Item 29

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(Chapter VI, the portion referenced in the LRA ER)

NMP - 285

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT NUCLEAR POWER STATION
UNIT 2

VOLUME I
EFFECT OF CIRCULATING WATER SYSTEMS ON
LAKE ONTARIO
WATER TEMPERATURE AND AQUATIC BIOLOGY

QL&M PROJECT NO. 191-9

FEBRUARY 1973

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SUMMARY

VI. EFFECTS OF NINE MILE POINT UNITS 1 AND 2 ON THE ECOLOGY OF LAKE ONTARIO

A biological system is comprised of intricate relationships between the physical and chemical characteristics of the water and the response of the biota to changes in these characteristics. Although conclusions can be drawn specific to a particular study, the purpose of each of the environmental investigations described herein is to define the interconnections among the components of the biological system and to use the data to estimate the effects, whether beneficial or adverse, of the proposed outfall on the environment. The specific areas of concern associated with the proposed Units 1 and 2 intake-discharge system are: (1) effect on Lake Ontario water quality, and (2) effect on aquatic biology.

This chapter summarizes, first, the ecological investigations conducted by Dr. John F. Storr in the years prior to 1972, and second, those by Dr. Storr and also by Quirk, Lawler & Matusky Engineers in 1972, in the vicinity of the proposed discharge. Appendix C contains detailed descriptions of the QL&M ecological investigations.

A. LAKE STUDIES PRIOR TO 1972

General

Ecological investigations prior to 1972 were conducted in the vicinity of Nine Mile Point under the auspices of Dr. John F. Storr. These studies encompassed pre- and post-operational periods of the Nine Mile Point Nuclear Power Station Unit 1, and included

observations of the effects of the thermal discharge on aquatic organisms and the effects on organisms of being drawn into and through the once-through cooling water system.

Initial environmental studies in 1963 monitored basic flow patterns in the eastern end of Lake Ontario, current speeds at selected points, and measurements of temperature. These data showed that with W to SW winds, a strong jet shore current was developed along the Oswego-Nine Mile Point shore which, by its momentum, continued out into the lake in a northeast direction after it reached the NW corner of the Nine Mile Point promontory. Concurrent upwellings were found along the N-E shore of the promontory. While the jet lake current was usually strong, up to 2 mph, the easterly inshore current was usually moderate and continued out into the open water of Mexico Bay, leaving the shore at the NE corner of the promontory.

With NW to E winds, the current flow was to the west, and this current carried out into the open lake from the NW corner of the promontory.

With SE to SSW winds, strong upwellings were found to occur along the shore of the promontory and subsequent measurements showed that a temperature drop of as much as 20°F might take place within a 24-hour period, especially during the month of July.

In 1968, a number of pre-operational field studies were initiated. Data on fish populations as to relative species diversity were gathered by means of experimental gill nets. The feeding habits of

these fish were examined by means of stomach content analyses. Fish abundance, location, and diurnal patterns of activity were determined. Benthic studies were conducted at 48 stations along the promontory twice per year.

Post-operational ecological studies, 1970-1971, were refined and expanded. Entrainment studies were carried out in 1971 on the effect on plankton passing through the cooling water system. These were supplemented with exploratory work in the lake.

Cladophora

In 1970-1971, a research program was conducted to determine the combined effects of temperature and hours of photoperiod on Cladophora glomerata, the primary filamentous algae commonly found attached to the rocks in the near shore areas of Lakes Erie and Ontario. The results of this study, as reported by Storr and Sweeney (53), showed that the optimum temperature for growth of the algae was 65°F. Thermal limits for growth, at the current level of nutrients found in the lakes, were approximately 53°F and 77°F. Light also played a minor role in growth with the rate of growth responding at an exponential rate to the increase in hours of photoperiod.

In the vicinity of Nine Mile Point, growth was observed to begin in May when light levels were adequate, but water temperatures were lower than optimum. By mid-July, lake temperatures were usually well above optimum and growth of the algae was depressed. A second increase in growth was apparent in August, at a lower level, as

thermal conditions approached optimum but a shorter photoperiod existed. At Nine Mile Point, almost all signs of growth had disappeared by some period in October. One of the major factors in creating differences in Cladophora growth from year to year would be the intensity of wave activity. As a general rule, Cladophora, or any other attached algae, will tend to grow at a more rapid rate when exposed to moving water. The increase in the rate of growth is almost linear with respect to the rate of water flow and this increase in growth is due to the greater amounts of nutrients brought into contact with the algae. The flow of water over the surface also tends to remove any metabolic products released by the plant, and this will also contribute to a generally higher metabolic rate.

Plankton

Investigation of the plankton in the Nine Mile Point area was initiated during 1964 from June to October, using three locations for collection. It was found that, while the two typical plankton blooms occurred seasonally, in mid-July and mid-October, there was a marked variation in plankton concentrations. With westerly winds, the offshore and western stations had much higher plankton concentrations than the eastern shore station. With southerly winds the shore locations had low plankton concentrations. With WNW to NE winds, when the lake current was flowing westerly, the eastern station had the highest concentration of plankton and the offshore station had the lowest.

Seasonal variations in species composition of the zooplankton were also analyzed. Considerable variation was found, with five species of rotifers, cladocerans, and copepods dominating throughout the year.

Entrainment

From June through November 1971, a series of entrainment studies was carried out on a periodic basis. The composition of the entrained plankton population was different from that of the surface water. The cooling water is drawn from a lower level of zooplankton concentration and little if any surface water is included. The zooplankton population in the cooling water was dominated throughout the year by various species of rotifers, with very few copepods or cladocerans. For the phytoplankton, only those which possessed flagella or cilia could be used in the study, since these are motile, i.e., Ceratium, Volvox, Pandorina.

Examination of the data from the study indicated a certain amount of variation in mortality with species and types of plankton. Of the ten data collection runs made, one was done when the station was down, i.e., the circulating pumps were operating, but no heat was added in the condenser. There was no perceptible change seen in mortality, compared to those runs in which the plant was on the line.

For both zooplankton and phytoplankton, an analysis of regression showed a rise in the percentage mortality with a rise in temperature between the range of 9.5 and 14.5°C. However, there was no significant correlation between the temperature rise across the condenser and the mortality rate. With regard to ultimate recovery of numbers after surviving entrainment, phytoplankton showed no significant change in lake population with change in condenser ΔT. However, there was a possible increased detrimental effect observed in the zooplankton population.

Benthos

The effect of the discharge on benthic organisms is most pronounced in the 5 ft depth since the thermal effect is confined to the upper few feet of the lake surface.

A general increase in June and August in total numbers of Gammarus over three years of study was indicated, particularly at the deeper depths. This was consistent with the increase in the total amount of algae providing increasing amounts of shelter for the organism. During both months, a large increase in the number of organisms was observed after the introduction of the thermal discharge, in the area of greatest thermal influence.

There has also been a rapid increase in numbers of Tendipes larvae in June over the three-year period. Individual studies, however, show that this increase was not in the area affected by the discharge, but is related to annual variations. The numbers in August

were erratic and no general trend was indicated as a result of thermal influence.

There was a general increase in the number of snails observed in June over the three-year period, but the increase was not related to the thermal discharge. For August, the numbers have been erratic.

There has been a marked increase in the number of sculpins, some minnows, and crayfish in the area of the discharge over the three-year period.

Fish

The fish in the area of Nine Mile Point appeared to be affected in two ways by the thermal discharge. There was some indication that the warmer water of the discharge in spring and early summer was an attraction for some fish and that the cooler water at the bottom in the area of the discharge was, at times, avoided by some fish. The kind and amounts of available food appeared to be more of an attractant than any particular direct influence of the thermal differences, at least for most fish. A few species of fish were strongly attracted to the warmer water at various periods in the year, primarily smallmouth bass, carp, and sunfish.

The comparison of two fishing transects, one passing close to the intake and discharge and one approximately 1,500 ft to the east, for data collected over a three-year period is presented month by month.

In June, there was an increase in fish population in the latter two years of sampling and this was not attributed to any thermal influence but primarily to flow and an increase in food items.

In July, the thermal discharge seemed to have attracted some fish to the warmer zone in 1971.

In August, there was a decrease in the numbers of fish in the area corresponding to a decline in the number of alewives from 1969 to 1970. Between 1970 and 1971 the pattern was similar to July.

In October, there had been a gradual and significant increase in numbers of fish from 1969 to 1971. Amphipods were increasingly abundant, and sculpins and crayfish also increased in numbers.

