.7
August	86.1	88.0	80.1	83.6	91.1	-	85.8
September	87.0	52.6	54.6	84.4	94.1	-	74.5
October	64.8	12.7	68.9	66.6	78.8	-	58.4
November	89.4	93.3	77.2	68.0	90.4	-	83.7
December	44.8	94.6	95.2	89.0	47.1	-	74.1
Average		62.8	60.3	65.2	61.4		64.7

(1) Based on 500 MWe prior to July 1971 and 610 MWe after July 1971.

III. PLUME DESCRIPTION

A. DISCHARGE ZONE

The guidance manual requires a discharge zone description, evidence of compliance with applicable water quality standards, and records of communications with regulatory agencies which indicate possible harmful effects. The guidance manual (page 22) defines the discharge zone as "that portion of the receiving waters which falls within the 2°C isotherm of the plume 30% or more of the time." The times of surveys should include at least a few months, and preferably indicative of a complete annual cycle. Thermal surveys of the Nine Mile 1 plume have been made over a period of five years in six different monthsto delineate the discharge zone within the receiving water body segment.

B. THERMAL SURVEYS

During the period since Nine Mile 1 went into operation in 1969, 25 field surveys of the plumes resulting from the discharge of heated condenser cooling water into the Lake Ontario have been conducted (Storr, 1971f, 1972d, 1973a, 1974, 1975). An examination of these data covering a period of five years, shows that the plume extent and direction are strongly dependent on wind-induced lake currents, wave action, and upwelling. However, the extent of the plume has no direct relationship with the actual wind speed; that is, high winds do not necessarily cause the longest plumes. By comparing plume surveys conducted during days of similar ambient temperatures, no definite relationship between the heat load (BTU/day) and the area of thermal influence can be established. Also there is no simple relationship between the heat load (BTU/day) and the plume's offshore extent, even for the same wind speed and direction. All these indicate the stochastic nature of the plumes, as influenced by the hydrodynamic characteristics of the lake.

C. STATISTICAL SUMMARY OF THE PLUME

A cumulative frequency distribution analysis of the 25 sets of data, given in Table III-1, was performed. The measured surface areas within the 2°C isotherm were arranged in a series of decreasing plume sizes. The area which is exceeded with a selected frequency is then obtained from the resulting cumulative frequency curve, Figure III-1. As shown in the figure, the surface plume area is greater than 160 acres thirty percent of the time.

A similar analysis was performed for the estimated volumes of the plume within the 2°C rise isotherm. The cumulative frequency curve is shown in Figure III-2. The volume exceeds 350 acre-ft 30% of the time. Thus, the calculated mean depth of the discharge zone is 2.19 ft.

TABLE III-1

THREE-DIMENSIONAL THERMAL SURVEYS - NINE MILE POINT
(Ref: Storr, 1971f, 1972d, 1973a, 1974, 1975)

Surface Area and Volume of Water Enclosed within 2°C Above Ambient Isotherms

SURVEY DATES	SURFACE AREA (ACRES)	VOLUME (ACRE-FT)	MEAN DEPTH (FT)	WIND SPEED (MPH)	WIND DIRECTION
8-08-74	369.50	1229.00	3.33	8-12	W/NW
9-05-74	72.00	235.20	3.27	5	E/SE
10-15-74	51.70	54.00	1.04	8-10	NW
6-27-73	75.97	116.15	1.57	15-20	S
8-03-73	142.65	394.09	2.76	10-12	NW
9-05-73	220.05	340.51	1.55	10-15	S
10-12-73	178.02	487.09	2.74	3-5	S
7-21-72	109.28	167.85	1.54	20	W
8-02-72	125.06	368.51	2.94	5-10	S/SE
8-16-72	117.25	301.43	2.57	5-8	S/SE
8-31-72	52.80	89.67	1.70	9	SW
10-20-72	137.86	195.19	1.42	10	NW
6-29-71	72.89	103.27	1.42	15-20	W/SW
7-13-71	43.44	83.52	1.92	10-15	S/SW
7-23-71	365.12	744.34	2.04	6-8	S/SW
7-30-71	161.38	219.75	1.36	0-5	E
8-16-71	84.08	198.01	2.36	5-10	N
8-25-71	106.34	324.86	3.05	0-10	S/SW
11-03-71	46.37	141.42	3.05	5-15	NW
11-16-71	267.61	1005.25	3.76	5-10	NW
7-22-70	136.25	314.74**	2.31*	NA	W
8-14-70	310.65	776.63**	2.50*	NA	NA
8-16-70	80.90	131.87**	1.63*	NA	NA
9-23-70	183.21	338.94**	1.85*	NA	NA
10-21-70	33.95	95.06**	2.82*	NA	NA

NA - Data not available
* - Estimated from the depth temperature profiles
** - Obtained from surface area X mean depth

CUMULATIVE FREQUENCY
OF PLUME SURFACE AREAS (ACRES)
WITHIN THE 2°C ISOTHERM

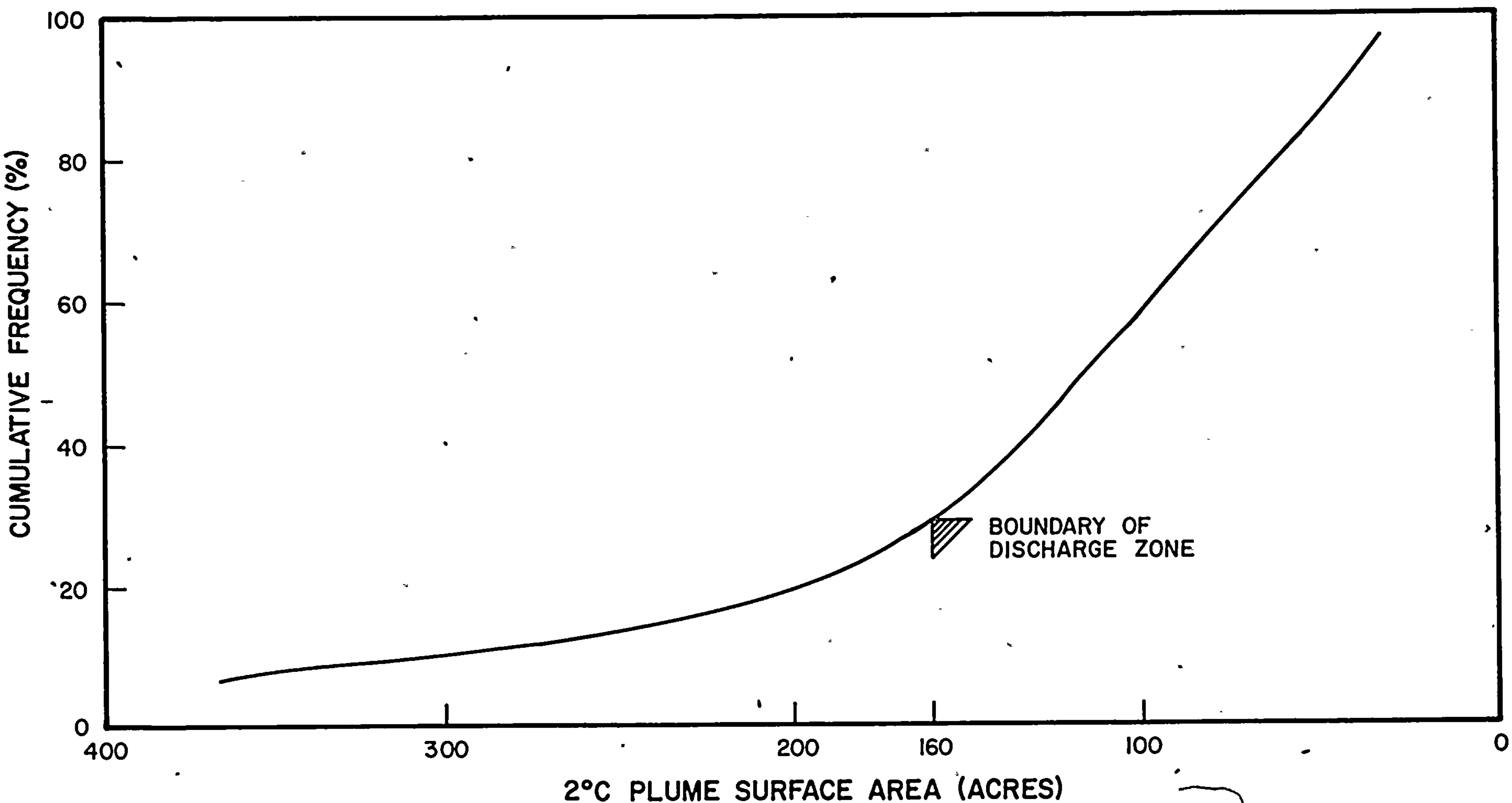


FIGURE III-1

CUMULATIVE FREQUENCY
OF PLUME VOLUMES (ACRE-FT)
WITHIN THE 2°C ISOTHERM

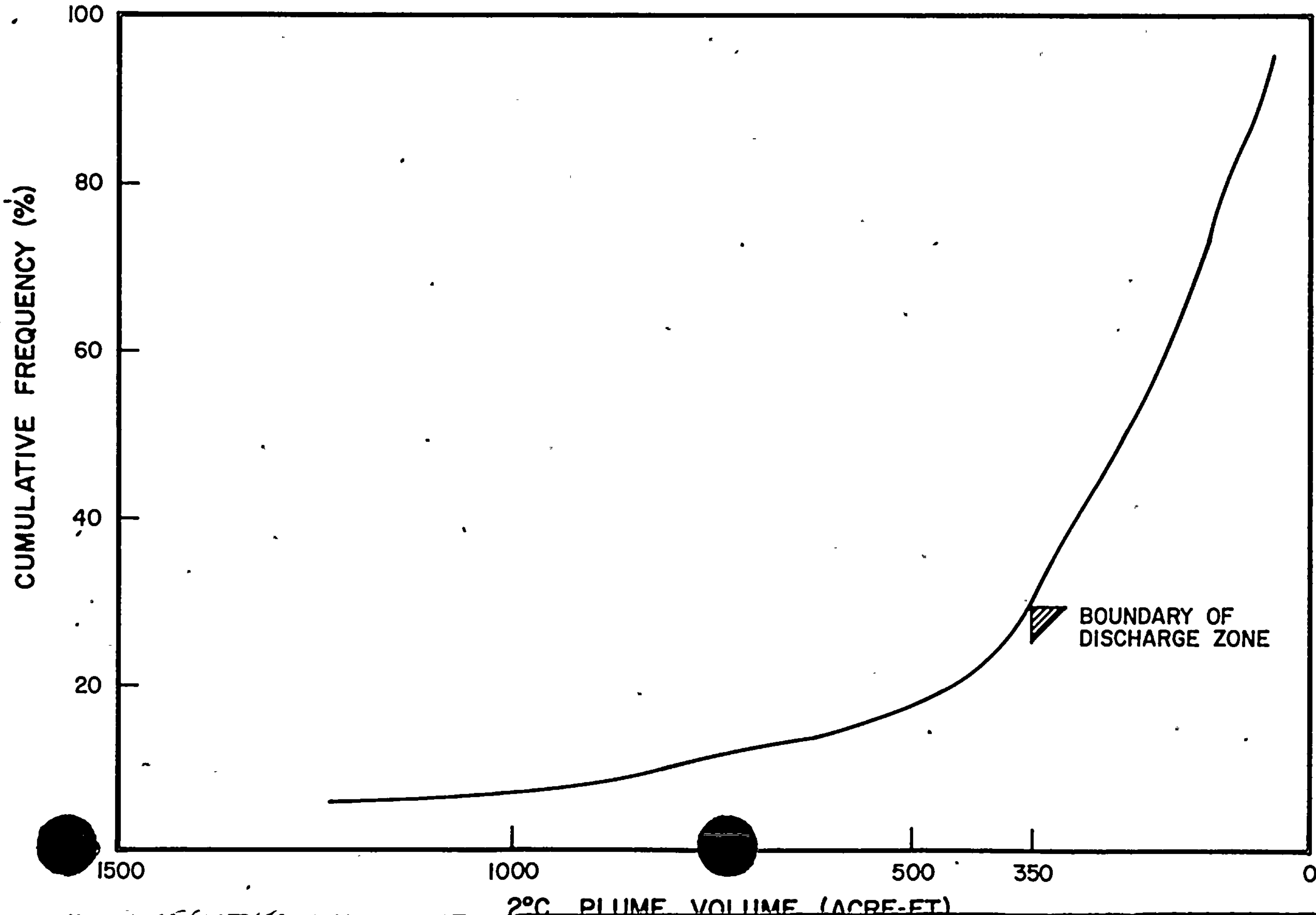


FIGURE III-2

Due to the stochastic nature of the plume the actual shape of a plume, which extends over an area, of 160 acres cannot be readily determined. The four surveys with 2°C isotherms closest to the 160-acre size have common areas almost symmetrical about the point of discharge and the plant transect (NMPP). A representative area of 160 acres enclosing the common area of all the plumes around the discharge point is illustrated as the discharge zone in Figure III-3. The representative discharge zone extends about 1875 ft on each side of the discharge point along the shore, and extends to a maximum of about 2365 ft offshore. Figure III-3 also shows the current ecological survey area around the Nine Mile Point Station.

D. EVIDENCE OF COMPLIANCE WITH APPLICABLE WATER QUALITY STANDARDS

Nine Mile 1 commenced operation in 1969 in compliance with existing New York State regulations (6 NYCRR 701.3) which required that discharge of heated liquids be limited to "none alone or in combination with other substances or wastes in sufficient amounts or at such temperatures as to be injurious to fish life..." Later thermal criteria imposed by the State on new discharges (July 1969) specifically exempted existing discharges such as Nine Mile 1 from the numerical criteria. On April 8, 1974 New York State certified that the discharge from Nine Mile 1 complied with water quality standards. EPA approved the New York State standards, then in effect, on May 8, 1974. On July 8, 1974 New York State certified in a letter to the Administrator: "Since the plant was constructed prior to the adoption of New York State Thermal Criteria, it is exempt from numerical limitations".

On September 20, 1974 New York State adopted a revision of the criteria (6 NYCRR 704) which imposed a criterion of 3°F maximum surface temperature elevation for discharges to lakes, but provided... "In determining that a discharge existing prior to July 25, 1969 has violated the standard for thermal discharges, as provided in subdivision (a) of section 704.1, the violation of any of the criteria contained in this Part shall not constitute evidence of a violation of such standard unless it is also shown that the violation of such criteria has contributed to the violation of the standard (6 NYCRR 704.6 (a)." Part 704.1(a), the standard, requires that all thermal discharges to the waters of the State shall assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on the body of water.

Thus the existing discharge is in compliance with applicable water quality criteria.

DISCHARGE ZONE AND ECOLOGICAL SAMPLING STATIONS AT NINE MILE POINT

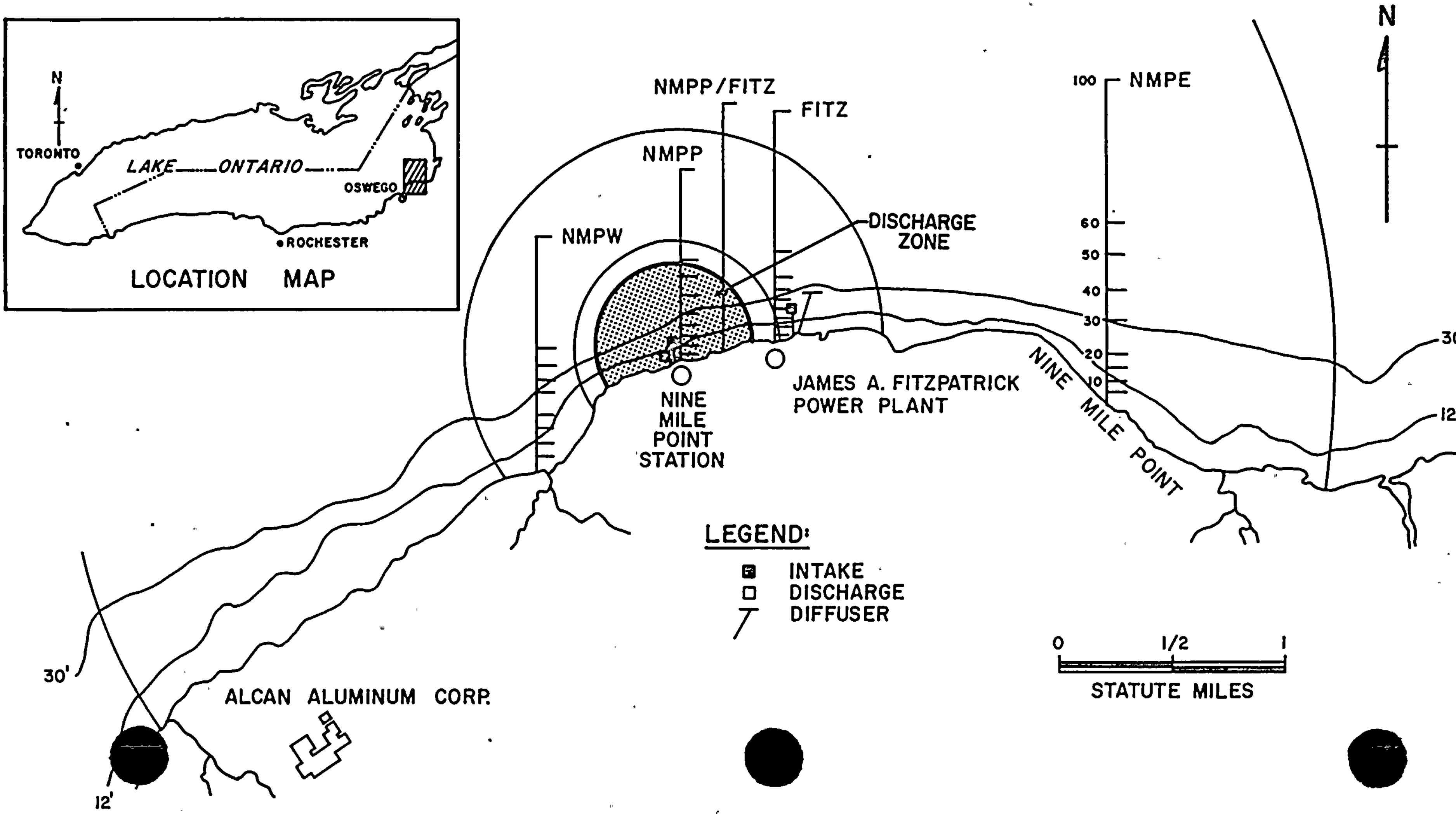


FIGURE III-3

E. RELATED WATER QUALITY CORRESPONDENCE

The guidance manual requires submission of all water quality related communications (which indicate possible harmful effects) between the applicant and any regulatory agency other than EPA during the last five years. Niagara Mohawk has received no such communication related to the thermal component of its discharge, the subject of this demonstration. A summary of permits received by the station was submitted with the previous 316(a) document on August 2, 1974. Since that time, NMPC has been issued a permanent operating license for Nine Mile 1. A copy of the license is appended to this document.

IV. BASELINE STUDIES AND COMMUNITY COMPOSITION

A. INTRODUCTION

In order to assess the effects of an electric generating station's thermal discharge on the aquatic community of a waterbody, the abundance, species composition, and distribution of the biota in relation to power plant operation must be delineated. This chapter provides information for Nine Mile 1 based on studies at Nine Mile Point and other areas in the vicinity. The major biological groups present in the study area will be considered, along with the factors which have been shown to affect these aquatic populations.

Prior to 1971, ecological investigations were conducted by Dr. J. F. Storr in the vicinity of the Nine Mile 1 under contract to Niagara Mohawk Power Corporation (Storr, 1973b). Storr collected data concerning the basic current flow patterns, and the plankton, benthos, and fish populations observed in the area from 1963 to the present. LMS conducted ecological investigations of the aquatic ecosystem in the vicinity of the Nine Mile Point Nuclear Station during 1972, 1973, and 1974 (QLM, 1973, 1974; LMS, 1975 in preparation). Because the generating stations at Oswego and Nine Mile Point are in close proximity (within approximately 12.8 km, 8 mi.), ecological data from both sites are utilized to evaluate ecological conditions in the area.

The programs conducted by LMS (QLM, 1973, 1974 LMS 1975) at Nine Mile Point consisted of surveys of plankton (phytoplankton, zooplankton, and ichthyoplankton), benthos, and fish populations during the spring through fall periods at various depths and transect locations. Impingement and entrainment of nektonic and planktonic populations were also monitored at the station's intake. Water quality was investigated by LMS in the vicinity of Nine Mile Point (QLM, 1973, 1974; LMS, 1975), including monthly determinations of inorganic nutrients, heavy metals, dissolved oxygen (DO), temperature, pH, and BOD concentrations. Each trophic level of the community within the vicinity of Nine Mile Point is discussed in the following sections.

Other studies in the immediate vicinity of the study area have been conducted by the Lake Ontario Environmental Laboratory (LOTEL) (RGE, 1974), by McNaught and Fenlon (1972), and McNaught and Buzzard (1973). The latter studies were concerned with the effects of plant operation on phytoplankton productivity and zooplankton populations.

This chapter summarizes the essential characteristics of the biological community found in the Nine Mile Point and Oswego area. Substantiation of the facts and conclusions presented herein is found in the previously submitted documentation of the lake surveys through 1973.

B. PHYTOPLANKTON

The phytoplankton stocks in Lake Ontario have been studied by a number of investigators, including Ogawa (1969), Davis (1966), QLM (1972), and LMS (1974, 1975). The species identified by these authors encompass all phytoplanktonic groups, notably diatoms, green algae, blue-green algae, and flagellates.

Several investigators have observed seasonal patterns of phytoplankton occurrence in Lake Ontario (Davis, 1966; Nalewajko, 1966, 1967; Munawar and Nauwerck, 1971; QLM, 1972,1974a). The seasonal patterns are correlated closely with natural changes in physical conditions, i.e, water temperature and light intensity, and with the supply of dissolved inorganic nutrients. Although there is some phytoplankton growth throughout the year, the annual cycle is usually characterized by two periods of rapid and unusually intense phytoplankton growth, termed "pulses" or "blooms." One pulse occurs during the spring and is dominated by diatoms; the other pulse occurs during the fall and is usually dominated by blue-green algae.

The seasonal patterns of phytoplankton observed in the vicinity of the Nine Mile Point reflect seasonal patterns previously reported in Lake Ontario. Community composition of phytoplankton identified in the area during 1974 is presented in Table IV-1. The diatom community during the spring was composed principally of Asterionella, Fragilaria, Cyclotella, Melosira, and Tabellaria (LMS, 1974). Reinwand (1969) found that Asterionella, Fragilaria, and Tabellaria were major genera of diatoms in Lake Ontario. Work conducted during 1972 (QLM, 1973) indicated that Asterionella, Fragilaria, and Tabellaria were the dominant diatoms in the study area.

Munawar and Nauwerck (1971) reported that green algae tended to be the dominant component of the phytoplankton in Lake Ontario during late summer and that blue-green algae were dominant during the fall bloom. LMS (1974) findings substantiate these conclusions with the green algae community, composed primarily of Scenedesmus, Cocystis, and Coelastrom and the dominate blue-green, Microcystis. Ogawa (1969) reported these genera to be common throughout the lake basin.

QLM (1974a) investigated phytoplankton abundance at individual sites to define possible "bloom" proportions of algae. Whipple et al. (1948) suggested that individual cell counts of algae exceeding 5×10^6 cells/l constituted bloom conditions, while densities greater than 3×10^6 cells/l indicated the existence of a troublesome concentration of algae. Utilizing Whipple's density definition, several phytoplankters, including Microcystis,

TABLE IV-1

SPECIES INVENTORY AND FREQUENCY OF OCCURRENCE OF THE PHYTOPLANKTON IN THE VICINITY OF NINE MILE POINT 1974

	26 APR	11 MAY	22 MAY	6 JUN	28 JUN	15 JUL	29 JUL	8 AUG	22 AUG	27 SEP	24 OCT	27 NOV	12 DEC
Class Chlorophyceae													
N*Actinastrum hantzschii			X	X	X								
**Ankistrodesmus convolutus													
*A. falcatus	X	X	X	X	X	X	X	X	X	X	X	X	X
Botryococcus sudeticus	X					X	X						
Carteria spp.		X	X	X		X		X	X				
*Characium sp.													
C. ornithocephalum						X							
N*Chlamydomonas sp.	X	X	X	X	X	X	X	X	X	X	X	X	
*Chodatella ciliata			X			X	X	X	X	X	X	X	X
C. longiseta										X			
C. quadriseta		X	X		X	X		X	X	X			
C. subsalsa								X					
N*Closterium spp.			X	X		X							X
*C. aciculare				X	X	X	X	X	X	X	X	X	X
C. venus				X									
Coelastrum cambricum					X			X		X			
*C. microporum		X	X	X	X	X	X	X	X	X	X	X	X
N*Cosmarium spp.	X	X			X	X	X	X	X	X	X	X	X
*Crucigenia sp.		X	X		X			X					
*C. quadrata			X				X						
*C. tetrapedia								X					
**Cylindrocapsa sp.													
N Dictyosphaerium ehrenbergianum						X		X		X		X	
*D. pulchellum		X	X	X		X	X	X	X	X	X		
*Echinosphaerella limnetica							X		X				
Elakatothrix gelatinosa				X		X	X	X				X	X
Errerella bornhemiensis						X	X		X	X			
N*Eudorina elegans	X		X	X		X	X	X	X	X	X	X	X
Franceia droescheri		X		X			X	X	X	X	X	X	
F. ovalis							X			X			
N*Gloeocystis spp.									X				
G. ampla			X										
G. gagas			X			X		X	X				
G. vesiculosa		X				X	X	X	X	X	X	X	
*Golenkinia paucispina							X			X			
G. radiata	X			X		X	X	X	X	X	X		
Kirchneriella lunaris								X					
*K. obesa							X						
K. subsolitaria							X						
*Micractinium pusillum	X	X	X	X	X	X	X	X	X	X	X		
*Mougeotia spp.	X	X	X	X	X	X	X	X	X	X	X	X	X
*Nephrocytium agardhianum								X					
N. limneticum						X	X	X					
N. lunatum						X							
*Oedogonium spp.		X		X	X	X		X	X	X	X	X	X
*Oocystis sp.			X	X									
*O. borgei	X			X	X	X	X	X	X	X	X	X	X
O. parva			X			X	X	X	X	X	X	X	X
O. pusilla						X	X	X	X	X			
N*Pandorina morum			X			X	X	X	X	X	X		X
N*Pediastrum boryanum	X	X	X	X			X			X			
*P. duplex		X		X	X	X	X	X	X	X	X	X	

TABLE IV-1 (continued)

	26 APR	11 MAY	22 MAY	6 JUN	28 JUN	15 JUL	29 JUL	8 AUG	22 AUG	27 SEP	24 OCT	27 NOV	12 DEC
Class Chlorophyceae (Continued)													
*P. simplex						X	X	X	X	X	X	X	
*P. tetras			X			X	X	X	X	X	X	X	X
*Phacotus lenticularis				X	X	X	X	X	X	X	X	X	X
Polyedriopsis spinulosa								X					
Quadrigula chodatii		X	X	X			X	X					
Q. lacustris						X	X			X			X
N*Scenedesmus sp.						X			X		X		
		X	X		X	X	X	X	X	X	X	X	X
S. abundans	X		X	X	X	X	X	X	X	X	X		
*S. acuminatus					X		X	X	X	X	X	X	
*S. bijuga	X	X	X	X	X	X	X	X	X	X	X	X	X
**S. brasiliensis													
*S. denticulatus						X	X	X	X	X	X	X	X
*S. dimorphus	X		X	X	X	X	X	X	X	X	X	X	X
S. longus							X	X	X				
*S. obliquus			X		X		X	X	X	X			X
S. opoliensis				X	X	X	X	X	X	X	X	X	X
*S. quadricauda	X	X	X	X	X	X	X	X	X	X	X	X	X
*Schroederia judayi									X				
*S. setigera			X		X	X	X	X	X	X	X		
Selenastrum minutum													X
*Sphaerocystis schroeteri							X	X	X				
N Spirogyra spp.		X											
N*Staurastrum spp.		X				X	X	X	X	X	X	X	
S. gracile			X					X	X	X	X	X	X
Tetraedron caudatum			X		X		X	X	X				
*T. minimum			X			X	X	X	X	X	X	X	X
*T. muticum					X		X	X	X	X			
T. pentaedricum			X										
*T. regulare					X		X			X			
*Tetraspora lacustris	X	X			X	X	X						
T. lamellosa						X							
*Tetrastrum sp.													
T. elegans							X						
*T. staurogeniaforme		X				X	X	X	X		X		X
Treubaria setigerum		X	X						X		X		
T. triappendiculata							X	X	X	X	X		
N Ulothrix spp.										X	X		
U. subconstricta			X										
Unidentified colony							X			X		X	
*Unidentified single cell			X	X	X	X	X	X	X	X	X	X	X
Unidentified germling								X	X				
Class Euglenophyceae													
N*Euglena spp.				X		X		X	X				
Lepocinclis spp.				X									
**Trachelomonas spp.													
Class Chrysophyceae													
N*Dinobryon sociale var. americanum		X	X	X	X	X	X						
N**Synura uvella													

TABLE IV-1 (continued)

	26 APR	11 MAY	22 MAY	6 JUN	28 JUN	15 JUL	29 JUL	8 AUG	22 AUG	27 SEP	24 OCT	27 NOV	12 DEC
Class Bacillariophyceae													
Amphiprora sp.	X												
N*Asterionella formosa	X	X	X	X	X	X	X	X			X	X	X
**Cocconeis spp.													
*Coscinodiscus subtilis						X	X	X	X	X	X	X	
N*Cyclotella spp.	X	X				X		X	X	X	X	X	
**C. meneghiniana													
**Cymatopleura elliptica													
Cymbella spp.	X			X								X	
N*Diatoma tenue var. elongatum	X	X	X	X	X	X	X	X		X	X	X	X
*D. vulgare	X												
*Eunotia curvata		X	X	X		X							X
N*Fragilaria capucina													
F. crotonensis	X	X	X	X	X	X	X	X			X	X	X
Gomphonema spp.							X				X		
**G. olivaceium													
*Gyrosigma spp.		X				X	X						X
N*Melosira spp.	X	X		X									X
*M. binderana	X	X	X	X	X		X	X		X	X	X	X
*M. granulata			X			X		X		X			
*M. islandica		X	X	X	X	X		X					
M. varians	X	X	X		X								
*Navicula spp.	X	X	X	X	X	X		X			X		
*N. tripunctata			X	X		X				X		X	X
*Nitzschia spp.	X			X	X	X				X	X		X
*N. acicularis													
*N. holsatica		X		X	X					X			X
*N. sigmoidea		X											
*Rhoicosphenia curvata	X					X		X				X	
N*Stephanodiscus spp.			X	X	X	X	X	X	X	X	X	X	X
*S. astrea	X	X	X	X		X							
*S. hantzschii var. pusilla	X		X		X	X	X	X	X	X		X	
*S. niagarae											X		
S. tenuis								X					
*Surirella spp.	X											X	
**S. ovata													
N*Synedra spp.	X	X	X	X	X	X						X	X
**S. ulna													
N*Tabellaria fenestrata	X		X	X	X	X	X			X		X	X
Class Dinophyceae													
N Ceratium hirundinella								X	X	X	X	X	
N*Glenodinium spp.	X	X		X	X	X	X	X	X	X	X	X	
Gymnodinium spp.		X		X									
*G. helveticum		X		X				X					
N*Peridinium spp.	X			X									
*P. aciculiferum	X	X	X	X		X	X	X	X	X	X		
*P. cinctum		X		X		X	X	X	X	X	X	X	
P. inconspicuum						X		X	X				
Class Myxophyceae													
N*Anabaena sp.		X	X	X			X	X					
A. flos-aquae				X		X		X					
A. macrospora				X		X							
A. spiroides													
N Aphanizomenon flos-aquae					X	X	X	X	X	X			X
Aphanocapsa spp.								X	X				
A. pulchra										X			X

TABLE IV-1 (continued)

Class Myxophyceae (Continued)	26 APR	11 MAY	22 MAY	6 JUN	28 JUN	15 JUL	29 JUL	8 AUG	22 AUG	27 SEP	24 OCT	27 NOV	12 DEC
*Aphanothece spp.		X				X							
*Chroococcus spp.						X	X				X		
C. dispersus	X				X	X	X	X	X	X		X	
*C. limneticus			X										
C. minutus						X	X	X					
*C. turgidus													
N*Coelosphaerium kuetzingianum		X						X					
C. naegelianum	X												
*Dactylococcopsis spp.													
D. smithi						X							
*Gloeocapsa spp.							X						
N Gomphosphaeria lacustris							X	X			X		
*Lyngbya limnetica	X	X	X	X	X	X	X	X	X	X	X	X	
Merismopedia tenuissima							X						
N*Oscillatoria sp.		X					X	X					
O. limnetica	X		X	X	X	X	X	X	X	X	X		
Phormidium sp.						X	X	X			X	X	
*Polycystis aeruginosa	X							X					
P. incerta						X							
*Unidentified single cell													
Class Cryptophyceae													
N*Cryptomonas erosa	X	X	X										
Katablepharis ovalis							X	X	X	X		X	
*Unidentified Cryptophyte	X		X	X					X		X		

KEY
* identified in windrow collections (windrow species collection dates not indicated)
** unique to windrow collections
N potential nuisance algal genus (Mackenthun, 1969)

Botryococeus sudetious, Volvox aureus, Glenodinuim paluste, and Euglena sp. reached or exceeded bloom proportions as determined through sampling conducted in 1973. The green algae, Dictyosphareum pulchellum, was the only species reported at troublesome levels. Microcystis, a blue-green algae, was the only species whose population exceeded bloom conditions on more than one sampling date; these dates however, were not consecutive. Sampling conducted in 1974 indicated a greater abundance of green algae and lower abundance of blue-green algal species. The slight shift in species composition was attributed to overall cooler water temperatures in 1974 compared to 1973 in the vicinity of Nine Mile Point.

The phytoplankton species in the vicinity of Nine Mile Point conform closely to the inventories of species recorded for shoal waters in Lake Ontario. The taxonomy of the Nine Mile Point phytoplankton reflects the same species shifts observed in other parts of the lake over the past 50 years. The taxonomy, distribution, and abundance of phytoplankters in the Nine Mile Point vicinity are essentially the same as has been determined for the lake as a whole.

C. ZOOPLANKTON

1. Microzooplankton

The second category of organisms is the microzooplankton, the members of which are an integral part of the aquatic community in the vicinity of Nine Mile Point. To facilitate a division of zooplanktonic populations on the basis of size, microzooplankton may be defined as those organisms retained by a 76μ mesh plankton net.

The microzooplankton fraction of the total zooplankton community in the vicinity of Nine Mile Point is composed of four major taxonomic groups: rotifers, cladocerans, copepods, and protozoans. Seventeen genera of rotifers and six genera of cladocerans have been identified; copepods were identified as adults and nauplii; and eight genera and two families of the most commonly occurring protozoans were identified through the 1974 sampling program.

Rotifers contribute the greatest percentage of microzooplankton abundance in the vicinity of Nine Mile Point. Members of this taxa exhibit a bimodal pattern of seasonal abundance with the first and normally largest pulse occurring during July and a second pulse in the early fall period. Sampling conducted by Storr (1971g) and LMS (1974) both observed the dominant rotifer to be Keratella sp.

TABLE IV-2

MICROZOOPLANKTON SPECIES INVENTORY

NINE MILE POINT - 1974

PROTOZOA
- Lobosa
  - Testacealobosa
    - Difflugiidae
      - Difflugia sp.
- Suctoria
  - Tentaculiferida
    - Acinetidae
      - Thecacineta sp.
      - Tokophrya sp.
    - Dendrosomidae
      - Staurophyra elegans
    - Podophryidae
      - Paracineta sp.
- Ciliata
  - Spirotrichida
    - Tintinnidae
      - Codonella cratera
  - Peritrichida
    - Epistylidae
      - Epistylis sp.
    - Vaginocolidae
    - Vorticellidae
      - Vorticella spp.
  - Holotrichida
    - Gymnostomina*

ROTIFERA
- Monogononta
  - Ploima
    - Brachionidae
      - Brachionus sp.
      - B. calyciflorus
      - B. quadridentata
      - B. urceolaris
      - Euchlanis sp.
      - Kellicottia longispina
      - Keratella sp.
      - K. cochlearis
      - K. quadrata
      - Notholca sp.
      - N. acuminata
      - Lepadella sp.
    - Lecanidae
      - Lecane sp.
    - Notommatidae
      - Cephaledella sp.
    - Trichocercidae
      - Trichocera sp.
      - T. cylindrica
      - T. multicrinus
      - T. porcellus
    - Gastropidae
      - Chromogaster ovalis
    - Asplanchnidae
      - Asplanchna sp.
    - Synchaetidae
      - Ploesoma sp.
      - P. hudsoni
      - P. lenticulare
      - P. truncatum
      - Polyarthra sp.
      - P. euryptera
      - Synchaeta pectinata
      - S. stylatata
      - S. tremula
  - Flosculariaceae
    - Testudinellidae
      - Filinia longiseta
    - Conochilidae
      - Conochilus sp.
      - C. unicornis
    - Conothecaceae
      - Collotheca mutabilis

* Suborder

TABLE IV-2
(Continued)

ARTHROPODA
Crustacea
Cladocera
Bosminidae
Bosmina spp.
Chydoridae
Chydorus sphaericus
Daphnidae
Ceriodaphnia lacustris
Daphnia spp.
D. galeata mendotae
D. longiremus
D. retrocurva
Holopedidae
Holopedium gibberum
Sididae
Diaphanosoma leuchtenbergianum
Copepoda**
Calanoida
Diaptomidae
Diaptomus spp.
D. minutus
Centropagidae
Limnocalanus macrurus
Temoridae
Eurytemora affinis
Cyclopoida
Cyclopidae
Diacyclops bicuspidatus thomasi
Mesocyclops edax
Tropocyclops prasinus mexicanus
Harpacticoida

** Subclass

Cladocerans formed the second highest percentage of the total microzooplankton population and occasionally the highest percentage observed (LMS, 1974). The seasonal pattern of cladoceran abundance was bimodal: the first peak occurring during July and the second usually greater peak during October or November. Storr (1971g) found Bosmina longirostris to be the dominant cladoceran with peak abundance for the species in the late summer/early fall period. Daphnia was the most abundant spring cladoceran having increased reproduction triggered by increasing water temperature. Differences noted in species composition and seasonal trends between Oswego and Nine Mile Point were in part the result of Oswego River influence on the lake biota (Storr, 1971g).

Copepods in the vicinity of Nine Mile Point exhibited the same general seasonal cycles as Cladocera with percentage levels of the total microzooplankton community between 10 and 20 percent (LMS, 1974). Copepod nauplii were abundant during the spring and adult forms in the late summer, reflecting the reproduction and growth of the organisms.

Protozoan abundance has been found to be highly variable; however, the general trend is for the lowest abundance to occur during the winter and highest abundance during the summer (LMS, 1975). The seasonal trend in abundance is probably the result of water temperature. The dominant protozoans identified belong to the family Vorticellidae.

The total microzooplankton population showed the combined seasonal trend in abundance of the four groups discussed previously. At most stations the result was a bimodal seasonal pattern. The greatest numbers of microzooplankters occurred during late July; there were approximately 1.5×10^6 microzooplankters/m^3 present at all stations during this month. Abundance throughout the sampling period was over 10^3 microzooplankters/m^3 on most sampling dates during 1973 (LMS, 1974).

Glooschenko et al. (1972) found a bimodal pattern in the seasonal abundance of zooplankton at a station in eastern Lake Ontario. The occurrence of the two peaks of abundance was similar to that observed by LMS studies in the vicinity of the Nine Mile Point Nuclear Station, but the number of organisms found by Glooschenko et al. was about an order of magnitude less than the number of organisms found in the vicinity of the Nine Mile Point Nuclear Station (see QLM, 1972 and 1974a) and Oswego.

Gachter et al. (1974) found a quadrimodal seasonal pattern of zooplankton biomass in the littoral areas of Lake Ontario; the first two pulses occurred during late February and late April and the last two pulses occurred during the time when pulses were observed by LMS in the waters off Nine Mile Point.

2. Macrozooplankton and Ichthyoplankton

Classifications according to size are widely used for distinguishing smaller and larger members of the plankton community. For the purposes of the 1973 survey in the Nine Mile Point vicinity, the term "macrozooplankton" was defined as those invertebrate zooplankters retained in a 571μ mesh plankton net; "ichthyoplankton" was defined as the vertebrate zooplankters (fish larvae) retained in a 571μ plankton net. However, invertebrate crustaceans of the same species may be found in both the macrozooplankton and microzooplankton collections due to the wide range of sizes encompassed by the developmental stages of these organisms.

Eleven major macrozooplankton taxa have been identified from collections made in the vicinity of Nine Mile Point and Oswego during 1973 and 1974 (QLM, 1974; LMS, 1975) (Table IV-3). The dominant macrozooplankton groups were cladocerans, copepods, and amphipods. Nematodes, hydroids, insect larvae (mainly diptera), and gastropods were occassionally observed in macrozooplankton samples. Two species, Pontoporeia affinis and Mysis ocolata relicta, which are cold water glacial relicts were observed primarily during periods of cold water upwellings. In general the greatest concentration of macrozooplankton was observed to the east of Nine Mile Point, probably resulting from current circulation around Mexico Bay.

Fish larvae samples were collected from spring through fall in the vicinity of Nine Mile Point in 1973 and 1974 with sampling extending over a longer period at the intake and discharge of Nine Mile 1 (QLM, 1974; LMS, 1975). All samples were analyzed for total egg and larval abundance with representative sub-samples identified and lengthed to evaluate growth. A complete species list is presented in Table IV-4. A total of twenty-two species representing twelve families have been identified in the vicinity of Nine Mile Point. Alewives were by far the most abundant larval species; the other species listed in Table IV-4 occurred on few collection dates or in small numbers.

There are few published data on the distribution and abundance of fish larvae in the Nine Mile Point area; some information is available (although not specifically related to the Oswego - Nine Mile Point vicinity) concerning the feeding habits of larval fish. Since alewives are the most abundant fish in the study area, the larvae of this fish was the dominant ichthyoplankter among the 22 larval species identified (QLM,1974; LMS, 1975). Although Lake Michigan populations may differ from Lake Ontario populations, Norden's (1968) study of alewife larvae in Lake Michigan will serve to provide same background

TABLE IV-3

MACROZOOPLANKTON SPECIES INVENTORY

NINE MILE POINT VICINITY - 1974

COELENTERATA
- Hydrozoa
  - *Cordylophora caspia (lacustris)*
  - *Hydra americana*

NEMATODA

PLATYHELMINTHES
- Turbellaria

ANNELIDA
- Polychaeta
  - Sabellidae
    - *Manayunkia speciosa*
- Oligochaeta

MOLLUSCA
- Gastropoda
- Pelecypoda

ARTHROPODA
- Arachnoidea
  - Hydracarina (Acarina)
    - Hygrobatidae
      - *Hygrobates* sp. A
      - *Hygrobates* sp. C
    - Limnesiidae
      - *Limnesia*
    - Unionicolidae
      - *Unionicola* sp. A
      - *Unionicola* sp. B
      - *Huitfeldtia rectipes*
    - Lebertiidae
      - *Lebertia*
    - Pionidae
      - *Piona*
      - *Forelia*
    - Zerconidae (Free Living Terrestial Forms)
- Crustacea
  - Branchipoda
    - Cladocera
      - *Leptodora kindtii*
  - Branchiura
    - *Argulus* sp.

