APPENDICES

POWER AUTHORITY OF THE STATE OF NEW YORK
JAMES A. FITZPATRICK NUCLEAR POWER PLANT

316(a) DEMONSTRATION SUBMISSION

PERMIT NO. NY0020109

76/302 & 260/002

APPENDIX A

FISH 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 3/
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: Smallmouth bass (Micropterus dolomieui)

I. Lethal threshold:

	acclimation temperature	larvae	juvenile	adult	data source[3/]
Upper		38* (9)	35 (3)		9, 3

*acclimation not given

	acclimation temperature	larvae	juvenile	adult	data source[3/]
Lower	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, 8
	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: 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, 11
Incubation and hatch		5-10 (10)	March-June (11)	10, 11

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.

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APPENDIX B

THERMAL BIOASSAY REPORT

THERMAL BIOASSAY

INTRODUCTION

The entrainment of organisms into the maximum temperature increases in the thermal plume of the James A. FitzPatrick Nuclear Power Plant will expose them to a gradient of rapidly diminishing temperature. Due to the high velocity of the discharge water and the rapid dilution with ambient water the exposure to the highest temperatures above ambient will be very short. One second after discharge the temperature will be reduced from 17.5°C above intake ambient to approximately 7.5°C above ambient. There are no data available on the effect of very short duration thermal shocks on fish which would approximate the conditions of entrainment in the FitzPatrick plume. Therefore, a thermal bioassay was conducted using a 6 second exposure time.

Yellow perch and coho salmon, both on the representative important species list for JAF, were selected for these bioassays. The experiments with coho salmon were abandoned because it was impossible to acclimate them to 20°C, the experimental acclimation temperature.

MATERIALS AND METHODS

Yellow perch were acquired from Zetts Fish Hatchery in Drifting, Pennsylvania and maintained in reconstituted water at 25±0.5°C in 10 twenty-gallon aquaria. The fish ranged in size from 3.9 to 5.5 cm, with a mean length of 4.6 cm. Weight ranged from 0.4 to 1.4 gms, with a mean of 0.8 gms.

Temperature was maintained at 25°C with a Jager thermostatically-controlled heating system. Both Biosurge undergravel and metaframe Dyna-Flo biofilters were used for aeration and filtration. Reconstituted water was made in 100 gallon batches by adding salts to aerated deionized water according to the following formula:

	gm/100 gal.
$NaSO_4$	36.3
$CaSO_4$	19.0
$MgSO_4$	22.7
KCl	1.8

The fish were allowed to acclimate to experimental conditions for two weeks. During this time and throughout the experiments they were fed both adult *Artemia salina* and Tetra min high protein fish food twice per day. Mortality during acclimation was less than 10% and none were lost during the last 96 hours before initiation of the experiments.

Immediately before initiation of the thermal experiments, water samples for chemical analysis were taken from each fish tank. Table 1 gives all the parameters measured and the value of each in the experimental tanks.

The first experiment involved exposing 2 tanks of fish acclimated to 25°C to 17.7°C above ambient for six seconds. the fish were collected with a bag type hand-held fish net and placed in a 1 mm mesh nylon net 30 cm on a side. When all the fish from one tank had been collected, the large net and fish were transferred to the 42.7°C water bath for six seconds, and then returned to 25°C tanks. The fish were exposed to air for a total of 30 seconds during transfer.

The control group of fish contained in a second set of two tanks were subjected to the same handling as the thermally shocked fish, but did not encounter changes in water temperature.

Within 24 hours after the 17.7°C shock more than 50 percent of the test fish had died, therefore, a series of 6 second temperature shock experiments between 4.4°C and 17.7°C were completed in order to determine the lethal tolerance limit of 50 percent of the yellow perch (LC-50). Five temperatures listed below and the ambient control temperature were tested as described previously.

*25°C Ambient + 0 = 25°C Control
*25°C Ambient + 4.4 = 29.4°C
*25°C Ambient + 8.9 = 33.9°C
25°C Ambient + 12.3 = 37.3°C
25°C Ambient + 13.3 = 38.3°C
*25°C Ambient + 17.7 = 42.7°C

In addition, a two second 17.7°C temperature shock treatment was performed on a single set of 23 fish using the same procedure described above.

The yellow perch were observed 1.5 hours, 3.0 hours, 6.0 hours, 12 hours, 24 hours, 48 hours, and 96 hours after each thermal shock. Dead fish were removed and counted at each observation. After 96 hours all remaining fish in each tank were removed and counted.

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*Replicates of asterixed temperatures were completed.

TABLE 1

CHEMICAL ANALYSES OF BIOASSAY EXPERIMENTAL TANKS

	TEMPERATURE TREATMENT									
PARAMETERS	17.7°C	17.7°C	0°C	0°C	4.4°C	4.4°C	8.8°C	8.8°C	12.3°C	13.3°C
pH	8.1	8.3	8.1	8.2	8.2	8.3	8.2	8.3	8.3	8.3
Alkalinity $CaCO_3$ mg/l	126	119	119	124	117	123	114	113	117	117
Sp. Cond. mhos/cm @25°C	385	374	415	405	440	409	403	418	418	403
TOC, mg/l	32	28	22	26	26	24	25	25	25	26
COD, mg/l	40	24	20	18	36	28	40	30	26	30
TSS, mg/l	5	2	2	<1	1	<1	<1	<1	<1	1
DO, mg/l	8.2	7.6	8.1	8.1	7.8	7.8	8.2	8.0	8.1	7.9

RESULTS

Cumulative numbers of fish dead after each observation for both the 2 and 6 second shock experiments are shown in Table 2. Table 3 provides a description of the reaction of the yellow perch following exposure to the elevated temperatures. Table 4 presents the percentage of the accumulated dead to the total number of test fish per tank. The temperature and the percent dead after 96 hours were plotted (Figure 1). The 96 hour LC-50 determined from the plot was 13.2°C when yellow perch are exposed to 6 second temperature shocks.

Results (Tables 2 and 4) of 2 second shocks at 17.7°C above the ambient were similar to the results at this temperature for the 6 second temperature shock. Temperature rather than shock length appears to affect mortality.

DISCUSSION

These experiments indicate that juvenile yellow perch, acclimated to 25°C can generally tolerate temperatures up to 12°C above acclimation for 6 seconds, but some mortality can be expected below 12°C. An increase of 4.4°C was stressful to the test fish. The test results indicate that a temperature of approximately 37°C is critical and increases above this temperature would be lethal regardless of exposure time. The 2 second exposures to a 17.7°C increase confirm this finding.

TABLE 2
YELLOW PERCH

Test Condition in	°C Above Ambient	No. of Test Fish	CUMULATIVE DEAD						
			1.5 hrs	3.0 hrs	6.0 hrs	12 hrs	24 hrs	48 hrs	96 hrs
25°C	0	28	0	0	0	0	0	0	0
25°C	0	28	0	0	0	0	0	0	0
29.4	4.4	24	0	0	0	0	0	0	1
29.4	4.4	22	0	0	0	0	0	0	1
33.8	8.8	28	0	0	0	0	0	0	3
33.8	8.8	34	0	0	0	0	0	2	4
37.5	12.3	27	1	2	2	2	2	2	2
38.3	13.3	35	17	20	20	20	20	20	20
42.7	17.7	29	25	26	26	26	26	26	26
42.7	17.7	23	18	19	20	20	20	20	20
2 sec.									
42.7	17.7	24	13	18	18	19	19	19	20

TABLE 3

OBSERVATION OF THE INITIAL YELLOW PERCH REACTION TO TEMPERATURE SHOCKS

1. CONTROL FISH

The control fish exhibited no reaction to the treatment with ambient water. Upon release from the net they darted to the bottom, then resumed normal swimming behavior.

2. 4.4°C TEMPERATURE SHOCK TREATMENT

After this treatment, the gill operculum was distended and the gill tissue was swollen and red. Fish activity was depressed for about a minute and fish tended to hyperventilate for some time after the heat exposure. Normal activity resumed in 5-15 minutes after the heat exposure.

3. 8.8°C TEMPERATURE SHOCK TREATMENT

The yellow perch reacted in a manner similar to the 4.4°C shocked fish, however, some fish remained clearly disoriented after 25 minutes.

4. 12.3°C TEMPERATURE SHOCK TREATMENT

The reaction of the fish was the same as the 8.8°C temperature treatment.

5. 13.5°C TEMPERATURE SHOCK TREATMENT

The gills of these fish were brilliant red and the operculum was greatly distended. Of the fish that survived this treatment, all locomotion initially stopped or was severly limited. All of these fish were disoriented for 30 to 90 minutes.

6. 17.7°C TEMPERATURE SHOCK TREATMENT

The yellow perch that were shocked with this temperature treatment immediately stopped all locomotion. The gill condition and disorientation was similar to the 13.5°C treatment.

FIGURE 1

96 HR LC-50 FOR YELLOW PERCH
EXPOSED TO SIX SECOND
TEMPERATURE SHOCKS

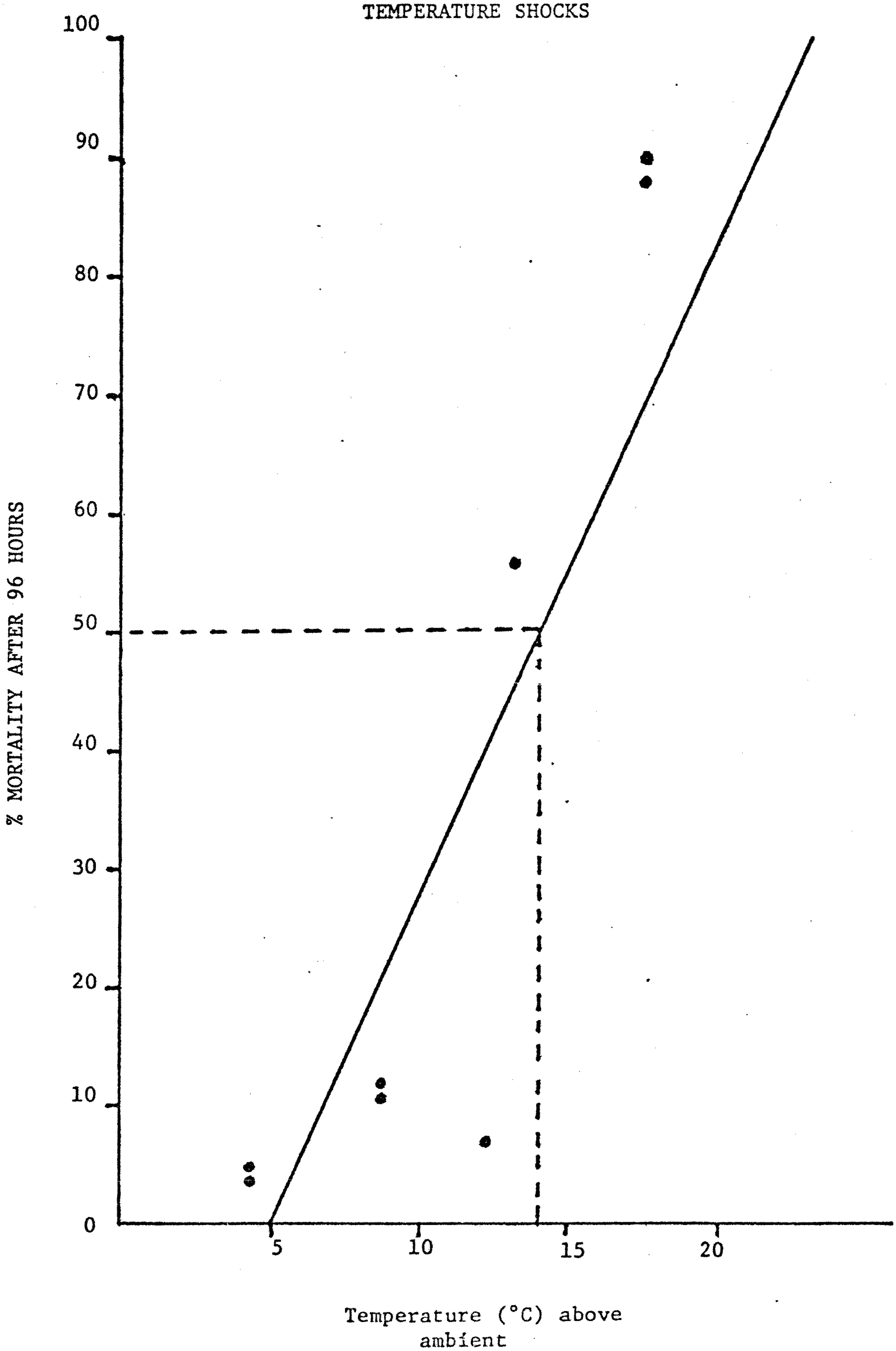

TABLE 4
YELLOW PERCH

Test Conditions in °C	Above Ambient	No. of Test Fish	CUMULATIVE DEAD (%) 1.5 hrs	3.0 hrs	6.0 hrs	12 hrs	24 hrs	48 hrs	96 hrs
25°C	0	28	0	0	0	0	0	0	0
25°C	0	28	0	0	0	0	0	0	0
29.4	4.4	24	0	0	0	0	0	0	04
29.4	4.4	22	0	0	0	0	0	0	05
33.8	8.8	28	0	0	0	0	0	0	11
33.8	8.8	34	0	0	0	0	0	06	12
37.5	12.3	27	04	07	07	07	07	07	07
38.3	13.3	35	49	57	57	57	57	57	57
42.7	17.7	29	86	90	90	90	90	90	90
42.7	17.7	23	78	83	87	87	87	87	87
2 Sec. Exp.									
42.7	17.7	24	54	75	75	79	79	79	83

APPENDIX C

REFERENCES NOT READILY AVAILABLE

P. Horne

F.-EL-SHAMY

Re: Evaluation of Thermal Effects in Southwestern Lake Michigan, Special Studies 1972-1973

TEMPERATURE EFFECTS ON FISH
JUNE 1972-JUNE 1973

by

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I. Introduction

General considerations: Lake Michigan is a natural resource of great value to all who inhabit or have occasion to visit its shorelines. This value is both esthetic in terms of recreational potential and economic in terms of commerce related to recreation, and value as a food source, pathway for transport, and water source. It is the latter category of economic utilization and its inherent conflict with esthetic values which is currently of central concern to the public, industry, and those government regulatory agencies which mediate disputes between the public and industry. Man has historically made use of natural waters as a sink for disposal of domestic and industrial wastes. This use has been dictated by economic and technological rationales and has not been in direct conflict with recreational or esthetic utilization in so far as adequate space was available for both. However, as population density and industrial development are increased and cultural and technological advances provide greater leisure time and mobility to the general public the conflict has intensified.

The power industry is particularly visible in this regard. Accelerated cultural and technological evolution is demanding ever increasing quantities of power. This in turn requires the utilities to construct more and larger generating facilities which, due to economic and engineering considerations, are most conveniently located in areas of prime esthetic and recreational value.

The process of converting chemical energy to electrical energy produces large quantities of waste heat as a by-product. This heat can be dissipated to the environment in several ways, the most desirable from the economic point of view of the power utility being to use a natural body of water as a heat sink. That this mode of heat dissipation is unacceptable or in contrast with esthetic or recreational considerations cannot be judged on an ipso facto basis. Rather, it is most effectively dealt with on a case by case basis, preferably from a multiple usage concept which considers the best interests of all parties concerned.

Study objectives: The welfare of the fish community in the receiving waters is one such aspect of concern. A healthy and diverse fish community is of obvious recreational value as well as being indicative of the well-being of the aquatic biota as a whole. The diverse ways in which alterations in water temperature affect fishes have been of interest to biologists long before power plants became a potential problem and a large body of literature has been developed. The present study is intended to supplement this literature by providing data derived in the laboratory which can be used in a predictive sense to evaluate potential effects of a heated effluent on fishes in Lake Michigan. Emphasis is placed on the survival of fishes in the face of altered temperatures as well as the possibility of distributional changes related to attraction or repulsion from areas of elevated temperature.

II. Summary and Conclusions

This is a laboratory study dealing with the effects of fluctuations in water temperature on various Lake Michigan fishes. Responses considered include performance (swimming) capabilities, survival and behavioral (avoidance-preference) reactions. The study is intended to provide data for a predictive assessment of fish response to heated discharges from Commonwealth Edison Company's Zion and Waukegan generating stations into southwestern Lake Michigan.

Swimming capabilities were determined for rainbow smelt, lake trout, rainbow trout and yellow perch. Swim speeds varied with species, acclimation temperature, test temperature and fish size. Results indicate that centerline velocities at the Waukegan Generating Station discharge canal are sufficient to limit access by smaller individuals of some species. However, the presence of protected areas throughout the canal make it possible for fish of any species or size to move freely to the maximum discharge temperature ($\Delta T = 8$ C). Water velocities at the Zion Station discharge are considerably greater and it is unlikely that fish will be able to swim into the plume to temperatures greater than 4 C above ambient.

Heat shock temperatures, upper lethal temperatures and lower lethal temperatures were determined for a number of species. Results varied with species, age class and acclimation state. Maximum discharge temperatures at the Zion and Waukegan generation stations do exceed heat shock and upper lethal levels for some species during the warmer months. However, these more heat-sensitive species are primarily those which inhabit deep, offshore waters during summer months, isolating them from elevated temperatures related to operation of either station. The alewife is the only species tested which appears to be susceptible to cold death resulting from station shutdown and the sudden disappearance of a heated plume. This susceptibility is limited to a brief period in early spring at the Waukegan Generating Station discharge canal only.

Avoidance and preferred temperatures were also determined for a variety of species. Species and acclimation-related differences in avoidance responses were comparable to those noted for survival studies. Avoidance temperatures were well below heat shock levels in all cases except for the yellow perch and generally approximated or were slightly below upper lethal temperatures. The failure of yellow perch to avoid temperatures exceeding lethal or heat shock limitations is not a matter for concern since upper lethal limits for this species exceed maximum discharge temperatures for both stations with the exception of late summer at Zion Station. In this case, lethal limits are exceeded only in areas near the discharge structures where high water velocities prevent access. All species tested were found to prefer temperatures above ambient during at least some portion of the year and may be attracted to the discharge plumes. However, preferred temperatures were consistently lower than avoidance levels by a considerable margin.

III. Materials and Methods

A. Experimental Fish

Laboratory studies have been conducted on a variety of fish species common to Lake Michigan. Emphasis has been placed on species which occur in large numbers or which are of sport or commercial interest. A variety of collection methods have been employed. Alewives, brook trout, brown trout, chinook salmon, coho salmon, yellow perch, golden shiners and largemouth bass were obtained by seining along the shoreline between Waukegan and Zion. Lake trout, rainbow smelt and slimy sculpins were collected by trawling offshore between Waukegan and Zion. Adequate numbers of lake trout and yellow perch could not be obtained from Waukegan-Zion waters. Lake trout were obtained from the Ann Arbor Laboratory of the Bureau of Sport Fisheries and Wildlife. Yellow perch and rainbow trout were purchased from a local supplier.

Test fish were maintained in the Commonwealth Edison Company Waukegan Laboratory located at the Waukegan Generating Station. This facility receives a continuous supply of water drawn directly from Lake Michigan. Fish were held in 1000 or 200 gallon tanks receiving a continuous input of untreated water. The 1000 gallon tanks were located in a fiberglass enclosure and received natural light. The 200 gallon tanks were located inside the laboratory where artificial lights were regulated by timers to simulate a natural photoperiod. All fish received daily feedings of a wet and/or dry commercial diet. Plankton-feeding species also had access to organisms in the water supply. Piscivorous species received regular feedings of live forage fishes obtained from Lake Michigan by seining. Care was taken to avoid crowding the fish and no disease problems were encountered.

Two types of temperature acclimation were employed, constant and seasonal or lake-inshore ambient. In the first case, fish were maintained in static tanks at controlled temperatures. Temperatures were varied from ambient to the desired level in a gradual fashion and care was taken to insure adequate time for complete acclimation. Fish acclimating to higher temperatures received a minimum of one day per degree of temperature increase, those acclimating to lower temperatures received a minimum of three days per degree of temperature decrease.

Fish in holding tanks were continuously at lake-inshore ambient temperatures and no special provisions were required to maintain this acclimation state. Laboratory water temperature records were frequently compared with concurrent field observations to insure that the thermal regime in the laboratory was similar to that existing in the Waukegan-Zion inshore area.

B. Performance Studies

A stamina tunnel similar to that described by Griffith (1966) was used to obtain performance data. The apparatus was an open loop of some 299 gallons capacity. Water was pumped into a fiberglass pipe from a header box by a propeller hooked to a variable speed D.C. motor of 3/4 horsepower. The water was forced through a set of screens into a five inch diameter clear plexiglass swimming chamber. At the rear of the chamber were three graphite rings hooked to a source of low-voltage A.C. to provide a shock stimulus to the fish.

Behind the rings, where the tunnel emptied into the header box, either a screen or a chute was fitted over the end of the tunnel. The header box contained three 4000 watt, 240 volt heaters, which when operated in unison were capable of raising the water temperature of the tunnel 1 C each 2 1/2 minutes. One of these heaters could be operated independently with a thermostat to provide precise temperature control. Speeds up to a maximum of 100 cm/sec were obtainable. Speed calibration was obtained with a pitot-tube manometer system. Speeds in cm/sec could also be read directly from an electronic tachometer.

A method similar to that described by Brett (1965) was employed to determine maximum sustained swimming speed. This is the greatest speed which a fish can maintain for a period of moderate length (45 minutes or less) as contrasted with burst speed, the maximum velocity which a fish can achieve; and cruising speed, the maximum velocity a fish can maintain for extended periods (days). From one to five fish, depending on size, were placed in the swimming chamber at their acclimation temperature for approximately 30 minutes, or until the test temperature was obtained. An introductory water velocity of from 1/2 to 1 body length sec^{-1} was maintained. At the end of the introductory period, speed was increased by approximately 1/3 body length sec^{-1}. Similar velocity increases were imposed each 45 minutes. As individual fish fatigued and were washed against the screen, they were removed. The test was continued until all fish had fatigued. Maximum sustained speeds were then calculated for each fish according to the following formula:

Max. sust. speed = Last recorded speed + time at new increment x increment of speed

That is to say, if a fish fatigued after swimming at 60 cm sec^{-1} for 15 minutes, and if the speed increments were 10 cm sec^{-1}, the maximum sustained speed would equal 50 cm sec^{-1} + (15 min/45 min x 10 cm sec^{-1}) = 53.3 cm/sec. The data were then averaged for each test.

C. Survival Studies

Tolerance tests were conducted in 22 or 150 liter fiberglass tanks, depending on the size of the fish. Water temperatures were regulated by opposing thermostatically-controlled heaters against continuous cooling and were accurate to ± 0.01 C. Cooling was achieved by loss of heat to the air. Aerators in each tank circulated the water, preventing stratification. All tests were conducted in water drawn directly from Lake Michigan.

Temperature tolerance has been evaluated on the basis of the critical thermal maximum (CTM) and the upper and lower incipient lethal temperatures. The general procedure for determination of the CTM as developed by Huntsman and Sparks (1924) was followed. Groups of five fish selected at random from the appropriate acclimation tank were transferred to test tanks containing water at the acclimation temperature. Water temperature was then increased at a rate of 0.3 C $minute^{-1}$. The temperature at which each fish lost equilibrium was recorded, the mean of these observations being the CTM.

The general procedure for determining upper and lower lethal temperatures was developed by F. E. J. Fry and his students (Fry et al. 1942), particularly by J. R. Brett (1952). In the case of heat tolerance, groups of 10 fish selected from a particular acclimation group were transferred abruptly to test tanks containing water at various high temperatures. Times to death (survival times) for individual fish were recorded by continuous observation. A cessation of respiratory movements and muscular contraction accompanied by a loss of response to touch were considered decisive criteria for heat death.

Survival times obtained for each test were plotted against cumulative percent mortality on linear axes to obtain a series of asymmetrical sigmoid distributions. Time-mortality curves were resolved into straight lines by converting mortality data into units of the standard deviation (probits) and survival time into logarithms.

For each acclimation group, a series of median survival times plotted against the corresponding test temperatures were compared with similar distributions for other acclimation groups. When these curves were rectified into straight lines by using the logarithm of median survival time plotted against test temperature a distinct break or change in slope of the semilogarithmic relationship occurred at that temperature where 50% mortality in the test group was not achieved. At this temperature, one-half of the population represented by the sample would be anticipated to be able to survive effects of heat for an indefinite time. This constitutes the best approximation of the upper incipient lethal temperature for a particular acclimation level. The occurrence of this break in the semilogarithmic plot also indicates that the test period was adequate for all temperature-associated mortality to occur.

The lower lethal temperature was more difficult to determine. Survival times for individual fish could not be obtained with any degree of reliability.

Estimates of the lower lethal limits are therefore based on percent survival over specific exposure periods. Groups of 10 fish were abruptly transferred to low temperatures. Each group was inspected daily and dead fish removed. At the end of 14 days, the remaining fish were transferred back to the acclimation temperature. Percent survival was calculated on the basis of those fish which exhibited complete recovery in 24 hours or less.

D. Behavior Studies

The behavioral response of fish to fluctuations in temperature was evaluated using a vertical temperature gradient, a horizontal temperature gradient, and a +/- choice apparatus. Choice of apparatus was dependent on the ecological characteristics of the test species or its stage of development. Species or age groups having a pelagic life style were tested in the vertical gradient. Demersal species were tested in the horizontal gradient. The +/- choice apparatus was used primarily to test avoidance responses to high temperatures. Where possible, species response was tested in more than one type of apparatus.

Fish response to a vertical temperature gradient was evaluated in an 800 liter cylindrical tank having a height of 78 cm and a diameter of 122 cm. A glass pane was set into the side of the tank. Horizontal lines on the pane at 7.5 cm intervals divided the tank into nine compartments for observational purposes. Two coils of aluminum tubing were suspended at the inside periphery of the tank. The top coil received water from a heated bath, water entering the top of the coil and passing to the drain from the bottom. The lower coil received water from a refrigerated bath, water entering the coil at the bottom and passing to the drain from the top. Lighting was supplied by a 200 watt incandescent bulb suspended over the tank center and wired to a dimmer switch. Vertical water temperature profiles were measured with a series of six thermistors suspended at 15 cm intervals at the tank center. A small fan mounted in front of the tank prevented fogging of the glass pane. The entire apparatus was enclosed in a light-proof room.

The tank was filled with water drawn from the intake canal of the Waukegan Generating Station. Water was first passed through a cellulose filter during periods of high turbidity. Water temperature was adjusted to correspond with the acclimation state of the particular test group. The light was dimmed until the thermistor probes were barely visible at the tank center. A group of five fish was selected from the acclimation tank and introduced to the gradient tank. Temperature differences between acclimation and test tanks were held to less than 1 C to the greatest extent possible.

Fish were held in the test tank (isothermal at the acclimation temperature) for 2 to 16 hours prior to establishing a temperature gradient. The duration of this period varied with the test species and was based on preliminary observations on time required for fish to adjust to the new surroundings. The light was gradually turned up during this adjustment period until the aluminum coils at the rear of the tank were barely visible.

A set of control observations was made to evaluate fish response to a neutral (no temperature gradient) situation. Vertical position of each fish was recorded at 30 sec. intervals for ten minutes (100 total observations). A temperature gradient was established by circulating heated and chilled water through the two aluminum coils. Top to bottom temperature differentials of from 2 C to 40 C were achieved by varying temperatures of heated and chilled water supplies and flow rates through the aluminum coils. In general, gradient dimensions extending from 5 C to 10 C below the acclimation temperature of the test fish to the approximate upper incipient lethal temperature were employed.

Five sets of observations were made to evaluate response to a thermal gradient. Position of each fish was recorded at 30 second intervals for ten minutes in each set. Gradient dimensions were altered periodically to insure that the vertical distribution of fish related to the temperature gradient rather than to some extraneous factor.

Data collected for each group of five fish consisted of 100 observations under control (isothermal at the acclimation temperature) conditions and five sets of observations (500 total) taken under test (gradient) conditions. Observations on two groups of five fish (two controls, ten test gradients) were considered a test series.

A histogram of fish distribution by compartment was prepared for each set of observations and transformed by eye to a continuous distribution. This continuous distribution of fish position was then compared with the temperature gradient to determine the modal preferred temperature (that temperature or position in the gradient most frequented by the fish). Means and variances were calculated for each test series, considering each set of observations to be independent.

Fish response to a horizontal gradient was tested in a steel trough, 182 cm long, 20 cm wide, and 20 cm high. The inside of the trough was painted with green latex. Water entered at one end and exited at the opposite via a standpipe. Water depth could be varied by adjusting the height of the standpipe. Water velocity in the trough was controlled by a valve and flow-meter in the input line. Stainless steel screens kept the fish away from the water input and drain. Lighting was supplied by two fluorescent tubes suspended above the trough. Twelve 250 watt heat lamps were mounted below the trough. The lamps were wired in groups of three to dimmer switches. Lines on the top lip of the trough divided it into twelve compartments. Horizontal water temperature profiles were measured with thermistor probes mounted in each compartment. The entire apparatus was enclosed in a light-proof box. A narrow slit covered by a one-way mirror permitted observation of the fish. Test procedures and analysis of results were similar to those described above for the vertical gradient.

The avoidance response of fish exposed to high temperatures was evaluated in a +/- choice apparatus. A rectangular tank 213 cm long, 60 cm wide, and 60 cm deep was divided into two compartments by a drain at the center. Water entered the tank through perforated PVC pipes at each end and flowed toward the center drain. Depth was controlled by varying the rates of water entry and exit. Temperatures in each compartment were regulated by mixing ambient temperature Lake Michigan water with chilled or heated water. Thermistors were located in each compartment to monitor water temperatures.

Lighting was supplied by banks of fluorescent tubes mounted overhead. The apparatus was housed in a black plastic enclosure. Fish were viewed through peepholes located in the ends of the enclosure.

The apparatus was filled with water at a temperature corresponding with the acclimation state of the test fish. Water depth was adjusted to approximately five times the body length of the fish by varying the rates of water entry and exit. Flow rates in each compartment were maintained at 2 to 6 liters $minute^{-1}$. Three to five fish were selected from the acclimation tank and transferred to the +/- choice apparatus. The number of test fish varied with their size. Fish were allowed 30 minutes to adjust to the new surroundings. Temperature in one compartment was then raised by 2 C to 4 C. A 15 minute period was allowed for the fish to explore the new situation. Position of each fish was then recorded continuously (by compartment) for a period of 5 or 10 minutes.

Temperatures in both compartments were increased by 2 C to 4 C. This sequence (temperature increase, adjustment period, observation) was continued until the fish would no longer enter the warmer compartment.

summer, or fall the warmer water tends to rise to the surface when winds are directed offshore or are lacking. However, thermal mixing is rapid and heat dissipation occurs within a short distance of the discharge point.

A limited study of plume configuration was conducted in April 1968 (Beer and Pipes, 1969). Heat input was mostly dissipated 650 to 900 m from the discharge during this period. The maximum horizontal (surface) dispersion of water temperature measurably above ambient was approximately 1000 m. Horizontal and vertical mixing was rapid throughout the study and excess heat had generally dissipated to less than 2 C above ambient within 450 m of the discharge point.

Under winter conditions the discharge plume may either mix from surface to bottom with lake water or sink beneath the receiving waters. Both conditions have been observed for the Waukegan Generating Station discharge (Pipes, Pritchard, and Beer, 1973).

Zion Station is also located on the southwest shore of Lake Michigan and is about 6.5 km (4 miles) north of Waukegan Generating Station. It is a nuclear fueled station having two 1050 MWe units. Cooling water enters the plant from an intake structure located about 800 m offshore at a depth of approximately 7 m (Figure 1). The velocity cap on top of the intake structure is submerged about 3 m.

Condenser cooling water flow across each unit is approximately 47 m^3 sec^{-1} (1670 ft^3 sec^{-1}) with a maximum temperature rise (ΔT) of 11 C. Cooling water for each unit is discharged to the lake through a separate discharge structure located about 230 m offshore. The discharge structures are separated by a distance of 94 m and are equidistant from the intake structure which passes between them. Cooling water is discharged through a series of rectangular ports and is intended to leave the discharge structure as a 1 m thick "sheet", 23 m wide from each side of the structure and 9 m wide from the offshore end.

Both units of the station have been operating intermittently since July 1973. It has not been possible during that period to acquire sufficient data to define plume characteristics relative to short term or seasonal physical factors. A predictive evaluation has been made (Pritchard-Carpenter, Consultants; 1970) which will be tested as station operation is stabilized.

B. Annual Temperature Cycle in Waukegan-Zion Waters

Ambient inshore water temperatures were monitored on a daily basis at the Waukegan Laboratory. In addition, water temperature data for the entire Waukegan-Zion region is available from a variety of previous and concurrent studies (Industrial BIO-TEST Laboratories, Inc. 1973a, b; 1974). A generalized temperature cycle for inshore waters based on these data and including the vicinity of the Waukegan Generating Station and Zion Station intake and discharge structures is shown in Figure 2.

Inshore water temperatures are stable at 0.0 C to 0.5 C throughout the winter (mid-December through February). The spring warming begins in March; however, the inshore region remains isothermal (no stable vertical or horizontal gradient) until June. Close inshore temperatures may be slightly

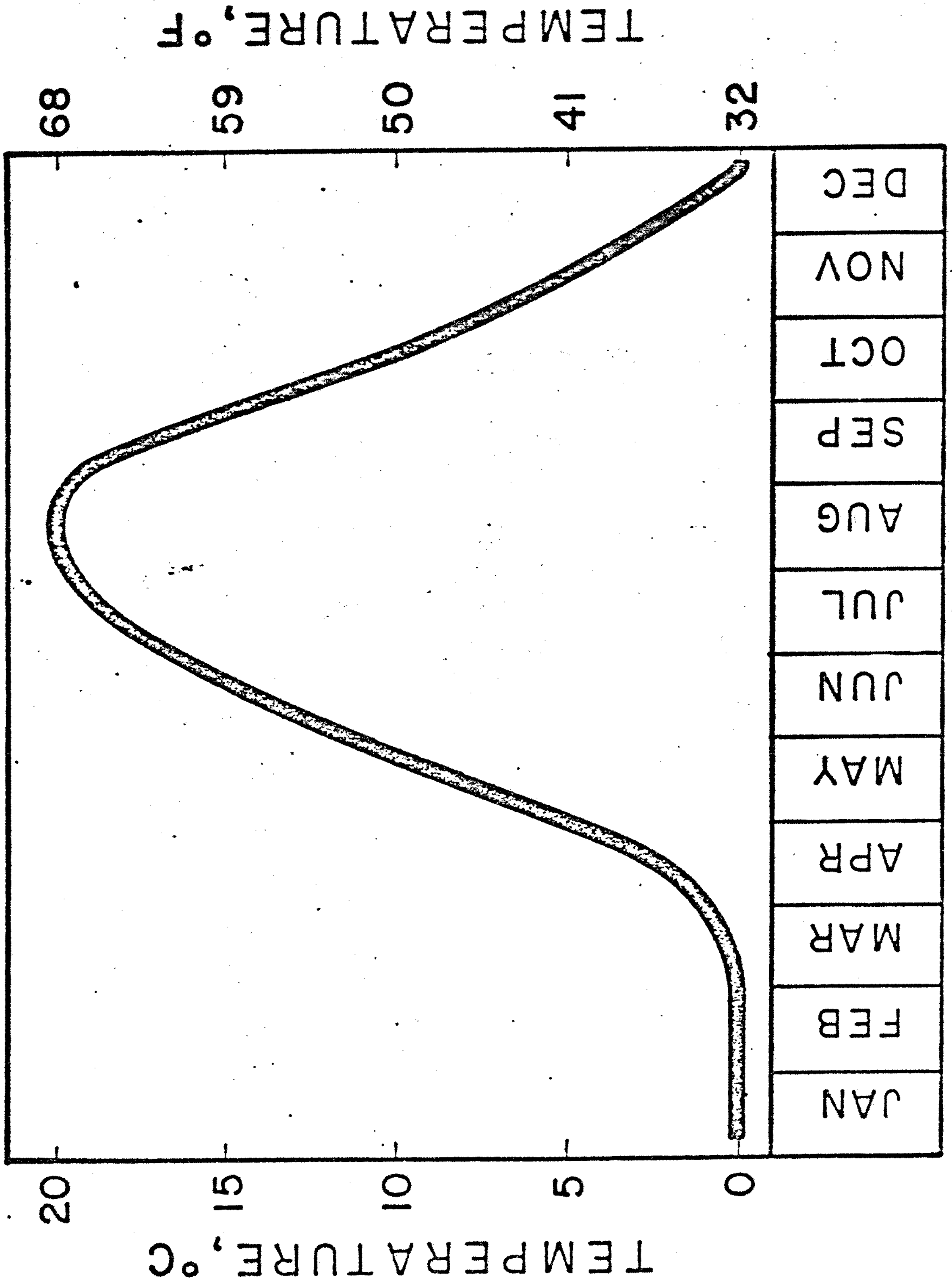

Figure 2. Annual water temperature cycle for the Waukegan-Zion region of Lake Michigan

higher than offshore for brief periods; however, wind and wave action maintain a mixed condition during the warming period.

Thermal stratification begins in June; however, a discrete thermocline is typically not formed until July. A strongly stratified condition is then maintained through August with the thermocline disappearing in September or October. The lake then maintains a mixed condition through the fall cooling period reaching minimum temperatures in mid-December.

Broad temperature fluctuations occur at frequent intervals during mid-summer. These fluctuations are associated with offshore winds pushing the warm surface waters out and an upwelling of cooler bottom waters along the shoreline. Temperature changes exceeding 10 C have been observed to occur in less than six hours at the Waukegan Laboratory. Similar fluctuations related to summer upwellings have been observed for inshore waters along the Wisconsin shoreline of Lake Michigan (Wisconsin Electric Power Company and Wisconsin-Michigan Power Company 1970).

C. Fish Populations in Waukegan-Zion Waters

Field studies (Industrial BIO-TEST Laboratories, Inc., 1973b, Briars, 1974; Cochran, 1974) utilizing trawls, gill nets, and beach seines have identified 28 species of fish which inhabit the Waukegan-Zion area (Table 1). Of those, the alewife, rainbow smelt, bloater, lake trout, brown trout, rainbow trout, coho salmon, chinook salmon, yellow perch and slimy sculpin would be considered the major or important members of the fish community either by reason of abundance or attractiveness as a sport or commercial species.

Table 1. Common and scientific names of fish species collected in the Waukegan-Zion sampling area.

Common Name	Scientific Name
1. Alewife	Alosa pseudoharengus
2. Smelt	Osmerus mordax
3. Bloater	Coregonus hoyi
4. Whitefish	Coregonus clupeaformis
5. Herring	Coregonus artedii
6. Lake Trout	Salvelinus namaycush
7. Brown Trout	Salmo trutta
8. Rainbow Trout	Salmo gairdneri
9. Coho Salmon	Oncorhynchus kisutch
10. Chinook Salmon	Oncorhynchus tshawytscha
11. Longnose Sucker	Catostomus catostomus
12. White Sucker	Catostomus commersoni
13. Carp	Cyprinus carpio
14. Spottail Shiner	Notropis hudsonius
15. Emerald Shiner	Notropis atherinoides
16. Longnose Dace	Rhinichthys cataractae
17. Fathead Minnow	Pimephales promelas
18. Golden Shiner	Notemigonus crysoleucas
19. Central Mudminnow	Umbra limi
20. Gizzard Shad	Dorosoma cepedianum
21. Yellow Perch	Perca flavescens
22. Slimy Sculpin	Cottus cognatus
23. Troutperch	Percopsis omiscomaycus
24. Ninespine Stickleback	Pungitius pungitius
25. Brook Stickleback	Culaea inconstans
26. Burbot	Lota lota
27. Largemouth Bass	Micropterus salmoides
28. White Crappie	Pomoxis annularis

The occurrence of these species in areas affected by the Zion Station and Waukegan Generating Station can be catagorized seasonally. The alewife and yellow perch are present primarily in the spring and summer while the smelt, bloater, lake trout, brown trout, rainbow trout and slimy sculpin occur in greatest abundance during late fall, winter, and early spring. Salmon are present only in the fall and spring. The various salmonid species are present only as yearling or older fish since they do not reproduce naturally in the Waukegan-Zion region. Alewives, smelt, yellow perch and slimy sculpin do spawn in the area and all age classes are susceptible to potential effects of the two station discharges.

D. Performance Studies

General considerations: An accessment of the swimming capabilities of the various resident fish species is required for two reasons. First, accepting the premise that fish may be attracted by elevated temperatures or currents around the discharge structures, the ability of fish to make use of discharge waters is limited by their ability to maintain themselves in the area. If water velocities are such that fish cannot swim into the plume the potential for a significant thermal exposure is limited to plume entrainment whereby a fish is swept through the discharge during the initial plase of the mixing process. Second, the ability of fishes to avoid entrainment at the intake structure and subsequent impingement on the bar racks or traveling screens is at least in part a function of their swimming ability.

Species differences: Swimming capabilities for four of the important species in Waukegan-Zion waters have been considered. These include the lake trout, rainbow trout, rainbow smelt and yellow perch. An attempt was made to consider the alewife and bloater as well. However, the susceptibility of the alewife to handling stress and the inability to obtain sufficient numbers of bloaters from the field made this attempt unsuccessful.

Sustained swimming speeds for all test species increased with increasing acclimation temperature (Figure 3). Rainbow smelt were the strongest swimmers, followed in ability by the rainbow trout, lake trout and yellow perch. Swimming speeds shown in the figure are in cm sec^{-1} and absolute differences in performance as shown are in part a function of fish size. However, the values shown represent the performance of the smaller size classes present in Waukegan-Zion waters and should be considered limiting (or conservative) in assessing the ability of mature fish to enter the plumes or avoid entrainment at intake structures.

Two patterns of response can be defined from the data shown in Figure 3. Rainbow smelt and lake trout are cold-water stenothermal species. Both species are restricted in their geographic distributions to cold, usually deep bodies of water which have relatively small annual temperature fluctuations. The rates of change in swimming capabilities with increasing temperature for these species is accordingly relatively small. The regression line which relates swimming speed to acclimation temperature for the lake trout is:

$$\text{Swim Speed} = 0.62\ (\text{Acclimation Temperature}) + 21.36$$
$$\text{and } r = 0.983$$

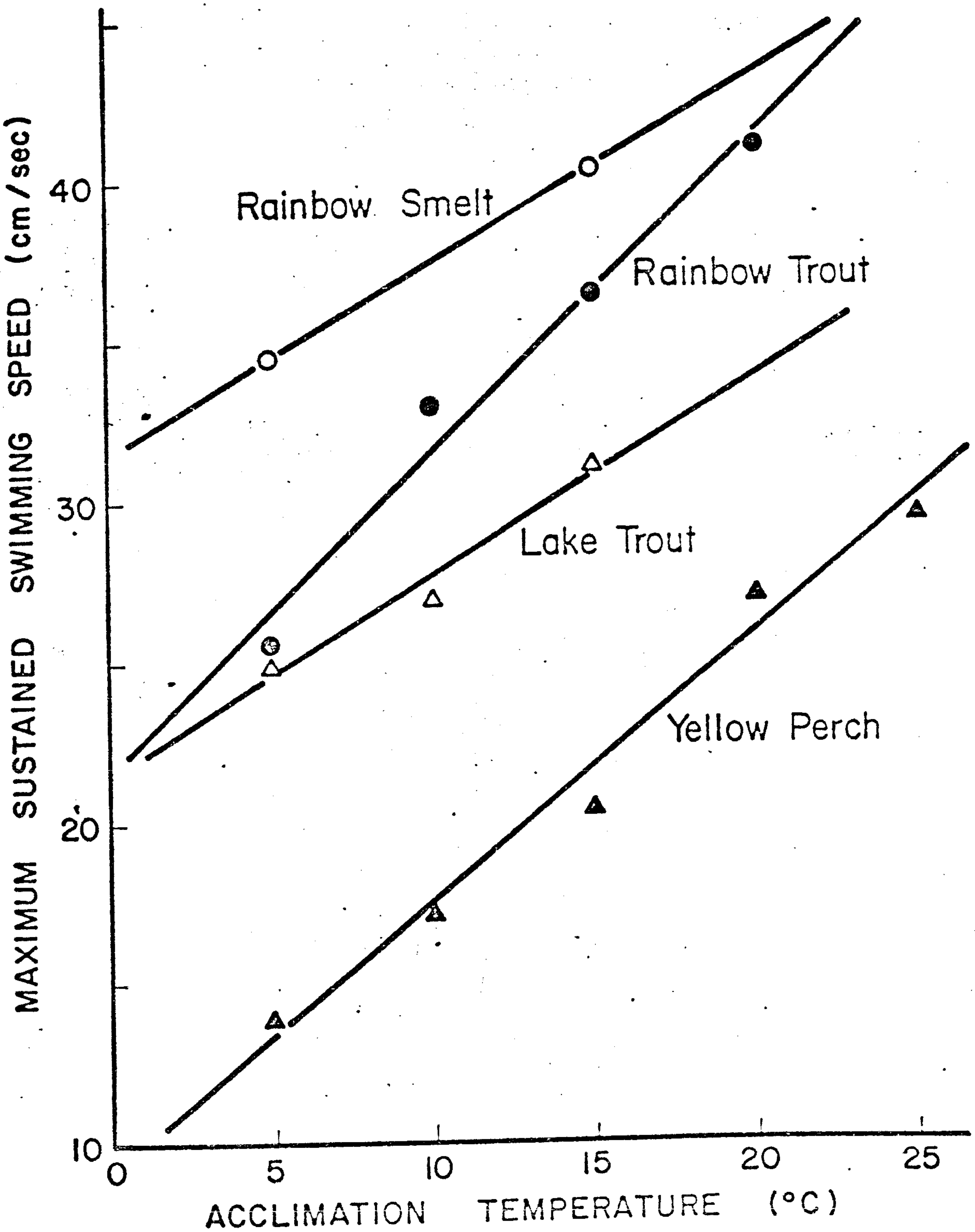

Figure 3. Maximum sustained swimming speeds of Lake Michigan fishes acclimated to constant temperatures. Mean standard lengths of test fish (cm): rainbow smelt, 13.4 cm; lake trout, 14.5 cm; rainbow trout, 10.3 cm; yellow perch, 10.2 cm.

No regression line could be calculated for the rainbow smelt since only two data points were obtained. However, the relationship (slope) appears to be comparable to the response of lake trout. In short, the physiological orientation for these species tends toward maximization of capability at the low end of their temperature scale.

The rainbow trout and yellow perch are also both North Temperate species. However, the rainbow trout is probably the most adaptable of all salmonid species with regard to high temperatures while the natural distribution of the yellow perch extends far to the south of the rainbow smelt and lake trout. Both the rainbow trout and yellow perch would be categorized as warm-water species relative to the other two test species and this is reflected in their response in the stamina tunnel. Swimming capabilities increased sharply with rising acclimation temperatures. Regression equations for the response lines are:

for the rainbow trout;

Swim Speed = 0.99 (Acclimation Temperature) + 21.65
and r = 0.987,

for the yellow perch;

Swim Speed = 0.84 (Acclimation Temperature) + 9.04
and r = 0.983.

Effects of size: The ability of fish to enter the plume or avoid entrainment at the intake will vary with size as well as species. That larger fish can swim faster than smaller individuals is intuitively obvious to the casual observer and the precise relationship has been considered experimentally for a number of species (Bainbridge, 1958; Brett, 1965; Brett and Glass, 1973). Fish used in our studies were selected to represent the smaller size classes for the various species which occur in Waukegan-Zion waters (disregarding juveniles). However, several studies were conducted to clarify the relationship between size and swimming abilities for the rainbow trout and yellow perch.

The same general results were obtained in each case (Figures 4, 5). Absolute swimming speed (cm sec^{-1}) increased with size while relative swimming speed (body lengths sec^{-1}) decreased. These results are in accord with the previously cited studies. (Note that the absolute swimming speeds for yellow perch are considerably higher than those indicated in Figure 3. This relates to a shorter time increment between velocity increases in the test procedure.)

Sustained vs. burst speeds: Maximum sustained swimming speeds were also determined at a variety of rates of water velocity increase for the rainbow trout and yellow perch. The intent of these studies was to estimate the burst speed or maximum speed which could be obtained. Water velocity in the performance tunnel was increased in increments of 1/3 body length sec^{-1} at time intervals of 5, 15, 30, 60, and 90 minutes for trout and 5, 15, 30, and 45 minutes for perch. Sustained swimming speed was plotted against the logarithm of time interval between rate increases to obtain an estimate of burst speed.

The estimated burst speed for rainbow trout was 3.6 body lengths sec^{-1} or 36 cm sec^{-1} for a fish having a standard length of 10 cm (Table 2). This gives a ratio of sustained speed to burst speed of 0.6 to 0.7 which is in close

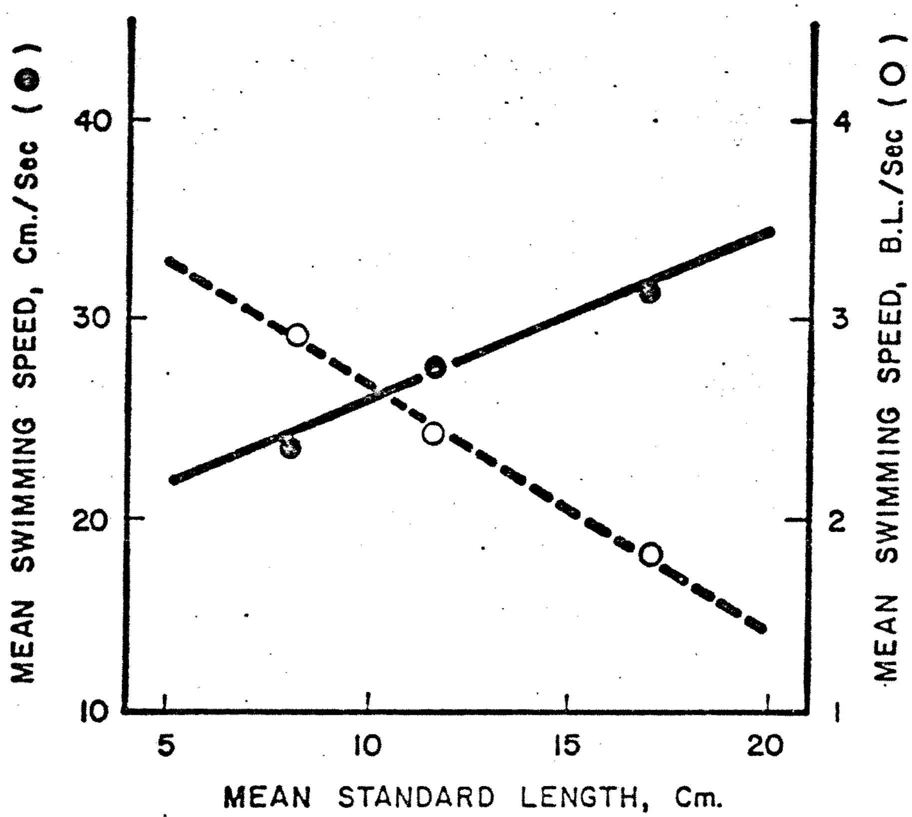

Figure 4. Effects of size on swimming capability of the rainbow trout. Fish were acclimated to 2 C and tested at 4 to 5 C.

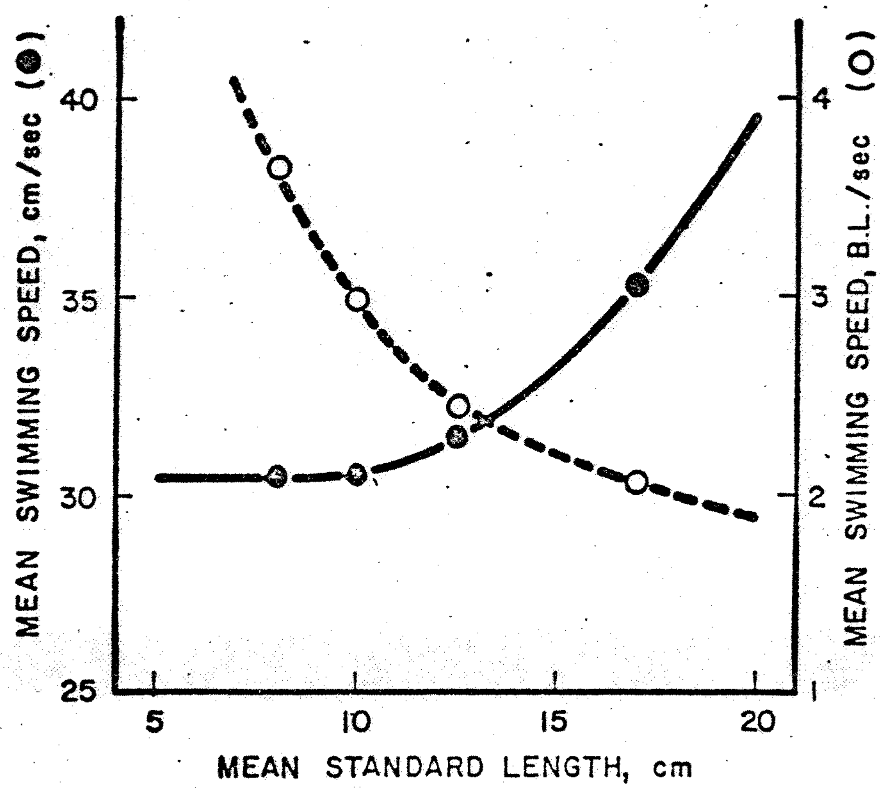

Figure 5. Effects of size on the swimming capability of the yellow perch. Fish were acclimated and tested at 20 C.

Table 2. Effects of the time increment between successive increases in water velocity on the swimming speeds of rainbow trout and yellow perch.

Acclimation Temperature		Time Increment (Minutes) 0[a]	5	15	30	45	60	90
		Rainbow Trout						
5	cm/sec	36	36.2	31.9	30.7	-	31.3	29.1
	b.l./sec	3.6	3.2	2.9	2.5	-	2.6	2.4
		Yellow Perch						
10	cm/sec	27	23.8	19.9	22.7	17.1	-	-
	b.l./sec	2.7	2.7	2.5	2.3	2.3	-	-
20	cm/sec	45	38.3	34.9	32.0	27.3	-	-
	b.l./sec	4.5	4.0	3.7	3.6	2.5	-	-

a/ Estimated burst speed for a fish having a standard length of 10 cm.

agreement with the work of others as summarized by Bell (1971). Yellow perch exhibited burst speeds of 2.7 body lengths sec^{-1} for 10 C acclimated fish and 4.5 body length sec^{-1} for 20 C acclimated fish. The ratio of sustained to burst speed in each case approximates 0.9 indicating a somewhat lower capability to escape entrainment for this species.

The effects of fluctuations in temperature: Fluctuating temperatures had a marked effect on the swimming capabilities of all species tested. In general, swimming speed was reduced at test temperatures below the acclimation level. Increasing the test temperature above the acclimation level consistently resulted in an increase in swimming capabilities until a "critical" temperature was reached above which swimming speeds declined.

Rainbow smelt acclimated to 5 C were tested at 5, 10, 15, and 20 C (Figure 6). Swimming speed increased gradually with temperature to a level of 15 C above which there was a sharp decline. Lake trout were acclimated to 5, 10, and 15 C and tested at 5, 10, 15 and 20 C. The range of swimming speeds observed was from 1.5 to 2.7 body lengths sec^{-1} for all tests conducted. Performance capabilities increased with rising test temperature; however, no clear distinction could be made between acclimation groups. Critical temperature for 5 C acclimated fish appears to be about 15 C as observed for rainbow smelt. Lake trout acclimated to 10 and 15 C apparently have critical temperatures exceeding 20 C.

Rainbow trout acclimated to 5, 10, 15, and 20 C were tested at temperatures ranging from 5 C to 25 C (Figure 7). Critical temperatures were

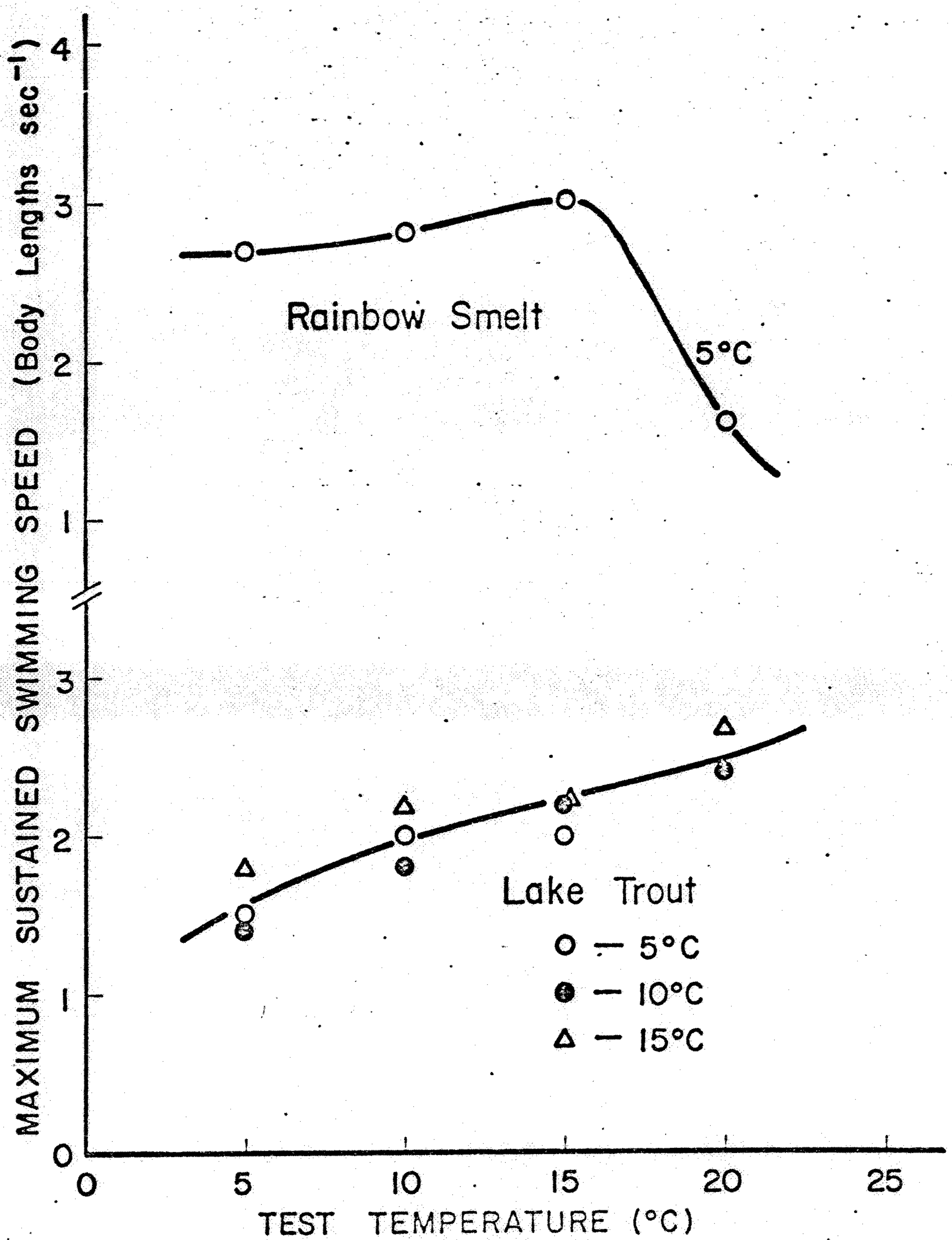

Figure 6. Maximum sustained swimming speeds of rainbow smelt and lake trout following acute changes in temperature. Acclimation temperatures are indicated.