The general attraction to the thermal discharge may be indirect in that organisms that are utilized as food items may be attracted to the warmer discharge area and hence attract their predators. For some of the major species of fish caught in the area, there does appear to have been a definite effect resulting from the introduction of the thermal discharge. This change has been superimposed upon the change in the total population level as the number of alewives declined from 1969 to 1970 and 1971 due to more severe than normal (54) lakewide mortality in early 1970. The change appeared to result primarily from an increase in the food supply related, probably, to an increase in the number of Gammarus and in the amount of food available for the spottail shiner, which, in turn, is used as food by the larger fish. Some fish, such as yellow perch and

white perch, displayed a definite preference for cooler water. For other fish, such as smallmouth bass, carp and sunfish, there was a definite attraction to the thermal discharge.

Stomach analysis of the yellow perch indicated that, for this species, the diet changed seasonally. Yellow perch feed on small fish, i.e., alewives, sculpin, and smelt, Gammarus, insect larvae, crayfish, snails, and fish eggs. White perch were observed to eat small fish, i.e., alewives and darters, fish eggs, Gammarus, and crayfish. Smallmouth bass were observed to feed on small fish and crayfish. Rock bass had a preference for crayfish, small fish, and fish eggs. Fish were found to be feeding actively in the area of the discharge.

Population distribution of fish was determined by use of the echo-sounder. To a degree, the counts obtained by this method reflected the diurnal habits of the various fish species. Many fish appeared to lie close to the bottom during the daylight hours, rising and spreading upward through the water column or moving toward and away from shore during the evening and night period. A few fish were active during the day and quiescent at night. In fact, there was a very complex activity pattern changing from hour to hour, depending on the size- and species-composition of the fish population.

To obtain a better insight into the behavioral patterns of fish and to compare the data from echo-sounding and net studies, the maximum

number of fish calculated for any one echo-sounder trace in the 24-hour studies has been compared to average numbers of fish netted per day. In comparing the two sets of data, it was found that there was considerable variation from month to month and between the same month from year to year. However, numbers recorded by echo-sounder in each period in 1970 and 1971 did show major similarities, except for the early spring recordings. For the rate of capture by the nets, the numbers of fish captured in August in the two years was lower than either in July or in the fall. In one year the spring catch was higher than the July one, and in the other year lower.

It would appear that in the pre-operational period, the area 1,500 ft east of the plant was much preferred over the area of the discharge. However, in the post-operational period, the discharge area was sometimes more strongly preferred than the area to the east, e.g., in August 1971.

With respect to fish distribution throughout the water column, more fish were to be found where water depths of from 18 ft to 35 ft occur, and the larger number of fish in this area would have occurred as they rose toward the surface. Most of the larger fish tended to be located along the bottom; some fish were concentrated in the area inshore of the discharge, 200 ft to 400 ft from shore.

An important consideration was the pattern of distribution along the entire Nine Mile Point promontory. For the total number of

fish, no regular pattern of distribution was strongly apparent, although several locations seemed to have a fairly persistent attraction for fish. It has been noted that the area of the discharge appeared to be one in which the pre-operational period was never heavily populated with fish and had fewer gammarids and other organisms. The pattern of lower numbers of fish in the area of the discharge, therefore, was not inconsistent with what would be expected.

For the larger fish recorded, there was a fairly consistent pattern of progressively larger numbers of fish toward the eastern end of the Nine Mile Point promontory. As with the total number of fish, there was no one point at the western end of the promontory which was a consistently low point. It was evident that the presence of the discharge was not resulting in any particular pattern of fish distribution in the area.

Horizontal echo-sounding traces were obtained for entire 24-hour periods three times during 1971. At four-hour intervals, these traces represented the number of fish recorded in the sonic cone for a radius of 60 ft around the boat. When the data for all studies were combined as an average, a diurnal pattern was suggested wherein the lowest numbers recorded occurred between 1100 and 1900 hours both for all fish and for large fish. Shifts throughout the 24-hour period were very similar for all fish and large fish at both the 7 ft and 15 ft depths.

Species distribution differed considerably between the discharge area and the area 1,500 ft east. The warmer water in the discharge area tended to attract large numbers of both sunfish and smallmouth bass which were more active during the daylight period. There were also other differences as shown by the fish net data.

A strong diurnal pattern was present in the discharge area. At both the 7 ft and 15 ft depths, the variation in fish activity and/or numbers showed no specific pattern from 0300 to 0700 hours. The numbers of fish at the 7 ft depth increased rapidly from 1500 hours to 1900 hours. Numbers may or may not decrease by 2300 hours. In the 15 ft depth, numbers were above those at the 7 ft depth at 1500 hours and remained constant at 1900 hours. A rise in numbers was found consistently at 2300 hours.

At the area 1,500 ft east, the numbers of fish at the 7 ft depth tended to increase, then decrease during the period 0300 to 1100 hours, but were greater than the numbers recorded at the 15 ft depth. At 1500 hours the lowest numbers were found, rising at 1900 hours and remaining at the same level at 2300 hours. At the 15 ft depth, numbers of fish declined throughout the morning, reached a low at 1500 hours, and rose again at the 1900 and 2300 hour periods. A strong diurnal movement was indicated at both the 7 ft and 15 ft depths suggesting that the fish were probably migrating shoreward and then lakeward to create the pattern. The more consistent and more obvious pattern at the east area suggests that the population was less heterogeneous than found in the discharge area

and that fewer species of fish were included in the make-up of the population.

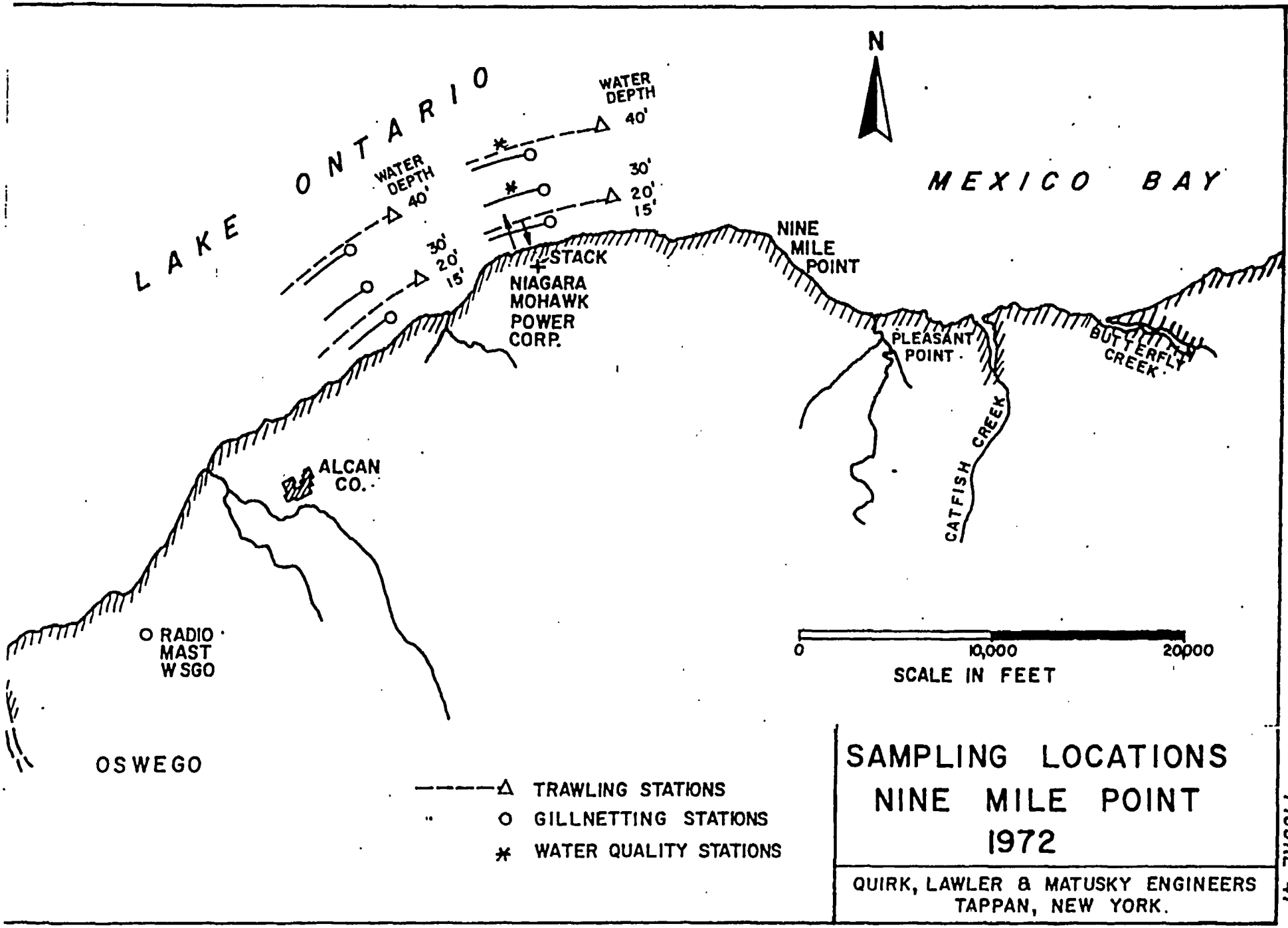
B. LAKE STUDIES DURING 1972

Dr. Storr continued his investigations into benthos, fish and plankton, while Quirk, Lawler & Matusky pursued complementary studies in water quality, fish impingement, other fish catch methods, etc. Details of QL&M's work are given in Appendix C. A summary of the year's work follows.