TABLE IV-3 (Continued)

- Malacostraca
  - Amphipoda
    - Gammaridae
      - Gammarus fasciatus
    - Haustoridae
      - Pontoporeia affinis
  - Mysidacea
    - Mysidae
      - Mysis oculata relicta
- Octracoda
  - Podocopa

INSECTA

- Neuroptera
  - Climacia areolaris
- Hemiptera
- Trichoptera
- Odonata
- Ephemeroptera
- Coleoptera
- Diptera
  - Chaoboridae
    - Chaoborus albipes
  - Simuliidae
  - Chironomidae
    - Chironomus
    - Cricotopus
    - Cryptochironomus
    - Pseudochironomus
    - Endochironomus
    - Demicryptochironomus
    - Parachironomus
    - Rheotanytarsus
    - Tanytarsus
    - Dicrotendipes
    - Paratendipes
    - Glyptotendipes
    - Orthocladius
    - Psectrocladius
    - Procladius
    - Polypedilum
    - Micropsectra
    - Phaenopsectra
    - Paracladopelma
    - Potthastia

TABLE IV-4
FISH AS REPRESENTED BY EGG AND LARVAL COLLECTIONS
IN THE VICINITY OF NINE MILE POINT 1973-1974

Family	Common Name	Scientific Name
Centrarchidae	Pumpkinseed	*Lepomis gibbosus*
	Smallmouth bass*	*Micropterus dolomieui*
Clupeidae	Alewife	*Alosa pseudoharengus*
	Gizzard shad*+	*Dorosoma cepedianum*
Cottidae	Mottled sculpin	*Cottus bairdi*
Cyprinidae	Carp	*Cyprinus carpio*
	Common shiner	*Notropis cornutus*
	Goldfish	*Carassius auratus*
	Emerald shiner⁑	*Notropis atherinoidis*
	Spottail shiner⁑	*Notropis hudsonius*
Gadidae	Burbot*	*Lota lota*
Osmeridae	Rainbow smelt	*Osmerius mordax* rus
Percichthyidae	White perch	*Morone americana*
	White bass⁑	*Morone chrysops*
Percidae	Johnny darter	*Etheostoma nigrum*
	Yellow perch	*Perca flavescens*
	Walleye*+	*Stizostedion vitrium*
	Log perch⁑	*Percina caprodes*
Percopsidae	Trout-perch*	*Perocopsis omiscomaycus*
Salmonidae	Cisco flake herring*	*Coregonus* sp.
Catostomidae	White sucker⁑	*Catostomus commersoni*
Gasterosteidae	Threespine stickleback⁑	*Gasterosteus aculeatus*

* 1974 only

⁑ 1973 only

\+ Egg only

information. Norden found that alewives spawned from June through August and that larvae greater than 5mm in length were most abundant during August, September, and October. Stomach content analysis revealed that alewife larvae fed predominantly on copepods and cladocerans 200 to 300μ in cross-section.

Larval alewives were found from June through early September in the Nine Mile Point area with the period of longest coninuous presence observed in 1974 (LMS, 1975). Seasonal abundance patterns for alewife larvae reflected a late spring abundance peak followed by a second higher peak in August. Length frequency data and abundance of eggs suggest that alewife spawning reached peak levels during the first half of July. The abundance of alewife larvae in night collections made from late June through early August was usually an order of magnitude greater than the abundance of these fish larvae in day collections. Norden (1968) and Scott and Crossman (1973) point to a nocturnal behavior pattern for this species.

The seasonal patterns of total larval abundance reflected the seasonal patterns of larval alewife abundance at most stations (LMS, 1974). During late October, however, a fall pulse of rainbow smelt young was found.

Rainbow smelt, johnny darters, carp, and mottled sculpin formed small percentages of the total fish larvae population during the early summer. The larvae of white perch, common shiners, yellow perch, emerald shiners, and pumpkinseeds were also represented in samples collected during the early summer. Spottail shiner larvae and unidentified shiner larvae were also collected on at least one sampling date (LMS, 1974).

Most of these larvae were found in samples collected between late June and late August; however, rainbow smelt larvae were collected during mid-May, and young of mottled sculpin larvae and rainbow smelt larvae were found in early November collections.

Larvae of the burbot and Coregonous sp. were collected during the earliest sampling dates in 1974 reflecting the cold water spawning of the burbot and late fall spawning of coregonid species (Scott and Crossman, 1973).

Since the majority of larvae collected were alewives, the trophodynamic importance of other species of fish larvae in the Nine Mile Point area seems to be comparatively minor. Rainbow smelt larvae occurred during more sampling efforts (19 of the 36 sampling dates) than any other species; alewives occurred in samples collected on 14 different dates. The occurrence of larval johnny darters,mottled sculpin, and white perch paralleled the occurrence of alewife larvae.

D. BENTHOS

Benthic organisms are those attached to the bottom, resting on the bottom, or living in the sediment of a body of water (Odum, 1971). Studies of the benthic community in Lake Ontario show that several organisms exhibit distinct distributional patterns. Brinkhurst (1969) reported that the general distribution in Lake Ontario followed the distribution of benthos in temperate oligotrophic water bodies having some inshore areas supporting eutrophic forms. Historically, benthic studies have been concentrated in the eastern portion of Lake Ontario (Johnson and Matheson, 1968; Johnson and Brinkhurst, 1971 a,b). The entire lake, including some stations in the Nine Mile Point area, has been sampled by some investigators (Hiltunen, 1969); other studies have been concentrated entirely in and around Oswego (Judd and Gemmel, 1971; Storr, 1972; QLM, 1972). Judd and Gemmel (1971) observed few organisms in the shore zone; the fauna increased in abundance and diversity with depth.

A primary objective of the 1973 and 1974 programs was to obtain information on the benthic community and determine the seasonal fluctuations of the related invertebrate populations. The study was also designed to evaluate the effect of operation of Nine Mile 1 on the benthic community.

Substrate in the vicinity of Nine Mile Point was found by LMS (1975) to be primarily bedrock with larger rocks, and some silt. The more eastern transects exhibited a greater proportion of finer particles as a result of Mexico Bay current patterns. Four transects each composed of five stations were sampled in the 1973 and 1974 benthic surveys. The transect designations were Nine Mile Point West (NMPW), Nine Mile Point Plant (NMPP), FitzPatrick (FITZ), and Nine Mile Point East (NMPE). The NMPW transect was approximately 8000 ft west of Nine Mile 1 and NMPE was approximately 8000 ft east of the J. A. FitzPatrick Nuclear Power Plant. The NMPP and FITZ transects were directly lakeward from each power station centerline. Depths sampled on each transect were 10, 20, 30, 40, and 60 ft. The nature of the transects and depths along each transect enabled comparison of benthic populations from east to west and evaluation of the benthic community in relation to depth at each transect.

A total of five phyla were represented in the benthic samples collected in the vicinity of Nine Mile Point; 85 genera have been identified (QLM, 1974, LMS, 1975). A species inventory of the benthic invertebrates is presented in Table IV-5. The majority of the organisms collected represent species associated primarily with the surface of the substrate, i.e., epi-benthic species, such as *Gammarus fasciatus*. However, several infaunal forms, including members of the class Nematoda, were also collected.

Seasonal trends in benthic invertebrate abundance in temperate zones usually follow this pattern; reproduction during the spring; growth

TABLE IV-5

BENTHOS

MACROINVERTEBRATE SPECIES INVENTORY

NINE MILE POINT - 1974

COELENTERATA
- Hydrozoa
  - Hydra sp.
  - Cordylophora caspia (lacustris)

NEMERTEA
- UID

NEMATODA[1]
- UID
- Alaimus sp.
- Anonchus sp.
- Butlerius sp.
- Dorylaimus sp.
- Bastianiidae
  - Genus A
  - Genus B
  - Genus C

PLATYHELMINTHES
- Turbellaria
  - Tricladida
    - Planariidae
      - Dugesia sp. ✓

ANNELIDA
- Polychaeta
  - Sabellidae
    - Manayunkia speciosa ✓
- Oligochaeta
  - Prosopora
    - Lumbriculidae
      - Stylodrilus heringianus ✓
  - Plesiopora
    - Tubificidae
      - IWOC - immature without chaetae
      - IWC - immature with chaetae
      - Aulodrilus americanus
      - A. limnobuis ✓
      - A. piqueti ✓
      - A. pluriseta ✓
      - Ilyodrilus templetoni ✓
      - Limnodrilus claparedianus ✓
      - L. hoffmeisteri ✓
      - L. profundicola ✓
      - L. spiralis
      - L. udekemianus ✓
      - Peloscolex ferox ✓
      - P. freyi ✓
      - P. multisetosus multisetosus ✓
      - P. multisetosus longidentus
      - Potamothrix moldaviensis ✓
      - P. vejdovskyi ✓
      - Tubifex tubifex ✓
    - Enchytraeidae
      - UID
    - Naididae
      - Arcteonais lomondi ✓
      - Nais barbata
      - N. bretscheri
      - N. elinguis
      - N. simplex
      - Ophidonais serpentina ✓
      - Paranais simplex
      - Piquetiella michiganensis ✓
      - Specaria josinae ✓
      - Stylaria fossularis
      - S. lacustris
      - Uncinais uncinata ✓
      - Vejdovskyella sp.
      - V. comata

[1] Only Genera are listed; taxonomy is under revision.
UID = Unidentified form.
✓ = occurrence in 1973 and 1974 benthic samples.

TABLE IV-5 (continued)

- MOLLUSCA
  - Gastropoda
    - Prosobranchia[2]
      - Valvatidae
        - *Valvata perdepressa*
        - *V. tricarinata*
      - Bulimidae
        - *Amnicola integra* √
        - *A. limosa* √
        - *A. lustrica* √
        - *Bithynia tentaculata*
      - Pleuroceridae
        - *Goniobasis livescens* √
        - *Pleurocera acuta*
    - Pulmonata[2]
      - Physidae
        - *Physa* spp. (immatures)
        - *P. integra* √
        - *P. sayii* √
      - Lymnaeidae
        - *Lymnaea catascopium* √
      - Planorbidae
        - *Gyraulus parvus* √
        - *Helisoma anceps* √
        - *H. trivolvis* √
      - Ancylidae
        - *Ferissia tarda*
  - Pelecypoda
    - Schizodonta
      - Unionidae
        - *Elliptio* sp.
    - Heterodonta
      - Sphaeridae
        - *Pisidium* spp. √
        - *Sphaerium* spp. √

- ARTHROPODA
  - Arachnoidea
    - Hydracarina
      - Hygrobatidae
        - *Hygrobates* spp. √
      - Limnesiidae
        - *Limnesia* sp.
      - Unionicaledae
        - *Huitfeldtia rectipes*
        - *Neumania* sp.
        - *Unionicola* sp. √
      - Lebertiidae
        - *Lebertia* sp. √
      - Torrenticollidae
      - Pionidae
        - *Forelia* sp. √
        - *Piona* sp. √
  - Crustacea
    - Ostracoda[2]
      - Podocopa
        - UID genera
    - Malacostraca[2]
      - Isopoda
        - Asellidae
          - *Asellus* sp. √
      - Amphipoda
        - Haustoridae
          - *Pontoporeia affinis* √
        - Gammaridae
          - *Gammarus fasciatus* √
      - Decapoda
        - Astacidae
        - Cambarinae[3]
          - *Cambarus robustus*
          - *Orconectes propinquus* √
  - Insecta
    - Diptera
    - UID[1] pupae
      - Chironomidae
      - Chironomini[4]
        - *Chironomus* sp. √
        - *Cryptochironomus* sp. √
        - *Cryptocladopelma* sp.
        - *Dicrotendipes* sp. √
        - *Glyptotendipes* sp.
        - *Microtendipes* sp. √

2 Subclass
3 Subfamily
4 Tribe
√ 1973 and 1974.

TABLE IV-5 (continued)

Parachironomus sp.
Paracladopelma sp.✓
Paralauterborniella sp.
Paratendipes sp.✓
Phaenopsectra sp.✓
Pseudochironomus sp.✓
Polypedilum sp.✓
Stictochironomus sp.✓
Xenohironomus sp.✓
Tanytarsini
Cladotanytarsus sp.
Micropsectra sp.[5]✓
Paratanytarsus sp.
Rheotanytarsus sp.
Tanytarsus sp.[5]
Tanypodinae[3]
Anatopynis sp.
Procladius sp.✓
Orthocladiinae[3]
Cardiocladius sp.
Cricotopus spp.✓
Heterotrissocladius sp.✓
Orthocladius sp.
Trissocladius sp.
Diamesinae[3]
Potthastia sp.
Ceratopogonidae
UID
Empididae
UID
Stratiomyidae
UID
Ephemeroptera
Heptageniidae
Stenonema sp.✓
Trichoptera
UID pupa
Hydroptilidae
Agraylea sp.
Leptoceridae
Athripsodes sp.✓
Oecetis sp.✓

5 Genera identification tentative.
✓ 1973 and 1974

through the summer and fall; and decreased numbers and activity with the onset of cold water temperature (Ruttner, 1963; Odum, 1971; Fretwell, 1972). This general trend was observed at the NMPP transect during 1973 and 1974.

On a seasonal basis the greatest abundance of benthic invertebrates was observed during late spring/summer months when the water temperature was increasing or at the yearly maximum. Biomass values for the total benthic collections were similar among the seasons sampled with a slightly higher value observed during the late spring period (LMS, 1974). A greater abundance and biomass was found at the two eastern transects (FITZ, NMPE) compared to the plant and western control transect.

Segmented worm abundance was found to be different by sampling date and transect. A greater abundance was found in the early summer (Oligochaeta) associated with Cladophora. A greater concentration was found at the eastern transects compared to the plant and west area. At both Nine Mile Point and in the vicinity of the Oswego Steam Station the lowest abundance for oligochaetes was observed during August which could be the result of avoidance (burrowing) and formation of protective cocoons (Pennak, 1953; Brinkhurst, 1969).

Amphipods, primarily Gammarus fasciatus, were most abundant during the early summer period with abundance values steadily decreasing through the late summer and fall. Pontoporeia affinis exhibited a greater dep preference than the more shallow G. fasciatus.

Dipterans important in the food chain of many fish species, exhibited a spring abundance peak followed by a steady decline as a result of fall emergence. As noted for the other major taxa the main concentrations of dipterans was found at the FITZ and NMPE transects.

The seasonal trend in benthic invertebrates with a greater abundance found during the spring and fall periods is mainly due to the presence of actively growing Cladophora. This filamentous green alga provides food and refuge for many invertebrate populations. Christie (1974) attributes the productivity in Lake Ontario observed during recent years to the growth of Cladophora and its associated fauna. This is confirmed by the studies of Nine Mile Point which showed that the greatest abundance and biomass were found at the shallow 10 ft stations, and that abundance and biomass generally decreased with increasing depth out to a depth of 60 ft. The two western transects had similar abundance and biomass, being much lower than the two eastern transects.

E. NEKTON

Fish communities in the Oswego and Nine Mile Point area of Lake Ontario were sampled from March through December 1973 and April through December 1974 by trawling, gill netting, and seining (LMS, 1974, 1975; QLM, 1974). Fish collections have been conducted on an intermittent schedule by Storr using gill nets and trap nets throughout the pre-operational and post-operational years. Collections conducted by LMS have been made along the same transects described in the benthos section. A taxonomic inventory of the fish species collected and identified is presented in Table IV-6.

A total of forty-six species representing twenty-one families have been identified in fish samples collected at Nine Mile Point during 1973 and 1974 (QLM, 1974, LMS, 1975). Over the two years of sampling approximately 75% of the fish collected (157,165) at lake stations and 90% of the fish collected at the travelling screens of the Nine Mile Point Plant were alewives. Rainbow smelt, spottail shiner, yellow perch, and white perch comprised approximately 18% of the total fish collected, indicating the small numbers of the other species reported in the taxonomic listing of the fish community.

On a seasonal basis the greatest abundance of fish was observed during the spring months corresponding to the spawning of rainbow smelt and the shoreward spawning migration of the dominant alewives. Abundance and fish diversity were the lowest during the warm water summer months and showed an increase especially in diversity during the fall. Lower values during the summer are in part due to post spawning migrations from the study area by adults and selectivity of sampling gear in relation to collecting smaller juvenile fish.

The greatest fish concentrations were found at the two eastern transects and the lowest at NMPW with the plant transect falling in between. The greatest concentration along the east of Nine Mile Point is consistent with findings for other trophic levels discussed. The shoreline community evaluated through seines was found to be low in abundance having the alewife as the dominant species. Cyprinids, mainly the important forage species spottail shiner, centrarchids, and white perch, were the major community members.

Storr (1970, 1969a,b; 1971a) in his pre-and postoperational studies at Nine Mile Point found very little change in the fish community as determined by gill net collections. Gizzard shad abundance is reported as increasing in Lake Ontario (Scott and Crossman, 1973) and Storr observed the presence of gizzard shad in the post-operational samples and its absence from

TABLE IV-6
INVENTORY OF FISHES COLLECTED FROM THE VICINITY
OF THE NINE MILE POINT NUCLEAR POWER STATION

Family	Common Name	Scientific Name
Petromyzontidae	Sea lamprey	Petromyzon marinus
Lepisosteidae	Longnose gar	Lepisosteus osseus
Anguillidae	American eel	Anguilla rostrata
Clupeidae	Alewife	Alosa pseudoharengus
	Gizzard shad	Dorosoma cepedianum
Osmeridae	Rainbow smelt	Osmerus mordax
Sciacnidae	Freshwater drum	Aplodinotus grunniens
Amiidae	Bowfin*	Amia calva
Gasterosteidae	Threespine stickleback	Gasterosteus aculeatus
Ictaluridae	Brown bullhead	Ictalurus nebulosus
	Black bullhead**	Ictalurus melas
	Stonecat	Noturus flavus
	Channel catfish*	Ictalurus punctatus
Salmonidae	Brown trout	Salmo trutta
	Chinook salmon	Oncorhynchus tshawutscha
	Cisco or Laka herring	Coregonus artedii
	Coho salmon*	Oacorhynchus kisutch
	Rainbow trout*	Salmo gairdneri namaycu
	Lake trout*	Salvelinus
Esocidae	Northern pike	Esox lueius
	Redfin pickerel*	Esox americanus
Gadidae	Burbot	Lota lota
Catostomidae	White sucker	Catostomus commersoni
	Northern hog sucker*	Hypentelium nigricans
Cyprinidae	Carp	Cyprinus corpio
	Golden shiner	Notemigonus cysoleucas
	Longnose dace	Rhinichthys cataractae
	Common shiner	Notropis cornutus
	Spottail shiner	Notropis hudsonius
	Emerald shiner	Notropis atherinoides
	Lake chub	Couesius plumbeus
Atherinidae	Brook silverside*	Labidesthes sicculus
Percopsidae	Trout-perch	Percopsis omiscomaycus
Cyprinodontidae	Banded killifish**	Fundulus diaphanus
Cottidae	Mettled sculpin	Cottus bairdi
Percichthyidae	White perch	Morone americana
	White bass	Morone chrysops
	Yellow bass	Morone mississippiensis
Centrarchidae	Rock bass	Ambloplites rupestris
	Bluegill**	Lepomis macrochirus
	Pumpkinseed	Lepomis gibbosus
	Smallmouth bass	Mireopterus dolomieui
	Black crappie	Pomoxis nigromaculatus
Percidae	Johnny darter	Etheostoma nigrum
	Yellow perch	Perca flavescens
	Walleye	Stizostedion ritreum

* collected only during 1974

** collected only during 1973

the preoperational collections. Bodola (1966) points to the congregation of this species at discharges in Lake Erie which may account for its presence at Nine Mile Point. Data on gizzard shad by LMS (1975) indicate an increasing population in the Nine Mile Point vicinity with the greatest concentration at the NMPP and FITZ transects.

F. SUMMARY

The aquatic community in the vicinity of Nine Mile Point as determined by several years of ecological studies is characteristic of Lake Ontario. Primary producers exhibit two main pulses with diatoms dominant in the spring and greens and blue-greens exhibiting greater abundance during the late summer/early fall. Primary and secondary consumers followed cyclic rhythms related to food availability and reproductive patterns. Ichthyoplankton, dominated by alewife larvae, were present from late April through early September with peak abundance noted in late July/early August. Overall low larval fish diversity and abundance suggest that the area around Nine Mile Point is not a major spawning ground. Benthos followed seasonal abundance and growth patterns. Spring values for benthic populations were high with many species associated with the green filamentous alga *Cladophora*. A second growth period of *Cladophora* in the fall exhibited similar associated faunal populations. The greatest percentage of benthic populations were epi-benthic including amphipods, ostracods, and acari.

The fish community was dominated by alewives comprising more than 75% of the total number collected. Other species present in appreciable numbers included rainbow smelt, spottail shiners, white perch, and yellow perch. Introduced species (alewife, rainbow smelt, white perch) comprised the greatest percentage of the fish community. Gizzard shad are now present at the site, but their number remains small as compared with the other species listed above.

V. SELECTION OF REPRESENTATIVE IMPORTANT SPECIES

A. RATIONALE

Four criteria were used to aid in the selection of representative important species, namely: 1) the recreational and commercial importance of the particular species, 2) the functional or trophic level within the aquatic ecosystem, 3) whether or not the organisms are a nuisance species or are endangered, and 4) an examination of community dominants with respect to biomass or to numerical abundance. This list of species was submitted to EPA Region II on June 30, 1975. EPA tranmitted an approved species list to NMPC on August 11, 1975 (see Table I-1). The species discussed in this chapter include all species cited on either list.

The sources of information which were used include: (1) published literature regarding the biology of a given species; (2) determinations of importance to the ecosystem based on biological monitoring programs which have been conducted in the Nine Mile Point area since 1963; and (3) design features, location of the discharge, and the plume resulting from the thermal discharge which may result in impact on the distribution and abundance of the selected species.

1. Recreational Fish Species

Among the most abundant recreational fish species observed in the vicinity of Nine Mile Point, based upon lake collections conducted during the biological sampling programs, are the smallmouth bass, yellow perch, and white perch. These species composed 8.1% (12,763) of the total catch in the 1973-1974 Nine Mile Point monitoring programs; they support a local sport fishery and serve as an attraction for anglers, especially during the vacation season. Based upon their recreational value, and because some spawning has been observed in the area, these species are considered representative fish species for the study site.

In recent years the Province of Ontario and New York State have begun fish stocking programs in Lake Ontario. The New York State fish stocking program includes the stocking of salmon (coho and chinook) and trout (brown,lake, and rainbow). Historically, the salmon stocking program was initiated based upon two factors: (1) the recreational value of salmon, and (2) the abundance of alewives, a potential food source, in Lake Ontario.

Because salmon have been reported to feed on alewives, it was anticipated that introduction of salmon into the lake would limit or control the alewife population as well as provide a recreational fishery. During 1974, approximately 400,000 lake trout and 42,000 brown trout were stocked in Lake Ontario; approximately 500,000 coho salmon and nearly 1,000,000 chinook salmon were introduced into 11 streams which flow into Lake Ontario. Trout and salmon represent minimal (<0.1%) numbers in the lake in the vicinity of Nine Mile Point, based upon lake and impingement collections by LMS during 1973 and 1974.

Although the low abundance of these species would seem to preclude them from consideration as representative important species, efforts by New York State to stock these species, as well as their potential recreational value, have led to their inclusion in this demonstration.

2. Commercially Important Species

Historically, fish productivity within Lake Ontario has been lower than that of the other Great Lakes. A combination of overfishing and the introduction of competitive fish species (e.g., alewife and rainbow smelt) has contributed to the decline in commercial fish production in Lake Ontario (Christie, 1973). Among the commercially important species in the lake at present are the rainbow smelt, white perch, and yellow perch. Although the alewife is commercially exploited in Lake Michigan, this species is presently not considered a commercially important species in Lake Ontario.

The alewife and rainbow smelt are the most abundant species in the vicinity of Nine Mile Point, constituting more than 75% of the lake collections and over 90% of fish impingement during 1973 and 1974. In both instances, the alewife dominated the fish community. Fish collections in the vicinity of Nine Mile Point indicate that white perch constituted 4.7% of the lake population at this location. In addition, analysis of white perch population dynamics (e.g., coefficient of maturity) indicates that this species spawned within the Nine Mile Point vicinity during 1973 and 1974. White perch will be considered representative due to their abundance and spawning near Nine Mile Point. Because of their abundance, the alewife and rainbow smelt also have been chosen for this demonstration.

3. Species Important to the Forage Base

The recreational and sport fish species of Lake Ontario prey upon several smaller fish species including alewife, johnny darter, emerald shiner, threespine stickleback, and spottail shiner (Scott and Crossman, 1973). The alewife has been selected previously due to its numerical abundance, its potential commercial value, and as a forage base for the stocked salmon population. The threespine stickleback has shown fluctuations in abundance from year to year and site to site which may be related to their schooling and spawning habits. Male sticklebacks establish and defend territories during the breeding season. They require a bottom with vegetation in order to build a nest, and since the area of such bottom is relatively small in the vicinity of Nine Mile Point, only a portion of the male population becomes established or fixed to a territory. The remaining males and non-reproducing females move about in groups and schools. The threespine stickleback are thus evaluated as a representative species due to their abundance in the collections and their resident spawning activities.

The dominance of the spottail shiner over other forage species in lake collections, their distribution over wider areas and greater depths, their continual presence on virtually all collection dates in the lake and plant, and their presence in stomachs of larger fish suggest that this species is an important representative of the community.

Gammarus fasciatus is an amphipod (invertebrate) chosen by the EPA as a representative species because of its importance as a forage base for the young and adults of many species of fish.

Cladophora a filamentous green algae which forms dense beds in the littoral zone of Lake Ontario, was also selected as a representative species. *Cladophora* has been cited by Christie (1974) as being primarily responsible for increasing the productivity of the limestone dominated shoreline. The algal growth provides food and shelter for invertebrate populations which in turn attract fish populations. A second factor for the selction of *Cladophora* as an important species is the strong environmental influence of temperature on the normal growth pattern of the alga (Bellis and McLarty, 1967; Herbst, 1969).

4. Threatened and Endangered Species

Lists of threatened and endangered species are published by the U.S. Department of the Interior. A review of these publications, current issues of the Federal Register, and technical literature indicates that the following species from the Great Lakes or Lake Ontario in particular are considered threatened, endangered, or rare:

1. Lake sturgeon (*Acipenser fulvescens*)
2. Blue pike (*Stizostedion vitreum glaucum*)
3. Kiyi (*Coregonus kiyi*)
4. Blackfin cisco (*Coregonus nigripinnis*/*prognathus*)
5. Shortnose cisco (*Coregonus reighardi*)

None of these fish have been collected in the vicinity of Nine Mile Point in the course of the extensive biological monitoring programs of the last three years.

The guidance manual suggests that descriptions of species protected by the Endangered Species Act (16 USC 1531 *et. seq.*) be described. Only the blue pike is so protected, but all rare species are listed here for the information of the reader.

Lake Sturgeon (Acipenser fulvescens)

Once the lake sturgeon was quite abundant in Lake Ontario; in fact, in 1855 a commercial processing plant was established at Sandusky, Ohio. Since then the lake sturgeon, especially in Lake Erie, has been almost eliminated. A detailed description of the decline of the Great Lakes sturgeon fishery can be found in Harkness and Dymond (1961). No lake sturgeons were collected in 1973 or 1974 in either the general ecological surveys or impingement collections.

Blue Walleye (Stizostedion vitreum glaucum) (also known as Blue Pike)

This species consisted of two subspecies, the yellow walleye, Stizostedion v. vitreum, and the blue walleye, S v. glaucum. The blue walleye was placed on the Rare and Endangered list (McAllister, 1970) as rare or perhaps extinct. Scott and Crossman (1973) conclude that it has totally dissappeared from Lakes Erie and Ontario. This is the only species which is legally protected by the Endangered Species Act, 16 USC 1531 et. seq. No blue walleye were collected in 1973 and 1974 by sampling programs near the site.

Blackfin Cisco (Coregonus nigripinnis prognathus)

The blackfin cisco once ranged throughout all the Great Lakes except Lake Erie, but now has disappeared from Lakes Ontario and Michigan. There were none collected in 1973 or 1974 by LMS.

Kiyi (Coregonus kiyi)

The kiyi was indigenous to the Great Lakes basin and was limited in distribution to the deeper waters of Lakes Ontario, Huron, Michigan, and Superior. It has virtually disappeared from Lake Ontario and probably persists only in Lake Superior. None were collected by LMS in 1973 or 1974.

Shortnose Cisco (Coregonus reighardi)

The shortnose cisco was once a valuable commercial species in Lake Ontario until at least the 1940s. It is now very rare and only two individuals have been reported in the literature in recent years (Wells, 1969). None were collected by LMS in 1973 or 1974.

In summary, the following species will be considered as representative important species at the Nine Mile Point site:

1.	Alewife	Alosa pseudoharengus
2.	Brown trout	Salmo trutta
3.	Coho salmon	Oncorhynchus kisutch
4.	Rainbow smelt	Osmerus mordax
5.	Smallmouth bass	Micropterus dolomieui

6. Spottail shiner — Notropis hudsonus
7. Threespine stickleback — Gasterosteus aculeatus
8. White perch — Morone americana
9. Yellow perch — Perca flavescens
10. Gammarus — Gammarus fasciatus
11. Cladophora — Cladophora glomerata

B. LIFE HISTORIES OF REPRESENTATIVE SPECIES

1. Alewife (Alosa pseudohorengus)

The alewife is an anadromous species that spends most of its adult life in marine waters and returns to fresh water to spawn. It occurs from Newfoundland to North Carolina (Scott and Crossman, 1973), and, in addition, 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 near-shore shallow water areas with sand and gravel bottoms. During the spring spawning season, the greater numbers of alewives move inshore 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. Spawning occurs at 16-28°C (60.8-82.4°F). The freshwater female may lay from 10,000 to 22,400 eggs (Odell, 1934; Norden, 1967). Mansueti (1956) noted that the eggs are broadcast at random and are demersal, essentially nonadhesive. The hatching period ranges from 48 to 96 hours at 22°C (71.6°F) and increases to six days at 15.5°C (59.9°F) (Rounsefell and Stringer, 1943). More detailed temperature data appear in Appendix A.

Following spawning, the adults move offshore into deeper waters during August and overwinter there until March (Graham, 1956). Christie (1973) noted offshore migrations of alewives to depths of 35 m (120 ft) during the late summer. Summer lethal threshold temperatures range from 3°C (5.4°F) above acclimation to a temperature of 32°C (89.6°F).

Like adults, juvenile alewives migrate inshore during the spring and undertake diel movements while inshore. They may be found in shallow water at night and on the bottom in 2-3 m (6-10 ft) of water during the day (Scott and Crossman, 1973). Odell (1934) noted that in Seneca Lake, New York alewife fry migrate to mid-depth lake waters during the fall and winter. Graham (1956) also indicated that young-of-the-year alewives remain near the spawning grounds until the late larval stage; they then migrate to shallow protected areas prior to movement into deep water. The young may attain a length of 51-75 mm by the fall (Scott and Crossman, 1973).

In a study of alewife growth in Lake Ontario, Graham (1956) noted that alewives experience an early period of rapid growth, the rate of which decreases with the onset of sexual maturity at age 2 for males and age 3 for females. Pritchard (1929) reported that females grow faster than males and attain a greater size throughout their life. The adult alewife are filter-feeders and prey principally on zooplanktonic organisms such as cladocerans, copepods, ostracods, and mysids; in fresh water they therefore compete with the indigenous forage fish species for food. Alewives are also an important food source for large piscivorous fish such as the lake trout, burbot, and salmon. Since its introduction into Lake Ontario during the 1800's, the alewife has increased substantially in abundance.

2. Brown Trout (*Salmo trutta*)

The brown trout is native to Europe and western Asia. It was introduced into North American waters during the 1800's and may be found throughout the Great Lakes region and the northeast coast of the United States (Scott and Crossman, 1973). This species is annually stocked in the New York portion of Lake Ontario by the New York State Department of Environmental Conservation.

Brown trout usually spawn during late autumn/early winter; in one study, Mansell (1966) 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 (1960) observed that many spawned on rocky reefs along the shore of Lake Superior. The number of eggs deposited by a spawning female trout is proportional to her size: the larger females deposit more eggs.

Age and growth studies of Lake Ontario brown trout indicated that individuals of this species may live for 13 years (Marshall and MacCrimmon, 1970); brown trout reached a length of 427 mm at age 4 (Mansell, 1966). Brynildson et al. (1963) noted that the optimum temperature range is 18.3°-23.9°C (64.9-75.0°F). Additional thermal data for brown trout is presented in Appendix A. Brown trout feed upon a broad spectrum of aquatic organisms including insects, crayfish, salamanders, molluscs, and other fishes. Smaller trout may be consumed by large brown trout which may, in turn, be preyed upon by mergansers (diving ducks).

3. Coho Salmon (*Oncorhynchus kisutch*)

The coho salmon is an anadromous species which occurs naturally in the Pacific Ocean and in rivers and streams which drain northwestern North America. Attempts to establish the coho salmon in the Great Lakes were unsuccessful until the 1960's when there were reports of limited natural reproduction occurring in Michigan (Scott and Crossman, 1973). In New York State, the New York State Department of Environmental Conservation annually stocks coho salmon in tributary streams of Lake Ontario.

The spawning runs of the coho in the Great Lakes take place from September to early October, although actual spawning occurs from October to November or from November to January, depending upon the spawning run (Scott and Crossman, 1973). Swift-running tributaries with gravel bottoms are usually selected as the spawning site.

The number of eggs deposited by the female varies with size of the female, location, and year. The adults die shortly after they spawn. 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 as they remain in 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 fry remain in freshwater streams or tributaries for a one-year period. 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 (Scott and Crossman, 1973).

The coho have lethal thermal thresholds of at least 2°C (3.6°F) above acclimation temperature, up to 25°C (77.0°F). Appendix A provides further thermal data. In fresh water, the young cohos feed upon insects,oligochaetes, and the young of other salmon. Large coho salmon prey primarily upon rainbow smelt and alewives; they, in turn, are prey for large birds and mammals including man, as well as the sea lamprey.

4. Rainbow Smelt (*Osmerus mordax*)

The original range of the rainbow smelt in eastern North America was restricted to the Atlantic coastal drainage basin from New Jersey to Labrador; whether or not the smelt is native to Lake Ontario is uncertain. Hubbs and Lagler (1958) believe that it is, whereas Scott and Crossman (1973) are of the opposite opinion. In either case, the first report of rainbow smelt taken from Lake Ontario was in 1931 by Mason (1933). They now occur in all of the Great Lakes and in many other Canadian and United States lakes. The smelt is an anadromous species, leaving the sea or large lakes in spring to spawn in freshwater streams. In Lake Ontario, spawning often occurs along the lake edge in shallow water on gravel shoals; Rupp (1965) believes that shore spawning may be as successful as stream spawning. Spawning runs of ripe smelt begin in March and continue through May (McKenzie, 1964). In Lake Ontario, spawning runs do not occur until water temperatures rise at least to 8.9°C (48°F) and the runs do not continue at temperatures warmer than 18.3°C (65°F).

Spawning occurs at night and the spawners move downstream to the lake during the day (Bailey, 1964; McKenzie, 1964). Smelt eggs are demersal, adhesive, and attach to bottom gravel. The number of eggs deposited is dependent upon the size of the female, ranging in number from approximately 8,000-30,000 (Scott and Crossman, 1973).

The smelt are a schooling, pelagic species and inhabit streams only during the spawning period. They are sensitive to temperature and light and remain in deep, bottom waters during the day. The lethal thermal threshold for smelt is reported by Altman and Dittmer (1966) to be 21.5-28.5°C (70.7-83.3°F).

Smelt are carnivorous and prey upon a variety of organisms including insects, oligochaetes, crustaceans, and other fish. Smelt are, in turn, preyed upon by lake trout, walleye, perch, salmon and a variety of birds.

5. Smallmouth Bass (*Micropterus dolomieui*)

Smallmouth bass are distributed in North America from southern Canada to Alabama, and west to Oklahoma (Hubbs and Lagler, 1958). 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) (Scott and Crossman, 1973). The male builds a nest on a gravel or rocky bottom usually near the protection of rocks or dense vegetation. The number of eggs deposited varies with the size of the female, ranging from 5,000-14,000. Smallmouth bass eggs are demersal, adhesive, and attach to stones in the nest. Hatching takes place over a period of 4-10 days in Canadian waters (Scott and Crossman, 1973).

Initially, growth is rapid, whereas growth of older fish is variable; reported landings include a female 13 years old, 584 mm in fork length. Males attain sexual maturity in their third to fifth year; females mature in their fourth to sixth year of life.

Diel and seasonal movements occur partly in response to ambient temperature fluctuations. Adults are found in shallow water on the spawning grounds during the spring; with the onset of summer temperatures, they move to greater depths. Studies have indicated that tagged fish undertake limited migrations of 0.8-8.0 km (0.5-5 miles) from the place of capture; some males have been observed to return to the vicinity of the nest in subsequent years during the spawning season. During the winter, smallmouth bass congregate near the bottom and are relatively inactive.

Thermal data are presented in Appendix A and indicate lethal thresholds of 35°C-38°C (95.0-100.4°F) and preferred summer temperatures of 21°-27°C (69.8-80.6°F).

The diet of smallmouth bass varies with age. Bass prey upon plankton and immature insects during early life, whereas adult bass include crayfish and a variety of fish in their dietary spectrum. Predators that feed upon bass eggs and fry include yellow perch, catfish, gar pike, sunfish, and turtles. (Scott and Crossman, 1973).

6. Spottail Shiner (*Notropis hudsonius*)

The spottail shiner is distributed in North America from sections of Canada, including the Great Lakes, south to the state of Georgia and in the midwestern United States (Scott and Crossman, 1973).

This species spawns during the spring and early summer throughout its Canadian range over sandy,shoal areas at temperatures near 20°C (68.0°F) (Peer, 1961; Carlander, 1969). The number of eggs spawned varies from 100-2600 for yearlings through two year-olds (McCann, 1959). Evidence is scanty regarding the use of the mouths and lower reaches of tributary streams for spawning. During the spring, these shiners may be found inshore; they migrate toward the shore during the daytime and move into deep waters as the lake or river waters warm. Lethal thresholds after acclimation to 7°-11°C (44.6-51.8°F) temperatures are 30°-31°C (86.0-87.8°F) (Trembley, 1961); additional temperature data are found in Appendix A.

Smith and Kramer (1964) noted that females grow faster than males. A maximum size of 132 mm in total length was indicated for a specimen collected from Lake Erie (Scott and Crossman, 1973).

The spottail shiner feeds upon a variety of organisms throughout its life cycle. In general, young fish prey upon small organisms including insects and cladocerans; older individuals consume their own eggs and young. As a fish of considerable forage value, the shiner is eaten by almost all predaceous species and therefore is extremely important in the trophic structure of the ecosystem.

7. 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.

The threespine stickleback spawns during the summer (June - July) in fresh water, building its nest in shallow, sandy areas (Scott and Crossman, 1973). The male entices the female to the nest by a distinctive courtship display; eggs are then laid in clusters and are adhesive to each other. Breder and Rosen (1966) stated that hatching occurs in 7 days at 19°C (66.2°F). The males tend the eggs and the young for several days after hatching.

Growth is rapid during the first year, but slows during the second year of life, with a maximum size of 102 mm attained in fresh water. Sexual maturity is attained during the first year and the individuals probably do not live longer than 3-1/2 years.

Lethal threshold temperature is listed in Appendix A as varying from 26°-33°C (78.8-91.4°F) after acclimation to 19°-20°C (66.2-68.0°F) temperature.

A voracious feeder, the threespine stickleback consumes various annelids, crustaceans, insects, and eggs and larvae of fish. They, in turn, are preyed upon by fish-eating birds as well as by larger fish including trout and salmon, and, therefore, serve as an important forage species.

8. White Perch (*Morone americana*)

White perch occur along the Atlantic coast of North America from New Brunswick, Prince Edward Island, and Nova Scotia to South Carolina. This species has been introduced into Lake Ontario and is common in the Hudson River below Albany, New York (Scott and Crossman, 1973).

In Lake Ontario, the white perch spawns during the spring from mid-May through June (Sheri and Power, 1968). Water temperatures during the spawning period range from 11°-15°C(51.8-59.0°F). Spawning usually takes place over a period of 1-2 weeks with successive releases of eggs during this time (Mansueti, 1961). Spawning is accomplished over a variety of substrates. The eggs are adhesive and attach to rocks, vegetation, and debris. The number of eggs spawned is dependent upon the size of the female and may range from 20,000-300,000 (Scott and Crossman, 1973). Hatching is controlled by ambient water temperature and ranges from approximately 4 days at 15°C (59.0°F) to 30 hours at 20°C (68.0°F). Thoits (1958) indicated that the young attained a length of 40-65 mm by July and August.

White perch growth rates vary with region and population. Land-locked populations, such as Lake Ontario white perch, exhibit a slower growth rate. Sex differences are also indicated with respect to growth: females appear to be, on the average, slightly larger than males.

Diel migrations have been noted for white perch, which appear to move to offshore waters during the day and inshore during the night. Sheri and Power (1968) also observed migration to the surface at night and a descent to deeper waters during the daylight hours.

The diet of freshwater populations is composed of insects, (especially chironomids) crustaceans, annelids, molluscs, and fish. Fish, including such species as yellow perch johnny darter and white perch, represent a significant portion of the diet of large white perch.

9. Yellow Perch (*Perca flavescens*)

There is some question as to whether there are one, two, or three separate species of yellow-perch-like fish in the Northern Hemisphere. In any case, the yellow perch and its sister species or sub-species have a circumpolar distribution in fresh water. In North America, the yellow perch occurs from Nova Scotia south along the Atlantic coast, previously to South Carolina, but now apparently to Florida and Alabama.

The yellow perch is a commercially valuable species throughout its range, and consequently there is considerable literature on various aspects of its life history. These fish are considered very adaptable because of the wide range of habitats in which they are found, including warm to cooler areas from large lakes to ponds, or quiet rivers. They are most abundant in the open water of large lakes with moderate vegetation (Scott and Crossman, 1973). Yellow perch are usually considered shallow water fishes and are usually not collected in water depths below 9.2 m (30 ft).

Both the young and adults form loose aggregations of 50 to 200 individuals segregated by size. The groups of young are found in shallower water and nearer shore than adults. Individuals adult members of schools are close together in summer and more separate in winter (Scott and Crossman, 1973).

Scott (1955), Hergenrader and Hasler (1968), and Muncy (1962) found that yellow perch undertake a spring migratory movement. Storr (1973) reported that, in the southeastern portion of Lake Ontario, migratory movements to the spawning ground occurred in the winter. In addition, movements inshore and out, vertical diel movements, and seasonal movements into and out of deeper water have been reported. These latter movements are probably responses to temperature and distribution of food. In the Bay of Quinte, Lake Ontario yellow perch make yearly spring movements in large numbers to the spawning grounds (Griffiths, 1974).

Everest (1973) found at the Hearn Generating Station on Lake Ontario that yellow perch were concentrated in the plume area as compared to a control area, especially during October. Yellow perch were found only from June to November. During October they were collected at temperatures of from 13°-22°C (55.4-71.6°F) at a time when ambient temperatures were around 9°-11°C (48.2-51.8°F). The final temperature preference for the species has been experimentally determined at 21°-24°C (69.8-75.2°F) (Ferguson, 1958). Data from the vicinity of Nine Mile Point do not support the results obtained by Everest (1973). Statistical tests show no significant differences in yellow perch abundance near the surface (where the buoyant plume exists) or at the plant transect as compared to controls in 1974 (LMS, 1975).

