V. BIOLOGICAL COMMUNITY

1. Introduction

The occurrence of such changes in the aquatic community that may result from the addition of heat by the condenser cooling system to the receiving waters is determined in part by assessing the abundance and diversity, distribution, trophic relationships and the dynamic aspects of the aquatic biota of the receiving water bodies. Studies of composition, diversity and type of community associations in natural and artificially heated aquatic regions are used to delineate the degree of response of the aquatic organisms to thermal addition. In this chapter, an assessment of four major biological groups present in the vicinity of JAF will be provided along with a discussion on the integrity of the biological community of the ecosystem.

Aquatic ecological studies have been conducted in the vicinity of JAF and NMP-1 since 1969; aquatic monitoring programs continue in accordance with the NRC requirements. The programs conducted by LMS (QLM, 1973; 1974; LMS, 1975; 1976) in the Nine Mile Point area have consisted of surveys of plankton (phytoplankton, zooplankton, and ichthyoplankton), benthos, and fish populations during the spring through fall periods at various depths and transect locations. Sampling by LMS has been relatively consistent since 1972 and sample locations are indicated in Figure V-1 to V-3. Impingement and entrainment of nektonic and planktonic populations were also monitored at the station's intake. Water quality was investigated by LMS in the vicinity of Nine Mile Point (QLM, 1973; 1974; LMS, 1975; 1976), including monthly determinations of the concentrations of inorganic nutrients, heavy metals, dissolved oxygen (DO), temperature, pH, and biochemical oxygen demand (BOD). Each trophic level of the community within the vicinity of Nine Mile Point is discussed in the following sections. Other studies were conducted in the study area by McNaught and Fenlon (1972), McNaught and Buzzard (1973) Storr (1973) and Lake Ontario Environmental Laboratory (LOTEL) (RGE, 1974).

The following analysis, with the exception of entrainment studies, is restricted to data collected through 1975. In 1975 JAF was in operation from July through December and load factors for this period were presented in Chapter II. It is important to point out that the plant averaged greater than 50% capacity from July through October when major thermal effects, if any, would be expected due to high ambient temperatures. Also, NMP-1, located 3000 ft west of JAF, began operation in 1969 and these studies can be used to indicate combined effects at JAF.