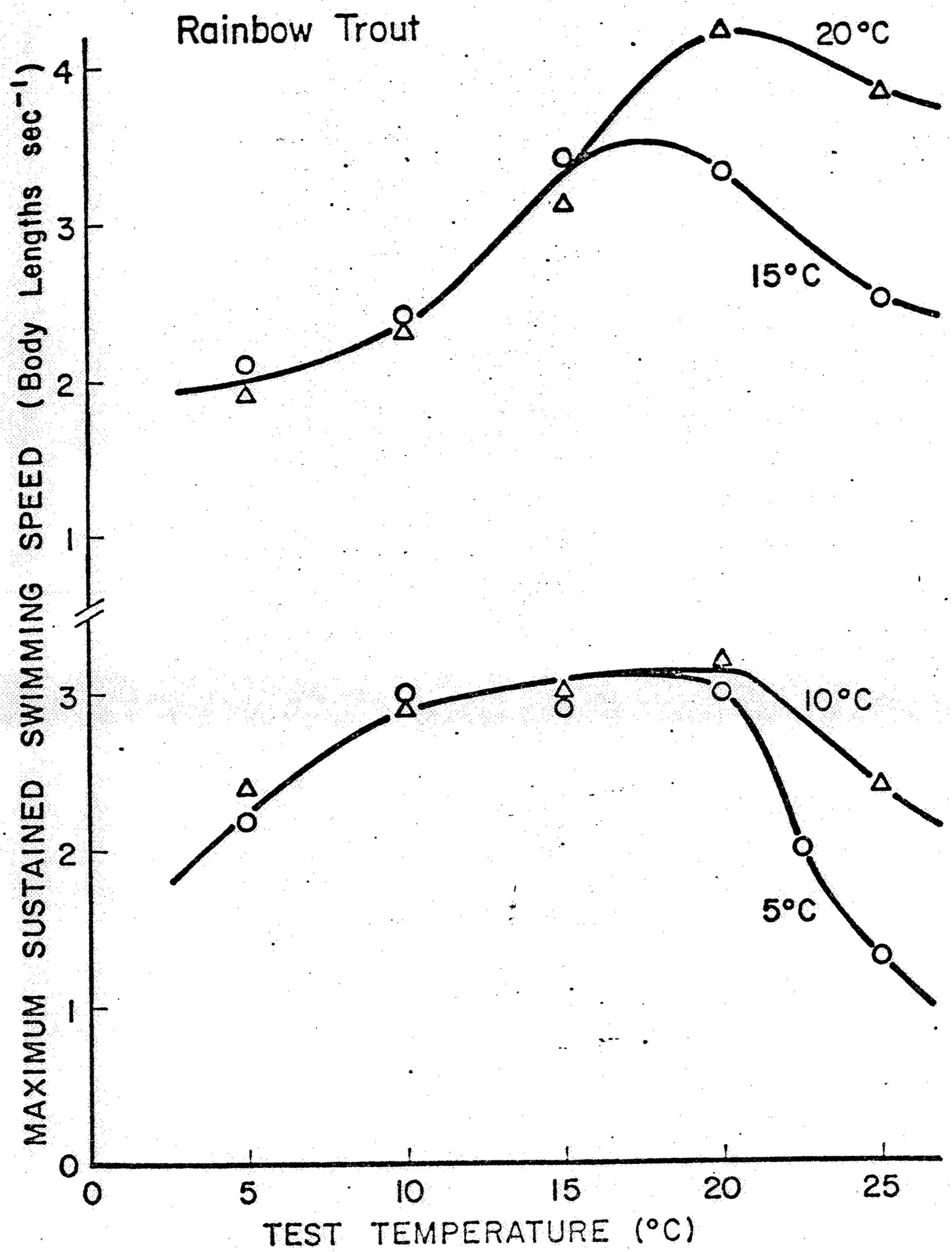

Figure 7. Maximum sustained swimming speeds of rainbow trout following acute changes in temperature. Acclimation temperatures are indicated.

exceeded for each acclimation group and were in the range >20 C to <25 C in each case. Yellow perch acclimated and tested under similar conditions exhibited a comparable response (Figure 8). Surprisingly, however, critical temperatures for perch at acclimation temperatures of 15 C and below seem to be lower than those for rainbow trout.

Acclimation to changing temperatures: We have shown that, for various Lake Michigan fishes, differences in performance capabilities exist between species, between fish of the same species acclimated to different temperatures, and between fish of the same species acclimated at the same temperature and tested at different temperatures. An aspect which has not been considered, however, is whether differences in performance capabilities observed for fish of the same species acclimated to the same temperature but tested at different temperatures represent transitory response levels which will change in a predictable fashion during the physiological process of acclimation to the test temperature. We know the response characteristics for the two limiting situations; fish acutely transferred to a new temperature regime and fish completely acclimated to test temperatures. What remains is to define the time course of change in response between these two situations.

A brief study was conducted using the yellow perch. Groups of ten fish ranging in length from nine to ten cm were acclimated to 10 C and 20 C. Test groups of five fish were then randomly selected from an acclimation category, placed in the tunnel at the acclimation temperature and maintained for 30 min at a water velocity of 5 cm sec^{-1}. Water velocity was increased in increments of

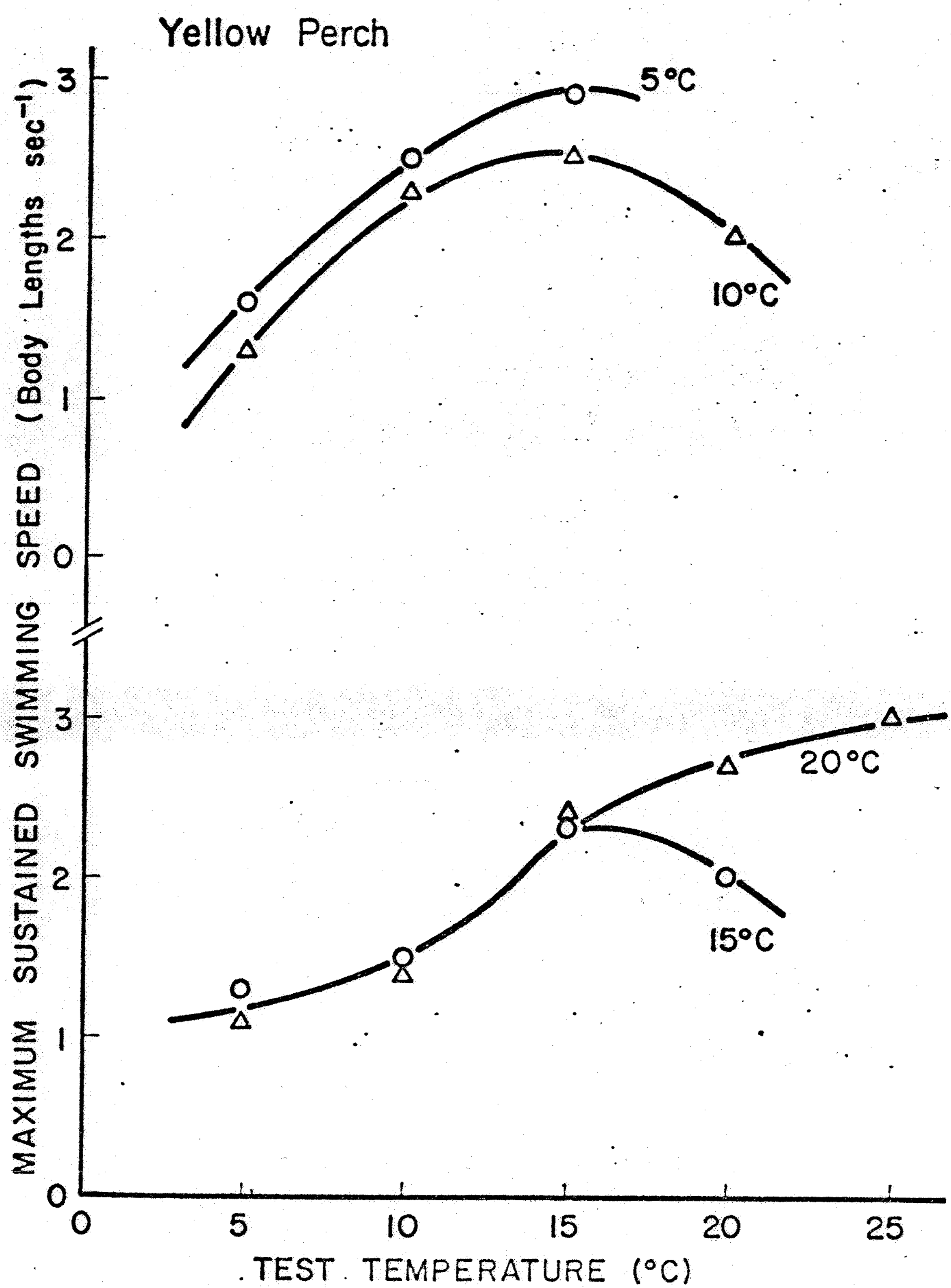

Figure 8. Maximum sustained swimming speeds of yellow perch following acute changes in temperature. Acclimation temperatures are indicated.

5 cm sec^{-1} at 15 min intervals. Individual fish were removed from the tunnel as they fatigued. This test sequence was continued for both acclimation groups at 24 hr intervals for four days to allow the fish to adjust to the procedure. On the fifth day, acclimation temperatures were reversed, 10 C fish being moved to 20 C and vice versa. The temperature change was imposed while the fish were in the stamina tunnel during the 30 min pre-test period. Fish were tested immediately following the reversal of acclimation temperatures and at 24 hr intervals thereafter for six days.

Perch acclimated to 10 C and 20 C had maximum sustained swimming speeds of 15.5 cm sec^{-1} and 25.2 cm sec^{-1} respectively on the first day of testing (Figure 9). These speeds increased to 21.0 cm sec^{-1} for 10 C acclimated fish and 33.0 cm sec^{-1} for 20 C fish on the second day. Performance levels for both acclimation groups then remained stable for the remainder of the four day training period. The improvement in swimming performance resulting from experience was approximately 2X greater for 20 C fish than for 10 C fish.

Since a random process was employed to select the five test fish from the ten fish acclimation group, test groups after day one might have contained both naive and experienced fish. However, variability of response remained approximately the same throughout the ten day test period suggesting a group effect wherein the presence of experienced individuals improved performance of naive fish.

An immediate increase in performance was observed following an increase in water temperature from 10 C to 20 C. Maximum sustained swimming speed

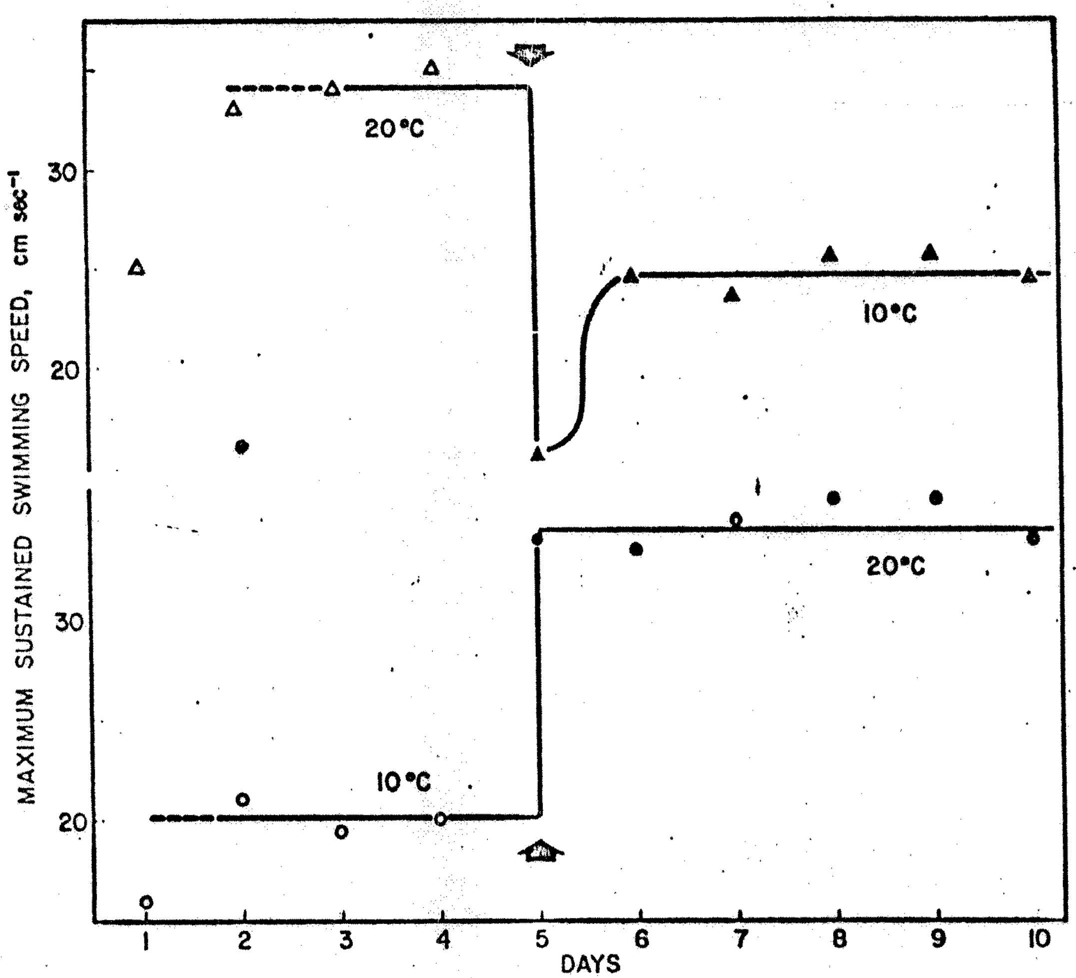

Figure 9. The effects of an abrupt change in temperature on the maximum sustained swimming speed of the yellow perch. The time of temperature change is indicated by arrows.

was raised to 33.5 cm sec^{-1}, a gain of 13.5 cm sec^{-1}. This value is comparable to the swimming speed of fish acclimated to 20 C for 30 days. Performance levels for this group remained stable for the remainder of the ten day period.

Fish transferred directly from 20 C to 10 C exhibited a loss of performance capability. Mean swimming speed decreased to 15.5 cm sec^{-1}, a loss of 18.5 cm sec^{-1}. Swimming speed for this group then increased to 24.5 cm sec^{-1} at the end of 24 hours, remaining at this level for the remainder of the test period.

The stable performance level for fish transferred from 20 C to 10 C (24.5 cm sec^{-1}) was somewhat higher than anticipated from swimming speeds observed for fish acclimated to 10 C only (20.0 cm sec^{-1}). The difference corresponds with the greater increase in performance associated with experience in the tunnel for 20 C acclimated fish when compared with 10 C acclimated fish.

In evaluating these results, it is important to recognize the complexity of temperature acclimation where different rates of application and levels of temperature may be involved in conjunction with seasonal, size, age and species differences. In general, our results contrast with studies on rates of change in tolerance following abrupt changes in temperature as discussed in the following section. For example, the opaleye, Girella nigricans, required one day to complete 90% acclimation of heat resistance following a temperature increase from 14 C to 26 C (Doudoroff, 1942). 15 days were required for a 90% loss of cold resistance. When the temperature change was reversed, more than 25 days were required for a 90% loss of heat resistance with a similar time needed for 90% gain in cold resistance. Similar examples are given by Brett (1971) for a number of species.

The results are in somewhat better agreement with observations on rates of change in metabolic rate (oxygen consumption) following temperature changes. For example, Klika (1965) found that for the goldfish (*Carassius auratus*) stable rates of oxygen consumption were regained in two to five days following an increase or decrease in temperature of 15 C.

Application of performance studies to Zion and Waukegan Generating Stations: While it is obvious from these studies that species differences in ability to avoid entrapment at the two intakes do exist, no conclusions regarding the abilities of individual species to avoid such entrapment can be drawn in the absence of data regarding water velocity profiles around the intake structures. Commonwealth Edison Company installs fish nets at the intakes of both stations during periods when the lake is ice free to exclude the larger fish from potential entrapment. Counts of fish entrapped are being made from collections at the traveling screens. Evaluation of these screen counts is currently the best method of determining individual species susceptibility to entrapment at the two stations.

The ability of fishes to utilize the heated plume areas in spite of discharge velocities can be considered more definitively. Water velocity clearly places no limit on access of any species to the Waukegan discharge. While the centerline velocities in the canal may exceed 1 m sec^{-1} the presence of numerous protected areas makes the movement of fish throughout the canal possible.

However, water velocities at the discharge ports at Zion Station will approximate 3 m sec^{-1} (Table 3) which is well beyond the swimming capabilities of any of the fish tested in this study. The water velocity is anticipated to still exceed 1 m sec^{-1} at the 4 C isotherm and penetration of the plume by any fish to temperatures exceeding this level for even brief periods is unlikely.

E. Survival Studies

General considerations: When fishes are exposed to an increase in water temperature a variety of responses may occur. If the increase is sufficiently small that no survival boundary is exceeded the response may be limited to a readjustment of metabolic and activity relationships (acclimation) without harmful effect. A somewhat larger increase coupled with the lack of a suitable escape route may still have no immediate observable effect. However, if the upper incipient lethal temperature is exceeded the fish will eventually die. Finally, a temperature increase may be of sufficient magnitude to shock the fish, causing a loss of equilibrium and eliminating any chance for willful escape. The first question addressed in our survival studies was therefore: Are increases in water temperature related to operations of Zion and Waukegan Generating Stations of sufficient magnitude to cause heat death among fishes resident to the discharge area?

Heat shock: Critical thermal maxima (CTMs) or heat shock temperatures were determined for a majority of the species that occur in Zion-Waukegan waters. Fish were tested following acclimation to both constant temperature (Table 4) and field or naturally fluctuating temperature (Table 5) conditions. CTMs

Table 3. Predicted[a/] distances, velocities, and exposure times for given values of excess temperature in one discharge plume from Zion Station.

ΔT	Distance From Discharge Point	Exposure Time For Plume Entrained Organisms	Center Line Velocity	
C	m		$m\ sec^{-1}$	$ft\ sec^{-1}$
11	0	0	2.9	9.5
10	37	13 sec	2.6	8.6
9	67	26 sec	2.3	7.6
8	98	40 sec	2.0	6.7
7	131	58 sec	1.7	5.7
6	167	1.35 min	1.5	4.8
4	212	1.92 min	1.1	3.8
3	280	3.07 min	0.9	2.9
2	408	6.17 min	0.6	1.9
1	1234	43 min	0.3	1.0

a/ Calculated from values given in Environmental Impact Report: Supplemental information to the Zion Environmental Report. Commonwealth Edison Co. and Battelle Columbus Laboratories. 1971.

Table 4. A summary of critical thermal maxima (°C) for Lake Michigan fishes acclimated to constant temperatures.

Species	Acclimation Temperature (°C) 5	10	15	20	25	30
Alewife (Adult)	24.7	28.7	29.9	31.9	32.8	-
Alewife (Young of Year)	24.7	26.7	29.5	31.9	34.3	36.7
Brook Trout (Yearling)	27.5	28.8	30.0	-	-	-
Brown Trout (Yearling)	-	27.8	-	-	-	-
Chinook Salmon (Yearling)	26.4	28.5	29.5	30.2	-	-
Coho Salmon (Yearling)	26.1	27.3	28.2	29.9	-	-
Fathead Minnow	28.5	31.9	32.7	35.7	36.7	38.5
Golden Shiner	27.9	30.3	33.0	35.0	37.6	39.0
Longnose Dace	28.4	30.5	31.4	33.9	35.4	36.7
Lake Trout (Yearling)	26.3	25.9	27.9	-	-	-
Rainbow Smelt	23.5	24.4	-	-	-	-
Rainbow Trout (Yearling)	27.9	28.4	29.7	31.1	-	-
Slimy Sculpin	23.4	25.0	27.1	29.4	-	-
Spottail Shiner	27.7	30.2	31.2	33.3	35.5	37.7
White Sucker	27.8	28.7	30.5	32.9	-	-
Yellow Perch (Adult)	26.6	29.3	31.6	33.8	35.4	-
Yellow Perch (Young of Year)	27.5	28.6	30.3	32.6	35.1	-
Acclimation Temperature + Zion ΔT max.	16	21	26	31	-	-
Acclimation Temperature + Waukegan ΔT max.	13	18	23	28	-	-

Table 5. A summary of critical thermal maxima (°C) for Lake Michigan fishes acclimated to field temperatures.

Species	Month Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Alewife (Adult)	-	-	-	26.3	-	28.6	30.1	-	29.7	26.6	-	24.3
Alewife (Young of Year)	-	-	-	-	-	-	-	31.5	-	-	27.1	23.4
Carp (Young of Year)	-	-	-	-	-	-	37.8	-	-	-	33.9	-
Fathead Minnow	-	-	-	-	-	-	33.3	-	-	-	-	-
Golden Shiner	23.1	26.3	27.7	29.5	32.3	31.5	31.8	-	31.8	-	27.8	25.8
Largemouth Bass (Young of Year)	25.9	24.7	26.5	28.2	29.2	-	32.1	35.5	32.8	-	30.1	27.1
Rainbow Smelt	-	-	-	-	24.5	-	-	-	-	-	-	-
Rainbow Trout (Yearling)	-	26.7	27.4	27.5	29.1	29.3	-	-	-	28.6	-	-
White Sucker (Young of Year)	25.0	-	-	-	-	-	30.7	-	28.7	-	-	-
Yellow Perch (Adult)	24.9	26.3	28.3	28.9	29.8	30.8	32.2	-	33.7	29.2	-	26.4
Yellow Perch (Young of Year)	25.5	24.3	27.5	27.5	28.9	30.2	-	33.6	-	28.8	-	25.9
Maximum Observed Field Temperature	2	5	9	10	13	17	18	20	15	12	10	5
+ Waukegan ΔT	10	13	17	18	21	25	26	28	23	20	18	13
+ Zion ΔT	13	16	20	21	24	28	29	31	26	23	21	16

increased with acclimation temperature in each case as expected. This increase was not in direct proportion and the margin of safety (difference between the CTM and maximum discharge temperature) was reduced during the warmer months for all species. However, the CTM for fish acclimated to midsummer inshore Lake Michigan water temperatures (15 C to 20 C) was never exceeded by maximum discharge temperatures at the Waukegan Generating Station and was exceeded only for the salmonid species, the rainbow smelt, and the slimy sculpin at Zion Station. These species all typically move offshore to cooler waters in summer months and are therefore spacially isolated from any effects of Zion Station during this critical period.

The margin of safety for the alewife at the Zion Station discharge is very small during the period of peak summer temperatures. The maximum discharge temperature at Zion Station will be 31 C (if inshore waters reach 20 C), only 0.9 C below the measured CTM for both adult and young of year alewives (Table 4). Field studies in the Waukegan-Zion region indicate that alewives are present in great abundance in the discharge vicinity during midsummer. However, the conclusion that alewives will not be subject to heat shock even during periods of peak summer water temperatures is supported by two facts. First, although the alewive as a pelagic species is a strong swimmer, it is a small fish rarely reaching 30 cm (1 ft) in length in fresh water. As such it is unlikely that this species will be able to swim into water velocities of the magnitude occurring at the outlet ports of the Zion Station discharge structure to reach waters at the maximum ΔT. Second, if alewives are plume-entrained which is the only other way they can be exposed to an appreciable temperature increase, they will not be exposed to the maximum ΔT and any appreciable exposure will be very brief (Table 3). There is one further consideration. Small alewives may be entrained at the Zion Station intake and passed through the condensers. This may be an adequate exposure to cause heat shock among a proportion of those entrained.

Alewife populations in Lake Michigan periodically suffer natural die-offs in late spring and early summer, the causes for which remain obscure. A variety of possible causes have been put forth including exhaustion of the food supply, ion-osmoregulatory difficulties and insufficient iodine content in Great Lakes waters. However, of greatest interest with regard to the use of lake waters for once-through cooling is the possibility that such mortalities result from an inability to adjust to the rapid fluctuations in temperature which occur during spring and summer and which may be accentuated by power plant operations. The short term ability of this species to tolerate rapid fluctuations in temperature has been considered above. However, it is also of importance to know how rapidly the alewife can reorient physiologically to temperature fluctuations. If the alewife is incapable of adapting to a new thermal regime at a rate comparable to other members of the fish community it may be more liable to problems of disease, parasitism and similar debilitating factors.

We have considered the rates at which heat tolerance (as CTM) is gained or lost following a 10 C fluctuation in temperature. The temperature range 10 C to 20 C was selected for study since it approximates mid-summer temperature fluctuations commonly encountered in southwest Lake Michigan as measured in our laboratory.

Groups of mature alewives were acclimated to 10 C and 20 C and transferred abruptly to the other temperature. CTMs or shock temperatures were measured immediately prior to transfer and at 24 hour intervals thereafter for 11 days. Fish acclimated to 10 C had an initial CTM of 28.9 C (Figure 10). The CTM increased rapidly following transfer to 20 C, acclimation being 90% completed by day 6.

Fish acclimated to 20 C had an initial CTM of 33.4 C. The CTM decreased following transefer to 10 C but at a more nearly linear (slower) rate than the change observed following a temperature increase. A 90% response (a change in the CTM equivalent to 90% of the maximum anticipated change) was achieved by day 11. Thus, the loss of heat tolerance following a decrease in temperature occurs at approximately one-half the rate of gain of heat tolerance following an equivalent temperature increase.

A similar sequence of tests was performed using the yellow perch as an experimental subject. Results were closely comparable to those obtained for the alewife with acclimation to the temperature increase being essentially complete by day 6 (Figure 11). Loss of heat tolerance was much slower and had not declined to a level comparable with that for 10 C acclimated individuals by day 11. The observed rates of acclimation for both species were closely comparable to those reported by Brett (1946) for goldfish (*Carassius auratus*), Allen and Strawn (1971) for channel catfish (*Ictalurus punctatus*), and for a variety

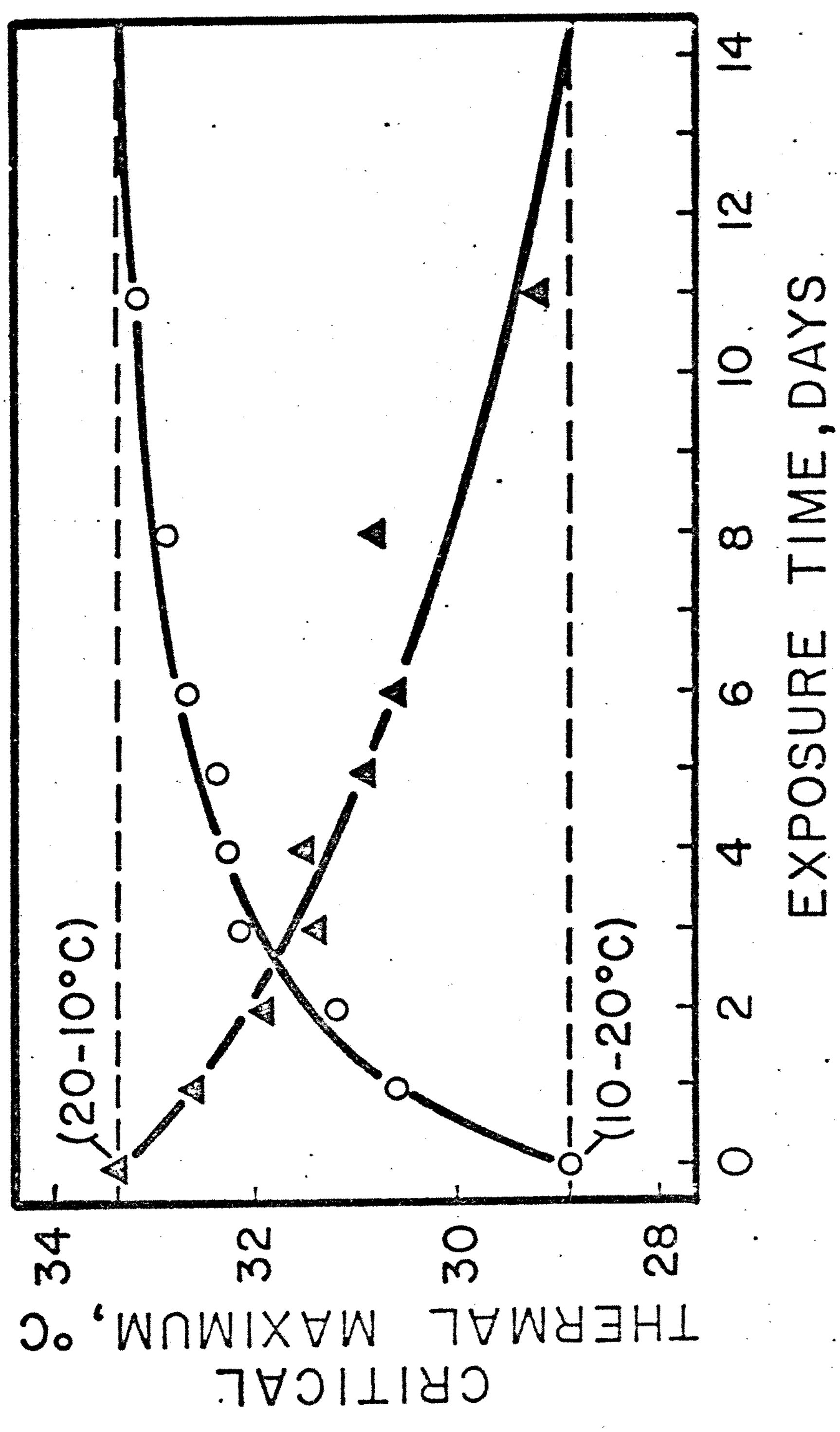

Figure 10. Critical thermal maxima (CTMs) for mature alewives subjected to a 10 C change in temperature.

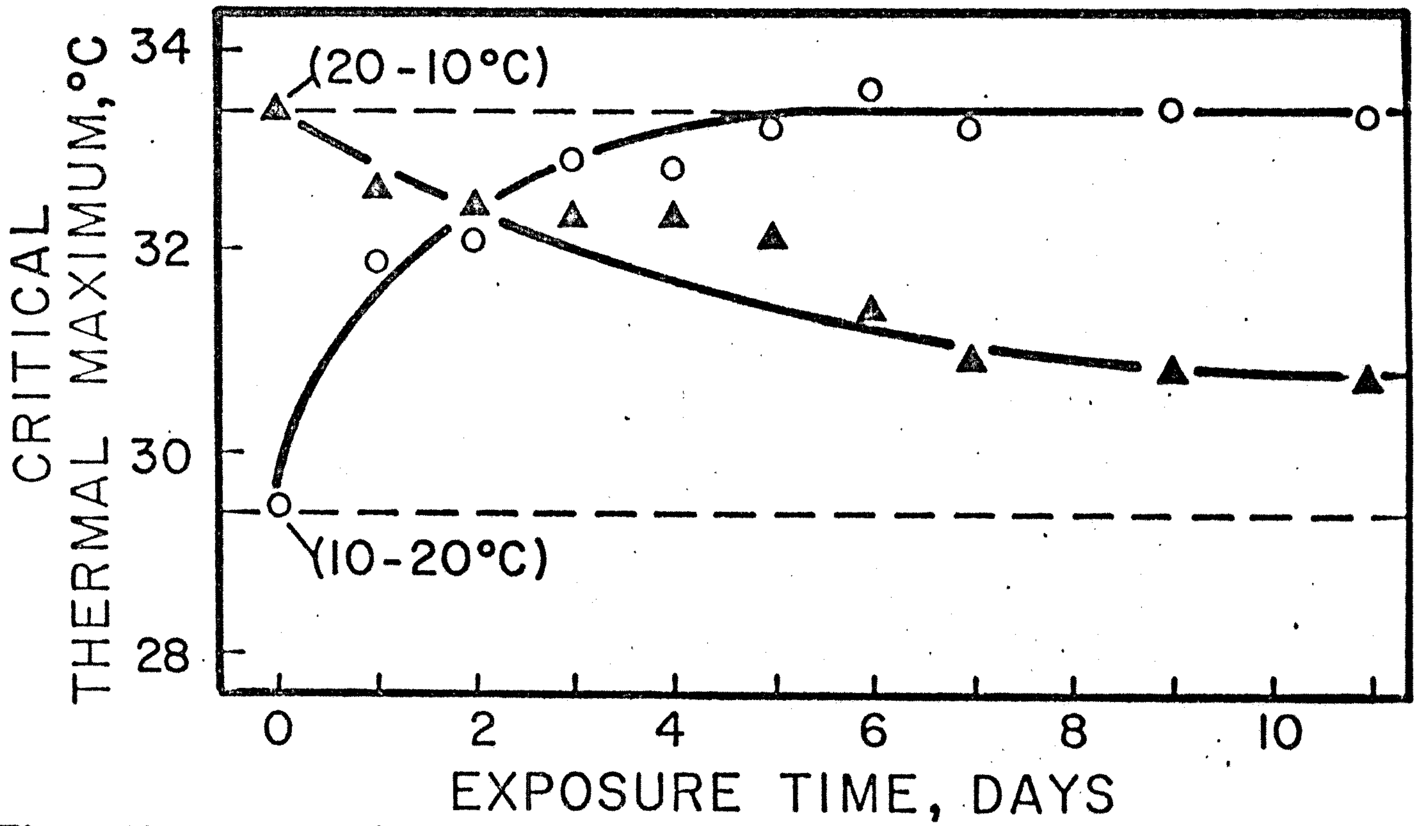

Figure 11. Critical thermal maxima (CTMs) for yellow perch subjected to a 10 C change in temperature.

of marine species as reviewed by Brett (1971).

Upper lethal temperatures: It is not necessary for a fish to be immediately incapacitated for it to suffer harmful, even lethal effects from an elevation of temperature. For each species and each thermal acclimation regime there is a family of less severe time-temperature relations (the resistance domain) which culminate in mortality. The upper boundary of this domain as characterized by a high temperature and short exposure time prior to death is approximated by the CTM or heat shock. The lower boundary with a less extreme temperature and longer exposure time is the upper incipient lethal temperature.

Upper incipient lethal temperatures were determined for mature and young of year alewives, yellow perch, rainbow trout and slimy sculpins in this study. The results of these tests and those of other workers for various Lake Michigan species are summarized in Table 6. In the first case, groups of 10 mature alewives acclimated to 10 C and transferred abruptly to various higher temperatures exhibited 100% survival at 22 C, 30% survival at 23 C and 0% survival at 24 C for a test duration of 7 days. The upper incipient lethal temperature for this acclimation level is therefore approximately 23.5 C. Median survival times at temperatures exceeding this limit ranged from 15 minutes at 28 C to 2600 minutes at 24 C (Figure 12).

Mature alewives acclimated to 15 C also had an estimated upper incipient lethal temperature of 23.5 C. Again, 100% survival was observed at a test temperature of 23 C while 80% of the test fish died at 24 C. Median survival times at equivalent lethal test temperatures were consistently increased over

Table 6. A summary of upper incipient lethal temperatures (°C) for Lake Michigan fishes.

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

a/ Edsall et. al., 1970
b/ Fry et. al., 1946
c/ Brett, 1952
d/ Edsall and Colby, 1970
e/ Hart, 1947
f/ Hart, 1952

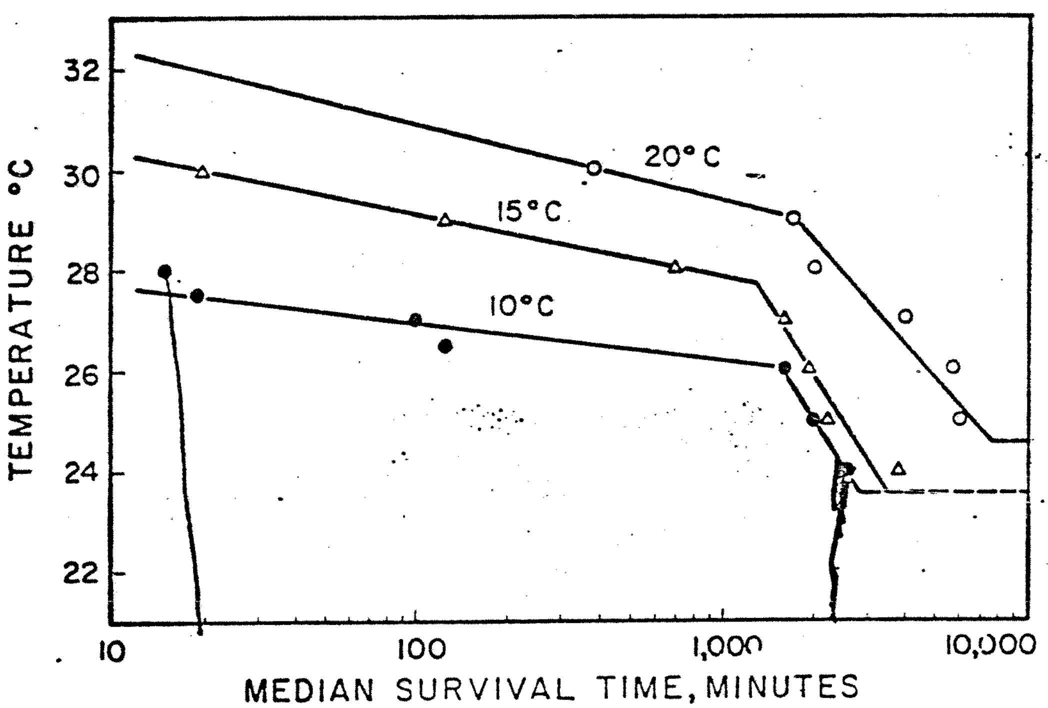

Figure 12. Median survival times for mature alewives subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

those for fish acclimated to 10 C. An increase in acclimation temperature to 20 C caused the upper incipient lethal temperature to rise to approximately 24.5 C. Again, median survival times at equivalent test temperatures were increased over those for fish acclimated to lower temperatures.

The general conclusions that can be drawn from this series of tests are first, that mature alewives acclimated to low temperatures are better able to withstand sudden increases in temperature. Fish acclimated to 10 C can survive a temperature increase of 13.5 C. Those acclimated to 15 C can tolerate only an 8.5 C increase while 20 C acclimated fish are within 4.5 C of their lethal limit. This conforms with the general conclusions of the heat shock tests discussed earlier.

However, even though the warm-adapted mature alewife is unable to tolerate as broad a temperature increase as the cold acclimated individual, the ability to tolerate limited exposure to temperatures exceeding the lethal limit is enhanced for warm-acclimated fish. For example, fish acclimated to 10 C and subjected to temperatures 0.5 C above their lethal limit can survive for a period of about 2600 minutes (or, in an ecological context, have just under two days to find waters of more equable temperature). Mature alewives acclimated to 15 C and exposed to a temperature increase exceeding their lethal limit by 0.5 C have a median survival time of 3600 minutes or 2 1/2 days. Further raising the acclimation level to 20 C increases this temporal safety margin to 6000 minutes or over four days. This relationship also holds for more severe temperature increments.

Upper incipient lethal limits were determined for young of year alewives acclimated to 10 C, 20 C and 25 C. Groups of 10 fish acclimated to 10 C and transferred to temperatures of 26 C, 26.5 C and 27 C exhibited 30%, 60% and 100% mortality, respectively. The estimated upper incipient lethal limit for this group is therefore slightly below 26.5 C (Figure 13). Young of year alewives acclimated to 20 C and 25 C had estimated incipient lethal temperatures of 30.3 C and 32.1 C.

Young of year alewives are therefore somewhat more tolerant of high temperatures than mature individuals, the difference being about 3 C for fish acclimated to 10 C and 6 C for 20 C acclimated fish. Some insight regarding these differences can be obtained by evaluating the survival curves shown in Figures 12 and 13. Distributions of median survival times are very similar at severe temperatures where mortality occurs rapidly. However, in those tests involving young of year fish, mortality due to high temperatures was essentially complete within 300 to 500 minutes following the temperature change, a young of year fish which survived for 500 minutes would not be anticipated to die as a result of heat experience. In the case of mature alewives, test mortality continued for periods exceeding 1000 minutes. In addition, mortality during the later portion of the tests (exposure time 500 minutes) proceeded at a different rate than that observed for groups which died quickly as indicated by the change in slope of the survival curves for mature alewives at an exposure time of approximately 1000 minutes.

Truncated distributions of the type noted for mature alewives are

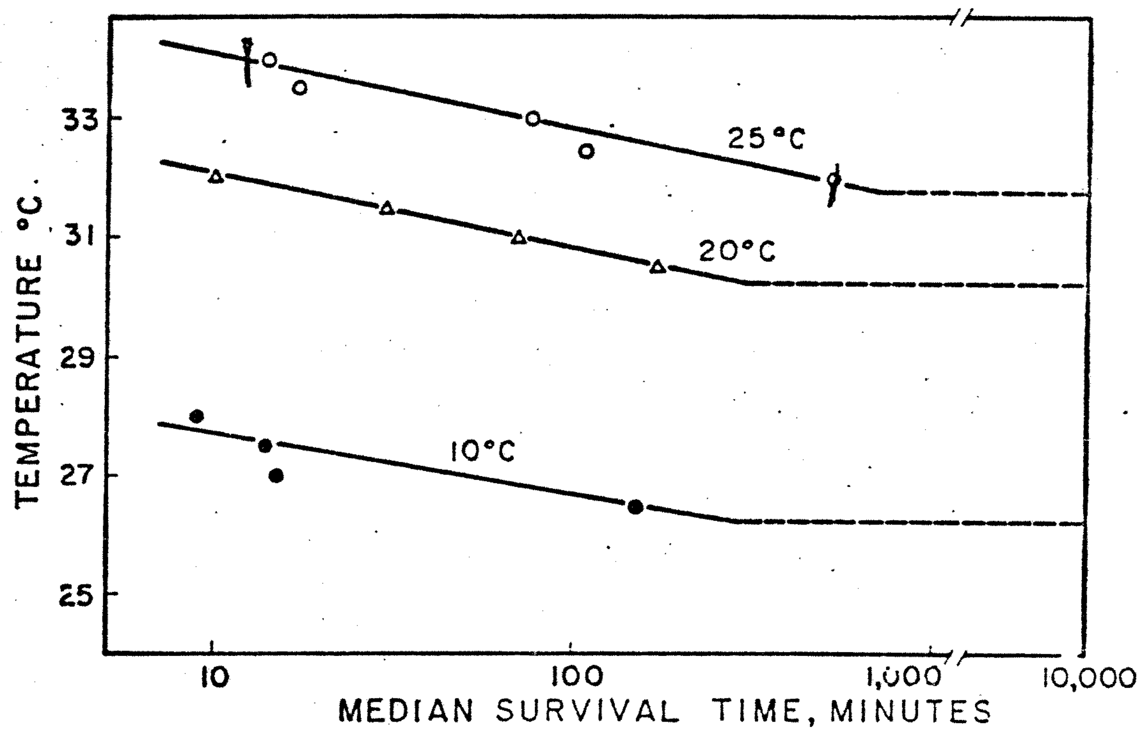

Figure 13. Median survival times for young of year alewives subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

indicative of multiple causes of mortality. While it is beyond the scope of this discussion to deal with possible causes of heat death, it should be recalled that the alewife in Lake Michigan is a land-locked form of an anadromous species. Thus, the young of year alewife as tested here is a true freshwater resident while the adults are marine fish living in a foreign environment. Differences in survival curves as observed here may therefore reflect ion-osmoregulatory difficulties experienced by mature alewives in freshwater. A contrary opinion is expressed by Stanley and Colby (1971). The differences in survival curves might also relate to a greater susceptibility to handling for older fish. In this case, the period of secondary mortality (exposure time >1000 minutes) for mature fish would not be attributed to thermal effects and estimates of lethal limits would be low by 2 C to 5 C. However, the similarity of initial portions of the response curves for both mature and young of year alewives and lack of mortality in concurrent control tests for both age groups suggest that handling stress was not a problem.

Results for studies of the yellow perch (Figure 14), rainbow trout (Figure 15), and slimy sculpin (Figure 16) were generally comparable to those for the mature alewife and will not be discussed further. Relating the observed upper incipient lethal temperatures to discharge temperatures at Zion and Waukegan Generating Stations, it can be seen (Table 5) that lethal limits will not be exceeded for any species at either station during that portion of the year when lake temperatures are below 10 C. Maximum discharge temperatures do exceed lethal limits for all species at one or both stations during the warmer

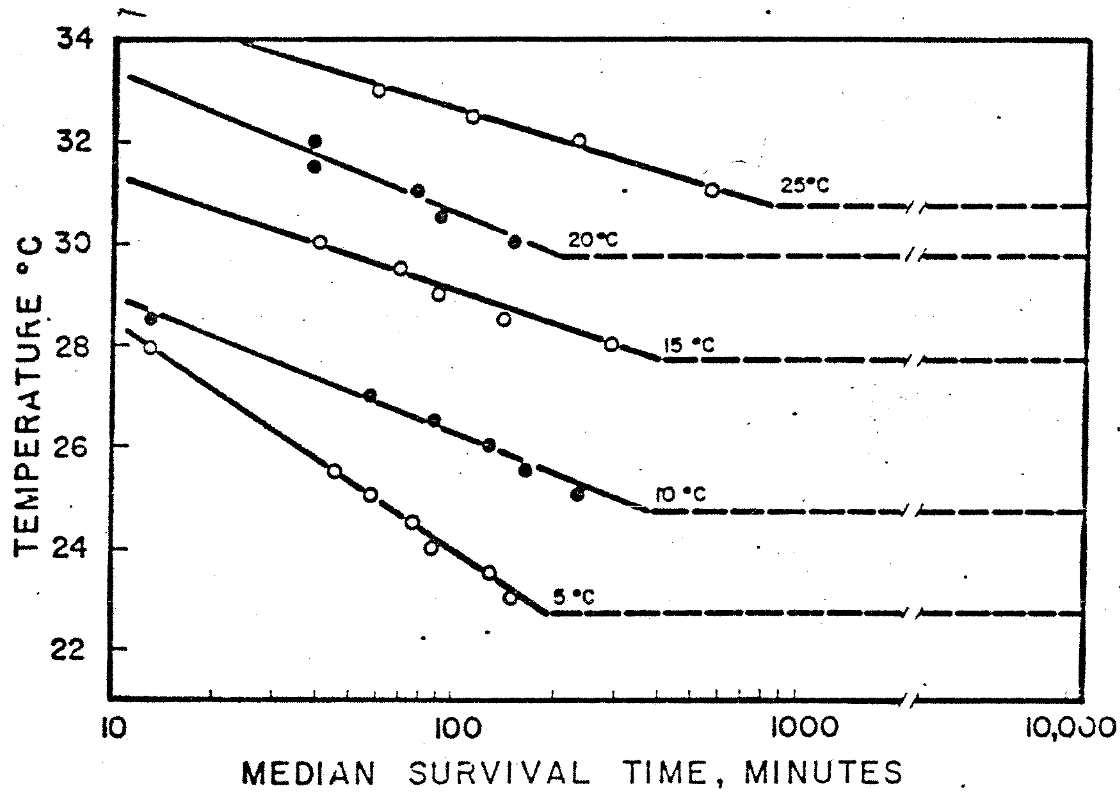

Figure 14. Mean survival times for yellow perch subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

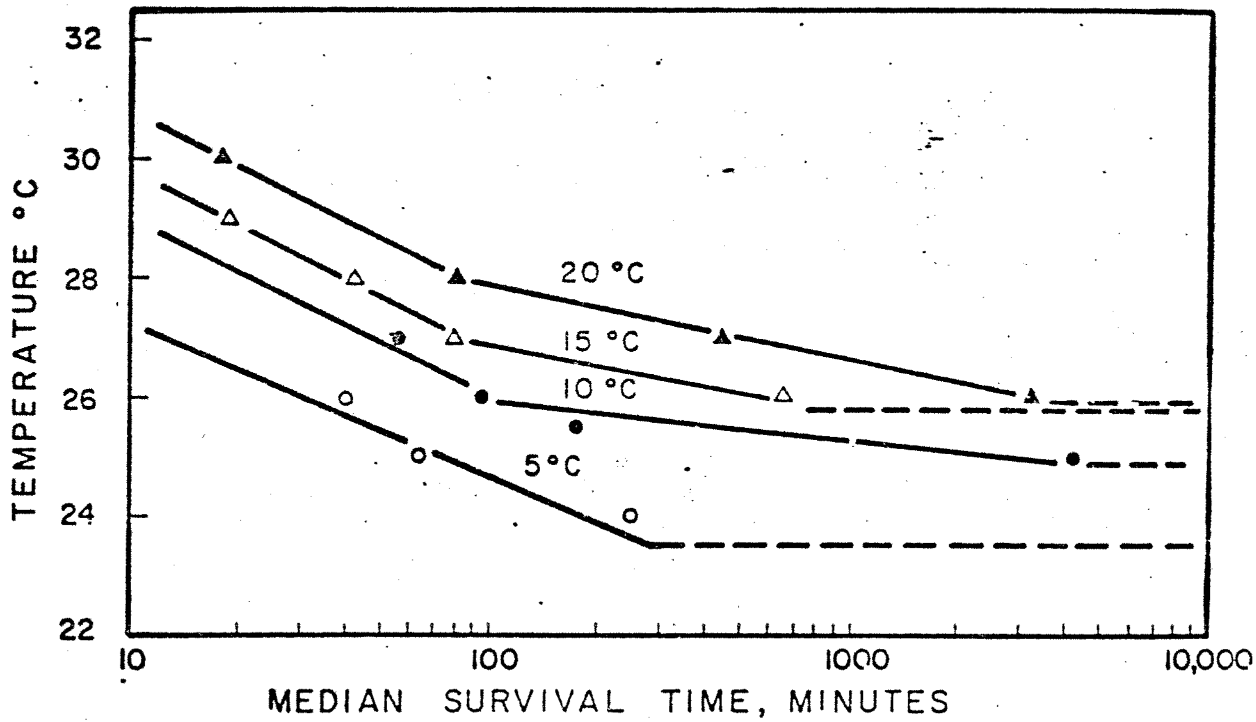

Figure 15. Median survival times for rainbow trout subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

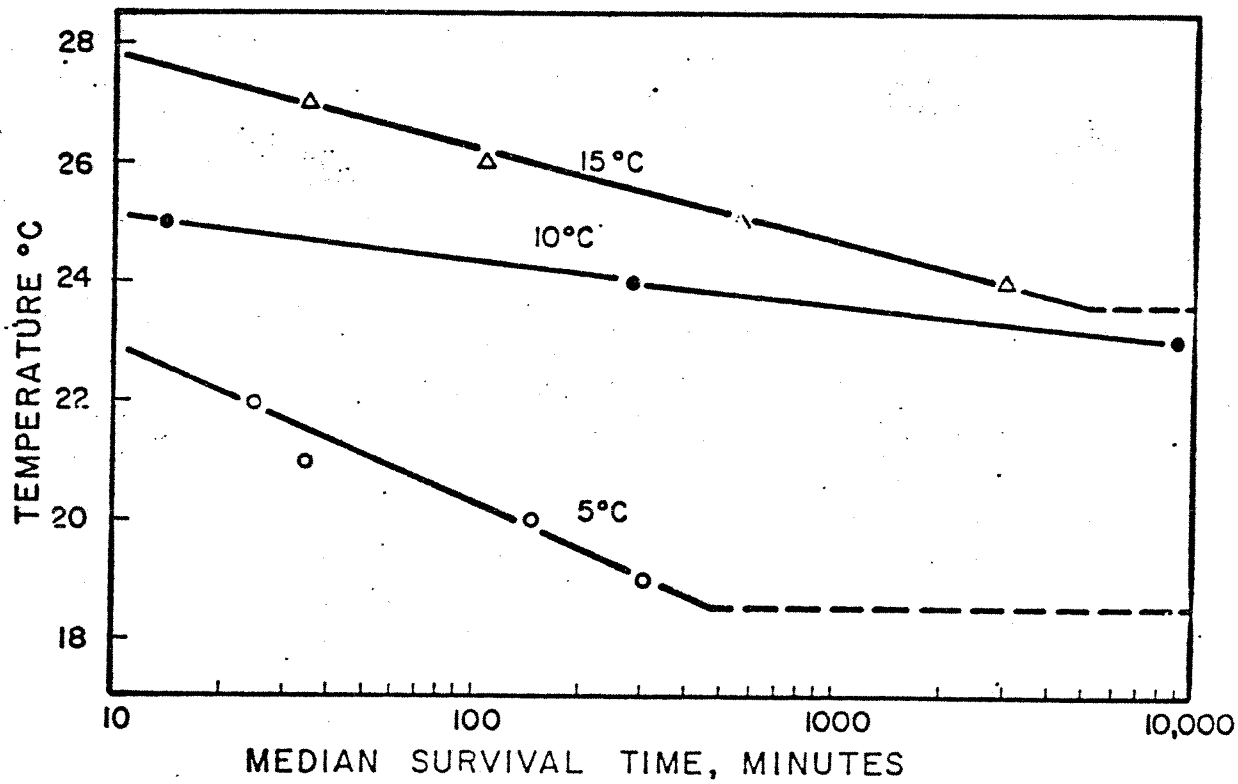

Figure 16. Median survival times for slimy sculpin subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

months. However, the significance of this in terms of harmful effects on the local fish community is questionable. The majority of the more heat sensitive species listed in Table 5 do not inhabit inshore waters during the warmer months and thus are isolated from any potential discharge effects. High water velocities at the Zion Station discharges (the potentially most stressful situation) provide still another isolating factor as discussed previously. There is also a temporal margin of safety in that lethal temperatures below the shock level are expressed only after a period of time (Figures 12 through 16) allowing a plume-entrained fish an opportunity to escape prior to harm. Finally, it will be shown in the following section (Section F) that in most cases fish recognize and avoid temperatures which approximate or exceed their lethal limits.

Lower lethal temperatures: Any fish which occurs in nearshore waters of Lake Michigan during the winter months must be able to survive at a temperature of 0.0 C. There is, however, a rational basis for considering lower lethal temperatures in the present study. If fish are able to maintain themselves within the confines of a discharge plume they may acquire some degree of heat acclimation. This may be to a temperature elevation of as much as 8 C in the case of the Waukegan Generating Station discharge and 2 C to 4 C at the Zion Station discharge. A cessation of operations at either station might then subject these warmer-acclimated individuals to a very sudden decrease in temperature.

Lower lethal temperatures for a variety of Lake Michigan species have been determined in this study and through the work of others (Table 7). In general, the warmer the temperature of acclimation the greater the decrease in

Table 7. A summary of lower incipient lethal temperatures (°C) for Lake Michigan fishes.

Species	Acclimation Temperature (°C) 5	10	15	20	25
Alewife[e]	-	4	5.4	7.8	-
Brook Trout[a] *closely related*	-	-	-	-	0.5
Chinook Salmon[b]	< 1[e]	0.8	2.5	4.5	-
Coho Salmon[b]	0.2[e]	1.7	3.5	4.5	-
Emerald Shiner[c]	-	-	1.6	5.2	8.0
Fathead Minnow[c]	-	-	-	1.5	-
Golden Shiner[d]	-	-	1.5	4.0	7.0
Largemouth Bass[d]	-	-	-	5.5	-
Rainbow Smelt[e]	< 1	< 1	-	-	-
Rainbow Trout[e] *closely related*	< 1	< 1	2.0	4.0	-
Slimy Sculpin[e]	< 1	1	4.0	0	-
Yellow Perch[c]	-	1.1	-	-	3.7
White Sucker[c]	-	-	-	2.5	6.0

a/ Fry et. al., 1946
b/ Brett, 1952
c/ Hart, 1947
d/ Hart, 1952
e/ Data from or confirmed by this study.

temperature which can be tolerated. For example, an alewife acclimated to 20 C can withstand a temperature drop of about 12 C. Reducing the acclimation level to 15 C caused a corresponding decline in the tolerable temperature decrease to about 10 C. An alewife acclimated to 10 C can withstand a ΔT of only 6 C.

Only the alewife would appear to be susceptible to cold death related to operations of the Zion and Waukegan Generating Stations of the species for which data is available. It appears in fact that this species is sufficiently cold sensitive that natural temperature fluctuations such as upwellings may cause mortalities during the spring months. The alewife does not typically occupy nearshore waters except during spring and summer. However, the presence of the discharge from Waukegan Generating Station may increase the possibility for mortality due to cold shock, particularly during early spring as the alewife makes its annual inshore migration.

F. Behavior Studies

General considerations: Fish may respond behaviorally to the presence of a heated effluent in a variety of ways. They may be attracted to the maximum temperature available. They may be repelled by maximum temperatures but attracted by intermediate levels. They may avoid any increase in temperature. Finally, they may exhibit no clear response at all. The emphasis in the present study is on the question of what temperatures various Lake Michigan species will avoid or select when presented with a choice. The application of laboratory behavioral studies to the prediction of fish response in the natural environment is a perilous undertaking at best. There are however, generalizations which can be drawn based on laboratory studies which identify anticipated trends in response to a natural gradient of temperatures. We assume that fish will be guided by temperature to respond as indicated by laboratory results and that these trends in response are subject to various degrees of modification relating to the action of other environmental factors.

Avoidance of elevated temperatures: When fish are presented with a choice of two temperatures which approximate their acclimation level they will generally spend the majority of their time in one of the two. This is an expression of temperature selection or preference in that the fish will move freely between the two levels but tend to frequent the preferred temperature area to the greatest extent. However, as the two choice temperatures are increased, eventually a level is reached where the fish will no longer enter the warmer of the two areas. This is the avoidance temperature. The shift in response from temperature selection or preference to avoidance is readily apparent to the observer and the avoidance temperature can be determined with considerable precision.

Avoidance temperatures have been determined for a number of Lake Michigan species (Table 8). Values vary with both species and acclimation temperature as expected. Cold water species such as rainbow smelt and slimy sculpin had lower avoidance temperatures than warm water forms such as yellow perch at equivalent acclimation levels. Changes in avoidance temperatures within species were directly related to changes in acclimation levels but

Table 8. Avoidance temperatures of Lake Michigan fish as determined in a +/- choice apparatus.

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

were not in direct proportion. For example, an increase in acclimation temperature from 5 C to 10 C for the brook trout caused only a 2 C increase in the avoidance level.