WATER QUALITY

Water quality samples were collected and analyzed during the 1972 ecological investigations. Figure 47 presents the two lake locations at which surface and bottom samples were taken, in addition to grab samples at the cooling water intake and discharge and a composite sample taken from the screenhouse discharge channel. The 1972 survey was conducted for six months between April and November 1972 (May and October excluded) with samples taken monthly. The analyses performed and the results of the analyses are presented in Table 18, which lists the minimum and maximum of the six values for each location.

Water quality was generally constant throughout the 1972 survey, and was also very similar to that at Oswego in 1970 and 1972. The results of the metals analyses indicate that the majority of samples had concentrations below the detection limits of the analytical procedure.



SAMPLING LOCATIONS NINE MILE POINT 1972

QUIRK, LAWLER & MATUSKY ENGINEERS
TAPPAN, NEW YORK.

FIGURE 47

TABLE 18

1972 WATER QUALITY MEASUREMENTS

LAKE ONTARIO NEAR NINE MILE POINT NUCLEAR STATION SITE

		30-foot Water Depth				40-foot Water Depth				Unit 1					
		Surface		Bottom		Surface		Bottom		Intake		Discharge		Composite**	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Alkalinity	mg/l	86	90	86	90	77	87	81	84	83	90	72	89	86	88
Color Units		20-30	30-40	20-30	40-50	10-20	30-40	20-30	30-40	10-20	30-40	0-30	30-40	20-30	20-30
Sp. Conductivity, mcro/cm		326	330	341	344	302	319	347	367	298	360	314	354	294	396
Turbidity	JTU	2	4	2	4	2	4	2	6	2	3	2	4	4	4
Phenol	mg/l	0	2.25	0	1.51	0	1.32	0	1.45	0	1.32	0	2.15	0	1.38
BOD	mg/l	1	5	0	4	1	3	1	2	1	3	0	3	0	2
COD	mg/l	2	42	2	51	3	40	3	41	1	44	1	25	4	13
TKN	mg/l	0	7.5	0	2.2	0	3	0	2.5	0	3.25	0	4.5	0	1.3
NH_3-N	mg/l N	0	4.7	0	1	0	1.7	0	0.6	0	2.30	0	1.7	0	0
Nitrate-N	mg/l N	0.04	0.30	0.04	0.28	0.04	0.40	0.02	0.30	0.04	0.30	0.04	0.36	0.04	0.32
T. Phosphorus	mg/l P	0.02	0.11	0.03	0.10	0.01	0.09	0.02	0.10	0.01	0.11	0.01	0.28	0.01	0.12
Ortho Phosphate	mg/l P	0.005*		0.010*		0.005*		0.01*		0.01*		0.01*		0.01*	
T. Volatile Solids	mg/l	109	133	90	111	95	187	82	114	114	141	134	153	112	153
Chloride	mg/l	22	72	23	83	22	75	24	62	28	72	26	58	36	39
Sulfate	mg/l	26.5	31	23.2	31.2	28.4	36	26	30	24.5	30	26.8	29	23.5	33
Total Solids	mg/l	266	302	197	297	250	324	223	309	284	291	271	306	255	300
Total SS	mg/l	0	5	0	11	0.1	4	0	9	0	5	0	16	0	9

* single value
**taken at screenhouse discharge channel

TABLE 18
(continued)

		30-foot Water Depth				40-foot Water Depth				Unit 1					
		Surface		Bottom		Surface		Bottom		Intake		Discharge		Composite**	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Beryllium	µg/l	<1	5	<1	<1	<1	15	<1	<1	8	8	<1	<1	<1	13
Cadmium	µg/l	<1	12	<1	10	<1	4	<1	4	1	4	<1	7	<1	4
Chromium	µg/l	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Copper	µg/l	<2	<2	<2	17	<2	<2	<2	<2	<2	68	<2	<2	<2	13
Lead	µg/l	<20	164	<20	<20	<20	<20	<20	<20	<20	25	<20	50	<20	<20
Mercury	µg/l	<1	1	<1	2	<1	1	<1	2	<1	17	<1	5	<1	2
Vanadium	µg/l	<60	<60	<60	429	<60	353	<60	404	<60	353	<60	93	<60	116
Zinc	µg/l	<2	<2	18	28	<2	75	22	24	<2	52	8	20	26	32
pH		8.0*		8.0*		8.0*		8.0*		8.0*		8.0*		8.0*	
Temperature	°F	66	70.5	62	68	65.5	72	61*		61*		87.8*		-	-
Fecal Streptococci #/100 ml		10.6*		10.8*		10.8*		10.9*		10.8*		10.6*			

* single value
** taken at screenhouse discharge channel

A statistical analysis of the data was made to determine what effect sampling location had on each water quality parameter within the Nine Mile Point area. The techniques employed were "analysis of variance" and "multiple comparison." In all cases, the data for a particular station for any parameter were grouped by the number of observations taken over the course of the year. Thus, it was assumed that the value of any parameter at any station was not a function of time. Any values below the appropriate detection limits were not used in the analysis, even though, in some cases, this resulted in certain stations being omitted from the analysis. The results of the statistical analysis indicated that zinc was the only measured parameter that exhibited a significant difference at the 95 percent confidence level within the sampling area. The average value for zinc was 36 µg/l, with a range from less than 2 µg/l to 75 µg/l. All in all, the water quality of the Nine Mile Point area does not appear to be drastically different from the water quality observed at Oswego in 1970 and 1972. Furthermore, based on the fact that the water quality at the Nine Mile Point Unit 1 intake and discharge does not differ from water quality in the lake itself, one would not expect any effect either adverse or beneficial on water quality from the proposed combined Units 1 and 2 intake-discharge system.

FISH IMPINGEMENT STUDY

General

A fish impingement monitoring program was carried out during summer and fall 1972 at the Nine Mile Point Nuclear Power Station Unit 1, with the following objectives:

(1) To determine the number of fish entering the existing intake structure and retained on the traveling screens.

(2) To identify diurnal and seasonal variations in the number of fish per day impinged.

(3) To relate the monitoring program results to the design, and assess the potential for fish impingement at the Unit 2 intake.

Procedure

Unit 1 has two cooling water pumps with a combined capacity of 250,000 gpm. It has three traveling screens which operate as one unit. Velocity of approach to the traveling screens at full flow is about 0.85 ft per second. Screen backwashing is done automatically for three minutes every hour, and all three are backwashed simultaneously. Material washed from the screens flows into a common trough running transversely across the screenhouse and then enters a conduit running north along one wall of the discharge channel at an elevation above that of the cooling water flowing in

the discharge channel. At a point still inside the screenhouse the conduit ends and the washings drop into the cooling water discharge channel.

At this point in the screenhouse floor, there is a removable trap-door through which a steel basket was lowered to catch the screen washings before they entered the discharge channel. The basket was lined with netting of 1/4-inch mesh size to capture small organisms. It was removed after completion of an hourly screen backwash cycle, and the collected fish were examined for physical appearance, sized, speciated, and the quantities and weights recorded.

On sixteen days between May 30, 1972 and January 30, 1973, the fish impinged on the traveling screens during a one-hour period were collected from four to fourteen times a day.

Results

The total catch for the monitoring period is listed in Table 19, where it is evident that alewives and rainbow smelt constitute more than 80 percent of the total.