Sheri and Power (1968) estimated the fecundity of yellow perch in the Bay of Quinte, Lake Ontario to range from 3,035-61,465 eggs for fish 131-257 mm long. Muncy (1962) reported that the fecundity of yellow perch in the Severn River varied from 5,900 eggs for a fish 173 mm in length to 109,000 eggs for one 358 mm long. Mean egg production for 20 fish ranging in size from 173-295 mm was 17,940 eggs while 5 larger females 302-358 mm had a mean egg production of 32,200 eggs.

10. Gammarus fasciatus

The amphipod Gammarus fasciatus is widely distributed in the fresh waters of North America. Its range extends from the Caribbean seacoast north to the St. Lawrence River System, and from the Atlantic coastal area as far west as the Mississippi River (Clemens, 1950).

Clemens (1950), in describing the reproductive cycle of G. fasciatus, noted that the sexes are separate and that reproduction is entirely sexual. Males are longer at the attainment of sexual maturity than females, for which the size at maturing varies with the temperature; at 6°C (42.8°F) females mature at 8.8mm, while at 26°C (78.8°F) they mature at 5.4mm. Egg production is positively correlated with body length and season. Clemens (1950) observed that the average monthly egg production per female decreased from April to September; the average number of eggs per female for the entire season was seventeen. Mature females lay eggs subsequent to each adult molt, and copulation occurs just subsequent to moulting, during ovulation, and for a short time afterward. The proximity of the two sexes at the time for fertilzation is ensured by the act of pairing, whereby the male carries the female until copulation is completed. During incubation the fertized eggs are carried in a brood pouch or marsupium under the female. The incubation period depends on temperature; at constant temperatures of 24, 22, 20, 18, and 15°C (75.2°, 71.6°, 68.0°, 64.4°, and 59°F) incubation lasted 7, 8, 9, 14, and 22 days, respectively. The maximum number of incubation periods or broods produced per female per year was estimated to be seventeen in Lake Erie. However, the actual number of broods produced per female is probably between five and eleven.

Immature gammarids reached maturity after seven molts (Clemens, 1950), with the interval between molts decreasing with increased temperature. In the laboratory at 21°C (69.8°F), Gammarus young required 42 to 53 days to reach maturity, whereas at temperatures varying from 14 to 22°C (57.2° to 71.6°F) young achieved maturity in 66 to 85 days.

An omniverous feeder, *Gammarus fasciatus* devours living and dead plant and animal matter, and may prey on such zooplankton as *Daphnia*, *Leptodora*, and copepods (Clemens, 1950). It also eats benthic organisms such as insect larvae, oligochaetes, and small isopods (Burbanck, 1972); in addition, male gammarids in particular are cannabalistic. *G. fasciatus* plays an important role in the trophic structure of many aquatic environments since it is in turn consumed extensively by a wide variety of fish and invertebrate predators (Scott and Crossman, 1973; LMS, 1974, 1975).

Temperature tolerance data on *G. fasciatus* is presented in Appendix A. Pentland (1930) observed that it is capable of enduring high temperatures. Lauer et al. (1975) observed that *Gammarus* sp. acclimated at 25°C (77°F) suffered no mortality when exposed for 1 hour to a temperature of 35.6°C (96°F); 92% of the organisms exposed to a temperature of 37°C (99°F) for 1 hour died within 24 hours.

11. *Cladophora glomerata*

Cladophora is a green alga with long, slim cells that form branching filaments. Some species grow attached to hard bottom objects; others float and may form tangled mats. Underwater currents may roll *Cladophora* into balls 3 or 4 inches in diameter; when its core decays, the ball rises to the surface.

The relatively high level of productivity in Lake Ontario is exemplified by the extensive growth and development of *Cladophora* in the near-shore zone on hard surfaces or other areas of "firm" bottom (Christie, 1974). In 1974, about 66% of the near-shore zone was covered by *Cladophora* between Niagara and Rochester, as was some 79% of the near-shore area between Rochester and Stony Point (Wezernak, Lyzenga and Polcyn, 1974). Expressed as dry weight, the standing crop of *Cladophora* in the western portion of Lake Ontario was 1.57 x 10^4 kg/km of shoreline within a 350 meter wide strip, compared to an extrapolated standing crop of 3.3 x 10^4 kg/km of shoreline in the eastern portion of the lake.

In southern Lake Ontario, *Cladophora* generally undergoes two short periods of intense vegetative growth during June and September, separated by a midsummer dying-off period; this growth pattern appears to be related to temperature (Bellis and McLarty, 1967). Maximum growth of Cladophora occurs at temperatures between 20 and 25°C (68 and 77°F) (McNaught, 1964: Lake Mendota, Wisconsin), and a lower temperature limit of about 12°C (53.6°F) was found by Storr and Sweeney (1971) in laboratory studies. More detailed temperature data for Cladophora are presented in Appendix A.

A number of physical factors other than water temperature play a role in the growth and development of Cladophora. Growth is abundant in areas of high phosphates; a concentration of 0.03 mg/l for this parameter is a critical minimum concentration (Herbst, 1969). The nitrogen demand of Cladophora (0.3 mg/l for inorganic nitrogen is the critical minimum concentration) is generally satisfied under natural conditions. Alkaline water (pH 7.5 - 8.5) is required for optimum growth.

Growth of Cladophora is also limited by currents, water depth, and light intensity. Normal water movement brings a fresh supply of nutrients to the alga and allow diffusable waste products to be removed. Strong wave action, however, is detrimental (fragmenting the filaments) and limits growth of Cladophora to an upper depth of 1-2 meters, while the lower depth limit is determined by the transparency of the water and light penetration. In areas where the lake waters are usually clear, Cladophora has been reported at depths of about 8 meters, but its growth is considerably reduced at depths greater than 4 meters.

Dense beds of Cladophora serve as a substrate or food source for a variety of plants and animals. Species of periphytic algae such as the diatom Cocconeis pediculus may cover entire filaments of mature Cladophora (Bellis and McLarty, 1967). In addition, the population of benthic macrofauna as well as the abundance of eggs of some fish species may be higher in areas covered by Cladophora than in exposed areas.

VI. IMPACT OF THERMAL DISCHARGE AT NINE MILE POINT

A. DISCUSSSION OF POTENTIAL THERMAL DISCHARGE IMPACTS

It will be shown in subsequent sections that the thermal discharge from Nine Mile 1 has not resulted in adverse aquatic effects in the Nine Mile Point area. The discussion analyzes the potential for direct effects due to the temperature rise or fall of the thermal discharge, or to indirect effects related more to the method of discharge than to the thermal component and is concerned with these effects as they may be related to the selected representative important species in the Nine Mile Point area.

1. Potential Direct Effects

a. Thermal Thresholds of Representative Species

The direct effects of heat on aquatic organisms are dependent on the ambient temperature of the water, the magnitude of the temperature differential, the type of discharge structure, the duration of exposure of an organism, the amount of area and/or volume affected, and the kinds and physiological state of the organisms.

The life history information for the representative important species indicates species-specific responses to ambient and plume temperature.

All changes either within a fish or between the fish and its environment ultimately are initiated through a physiological response. These changes can lead to alterations of the behavior or ecological structure. More fundamentally, physiological changes within fish can be viewed as acute or latent. Acute effects generally can be equated to immediate responses while latent effects include a host of other changes including alterations in osmosis, metabolism, excretion, respiration, brain function, reproduction, growth, and so on.

A "zone of tolerance" characterizes species after acclimation as to their high or low lethal temperatures. The available information on the thermal tolerances of the representative important species is presented in Appendix A. Within this temperature range, the fish can survive, but some alterations in the physiological characteristics of the fish occur with changes in temperature.

Temperature effects can be modified by the past thermal history of the fish. Temperature acclimation is a physiological adjustment by the organism to a given thermal level. The ability to acclimate is limited within a range of temperatures. The maximum upper or lower acclimation points have been called the "ultimate incipient lethal level" by Fry (1947). When a change in temperature occurs, and the change is large enough to be of physiological significance, and when insufficient time is available for acclimation, a condition referred to as "thermal shock" can occur. Thermal shock is characterized by disorientation and cessation of directed activities and can result from high or low temperatures. The critical thermal maximum (CTM) is the thermal point at which the locomotory activity becomes disorganized and the fish loses its ability to escape from conditions that may cause death.

The selection of a particular thermal regime when a temperature gradient is available has been termed thermal preference. Fry (1947) further defined that temperature "around which all individuals will ultimately congregate, regardless of their thermal experience before being placed in the gradient" as the final preferendum. Ferguson (1958) presents a review of many early investigations which dealt primarily with temperature preference from field data.

Thermal preferences exhibited by aquatic organisms results on a seasonal basis in avoidance or attraction to thermally enriched zones. Summer preferences below the temperature in the thermal plume would result in an avoidance reaction while during period, of cold water temperatures a preference for warmer water would attract the organisms to the plume.

Recent work has shown that the effects of temperature are influenced by a multitude of other factors, e.g., the length, weight, sex, and age of the fish as well as the photoperiod, light intensity, diet, water chemistry and salinity (Halsband, 1953; Hoar and Robertson, 1959; Mildrim and Gift, 1971; Cherry et al., 1975).

The thermal data for each species (see Appendix A) and the 316(a) Technical Guidance Manual have been reviewed and critical conditions for quantitative evaluation have been identified; particular attention is focused on the occurrence of lethal warm temperatures and temperature elevations. It should be noted that the acclimation temperatures reported were determined from regulated studies and do not take into consideration the myriad number of environmental parameters which influence fish.

During the warmest water temperature period (June-September), the ambient temperature of 23.3°C (71°F) is exceeded 10% of the time at Nine Mile Point (LMS, 1975); the mean summer ambient temperature is 19.4°C (67°F). The maximum discharge temperature rise of the plant at full capacity is 17.3°C (31.2°F); however, this is diluted rapidly by discharge at 1.2 m/sec (4 fps) exit velocity. The maximum surface temperature rise above ambient is about 6.9°C (12.4°F) at capacity operation. The seasonal loads described in Chapter II further reduce the temperature in the plume. The August plant load for example is 86% based on the five years of plant operation to date. load factor

The summer lethal thermal thresholds corresponding to the most critical temperature period for representative important species are listed in Table VI-1. Some of the associated acclimation temperatures are not specified (see Appendix A for the complete available data list); thus, the thresholds may in some cases be conservatively low due to acclimation temperatures below the normal summer Lake Ontario ambient temperature. Only three species have lethal threshold temperatures which may occur in the thermal plume downstream of the initial jet portion of the discharge. These species are the, brown trout, coho salmon, and rainbow smelt. The remaining species have all exhibited upper tolerance limits in excess of the expected plume temperatures during the warmer summer months. alewife ?

The range of lethal threshold temperatures for the alewife is 23.0°C-32.2°C (73.4°F-90.0°F) with acclimation temperatures of 20°C (68°F) to 20.3°C (68.5°F) respectively. Graham (1956) reported a 23°C (73.4°F) lethal threshold (at a 20°C (68°F) acclimation temperature) for alewives immediately after rising from the cold depth where they overwintered. Preferenda, however, indicate that the alewife will migrate from (avoidance) the lethal temperature toward 21.3°C (70.3°F). Overwintering fish are continually under an osmoregulatory stress and their ability to withstand a thermal stress at this time of the year is at a minimum when compared to other times of the year.

The three species whose reputed summer maximum temperature tolerance would be equaled or exceeded by the thermal plume are normally associated with cold water habitats. Scott and Crossman (1973) cite thermal preferenda for the coho salmon as 12°-14°C (53.6°-57.2°F); 7.2°-15.6°C (44.7°-60.0°F) for rainbow smelt, and 18.3°-23.9°C (64.6°-75.1°F) for the brown trout. The preference for colder water would normally limit the number of each species in the warmer near shore zone during the summer months.

Brown trout have a lethal threshold of 23.5°-25°C (74.3°-77.0°F). The 25°C (77.0°F) threshold is associatd with 14°-18°C (57.2°-

TABLE VI-1

SUMMARY OF UPPER LETHAL THRESHOLD TEMPERATURES

Species	Summer Lethal Threshold*
Alewife	23°-32.2°C (73.4°-90°F)
Brown trout	23.5°-25°C (74.3°-77.0°F)
Coho salmon	24°-25°C (75.2°-77.0°F)
Rainbow smelt	21.5°-28.5°C (70.7°-83.3°F)
Smallmouth bass	35°C (95°F)
Spottail shiner	>30.8°C (>87.4°F)
Threespine stickleback	25.8°-33°C (78.4°-91.4°F)
White perch	34.7°C (94.5°F)
Yellow perch	29°-32°C (84.2°-89.6°F)
Gammarus fasciatus	34°-37°C (93.2°C-98.6°F)
Cladophora glomerata	>25°C (77°F)

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

64.4°F) acclimation temperatures. Summer ambient near the site exceeds 20°C (68°F); but depending on acclimation temperature, the lethal threshold for brown trout way not be exceeded. The lethal threshold for coho salmon is 24°-25°C (75.2°-77°F) which is rarely exceeded by ambient temperatures at the site. The natual frequency of occurrence of this lethal threshold near the water surface is about 6% of the time or about 7 days during the summer. In addition preference for colder water temperatures (Appendix A) by these species during the summer when the lethal limits and/or preferenda are exceeded in the plume would place the organisms in areas not affected by the increased temperatures.

Summer lethal threshold reported for rainbow smelt range from 21.5°-28.5°C (70.7°-83.3°F). The lower range is not applicable since summer ambient temperatures sometimes exceed 25°C (77°F) during the period when smelt are present in the area, yet no die-offs have been observed by sampling crews working in the area. At maximum ambient temperatures, 26.7°C (80°F), the upper end of the lethal range, 28.5°C (83.3°F), corresponds to a 1.8°C (3.3°F) temperature rise.

The summer lethal temperatures are nearer to the highest acclimation temperatures (presented in Appendix A) for all species except white perch, which has a summer upper lethal threshold of 34.7°C (94.5°F).

Thermal tolerance limits differ for different life stages of the same species. Literature evaluation of thermal tolerances for juvenile and adult fish done by deSylva (1969) showed that juveniles were usually eurythermal while adults were stenothermal.[1] Brown (1974) reporting on the tolerance limits of several fish species notes the general higher and lower tolerance limits for the larval and juvenile fish as compared to the adults. This suggests that thermal tolerance date based on adult organisms would be more than adequate to protect the younger members of the population.

b. <u>Plant Shut-down Effects</u>

The potential for cold shock, a phenomenon which results in fish stress and is caused by a rapid decrease in water temperature,

[1] eurythermal-tolerance to a broad range of temperatures, stenothermal-tolerance restricted to a narrow range (Ruttner, 1953).

illustrates the importance of lower thermal tolerance limits. Cold shock may occur when the addition of heated water is terminated during the colder part of the year due to plant shutdown. The severity of cold shock stems from the physiological inability of fish to adjust to descending temperatures as well as they can acclimate to ascending temperatures (Speakman and Krenkel, 1972). Brett (1944) and Jones (1964) documented the greater sensitivity of fish to decreasing water temperatures compared to corresponding increases in water temperature using fish with similar thermal histories.

Temperature preference studies conducted by Reutter and Herdendorf (1974) on several species of fish collected in Lake Erie, including the alewife, smallmouth bass, spottail shiner, coho salmon, and yellow perch, from the representative important species list for Nine Mile Point, showed that all fish species preferred temperatures above ambient during fall, winter, and spring months, while summer preferences were near or slightly above ambient temperature. A review by Sylvester (1972) of thermal tolerance studies showed that at low acclimation temperatures fish usually preferred water areas having temperatures higher than ambient. Cherry et al. (1975) found that all of 13 species of cyprinid, centrarchid, ictalurid, and salmonid fishes tested, including several on the Nine Mile Point list, preferred warmer temperatures at ambient temperatures below 18°C (64.4°F). Nine of the species preferred warmer temperatures when the ambient temperature was as high as 27°C (80°F), suggesting that attraction of some species to thermal plumes would occur throughout the year.

A second observation made by Reutter and Herdendorf (1974) was that even though fish could detect temperatures in excess of the critical thermal level for a particular acclimation temperature, all fish tested would swim into the area and die under fall, winter, and spring acclimation temperatures. However, they also noted that the critical thermal level for the fish species tested under laboratory conditions would not be exceeded during any time of the year by power plants located along the shores of Lake Erie, assuming acclimation to ambient lake temperatures.

Lake Ontario summer temperatures are similar to those reported by Reutter and Herdendorf (1974) for Lake Erie, hence this conclusion applies to the Nine Mile Point site as well.

The temperature data sheets presented for each selected species in Appendix A include limited information on lower lethal threshold values. The most sensitive species for which data exist is the alewife which has a reported lethal threshold of 0.2°C (32.4°F) at 5°C

(41°F) acclimation temperature. During the period in mid-winter when the lake ambient temperature is near 0.2°C (32.4°F), alewife might be expected to suffer some mortality if the plant shuts down abruptly and if the alewife have not responded to the preferred temperatures by moving off-shore into 4°C (39°F) mid-lake waters.

Centrarchids including the smallmouth bass are normally associated with warm water habitats (Mihursky and Kennedy, 1967). Keast (1968) found that smallmouth bass activity was initiated in the spring by a temperature of 8.5°C (46.1°F). Gammon (1971, cited in Brown, 1974) observed smallmouth bass avoiding a thermal discharge during the summer but assuming positions within the plume in the winter. The winter preferred temperature of greater than 8°C (46.4F) (Munther, 1968), which is near the expected maximum surface temperature rise at peak output of the plant and the lower tolerance level of 2°C (35.6°F) reported for smallmouth bass acclimated at 15°C (59°F) could cause thermal shock to plume associated organisms.

Tables II-1 through II-6 presented the available information on scheduled and non-scheduled plant shutdown since Nine Mile Point Unit 1 commenced operation in December 1969. The extensive field sampling program conducted in the vicinity of Nine Mile Point has resulted in personnel being present during several plant shutdowns, many during the colder water periods. To date no observations of cold shock mortality have been made as a result of shutdowns by Nine Mile Point Unit 1.

2. Potential Indirect Effects

a. The Effects of Currents, Pressure Changes, and Dissolved Oxygen

It is recognized that operation of the Nine Mile Point plant and subsequent discharge through the submerged discharge system could result in the following:

1. production of currents which may act as a near-field attractant to fish,

2. water movements which could draw the passive fish eggs and larvae into the dispelled waters (plume entrainment) exposing them to temperatures higher than ambient,

3. movement of plume-entrained organisms toward the surface with a resultant decrease in the pressure, and

4. potential reduction in dissolved oxygen by biological oxygen demand or heating.

It will be shown in subsequent sections that none of these potential indirect effects have adversely affected the biological community in the vicinity of Nine Mile Point.

Current Production

That fish orient themselves with water currents has been known at least since Gudger (1949) described a group of trout (Salmo gairdneri) arrayed in extremely regular ranks near the bottom of a swiftwater stream. Breder (1959) generalizes, for schools of fish in flowing water, that "it must be remembered that it is possible to arrange the distribution and form of the schools into almost any outline desired by suitable adjustment of the amount of flow and its direction." Thus, the currents created by the discharge diffuser may assume patterns which, in the near field, affect the orientation of fish. Kelso (1974), working with several species of fish in the vicinity of two Canadian power plants, concludes that the fish were attracted by the currents produced by the discharge rather than by its heat. He found that the fish made what appeared to be feeding forays into the heated areas, remained there for some 20 minutes, and then left the area. This behavior occurred both when the plants were rejecting heat and when the circulating pumps were operating but no heat was being discharged.

The early life stages of fish can also be affected by entrainment into the plume, where they are subjected to heat (see section VI A1).

Pressure Changes

As the heated water rises, the planktonic organisms within the water column will also rise and be exposed to a change in pressure. For the Nine Mile 1 discharge this change is about 0.4 atmospheres pressure in about 20 seconds.

Tsvetkov et al. (1972), after studying the effects of hydrostatic pressure changes on fish, concluded:

1. acclimation of fish to a pressure is critical in determining mortalities resulting from rapid changes in pressure,

2. for fish survival, the rate of pressure change is more important than the magnitude of the pressure applied,

3. injury and mortality, especially in physoclists (fish without connection between air bladder and gut), occurs when the pressure release rate is greater than the normal decompression rate for fish,

4. rapid pressure changes can affect physostomous fish (fish with functional connection between gut and swim bladder), and

5. sensitivity to rates and magnitudes of pressure changes is greater for the young of fish with developed swim bladders than for older fish.

Most investigations of the effects of pressure on fishes have dealt with the lethal thresholds of increasing pressure while little has been published on the effects of a reduction of pressure toward atmospheric pressure.

Tsvetkov et al. (1972) exposed both physostomous and physoclist fishes to modeled changes in the magnitude and rates of change of hydrostatic pressure during passage through turbines. Pressures from 1-6 atmospheres were applied by air pressure to the surface of the water in order to acclimate the fish, which were allowed to adapt to neutral buoyancy. The rates of releasing pressure to atmospheric pressure ranged from 0.1-6 atm/sec. To observe possible delayed mortalities, all surviving fish were maintained up to four days.

Swim bladder injury and gas disease were the causes of pressure-induced mortalities. Death occurred within 10 seconds to 15 minutes after rapid release from the acclimation pressure, when rupturing of the swim bladder wall occurred. In the physostomous fishes, no swim bladder damage was observed when the rate of pressure release was retarded, but rupturing of other internal organs did occur as the swim bladder expanded, compressing the other organs. Fingerlings of the roach *Rutilus rutilus* (L.) [a physostome] displayed 100% mortality at a pressure release rate of 3 atm/sec, 40-72% mortality at 0.1-0.5 atm/sec, and 10% mortality when the rate was below 0.1 atm/sec.

Alewife were subjected to pressure changes from 0 to 36 psi over a fifteen minute test period and then returned to 0 pressure by Stone and Webster Engineers (1975). Observations were made during the test and the test organisms were maintained for one week to evaluate latent effects. The results of the preliminary study generally indicated little effect of the pressure changes on the test organisms.

Generally, the physostomes, including the alewife and rainbow smelt, will not be adversely affected by the reduction of 0.03 atm/sec expected to occur within the rising discharge waters. In addition, it is unlikely that this rate of pressure reduction would adversely affect the physoclists, e.g., the white perch, yellow perch, and spottail shiner.

Dissolved Oxygen

The effect of the thermal component of the discharge on levels of dissolved oxygen has been considered, and has not been attributed to any adverse effects upon the Nine Mile Point aquatic community.

Oxygen concentrations measured in the Nine Mile Point vicinity of Lake Ontario are consistently greater than minimum values necessary for growth and development of even the most sensitive species (5.0 mg/l Salmonids).

Oxygen concentrations recorded by QLM in 1973 ranged from 9.2 to 10.2 mg/l (QLM, 1974a). With a subsequent increase in temperature of 4°C (7.2°F) the expected level would be 8.5 to 9.4 mg/l (Fair, Geyer and Okun, 1968). These values are well within the acceptable range for survival, growth, and reproduction of the fish populations present in the area of the thermal discharge (LMS, 1975).

Additional studies have been conducted at Nine Mile Point Unit 1 to quantify the dissolved oxygen reduction on passage through the power plant. Analyses of the 1973 data documented that the reduction averaged 0.3 mg/l even though the inlet water was supersaturated.

3. Cladophora Growth

The impact of thermal discharge from Nine Mile Point will not have a measurable effect on the growth of Cladophora. The rapid dilution and surface location of the plume should neither stimulate nor deter the normal subsurface growth pattern. Furthermore during the warm water period when the thermal limit of Cladophora would be exceeded in the thermal plume normal growth would have already ceased. Early or late stimulation of growth in the vicinity of the thermal zone is not anticipated because of the decided photoperiod influence on the initiation and termination of growth in the spring and fall, respectfully (Storr & Sweeney, 1971).

The filamentous green alga Cladophora is characterized as a summer dominant having intensive vegetative growth observed during two short periods in May-June and August-September (Bellis and McLarty, 1967). Storr and Sweeney (1971) working with Cladophora collected in the vicinity of Nine Mile Point and incubated in the laboratory concluded that optimum growth occurred at approximately 18.0°C (65°F) while lower and upper tolerance limits were about 11°C (53°F) and 25°C (77°F), respectively. These findings were similar to the temperature-growth pattern cited by Herbst (1969) for Cladophora in all of the Great Lakes. Growth of Cladophora has also been shown to be strongly influenced by photoperiod (Bellis and McLarty, 1967; Storr and Sweeney, 1971).

Christie (1974) cites the recent increase in Cladophora in Lake Ontario as the prime reason for increases in productivity. The filamentous algae offers food and refuge for several macroinvertebrate populations which are preferred food for fish. This observation of greater organism abundance associated with Cladophora is supported by benthic sampling conducted in the vicinity of Nine Mile Point during the time of algal growth and development (LMS, 1974, 1975).

B. AESTHETIC CHANGES IN RECEIVING WATER BODY

In general two aesthetic problems unrelated to operatin of Nine Mile 1 occur throughout the littoral zone of Lake Ontario including the area of Nine Mile Point. These are the fragmentation of the alga Cladophora and the annual die-off of the alewife. The annual die-off of alewives occurs throughout the lower Great Lakes.

Cladophora growth increases the productivity of the littoral zone of Lake Ontario through protection and food availability to several invertebrate and vertebrate populations. However, during periods of high wind and wave action the filaments of the algae break off, float to the surface, and collect along the shore. The loose decaying mats offer an excellent breeding ground for several undesirable organisms, such as biting midges, or gnats.

Similar to the decaying Cladophora, the rotting bodies of the alewife along the shores of the Lake cause undesirable odors and serve as a food source for organisms such as rodents. It should be noted that both the Cladophora and alewife problem existed prior to the completion of Nine Mile 1 and no change in the problem has been noted since the plant has started operation.

No change in taste, color, or odor of lake water attributable to the operation of Nine Mile Point Unit 1 has been observed during any of the aquatic biological or water quality programs.

C. CHANGES IN COMMUNITY STRUCTURE

1. Simplification of trophic structure

Changes in community structure can be identified by changes in population dynamics and species diversity. Specific changes in the species diversity and population dynamics in the Nine Mile Point area will be discussed in Sections VI-D and VI-E respectively. Changes in community structure which are symptomatic of an adverse trend in population intgeractions are discussed in the following paragraphs. Subsequent sections will show that significant adverse trends do not exist in the Nine Mile Point vicinity.

Changes in environmental factors (abiotic, and biotic) which result in shifts of the representation by members of the aquatic community also cause changes in the community structure. One of the primary abiotic factors that may influence the structure of the aquatic community is temperature. The high heat capacity of water minimizes temperature changes; thus the changes occur slower and with a smaller range of variation in water than in air for example. Populations evolve so that they can respond to the normal fluctuations in temperature during a seasonal cycle; alterations to the cycle could result in simplification of the trophic structure through population elimination.

The result of trophic structure simplification usually results in lower productivity due to inefficient use of available energy.

2. Nuisance Species

Nuisance organisms may be either plant or animal and are defined as species that cause or have been known to cause trouble in aquatic ecosystems (Mackenthun, 1969). Any species which may be a hazard to ecological balance or human health and welfare that is not naturally a feature of the indigenous community must be defined as a nuisance species, according to the guidance manual.

a. Phytoplankton

Industrial development and population growth especially around the Lower Great Lakes has resulted in the addition of large amounts of nutrients and these combined with the proper environmental conditions (e.g., light, temperature) could cause increased nuisance species abundance especially at the primary producer level (e.g., phytoplankton). Certain algal species when present in large quantities (blooms) can be classified as nuisances because they cause bad taste and odors and have the potential to cause fish kills through reduction of dissolved oxygen (Palmer, 1962).

Bloom conditions for some algal species have been observed in the Nine Mile area (LMS; 1974, 1975); however, at no time have any of the blooms persisted for an extended period of time or over a major portion of the study area, nor have they been observed to affect the taste or odor of the water. Blue-green algae dominate the period corresponding to the warmer water conditions at times reaching bloom proportions, but none of the more abundant species caused any nuisance problems such as dissolved oxygen reduction. Sampling conducted during 1973 and 1974 has indicated a general decrease in the abundance of blue-green algae in 1974 as a result of lower lake water temperature. The primary thermal influence in the Nine Mile Point vicinity is the ambient lake temperature The thermal discharge from Nine Mile 1 has not been observed to influence algal levels.

b. Nekton

The fish fauna of Lake Ontario and the other Great Lakes have undergone changes in composition due to the decline of piscivorous species such as the lake trout, and the increase of recently introduced species including alewife, rainbow smelt, white perch, and gizzard shad (Miller, 1957; Christie, 1974). Mayr (1966) discusses the potential impact of an invading species on one already established in an area. In general, through competition for food or space the invading (introduced) species may increase at the expense of the resident population, and in time they may completely eliminate the resident species. Christie (1974) suggests that the populations of alewife, rainbow smelt, and white perch did not directly cause the decline of the large piscivores, e.g. the lake trout or Atlantic salmon, but increased as a result of lack of predatory pressure as the piscivores were overfished or damaged by the sea lamprey. Further, the alewife may have caused a decline in the abundance of some planktivores with which it competes, e.g., slimy sculpin and the shiners.

The landlocked alewife population is usually considered a nuisance species because of its annual die-off. The resultant masses of decomposing carcasses litter the shoreline and reduces its recreational values for swimming and has the potential to clog municipal and industrial water intakes. Significant expenditures of time and money by State and local agencies and private citizens are involved in removing the alewives from the beaches. The annual die-offs normally occur during the spring-early summer months and have been attributed to the inability of the cold water acclimated population to tolerate the warmer shore zone waters on their spawning migration (Graham, 1957).

The alewife represents a biological threat to indigenous lake fish populations because adult alewives feed principally on zooplankton such as copepods, cladocerans, mysids, and ostracods (Rhodes and McComish, 1975). They are in direct competition for these food items with resident forage species in Lake Ontario, including emerald shiner and slimy sculpin (Smith, 1973). At present the impact of the alewife in Lake Ontario is not completely understood, but its vast numbers and competition for food with other species has probably had some affect on the fish community structure. The alewife has been reported to be an important food item in the diet of piscivorous fishes such as the lake trout and freshwater burbot. Coho salmon, recently introduced into Lake Michigan and Lake Ontario, eat large numbers of alewives (Scott and Crossman, 1973), and may eventually reduce the size of the alewife population. Other fish species including rainbow trout, cisco, smallmouth bass, and perch are also known to feed on alewives.

Rainbow smelt was first reported in Lake Ontario in 1931 (Mason, 1933) and the species now occurs in all areas of the lake to a depth of 46m (Christie, 1974). The abundance of smelt in Lake Ontario strongly suggests its impact on resident species. The diet of smelt, with the young feeding on invertebrates and the adults on invertebrates and other fish, places them in competition with other species at the younger stage of development and makes them serious predatory threat to less abundant species as adults (Christie, 1974). Smelt in the Great Lakes today are the subject of an extensive commercial fishery.

The white perch, a relative newcomer to Lake Ontario, is now resident throughout the Great Lakes. It gained access to Lake Ontario presumably via the Oswego River, from Hudson River populations moving northward and westward through the Mohawk River and Erie Barge Canal (Scott and Christie, 1963). White perch thrive in a variety of habitats, but the growth rate varies widely and is dependent on the region and on the environmental situation of the population under study. Scott and Crossman (1973) state that "old landlocked populations in small oligotrophic lakes in the Atlantic coastal region will possibly have a slower rate of growth than newly expanding populations, such as those in Lake Ontario."

The species appears well suited for a predaceous life (Scott and Crossman, 1973). As young, they eat microzooplankton; as the fish grow, aquatic insect larvae become important in their diet. Adults reportedly consume a high percentage of fish eggs and fishes including yellow perch, smelt, johnny darters, and other white perch (Cooper, 1941; Leach, 1962). The food preference of the white perch at each stage of development is similar to the yellow perch, both populations also have similar habitat preferences (Scott and Crossman, 1973). The similar food and habitat preferences brings white perch into competition with the resident yellow perch. The white perch is generally regarded as an excellent pan fish, but in areas overpopulated by the species they seldom attain a size large enough to attract anglers. They are fished commercially in the Chesapeake Bay region and in the Bay of Quinte region of Lake Ontario, where their successful competition with game fishes for available food could be a serious problem. Mansueti (1961) in a comprehensive study of the white perch in the Patuxent River estuary in Maryland indicated that the population tends to be unstable due to the multiple spawnings over several years by adults, the tendency to overpopulate in closed systems, and the competition for food with resident species.

The gizzard shad is another (probable) introduced species in Lake Ontario (Miller, 1956), which appears to be increasing in abundance. Young gizzard shad are reported to be forage fish for several piscivorous species; however, their rapid growth makes them too large for most predatory fish by age two (Bodola, 1966). Miller (1960) points to the rapid growth of gizzard shad, especially in shallow warm water areas, having high productivity as a problem to resident populations; because of intensive competition, and loss of energy to higher trophic levels. Feeding preference studies on the gizzard shad indicate that young individuals feed on zooplankton, and adults after development of the gizzard and gill rakers consume phytoplankton (Cramer and Marzolf, 1970). The feeding preference of the gizzard shad brings them into competition with certain resident forage species such as the emerald shiner.

Like the alewife the gizzard shad undergoes massive mortalities in the Great Lakes which create problems along the shores. Miller (1956) noted that the peak gizzard shad abundance in Lake Erie was in the fall and that the species was particularily attracted to industrial thermal discharges. Gammon (1971) observed gizzard shad in a thermal plume with a temperature up to 34°C (93.2°F). Sampling conducted at Nine Mile Point during 1974 suggest that gizzard shad are located in the warmer water areas during the colder months. No die-offs of gizzard shad have been observed to date during plant shut-downs.

D. LIFE CYCLE ACTIVITY OF SELECTED SPECIES IN THE STUDY AREA

1. Introduction

One category of evidence for consideration in a demonstration of no prior appreciable harm is completion of life cycles in the area influenced by the thermal discharge. On August 11, 1975, the EPA transmitted a list of representative important species to be given consideration in the Nine Mile Point demonstration. The life cycles of these species are described in Chapter V; site specific data for these species are presented in this section. Where available, information on time of spawning, fecundity, egg and larvae abundance and distribution and abundance from 1969 to 1974 is cited.

Information on reproduction illustrates whether or not the representative important species are completing their life cycles in the plume area in a manner similar to the manner in other natural areas. Feeding studies indicate trophic relationships of the species and potential problem areas through competition. Studies of growth evaluate temporal development of the species relating morphological characteristics to environmental conditions. Distribution among years (1969-1974), presence in 1974 of various age classes, and distribution among transects in the vicinity of Nine Mile Point help to determine potential impact of the operation of Nine Mile Point Unit 1 on the aquatic community.

The time of spawning was determined by examining the coefficient of maturity data for males and females collected in the vicinity of Nine Mile Point during 1974 (see LMS, 1975 for further detail). The abundance and distribution of eggs and larvae of fish is derived from sampling conducted at the surface, mid-depth, and bottom at three radii, 1/2, 1, and 3 miles east and west of the discharge during 1973 and 1974. Recruitment data were obtained from plotting length versus frequency of capture by month for fish collected with trawls and gill nets. Feeding data were gathered by examining the stomach contents of individuals captured during four hour intervals with gill nets throughout 1974. Growth data were calculated from the analysis of scales annuli and lengths of the fishes (see LMS, 1975 for further detail). The abundance of organisms from 1969 to 1974 were obtained through the analysis of data collected by Storr (1969 a,b,c, 1970 a,b,c,d, 1971 a,b,c,d, 1972 a,b,c,d), QLM (1974), and LMS (1975).

Storr collected fish with gill nets along two transects. One transect was located consistently lakeward from Nine Mile 1 (Storr's E_1 transect) which corresponds to the LMS (1975) transect labelled NMPP (Figure VI-1). Storr's other sampling transect was changed periodically but was either E_3 or E_4. Transect E_3 was located approximately

SAMPLING TRANSECTS
NINE MILE POINT 1969-1974

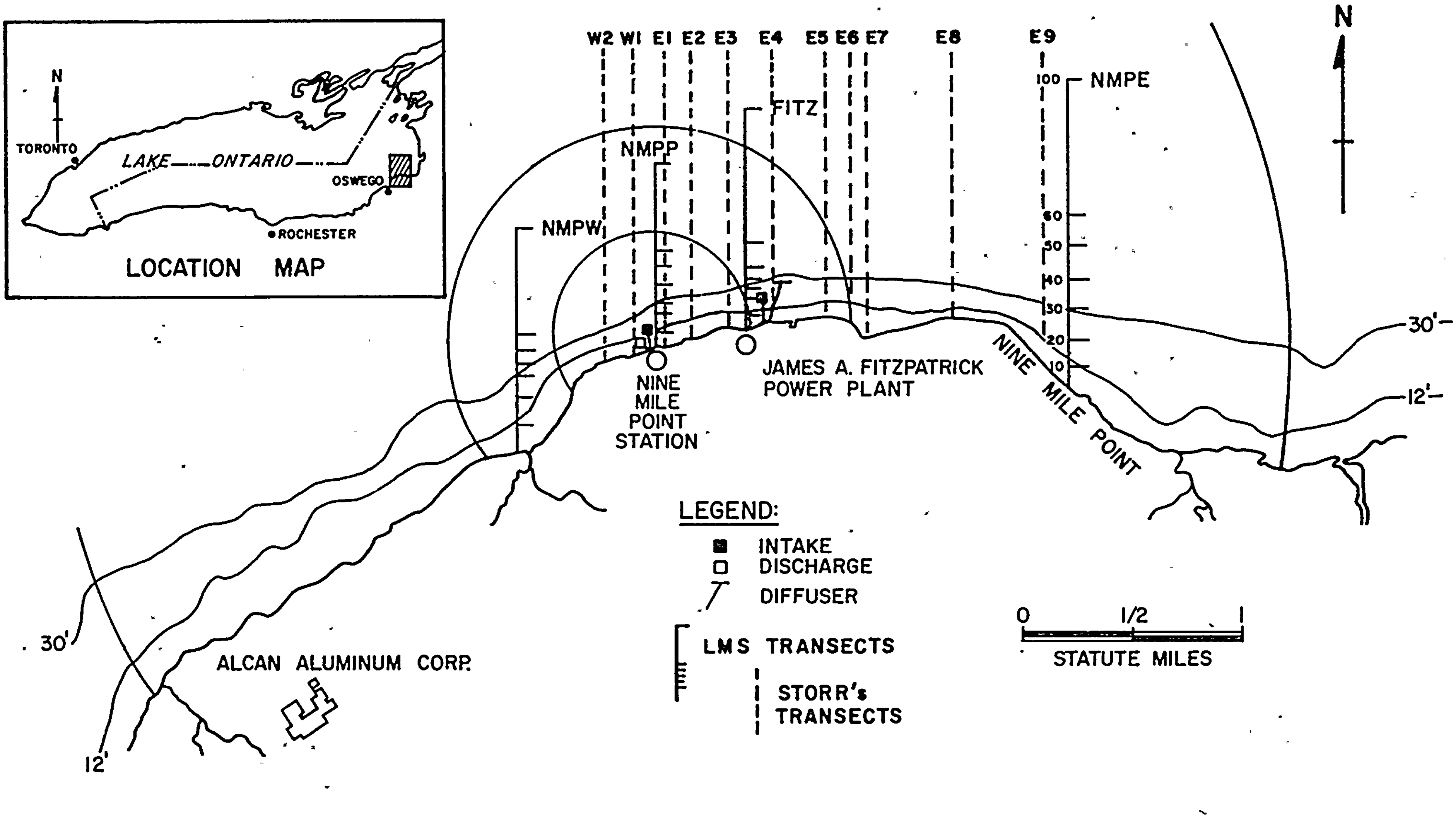


FIGURE VI-1

1000 ft west of E_4 which is lakeward from the FitzPatrick plant. Transect E_4 is equivalent to LMS's FITZ transect. Analyses presented in Chapter III revealed that the 2°C isotherm extended 1875 ft west and east of the discharge 30% of the time. Transect E_3 is located east of this area and transect E_4 (FITZ) east of E_3 (Figure VI-1). Therefore, catch/effort data from E_1 and NMPP were considered to represent sampling from the same area and within the discharge zone, whereas the data from either E_3 or E_4 and FITZ were considered to represent sampling from the area outside of the discharge zone. Only data from gill nets located in the same water depth were used.

During 1974 sampling was conducted along four transects (NMPW, NMPP, FITZ, and NMPE). For spatial comparisons among these transects, catch per 12 hours for gill nets, were calculated separately for each depth contour (i.e., 15, 30, 40, and 60 ft), for the surface and bottom, for day and night, and for each transect.

The catch per 24 hr data calculated from Storr's and LMS's work were compared with a two way analysis of variance (ANOVA). The analysis of variance is a procedure used to test statistical hypotheses concerning linear combinations of the means of several populations. The total variation in a set of data is partitioned into components associated with possible sources of variability. Then the relative importance of the different sources is assessed by F-tests between each component of variation and the "error" variation (Elliott, 1971). ANOVA's were conducted on five species (i.e., alewife, rainbow smelt, white perch, yellow perch, and smallmouth bass) which were collected frequently enough to warrant statistical analysis. The test compared the numbers per 24 hrs among years and between the transects (NMPP and FITZ). The fishery statistics and life history data are reported for each species in order to demonstrate the successful completion of the organism's life cycle.

In addition, benthic samples collected from comparable depths among the years 1969-1974 were evaluated for the abundance of the amphipod, Gammarus facsiatus and biomass for Cladophora glomerata. Data from all transects sampled on a seasonal cycle was pooled as to those transects affected by the thermal plume and those not located in the area of influence.

2. Alewife

a. Reproduction

The times and related water temperatures observed during the annual spring spawning of landlocked freshwater alewife populations have been noted by several investigators. The average surface temperature was 20.6°C (69.1°F) while the average bottom temperature was 16.8°C (62.2°F) for freshwater alewife populations in Maine, 13°-21°C (55.4-69.8°F) (Rounsefell and Springer, 1945), Wisconsin, 13°-16°C (55.4-60.8°F) (Threinen, 1958), and New Jersey, 17°-19°C (62.6-66.2°F) (Gross, 1959).

Spawning time of alewives was determined by examining the coefficient of maturity data for 825 males and 873 females collected in the vicinity of Nine Mile Point from April through November, 1974 (Table VI-2). Peak spawning occured during the first two weeks of July, a time when the surface water temperature ranged from 13.5° to 22.0°C (56.3°-71.6°F).

Examination of alewife ovaries collected near the spawning peak revealed eggs at two distinct stages of development, distributed homogeneously throughout the ovary. Smaller, white eggs ranged in size from 0.2 to 0.4mm with an average diameter of 0.3mm, larger, yolk-laden eggs which were those most likely to be spawned during the short spawning season varied from 0.5 to 0.8mm with an average diameter of 0.56mm.

Total egg counts for fish in the 1974 study ranged from 8,981 to 50,274 eggs with a mean of 31,613 eggs. In 1973 (QLM, 1974), the total egg counts for 11 alewives from the Nine Mile Point vicinity of Lake Ontario ranged from 25,797 to 67,739 eggs, with a mean of 46,821 eggs. 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 (Norden, 1967). Since only mature eggs are spawned during a season, total egg count may overestimate the actual fecundity of freshwater alewives.

Bigelow and Schroeder (1953) and Kissil (1969) report that spawning groups of anadromous alewives usually contain more males than females. A possible explanation for the difference in abundance between the sexes is, as suggested by Pritchard (1929), that females live longer than males and therefore over time a predominance of females should be expected.