A comparison of avoidance temperatures with heat shock temperatures (CTMs) and upper lethal temperatures is of greatest importance. CTMs generally exceed avoidance temperature by a considerable margin. For example, in the case of the brook trout avoidance temperatures were 6 C to 8 C below levels which cause heat shock. The exception is the yellow perch for which avoidance temperatures were within 2 C of the CTM in all tests and actually exceeded the CTM for fish acclimated to 10 C and 15 C. Yellow perch did on occasion suffer heat shock in the +/- choice apparatus.

Temperature preference: Lake Michigan species as tested in a temperature gradient exhibited three types of response (Tables 9, 10). Species such as the lake trout and slimy sculpin which have been categorized by performance and survival studies as cold-water forms were attracted to temperatures elevated above lake ambient only during winter and early spring. Somewhat more eurythermal species like the alewife and rainbow trout preferred temperatures above ambient for the majority of the year excepting some part of the summer. Finally the most eurythermal or warm-water forms such as the golden shiner, largemouth bass and yellow perch were attracted to temperatures above ambient throughout the year.

Preferred temperatures were always well below avoidance and survival limits. For example, in the case of the rainbow trout, fish acclimated to 5 C

Table 9. A summary of preferred temperatures (°C) for Lake Michigan fishes acclimated to constant temperatures.

Species	Acclimation Temperature (°C) 5	10	15	20	25
Fathead Minnow	-	21.2	-	26.5	-
Golden Shiner	18.6	22.2	25.6	25.8	27.2
Lake Trout	9.0	8.7	10.8	-	-
Rainbow Trout	12.2	13.5	14.9	16.0	-
Slimy Sculpin	8.5	-	11.1	-	-
Yellow Perch	16.9	19.7	20.0	25.2	26.4
Acclimation Temperature + Zion ΔT max.	16	21	26	31	-
Acclimation Temperature + Waukegan ΔT max.	13	18	23	28	-

Table 10. A summary of preferred temperatures (°C) for Lake Michigan fishes acclimated to field temperatures.

Species	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Alewife (Adult)	12	-	-	-	21	19	-	16	16	-	16	11
Alewife (Young of Year)	-	-	-	-	-	-	-	25	24	-	21	19
Carp	-	-	-	-	-	-	31	-	-	-	-	-
Golden Shiner	12	16	18	20	23	24	26	-	20	-	14	13
Largemouth Bass	20	20	23	25	26	-	31	29	27	-	25	22
Longnose Dace	-	-	-	-	-	-	31	-	-	22	-	-
Rainbow Trout	-	13	14	14	15	16	-	-	-	-	-	-
Yellow Perch (Adult)	13	15	17	19	20	21	-	24	-	20	-	17
Yellow Perch (Young of Year)	17	16	20	19	21	25	-	27	-	22	-	19
Maximum Observed Field Temperature	2	5	9	10	13	17	18	20	15	12	10	5
+ Waukegan ΔT	10	13	17	18	21	25	26	28	23	20	18	13
+ Zion ΔT	13	16	20	21	24	28	29	31	26	23	21	16

preferred a temperature of approximately 12 C. The avoidance level for these fish exceeded 20 C while the upper lethal temperature was 23.4 C and the heat shock temperature 27.9 C.

Seasonal factors appeared to be of greater importance in determining preferred temperatures than were lake temperatures in some cases. For example, the maximum preferred temperature for the mature alewife was observed in May. This corresponds temporally with the later portion of the annual inshore migration for this species and with the initial portion of the spawning period. Preferred temperatures then declined despite rising lake temperatures, reaching a summer minimum in August. Preferred temperatures remained stable throughout fall in spite of declining water temperatures. However, in December and January as lake temperatures approached the annual minimum, preferred temperature decreased to its minimum value.

Preferred temperatures were also affected by the age of the test fish. Adult and young of year alewives and yellow perch were tested at a number of acclimation temperatures (Table 10). Young of year fish were consistently attracted to higher temperatures than were adults. Differences as large as 9 C for the alewife and 4 C for the perch were noted.

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M. J. Skelly

NINE MILE POINT FISH TAGGING PROGRAM

1974 ANNUAL REPORT

Niagara Mohawk Power Corporation

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NINE MILE POINT FISH TAGGING PROGRAM

1974 ANNUAL REPORT

1. MAJOR ACCOMPLISHMENTS OF THE 1974 STUDY

The Nine Mile Point Fish Tagging Program was developed to assist in determining any impact on the Lake Ontario fish community of the water intake and discharge from the Niagara Mohawk Power Corporation Nuclear-Electric Generating Station at Nine Mile Point on Lake Ontario. During the three-year study period from 1972 to 1974, 9,919 fish, comprising 22 species, were tagged and catalogued. By the end of 1974, 956, or 9.64%, of these tags had been returned. Valuable information has been obtained from these tag returns, and from subsequent computer analyses of the data. The vagility and residence times of fish in the Nine Mile Point area, as well as specific dispersal patterns for certain species, have been elucidated. In addition, several migratory patterns and changes within the fish community have been suggested.

In brief, computer analyses of the data obtained from tags returned by December 1974 have indicated that:

- Although fish are attracted to the discharge area for several reasons, the attraction appears to be only transient. A continuous dispersal pattern of tags returned from fish tagged in the area indicates that fish move freely into and out of the thermal plume.

- The effects of the water discharge vary considerably with time, as local species assemblages differ seasonally with climatic changes.

- Tagged fish species migrate along the shore, generally within a 70 mile range of NMP, showing a definite seasonal pattern of movement. Fish appear to return to the point of tagging roughly one year from the tagging date after moving throughout this 70 mile range. Enough data has been collected from tag returns to suggest a cyclic seasonal migratory pattern for the yellow perch, pumpkinseed, and brown bullhead, although the rates and distances of dispersal vary.

- The rate of movement of individual fish away from the tagging location is quite different, and appears to be characteristic of specific species of fish. It has been indicated that individual brown bullheads, for instance, remain in the area for only two to three days, whereas pumpkinseeds may remain for several weeks.

- Yellow perch show a clear pattern of overwintering in the Sandy Pond area, 20 miles northeast of NMP, and returning westward in the spring. Pumpkinseed returns indicate a rapid, brief, but extensive, migratory movement in late winter.

- The general summer movement of tagged species is eastward along the shore of the lake, apparently drifting with dominant lake currents, although a westward migratory pattern in August is suggested for some species, such as the brown bullhead.

2. OBJECTIVES AND INVESTIGATIVE METHODS OF THE STUDY

This study, which began in July 1972, has yielded increasingly precise information to enable evaluation of any impact on the fish community of Lake Ontario by the water intake and discharge of the Niagara Mohawk Power Corporation Nuclear-Electric Generating Station at Nine Mile Point on Lake Ontario. The objectives of the study were:

- To examine if any possible impact of impingement on the fish population affected either a local fish community, or the broader regional fish community.
- To determine residence time for as many fish species as possible in the area.
- To determine the extent and direction of dispersal patterns for various fish species and the vagility or amount of movement of individual fish.
- To determine whether fish in the area comprise a community of some temporal duration, or whether they instead are representative of a stable regional fish community with their transience, therefore, governed by edaphic conditions.

2.1 Summary for 1972-1974

To realize these objectives, during the period from July 1972 through October 1974, 9,919 fish, representing 22 species, were caught, catalogued, tagged, and released (Table 1). Almost ten percent of these fish were subsequently recaptured and reported, either by anglers or, to a lesser extent, by our own nets. The information supplied by these tag returns has been consolidated and analyzed in a variety of ways. A comprehensive computer analysis in 1974 has revealed several important factors (discussed more fully in Section 3) concerning the migration, dispersion, and ecology of the fish community in the study area. These include:

- species found at Nine Mile Point are recurring, but not permanent, residents, demonstrating a one-year cycle of movement.

- although fish are attracted to the discharge, they are not trapped by it, but move freely around the area.

- the concentration of fish in the area appears to be greatest from April through September.

- dispersal (migratory) patterns observed differ for each species of fish tagged.

- multiple recaptures (re-released fish) indicate eastward migration patterns in summer and fall, and westward patterns in the spring.

- numbers of tags returned indicate seasonal fishing pressure by anglers.

- percentages of various species returned reflect the popularity and resulting fishing pressure on a given species. Smallmouth bass, pumpkinseed, yellow perch, and rock bass, respectively, were those species whose tags were returned in the highest numbers overall. At Nine Mile Point angler recaptures showed yellow perch, pumpkinseed, rock bass, and brown bullhead, respectively, to be the most popularly caught fish.

2.2 Methodology

2.2.1 Netting

Throughout the study, fish were caught in trap nets, tagged, and returned to the lake at their place of capture. Information concerning all fish that have subsequently been recaptured has been collected and analyzed.

In the first phase of the study, which began in July 1972, one trap net was used at transect E-1 (Figure 1) at Nine Mile Point, set shoreward and east of the discharge in about eight feet of water. The net, manufactured by the

Sterling Net Corporation, had a rigid frame and a double heart, and measured 4'x6'x8' in the body. The center lead was 125 feet in length with 30 foot wings (Figure 2). The bottom webbing was 3/4" stretch mesh, while the center lead was of 1-1/2" mesh. Four of these smaller nets were used for the remainder of 1973, and throughout 1974. The nets were set with the mouth shoreward and the body generally set in seven to ten feet of water. Table 1 summarizes the transect location, the date, and the number of fish captured and tagged during each tagging period.

2.2.2 Tagging Locations

While there was a single tagging station at Nine Mile Point in 1972 and 1973 which was located shoreward of the upwelling discharge with the opening facing E-1, a number of tagging stations were established in 1974 (as shown in Figure 1). Unfortunately, the study could not be implemented until late in the spring of 1974 and the proposed tagging schedule was not able to be carried out. The study concept was to establish a series of four tagging locations beginning at North Sandy Pond at the eastern end of Lake Ontario, at Dempster Beach, Nine Mile Point, and the Oswego River area. These locations were roughly 10-15 miles apart. The tagging study was to progress from North Sandy Pond westward until August, then reversed in the fall. Nine Mile Point was to remain as the principal tagging station. Two purposes were to be accomplished by this program:

1) Yellow perch winter in North Sandy Pond and spawn in that area, moving westward in spring and eastward in fall to return to North Sandy Pond. Since this is a major fish species at Nine Mile Point, it was hoped to follow the movement of this fish by the program and expand our knowledge of this movement.

2) By tagging at locations other than Nine Mile Point, a much broader pattern of movement of fish could be established. Analyses of this tag return data will give a broader base for the analysis of fish movement and overcome the bias of a single tagging location at Nine Mile Point. Too many of the fish tagged at Nine Mile Point are recaptured by the heavy angling pressure around the discharge, resulting in information of low value in determining fish movement.

In 1975 the program expanded the tagging program to include the area at the new Sterling Site and the Ginna Station. This phase of the tagging program was supported by Rochester Gas and Electric.

2.2.3 Fish Tags

During the week of a tagging study, the fish were removed daily from the nets a few at a time, placed in a plastic holding tank in the boat, measured for total length, and then tagged. A sketch of the plastic tags used, which were manufactured by the Floy Tag and Manufacturing Company, Inc., is included in Figure 2. The needle of a tagging gun was inserted into the fish musculature below and posterior to the center of the dorsal fin, with the anchor of the tag inserted to a depth of about 1/2", depending on the size of the fish. The tubing portion of the anchored tag contained the following two lines of printing:

Box 99 SUNY at BFLO 14214
#0000 Reward $2.00 Date

The two dollar reward was given to encourage the return of the tag and to compensate the returnee in small part for cost and trouble. When a tag was received, the reward, a form letter indicating the date and location of the tagging of the fish, plus a questionnaire with a return addressed and stamped envelope were sent to the fisherman. A sample of the form letter and questionnaire is included with this report. Almost all questionnaires were returned, although the information supplied was often incomplete.

After the data are analyzed, a short summary letter of the results obtained to date is sent to each individual who has returned a fish tag. This is done to stimulate interest. A number of letters were received from tag returners, and these were answered as best as possible. This year the summary report for 1972 and 1973 was also offered to tag returners, and 61 of these reports were requested and sent.

All tagged fish recaptured in trap nets were returned to the lake after the tag number, the length of the fish, and the date of recapture had been recorded. In a few instances, sport fishermen have also informed us of the tag number, location, and date of a fish caught and then released. This has been helpful in detailing the movement of the fish along the shore and throughout the Nine Mile Point area.

2.2.4 Data Files and Analysis

Fish tag return data have been divided into two groups in the accompanying appendix. One group lists tag returns for fish recaptured in our own trap nets, and the other, larger group of tables, lists tags returned by sport fishermen and, in a few instances, by commercial fishermen.

Information supplied by these tag returns was consolidated and recorded on IBM cards for computer analysis, the initial results of which are included in Section 3 of this report. Maintaining the card file is a time consuming, but necessary, job due to the complexity of the data. Computer analyses were used to construct all tables and to compute the construction of all dispersion plots.

3. DISCUSSION OF RESULTS

Included in this section is a discussion of the attached Summary Tables, which reflect various aspects of the total number of fish tagged during the three-year tagging period between July 1972 and October 1973, as well as information obtained from tags of recaptured fish returned before the end of 1974. A discussion of the possible impact of impingement or other effects of the intake and discharge of the Generating Station on the fish community is then included as Section 3.2, and this is followed by a summary of dispersal patterns for tagged fish species that have been determined from the consolidated tag return data.

3.1 Summary Tables

The attached tables reflect that 9.64% of fish tagged during 1972 through 1974 were subsequently reported as recaptured. The majority of the returned tags (82.95%) were sent in by anglers from widely distributed locations. The remainder (17.05%) represented fish recaptured in our own nets (Table 2). Even these, however, reflect a wide temporal distribution, ranging from the same day to an interval of 438 days from the date of original tagging to the date of recapture. An even greater range has been established by angler tag returns: intervals over 400 and 500 days between tagging and recapture are common, and one rock bass was captured 748 days after tagging (Appendices 1 & 2). The species-wide distribution of tags returned by anglers is partially dictated by the common angling locations and the angling methods used at different areas and in different climatic conditions and, therefore, do not necessarily fully represent the distribution of the fish community as a whole after tagging. For example, although relatively few smallmouth bass were tagged during the three-year period, 18.18% of these desirable fish were recaptured by anglers. Overall, however, tag returns were reflective of the number of fish tagged of each species. The four most commonly tagged species, the pumpkinseed, rock bass, yellow perch, and brown bullhead, accounted for 87.79% of the total number of tagged fish, while the tags returned for these four species accounted for 95.71% of all returned tags (Tables 1 & 2).

Taggings were generally limited to certain species. Smelt and alewives, for example, although plentiful in the area, were noted but not tagged. This was due to a number of factors including their small size and subsequent increase in trauma from tagging. These fish have high numbers and very high mortalities; therefore, the numbers of these fish that would have to be tagged would be several orders of magnitude higher than for other fish. In addition, these fish are not commonly caught by angling and, therefore, an intensive capture effort would have to be mounted to find these fish.

The small amount of information that could be gathered and large costs of such an effort were judged to be prohibitive. Many pike were observed during nettings, but very few were tagged due to their small size. Eels were noted throughout the three-year period, but were not tagged until June of 1973.

Fish tag returns indicate that the species found at Nine Mile Point are recurring, but not permanent residents. The rate of dispersion varies, but analysis has indicated definite dispersion patterns for all species for which there have been a significant number of tag returns. Patterns of dispersion are evident both for individual fish and for entire species. Fish tag returns indicate that back and forth movement along the shore in the area is probably common for individual fish. This has been confirmed in an unpublished study done by Dr. Coutant using sonic tags on fish at a discharge. Tag returns, furthermore, indicate seasonal migrations by larger fish species. This is suggested by the data in Table 1, and it has, further, been possible to plot the movements of the yellow perch, pumpkinseed, and brown bullhead (Section 3.3).

All live, tagged fish that were recaptured in our own nets, and occasionally tagged fish caught by anglers, were recorded and re-released. This has helped in detailing the movement of fish along the shore and throughout the Nine Mile Point area.

As shown in Table 3, the percentage of tags returned increases greatly with time; 80.45% of all tags returned have been from fish tagged during 1972 and 1973. We, therefore, expect to gain ever increasing insight into the complex ecology of the Nine Mile Point area as tag returns continue to filter in.

3.2 The Possible Impact of Impingement or Other Effects of the Intake and Discharge of the Generating Station on the Tagged Fish Species

The concentration of fish in the area appears to be maximum in the period from April through September. The warmer water fish leave the shore region during the fall and winter and are replaced by smelt, which in turn leave the area in April or May. Results of this and other fish netting and fish distribution studies further indicate that, in general, fish in this area are more active in July and August, and less active during the cool spring periods.

Fish may be attracted to the discharge area for several reasons, but the attraction appears to be of only short duration for most individual fish, since dispersion is constantly occurring. Fish entering the water intake are impinged, and then washed from the traveling screens and returned to the lake via the discharge where large predatory species may feed upon those killed or weakened. Invertebrates also feed upon remains and plankton from the discharge, also providing food. The discharge area thus has become an active feeding station, which may account for a steady increase in the percentage of brown bullheads in the area. The upwelling of the discharge also modifies local wave activity and currents. Large numbers of fish may collect downcurrent from the discharge in response to strong lake currents, and large concentrations of fish are found throughout the summer in the relatively quiet area between the discharge and the shore. The smallmouth bass population was found to be concentrated beneath the warm water of the plume between the discharge structure and the shore. Fishing pressure is very strong in this area, and is reflected by the high number of angler tag returns received from here (Table 2). Pumpkinseed were also attracted to the discharge area in large numbers during the summer months.

The shallow, shoreward water is warmed by the thermal discharge which, in combination with reduced wave activity, has resulted in a large increase in the scud Gammarus, a half-inch crustacean that is a major food source for some larger fish (Aquatic Environment Studies, 1968-1972, Nine Mile Point Nuclear Station Unit 1, Niagara Mohawk Power Corporation). The warmer layer of water has, in addition, resulted in an increase in plankton crustaceans. The biomass of lower trophic levels has, therefore, increased and greater numbers of fish can be supported. Many rock bass were captured in the discharge area. Certain fish that feed close to the shore at night (yellow and white perch, for example) were seen to avoid the thermal area during the summer and were caught instead in the cooler waters 2000 feet to the east of the discharge.

Although many fish species commonly found in the Nine Mile Point area can be considered as local residents during some times of the year, other species are more accurately considered as short-term transients from the larger regional or lake community. The local communities of either fish or assemblages of many organisms are not permanent, but instead have seasonal successions of populations and other features such as total biomass and energy flow. These are strongly influenced by regional climatic, limnological, and edaphic effects.

Most of the tagged species represented a relatively constant percentage of the entire tagged fish community during the three years of tagging. There were, however, two notable exceptions. In 1972, pumpkinseeds accounted for 50.42% of the total number of fish tagged; in 1973, pumpkinseeds represented only 25.47%; and in 1974 the representation of pumpkinseed fell to only 12.45% of the total number. Brown bullheads showed the opposite trend; whereas only 10.25% of the total number of fish tagged in 1972 were brown bullheads, in 1973 this rose to 27.88%, and in 1974 brown bullheads represented 36.74% of the total number. Pumpkinseeds appear to be longer term residents of the area, and disperse at a much slower rate than brown bullheads. It could be that some larger predatory fish attracted to the discharge area, as well as heavy fishing in the area, are making an impact on the pumpkinseed population. Individual brown bullheads, on the other hand, have a high rate of dispersion and thus may not be subjected to these stresses. Certainly the food supply for brown bullheads has increased in the discharge area due to the impingement of fish on the intake traveling screens. Future nettings in the area and in other locations will help to clarify this trend.

3.3 Determined Dispersal Patterns for Tagged Fish Species in the Nine Mile Point Area

To some degree, individual fish display different physiological and behavioral responses to the environmental parameters and other species present at any one time. Patterms of behavior described for a particular species of fish, then, imply the actions of the majority, but exceptions will be found and results are of a statistical nature. Information obtained from recaptures in our own trap nets is relatively simple to interpret, since these returns come from a specific site during specific time periods and from comparable fishing efforts. Angling returns are more irregular and complex, since they depend not only upon varying and selective fishing pressures, methods (especially bait), and locations, but also upon weather conditions, seasonal parameters, and, of course, the fish themselves.

The dispersal point is established at the location at which a fish is caught, tagged, and returned to the lake. A dispersal pattern is indicated by the percentage of the tagged fish of a species subsequently recaptured at various locations, including the dispersal point, and by the time interval and distance from the dispersal point between the date of tagging and the date of recapture. Computer analysis of these data has yielded indications of the relative dispersal rates, relative motility, and migratory pressures ? and patterns of the tagged fish species.

At present, the total number of fish tagged and the percentage of tag returns has enabled comprehensive analysis of the dispersal patterns for three fish species, the pumpkinseed, brown bullhead, and yellow perch, which together comprise 78.75% of all fish tagged, and are represented by 85.04% of all tags returned.

Figure 4 shows the dispersal patterns determined for these species, by plotting the average distance from the dispersal point to the point of recapture, as a function of the time interval between tagging and recapture. It is expected that future tag returns will permit similar analyses of additional species.

Various patterns of behavior that are either indicated or suggested for particular species by the data presently accumulated are summarized in the following discussions.

3.3.1 Pumpkinseed (*Lepomis gibbosus*)

Between July 1972 and October 1974 a total of 2,248 pumpkinseeds were captured in our nets and catalogued, and of these 2,187 of the fish were tagged and released. By the end of 1974, 310, or 14.17% of these tags, had been returned, either by anglers or by our own people after a fish had been recaptured and again released from trap nets. As shown in Table 2, pumpkinseed tag returns accounted for 32.43% of the total number of returned tags, and the majority of the tags were returned by anglers. This reflects the aggressiveness of the pumpkinseed, which is readily caught by anglers. Figure 5, on which the number of returned pumpkinseed tags is plotted as a function of the distance to recapture, shows that the vast majority of pumpkinseeds were recaptured within a few miles of the dispersal point. Movement back and forth along the shore in the area was indicated, and these fish appear to be quite mobile within a 'home-range' area, without one particular permanent or even semi-permanent point of residence.

Tags returned in 1974 for fish tagged in 1972 and 1973 have helped to clarify dispersion rate. At the end of 1973, more than 50% of the tags returned by anglers for pumpkinseed were taken in the area of the discharge within one week of tagging. In 1974, only 32% of the tags were taken seven or less days from the tagging date, and most were caught in the area after a considerably longer period. This indicated a much greater residence time than had been indicated previously. It now appears that an individual pumpkinseed may reside in the Nine Mile Point area for as long as 28 weeks, and return to the dispersal point one year after tagging.

The pumpkinseed thus display a relatively slow rate of dispersion away from the Nine Mile Point area, and are abundant in the area throughout the summer months. Between 200 and 250 days after tagging they rapidly travel a distance of up to 60 miles away from the point of tagging for a short interval of time, and return to the dispersal point between 325 and 375 days after tagging (Figure 6). Although an annual cycle is suggested, this cannot be established, since no pumpkinseed tags have been returned more than 371 days after tagging. Nevertheless, since most of these fish were tagged in mid-summer, a short-term winter migration may be indicated. Unfortunately, a number of anglers neglected to inform us of the exact capture location and, as a result, insufficient data is available to detail this movement at present. The plot may also be interpreted to show movement away from the area to spawn. If this is assumed, then pumpkinseeds would have to be considered permanent residents of the Nine Mile Point area.

The percentage of pumpkinseeds found within the total number of fish caught for tagging in our nets has been decreasing since 1972. It has not yet been determined if this is reflected in any way in the dispersal pattern. Future tag returns from both the Nine Mile Point area and from taggings in other areas made by our teams may help to explain this phenomenon.

3.3.2 Yellow Perch (*Perca flavescens*)

During the three-year tagging period between 1972 and 1974, 2,672 yellow perch were captured in our nets and catalogued, and 2,622 of these fish were tagged and released. By the end of 1974, 322, or 12.28% of the total number tagged had been returned. The distribution pattern determined for yellow perch from these tag returns is very different from that of the pumpkinseed, and an annual cycle is strongly suggested (Figure 4). Yellow perch displayed a high rate of dispersal, and they appear to stay away from the Nine Mile Point area for long periods of time. The largest number of tags received from fish caught outside the Nine Mile Point area were taken in the fall and winter in the North Sandy Pond area (Figure 3). This is an area approximately 20 miles from the Nine Mile Point area, where winter ice fishing is heavy (which certainly influenced the statistical data). There appears to be a major migration of the yellow perch community to North Sandy Pond each fall; the number of yellow perch captured in tagging nets falls rapidly in early August although there appears to be a subsequent movement back into the Nine Mile Point area before the fall migration begins (Table 2). The yellow perch appear to spawn in North Sandy

Pond and then move westward along the shore, returning to the Nine Mile Point area early in the year. The small peak seen in Figure 4 indicating a second movement away from Nine Mile Point approximately 328 days after tagging may be caused by a return to the North Sandy Pond area for spawning.

The percentage of yellow perch caught in our tagging nets for each of the three years has remained constant, rising from 21.85% in 1972 to 24.85% in 1973 and 32.00% in 1974. During the warmer months netting data suggests that the yellow perch, like the pumpkinseed, range over the entire Nine Mile Point area, dispersing rapidly from the immediate tagging location. The yellow perch, however, disperse to greater distances far more rapidly than the pumpkinseed. Analysis of tag return data in 1973 had suggested that the individual yellow perch was a long-term resident of the Nine Mile Point area during the summer months. The incorporation of additional return data now indicates far more motility.

The data for this species is difficult to analyze; recaptures are somewhat erratic from week to week, which may indicate that the fish may travel in schools, respond quickly to lake conditions, and are available for recapture along the shore area only when conditions are favorable. Future tag return data will be helpful in clarifying behavioral patterns.

3.3.3 Brown Bullhead (*Ictalurus nebulosus*)

The brown bullhead population has apparently been increasing steadily in the Nine Mile Point area since 1972. In 1972 they represented 10.25% of the total number of fish caught and tagged, in 1973 this rose to 27.88%, and in 1974 36.74% of all fish tagged were brown bullheads. An increased food supply resulting from the impingement of fish on the intake traveling screens may be the cause of this apparent brown bullhead population increase.

During 1972, 1973, and 1974 a total of 3,027 brown bullheads were captured in our tagging nets, and 3,021 of these were tagged and released. By the end of 1974, 181, or 5.99% of these tags, had been returned. Data supplied by these returns indicate that the brown bullhead has a high rate of dispersion (Figure 4). There is at present no indication of any predominant location or even direction, however, in which this dispersion occurs.

Although individual brown bullheads move rapidly away from the dispersal point, on the whole they do not appear to travel far (although one exceptional fish was reported to have traveled 110 miles in 452 days). Except for the distance traveled, the dispersal pattern for brown bullheads is quite similar to that plotted for yellow perch. The brown bullhead population appears to move out of the Nine Mile Point area in the fall, returning through the early spring with a short secondary movement out of the area approximately 50 days later. This, as with both the pumpkinseeds and yellow perch, could be interpreted as a short-term movement for spawning.

3.3.4 Rock Bass (*Ambloplites rupestris*)

A total of 903 rock bass were captured during the three-year tagging period. Of these fish 878 were tagged and released, and 102, or 11.62% of the tags, have been returned. Although this is a high percentage of the total fish tagged, the actual number of returned tags was insufficient to determine any detailed patterns of distribution. Fish recaptured outside of the Nine Mile Point area had dispersed both to the east and west, and the distances traveled since the date of tagging were quite varied. Tag returns indicate that the rock bass has a wide range along the shore of the Nine Mile Point area. The species appears to be most abundant in the discharge area during July, but individual fish have been recaptured close to the tagging location throughout the summer. Twenty-two of the returned tags were taken more than 300 days after tagging, and for these the average distance traveled was 10.96 miles from the dispersal point. One fish was recaptured 748 days after tagging, only 7.0 miles from the tagging location. It is expected that additional tag returns will soon enable the determination of a detailed dispersal pattern for this species.

3.3.5 White Perch (*Morone americana*)

During the three-year period, 709 white perch were captured, and 701 of these were tagged and released. A very small percentage of these fish have been subsequently recaptured. By the end of 1974, only 12, or 1.71%, of the tags had been returned for this species, and all were returned by anglers; no white perch have been recaptured in our own nets. Moreover, an average of 290.5 days elapsed between the date of tagging and the date of recapture for these 12 fish. Six of the fish were caught at the dispersal point, and the other six were caught an average of 34 miles from the dispersal point. It may be that the low percent of recapture for the white perch reflects a high mortality of this species after tagging; very often white perch were noted to be in a distressed condition after tag insertion. However, the distances traveled by half of the fish that were recaptured suggests that this species may also, or instead, have a wide and rapid dispersal pattern.

3.3.6 Smallmouth Bass (*Micropterus dolomieui*)

The smallmouth bass has the highest percentage of tag returns of all species tagged from July 1972 to October 1974. Although only 88 smallmouth bass were tagged and released during the entire period, 16, or 18.18% of the tags, have been returned. None of the fish were recaptured in our own nets, yet 13 were recaptured at the dispersal point. Four fish were caught over 300 days after tagging; one was recaptured at the dispersal point, the other three were recaptured an average of 37.93 miles from the tagging location. The smallmouth bass is attracted to the warm waters between the discharge structure and the shore. It is thus perhaps not surprising that they are easily caught and that they are caught close to the dispersal point.

3.3.7 Other Tagged Species

There were not enough tag returns for any of the remaining 16 tagged species to permit analysis of dispersion patterns. In general, relatively few fish of any of these species were tagged. Thus, even though the percentage of tags returned for all fish tagged of some species, the black crappie, for example, is quite high, the actual number is far too low to permit dispersal pattern analysis at the present time.

TABLE 1: Summary of Fish Taggings by Date and Location for 1972-1974

Species	7/17-7/23/72	8/17-8/25/72	6/5-6/9/73	7/16-7/24/73	7/31-8/3/73	8/6-8/9/73	9/5-9/6/73	10/12-10/13/73	5/29-6/5/74	5/14-5/16/74	5/28-5/30/74	7/2-7/5/74	7/31-8/5/74	8/8-8/10/74	8/27-9/2/74	9/4-9/5/74	10/15-10/21/74	TOT 19 19
	TAGGING PERIOD																	
Location	NMP	NMP	NMP	NMP	NMP	NMP	NMP	NMP	NMP	NMP	NMP	SP	NMP	OH	NMP	OH	SP	
Pumpkinseed	36	445	5	407	240	298	179	17	10	30	2	226	87	53	105	21	26	218
White perch	54	4	63	74	40	129	4		25	12	7	69	33	34	28	125		70
Rock bass	9	61	76	176	43	16	11	47	181	83	25	101	21	7	10	11		87
Yellow perch	17	203	385	397	271		22	14	500	98	103	208	87	18	130	68	101	262
White bass																1		
Smallmouth bass	11	5	17	12	3	13	8	3	4	2	1		1	2	3	3		8
Burbot																1		
Brown bullhead	5	102	3	149	988	71	51		1	286		24	146	94	689	347	65	302
Black bullhead										1								
Carp	1	3		5		5						1		1		4	1	2
Goldfish					22	1												2
Black crappie	2	2		20			4					24			3		3	5
Walleye												1				1		
White sucker	1	12	32	19	16	33	2	15	44	10	10	2	1	1	3		5	20
Gizzard shad	1	1																
Bluegill		1	1			14			1	1		12			2	1	3	3
Eel				7	3			2	10	3	4		3	1	3	1	3	4
Pickerel									1								1	
Northern pike				1								2						
Bowfin					1							4	2	2		4		1
Redhorse sucker						11								1				1
Freshwater drum								1										
TOTAL	137	839	582	1267	1627	591	281	99	777	526	152	674	381	214	976	588	208	991

TABLE 2: Summary of Fish Taggings and Recaptures by Location

	Tagging Locations				Fish Recaptured in Trap Nets		Recapture Locations: Fish Recaptured by Anglers						
Species	NMP	Sandy Pond	Oswego Harbor	TOTAL	Total # Returned in Nets	% of Total Tagged	Sodus Bay	Port Bay	Little Sodus Bay	Fairhaven Bay	Oswego Harbor	Oswego River	Lake-view
Pumpkinseed	1861	252	74	2187	54	2.47	4	1		3	1		
White perch	473	69	159	701	0	0		1			1	1	
Rock bass	759	101	18	878	16	1.82	3		1	1	5		
Yellow perch	2227	309	86	2622	58	2.21		1	1		17	7	6
White bass	0	0	1	1	0	0							
Smallmouth bass	83	0	5	88	0	0							
Burbot	0	0	1	1	0	0							
Brown bullhead	2491	89	441	3021	29	0.96	1				5	5	1
Black bullhead	1	0	0	1	0	0							
Carp	14	2	5	21	0	0							
Goldfish	23	0	0	23	0	0							
Black crappie	31	27	0	58	5	8.62							
Walleye	0	1	1	2	0	0							
White sucker	198	7	1	206	1	0.48	1						
Gizzard shad	2	0	0	2	0	0							
Bluegill	20	15	1	36	0	0						1	
Eel	35	3	2	40	0	0							
Pickerel	1	1	0	2	0	0							
Northern pike	1	2	0	3	0	0							
Bowfin	3	4	6	13	0	0							
Redhorse sucker	11	0	1	12	0	0							
Freshwater drum	1	0	0	1	0	0							
TOTAL	8235	882	802	9919	163	—	9	3	2	4	29	14	7
% of Total Tagged	83.02	8.89	8.09	—	1.64	—							
% of Total Returned	—	—	—	—	17.05	—	1.13	0.38	0.25	0.50	3.66	1.77	0.88

TABLE 2 (Continued)

Recapture Locations: Fish Recaptured by Anglers

Species	NMP	Shore Oaks	Catfish Creek	Dempster Beach	Mexico Point	Salmon River	Port Ontario	Selkirk St. Park	South Sandy Pond	North Sandy Pond	Colwell Pond	Henderson Harbor	Unknown
Pumpkinseed	50		7	1	1	1		1		6		1	179
White perch	3									2			4
Rock bass	26		3		9	3	1	1		1		2	30
Yellow perch	69	8	4	5	6		2	1	20	40			77
White bass													
Smallmouth bass	7												9
Burbot													
Brown bullhead	24	1	12	1	24	5	23	5		5	7	1	32
Black bullhead													
Carp													
Goldfish													
Black crappie									1				0
Walleye													
White sucker	1						1	1					0
Gizzard shad													
Bluegill													1
Eel													
Pickerel													
Northern pike													
Bowfin													
Redhorse sucker													
Freshwater drum													
TOTAL	180	9	26	7	40	9	27	9	21	54	7	4	332
% of Total Tagged													
% of Total Returned	22.70	1.14	3.28	0.88	5.04	1.14	3.40	1.14	2.65	6.81	0.88	0.50	41.87

TABLE 2 (Continued)

Recapture Locations: Fish Recaptured by Anglers

Species	TOTAL	% Returned of Total Tagged	Total Tags Returned	% of Total Tagged
Pumpkinseed	256	11.70	310	14.17
White perch	12	1.71	12	1.71
Rock bass	86	9.79	102	11.62
Yellow perch	264	10.07	322	12.28
White bass	0	0	0	0
Smallmouth bass	16	18.18	16	18.18
Burbot	0	0	0	0
Brown bullhead	152	5.03	181	5.99
Black bullhead	0	0	0	--
Carp	0	0	0	--
Goldfish	0	0	0	--
Black crappie	1	1.72	6	10.34
Walleye	0	0	0	--
White sucker	4	1.94	5	2.43
Gizzard shad	0	0	0	--
Bluegill	2	5.55	2	5.55
Eel	--	--	--	--
Pickerel	--	--	--	--
Northern pike	--	--	--	--
Bowfin	--	--	--	--
Redhorse sucker	--	--	--	--
Freshwater drum	--	--	--	--
TOTAL	793	7.99	956	9.64
% of Total Tagged	7.99	--	9.64	--
% of Total Returned	100.00	--	--	--

Table 3: Summary of Fish Taggings and Returns for Years 1972-1974

Tag Returns by Year for Fish Tagged in 1972

Species	Tagged 1972	% of '72 Tags Returned in 1972	# in 1972	% Returned in 1973	# in 1973	% Returned in 1974	# in 1974	Total # Returned	Total % Returned
Pumpkinseed	481	17.88	86	5.82	28			114	23.70
White perch	58			5.17	3			3	5.17
Rock bass	70	10.00	7	4.28	3	1.43	1	11	15.71
Yellow perch	220	5.45	12	13.18	29	1.82	4	45	20.45
White bass									
Smallmouth bass	16	43.75	7	6.25	1	--	--	8	50.00
Burbot									
Brown bullhead	107			3.74	4	1.87	2	6	5.61
Black bullhead									
Carp	4								
Goldfish									
Black crappie	4								
Walleye									
White sucker	13								
Gizzard shad	2								
Bluegill	1								
Eel									
Pickerel									
Northern pike									
Bowfin									
Redhorse sucker									
Freshwater drum									
TOTAL	976	11.48	112	6.97	68	0.72	7	187	19.16

TABLE 3 (Continued)

	Tag Returns by Year for Fish Tagged in 1973							Tag Returns for Fish Tagged in 1974		
Species	Tagged 1973	% of '73 Tags Returned in 1973	# in 1973	% Returned in 1974	# in 1974	Total '73 Tags Returned	Total % '73 Tags Returned	Tagged 1974	Total # Returned	Total % Returned
Pumpkinseed	1146	11.43	131	3.23	37	168	14.66	560	28	5.00
White perch	310	0.97	3	1.61	5	8	2.58	333	1	0.30
Rock bass	369	8.94	33	6.23	23	56	15.17	439	34	7.74
Yellow perch	1089	8.81	96	7.99	87	183	16.80	1313	94	7.16
White bass								1		
Smallmouth bass	56	3.57	2	5.35	3	5	8.93	16	3	18.75
Burbot								1		
Brown bullhead	1262	3.57	45	9.03	114	159	12.60	1652	16	0.97
Black bullhead								1	0	
Carp	10							7	0	
Goldfish	23							0	0	
Black crappie	24							30	6	20.00
Walleye								2	0	
White sucker	117			3.42	4	4	3.42	76	1	1.32
Gizzard shad								0	0	
Bluegill	15							20	2	10.00
Eel	12							28	0	
Pickerel								2	0	
Northern pike	1							2	0	
Bowfin	1							12	0	
Redhorse sucker	11							1	0	
Freshwater drum	1							0	0	
TOTAL	4447	6.97	310	6.14	273	583	13.11	4496	185	4.11

TABLE 3 (Continued)

Summary of Fish Tag Returns

Species	Total Tagged 1972-1974	Total Returned 1972-1974	Total % Returned 1972-1974
Pumpkinseed	2187	310	14.17
White perch	701	12	1.71
Rock bass	878	102	11.62
Yellow perch	2622	322	12.28
White bass	1		
Smallmouth bass	88	16	18.18
Burbot	1		
Brown bullhead	3021	181	5.99
Black bullhead	1		
Carp	21		
Goldfish	23		
Black crappie	58	6	10.34
Walleye	2		
White sucker	206	5	2.43
Gizzard shad	2		
Bluegill	36	2	5.55
Eel	40		
Pickerel	2		
Northern pike	3		
Bowfin	13		
Redhorse sucker	12		
Freshwater drum	1		
TOTAL	9919	956	9.64

SAMPLE FORM LETTER SENT TO ANGLERS RETURNING FISH TAGS

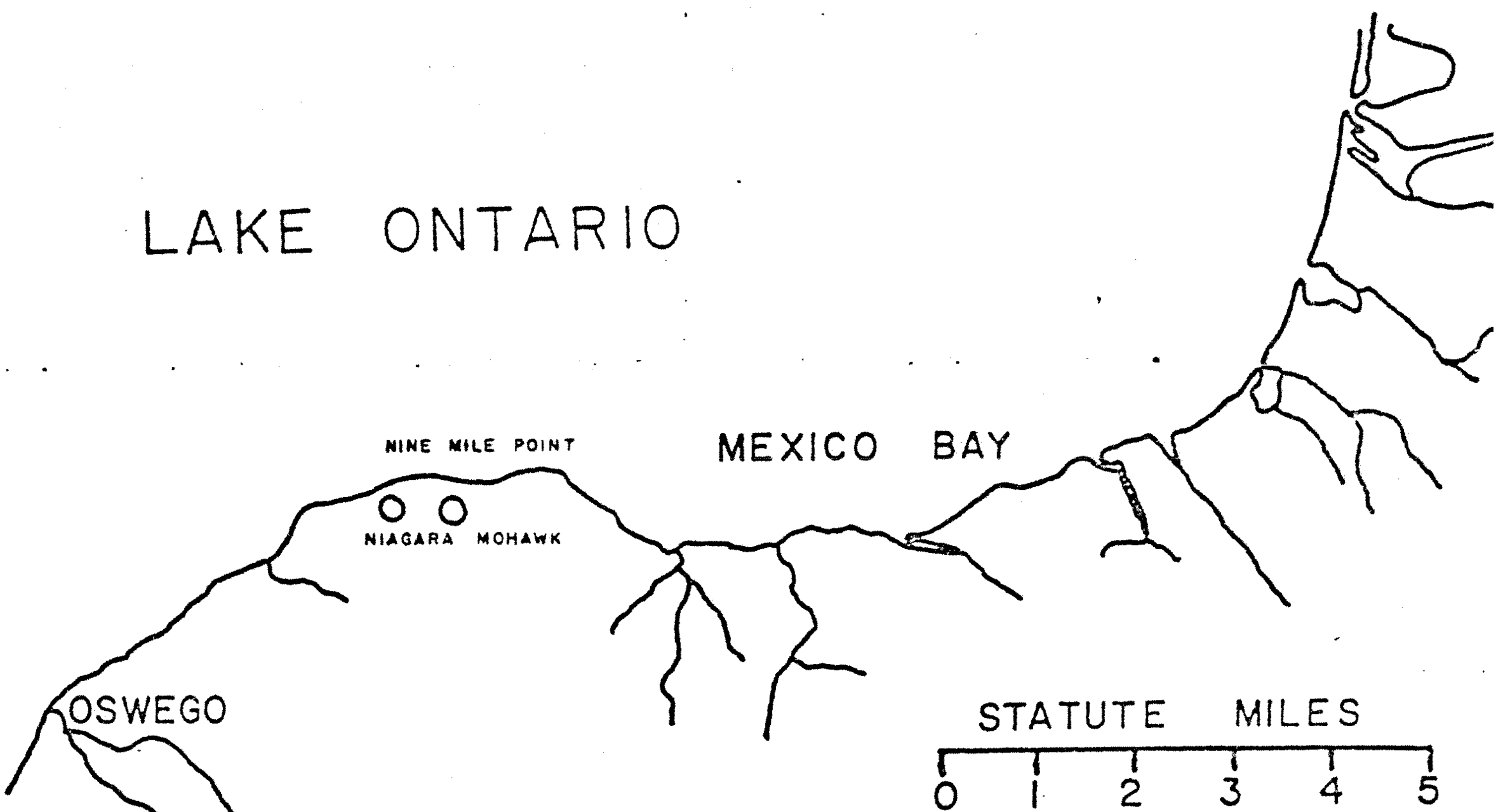
State University of New York at Buffalo

DEPARTMENT OF BIOLOGY

FACULTY OF NATURAL SCIENCES AND MATHEMATICS

To The Fish Tag Returner:

We have recently received your letter concerning the fish that you caught in Lake Ontario. The tagging program is part of a study sponsored by Niagara Mohawk Power Corporation on fish populations and their movements along the southern shore of Lake Ontario. The fish that you caught was tagged and released on ________________ at the tagging location indicated on the map below.



Thank you for your cooperation in returning the fish tag. Enclosed with this letter is your $2.00 reward for each tag. We would greatly appreciate it if you would complete and return the enclosed questionnaire. This information is vitally needed for our on-going research program.

Thank you again for your help.

Sincerely,

John F. Storr

John F. Storr, Ph.D.
Department of Biology
SUNY/B

Enc.

HEALTH SCIENCES BUILDING BUFFALO, NEW YORK 14214 TEL.(716)831-2633

SAMPLE QUESTIONNAIRE SENT TO ANGLERS RETURNING FISH TAGS

State University of New York at Buffalo

DEPARTMENT OF BIOLOGY

FACULTY OF NATURAL SCIENCES AND MATHEMATICS

Name of Tag Returner ______________________________

Fish Species ______________________________________

Tag Number _______________________________________

Please provide to the best of your memory, the information requested below, and return this questionnaire in the enclosed stamped envelope.

1) What date was the fish caught?

2) At what location was the fish caught? (Please give location as detailed as possible).

3) What time of day was the fish caught?

4) About what was the size of the fish? (length and weight)

5) Did the tag cause irritation to the fish?

6) What type of bait or lure was used?

7) Do you recall about how many fishermen were in the area that day?

8) About how many fish of each kind did you catch that day?

HEALTH SCIENCES BUILDING BUFFALO, NEW YORK 14214 TEL.(716)831-2633

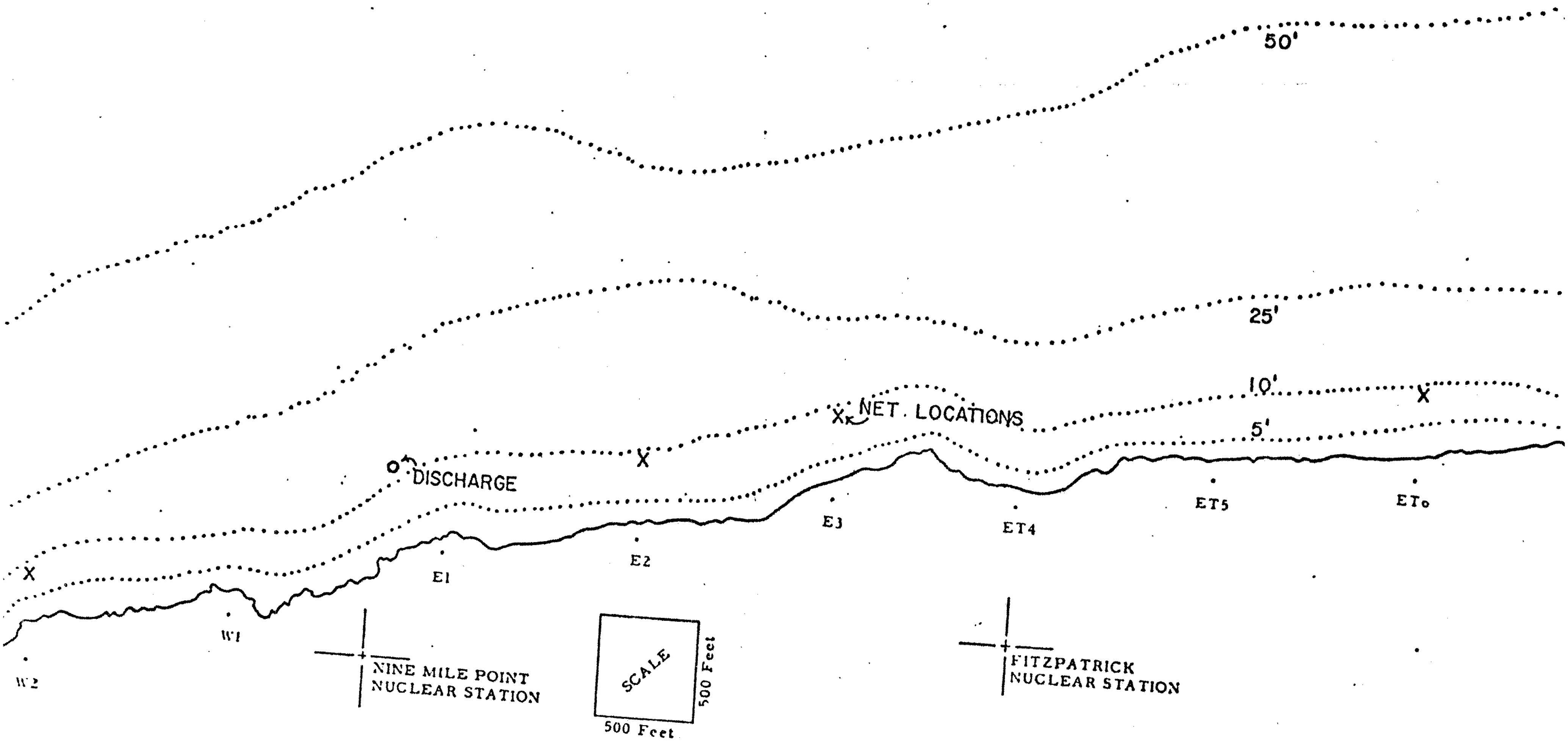
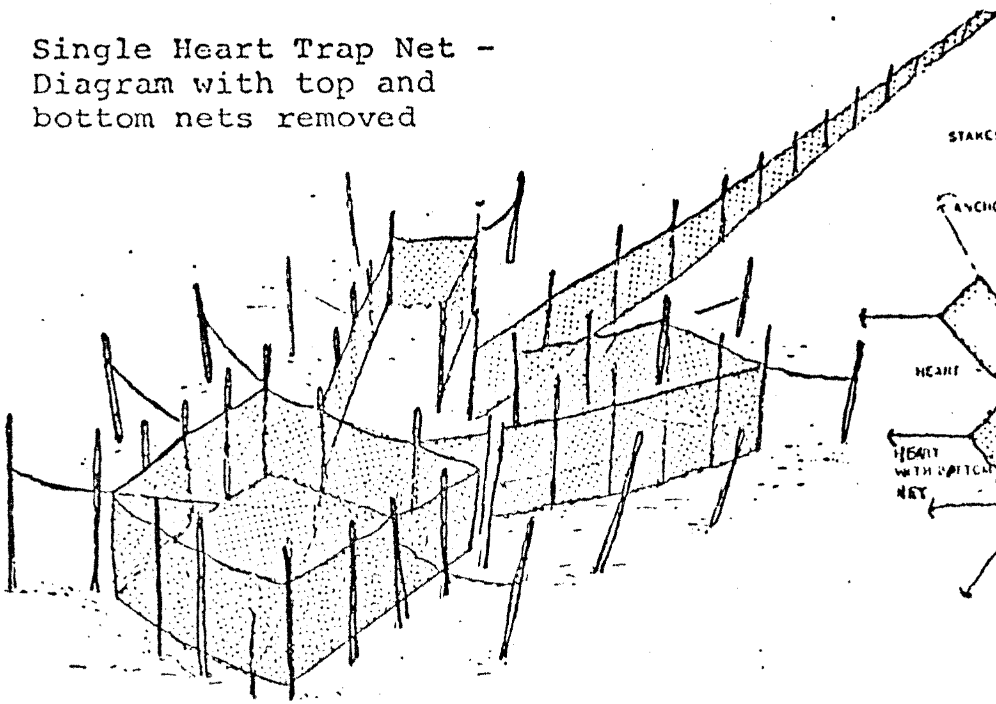
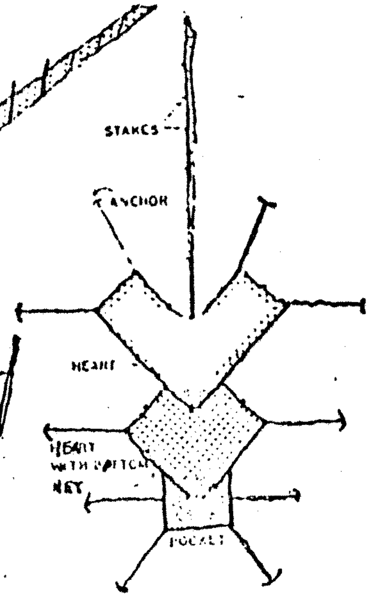

50'
25'
10'
5'
NET. LOCATIONS
DISCHARGE
W2
W1
E1
E2
E3
ET4
ET5
ETo
NINE MILE POINT
NUCLEAR STATION
SCALE
500 Feet
500 Feet
FITZPATRICK
NUCLEAR STATION

FIGURE 1

Single Heart Trap Net -
Diagram with top and
bottom nets removed

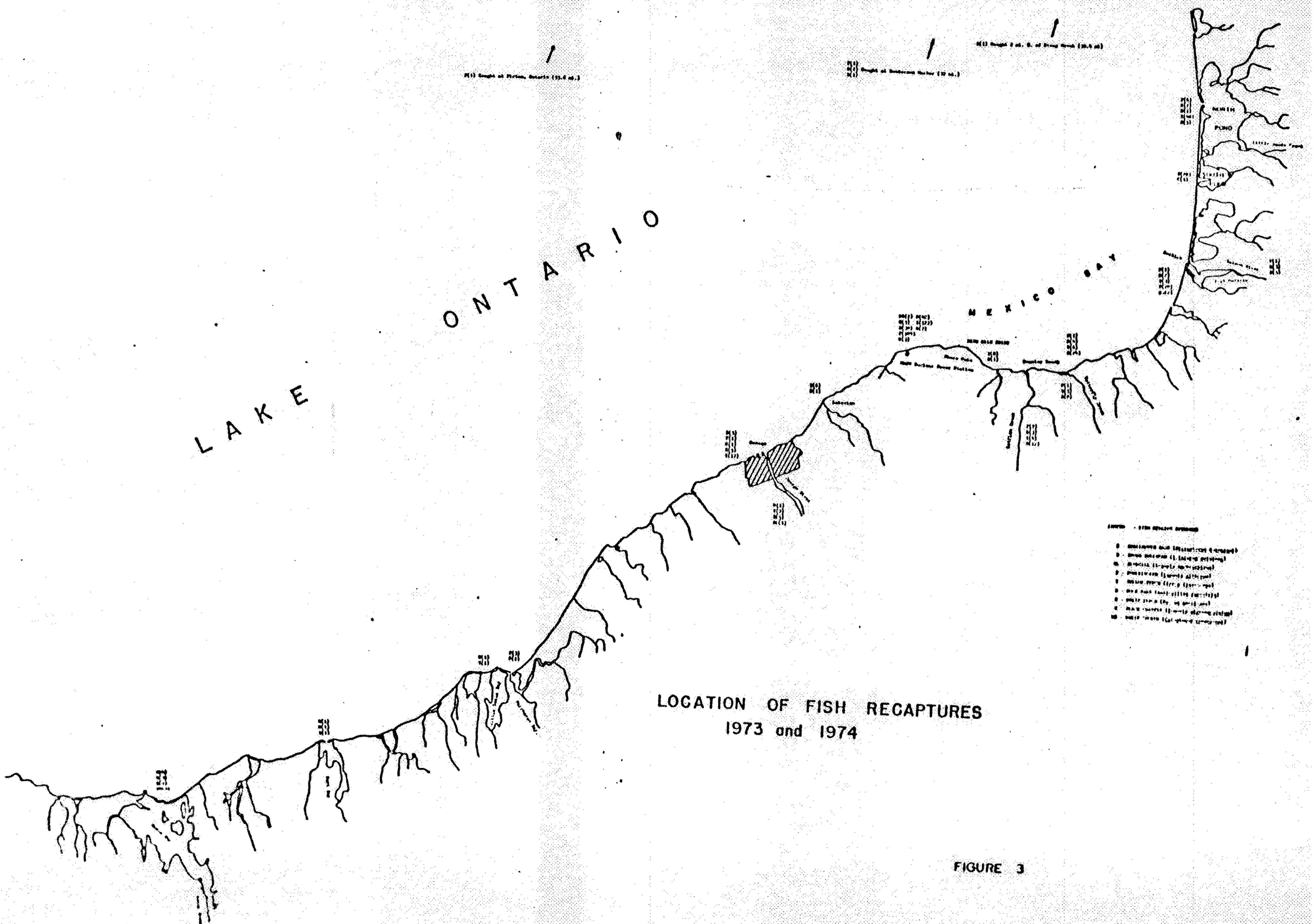




Top view of Double Heart
Trap Net

Fish Tag used in study
(actual size)

FIGURE 2



LOCATION OF FISH RECAPTURES
1973 and 1974

FIGURE 3

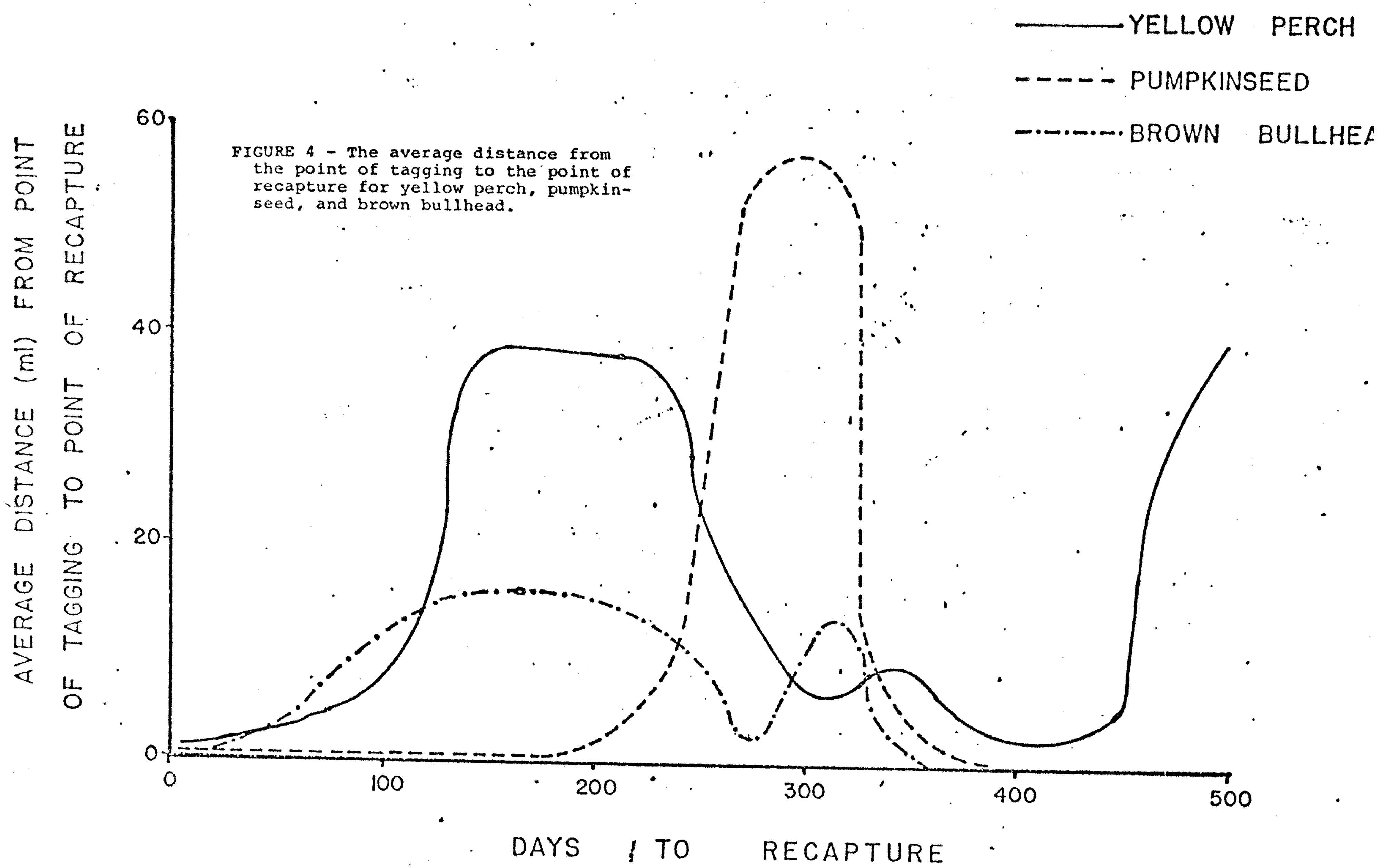


FIGURE 4 - The average distance from the point of tagging to the point of recapture for yellow perch, pumpkinseed, and brown bullhead.