May, June, and July 1972

Studies of daily fish movement in the lake have shown that the density of the fish population close inshore reaches a maximum during the night hours. It seemed reasonable to expect that the number of fish removed from the screens would show a similar maximum. Consequently, the first study was made from 10:00 p.m. to 8:30 a.m. on

TABLE 19

TOTAL FISH IMPINGEMENT CATCH

May 30, 1972 to January 30, 1973

Species	Number	Percent of Total
Alewife	5,932	45.67%
Rainbow Smelt	4,709	36.26
Three-spine Stickleback	783	6.03
Johnny Darter	355	2.73
Mottled Sculpin	287	2.21
Spottail Shiner	232	1.79
Yellow Perch	232	1.79
Troutperch	132	1.02
Gizzard Shad	100	0.77
White Perch	68	0.52
Emerald Shiner	54	0.42
Sunfish	24	0.18
Rock Bass	20	0.15
Smallmouth Bass	10	0.08
Carp	7	0.05
American Eel	7	0.05
Lamprey Eel	7	0.05
Common Shiner	6	
White Sucker	5	
Brown Bullhead	4	
Mud Minnow	3	
Longnose Chub	2	
Goldfish	2	
1 of each of 7 species	7	
Total	12,987	99.77%

the night of May 30-31. The screen backwash (i.e., all the material that had accumulated on the screens during the hour previous) was collected each hour. The reactor was not operating on that date, although the pumps were left running. In addition, maintenance was being performed on the traveling screens and on the backwash timer, which was malfunctioning. The study was repeated on the night of June 22-23, from 6:30 p.m. to 6:30 a.m. with all plant systems in operation. A third extended study was performed on July 14 from 9:30 a.m. to 10:30 p.m. Figures 48, 49, and 50 are plots of the numbers of fish impinged per hour during the three extended runs, namely those of May 30-31, June 22-23, and July 14, 1972.

The daily hourly catches during these three study periods are tabulated below:

	Number of Fish Caught per Hour			
	Average		Maximum	
	With Alewives	Without Alewives	With Alewives	Without Alewives
May 30-31	144	50	490	186
June 22-23	629	341	1,459	712
July 14	85	29	121	47

The maximum catches were recorded between 11:00 p.m. and 3:00 a.m. in these studies, while the minimum catches tended to occur during the late morning hours.

After the three initial studies, additional studies were scheduled for two days a month. During those days, backwashings were col-