For the nine-month sampling period in the Nine Mile Point vicinity (1974), more female alewives were collected by gill nets and trawls than males (LMS, 1975); the males constituted 22.69% and females, 77.31%. The dominance of females in the lake collections was also observed in 1973 (QLM, 1974) with 9.8% males and 90.2% females. If the Nine Mile Point vicinity were a major spawning ground, it would have been expected that more males would be caught than females. One possible conclusion based on the preponderance of females in the samples is that the Nine Mile Point vicinity is not a spawning area for alewives.

Graham (1956) noted that peak spawning activity for alewives in the Bay of Quinte, on the north shore of eastern Lake Ontario was near the end of July. Larvae were observed to remain in the shallow shore zone at least until late larval stages had been reached during the early fall period. Wells (1968) studies alewife distribution in Lake Michigan and found the greatest

TABLE VI-2

COEFFICIENT OF MATURITY VALUES, SAMPLE SIZE AND COLLECTION DATES FOR ALEWIVES

NINE MILE POINT - 1974

	MALES		FEMALES	
Collection Date	Sample Size	Coefficient of Maturity	Sample Size	Coefficient of Maturity
11-19 Apr	104	1.18	104	2.66
23-24 Apr	101	1.35	104	3.08
6-8 May	44	1.68	73	3.36
19-23 May	95	2.39	111	3.78
3-9 Jun	106	4.50	106	6.43
17-21 Jun	50	5.92	50	8.73
9-11 Jul	50	5.48	50	12.12
23-27 Jul	50	2.45	50	5.54
7-9 Aug	25	0.62	25	1.92
20-22 Aug	25	0.66	25	1.49
9-12 Sep	25	0.69	25	1.66
23-25 Sep	25	0.60	25	2.33
8-11 Oct	25	0.65	25	1.65
24-28 Oct	25	0.94	25	1.68
7-9 Nov	25	0.88	25	1.93
19-20 Nov	25	0.86	25	1.98
6-7 Dec	25	1.08	25	2.22
Total	825		Total 873	

$$\text{Coefficient of maturity} = \frac{\text{gonad weight}}{\text{fish body weight} - \text{gonad weight}} \times 100$$

concentration located near the surface gradually assuming a mid-depth to bottom preference with increased age.

Alewife eggs were first observed in samples collected at Nine Mile Point on 19-20 June, and peak egg abundance was found during the second and third week of July, 1974 (Figure VI-2). This corresponds very closely to the observed time of spawning reported by Graham (1956). As expected, egg concentrations were higher in bottom samples since the alewife has demersal eggs which are broadcast at random (Mansueti and Hardy, 1967). The greatest concentration of alewife eggs was at the 20 ft depth contour stations in the immediate vicinity of Nine Mile Point Unit 1, and the lowest numbers were observed at the 3 mile east transect and at the deeper depth contour stations north of the point.

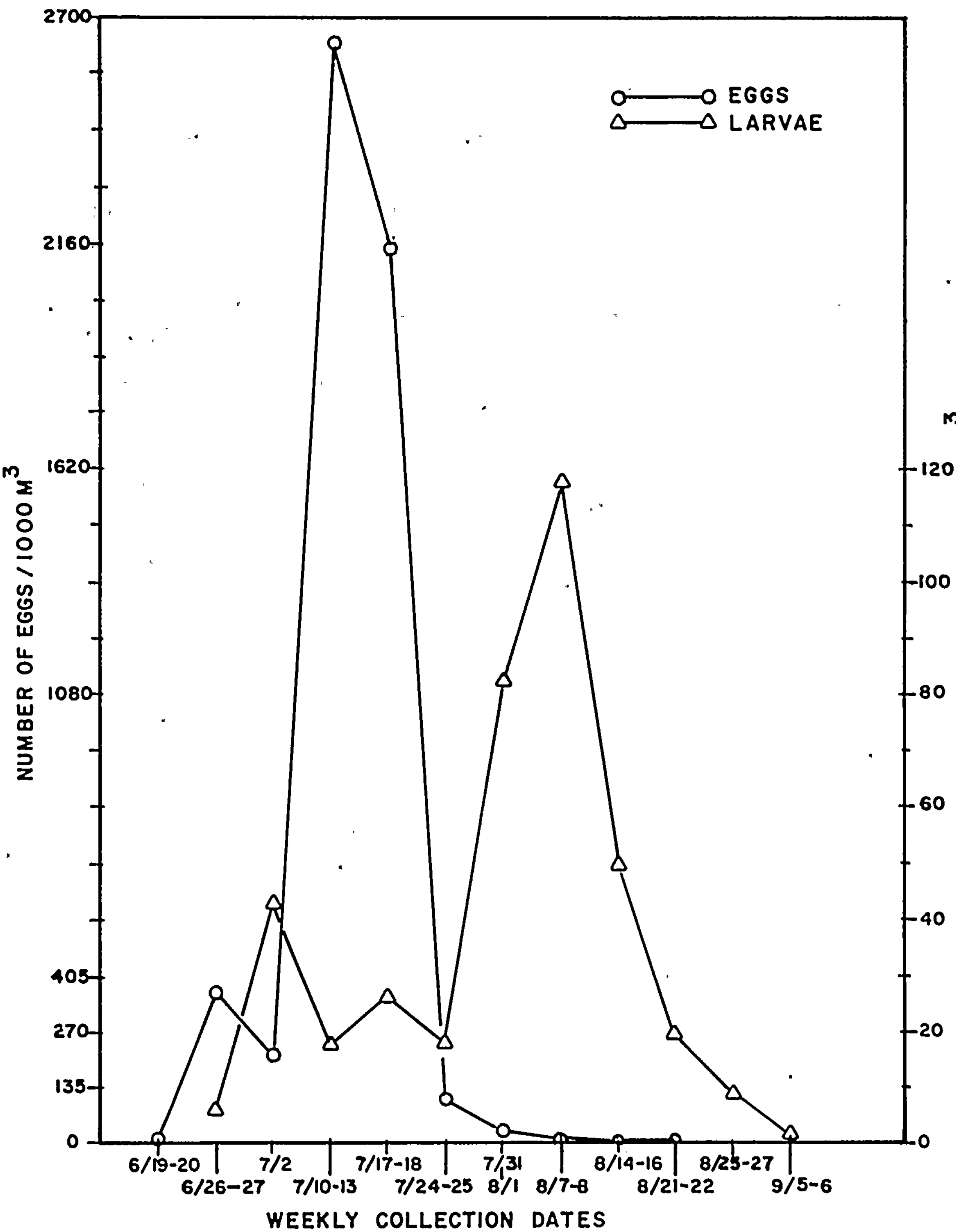
Alewife larvae were present in ichthyoplankton samples from the end of June through the middle of September, 1974. Peak abundance in the area around Nine Mile Point occured during the last week in July and the first week of August. Length frequency information (LMS, 1975) suggests that the larvae averaged 10.8mm during the period of peak abundance reaching the level of juvenile before emigrating from the Nine Mile Point area in September. Collections made at Nine Mile Point had significantly greater numbers of larvae in surface samples compared to bottom samples confirming the preference of the larvae for surfaces waters. Presence of larvae in samples from the end of June onward points to the prolonged spawning period by alewives in Lake Ontario and the small early July larval peak may be the result of a separate spawning in the area around Nine Mile Point.

A fairly uniform distributional pattern for alewife larvae was observed in the area of Nine Mile Point with the exceptions being the stations 0.5 miles to the west of the plant and the 100 ft deep water station. At these stations, significantly fewer larvae were collected compared to the other stations.

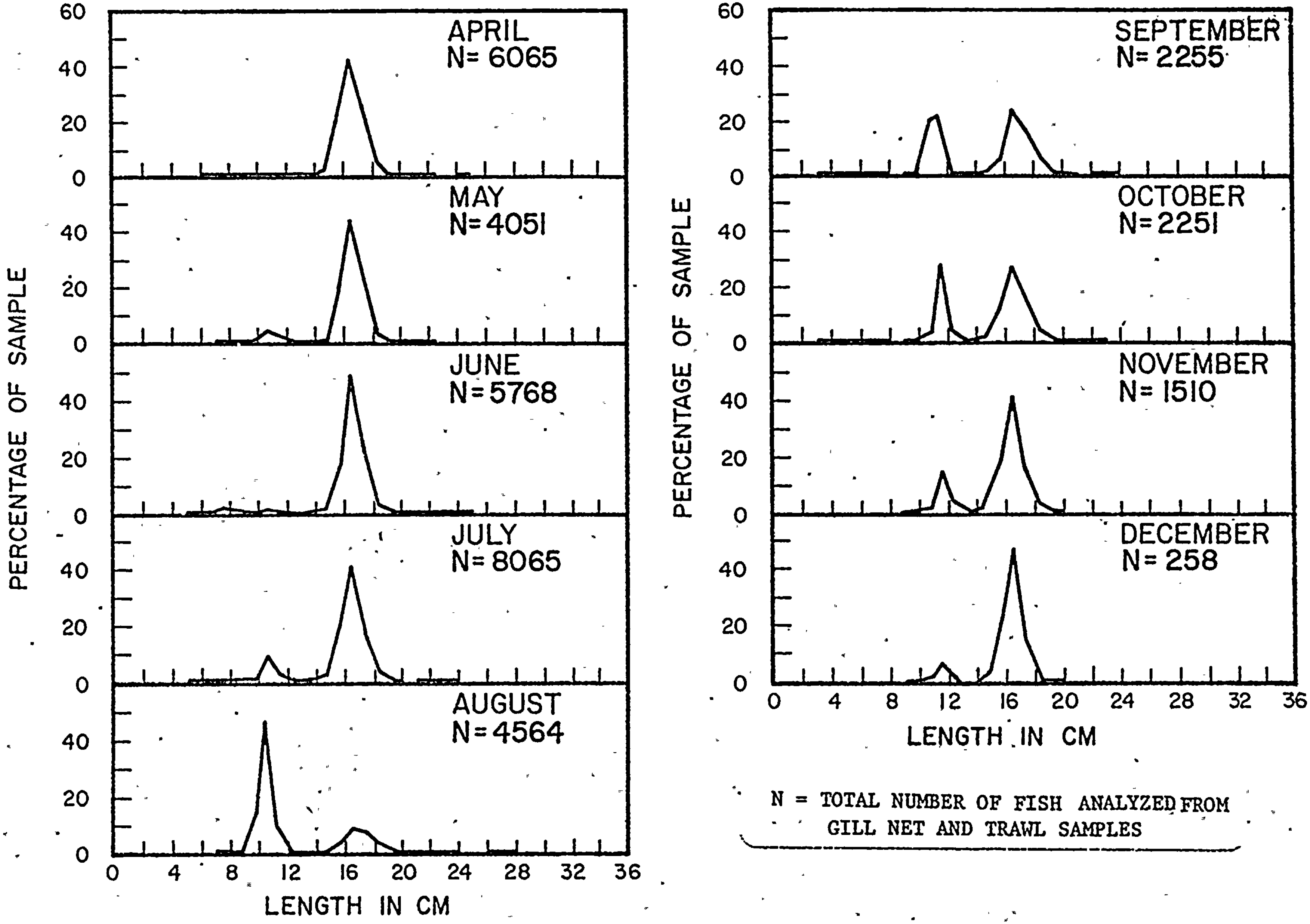
The analysis of the length frequency distribution of fish populations gives insight into individual growth rates throughout the year, the presence of fish of different sizes (ages) within the area, i.e., recruitment, and a graphic comparison of the relative abundance of young fish to older fish. Figure VI-3 shows the length frequency distribution on a monthly basis for alewives. In April, the population within the vicinity of Nine Mile Point consisted mainly of adults between 15 and 19 cm in length. By May, a few yearling fish (age group I) began to appear, indicating the start of their inshore migration to feeding grounds. This trend continued until August when the inshore population was dominated by yearling fish between 9 and 12 cm long.

MEAN NUMBER OF EGGS AND LARVAE OF ALEWIFE BY SAMPLING DATE

NINE MILE POINT — 1974



LENGTH FREQUENCY DISTRIBUTION FOR LAKE ALEWIFE
NINE MILE POINT
1974



N = TOTAL NUMBER OF FISH ANALYZED FROM GILL NET AND TRAWL SAMPLES

FIGURE VI-3

b. Feeding

Information on the feeding habits of alewives in the vicinity of Nine Mile Point is not currently available. Norden (1968) found a definite food preference by larval alewives in Lake Michigan for cladocerans and copepods with incidental occurrences of diatoms and plant material. Adult alewives from Lake Michigan fed primarily on copepods and cladocerans similar to the larvae (Rhodes and McComish, 1975); however, during the summer dipteran larvae were a preferred item and the deepwater amphipod, *Pontoporeia affinis*, was heavily utilized during the early fall. Wells (1970) noted heavy feeding pressure on *Leptodora kindtii* which is one of the predominant macrozooplankters in the vicinity of Nine Mile Point. All of the food items reported for larval and adult alewives are abundant in the Nine Mile Point area (LMS, 1975).

c. Growth

The growth of alewives at Nine Mile Point was evaluated using two criteria, time of annulus formation and rate of body growth. Norden (1967) reported that in Lake Michigan 15% of alewives formed their annulus during June and the remainder during July. These results are similar to the time of annulus formation at Nine Mile Point. Annulus formation was reported in 36% of the alewives captured during June, 43% during July, and 100% during August (LMS, 1975).

Growth curves (calculated from the summation of the grand average annual increments of length) for both male and female alewives assumed approximately the same form; however, females were larger after the second and subsequent years of life (Figure VI-4). Alewives displayed rapid growth during the first two years of life. After the first and second years of life, alewives were 43% and 67%, respectively, of the length attained after six years of growth. Growth declined rapidly during the second and third years of life, and generally continued to decline through age six.

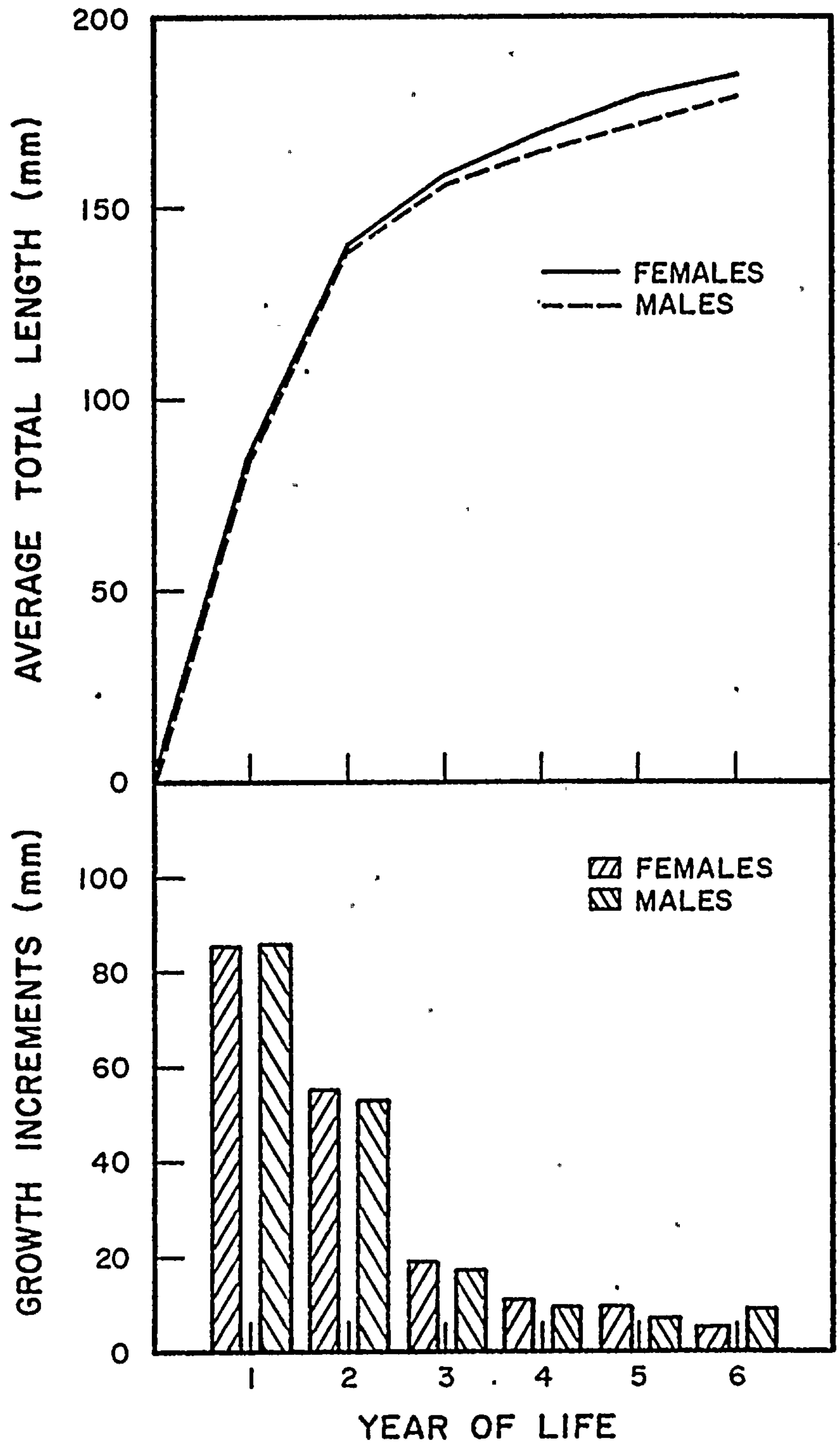
T-tests ($p = 0.05$) on the differences between the grand average calculated lengths of male and female alewives for each year of life revealed that female alewives were significantly larger than males at age three and four (LMS, 1975). No significant differences were exhibited at ages one, two, five, or six.

The calculated growth of male and female alewives was plotted by age class (i.e., year spawned) so that differences or similarities among age classes could be observed (Figures VI-5 and VI-6). These graphs show (where comparisons are possible) that for fish spawned

FIGURE VI-4

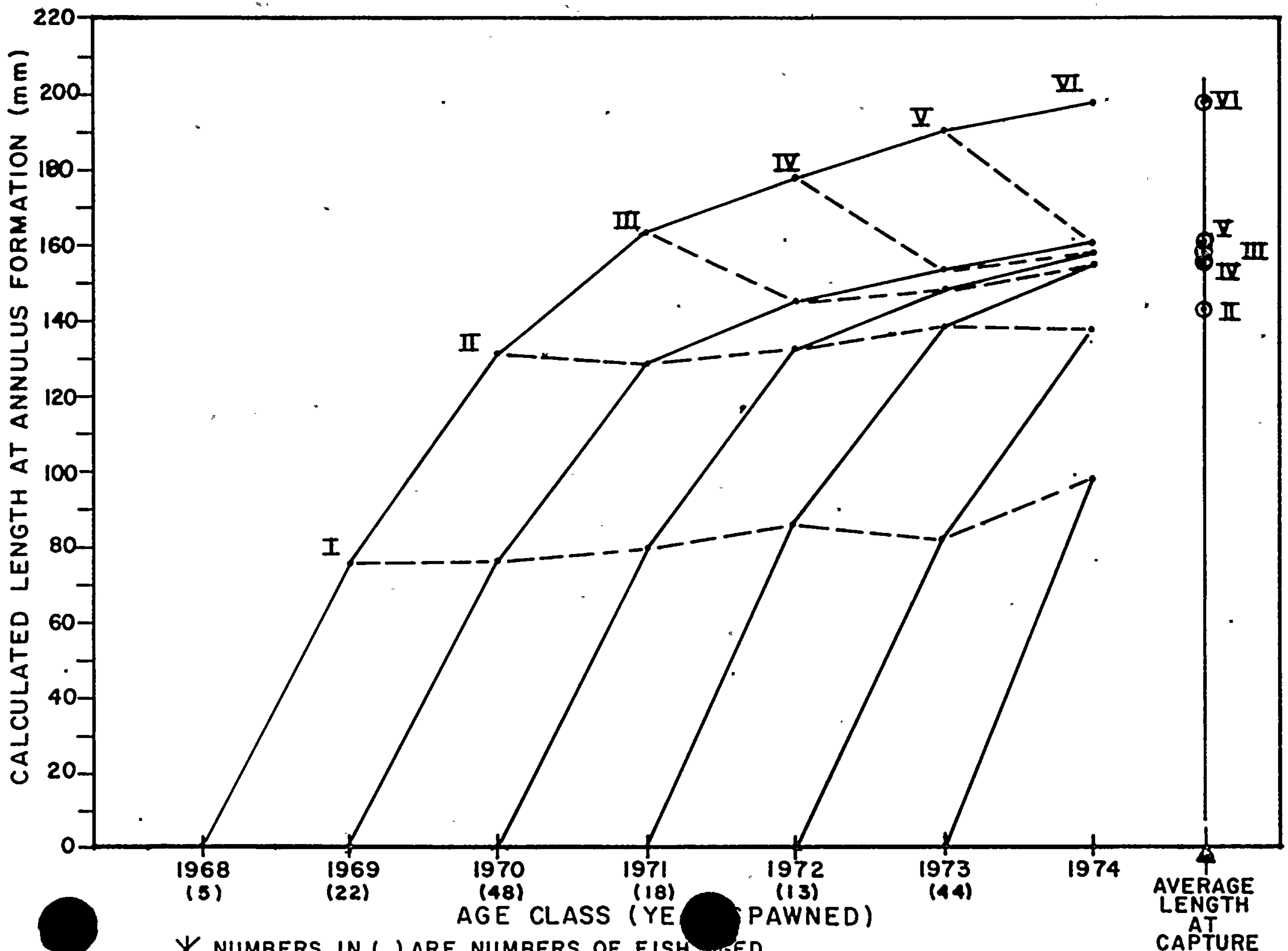
GROWTH CURVES AND ANNUAL GROWTH INCREMENTS OF MALE AND FEMALE ALEWIVES

NINE MILE POINT 1974



COMPARISON OF THE CALCULATED GROWTH OF MALE ALEWIVES AMONG FIVE AGE CLASSES FOR FISH COLLECTED BY GILL NETS & TRAWLS*

NINE MILE POINT-1974

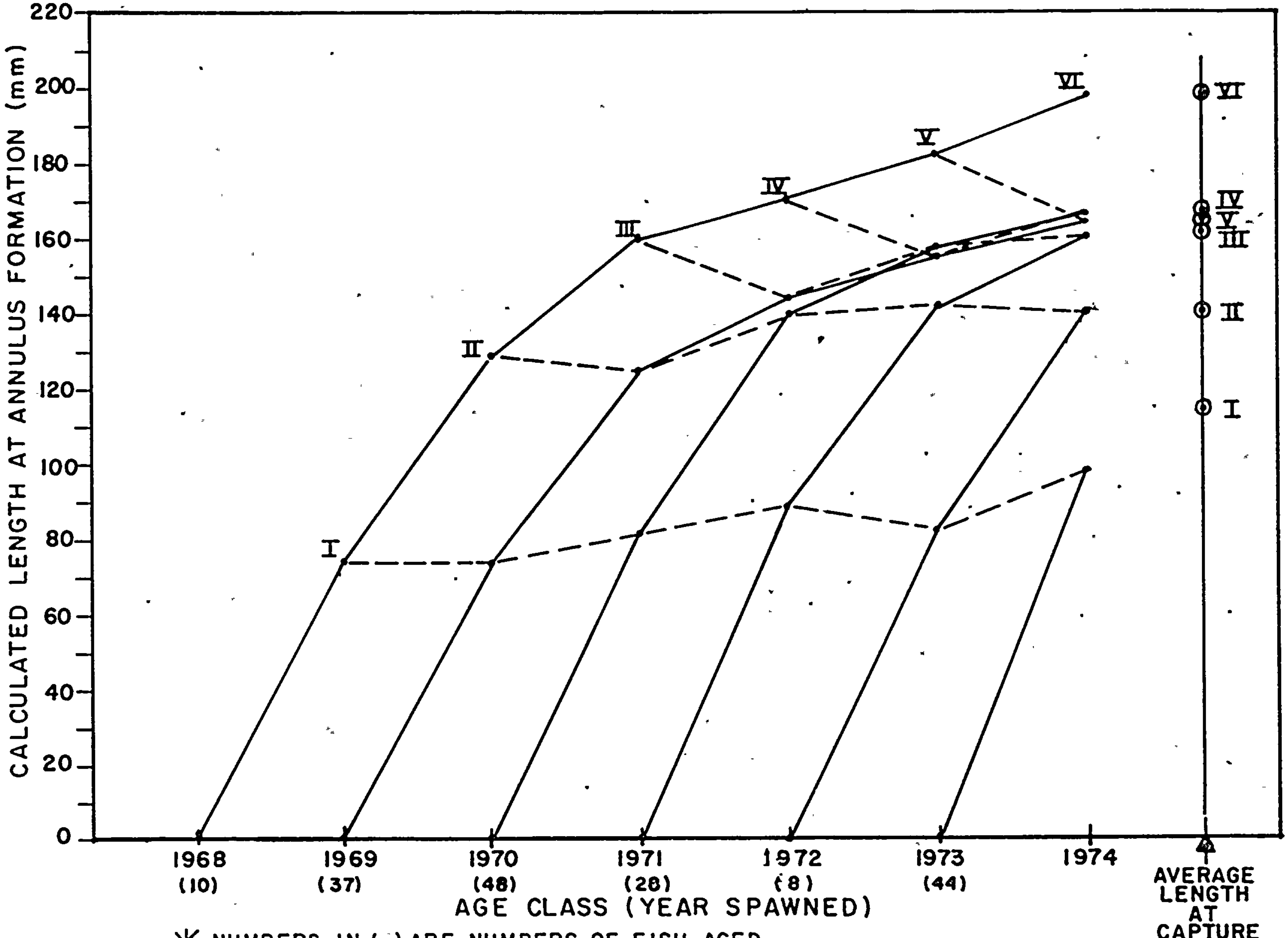


* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-5

COMPARISON OF THE CALCULATED GROWTH OF FEMALE ALEWIVES AMONG SIX AGE CLASSES FOR FISH COLLECTED BY GILL NETS & TRAWLS*

NINE MILE POINT-1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-6

from 1969 to 1973 growth was similar for age I, II, III, and IV. However, it appears that fish spawned in 1968 grew faster from age III to VI. This phenomena may be attributed to the small sample size or the fact that only larger, faster growing individuals survive for 6 years and are then available for capture. or net selectivity for largest, fastest growing individuals

Total alewife biomass and average biomass per fish were compared on a monthly basis among transects for the 1974 collections using gill net data (LMS, 1975). No observable pattern or difference among transects was observed in either the total biomass or average fish biomass. Similarity of biomass distribution patterns suggests even distribution of comparable size (life stage) organisms in the Nine Mile Point vicinity.

d. Abundance 1969-1974

The average number of fish collected per 24 hr from 1969 to 1974 is presented in Figure VI-7. This plot shows that the alewife abundance during the spawning migration has increased 13 fold from 1972 to 1974. Christie (1974) reports that in Lake Ontario the alewife has shown 2 to 3 year oscillations resulting in 10-fold changes in the abundance of individuals during spawning. Similar cyclic changes have been reported from other lake populations (Smith, 1970; Rothschild, 1966, Lackey, 1970). The two way ANOVA verified these observations (Table VI-3). That is, there were significantly more alewife collected during 1973 and 1974 than during any other year. In addition, during 1972 the fewest number of alewives were collected. There were no significant differences between the NMPP and FITZ transects for this data set.

e. Distribution-1974

A three-way analysis of variance (ANOVA) comparing the gill net catch per unit effort by sample depth among three seasons (spring - April, May, June; summer - July, August, September; and fall - October, November and December) and four sampling transects (Figure VI-1) revealed that alewives were more abundant in the evening hours and during the spring and summer periods than during the fall (LMS, 1975). This trend agrees with previously published observations that alewives return to the deeper water of Lake Ontario following spawning activity (Graham, 1956; Scott and Crossman, 1973).

For surface gill net collections there was no difference in the distribution of fish among the transects. However, bottom gill net collections yielded significantly more alewives from the FITZ transect than from the other three transects, in contrast to the long-term, 1969-1974, transect comparison noted above wherein no significant difference was noted.

NUMBER OF ALEWIFE COLLECTED BY GILL NET
NINE MILE POINT - 1969-1974

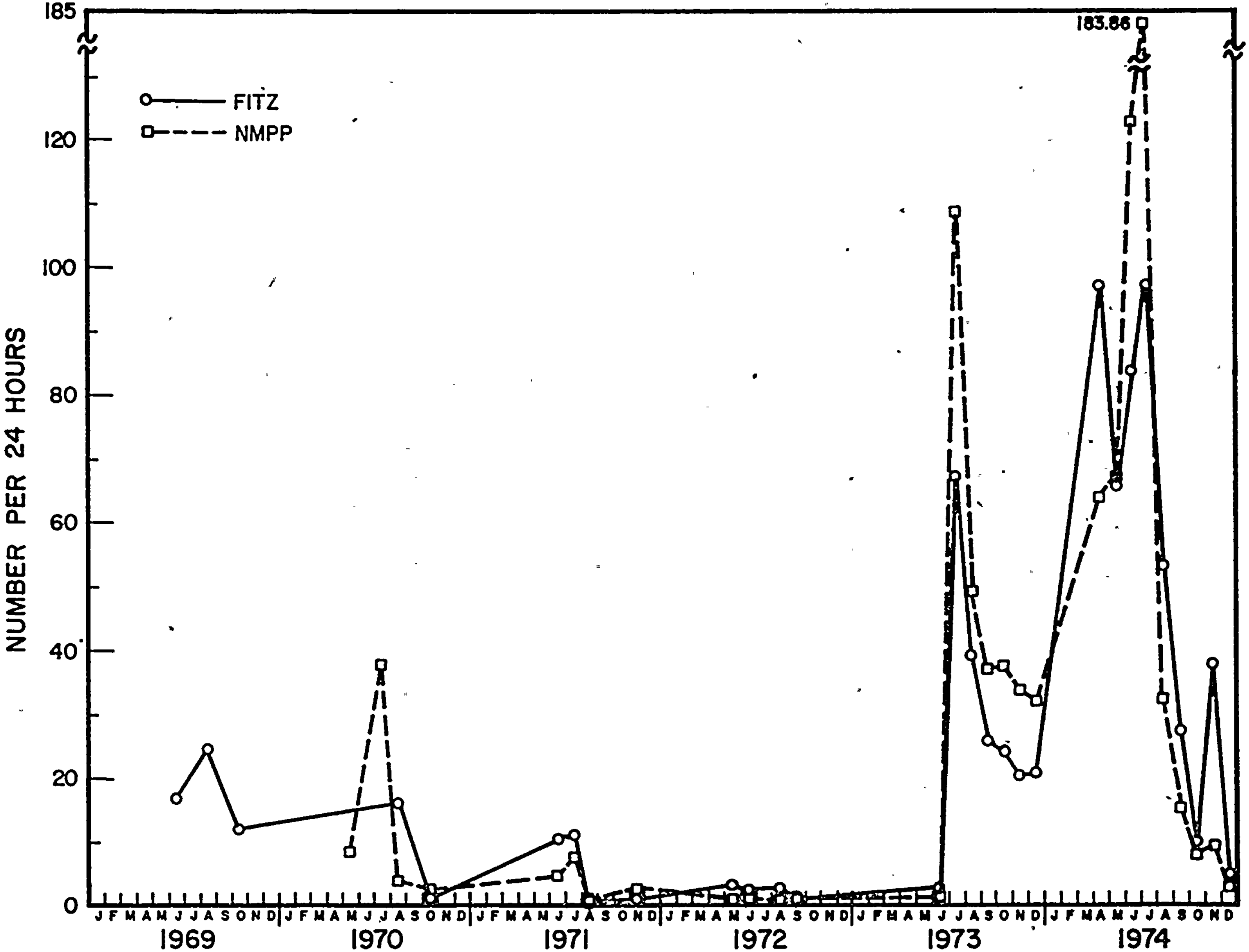


FIGURE 7

TABLE VI-3

TWO-WAY ANALYSIS OF VARIANCE COMPARING THE CATCH/EFFORT OF ALEWIVES BETWEEN THE NMPP AND FITZ TRANSECTS

NINE MILE POINT - 1969-1974

SOURCE	Degree of Freedom (Error)	Sum of Squares (Error)	Mean of Squares	F-Test
BETWEEN STRATA	10	17.0257	1.7026	6.392 (9<.0005)
WITHIN STRATA	48	12.7863	0.2664	
TOTAL	58	29.8120		

STUDENT-NEUMAN-KEULS TEST - DATES (α= .05)

Largest: F-74 P-74 P-73 F-73 1969 F-70 P-70 F-71 P-71 F-72 P-72: Smallest

F = FITZ transect P = NMPP transect

Bartlett's test for homoscedasticity: χ^2_{10} - 10.074 (P>.25)

* Transformation is log (catch/effort)

Underlined segments resulting from the Student-Neuman-Kuels Test are statistically similar. Line breaks denote significant differences.

Two-way analyses of variance were run separately for the day and night gill net collections to compare the distribution of fish among sampling seasons and depths (surface and bottom) so that differences in the diurnal behavior of the fish could be identified. There was no significant interaction between the two variables during the daylight hours; there were, however, significantly more fish collected from the bottom than from the surface during daylight hours. Conversely, at night more fish were collected at the surface than at the bottom, and there was a significant interaction between sample depth and season during the night. This may be correlated with the night spawning activity of alewives in shallow waters.

f. Conclusion

The data presented above for alewives can be summarized as follows:

- Spawning occurs within the natural time period and temperature range observed for other freshwater populations.

- Females are as fecund as females from other areas in Lake Ontario and other lakes.

- Eggs and larvae of alewife dominate in the area indicating successful spawning; however, sex ratio data suggests that the Nine Mile Point Area may not be a preferred or major spawning area.

- Recruitment of younger fish into the fishery is demonstrated by their contribution of 50% of the September and October captures.

- Growth is typical for the species and has not changed significantly over the past six years.

- Alewife abundance has increased at Nine Mile Point from 1972 to 1974 probably in response to the two or three year abundance oscillations noted for landlocked alewife populations in Lake Ontario.

- The NMPP transect has not been a focal point for alewife concentration, nor has it been avoided over the 1969 to 1974 period.

3. Rainbow smelt

a. Reproduction

Rainbow smelt spawning occurred during April as determined by examining the coefficient of maturity data for 688 males and

1,056 females collected in the vicinity of Nine Mile Point from January through December 1974. There is evidence to suggest that rainbow smelt may use the Nine Mile Point vicinity as a spawning ground because trawl collections in this area in April contained mature ripe females representative of a spawning population.

A listing of fecundity data from some other investigations performed on rainbow smelt in the Great Lakes follows:

Reference	Location	Size of Females	Number of Females	Mean # of Eggs Per Female
Bailey (1964)	Lake Superior	188 - 224 mm	10	31,338
Baldwin (1950)	Lake Huron	140 - 224 mm	5	20,500
Van Oosten (1940)	Lake Michigan	185 - 196 mm	-	25,000
LMS (1975)	Lake Ontario	138 - 213 mm	24	17,002

The fecundity of rainbow smelt in the Nine Mile Point vicinity varied with fish length from a total of 6,212 eggs to 29,050 eggs, with a mean of 17,002 eggs. When allowance is made for the size of the fish, the estimates of Baldwin (1950) and Van Oosten (1940) are most nearly comparable to those of this study.

Bailey (1964) reported that rainbow smelt egg diameters in Lake Superior ranged from 0.79 to 0.99 mm with a mean of 0.86 mm. For the 24 sexually mature female smelt examined, ovaries contained eggs ranging in diameter from 0.4 to 1.1 mm with a mean diameter of 0.7 mm.

The ratio of male to females is one indication of spawning activity. MacCullen and Regier (1970) found that males predominated in spawning areas during both the early and late parts of the spawning season. Of 5,542 rainbow smelt collected by trawls and gill nets from April to December 1974 (LMS, 1975), 50.3% were males and 49.7% were females; most were collected in April and May. During the remainder of the year (June-December), females predominated in the collections with 73 males and 410 females.

Adult rainbow smelt normally migrate from deeper offshore waters to the near shore area in late winter/early spring in preparation for spawning in tributary streams and along the lake's shore (Scott and Crossman, 1973). At Nine Mile Point in 1974 rainbow smelt eggs were collected from 25 April through 22 May with the peak period occurring on 22 May (Figure VI-8). The small numbers of smelt eggs collected in 1974 were distributed evenly over the Nine Mile Point area.

Rainbow smelt larvae were collected from 22 May to 25 July with the greatest concentration occurring in samples from 19-20 June (Figure VI-8). More larvae were collected at night corresponding

MEAN NUMBER OF EGGS AND LARVAE
OF RAINBOW SMELT
BY SAMPLING DATE
NINE MILE POINT - 1974

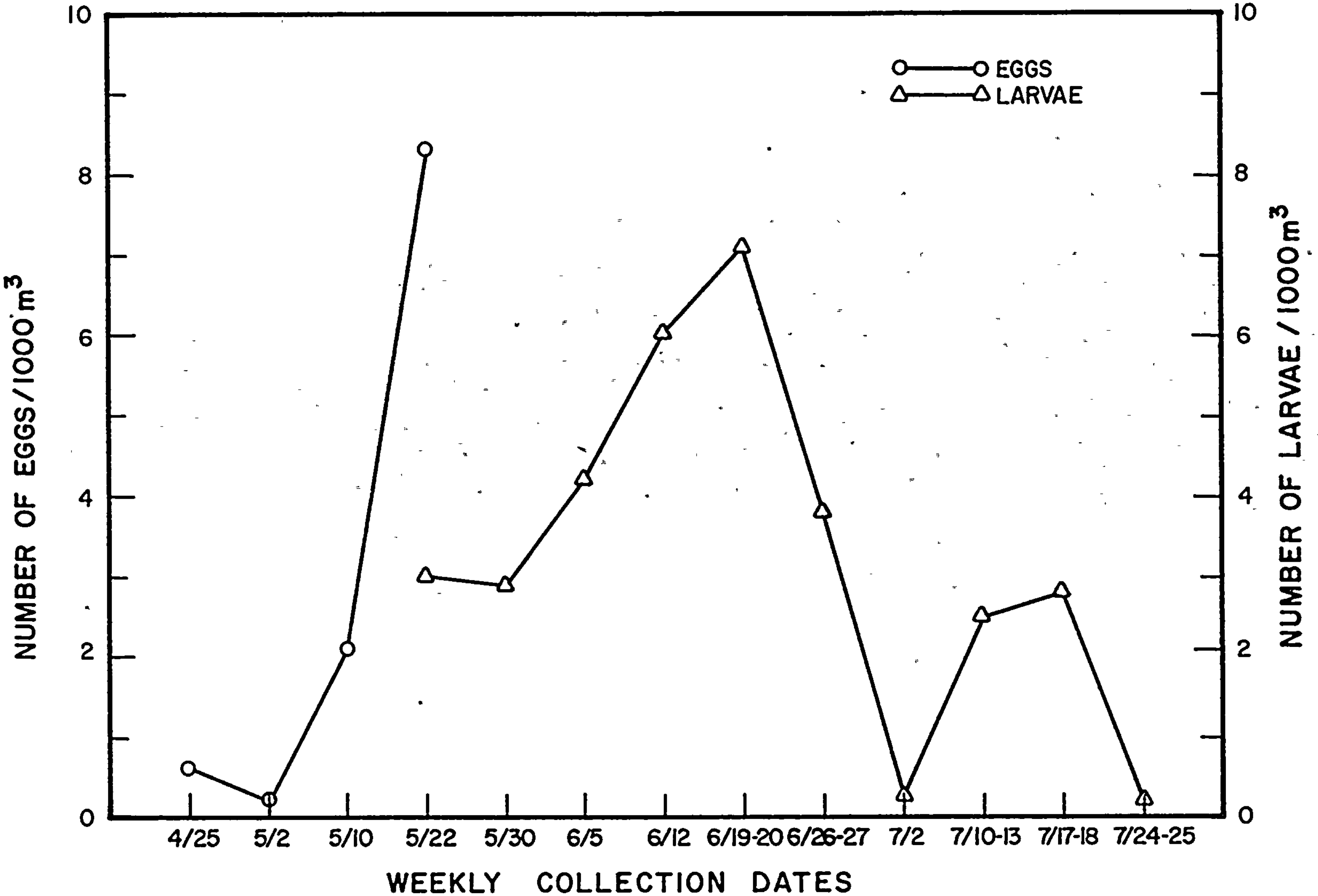


FIGURE VI-8

to the nocturnal activity of the species (Scott and Crossman, 1973). Generally, the shallower stations (20 ft depth contour) experienced the greatest abundance of rainbow smelt larvae during the spring with the average larval abundance decreasing with distance from shore. As the larvae matured the deeper water stations became the preferred depth contour corresponding to the offshore migratory pattern observed for the species (Wells, 1968).

Larval growth based on length frequency data suggest a period of rapid growth in the Nine Mile Point vicinity. Larvae on 22 May averaged 5.2mm; during the peak abundance period on 19-20 June they averaged 9.3 mm, and growth had proceeded to approximately 20 mm by the end of July.

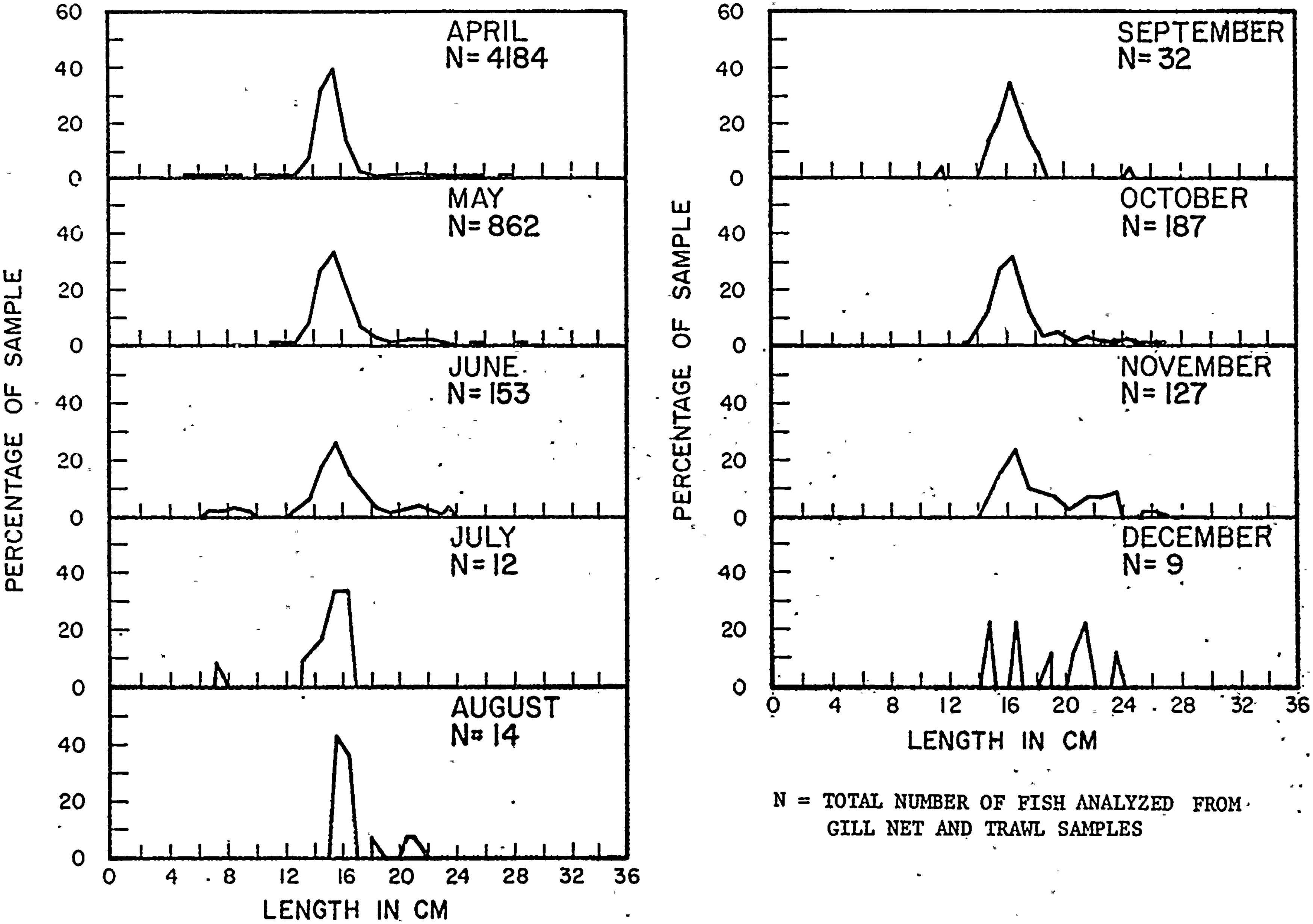
The length-frequency distribution plotted for adult rainbow smelt collected with trawls and gill nets is illustrated in Figure VI-9. These data show that the majority of smelt present within the Nine Mile Point vicinity are between 14 and 17 cm long and hence most are probably in age group III and older. As was noted earlier (QLM, 1974), these fish presumably represent migrants on the way to spawning grounds. This figure also demonstrates that several year classes are present and that recruitment of younger fish into the adult fishery is occurring.