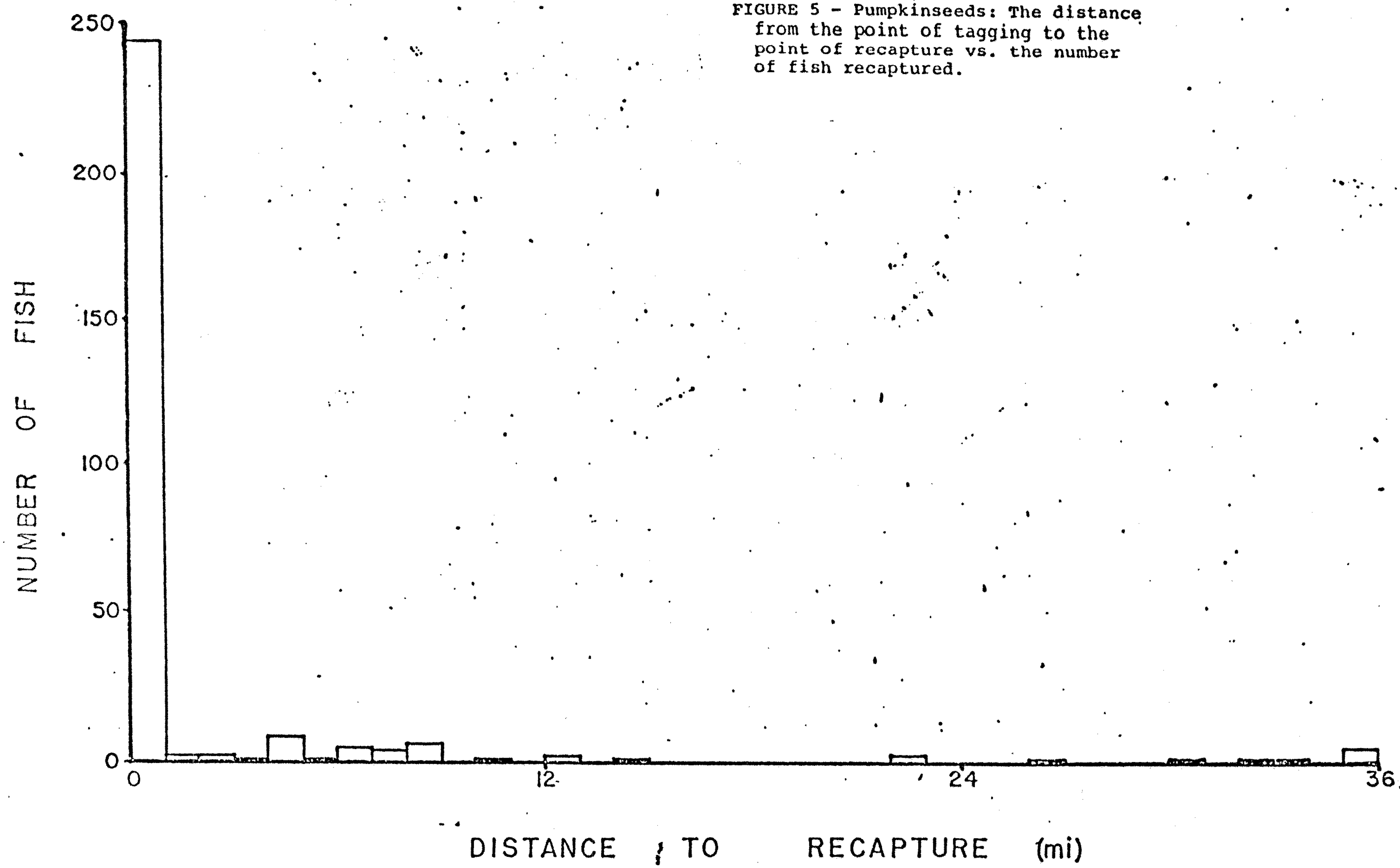
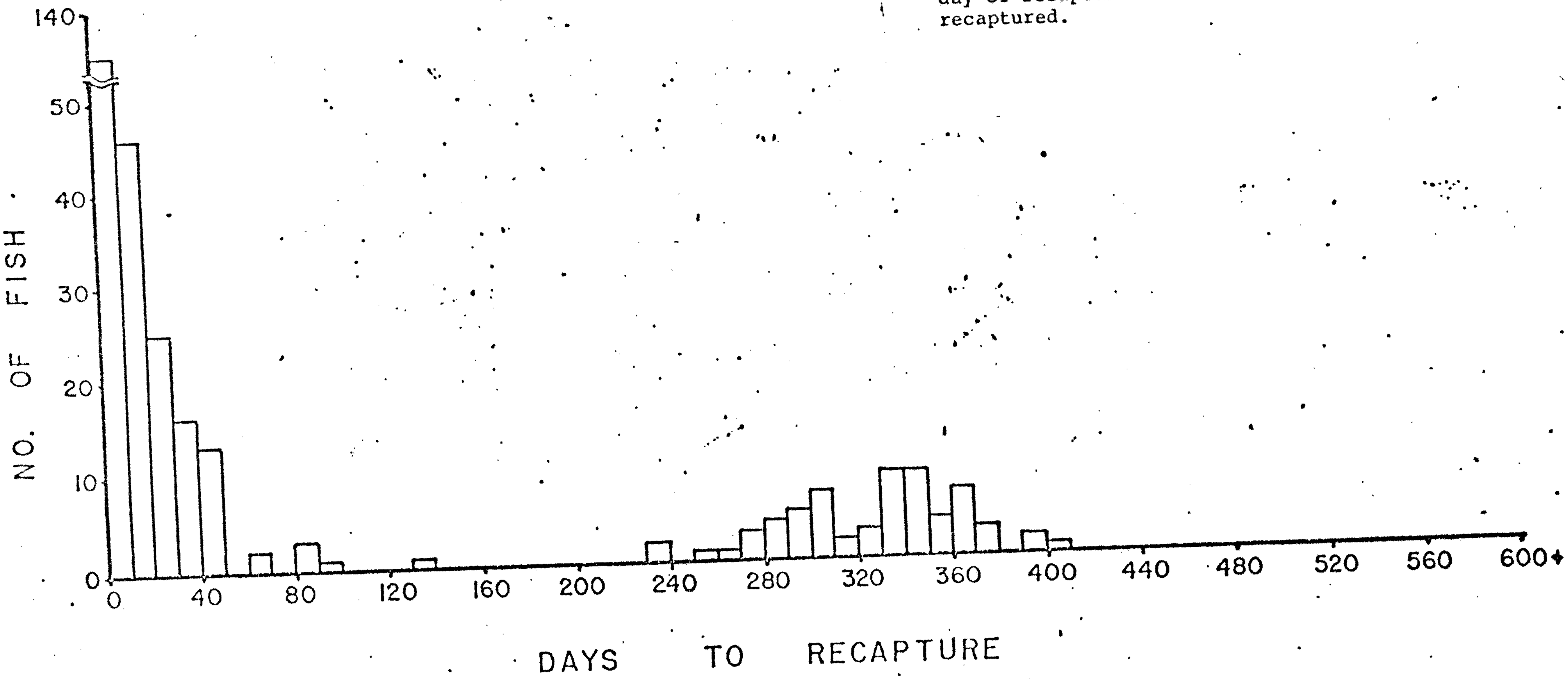


FIGURE 5 - Pumpkinseeds: The distance from the point of tagging to the point of recapture vs. the number of fish recaptured.

FIGURE . Pu[illegible]nse[illegible] The [illegible]mber days from the day of tagging to the day of recapture vs. number of fish recaptured.



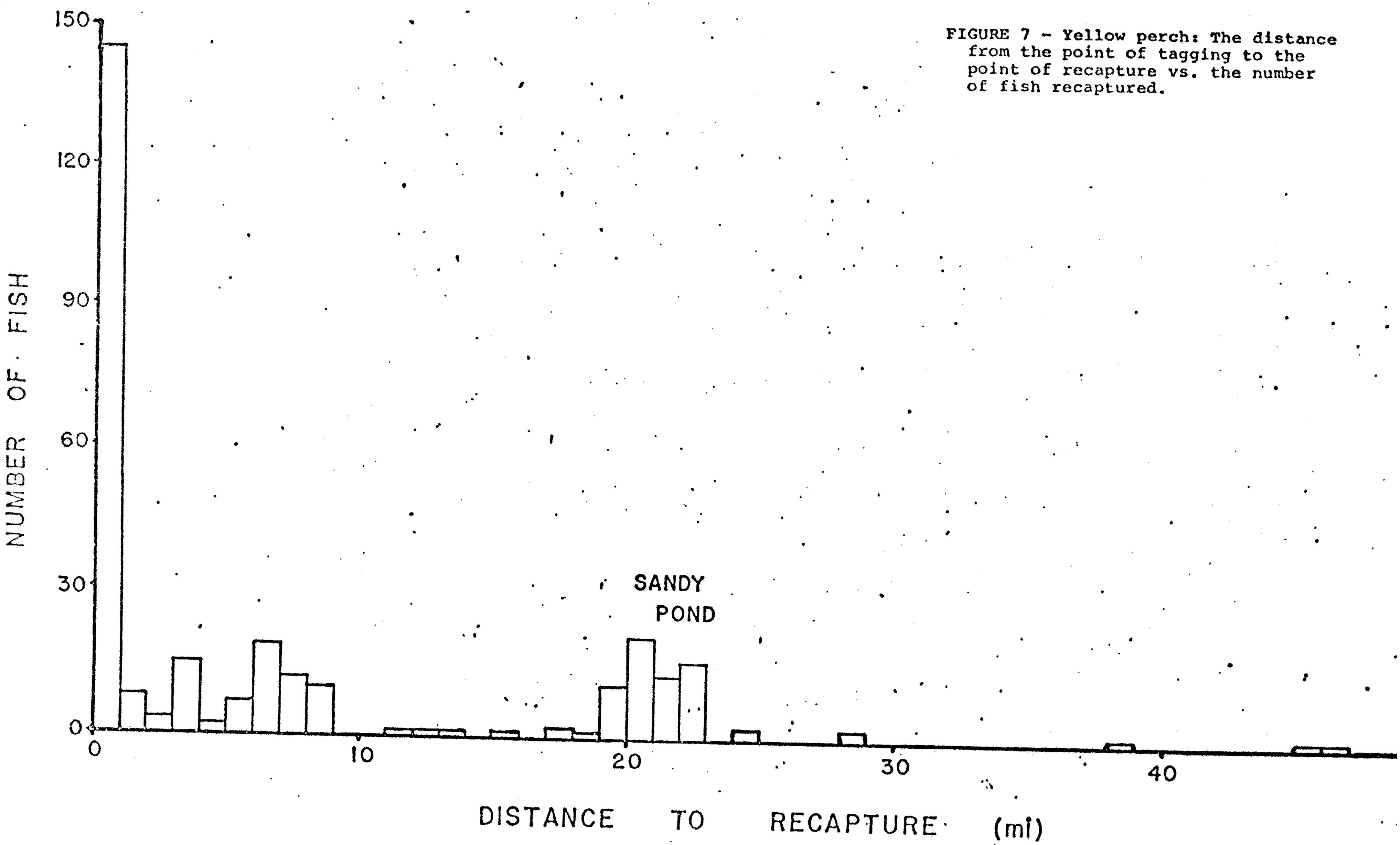


FIGURE 7 - Yellow perch: The distance from the point of tagging to the point of recapture vs. the number of fish recaptured.

FIGURE 7a - Yellow perch: The number of days from the day of tagging to the day of recapture vs. the number of fish recaptured.

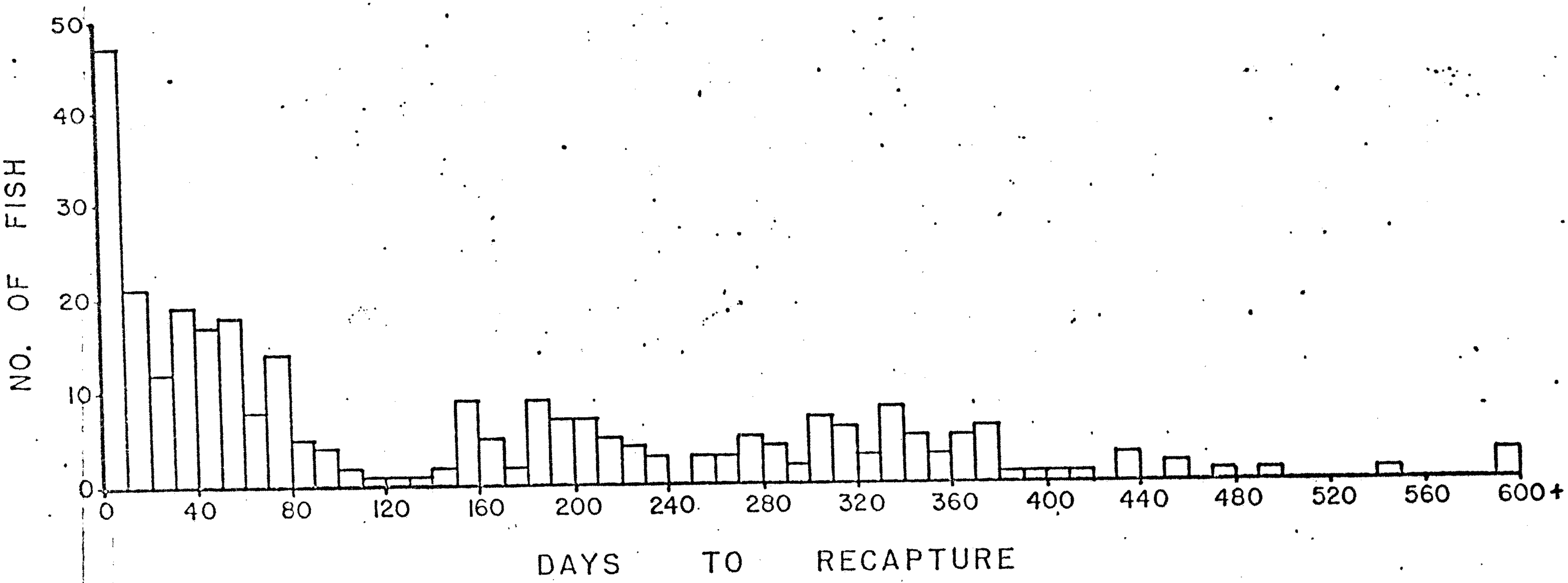
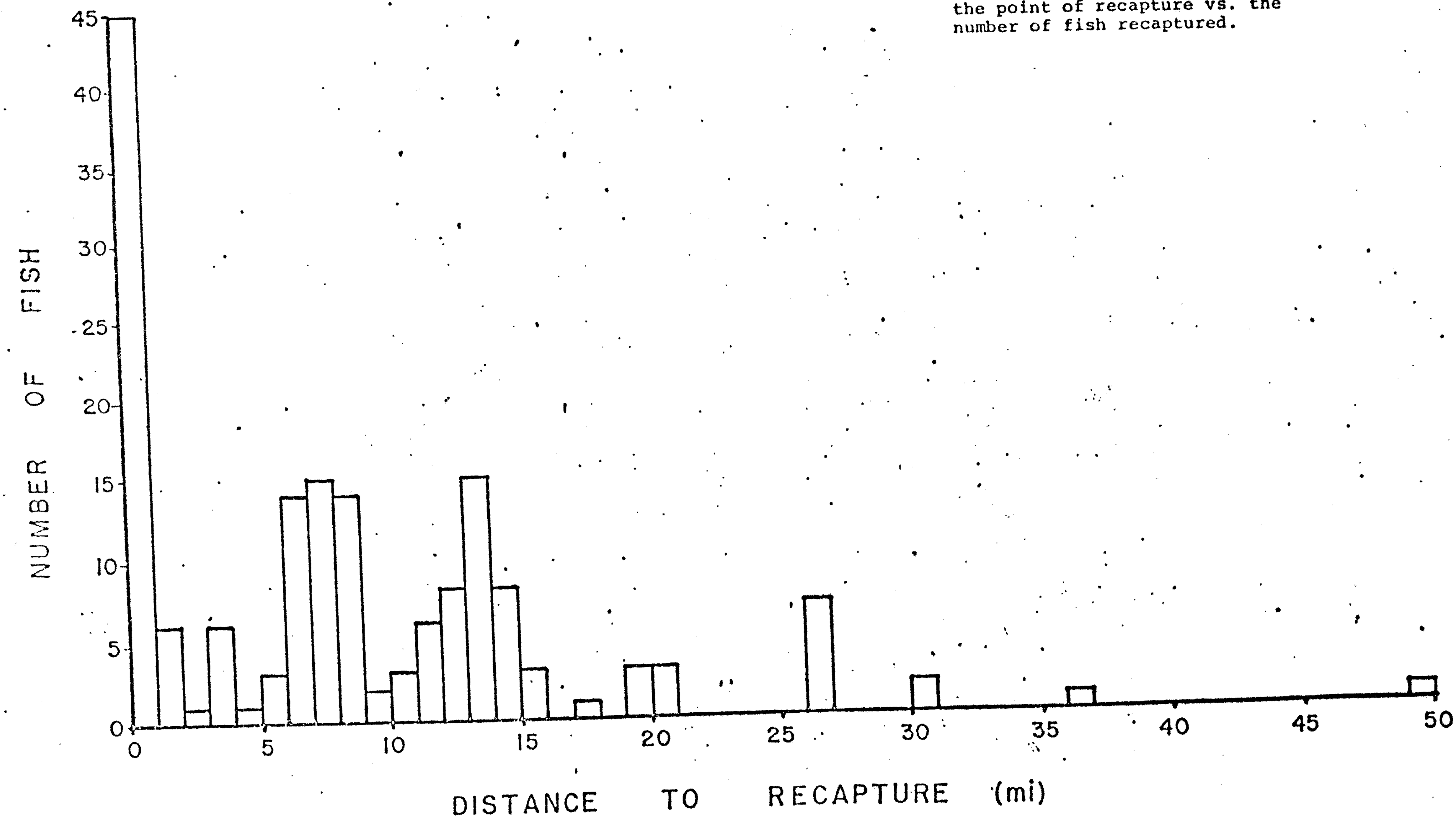


FIGURE 8 - Brown bullhead: The distance from the point of tagging to the point of recapture vs. the number of fish recaptured.



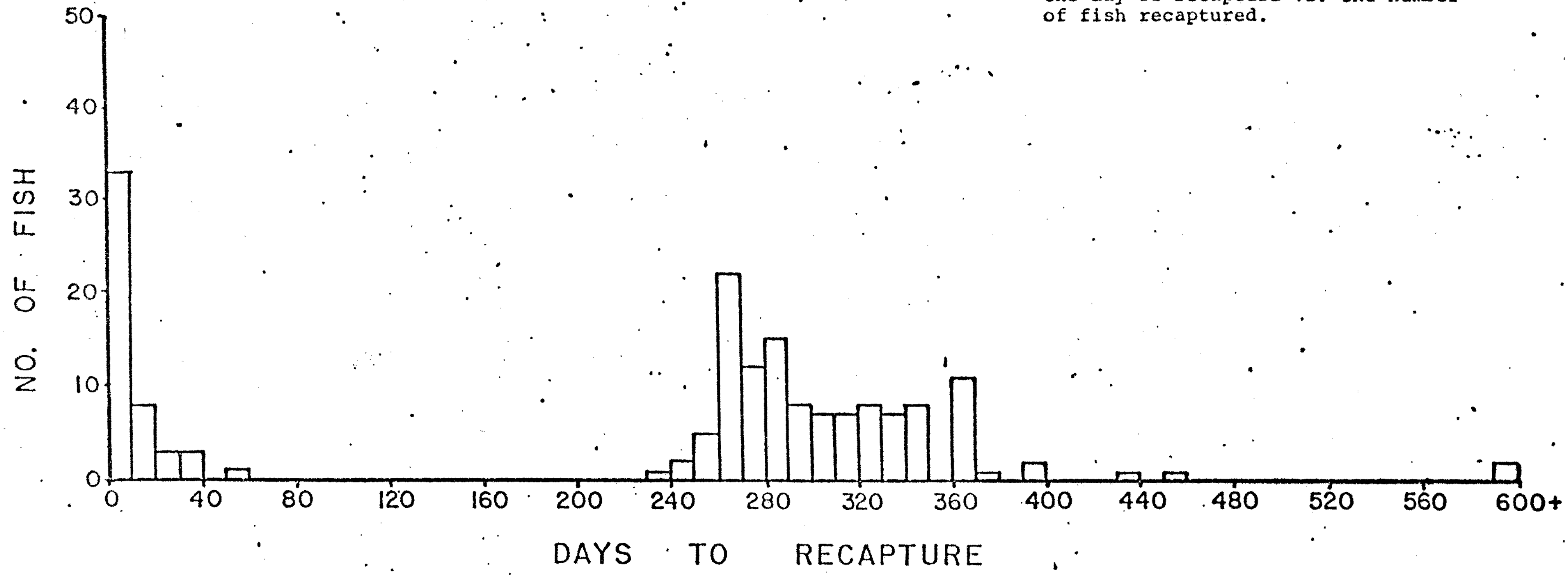


FIGURE 8a - Brown bullhead: The number of days from the day of tagging to the day of recapture vs. the number of fish recaptured.

APPENDICES

APPENDIX 1

Tagged Fish Recaptured by Anglers
Species: Yellow Perch
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00007	23.3	7/17/72	Nine Mile Pt E-1	3/26/73	252	0.0	Worm
00028	20.8	6/ 4/72	Nine Mile Pt E-1		0	W 0.5	--
00042	17.6	7/18/72	Nine Mile Pt E-1	5/30/74	681	W 6.8	--
00045	23.0	6/ 4/72	Nine Mile Pt E-1	8/ 9/73	431	0.0	--
00051	22.0	6/ 5/73	Nine Mile Pt E-1	7/ 3/73	28	0.0	Artific
00054	22.0	6/ 5/73	Nine Mile Pt E-1	6/ 6/73	1	0.0	Worm
00056	22.0	6/ 5/73	Nine Mile Pt E-1	1/22/74	231	E 19.4	Artific
00065	22.0	6/ 5/73	Nine Mile Pt E-1	7/28/73	53	0.0	Worm
00067	20.9	6/ 5/73	Nine Mile Pt E-1	8/28/73	84	E 3.0	Worm
00071	26.2	6/ 5/73	Nine Mile Pt E-3	9/23/73	110	E 20.6	Minnow
00076	18.0	7/20/72	Nine Mile Pt E-1	4/25/73	279	E 12.0	Worm
00077	23.5	6/ 5/73	Nine Mile Pt E-3	10/15/74	497	E 19.2	Minnow
00078	18.3	7/20/72	Nine Mile Pt E-1	7/25/73	370	0.0	Worm
00103	24.1	6/ 5/73	Nine Mile Pt E-3	6/23/73	18	W 0.4	Minnow
00107	16.0	6/ 5/73	Nine Mile Pt E-3	4/ 3/74	302	E 22.2	Artific
00111	19.3	6/ 5/73	Nine Mile Pt E-3	3/ 1/74	269	E 20.3	Artific
00114	19.5	7/20/72	Nine Mile Pt E-1	8/23/72	34	0.0	--
00135	18.7	6/ 5/73	Nine Mile Pt E-3	7/18/73	43	E 3.0	--
00140	26.0	6/ 5/73	Nine Mile Pt E-3	5/15/74	344	E 60.0	Artific
00142	28.7	6/ 5/73	Nine Mile Pt E-3	8/ 3/73	59	E 3.8	Worm

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00143	26.3	6/ 5/73	Nine Mile Pt E-3	7/26/73	51	E 6.6	Crustacean
00168	21.6	8/17/72	Nine Mile Pt E-1	9/20/72	34	E 0.2	--
00169	21.0	8/17/72	Nine Mile Pt E-1	8/18/72	1	0.0	--
00198	28.6	6/ 6/73	Nine Mile Pt E-3	6/30/74	389	W 7.0	Minnow
00201	21.3	5/ 6/73	Nine Mile Pt E-1	8/19/74	470	E 8.0	Worm
00202	25.2	6/ 6/73	Nine Mile Pt E-3	6/30/73	24	W 0.4	--
00210	28.0	8/17/72	Nine Mile Pt E-1	6/ 2/73	289		--
00211	24.7	8/17/72	Nine Mile Pt E-1	1/23/73	159	E 21.0	Minnow
00214	18.0	8/17/72	Nine Mile Pt E-1	9/24/72	38	0.0	--
00227	17.0	6/ 6/73	Nine Mile Pt E-1	8/ 7/73	62	0.0	Worm
00228	22.6	5/ 6/73	Nine Mile Pt E-1	7/10/74	430	E 0.2	--
00235	21.8	6/ 6/73	Nine Mile Pt E-1	6/ 6/73	0	0.0	--
00246	19.7	6/ 6/73	Nine Mile Pt E-1	8/24/73	79	0.0	Other
00255	23.2	8/18/72	Nine Mile Pt E-1	9/23/72	36	E 0.2	--
00260	22.8	8/18/72	Nine Mile Pt E-1	5/ 3/73	258	0.0	Worm
00275	23.3	6/ 6/73	Nine Mile Pt E-2		0	W 0.6	--
00276	25.6	8/18/72	Nine Mile Pt E-1	9/29/72	42	E 0.2	--
00315	23.6	6/ 7/73	Nine Mile Pt E-6	7/17/73	40	W 0.8	Artific
00315+	23.6	6/ 7/73	Nine Mile Pt E-6	3/ 3/74	269	E 22.9	Artific
00320	23.0	6/ 7/73	Nine Mile Pt E-3	6/23/73	16	E 6.6	Worm
00337	22.8	8/20/72	Nine Mile Pt E-1	8/31/72	11	0.0	Worm

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00338	21.0	8/19/72	Nine Mile Pt E-1	2/13/74	543	E 19.2	Minnow
00352	24.2	6/ 7/73	Nine Mile Pt E-3	7/ 7/73	30	W 8.0	Worm
00357	27.2	6/ 7/73	Nine Mile Pt E-3	7/22/73	45	W 0.4	Worm
00358	19.5	6/ 7/73	Nine Mile Pt E-3	7/ 7/73	30	W 0.4	Artific
00372		8/19/72	Nine Mile Pt E-2	9/20/74	762	0.0	Worm
00375	26.6	6/ 7/73	Nine Mile Pt E-1	6/30/73	23	0.0	Worm
00378	19.0	6/ 7/73	Nine Mile Pt E-1	6/ 6/74	364	W 6.8	--
00382	23.5	6/ 7/73	Nine Mile Pt E-1	6/ 6/74	364	W 6.8	--
00389	23.3	6/ 7/73	Nine Mile Pt E-1	7/ 7/73	30	W 8.0	Worm
00390	21.0	6/ 7/73	Nine Mile Pt E-1	8/10/73	64	E 3.5	Worm
00410+	24.6	6/ 7/73	Nine Mile Pt E-1	7/15/74	403	E 5.0	--
00416	24.0	6/ 7/73	Nine Mile Pt E-1	8/17/74	436	0.0	Worm
00421	23.4	6/ 7/73	Nine Mile Pt E-1	6/22/73	15	0.0	Worm
00429	27.0	8/21/72	Nine Mile Pt E-1	8/22/73	366	0.0	Minnow
00436	19.0	6/ 8/73	Nine Mile Pt E-3	12/26/73	201	E 22.0	--
00443	19.5	6/ 8/73	Nine Mile Pt E-3	9/ 1/73	85	E 6.0	Worm
00466	24.4	6/ 8/73	Nine Mile Pt E-1	1/22/74	228	E 19.0	Artific
00473	22.5	6/ 8/73	Nine Mile Pt E-1	9/ 1/74	450	0.0	Worm
00477	17.6	6/ 8/73	Nine Mile Pt E-1	12/29/73	204	W 6.6	Minnow
00478	20.3	6/ 8/73	Nine Mile Pt E-1	10/ 7/73	121	E 3.0	Worm
00482	21.2	6/ 8/73	Nine Mile Pt E-1	5/ 4/74	330	W 21.0	Minnow

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00493	16.0	6/ 8/73	Nine Mile Pt E-1	6/ 8/73	0	0.0	--
00496	18.5	8/22/72	Nine Mile Pt E-3	2/25/73	187	E 21.0	Minnow
00505	24.5	7/22/72	Nine Mile Pt E-1	7/30/72	8	0.0	Worm
00539	23.4	8/22/73	Nine Mile Pt E-1	10/15/73	54	E 19.0	Minnow
00542	19.5	8/20/72	Nine Mile Pt E-1	8/21/72	1	0.0	--
00543	17.3	8/22/72	Nine Mile Pt E-1	2/ 3/73	165	E 21.0	--
00544	21.5	6/ 8/73	Nine Mile Pt E-2		0	E 20.0	Minnow
00550	22.0	8/22/72	Nine Mile Pt E-1	1/23/73	154	E 21.0	Minnow
00579	22.5	8/22/73	Nine Mile Pt E-2	4/ 9/74	230	E 22.0	Artific
00581	24.0	8/22/72	Nine Mile Pt E-1	8/10/73	353	0.0	Other
00654	22.6	8/22/72	Nine Mile Pt E-1	7/ 1/73	313	0.0	Worm
00661	23.3	8/22/72	Nine Mile Pt E-1	6/21/73	303	0.0	Worm
00739	15.0	7/23/72	Nine Mile Pt E-1	6/20/73	332	0.0	Worm
00750	21.8	8/23/72	Nine Mile Pt E-2	5/11/74	626	W 6.8	Worm
00854	21.7	8/25/72	Nine Mile Pt E-1	6/25/73	304	0.0	Worm
00857	18.5	8/25/72	Nine Mile Pt E-1	2/27/73	186	E 21.0	--
00860	19.3	8/25/72	Nine Mile Pt E-1	2/18/73	177	E 21.0	Artific
00912+	23.5	8/23/72	Nine Mile Pt E-1	6/ 5/73	286	0.0	Worm
00913	19.0	8/25/72	Nine Mile Pt E-1	7/ 1/73	310	0.0	Worm
00919	20.0	8/25/72	Nine Mile Pt E-1	6/20/73	299	0.0	Worm
00922	21.0	8/25/72	Nine Mile Pt E-1	1/25/73	153	E 21.0	--

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00930	23.0	8/25/72	Nine Mile Pt E-1	7/ 3/73	312	W 7.5	Worm
00932	25.0	8/25/72	Nine Mile Pt E-1	5/ 9/73	257	W 3.0	Worm
00940	25.0	8/25/72	Nine Mile Pt E-1	7/29/73	338	0.0	Worm
02036	21.2	7/17/73	Nine Mile Pt E-1	9/ 2/73	47	E 0.3	Worm
02038	28.8	7/17/73	Nine Mile Pt E-6	8/28/73	42	W 0.5	Worm
02106	27.9	7/17/73	Nine Mile Pt E-1	1/25/74	192	W 20.0	Minnow
02113	23.2	7/17/73	Nine Mile Pt E-1	7/10/74	358	W 38.0	Worm
02209	24.2	7/17/73	Nine Mile Pt W-2	12/27/73	163	E 20.4	--
02354	22.3	7/18/73	Nine Mile Pt E-3	8/14/73	27	0.0	Worm
02375	21.4	7/18/73	Nine Mile Pt E-1	2/18/74	215	E 21.4	--
02376	20.8	7/18/73	Nine Mile Pt E-1	7/18/73	0	0.0	--
02381	19.3	7/18/73	Nine Mile Pt E-1	2/17/74	214	E 20.8	Artific
02388	19.3	7/18/73	Nine Mile Pt E-1	8/19/73	32	0.0	--
02393	23.0	7/18/73	Nine Mile Pt E-1	2/ 8/74	205	E 20.1	Artific
02513	24.5	7/19/73	Nine Mile Pt E-6	8/ 5/73	17	E 3.5	Worm
02535	21.7	7/19/73	Nine Mile Pt E-3	7/22/73	3	E 3.0	--
02536	25.7	7/19/73	Nine Mile Pt E-3	5/18/74	303	W 7.1	Worm
02579	26.0	7/19/73	Nine Mile Pt E-1	9/ 1/73	44	W 28.0	Worm
02580	25.2	7/19/73	Nine Mile Pt E-1	5/21/7	306	W 7.0	Minnow
02667	18.0	7/20/73	Nine Mile Pt E-1	5/ 1/74	285	E 13.0	--
02691	16.5	7/20/73	Nine Mile Pt E-6	8/10/73	21	W 0.6	--

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
02699	18.1	7/20/73	Nine Mile Pt E-6	4/30/74	284	E 8.0	Worm
02707	17.3	7/20/73	Nine Mile Pt E-6	12/26/73	159	E 22.5	Artific
02789	24.2	7/21/73	Nine Mile Pt E-1	7/29/73	8	0.0	Worm
02807	23.0	7/21/73	Nine Mile Pt E-1	1/25/74	188	E 22.5	Artific
02808	20.0	7/21/73	Nine Mile Pt E-1	9/30/73	71	E 21.0	Minnow
02849	23.6	7/21/73	Nine Mile Pt E-3	9/ 3/73	44	E 4.6	Worm
02874	21.0	7/21/73	Nine Mile Pt E-6	8/17/74	392	E 1.0	Worm
02909	23.0	7/21/73	Nine Mile Pt E-6	2/14/74	208	E 19.1	Minnow
02912	22.0	7/22/73	Nine Mile Pt W-2	2/27/74	220	E 22.4	Artific
02913	23.0	7/22/73	Nine Mile Pt W-2	1/ 5/74	167	E 20.4	--
02914	22.0	7/22/73	Nine Mile Pt W-2	8/ 4/73	13	E 0.4	Worm
02918	20.2	7/22/73	Nine Mile Pt W-2	7/22/73	0	0.0	--
02919	18.6	7/22/73	Nine Mile Pt W-2	3/16/74	237	E 22.4	Artific
02920	18.5	7/22/73	Nine Mile Pt W-2	7/23/74	366	E 0.6	--
02926	16.5	7/22/73	Nine Mile Pt W-2	8/ 1/73	10	W 0.0	Minnow
02926+	16.5	7/22/73	Nine Mile Pt W-2	12/27/73	158	E 24.4	Minnow
02947	22.0	7/22/73	Nine Mile Pt W-2		0	E 20.4	Minnow
02952	22.0	7/22/73	Nine Mile Pt W-2	1/23/74	185	E 22.0	Artific
03027	25.8	7/22/73	Nine Mile Pt E-1	2/13/74	206	E 20.0	Minnow
03056	25.0	7/22/73	Nine Mile Pt E-3	10/21/73	91	E 20.6	--

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
03057	24.0	7/22/73	Nine Mile Pt E-3	7/22/73	0	E 3.0	--
03074	24.2	7/22/73	Nine Mile Pt E-6	5/30/74	312	W 6.8	Minnow
03099	24.9	7/23/73	Nine Mile Pt W-2	8/15/73	23	E 7.4	Worm
03103	23.0	7/23/73	Nine Mile Pt W-2	1/20/74	181	E 20.0	Artific
03104	26.8	7/23/73	Nine Mile Pt W-2	1/22/74	183	E 20.0	Artific
03147	25.5	7/23/73	Nine Mile Pt E-1	5/20/74	301	W 6.8	Minnow
03174	25.5	7/23/73	Nine Mile Pt E-3	10/ 7/73	76	E 20.6	Minnow
03175	17.6	7/23/73	Nine Mile Pt E-3	1/20/74	181	E 19.5	Artific
03176	16.8	7/23/73	Nine Mile Pt E-3	8/ 9/73	17	W 0.6	Other
03217	21.5	7/24/73	Nine Mile Pt E-3	8/ 3/73	10	0.0	Worm
03223	21.2	7/24/73	Nine Mile Pt E-3	5/25/74	305	W 7.3	Minnow
03225	17.0	7/24/73	Nine Mile Pt E-3	2/15/74	206	E 21.7	Other
03233	22.5	7/24/73	Nine Mile Pt E-3	1/ 5/74	165	E 21.5	Artific
03271	26.0	7/24/73	Nine Mile Pt E-1	4/20/74	270	E 22.0	Artific
03273	24.0	7/24/73	Nine Mile Pt E-1	5/18/74	298	W 6.8	Minnow
03453	21.7	7/31/73	Nine Mile Pt W-2	8/23/73	23	E 0.6	--
03457	20.7	7/31/73	Nine Mile Pt W-2	12/26/73	148	E 20.4	Minnow
03463+	22.8	7/31/73	Nine Mile Pt W-2	3/16/74	228	E 22.4	--
03469	23.3	7/31/73	Nine Mile Pt W-2	8/12/74	377	0.0	Worm
03474	18.5	7/31/73	Nine Mile Pt W-2	8/ 7/74	372	W 2.5	Worm

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
03516	20.5	7/31/73	Nine Mile Pt W-2	4/29/74	272	E 8.4	Worm
03581	26.0	7/31/73	Nine Mile Pt E-1	6/29/74	333	W 6.8	Minnow
03595	22.0	7/31/73	Nine Mile Pt E-1	12/29/73	151	E 22.0	--
03598	21.0	7/31/73	Nine Mile Pt E-1	1/17/74	170	E 20.0	Minnow
03721	18.2	8/ 1/73	Nine Mile Pt W-2	10/14/73	74	E 8.4	Worm
03722	22.9	8/ 1/73	Nine Mile Pt W-2	2/28/74	211	E 20.4	Artific
03763	24.0	8/ 1/73	Nine Mile Pt E-1	8/19/73	18	0.0	Worm
03771	23.0	8/ 1/73	Nine Mile Pt E-1		0	E 20.0	--
03772	18.5	8/ 1/73	Nine Mile Pt E-1	1/ 5/74	157	E 22.0	Minnow
03777	24.5	8/ 1/73	Nine Mile Pt E-1	8/10/74	374	E 6.0	Crustacean
04564	21.2	8/ 1/73	Nine Mile Pt W-2	1/15/74	167	E 17.4	Minnow
04577	17.3	8/ 1/73	Nine Mile Pt W-2		0	E 20.4	--
04585	23.7	8/ 1/73	Nine Mile Pt W-2	2/ 9/74	192	E 20.4	--
04592	19.0	8/ 1/73	Nine Mile Pt W-2	3/10/74	221	W 6.4	--
04593	16.7	8/ 1/73	Nine Mile Pt W-2	2/ 2/74	185	E 20.4	--
04595	20.9	8/ 1/73	Nine Mile Pt W-2	2/15/74	198	E 22.4	--
04597	19.5	8/ 3/73	Nine Mile Pt W-2	8/ 3/73	0	0.0	--
04598	21.8	8/ 1/73	Nine Mile Pt W-2	2/ 3/74	186	E 22.4	--
04603	19.3	8/ 1/73	Nine Mile Pt W-2	2/14/74	197	E 20.0	--
04604	19.2	8/ 1/73	Nine Mile Pt E-6	10/25/74	450	0.0	--

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
04642	23.4	8/ 1/73	Nine Mile Pt W-2	8/ 6/73	5	E 8.4	--
04755	20.2	8/ 3/73	Nine Mile Pt W-2	3/ 3/74	212	E 20.4	--
04762	23.0	8/ 3/73	Nine Mile Pt W-2	8/15/74	377	0.0	Worm
04767	23.3	8/ 3/73	Nine Mile Pt W-2	2/22/74	203	E 20.4	--
04770	22.0	8/ 3/73	Nine Mile Pt W-2	1/ 6/74	156	E 22.4	--
04803	22.2	8/ 3/73	Nine Mile Pt E-6	1/ 6/74	156	E 19.0	Artific
04816	21.8	8/ 3/73	Nine Mile Pt E-6	2/ 9/74	190	E 19.0	Artific
04832	17.8	8/ 3/73	Nine Mile Pt E-6	4/20/74	260	E 21.0	Artific
04833	22.0	8/ 3/73	Nine Mile Pt E-6	3/ 2/74	211	E 19.0	Minnow
04880	23.5	8/ 3/73	Nine Mile Pt E-3	2/ 9/74	190	E 24.0	--
04908	17.7	8/ 3/73	Nine Mile Pt E-1	2/ 9/74	190	E 20.0	--
04910	16.7	8/ 3/73	Nine Mile Pt E-1	9/21/74	414	E 0.2	--
04924	21.4	8/ 3/73	Nine Mile Pt E-1	12/27/73	146	E 11.6	Minnow
05587	23.8	9/ 5/73	Nine Mile Pt E-6	6/ 6/74	274	W 7.8	--
06093	26.4	10/13/73	Nine Mile Pt E-3	8/27/74	318	E 1.6	Crustacean
06087	20.4	10/30/73	Nine Mile Pt E-3	8/ 4/74	278	W 0.5	--
06312	25.6	5/29/74	Nine Mile Pt E-6	5/30/74	1	W 0.6	--
06313	22.6	5/29/74	Nine Mile Pt E-6	6/15/74	17	E 0.3	Artific
06314	25.2	5/29/74	Nine Mile Pt E-6		0	E 2.0	--
06350	24.4	5/30/74	Nine Mile Pt E-6		0	W 1.5	--

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
06352	23.3	5/30/74	Nine Mile Pt E-6	6/ 4/74	5	E 0.1	--
06360	25.7	5/30/74	Nine Mile Pt E-6	7/ 6/74	37	E 19.0	--
06363	23.5	5/30/74	Nine Mile Pt E-6	6/15/74	16	0.0	Worm
06363+	23.5	5/30/74	Nine Mile Pt E-6	7/15/74	46	E 7.0	--
06367	25.0	5/30/74	Nine Mile Pt E-6	8/10/74	72	E 7.0	Worm
06369	21.0	5/30/74	Nine Mile Pt E-6	5/31/74	1	W 0.6	--
06380	21.0	6/ 1/74	Nine Mile Pt E-6		0	E 47.0	Worm
06382	20.8	5/30/74	Nine Mile Pt E-6	8/22/74	84	W 2.5	Worm
06389	26.6	5/30/74	Nine Mile Pt E-6	5/31/74	1	W 0.6	--
06455	21.2	5/30/74	Nine Mile Pt E-3	9/ 6/74	99	E 3.0	Worm
06460	31.1	5/30/74	Nine Mile Pt E-3		0	W 1.1	--
06482	18.8	5/30/74	Nine Mile Pt E-3	8/ 7/74	69	W 18.8	Worm
06489	20.0	5/30/74	Nine Mile Pt E-3	9/11/74	104	E 6.6	Worm
06519	21.3	5/30/74	Nine Mile Pt E-1	6/20/74	21	0.0	Worm
06536	22.0	5/31/74	Nine Mile Pt E-3	7/11/74	41	0.0	Worm
06537	20.2	5/31/74	Nine Mile Pt E-3	9/11/74	103	E 3.2	Worm
06551	24.6	5/31/74	Nine Mile Pt E-3	7/22/74	52	W 3.0	Worm
06563	24.5	5/31/74	Nine Mile Pt E-3		0	W 0.7	--
06569	24.2	5/31/74	Nine Mile Pt E-3	6/12/74	12	E 1.0	--
06574	25.7	5/31/74	Nine Mile Pt E-3		0	W 0.9	--
06580	28.0	5/31/74	Nine Mile Pt E-3	6/ 5/74	5	E 0.6	--

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance		Bait Used
06581	28.8	5/31/74	Nine Mile Pt E-3		0	W	0.9	--
06605	20.7	5/31/74	Nine Mile Pt E-3	7/23/74	53	E	0.6	--
06622	26.7	6/ 1/74	Nine Mile Pt E-6	8/17/74	77	W	3.2	--
06623	21.6	6/ 1/74	Nine Mile Pt E-6	8/31/74	91	E	5.0	Worm
06626	21.2	6/ 1/74	Nine Mile Pt E-6	6/23/74	22	E	4.2	Artific
06652	25.5	6/ 1/74	Nine Mile Pt E-3	6/ 3/74	2	W	7.0	--
06654	25.0	6/ 1/74	Nine Mile Pt E-3	6/11/74	10	W	2.0	Worm
06675	18.0	6/ 1/74	Nine Mile Pt E-3	8/17/74	77		0.0	Worm
06694	22.7	6/ 2/74	Nine Mile Pt E-3	8/12/74	71		0.0	Worm
06696	24.7	6/ 2/74	Nine Mile Pt E-3		0	W	0.6	--
06715	19.8	6/ 2/74	Nine Mile Pt E-1	6/19/74	17	W	6.8	Worm
06720	22.7	6/ 5/74	Nine Mile Pt W-2	8/26/74	82	E	0.4	Other
06728	24.2	6/ 3/74	Nine Mile Pt E-6		0	W	1.5	--
06736	24.2	6/ 3/74	Nine Mile Pt E-6		0	W	1.5	--
06740	22.2	6/ 3/74	Nine Mile Pt E-6	7/10/74	37		0.0	Worm
06746	20.7	6/ 3/74	Nine Mile Pt E-6	7/23/74	50		0.0	Worm
06748	22.1	6/ 3/74	Nine Mile Pt E-6		0	W	1.5	--
06752	23.0	6/ 3/74	Nine Mile Pt E-6	6/ 4/74	1	W	0.6	--
06776	27.6	6/ 3/74	Nine Mile Pt E-3		0	W	0.7	--
06785	22.2	6/ 3/74	Nine Mile Pt E-3	8/13/74	71	W	28.0	Worm
06791	25.7	6/ 3/74	Nine Mile Pt E-3		0	W	0.7	--

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance		Bait Used
06793	18.3	6/ 3/74	Nine Mile Pt E-3	6/28/74	25	E	0.6	Worm
06795	22.0	6/ 3/74	Nine Mile Pt E-3	8/ 1/74	59	E	5.8	--
06801	21.7	6/ 3/74	Nine Mile Pt E-3	6/28/74	25	E	0.6	Worm
06808	17.8	6/ 3/74	Nine Mile Pt E-3	7/21/74	48	W	6.4	Worm
06830	21.8	6/ 3/74	Nine Mile Pt E-3	8/14/74	72	W	0.5	--
06831	21.0	6/ 3/74	Nine Mile Pt E-3	10/15/74	134	W	15.0	Artific
06893	24.0	6/ 4/74	Nine Mile Pt E-3	7/24/74	50	E	5.0	Artific
06901	28.5	6/ 4/74	Nine Mile Pt E-3		0	W	0.7	--
06903	22.3	6/ 4/74	Nine Mile Pt E-3		0	W	0.7	--
06906	23.5	6/ 4/74	Nine Mile Pt E-3		0	W	0.7	--
06907	26.4	6/ 4/74	Nine Mile Pt E-3	8/ 1/74	58	E	5.8	--
07002	17.5	6/ 5/74	Nine Mile Pt E-3	9/ 3/74	90		0.0	Worm
07016	22.7	6/ 5/74	Nine Mile Pt E-3		0	E	48.0	--
07020	23.2	6/ 5/74	Nine Mile Pt E-3	6/23/74	18	E	0.8	Worm
07112	22.7	6/14/74	Nine Mile Pt E-2	6/19/74	5	E	8.0	Artific
07355	24.4	6/14/74	Nine Mile Pt E-1	8/25/74	72	E	8.2	Worm
07536	22.1	6/16/74	Nine Mile Pt E-1	7/ 5/74	19	E	6.0	Worm
07568	23.3	6/16/74	Nine Mile Pt W-2	7/18/74	32	E	5.4	Worm
07699	15.8	6/28/74	Nine Mile Pt E-1	7/11/74	13	W	56.0	Crustacean
07733	23.6	6/29/74	Nine Mile Pt E-1	7/ 4/74	5	W	0.7	Worm
07768	26.0	6/30/74	Nine Mile Pt E-3	8/23/74	54	W	17.6	Worm

Tagged Fish Recaptured by Anglers
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
07841	15.8	7/ 2/74	Sandy Pond 3	8/ 4/74	33	0.0	Worm
07850	5.5	7/ 2/74	Sandy Pond 3	8/ 4/74	33	0.0	Worm
07889	15.0	7/ 2/74	Sandy Pond 2	8/20/74	49	0.0	Worm
08135	16.3	7/ 4/74	Sandy Pond 4	8/24/74	51	0.0	Worm
08224	23.7	7/ 4/74	Sandy Pond 1	8/20/74	47	0.0	Minnow
08248	24.4	7/ 4/74	Sandy Pond 1	7/21/74	17	W 5.0	Worm
08671	21.8	7/31/74	Nine Mile Pt E-6	8/13/74	13	E 1.0	Worm
08672	19.7	8/31/74	Nine Mile Pt E-6	11/ 7/74	68	W 8.3	Minnow
08734	19.8	7/ 4/74	Nine Mile Pt E-1	8/25/74	52	0.0	Worm
08909	17.5	8/ 4/74	Nine Mile Pt E-1	10/28/74	85	W 7.3	Minnow
09115	20.7	8/ 1/74	Oswego Harbor E-3	8/ 8/74	7	E 6.5	Worm
09568	19.7	8/28/74	Nine Mile Pt W-1	11/ 3/74	67	W 6.5	Minnow
09678	21.7	8/29/74	Nine Mile Pt W-1	11/ 2/74	65	W 6.5	Minnow
09744	23.3	8/30/74	Nine Mile Pt W-1		0	W 6.5	Minnow
09811	18.9	8/30/74	Nine Mile Pt E-3	11/ 8/74	70	W 7.2	Minnow
10241	18.6	10/ 1/74	Oswego Harbor E-2	10/31/74	30	W 0.2	--
10767	22.0	10/ 3/74	Oswego Harbor E-2	10/20/74	17	W 0.4	Minnow

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00083	16.2	7/20/72	Nine Mile Pt E-1	8/ 2/72	13	0.0	Worm
00083+	16.2	7/20/72	Nine Mile Pt E-1	12/ 5/72	138	0.0	Worm
00107	16.5	7/23/72	Nine Mile Pt E-1		0	E 22.0	Crustacean
00119	19.5	7/23/72	Nine Mile Pt E-1	8/22/72	30	0.0	--
00158	20.0	8/17/72	Nine Mile Pt E-1	10/ 1/72	45	W 6.6	Worm
00164+	15.5	8/17/72	Nine Mile Pt E-1	8/25/72	8	0.0	--
00175	19.0	8/17/72	Nine Mile Pt E-1	8/19/72	2	0.0	Worm
00180+	16.8	8/17/72	Nine Mile Pt E-1	8/23/72	6	0.0	--
00183	17.7	8/17/72	Nine Mile Pt E-1	8/20/72	3	0.0	Worm
00185	16.0	8/17/72	Nine Mile Pt E-1	8/18/72	1	0.0	--
00188	16.0	8/17/72	Nine Mile Pt E-1	10/ 1/72	45	0.0	Worm
00197	19.0	8/17/72	Nine Mile Pt E-1	9/14/72	28	E 4.6	Minnow
00200	15.3	8/17/72	Nine Mile Pt E-1	10/ 1/72	45	0.0	Worm
00217	20.0	8/17/72	Nine Mile Pt E-1	6/27/73	314	E 7.8	Worm
00223	18.4	8/17/72	Nine Mile Pt E-1	8/27/72	10	0.0	Worm
00253	16.8	8/17/72	Nine Mile Pt E-1	8/24/72	7	0.0	Worm
00265	18.3	8/18/72	Nine Mile Pt E-1	10/ 1/72	44	0.0	Worm
00268+	19.3	8/18/72	Nine Mile Pt E-1	7/18/73	334	0.0	Worm
00273	9.5	8/18/72	Nine Mile Pt E-1	9/ 1/72	14	0.0	Worm
00278	16.7	8/18/72	Nine Mile Pt E-1	8/19/72	1	0.0	Worm
00281	17.8	8/18/72	Nine Mile Pt E-1	8/20/72	2	E 0.2	Worm

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00283	17.5	8/18/72	Nine Mile Pt E-1	10/ 1/72	44	0.0	Worm
00297	17.3	8/19/72	Nine Mile Pt E-1	6/11/73	296		--
00313	28.0	8/19/72	Nine Mile Pt E-3	7/17/73	332	W 0.4	--
00314	14.8	8/19/72	Nine Mile Pt E-1	8/20/72	1	0.0	--
00321	19.0	8/20/72	Nine Mile Pt E-1	8/26/72	6	0.0	Worm
00322	18.6	8/20/72	Nine Mile Pt E-1	9/ 1/72	12	0.0	Worm
00330	16.5	8/19/72	Nine Mile Pt E-1	9/14/72	•26	0.0	Minnow
00345	16.0	8/19/72	Nine Mile Pt E-1	8/19/72	0	0.0	--
00346	17.5	8/19/72	Nine Mile Pt E-1	9/ 5/72	17	0.0	Worm
00350	16.0	8/19/72	Nine Mile Pt E-1	9/14/72	26	0.0	Minnow
00352	16.2	8/19/72	Nine Mile Pt E-1	10/ 1/72	43	0.0	Worm
00354	19.0	8/20/72	Nine Mile Pt E-1	8/25/73	370	0.0	--
00354+	19.0	8/20/72	Nine Mile Pt E-1	8/26/73	371	0.0	--
00359	14.5	8/19/72	Nine Mile Pt E-1	9/14/72	26	0.0	Worm
00360	15.8	8/19/72	Nine Mile Pt E-1	8/22/72	3	0.0	--
00363+	14.7	8/20/72	Nine Mile Pt E-1	8/23/73	368	0.0	--
00374	19.7	8/19/72	Nine Mile Pt E-1	9/ 1/72	13	0.0	Worm
00381	16.0	8/19/72	Nine Mile Pt E-1	9/14/72	26	0.0	Minnow
00385	13.5	8/19/72	Nine Mile Pt E-1	9/14/72	26	0.0	--
00395	17.0	8/19/72	Nine Mile Pt E-1	8/26/72	7	0.0	Minnow
00404	17.0	8/20/72	Nine Mile Pt E-1	8/22/72	2	0.0	--

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00408	17.0	8/21/72	Nine Mile Pt E-1	8/23/73	367	0.0	--
00411	16.5	8/20/72	Nine Mile Pt E-1	8/21/72	1	0.0	Worm
00412	16.5	8/20/72	Nine Mile Pt E-1	8/24/72	4	0.0	--
00415	16.0	8/20/72	Nine Mile Pt E-1	8/26/72	6	0.0	Worm
00421	15.5	8/20/72	Nine Mile Pt E-0	8/26/72	6	0.0	Worm
00431	16.7	8/20/72	Nine Mile Pt E-1	7/22/73	336	0.0	Worm
00432	16.0	8/20/72	Nine Mile Pt E-1	7/18/73	332	0.0	--
00433	15.3	8/20/72	Nine Mile Pt E-1	10/ 1/72	42	0.0	Worm
00460	18.0	8/21/72	Nine Mile Pt E-1	8/23/72	2	0.0	--
00462	15.0	8/21/72	Nine Mile Pt E-1	6/22/73	305	W 6.0	Worm
00474	18.0	8/22/72	Nine Mile Pt E-1	9/16/72	25	0.0	Worm
00487	16.3	8/22/72	Nine Mile Pt E-1	8/24/72	2	0.0	Worm
00510	20.0	8/22/72	Nine Mile Pt E-1	10/ 1/72	40	0.0	Worm
00512	15.0	8/22/72	Nine Mile Pt E-1	8/29/72	7	0.0	Worm
00515	16.0	8/22/72	Nine Mile Pt E-1	9/ 1/72	10	0.0	--
00517	16.0	8/22/72	Nine Mile Pt E-1	7/31/73	343	0.0	--
00522	13.0	8/22/72	Nine Mile Pt E-1	11/20/72	90	0.0	--
00542	19.5	8/22/72	Nine Mile Pt E-1	8/23/72	1	0.0	--
00544	19.2	8/22/72	Nine Mile Pt E-1	8/26/72	4	0.0	Minnow
00545	14.0	8/22/72	Nine Mile Pt E-1	9/ 1/72	10	0.0	Worm
00600	15.2	8/23/72	Nine Mile Pt E-1	9/30/72	38	0.0	Worm

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00604	17.5	8/23/72	Nine Mile Pt E-1	9/18/72	26	0.0	Worm
00609	14.8	8/23/72	Nine Mile Pt E-1	10/ 1/72	39	0.0	Worm
00614	17.0	8/23/72	Nine Mile Pt E-1	8/27/72	4	0.0	Worm
00615	16.3	8/23/72	Nine Mile Pt E-1	11/20/72	89	0.0	--
00621	14.3	8/23/72	Nine Mile Pt E-1	11/20/72	89	0.0	--
00622	16.0	8/23/72	Nine Mile Pt E-1	8/24/72	1	0.0	Worm
00624	14.0	8/23/72	Nine Mile Pt E-1	8/ 3/73	345	E 0.8	--
00626	24.2	8/23/72	Nine Mile Pt E-1	8/ 4/73	346	0.0	Worm
00644	18.8	8/23/72	Nine Mile Pt E-1	9/ 1/72	9	0.0	Worm
00650	15.7	6/13/73	Ginna S E-0		0	E 106.0	Worm
00664	16.5	8/23/72	Nine Mile Pt E-1	5/29/73	279	E 37.0	Worm
00666	17.0	8/23/72	Nine Mile Pt E-1	8/24/72	1	0.0	Worm
00667	17.8	8/23/72	Nine Mile Pt E-1	8/25/72	2	0.0	--
00671	19.3	6/13/73	Ginna S E-0		0	E 106.0	Worm
00672	16.5	8/23/72	Nine Mile Pt E-1	10/ 1/72	39	0.0	--
00703	15.4	8/24/72	Nine Mile Pt E-1	10/ 1/72	38	0.0	Worm
00704	20.4	8/24/72	Nine Mile Pt E-1	8/ 3/73	344	0.0	Worm
00709	19.0	8/24/72	Nine Mile Pt E-1	10/ 1/72	38	0.0	Worm
00719	15.5	8/24/72	Nine Mile Pt E-1	10/ 1/72	38	0.0	Worm
00721	14.8	8/24/72	Nine Mile Pt E-1	9/14/72	21	0.0	Worm
00728	15.0	8/24/72	Nine Mile Pt E-1	10/ 1/72	38	0.0	Worm