FISH SAMPLING STATIONS
NINE MILE POINT VICINITY - 1975

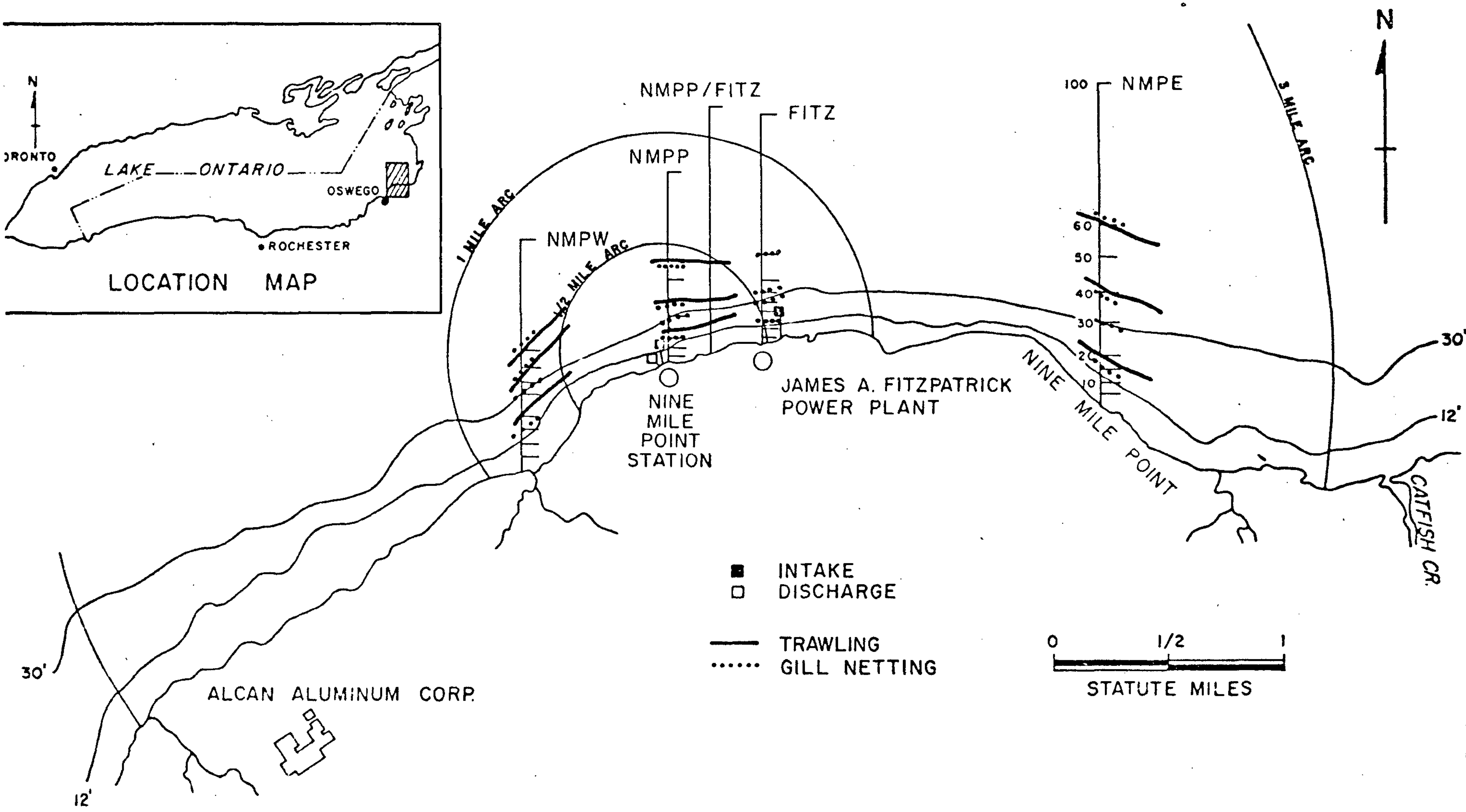


FIGURE V-1

BENTHOS SAMPLING STATIONS
NINE MILE POINT VICINITY - 1975

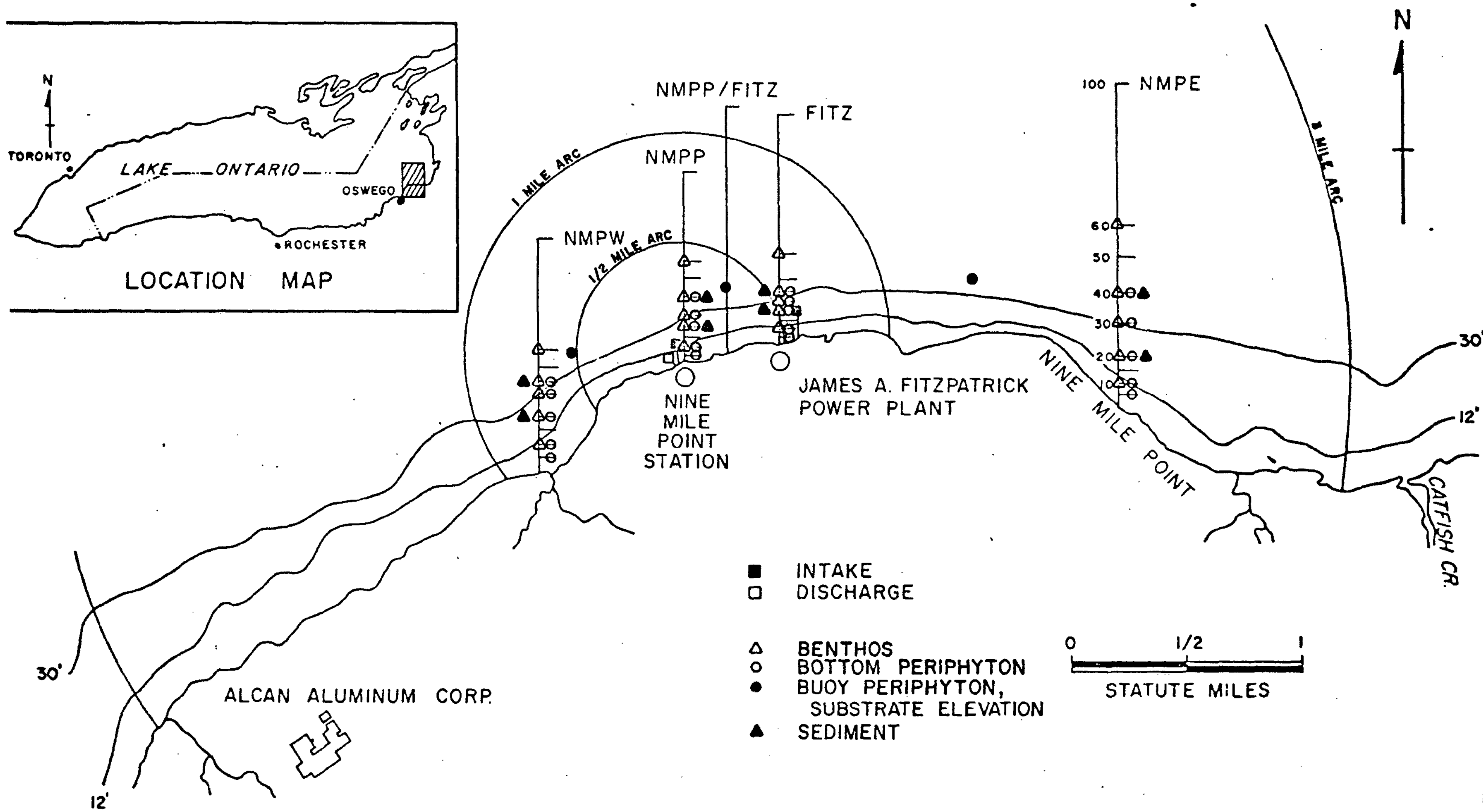


FIGURE V-2

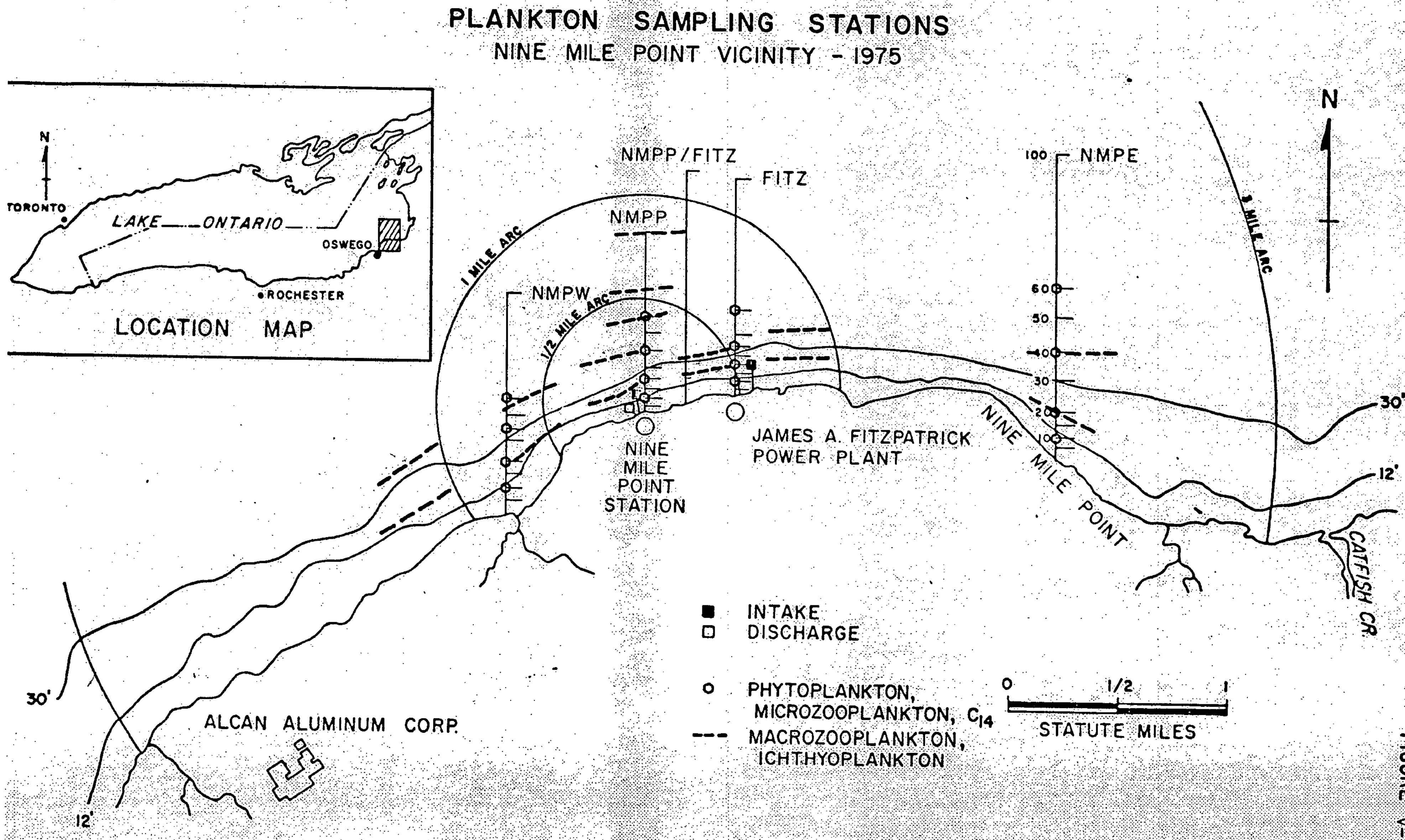

PLANKTON SAMPLING STATIONS
NINE MILE POINT VICINITY - 1975
LOCATION MAP
TORONTO
LAKE ONTARIO
OSWEGO
ROCHESTER
N
NMPP/FITZ
FITZ
NMPP
NMPW
NMPE
1 MILE ARC
1/2 MILE ARC
3 MILE ARC
100
60
50
40
30
20
10
NINE MILE POINT STATION
JAMES A. FITZPATRICK POWER PLANT
NINE MILE POINT
CATFISH CR.
30'
12'
ALCAN ALUMINUM CORP.
INTAKE
DISCHARGE
PHYTOPLANKTON, MICROZOOPLANKTON, C14
MACROZOOPLANKTON, ICHTHYOPLANKTON
0
1/2
1
STATUTE MILES

FIGURE V-3

2. Phytoplankton

The species of phytoplankton collected during 1974 and 1975 in the vicinity of Nine Mile Point are grouped at the class level according to the classification scheme of Prescott (1962) and are shown in Table V-1. Green algae composed the majority of genera identified in both 1974 (42 genera) and 1975 (51 genera; 41 genera were identified in 1973). Of the other groups, 20 and 18 genera of diatoms (19 genera in 1973) were identified in 1974 and 1975, respectively, as well as 14 and 16 genera of blue-green algae (18 genera in 1973). For those two years, 10-23 genera were identified among the other classes of phytoplankton.