The biomass data for rainbow smelt indicates a trend toward an increase in the average weight per individual from April to June with the decrease noted in the average fish weight caught during July indicative of young fish recruitment. The time of recruitment corresponds to the length frequency data discussed above. No observable trend was noted in either total biomass or average fish biomass among transects on a monthly basis.

b. Feeding

Rainbow smelt are reported by Christie (1974) to feed on invertebrates when they are small changing to a piscivorous diet as they mature. Burbidge (1969) reported a seasonally varying diet with the dominant food item corresponding to the most abundant invertebrate suggesting an opportunistic feeding pattern. O'Gorman (1974) reported a definite predation by rainbow smelt in the fall on young alewives when both populations are located in the deeper water off shore; however, Burbidge (1969) only observed the remains of young smelt in the stomachs of larger rainbow smelt. The most 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.

LENGTH FREQUENCY DISTRIBUTION FOR LAKE RAINBOW SMELT
NINE MILE POINT
1974



N = TOTAL NUMBER OF FISH ANALYZED FROM GILL NET AND TRAWL SAMPLES

FIGURE VI-9

Presently feeding habits of smelt in the Nine Mile Point Area is not available, though abundance of preferred food items would not be restrictive to smelt growth and development.

c. Growth

Bailey (1964) reported the completion of annulus formation for Lake Superior smelt between mid-June and 24 August. Annulus formation occurred earlier in sexually immature fish compared to sexually mature individuals.

Monitoring of rainbow smelt annulus formation in the vicinity of Nine Mile Point began in mid-April 1974, and the time of formation was determined for 307 male and female rainbow smelt. Fourteen percent of the smelt collected during April, and 12% collected during May, had formed their annulus. Peak annulus formation (72%), based on a significant sample size, occurred during June; all smelt sampled after June had formed their annulus. In 1973, peak annulus formation of smelt in the Nine Mile Point vicinity also occurred during June (89%) and was complete by August (QLM, 1974). This is earlier than the time found by Bailey (1964) for the colder Lake Superior.

McKenzie (1958) reported that female smelt in the Miramichi River, New Brunswick, Canada were larger than males after the second year of growth Bailey (1964) reported that age three and older female smelt in Lake Superior were larger than males. Burbidge (1969) found that female smelt in Lake Michigan attained a greater mean length than males after the second year of life, but that the female size advantage was significant only for the fourth year of life. The more rapid growth of female smelt was also reported by Van Oosten (1947) in Green Bay, Lake Michigan; by Baldwin (1950) in South Bay, Lake Huron; and by Hale (1960) in western Lake Superior.

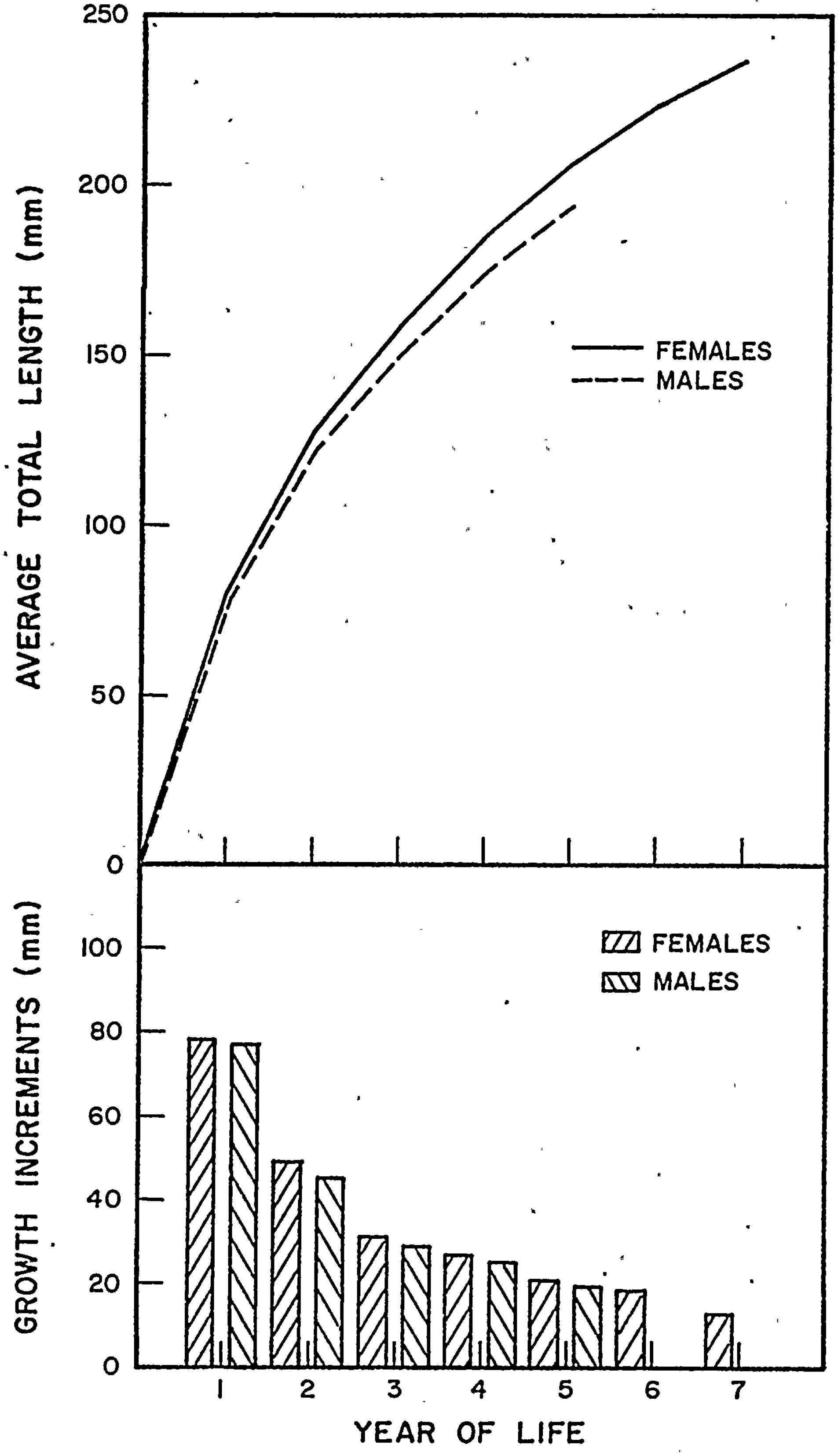
The growth curves (calculated from the summation of the grand average annual increments of length) for both male and female smelt (Figure VI-10) had the same form, although females appeared larger after the first year of life (LMS, 1975). A t-test ($p = 0.5$) on the differences between the grand average calculated lengths of male and female smelt for each year of life revealed that females were significantly larger than males at age two and older.

The growth by each age class for males and females is plotted as a function of age in Figures VI-11 and VI-12. These figures show that growth has been uniform over the past six years. The absence of 1973 year class is because the gill nets do not collect small rainbow smelt.

FIGURE VI-10

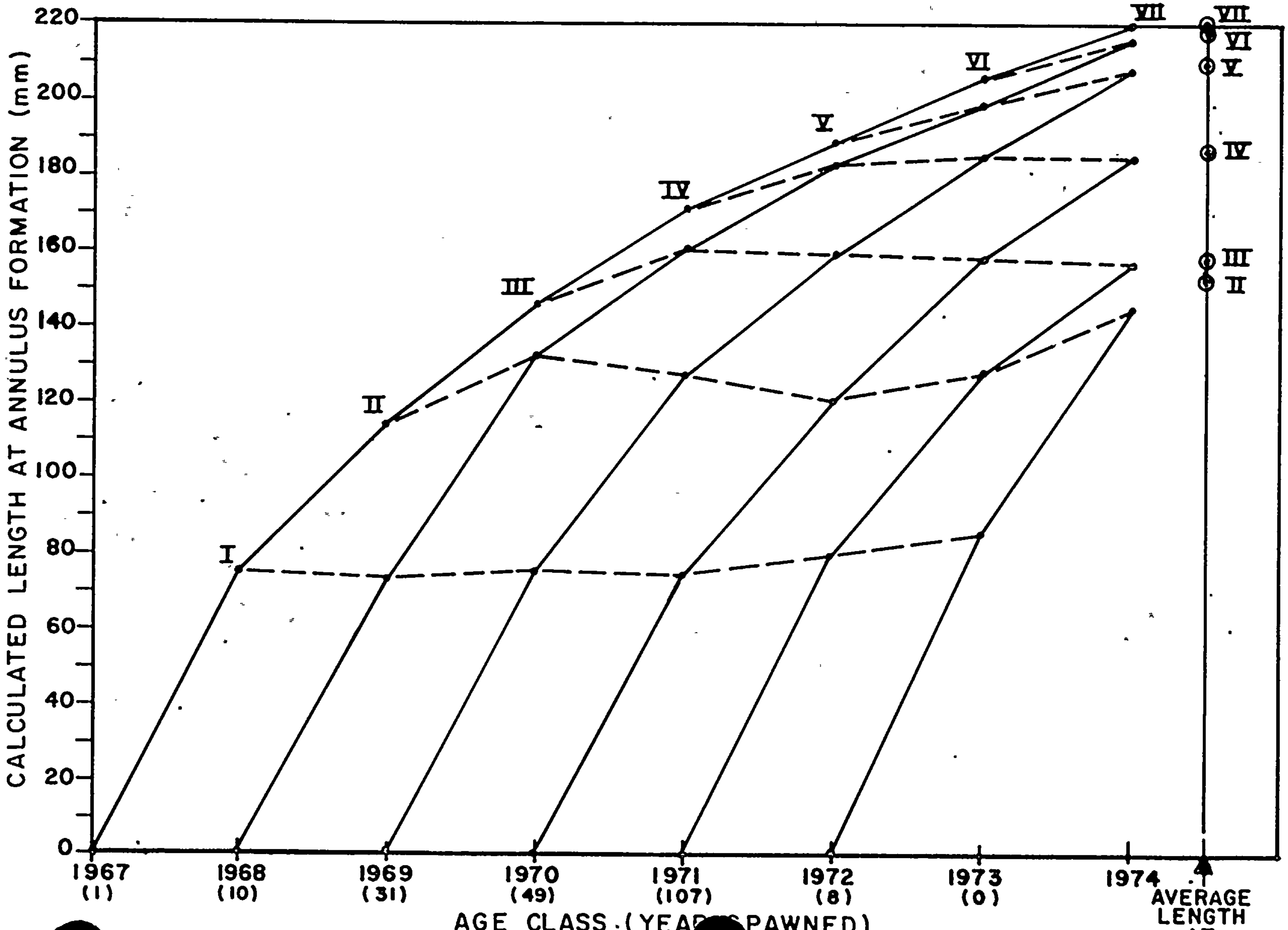
GROWTH CURVES AND ANNUAL GROWTH INCREMENTS OF MALE AND FEMALE RAINBOW SMELT

NINE MILE POINT 1974



COMPARISON OF THE CALCULATED GROWTH OF FEMALE RAINBOW SMELT AMONG SIX AGE CLASSES FOR FISH COLLECTED BY GILL NETS & TRAWLS*

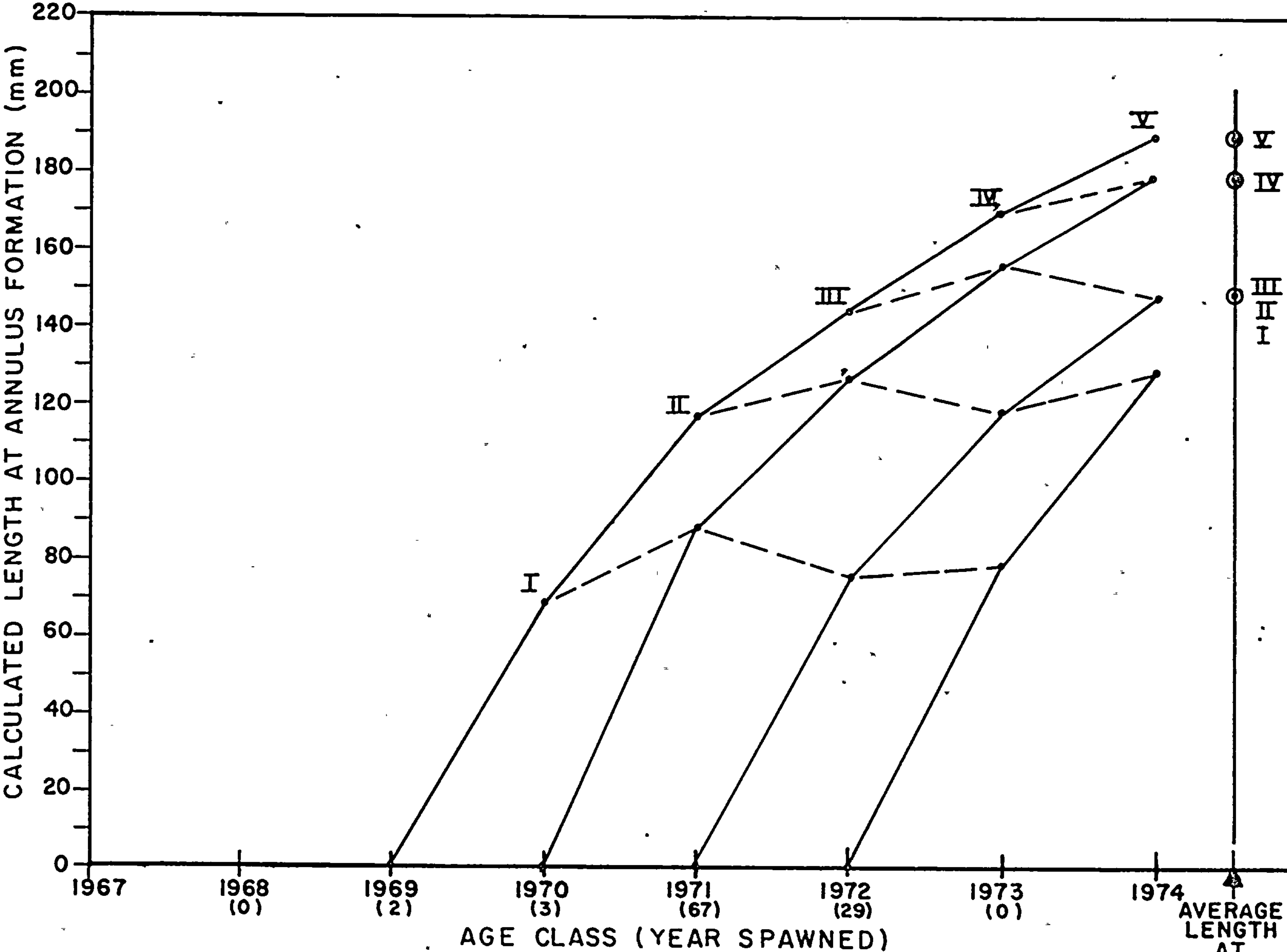
NINE MILE POINT-1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH [illegible]D

FIGURE VI-11

COMPARISON OF THE CALCULATED GROWTH OF
MALE RAINBOW SMELT
AMONG FIVE AGE CLASSES
FOR FISH COLLECTED BY GILL NETS & TRAWLS*
NINE MILE POINT-1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-12

d. Abundance 1969 -1974

The catch per 24 hr of rainbow smelt from 1969 to 1974 is presented in Figure VI-13. Yearly peaks of abundance are present and correspond to the time of the spawning migration of the species. Statistical analyses show that there were no significant differences between the transects or among the years (Table VI-4).

e. Distribution - 1974

A two-way analysis of variance (ANOVA) on the day gill net catch per effort for rainbow smelt, (LMS, 1975), comparing the distribution by sampling depth (bottom and surface) and among the three seasons (spring, summer, and fall), revealed that more fish were collected from the bottom than from the surface, and that more were collected during the spring than during either the summer or fall months. A similar ANOVA for the night collections revealed that more fish were collected from the surface, and more in the spring than during the other seasons. Since rainbow smelt diurnal distribution differed between sampling depth, these parameters were treated independently in the analysis of distributional differences among transects. A three-way ANOVA was performed on the distribution of smelt among seasons, between day and night, and among the four sampling transects (LMS, 1975). These tests showed that there were no significant differences in the distribution of rainbow smelt among the four sampling transects during 1974.

f. Conclusion

The data presented above on rainbow smelt can be summarized as follows:

- Spawning occurs during the natural period for the species (May); however, sex ratio data was inconclusive as to preference for the area around Nine Mile Point.

- Females are as fecund as females of other populations.

- Collection of eggs and larvae near Nine Mile Point indicate successful reproduction during 1973 and 1974.

- Growth of rainbow smelt over the last six years appears to be uniform and as expected for the species.

- There were no significant differences in the catch/effort of rainbow smelt from 1969 to 1974 or between the NMPP and FITZ transects.

NUMBER OF RAINBOW SMELT
COLLECTED [illegible] GILL NET
NINE MILE POINT - 1969-1974

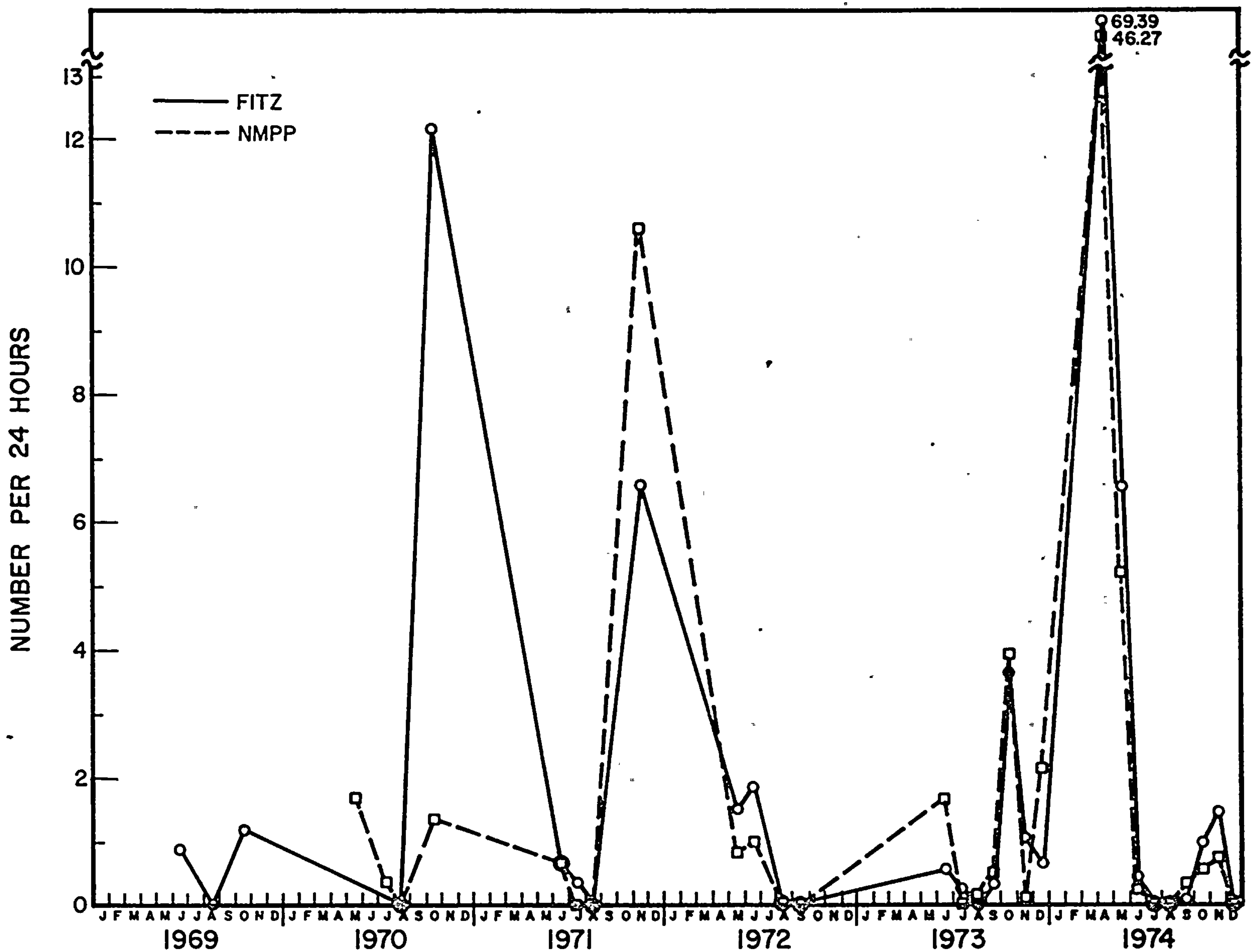


FIGURE VI-13

TABLE VI-4

TWO-WAY ANALYSIS OF VARIANCE COMPARING THE CATCH/EFFORT OF RAINBOW SMELT BY GILL NETS BETWEEN THE NMPP AND FITZ TRANSECTS*

NINE MILE POINT - 1969-1974

SOURCE	Degree of Freedom (Error)	Sum of Squares (Error)	Mean of Squares	F-Test
BETWEEN STRATA	10	0.5317	0.0532	0.282 (P>0.5)
WITHIN STRATA	48	9.0599	0.1888	
TOTAL	58	9.5916		

Bartlett's Test for homoscedasticity: $\chi^2_{10.} = 17.896$ (P>0.5)

* Transformation is log (1+ catch/effort)

4. White Perch

a. Reproduction

Sheri and Power (1968) reported that white perch in the Bay of Quinte, Lake Ontario commenced spawning in mid-May and that spawning extended to the end of June, a period when water temperatures were in the range of 11° to 15°C (51.8°-59°F). The estimated fecundity of white perch in the Bay of Quinte ranged from 5,210 eggs for an age group I fish to 247,681 eggs for an age group VIII fish, with an average of 65,360 eggs. In their fecundity analysis Sheri and Power (1968) observed three distinct egg sizes within the ovary and counted only the largest size. Mansueti (1961), noting that only a portion of the total number of eggs in an ovary of an individual are released at one time, suggested that the eggs ripen progressively and are released during two or three spawning acts over a period of two weeks. Taub (1969) estimated the mean total egg production for 10 white perch ranging in length from 265-302 mm in Quabbin Reservoir, Massachusetts at 271,000 eggs.

The spawning time was determined by examining the coefficient of maturity data for 408 male and 429 female white perch collected from April through November in 1974 (LMS 1975). These data showed that maturation of the gonads occured in late May; the first white perch larvae were collected on 22 May 1974. The water temperature at this time varied from 5.5° to 13.0°C (41.9°-55.4°F), averaging 10.8°C (51.4°F) on the surface and 7.2°C (45.0°F) on the bottom. The time of spawning in the vicinity of Nine Mile Point and Bay of Quinte by white perch populations were observed to be similar.

QLM (1974) estimated the mean total egg production of 32 white perch collected in 1973 ranging in length from 118-298mm at 159,881 eggs. The mean total egg production for white perch from the Nine Mile Point 1974 study for 34 fish ranging in length from 192-250mm was 161,530 eggs while 5 larger fish ranging from 266-325mm had a mean total egg production of 308,530 eggs. These fecundity estimates, based on specific length intervals, are in close agreement with those reported by QLM (1974) and Taub (1969). The reproductive potential of white perch appears to be variable among populations from different bodies of water.

There was no annual difference between the percentages of male and female fish collected inshore from April through December (LMS, 1975); however, there was a monthly difference observed. Hildebrand and Schroeder (1928) reported a preponderance of males on the spawning grounds during May in Chesapeake Bay. Based on sex ratios, it appears that white perch spawned in the Nine Mile Point vicinity in 1974, and that the spawning activity reached a peak in June, when 249 males wee collected and only 114 females. This observation is in agreement with the May peak in gonad maturation and the collection of larval white perch on 22 May.

Observations on white perch in the Bay of Quinte found spawning extending from mid-May through June (Sheri and Power, 1968). White perch eggs were collected on two sampling dates in 1974 encompassing the end of the month of May (Figure VI-14). Collection of white perch larvae during the end of May suggests that spawning occured at an earlier date than represented by the 1974 egg samples, probably at an area other than Nine Mile Point.

Larvae of the white perch were present in the vicinity of Nine Mile Point from the end of May through the middle of July. Spawning by adults usually covers several weeks (Scott and Crossman, 1973) and results in a comparatively stable larval population around Nine Mile Point through the months of June and July. Decreased larval abundance on 2 July (Figure VI-14) results from daylight samples being collected on that date only. Adjacent dates have nocturnal samples which encompass the period of greatest white perch activity (Sheri and Power, 1969) resulting in greater abundance compared to the 2 July date. The observed rapid growth of white perch in Lake Ontario (Sheri and Power, 1968) would enable the young to avoid the larval sampling devices by the middle of July as was observed. The small number of larvae collected does not permit an evaluation of the distributional pattern in the study area.

The length frequency distributions of adult white perch are presented in Figure VI-15. During April the catch was made up of fish in age class III or IV and yearlings (estimated from total length), with a small percentage of age class II individuals. In May most of the fish were mature adults of age class III to VI, and presumably represented the spawning population. The same trend continued until October when the main portion of fish were age class I and II. The young-of-the-year are not observed on these graphs because the seine data were not included in these analyses.

The younger, sexually immature fish did not appear in the vicinity of Nine Mile Point until October and November. These groups of fish were probably feeding aggregations, and were collected from only the FITZ transect. Figure VI-15 illustrates the recruitment of young fish into the adult population.

MEAN NUMBER OF EGGS AND LARVAE
OF WHITE PERCH
BY SAMPLING DATE
NINE MILE POINT — 1974

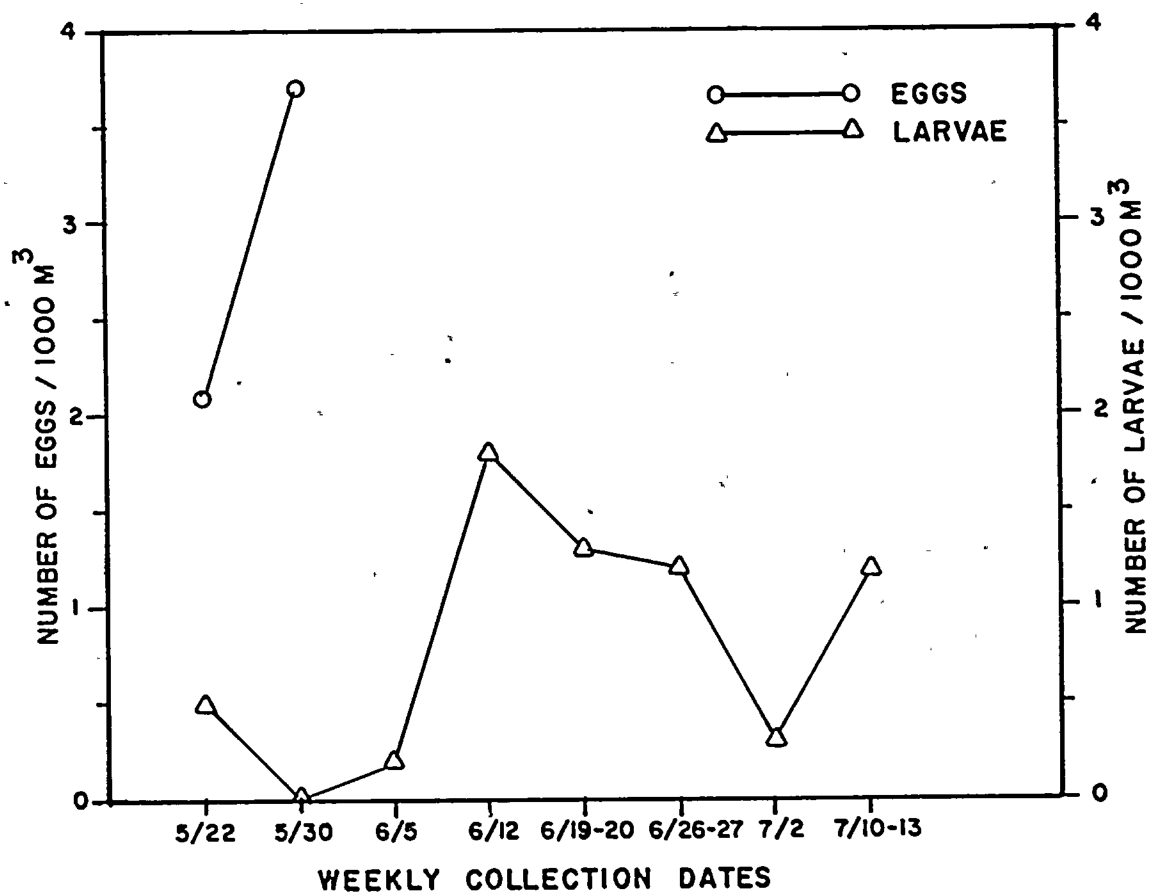
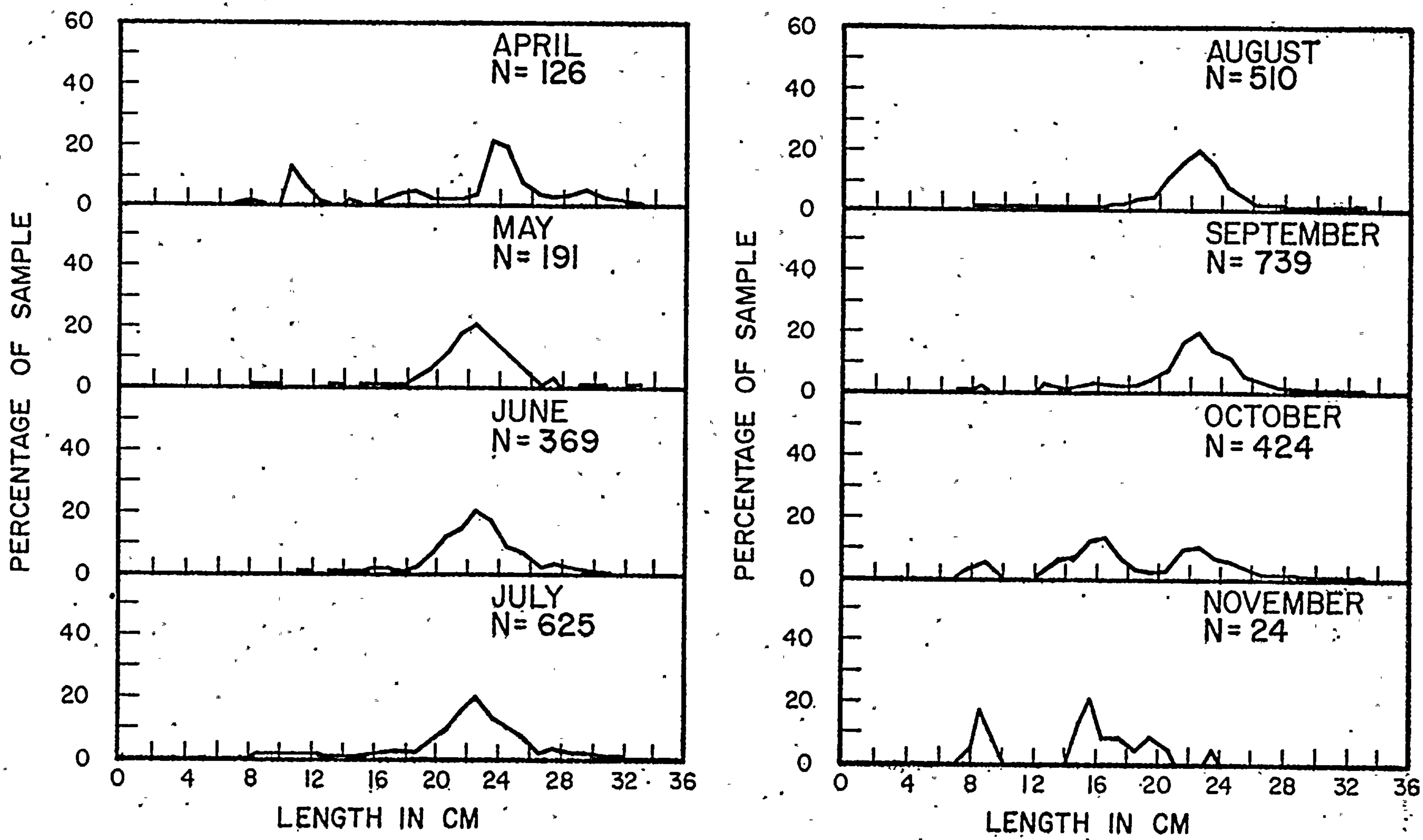


FIGURE VI-14

LENGTH FREQUENCY DISTRIBUTION FOR LAKE WHITE PERCH
NINE MILE POINT
1974



N = TOTAL NUMBER OF FISH ANALYZED FROM
GILL NET AND TRAWL SAMPLES

FIGURE VI-15

Biomass information for total white perch and average weight per fish were evaluated by month for each transect in 1974 (LMS, 1975). The main period of young fish recruitment observed in October was most evident at the FITZ transect. The period corresponding to secondary recruitment noted in April was observed primarily at NMPE with FITZ showing an older population. There was no observable biomass distribution pattern among transects at Nine Mile Point except during the period of recruitment.

b. Feeding

The diet of the white perch has been observed to change with season and growth of the fish. Young white perch feed on crustaceans and insects while the older, larger fish exhibit a piscivorous diet feeding on fish species including yellow perch, rainbow smelt, johnny darters, and other white perch (Cosper, 1941; Leach, 1962). Work conducted on feeding patterns of white perch in the vicinity of Nine Mile Point found a larger variety of food items consumed during the spring by small white perch (< 21.0cm) than the fall; fish eggs were the predominant diet in the spring, and amphipods were the dominant food item in the stomachs analyzed during the fall. Stomachs of white perch larger than 21.1cm in total length contained primarily fish (alewives identified) during both seasons (Williams and Miller, 1973; LMS, 1975). All of the food items found to be preferred by white perch have been found in abundance in the area of Nine Mile Point (LMS, 1975).

c. Growth

Annulus formation was reported by Sheri and Power (1969) during a 10-year study of white perch inhabiting the Bay of Quinte; peak annulus formation occurred during July for five years, during June for two years, and during August for two years.

The time of annulus formation was determined by examining the scales from 375 white perch collected between April and October 1974 at Nine Mile Point (LMS, 1975). Annulus formation had occurred in 47% of the white perch captured during July and 99% during August. During 1973, the majority of white perch at Nine Mile Point had formed their annulus by September, with the greatest percentage also observed during August (QLM, 1974).

The time of annulus formation must be determined in order to compute the age of a fish (QLM, 1974). Because this time is species-specific and influenced by environmental conditions, it may provide insight into differential growth rates by delineating the start and length of the growing season. The agreement among the data presented herein and previously published reports (as cited above) indicate that the beginning and termination of the growing seasons are similar among white perch populations.

The growth curves (calculated from the summation of the grand average annual increments of length) for both male and female white perch (Figure VI-16) had approximately the same form; however, females appeared larger after the second and subsequent years of life. Differences between the grand average calculated lengths of male and female white perch were determined with t-tests for each year of life (LMS, 1975). These tests also confirmed that females were significantly larger ($p<0.05$) than males after the second year of life. The faster growth of female white perch has been reported in Lake Ontario (QLM, 1974), and throughout the range of the species (Mansueti, 1961; Miller, 1963; Wallace, 1971; St. Pierre and Davis, 1972).

The calculated growth of male white perch for twelve age classes and for ten age classes of females are presented in Figures VI-17 and VI-18 The growth of females appears uniform for age class I. An increase is apparent for the female fish spawned in 1964 but this is most likely due to the fact that only the larger, faster growing individuals survive to age ten. Growth appears uniform for the other year classes with the exception of 1965 and 1966, but the sample size is too small to draw any definitive conclusions. Of particular significance is that growth from 1968 to 1974 for ages I and II is similar and that plant operation began in the fall of 1969. It can therefore be concluded that the operation of Nine Mile Point Unit 1 has not affected the growth rate of white perch. The first year growth of Nine Mile Point white perch is comparable to that of other fast growing populations; however, perch from this area appear to grow faster during the second through eighth year of life compared to fish from all other populations, with the exception of the Connecticut River white perch. Growth after age five appears to slow down and is intermediate when compared to that of other populations, (LMS, 1975). Nine Mile Point white perch appear to grow faster than white perch in the Bay of Quinte for ages two through six, whereas white perch from the Bay of Quinte appear to grow more rapidly after the eighth year of life; however, small sample sizes in these age groups make comparisons dubious.