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00729	16.8	8/24/72	Nine Mile Pt E-1	10/ 1/72	38	0.0	--
00736	14.0	8/24/72	Nine Mile Pt E-1	8/24/72	0	0.0	Worm
00741	19.0	8/24/72	Nine Mile Pt E-1	10/ 1/72	38	0.0	Worm
00744	15.5	8/24/72	Nine Mile Pt E-1	8/ 7/73	348	0.0	--
00747	14.8	8/24/72	Nine Mile Pt E-1	9/ 1/72	8	0.0	--
00785	13.0	8/24/72	Nine Mile Pt E-1	7/18/73	328	0.0	--
00791	18.0	8/24/72	Nine Mile Pt E-1	9/25/72	32	0.0	Worm
00800	17.5	8/25/72	Nine Mile Pt E-1	9/ 5/72	11	0.0	--
00816	19.5	8/25/72	Nine Mile Pt E-1	5/30/73	278	0.0	--
00826	18.0	8/25/72	Nine Mile Pt E-1	8/31/72	6	0.0	Worm
00879	20.0	8/25/72	Nine Mile Pt E-1	9/13/72	19	E 4.2	Worm
00886	15.5	8/25/72	Nine Mile Pt E-1	7/17/73	326	W 0.4	--
00888	16.5	8/25/72	Nine Mile Pt E-1	9/ 1/72	7	0.0	Worm
02072	17.3	7/17/73	Nine Mile Pt E-3	7/19/73	2	W 0.4	Worm
02085	20.2	7/17/73	Nine Mile Pt E-3	7/18/73	1	W 0.4	--
02087	17.0	7/17/73	Nine Mile Pt E-3	9/ 2/73	47	E 6.4	Worm
02089	16.7	7/16/73	Nine Mile Pt E-3	7/20/73	4	W 0.4	--
02092	15.6	7/17/73	Nine Mile Pt E-3	7/18/73	1	W 0.4	Worm
02097	15.8	7/17/73	Nine Mile Pt E-3	8/ 1/73	15	W 0.4	--
02098	18.4	7/17/73	Nine Mile Pt E-3	7/ 2/74	350	E 8.0	--

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
02153	17.8	7/17/73	Nine Mile Pt E-1	7/26/73	9	W 2.0	Other
02160	17.5	7/17/73	Nine Mile Pt E-1	8/15/73	29	0.0	Worm
02162	18.0	7/16/73	Nine Mile Pt E-1	7/31/73	15	0.0	--
02169	17.6	7/17/73	Nine Mile Pt E-3	7/18/74	366	0.0	Worm
02171	19.3	7/17/73	Nine Mile Pt E-1	7/20/73	3	0.0	Worm
02173	19.3	7/18/73	Nine Mile Pt E-1	8/ 3/73	16	E 0.8	Worm
02177	16.5	7/16/73	Nine Mile Pt E-1	8/ 1/73	16	W 8.0	--
02178	13.5	7/17/73	Nine Mile Pt E-1	8/29/73	43	0.0	--
02181	14.6	7/16/73	Nine Mile Pt E-1	7/31/73	15	0.0	Worm
02183	14.6	7/17/73	Nine Mile Pt E-1	7/20/73	3	0.0	--
02200	20.0	7/17/73	Nine Mile Pt W-2	8/ 1/73	15	E 0.4	Worm
02203	16.6	7/16/73	Nine Mile Pt W-2	7/31/73	15	E 10.4	Worm
02204	17.5	7/17/73	Nine Mile Pt W-2	8/ 7/73	21	E 0.4	Worm
02206	16.6	7/17/73	Nine Mile Pt W-2	7/18/73	1	E 0.4	--
02212	17.1	7/17/73	Nine Mile Pt W-2	8/ 7/73	21	E 0.4	Worm
02216	16.7	7/17/73	Nine Mile Pt W-2	8/ 7/73	21	E 0.4	Worm
02221	15.2	7/17/73	Nine Mile Pt W-2	7/20/73	3	E 0.6	--
02222	18.5	7/17/73	Nine Mile Pt W-2	6/15/74	333	E 8.0	Worm
02224	18.5	7/17/73	Nine Mile Pt W-2	7/19/73	2	E 0.4	Worm
02306	17.7	7/17/73	Nine Mile Pt W-2	8/26/73	40	W 5.9	Worm
02358	17.5	7/18/73	Nine Mile Pt E-3	7/20/73	2	W 0.4	--

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
02359	17.6	7/18/73	Nine Mile Pt E-3	7/20/73	2	W 0.4	Worm
02361	17.1	7/18/73	Nine Mile Pt E-3	8/18/73	31	W 0.4	Worm
02405	16.9	7/18/73	Nine Mile Pt E-1	7/18/73	0	0.0	Worm
02428	16.4	7/18/73	Nine Mile Pt E-1	7/22/73	4	0.0	Worm
02429	17.4	7/18/73	Nine Mile Pt E-1	7/20/73	2	0.0	Worm
02442	17.3	7/18/73	Nine Mile Pt W-2	7/19/73	1	E 0.4	Worm
02450	17.4	7/18/73	Nine Mile Pt W-2	7/18/73	0	E 0.4	Worm
02456	16.5	7/18/73	Nine Mile Pt W-2	7/19/73	1	E 0.4	Worm
02465	15.3	7/18/73	Nine Mile Pt W-2	7/20/73	2	E 0.4	--
02476	19.5	7/18/73	Nine Mile Pt W-2	7/22/73	4	E 0.4	Worm
02494	17.0	7/18/73	Nine Mile Pt W-2	7/29/73	11	E 0.4	Worm
02495	19.1	7/18/73	Nine Mile Pt W-2	7/18/73	0	E 0.4	--
02501	16.3	7/17/73	Nine Mile Pt W-2	7/19/73	2	E 0.4	Worm
02505	13.5	7/18/73	Nine Mile Pt W-2	8/ 9/73	22	E 0.4	Worm
02542	17.2	7/18/73	Nine Mile Pt E-3	7/23/73	5	W 0.4	Worm
02602	18.2	7/19/73	Nine Mile Pt E-1	7/19/73	0	0.0	Worm
02603	15.0	7/19/73	Nine Mile Pt E-1	8/ 4/73	16	0.0	--
02604	18.2	7/19/73	Nine Mile Pt E-1	7/20/73	1	0.0	--
02607	15.6	7/19/73	Nine Mile Pt E-1	7/20/73	1	0.0	--
02608	15.3	7/19/73	Nine Mile Pt E-1	8/15/73	27	0.0	--

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance		Bait Used
02609	15.7	7/19/73	Nine Mile Pt E-1	7/21/73	2		0.0	--
02614	17.2	7/19/73	Nine Mile Pt E-1	7/19/73	0		0.0	Worm
02639	19.6	7/20/73	Nine Mile Pt W-2	7/22/73	2	E	0.4	Worm
02654	15.5	7/20/73	Nine Mile Pt E-1	7/22/73	2		0.0	Worm
02674	16.8	7/20/73	Nine Mile Pt E-1	7/22/73	2		0.0	Worm
02681	17.3	7/20/73	Nine Mile Pt E-3	7/22/73	2	W	0.4	Worm
02684	16.7	7/20/73	Nine Mile Pt E-3	7/20/73	0	W	0.4	--
02720	18.0	7/21/73	Nine Mile Pt W-2	7/29/73	8	E	3.9	Worm
02722	17.6	7/21/73	Nine Mile Pt W-2	7/22/73	1	E	0.4	--
02729	17.4	7/21/73	Nine Mile Pt W-2	7/22/73	1	E	0.4	--
02755	16.0	7/21/73	Nine Mile Pt W-2	7/23/73	2	E	0.4	Worm
02757	16.5	7/21/73	Nine Mile Pt W-2	8/29/73	39	E	0.4	--
02758	17.0	7/21/73	Nine Mile Pt W-2	4/28/74	281	E	12.0	Worm
02760	15.6	7/21/73	Nine Mile Pt W-2	7/23/73	2	E	0.4	--
02761	15.0	7/21/73	Nine Mile Pt W-2	7/23/73	2	E	0.4	--
02821	17.3	7/21/73	Nine Mile Pt E-1		0		0.0	Worm
02826	13.0	7/21/73	Nine Mile Pt E-1	8/18/73	28		0.0	--
02827	16.2	7/21/73	Nine Mile Pt E-1	7/22/73	1		0.0	--
02831	17.3	7/21/73	Nine Mile Pt E-1	9/ 1/73	42	E	6.0	--
02836	14.6	7/21/73	Nine Mile Pt E-1	7/28/73	7		0.0	Worm
02845	14.5	7/21/73	Nine Mile Pt E-1	8/ 8/73	18		0.0	Worm

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
02852	17.5	7/21/73	Nine Mile Pt E-3	7/26/74	370	0.0	--
02884	17.0	7/21/73	Nine Mile Pt E-6	8/19/73	29	W 0.9	Worm
02943	16.3	7/22/73	Nine Mile Pt W-2	10/18/73	88	W 33.6	Worm
03025	15.2	7/22/73	Nine Mile Pt E-1	7/22/73	0	0.0	--
03054	16.5	7/22/73	Nine Mile Pt E-1	7/22/73	0	0.0	Worm
03118	16.8	7/23/73	Nine Mile Pt W-2	8/ 2/73	10	E 0.4	Worm
03137	17.4	7/23/73	Nine Mile Pt W-2	8/ 4/73	12	E 0.4	--
03193	17.6	7/23/73	Nine Mile Pt E-3	8/15/73	23	W 0.4	--
03213	16.2	7/23/73	Nine Mile Pt E-6	6/ 1/74	313	E 12.0	Worm
03246	18.2	7/24/73	Nine Mile Pt E-3	8/ 7/73	14	W 0.4	Minnow
03247	15.5	7/24/73	Nine Mile Pt E-3	7/30/73	6	W 0.4	Minnow
03249	18.0	7/24/73	Nine Mile Pt E-3	8/22/73	29	W 0.4	Worm
03293	19.0	7/24/73	Nine Mile Pt E-1	7/28/73	4	0.0	--
03297	14.5	7/24/73	Nine Mile Pt E-1	7/31/73	7	0.0	Worm
03326	16.5	7/31/73	Nine Mile Pt E-6	8/ 1/73	1	W 0.9	Worm
03330	21.2	7/31/73	Nine Mile Pt E-1	8/ 8/73	8	0.0	Worm
03332	16.0	7/30/73	Nine Mile Pt E-6	7/30/73	0	0.0	--
03481	22.8	7/31/73	Nine Mile Pt W-2	6/ 3/ 4	0	W 20.2	--
03489+	20.0	7/31/73	Nine Mile Pt W-2	5/27/74	300	E 26.0	--
03609	17.0	7/31/73	Nine Mile Pt E-1	8/ 2/73	2	0.0	--

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
03654	21.8	7/31/73	Nine Mile Pt E-3	8/ 2/74	367	E 0.6	--
03658	19.0	7/31/73	Nine Mile Pt E-1	8/ 9/73	9		Worm
03661	18.9	7/31/73	Nine Mile Pt E-3	8/ 2/73	2	W 0.4	--
03662	17.6	7/31/73	Nine Mile Pt E-3	8/ 2/73	2	W 0.4	--
03663	17.0	7/31/73	Nine Mile Pt E-3	8/29/73	29	W 0.4	--
03664	15.8	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	W 8.4	Worm
03671	17.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	W 0.4	--
03675	18.2	7/31/73	Nine Mile Pt E-3	8/26/73	26	W 0.4	Worm
03788	18.3	8/ 1/73	Nine Mile Pt E-1	8/29/73	28		--
03808	15.4	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0	--
03810	16.4	8/ 1/73	Nine Mile Pt E-1	8/ 1/73	0	0.0	Worm
03812	12.8	8/ 1/73	Nine Mile Pt E-6	7/10/74	343	0.0	Worm
03862	15.3	8/ 1/73	Nine Mile Pt W-2	8/19/73	18	E 0.4	Worm
03863	16.0	8/ 1/73	Nine Mile Pt E-6	5/25/74	297	W 22.0	Worm
03864	16.7	8/ 1/73	Nine Mile Pt E-6	8/21/73	20	W 0.9	--
04625	17.8	8/ 1/73	Nine Mile Pt W-2	8/ 1/73	0	0.0	--
04632	16.0	8/ 1/73	Nine Mile Pt W-2	7/ 3/74	336	7.8	--
04742	17.3	8/ 1/73	Nine Mile Pt E-3	8/ 4/73	3	W 0.4	--
04744	18.2	8/ 1/73	Nine Mile Pt E-3	8/19/73	18	W 0.4	Worm
04790	18.0	8/ 3/73	Nine Mile Pt W-2	8/ 3/73	0	0.0	--
04827	14.7	8/ 4/73	Nine Mile Pt E-6	8/15/73	11	W 0.9	--

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
04855	18.2	8/ 1/73	Nine Mile Pt E-3	8/14/73	13	W 0.4	--
04887	20.7	8/ 1/73	Nine Mile Pt E-3	8/ 1/73	0	W 0.4	Worm
04890	16.7	8/ 3/73	Nine Mile Pt E-3	7/28/74	359	E 8.0	--
04895	15.1	8/ 3/73	Nine Mile Pt E-3	8/ 7/73	4	W 0.4	Worm
04935	19.3	8/ 1/73	Nine Mile Pt E-1	8/ 1/73	0	0.0	--
04936	15.6	8/ 1/73	Nine Mile Pt E-1	8/15/73	14	0.0	Worm
04938	16.0	8/ 1/73	Nine Mile Pt E-1	8/ 7/73	6	0.0	--
05085	14.4	8/ 7/73	Ginna S E-0	4/18/74	254	E 35.0	--
05157	13.7	8/ 7/73	Nine Mile Pt E-2	6/ 7/74	304	W 35.0	Worm
05259	16.2	8/ 8/73	Nine Mile Pt E-2	6/ 2/74	298	W 35.0	Worm
05293	13.0	8/ 8/73	Nine Mile Pt E-2	6/24/74	320	W 35.0	--
05472	17.5	8/ 8/73	Nine Mile Pt E-0	5/17/74	282	W 32.0	--
05543	18.0	9/ 4/73	Nine Mile Pt E-6	6/ 9/74	278	E 30.0	--
05550	16.3	9/ 5/73	Nine Mile Pt E-6	6/15/74	283		--
05565	18.3	9/ 5/73	Nine Mile Pt E-6	4/27/74	234	W 1.2	Worm
05644	15.6	9/ 5/73	Nine Mile Pt E-3	7/ 7/74	305	E 8.0	--
05655	14.7	9/ 5/73	Nine Mile Pt E-1	7/10/74	308		--
05656	18.0	9/ 5/73	Nine Mile Pt E-1	7/ 3/74	301	E 7.9	--
05662	15.0	9/ 5/73	Nine Mile Pt E-1	6/17/74	285	E 14.0	Worm
05698	19.7	9/ 5/73	Nine Mile Pt W-2	8/26/74	355	0.0	Worm

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
05699	17.0	9/ 5/73	Nine Mile Pt W-2	7/10/74	308	0.0	Worm
05738	17.3	9/ 5/73	Nine Mile Pt W-2	8/26/74	355	0.0	Worm
05748	17.4	9/ 5/73	Nine Mile Pt W-2	9/ 8/74	368	0.0	Worm
05757	18.7	9/ 5/73	Nine Mile Pt W-2	5/27/74	264	W 22.0	--
06667	15.8	6/ 1/74	Nine Mile Pt E-3	8/ 1/74	61	E 4.0	--
07392	17.2	6/14/74	Nine Mile Pt W-2	6/21/74	7	E 7.8	--
08020	14.8	7/ 3/74	Sandy Pond 4	8/12/74	40	E 2.0	Worm
08146	13.2	7/ 4/74	Sandy Pond 4	7/ 9/74	5	0.0	Worm
08339	18.3	7/ 4/74	Sandy Pond 1	7/14/74	10		Worm
08650	18.5	7/31/74	Nine Mile Pt E-1	8/ 9/74	9	0.0	--
08716	18.5	8/ 1/74	Nine Mile Pt E-3	8/ 9/74	8	0.0	--
08717	17.0	8/ 1/74	Nine Mile Pt E-3	8/13/74	12	0.0	--
08718	14.7	8/ 1/74	Nine Mile Pt E-3	10/ 9/74	69	0.0	Worm
08720	14.0	8/ 1/74	Nine Mile Pt E-3	9/ 4/74	34	0.0	Worm
08738	21.0	8/ 2/74	Nine Mile Pt E-1	8/13/74	11	0.0	Worm
08739	17.6	8/ 2/74	Nine Mile Pt E-1	8/16/74	14	0.0	Worm
08860	18.8	8/ 3/74	Nine Mile Pt E-1	8/20/74	17	0.0	--
08861	13.8	8/ 3/74	Nine Mile Pt E-1	8/26/74	23	0.0	Worm
08884	16.7	8/ 3/74	Nine Mile Pt E-6	8/15/74	12	0.0	Worm
08922	19.2	8/ 4/74	Nine Mile Pt E-6	8/14/74	10	0.0	Worm
08923	21.1	8/ 4/74	Nine Mile Pt E-6	8/ 9/74	5	0.0	Worm

Tagged Fish Recaptured by Anglers
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
09284	17.1	8/27/74	Nine Mile Pt W-1	9/ 5/74	9	0.0	Worm
09590	14.7	8/28/74	Nine Mile Pt W-1	8/31/74	3	0.0	Worm
09684	14.6	8/29/74	Nine Mile Pt W-1	8/30/74	1	0.0	Worm
09797	16.4	8/30/74	Nine Mile Pt E-1	8/31/74	1	0.0	--
09819	16.5	8/30/74	Nine Mile Pt E-3	9/ 2/74	3	0.0	Worm
09884	15.9	8/31/74	Nine Mile Pt W-1	9/ 9/74	9	0.0	Worm
10314	18.6	9/ 5/74	Oswego Harbor E-3	9/15/74	10	0.0	--
10319	14.5	9/ 5/74	Oswego Harbor E-3	10/ 9/74	34	E 6.3	Worm

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00246	24.8	8/17/72	Nine Mile Pt E-1	4/22/74	613	E 36.0	--
00292	38.5	8/19/72	Nine Mile Pt E-2	4/19/74	608	E 10.0	Worm
00527	25.6	8/21/72	Nine Mile Pt E-2	8/ 1/73	345	E 0.8	Worm
00531	22.0	8/22/72	Nine Mile Pt E-1	5/ 6/73	257	E 12.0	Worm
02120	34.1	7/17/73	Nine Mile Pt E-1	7/15/74	363	E 6.0	--
02345	26.5	7/18/73	Nine Mile Pt E-6	7/18/74	365	W 1.0	Worm
02423	24.5	7/18/73	Nine Mile Pt E-1	4/27/74	283	E 15.0	Worm
02438	30.8	7/18/73	Nine Mile Pt W-2	5/20/74	306	E 20.4	--
02569	23.1	7/19/73	Nine Mile Pt E-1	4/30/74	285	0.0	Worm
02572	33.6	7/19/73	Nine Mile Pt E-1	6/11/74	327	W 7.5	Worm
02591	33.5	7/19/73	Nine Mile Pt E-1	4/12/74	267	E 20.0	Worm
02766	38.5	7/21/73	Nine Mile Pt W-2	7/29/73	8	E 14.9	--
02770	29.2	7/21/73	Nine Mile Pt W-2	6/ 1/74	315	E 15.4	Worm
02857	33.7	7/21/73	Nine Mile Pt E-6	6/25/74	339	E 6.8	--
03316	33.0	7/31/73	Nine Mile Pt E-6	9/ 8/73	39	W 7.8	Worm
03346	34.6	7/31/73	Nine Mile Pt E-6	7/15/74	349	E 5.0	--
03351	34.2	7/31/73	Nine Mile Pt E-6	5/ 4/74	277	E 8.0	--
03359	34.5	7/31/73	Nine Mile Pt E-6	6/25/74	329	E 6.4	--
03377	29.0	7/31/73	Nine Mile Pt E-6	5/29/74	302	E 7.0	--
03388	27.7	7/31/73	Nine Mile Pt E-6	4/21/74	264	E 14.0	Other
03391	33.0	7/31/73	Nine Mile Pt E-6	7/15/74	349	E 5.0	--

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
03392	30.5	7/31/73	Nine Mile Pt E-6	5/ 8/74	281	E 14.0	Worm
03398	31.6	7/31/73	Nine Mile Pt E-6	5/ 2/74	275	E 8.5	Worm
03406	30.7	7/31/73	Nine Mile Pt E-6	4/20/74	263	E 14.0	Worm
03415	33.2	7/31/73	Nine Mile Pt E-6	7/ 5/74	339	E 6.5	Worm
03430	31.7	7/31/73	Nine Mile Pt E-6	10/26/74	452	E 110.0	Worm
03433	32.0	7/31/73	Nine Mile Pt E-6	4/25/74	268	E 14.0	Worm
03441	29.3	7/31/73	Nine Mile Pt E-6	5/18/74	291	E 7.0	Worm
03507	23.7	7/31/73	Nine Mile Pt W-2	8/ 2/74	367	E 0.4	Crustacean
03524	27.0	7/31/73	Nine Mile Pt W-2	5/29/74	302	E 8.4	--
03538	23.5	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	E 0.4	Artific
03540	25.2	7/31/73	Nine Mile Pt W-2	8/ 2/74	367	E 0.6	--
03554	32.8	7/31/73	Nine Mile Pt W-2		0	W 0.1	--
03625	32.2	7/31/73	Nine Mile Pt E-3	5/18/74	291	E 11.2	Worm
03626	32.7	7/31/73	Nine Mile Pt E-3	5/28/74	301	E 20.0	--
03632	33.8	8/ 1/73	Nine Mile Pt E-3	6/27/74	330	E 17.1	--
03640	31.3	8/ 1/73	Nine Mile Pt E-3	6/21/74	324	E 7.1	--
03641	34.2	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4	Worm
03643	25.5	7/31/73	Nine Mile Pt E-3	6/ 2/74	306	W 7.8	--
03644	30.3	7/31/73	Nine Mile Pt E-3	4/29/74	272	E 14.0	Worm
03690	33.7	7/31/73	Nine Mile Pt E-3	4/22/74	265	E 12.7	Minnow
03695	33.7	7/31/73	Nine Mile Pt E-3	6/28/74	332	W 8.0	--

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
03698	35.2	7/31/73	Nine Mile Pt E-3	5/ 3/74	276	W 8.0	--
03700	32.6	7/31/73	Nine Mile Pt E-3	5/12/74	285	E 12.6	--
03715	34.2	7/31/73	Nine Mile Pt E-3	8/ 6/73	6	E 11.0	--
03758	33.2	8/ 1/73	Nine Mile Pt W-2	6/20/74	323	W 1.0	Worm
03829	34.0	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
03837	33.7	8/ 1/73	Nine Mile Pt E-6	7/12/74	345	E 3.0	Artific
03847	29.6	8/ 1/73	Nine Mile Pt E-6	6/12/74	315	E 6.5	--
03850	31.8	8/ 1/73	Nine Mile Pt E-6	4/22/74	264	E 26.0	--
03852	29.8	8/ 1/73	Nine Mile Pt E-6	5/ 3/74	275	E 14.0	Worm
03852+	29.8	8/ 1/73	Nine Mile Pt E-6	5/10/74	282	W 0.8	--
03873	34.8	8/ 1/73	Nine Mile Pt E-6	4/26/74	268	E 12.0	Worm
03879	29.3	8/ 1/73	Nine Mile Pt E-6	4/22/74	264	E 26.0	Worm
03883	29.2	8/ 1/73	Nine Mile Pt E-6	5/13/74	285	E 26.0	--
03889	29.5	8/ 1/73	Nine Mile Pt E-6	4/18/74	260	E 19.0	--
03891	31.5	8/ 1/73	Nine Mile Pt E-6	6/11/74	314	W 8.0	Other
03894	34.1	8/ 1/73	Nine Mile Pt E-6	8/24/73	23	W 0.3	--
03910	32.0	8/ 1/73	Nine Mile Pt E-6	7/ 2/74	335	E 8.0	--
03911	34.0	8/ 1/73	Nine Mile Pt E-6	4/26/74	268	E 12.0	Worm
03919	27.5	8/ 1/73	Nine Mile Pt E-6	6/25/74	328	E 6.5	--
03933	30.0	8/ 1/73	Nine Mile Pt E-6	8/ 1/74	365	E 4.0	--
03938	28.9	8/ 1/73	Nine Mile Pt E-6	7/ 7/74	340	E 8.0	--

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
03939	30.2	8/ 1/73	Nine Mile Pt E-6	4/14/74	256	E 13.0	Worm
03940	28.0	8/ 1/73	Nine Mile Pt E-6	6/ 6/74	309	E 13.0	Worm
03950	34.3	8/ 1/73	Nine Mile Pt E-6	4/28/74	270	E 13.0	Worm
03951	26.3	8/ 1/73	Nine Mile Pt E-6	4/22/74	264	E 26.0	--
03959	29.6	8/ 1/73	Nine Mile Pt E-6		0	W 29.6	--
03962	35.6	8/ 1/73	Nine Mile Pt E-6	8/ 4/73	3	W 0.9	--
03975	33.0	8/ 1/73	Nine Mile Pt E-6	5/12/74	284	E 8.5	--
03981	30.8	8/ 1/73	Nine Mile Pt E-6	5/10/74	282	E 13.0	--
03990	33.0	8/ 1/73	Nine Mile Pt E-6	6/14/74	317	E 6.5	--
03992	35.2	8/ 1/73	Nine Mile Pt E-6	8/16/73	15	E 30.4	--
03999	33.7	8/ 1/73	Nine Mile Pt E-6	8/ 1/74	365	E 5.0	--
04016	33.8	8/ 1/73	Nine Mile Pt E-6	5/29/74	301	E 8.0	--
04020	29.0	8/ 1/73	Nine Mile Pt E-6	4/27/74	269	E 15.0	Worm
04023	26.6	8/ 1/73	Nine Mile Pt E-6	5/20/74	292	W 8.0	--
04024	35.3	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04040	26.7	8/ 1/73	Nine Mile Pt E-6	6/25/74	328	E 6.5	--
04058	28.2	8/ 1/73	Nine Mile Pt E-6	6/13/74	316	E 26.0	--
04075	35.0	8/ 1/73	Nine Mile Pt E-6	4/30/74	272	E 13.0	Worm
04086	27.2	8/ 1/73	Nine Mile Pt E-6		0	E 48.0	Worm
04087	27.8	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04093	30.7	8/ 1/73	Nine Mile Pt E-6	4/28/74	270	E 7.0	Other

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
04095	28.3	8/ 1/73	Nine Mile Pt E-6	7/ 2/74	335	E 13.0	Worm
04108	36.2	8/ 1/73	Nine Mile Pt E-6	5/14/74	286	E 12.0	Worm
04119	34.6	8/ 1/73	Nine Mile Pt E-6	8/ 8/73	7	W 3.9	--
04132	35.2	8/ 1/73	Nine Mile Pt E-6	8/ 1/74	365	E 3.0	--
04140	33.6	8/ 1/73	Nine Mile Pt E-6	4/26/74	268	E 13.0	Worm
04141	34.0	8/ 1/73	Nine Mile Pt E-6	8/24/73	23	W 0.3	--
04163	32.2	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04180	34.0	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04188	29.3	8/ 1/73	Nine Mile Pt E-6	8/27/73	26	W 7.9	Worm
04196	32.0	8/ 1/73	Nine Mile Pt E-6	5/11/74	283	E 13.0	Worm
04200	29.4	8/ 1/73	Nine Mile Pt E-6	4/23/74	265	E 26.0	--
04213	39.2	8/ 1/73	Nine Mile Pt E-6	6/25/74	328	E 6.5	--
04216	31.8	8/ 1/73	Nine Mile Pt E-6	5/25/74	297	E 11.0	Worm
04222	35.7	8/ 1/73	Nine Mile Pt E-6	8/ 1/74	365	E 3.0	--
04227	26.0	8/ 1/73	Nine Mile Pt E-6	5/13/74	285	E 26.0	--
04233	0.0	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04237	26.0	8/ 1/73	Nine Mile Pt E-6	8/15/74	379	E 1.0	Worm
04240	31.0	8/ 1/73	Nine Mile Pt E-6	5/ 8/74	280	E 13.0	Worm
04245	27.8	8/ 1/73	Nine Mile Pt E-6	4/13/74	255	E 12.0	Worm
04252	29.5	8/ 1/73	Nine Mile Pt E-6	5/18/74	290	E 13.5	--
04261	31.5	8/ 1/73	Nine Mile Pt E-6	4/21/74	263	E 13.0	Worm

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
04287	26.8	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04309	33.4	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04311	32.5	8/ 1/73	Nine Mile Pt E-6	8/ 3/73	2	W 0.9	Crustacean
04316	25.4	8/ 1/73	Nine Mile Pt E-6	4/24/74	266	E 11.5	Worm
04327	30.2	8/ 1/73	Nine Mile Pt E-6	8/ 2/74	366	E 19.0	Worm
04333	34.0	8/ 1/73	Nine Mile Pt E-6		0	W 1.5	--
04355	31.7	8/ 1/73	Nine Mile Pt E-6	5/24/74	296	E 13.0	Worm
04358	28.5	8/ 1/73	Nine Mile Pt E-6	4/29/74	271	E 10.0	Worm
04363	30.6	8/ 1/73	Nine Mile Pt E-6	4/28/74	270	E 7.0	Other
04366	35.6	8/ 1/73	Nine Mile Pt E-6	6/12/74	315	E 6.8	--
04415	30.7	8/ 1/73	Nine Mile Pt E-6	8/ 3/74	367	0.0	--
04416	26.2	8/ 1/73	Nine Mile Pt E-6	5/ 5/74	277	E 3.6	--
04422	31.4	8/ 1/73	Nine Mile Pt E-6	4/20/74	262	E 3.6	Worm
04427	32.2	8/ 1/73	Nine Mile Pt E-6	4/24/74	266	E 13.0	Worm
04431	31.4	8/ 1/73	Nine Mile Pt E-6	4/27/74	269	E 30.0	Worm
04433	32.0	8/ 1/73	Nine Mile Pt E-6	5/26/74	298	E 8.0	--
04434	29.7	8/ 1/73	Nine Mile Pt E-6	4/26/74	268	E 10.0	Worm
04446	34.0	8/ 1/73	Nine Mile Pt E-6	8/ 8/73	7	W 2.0	Artific
04461	29.2	8/ 1/73	Nine Mile Pt E-6	5/10/74	282	E 7.0	Worm
04463	30.5	8/ 1/73	Nine Mile Pt E-6	5/ 5/74	277	E 8.0	--
04464	33.4	8/ 1/73	Nine Mile Pt E-6	7/ 7/74	340	E 8.0	--

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
04472	30.0	8/ 1/73	Nine Mile Pt E-6	4/23/74	265	E 13.0	Worm
04484	34.3	8/ 1/73	Nine Mile Pt E-6	8/ 7/73	6	E 14.2	--
04486	28.5	8/ 1/73	Nine Mile Pt E-6	4/20/74	262	E 19.0	Worm
04503	31.0	8/ 1/73	Nine Mile Pt E-6	5/10/74	282	E 11.0	Worm
04513	27.5	8/ 1/73	Nine Mile Pt E-6	6/25/74	328	E 6.5	--
04538	31.5	8/ 1/73	Nine Mile Pt E-6	5/11/74	283	E 9.5	Worm
04545	31.0	8/ 1/73	Nine Mile Pt E-6	6/11/74	314	E 6.5	--
04860	28.0	8/ 3/73	Nine Mile Pt E-3	8/31/74	393	W 6.4	Worm
04891	30.2	8/ 3/73	Nine Mile Pt E-6	4/18/74	258	E 12.0	Worm
05569	31.2	9/ 5/73	Nine Mile Pt E-6	4/29/74	236	E 11.0	Worm
05623	27.5	9/ 4/73	Nine Mile Pt E-3	5/20/74	258	E 7.0	Worm
05670	32.5	9/ 5/73	Nine Mile Pt E-1	6/25/74	293	E 7.5	--
05766	31.0	9/ 5/73	Nine Mile Pt W-2	5/ 4/74	241	E 9.4	--
05824	29.0	9/ 6/73	Nine Mile Pt E-6	5/12/74	248	E 13.0	--
07170	28.2	6/14/74	Nine Mile Pt E-2	7/ 3/74	19	E 7.3	--
07381	27.3	6/14/74	Nine Mile Pt W-2		0	W 0.1	--
07490	28.8	6/16/74	Nine Mile Pt E-2	6/25/74	9	E 7.1	--
08807	16.0	8/ 2/74	Nine Mile Pt E-3	9/27/74	56	0.0	Worm
09036	27.5	8/ 8/74	Oswego Harbor E-2	8/ 8/74	0	E 0.2	--
09064	18.7	8/ 8/74	Oswego Harbor W-1	8/17/74	9	W 6.9	Other

Tagged Fish Recaptured by Anglers
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
09455	20.3	8/27/74	Nine Mile Pt E-3	9/27/74	31	0.0	Worm
09668	25.0	8/29/74	Nine Mile Pt W-1	9/16/74	18	W 7.3	Worm
10066	25.0	8/31/74	Nine Mile Pt E-3	9/ 8/74	8	0.0	--
10157	19.0	8/ 3/74	Nine Mile Pt E-3	9/ 2/74	30	0.0	Worm
10503	26.8	9/ 5/74	Oswego Harbor E-3	9/16/74	11	0.0	Crustacean
10564	19.7	9/ 5/74	Oswego Harbor E-3	9/11/74	6	0.0	Worm

Tagged Fish Recaptured by Anglers
Species: White Sucker

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00601	29.2	6/12/73	Ginna S E-2	7/22/74	405	E 58.0	Worm
00733	26.0	6/13/73	Ginna S E-0	6/13/74	365	E 36.0	--
05578	30.6	9/ 5/73	Nine Mile Pt E-6	5/ 5/74	242	E 11.0	Worm
06077	42.5	10/13/73	Nine Mile Pt W-2	6/30/74	260	E 13.6	--

Tagged Fish Recaptured by Anglers
Species: Smallmouth Bass

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
00026	29.0	7/19/72	Nine Mile Pt E-1	8/14/72	26	0.0	--
00068	34.4	7/20/72	Nine Mile Pt E-1	8/ 1/72	12	0.0	Crustacean
00116	30.3	7/23/72	Nine Mile Pt E-1	8/12/72	20	0.0	Minnow
00117	30.0	7/23/72	Nine Mile Pt E-1	7/24/72	1	0.0	Worm
00141	31.2	7/23/72	Nine Mile Pt E-1	8/12/72	20	0.0	Crustacean
00142	34.0	7/23/72	Nine Mile Pt E-1	9/ 5/72	44	0.0	Worm
00521	35.3	6/ 8/73	Nine Mile Pt E-2	8/26/74	444	E 41.8	Worm
00528	35.3	6/ 8/73	Nine Mile Pt E-2	11/ 1/74	511	E 60.0	--
00625	27.5	8/22/72	Nine Mile Pt E-2	7/20/73	332	0.0	Minnow
02587	27.3	7/19/73	Nine Mile Pt E-1	7/20/74	366	W 12.0	Minnow
02620	38.7	7/20/72	Nine Mile Pt W-2	7/30/72	10	E 0.4	Worm
05620	32.3	9/ 6/73	Nine Mile Pt E-3		0	W 0.9	--
05793	31.0	9/ 6/73	Nine Mile Pt W-2		0	W 0.1	--
06606	36.8	5/31/74	Nine Mile Pt E-3	6/ 4/74	4	E 0.7	--
06961	30.3	6/ 5/74	Nine Mile Pt E-6	8/ 4/74	60	E 0.5	Minnow
08949	38.7	8/ 5/74	Nine Mile Pt E-3	8/20/74	15	W 0.4	Worm

Tagged Fish Recaptured by Anglers
Species: Black Crappie

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
08271	23.0	7/ 4/74	Sandy Pond 1	7/12/74	8	0.0	--

Tagged Fish Recaptured by Anglers
Species: Bluegill

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance	Bait Used
06278	17.0	5/24/74	Ginna S E-0	5/25/74	1		Minnow
09887	17.0	8/31/74	Nine Mile Pt W-1	9/ 2/74	2	W 6.8	Worm

APPENDIX 2

Tagged Fish Recaptured in Nets
Species: Yellow Perch
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
00011	20.3	6/ 5/73	Nine Mile Pt E-1	7/25/73	50	0.0
00052	21.8	6/ 5/74	Nine Mile Pt E-1	6/28/74	23	0.0
00054+	22.0	6/ 5/73	Nine Mile Pt E-1	7/20/73	45	0.0
00069	21.7	6/ 5/73	Nine Mile Pt E-1	6/ 5/74	365	E 0.4
00097	23.0	6/ 5/73	Nine Mile Pt E-3	8/ 1/73	57	W 0.4
00098	20.8	6/ 5/73	Nine Mile Pt E-3	7/23/73	48	0.0
00100	19.3	6/ 5/73	Nine Mile Pt E-3	8/ 9/73	65	0.0
00101	20.0	6/ 5/73	Nine Mile Pt E-3	8/ 1/73	57	W 0.8
00204	23.2	6/ 6/73	Nine Mile Pt E-3	6/ 7/73	1	W 0.4
00261	23.1	6/ 6/73	Nine Mile Pt E-2	8/24/73	79	0.0
00377	21.0	6/ 7/73	Nine Mile Pt E-1	8/24/73	78	0.0
00383	25.3	6/ 7/73	Nine Mile Pt E-1	8/ 3/73	57	W 0.4
00410	24.6	6/ 7/73	Nine Mile Pt E-1	6/ 1/74	359	E 1.0
00440	26.5	8/19/72	Nine Mile Pt E-1	8/ 1/73	347	W 0.4
00629	22.0	8/21/72	Nine Mile Pt E-1	8/ 3/73	347	E 0.8
00633	24.8	8/22/72	Nine Mile Pt E-1	7/19/73	331	0.0
00640	19.6	8/21/72	Nine Mile Pt E-1	8/ 1/73	345	E 0.8
00755	28.0	8/22/72	Nine Mile Pt E-1	7/19/73	331	0.0
00780	26.0	8/24/72	Nine Mile Pt E-1	8/26/72	2	W 1.3
00912	23.5	8/23/72	Nine Mile Pt E-1	8/25/72	2	0.0
02119	23.7	7/17/73	Nine Mile Pt E-1	7/21/73	4	0.0

Tagged Fish Recaptured in Nets
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
02382	21.4	7/19/73	Nine Mile Pt E-1	6/ 4/74	320	W 0.4
02434	23.3	7/18/73	Nine Mile Pt W-2	7/31/73	13	0.0
02480	23.7	7/18/73	Nine Mile Pt W-2	7/21/73	3	0.0
02584	23.6	7/19/73	Nine Mile Pt E-1	7/20/73	1	0.0
02661	20.8	7/20/73	Nine Mile Pt W-2	8/ 1/73	12	0.0
02663	21.0	7/20/73	Nine Mile Pt E-1	8/29/73	40	0.0
02695	17.6	7/20/73	Nine Mile Pt E-6	6/ 3/74	318	0.0
02711	26.9	7/21/73	Nine Mile Pt W-2	8/ 1/73	11	0.0
02810	21.0	7/21/73	Nine Mile Pt E-1	8/24/73	34	0.0
02811	21.2	7/21/73	Nine Mile Pt E-1	7/31/73	10	0.0
02887	16.0	7/22/73	Nine Mile Pt W-2	9/20/73	60	0.0
02901	26.5	7/22/73	Nine Mile Pt W-2	7/26/73	4	0.0
02929	17.0	7/22/73	Nine Mile Pt W-2	7/26/73	4	0.0
03039	22.0	7/22/73	Nine Mile Pt E-1	8/ 1/73	10	0.0
03039+	22.0	7/22/73	Nine Mile Pt E-1	8/29/73	38	0.0
03044	17.0	7/22/73	Nine Mile Pt E-1	6/18/74	331	0.0
03152	22.0	7/21/73	Nine Mile Pt E-1	7/24/73	3	E 0.4
03153	22.2	7/23/73	Nine Mile Pt E-1	8/24/73	32	0.0
03155	21.0	7/23/73	Nine Mile Pt E-I	8/24/73	32	0.0
03167	22.6	7/23/73	Nine Mile Pt E-3	6/30/74	342	W 0.4
03229	17.2	7/24/73	Nine Mile Pt E-3	7/31/73	7	W 0.8

Tagged Fish Recaptured in Nets
Species: Yellow Perch

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
03463	22.8	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	E 0.4
03464	23.6	7/31/73	Nine Mile Pt W-2	6/17/74	321	0.0
03582	24.5	7/31/73	Nine Mile Pt W-2	6/28/74	332	0.0
03589	22.3	7/31/73	Nine Mile Pt E-1	8/ 1/73	1	W 0.4
03590	26.7	7/31/73	Nine Mile Pt E-1	6/17/74	321	0.0
04809	22.5	8/ 3/73	Nine Mile Pt E-6	8/ 9/74	371	0.0
06307	27.0	5/29/74	Nine Mile Pt E-6	6/28/74	30	E 1.0
06429	20.6	5/30/74	Nine Mile Pt E-6	7/ 9/74	40	0.0
06457	23.0	5/30/74	Nine Mile Pt E-3	6/ 3/74	4	0.0
06463	24.0	5/30/74	Nine Mile Pt E-3	6/ 4/74	5	0.0
06849	21.5	6/ 3/74	Nine Mile Pt E-1	6/ 5/74	2	E 0.4
06951	20.8	6/ 4/74	Nine Mile Pt E-1	7/31/74	57	0.0
07777	26.8	6/30/74	Nine Mile Pt E-6	7/ 9/74	9	W 1.2
07862	15.7	7/ 2/74	Sandy Pond 3	7/ 5/74	3	0.0
08119	27.3	7/ 3/74	Sandy Pond 1	7/ 5/74	2	0.0
08694	23.6	8/ 1/74	Nine Mile Pt E-1	8/ 2/74	1	0.0

Tagged Fish Recaptured in Nets
Species: Pumpkinseed
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
00102	19.0	7/23/72	Nine Mile Pt E-1	8/31/72	39	0.0
00164	15.5	8/17/72	Nine Mile Pt E-1	8/25/72	8	0.0
00178	18.5	8/17/72	Nine Mile Pt E-1	8/ 1/73	349	W 0.4
00180	16.8	8/17/72	Nine Mile Pt E-1	8/23/72	6	0.0
00267	20.3	8/18/72	Nine Mile Pt E-1	8/20/72	2	0.0
00268	19.3	8/18/72	Nine Mile Pt E-1	8/23/72	5	0.0
00363	14.7	8/20/72	Nine Mile Pt E-1	8/23/72	3	0.0
00411+	16.5	8/20/72	Nine Mile Pt E-1	8/22/72	2	0.0
00434	14.3	8/20/72	Nine Mile Pt E-1	8/21/72	1	0.0
00434+	14.3	8/20/72	Nine Mile Pt E-1	8/23/72	3	0.0
00459	19.0	8/21/72	Nine Mile Pt E-1	7/24/73	337	W 0.4
00469	15.3	8/21/72	Nine Mile Pt E-1	6/ 8/73	291	0.0
00469+	15.3	8/21/72	Nine Mile Pt E-1	7/17/73	330	W 0.4
00487+	16.3	8/22/72	Nine Mile Pt E-1	9/ 5/72	14	0.0
00509	18.5	8/22/72	Nine Mile Pt E-1	8/ 1/73	344	E 0.4
00594	20.8	8/22/72	Nine Mile Pt E-1	8/23/72	1	0.0
00594+	20.8	8/22/72	Nine Mile Pt E-1	7/23/73	335	E 0.4
00600+	15.2	8/23/72	Nine Mile Pt E-1	8/ 1/73	343	E 0.4
00644+	18.8	8/23/72	Nine Mile Pt E-1	6/13/73	294	0.0
02051	16.4	7/17/73	Nine Mile Pt E-6	8/ 1/73	15	0.0
02155	16.3	7/17/73	Nine Mile Pt E-1	7/22/73	5	E 0.8

Tagged Fish Recaptured in Nets
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
02164	21.0	7/17/73	Nine Mile Pt E-1	7/18/73	1	W 0.4
02166	17.9	7/17/73	Nine Mile Pt E-1	7/18/73	1	0.0
02166+	17.9	7/17/73	Nine Mile Pt E-1	7/20/73	3	0.0
02180	15.3	7/17/73	Nine Mile Pt E-1	7/22/73	5	0.0
02464	18.6	7/18/73	Nine Mile Pt W-2	7/22/73	4	0.0
02464+	18.6	7/18/73	Nine Mile Pt W-2	7/31/73	13	E 0.8
02497	16.8	7/18/73	Nine Mile Pt W-2	7/21/73	3	0.0
02543	21.0	7/19/73	Nine Mile Pt E-3	7/31/73	12	0.0
02547	20.2	7/19/73	Nine Mile Pt E-3	7/20/73	1	W 0.8
02635	19.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	0.0
02723	17.9	7/21/73	Nine Mile Pt W-2	8/ 1/73	11	0.0
02834	15.3	7/21/73	Nine Mile Pt E-1	7/31/73	10	E 0.8
02957	17.8	7/22/73	Nine Mile Pt W-2	8/27/74	401	0.0
02967	20.5	7/22/73	Nine Mile Pt W-2	8/ 1/73	10	0.0
03299	16.2	7/24/73	Nine Mile Pt E-1	7/24/73	0	0.0
03327	19.0	7/17/73	Nine Mile Pt E-6	8/ 3/73	17	0.0
03382	18.2	7/31/73	Nine Mile Pt E-6	8/ 1/73	1	0.0
03489	20.0	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	0.0
03497	18.2	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	0.0
03672	17.8	7/31/73	Nine Mile Pt E-3	8/29/74	394	W 0.8
03673	17.2	7/17/73	Nine Mile Pt E-3	8/ 3/73	17	W 0.4

Tagged Fish Recaptured in Nets
Species: Pumpkinseed

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
03681	20.5	7/17/73	Nine Mile Pt E-3	8/ 3/73	17	E 0.4
03726	21.8	8/ 1/73	Nine Mile Pt W-2	8/27/74	391	0.0
03784	18.0	8/ 1/74	Nine Mile Pt E-1	8/30/74	29	E 0.4
03836	16.8	8/ 1/73	Nine Mile Pt E-6	8/ 3/73	2	0.0
04615	16.2	8/ 1/73	Nine Mile Pt W-2	8/ 3/73	2	0.0
04893	17.7	8/ 3/73	Nine Mile Pt E-3	7/31/74	362	0.0
04929	16.9	8/ 3/73	Nine Mile Pt E-1	8/ 3/73	0	0.0
05745	17.5	9/ 5/73	Nine Mile Pt W-2	9/ 1/74	361	E 0.4
06036	15.7	10/12/73	Nine Mile Pt W-2	6/ 1/74	232	E 1.0
06593	22.8	5/30/74	Nine Mile Pt E-3	6/ 3/74	4	0.0
08149	15.6	7/ 4/74	Sandy Pond 4	7/ 5/74	1	0.0
08871	17.5	8/ 3/74	Nine Mile Pt E-3	8/ 4/74	1	0.0

Tagged Fish Recaptured in Nets
Species: Brown Bullhead
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
00293	34.0	8/19/72	Nine Mile Pt E-1	7/31/73	346	E 0.8
00387	34.5	8/20/72	Nine Mile Pt E-1	7/31/73	345	W 0.4
02068	30.8	7/17/73	Nine Mile Pt E-3	8/ 1/73	15	E 0.4
02285	31.4	7/17/73	Nine Mile Pt W-2	7/31/73	14	E 1.1
02322	33.5	7/18/73	Nine Mile Pt E-6	8/ 1/73	14	0.0
02786	31.8	7/21/73	Nine Mile Pt E-1	8/ 1/73	11	E 0.4
03503	36.0	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	E 0.8
03551	30.7	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	E 1.1
03630	32.3	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03641+	34.2	7/31/73	Nine Mile Pt E-3	10/12/74	438	0.0
03642	33.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03689	32.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03701	31.6	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03704	33.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03834	32.3	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03838	35.2	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03936	29.8	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03964	29.1	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03977	31.3	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
04001	32.8	8/ 1/73	Nine Mile Pt E-6	8/31/74	395	W 0.4
04049	33.0	8/ 1/73	Nine Mile Pt E-6	8/ 3/73	2	0.0

Tagged Fish Recaptured in Nets
Species: Brown Bullhead
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
00293	34.0	8/19/72	Nine Mile Pt E-1	7/31/73	346	E 0.8
00387	34.5	8/20/72	Nine Mile Pt E-1	7/31/73	345	W 0.4
02068	30.8	7/17/73	Nine Mile Pt E-3	8/ 1/73	15	E 0.4
02285	31.4	7/17/73	Nine Mile Pt W-2	7/31/73	14	E 1.1
02322	33.5	7/18/73	Nine Mile Pt E-6	8/ 1/73	14	0.0
02786	31.8	7/21/73	Nine Mile Pt E-1	8/ 1/73	11	E 0.4
03503	36.0	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	E 0.8
03551	30.7	7/31/73	Nine Mile Pt W-2	8/ 1/73	1	E 1.1
03630	32.3	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03641+	34.2	7/31/73	Nine Mile Pt E-3	10/12/74	438	0.0
03642	33.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03689	32.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03701	31.6	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03704	33.0	7/31/73	Nine Mile Pt E-3	8/ 1/73	1	E 0.4
03834	32.3	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03838	35.2	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03936	29.8	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03964	29.1	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
03977	31.3	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	0.0
04001	32.8	8/ 1/73	Nine Mile Pt E-6	8/31/74	395	W 0.4
04049	33.0	8/ 1/73	Nine Mile Pt E-6	8/ 3/73	2	0.0

Tagged Fish Recaptured in Nets
Species: Brown Bullhead

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
04129	29.3	8/ 1/73	Nine Mile Pt E-6	8/ 1/73	0	W 0.4
04291	32.7	8/ 1/73	Nine Mile Pt E-6	7/31/74	364	W 1.0
04530	26.0	8/ 1/73	Nine Mile Pt E-6	8/ 3/73	2	0.0
05763	32.2	9/ 1/73	Nine Mile Pt W-2	7/31/74	333	E 0.4
08665	26.8	7/31/74	Nine Mile Pt E-1	8/ 2/74	2	E 0.4
09500	24.0	8/27/74	Nine Mile Pt E-3	8/30/74	3	0.0
10092	28.0	8/31/74	Nine Mile Pt E-3	9/ 2/74	2	W 0.4
10643	26.5	9/ 5/74	Oswego Harbor E-3	9/ 6/74	1	0.0

Tagged Fish Recaptured in Nets
Species: Rock Bass
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
00147	17.4	8/17/72	Nine Mile Pt E-1	8/23/73	371	0.0
02034	16.5	7/17/73	Nine Mile Pt E-6	7/23/73	6	0.0
02056	17.0	7/17/73	Nine Mile Pt E-6	8/ 1/73	15	0.0
02134	20.1	7/17/73	Nine Mile Pt E-1	8/ 1/73	15	0.0
02139	20.7	7/17/73	Nine Mile Pt E-1	8/ 3/73	17	0.0
02142	17.3	7/17/73	Nine Mile Pt E-1	7/18/73	1	0.0
02142+	17.3	7/17/73	Nine Mile Pt E-1	7/24/73	7	0.0
02149	16.5	7/18/73	Nine Mile Pt E-1	8/ 1/73	14	E 1.0
02150	17.1	7/18/73	Nine Mile Pt E-1	8/ 3/73	16	0.0
02407	19.0	7/19/73	Nine Mile Pt E-1	7/25/73	6	E 0.4
02578	20.0	7/20/73	Nine Mile Pt E-1	7/25/73	5	E 0.4
02949	16.8	7/23/73	Nine Mile Pt E-1	8/ 1/73	9	E 1.1
04797	16.3	8/ 1/73	Nine Mile Pt W-2	5/31/74	303	E 1.0
05667	16.0	9/ 5/73	Nine Mile Pt W-2	10/24/73	49	0.0
06766	16.3	6/ 3/74	Nine Mile Pt E-1	8/ 2/74	60	0.0
07917	24.8	7/ 2/74	Sandy Pond 1	7/ 5/74	3	0.0

Tagged Fish Recaptured in Nets
Species: White Sucker

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
06717	43.7	6/ 2/74	Nine Mile Pt W-2	7/ 9/74	37	0.0

Tagged Fish Recaptured in Nets
Species: Black Crappie
[+ indicates more than one recapture of that fish]

Tag Number	Length (cm)	Date Tagged	Tagging Location	Date Captured	Interval (Days)	Direction & Distance
08066	24.3	7/ 3/74	Sandy Pond 1	7/ 5/74	2	0.0
08067	28.3	7/ 3/74	Sandy Pond 1	7/ 5/74	2	0.0
08067+	28.3	7/ 3/74	Sandy Pond 1	7/ 6/74	3	0.0
08068	29.7	7/ 3/74	Sandy Pond 1	7/ 5/74	2	0.0
08069	23.7	7/ 3/74	Sandy Pond 1	7/ 5/74	2	0.0

APPENDIX D

WATER QUALITY RELATED COMMUNICATIONS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

July 1, 1976

Mr. Zakaria E. Chilazi, Manager
Thermal Power Generation
Nuclear and Fossil Projects
Power Authority of the State of New York
10 Columbus Circle
New York, N.Y. 10019

Dear Mr. Chilazi:

At the meeting of June 3, 1976 between your company and Region II personnel, several questions were raised regarding PASNY's 316(b) submission for the Fitzpatrick facility. At that time, you indicated to my staff that PASNY no longer intended to submit the "predictive" 316(b) assessment outlined to EPA in your letter of June 16, 1975. Instead, the 316(b) report would contain one year's worth of actual plant monitoring data, and would be submitted to EPA by late 1977 or early 1978. My staff was requested to inform PASNY as to whether EPA was amenable to this proposal.

In view of the current operating status of the Fitzpatrick facility, and considering that the biological program has already commenced, we believe that both EPA's and PASNY's interests can best be served at this late date by the submission of on-line monitoring data.

Regarding your request for EPA approval of PASNY's 316(b) study plan, this Region cannot approve the original July 16, 1975 proposal since it is no longer valid. We therefore request that PASNY submit to EPA for review, a study plan reflective of the change from predictive studies to on-line monitoring data. This submittal should include the following:

1) details of the biological monitoring program presently being conducted at Fitzpatrick;

2) a detailed outline of the 316(b) study report;

3) a detailed timetable for both data collection and report preparation; and

4) the proposed date for submission of the final report.

Please contact me should you have any questions regarding the above.

Thank you for your cooperation on this matter.

Yours truly,

Harvey Lunenfeld, P.B., Chief
Energy and Thermal Wastes Section
Water Facilities Branch

COPY

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019
(212) 397-6200

June 28, 1976

Mr. Peter A. A. Berle, Commissioner
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12201

Dear Mr. Berle:

Power Authority staff have reviewed your June 16, 1976 letter to Chairman FitzPatrick reporting your concern with impingement at the James A. FitzPatrick Plant during the month of May. We share your concern and have initiated certain activities to determine the significance of these losses to the Nine Mile Point area ecosystem. We would be pleased to discuss this effort to assess ecological significance with your staff and come up with a recommendation which will be responsive to this concern. We will also discuss with your staff the comments generated by them with regard to our contingency plan.

We look forward to meeting with your staff to discuss this mutual concern.

Very truly yours,

George T. Berry
General Manager

PH/co

bcc: Chairman FitzPatrick

CONCURRENCES

Peter A. A. Berle
Commissioner

STATE OF NEW YORK
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK 12233

June 16, 1976

Dear Jim:

I am writing to express my concern over the large number of dead fish collected at the James A. Fitzpatrick generating facility during the month of May. I am particularly concerned about the extraordinarily large number collected May 19-20 (101,647) and May 20-21 (464,715).

The overall ecological impact of this unnatural fish kill remains to be specifically determined. However, because of its magnitude and potential importance, I believe it necessary to take steps now to determine the effect of this type of fish kill and to take measures to prevent its reoccurrence.

My staff has recently completed its review of your contingency plan submitted to the Department some time ago. Our comments are being forwarded to your staff along with the suggestion that a technical meeting be convened in order to discuss appropriate further steps that might be taken regarding this situation. My staff is also analyzing the entire Lake Ontario picture with respect to the other operating electric power generating facilities in order to gain more thorough understanding of the situation.

I hope you share my concern in this matter and look forward to a cooperative and productive effort to arrive at an appropriate and reasonable resolution of this potentially adverse environmental situation.

Sincerely,

Peter A. A. Berle

Mr. James A. Fitzpatrick
Chairman
Power Authority of the
State of New York
10 Columbus Circle
New York, New York 10019

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Peter A. A. Berle
Commissioner

June 24, 1976

Mr. George T. Berry
General Manager and Chief Engineer
Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Dear Mr. Berry:

The Department of Environmental Conservation (DEC) has reviewed the information submitted by Mr. Chilazi on December 29, 1975, regarding plans to satisfy the conditions of the 401 Certification for the James A. Fitzpatrick Power Plant. The following responses correspond to the Power Authority's proposals of December 1975 for each of these conditions:

Condition 1

Condition 1 requires a DEC approved monitoring program. As yet, no such program has been submitted to DEC for review and approval. Such a program should have been submitted to DEC well before this date. It should be submitted for DEC review and approval as soon as possible.

Further, there is no termination date for Condition 1. Monitoring must continue daily until a change is approved by DEC. PASNY should report by letter at least monthly within 30 days of the end of the month the results of the daily fish collection data. (Impingement of other aquatic life forms, such as invertebrates, should also be reported). At a minimum, the DEC will require data on the number of fish impinged by species, an average weight/fish for each species, and a total number and weight of all fish impinged. Information such as wind conditions, temperature changes, plant operating characteristics, etc., which may be responsible for variations within the fish impingement values should also be reported in the monthly reports.

Condition 1 also requires that fish abundance data be submitted to DEC. Such data should include comparisons to other studies on Lake Ontario.

Condition 2

Condition 2 of the "401 Certification" states:

"Prior to the full operation of the plant, the applicants shall submit a report for the approval of the Department of Environmental Conservation describing a contingency plan for operations to be implemented in the event a serious fish kill, or other serious aquatic life incident, occurs as a result of the operation of this facility."

DEC staff have reviewed the Power Authority's proposed "Fish Kill Contingency Plan, James A. Fitzpatrick Nuclear Power Plant" and find it unacceptable. The proposal as submitted is nothing more than a reporting plan stating that when fish collections exceed 20,000 fish in a 24-hour period, DEC, NRC, and PASNY management will be notified. An adequate contingency plan must include the following:

1. In addition to fish kills, the contingency plan should cover other aquatic life incidents, such as impingement of a large number of invertebrates.

2. The plan should clearly define a serious fish kill and provide a basis for this definition. Accordingly, a fish collection of 20,000 fish in a 24-hour period may or may not be an appropriate action level. However, the maximum fish kill level may be too high for individual species and the contingency plan should provide action levels for individual species as well.

   A one-day actionable level should be established. This limit should be different for various species.

3. The plan should provide for specific daily activities by designated Station operating personnel in checking to ascertain if a large fish impingement is taking place. The plan should establish definite monitoring procedures to determine when a fish kill buildup has started. Specific reference to the monitoring requirements pursuant to Condition 1 of the "401 Certification" should be made.

4. The contingency plan should provide for specific actions by Station operating personnel to reduce fish impingement as well as notification of regulatory agencies. It must not provide just one or the other.

The plan should provide specific actions for designated Station operating personnel that will be initiated (e.g. reducing the number of operating circulating water pumps) at specific environmental action levels. The plan must contain specific actions which can be initiated for quick reaction in situations of excessive fish kills. The plan also should specify all the capabilities (modes of operation, etc.) the plan has for reducing impingement losses, criteria for making choices among the capabilities and the general conditions when each capability will be used.