Seasonal changes in the abundance of phytoplankton were evident in the vicinity of the NMP-1 and JAF. These seasonal changes also varied among years depending on the lake conditions (QLM, 1973; LMS, 1974). Munawar and Nauwerck (1971) reported that green algae tended to be the dominant component of the phytoplankton in Lake Ontario during late summer and that blue-green algae were dominant during the fall bloom. Reinwand (1969) found that *Asterionella*, *Fragilaria* and *Tabellaria* were major genera of diatoms in Lake Ontario. Findings of LMS (1974) for the Nine Mile Point vicinity are in agreement with the findings for the lake as a whole.

The following evaluations are restricted to comparing data collected at the 40-ft depth contour in 1975 when JAF was operating part of the year. We cannot compare preoperational-operational abundances because improvements in collection and laboratory techniques in each of the years which makes these comparisons very difficult to interpret. Changes in techniques are indicated in Table V-2.

The 40-ft depth contour was selected for this analysis after review of hydrothermal studies at JAF which demonstrate that this contour is affected the greatest by JAF's discharge. In addition, NMP-1 discharge affects this depth contour which makes it particularly suitable for an intensive evaluation to determine effects from both plants.

3. Total Phytoplankton

The total phytoplankton abundance (number/ml) showed a biomodal periodicity in 1975. The two maxima observed in 1975 occurred on 8 July and 24 August; however, phytoplankton abundance also increased sharply on 10 and 24 June 1975 (Table V-3*).

The ANOVA includes data from the period April-June when JAF was not operating and thus absence of significant main effects (average of

*This increase is attributed to the improved technique. (See the conclusion at the end of the section.)

TABLE V-1

PHYTOPLANKTON SPECIES INVENTORY

NINE MILE POINT VICINITY - 1974-1975

MYXOPHYCEAE	CHLOROPHYCEAE
Anabaena sp.	*Actinastrum gracillimum*
A. flos-aquae	*A. Hanzschii*
A. macrospora	*Akistrodesmus falcatus*
Anacystis sp.	*A. falcatus* v. *tumidus*
A. aeruginosa	*A. nanoselene*
A. incerta	*A. spirotaenia*
Aphanizomemnon flos-aquae	*Asterococcus limneticus*
Aphanocapsa sp.	*Botryococcus sudeticus*
A. delicatissima	*Carteria* sp.
A. elachista	*C. cordiformis*
A. pulchra	*C. klebsii*
A. rivularis	*Characium ornithocephalum*
Aphanothece sp.	*Chlamydomonas* sp.
A. nidulans	*C. globosa*
A. saxicola	*C. pseudopertyi*
Chroococcus sp.	*Chlorogonium* sp.
C. dispersus	*Chodatella* sp.
C. dispersus v. *minor*	*C. ciliata*
C. limneticus	*C. citriformis*
C. minutus	*C. longiseta*
Coelosphaerium dubium	*C. quadriseta*
C. kuetzingianum	*C. subsalsa*
C. naegelianum	*C. wratislawiensis*
C. pallidum	*Chlorella* sp.
Dactylococcopsis smithi	*Closterium* sp.
Gloecapsa sp.	*C. aciculare*
Gomphosphaeria lacustris	*C. monoliferum*
Lyngbya limnetica	*C. venus*
Merismopedia glauca	*Coelastrum cambricum*
M. tenuissima	*C. microporum*
Oscillatoria sp.	*C. reticulatum*
O. agardhii	*Coranastrum aestivale*
O. geminata	*Cosmarium* sp.
O. limnetica	*Crucigenia* sp.
O. minima	*C. apiculata*
O. tenuis	*C. crucifera*
Phormidium sp.	*C. lauterbornii*
Plectonema sp.	*C. quadrata*
Polycystis aeruginosa	*C. rectangularis*
P. incerta	*C. tetrapedia*
Rhabdoderma lineare	*Dictyosphaerium ehrenbergianum*
R. minima	*D. puchellum*
Rhaphidiopsis sp.	*Dispora crucigenoiodes*
UID Chroococcales	*Echinosphaerella limnetica*
	Elaktothrix genatinosa

TABLE V-1 (Continued)

PHYTOPLANKTON SPECIES INVENTORY

CHLOROPHYCEAE (Continued)

Errerella bornhemiensis
Eudorina elegans
Franceia droescheri
F. ovalis
F. tuberculata
Gloecystis sp.
G. ampla
G. gigas
G. planktonica
G. vesiculosa
Gloeotila curta
Golenkinia paucispina
G. radiata
Kirchneriella contorta
K. lunaris
K. obesa
K. subsolitaria
Lobomonas sp.
L. ampla
Micractinium pusillum
Mougeotia sp.
Nephrocytium agardhianum
N. limneticum
N. lunatum
Oedogonium sp.
Oocystis sp.
O. borgei
O. lacustris
O. parva
O. pusilla
O. solitaria
O. submarina
Pandorina morum
Pediastrum boryanum
P. duplex
P. simplex
P. tetras
Pedinomonas minutissima
Phacotus lenticularis
Polyedriopsis spinulosa
Polytoma sp.
Quadrigula sp.
Q. chodatii
Q. closteroides
Q. lacustris
Radiococcus nimbatus