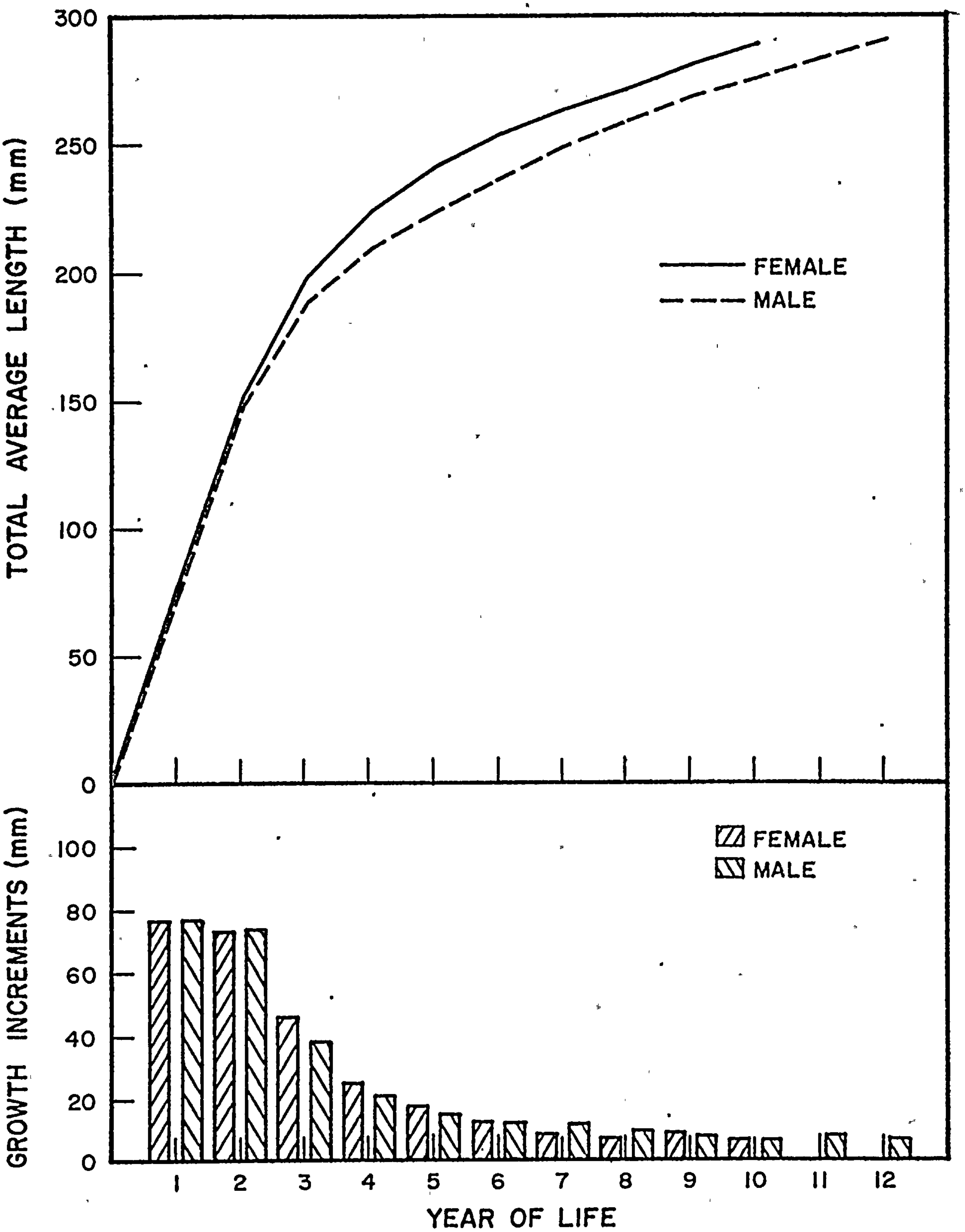
d. Abundance 1969-1974

The white perch catch/effort data are presented in Figure VI-19 These data show that yearly peaks of abundance occur from June to August with the greatest peaks occurring in July. The white perch spawns from May through June so the July peak is not due to inshore spawning activity. However, alewife are spawning during this time period and white perch stomachs contain large numbers of alewife eggs during this time (LMS, 1975). It can be speculated then that the appearance of July abundance peaks

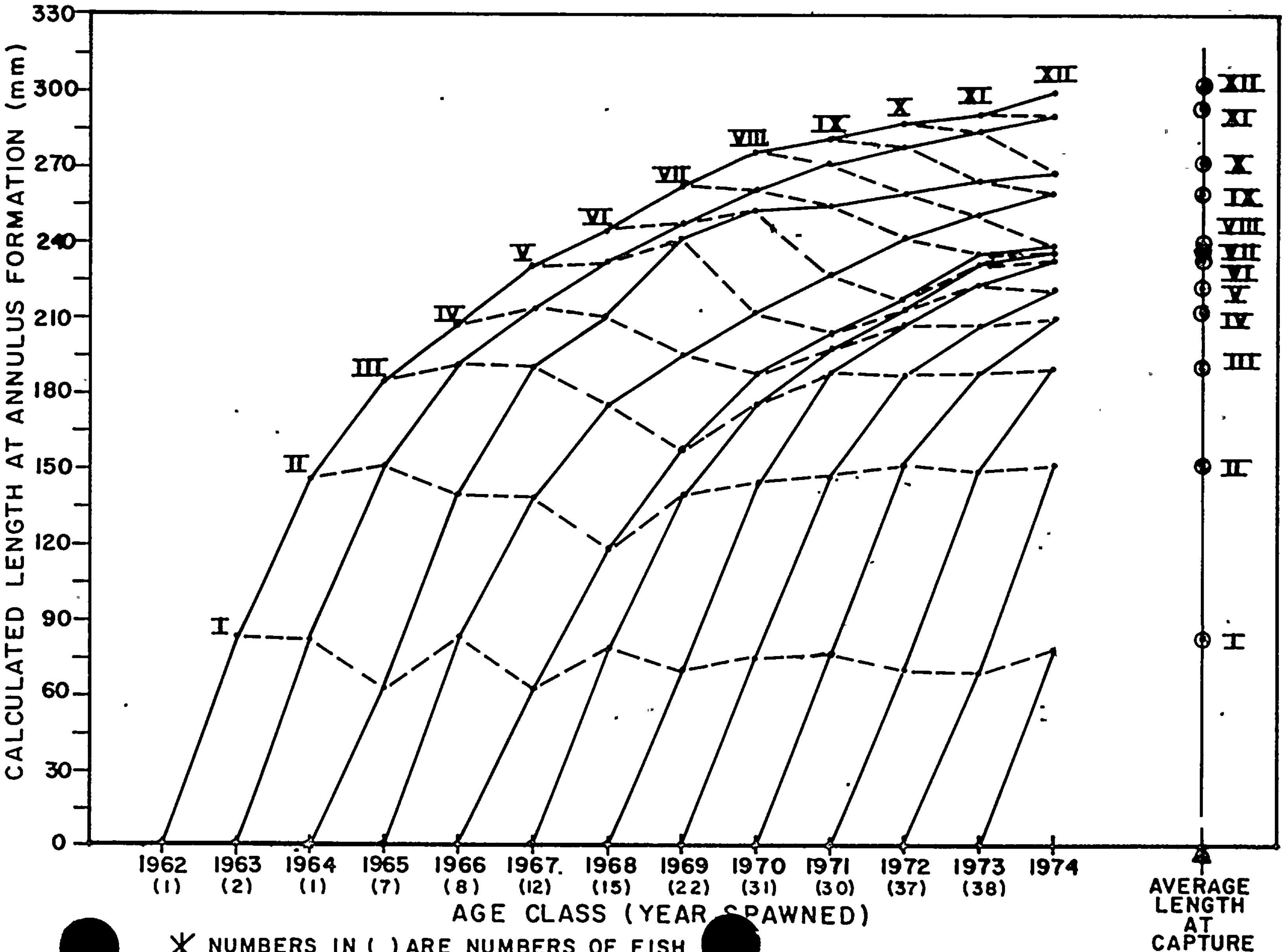
FIGURE VI-16

GROWTH CURVES AND ANNUAL GROWTH INCREMENTS OF MALE AND FEMALE WHITE PERCH

NINE MILE POINT 1974



COMPARISON OF THE CALCULATED GROWTH OF
MALE WHITE PERCH
AMONG TWELVE AGE CLASSES
FOR FISH COLLECTED BY GILL NETS & TRAWLS*
NINE MILE POINT-1974

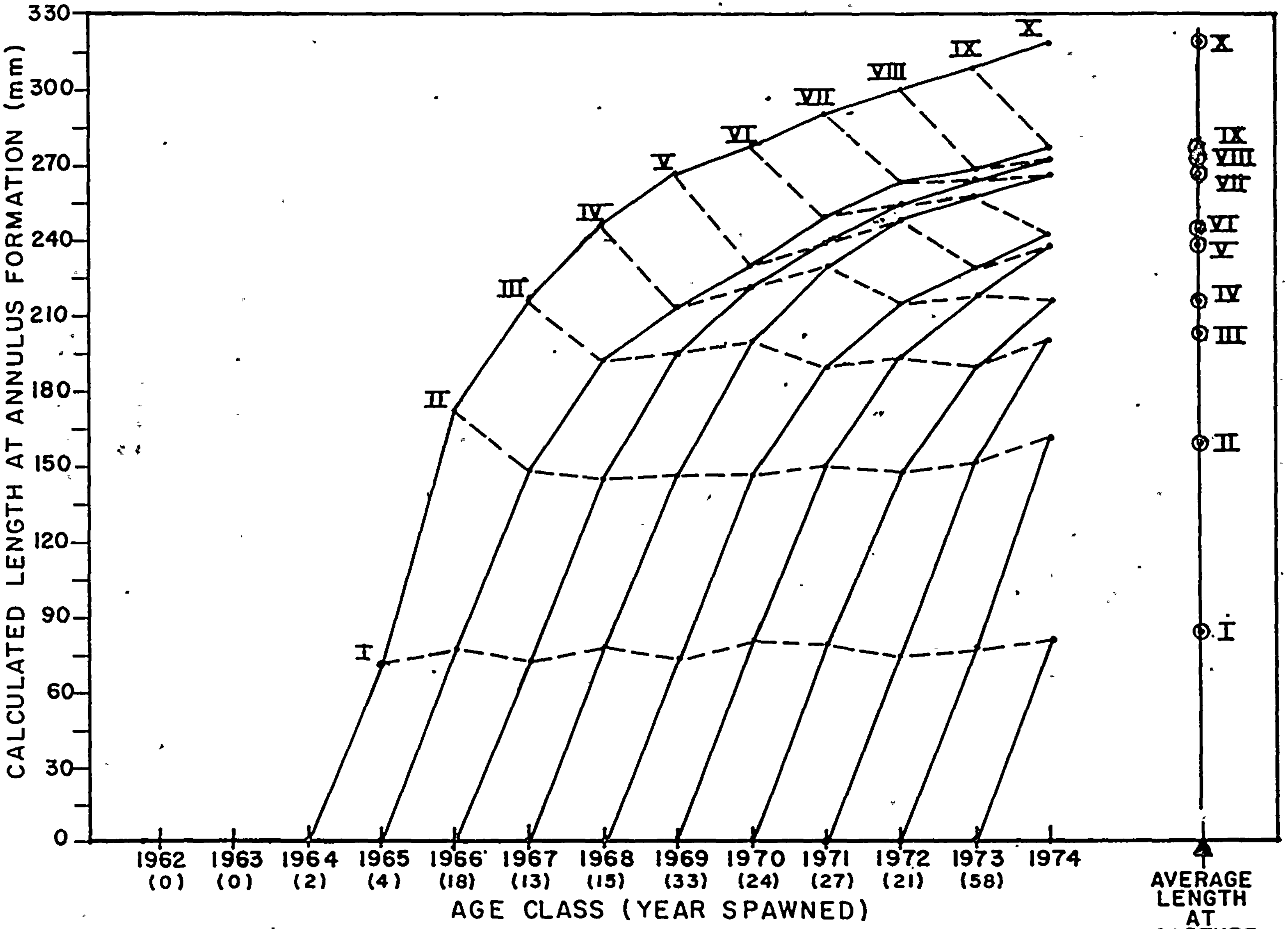


* NUMBERS IN ( ) ARE NUMBERS OF FISH

FIGURE VI-17

COMPARISON OF THE CALCULATED GROWTH OF
FEMALE WHITE PERCH
AMONG TEN AGE CLASSES
FOR FISH COLLECTED BY GILL NETS & TRAWLS*

NINE MILE POINT-1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-18

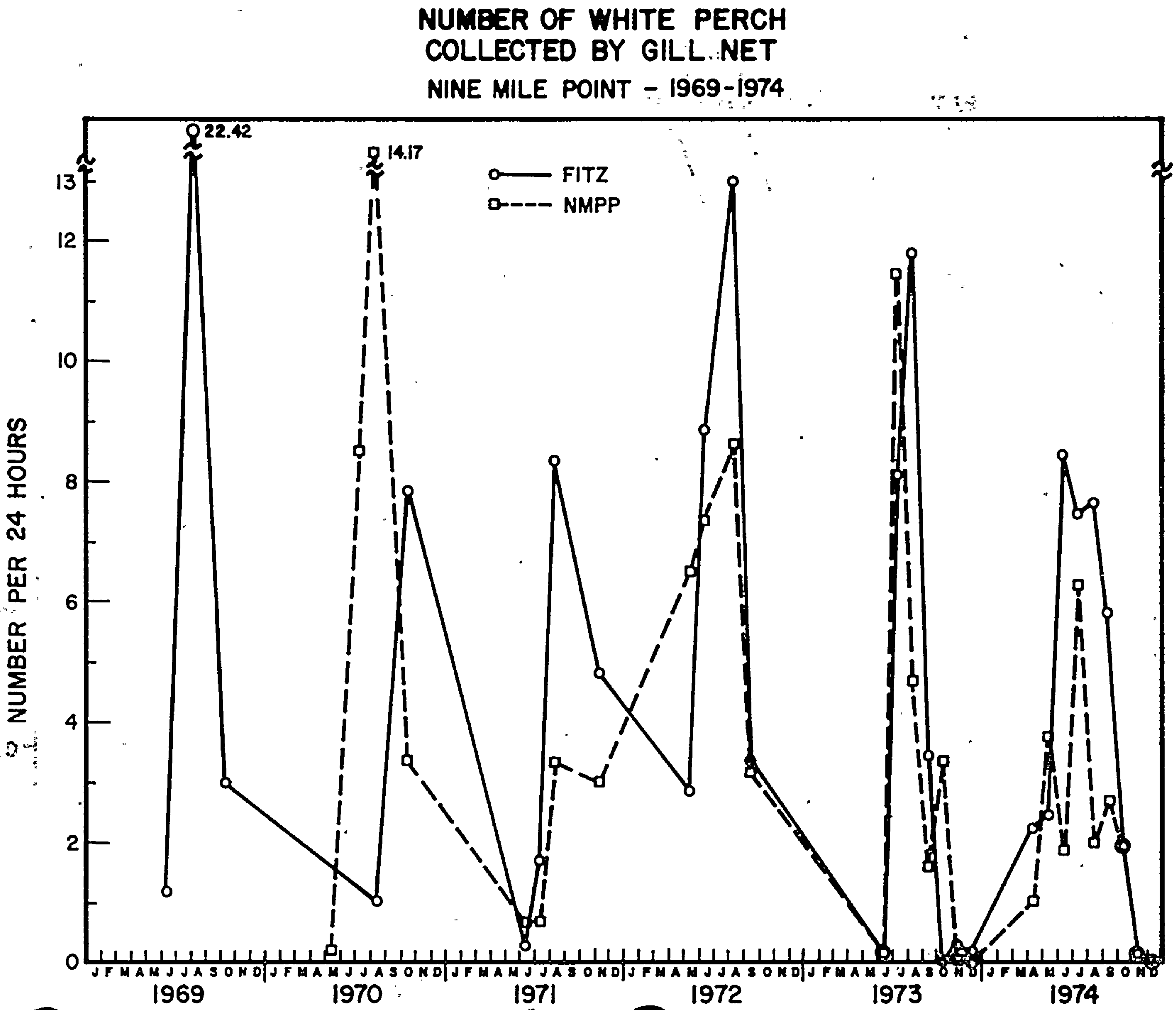

NUMBER OF WHITE PERCH
COLLECTED BY GILL NET
NINE MILE POINT - 1969-1974
22.42
14.17
FITZ
NMPP
NUMBER PER 24 HOURS
0
2
4
6
8
10
12
13
J F M A M J J A S O N D
1969
1970
1971
1972
1973
1974

FIGURE 19

is due to the white perch moving inshore to prey upon alewife eggs and larvae. Statistical analyses (Table VI-5) showed that there were no significant differences in catch/effort from 1969 to 1974 or between the NMPP and FITZ transect.

e. Distribution 1974

A two-way ANOVA was conducted on day and night gill net data, comparing white perch distribution between sampling depths and among seasons (LMS, 1975). Throughout the year, during both day and night sampling, more fish were collected in the bottom gill nets than in the surface gill nets. For daytime collections, there were no differences among seasons; however, more fish were collected at night during the summer (July, August, September) than during either the spring (April, May, June) or fall (October and November). Sheri and Power (1969) found vertical diel movement of white perch with concentrations of fish near the bottom during the day, but near the surface at night; this was not observed during the present study.

Because of significant differences in white perch distribution by sample depth and season in the case of night collections, depth was considered separately during the analyses of transect differences. A three-way ANOVA was conducted on gill net data from surface and bottom collections with the variables of day/night, seasons, and transects (LMS, 1975). There were no significant differences in the distribution of white perch among all the transects based on surface collections; however, the abundance at NMPE transect was greater than that reported from the west transect for bottom collections. The largest bottom collection was also made at NMPE transect, and the second greatest abundance collected at the FITZ transect, with no significant difference between NMPW and NMPP transects. These data indicate that white perch are congregating neither in the thermally rich surface water, nor in the immediate vicinity of the discharge from the Nine Mile Point Nuclear Station.

f. Conclusions

The data presented above for white perch can be summarized as follows:

- White perch spawn in the vicinity of Nine Mile Point during May and June which is similar to other populations of white perch in Lake Ontario.

- Females collected in 1974 were as fecund or more fecund than white perch populations from other North American areas.

TABLE VI-5

TWO-WAY ANALYSIS OF VARIANCE COMPARING THE CATCH PER EFFORT OF WHITE PERCH AMONG YEARS AND BETWEEN THE NMPP AND FITZ TRANSECTS*

SOURCE	Degree of Freedom (Error)	Sum of Squares (Error)	Mean of Squares	F-Test
BETWEEN STRATA	10	1.3681	0.1368	.934 (>0.25)
WITHIN STRATA	48	7.0341	0.1465	
TOTAL	58	8.4021		

Bartlett's Test for homoscedasticity: $\chi^2_{10} = 7.389$ (>0.5)

- Eggs and larvae were found during May and June in both 1973 and 1974 indicating successful spawning in the area.

- Food items consumed were abundant in the Nine Mile area and similar to those food items found in the stomach of other populations.

- Growth among year classes was observed to be uniform and followed normally observed trends.

- No apparent discrepancies were found to exist in yearly abundance patterns from 1969 to 1974.

- No significant difference among the four sampling transects at Nine Mile Point in the nearshore distribution of white perch was found.

5. Yellow Perch

a. Reproduction

Muncy (1962) reported yellow perch movement to the spawning grounds in the Severn River, Maryland from late February to early March, a period when water temperatures were 3.98°-6.7°C (39°-44°F).

The time of spawning for yellow perch in the vicinity of Nine Mile Point was determined by examining the coefficient of maturity data for 351 males and 537 females collected from January through December 1974 (LMS, 1975). These data reveal that peak spawning occurred during the first two weeks in April. Water temperature during this period was 0.7°-6.2°C (33.3°-43.2°F) with a mean temperature of 3.3°C (37.9°F). This observation corresponds very closely to that found by Muncy (1962)

Sheri and Power (1969) estimated the fecundity of yellow perch in the Bay of Quinte, Lake Ontario at from 3,035 to 61,465 total eggs for fish 131-257mm long. Muncy (1962) reported total egg counts from 5,900 to 109,000 for yellow perch from 173 to 358mm in length in the Severn River, Maryland. Mean egg production for 20 fish ranging in size from 173-295mm was 17,940 eggs, while mean egg production for five larger females (302-358mm) was 32,200 eggs (Muncy, 1962)

The ovaries of the 18 sexually mature females (collected in the vicinity of Nine Mile Point) examined contained eggs of one type ranging in diameter from 0.6 to 1.5mm with a mean of 0.93mm. The fecundity estimates, based on total egg counts, ranged from 4,840 eggs (fish body length 150mm, weight 42.2g) to 50,000 eggs

(290mm length, 429.3g weight), with a mean of 25,077 eggs (LMS, 1975).

When allowance is made for the size of the females among the studies the estimates from the different areas evaluated appear to be comparable to those of yellow perch in the vicinity of Nine Mile Point during 1974 (LMS, 1975).

Scott and Crossman (1973) and Muncy (1962) state that males arrive on the spawning grounds before females and remain there longer; the females leave immediately after spawning. Therefore, more males will be found on the spawning grounds during the reproductive season. However, the sex ratio was biased toward females in the vicinity of Nine Mile Point during the spawning season for yellow perch (April, May, June). This observation, in addition to the fact that few larvae were collected from the area, indicates that yellow perch probably did not use the Nine Mile Point vicinity as a spawning ground (LMS, 1975). In addition, Storr (1973) showed that 40% of the yellow perch tagged and released in the Nine Mile Point vicinity moved eastward out of the area. The majority were recaptured at North Sandy Pond, an area which has been assumed to be the spawning grounds for the southern population of yellow perch in Lake Ontario. A few strands of yellow perch eggs were found by divers during the harvesting of buoy periphyton collections near Nine Mile Point, indicating that at least one fish spawned within the area.

Larvae of the yellow perch were collected sporadically during 1973 and 1974 in the vicinity of Nine Mile Point with the initial collection occurring during the middle of May. Very few larvae were collected indicating very little use of the Nine Mile Point area as a nursery ground by this species.

The length-frequency data (Figure VI-20) indicate a trimodal distribution of ages, including fish of age groups two through eight, during April and May. Proportionately fewer older fish were present during June. For the remainder of the year, ages one through eight, fish were fairly uniformly represented.

Throughout the year, age classes three through five predominated in collections, due possibly to the use of gill nets, which are size selective. Some yearlings were collected during June, July, and August, but no young-of-the-year yellow perch were collected with seines, trawls, or gill nets, and few in larval tows (LMS, 1975). These data do, however, indicate that the recruitment of young fish into the adult fishery continues.

LENGTH FREQUENCY DISTRIBUTION FOR LAKE YELLOW PERCH
NINE MILE POINT
1974

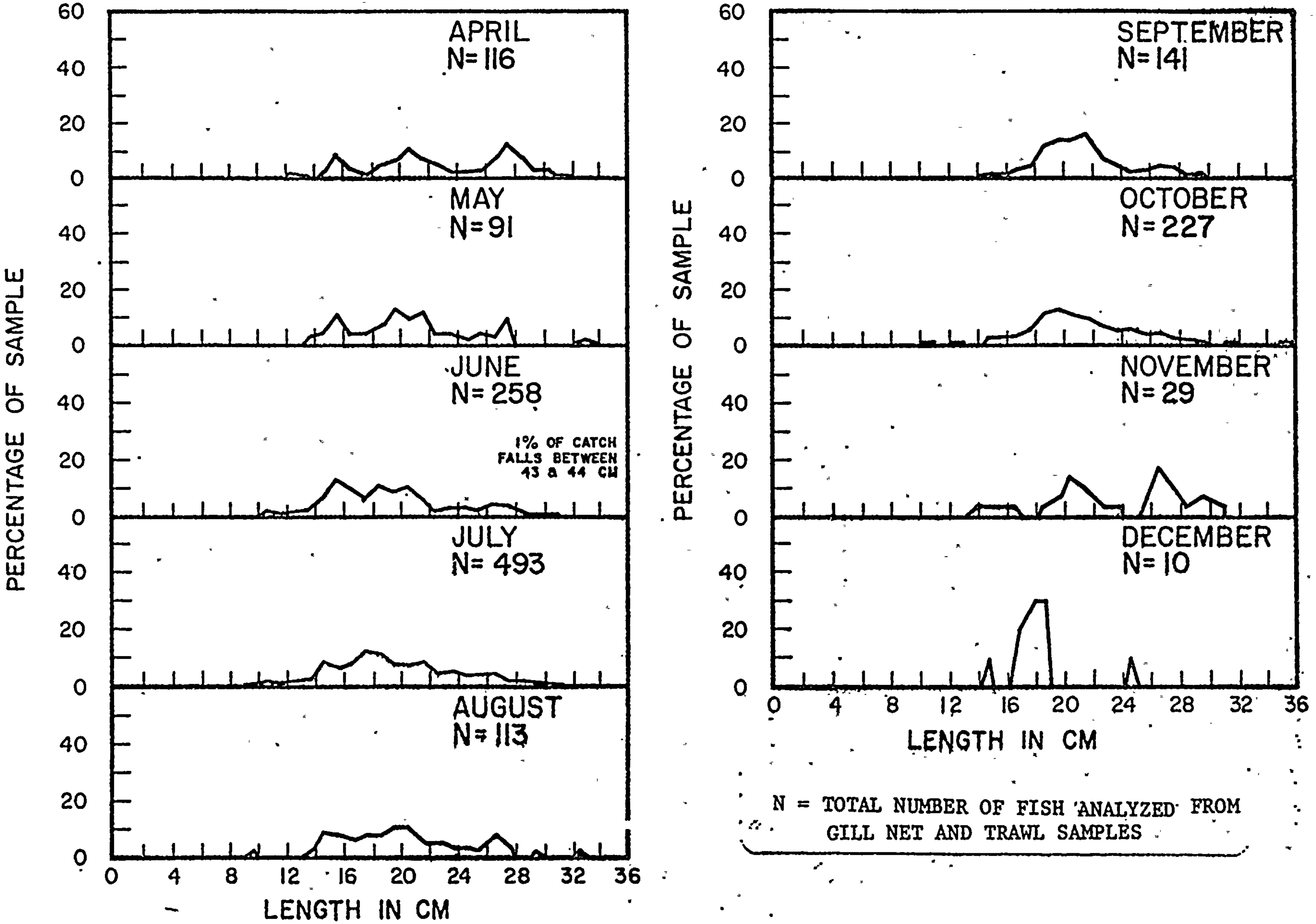


FIGURE VI-20

b. Feeding

The yellow perch is generally considered to be a facultative planktivore, feeding mostly on small fish, some crustaceans, and insects. The larvae feed on zooplankton and insect larvae, and when they grow to a length of 5.0 to 7.5cms, their diet changes to larger zooplankton, insects, crayfish, snails, and small fish, including their own species (McClane, 1964). Tharatt (1959) found that alewives were the principal food of yellow perch in Saginaw Bay.

The fish collected during the spring of 1974 (LMS, 1975) contained a greater variety of food items in their stomachs than those recorded from the fall collection. Of the stomachs examined, 53.7% contained fish (mottled sculpin and alewives identifiable) and 26.8% contained fish eggs and Gammarus fasciatus. During the fall sampling period, fish (alewife identified) and amphipods were the only identifiable materials in the stomachs of yellow perch.

The results of the 1974 stomach content analysis agreed with results from a study conducted on fish collected during 1972 (Williams and Miller, 1973).

Food preference by season for the yellow perch is very similar to that of the white perch as indicated through stomach content studies. The greater numbers of white perch in the area around Nine Mile Point suggests that competition between the yellow and white perch is occurring. Also, the alewife is plantivorous and probably competes with young yellow perch.

c. Growth

Jobes (1952) reported annulus formation in Lake Erie yellow perch to occur between early April and mid-July. The time of annulus formation was determined by examining scales from 170 yellow perch caught between April and October 1974 at Nine Mile Point. Annulus formation was completed by some yellow perch during April and May, peaked during June, and was complete for all fish examined by July 1974 (LMS, 1975); a similar pattern occurred in the Nine Mile Point vicinity in 1973 (QLM, 1974). The 1973 and 1974 data from Nine Mile Point are consistent with the annulus formation time for the Lake Erie population.

Hile and Jobes (1942) and El-Zarka (1959) reported that female yellow perch were larger after age two. Hile and Jobes (1941) in an earlier study at the same location found the same pattern of growth after the third year of life.

The growth curves (calculated from the summation of the grand average annual increments of length) for both male and female yellow perch from Nine MIle Point (Figure VI-21) had the same form; however, females generally appeared to be larger. A t-test of the yearly differences in grand average calculated length, however, revealed no significant differences ($p>0.05$) (LMS, 1975).

Calculated growth of male and female yellow perch was plotted as a function of age (Figures VI-22 and VI-23). These graphs show that female yellow perch growth for the first three years has been similar for the past 9 years. After female fish reach four years of age, growth of individuals spawned between 1966 and 1968 exhibited a progressively slower growth rate. Yellow perch spawned in 1969 showed an increased rate of growth after 4 years of age. Male yellow perch appear to have grown uniformly from 1968 to 1972. No 1973 year class fish were collected during 1974 perhaps due to selectivity of gill nets for larger fish. Statistical comparisons of Nine Mile Point yellow perch growth with that of other populations were not possible.

Comparison of growth rates between the yellow perch collected at Nine Mile Point and other water bodies (discussed in more detail in LMS, 1975) indicates a great deal of variability between water bodies. The Nine MIle Point population does not appear to be greatly different from those in other collections.

Comparison of total biomass and average biomass per fish were calculated for each month by transect (LMS, 1975). No transect or monthly difference in biomass was observed in the Nine Mile Point vicinity.

d. Abundance 1969-1974

The catch per 24 hrs of yellow perch from 1969 to 1974 is plotted in Figure VI-24. This plot shows a slight decrease in the abundance of yellow perch over the time period. Statistical analyses confirm this observation revealing that fewer yellow perch were collected in 1974 than in any other year (Table VI-6). This decrease in yellow perch abundance may be due to competition between young yellow perch and alewives. This hypothesis becomes supportable when it is realized that alewives increased many fold during 1973 and 1974.

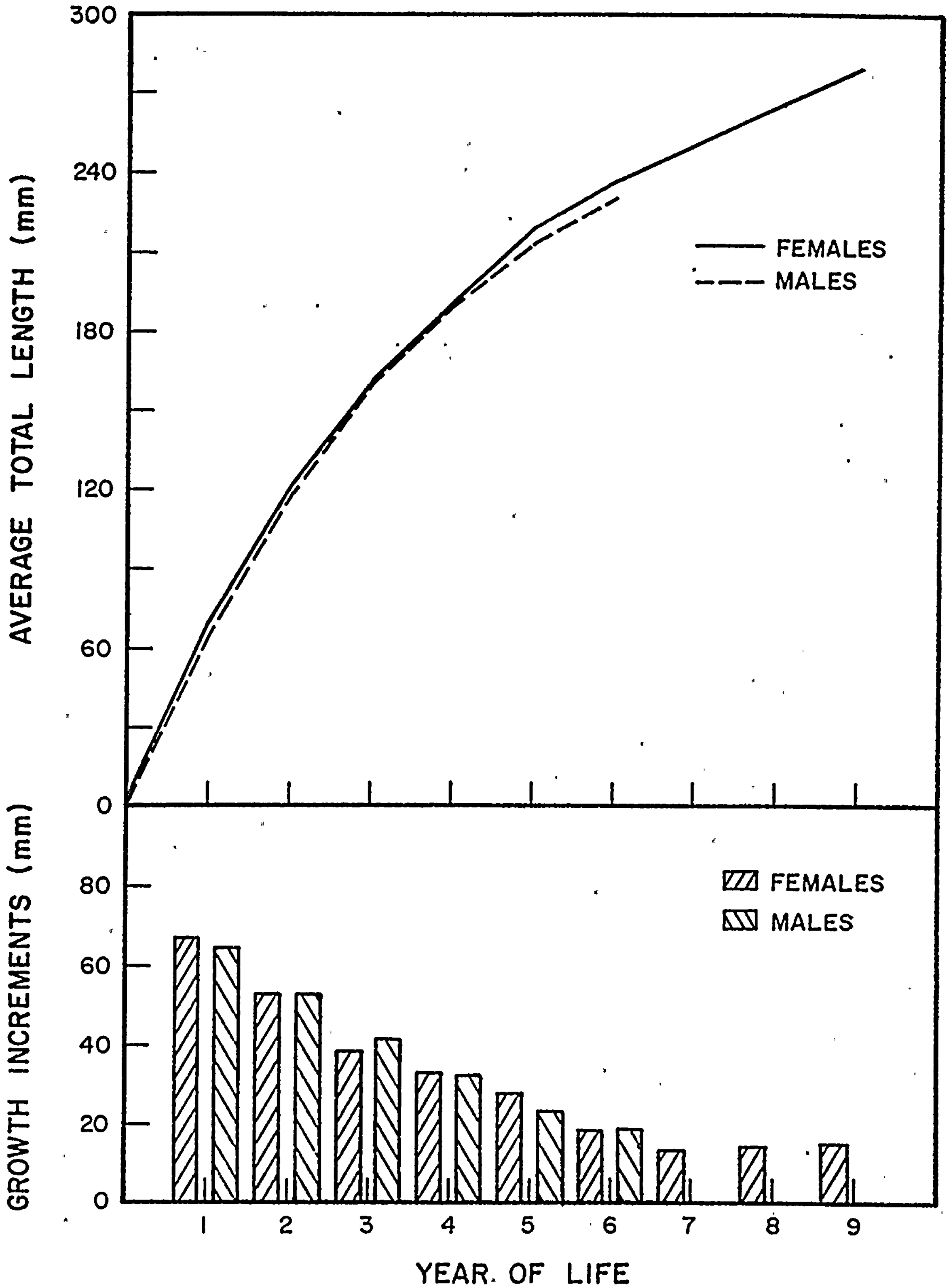
e. Distribution 1974

Two-way ANOVAs, one each for day and night, were conducted comparing yellow perch distribution by sampling depth (surface and bottom) and among seasons for 1974 (LMS, 1975). Significantly more yellow perch were collected in the bottom gill nets than the surface

FIGURE VI-21

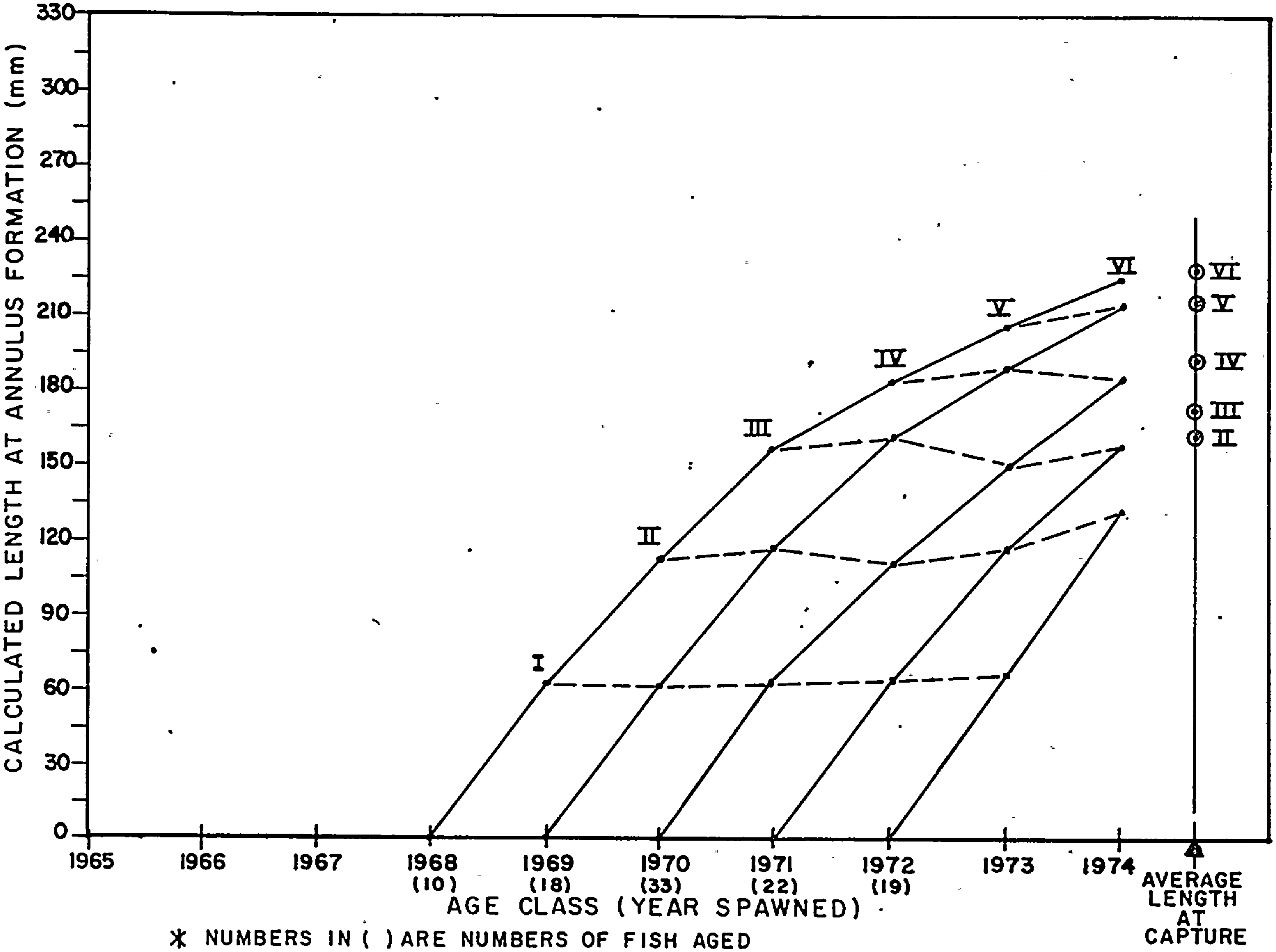
GROWTH CURVES AND ANNUAL GROWTH INCREMENTS OF MALE AND FEMALE YELLOW PERCH

NINE MILE POINT 1974



COMPARISON OF THE CALCULATED GROWTH OF MALE YELLOW PERCH AMONG FIVE AGE CLASSES FOR FISH COLLECTED BY GILL NETS & TRAWLS*

NINE MILE POINT-1974

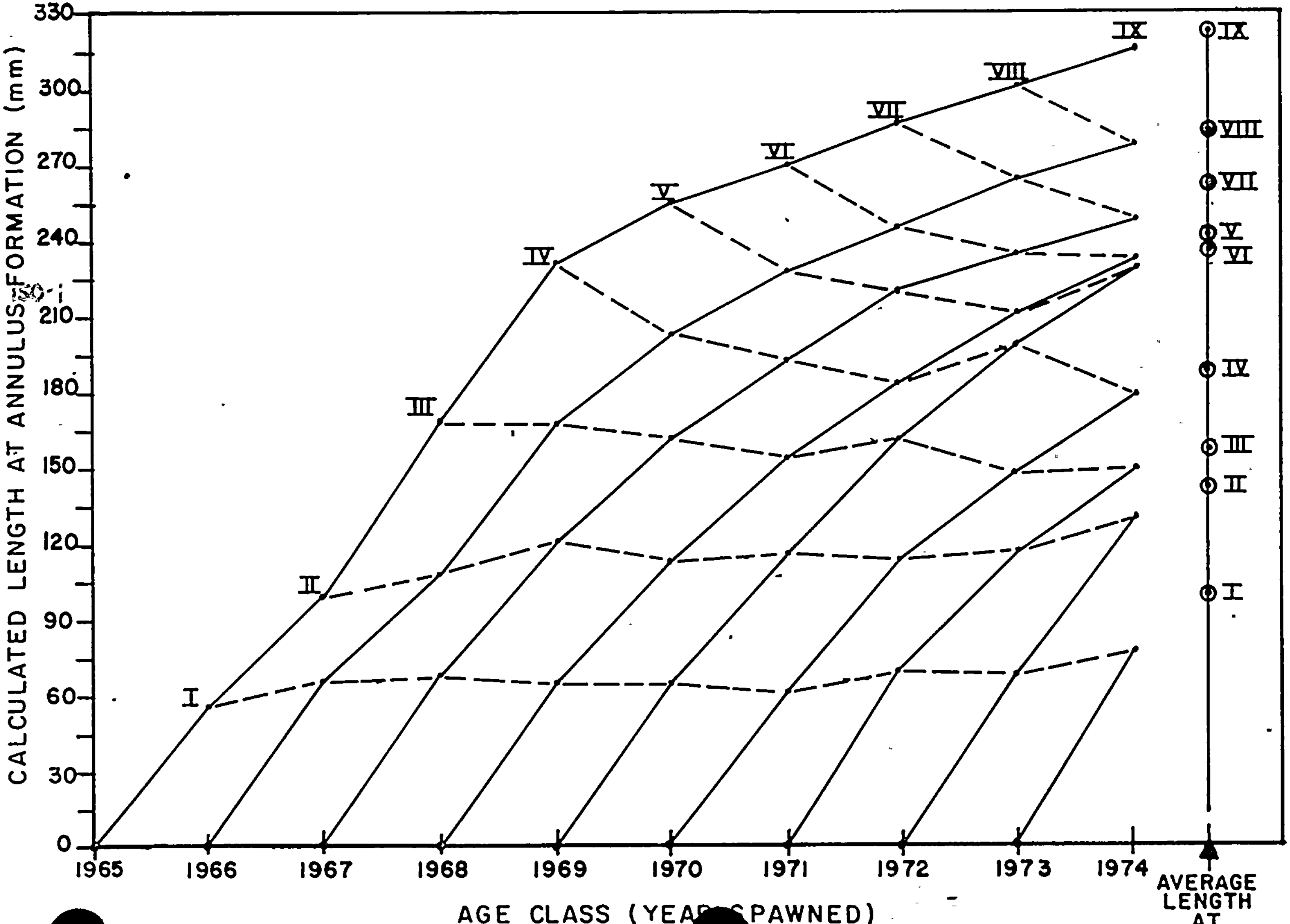


* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-22

COMPARISON OF THE CALCULATED GROWTH OF
FEMALE YELLOW PERCH
AMONG NINE AGE CLASSES
FOR FISH COLLECTED BY GILL NETS & TRAWLS*

NINE MILE POINT-1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH ... D

FIGURE VI-23

NUMBER OF YELLOW PERCH
COLLECTED BY GILL NET
NINE MILE POINT - 1969-1974

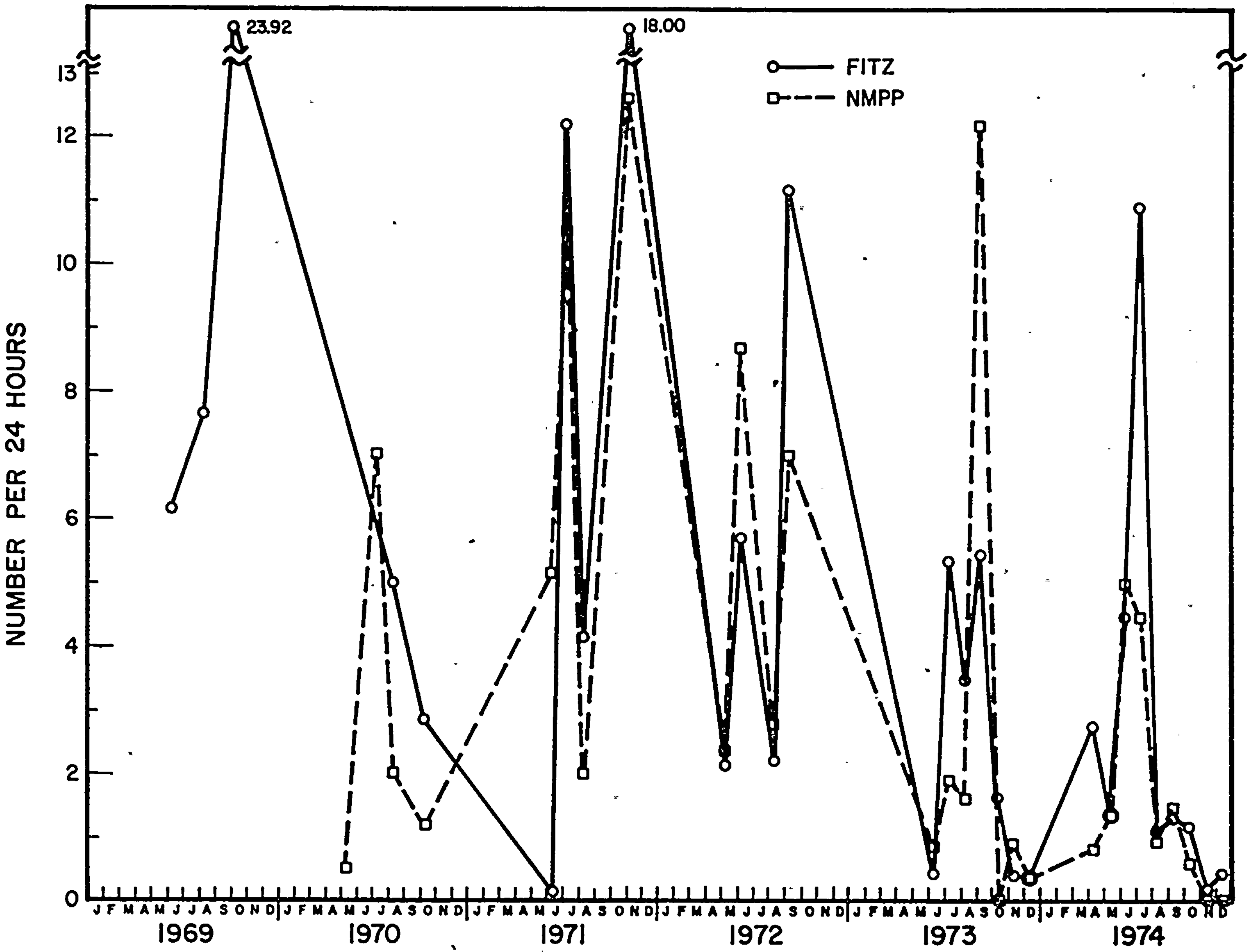


FIGURE VI-24

TABLE VI-6

TWO-WAY ANALYSIS OF VARIANCE COMPARING THE CATCH/EFFORT OF YELLOW PERCH BY GILL NETS BETWEEN THE NMPP AND FITZ TRANSECTS

NINE MILE POINT - 1969-1974

SOURCE	Degree of Freedom (Error)	Sum of Squares (Error)	Mean of Squares	F-Test
BETWEEN STRATA	10	2.6716	0.2682	2.607 (P>0.025)
WITHIN STRATA	48	4.9382	0.1029	
TOTAL	58	7.6198		

STUDENT-NEUMAN-KEULS TEST - DATES (α= 0.05)

Largest: 1969 P-71 F-71 P-72 F-70 F-72 P-70 F-73 F-74 P-73 P-74: Smallest

F = FITZ transect
P = NMPP transect

Bartlett's Test for homoscedasticity: χ^2_{10} = 3.968 (P>0.5)

* Transformation is log (1+ catch/effort)

Underlined segments resulting from the Student-Neuman-Kuels Test are statistically similar. Line breaks denote significant differences.

nets during both day and night, suggesting that the yellow perch in the vicinity of Nine Mile Point select bottom waters. According to Scott and Crossman (1973), these fish move up and down in the water column daily. More fish were generally collected during the summer (July, August and September) than during the spring; however, no consistent trend was observed for the fall collections. The greater abundance of yellow perch in the Nine Mile Point area at a time other than their spawning season indicates indirectly that they did not utilize this area for spawning.

In addition, three-way ANOVAs, one each for bottom and surface collections, were conducted comparing the distribution of fish between day and night, among the seasons, and among the sampling transects (LMS, 1975). A significant sampling depth x season interaction was shown for daytime catches; follow up analyses showed a significant difference among seasons only for bottom catches. Bottom gill net catch data indicate that more yellow perch were collected from the NMPE and FITZ transects than from the NMPW transect. The number of fish caught at the NMPP transect could not be separated from that caught at the other transects, thus, indicating that the yellow perch were not concentrated in the immediate vicinity of the Nine Mile Point Nuclear Station.

Everest (1973) found at the Hearn Generating Station in northwestern Lake Ontario that yellow perch, which were found only from June to November, were concentrated in the plume area as compared to a control area. This occurred especially during October, when these fish were collected at temperatures between 12-22°C, but when ambient temperatures were around 9-11°C. The highest temperature preference for the species has been experimentally determined at 21-24°C (Ferguson, 1958). The data and results presented in this report do not support the results obtained by Everest (1973). If yellow perch were selecting the thermal plume at Nine Mile Point, then collection data would be expected to indicate: 1) more fish at the surface, and 2) more fish at NMPP transect. Neither result was obtained (LMS,1975).

f. Conclusions

The date presented above on yellow perch can be summarized as follows:

- A spawning population was present in the vicinity of Nine Mile Point during the first two weeks of April; however, sex ratio information indicates that the Nine Mile Point area is not a preferred spawning site.

- Females were as fecund as yellow perch collected in other areas.

- Eggs were not collected though a few egg masses were observed in the area. Larvae were present during the spring but in very low abundance.

- Recruitment of young fish was observed during the late summer/ early fall.

- Feeding in the Nine Mile Point area appears to be natural for the species.

- Growth is uniform among age classes.

- A decrease in abundance was evident among the years 1969 to 1974 probably due to competition between young yellow perch and alewives. This decrease was uniform in the Nine Mile Point area as there was no significant difference between transects located within the plume and transects located outside of the plume.