FIGURE 48

NINE MILE POINT
NUCLEAR POWER STATION

FISH IMPINGEMENT STUDY

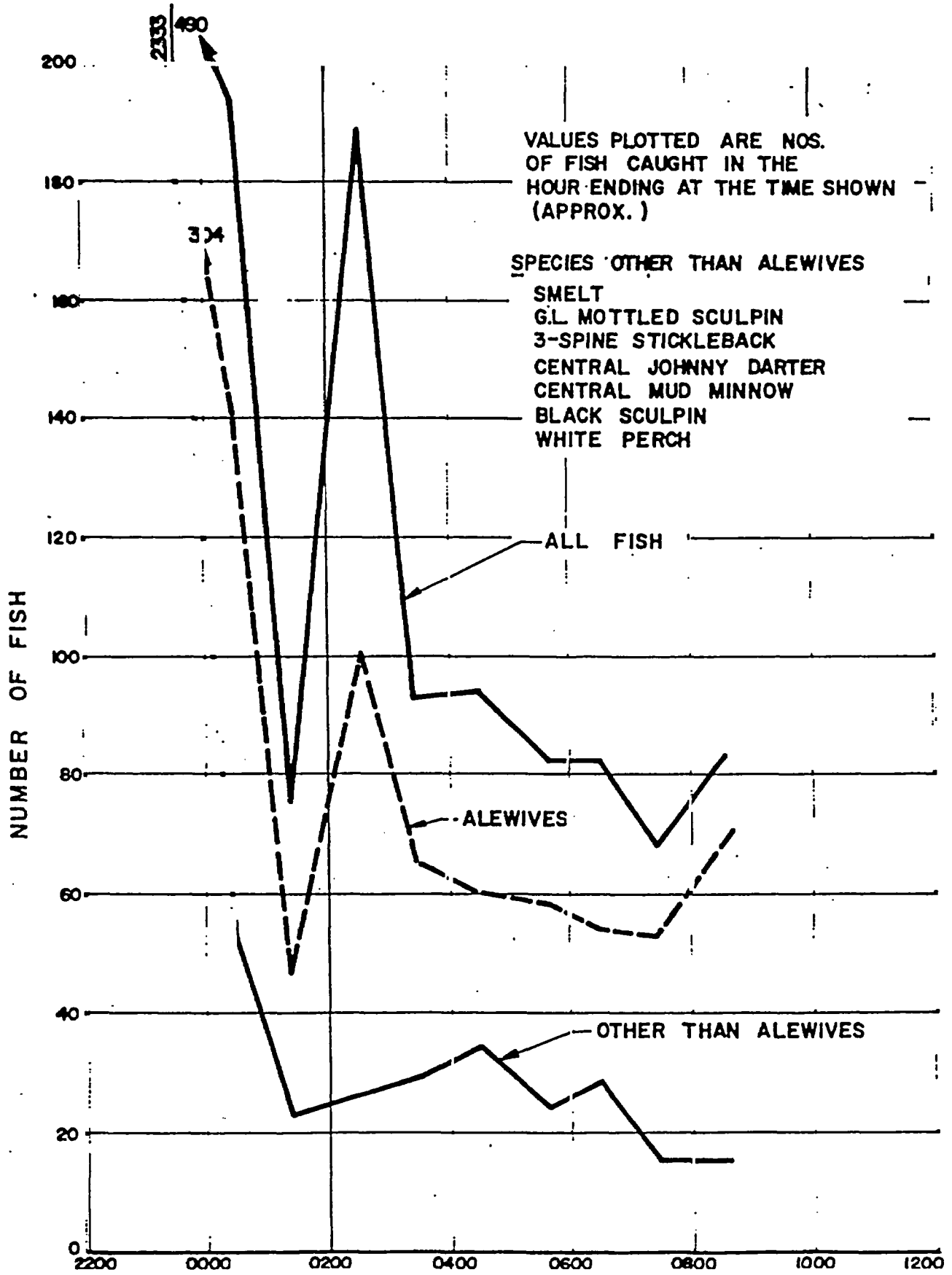


FIGURE 49

NINE MILE PONT
NUCLEAR POWER STATION

FISH IMPINGEMENT STUDY

VALUES PLOTTED ARE NOS.
OF FISH CAUGHT IN THE
HOUR ENDING AT THE TIME SHOWN

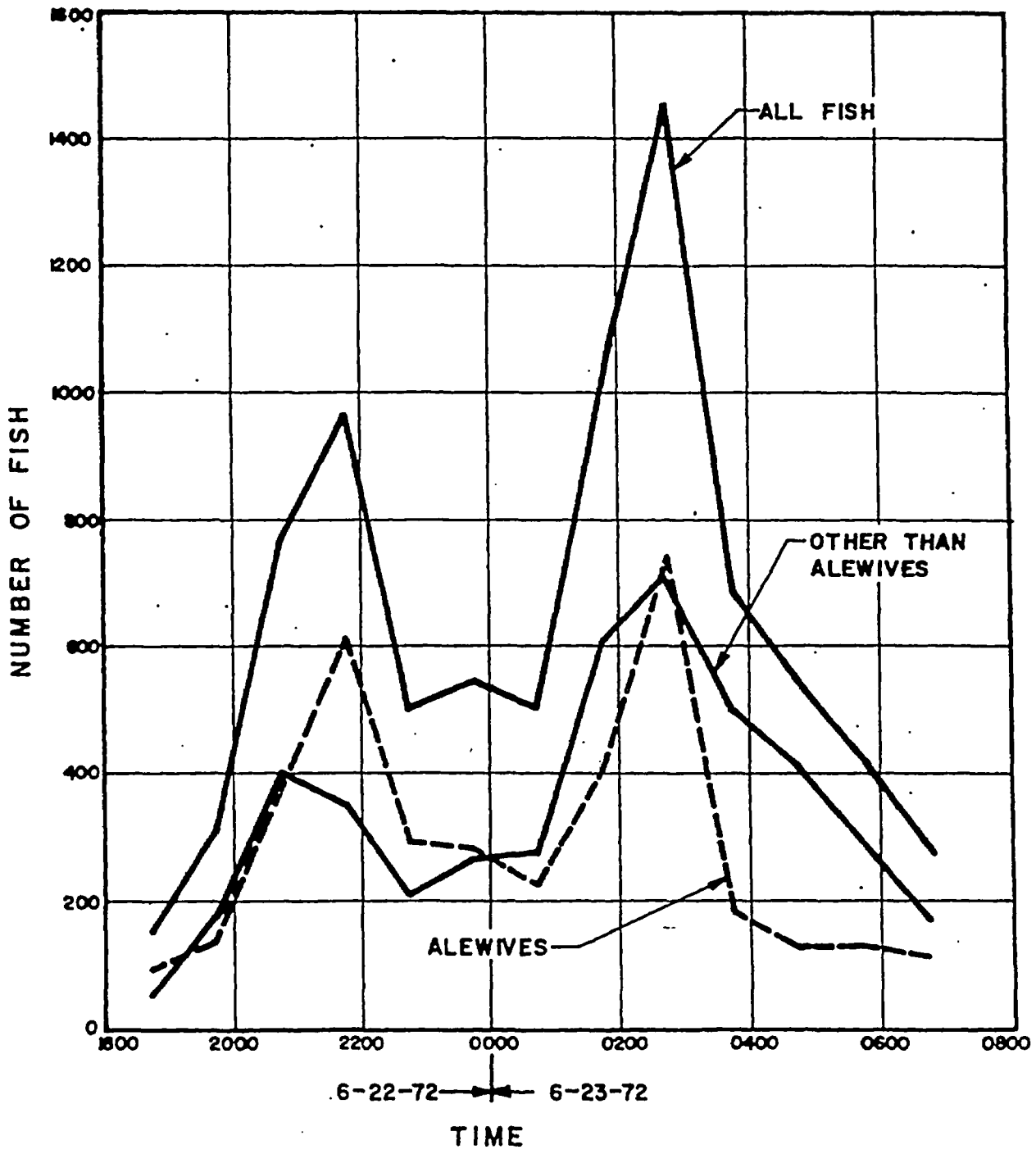


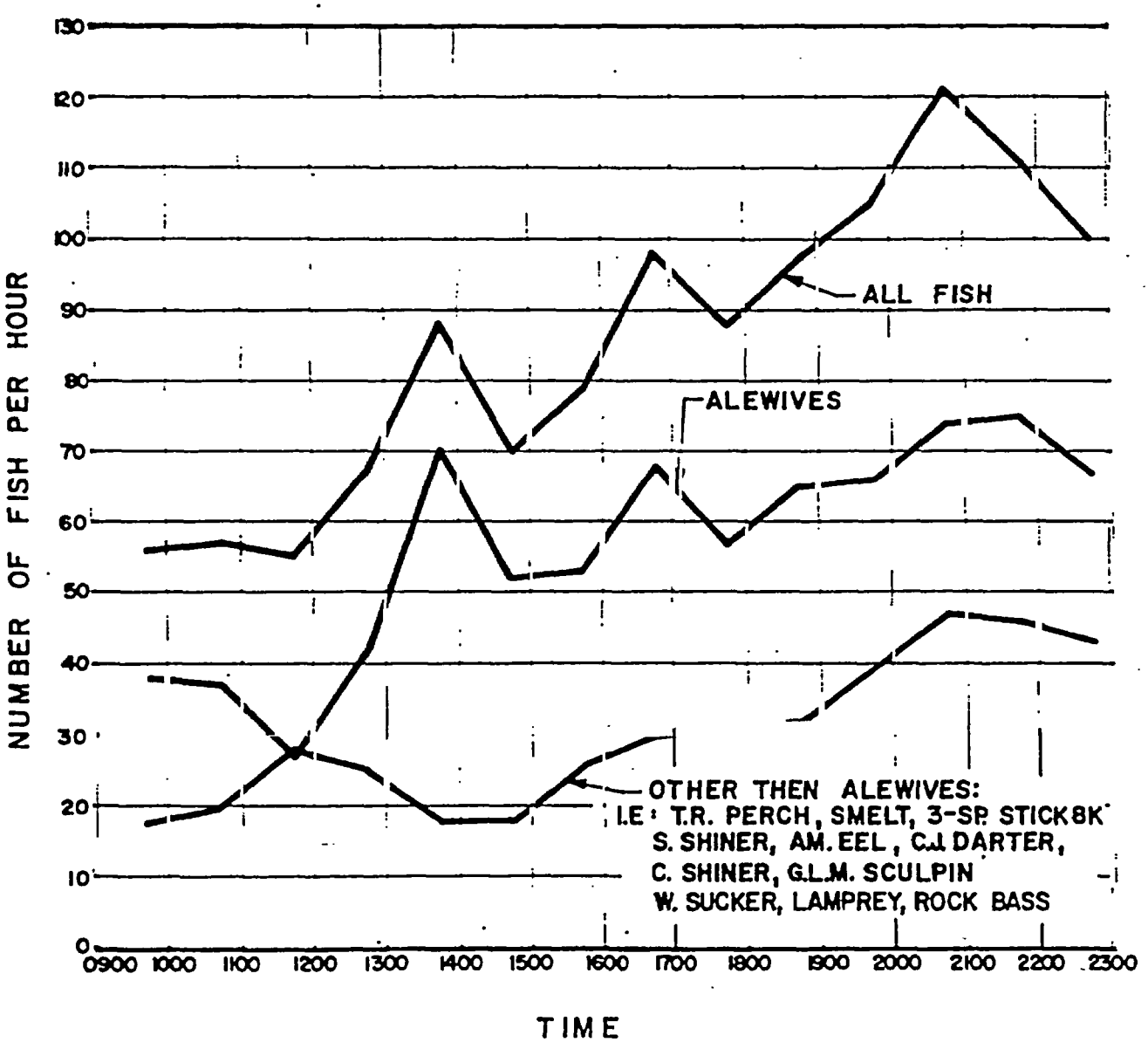
FIGURE 50

NINE MILE POINT
NUCLEAR POWER STATION

FISH IMPINGEMENT STUDY

JULY 14, 1972

VALUES PLOTTED ARE NOS.
OF FISH CAUGHT IN THE
HOUR ENDING AT THE TIME SHOWN



lected for two or three hours at a time in each of the three operating shifts. The fish analysis was expanded to measuring the length and weight of practically every fish, determining its sex, and recording its appearance. Descriptions of these studies are presented below.

August 1, 1972

The study was performed over a total period of six hours, in three runs of two hours each, in late evening, early next morning and near noon. Weather was calm and clear, both circulating pumps were running, and the inlet temperature was 77.5°F. A total of 45 alewives was collected in the six hours, most in good condition. No smelt were taken, and five other species accounted for a total of 20 more fish. Six fish were over 7 inches long, and they were dead or in very bad condition.

August 9, 1972

There were high winds and waves on this date, gradually decreasing. Both circulating pumps were running, and inlet temperature was 73.7°F. The study was performed over a total period of eight hours comprising the four hours ending at 0100 hours, and two 2-hour periods ending at 1000 hours and 1630 hours. As the day wore on, the alewife hourly rate dropped from 79 to 1. The impingement rate for non-alewives rose to a peak of 74 per hour at 0100 hours and then dropped to 15 per hour. This pattern is different enough from that

shown in the first three runs to indicate the effect of heavy weather in the lake. Another change was the appearance of post-larval fish, an average of nearly 100 per hour being counted. These have not been seen in the catch net, before or since. The condition of the fish was poorer than usual, many being bruised and scraped, others with patches of decay on their sides.

August 24, 1972

Weather was overcast, humid and calm. The study was performed over a total period of seven hours, comprising two hours ending at 0900 hours, two hours ending at 1700 hours, and three hours ending at midnight. Both circulating pumps were running and inlet temperature was 73.3°F. Three hours out of the seven had no fish at all. A total of five fish was collected, all dead or injured. They comprised one alewife (5-1/2 inches long) and one yellow perch, one smallmouth bass and two brown bullhead, all over 7 inches long. No small fish were present.

September 7, 1972

Weather was hazy and calm. The study was performed over a total period of eight hours, comprising two hours ending at 1000 hours, two hours ending at 1730 hours, and four hours ending at 0030 hours. Of the first four hours, two gave no fish at all, and two yielded a total of 5 fish, all in bad condition. In the four night hours, fish intake increased, a total of 35 alewives, 14 rainbow smelt, and 3 other fish being collected. Of these, only 5 were in good condition.

September 25, 1972

Weather was overcast and humid, with 10 mph winds from south to southwest. Both circulating pumps were running, but the plant power output had been reduced to 57 percent. Inlet temperature was 70.5°F. The study period totaled seven hours, comprising two hours ending at 1040 hours, two hours ending at 1740 hours, and three hours ending at 0040 hours. Fish were collected in only four of the seven hours, for a total of six alewives and two of other species. The alewives were all juveniles; the other two were larger fish, one dead and one injured.

October 12, 1972

Weather was overcast and rainy, with winds 15 to 20 mph. The study period totaled seven hours, two hours ending at 0920 hours, two hours ending at 1720 hours, and three hours ending at 0020 hours. Few fish were collected in the daylight hours, most of them appearing in the last three samples. Total catch was 65 alewives, 13 rainbow smelt, and 6 others. Most of the fish were juveniles, and a few appeared underfed, although otherwise in good condition.

October 17, 1972

Weather was stormy, with winds WNW at 35 mph. One morning sample was collected at 0745 hours, and three evening samples, ending at 2345 hours. The total for the four hours was 16 alewives, 34 rainbow smelt, and 35 of other species. A majority of the fish were juveniles, in good condition.

November 7, 1972

Weather was rainy and overcast, with winds SE or E at 20 mph, changing to N at 40 mph. Samples were taken for two hours ending at 0920 hours, two hours ending at 1720 hours, and three hours ending at 0020 hours. A total of 9 fish was counted in the seven samples. Three of the fish appeared in good condition; the rest were injured or thin.