CHLOROPHYCEAE (Continued)

Scenedesmus sp.
S. abundans
S. acuminatus
S. acutiformis
S. arcuatis
S. bijuga
S. bijugatus
S. brasiliensis
S. denticulatus
S. dimorphus
S. incrassatulus
S. intermedius
S. longus
S. obliquus
S. opoliensis
S. quadricauda
Schroederia judayi
S. setigera
Selenastrum minutum
S. westii
Sphaerocystis schroeteri
Spirogyra sp.
Staurastrum sp.
S. gracile
Tetradesmus sp.
Tetraedron caudatum
T. minimum
T. muticum
T. pentaedricum
T. regulare
T. trigonum
Tetraspora lacustris
T. lamellosa
Tetastrum elegans
T. heteracanthum
T. staurogeniaforme
Treubaria setigerum
T. triappendiculata
Trochiscia sp.
Ulothrix sp.
U. subconstricta
Westella linearis
UID Chlorophyceae
UID colony
UID single cell
UID germling

TABLE V-1 (Continued)

PHYTOPLANKTON SPECIES INVENTORY

EUGLENOPHYCEAE
- *Euglena* sp.
- *Lepocinclis* sp.
- *Phacus* sp.
- *Trachelomonas* sp.

CHRYSOPHYCEAE
- *Chromulina* sp.
- *Chrysamoeba* sp.
- *Chrysarachinion insidians*
- *Chrysochromulina parva*
- *Chrysoephaerella longispina*
- *Dinobryon* sp.
- *D. bavaricum*
- *D. divergens*
- *D. sociale*
- *D. sociale* v. *americanum*
- *Kephyrion* sp.
- *Mallomonas* sp.
- *Ochromonas* sp.
- *Rhizochrysis* sp.
- *Stelexmonas* sp.
- *Uroglena* sp.
- UID Chrysomonadales

BACILLARIOPHYCEAE
- *Amphiprora* sp.
- *Amphora ovalis*
- *Asterionella formosa*
- *Cocconeis* sp.
- *Coscinodiscus lacustris*
- *C. Rothii*
- *C. subtilis*
- *Cyclotella* sp.
- *C. atomus*
- *C. glomerata*
- *C. meneghiniana*
- *C. pseudostelligera*
- *C. stelligera*
- *Cymbella* sp.
- *Diatoma elongatum*
- *D. tenue* v. *elongatum*
- *D. vulgare*
- *Eunotia curvata*
- *Fragilaria capucina*
- *F. crotonensis*
- *F. vaucheriae*

BACILLARIOPHYCEAE (Continued)
- *Gomphonema* sp.
- *G. olivaceum*
- *Gyrosigma* sp.
- *G. attenuatum*
- *Melosira* sp.
- *M. binderana*
- *M. granulata*
- *M. granulata* v. *angustissima*
- *M. islandica*
- *M. italica*
- *M. italica* v. *subarctia*
- *M. varians*
- *Navicula* sp.
- *N. cryptocephala*
- *N. tripunctata*
- *Nitzschia* sp.
- *N. acicularis*
- *N. dissipata*
- *N. gracilis*
- *N. holosatica*
- *N. palea*
- *N. sigmoidea*
- *Rhoicosphenia curvata*
- *Stephanodiscus* sp.
- *S. astrea*
- *S. astrea* v. *minutulus*
- *S. hantzschii*
- *S. hantzschii* v. *pusilla*
- *S. niagarae*
- *S. tenuis*
- *Surirella* sp.
- *Synedra* sp.
- *S. acus*
- *S. rumpens*
- *S. ulna*
- *Tabellaria fenestrata*
- *T. flocculosa*

CRYPTOPHYCEAE
- *Chroomonas* sp.
- *C. acuta*
- *Cryptaulax rhomboidea*
- *Cryptomonas* sp.
- *C. erosa*
- *C. erosa* v. *reflexa*
- *C. marsonii*

TABLE V-1 (Continued)

PHYTOPLANKTON SPECIES INVENTORY

CRYPTOPHYCEAE (Continued)
Cryptomonas obovata
C. ovata
C. phaseolus
C. platyuris
C. pusilla
C. reflexa
C. rotrata
Katablepharis ovalis
Rhodomonas minuta
R. minuta v. *nannoplanctica*
Sennia parvula
UID Chryptophyte
DINOPHYCEAE
Amphidinium sp.
Ceratinum hirundinella
Glenodinium sp.
G. pulvisculus
Gymnodinium sp.
G. helveticum
G. ordinatum
G. varians
Peridinium sp.
P. aciculiferum
P. cinctum
P. cunningtonii
P. inconspicuum