6. Smallmouth Bass

a. Reproduction

Fecundity measurements were not performed on smallmouth bass because these fish were not present in collections during the spring coinciding to the expected time of spawning (Scott and Crossman, 1973).

The sexes were equally represented among smallmouth bass collected with gill nets in the vicinity of Nine Mile Point over the year 1974. (LMS, 1975). Smallmouth bass spawn as pairs, and therefore it should be expected that in a spawning area individuals would be distributed equally between the sexes.

Eggs of the smallmouth bass are spawned in nests usually in shallow water areas during the late spring and early summer months. Adult males guard the nest through early larval development when the larvae begin to leave the nest (Scott and Crossman, 1973). Eggs of the smallmouth bass have never been identified in collections at Nine Mile Point and during 1974 only one larvae was collected. Presence of adults in the area strongly suggests that some spawning and larval development occur; however, the nesting habits preclude collection of the eggs and larval forms.

The length frequency distributions for the smallmouth bass (LMS, 1975) indicate that during April and May, only large (old) fish were collected. Three slightly smaller bass were collected in June and several age classes were collected during July. Overall there was a predominance of large (old) smallmouth bass, suggesting an unstable population based on the fact that stable fish populations are more heavily represented by the younger age class. However, it should be noted that most of this discussion is based on collections by gill nets, which are size selective and do not catch small, smallmouth bass.

b. Feeding

There is a progression of preferred food items with increase in the size of smallmouth bass from plankton, to aquatic insects, to crayfish and fish (Scottland Crossman, 1973). Only adult smallmouth bass have been examined from collections at Nine Mile Point. Williams and Miller, (1973) reported a preference for forage fish primarily the spottail shiner and crayfish, during the summer with the crayfish becoming more prevalent in the fall months as forage fish became less abundant. Only four specimens were examined in 1974 with the dominant forage fish consumed being small alewife and the decapod, crayfish. The abundance of small alewife in the Nine Mile Point area would make this a preferred area for foraging by smallmouth bass.

c. Growth

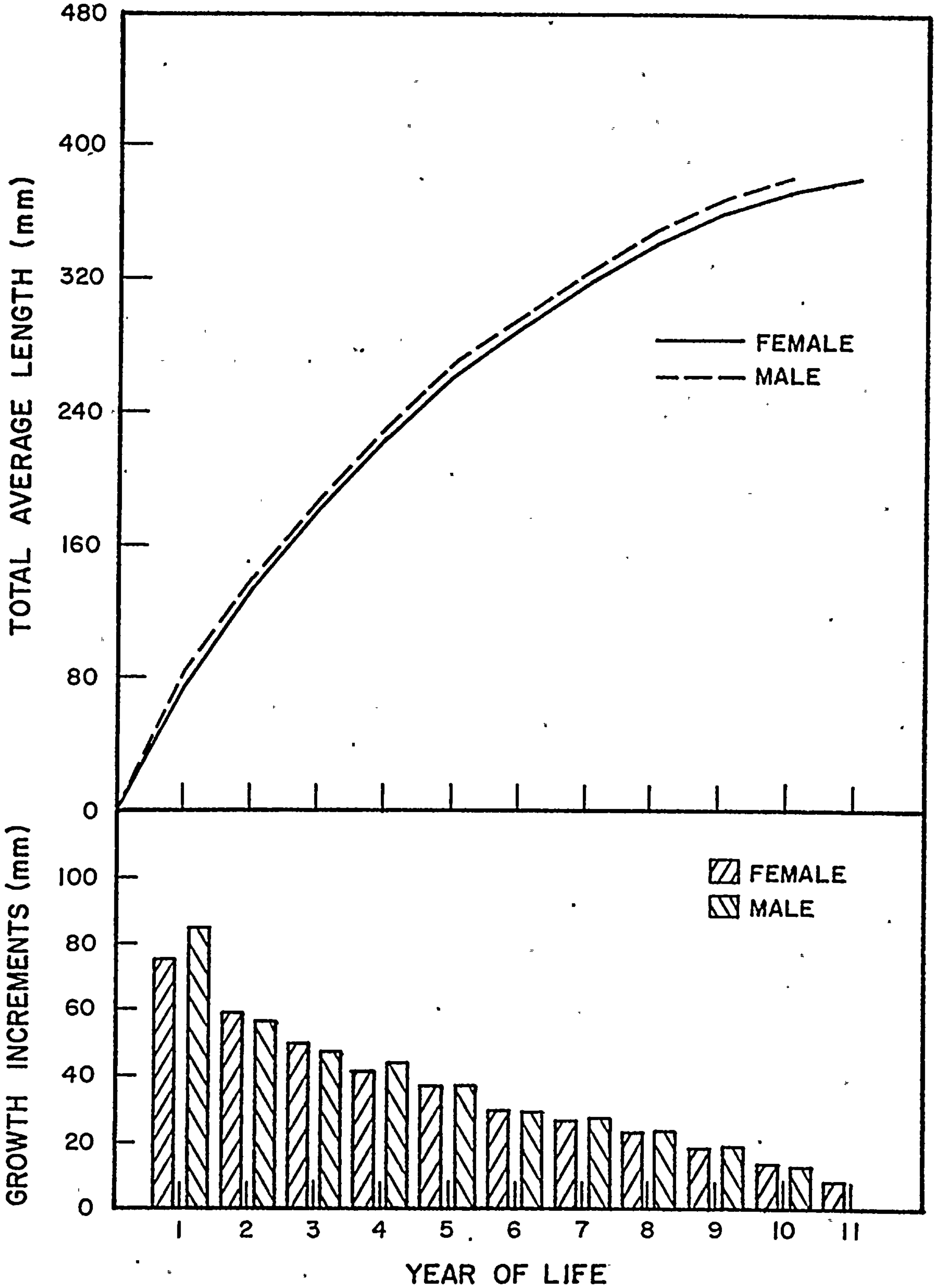
Reynolds (1965) reported that annulus formation in smallmouth bass occurred in late May in the Des Moines River, Iowa; Suttkus (1955) observed that annulus formation for smallmouth bass was completed during May and June for a small stream population in Falls Creek, New York. Annulus formation began during May and June for smallmouth bass from Nine Mile Point, peaked during July (52%) and was essentially complete by August.

The growth curves (calculated from the summation of the grand average annual increments of length) for both male and female smallmouth bass (Figure VI-25) had the same form, but males appeared larger at all ages. A t-test of the differences between the grand average calculated lengths of male and female smallmouth bass for each year of life revealed that males were significantly larger at ages 1, 3, 5, 6, 8, and 9 ($p < 0.05$). In 1973, QLM (1974) reported that only five-year-old males were significantly larger than females. Stone et al. (1954) reported little difference in the growth of male and female smallmouth bass in the St. Lawrence region of Lake Ontario; Suttkus (1955) also found no difference in the growth between the sexes for smallmouth bass in Fall Creek, New York.

FIGURE VI-25

GROWTH CURVES AND ANNUAL GROWTH INCREMENTS OF MALE AND FEMALE SMALLMOUTH BASS

NINE MILE POINT 1974



Calculated growth of male and female smallmouth bass were plotted as a function of age (Figures VI-25 and VI-26). These plots show that first year growth has not been uniform with from 40 to 100% change occurring between any two years. In addition for both sexes there are year classes missing (not collected) indicating a low abundance of these years representatives. Growth of females appears to be more regular than male growth at least for age class I.

Based on the limitations of comparing data among growth studies described in LMS (1975) the following points are apparent. The difference between the estimated growth of smallmouth bass at Nine Mile Point for 1973 and 1974 was the greatest at ages one and two, but decreased with increasing age; estimates of growth were similar at ages six to eight. The growth estimates at Nine Mile Point were similar to those at Tadenac Lake, Ontario for ages one to four and to the St. Lawrence River-Lake Ontario area for ages five to seven. The growth estimates for fish in these two studies were greater than Nine Mile Point estimates for the remaining years of life. Smallmouth bass in Cayuga Lake, Lake Michigan, and the Des Moines River, Iowa appear to grow faster than smallmouth bass at Nine Mile Point.

Biomass data showed no difference in either total or average weight per fish among transects at the Nine Mile Point during 1974.

d. Abundance 1969-74

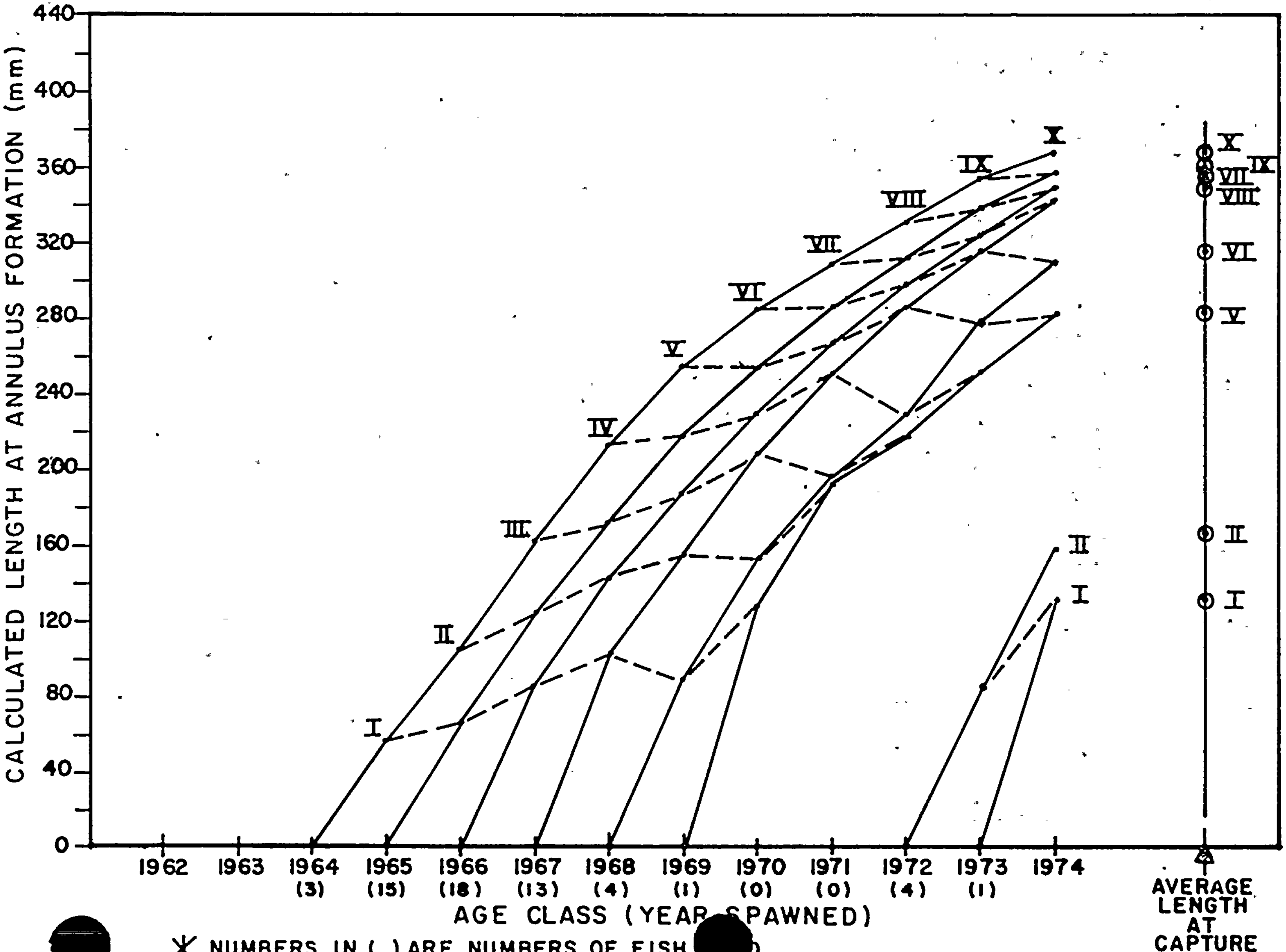
The two way analysis of variance showed that there were no significant differences in smallmouth bass catch/effort among the six years or between the transects NMPP and FITZ. The catch/effort information is presented in Figure VI-28 and the results of the ANOVA in Table VI-7.

e. Distribution 1974

The three-way ANOVA compared differences between day and night or among sampling transects. A statistical difference in abundance among transects was expected, based on qualitative information from LMS divers and fisherman, who reported that smallmouth bass actively congregate within the area of the Nine Mile Point discharge. In addition, John Kelso (personal communication, Canada Center for Inland Waters, Burlington) reported that smallmouth bass in 1973 made frequent forays into "hot" areas of the Pickering Generating Station discharges. Sonic tagging showed that the fish entered the hot areas for only a few minutes, and then returned to the area just outside of the plume where they remained

COMPARISON OF THE CALCULATED GROWTH OF
MALE SMALLMOUTH BASS
AMONG EIGHT AGE CLASSES
FOR FISH COLLECTED BY GILL NETS & TRAWLS*

NINE MILE POINT - 1974

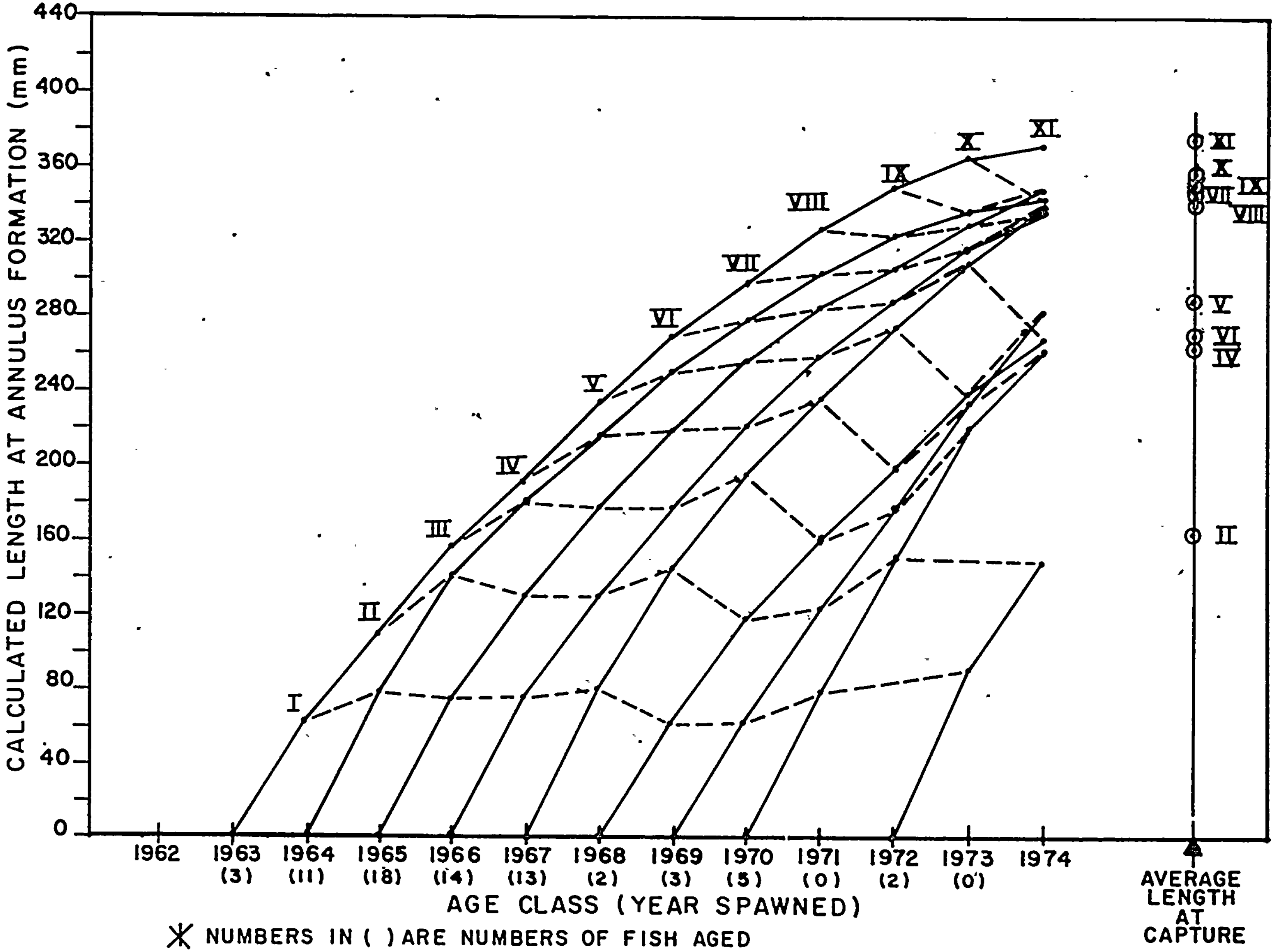


* NUMBERS IN ( ) ARE NUMBERS OF FISH ...D

FIGURE VI-26

COMPARISON OF THE CALCULATED GROWTH OF FEMALE SMALLMOUTH BASS AMONG NINE AGE CLASSES FOR FISH COLLECTED BY GILL NETS & TRAWLS*

NINE MILE POINT - 1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-27

NUMBER OF SMALLMOUTH BASS COLLECTED BY GILL NET

NINE MILE POINT - 1969-1974

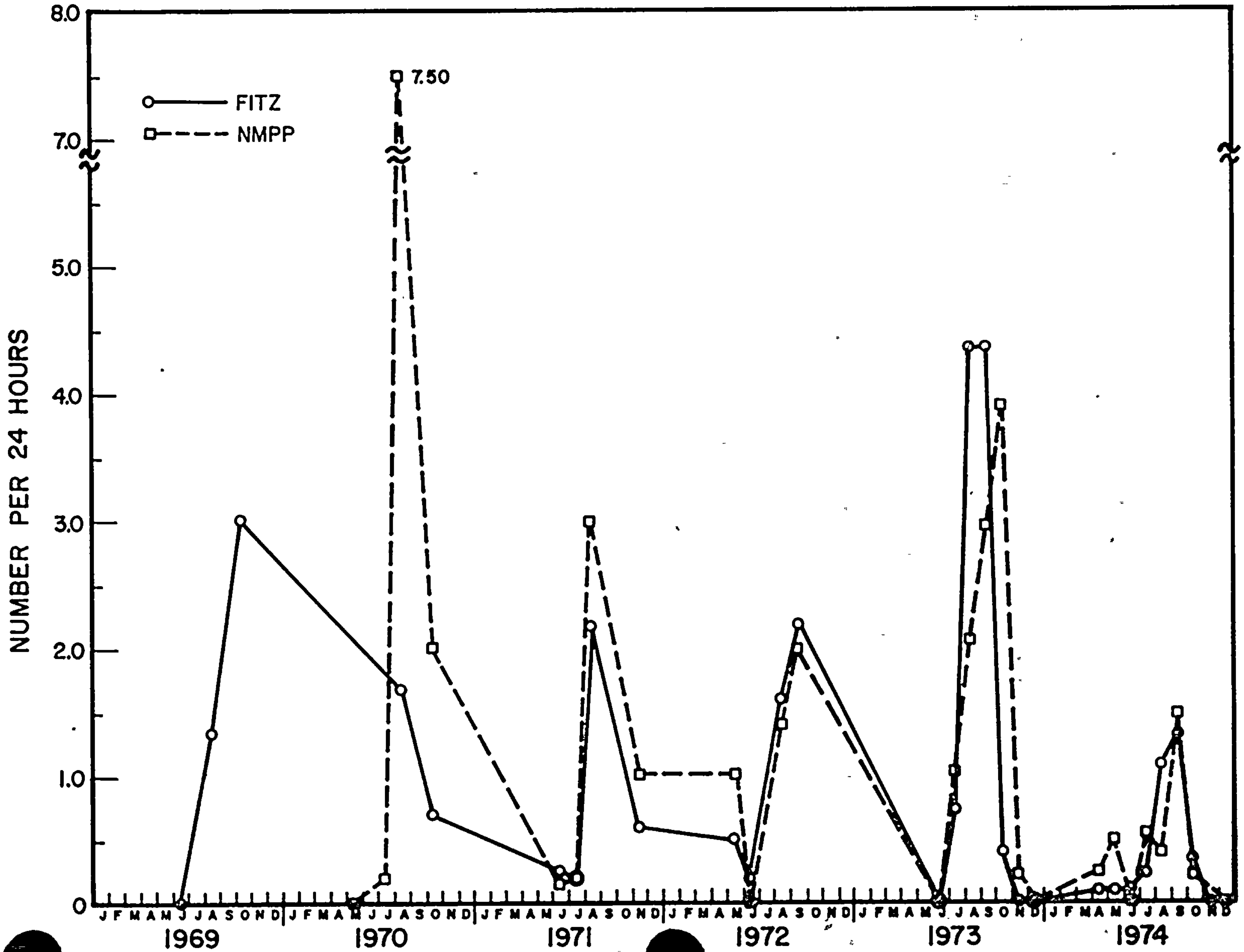


FIGURE VI-28

TABLE VI-7

TWO-WAY ANALYSIS OF VARIANCE COMPARING THE CATCH/EFFORT OF SMALLMOUTH BASS AMONG YEARS AND BETWEEN THE NMPP AND FITZ TRANSECTS*

NINE MILE POINT - 1969-1974

SOURCE	Degree of Freedom (Error)	Sum of Squares (Error)	Mean of Squares	F-Test
BETWEEN STRATA	10	0.4271	0.0427	0.731 (P>0.25)
WITHIN STRATA	48	2.8029	0.0584	
TOTAL	58	3.2299		

Bartlett's Test for homoscedasticity: $\chi^2_{10} = 13.427$ (P>0.10)

* Transformation is log (1+ catch/effort)

until the next foray. No transect difference was apparent in the Nine Mile Point Nuclear Station vicinity;,this may have been due to the relatively small numbers of smallmouth bass collected.

More smallmouth bass were collected, however, during the summer (July, August, September) than during either spring (April, May, June) or fall (October, November, December).

f. Conclusions

The data presented above on smallmouth bass in the vicinity of Nine Mile Point can be summarized as follows:

- Estimates of time of spawning and fecundity could not be done due to the absence of spawning adults in the collections.

- Between the years 1973 and 1974 only one smallmouth bass larvae has been collected. The absence of larvae in probably due to the nest building habits of the adults.

- Feeding appears to be normal for the species.

- Growth is irregular and some age classes mainly the younger ones are quite low in abundance.

- There has been no noticeable change in the catch/effort of smallmouth bass from 1969 to 1974.

- Transect differences between those located in the plume and those outside of the plumes influence were similar.

7. Threespine Stickleback

a. Reproduction

No data are available on the time of spawning or the fecundity of threespine sticklebacks in the vicinity of Nine Mile Point.

Eggs of the threespine stickleback have never been collected in the vicinity of Nine Mile Point, and larvae were reported only from collections conducted in 1973. Nest building and guardianship of the eggs and young by the adult males precludes collection with the currently used sampling gear.

b. Feeding

The threespine stickleback is an opportunistic feeder consuming any available animal food source including their own eggs and young (Hynes, 1950). Information on feeding habits for threespine sticklebacks collected in the area of Nine Mile Point is not currently available.

c. Growth

No data are available on the growth of the threespine stickleback in the vicinity of Nine Mile Point.

d. Abundance

During 1973, 78 threespine sticklebacks were collected and during 1974 29 were collected. There was no apparent concentration of sticklebacks at any one of the transects.

8. Spottail Shiner

a. Reproduction

No data are available on either the time of spawning or fecundity of the spottail shiner in the vicinity of Nine Mile Point.

The larvae of the spottail shiner, an important forage species, has been reported in the Nine Mile Point area from only 1973 collections. Spawning is reported to occur over sandy substrates (Scott and Crossman, 1973) which is not found in the area around Nine Mile Point, but does exist towards the east (LMS, 1975). The absence of eggs and very small numbers of larvae collected suggest that the Nine Mile Point vicinity is not a preferred spawning or nursery area for this species.

b. Feeding

Large crustaceans such as Leptodora and Daphnia, and insects all of which are abundant around Nine Mile Point are considered important food items for the spottail shiner. Food habits for spottails collected in the vicinity of Nine Mile Point are not available; however, all reported food items have been reported in collections from the study area.

c. Distribution and Abundance

The spottail shiner represented 5.6% of the total fish collected in 1974 with 5459 fish. It is also the most abundant (based

NUMBER OF SPOTTAIL SHINERS COLLECTED BY GILL NET

NINE MILE POINT — 1974

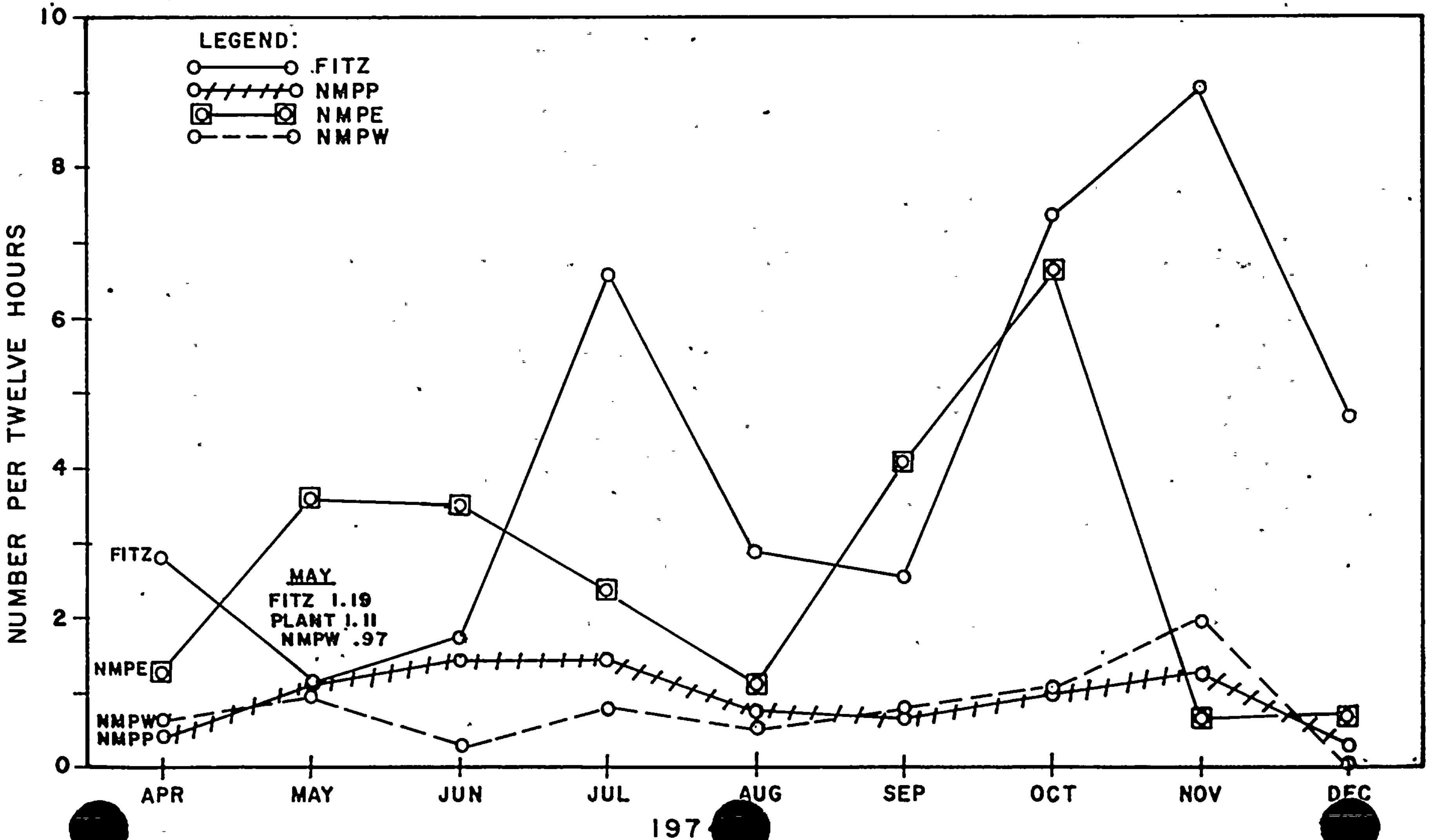


FIGURE VI-29

on catch/effort) natural fish (i.e., not recently introduced) in the vicinity of Nine Mile Point.

Bottom gill nets during sampling conducted in 1974 yielded 5377 of the 5459 spottail shiners collected, indicating that shiners prefer the bottom. This distribution is correlated with the feeding habits of spottails, which consume principally plankton (e.g., Daphnia, Bosmina, and Leptodora) and aquatic insect larvae (e.g., chironomids), organisms which are usually abundant in bottom collections.

The catch/effort data was plotted by month and sampling transect in Figure VI-29 for 1974. These data indicate a predominance of spottails to the east of the Nine Mile Point Plant, with the greatest abundance at the FITZ transect.

Since most spottail shiners were collected from the bottom and in areas other than the NMPP transect, it can be concluded that they were not selecting the warmer surface waters of the thermal plume.

9. Brown Trout

a. Reproduction

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

b. Feeding

Brown trout feed on a wide variety of organisms ranging from insects, molluscs, amphibians, decapods, and fish. The wide range of food items consumed would not preclude brown trout from the area of Nine Mile Point; however, no information of feeding habits is currently available.

c. Abundance

A total of 31 brown trout were collected in 1973 and 75 in 1974. Of the total 106 fish, 81 were collected with surface gill nets and 25 with bottom gill nets. The brown trout is stocked annually by NYSDEC in many rivers emptying into Lake Ontario.

10. Coho Salmon

a. Reproduction

No data are available on the fecundity or time of spawning 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 re-stocking programs. At present no information is available on any natural reproduction by the introduced fish and in the vicinity of Nine Mile Point no eggs or larvae have been collected.

b. Feeding

Coho salmon are reported to feed primarily on alewife and rainbow smelt (Christie, 1974). Information on coho salmon feeding in the Nine Mile Point vicinity is not presently available.

c. Abundance

Two coho salmon were collected by Storr (1970a) in 1969, one in 1970, none in 1971, 1972, and none in 1973 by QLM (1974) or by LMS (1975) in 1974.

11. *Gammarus fasciatus*

a. Life Cycle

The life cycle and feeding for nearctic populations of *Gammarus* were discussed in Section V-B. In depth analysis of the population present in the vicinity of Nine Mile Point has not been conducted; however, seasonal distributional trends with peak abundance occurring during late summer/early fall (LMS, 1974, 1975) corresponds to the general literature presented.

b. Abundance 1969 - 1974

The number of *Gammarus fasciatus* collected in benthic surveys in the vicinity of Nine Mile Point from 1969 to 1974 is presented in Figure VI-30. Benthic surveys were limited during the years 1969 through 1972 encompassing only two, primarily summer collections; however, the graph indicates the same population trends among years. Sampling techniques were different between 1969-1972 and 1973-1974 which may account for some of the difference in abundance values; however the trends among years are similar. The yearly abundance

MEAN MONTHLY ABUNDANCE OF GAMMARUS FASCIATUS
COLLECTED BY BENTHIC PROGRAMS
NINE MILE POINT - 1969-1974

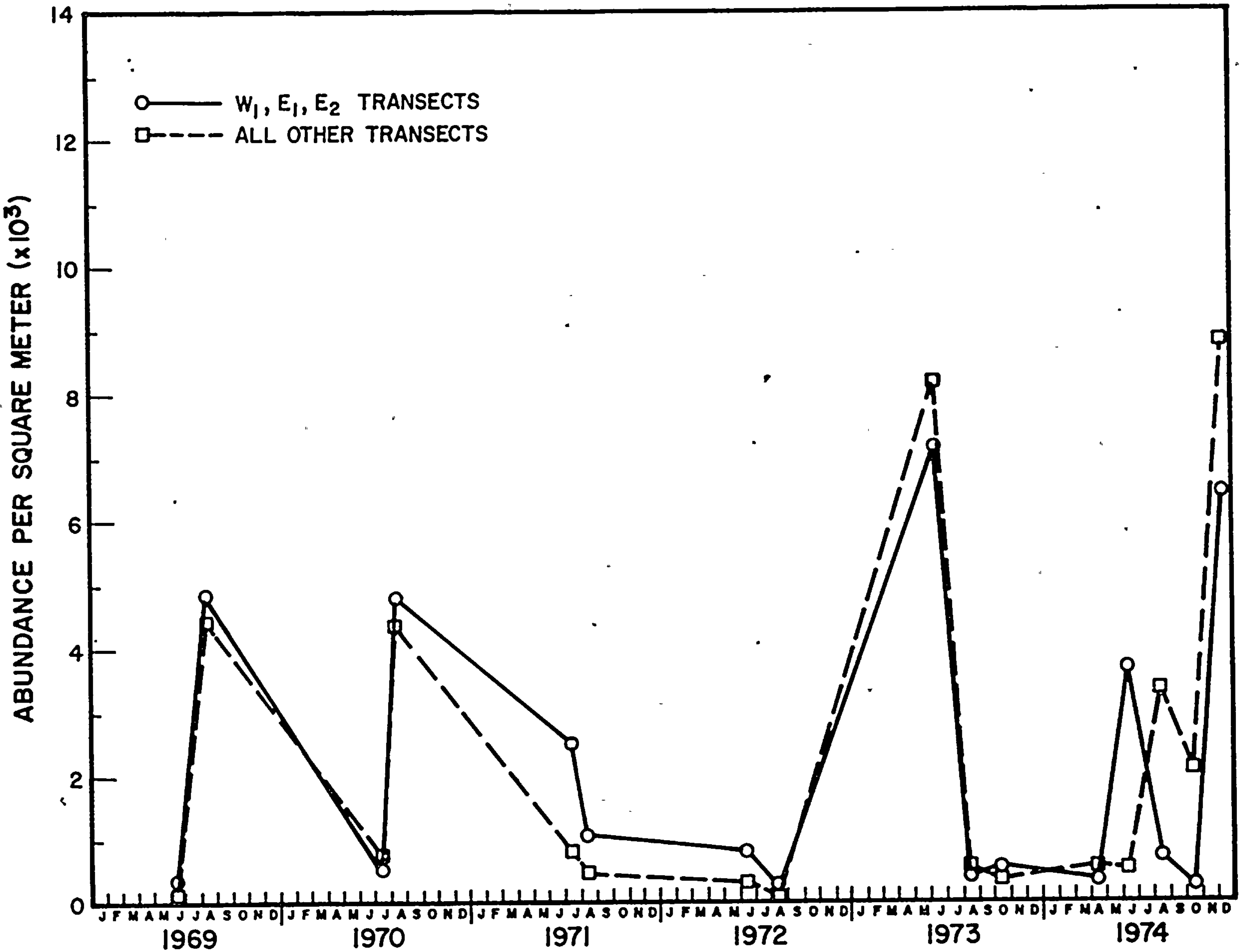


FIGURE VI-30

and transect abundance corresponding to locations within the designated plume and station not affected by the plume were tested for differences using a two-way analysis of variance (ANOVA) (Table VI-8). There was no significant difference observed in either yearly or transect abundance of Gammarus at Nine Mile Point.

Distributional trends for Gammarus collected during 1974 at Nine Mile Point were evaluated using an ANOVA (LMS, 1975). The statistical test results showed a significantly greater abundance of the amphipod at the shallower 20 ft stations located to the east of the plants discharge and the lowest abundance at the 80 and 100 ft depth contour stations to the north of the plant.

c. Conclusion

The information presented for Gammarus fasciatus in the vicinity of Nine Mile Point can be summarized as follows:

- Seasonal trends in abundance indicates that Gammarus, an important food item, successfully completes an annual reporductive cycle in the study area.

- Comparison of abundance values from benthic samples collected before and after plant operation (1969-1974) show no significant difference.

- Evaluation of G. fasciatus abundance between stations located in the designated plume and stations not affected by the thermal discharge showed no significant differences.

- The thermal discharge from Nine Mile Point Unit 1 does not affect Gammaras fasciatus as evidenced by the presented information.

12. Cladophora glomerata

a. Cladophora glomerata

The biomass of the dominant algal species Cladophora collected in benthic sampling programs among the years 1969 to 1974 at transects located within the influence and not within the influence of the Nine Mile Point thermal plume is graphically presented in Figure VI-31. Biomass values were tested for significant differences using a two-way ANOVA, and the results (Table VI-9) show no significant difference among years or between transects. The results indicate that the thermal discharge of Nine Mile Point Unit 1 has not altered the seasonal growth cycle of the algae discussed in section V-B, nor caused a significant increase in the biomass.

TABLE VI-8

TWO-WAY ANALYSIS OF VARIANCE FOR YEARLY AND TRANSECT ABUNDANCE* OF GAMMARUS FASCIATUS

NINE MILE POINT - 1969-1974

SOURCE	Degree of Freedom (Error)	Sum of Squares (Error)	Mean of Squares	F-Test
BETWEEN STRATA	11	1.8980	0.1726	0.468 (P>0.25)
WITHIN STRATA	20	7.3669	0.3683	
TOTAL	31	9.2649		

Bartlett's Test for homoscedasticity: $\chi^2_{11} = 3.854$ (P>0.25)

* Log transformed

MEAN MONTHLY BIOMASS OF CLADOPHORA COLLECTED BY BENTHIC PROGRAMS

NINE MILE POINT - 1969-1974

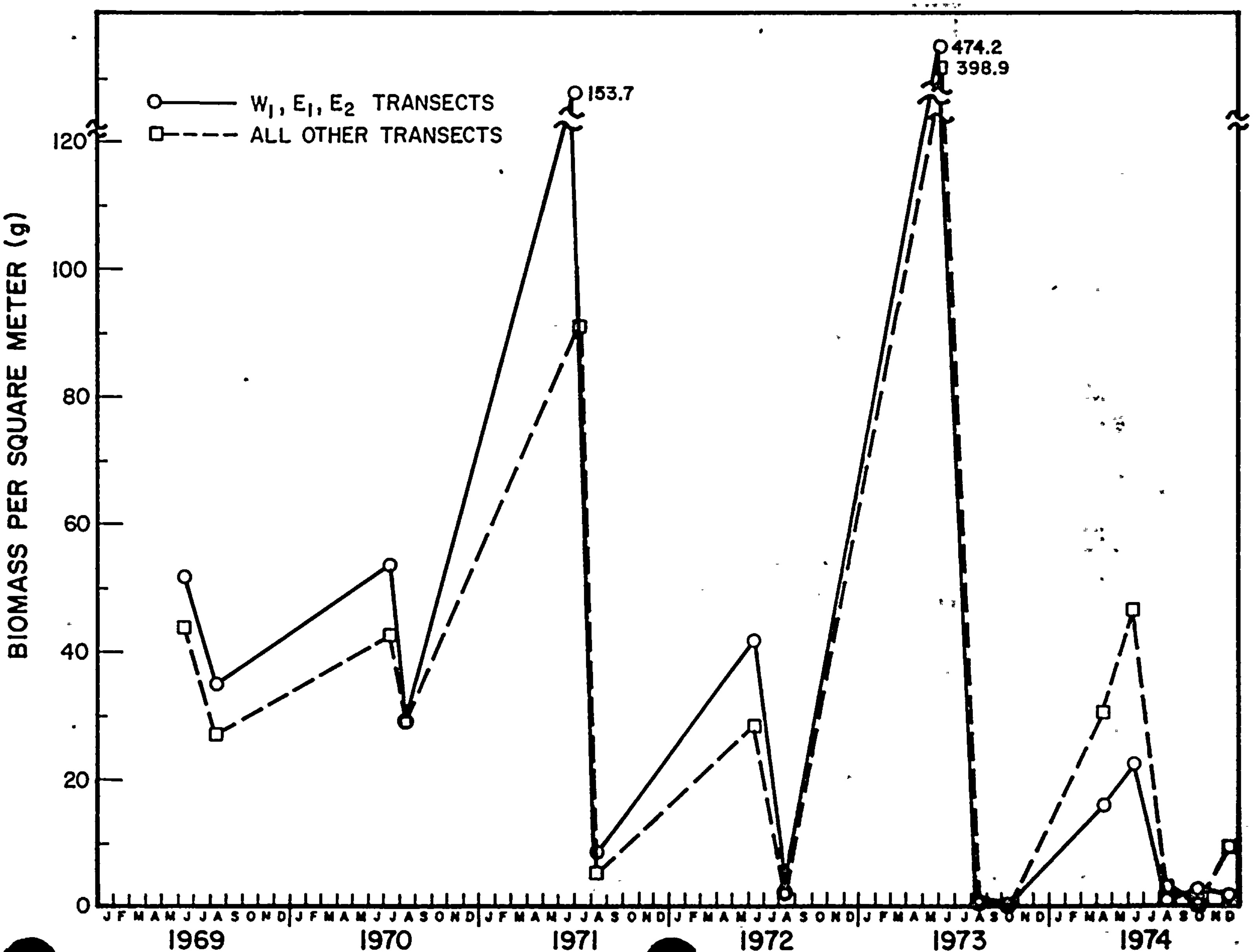


FIGURE VI-31

TABLE VI-9

TWO-WAY ANALYSIS OF VARIANCE FOR YEARLY AND TRANSECT BIOMASS* OF CLADOPHORA GLOMERATA

NINE MILE POINT - 1969-1974

SOURCE	Degree of Freedom (Error)	Sum of Squares (Error)	Mean of Squares	F-Test
BETWEEN STRATA	11	3.4483	0.3135	.430 (P>0.25)
WITHIN STRATA	20	14.5861	0.7293	
TOTAL	31	18.0344		

Bartlett's Test for homoscedasticity: $X^2_{11} = 13.061$ (P>0.25)

* Log transformed

13. Summary

The life cycle activity, where information was available, for the representative important species in the vicinity of Nine Mile Point was discussed in this section. Population parameters evaluated included; time of spawning based on the calculation of coefficient of maturity, fecundity, time of annulus formation, egg and larvae abundance, growth, sex ratio, recruitment and year class structure. In addition, distributional trends among years (1969-1974) encompassing pre-operational and post-operational Nine Mile 1 conditions based on catch per effort for gill nets was evaluated statistically using analysis of variance. Transects continously sampled from 1969 through 1974 were grouped as to their location in relation to the designated thermal plume and evaluated for significant differences in abundance again using the analysis of variance.

The alewife, rainbow smelt, white perch, and yellow perch were collected in sufficient quantity and at all stages of development to demonstrate completion of a normal life cycle in the vicinity of Nine Mile Point. Absence of life stage data or low abundance for the smallmouth bass, threespine stickleback, and spottail shiner preclude definitive statements concerning life cycle completion; however, indirect evidence from available literature strongly suggests that these species complete reproductive, growth, and developmental cycles in the Nine Mile Point vicinity. The salmonids, brown trout and coho salmon do not normally reproduce in limnetic environments, and low abundance values for each species do not indicate a definite use by any life stage of the study area. The amphipod Gammarus fasciatus and alga Cladophora glomerata exhibited seasonal trends in abundance (biomass) indicating completion of an annual life cycle.

Yearly catch per effort data for the rainbow smelt, white perch, and smallmouth bass collected by gill nets showed no significant difference among the years 1969 to 1974. Alewives have increased in abundance with significantly greater numbers collected during 1974 compared to the earlier years. Alewives exhibit oscillations in abundance over two to three year periods and the increase in 1974 is probably normal for the population. Yellow perch exhibited a general decline in abundance over the six years having significantly fewer collected in 1974. The decline in yellow perch abundance may be the result of competition with the increasing alewives. No significant differences were observed in the yearly abundance of G. fasciatus or the biomass of C. glomerata at Nine Mile Point among the pre-operational and post-operational years.

No influence on the distribution of the representative important species by the thermal discharge from Nine Mile Point Unit 1 was observed on a significant level in a statistical comparison of transects located within the influence of the plume and those located outside of the plume.