5. The plan should provide shutdown levels. However, total immediate shutdown should be avoided during periods when cold shock might be significant. A prolonged reduction of power may be appropriate for such times.

6. The plan should clearly provide Station operating personnel procedure to seek DEC advice on actions to be taken as well as assurance that DEC employees will have access to the site.

7. The DEC Regional Supervisor for Fish and Wildlife and/or a DEC designated alternate should be notified by phone immediately when an "Environmental Incident - Fish Kill" occurs. If such an incident occurs during non-DEC working hours, the Supervisor of Fish and Wildlife and/or a DEC designated alternate should be notified at his residence. He should be notified each day until the fish impingements fall below actionable levels.

8. The plan should provide that PASNY prepare an overall report within 30 days of an environmental incident to be submitted to DEC. Such report should describe the problems encountered, the actions taken, the effectiveness of the actions, the environmental significance and any recommendations to help avoid the type of situation encountered and recommendations to improve the actions taken to mitigate the problem.

9. The plan should consider impacts due to plant operation beyond just problems associated with the cooling water intake system (e.g. fish kills due to thermal shock as a result of rapid plant shutdown).

10. The plan should establish a procedure for PASNY and DEC to seek future modifications of the plan.

Condition 3

DEC has not been afforded the opportunity to review the Power Authority's sampling procedures for the required entrainment study. These studies should include a comparison of the data gathered with other similar studies on Lake Ontario.

Condition 4

All reports should be submitted to the Director of Environmental Analysis, Office of Environmental Analysis and Permits, NYS Department of Environmental Conservation, 50 Wolf Road, Albany, New York 12233, and to the Regional Supervisor of Environmental Analysis, P.O. Box 1169, Cortland, New York 13046.

Conditions 5 and 6

The monitoring and reporting pursuant to Conditions 5 and 6 are acceptable.

Condition 7

DEC has approved only the sanitary waste treatment facility and not a waste treatment plant for chemicals and oils. Discharges for these substances must comply with all Federal effluent standards and State water quality standards.

Condition 8

The proposed surveys appear to provide a program which will allow for assessment of thermal discharge plumes. On this basis, we tentatively accept the program. However, this acceptance is subject to evaluation of the survey results.

Condition 9

The thermal survey program shall continue until DEC approves modifications to it based on the results of surveys for maximum thermal load during seasonal variations.

It is recommended that the staff of the Power Authority meet with that of DEC to discuss the proposed programs and the Department's concerns regarding them. I understand that such a meeting is being arranged.

Sincerely,

Theodore L. Hullar

Theodore L. Hullar, Ph.D.
Deputy Commissioner for
Programs and Research

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019
(212) 397-6200

April 23, 1976

Ms. Barbara Pastalov
Enforcement and Regional Counsel Division
U. S. Environmental Protection Agency
Region II
26 Federal Plaza
New York, New York 10007

Subject: James A. FitzPatrick Nuclear Power Plant
316(a) and (b) Demonstration - Permit No. NY0020109

Dear Ms. Pastalov:

On April 7, 1976 our Mr. Peter Howe discussed with you the Authority's request for a three month submittal date extension of the James A. FitzPatrick 316(a) Demonstration. You indicated that the U. S. EPA Region II needs more detailed information in support of such request than that contained in the Authority's March 2, 1976 letter to Mr. Meyer Scolnick. The requested extension will allow incorporation into the Demonstration of measured thermal plume data rather than predicted data which may be subject to change.

Granting the extension will permit one full year of thermal plume studies to be included in the Demonstration. A Type II Demonstration requires that information related to mixing zones and water quality standards be discussed. While we have undertaken extensive mathematical and hydraulic modeling of the discharge, actual plume studies are scheduled to begin this month and will also be conducted in June, late August and October. The existing October 1, 1976 deadline will not permit us to include the late August and October plume studies. Since thermal plumes are strongly dependent on ambient temperature the last two plume studies should be included in the 316(a) Demonstration. There are also a number of other variables in addition to ambient temperature, such as lake currents, which influence the thermal plume. The incorporation of thermal plume studies done under differing conditions will add greater validity to any ultimate conclusions.

CONCURRENCES (INITIAL & DATE)	[illegible] 4/23/76	[illegible]			

Ms. Barbara Pastalov
Page Two
April 23, 1976

Another benefit of extending the Demonstration concerns the time-temperature relationships of plume entrained organisms. Such relationships form an essential element of the 316(a) Type II Demonstration and time-temperature profiles calculated from plume studies rather than models should be included in the Demonstration, if at all possible.

Should you have need for any further information in support of our three month extension request, please contact Mr. Peter Howe at (212) 397-6460.

Very truly yours,

Zakaria E. Chilazi, Manager
Thermal Power Generation
Nuclear and Fossil Projects

PHH:cam

bcc: A. J. Martin
G. I. Stillman
J. Helland
P. H. Howe ←

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019

(212) 397-6200

May 26, 1976

Mr. Terence Curran, Director
Office of Environmental Analysis
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233

Dear Mr. Curran:

In our letter to you of December 29, 1975 we submitted for your review and approval a Contingency Plan for actions to be implemented in the event of a serious fish kill at the James A. FitzPatrick Nuclear Power Plant.

In view of recent fish kill exceeding 20,000 per day of alewives, a need has arisen for an approved Contingency Plan to be made available to the Site for implementation.

By this letter we are requesting that the Authority be advised of your position regarding our proposed Contingency Plan in order to formalize it for proper implementation.

Very truly yours,

Zakaria Chilazi, Manager
Thermal Power Generation
Nuclear and Fossil Projects

bcc: Messrs. A. Martin, Helland, Hultgren, Leonard, R. Smith, Toennies, Howe, Stillman

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019
(212) 397-6200

March 31, 1976

Mr. Thomas E. Quinn, Project Engineer
Acting Assistant Director
Bureau of Industrial Programs
New York State Department of Environmental Conservation
Division of Pure Waters
50 Wolf Road
Albany, New York 12201

Subject: James A. FitzPatrick Nuclear Power Plant
Hydrothermal Field Surveys

Dear Mr. Quinn:

Following our conversation March 29, 1976, the James A. FitzPatrick thermal plume survey will include temperature measurements up to a distance of 5000 feet from the stations discharge or 1°F above ambient whichever is encountered first in the survey. For the field work, ambient will be defined as the average surface temperature along transect perpendicular to shore nearest to the discharge where no dye is encountered. Dye, as you know, is being used as a tracer for the discharge and is conservative or overestimates the actual temperature increase due to the stations discharge.

Very truly yours,

Zakaria Chilazi
Manager
Thermal Power Generation
Nuclear & Fossil Projects

JH/PH/jw
cc: Mr. H. Lunenfeld - U. S. E. P. A.
bcc: C. Carter, J. Toennies, J. Helland, P. Howe

CONCURRENCES (INITIAL & DATE) | [illegible] 3/31/76 | [illegible] 3/31/76 | | |

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019
(212) 397-6200

March 25, 1976

Director of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Robert W. Reid, Branch Chief
Operating Reactors Branch #4

Subject: James A. FitzPatrick Nuclear Power Plant
Hydrothermal Field Studies
Docket No. 50-333

Dear Sir:

Confirming my telephone conversation on March 24, 1976 with your Mr. M. Fairtile, I am attaching a copy of a document describing the scope of work planned for the hydrothermal field studies to be performed for the James A. FitzPatrick Nuclear Power Plant.

In response to Mr. Fairtile's request, the standard applicable methods as mentioned in Paragraph 4.2.1 on Page 32 of the Environmental Technical Specifications consist of locating radar transmitters (transponders) on the shoreline by standard commonly used engineering surveying methods. The transects will be located using radar receivers on the boats to identify selected points on the transects.

Very truly yours,

Zakaria Chilazi
Manager
Thermal Power Generation
Nuclear & Fossil Projects

Att.
JH/jw
bcc: R. Howe, A. Martin, J. Holland

CONCURRENCES (INITIAL & DATE)

J.O.No. 11825

SCOPE OF HYDROTHERMAL FIELD SURVEYS

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

POWER AUTHORITY OF THE STATE OF NEW YORK

7.2.1 Current

7.2.2 Temperature

7.3 Surveys

7.3.1 Temperature and Dye Data

7.3.2 Background Flourescence

7.3.3 Temperature and Dye Measurements at the Screenwell

7.4 Survey Log

8.0 REPORTS

1.0 INTRODUCTION

This Scope of Work was prepared for the James A. FitzPatrick Nuclear Power Plant postoperational surveys contracted by the Power Authority of the State of New York.

Specifically, these field surveys are proposed so that data can be gathered during two separate years on Lake Ontario for the purpose of meeting environmental technical specifications.

2.0 GENERAL SCOPE OF WORK

This Scope of Work shall require the gathering of field data necessary for the determination of current speed and direction, natural water temperatures, and the surface and subsurface temperature patterns during operation of the James A. FitzPatrick Nuclear Power Plant.

Whenever the term "Engineers" is used, the term is defined as Stone & Webster Engineering Corporation. Whenever the term "Contractor" appears, the term is used to define the company contracted to perform this Scope of Work.

2.1 Conduct of Field Surveys

The surveys will be in effect for two years following the initial full power operations of the FitzPatrick Plant. At the end of this two-year study period, the results shall be evaluated and a report with appropriate recommendations as to the future of the program shall be submitted to the Atomic Energy Commision Directorate of Licensing for consideration. As required by the Environmental Technical Specifications, a minimum of four postoperational surveys must be conducted each year.

2.1.1 In Situ Station

The in situ station shall continuously measure data during each of the surveys. This station will be used to determine the existing ambient lake conditions during each survey.

The Contractor shall install a data gathering system to continuously monitor required data as discussed in detail in Section 3.0. The position of the system will be determined by the Engineers. The preliminary location is shown on the attached figure.

2.1.2 Surveys

The Contractor shall conduct surveys to gather the required data as discussed in detail in Section 4.0. All surveys shall be mad in conjunction with the data continuously monitored at the in situ station as described in Section 2.1.1 above. Each survey shall consist of five runs a day for two days. Each run shall consist of simultaneous temperature and dye measurements along each of the transects and at each of the vertical profiling stations. Each run should be completed in 1 to 1 1/2 hours.

2.2 Contractor Responsibility

The Contractor shall supply all personnel, expenses, insurance, boats, vehicles, equipment, instruments, services, facilities, power, consumable material, and support necessary for the successful completion of this investigation.

Additionally, the Contractor shall secure all permits, leases, and public notices required for the survey.

2.3 Periods of Investigation

The exact time that each survey is to be conducted cannot be predetermined since the objective of the studies is to survey several different sets of critical lake conditions. The critical lake conditions include low lake level, high temperature, calm condition, and easterly current. Thus, the four surveys will not necessarily be spaced evenly over the year. Efforts will be made to cover the four seasons; however, the naturally severe lake conditions that normally exist during the late fall, winter, and early spring months will probably preclude any survey work during those periods.

3.0 MEASUREMENT AT THE IN SITU STATION

The Contractor will supply and install the in situ station. The station will consist of a series of current meters and temperature recorders. Also, a pressure sensor should be installed with the system to measure and record variations in lake level. The station should be designed to withstand all lake conditions possible during the survey period.

A permanent instrument tower located on the lake bottom is initially proposed for the in situ station. However, the Contractor may propose an alternative to the permanent tower if the alternative is more cost efficient and can still meet the required accuracies as discussed in Section 6.1. All of the instruments will be installed at the beginning of each survey, record continuously throughout the survey, and be removed at the end of each survey.

The instrument tower shall be positioned at the designated location as shown in the attached figure. The tower will be located approximately 2,000 ft east of the diffuser and in approximately 38 ft of water. All depths, including the location of the instruments, are given with respect to mean lake El 246 ft.

3.1 Current

Current meters will be located at depths of 10, 20 and 30 ft.

4,000 ft long and shall be marked by permanent stakes on the shore. In addition, at least three buoys shall mark each transect in the near-field to assure consistency of the measurements.

4.2 Temperature Measurements

The Contractor shall conduct temperature measurements along the designated transects and profiling stations as shown in the attached figure. Temperatures will be measured continuously along each transect at depths of 1, 2, 6, 10, and 15 ft. Continuous vertical temperature profiles will be made at the designated profiling stations. Also, the temperature in the intake bay of the screenwell should be monitored during the surveys.

4.3 Dye Measurements

4.3.1 Background Fluorescence

- Prior to dye release and during the establishment of the transects, the Contractor shall make measurements to determine the naturally occuring background fluorescence of the lake. Water temperature measurements should be taken simultaneously with all fluorescence measurements to allow an accurate temperature correction of the fluorescence measurements.

4.3.2 Dye Release

Fluorescent dye will be released into the intake side of the cooling water system just prior to the pump entrances. The type of dye released shall be identified by the Contractor and shall be used only with the consent of the Engineers. The flow rate of the dye release shall be 1.5 lb/hr.

4.3.3 Dye Studies

After a minimum of 12 hr of dye release to allow for the establishment of steady state conditions, and while dye is still being released, the Contractor shall conduct measurements of fluorescence and temperature along the designated transects and profiling stations. Fluorescence will be monitored continuously along each transect at depths of

2, 6, and 10 ft. Continuous vertical profiles will be made at the designated profiling stations. Also, the dye concentration in the intake shaft of the screenwell should be measured during the surveys, for the purpose of measuring possible recirculation.

5.0 STONE & WEBSTER COORDINATION

Stone & Webster personnel will be on-site during installation of the in situ station, and during the surveys described herein. The engineer shall be the Engineer's Representative on site.

The Engineer's Representative shall monitor, advise, and modify where necessary all activities associated with this study.

6.0 INSTRUMENT CALIBRATION AND ACCURACY

6.1 Accuracies

The following accuracies of data measurement are requried for this study:

Current Speed	±0.1 ft per sec
Current Direction	±5 deg true bearing
Water temperature	±0.1 F
Fluorescence	±0.02 ppb
Pressure Sensor	±0.2 ft

6.2 Calibration

All instruments used in this study shall be calibrated prior to leaving the Contractor's office, and these calibrations shall be verified upon their return to the Contractor's office.

A calibration graph and a certificate of calibration, traceable to the National Bureau of Standards, comprised of instrument model and number, date of calibration, method of calibration, and percent deviation from true readings taken shall be incorporated as part of the report.

Additionally, field calibrations of instruments at the start and completion of each survey day, and during mid-survey when possible, shall be done. A record of these calibrations shall be entered in the survey log.

7.3.3 Temperature and Dye Measurements at the Screenwell

The data taken at the screenwell should be tabulated as in Section 7.1. Data to be tabulated should include dye measurement, temperature, and corrected dye concentration.

7.4 Survey Log

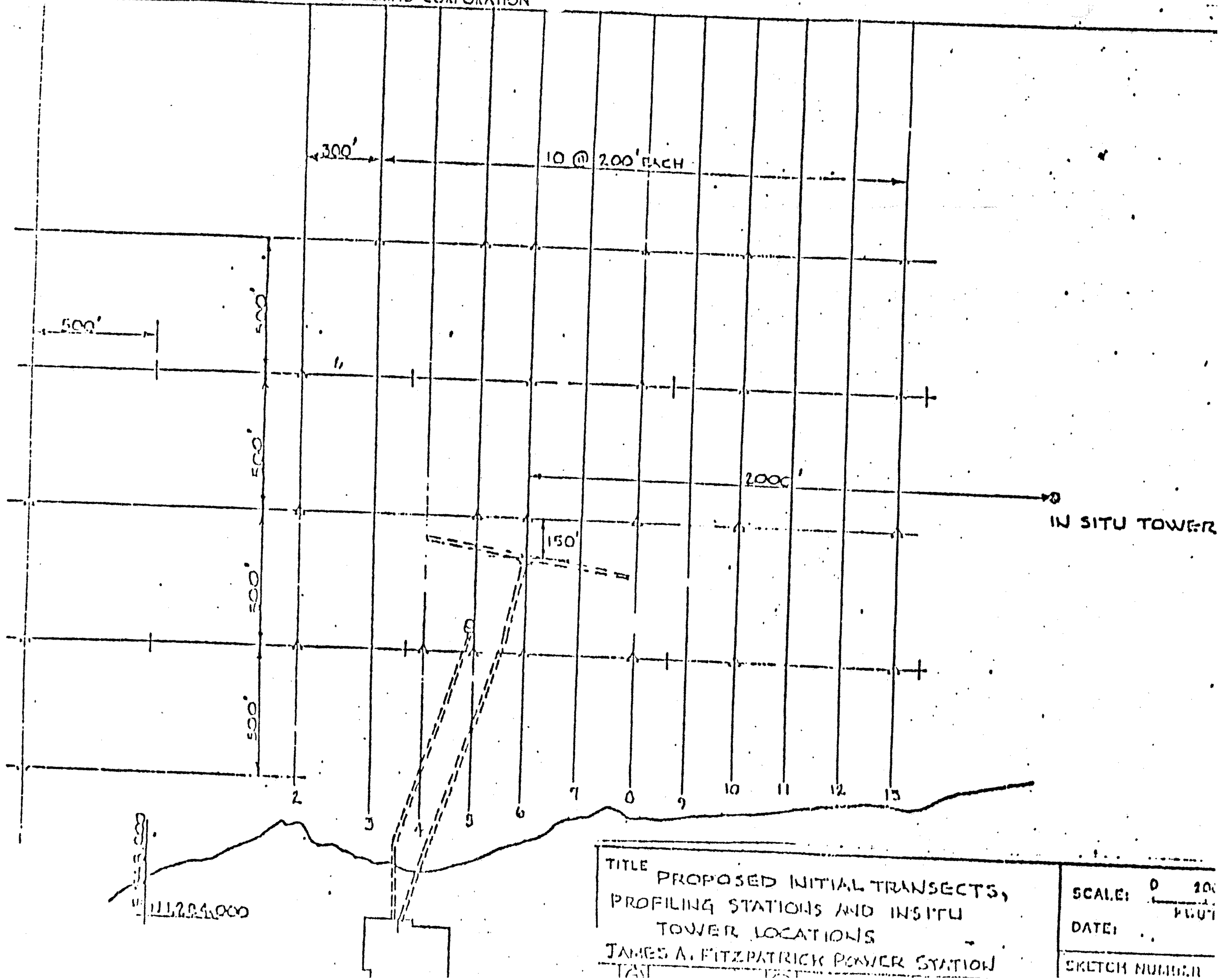
A significant events log will be maintained for each survey by the Contractor and submitted to the Engineers. Cloud cover observations and periods of precipitation may be incorporated as part of this log. This log shall be part of the report.

8.0 REPORTS

An interim report shall be prepared by the Contractor for each survey and submitted within four weeks after the survey. A final report will be submitted six weeks after the last survey.

The Engineers will review each report and submit their comments to the Contractor. Revised reports will be submitted one month from receipt of the Engineers' comments.

STONE & WEBSTER ENGINEERING CORPORATION



TITLE PROPOSED INITIAL TRANSECTS, PROFILING STATIONS AND INSITU TOWER LOCATIONS

JAMES A. FITZPATRICK POWER STATION

SCALE: 0 100 FEET

DATE:

SKETCH NUMBER

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019

(212) 397-6200

March 2, 1976

Mr. Meyer Scolnick
Director, Enforcement and
Regional Counsel Division
U.S.E.P.A.
Region II
26 Federal Plaza
New York, NY 10007

SUBJECT: James A. FitzPatrick Plant
NPDES Permit No. NY 0020109

Dear Mr. Scolnick:

As a follow up to our meeting with your staff on December 8, 1975, we are submitting the following information:

1. The intake water temperature will be monitored at a location before any tempering occurs. This procedure will be performed in response to a request by the New York State Department of Environmental Conservation.

2. We are enclosing a detailed engineering and construction schedule for the installation of cooling towers at the FitzPatrick Plant. Commencement of implementation of the enclosed schedule would coincide with the date of a negative determination by EPA with respect to the Authority's 316(a) demonstration.

3. Enclosed is a copy of the proposed scope of work for the hydrothermal field surveys. The methods will generally be as indicated in this report. However, the number of plume studies per study period may be reduced.

Due to the presence of ice at Oswego harbor and adjacent waters, it will be impossible to commence actual field studies on March 1, 1976. Historical data indicates that iceout occurs in the Oswego area between March 15 and April 1, of each year.

The contractor, Aquatec, Inc., plans to complete mobilization of its personnel and equipment within one week after iceout and will install the hydrographic tower at that time. Installation of the hydrographic tower is expected to require one or two weeks depending upon lake conditions. The contractor will be prepared to commence field surveys within four months following March 1, 1976 as required by Condition 13(c) of the NPDES permit. Survey reports will be submitted to EPA and NYSDEC within eight weeks following the month in which the survey was conducted, as agreed upon at our meeting of December 8, 1975.

316(a) Demonstration

The Authority respectfully requests that the submittal date for the FitzPatrick Plant's 316(a) Demonstration contained in Condition 12(a) be changed from October 1, 1976 to January 1, 1977. This will permit our consultant, Lawler, Matusky & Skelly to include operational biological monitoring data in the Demonstration for the critical summer and early fall months when ambient temperatures are at a maximum. This extension will also permit incorporation of the results of a full year's thermal plume studies. The Demonstration will continue to emphasize a Type II approach but inclusion of operational data should be beneficial to the U.S. EPA and PASNY.

If you have any questions concerning the above, please contact me at (212) 397-6210.

Very truly yours,

Angel J. Martin

Encls.

AJM:ab

bcc: Messrs. Chilazi
Helland
D. Wallace
Howe
Kalita

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

February 12, 1976

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Power Authority of the State of
New York
10 Columbus Circle
New York, New York 10019

Re: Power Authority of the State of
New York
Permit No. NY0020109

Dear Sir:

The Regional staff for Region II of the United States Environmental Protection Agency has tentatively determined to issue a National Pollutant Discharge Elimination System (NPDES) permit under the Federal Water Pollution Control Act Amendments of 1972 (the Act) for discharge of wastewater pollutants from the above-mentioned facility.

Pursuant to NPDES Regulations (40 CFR 125; 38 Fed. Reg. 13528, May 22, 1973) we are enclosing copies of (a) a Public Notice; (b) a Draft Permit specifying the effluent limitations and other conditions which we have tentatively determined are necessary to carry out the provisions of the Act; and (c) a Fact Sheet, if available.

We would welcome receiving any written comments, as extensively documented as possible, which your facility may wish to submit regarding this proposed permit. If you have any comments, please be sure that they arrive in this office, Attention: Status of Compliance Branch by the date cited in the attached Public Notice.

Thank you for your cooperation.

Sincerely yours,

Richard A. Baker

Richard A. Baker
Chief
Status of Compliance Branch
Enforcement and Regional Counsel Division

Enclosures

Region II
26 Federal Plaza
New York, New York 10007
212-264-2515

PUBLIC NOTICE OF SUBMITTAL OF PLAN OF STUDY AND DEMONSTRATION PURSUANT TO 40 CFR §122.7

No. NPDES 76-94

Date: FEB 20, 1976

Notice is hereby given that the United States Environmental Protection Agency (EPA) has received from

Power Authority of the State of New York
10 Columbus Circle
New York, New York

(the permittee) a plan of study and demonstration submitted pursuant to 40 CFR §122.7. This submittal constitutes a part of the permittee's request for a variance from the thermal limitations imposed in its permit NY0020109 (James A. Fitzpatrick Generating Station) pursuant to §301 of the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. §1251 et. seq. ("the Act"). A plan of study and demonstration outlines the studies to be conducted, the type of demonstration to be submitted, and a schedule for completion and submittal of the demonstration by the permittee, in support of its requests for a variance pursuant to §316(a) of the Act.

Pursuant to 40 CFR §122.6 EPA invites public inspection of and comment on the plan of study submitted. The plan of study may be inspected at the Status of Compliance Branch, EPA Region II, at the above address, Room 818, Monday through Friday between the hours of 8:30 a.m. and 4:00 p.m. Arrangements to examine a particular plan of study must be made at least one day in advance by calling the Status of Compliance Branch at (212) 264-9881 during the above-mentioned hours. Copies will be provided at the cost of $.20 per copy sheet. All requests to examine a plan of study and demonstration must be received by the Status of Compliance Branch no later than MAR 19 1976

Public notice of EPA's final determination with respect to the variance requested by the permittee will be given as soon as possible following the permittee's submittal of its demonstration pursuant to §316(a) of the Act.

Richard A. Baker
Chief
Status of Compliance Branch
Enforcement Division

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019

(212) 397-6200

February 5, 1976

Ms. Barbara Pastalove, Biologist
U. S. Environmental Protection Agency
Energy and Thermal Wastes Section, Region II
26 Federal Plaza
New York, New York 10007

Subject: James A. FitzPatrick Nuclear Power Plant
316(a) and 316(b) Study Plans

Dear Ms. Pastalove:

We sent our 316(a) and 316(b) study plans to Mr. Lunenfeld by our letter of June 16, 1975 for approval by EPA before we initiated the studies. Since then we have received no word with respect to their acceptability. Until we receive your approval or your comments, if the plans need adjustment, we cannot begin the work full force.

I understand that a meeting was proposed for February 10. Due to the unavailability of the individuals responsible for the demonstration plans, I must postpone such a meeting until another date. In the meantime, I would appreciate receiving your thoughts about our proposed plans as soon as possible in order to meet the scheduled date of October 1976 for the complete submittal of the 316(a) demonstration for the FitzPatrick Plant.

Very truly yours,

Zakaria E. Chilazi, Manager
Thermal Power Generation
Nuclear and Fossil Projects

DW:cam

bcc: D. Wallace, A. Martin, P. Howe

CONCURRENCES (INITIAL & DATE)	N 2-5-76				

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

AUG 11 1975

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Mr. George T. Berry
General Manager and Chief Engineer
Power Authority of State of New York
10 Columbus Circle
New York, New York 10019

Attn: Zakaria E. Chilazi

Re: Designation of representative important species pursuant to 40 CFR §122.9(b)(2)(ii)(A); James A. Fitzpatrick Nuclear Power Plant; Scriba, New York

Permit No.: NY0020109

Dear Mr. Berry:

Pursuant to the regulations for §316(a) of the Federal Water Pollution Control Act Amendments of 1972, 40 CFR Part 122, your company has requested that the Regional Administrator designate those representative, important species whose protection and propagation will assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on Lake Ontario. Pursuant to §122.9(b)(2)(ii)(A) of these regulations, I have sought the advice and recommendation of the Commissioner of the New York State Department of Environmental Conservation, the Secretary of Commerce, and the Secretary of the Interior in selecting representative, important species for the above-referenced generating station. The species listed on the attached sheet are hereby designated by EPA as the representative, important species for the subject facility.

Your company must submit such data and other information in support of your §316(a) waiver request within 90 days of receipt of this letter, or a written plan of study and demonstration pursuant to §122.7 of these regulations within 60 days of receipt of this letter.

A timely submittal is necessary for EPA to proceed with the evaluation of your plan of study and/or demonstration.

Sincerely,

Gerald M. Hansler, P.E.
Regional Administrator

cc: Terrence Curran, Director
Office of Environmental Analysis
New York State Department of Environmental Conservation
50 Wolf Road
Albany, N.Y. 12201

Attachment

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.

COPY

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019

(212) 265-6510

June 16, 1975

Mr. Harvey Lunenfeld
Chief, Energy and Thermal Wastes Section
Region II
U. S. Environmental Protection Agency
26 Federal Plaza
New York, New York 10007

Re: 316 (a) and 316 (b) Studies - James A. FitzPatrick

Dear Mr. Lunenfeld:

As requested during the meeting at your office on May 14, 1975, I am pleased to enclose our 316 (a) and 316 (b) study outlines for the James A. FitzPatrick nuclear plant.

I am also enclosing, as requested during our meeting, a list of representative important species for Lake Ontario. I would appreciate your prompt review and approval of this list so that the Power Authority may proceed expeditiously with the studies.

If you have any questions concerning the outlines or the list, please feel free to contact me at (212) 265-6510, extension 303 or 304.

Very truly yours,

Zakaria E. Chilazi
Manager, Thermal Power Generation

Encs.

AJM:ko'c

bcc: Messrs. A. J. Martin, ZEC/D. Wallace, Lawler Matusky & Skelly,
J. Toemis/NMPC, J. Helland/Eng. Files

CONCURRENCES (INITIAL & DATE)

TYPE II - 316(a) DEMONSTRATION OUTLINE
JAMES A. FITZPATRICK PLANT

I. INTRODUCTION

A. Regional and Site Description

B. General Description Aquatic Ecology and Limnology

C. General Description of Previous Studies and Where Found

D. Previous Environmental Reviews by Other Governmental Agencies

II. PLANT COOLING SYSTEM

A. General Plant Description (including load factor and shutdowns)

B. Description - Circulating Water System
   1. Thermal discharge
   2. Chemical discharge

III. ENGINEERING EVALUATION OF THE DISCHARGE

A. Description of Hydrographic Characteristics of Site

B. Description of Thermal Characteristics of Site

C. Predicted and Measured Plumes (including rise in shoreline and bottom temperatures)
   1. FitzPatrick
   2. FitzPatrick plus Nine Mile 1
   3. FitzPatrick, Nine Mile 1 and Oswego 1-6

D. Identification of Water Body Segments

E. Conclusion
   1. Definition of seasonal immediate discharge zone
   2. Compliance with State Water Quality Criteria

IV. SITE BIOLOGY

V. REPRESENTATIVE IMPORTANT SPECIES

A. Identification

B. Life History (including migration paths and spawning areas)

C. Thermal Tolerance

VI. THERMAL EFFECTS UPON REPRESENTATIVE IMPORTANT SPECIES

A. Plume Entrainment
   1. Ichthyoplankton
   2. Fish

B. Physiological and Behavioral Effects
   1. Ichthyoplankton
   2. Fish

VII. CONCLUSION

316 (b) DEMONSTRATION OUTLINE

JAMES A. FITZPATRICK PLANT

I. INTRODUCTION

A. Regional and Site Description

B. General Description Aquatic Ecology and Limnology

C. General Description of Previous Studies and Where Found

D. Previous Environmental Reviews By Other Governmental Agencies

II. PLANT COOLING SYSTEM

A. General Plant Description

B. Description of Circulating Water System

1. Structural and Operational

2. Hydraulic

3. Chemical

III. SITE BIOLOGY

IV. ENTRAINMENT ASSESSMENT FOR SELECTED TAXA

A. Estimated Number of Entrained Organisms

B. Mortality and Injury of Entrained Plankton

C. Mixed Model Evaluation For Selected Water Body Segments

D. Conclusion of Entrainment Effects On Populations

V. IMPINGEMENT ASSESSMENT FOR SELECTED TAXA

A. Estimated Number of Impinged Organisms

B. Mixed Model Evaluation for Selected Water Body Segments

C. Conclusion of ~~Entrainment~~ Impingement Effects on Population

VI. COST-BENEFIT CONSIDERATIONS

VII. CONCLUSION

SELECTION OF REPRESENTATIVE IMPORTANT SPECIES FOR LAKE ONTARIO

A. INTRODUCTION

The National Pollution Discharge Elimination System (NPDES) permits issued for power stations on Lake Ontario require assessment of the effects of the thermal discharge and the intake operation on a balanced indigenous population. The EPA proposed in its draft Technical Guidance Manual and in subsequent technical discussions that the demonstration be based on the measured or projected impact on selected species of the aquatic ecosystem. The purpose of this document is to describe basis for the selection of certain species as representative in assessing the impacts in the vicinity of Nine Mile Point and Oswego.

This proposal on the selection of representative important species is based upon three sources of information: (1) published literature related to species interactions and the importance of certain species to the ecosystem; (2) biological monitoring programs which have been conducted in the Nine Mile Point/Oswego area since 1963; (3) design features, location and predicted plumes of the discharges.

The guidance manual describes bases for selection of representative important species and suggests that until species are identified by the Regional Administrator, it is prudent to select species from a non-degraded environment, choosing those which are primarily community dominates with respect either to biomass or to numerical abundance. Consideration is also to be given to nuisance species, endangered species, and species of commercial or recreational value.

B. BASES FOR SELECTION OF REPRESENTATIVE IMPORTANT SPECIES

1. ABUNDANCE OF FISHES AT THE FITZPATRICK SITE (NINE MILE POIN

The relative abundance of various fish species in the site vicinity was determined based on gill net, trawl and seine data collected during 1973. Table 1 lists selected fish species from the FitzPatrick site vicinity. It is apparent from Table 1 that the alewife dominates fish abundance in both lake and impingement collections at Nine Mile Point Unit 1. The alewife thus represents an important species.

2. THREATENED AND ENDANGERED SPECIES

A list of threatened and endangered species is published by the U.S. Department of the Interior and New York State Department of Environmental Conservation. The following Lake Ontario species are listed as threatened or endangered:

TABLE 1

RELATIVE ABUNDANCE OF FISH SAMPLED

Species	1973 Lake[1] at Nine Mile Point		1973 Impingement[1] (NM Point 1)		1974 Impingement[2] (NM Point 1)	
	#	%	#	%	#	%
Alewife	45,043	75.5	644,681	97.8	1,181,149	94.4
Brown Trout	31	<.1	1	<.1	1	<.1
Chinook Salmon	5	<.1	0	0	0	<.1
Coho Salmon	0	0	0	0	2	<.1
Emerald Shiner	79	0.1	142	<.1	2,939	0.2
Gizzard Shad	386	0.6	659	0.1	2,486	0.22
Johnny Darter	103	0.2	119	<.1	693	<.1
Rainbow Smelt	1,301	2.2	10,751	1.6	41,707	3.3
Smallmouth Bass	828	1.4	20	<.1	172	<.1
Spottail Shiner	3,117	5.2	69	<.1	1,348	0.1
Threespine Stickleback	78	0.1	775	0.1	6,714	0.5
White Perch	4,372	7.3	249	<.1	6,361	0.5
Yellow Perch	2,264	3.8	145	<.1	647	<.1
Others	2,065	3.5	1,430	0.2	7,030	0.6
Total	59,672		659,041		1,251,249	

[1] Quirk, Lawler & Matusky Engineers, 1974
[2] Lawler, Matusky & Skelly Engineers, 1975

1. Lake sturgeon (*Acipenser fulvescens*)

2. Blue pike (*Stizostedion vitreum glaucum*)

3. Blackfin cisco (*Coregonus nigripinnis nigripinnies*)

4. Deepwater cisco (*Coregonus johannae*)

None of these fish have been collected in the vicinity of either Nine Mile Point or Oswego in the course of the extensive biological monitoring programs of the last three years. Therefore none of these species will be considered as representative or important for the Nine Mile Point Site.

3. RECREATIONAL FISH SPECIES

The most abundant recreational fish species observed in the vicinity of Nine Mile Point is the smallmouth bass, a species which maintains a substantial local fishery and serves as an attraction for many New York State fishermen during the vacation season. Therefore, the smallmouth bass should be selected as one of the representative important species.

In recent years both Canada and New York State have begun some stocking programs in Lake Ontario and its tributaries. The New York State program includes the stocking of salmonidae (coho and chinook salmon and brown and rainbow trout), which have already begun to contribute to the recreational fishery of Lake Ontario. We understand that Canada is discontinuing its coho program since the species are not self-propagating in Lake Ontario (Ontario Hydro, 1975). Historically, the salmon stocking program was initiated for two reasons (1) to provide a recreational fishery of salmon and (2) to reduce the nuisance abundance of alewife. Because salmon feed extensively on alewives as well as rainbow smelt their introduction was thought to have the two-fold advantage of limiting alewife population at the same time as providing a recreational fishery.

Abundance of salmon collected in the vicinity of Nine Mile Point and Oswego has been minimal ($< 0.1\%$) with only several salmon being collected between the lake and impingement collections in this area of the lake. Informal communications with the Cape Vincent Fishery Laboratory indicate that the salmon are present along the entire south shore of Lake Ontario. Because of the State stocking program and the potential value of this fishery for recreational fishermen, this species will be considered as a representative important species, although its very low abundance near the sites is expected to discount any potential impact on this population.

The second species currently being stocked in Lake Ontario by New York State is the brown trout, which has been collected in small numbers (<0.1%) in the vicinity of Nine Mile Point. In 1973, 31 brown trout were collected from the lake sampling program out of a total of nearly 60,000 fish. The low abundnace of brown trout would appear to preclude it from consideration as a representative important species; however, due to the State's efforts to stock this species in Lake Ontario and its potential recreational value, the brown trout will be considered in the demonstration as a representative important species.

4. FISH SPECIES OF COMMERCIAL VALUE

An alewife fishery exists on Lake Michigan, a smelt fishery throughout most of the Great Lakes, and some yellow perch fishing, especially along the Canadian shore. In general there are few commercial fisheries remaining on Lake Ontario. The alewife of Lake Ontario has been described as an over-populated species whose abundance is unstable, as indicated by its periodic mass die-offs. Alewife die-off was considered an environmental problem and a public nuisance when the last major event occurred in the late 1960's. Partially in consideration of minimizing this problem, New York State began its program of stocking salmon to feed upon the alewife. The alewife represents a dominant species both in lake collections and impingement.

The second most abundant spcies in impingement collections is the rainbow smelt, which constituted 1.6% and 3.3% of the annual impingement in 1973 and 1974 respectively, at Nine Mile Point Unit 1. Comparable abundance was observed in the lake collections in 1973. The relative abundance of the rainbow smelt and its potential value as a commercial fishery indicate that it should be selected as a representative important species.

The yellow perch was considered as a potential representative important species as well, contributing 3.8% of the total fish in 1973 lake collections near Nine Mile Point. Yellow perch contribute to both the recreational and the commercial fishery of the lake. However, by comparison with the smallmouth bass or the stocked fish species, the yellow perch is less important in both abundance and recreational value along the New York shores of Lake Ontario. Furthermore, because it is cited as a species tolerant of environmental changes (Scott and Crossman, 1973), it has not been selected as a representative important species for the Nine Mile Point and Oswego area.

The white perch contributed 7.3% to the 1973 lake fish collection in the vicinity of Nine Mile Point sampled by gill nets, surface trawls, bottom trawls, and seines. Ichthyoplankton collections and coefficients of maturity obtained for adult white perch near Nine Mile Point and Oswego indicate that some spawning of the species occurs near the sites. The white perch also represents a contribution to the sport fishery of Lake Ontario, although some describe it as a competitor with game fish for a limited food supply (Scott and Crossman, 1973). For these reasons it is suggested that the white perch be included in the list of representative important species.

5. SPECIES REPRESENTING THE FORAGE BASE

The recreational fish species of Lake Ontario feed on several smaller species including alewife, threespine stickleback, johnny darter, emerald shiner, and spottail shiner (Scott and Crossman, 1973). The alewife has been selected due to its numerical dominance, its potential value as a commercial fishery, and as a forage base for the stocked salmon population. Of the remaining species mentioned above, threespine stickleback represent the largest contributor to annual impingement at the power stations, although their impingement rate is variable from year to year and from station to station. The abundance of this species in lake collections in 1973 as compared to impingement collections indicates that it is apparently more susceptible to impingement impact than would be expected based on its relative abundance in lake collections. Since this species builds a nest in which to spawn and resides in a given site vicinity, it has been selected as a representative important species representing, along with alewife, the forage base for Lake Ontario.

C. SUMMARY

In conclusion, on biological bases along, the following species would be recommended as representative important species for the assessment of impacts at Nine Mile Point and Oswego:

1. Smallmouth bass (Micropterus dolomieui)
2. White perch (Morone americana)
3. Alewife (Alosa pseudoharengus)
4. Rainbow smelt (Osmerus mordax)
5. Threespine stickleback (Gasterosteus aculeatus)

Since New York State is introducing additional species which are not part of the existing indigenous population of Lake Ontario, namely the coho salmon (Oncorhynchus kisutch) and brown trout (Salmo trutta) these species will also be included as important.

After consultation with the EPA Technical Guidance Manual and technical meetings with the EPA, it is apparent that other species (non-fish) may be require in cases of outfalls which may impact the shoreline or the lake bed. Nine Mile Unit 1 discharge results in shoreline temperature rise, thus potentially impacting Cladophora and Gammarus. In contrast the FitzPatrick discharge is designed to achieve rapid dilution and is not expected to affect shoreline temperatures. On this basis, it is suggested that Cladophora and Gammarus not be considered as representative important species for the FitzPatrick demonstration.

LITERATURE CITED

1. Lawler, Matusky & Skelly Engineers, 1975. Impingement Studies at Nine Mile Point Nuclear Station Unit 1. Report prepared for Niagara Mohawk Power Corp.

2. Quirk, Lawler & Matusky Engineers, 1974. 1973 Nine Mile Point Aquatic Ecology Studies. Report prepared for Niagara Mohawk Power Corp.

3. Scott, W.B., and E.J. Crossman, 1973. Freshwater Fishes of Canada. Fish. Res. Bd. Canada. Bull. 184. 966 p.

4. Ontario Hydro Electric Power Commission, 1975. Personal Communication.

December [illegible], 1975

Sandra Kunsberg, Esq.
U. S. Environmental Protection Agency
Region II
Room 1009
26 Federal Plaza
New York, New York 10007

Dear Ms. Kunsberg:

In accordance with our agreement at the informal pre-hearing conference held at EPA, Region II on December [illegible], 1975, enclosed please find a copy of Appendix A which sets forth the substance of agreement by all parties on issues to be considered at Adjudicatory Hearings for the Astoria No. 6 and James A. FitzPatrick NPDES permits. Appendix A contains revised permit conditions for those conditions upon which the parties were in agreement.

It is our understanding that EPA, Region II will prepare stipulations in accordance with the revised permit conditions to be submitted to all parties for their approval. Those issues to which the parties have stipulated their agreement will then be removed from further consideration at the Adjudicatory Hearings.

Enclosed also is a proposed revised condition for "Non-compliance with Conditions". That condition, if acceptable to all parties, will be embodied in Condition 15 of the Astoria No. 6 permit and Condition 16 of the James A. FitzPatrick permit, respectively.

Extra copies of Appendix A are enclosed for distribution to New York State Department of Environmental Conservation and Interstate Sanitation Commission.

Sincerely,

Angel J. Martin

Encs. AJK:meb
bcc: Chilazi, Kalita, Lilly, Woods, Helland, Morhous, Wallace, M. Barr: LeBoeuf Lamb, Dr. Skelly

Proposed Revision of "Non-compliance with Conditions" Permit Condition

The Authority proposes that Condition 15 of the Astoria No. 6 permit and Condition 16 of the James A. FitzPatrick permit be retained in their entirety with the following addition to be made to the last paragraph of each.

> "Nothing in this permit shall be construed to relieve the permittee from appropriate civil or criminal penalties for non-compliance, except that upon proof satisfactory to the Administrator that non-compliance was caused by acts of nature or other causes beyond the reasonable control of the permittee, such non-compliance shall not be deemed a violation of the permit. (new matter underlined)

APPENDIX A

Listed below are the issues discussed at the December 8, 1975 pre-hearing conference attended by representatives from EPA Region II, NYSDEC, ISC and the Power Authority. Issues agreed upon by the parties and the substance of permit condition language which should be contained in appropriate stipulations are set forth. Many issues involving modification of permit language with legal implications will be embodied in revised permit conditions which will be identical for Astoria No. 6 and JAF permits.

Astoria No. 6

(1) Condition 3: Opportunity for hearing with regard to the imposition of a compliance schedule for future toxic effluent standards.

Ms. Kunsberg indicated that in addition to the judicial review afforded permittees under FWPCA §509(b), Condition 3 is presently undergoing revision by EPA in Washington. The revised condition to be submitted to the Authority for approval will substantially conform to the Authority's August 22, 1975 request that a sentence be added to Condition 3 preserving the permittee's right to " a hearing on the method of application of any toxic effluent standard or prohibition".

The same revision will be incorporated in Condition 3 of the JAF permit.

(2) Condition 5: System Maintenance. At the pre-hearing conference all parties agreed to the deletion of the words "at all times" as suggested by the Authority. Subsequently, the attorney for EPA notified the Authority

that EPA would have to retract its agreement and take the position that the permit condition must stand as issued. Ms. Kunsberg indicated that the EPA position is mandated by 40 C.F.R. §122.22.

The issue remains unresolved.

Condition 5 of the JAF permit will also be so modified.

(3) Condition 9(b)(1): Condensor Cooling Water Effluent Limitations.

It was agreed that the following modifications would be incorporated in 9(b)(1).

1. An asterisk would be added following subsection (c) of 9(b)(1).

2. The asterisked paragraph following 9(b) (1) would be revised to read as follows:

* These limitations may be exceeded during periods when one or more condensing units are operating with only one circulating water pump (per unit), due to pump breakdown, routine pump maintenance, or thermodynamic fluctuation or malfunction in the process steam cycle. In no event shall the limitations for intake-discharge temperature difference or net rate of addition of heat to the receiving water contained in 9(b)(1)(b) and (c) respectively be exceeded by more than 5%. In the event of pump breakdown or thermodynamic fluctuation or malfunction in the process steam cycle, the permittee shall take corrective action as soon as possible. Where possible, routine pump maintenance resulting in these limitations being exceeded should be avoided during June-September. The permittee shall indicate on the Discharge Reporting Form (1) which circulating water pumps, if any, were not in operation, (2) the dates and times such pumps were not operating, (3) the reason(s) for such pumps not operating and (4) the period(s) (dates and times) during which these limitations were exceeded. In no case shall these limitations be exceeded more than 10% of the time during the operating year." (new matter underlined).

(4) Condition 9(b)(2): Oil Storage Runoff.

1. It was agreed that "Furnace Wash Wastes" and "Fly Ash Wastes", which are included within the term "Boiler Fireside Wash Wastes" would be deleted from the second paragraph of 9(b)(2).

2. A "no discharge" limitation was initially included for "Oil Storage Runoff" because Con Ed indicated in its application that there would be no discharge from the oil storage area. EPA, DEC and the Authority agreed that EPA's guideline limits of an average 15 mg/l per day and a maximum 20 mg/l per day would be reasonable and attainable for the oil storage area waste stream at Astoria No. 6. ISC persisted in its request that a maximum limit of 1 mg/l be imposed and will require an adjudicatory hearing on that issue.

(5) Condition 10(a)(1): Required limitations commencing July 1, 1977. The following items were established:

1. The Authority will seek an ocean dumping permit for boiler chemical cleaning wastes in conjunction with Con Ed, probably via an amendment to the Con Ed application. Ms. Kunsberg indicated that the Con Ed application is about to be denied by EPA.

2. It was clarified that the poundage limitations represent conversion of the allowable concentration set forth in EPA effluent guidelines.

3. "Oily drain wastes" do not include wastes from oil storage areas.

4. "Gross" limitations are imposed whenever the water source is other than the East River.

5. ISC raised the same objection to oil and grease limitations as indicated in (4) above.

(6) Condition 10(a)(2): No discharge of "garbage, cinders, ashes, oils, sludge or other refuse in the waters of the marine district."

Mr. Quinn of DEC clarified the condition in that it was intended to be an "anti-dumping" limitation to prevent the dumping of such materials within the marine district. DEC agreed to supply the Authority with an interpretation of the limitation to that effect. Contingent upon such interpretation there should be no difficulty in complying with the condition.

(7) Condition 10(a)(3): §316 (a) Demonstration.

EPA revealed that a favorable determination on the Authority's 316(a) demonstration has been made and is forthcoming. DEC will agree with the 316(a) decision and the Authority agreed to withdraw its objection to the condition contingent upon a favorable 316(a) decision.

(8) Condition 11: Compliance Schedule:

It was agreed that the schedule will have to be revised. The Authority reiterated its belief that the issue of ocean dumping will be resolved in its favor. EPA will insist upon limitations being implemented by July 1, 1977.

The Authority and EPA agreed to the submission by the Authority of alternative reasonable schedules of compliance: one to be implemented in the event ocean dumping is to be permitted; the other in the event a waste treatment facility is required. The schedules will be submitted by March 1, 1976.

EPA would like at that time also to see plans for whatever treatment facilities (if any) or conduits will be utilized even if ocean dumping is permitted.

The Authority indicated that if a limitation less than the 15-20 mg/l limitation for oil in contaminated drains effluents is imposed as a result of an adjudicatory hearing decision, a revised compliance schedule would have to be submitted.

(9) Condition 12(c): Biological Monitoring and Isotherm Plots.

1. 12(c)(1) and (2) required submittal of all impingement and entrainment data collected "to date" by June 1, 1975. No submittal was necessary because the plant was not operational and no data was collected.

2. EPA and DEC agreed to accept the Authority's proposed date of April 1, 1976 for the submittal of a detailed biological study program as required by 12(c)(3).

3. 12(c)(4): DEC agreed to the Authority's request that filing of triaxial isothermal measurements be deferred until July and August of 1977 and repeated in 1979.

4. 12(c)(5): EPA agreed that the Authority has satisfied the condition requiring a study of the impact of cooling towers upon aviation and navigation.

(10) Condition 12(h): Reporting.

EPA would not accept the Authority's proposal for quarterly rather than monthly reports, but the second paragraph of 12(h) will be modified to allow submittal of reports on the 30th day of each month reporting data from the previous month.

The JAF permit will also be so modified.

(11) Condition 13: Sludge Disposal. Modifications proposed by the Authority were accepted by EPA and DEC.

The first sentence of Condition 13 will be modified to read as follows:

"Collected Screenings, sludges and other solids and precipitates separated from the permittee's discharge authorized by this permit and/or intake or supply water by the permittee shall be disposed of in such a manner as to [prevent entry of such materials] provide reasonable assurance that such materials will not enter into navigable waters or their tributaries."

Condition 13(b) will be modified to read:

"b. Their final disposal location if disposed of by permittee or their final reported disposal location if disposed of by independent contractor."

JAF permit Condition 14 will also be so modified.

(2) Condition 14: Discharge containing Parameter not previously reported.

All parties agreed to the revision proposed by the Authority. Condition 14 will be amended to read as follows:

"The permittee shall not discharge any waste water containing a substance or characterized by a parameter which was indicated as absent in its NPDES permit application [.] unless such substance or parameter was present in the intake water and was not added as a result of plant operations. In the event of [such a discharge,] the discharge of a substance indicated as absent in its NPDES permit application which was not present in the intake water, the permittee shall notify the Regional Administrator and the State Agency prior to the discharge."

JAF permit Condition 15 will also be so revised.

(13) Condition 15: Non-compliance with Conditions.

EPA will not accept any general language such as that proposed by the Authority in its August 22, 1975 letter. However, Ms. Kunsberg indicated that a revised condition embodying the concept of Force Majeure would be considered by EPA. The Authority agreed to submit a revised condition for consideration by EPA. The same will apply to JAF permit Condition 16.

JAF Permit

(1) Agreement was reached on the meaning of the term "commercial operation" in permit conditions. Whenever the term appears in the permit the date "March 1, 1976" will be substituted.

(2) Right to hearing before the imposition of future toxic effluent standards. See paragraph (1) under Astoria No. 6.

(3) System Maintenance. See paragraph (2) under Astoria No. 6.

(4) Condition 10(b)(1)(a): Condensor cooling water effluent limitations.

1. It was agreed that the discharge-intake temperature difference will be revised to be consistent with 32.4 F requirement of NRC Tech Specs.

2. A triple asterisked paragraph will be added allowing the effluent limitations set forth in 10(b)(1)(a)(2) and (3) to be exceeded by 5%. The 5% maximum will apply to ΔT and net rate of addition of heat, but not to the maximum discharge temperature of 112°F.

The triple asterisked paragraph will read:

"***The discharge-intake temperature difference and net rate of addition of heat to the receiving water may exceed the limitations specified in subsections (2) and (3) by 5% due to thermodynamic fluctuation or malfunction in the process steam cycle. In no case shall these limitations be exceeded more than 10% of the time during the operating year."

3. DEC also wants intake water temperature monitored before tempering. EPA and the Authority agreed to measurement after tempering (inlet-outlet monitoring). Mr. Chilazi will attempt to reach agreement with Mr. Quinn and report to EPA.

(5) Condition 12(b): Since the Authority will have no difficulty complying with 11(b) (Anthracite Filter Backwash), the 12(b) compliance schedule will be deleted and 11(b) will be imposed effective March 1, 1976.

(6) Condition 13(a): Sampling Schedule for Discharge No. 001. EPA and the Authority agreed to inlet-outlet temperature monitoring. DEC maintained the position that it also wants water temperature before tempering measured.

(7) Condition 13(b)(1): The Authority withdrew its objection and agreement was reached with EPA that the Authority would be required to submit a seven-day monitoring report within two months of March 1, 1976 for only Discharge 013 (Clearwell Overflow).

(8) Condition 13(c): It was agreed that triaxial isothermal survey reports would not be due until 8 weeks following the month in which the survey was taken, rather than the 20 days allowed by 13(c) as presently written. Condition 13(c) will be revised accordingly.

(9) 316(a) Discussion: The following items were discussed with respect to 316(a).

1. EPA biologists apparently expected the JAF 316(a) demonstration to be made by October, 1975, but that was not the Authority's understanding, nor was there any written representation of such agreement. Authority engineering, after meeting with consultants, will prepare a schedule to be submitted to EPA.

2. If the 316(a) demonstration should be unsuccessful EPA would like as soon as possible to establish a schedule to determine whether it will be feasible to comply with closed-cycle cooling by July 1, 1981. In the event of a negative 316(a) determination, EPA would like to know by what date such determination must be made to enable implementation of a closed-cycle cooling system by July 1, 1981.

(10) There was a general discussion of the issue raised by DEC "whether the final NPDES permit must require the submission of a report on station output pursuant to a Section 401 Certification".

If the issue cannot be resolved it may have to go to an adjudicatory hearing.

(11) Conditions 13(h) (Reporting), 14 (Sludge Disposal), 15 (Discharge Containing Parameter Not Previously Reported) and 16 (Non-Compliance) will be resolved in the same manner as indicated for the Astoria No. 6 permit.

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019
(212) 397-6200

December 29, 1975

Mr. Terence Curran, Director
Office of Environmental Analysis
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233

Dear Mr. Curran:

Pursuant to Condition 2 of the 401 Certification for the FitzPatrick Nuclear Power Plant, the Power Authority of the State of New York hereby submits its contingency plan (Attachment 1) for "actions to be implemented in the event of a serious fish kill--environmental incident" for NYSDEC approval. Pursuant to Condition 3, the thermal mapping program (Attachment 2) is hereby submitted. If you have questions about these submittals, please call me or Deborah Wallace of my office.

In addition to fulfillment of Conditions 2 and 3, the Authority has worked toward fulfillment of the other 401 conditions. The status of this work is listed below by condition.

Condition 1

Condition 1 requires the applicant to measure fish impingement at the plant intake. The Power Authority has contracted Lawler, Matusky and Skelly Engineers (LMS) to fulfill the requirement. The program was initiated on September 10, 1975 and continues to be conducted in accordance with the criteria set forth in the J. A. FitzPatrick Plant Environmental Technical Specifications. The results of the study will be summarized in the Nine Mile Point Site Aquatic Ecology Studies annual report. This report will be submitted to the NYSDEC in fulfillment of Condition 1 in mid-1976.

Condition 5

Condition 5 requires the Power Authority to submit to the NYSDEC "an assessment of the significance of entrainment mortality on the local area and on Lake Ontario". LMS has been contracted to perform the required

CONCURRENCES (INITIAL & DATE)

assessment in conjunction with the impingement program which fulfills Condition 1. Entrainment studies will be initiated in the spring in accordance with criteria set forth in the plant Environmental Technical Specifications. The results of the studies will be summarized in the annual report along with the impingement studies. This report will be submitted to the NYSDEC in fulfillment of Condition 3 in early 1977.

Condition 4

Condition 4 requires that any reports pertaining to the environment which are prepared for other agencies be also submitted to the NYSDEC. The Power Authority is currently reviewing all environmental reports which are being prepared for other agencies and will establish procedures which insure that such reports are forwarded to the NYSDEC. We will keep you informed of the development of these procedures and the schedule for submittals.

Conditions 5 and 6

Conditions 5 and 6 require monitoring and recording of intake and effluent temperatures, discharge flow, and plant electrical output. This information is to be logged and reported monthly (in accordance with Condition 9) to the NYSDEC. The Power Authority has, commencing with the month of October 1975, initiated this program. The data to be reported will include:

(1) daily minimum, maximum, and average gross station electrical output;

(2) daily minimum, maximum and average circulating water flow as determined by the pump curves reflecting the method of operation;

(3) daily minimum, maximum and average intake and discharge temperatures as measured at the condenser intake and outlet.

Operating reports will be prepared monthly and submitted to NYSDEC within 30 days of the end of the month. This change to 30 days from 15 was agreed upon by U. S. EPA, NYSDEC and PASNY at a meeting in the EPA Region II Office on December 8, 1975. The Authority also agreed at this meeting to advise NYSDEC whether the temperature is also being monitored before tempering. This is to advise that the intake temperature is monitored before tempering.

Mr. Terence Curran, Director
Page Three
December 29, 1975

Condition 7

Condition 7 requires that oil and chemical discharges be "treated before any dilution in facilities approved by the NYSDEC". The Power Authority received on November 13, 1970, approval from NYSDEC for the engineering plans and specifications associated with the proposed sewage treatment system which will serve the plant. Since all waste treatment facilities are designed to comply with New York State and U.S. EPA standards, approvals for other in-plant waste treatment facilities have not been sought. It is our belief that no further approvals are necessary except for those approvals specifically requested in the JAF NPDES Permit.

Condition 9

Condition 9 requires monthly reporting to the NYSDEC of those data collected in accordance with Conditions 5, 6, 7 and 8. As stated above, monthly reports of plant operating data in accordance with Conditions 5 and 6 are being furnished commencing with the month of October 1975. Condition 7 reporting requirements will be satisfied by the monthly monitoring reports filed with the EPA under NPDES Permit regulations with copies sent to NYSDEC. In accordance with the Environmental Technical Specifications and Condition 8 of the 401 Certification, a minimum of four thermal surveys will be made during several different sets of critical lake conditions and shall be spaced to cover the four seasons. Results of these tri-axial isothermal mapping studies will be submitted to the NYSDEC upon completion.

Very truly yours,

Zakaria E. Chilazi, Manager
Thermal Power Generation
Nuclear and Fossil Projects

bcc: All w/atts.

Messrs. Martin, Helland, Hultgren, Lempges/~~Nine Mile~~ Point, Smith/JAF, Abbott/JAF, Toennies/ NMPC, Ms. Wallace

FISH KILL CONTINGENCY PLAN

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

SCRIBA, NEW YORK

Background

Condition 2 of the New York State Department of Environmental Conservation (NYSDEC) dated June 1, 1973, and Condition 4.1.1b (pages 25 and 26) of the Nuclear Regulatory Commission (NRC) Operating License dated October 17, 1974, establish the requirement for the preparation and implementation of a "Fish Kill Contingency Plan". The Plan will be submitted to both NYSDEC and NRC for review and approval.