TABLE V-2

COLLECTION AND ANALYSES METHODS FOR PHYTOPLANKTON AND MICROZOOPLANKTON

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1973-1975

YEAR	TYPE	SAMPLING METHOD	ANALYSIS METHOD
1973	MICRO-lake	Vertical tows (12 cm net) 2 reps 76 μ net	Sedgewick-Rafter
	PHYTO-lake	1) 20 liters surf. water thru 28 μ net 2) Whole water (June-December)	Palmer-Maloney
1974	MICRO-lake	Vertical tows (76 μ Wisconsin Net)	Sedgewick-Rafter
	PHYTO-lake	Whole water	Palmer-Maloney
1975	MICRO-lake	Clarks-Bumpus 76 μ mesh	Sedgewick-Rafter
	PHYTO-lake	Whole water	Utermohl

TABLE V-3

ABUNDANCE AND BIOMASS OF WHOLE WATER PHYTOPLANKTON* AT 40-FT DEPTH CONTOUR BY TRANSECT

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. TOTAL PHYTOPLANKTON

DATE	NMPW No./ml	NMPW mg/m³	NMPP No./ml	NMPP mg/m³	FITZ No./ml	FITZ mg/m³	NMPE No./ml	NMPE mg/m³
29 APR	2517	1253.92	3443	2445.11	2670	1302.48	2279	1395.42
6 MAY	2593	418.20	2624	610.04	1937	416.20	3939	644.50
20 MAY	2667	532.09	4028	1527.01	4355	1299.81	3803	2095.35
10 JUN	42423	1924.82	30212	1186.02	16942	780.57	18037	908.94
24 JUN	36919	2060.78	30164	3019.80	17945	2198.33	14277	1276.12
8 JUL	71273	1165.04	50983	795.80	36125	598.94	23195	700.98
29 JUL	2847	566.50	9682	2091.33	13483	2223.00	9325	2538.28
4 AUG	17347	2945.92	12386	1524.61	5567	1213.91	6558	753.94
24 AUG	31342	2504.18	12799	314.47	15967	655.46	32501	1169.92
18 SEP	7672	394.76	6940	464.08	7043	831.83	5831	614.03
27 OCT	7414	1456.18	9008	1550.54	6635	1389.25	8656	1226.32
17 NOV	2171	612.25	2916	807.39	3060	594.34	2509	624.56
12 DEC	1796	413.35	1672	395.43	1855	429.47	1646	372.34
MEAN	17605	1249.84	13604	1287.05	10276	1071.74	10197	1101.59

II. DIATOMS

DATE	NMPW No./ml	NMPW mg/m³	NMPP No./ml	NMPP mg/m³	FITZ No./ml	FITZ mg/m³	NMPE No./ml	NMPE mg/m³
29 APR	1502	933.88	1667	2011.22	1298	871.21	920	826.57
6 MAY	377	162.36	473	237.38	339	286.63	414	206.00
20 MAY	448	127.99	2076	941.12	1835	984.33	1442	868.44
10 JUN	2483	738.06	408	236.95	525	351.32	763	239.44
24 JUN	300	167.65	125	111.76	113	115.74	75	45.93
8 JUL	173	238.39	85	57.86	93	47.73	25	3.43
29 JUL	62	45.44	1502	1120.20	1555	988.28	1050	697.65
4 AUG	405	338.47	324	207.85	4	2.94	32	9.26
24 AUG	208	166.49	45	11.37	40	15.29	430	165.43
18 SEP	250	61.06	169	34.11	308	147.48	235	82.84
27 OCT	522	371.49	420	275.49	361	289.01	529	264.88
17 NOV	219	249.90	263	203.01	318	203.51	134	106.01
12 DEC	123	205.24	230	172.12	183	199.77	144	154.36
MEAN	544	292.80	599	432.34	536	346.40	476	282.33

*Mean of original and replicate samples

TABLE V-3 (Continued)

ABUNDANCE AND BIOMASS OF WHOLE WATER PHYTOPLANKTON* AT 40-FT DEPTH CONTOUR BY TRANSECT

III. GREEN ALGAE

DATE	NMPW		NMPP		FITZ		NMPE	
	No./ml	mg/m^3	No./ml	mg/m^3	No./ml	mg/m^3	No./ml	mg/m^3
29 APR	382	28.80	645	29.20	394	34.97	377	35.63
6 MAY	432	21.64	374	36.81	285	12.40	336	14.23
20 MAY	1128	77.79	1506	82.46	1649	148.89	1453	102.27
10 JUN	4490	180.07	1170	70.88	828	48.72	1460	75.20
24 JUN	2040	121.30	2345	212.81	1743	153.66	615	63.71
8 JUL	1843	262.63	1545	182.35	920	153.77	795	191.47
29 JUL	429	40.74	2777	269.04	3097	316.46	2550	287.84
4 AUG	2334	420.44	2036	244.51	1379	175.00	2075	197.27
24 AUG	4055	386.38	1553	152.25	2338	225.76	3948	306.60
18 SEP	1012	92.50	1390	159.98	904	156.06	1310	182.85
27 OCT	1109	454.15	821	264.72	824	232.09	641	341.85
17 NOV	157	92.44	230	199.61	144	31.52	177	104.49
12 DEC	180	58.19	179	29.92	207	56.45	155	47.92
MEAN	1507	172.08	1275	148.81	1132	134.29	1222	150.10