E. COMMUNITY STRUCTURE

Evaluation of the fish community at Nine Mile Point demonstrates that:

(1) the community as a whole is intact (as required on p.26 of the guidance manual), and

(2) the community structure has not been simplified as a result of the Nine Mile 1 discharge (this evaluation is required on p.23 of the guidance manual).

The distribution of individuals among species within a community can take a variety of forms and many computational techniques have been developed to represent these distributions (see review by Peet, 1974). One of the most common and widely accepted statistics used to relate the number of species and the distribution of individuals among those species is the Shannon-Weaver species diversity index (Shannon and Weaver, 1949). Pielou (1966) explained the use of this information theory index to diversity measurements, suggesting that heterogeneity can be equated with the amount of uncertainty that exists regarding the species of an individual selected at random from a population. The more species there are and the more nearly even their distribution, the greater the diversity.

Smith (1966), Fischer (1960), and Elton (1958) believe that diversity is least in simpler, less stable ecosystems. Many exceptions to this general rule can be found, nonetheless, the species diversity index is one way of measuring the heterogeneity of a system. In addition, Hutcheson (1970) has developed a sampling theory for the Shannon-Weaver formulation thus allowing for parametric comparisons of diversity measures. By calculating species diversity and then comparing them statistically, it is possible to document whether or not a statistically significant change in the heterogeneity of the community has occurred. Furthermore, since species do not exist as independent entities but interact with one another, the measure of heterogeneity becomes a measure of structure. Thus, comparisons of diversity may also reveal changes in community structure.

A monthly species diversity for the fish collected during 1973 and 1974 from six sampling transects in the vicinity of Nine Mile Point was calculated using the Shannon-Weaver formulation. These data are presented in Figure VI-32. This graphic presentation illustrates the dynamic nature of the community within this area. For both years diversity is highest during September and October which is followed by a decrease to December. The lowest diversity values are found during June and July. This corresponds to the time of the maximum inshore migration of the alewife. When one species predominates in the collection, the diversity of the collection will decrease.

A three-way analysis of variance was conducted on the monthly diversity data comparing the two sampling years, the six transects, and the sampling months.

There were no significant differences (at = 0.01) among the sampling transects for any temporal comparison (Table VI-10). Thus it can be concluded that the species diversity is similar at each transect. In addition there was not a significant difference in the mean annual species diversity. However, there were significant differences between the months when compared by year. June, July, and August 1973 species diversity values were higher than these months in 1974. It was shown previously that alewife abundance (catch/effort) had increased during 1974. This would tend to decrease the species diversity values for the months in 1974 when alewives were most abundant (i.e., June, July and August).

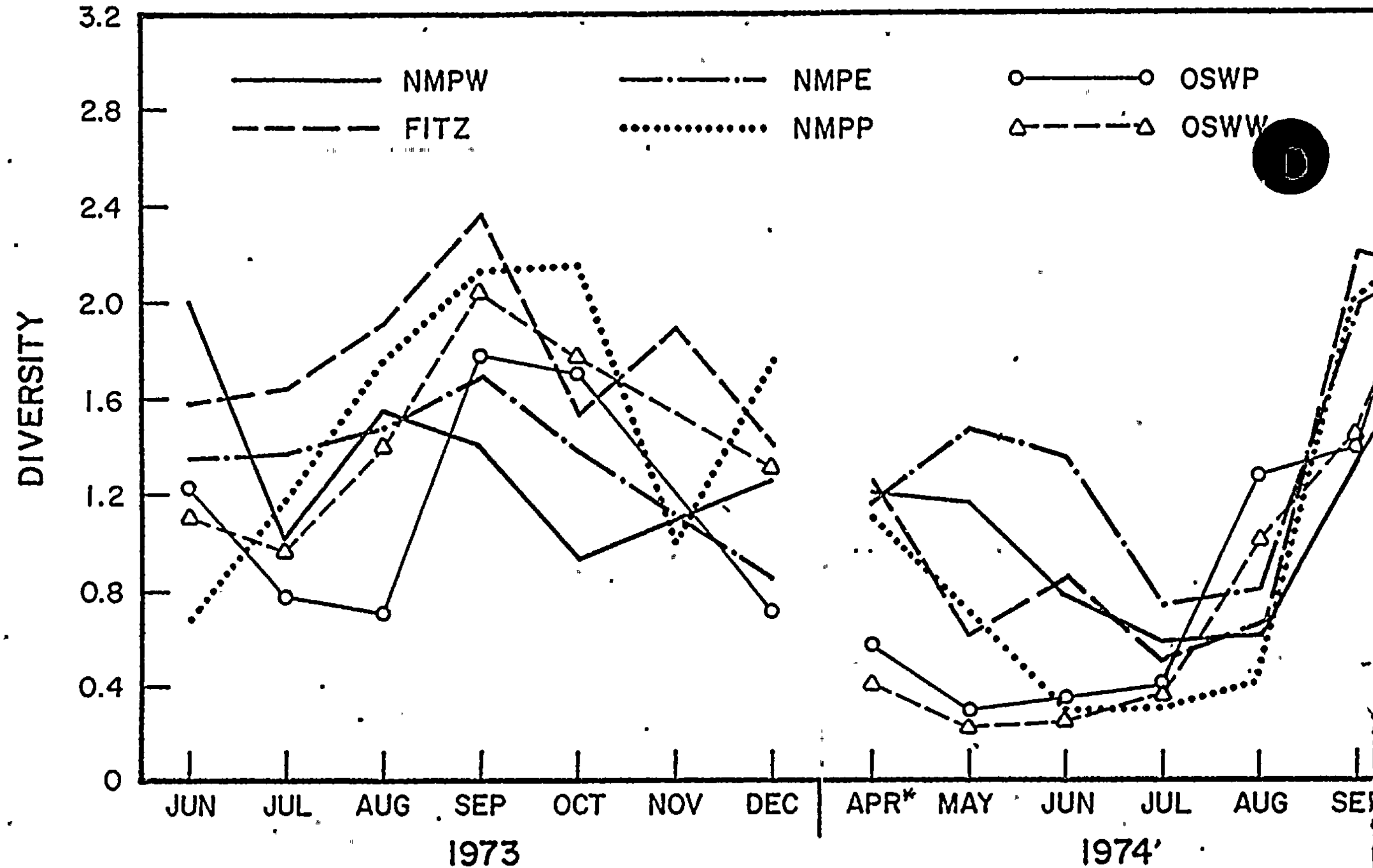
One other monthly difference was noted; the mean species diversity for October 1974 was greater than for October 1973. This is due to a decreased catch of alewives in 1974 and an increase in abundance of white perch, yellow perch, spottail shiners, and gizzard shad.

The lack of a difference between the average yearly values indicates that there has not been a statistically significant change in the community heterogeneity (or structure) for the period. The lack of differences among the transects indicates that the thermal discharge from Nine Mile 1 has not resulted in a statistically significant change in the community heterogeneity at the NMPP transect.

F. ECONOMIC AND RECREATIONAL USE OF THE STUDY AREA

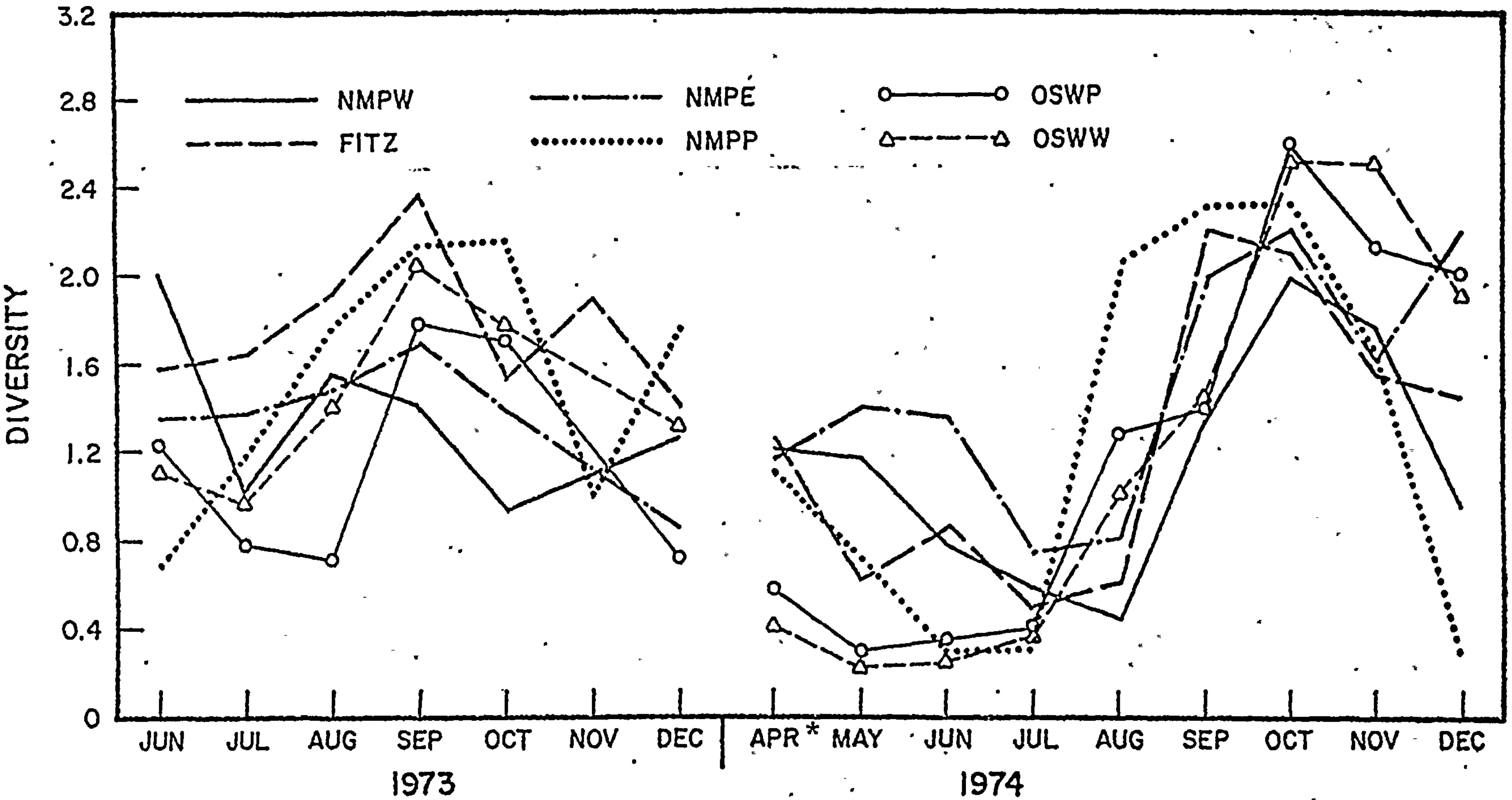
An important consideration in evaluating water resources and the potential impact from a point source discharge is the availability and suitability of the area for recreational activity. Water activities near Nine Mile Point including boating, swimming, and fishing by both residents and tourists are beneficial to the local economy; therefore, any impairment to the use of the available water resources would result in an economic impact.

MONTHLY SPECIES DIVERSITY OF GILL NET COLLEC
IN THE VICINITY OF OSWEGO AND NINE MILE POI
1973-1974



*COLLECTIONS WERE NOT DONE DURING JAN., FEB., & MAR. OF 1974

MONTHLY SPECIES DIVERSITY OF GILL NET COLLECTIONS IN THE VICINITY OF OSWEGO AND NINE MILE POINT 1973-1974



* COLLECTIONS WERE NOT DONE DURING JAN, FEB, AND MAR OF 1974

FIGURE VI- 32

TABLE VI-10

THREE WAY ANALYSIS OF VARIANCE COMPARING THE GILL NET SPECIES DIVERSITY IN 1973 TO 1974, AMONG THE SIX SAMPLING TRANSECTS, AND FOR EACH MONTH

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	DEGREES OF FREEDOM (ERROR)	MEAN OF SQUARES (ERROR)	F-test
YEARS	1	0.786	35	0.303	2.594
TRANSECTS	5	0.918	55	0.159	1.155
MONTHS	5	12.505	55	0.223	11.316**
YEAR X TRANSECT	5	1.760	25	0.141	2.496
MONTH X TRANSECT	25	3.452	25	0.141	0.979
YEAR X MONTH	5	5.316	25	0.141	7.540**

** = Significant at α= 0.01

DIFFERENCES BETWEEN YEARS, BY MONTH (1973-1974)

MONTH +	DIFFERENCE	T-test	YEARLY COMPARISON
June	0.677	3.123**	73>74
July	0.682	3.146**	73>74
August	0.716	3.303	73>74
September	0.159	0.733	-
October	0.711	3.280**	74>73
December	0.265	1.222	-

** = Significant at α=0.01

+ = Only six months were compared between years because data were not available for the winter months (January, February, March) and for the months of May and November in 1973 at all transects

Access to the waters in the vicinity of Nine Mile Point includes boating facilities at Oswego and at a new small craft harbor in Mexico Bay to the east of Nine Mile Point. Information on the extent of use of the waters in the Nine Mile Point vicinity is not available; however, observations by sampling crews indicate that the area is extensively used by fishermen during the summer months. Observations made during 1973 and 1974 when crews have been working in the area also indicate that the area is heavily used by small craft cruising or sailing along the lake's shore.

The principal game fish taken in the study area is reported to be the smallmouth bass. Sport fish including the smallmouth bass, white perch, yellow perch, and several pike species were discussed in Chapter V. Numerous smaller pan fish species include white bass, crappie, and several sunfish that are resident in the Nine Mile Point area. The State of New York is presently committed to an extensive salmonid stocking program in the eastern section of Lake Ontario. The stocking program includes coho and chinook salmon, and brown, lake, and rainbow trout; these fish species have been observed collected in the Nine Mile Point area (QLM, 1974; LMS, 1975) indicating an increase in fish species available to sport fishermen.

The presence of resident and stocked game fish in the area of Nine Mile Point is in part the result of several forage species, which are preferred food items for the game fish. The macro-invertebrate Gammarus fasciatus is abundant during the summer/fall period (LMS, 1975) and has been reported as a major food item for several fish species (Scott and Crossman, 1973). Forage fish species include the spottail shiner, emerald shiner, alewife, and johnny darter. The stocked salmon are known to feed on alewife and it is hoped they will help to control the extensive Lake Ontario alewife population.

In summary, biological surveys conducted in the vicinity of Nine Mile Point have indicated the presence of several desirable game fish populations, and the food base to support them. Field crew observations suggest extensive use of the area by sport fishermen. The presence of game fish and preference of the area by fishermen indicates that the operation of Nine Mile 1 has not had a detrimental effect on the recreational use of the area, nor the area's economy.

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APPENDIX A

TEMPERATURE DATA SHEETS

FISH TEMPERATURE DATA SHEET

Species: Alewife (Alosa pseudoharengus)

I. Lethal threshold:

	acclimation temperature	larvae	juvenile	adult	data source 3/
Upper	10		2	20	3
	15			23	5
	20			23	3
	Summer			26.7-32.2	6
	Summer		23		3
Lower	17			7	4

II. Growth 1/

	larvae	juvenile	adult	
Optimum and [range 2/]				

III. Reproduction:

	optimum	range	month(s)	
Migration				
Spawning		15.6-27.7		4
		13-16		2
Incubation and hatch		15.5-22 for 6to2 days		1
		17.7		7

IV. Preferred:

acclimation temperature	larvae	juvenile	adult	
Spring			21.2	8

1 As reported or net growth (growth in wt minus wt of mortality).
2 As reported or to 50% of optimum if data permit.
3 Data sources:

1. Rounsefell and Springer, 1945
2. Threiner, 1958
3. Graham, 1956
4. Dept. of Int., 1970
5. Altman and Dittmer, 1966
6. Trembley, 1960 for LD 50
7. Desall, 1970
8. Reutter and Hendendorf, 1974

FISH TEMPERATURE DATA SHEET

Species: Brown trout (Salmo trutta)

I. Lethal threshold:	acclimation temperature	larvae	juvenile	adult	data source[3]
Upper				23.5	5
	14-18			25	3
Lower					

II. Growth 1/	larvae	juvenile	adult	
Optimum and			18.3-23.9	2
[range 2/]			8-17	4
			12	6
			12.4-17.6	7

III. Reproduction:	optimum	range	month(s)	
Migration				
Spawning		6.7-8.9	Oct-Nov	1
Incubation and hatch	7.3 for 64 days 10.0 for 41 days			8

IV. Preferred:	acclimation temperature	larvae	juvenile	adult	

1/ As reported or net growth (growth in wt minus wt of mortality).
2/ As reported or to 50% of optimum if data permit.
3/ Data sources:

1. Mansell, 1965
2. Brynildson et al., 1963
3. Klein, 1962
4. Brett, 1970
5. Bishai, 1960
6. Swift, 1961
7. Ferguson, 1958
8. Bardech et al., 1972

FISH TEMPERATURE DATA SHEET

Species: Coho salmon (Oncorhynchus kisutch)

I. Lethal threshold:

	acclimation temperature	larvae	juvenile	adult	data source 3/
Upper	5		23		1
	10		24	21*(3)	1,3
	15		24		1
	20		25		1
	23		25		1
		*Acclimation temp. unknown			
Lower	5		0.2		1
	10		2		1
	15		3		1
	20		5		1
	23		6		1

II. Growth 1/

	larvae	juvenile	adult	
Optimum and		15*		2
[range 2/]		(5-17)		6
		*unlimited food		

III. Reproduction:

	optimum	range	month(s)	
Migration		7-16(5)		5
Spawning		7-13(3)	Fall	3
Incubation and hatch			Winter-Spring	

IV. Preferred:

acclimation temperature	larvae	juvenile	adult	
Winter			13	4
Spring		11.4		7

1/ As reported or net growth (growth in wt minus wt of mortality).
2/ As reported or to 50% of optimum if data permit.
3/ Data sources:

1. Brett, 1952
2. Great Lakes Research Labortory, 1973
3. Anonymos, 1971
4. Edsall, 1970
5. Burrows, 1963
6. Averett, 1968
7. Reutter and Hendendorf,1974

FISH TEMPERATURE DATA SHEET

Species: Rainbow smelt (Osmerus mordax)

I. Lethal threshold:

	acclimation temperature	larvae	juvenile	adult	data source
Upper				21.5-28.5	1
Lower					

II. Growth [1]

	larvae	juvenile	adult	
Optimum and				
[range[2]]				

III. Reproduction:

	optimum	range	month(s)	
Migration			March-April	5
Spawning	8.9			2
Incubation		11-15	June	4
and hatch		6-10 for 29 to 19 days		3

IV. Preferred:

acclimation temperature	larvae	juvenile	adult	
			7.2	6

1 As reported or net growth (growth in wt minus wt of mortality).
2 As reported or to 50% of optimum if data permit.
3 Data sources:

1. Altman and Dittmer, 1966
2. Scott and Crossman, 1973
3. McKenzie, 1964
4. Sheri and Power, 1968
5. QLM, 1974 Nine Mile Study
6. Hart and Ferguson, 1966

FISH TEMPERATURE DATA SHEET

Species: Spottail shiner (Notropis hudsonius)

I. Lethal threshold:	acclimation temperature	larvae	juvenile	adult	data source 3/
Upper	11			30.8	1
	7			30.3	1
Lower					

II. Growth 1/	larvae	juvenile	adult	
Optimum and				
[range 2/]				

III. Reproduction:	optimum	range	month(s)	
Migration				
Spawning	20			3,4
Incubation and hatch				

IV. Preferred:	acclimation temperature	larvae	juvenile	adult	
				14	2
	Winter			10.2	5
	Spring			14.5	5

1/ As reported or net growth (growth in wt minus wt of mortality).
2/ As reported or to 50% of optimum if data permit.
3/ Data sources:

1. Trembley, 1961, LD 50
2. Meldrim and Gift, 1971
3. Peer, 1961
4. Carlander, 1969
5. Reutter and Herdendorf, 1974

FISH TEMPERATURE DATA SHEET

Species: Smallmouth bass (Micropterus dolomieui)

I. Lethal threshold:	acclimation temperature	larvae	juvenile	adult	data source
Upper		38* (9)	35 (3)		9, 3

*acclimation not given

Lower	acclimation temperature	larvae	juvenile	adult	data source
	15(3)	4(9)*	2(3)		3, 9
	18		4		3
	22		7		3
	26		10		3

*acclimation temperature not given

II. Growth 1/	larvae	juvenile	adult	
Optimum and	28-29(2)	26 (3)		2, 3
[range 2/]				

III. Reproduction:	optimum	range	month(s)	
Migration				
Spawning	17-18(5)	13(8)-21(7)	May-July(8)	5, 7
	16.1-18.3	12.8-20.0		12
Incubation and hatch			May-July	

IV. Preferred:	acclimation temperature	larvae	juvenile	adult	
	Summer			21-27	6
	Winter			>8*(1)-28(4)	1, 4
	21			20.3-21.3	10
				20-30**	11
	Winter		18.0	12-13	13
	Spring		19-24	15-16	13
	Summer		31.0	30.0	13
	Fall		24-27	21-23	13
	Fall			26.6	14

FISH TEMPERATURE DATA SHEET
(Continued)

Species: Smallmouth bass, Micropterus dolomieui) (Continued)

1/ As reported or net growth (growth in wt minus wt of mortality)
2/ As rported or to 50% of optimum if data permit.
3/ Data sources:

1. Munther, 1968.
2. Peek, 1965.
3. Morning and Pearson, 1973.
4. Fergusen, 1958
5. Breder and Rosen, 1966
6. Emig, 1966.
7. Hubbs and Baily, 1938
8. Surber, 1974
9. Larimore and Duever, 1968
10. Ferguson, 1958
11. Cherry, et al., 1975
12. Scott and Crossman, 1973
13. Barans and Tubb, 1973
14. Reutter and Herdendorf 1974

FISH TEMPERATURE DATA SHEET

Species: Threespine stickleback (Gasterosteus aculeatus)

I. Lethal threshold	acclimation temperature	larvae	juvenile	adult	data source[3/]
Upper	19			25.8	1
	20			27.2	2
				31.7-33	3
Lower					

II. Growth[1/]	larvae	juvenile	adult	
Optimum and				
[range[2/]			< 37.1	3

III. Reproduction:	optimum	range	month(s)	
Migration				
Spawning				
Incubation and hatch		19 for 7 days		4

IV. Preferred:	acclimation temperature	larvae	juvenile	adult	

1/ As reported or net growth (growth in wt minus wt of mortality).
2/ As reported or to 50% of optimum if data permit.
3/ Data sources:

1. Blahm and Parente, 1970
2. Jordan and Garside, 1972
3. Altman and Pittner, 1966
4. Breder and Rosen, 1966

FISH TEMPERATURE DATA SHEET

Species: White perch (Morone americana)

I. Lethal threshold	acclimation temperature	larvae	juvenile	adult	data source 3/
Upper	1.1			6.6	2
	24.8			34.7	2
Lower					

II. Growth 1/	larvae	juvenile	adult	
Optimum and			23.9	1
[range 2/]				

III. Reproduction:	optimum	range	month(s)	
Migration				
Spawning		11-15	May-June	4
Incubation and hatch		15-20 for 4.5-1.2 days		3

IV. Preferred:	acclimation temperature	larvae	juvenile	adult	

1/ As reported or net growth (growth in wt minus wt of mortality).
2/ As reported or to 50% of optimum if data permit.
3/ Data sources:

1. Meldrim and Gift, 1971
2. Meldrim and Gift, 1971, minimum avoidance temperature
3. Scott and Crossman, 1973
4. Sheri and Power, 1968

FISH TEMPERATURE DATA SHEET

Species: Yellow perch (Perca flavescens)

I. Lethal threshold:

	acclimation temperature	larvae	juvenile	adult	data source[3]
Upper	5			21.3	1
	9-18			13-22	12
	10			25	1
	22-24			29-30	2
	25			29.7	3,1
Lower	25		4		1

II. Growth [1/]

	larvae	juvenile	adult	
Optimum and				
[range[2/]]			13-20	5,6

III. Reproduction:

	optimum	range	month(s)	
Migration				
Spawning	12(11)	7.2-12.8 (9)		9, 1
Incubation and hatch		5-10 (10)	March-June (11)	10, 1

IV. Preferred:

acclimation temperature	larvae	juvenile	adult	
			21-24	4
			19.7 (field)	4
10		19.3	17.0	4
15		23.0	20.0	4
20		23.1	20.5	4
			10-29	7
24		20.23		8
Winter		10-13	7-12	13
Winter			14.1	14
Spring		18.0	13-16	13
Summer		25-27	27.0	13

1. Hart, 1947
2. Black, 1953
3 Brett, 1956
4. Ferguson, 1958
5. Cobble, 1966
6. Weatherly, 1963
7. Barans and Tubb, 1973
8. McCauley, 1973
9. Breder and Rosen, 1966
10. QLM, 1974 Nine Mile Study
11. Jones, et al., 1973
12. Everest, 1973

FISH TEMPERATURE DATA SHEET

Species: Gammarus fasciatus (Amphipoda)

I. Lethal threshold:

	acclimation temperature	larvae	juvenile	adult	data source 3/
Upper	2.5°C			28°C*	1
	11°C			31°C*	1
	19.8°C			34°C	1
	25°C			37°C*	1
Lower	* 30 minute TLm for Gammarus sp. in Hudson				

II. Growth 1/

	larvae	juvenile	adult	
Optimum and				
[range 2/]	interval between moults	6-11 days (18°C)	8-15 days (21°C)	
		4-11 days (21°C)		2
		3-6 days (25°C)		

III. Reproduction:

	optimum	range 5/		
Spawning	Summer	lower limit = 10°C(fall)		2
		lower limit = 4°C(spring)		
Incubation and hatch	7 days at 24°C; 9 days at 20°C; 14 days at 18°C; 22 days at 15°C			2

IV. Preferred:

acclimation temperature	larvae	juvenile	adult	
prefers cool waters				

1/ As reported or net growth (growth in wt minus wt of mortality).
2/ As reported or to 50% of optimum if data permit.
3/ Data sources:.
4/ Twenty-four hour latent mortality was observed following 30 minute and 60 minute elevated temperature exposures. Gammarus sp. acclimated at 25°C suffered no mortality when exposed to 35°C for 1 hour; when exposed to 37°C for 1 hour 92% of Gammarus sp. died within 24 hours.
5/ Reproduction at 30°C

FISH TEMPERATURE DATA SHEET

Species: Gammarus fasciatus (Amphipoda) (Continued)

1. Lauer, G.J., W.T. Walker, D.W. Bath, W. Makes, R. Heffner, T. Ginn, L. Zubarik, P. Bibke and P. Storm. 1974.
2. Clemens, H.P. 1950.
3. Pentland, E.S. 1930.
4. Embody, G.C. 1912.

APPENDIX B

REGULATORY CORRESPONDENCE

FACILITY OPERATING LICENSE NO. DPR-63
with "Section 2.1 Thermal" of Appendix B
to the license.

UNITED STATES

ATOMIC ENERGY COMMISSION

WASHINGTON, D.C. 20545

December 26, 1974

Docket No. 50-220

Niagara Mohawk Power Corporation
ATTN: Mr. Philip D. Raymond
Vice President - Engineering
300 Erie Boulevard West
Syracuse, New York 13202

Gentlemen:

The Commission has issued the enclosed Facility Operating License No. DPR-63 to operate the Nine Mile Point Nuclear Station Unit No. 1 at steady state reactor core power levels not in excess of 1850 megawatts (thermal) in accordance with the provisions of the license and the Technical Specifications. This action is in response to your application for a full-term operating license notarized June 27, 1972.

The Nine Mile Point Nuclear Station Unit No. 1 has operated since August 22, 1969 under Provisional Operating License No. DPR-17. Facility Operating License No. DPR-63 supersedes Provisional Operating License No. DPR-17 in its entirety.

The radiological portion of the Technical Specifications, identified as Appendix A, were issued with Provisional Operating License No. DPR-17 and are being reissued in their entirety to incorporate all the applicable changes through Change No. 13. In addition, changes have been included in the reissued Technical Specifications, Appendix A, that correspond with those requested by applications for amendments to your license notarized September 20, and November 18, 1974. The environmental portion of the Technical Specifications, identified as Appendix B, are being issued for the first time and together with Appendix A constitute the complete Technical Specifications. The numbering system for amendments to the license and changes to the Technical Specifications for this newly issued Facility Operating License No. DPR-63 will begin with number 1.

RECEIVED
DEC 31 1974
P. D. RAYMOND

Two copies of Amendment No. 8 to Indemnity Agreement No. B-36 are enclosed. Please sign and return one copy to this office.

A copy of the Federal Register Notice is also enclosed.

Sincerely,

George Lear

George Lear, Chief
Operating Reactors Branch #3
Directorate of Licensing

Enclosures:
1. Facility Operating License No. DPR-63
2. Federal Register Notice
3. Amendment No. 8 to Indemnity Agreement No. B-36 (2 copies)

cc: w/enclosures

Mr. Arvin E. Upton, Esquire
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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

U. S. ATOMIC ENERGY COMMISSION

NIAGARA MOHAWK POWER CORPORATION

DOCKET NO. 50-220

FACILITY OPERATING LICENSE

License No. DPR-63

1. The Atomic Energy Commission (the Commission) has found that:

   A. The application for license, as amended, filed by the Niagara Mohawk Power Corporation (the licensee) complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations as set forth in 10 CFR Chapter I and all required notifications to other agencies or bodies have been duly made;

   B. Construction of the Nine Mile Point Nuclear Station Unit No. 1 has been substantially completed in conformity with Construction Permit No. CPPR-16 and the application, as amended, the provisions of the Act and the rules and regulations of the Commission;

   C. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the rules and regulations of the Commission;

   D. There is reasonable assurance: (i) that the activities authorized by this operating license can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the rules and regulations of the Commission;

   E. The licensee is technically and financially qualified to engage in the activities authorized by this operating license in accordance with the rules and regulations of the Commission;

   F. The licensee has satisfied the applicable provisions of 10 CFR Part 140 "Financial Protection Requirements and Indemnity Agreements" of the Commission's regulations;

   G. The issuance of this full-term operating license will not be inimical to the common defense and security or to the health and safety of the public;

H. After weighing the environmental, economic, technical, and other benefits of the facility against environmental and other costs and considering available alternatives, the issuance of the full-term Facility Operating License No. DPR-63 (subject to the conditions for protection of the environment set forth herein) is in accordance with Appendix D, 10 CFR Part 50 of the Commission's regulations and all applicable requirements have been satisfied; and

I. The receipt, possession, and use of source, byproduct and special nuclear material as authorized by this license will be in accordance with the Commission's regulations in 10 CFR Parts 30, 40 and 70 including Sections 30.33, 40.32, 70.23 and 70.31.

2. Facility Operating License No. DPR-63 is hereby issued to the Niagara Mohawk Power Corporation to read as follows:

A. This license applies to the Nine Mile Point Nuclear Station Unit No. 1, a single cycle, forced circulation, boiling light water reactor, and associated equipment (the facility), owned by the Niagara Mohawk Power Corporation. The facility is located on the Nine Mile Point site on the southeast shore of Lake Ontario in Oswego County, New York and is described in the "Final Safety Analysis Report" (with its Amendments Nos. 3 through 13 and its Supplements Nos. 1 through 10) and the "Environmental Report" (with its Supplements Nos. 1 through 3).

B. Subject to the conditions and requirements incorporated herein, the Commission hereby licenses the Niagara Mohawk Power Corporation:

(1) Pursuant to Section 104b. of the Act and 10 CFR Part 50, "Licensing of Production and Utilization Facilities", to possess, use and operate the facility at the designated location in Oswego County, New York, in accordance with the procedures and limitations set forth in this license;

(2) Pursuant to the Act and 10 CFR Part 70, to receive, possess, and use at any one time up to 3800 kilograms of contained uranium 235 in connection with operation of the facility;

(3) Pursuant to the Act and 10 CFR Part 30, to receive, possess, and use in connection with operation of the facility 24 curies of Cobalt 60 as a sealed source; 430 millicuries of Cobalt 60 as two sealed sources of not more than 400 millicuries and 30

millicuries each; 500 microcuries of Cobalt 60 as five sealed sources not to exceed 100 microcuries each; 101 millicuries Cobalt 60, 3 millicuries Strontium 90, 101 millicuries Iodine 131, 102 millicuries Cesium 137, and 13 millicuries of any byproduct material with Atomic Nos. between 8 and 83, inclusive, in any chemical and/or physical form; 25,000 curies Antimony 122-124 as ten sealed sources not to exceed 2,500 curies each; and six curies Americium 241 as a sealed source; and

(4) Pursuant to the Act and 10 CFR Parts 30 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30; Section 40.41 of Part 40; Section 50.54 and 50.59 of Part 50; and Section 70.32 of Part 70. The license is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect and is also subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 1850 megawatts (thermal).

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B attached hereto are hereby incorporated in this license. The licensee shall operate the facility in accordance with the Technical Specifications.

D. This license is subject to the following additional conditions for the protection of the environment:

(1) The licensee will complete construction of a new radwaste facility in conformance with the design defined and evaluated in the FES, to be operational no later than June 1976.

(2) Pursuant to Section 401(d) of the Federal Water Pollution Control Act Amendments of 1972, this permit is subject to the requirements set forth in a certification dated April 9, 1974, issued to the licensee by the State of New

York. Inclusion of the State requirements herein shall not relieve licensee of its obligation to obtain Commission approval, pursuant to the Act and regulations promulgated pursuant thereto, of any intake or discharge design which may ultimately be required by the State of New York.

(3) Pursuant to Section 402 of the Federal Water Pollution Control Act Amendments of 1972, this permit is subject to the requirements that will be set forth in a certification to be issued to the licensee by the Environmental Protection Agency (EPA). Inclusion of the EPA requirements herein shall not relieve licensee of its obligation to obtain Commission approval, pursuant to the Act and regulations promulgated pursuant thereto, of any intake or discharge design or alternate heat dissipation system which may ultimately be required by the Environmental Protection Agency.

E. This license is effective as of the date of issuance and shall expire on April 11, 2005.

FOR THE ATOMIC ENERGY COMMISSION

A. Giambusso

A. Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing

Attachment:
Appendices A & B -
Technical Specifications

Date of Issuance: December 26, 1974

U. S. ATOMIC ENERGY COMMISSION

DOCKET NO. 50-220

NIAGARA MOHAWK POWER CORPORATION
(Nine Mile Point Nuclear Station Unit No. 1)

NOTICE OF ISSUANCE OF A FACILITY OPERATING LICENSE

Notice is hereby given that the U. S. Atomic Energy Commission (the Commission) has issued Facility Operating License No. DPR-63 to Niagara Mohawk Power Corporation (the licensee) authorizing operation of the Nine Mile Point Nuclear Station Unit No. 1 at steady state reactor core power levels not in excess of 1850 megawatts (thermal), in accordance with the provisions of the license and the Technical Specifications. The Nine Mile Point Nuclear Station Unit No. 1 is a boiling light water reactor located on the Nine Mile Point site on the southeast shore of Lake Ontario in Oswego County, New York.

The Nine Mile Point Nuclear Station Unit No. 1 has been operated since August 22, 1969, under Provisional Operating License No. DPR-17. Facility Operating License No. DPR-63 supersedes Provisional Operating License No. DPR-17 in its entirety.

Notice of Proposed Issuance of Full-Term Operating License was published in the FEDERAL REGISTER on December 5, 1972 (37 F.R. 25870). The full-term operating license was not issued previously, pending review of the environmental considerations required by the September 9, 1971 revision of Appendix D to 10 CFR Part 50. The Regulatory staff has completed its review and the Final Environmental Statement was issued in January, 1974 (notice of which was published in the FEDERAL REGISTER on January 25, 1974 (39 F.R. 3309).

The application for the full-term operating license complies with standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations. The Commission has made appropriate findings as required by the Act and the Commission's rules and regulations in 10 CFR Chapter I, which are set forth in the license. The license is effective as of its date of issuance and shall expire on April 11, 2005.

For further information concerning this action, see (1) the licensee's application for a full-term operating license notarized June 27, 1972, accompanied by the licensee's Environmental Report, (2) Amendment Nos. 1, 2 and 3 to the application for the full-term operating license dated November 2 1973, and March 14 and April 24, 1974 respectively, (3) applications for amendments to license notarized September 26 and November 18, 1974, (4) the Commission's Draft Environmental Statement dated June 3, 1973, (5) the Final Environmental Statement dated January 21, 1974, (6) Facility Operating License No. DPR-63, complete with Technical Specifications (Appendices A and B), (7) the related Safety Evaluation prepared by the Directorate of Licensing dated July 3, 1974, (8) the report of the Advisory Committee on Reactor Safeguards dated September 10, 1974, and (9) Supplement 1 to the Safety Evaluation prepared by the Directorate of Licensing dated November 15, 1974, which are available for public inspection at the Commission's Public Document Room at 1717 H Street, N. W. Washington, D. C., and at the Oswego City Library at 120 East Second Street, Oswego, New York.

A copy of items (5), (6), (7), (8) and (9) may be obtained upon request addressed to the U. S. Atomic Energy Commission, Washington, D. C. 20545, Attention: Deputy Director for Reactor Projects, Directorate of Licensing - Regulation.

Dated at Bethesda, Maryland, this 26th day of December, 1974.

FOR THE ATOMIC ENERGY COMMISSION

George Lear

George Lear, Chief
Operating Reactors Branch #3
Directorate of Licensing

APPENDIX C

STATION

THERMAL LIMITATIONS

excerpted from Appendix B:

ENVIRONMENTAL TECHNICAL SPECIFICATIONS
of facility operating license (DPR-63)

2.0 LIMITING CONDITIONS FOR OPERATION

2.1 Thermal

2.1.1 Maximum ΔT Across the Main Condenser

OBJECTIVE

The purpose of this Specification is to limit the thermal stress to the aquatic ecosystem by limiting the maximum ΔT across the condenser.

SPECIFICATION

Maximum ΔT across the main condenser during normal Station operation shall be limited to 32 F. If during normal Station operation the main condenser ΔT exceeds 32 F for a period of eight hours in any given 24 hour period the cause of this deviation shall be investigated and positive action shall be taken to reduce the ΔT to within the Specification. Positive action also shall be taken to prevent any such deviations in the future. In addition, a report shall be submitted in accordance with Section 5.6.2.

MONITORING REQUIREMENT

The main condenser ΔT shall be monitored and recorded once per hour.

The temperatures at the main condenser inlet and in the screenwell bay (upstream from the discharge tunnel) shall be monitored by two RTD's in each location. The RTD's shall be accurate to 0.5 F. The difference of these temperatures, ΔT_1, shall be computed. A ΔT_1 of 31.2 F corresponds to the ΔT Specification of 32 F, because the water in the screenwell bay is a mixture of main condenser cooling water and service water. The redundant temperature sensors provide backup monitoring in the event of sensor failure.

BASES

Nine Mile Point Unit 1 holds a permit from the New York State Department of Health to discharge cooling water to Lake Ontario when operating with a maximum ΔT across the main condenser of 32 F[1]. Lake studies and operating experience indicate that mortality of plankton, eggs, and larvae entrained in the condenser will not have a significant effect on the populations of the species involved.[2,3]

Station service water flow is 40 cubic feet per second (cfs), with a maximum temperature rise of 20 F. When the main condenser flow of 557 cfs with a maximum temperature rise of 32 F is mixed with the service water flow, the maximum temperature rise of the combined flow is 31.2 F.

2.1.2 Maximum Discharge Temperature

NOT APPLICABLE

2.1.3 Maximum BTU Per Hour

NOT APPLICABLE

2.1 Rate of Change of Discharge Temperature

OBJECTIVE

The purpose of this Specification is to limit the temperature changes to which fish in the discharge plume may be subjected during normal Station startups, shutdowns, and power level changes.

SPECIFICATION

The discharge temperature shall not be changed by more than 18 F in any hour. This Specification shall not apply to temperature changes occurring during forced shutdowns, or to the temperature increase at the intake resulting from flow reversal.

MONITORING REQUIREMENT

Discharge temperature shall be monitored and recorded hourly as provided in the Monitoring Requirement of Section 2.1.1.

BASES

The cooling water discharge is diluted by a factor of at least 2.5 as it rises from the submerged discharge ports, outside of a conical volume of 100 foot maximum radius extending from the discharge structure to the lake surface. Therefore, outside of this volume, an 18 F per hour discharge temperature change would result in a maximum lake water temperature change of 7 F per hour. Moreover, while the specified rate of change may be reached in the first hour of a shutdown or power change, the rate will be less than 10 F per hour in subsequent hours. This would produce a 4 F per hour change in the lake, as described above.

Fish in Lake Ontario experience natural lake water temperature changes of 6 to 9 F per hour with a frequency greater than the expected frequency of changes induced by the Station. In 1974, for example, temperature drops of 9.5, 8.5, and 6.5 F per hour were recorded in the Station logs on July 29, September 3, and August 15, respectively.

2.1.5 Heat Treatment of Circulating Water System

OBJECTIVE

To limit the thermal stress to the aquatic ecosystem by limiting the circulating water temperature increase over lake ambient temperature resulting from tempering and reverse flow procedures.

SPECIFICATION

When the ambient lake temperature is between 32 F and 50 F, the discharge temperature shall not exceed the ambient lake temperature by more than 50 F, except during reverse flow operations. At no time during tempering, except during reverse flow operations, shall the discharge temperature exceed 82 F.

Following a flow reversal, the discharge temperature shall not exceed the ambient lake temperature by more than the following values:

70 F for the first hour following flow reversal
60 F for the second hour following flow reversal
50 F two hours following flow reversal and thereafter

MONITORING REQUIREMENT

The discharge temperature shall be monitored and recorded hourly as provided in the Monitoring Requirement of Section 2.1.1.

BASES

When lake temperature is less than 50 F, part of the discharge flow in the screenwell is recirculated to the intake to maintain condenser inlet temperature between 40 F and 50 F. This procedure is known as "tempering." The maximum circulating water temperature rise due to tempering is 18 F, and occurs when the lake temperature is 32 F. When this is added to the 32 F maximum condenser temperature rise, the maximum rise is 50 F over ambient lake temperature. Maintaining the condenser inlet temperature at no more than 50 F during tempering ensures that the discharge temperature will not exceed 82 F during tempering.

The amount of tempering is controlled by moving a gate in the screenwell and is normally adjusted to maintain the optimal condenser inlet temperature of approximately 45 F. The gate can be adjusted to achieve this temperature within an error of approximately 5 F.

2.1.5 (Cont'd)

Flow reversal is required to correct intake icing at low intake temperatures. Flow reversal is also required to return to normal flow operations from reverse flow operations.

Prior to flow reversal Station power is reduced to approximately 75 percent power or less. Reversal is achieved by moving gates in the screenwell. Immediately after flow reversal, heated water in the discharge tunnel at essentially the condenser outlet temperature is drawn through the condenser. The reverse flow configuration also requires that some tempering be continued. Accordingly, the 70 F maximum difference between discharge temperature and ambient lake temperature was determined taking into account the elevated intake water temperature, a temperature rise due to tempering, and the condenser rise.

All of the heated water contained in the discharge tunnel at the time of flow reversal passes through the condenser within approximately 6 minutes. Operating experience has shown that dilution of the heated lake water near the discharge structure, sufficient to achieve a discharge temperature no more than 60 F higher than the ambient lake temperature, occurs within one hour after flow reversal. Within two hours the lake temperature near the discharge structure is essentially the ambient lake temperature. Therefore, the discharge temperature can be maintained within 50 F above the ambient lake temperature subsequent to this two hour interval.

Operating experience has shown that reverse flow is required less than five times each winter.