November 20, 1972

The power station was shut down on this date, but since the cooling water circulating pumps continued to operate, a 24-hour impingement sampling program was conducted to see if any shift in the diurnal pattern had occurred since the summer months. No peak concentration was observed, only 35 fish being collected in 21 hours of sampling.

However, the sampling program was interrupted by a reverse flow test of the circulating water system. The test lasted approximately 15 minutes and, in the two hours immediately following, an increased impingement rate was observed. One hundred and fifty fish, representing eleven species, were captured in those two hours, and most of them were alive and in good condition. The species, in order of abundance, were:

Alewives	77
White Perch	28
Rock Bass	17
Pumpkinseed	12
Gizzard Shad	4
Mottled Sculpin	3
Smallmouth Bass	3
Yellow Perch	3

and one each of rainbow smelt, spottail shiner, and lamprey eel.

At the time of the test, the lake temperature was 44.4°F, the condenser intake was 44.9°F, and the weather was overcast and windy, with an air temperature of 37.4°F.

December 5, 1972

There was a total of eight hours of sampling, four hours beginning at 8 p.m., two hours the next morning starting at 8 a.m., and two more hours that afternoon starting at 3 p.m. Weather was overcast, winds veering from SE, through S, to W, increasing in strength in the process, from 12 mph to 45 mph before slackening to 35 mph. The air temperature dropped from 57.2°F to 38.4°F during the daylight hours. Water temperatures were 39.0°F in the lake and 43.0°F in the screenwell. The power station was at full output, approximately 610 MWe. A total of 29 fish was collected, 17 of them rainbow smelt and none of them alewives. Most were dead at capture, but appeared to be in good condition.

December 29, 1972

Weather was cold, with light snow turning to rain. Winds moved from SSW at 15 mph to WSW at 25 mph, to W at 20 mph, air temperatures ranging from 34.4°F in the early morning to 37.8°F in the evening. The lake was rough, with temperatures between 32.8°F and 34.6°F. Screenwell temperatures ran consistently 4.5°F higher. Sampling consisted of two hours starting at 6:30 a.m., two hours starting at 1:30 p.m., and four hours starting at 8:30 p.m. A total of 328 fish was collected, of which 223 were rainbow smelt,

47 were yellow perch, 20 were gizzard shad, and one was an alewife. Most were small, and three-quarters were dead on capture. The power station was at full capacity.

January 2, 1973

Sampling commenced at 8:00 p.m. for five hours, when the lake was rough; winds were W at 26 mph and the air temperature was 31.2°F. By the following morning, when two hours of sampling were done, starting at 8:00 a.m., the wind had moved to SW at 16 mph, the lake was calming, and the air had cooled to 30.0°F. In the afternoon, when two more hours of sampling were done, starting at 2:00 p.m., the lake was calm, the wind was SE at 10 mph, and the air had warmed to 35.2°F. Lake temperature was 35.5°F to 36.0°F, with the screenwell 4.2° to 5.2°F higher throughout the day. The power station was at full capacity. A total of 599 fish was collected, of which 473 were rainbow smelt, 42 were gizzard shad, 22 were yellow perch, and one was an alewife. More than half were dead on capture, and many were in poor condition with gut reduced.

January 29, 1973

From 1:30 p.m., when two hours of sampling were begun, through 12:30 a.m., when another four hours of sampling ended, the weather was cloudy, with winds NW at 40 mph, moderating to 24 mph. The lake was very rough, with temperatures falling from 34.2°F to 32.5°F. By the following morning, when two hours of sampling were begun at 7:30 a.m., the wind had veered to SSW at 20 mph. Screenwell temperatures were about 7.5°F higher than the lake throughout.

Station output was slightly less than full, at about 600 MWe.. A total of 271 fish was collected, of which 205 were rainbow smelt, 26 were gizzard shad, and 16 were yellow perch. Most fish were dead, and many were in poor condition.

Conclusions

Table 20 lists the data for the monitoring program period, in the form of maximum and average fish impingement rates per hour, month by month.

The monitoring program period described herein lasted approximately eight months. It was found that the average alewife weight was approximately 0.75 oz. and the average rainbow smelt weight was about 0.125 oz. A similar average figure for the other species was difficult to arrive at because of the small hourly catch and the variety of species. However, it was certainly somewhat less than that for the alewives. Assuming an average fish weight of 0.75 oz. for alewives, 0.125 oz. for rainbow smelt, 0.4 oz. for all other species, and assuming also the average number of fish per hour as indicated in Table 20, the approximate total weight of fish backwashed from the cooling water intake screens during the eight-month period would have been approximately:

Alewives	12,500 lbs.
Rainbow Smelt	1,800 lbs.
Other Species	2,700 lbs.

TABLE 20

FISH IMPINGEMENT RATES

Number of Fish per Hour

Month	All Species		Alewives		Rainbow Smelt		Others	
	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
June	1,459	629	747	287	544	245	230	97
July	121	85	75	56	31	17	21	12
August	135	33	79	13	6	1	68	18
September	19	4	13	3	6	1	2	1
October	30	15	22	7	11	4	17	3
November	7	2	4	1	2	0	4	1
December	59	22	1	0	41	15	18	7
January	95	51	1	0	88	38	23	11
Average for entire sampling period		85		39		31		15

To provide some perspective of what these values mean, the following comparisons are offered. The total landing of all fish from Lake Ontario during 1971 was 3,211,000 lbs. (52). This quantity does not include alewives which are considered to have no commercial or sport value. Therefore, the amount of 4,500 lbs. presented above as an estimate of the total eight-month weight of impinged fish, excluding the alewife, is only 0.14 percent of the annual landings.

It is planned to continue the monitoring program through the spring of 1973, in order to complete a study record of the annual pattern, but the following conclusions can be drawn from the data collected to date:

(1) The alewife and rainbow smelt predominate overwhelmingly in the total catch of impinged fish. Out of a total of 12,987 individuals taken, 10,641 (81.93 percent) were alewives and smelt. Of the remaining 2,346, nine species accounted for 2,243, the remaining 103 being distributed among 19 other species. Considering yellow perch, white perch, and smallmouth bass to be the species most commonly caught in the area as sport fish, these species account for only 310 individuals of the 12,987 total.

(2) Studies of daily fish movement in the lake had previously shown that the fish population close inshore reached a maximum during the night hours. It seemed reasonable to expect that the number of fish removed from the screens

would show a similar maximum. This, indeed, proved to be the case in the summer, although the high point occurred several hours earlier than in the lake. However, by the late fall, no significant diurnal peak was apparent.

(3) In addition to the diurnal variation in fish impingement rate, there was also a seasonal one. On May 30, 1972 (the first run made), an average of 144 fish per hour was collected during the night. By June 22, 1972, this had risen to 629 fish per hour. This is that time in their natural life cycle when alewives are generally found washed ashore dead in large numbers (54). By the end of July, a complete day's catch had dropped almost to zero. A second very low peak (30 fish per hour) appeared in October, and a third, moderately low peak appeared in early January (95 fish per hour).

(4) During stormy weather, there is a considerable increase in the fish impingement rate.

(5) The bulk of the alewives entering the plant intake do so during June and early July, which coincides with that point in their life cycle when they are being washed ashore dead in vast numbers anyway. The records also indicate that in summer and fall, the number of rainbow smelt collected follows a pattern similar to that of the alewives, i.e., when alewives appear in large numbers, so

do the smelt, and when the alewives are few, the smelt are few or entirely absent. However, in the winter months, when alewives are entirely absent, rainbow smelt continue to be collected.