IV. BLUE-GREEN ALGAE

29 APR	200	9.59	305	15.51	160	4.74	175	1.98
6 MAY	200	2.27	489	23.22	261	7.61	464	8.95
20 MAY	545	12.94	294	12.31	667	15.94	626	30.07
10 JUN	28740	112.80	23852	86.94	12500	64.68	11194	37.14
24 JUN	21267	42.11	9836	58.14	1848	10.70	2675	9.36
8 JUL	66218	28.26	47443	26.28	33198	21.95	19578	15.90
29 JUL	1460	0.70	4263	58.77	7547	65.89	3536	41.33
4 AUG	13132	195.91	8178	222.97	2465	43.25	2447	29.03
24 AUG	23414	100.05	8981	46.86	11199	50.13	23303	100.82
18 SEP	5616	43.76	4281	40.00	4023	27.27	2954	35.05
27 OCT	3767	75.00	5283	87.16	3626	41.65	5149	57.47
17 NOV	1126	21.66	1617	31.21	1814	46.73	1461	36.84
12 DEC	1036	8.88	867	6.65	1049	9.73	973	8.93
MEAN	12825	50.30	8899	55.08	6181	31.56	5733	31.76

*Mean of original and replicate samples

sample locations over the year) should be approached with caution for JAF. However, there is no trend for the FITZ transect for operational months when abundance was consistently high or low (Table V-3).

There was no significant difference in either the abundance (Table V-4) or the biomass (Table V-5) of the total phytoplankton among the four 40 ft sample locations, thus indicating the lack of any significant plant effect, in the operational year from JAF and NMP-1.

4. Diatoms

In 1975 there was no significant difference among the four sample locations (Table V-3), nor did the FITZ or NMPP locations exhibit trends of consistently high or low abundances. This demonstrates that operation of both NMP-1 and JAF did not measurably affect diatom abundances. Differences that exist in monthly abundances between locations is attributed to natural variability and patchiness in the light of definable trends.

There was a significant difference ($\alpha = .01$) in diatom biomass among transects in 1975 (Table V-5). The average diatom biomass at NMPP 40 ft stations exceeded those at the other transects. This difference was significant only on 29 April (Table V-5). A second peak in biomass occurred on 29 July at NMPP, FITZ and NMPE 40-ft stations (Table V-3).

April is the month of maximum diatom biomass and abundance at the NMPP transect was approximately two fold higher than at any of the other sample locations. This difference almost equals the next highest biomass of the year. Because biomass for the rest of the year at NMPP is not consistently high or low, we attribute the April difference to the patchy nature of phytoplankton. We also note that differences of the magnitude discussed above frequently occur between the two control or reference locations, NMPW and NMPE.

5. Green Algae

Green algal abundance was highest in July/August 1975 (Table V-3). The presence of large numbers of green algae in late summer is characteristic of algal populations in Lake Ontario (Ogawa, 1969; Munawar and Nauwerck, 1971), and has also been reported by Schelske et al. (1971) for Lake Michigan populations.

The biomass (mg/m^3) of green algae increased from April to May, fluctuated during the summer and declined in November and December 1975 (Table V-3). This pattern of green algal growth has been reported for those organisms by Patrick (1969).

TABLE V-4

STATISTICAL ANALYSIS OF PHYTOPLANKTON ABUNDANCE AT 40 FT STATIONS

JAMES A FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. TOTAL PHYTOPLANKTON

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	12	18.8468	1.5706	30.56**
TRANSECTS	3	0.1203	0.0401	0.78
ERROR	36	1.8519	0.0514	
WITHIN SAMPLES	52	0.5127	0.0099	
TOTAL	103	21.3317		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

	8	10	24	24	4	29	27	18	20	29	6	17	12	
Largest:	JUL	JUN	JUN	AUG	AUG	JUL	OCT	SEP	MAY	APR	MAY	NOV	DEC	: Smallest

II. DIATOM

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	12	19.1972	1.5998	4.28**
TRANSECTS	3	0.5129	0.1710	0.46
ERROR	36	13.4425	0.3734	
WITHIN SAMPLES	52	2.6623	0.0512	
TOTAL	103	35.8149		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

	20	29	10	29	27	6	18	17	24	12	24	4	8	
Largest:	MAY	APR	JUN	JUL	OCT	MAY	SEP	NOV	AUG	DEC	JUN	AUG	JUL	: Smallest

TABLE V-4 (Continued)

STATISTICAL ANALYSIS OF PHYTOPLANKTON ABUNDANCE AT 40 FT STATIONS

III. GREEN ALGAE

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	12	15.4986	1.2916	17.27**
TRANSECTS	3	0.1429	0.0476	0.64
ERROR	36	2.6912	0.0748	
WITHIN SAMPLES	52	1.0159	0.0195	
TOTAL	103	19.3486		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

Largest: 24 AUG, 29 JUL, 4 AUG, 10 JUN, 24 JUN, 20 MAY, 8 JUL, 18 SEP, 27 OCT, 29 APR, 6 MAY, 12 DEC, 17 NOV : Smallest