Plan Initiation

Reference Appendix B to Facility Operating License No. DPR-59 for James A. FitzPatrick Nuclear Power Plant: Subject: Environmental Technical Specifications: Paragraph 4.1.1b(2) is quoted as follows:

> "In the event the number of fish collected during a 24-hour period exceeds 20,000 fish, sampling shall be continued on a daily basis until the number of fish collected diminishes to less than 20,000 in a 24-hour period."

The above statement defines a "serious fish kill" which, in accordance with Condition 2 of the NYSDEC 401 Certificate, initiates action under this plan.

Implementation Actions

Station operating personnel are advised to be "on the alert" for schooling of fish in the intake flow of cooling water to condensers. In addition to and concurrent with operational actions to insure safe and efficient station power generation, the following actions will be taken:

(a) Notify the following supervisory personnel of the possible occurrence of an "Environmental Incident--Fish Kill".

1. Shift Superintendent

2. Plant Superintendent

(b) Notify plant biologists of the possible occurrence of an "Environmental Incident--Fish Kill". Biologists will be directed to initiate impingement sampling immediately and determine, as soon as possible, whether or not impingement exceeds 20,000 fish per day.

Action to be Taken Upon Determination of an "Environmental Incident--Fish Kill"

(a) In the event the number of fish collected is determined to exceed 20,000 in a 24-hour period:

1. Notify the NRC Director of the Regional Office of Inspection and Enforcement in accordance with ETS non-routine reporting requirements, Mr. James O'Reilly, phone (215) 337-1150.

2. Notify the NYSDEC Office of Environmental Analysis, Mr. Terence Curran, phone (518) 457-2223.

3. Notify the Director of Environmental Affairs, Niagara Mohawk Power Corporation, Mr. J. M. Toennies, phone (315) 474-1580.

4. Notify the FitzPatrick Project Engineer, PASNY, Mr. John Helland, phone (212) 397-6317.

5. Continue to monitor fish impingement as required by ETS.

(b) If the number of fish collected exceeds 20,000 per 24 hours for greater than 5 days in succession:

1. Notify, by telegram, NRC, EPA Region II, and NYSDEC and meet with them to discuss modifications in operation to reduce the number of fish being impinged.

(c) Upon agreement:

1. Implement operational modifications, continue impingement monitoring, and note any change in the numbers collected.

2. If number 1 is successful, continue operation in this mode until the number of fish is consistently (48 hours or more) less than 20, 000 per 24-hour period.

3. If number 1 is unsuccessful, notify all individuals listed in Paragraph (a) above and request additional instructions.

w York State Department of Environmental Conservation
N. Y. 12233

Henry L. Diamond, Commissioner

June 1, 1973

Mr. Asa George
General Manager
Power Authority of the
State of New York
10 Columbus Circle
New York, New York 10019

Dear Sir:

We have reviewed your request of March 9, 1973, pursuant to Section 401(a)(1) of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) (the "Act") and referred, for details, to your permit to operate and discharge dated November 28, 1972, and letter of approval dated November 27, 1972.

Based upon the foregoing and that public notice was duly given, the Department of Environmental Conservation hereby certifies in accordance with Section 401(a)(1) of the Act, that as of the date hereof, there is no effluent limitation or other limitation formally established under Sections 301(b) and 302 of the Act and there is no standard formally established under Sections 306 and 307 of the Act applicable to the activity which the Power Authority of the State of New York proposes to conduct (namely, the operation of the James A. Fitzpatrick Nuclear Power Plant, located on the south shore of Lake Ontario, in the Town of Scriba, Oswego County, New York.)

Pursuant to Section 401(d) of the Act and in accordance with the requirements of the New York State Environmental Conservation Law and the Official Compilation Codes, Rules and Regulations of the State of New York, particularly Parts 700-704 Classifications and Standards governing the Quality and Purity of Waters of New York State (Water Quality Standards), this certification hereby sets forth the following requirements which shall become conditions on any Federal license or permit subject to the provisions of this section:

1. The applicants must sample and monitor the traveling screens, trash racks, and forebay at the Fitzpatrick Plant in a manner approved by the Department of Environmental Conservation. Fish abundance data must also be submitted to the Department of Environmental Conservation.

2. Prior to the full operation of the plant, the applicants shall submit a report for the approval of the Department of Environmental Conservation describing a contingency plan for operations to be implemented in the event a serious fish kill, or other serious aquatic life incident, occurs as a result of the operation of this facility.

3. The applicants must collect and sample organisms at the discharge. The applicants must submit to the Department of Environmental Conservation their assessment of the significance of entrainment mortality on the local area and on Lake Ontario.

4. A copy of all reports pertaining to the environment which the applicants prepare for any federal, state, or local agency, should also be submitted to the Department of Environmental Conservation.

5. Intake and effluent temperatures and flow must be measured and recorded continuously.

6. Plant electrical output must be monitored and daily maximum and minimum recorded and daily average determined and recorded.

7. All oil and chemical discharges must be treated before any dilution in facilities approved by the New York State Department of Environmental Conservation.

8. Triaxial isothermal mapping by actual temperature measurement must be conducted on a frequency in such a manner and pursuant to a program approved by the New York State Department of Environmental Conservation.

9. Reports of tests and measurements pertaining to temperatures, flows, electrical output, oil and chemical discharges, and triaxial isothermal mapping as prescribed by the New York State Department of Environmental Conservation must be submitted monthly.

The applicants shall also comply with all provisions of any other Department approvals and permits.

This certification is issued solely for the purpose of Section 401(a)(1) of the Act and should not be construed to indicate approval of the project for any other purposes.

Very truly yours,

Terence P. Curran

Terence P. Curran
Director of Environmental Analysis

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019

(212) 283-6310

April 20, 1973

Mr. Willard A. Bruce, Chief
Industrial Works Section
Division of Pure Waters
New York State Department of
Environmental Conservation
50 Wolfe Road
Albany, New York 12201

Subject: James A. FitzPatrick Nuclear Power Plant
Discharge Permit

Dear Mr. Bruce:

Referring to your letter of January 16, 1973 regarding the chemical wastes in association with the Thermal Discharge Permit for the FitzPatrick Plant, attached are two (2) copies of an engineering report prepared in response to your request.

We trust that the information contained in this report satisfies your requirements and we request that this information and the temperature rise through the Plant as stated in our letter to you of January 9, 1973 be made a part of the new Permit issued by your Department.

Very truly yours,

Asa George
General Manager

R. C. CLANCY
APR 23 1973

PROJECT MANAGE[illegible]
APR [illegible]

Atts. 2
bcc. w/att. - Messrs. Cleveland, Walnrib, Goodman, Burt, Clancy
PASNY - Messrs. George, DeCarolis, Cicolo, Chiflasi, Clark,
Thiessmann, Leopold, Lilly, Davison, Wise

The following is an Engineering Report concerning the chemical wastes associated with the operation of the FitzPatrick Plant which will be discharged to Lake Ontario after treatment and complete mixing with the plant condenser and auxiliary system cooling water systems.

I. DISCUSSION

The chemical wastes associated with the operation of the James A. FitzPatrick Nuclear Power Plant are the (A) Makeup Water Treatment System, (B) Floor Drain System, (C) Detergent Waste System and (D) Evaporator Effluent. These wastes will be treated where applicable prior to discharge to Lake Ontario. Treated wastes will be completely mixed with the condenser and auxiliary system cooling water prior to discharge to Lake Ontario through a submerged multi-port jet discharge structure.

System descriptions, waste characterizations, and the environmental impact of these wastes on Lake Ontario are discussed in detail in subsequent sections of this report.

A. Makeup Water Treatment System

The makeup water treatment system under normal operation will provide 50 gpm of demineralized water with capability to provide 200 gpm of demineralized water, if required. The makeup water treatment system includes chlorination facilities, a contact clarifier, a series of three anthracite filters arranged in parallel, a neutralizer clearwell, an activated carbon bed, a vacuum deaerator, and cation, anion, and mixed bed demineralizers. A schematic diagram of the makeup water treatment system and associated chemical waste treatment facilities is shown in Section A of Figure 1.

Raw water from Lake Ontario will be taken from the service water pumps and conveyed to the makeup water treatment system. Table 1 presents water quality data reported by the New York State Department of Environmental Conservation for Lake Ontario at Oswego, New York.

Chlorine gas from 150 lb cylinders will be added to the makeup water prior to the contact clarifier tank to prevent

REPORT ON LIQUID WASTE SYSTEMS

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

POWER AUTHORITY OF THE STATE OF NEW YORK

APRIL 20, 1973

biofouling in the system. Approximately 30 parts per million (ppm) of chlorine, as Cl_2, will be fed from automatic chlorination equipment to the contact clarifier influent. The contact clarifier is designed to remove hardness and suspended solids from the raw water by the addition of 150 ppm of the hydrated lime and 50 ppm of ferric sulfate. This system would require blowdown of approximately 300 lb per day of solids consisting of calcium carbonate, magnesium hydroxide, ferric hydroxide, and suspended solids removed from the lake water. However, recent studies have indicated that satisfactory operation of the system could be achieved without the addition of hydrated lime. The system is presently being operated without lime addition. In this case, the hardness present in the lake water is removed in the cation demineralizer, and the contact clarifier would require blowdown of 50 lb per day of solids consisting of ferric hydroxide and suspended solids removed from the lake water.

Effluent from the contact clarifier will be conveyed to three anthracite filters for further removal of suspended solids. Filtrate will then be pumped to a neutralizer clearwell where the pH will be adjusted with acid to approximately 7.0.

TABLE 1

Lake Ontario Water Quality Data Recorded at Oswego, New York City Water Intake 6,500 Ft Into Lake at 40 Ft Below Lake Level*

Paramete	Units	Concentrations, Mean
Hardness ($CaCO_3$)	mg/l	146.0
Alkalinity ($CaCO_3$)	mg/l	94.0
Calcium (Ca)	mg/l	44.0
Chlorides (Cl)	mg/l	30.3
Iron (Fe)	mg/l	0.6
Manganese (Mn)	mg/l	0.01
Magnesium (Mg)	mg/l	8.9
Ammonia, Nitrogen (N)	mg/l	0.47
Nitrates (N)	mg/l	0.14
Nitrites (N)	mg/l	0.005
Phosphates (PO_4)	mg/l	0.19
Potassium (K)	mg/l	1.6
Sodium (Na)	mg/l	16.6
Sulfates (SO_4)	mg/l	30.1
pH	--	7.9
Turbidity	ft	8.4
Temperature	F	49.3
Dissolved Oxygen	ppm	10.9
5-Day BOD	ppm	1.25
Color	--	8.5
Conductivity	mmhos	306
Coliform Bacteria	No./100	56
COD Dichromate	ppm	7.9
Res. on Evap. (Total)	ppm	243
Res. on Evap. (Fixed)	ppm	135
Suspended Solids (Total)	ppm	10.5
Suspended Solids (Fixed)	ppm	5.5

*Data Recorded by New York State Department of Environmental Conservation

Clarified water from the clearwell will be conveyed to an activated carbon bed for removal of dissolved organic material, residual chlorine, and small amounts of suspended solids prior to demineralization. Effluent from the activated carbon bed will be pumped through ion exchange units for dissolved solids removal. The cation and anion units essentially remove all dissolved solids with the effluent passed through a mixed bed unit to remove the remaining trace quantities of dissolved solids. A vacuum deaerator is located between the cation and anion units to remove entrained gases such as carbon dioxide, oxygen, and nitrogen. Effluent from the mixed bed units will be reactor grade demineralized water which will be pumped to a storage tank for use in the steam supply system.

The operation of the makeup water treatment system, as shown in Section A of Figure 1, will result in five waste streams. These waste streams are numbered on Figure 1 from 1 to 5, and include contact clarifier blowdown, anthracite filter backwash, activated carbon bed backwash, cation and anion demineralizer regeneration wastes, and mixed bed demineralizer regeneration wastes. A detailed description of each waste is presented below:

Contact Clarifier Blowdown (1)

The contact clarifier blowdown includes suspended solids removed from Lake Ontario intake water and ferric hydroxide flocculant resulting from the addition of 50 ppm of ferric sulfate. It is estimated that the contact clarifier will require blowdown of 50 lb per day or 18,250 lb per yr of solids during an average makeup water rate of 100 gpm. Under normal operation, excess solids will be blown down from the clarifier once every 8 hr for a period of 55 sec at a flow rate of 220 gpm. The approximate suspended solids concentration of the blowdown will be 10,000 ppm. The change in the circulating water suspended solids concentration after complete mixing with the contact clarifier blowdown would be 6.2 ppm above the ambient level during the three 55 sec blowdown periods each day. Additional dilution will occur upon discharge by the submerged multi-port diffusers.

Filter Backwash (2)

Suspended solids present in the contact clarifier effluent will be removed by the three anthracite filters. It is estimated that the carryover suspended solids concentration to the anthracite filters will be 10 ppm. These filters will be cleaned either automatically or manually by backwashing when the head loss through the filter reaches a predetermined level.

At an average, makeup water treatment flow of 100 gpm, 12.6 lb per day or 4,600 lb per yr of suspended solids will be removed by the anthracite filters. One of the three filters will be backwashed once every day at a rate of 15 gpm/ft² for 4 min resulting in a total backwash volume of 4,700 gal. This backwash will have an approximate suspended solids concentration of 320 ppm and will be discharged at a rate of 1,180 gpm to the circulating water over a 4 min period. The change in the circulating water suspended solids concentration after complete mixing with the filter backwash would be 1.0 ppm. As shown in Table 1, the average suspended solids level in Lake Ontario water is 10.5 ppm.

Activated Carbon Bed Backwash (3)

Backwashing of the seven foot diameter activated carbon bed will occur, on the average, once a month at a washing rate of 10 gpm/ft² for 10 min. At a maximum capacity of 200 gpm through the carbon bed, backwashing would be required every 1 1/2 to 2 weeks.

Each backwash will result in 3,850 gal of wash water which will be conveyed to the makeup water demineralizer regeneration neutralization tank prior to discharge over a period of 1 hr at a rate of 50–150 gpm. The backwash will contain small amounts of residual suspended solids that pass through the anthracite filters, which precede the activated carbon unit. Under normal anthracite filter operation, approximately 1.0 ppm of suspended solids is expected in the effluent. At an average makeup water treatment system flow rate of 50 gpm, approximately 18 lb of suspended solids are expected to be removed by the carbon bed after 30 days of operation (equivalent to 215 lb per year). This quantity of solids will result in an approximate backwash suspended solids level of 560 ppm which will be discharged to the condenser circulating water. The change in the circulating water suspended solids concentration after complete mixing with the carbon bed backwash would be 0.2 ppm.

Cation and Anion Demineralizer Regeneration Wastes (4)

The cation and anion demineralizers will remove approximately 99+ percent of the dissolved solids present in the activated carbon bed effluent. These demineralizers are designed to produce 218,000 gal of demineralized water before regeneration is required. At a normal plant makeup water requirement of 50 gpm, the cation and anion demineralizers will be regenerated once every three days. Infrequent periods of peak makeup water demand requiring 200 gpm of demineralized water would necessitate C/A regeneration once a day.

During regeneration, dilute solutions of sulfuric acid (H_2SO_4) and sodium hydroxide (NaOH) will be pumped through the demineralizers to restore the resins to their hydrogen and hydroxyl forms for service operation.

The 30,000 gal of cation and anion demineralizer wastes will be neutralized with acid to a pH between 6.0 and 8.0. Regeneration of the demineralizers will result in approximately 33,000 gal of waste which will consist, after neutralization, mainly of sodium sulfate and other dissolved constituents which were originally present in the raw water supply. The neutralized effluent will flow by gravity from the neutralization tank at a rate of 50–150 gpm and will be completely mixed with the plant circulating water flow prior to discharge to Lake Ontario.

Table 2 presents the expected chemical composition of the cation and anion demineralizer regeneration waste after neutralization. The table also includes the expected change in circulating water concentration after complete mixing with the cation and anion regeneration wastes. In addition Table 2 also presents the total quantity of each constituent that will be discharged to the lake in lb/regeneration and lb per yr.

TABLE 2

Chemical Discharge Associated With Cation-Anion Demineralizer Regeneration Wastes*

cnstituent	Stream No. 4 Concentration, ppm	Change in Circulating Water Concentration after Complete Mixing, ppm	Lb/Regeneration	Lb/Year
odium, Na	1,457	0.216	403.5	49,227
otassium, K	9.6	0.0012	2.7	329
alcium, Ca	264	0.0335	73.1	8,918
agnesium, Mg	53.3	0.0068	14.8	1,806
ron, Fe	5.4	< 0.001	1.5	183
anganese, Mn	0.07	< 0.001	0.02	2
mmonia	3.60	< 0.001	0.99	121
hloride, Cl	183.4	0.023	50.8	6,198
ulfate, SO4	3,020	0.447	8,365	102,053
itrite, N	.04	< 0.001	0.01	1
itrate, N	.83	< 0.001	0.23	28
hosphate, PO4	1.16	< 0.001	0.32	39
DS	4,998	2.100	1,384	
H, Units	6.0-8.0	-	-	-

Discharge Rate - 50-150 gpm

Total Waste Volume Per Discharge - 33,000 gallons

Duration of Discharge - 10 hours

Average Frequency of Regeneration - Once Every 3 Days

Maximum Frequency of Regeneration - Once Every Day

*Includes 36 lb - 93% H2SO4 added for neutralization - Based on average makeup water requirement of 50 gpm.

Mixed Bed Demineralizer Regeneration Wastes (5)

The mixed bed (MB) demineralizer will remove the remaining 1 percent of dissolved solids primarily sodium, potassium, and ammonia that pass through the C/A demineralizer units. The MB demineralizer is designed to treat approximately 1,200,000 gal. of anion demineralizer effluent before regeneration is required. At a normal plant makeup water requirement of 50 gpm, the MB unit will be regenerated once every sixteen days. Infrequent periods of peak makeup water demand would require MB regeneration once every four days.

As with the cation and anion demineralizer regeneration, dilute solutions of sulfuric acid and sodium hydroxide will be passed through the unit to restore the resins to their hydrogen and hydroxyl forms for service operation.

Prior to discharge, MB regeneration wastes will be neutralized with caustic to a pH between 6.0 and 8.0. Regeneration of the MB demineralizer will result in approximately 5,745 gal. of waste which will consist, after neutralization, mainly of sodium sulfate and other dissolved constituents originally present in Lake Ontario. The neutralized effluent will flow by gravity from the neutralization tank at a rate of 50–150 gpm and is completely mixed with the station circulating water flow prior to discharge to Lake Ontario.

Table 3 presents the expected chemical composition of the MB demineralizer regeneration wastes after neutralization. Table 3 also includes the expected change in the circulating water concentration after complete mixing with MB regeneration wastes. In addition Table 3 presents the total quantity of each constituent that will be discharged to the lake in lb/regeneration and lb per yr.

TABLE 3

Chemical Discharge Associated With Mixed Bed Demineralizer Regeneration Wastes*

Constituent	Stream No. 5 Concentration, ppm	Change in Circulating Water Concentration after Complete Mixing, ppm	Lb/Regeneration	Lb/Year
Sodium, Na	1897.	0.273	90.8	1,998
Potassium, K	20.9	< 0.001	1.0	22
Calcium, Ca	-	-	-	-
Magnesium, Mg	-	-	-	-
Iron, Fe	-	-	-	-
Manganese, Mn	-	-	-	-
Ammonia	10.4	< 0.001	0.5	11
Chloride, Cl	-	-	-	-
Sulfate, SO4	3,611	0.580	172.8	3,802
Nitrite, N	-	-	-	-
Nitrate, N	-	-	-	-
Phosphate, PO4	-	-	-	-
TDS	5,539		265.1	5,833
pH, Units	6.0-8.0	-	-	-

Discharge Rate - 50-150 gpm

Total Waste Volume Per Discharge - 5,745 gallons

Duration of Discharge - 70 minutes

Average Frequency of Regeneration - Once Every 16 Days

Maximum Frequency of Regeneration - Once Every 4 Days

*Includes 58 lb - 100% NaOH added for neutralization - Based on average makeup water requirement of 50 gpm.

B. Floor Drain System

Floor drainage will consist primarily of condensate and pump seal leakage with small amounts of floor washdown, demineralizer leaks, and centrate from the precoat solid bowl centrifuge as shown in Section B of Figure 1.

Water from the floor sumps will be conveyed to a precoat filter for removal of suspended solids and trace quantities of oil. Sediment and floating oil in the equipment and floor drain sumps will be removed and disposed to an off-site storage area once a year. Influent to the precoat filter is expected to contain approximately 20 ppm of suspended solids and have a conductivity of less than 50 umhos. Cleaning floors within the plant is expected to require 50 lb per year of biodegradable detergent containing trisodium phosphate.

Cleaning of the precoat filter will be accomplished by conveying the removed suspended solids and precoat media to a sludge tank for thickening prior to dewatering in a solid bowl centrifuge. The filter media will be recovered from the centrifuge for reuse, and the dewatered solids will be drummed for off-site disposal. Centrate and sludge tank supernatant will be recycled to the precoat filter.

Precoat filtrate will be conveyed to a sample tank and then it will be discharged to the lake after being completely mixed with circulating water. Wastes associated with the floor drains that will be discharged to the lake are designated as waste stream Nos. 6 and 7 in Section B of Figure 1, and will be discussed in more detail below:

Floor Drain Discharge (6)

Precoat filtrate that has an acceptable activity in the sample tank will be completely mixed with circulating water and discharged to the lake. The average flow is expected to be 0.9 gpm of filtered water containing small amounts of dissolved solids.

C. Detergent Waste System

The detergent waste system, shown in Section C of Figure 1, will collect personnel decontamination wastes from showers and sinks, laboratory soap wastes, small tool and large equipment decontamination wastes, and spent fuel cask cleaning wastes. Drainage from this system will be conveyed to one of two 1,000 gal hold-up tanks for activity monitoring. It is expected that one tank would fill every 2 weeks and the contents discharged at an approximate rate of 30 gpm.

If the activity of the waste is unacceptable for discharge to the lake, the wastes will be conveyed to a thin film evaporator in the floor drain treatment system (as described in Section B). When possible, wastes with acceptable activity for discharge to the lake would also be conveyed to the thin film evaporator for water recovery.

Laboratory chemical wastes will be conveyed to the waste evaporator for concentration to solids prior to drumming and off-site disposal. None of the laboratory chemical wastes will be discharged to Lake Ontario.

The detergent wastes which will be treated and discharged to the lake are shown schematically as waste stream No. 8 in Section C of Figure 1 and will be discussed in more detail below:

<u>Detergent Drainage</u> (7)

As mentioned in the above section, detergent drainage is associated with several sources and is highly variable in flow and concentration. Due to the small daily quantities of detergent drainage, the total drainage contaminant quantities have been estimated on an annual basis.

The personnel decontamination wastes consist of drainage from plant decontamination showers and hand sinks. It is estimated that the shower will not be used more than 10 to 12 times a year. Hand decontamination is more frequent but represents smaller flows containing small amounts of surgical hand soap (approximately 12 lb per year of Septisol or equivalent). It is estimated that 6 times a year, decontamination with titanium dioxide, potassium permanganate, and sodium bisulfite will be necessary. This would result in an approximate discharge of 1/2 lb of each of these chemicals per year to the detergent drain tanks. The quantity of wash water discharged to the treatment system is estimated to be 1,000 gallons a year.

Laboratory soap wastes will result from the cleaning of glassware and will be conveyed to the detergent drain tanks. It is estimated that the wastes will contain 24 lb per yr of biodegradable detergent in 12,000 gal of wash water.

The small tool and large equipment decontamination will result in the discharge of approximately 10,000 gal of wash water per year containing 10 lb of biodegradable detergent.

Prior to shipment, the casks will be washed down with a biodegradable detergent to remove spent fuel pool water using approximately 50 lb of TSP detergent in 14,000 gal of water.

The total detergent discharge to the drain tanks from the above cleaning operations will be 100 lb in approximately 37,000 gal of washwater per year. This will result in an average detergent concentration of 300 ppm. At a detergent drain tank discharge of 30 gpm and a detergent concentration of 300 ppm, the anticipated circulating water detergent concentration would be 0.03 ppm. However, as mentioned previously, detergent waste with high activities along with much of the wastes acceptable for discharge will be sent to a thin film evaporator for water recovery. Therefore, only a portion of the wastes with acceptable activity will be completely mixed with circulating water and discharged to the lake.

D. Evaporator Effluent (8)

As mentioned above, filtrate from the sample tank that does not meet activity requirements along with high activity detergent drain tank wastes will be evaporated. When possible, effluent from these systems will be sent to the steam supply system for reuse. Otherwise, the distilled water from the sample tank will be completely mixed with circulating water and discharged to the lake. In this case, the average discharge rate would be 14 gpm for a period of approximately 20 days per year. Evaporator bottoms wastes will be drummed for off-site disposal.

II. IMPACT

As described in Sections A, B, C, and D, chemical waste associated with the operation of the James A. FitzPatrick Nuclear Power Plant will be intermittently discharged to Lake Ontario via the circulating water. The concentrations of dissolved solids after mixing with circulating water represent a small increase over ambient lake water. However, due to the infrequency and short duration of the discharges as well as the rapid dilution which will occur in the lake, it is not expected that these very small concentrations will have any impact on the receiving water. Further, only an extremely small percentage of organisms (plankton, larvae, and eggs) entrained in the plant circulating water will be subjected to higher concentrations of dissolved solids as they pass through the circulating water system due, again, to the infrequency and short duration of the discharges. These organisms are quickly carried out of the system into the lake where dilution brings them rapidly to ambient lake conditions. Therefore, it is expected that suspended solids from blowdown and backwashing wastes will not have a significant impact on organisms in the circulating water or in Lake Ontario.

Dissolved solids from all sources represent only a small percentage increase above ambient lake conditions and are not expected to have any impact on the biota of the lake.

The maximum concentration of phosphate at the point of discharge to the lake will be 0.03 ppm. Phosphates at this level are not toxic and, considering the infrequency of the discharge, it is not expected that detergents will have an adverse impact on the biota of the lake.

Titanium dioxide, potassium permanganate, and sodium bisulfite will be used occasionally for decontamination. This use will amount to approximately 1/2 lb of each chemical per year. Where possible, these wastes will be conveyed to the thin film evaporator with the detergents. If they are discharged to the circulating water, only negligible concentrations will enter the lake and should, therefore, have no effect on the biota.

New York State Department of Environmental Conservation
Albany, N. Y. 12201 Division of Pure Waters

Henry L. Diamond
Commissioner

November 27, 1972

Power Authority of the
State of New York
10 Columbus Circle
New York, New York 10019

Attention: Mr. Asa George

Re: Permit to Discharge (Cooling Water)
James A. Fitzpatrick Nuclear
Power Plant - (PASNY)
Scriba (T), Oswego County

Gentlemen:

The Permit to Operate and to Discharge Wastes to the Waters of the State dated November 28, 1972, is attached.

Permit

This permit carries qualifying conditions as specified in Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York, Part 652:

1. The operation permit shall be suitably framed and prominently displayed at the treatment works;

2. The permit is revocable or subject to modification or change pursuant to Article 17 of the Environmental Conservation Law;

3. The facilities shall be continuously operated and maintained so as to comply with the Environmental Conservation Law and all applicable laws, ordinances, codes, rules and regulations;

4. The facilities shall not receive or be committed to receive wastes beyond their design capacity as to volume and character of wastes treated;

5. The facilities shall not be changed or modified or otherwise altered as to type or degree or capacity of treatment provided, volume or character of wastes treated, disposal of treated effluent, or treatments and disposal of separated gases, liquids, solids or combinations thereof resulting from the treatment process without the prior written approval of the permit issuing official.

Additional conditions specified in this permit include:

1. Effluent limitations
2. Operational reports
3. Temperature limitations
4. Radioactive concentration limitations
5. Emergency situations
6. Cessation of operation and discharge

Management Responsibility

A competent operator shall be employed in responsible charge of the complete and actual plant operation and the process shall be adjusted and performance controlled for maximum removal of contaminants.

Objectives

The plant shall be operated to prevent pollution, safeguard receiving water quality and assure prolonged life of facilities through proper management, operation and maintenance.

Required Analyses

The minimum tests and measurements of influent wastewater, unit process effluent and final effluent as applicable are:

Tri-axial, post operational temperature studies designed to verify thermal diffusion patterns.

Ecology studies in accordance with the recommendations of the Division of Fish and Wildlife - DEC (Department of Environmental Conservation)

Radiological monitoring in accordance with the requirements of the Bureau of Radiological Pollution Control - Department of Environmental Conservation.

Continuous monitoring of discharge flow. Influent lake temperature and effluent discharge temperature.

Information can be obtained from the Syracuse Regional Office of the Department of Environmental Conservation, 100 Elwood Davis Road, North Syracuse, New York, regarding sampling, frequency, laboratory analyses and submission of operating reports.

The approved facilities consist of a thermal discharge and diffuser tunnel extending approximately 1367 feet into Lake Ontario.

Sincerely,

Willard A. Bruce

Willard A. Bruce, P.E.
Chief
Industrial Works Section

AA/dt
Attachment

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PERMIT

To Operate a Waste Treatment Facility and to Discharge Wastes to the Waters of New York State

1. Permittee:	2. Location of Facility (C,V,T):	3. County:	4. Entity or Service Area:
Power Authority f the State of ew York	Scriba (T)	Oswego	James A. Fitzpatri Nuclear Power Pla

5. Type of Waste: ☐ Sewage ☒ Industrial Specify 4911 ☐ Other Specify

6. Type of Facility: Thermal Diffuser

7. Grade of Operator Required: N/A

8. Point of Discharge:
Location (C,V,T): Scriba (T)
Surface water: Class A
Ground water: Class

Major Drainage Basin Lake Ontario
Name of Receiving Water Lake Ontario
Name of Receiving Water to which Ground Water is Tributary

This permit is issued under the provisions of Article 17 of the Environmental Conservation Law and Part 652 of the Administrative Rules and Regulations contained in Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (6 NYCRR 652) and is subject to the conditions specified in 6 NYCRR 652 and the following conditions:

1. THAT the effluent from the works shall have the following limits:
   (a) The volume of discharged wastewater shall not exceed a monthly average of 534 million gallons per day;
   (b) The discharged wastewater shall not contain additional wastes other than heat;
   as determined by appropriate sampling and standard testing methods.

2. THAT summary reports including results of tests and flow measurements as required by the Department of Environmental Conservation, shall be submitted to the Department on forms furnished by or satisfactory to the Department and that operating records shall be kept by the permittee.

3. THAT the temperature of the discharge in the effluent diffuser shall not exceed the lake temperature by more than 31.5°F.

4. THAT quantities or concentrations of radioactivity in the effluent are subject to the requirements of the United States Atomic Energy Commission as specified in Title 10, Code of Federal Regulations, Part 20 and Part 50, or as otherwise specified in applicable licenses issued by the United States Atomic Energy Commission.

5. THAT should any unusual situation occur causing a potential violation of water quality standards or creating a potentially hazardous condition, the permittee will immediately notify the Department of Environmental Conservation Syracuse Regional Office, when such conditions begin and when the condition ceases.

6. THAT should the operation of and the discharge from this facility permanently cease, this Permit is voided and automatically revoked.

ISSUED FOR THE NEW YORK STATE COMMISSIONER OF ENVIRONMENTAL CONSERVATION

[signature] Designated Representative — November 28, 1972 Date — November 27, 19 Expires

Distribution: White - Applicant; Pink - Central Office; Yellow - File (LHO or DHO); Green - Other

STONE & WEBSTER ENGINEERING CORPORATION
P. O. BOX 2325 BOSTON, MASSACHUSETTS 02107

DATE March 29, 1971
J. O. NO. 11325
P. O. NO.
OUR NO. PAS-2879
REF.

VIA

TO
MR ASA GEORGE-CHIEF ENGINEER
POWER AUTHORITY OF THE STATE
OF NEW YORK
10 COLUMBUS CIRCLE
NEW YORK NY 10019

DEAR SIRS:

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CORRESPONDENCE AND NOTES OF CONFERENCE
NEW YORK STATE DEPT. OF HEALTH
JAMES A. FITZPATRICK NUCLEAR POWER PLANT

Enclosed are one copy each of all Notes of Conference and correspondence from our files relating to transactions with the New York State Department of Health relating to the Fitzpatrick Plant discharge.

This material was requested in our Tel-Con of March 25, 1971.

Files relating to sewage disposal are being assembled and will follow shortly.

Yours very truly,

J. Wainrib

J. Wainrib

Copy to:
AGeorge

Mr. Asa George

J.O.No. 11825
PAS No. 2250

NOTES OF CONFERENCE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

Meeting with the New York State Health
and Conservation Departments
Held at 84 Holland Avenue
Albany, New York
March 25, 1970, 2:00 P.M.

-:-

Present for:

New York State Health Department		
Associate Director - Division Pure Waters, New York		E. F. Seebold
Acting Chief, Industrial Facilities Section		T. E. Quinn
Industrial Facilities Section		T. Adamczyk
Bureau of Water Quality Management		S. P. Mathur
New York State Conservation Department		G. E. Burdick
Niagara Mohawk Power Corporation	- Messrs.	R. C. Clancy
		R. J. Levett
		K. C. Swanson
		H. Smith
Power Authority of the State of New York	- Messrs.	A. George
		Z. E. Chilazi
Stone & Webster Engineering Corporation	- Messrs.	J. Wainrib
		G. E. Hecker

The purposes of the meeting were to (a) discuss the design of the intake structure, and (b) to submit and discuss written answers to the questions raised by the state regarding predicted thermal discharge patterns.

Stone & Webster made a brief presentation of the written answers being submitted to the state at the latter's request. Items covered were Hydro-thermal Analyses, Model Studies, Predicted Surface Temperature Patterns, Effects of Nine Mile Point Discharges, and Adverse Wind Conditions. Drawings showing the predicted cumulative temperature patterns were submitted to the state as part of the written answers. Mr. Quinn indicated that the state would require some time to study the submittal.

Niagara Mohawk made a brief presentation as to their experience with fish at the Oswego Steam Station and the Nine Mile Point Nuclear Station. Except for one occasion of alewives being forced into the Oswego intake during the passage of massive schools past the site, no fish problems have been experienced at Oswego. Fish have been observed to leave the intake screenwell and swim against the tunnel and intake velocities of approximately 45 and 2 ft/sec, respectively, to the open lake. Almost no fish have been observed in the Nine Mile Point screenwell. The velocity at the intake of this plant is 1.8 ft/sec. A letter from Dr. J. F. Storr, consultant on fish biology and limnology, confirming the design of the FitzPatrick intake with a velocity of 1.4 ft/sec was submitted to the state. The possibility of electric or bubble-type fish screens was mentioned after everyone agreed that a fine mesh screen at the intake in the lake was completely impractical.

Mr. Burdick indicated that electric or bubble screens were not acceptable to the state since they do not work. He did not question the velocity at the intake, but desired that some sort of fish saving device be considered for the intake screenwell. More specifically, he stated that provisions should be made in the screenwell upstream from the trash racks and traveling screens to install some sort of fish saving device if station operating experience indicates this is desirable.

Mr. George stated that the Power Authority will make the necessary provisions in the screenwell for a possible future fish saving device. It was the consensus of all that such a device would be a pioneering effort, and none present could specify the desired conceptual design of such a device.

J.O. No. 11825
PAS No. 2151

Conf Notes

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NOTES OF CONFERENCE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

Meeting with the New York State Health Department
Held at 845 Central Avenue, Albany, New York
On March 6, 1970, at 10:00 A.M.

-:-

Present for:

New York State

Atomic Energy Council, Dept. of Commerce	-	Mr. G. Anastas
Public Service Commission	-	Mr. P. Pomeranz
Director, Nuclear Engineering Dept. of Health	-	Mr. T. Cashman
Conservation Dept., Pollution Branch	-	Mr. G. Burdick
Department of Health	- Messrs.	J. Mathur A. Adamczyk T. Quinn
Senior Meteorologist, DAR, Dept. of Health	-	Mr. H. Seitz
Senior Pub. Inf. Spec.	-	Mr. C. T. Horton, Jr.
Senior Engineer Bureau of Radiological Health	-	Mr. K. Anderson
State University of New York at Buffalo, Consultant in Ecology	-	Dr. J. Storr
Niagara Mohawk Power Corporation (NMPC)	- Messrs.	R. C. Clancy R. Bowers
Power Authority of the State of New York (PASNY)	- Messrs.	A. George Z. E. Chilazi
Stone & Webster Engineering Corporation (S&W)	- Messrs.	B. Brodfeld W. O. Chatfield J. Wainrib G. E. Hecker

Mr. Cashman indicated that New York State had two objectives for the meeting:

a. A review of the application by PASNY for a state construction permit

b. A discussion of radiological programs and engineered safeguards as related to the state's position at the AEC public hearing

Mr. George made a brief introduction in which he indicated full cooperation with the state agencies and stated the need for a construction permit in view of the project schedule.

S&W gave a presentation of the field, model, and analytic studies, described the adopted design, and stated that cooling water flow from the diffuser structure will comply with the state thermal criteria under all conditions. The state asked three questions regarding material in the "Engineering and Ecological Studies" report:

a. Why does the report show a 3 F rise isotherm of greater extent than that allowed, and for what reasons are the field temperatures with currents expected to be lower than indicated by the model?

b. How were the cumulative FitzPatrick temperatures computed to include the effect of Nine Mile Point Nuclear Station?

c. What would be the effects of an onshore wind?

S&W replied that, regarding question "a," the 3 F rise isotherm was computed using model data with currents and that the model gave temperatures considerably in excess of field conditions for several reasons. These reasons, which were stated in the previously submitted report, were amplified on, and it was pointed out that the drawings in question have an explanatory note to this effect. Regarding question "b," the basic procedures for calculating the effects of Nine Mile Station were expanded on, and it was agreed that more detailed information on these computations would be supplied. Relative to item "c," it was stated that only infrequent and unusually strong winds from the north could induce some surface flow toward the shoreline but that this flow would come from the edges of the plume where the lakeward flow velocities were lower and not from the central and main body of the discharge. The intake would therefore not be affected, and any flow reaching the shore would have a temperature rise of less than 3 F. It was agreed that an informal meeting between the state and S&W would be beneficial to all concerned.

Dr. Storr presented a summary of the ecologic studies conducted to date and the plans for future field studies, including temperature surveys. Basic results to date were the general sparseness and variability of fish, the restriction of bottom biota to the 5 to 20 ft depth contours, and the indication from the laboratory study that the algae cladophora experienced maximum growth at 65 F.

Mr. Burdick asked about the velocity at the intake structure and was informed it would be about 1.4 fps. NMPC stated that they have found negligible fish in the screenwell with similar intake velocities at the Nine Mile Point Nuclear Station. Although Mr. Burdick indicated the state prefer 1.0 fps, he recognized the implied construction problems and showed interest in what could be done to attenuate potential problems after plant operation.

Dr. H. Seitz questioned the use of the meteorological data and the sources thereof. S&W stated that the data were collected for Nine Mile Point, and the same data were used. On the questions of dispersion parameter, the same answer was given. The data were initially collected by Nine Mile Point and analyzed by Mr. Maynard Smith of Brookhaven using four classes of winds.

The state also asked whether there should not be a sample station closer to shore than the ones that we have shown. As a matter of fact, they asked whether it should not be adjacent to the shore. We replied that the possibility of placing a station there would be evaluated.

Copy to
AGeorge
ZEChilazi-3 (encs.)
JFStorr (enc.)

WBAllred
MECleveland
DKFeldtmose
CEGoodman
SCLeland
HELesser
LSMaciejewski
JWainrib
EKHuse
✓DStein/Job Book

JPAllen
JRGuerts
RJMacDonald
RCMiller
RWGunwaldsen
APStakutis/ETWitt
WSRoberts, Jr.
AASmith
General Files
BBrodfeld

April 8, 1969

J.O. No. 11825
PAS No. 429

Mr. Asa George
Chief Engineer
Power Authority of the State of New York
10 Columbus Circle
New York, N. Y. 10019

Dear Sir:

NOTES OF CONFERENCE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT

We are enclosing three copies of notes of conference held at the New York State Conservation Department in Albany, New York, on March 31, 1969.

We trust that these notes are in accordance with your understanding; if not, please advise us.

Yours very truly,

J. Wainrib
Project Engineer

Enclosures

BB:mab

J. No. 11825
S No. 429

NOTES OF CONFERENCE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

Held in the offices of
New York State Conservation Department
in Albany, New York
on March 31, 1969

Present for:

Power Authority of the State of New York	-	Mr. I. G. Stubbart
Niagara Mohawk Power Corporation	-	Mr. T. W. Philbin
New York State Conservation Department	-	Messrs. W. G. Bentley G. Burdick W. A. Pierce
Stone & Webster Engineering Corporation	-	Mr. B. Brodfeld

The purpose of the meeting was to discuss the scope of ecological studies to be carried out at the site.

Mr. Stubbart stated the policy of the Power Authority of the State of New York as follows:

1. The Authority have decided to meet the thermal discharge criteria set by the State and not to challenge the regulations.

2. In view of the tightness of the construction schedule for James A. FitzPatrick Nuclear Power Plant, it is necessary that detailed design of discharge and intake structures be initiated on July 1, 1969, and the application for a water permit be filed in October 1969, so that tunnel construction can start early in 1970. Each day of delay in commercial operation would cost approximately $80,000.

3. In view of the Power Authority commitment to generate low-cost power, the scope of ecological studies should be limited to what the New York Conservation Department believe is essential.

M. Brodfeld stated that, in accordance with the expressed policy of the Power Authority, the design of the discharge structure for condenser cooling water will be governed by the criterion of 3 F permissible temperature rise at lake surface outside a 300 ft radius circle, or an equivalent area. The field and laboratory studies, as well as theoretical analyses, will be aimed at proving that this criterion will be met when the combined effects of Nine Mile Point Station, Unit No. 1 and James A. FitzPatrick Nuclear Power Plant are considered. It is understood that the issuance of the water permit will not be contingent on any ecological studies which may be required by the New York State Conservation Department. A brief presentation was made of the presently considered design concepts aimed at achieving the desired thermal effects, such as diffuser pipe anchored on the lake bottom, or embedded in a trench, or tunnel with several discharge shafts.

Messrs. Bentley and Burdick stated their agreement with the described concept of a multi-port submerged discharge structure. Mr. Bentley indicated that while, in general, ecological studies are required over one year prior to issuing a water permit, this will not be necessary in the case of the James A. FitzPatrick Nuclear Power Plant in the context of meeting the regulations and in view of studies already carried out for Nine Mile Point Station. The ecological studies would have to start in the summer of 1969, continue for one year and then be repeated after the plant is in operation. The purpose of these studies is to provide background information and help refute possible criticism after the plant is in operation, for example in regard to effects on alewife.

The New York State Conservation Department have no objection to filing the water permit application in October 1969 and, if the state thermal criteria are met, no problem is anticipated in connection with the permit. While the regulations have not been finalized officially, the hearings which were held in March 1969 showed that no new facts have been presented, and it is reasonable to assume that the 3 F criterion is a safe design basis. It is expected that the regulations will be formally adopted in the fall of 1969.

Mr. Bentley stated that the New York State Conservation Department will fully cooperate with the Power Authority in connection with all ecological studies to be carried out.

Mr. Stubbart indicated that the docking facilities at the site would be made available to the crews of the Conservation Department in connection with any lake work they may carry out. However, a certain training program will be necessary as required by nuclear safety regulations. Representatives of the Conservation Department were also invited to see the model tests at the Alden Research Laboratories.

Dr. Storr discussed, in principle, the scope of the ecolgical studies to be carried out at the James A. FitzPatrick site. It was agreed that, while studies can be intermittent, the elapsed time between surveys should, in general, be less than two to three months. Net lengths of 400 to 500 ft would be adequate. Counts of all fish including alewife are required.

Messrs. Bentley and Pierce indicated that, in addition to the temperature surveys which will be carried out, it is necessary that the fish nets be provided at the lake bottom with maximum-minimum thermometers which would show the extreme temperatures during each fish survey.

Dr. Storr will prepare a detailed program of the proposed ecological studies which, after review by the Power Authority, will be discussed with representatives of the Conservation Department.

ZLeonard
TWPhilbin (1 enc.)

DAFeldtmose
CEGoodman(enc.)PD
SCLeland
HELesser
LSMaciejewski
JWainrib
TKHuse
ABleiweis
RDShillady
AASmith
DStein/Job Book
General Files
BBrodfeld

March 28, 1969

J.O.No. 11825
PAS No. 377

Mr. Asa George
Chief Engineer
Power Authority of the State of
New York
10 Columbus Circle
New York, N. Y. 10019

Dear Sir:

NOTES OF CONFERENCE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT

Enclosed are three copies of notes of conference held in the Boston office of Stone & Webster Engineering Corporation on March 19, 1969.

We trust that these notes are in accordance with your understanding; if not, please advise us.

Yours very truly,

J. Wainrib
Project Engineer

Enclosures

BB:mab

J.O. No. 11825
ES No. 377

NOTES OF CONFERENCE
JAMES A FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

Held in the offices of
Stone & Webster Engineering Corporation,
Boston, Massachusetts, on
March 19, 1969

Present for:

Power Authority of the State of New York	- Messrs.	A. George I. Stubbart
Niagara Mohawk Power Corporation	- Mr.	T. W. Philbin
Stone & Webster Engineering Corporation	- Messrs.	R.W. Gunwaldsen N.B. Cleveland J. Wainrib B. Brodfeld R.C. Miller G.E. Hecker J.P. Allen, Jr.

The purpose of the meeting was to discuss a program of field and laboratory studies recommended by Stone & Webster and the approach to be used during the forthcoming meetings with New York State officials.

Mr. Gunwaldsen emphasized the tightness of the construction schedule and the need for meeting certain important deadlines, such as: starting discharge and intake tunnels no later than December 1969; finalizing tunnel design no later than October 1969; completion of model studies before October 1969. To make sure that construction work on the tunnels proceeds on a safe basis, preliminary discussions with interested New York State agencies should take place periodically, and the application for a water permit should be filed no later than November 1969. Current engineering work and laboratory studies are proceeding based on the understanding that PASNY have decided to meet the New York State temperature criteria; that is, 3 F outside a 300 ft radius, or an equivalent area.

The program prepared by Stone & Webster is based on the premise that all field surveys, laboratory investigations and theoretical analyses to be carried out in connection with the discharge of condenser cooling water fall within two categories: (a) studies directly related to the application for a water permit and aimed at presenting evidence that the New York State temperature criteria are met; (b) studies not related to the application for a water permit and designed only to keep track of aquatic life and water quality at the site both before and after plant operation. While the program of the latter studies would be presented to, and discussed with, interested New York State agencies, the water permit would not be contingent on completion of such studies. A detailed breakdown of proposed studies in this category was presented by Stone & Webster representatives. Their costs were estimated in a very preliminary way at $70,000 to $100,000, depending on the number of years in which they would have to be carried out.

Mr. George indicated that an informal meeting with New York State officials should be held as soon as possible to discuss the program of ecological studies. Dr. J. F. Storr, Messrs. Stubbart, Philbin and Brodfeld will participate at the meeting. The discussions will be held in the context of meeting New York State temperature criteria. Subsequent to this informal meeting another, more formal meeting will be held to present the discharge concepts.

Mr. George requested that a construction schedule be submitted to PASNY to show the timing of tunnel construction. Stone & Webster representatives indicated that a chart will be submitted shortly.

The various discharge concepts currently considered by Stone & Webster were presented, and their relative merits were briefly commented upon.

Mr. Philbin expressed the concern of Niagara Mohawk Power Corporation that meeting the 3 F temperature criterion would both create a precedent and increase the cost of discharge structures for subsequent units, since large amounts of cold water would be necessary to attain the necessary dilution.

Mr. Gunwaldsen indicated that it might be possible to induce currents at the site by taking advantage of jet entrainment. A T-orientation of the discharge structure, if demonstrated effective, would result in minimum interference with subsequent units.

It was indicated that a 30-day waiting period is necessary to obtain a permit from the U.S. Army Corps of Engineers in connection with instrument towers and float surveys in Lake Ontario. Mr. Philbin advised that Niagara Mohawk have prepared the application, which will be sent to PASNY on March 24, 1969. Mr. George indicated that he would give priority to getting the application out as soon as possible.

[illegible]
[illegible] 11825 [illegible]
No. 242

NOTES OF CONFERENCE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

Held at the offices of
The New York State Department of Health,
Albany, New York,
on January 24, 1969

Present for:

Power Authority of the State of New York	Messrs.	A. George I. G. Stubbart
Niagara Mohawk Power Corporation	Messrs.	H. Philipp T.W. Philbin
New York State Department of Health	Messrs.	D.B. Stevens S.P. Mathur T. Cashman W.J. Kelleher T.E. Quinn
New York State Conservation Department	Messrs.	I.E. Wilson W.G. Bentley W.A. Pierce C. Burdick
Stone & Webster Engineering Corporation	Messrs.	B. Brodfeld G.E. Hecker

---

The purpose of the meeting was to make a presentation of the proposed field and laboratory studies in connection with the discharge of condenser cooling water at the James A. FitzPatrick Nuclear Power Plant, and to discuss possible discharge concepts.

Mr. Brodfeld made the presentation in accordance with the decisions made at the meeting held the previous day by representatives of PASNY, Niagara Mohawk and Stone & Webster. He described in detail the proposed field and laboratory studies.

Mr. Philipp asked whether a Nine Mile Point type discharge, with surface temperature rises of about 16 F in the vicinity of the outlet, would create any concerns. He emphasized the advantages of increased heat transfer to atmosphere.

Bentley stated that the proposed field and laboratory studies were very useful. He indicated that exceptions to the current criteria would be taken into consideration, provided comprehensive ecological studies are made to show that no harmful effects would result for aquatic life. The time unit for such studies is a year. Studies such as those made by Dr. J. J. Storr for Nine Mile Point would not be sufficient, and more would be expected at this time. The chemistry of the water should be studied.

In reply to a question, Mr. Bentley indicated that, if no exception from the current criteria were requested, an ecological study would still be necessary, but its scope would be smaller than that required if an exception is asked for. He stated that the ecology consultant for PASNY should discuss the proposed scope of the study with Department of Health officials. They would be willing to work with that consultant, so that they can make comments on the various discharge concepts before a full year elapses. Mr. Bentley listed various aquatic species which could be affected by increased temperatures, among which he also mentioned the Clodophera algae. He stated that inflow of warm water into Mexico Bay would be a cause of concern.

Mr. Burdick indicated that he would be concerned by temperature rises higher than the 3 F specified in the regulations. He said that an ecological study is necessary to prove that even these temperature rises are not excessive. He mentioned, however, that he did not know who would have the obligation to make such a study, if the regulations were complied with.

Mr. Kelleher indicated that he did not expect special radiological problems at this site.

Mr. Wilson stated that a part of the public in the general area of the site has expressed some concern regarding possible effects of the plant on the lake.

Mr. George stated that he appreciated the cooperation of New York State officials, and indicated that the Power Authority would welcome visits from representatives of the various New York State departments to Alden Research Laboratories. Similar meetings will be held in the future.

After the meeting with New York State officials, Messrs. George, Stubbart, Philipp, Philbin, Brodfeld and Hecker had a brief discussion. It was decided that Stone & Webster will review the schedule to determine whether the studies on the discharge arrangement can be expanded to include the three concepts discussed. Stone & Webster will prepare a cursory analysis of the thermal effects of these three types of outlet. It was estimated that this would require approximately a month.

Dr. Storr will make a proposal to Stone & Webster regarding the scope of the ecological studies. Stone & Webster will then make a recommendation to PASNY.

CEGoodman
DStein/Job Book
General Files
BBrodfeld

February 6, 1969

J.C.No. 11825
PAS Nos. 241
242

Mr. W. S. Chapin
General Manager
Power Authority of the State of New York
10 Columbus Circle
New York, N.Y. 10019

Dear Sir:

CONFERENCE WITH NEW YORK STATE OFFICIALS
JAMES A. FITZPATRICK NUCLEAR POWER PLANT

Enclosed are three copies each of notes of conference held on January 23, 1969, by representatives of the Power Authority of the State of New York, Niagara Mohawk Power Corporation and Stone & Webster Engineering Corporation, and on January 24, 1969 by all the above and officials of the New York State Department of Health and the Conservation Department.

We trust that these notes are in accordance with your understanding; if not, please advise us.

We have carefully reviewed the matters discussed at these meetings and believe that an extension of the hydrothermal and ecological studies would have serious effects on the construction schedule. Therefore, we recommend that a meeting of PASNY and Stone & Webster representatives be arranged to discuss this matter.

Yours very truly,

J. Wainrib
Project Engineer

Enclosures

BB:MLS

[illegible]o. 11825
[illegible]No. 241

NOTES OF CONFERENCE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

Held at the Thruway Motor Inn,
Albany, New York,
on January 23, 1969

Present for:

Power Authority of the State of New York	- Messrs.	A. George I. G. Stubbart
Niagara Mohawk Power Corporation	- Messrs.	H. Philipp T. W. Philbin
Stone & Webster Engineering Corporation	- Messrs.	B. Brodfeld G. E. Hecker

---

The purpose of the meeting was to discuss the presentation to be made on January 24, 1969, at a meeting with representatives of the New York State Department of Health and the Conservation Department.

Mr. Brodfeld presented several drawings outlining the concept of a diffuser type discharge aimed at meeting the New York State thermal discharge criteria, and in particular the 3 F permissible temperature rise at the lake surface. He also discussed the scope of the proposed field and model investigations to be carried out in conjunction with analytical studies.

Mr. Philipp suggested that the concept of the diffuser type discharge, based on the 3 F temperature rise, should not be presented to New York State officials, since this would create a precedent, and that advantage should be taken of the exception clause in the regulations. He specifically recommended that the representatives of the New York State Department of Health and the Conservation Department be asked what their concerns would be if the discharge structure of James A. FitzPatrick Nuclear Power Plant were of the same type as that adopted for Nine Mile Point Nuclear Station. He indicated that, in his opinion, their main concern regards the effects of warm water on Clodophera algae.

...d that a study proposed by Dr. J. J. Storr for the summer of 1969 could give a satisfactory answer. He also stated that, in the opinion of Niagara Mohawk, conditions in Lake Ontario warrant higher temperature rises than those currently permitted, and that such higher temperatures would ultimately be more beneficial, since they would result in greater heat transfer to atmosphere.

Mr. Brodfeld indicated that, in his opinion, requesting an exception to present New York State regulations will lead to delays in engineering-design work and will therefore affect the construction schedule prepared by Stone & Webster Engineering Corporation, in particular with respect to the intake and discharge tunnels. Extended ecological studies would be required to justify the exception and there would be no assurance of a positive result. Public hearings will probably be necessary in compliance with the regulations, and this could result in further delays. While the present regulations have serious shortcomings, using the James A. FitzPatrick project as a test case does not seem to be the best way to challenge these regulations.

Mr. Stubbart agreed with the Niagara Mohawk suggestion that the possibility of an exception be explored at the meeting with New York State officials. He suggested that the concept of a surface discharge also be discussed, and emphasized the economic advantages of such a discharge. He questioned the tightness of the schedule in respect to intake and discharge tunnels.

Mr. George advised that the presentation at the meeting with New York State officials be confined to the scope of the proposed model studies and field surveys, and to the presentation of the three possible discharge concepts; that is, surface discharge, Nine Mile Point type outlet and diffuser type outlet. The purpose of such a presentation would be to see how flexible the state officials are in their interpretation of the regulations and to insure that a more economical design for the discharge structure would not have been bypassed by immediately complying with the 3 F surface temperature rise restriction. Final decisions will be made based on the results of the meeting to be held January 24, 1969.

[illegible]

CRClaxton
DKFeldtmose
WSRoberts, Jr.
JWainrib
LSMaciejewski
CLWhitford
CEGoodman
ABleiweis
HELosser
EEForslind
DMStein/Job Book
General Files
DPMcKittrick

July 15, 1970

J.O.No. 11825
PAS-2774

Mr. Asa George
Chief Engineer
Power Authority of the State of New York
10 Columbus Circle
New York, N. Y. 10019

Dear Sir:

REVIEW OF PSAR BY THE N.Y. STATE DEPT. OF HEALTH
JAMES A. FITZPATRICK NUCLEAR POWER PLANT

We have reviewed the letters from the State of New York - Department of Health and the State Geologist's office enclosed with your letter of June 24, 1970. With regard to your specific requests, we offer the following comments:

1. "Response to Item 1 on page 2 of Mr. Kriedler's letter of May 13, 1970, to Mr. Cashman."

   No stress tests were made directly by Dr. Bombolakis. Rather, Dr. Bombolakis supervised and directed the overcoring tests conducted by F. Wright of Lucius Pitkin, Inc. The techniques involved in stress measurement by overcoring, and the results of the tests are described in Appendix F, Supplement 1, of the PSAR. Specifically, these tests are described on page F6 and in Dr. Bombolakis' letter included in the supplement. However, if further information is required, we are enclosing with this letter three copies of a report by Dr. Bombolakis describing the tests and the results thereof in considerable detail.

2. "Your position with respect to the items outlined on page 1 of Mr. Kriedler's letter."

The comments offered by Mr. Kriedler with respect to site geology and stratigraphy are somewhat academic and are not significant insofar as any effect on the project is concerned. However, we will investigate his comments fully, and if they can be substantiated would recommend, for the sake of ac[illegible]racy, a revision to the geologic section when the FSAR is filed.

If any further information is required with respect to this matter, do not hesitate to contact us.

Yours very truly,

J. Wainrib
Project Engineer

DPM:GMS

13640

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N.Y. 10019
212 – CO 5-6510

7.6

May 4, 1970

Job 11825 - 70-151

Stone & Webster Engineering Corp.
P. O. Box 2325
Boston, Massachusetts 02107

Attention: Mr. J. Wainrib

Gentlemen:

Attached is a copy of a letter from the New York State Department of Health dated April 30, 1970, which transmits a corrected construction permit (thermal discharge) for the J. A. FitzPatrick Nuclear Power Plant.

You are requested to discard the copy of the incorrect permit previously sent to you.

Very truly yours,

Asa George

Asa George
Chief Engineer

cc: Mr. N. B. Cleveland w/att.

STATE OF NEW YORK
DEPARTMENT OF HEALTH
84 HOLLAND AVENUE
ALBANY, NEW YORK 12203

DEPUTY COMMISSIONER
DIVISION OF PURE WATERS
PAUL W. EASTMAN, P.E.
ASSISTANT COMMISSIONER

April 30, 1970

Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Attention: Mr. Asa George

Gentlemen:

Re: Permit (Thermal Discharge)
James A. Fitzpatrick Nuclear Power
Plant - PASNY
Scriba (T), Oswego County

Item 14 (design flow) of the construction permit dated April 14, 1970 for this project was incorrectly recorded by our office. We are enclosing a corrected permit of the same date as a replacement. Please discard the incorrect permit.

Very truly yours,

Thomas E. Quinn, P. E. Chief
Industrial Facility Section

TEQ:AA:SG
cc: Watertown District Office
Syracuse Regional Office
Stone & Webster Engineering Corp.

PERMIT TO CONSTRUCT A WASTE DISPOSAL SYSTEM

Under the provisions of Article 12 of the Public Health Law and 10 NYCRR 73.