EFFECTS ON AQUATIC BIOLOGY

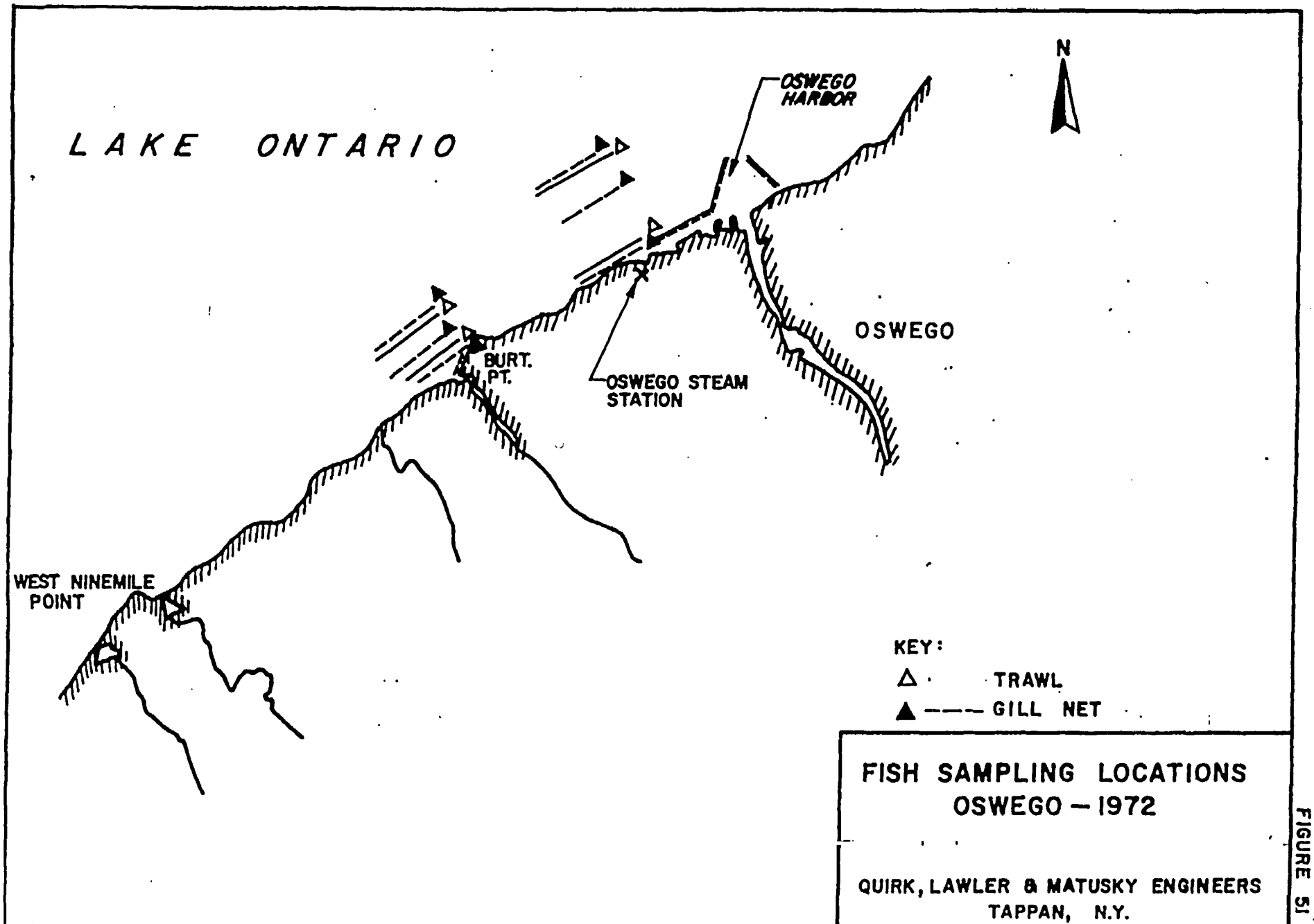
Fish populations in the vicinity of the proposed discharge for Unit 2 at Nine Mile Point were determined by fathometric, trawling, and gill netting surveys. The sampling locations for the gill nets and trawling transects used during the 1972 sampling program are illustrated on Figure 47. Impingement surveys at the Nine Mile Point Power Station were also undertaken as part of the 1972 monitoring program. The complete results of the field investigations are presented in Appendix C.

The numbers and species of fish present in the discharge area varied from month to month (Table 21). Trawl data indicate that the peak concentrations of fish occurred in June and that a corresponding maximum number of species occurred in May and June. This pattern of monthly fish concentrations was similar at the Nine Mile Point west control and also at the two Oswego sampling locations shown in Figure 51 (2). The number of different species of fish captured in any one trawl generally decreased after June.

TABLE 21

SPECIES LIST TOTAL NUMBER OF FISH PER MONTH
DURING NINE MILE POINT IMPINGEMENT STUDY, 1972

Species	May	June	July	August	September	October	November	December	Total
Alewife		3,736	791	279	43	81	97	1	5,814
American Eel		1	1	3	1		1		7
Bluegill		5		2					7
Brown Bullhead		1		2					3
Carp				4			1	1	6
Common Shiner			3	2					5
Emerald Shiner		4				29		11	44
Five-spine Stickleback		1							1
Gizzard Shad									
Goldfish								1	1
Gold Shiner								1	1
Johnny Darter	25	296	1	29	1		1		353
Lake Northern Chub								1	1
Lamprey Eel		2	1				2	3	8
Longnose Dace						1			1
Mottled Sculpin	82	111	4	60	2	6	7	5	277
Northern Logperch				1					1
Northern Pike								1	1
Pumpkinseed				4	1		12		17
Rainbow Smelt	282	3,178	235	23	14	47	8	240	4,027
Rock Bass			1	1			17		19
Sauger				2					2
Smallmouth Bass		2		1	1	1	5		10
Spottail Shiner		40	82	101			1	5	229
Three-spine Stickleback	12	658	57	7		5		12	751
Troutperch		121	13	13					147
White Bass							1		1
White Perch	1			14		1	32	6	54
White Sucker			1	4					5
Yellow Perch		19		119	2	1	6	47	194
Post-larval				781	50				831
Total	1,188	8,175	1,190	1,452	115	175	198	357	12,850
Number hours sampled	10	13	14	21	15	11	30	15	
Average number/hour	119	629	85	69	8	16	7	24	
Temperature range	48.0	49-61	68-72	72-77	70-73	53-59	44-55	38-46	



FISH SAMPLING LOCATIONS
OSWEGO – 1972

QUIRK, LAWLER & MATUSKY ENGINEERS
TAPPAN, N.Y.

FIGURE 51

Impingement surveys also indicated a maximum fish concentration in June at the Nine Mile Point plant site (Table 21). However, the greatest species diversity in fish captured by impingement occurred in August. Ten species were captured with the trawl during May and June at the Nine Mile Point plant site, whereas twenty species were collected in impingement samples in August. During these periods of maximum species diversity, ten species were collected in impingement samples that were never captured with the trawl.

Subsequent impingement sampling in the months after June showed a decrease in numbers of fish and, after August, showed a decrease in the number of species until November and December, at which time the number of species impinged again increased.

In August, post-larval fish, tentatively identified as alewife, smelt, and shiner types, were captured in the trawl at the Nine Mile Point plant site and west control, and also in impingement collections. During the impingement surveys, these post-larval fish were collected during a period of stormy weather and with corresponding large quantities of Cladophora. Since these fish were small enough to pass through the 1/2-inch steel mesh of the traveling screens, their capture was possible only by their entanglement in the matted algae. It is possible that greater larval fish concentrations can be associated with the Cladophora growth which supplies food and protection. The turbulence of wave activity during a storm will tear loose the algae and its inhabiting organisms from the bottom substrates. This free-floating algae mat is then liable to impingement.

A diurnal variation of fish concentrations is indicated by trawl, gill net, and fathometric data, fish concentrations increasing at night in the near shore area. At Nine Mile Point, night trawling produced 80.2 percent of the total daily catch at the plant site and 80.4 percent of the total daily catch at the west control. This daily movement of fish was also observed during impingement collections on May 30, June 22, and July 14. The impingement data for June 22 indicated that a maximum concentration of impinged fish occurred at night between 2100 and 0300 hours. However, the impingement data for November 21 showed no peaking in the impingement rate.

The results of the impingement studies conducted at the Nine Mile Point Nuclear Station and the Oswego Steam Station show that there is an increase in the number of fish impinged during December and January at Nine Mile Point while the number of fish impinged at Oswego remains about the same (Table 22). The major species collected at Nine Mile Point during December in decreasing order were the rainbow smelt, the gizzard shad and yellow perch and emerald shiners. During the January sampling at Nine Mile Point, fish were collected at the rate of 50 to 82 per hour with no observable peak in concentration of any species. At Oswego, in January only five species were captured, rainbow smelt being the most abundant species (Table 22). The nightly onshore movement of fish may not occur during the colder months of the year, when benthic and plankton productivity are retarded by the cold water.