1.	2. Location of Works (C.V.T):	3. County:	4.
...thority of ...e of New	Scriba (T)	Oswego	James A. Fitzpatrick Nuc Power Plant

...struction of the approved works, the permittee accepts and agrees to abide by and conform with the following:

1. ... construction permit shall be maintained on file by the permittee.
2. ... the permit is revocable or subject to modification or change pursuant to Article 12 of the Public Health Law.
3. THAT the facilities shall be fully constructed and completed in compliance with the engineering report, plans and specifications as approved.
4. THAT the facilities shall not be placed in operation until construction has been completed and an operation permit has been issued, or unless ordered to be operated by the Commissioner or by a Court.
5. THAT the construction of the facilities shall be under the supervision of a person or firm qualified to practice professional engineering in the State of New York under the Education Law of the State of New York, whenever engineering services are required by such law for such purposes.
6. THAT where such facilities are under the supervision of a professional engineer, he shall certify to the Department and to the permittee that the constructed facilities have been under his supervision and that the works have been fully completed in accordance with the approved engineering reports, plans, specifications and permit.
7. THAT the construction of the facilities shall commence by October 1, 1970 and be fully completed by October 1, 1973.

ISSUED FOR THE STATE COMMISSIONER OF HEALTH	DATE
[signature] Designated Representative	4/14/7

(SEE REVERSE SIDE)

Distribution: White – Applicant; Pink – Central Office (BED); Yellow – File (LHO or DHO); Green – Other

San. 2 (Rev. 11/67)

...cial | [ ] 65 Private-Other | [ ] 19 Federal | [ ] 18 Indian Reservation
...Works Corp. | [ ] Private-Institutional | [ ] 20 State
... | [ ] 25 Board of Education

...ction:
Collection: [ ] 1 New [ ] 2 Additions or Alterations
Treatment and/or Disposal: [X] 1 New [ ] 2 Additions or Alterations

...ction:
Collection System N/A
Treatment and/or Disposal $6,000,000

[ ] ... Sewage
[ ] Industrial Specify
[X] Other Specify Thermal

[ ] 1 None
[ ] 2 Septic Tank
[ ] 3 Primary
[ ] 4 Intermediate
[ ] 5 Secondary
[ ] 6 Tertiary
[ ] 7 Complete
[X] 8 Not Applicable

Location (C,V,T) Scriba (T)
Major Drainage Basin Lake Ontario
...Name of Watercourse Lake Ontario
Surface Water Class A
...Name of Watercourse to which ground water is tributary
Ground Water Class

...Treatment Works:
...A. Fitzpatrick
...Power Plant

12. Grade of Plant Operator Required: N/A

13. Disinfection Required: [ ] 1 Continuous [ ] 2 Seasonal [X] 3 None

...(...): ...,000,000

15. Design Equivalent Population (BOD Basis): N/A

16. Design Plant Efficiency (% BOD Removal): N/A

...units, such as number, name and capacity of units:

...charge tunnel - 1,367 feet long
approximately 14 feet x 14 feet in X-sec.

...iffuser tunnel - 774 feet long with 6 diffuser heads

...diffuser heads - consisting of two nozzles each 2.5 feet in diameter

...STER ENGINEERING CORPORATION

TO:

NBCLEVELAND
CRCLAXTON
DKFELDTHOSE
WSROBERTS, JR.
LSMACIEJEWSKI
CEGOODMAN
RDSHILLADY
ABLEIWEIS
HELESSER
JPBURRIS
EEFORSLIND
JPALLEN
BEROSFELD
JFCAMPELLO
RCCARTER
GAGERRIDGE
JRGEURTS
LRBURR
RCMILLER
LPWALKER
LJPIERCE
APSTAKUTIS
AFSHARRY, JR.-3
CLWHITFORD
PD
AASMITH
EPSTEIN/JOB BOOK
GENERAL FILES
JWAINRIB

BOSTON, MASSACHUSETTS

APRIL 27, 1970

File in Job Book 7.6

ASA GEORGE, CHIEF ENGINEER
POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE
NEW YORK, N. Y. 10019

70-69 N. Y. STATE LICENSE DATED 4/4/70 INCLUDES ITEM 14 DESIGN FLOW IN GALLONS PER DAY 5,330,000. YOUR APPLICATION AS PER LETTER TO INGRAHAM FROM CHAPIN DATED 1/9/70 ASKED FOR 534,000,000 GALLONS PER DAY. THE LATTER NUMBER IS CORRECT AND THE STATE SHOULD BE NOTIFIED OF ERROR.

J. WAINRIB
STONE & WEBSTER ENGINEERING CORPORATION

CHARGE TO J.O.NO. 11825

JW:KB-nm

in front of the traveling screens to permit the installation of fish saving devices if necessary and can be committed to such installation on need it need not be considered further at this time." (W. G. Bentley to J.P. Mathur; 4/6/70)

As the above comment translates to possible design changes in the forebay structure, it is requested that such be included in plans for the project.

The Public Health Law requires that plans and specifications be approved prior to the issuance of a permit for the construction of a new outlet. It is our understanding that intake and discharge plans have been prepared for the purposes of receiving bids for construction and that no delay would develop in submitting them for approval. The plans should incorporate for our purposes plan and profile of the engineering features on full size drawings. Details of structural members and reinforcing are not required.

Four sets of these plans and specifications, and three additional copies of the engineering report, all signed and sealed by a professional engineer licensed in New York State, are required for our approval.

Very truly yours,

Thomas E. Quinn, P.E.
Acting Chief
Industrial Facilit[y]

TEQ:SG
cc: PASNY: Mr. George
Syracuse Regional Office
Watertown District Office

to: CEGoodman, RDShillady, ABleiweis, JPBurris, HELesser, EEForslind, RCMiller, BBrodfeld, JWainrib, DLStein/Job Book, General Files, LSMaciejewski

April 1, 1970

J.O.No. 11825

. T. E. Quinn
. ng Chief, Industrial Facility Section
. York State Health Department
. Holland Avenue
Albany, New York

Dear Sir:

THERMAL DISCHARGE
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

We received your letter to Mr. R. W. Gunwaldsen and wish to advise you as follows.

The Alden Research Laboratory's evaluation of the model studies was sent to you by special messenger on March 27, 1970.

Other than neutralized make-up water wastes, there will be no discharges to the lake such as oil, chemical rinses, and chemical dumps.

The construction discharges of chemical cleaning compounds or other flushing compounds will not be discharged into the lake. We shall construct a settling pond on the site for storage and neutralization of these wastes.

As stated during our meeting in Albany on March 23, 1970, we wish to assure you that we shall not discharge any wastes into the lake without prior notification and approval of your department.

Yours very truly,

J. Wainrib
Project Engineer

LSM:krs

STATE OF NEW YORK
DEPARTMENT OF HEALTH
84 HOLLAND AVENUE
ALBANY, NEW YORK 12203

DWIGHT F. METZLER, P.E.
DEPUTY COMMISSIONER

DIVISION OF PURE WATERS
PAUL W. EASTMAN, P.E.
ASSISTANT COMMISSIONER

April 10, 1970

NOTED APR 13 1970 R.W.G.

NOTED

Mr. R. W. Gunwaldson
Chief Hydraulic Engineer
Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, Mass. 02107

Dear Mr. Gunwaldson:

Re: Report Approval: PASNY
Fitzpatrick Nuclear Power Plant
Thermal Discharge
Scriba (T), Oswego County

The engineering report and supplement for the above referenced project have been reviewed and found acceptable and are herewith approved. The Bureau of Industrial Wastes concurs in the conclusions of the engineer regarding analysis of temperature distribution.

Representatives of the Bureau of Water Quality Management have interpreted the thermal criteria as applicable to this discharge and determined that the criteria are satisfied.

Representatives of the Bureau of Radiological Health have reviewed the rad waste handling systems and the concentrations of radionuclides that will be in the effluent and agree that adequate control will exist.

Rpresentatives of the Division of Fish and Game, New York State Conservation Department have reviewed the report for ecological aspects and have provided generally favorable response, except for the following:

"There is a question on fish protection in the intake system. If the Power Authority carries through on the commitment to leave sufficient open space in the intake channel

NOTED MAR 31 1970 R.H.B.

NOTED APR 1 1970 D.E.H.

March 27, 1970

NOTED APR 2 1970 R.M.M.

Mr. Thomas E. Quinn
[illegible]ical Facilities Section
New York State Health Department
[illegible] Holland Avenue
Albany, New York

Dear Mr. Quinn:

We are taking this opportunity to comment on certain portions of an "Answer to Questions" discussion transmitted to you by Stone and Webster Engineering Corp- oration under a letter dated 23 March 1970. The particular sections of interest to ARL deal with the data and results developed at least in part from our model studies of the Fitz Patrick site.

In the development of the model studies a number of changes in power plant design resulted in different cooling water flow rates and in different temperatures. The computations carried out on pages 3 and 4 of the comments are quite straight for- ward and ARL review indicates the values are correct and the adjustment in order.

The turbulence level in the model and in the prototype is referenced to the Rey- nolds Number in each case as the usual indicator of the turbulence. The levels of turbulence in the model do not appear to be greatly out of line with accepted practice. Although the Reynolds Number is low it is not below the transition range. It is recognized that any increase in Reynolds Number would result theoret- ically in some increased mixing it is not readily apparent how a value could be assigned to this increase. Therefore, it is felt that no numerical decrease in temp- erature or % change in temperature should be assigned and that the expected im- provement be assigned as a safety margin or indication of a conservative approach.

The velocity profile in the model does have the characteristic flat profile expected from a gravity flow while the usual lake current generated by wind will have the greater velocities at the surface. Several approaches to the evaluation of this effect all appear to give similar results and the assessment carried out on this part of the study is a reasonable one.

ALDEN RESEARCH LABORATORIES
WORCESTER POLYTECHNIC INSTITUTE
30 SHREWSBURY STREET, HOLDEN, MASSACHUSETTS 01520
TELEPHONE: 617 829-4323

The change in direction of easterly lake currents has been reviewed in the light of the model studies. Using a somewhat different approach than Stone and Webster Engineering Corporation we have arrived at a somewhat different percentage change due to the current direction (A factor of 0.85 instead of 0.75). However, we believe that this tends to confirm the effect and the change with this near check.

In review as we stated in the model report, our experience has been that results from similar model studies have been conservative when compared with field measurement and that the magnitude and direction of the adjustments indicated are in order.

If there are any points which we might help to clear up in the future, please feel free to call on us.

Very truly yours,

Lawrence C. Neale

Lawrence C. Neale

LCN/dcb
cc: Mr. Ralph W. Gunwaldson
Stone and Webster Eng. Corp.

ALDEN RESEARCH LABORATORIES
WORCESTER POLYTECHNIC INSTITUTE
30 SHREWSBURY STREET, HOLDEN, MASSACHUSETTS 01520
TELEPHONE: 617 829-4323

S. INGRAHAM, M.D.
COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF HEALTH
84 HOLLAND AVENUE
ALBANY, NEW YORK 12208

ENVIRONMENTAL HEALTH SERVICE
DWIGHT F. METZLER, P.E.
DEPUTY COMMISSIONER
DIVISION OF PURE WATERS
PAUL W. EASTMAN, P.E.
ASSISTANT COMMISSIONER

March 26, 1970

MAR 31 1970

Mr. R. W. Gunwaldsen
Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, Massachusetts 02107

Dear Mr. Gunwaldsen:

Re: Thermal Discharge
James A. Fitzpatrick
Nuclear Power Plant

We have received your reply to our letter of March 13, 1970, and are in the process of evaluating it. However as verbally requested to members of your staff, we wish to have Alden Research Laboratories present to us an engineering evaluation of your interpretation of their model studies.

In expediting the above project our office covered only major points of consideration. We have some additional secondary considerations that require clarification and that have been verbally conveyed to members of your staff.

<u>Effluent Characteristics</u>

Other than increased temperature are there any other possible pollutants that will be discharged such as oil, chemical rinses or chemical dumps? If so, what are they and how will they be treated?

<u>Construction Discharges</u>

What provisions have been made to protect the receiving water from chemical compounds used during construction of the power plant. These would be possible acid, alkaline or other flushing operations used to purge the piping system prior to start up.

If discharges of this nature are anticipated, please submit to our office the concentrations, volumne, and methods of treatment.

Very truly yours,

Thomas E. Quinn, P.E.
Acting Chief
Industrial Facility Section

TEQ:lt
cc: Mr. Asa George
Mr. G. E. Hecker
Syracuse Regional Office
Watertown District Office

STONE & WEBSTER ENGINEERING CORPORATION

N.Y. State License 7.6

Copy to
AGeorge (2 encs.)
LCHeale (enc.)
LRBurr
WOChatfield (enc.)
NBCleveland (enc.)
CRClaxton
DKFeldtmose
WSRoberts, Jr.
JWainrib (enc.)
LSMaciejewski
CEGoodman
RDShillady
ABleiweis
JPBurris
HELesser
IEForslind
RCMiller (enc.)
BBrodfeld
DMStein/Jo
Book
General Fi
GEHecker

March 23, 1970

J.O.No. 11825

Mr. Thomas E. Quinn
Acting Chief Industrial Facilities Section
New York State Health Department
84 Holland Avenue
Albany, New York

Dear Sir:

THERMAL DISCHARGE PERMIT
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

I have asked the engineers who were responsible for the preparation of the "Engineering and Ecological Studies" report to answer the questions raised by your staff in your letter of March 13, 1970 addressed to Mr. B. Brodfeld. These answers are attached. If you need additional information please contact us.

Yours very truly,

R. W. Gunwaldsen
Chief Hydraulic Engineer

Enclosures

GEH:mab

B. Redfield Dick Schiffer 7.6
J.O.No. 11825 A.S.M., G. Hecker
J. Allen

TEL-CON-NOTE

PROJECT	TIME OF CALL	DATE
PASNY	10:20 A.M.	3/20/70

Personnel	Name	Company	Initiated By
1.	- CHILDS?		
2.	MAINARDI? J. Mainardi		

TOPIC: N.Y State Permit

DISCUSSION:

1. Conservation Dept wants to see 1 ft/sec. velocity. (we now have 1.4?)
Bentley - Buamels are interested.
~~Storm...~~

2. A screen is required at the intake entrance.

3. A drawing must be handed to be a substitute for the one in the report which will show 3° out above. That one should be a in final form.

4. We want details of the design of

ACTION REQUIRED: the intake - the screen -

5. Dr. Sherr - Hecker... ?

6. Hearing on ... should be expedited.

Dick Schiffer thinks ... Discuss ... in ... of ...

COPY

Copy to AGeorge

CSGoodman
RDShillady
ABleiweis
JPBurris
HELesser
EEForslind
RCMiller
BBrodfeld
JWainrib

DMStein/Job Book
General Files
GEHecker

7.6

Mr. T. E. Quinn
Acting Chief, Industrial Facility Section
New York State Health Department
84 Holland Avenue
Albany, New York

March 19, 1970

J.O.No. 11825

Dear Sir:

APPLICATION FOR THERMAL DISCHARGE PERMIT
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
POWER AUTHORITY OF THE STATE OF NEW YORK

This is to acknowledge receipt of your letter dated March 13, 1970, in which you itemized the questions your section has regarding the "Engineering and Ecological Studies" report submitted as part of an application by the Power Authority of the State of New York for a thermal discharge permit for the James A. FitzPatrick Nuclear Power Plant.

A copy of your letter was given to our Mr. G. E. Hecker at the meeting he had with Mr. John Mathur and Mr. Tony Adamczyk of the Health Department on March 16, 1970. During this meeting, the questions in your letter were discussed item by item, and Mr. Hecker provided oral answers to each. Mr. Adamczyk indicated his satisfaction with the answers, and requested that they be submitted in writing. A meeting has been arranged between Mr. Hecker and Mr. Adamczyk for March 25, 1970, at which time we will supply you with the written answers to your questions.

Yours very truly,

J. Wainrib
Project Engineer

GEH:les

January 23, 1970

Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Att: Mr. W. S. Chapin, General Manager

Gentlemen:

Re: Cooling Water Discharge
Power Authority of the State of N.Y
Fitzpatrick Nuclear Power Plant
Scriba (T), Oswego County

This project has been received and assigned for review.

Should our review engineer have any questions concerning your project, he will contact your project engineer directly

Very truly yours,

[illegible] H. Blac[illegible], Director
Bureau of Industrial Wastes

cc: Syracuse Regional Office
Watertown District Office
Stone & Webster Eng. Corp.

STONE & WEBSTER ENGINEERING CORPORATIO
225 FRANKLIN STR BOSTON, MASSACHUSETTS 02107

DATE January 2, 19
J.O. NO. 11825
P.O. NO. PAS - 1611
LTR. NO.
REF. Teletype 69-1

7.6

VIA

TO MR ASA GEORGE-CHIEF ENGINEER
POWER AUTHORITY OF THE STATE
OF NEW YORK
10 COLUMBUS CIRCLE
NEW YORK NY 10019

DEAR SIRS:

THE FOLLOWING ARE [X] ATTACHED: [ ] SENT SEPARATELY:

1 COPIES ____ PRINTS ____ REPRODUCIBLES

EACH OF

[ ] DRAWINGS [ ] SPECIFICATIONS
[X] DOCUMENTS [ ] NOTES OF CONFERENCE

STATUS			PLEASE NOTE		SENT FOR YOUR	
[ ] FINAL	[ ] APPROVED FOR GENERAL ARRANGEMENT ONLY				[ ] APPROVAL	[ ] COMMENT
[ ] APPROVED	[ ] APPROVED AS REVISED	[ ] REVISIONS AS NOTED	[ ] REVISIONS	[ ] OMISSIONS	[ ] USE	[X] INFORMATION
[ ] NOTED	[ ] NOTED AS REVISED	[ ] PRELIMINARY	[ ] ADDITIONS	[ ] CORRECTIONS	[X] FILES	[ ] CONCURRENCE
[ ] SUITABLE	[ ] SUITABLE AS REVISED	[ ]	[ ] COMMENTS	[ ]	[ ]	

YOUR ATTENTION IS DIRECTED TO THE FOLLOWING:

RELEASED FOR: [ ] FABRICATION [ ] PURCHASE OF NECESSARY MATERIALS

[ ] PLEASE REVISE DRAWINGS AND SUBMIT ____ PRINTS ____ REPRODUCIBLES.

[ ] PLEASE SUBMIT ____ PRINTS EACH OF DRAWINGS MARKED "APPROVED", "NOTED", OR "SUITABLE".

[ ] PLEASE SUBMIT ____ PRINTS ____ REPRODUCIBLES OF EACH SHOP DETAIL DRAWING.

[ ] PLEASE RETURN ONE COPY EACH OF THIS MATERIAL BEARING YOUR APPROVAL OR COMMENTS.

[ ] PLEASE ACKNOWLEDGE RECEIPT OF THIS MATERIAL BY SIGNING AND RETURNING THE ENCLOSED COPY OF THIS FORM.

[ ] WE TRUST THAT THESE NOTES ARE IN ACCORDANCE WITH YOUR UNDERSTANDING: IF NOT, PLEASE ADVISE US.

SEWAGE DISPOSAL SYSTEM
JAMES A. FITZPATRICK NUCLEAR POWER PLANT

Enclosed is one copy of a letter dated September 9, 1969, from John B. Belknap, Watertown District office, New York State Department of Health, to which we referred in our teletype 69-158 concerning chlorination of the sand filter effluent to Lake Ontario.

COPIES FOR PERSONNEL
AT 470/6 DETACHED
AND DISTRIBUTED.

Yours very truly,

J. Wainrib

Copies to:
George

GEGoodman
Wainrib
ESMaciejewski
JRPPerry - 3
MStein/Job Book
CCarter (Encl.)

EForslind/MAG

NOTED DEC 3 1 1969 J.Wainrib
NOTED DEC 3 1 1969 ESM
NOTED JAN 2 1970

JOHN F. STORR, Ph.D.
Consultant in Oceanography and Limnology
51 Meadow Lea Drive
Buffalo, New York 14226

NOB DOC
N.Y. State
LICENSE

December 8, 1969

Stone and Webster Engineering Corporation
225 Franklin Street
Boston, Massachusetts, 02107

7.6

RE: LAKE STRUCTURE, HYDROTHERMAL EFFECTS AND ECOLOGICAL REPORT OF THE JAMES A. FITZPATRICK NUCLEAR POWER PLANT

This report concerns a review of the lake structure, basic flow patterns of the thermal discharge and temperature distribution of the thermal discharge as related to the hydrothermal effects and the ecological effects in Lake Ontario lakeward of the James A. Fitzpatrick Nuclear Power Plant at Nine Mile Point. The report has been divided into phases for purposes of discussing the various aspects of the discharge and presenting predictions as to probable effects on the ecology of the area.

A. Discharge Structure

The discharge is a series of six pairs of nozzles elevated some 6' above the rubble bottom at their center line. Each pair of discharge nozzles diverge by an angle of 42° to give the optimum diffusion. Several aspects related to the ecology of the lake may be discussed.

1. Fish into Discharge

Discharge velocities will be about 13.25 f.p.s. Such a high rate of discharge is well above the maximum sustainable swimming speed of any fish in the lake. It is conceivable, therefore, that any fish or other organism entrained in the discharge flow would be swept away and, because of the high turbulence and rapid mixing, the exposure to higher water temperatures would be very brief and certainly not lethal since the entrained organism would be in the peripheral area which maintains maximum dilution.

2. Scour

Even though initial velocities from the nozzles are high, two factors tend to eliminate scour of the bottom. The first is the six foot height (to center line) of each of the nozzles; the second is the nature of the rubble bottom itself. Throughout larger sized rocks. Although the precise location of the discharge nozzles has not been explored by diving, the area in the near vicinity is recorded as being a mixture of sand and larger rocks varying in size up to several meters in dimension and up to 40-50cm thick. Fathometric recordings in the area indicate that the bottom at 30' and deeper has a greater than 1° slope lakeward and scattered rock more than 1 foot in height and of several feet in extent, thus confirming the findings from the limited area of search by the diver. Scour, therefore, does not appear to be a problem.

3. Created Current Flow

Model analysis of the created current patterns indicates a lakeward flow in the area of the discharge of about 1.0 f.p.s. maximum in the center of the discharge configuration with a shoreward flow of up to .4 f.p.s. at the east and west extremities. A continuous flow pattern may be attractive to fish which would respond positively to such a flow. Since this created circulation will tend to draw food into the area for such fish by creating a near complete food chain, the only probable effect may be the attraction of fish to the area. Certainly there will be some modification of wave activity particularly in the areas of major lakeward movement. This is more likely to affect the shallow water area close to shore rather than a depth of 20' or more. The lakeward flow may create a lee, so to speak, which lessens the wave activity at shore in very moderate weather.

In a similar manner this created current will affect the lake currents in the very immediate region and likewise the ecology of the near shore area. At no time will the current flow be zero. The effects, however, are positive and may encourage a very moderate increase in the total biota.

Heavy wind effects will not be modified significantly either as to wave or lake currents.

On the surface one would expect that in the area of strongest lakeward flow waves would tend to be steepened and under particular configurations of wave height, break more readily. The area, therefore, will tend to be one of increased chop. This has no particular ecological significance.

I do not see that the large eddies created at either end of the discharge configuration have any particular ecological significance. It is doubtful whether such eddies would collect any floating material or cause any significant downsinking or upwelling (depending on direction of flow).

B. Intake Structure

The intake structure takes in water from the near shore side entirely in order to maintain the smooth flow pattern created by the discharge st ctures. The intake area is 8' x 70' with a rise of 3' above the bottom to the lower edge of the intake. The intakes is along the periphery of the 134° sector. The expected intake velocity is about 1.4 f.p.s.

1. Fish Entrainment

There is no particular method by which fish can be kept out of the intake except by a response to the flow of water itself. The rate of flow is similar to that at the intake of the Oswego Steam Station. Personal observations and reports from this station indicate no problem with fish except for Alewives. A larger fish is occassionally seen in the intake water. The intake into the condenser is guarded by a travelling screen which may or may not lift the fish out of the intake well. Alewives have in some years proven to be a problem at Oswego but this is entirely due, I believe, to the location of the intake. In the spring, in some years, vast schools of Alewives gather off the mouth of the Oswego River and it is entirely probable that by sheer compaction these fish enter the intake. When they have entered they have done so at a particular hour during the night, in a compact mass, and during the a period of only a few days during the entire year. This would not be expected to happen in the Nine Mile Point area since no river or stream exists which would be attractive to them.

It is impossible to say just what attraction the alewives have to the River. Since this is unknown, a remote possibility exists that the discharge may create a pseudo-river flow which may be attractive in the spring of the year.

C. Temperature Considerations

The maximum rise of the discharge (but not necessarily the constant rise) is estimated to be not greater than 32.5°F. With an ambient temperature of 70°F, discharge temperature of over 100°F. may occur for short periods.

1. Entrainment of Organisms at Nozzle

As stated above, the very strong flow (13.25 f.p.s.) mixing will be very rapid and temperature of the mixed water will fall very rapidly. Any fish or other organism entrained in the discharge could only be entrained in the peripheral area of the discharge (due to the very strong flow) and the temperature drop would be so rapid that it is difficult to conceive that even the highest temperature would have any particular ecological effect.

2. Entrained Organisms

The number of minutes any entrained planktonic organism would be exposed to the maximum temperature water would be very few indeed. The water passess through the condenser, is heated, and travels through the tunnel to the discharge.

All of the work on planktonic organisms to date indicate that only a few percent of the larger zooplankton are damaged and these apparently by mechanical activity rather than thermal. No maximum temperature rise of greater than 20°F. has been worked with to date.

3. Lake Temperature Rise

Surface temperature less than 3F° above ambient are expected to be achieved. Certainly no thermal damage to any organisms can be expected with this low temperature rise. A calculated gradient over a two mile stretch with a lake current of 0.2 f.p.s. might range from 3F° to 1.0F°. Naturally occurring temperature gradients of over 5F° have been recorded in the same area in the same distance.

4. Effect at Shore

According to the model studies water of greater than ambient temperature will never reach shore. This does not preclude that winds might not carry mixed discharge water to the shore but in any case it could never be greater than 3F° above ambient from this discharge alone and would be expected to be less than 2F°.

D. Summary

The total effect of the temperature input would appear to be positive promoting growth of plants and making the water temperature more acceptable to most organisms. Preliminary results from the Cladophora growth vs. temperature studies indicate that 65°F is optimum for growth and that higher temperatures discourage growth. This may or may not apply to the particular set of ecological factors at Nine Mile Point with a continuous supply of nutrients (as opposed to a limited nutrient supply in the experimental tanks).

The very low rise in surface temperature and the direction away from shore would appear to limit any shore temperature effect where maximum effects would be evident. Nevertheless, the volume of water affected on initial mixing (10,000 c.f.s.) and the creation of the current lakeward may have some significant ecological impact particularly during calm periods. The pulling shoreward of cooler bottom may occur and it is entirely conceivable that surface temperatures may be less than ambient during some periods of the year. If cooler water is induced toward shore this may have some effect upon the attractiveness of the area for fish which may well counterbalance the "attractive current effect" mentioned above.

All in all I feel that more ecological changes will come about in the area as a result of drawing some 10,000 c.f.s. of water along the bottom and inducing a lakeward flow at the surface of a similar amount, than will be brought about by the thermal addition.

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE · NEW YORK, N.Y. 10019
212 — CO 5-6510

August 4, 1970

Mr. T. J. Brosnan
Vice President and Chief Engineer
Niagara Mohawk Power Corporation
300 Erie Boulevard West
Syracuse, New York 13202

Dear Tom:

We are pleased to attach a copy of the U. S. Corps of Engineers' permit for the construction of the cooling water intake and discharge structures at the James A. FitzPatrick Nuclear Power Plant.

Sincerely,

Asa

Asa George
Chief Engineer

Att.

cc: Mr. P. A. Burt, Superintendent w/att.
Nine Mile Point Nuclear Station
Niagara Mohawk Power Corporation

DEPARTMENT OF THE ARMY
BUFFALO DISTRICT. CORPS OF ENGINEERS
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207

IN REPLY REFER TO NCBCO-S

29 July 1970

Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Attn: W.S. Chapin, General Manager

Gentlemen:

Inclosed is Department of the Army permit authorizing the Power Authority of the State of New York to construct a submerged water intake structure and a submerged water discharge structure that will be connected to shore by tunnels in rock below the existing lake bottom. This work is located in Lake Ontario at Nine Mile Point, Town of Scriba, Oswego County, New York.

Please note condition (m) of the permit which requires that this office be informed of the commencement and completion of the authorized work. Forms for this purpose are inclosed.

Please acknowledge receipt of the permit.

Sincerely yours,

V. H. Hourigan

V. H. HOURIGAN, Chief
Construction - Operations Division

4 Incl
1. Permit
2. Form 8
3. Form 9
4. C.G. Notice

DEPARTMENT OF THE ARMY

PERMIT

Contract No. DACW49-C-70-0048
Buffalo District
Corps of Engineers
Buffalo, New York 14207

NCBCO-S
No. 70-55

15 July 1970

Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Gentlemen:

Referring to written request dated 21 January 1970, upon the recommendation of the Chief of Engineers, and under the provisions of Section 10 of the Act of Congress approved March 3, 1899 (33 U.S.C. 403, entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes", you are hereby authorized by the Secretary of the Army to perform the following work: To construct a submerged water intake structure and a submerged water discharge structure that will be connected to shore by tunnels in rock below the existing lake bottom. All excavated material not required for backfill will be placed on upland property above high water. This work is located in Lake Ontario at Nine Mile Point, Town of Scriba, Oswego County, New York, about 7½ miles northeasterly of Oswego Harbor, New York and is in accordance with the plans and drawings attached hereto in 6 sheets marked: "Proposed Lake Water Intake and Discharge in Lake Ontario at Nine Mile Point, Oswego Co., New York Application By: Power Authority of The State of New York, 1-21-70", subject to the following conditions:

(a) That this instrument does not convey any property rights either in real estate or material, or any exclusive privileges; and that it does not authorize any injury to private property or invasion of private rights, or any infringement of Federal, State or local laws or regulations, nor does it obviate the necessity of obtaining State or local assent required by law for the structure or work authorized.

(b) That the structure or work authorized herein shall be in accordance with the plans and drawings attached hereto and construction shall be subject to the supervision and approval of the District Engineer, Corps of Engineers, in charge of the District in which the work is to be performed.

(c) That the District Engineer may at any time make such inspections as he may deem necessary to assure that the construction or work is performed in accordance with the conditions of this permit and all expenses thereof shall be borne by the permittee.

(d) That the permittee shall comply promptly with any lawful regulations, conditions, or instructions affecting the structure or work authorized herein if and when issued by the Federal Water Quality Administration and/or the State water pollution control agency having jurisdiction to abate or prevent water pollution, including thermal or radiation pollution. Such regulations, conditions or instructions in effect or hereafter prescribed by the Federal Water Quality Administration and/or the State agency are hereby made a condition of this permit.

(e) That the permittee will maintain the work authorized herein in good condition in accordance with the approved plans.

(f) That this permit may, prior to the completion of the structure or work authorized herein, be suspended by authority of the Secretary of the Army if it is determined that suspension is in the public interest.*

(g) That this permit may at any time be modified by authority of the Secretary of the Army if it is determined that, under existing circumstances, modification is in the public interest.* The permittee, upon receipt of a notice of modification, shall comply therewith as directed by the Secretary of the Army or his authorized representative.

(h) That this permit may be revoked by authority of the Secretary of the Army if the permittee fails to comply with any of its provisions or if the Secretary determines that, under the existing circumstances, such action is required in the public interest.*

(i) That any modification, suspension or revocation of this permit shall not be the basis for a claim for damages against the United States.

(j) That the United States shall in no way be liable for any damage to any structure or work authorized herein which may be caused by or result from future operations undertaken by the Government in the public interest.

(k) That no attempt shall be made by the permittee to forbid the full and free use by the public of all navigable waters at or adjacent to the structure or work authorized by this permit.

(l) That if the display of lights and signals on any structure or work authorized herein is not otherwise provided for by law, such lights and signals as may be prescribed by the United States Coast Guard shall be installed and maintained by and at the expense of the permittee.

(m) That the permittee shall notify the District Engineer at what time the construction or work will be commenced, as far in advance of the time of commencement as the District Engineer may specify, and of its completion.

(n) That if the structure or work herein authorized is not completed on or before thirty-first day of December 1973, this permit, if not previously revoked or specifically extended, shall cease and be null and void.

(o) That the legal requirements of all Federal agencies be met.

(p) That this permit does not authorize or approve the construction of particular structures, the authorization or approval of which may require action by the Congress or other agencies of the Federal Government.

(q) That all the provisions of this permit shall be binding on any assignee or successor in interest of the permittee.

(r) That if the recording of this permit is possible under applicable State or local law, the permittee shall take such action as may be necessary to record this permit with the Registrar of Deeds or other appropriate official charged with the responsibility for maintaining records of title to and interests in real property.

(s) That the permittee agree to make every reasonable effort to prosecute the construction or work authorized herein in a manner so as to minimize any adverse impact of the construction or work on fish, wildlife and natural environmental values.

(t) That the permittee agrees that it will prosecute the construction of work authorized herein in a manner so as to minimize any degradation of water quality.

(u) That the permittee shall cooperate with the Fish and Wildlife Service, Federal Water Quality Administration, New York State Conservation Department, and other interested State and Federal agencies in developing plans for needed ecological surveys; initiate these surveys at least two years before reactor operations begin; and continue them on a regular basis until it has been conclusively demonstrated that no significant adverse conditions exist, and that applicable Federal and State water quality standards are met on a continuing basis.

(v) That the permittee meet with appropriate Federal and State resource agencies at frequent intervals to discuss new plans and to evaluate results of existing surveys.

(w) That the permittee will construct, operate and maintain such fish protective facilities over the intake structures as needed to prevent significant damages to the fishery resources.

(x) That the permittee will make modifications in project structures and operation, such as extension of the outfalls to a greater distance into the lake, installation of cooling towers or ponds, reduction of entrance velocities at the cooling system intake, or other acceptable treatment facilities, should the results of any studies show an adverse effect on the ecology of the lake, or that nuisance conditions of cladophora or other algal species will be caused by the increase in local water temperature, and to protect the fish and wildlife resources of the area.

(y) That in approving this permit reliance has been placed on information and data provided by the permittee concerning the nature of the effluent and the frequency of discharges.

The Power Authority of the State of New York has furnished the following information concerning its proposed intake and discharge facilities:

- Total condenser cooling water flow	785 cfs
- Maximum service water flow	40 cfs
- Water temperature rise through the Plant	31.5 F
- Water temperature rise at lake water surface and 300 ft. from point of discharge	Not exceeding 3F

- Solids in the discharge water are summarized as follows:

Item	Material	Soluble	Expected Average Daily Release (lbs.)	N. Y. State Limitations (ppm)
1.	Sodium Sulfate	Yes	1165	250
2.	Ferric Oxides	No	Trace	0.3
3.	Ferric Sulfates	No	10	0.3
4.	Chromates	Yes	Maint. Only	0.05
5.	Calcium Carbonate	Yes	50	None
6.	Hydrated Lime	Yes	50	None
7.	Metallic Oxides	No	Trace	Varies depende upon specific compound

- The condenser cooling and service water are discharged continuously during Plant's operation. The radwaste is a batch type release and it is discharged infrequently and the rate of flow is controlled.
- Chromate is the only toxin expected.
- The sewage system will not release through the subject discharge system.

Permittee may not discharge any liquids or solids other than or at levels in excess of those approved herein unless a modification of this permit is approved by the Secretary of the Army or his authorized representative.

(z) The permittee shall maintain adequate records of the nature and frequency of discharges and shall from time to time furnish such additional data concerning discharges as the District Engineer may require.

(aa) This permit will terminate on 15 July 1971 unless the permittee submits to the District Engineer the certification provided for in Section 21(b)(8) of PL 91-224, the Water Quality Improvement Act of 1970, within one (1) year from the date of this permit.

* A judgment as to whether or not suspension, modification or revocation is in the public interest involves a consideration of the impact that any such action or the absence of any such action may have on factors affecting the public interest. Such factors include, but are not limited to navigation, fish and wildlife, water quality, economics, conservation, aesthetics, recreation, water supply, flood damage prevention, ecosystems and, in general, the needs and welfare of the people.

By Authority of the Secretary of the Army:

RAY S. HANSEN — Date: 31 [illegible] 1970
Colonel, Corps of Engineers
District Engineer

Permittee hereby accepts the terms and conditions of this permit.

Signature [signature] — Permittee — Date: 7-23-70

S. INGRAHAM, M.D.
COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF HEALTH
84 HOLLAND AVENUE
ALBANY, NEW YORK 12208

ENVIRONMENTAL HEALTH SERVICES
DWIGHT F. METZLER, P.E.
DEPUTY COMMISSIONER

DIVISION OF PURE WATERS
PAUL W. EASTMAN, P.E.
ASSISTANT COMMISSIONER

April 30, 1970

Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Attention: Mr. Asa George

Gentlemen:

Re: Permit (Thermal Discharge)
James A. Fitzpatrick Nuclear Power
Plant - PASNY
Scriba (T), Oswego County

Item 14 (design flow) of the construction permit dated April 14, 1970 for this project was incorrectly recorded by our office. We are enclosing a corrected permit of the same date as a replacement. Please discard the incorrect permit.

Very truly yours,

Thomas E. Quinn, P. E. Chief
Industrial Facility Section

TEQ:AA:SG
cc: Watertown District Office
Syracuse Regional Office
Stone & Webster Engineering Corp.

NEW YORK STATE DEPARTMENT OF HEALTH

PERMIT TO CONSTRUCT A WASTE DISPOSAL SYSTEM

is permit is issued under the provisions of Article 12 of the Public Health Law and 10 NYCRR 73.

1. Name of Permittee:	2. Location of Works (C.V.T):	3. County:	4. Entity or Area Served:
Power Authority of the State of New York	Scriba (T)	Oswego	James A. Fitzpatrick Nuc Power Plant

initiating construction of the approved works, the permittee accepts and agrees to abide by and conform with the following:

1. THAT the construction permit shall be maintained on file by the permittee.
2. THAT the permit is revocable or subject to modification or change pursuant to Article 12 of the Public Health Law.
3. THAT the facilities shall be fully constructed and completed in compliance with the engineering report, plans and specifications as approved.
4. THAT the facilities shall not be placed in operation until construction has been completed and an operation permit has been issued, or unless ordered to be operated by the Commissioner or by a Court.
5. THAT the construction of the facilities shall be under the supervision of a person or firm qualified to practice professional engineering in the State of New York under the Education Law of the State of New York, whenever engineering services are required by such law for such purposes.
6. THAT where such facilities are under the supervision of a professional engineer, he shall certify to the Department and to the permittee that the constructed facilities have been under his supervision and that the works have been fully completed in accordance with the approved engineering reports, plans, specifications and permit.
7. THAT the construction of the facilities shall commence by October 1, 1970 and be fully completed by October 1, 1973.

ISSUED FOR THE STATE COMMISSIONER OF HEALTH	DATE
[signature] Designated Representative	4/14/70

(SEE REVERSE SIDE)

Distribution: White – Applicant; Pink – Central Office (BED); Yellow – File (LHO or DHO); Green – Other

San 2 (rev. 11/67)

ject Description:
5. Type of Ownership:

- [ ] Municipal
- [ ] Industrial
- [ ] Commercial
- [ ] 6 Sewage Works Corp.
- [ ] 67 Private-Home
- [ ] 68 Private-Other
- [ ] Private-Institutional
- [ ] 26 Board of Education
- [X] 1 Authority
- [ ] 19 Federal
- [ ] 20 State
- [ ] 30 Interstate
- [ ] 40 International
- [ ] 18 Indian Reservation

6. Type & Nature of Construction:
Collection: [ ] 1 New [ ] 2 Additions or Alterations
Treatment and/or Disposal: [X] 1 New [ ] 2 Additions or Alterations

7. Estimated Cost of Construction:
Collection System N/A
Treatment and/or Disposal $6,000,000

8. Type of Waste: [ ] 1 Sewage [ ] Industrial Specify ______ [X] Other Specify Thermal

9. Degree of Treatment: [ ] 1 None [ ] 2 Septic Tank [ ] 3 Primary [ ] 4 Intermediate [ ] 5 Secondary [ ] 6 Tertiary [ ] 7 Complete [X] 8 Not Applicable

10. Point of Discharge:
Location (C,V,T) Scriba (T)
Major Drainage Basin Lake Ontario
Surface Water: Name of Watercourse Lake Ontario
Surface Water Class A
Ground Water: Name of Watercourse to which ground water is tributary ______
Ground Water Class ______

11. Name of Receiving Treatment Works: James A. Fitzpatrick Nuclear Power Plant

12. Grade of Plant Operator Required: N/A

13. Disinfection Required: [ ] 1 Continuous [ ] 2 Seasonal [X] 3 None

14. Design Flow (Gals./day): 534,000,000

15. Design Equivalent Population (BOD Basis): N/A

16. Design Plant Efficiency (% BOD Removal): N/A

Description of works, such as number, name and capacity of units:

1 - discharge tunnel - 1,367 feet long
approximately 14 feet x 14 feet in X-sec.

1 - diffuser tunnel - 774 feet long with 6 diffuser heads

6 - diffuser heads - consisting of two nozzles each 2.5 feet in diameter

COPY

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N.Y. 10019

212—CO 5-6510

April 20, 1970

Mr. T. J. Brosnan
Vice President and Chief Engineer
Niagara Mohawk Power Corporation
300 Erie Boulevard West
Syracuse, New York 13202

Dear Tom:

I am pleased to attach a copy of the thermal discharge permit for the FitzPatrick Nuclear Plant issued by the New York State Department of Health.

Sincerely,

Asa George

Asa George
Chief Engineer

Att: Dept. of Health ltr. 4/14/70 w/permit

cc: Mr. P. A. Burt/Lycoming w/atts.
✓ Mr. R. Clancy/Syracuse w/atts.

.LIS NGRAHAM, M.D.
COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF HEALTH
84 HOLLAND AVENUE
ALBANY, NEW YORK 12208

ENVIRONMENTAL HEALTH SERVICES
DWIGHT F. METZLER, P.E.
DEPUTY COMMISSIONER

DIVISION OF PURE WATERS
PAUL W. EASTMAN, P.E.
ASSISTANT COMMISSIONER

April 14, 1970

Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Attention: Mr. Asa George

Gentlemen:

Re: Permit (Thermal Discharge)
James A. Fitzpatrick Nuclear Power Plant
Scriba (T), Oswego County

Transmittal

The construction permit for this project, dated April 14, 1970, is attached.

One approved copy of the design report, specifications, and plans is being forwarded separately.

Permit to Construct

This permit carries qualifying conditions:

1. Permit filing
2. Revocability and modification
3. Construction conformance
4. Start of operation
5. Construction supervision
6. Construction certification
7. Construction time limitations

THE ATTACHED CONSTRUCTION PERMIT DOES NOT CONSTITUTE AUTHORITY TO OPERATE THE APPROVED FACILITIES. PLEASE NOTE INSTRUCTIONS BELOW REGARDING OPERATION PERMIT.

Permit to Operate

Pursuant to provisions of Part 73 of Title 10 of the official compilation of Codes, Rules and Regulations of the State of New York, a permit to operate the constructed facilities is required.

Upon completion of the facilities, application for the permit to operate should be promptly submitted to the Bureau of Industrial Wastes of the New York State Department of Health, 84 Holland Avenue, Albany, New York, accompanied by a Certificate of Construction Compliance, executed by the New York State licensed professional engineer supervising construction.

The Bureau of Industrial Wastes will contact you in the near future to provide application forms and instructions for the operating permit.

Assistance

Information can be obtained from this office regarding construction certification.

Facilities Approved

Approved plans call for the installation of a multi-outlet submerged discharge (diffuser).

Very truly yours,

Thomas E. Quinn, P.E.
Acting Chief
Industrial Facility Section

TEQ:AA:lt
Attachment
Permit
cc: Watertown District Office
Syracuse Regional Office
Stone & Webster Engineering Corp.

NEW YORK STATE DEPARTMENT OF HEALTH

PERMIT TO CONSTRUCT A WASTE DISPOSAL SYSTEM

This permit is issued under the provisions of Article 12 of the Public Health Law and 10 NYCRR 73.

1. Name of Permittee:	2. Location of Works (C.V.T):	3. County:	4. Entity or Area Served:
Power Authority of the State of New York	Scriba (T)	Oswego	James A. Fitzpatrick Nuclear Power Plant

By initiating construction of the approved works, the permittee accepts and agrees to abide by and conform with the following:

1. THAT the construction permit shall be maintained on file by the permittee.
2. THAT the permit is revocable or subject to modification or change pursuant to Article 12 of the Public Health Law.
3. THAT the facilities shall be fully constructed and completed in compliance with the engineering report, plans and specifications as approved.
4. THAT the facilities shall not be placed in operation until construction has been completed and an operation permit has been issued, or unless ordered to be operated by the Commissioner or by a Court.
5. THAT the construction of the facilities shall be under the supervision of a person or firm qualified to practice professional engineering in the State of New York under the Education Law of the State of New York, whenever engineering services are required by such law for such purposes.
6. THAT where such facilities are under the supervision of a professional engineer, he shall certify to the Department and to the permittee that the constructed facilities have been under his supervision and that the works have been fully completed in accordance with the approved engineering reports, plans, specifications and permit.
7. THAT the construction of the facilities shall commence by October 1, 1970 and be fully completed by October 1, 1973.

(SEE REVERSE SIDE)

ISSUED FOR THE STATE COMMISSIONER OF HEALTH	DATE
[signature] Designated Representative	4/14/70

Distribution: White – Applicant; Pink – Central Office (BED); Yellow – File (LHO or DHO); Green – Other

Proj--t Description:

5. ~~pe of Ownership:

- [ ] Municipal
- [ ] Industrial
- [ ] Commercial
- [ ] 6 Sewage Works Corp.
- [ ] 67 Private-Home
- [ ] 68 Private-Other
- [ ] Private-Institutional
- [ ] 26 Board of Education
- [X] 1 Authority
- [ ] 19 Federal
- [ ] 20 State
- [ ] 30 Interstate
- [ ] 40 International
- [ ] 18 Indian Reservation

6. Type & Nature of Construction:

Collection: [ ] 1 New [ ] 2 Additions or Alterations

Treatment and/or Disposal: [X] 1 New [ ] 2 Additions or Alterations

7. L-timated Cost of Construction:

Collection System N/A Treatment and/or Disposal $6,000,000

8. ~~pe of Waste: [ ] 1 Sewage [ ] Industrial Specify ____ [X] Other Specify Thermal

9. Degree of Treatment:

[ ] 1 None [ ] 2 Septic Tank [ ] 3 Primary [ ] 4 Intermediate [ ] 5 Secondary [ ] 6 Tertiary [ ] 7 Complete [X] 8 Not Applicable

10. Point of Discharge:

Location (C,V,T) Scriba (T) Major Drainage Basin Lake Ontario

Surface Water: Name of Watercourse Lake Ontario Surface Water Class A

Ground Water: Name of Watercourse to which ground water is tributary ____ Ground Water Class ____

11. Name of Receiving Treatment Works:	12. Grade of Plant Operator Required:	13. Disinfection Required:
~ames A. Fitzpatrick ~uclear Power Plant	N/A	[ ] 1 Continuous [ ] 2 Seasonal [X] 3 None
14. Design Flow (Gals./day):	**15. Design Equivalent Population (BOD Basis):**	**16. Design Plant Efficiency (% BOD Removal):**
~,330,000	N/A	N/A

Description of works, such as number, name and capacity of units:

1-discharge tunnel-1,367 feet long
approximately 14 feet x 14 feet in X-sec.

1-diffuser tunnel-774 feet long with 6 diffuser heads

~-diffuser heads-consisting of two nozzles each 2.5 feet in diameter

[illegible] INGRAHAM, M.D.
[COMM]ISSIONER

STATE OF NEW YORK
DEPARTMENT OF HEALTH
84 HOLLAND AVENUE
ALBANY, NEW YORK 12208

DWIGHT F. METZLER, P.E.
DEPUTY COMMISSIONER

DIVISION OF PURE WATERS
PAUL W. EASTMAN, P.E.
ASSISTANT COMMISSIONER

April 10, 1970

Asa George, P.E.
Chief Engineer
Power Authority of the State of New York
10 Columbus Circle
New York, New York 10019

Dear Mr. George:

Re: Report Approval: PASNY
Fitzpatrick Nuclear Power Plant
Thermal Discharge
Scriba (T), Oswego County

Please find attached your copy of the Department's approval of the thermal discharge for this plant. Paragraph five contains a request from the New York State Department of Conservation that requires a committment by PASNY to a future course of action.

The Department of Conservation requests that this be confirmed as a condition of final plan approval. We would appreciate your response.

PASNY is to be congratulated for providing leadership in the application of advanced engineering principles to the handling of waste heat from a thermal generating station. It has been a pleasure to work with you, members of your staff, and your consultants in reaching a satisfactory solution to this problem of mutual concern.

I look forward to dealing with you again on future projects.

Very truly yours,

Thomas E. Quinn, P.E.
Acting Chief,
Industrial Facility Section

TEQ:SG
cc: Syracuse Regional Office
Watertown District Office

PASNY: Mr. George

April 10, 1970

Mr. R. W. Gunwaldson
Chief Hydraulic Engineer
Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, Mass. 02107

Dear Mr. Gunwaldson:

Re: Report Approval: PASNY
Fitzpatrick Nuclear Power Plant
Thermal Discharge
Scriba (T), Oswego County

The engineering report and supplement for the above referenced project have been reviewed and found acceptable and are herewith approved. The Bureau of Industrial Wastes concurs in the conclusions of the engineer regarding analysis of temperature distribution.

Representatives of the Bureau of Water Quality Management have interpreted the thermal criteria as applicable to this discharge and determined that the criteria are satisfied.

Representatives of the Bureau of Radiological Health have reviewed the rad waste handling systems and the concentrations of radionuclides that will be in the effluent and agree that adequate control will exist.

Representatives of the Division of Fish and Game, New York State Conservation Department have reviewed the report for ecological aspects and have provided generally favorable response, except for the following:

"There is a question on fish protection in the intake system. If the Power Authority carries through on the commitment to leave sufficient open space in the intake channel

in front of the traveling screens to permit the installation of fish saving devices if necessary and can be committed to such installation as need it need not be considered further at this time." (W. G. Bentley to J.P. Mather; 4/6/76)

As the above comment translates to possible design changes in the forebay structure, it is requested that such be included in plans for the project.

The Public Health Law requires that plans and specifications be approved prior to the issuance of a permit for the construction of a new outlet. It is our understanding that intake and discharge plans have been prepared for the purposes of receiving bids for construction and that no delay would develop in submitting them for approval. The plans should incorporate for our purposes plan and profile of the engineering features on full size drawings. Details of structural members and reinforcing are not required.

Four sets of these plans and specifications, and three additional copies of the engineering report, all signed and sealed by a professional engineer licensed in New York State, are required for our approval.

Very truly yours,

Thomas E. Quinn, P.E.
Acting Chief
Industrial Facility Section

TEQ:SG
cc: PASNY: Mr. George -
Syracuse Regional Office
Watertown District Office

needed ecological surveys; initiate these surveys at least two years before reactor operations begin; and continue them on a regular basis or until it has been conclusively demonstrated that no significant adverse conditions exist.

3. Meet with appropriate Federal and State resource agencies at frequent intervals to discuss new plans and to evaluate results of existing surveys.

4. Construct, operate, and maintain such fish protective facilities over the intake structures as needed to prevent significant damages to the fishery resources.

5. Make such modifications in project structure and operation, including facilities for cooling discharge waters and reducing entrance velocities at the cooling system intake as may be determined necessary to protect the fish and wildlife resources of the area.

At this time the Department of the Interior has not indicated that the above special conditions will be their ultimate recommendation. However, it is not likely that there will be any changes in the proposed special conditions recommended by the Bureau of Sport Fisheries and Wildlife. Therefore, in the interim and in the matter of saving time, it is requested that this office be advised as to whether the above special conditions are acceptable to the Power Authority of the State of New York. In the event the special conditions are not acceptable, the reasons for their unacceptability to the Power Authority should be made known.

Sincerely yours,

V. H. Hourigan

V. H. HOURIGAN, Chief
Construction-Operations Division

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N.Y. 10019
212 — CO 5-6510

April 15, 1970

11825

Department of the Army
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Attention: Mr. V. H. Hourigan, Chief
Construction-Operations Division

Reference: NCBCO-S

Gentlemen:

We have your letter of April 10, 1970 relative to the Power Authority's application for a Department of the Army permit to construct a submerged water intake structure and a submerged water discharge structure in Lake Ontario at Nine Mile Point, Oswego County, New York, for the J. A. FitzPatrick Nuclear Power Plant.

We comment as follows on each of the proposed special conditions set forth in your letter, which are in addition to the standard conditions contained in a Department of the Army permit:

"1. Conform with all appropriate Federal and State Water Quality Standards, including allowable temperature increase standards."

The adopted intake and discharge structures for the FitzPatrick Plant will produce thermal patterns which comply with the criteria governing thermal discharges recently adopted by the State of New York. These criteria were developed by the Water Resources Commission of New York State in cooperation with the Federal Water Pollution Control Administration. The

Department of Health of the State of New York, which has jurisdiction in this matter, has approved the thermal discharge for this plant.

"2. Cooperate with the Fish and Wildlife Service, Federal Water Pollution Control Administration, New York State Conservation Department, and other interested State and Federal agencies in developing plans for needed ecological surveys; initiate these surveys at least two years before reactor operations begin; and continue them on a regular basis or until it has been conclusively demonstrated that no significant adverse conditions exist."

An ecological survey program for the entire Nine Mile Point lakefront area has been established by our consultant on ecology, Dr. John Storr of the State University of New York at Buffalo. This program was developed jointly at a number of meetings held with representatives of the Departments of Health and Conservation of the State of New York and approved by them. The program was initiated in June of 1969. The results of the surveys already completed were incorporated in the Authority's report to the New York State Department of Health accompanying our application for thermal discharge permit for the FitzPatrick Nuclear Power Plant. A copy of this report was sent to Mr. Jack Harney of the Department of Interior's Fish and Wildlife Service in Concord, N. H. A summary report of the studies completed to date was also transmitted to the Atomic Energy Commission, Division of Reactor Licensing.

The Power Authority in cooperation with the Niagara Mohawk Power Corporation has developed a continuous ecological survey program for the Nine Mile Point lakefront area, extending from 1970 through 1974. Dr. Storr will carry out this program which, when finalized, will be discussed with the appropriate Federal and New York State agencies.

"3. Meet with appropriate Federal and State resource agencies at frequent intervals to discuss new plans and to evaluate results of existing surveys."

As in the past, meetings will be arranged at frequent intervals with Federal agencies and the New York State Departments of Health and Conservation to present new plans and results of the completed surveys in connection with programs named in paragraph 2. above.

"4. Construct, operate, and maintain such fish protective facilities over the intake structures as needed to prevent significant damages to the fishery resources."

At the request of the Conservation Department of the State of New York, we have agreed to leave sufficient open space in the intake channel in front of the traveling water screens to permit the installation of fish-saving devices if found necessary following the plant operation. This commitment has been confirmed by letter dated April 15, 1970 to the New York State Department of Health (copy of which is attached).

"5. Make such modifications in project structure and operation, including facilities for cooling discharge waters and reducing entrance velocities at the cooling system intake as may be determined necessary to protect the fish and wildlife resources of the area."

The velocity of 1.4 feet per second at the entrance of the lake intake structure was discussed with the New York State Department of Conservation and was found acceptable as was the velocity of 1.25 feet per second in front of the traveling water screens.

We believe that the above comments will fully meet and satisfy the concerns of the Fish and Wildlife Service of the Department of Interior.

In view of our difficult construction schedule for this project, we respectfully request that a Department of Army permit be issued to the Power Authority at the earliest possible time. Bids were taken for this work and a letter of intent has been given to S. J. Groves & Sons Company. This contractor is now on the job and mobilizing his equipment.

Sincerely,

W. S. Chapin
General Manager

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N.Y. 10019
212—CO 5-6510

April 15, 1970

Mr. Thomas E. Quinn, P. E.
Acting Chief, Industrial Facility Section
New York State Department of Health
84 Holland Avenue
Albany, New York 12208

Dear Mr. Quinn:

We appreciate very much receiving your letter of April 10, 1970 relative to the thermal discharge permit for the Power Authority's J. A. FitzPatrick Nuclear Power Plant.

Regarding the concern of the N. Y. State Department of Conservation, we would like to advise you formally that sufficient open space in the intake channel will be provided ahead of the traveling water screens to permit the installation of fish-saving devices if found necessary.

We would like to confirm the delivery to you by our Engineers of four sets of the requested plans and specifications and three additional copies of the engineering report, all signed and sealed by a professional engineer licensed in New York State.

We appreciate the cooperation which you and your associates provided in processing our application for the thermal discharge permit.

Very truly yours,

Asa George
Chief Engineer

NF- [illegible]
NYS Dept of Health

April 10, 1970

Mr. R. W. Gunwaldson
Chief Hydraulic Engineer
Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, Mass. 02107

Dear Mr. Gunwaldson:

Re: Report Approval: PASNY
Fitzpatrick Nuclear Power Plant
Thermal Discharge
Scriba (T), Oswego County

The engineering report and supplement for the above referenced project have been reviewed and found acceptable and are herewith approved. The Bureau of Industrial Wastes concurs in the conclusions of the engineer regarding analysis of temperature distribution.

Representatives of the Bureau of Water Quality Management have interpreted the thermal criteria as applicable to this discharge and determined that the criteria are satisfied.

Representatives of the Bureau of Radiological Health have reviewed the rad waste handling systems and the concentrations of radionuclides that will be in the effluent and agree that adequate control will exist.

Representatives of the Division of Fish and Game, New York State Conservation Department have reviewed the report for ecological aspects and have provided generally favorable response, except for the following:

"There is a question on fish protection in the intake system. If the Power Authority carries through on the commitment to leave sufficient open space in the intake channel

in front of the traveling screens to permit the installation of fish saving devices if necessary and can be committed to such installation on need it need not be considered further at this time." (W. G. Bentley to J.P. Mathur; 4/5/78)

As the above comment translates to possible design changes in the forebay structure, it is requested that such be included in plans for the project.

The Public Health Law requires that plans and specifications be approved prior to the issuance of a permit for the construction of a new outlet. It is our understanding that intake and discharge plans have been prepared for the purposes of receiving bids for construction and that no delay would develop in submitting them for approval. The plans should incorporate for our purposes plan and profile of the engineering features on full size drawings. Details of structural members and reinforcing are not required.

Four sets of these plans and specifications, and three additional copies of the engineering report, all signed and sealed by a professional engineer licensed in New York State, are required for our approval.

Very truly yours,

Thomas E. Quinn, P.E.
Acting Chief
Industrial Facility Section

TEQ:SG
cc: PASNY: Mr. George
Syracuse Regional Office
Watertown District Office