TABLE 22

COMPARISON OF FISH IMPINGEMENT RATES AND SPECIES

NINE MILE POINT VS. OSWEGO

December 1972 and January 1973

	Nine Mile Point			Oswego		
	12/5/72	12/19/72	1/2/73	12/4/72	12/18/72	1/5/73
Alewife	-	1	-	7	1	-
Bullhead	-	-	-	1	1	-
Carp	-	1	1	-	-	-
Central Mudminnow	-	-	1	-	-	-
Emerald Shiner	2	11	11	2	39	17
Gizzard Shad	-	20	35	8	-	2
Goldfish	-	1	-	-	-	-
Golden Shiner	-	1	-	-	-	-
Lake Northern Chub	-	1	-	-	-	-
Lamprey Eel	2	1	-	-	1	-
Minnow	-	-	-	-	1	-
Mottled Sculpin	3	2	8	8	3	-
Northern Channel Catfish	-	-	1	-	-	-
Northern Pike	-	1	-	-	1	-
Rainbow Smelt	17	223	366	40	49	71
Smallmouth Bass	-	-	-	1	-	-
Spottail Shiner	2	3	-	-	-	-
Three-spine Stickleback	1	11	15	1	-	-
Troutperch	-	-	2	-	-	1
White Perch	3	4	6	-	1	-
White Sucker	-	-	1	-	-	-
Yellow Perch	-	47	21	1	58	3
Total	29	328	468	69	153	94
Number hours sampled	7	8	9	9	9	7
Number fish/hour	4	41	52	7-8	17	13-14

Condition factors were calculated for selected species of fish captured in the lake from April through November and also for selected species of fish captured by impingement from August through December (Table 23). Comparison of the condition factors computed for different fish length intervals helps explain the physical condition of the fish that become impinged in relation to the condition of lake fish.

Small fish, i.e., johnny darters, mottled sculpins, rainbow smelt, spottail shiners, and alewives, could be impinged solely owing to their size, i.e., they may not be able to escape the force of the intake flow. However, the data accumulated so far are still inconclusive. Johnny darters ranged from 3.0 to 6.0 cm in length, and the condition factors of the impinged johnny darters were greater than those of the lake johnny darters. Mottled sculpins ranged from 3.0 to 8.0 cm in length, and the condition factor of the sculpins impinged was 30 percent lower than those of the lake sculpins. However, their short length would make them more vulnerable to impingement. Rainbow smelt ranged from 3.0 to 22.0 cm in length, and the condition factors of smelt impinged that were below 13.0 cm impinged smelt had increasingly lower condition factors than lake smelt. Spottail shiners ranged from 3.0 to 14.0 cm in length and all of the spottail shiners impinged had lower condition factors compared to the lake spottail shiners. Alewives ranged from 3.0 to 22.0 cm in length and they were similar to the smelt in that the

TABLE 23

CONDITION FACTORS OF FISH CAPTURED IN LAKE ONTARIO
VS. FISH IMPINGED AT NINE MILE POINT

May to December 1972

K_L = Condition factor of fish in the lake

K_I = Condition factor of fish impinged

Length Interval	Alewife		Gizzard Shad		Johnny Darter		Mottled Sculpin		Rainbow Smelt		Rock Bass		Spottail Shiner		Yellow Perch	
(cm)	K_L	K_I	K_L	K_I	K_L	K_I	K_L	K_I	K_L	K_I	K_L	K_I	K_L	K_I	K_L	K_I
3	-	.72	-	-	.92	.94	-	1.52	-	.36						
4	.67	.72	-	-	.71	.86	1.16	.93	-	.36			-	1.59	-	1.04
5	.75	.74	-	-	.98	1.02	1.56	1.16	-	.41			-	-		1.07
6	.79	.65	-	.92	-	.99	1.68	1.13	.40	.41			-	.86	-	1.06
7	.61	.75	-	.77			1.63	1.11	.44	.41			.89	.84	.96	1.01
8	.49	.80	-	.82			1.53	1.08	.45	.46				.88	-	1.01
9	.56	.79	-	.85					.49	.43			-	.89	-	1.04
10	.60	-		.90					.45	.44			.98	.84	-	.98
11	.60	.91	1.04	.91					.55	.46			1.02	.81	.81	1.19
12	.69	.56	1.00	.98					.49	.50		2.15	1.00	.79	.84	1.22
13	.67	.63	1.00	.96					.56	.52			.90	.70	-	-
14	.67	.62	-	1.04					.59	.46	2.51	2.28	1.00	-	-	-
15	.67	.60		-					.63	.44		2.24			-	1.16
16	.62	.58	1.08	-					.60	.45		2.29			-	1.49
17	.61	.56	1.20	-					.59	.49		-			-	1.22
18	.61	.57							.58	.39	2.34	2.17			1.47	1.37
19	.74	.49							.51	.46	2.31	2.20			1.46	1.54
20	.82	.55							-	.33	2.36	2.19			1.46	1.29
21	.75								.49		2.30	2.28			1.44	1.21
22	.79								-	.41	-	-			1.42	1.32
23	-										-	1.86			1.45	-
24											2.44	-			1.40	1.24
25											2.43	-			1.46	-
26											2.49	-			1.40	-
27															1.39	-

alewives impinged that were less than 11.0 cm had condition factors similar to alewives in the lake, but those impinged that were above 11.0 cm in length had increasingly lower condition factors compared to lake alewives.

Larger fish, e.g., gizzard shad, rock bass, and yellow perch, may be impinged depending on their length (age) and their condition factor. The impinged gizzard shad ranged from 6.0 to 14.0 cm in length. Gizzard shad below 10.0 cm were not observed in lake catches, but the shad from 10.0 to 14.0 cm observed in the lake had higher condition factors than the shad of the same length that were impinged. No rock bass below 11.0 cm in length were observed in lake catches or impingement catches. According to age-length regression data (2), these would be included in the I and II year old age classes. The rock bass that were impinged ranged from 12.0 to 23.0 cm, and therefore belong to the II, IV, and V year old age classes. The condition factors of rock bass impinged were slightly lower than the condition factors of the lake rock bass. Yellow perch give the best estimate of length as compared to impinged fish. Those impinged ranged from 4.0 to 24.0 cm in length, and while yellow perch below 17.0 cm were not often captured in the lake, they were prominent in impingement catches. These impinged perch, of the I, II, and III year age classes, had higher condition factors compared to the perch of comparable length found in the lake. However, above 18.0 cm, age classes III and IV, the perch impinged had increasingly lower condition factors than the perch of the same age in the lake.

The fish collected in the impingement studies have usually been small fish, e.g., alewives, smelt, shiners, etc., and condition factor does not appear to differ significantly from those of the same size taken in the lake. However, in the larger members of these species, a decrease in condition is noticeable. Larger fish, e.g., rock bass, yellow perch, gizzard shad, etc., will only be impinged in large numbers during their early years, that is, the I, II, and III year age classes. The condition of these small fish will not affect their vulnerability to impingement, but larger fish, IV years and over, may be more susceptible to impingement if they have a low condition factor.

Even though there is only a 13°F temperature rise across the condenser at Oswego, the thermal plume into the turning basin of Oswego harbor is known to be a favored habitat for many overwintering fish (23). However, the separation of the discharge from the intake by the harbor wall makes impingement of these fish at Oswego impossible. At Nine Mile Point, the intake is separated from the discharge by only about 500 ft of open water. It is possible that fish are residing in the Nine Mile Point discharge plume and also that these fish may be the major contributors to the increase in impingement that takes place immediately after a reversal of cooling water flow. This emergency operation is performed only in the winter, when buildup of frazil ice on the bar racks of the intake structure begins to impede cooling water flow, thereby jeopardizing plant operation.

When the combined discharge for Units 1 and 2 goes into operation, its high-velocity jets will cause rapid dilution and will be directed lakeward, away from the intakes. Thus any fish that do reside in the plume will be a considerable distance from the intake, and the likelihood of their impingement will be less. Furthermore, the bar racks of Unit 2's intake structure will be heated, and therefore, the need for flow reversal will be less. Both of these design features are expected to reduce the annual fish impingement rate in both units of the Nine Mile Point Nuclear Power Station.

It is recognized that sudden unit shutdowns during the colder months may stress fish which are acclimated to warmer temperatures (35). The discharge is designed so that only a small deep water volume is more than 3°F above ambient, and the high velocity of discharge is expected to limit the number of fish that may be acclimated to temperatures higher than 3°F above ambient. In the event of an unplanned shutdown, these fish, in all likelihood, would follow the dissipating plume to minimize thermal stress. Outside of this region, it is expected that the small temperature differential above ambient (less than 3°F) will not stress fish populations in the event of a unit shutdown. The probability of both units being shut down at the same time is remote and the combined diffuser system will ensure that some warm water will be discharged even if one unit were to shut down, thereby reducing the possibility of thermal stress due to a drop in temperature.

Planned shutdowns would never be carried out for both units simultaneously and, normally, the discharge temperature of the unit to be shut down would be lowered gradually over a period of hours. It is expected that each unit would have a planned shutdown once a year, in the spring or fall, i.e., not the coldest months.

Entrainment experiments were performed in a continuing program to evaluate the percent mortality occurring among organisms subjected to passage through the power plant cooling system. Evidence is accumulating that the condenser temperature rise is not as critical as the maximum temperature attained. Thus, if the maximum condenser outlet temperature is 105°F, mortality is probably 100%. However, if the maximum temperature reached is 95°F, mortality is of the order of 20-30%.