IV. BLUE-GREEN ALGAE

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	12	46.0918	3.8410	41.43**
TRANSECTS	3	0.3066	0.1022	1.10
ERROR	36	3.3355	0.0927	
WITHIN SAMPLES	52	2.4413	0.0469	
TOTAL	103	52.1752		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

Largest: 8 JUL, 12 JUN, 24 AUG, 24 JUN, 4 AUG, 27 OCT, 18 SEP, 29 JUL, 17 NOV, 12 DEC, 20 MAY, 6 MAY, 29 APR : Smallest

TABLE V-5

STATISTICAL ANALYSIS OF PHYTOPLANKTON BIOMASS AT 40 FT STATIONS

JAMES A FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. TOTAL PHYTOPLANKTON

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	12	4.6639	0.3887	4.82**
TRANSECTS	3	0.0270	0.0090	0.11
ERROR	36	2.9007	0.0806	
WITHIN SAMPLES	52	0.3537	0.0068	
TOTAL	103	7.9453		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

Largest: 24 JUN 29 JUL 4 AUG 29 APR 27 OCT 20 MAY 10 JUN 24 AUG 8 JUL 17 NOV 18 SEP 6 MAY 12 DEC : Smallest

II. DIATOM

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	3	0.6123	0.2041	0.40
TRANSECTS	12	21.5992	1.7999	3.51**
ERROR	36	18.4515	0.5125	
WITHIN SAMPLES	52	5.8904	0.1133	
TOTAL	103	46.5534		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

Largest: 29 APR 20 MAY 29 JUL 10 JUN 27 OCT 6 MAY 17 NOV 12 DEC 4 AUG 24 JUN 24 AUG 8 JUL 18 SEP: Smallest

TABLE V-5 (Continued)

STATISTICAL ANALYSIS OF PHYTOPLANKTON BIOMASS AT 40 FT STATIONS

III. GREEN ALGAE

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	12	12.9641	1.0803	11.13**
TRANSECTS	3	0.0751	0.0250	0.26
ERROR	36	3.4966	0.0971	
WITHIN SAMPLES	52	1.3216	0.0254	
TOTAL	103	17.8574		

**Significant at $\alpha = .01$

TUKEY T TEST - DATES ($\alpha = .05$)

	27	24	4	29	8	18	24	17	20	10	12	29	6	
Largest:	OCT	AUG	AUG	JUL	JUL	SEP	JUN	NOV	MAY	JUN	DEC	APR	MAY:	Smallest

IV. BLUE-GREEN ALGAE

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	12	16.4145	1.3679	4.89**
TRANSECTS	3	0.9954	0.3318	1.19
ERROR	36	10.0764	0.2799	
WITHIN SAMPLES	52	5.0044	0.0962	
TOTAL	103	32.4907		

**Significant at $\alpha = .01$

TUKEY T TEST - DATES ($\alpha = .05$)

	4	10	24	27	29	18	17	24	8	20	6	12	29	
Largest:	AUG	JUN	AUG	OCT	JUL	SEP	NOV	JUN	JUL	MAY	MAY	DEC	APR:	Smallest

There were no significant differences in biomass or abundances at the 40 ft locations in 1975 (Tables V-4 and V-5). Also, there were no trends of consistently high or low abundances. These two considerations lead us to conclude that operation of both plants has not effected green algae abundance.

6. Blue-green Algae

Blue-green algae are characterized as having rapid growth in warm and nutrient-rich waters. They were abundant at the 40-ft stations in June, July and August (Table V-3) throughout the summer in 1975.

Blue-green algae were reported to be the dominant phytoplankton in Lake Michigan in late August and early September (Schelske et al., 1971), a pattern similar to that found in the study area. These authors attributed the blue-green algal peaks to increased nutrient concentrations.

There was no significant difference among the four sample locations in either abundance (Table V-4) or biomass (Table V-5) of blue-green algae. This indicates that neither the NMP-1 discharge nor the JAF discharge significantly influenced the abundance of blue-green algae at the 40 ft stations of any of the transects. This conclusion, with the reservation that JAF was not operating early in the year, is none the less very important in that the plant was operating at greater than 50% capacity July, August and September when a stimulatory effect on blue-green algae and inhibition of other phyla could occur.

a. Effect of Plume Entrainment on Phytoplankton Productivity

If plume entrainment was measurably affecting the algal community, both primary production and/or standing stock could be atlered; increases, decreases, or no change in these parameters is possible. The effect of plume entrainment was tested by comparing production rates (mg C assimulated/m^3/hr) and standing stock (μg chlorophyll a/l) in the plume, both actual and simulated, to values at the intake. In that chlorophyll a is rapidly reduced to phaeopigments on cell death, this parameter can also be used to estimate phytoplankton assemblage viability. These experiments were conducted from May through September 1976 according to the following design.

Whole water intake samples for plume and plant entrainment analyses were obtained by submerged pump from the intake forebay and discharge aftbay during the entire sampling period, May through September (Table V-6). Samples for determination of plume effects were either obtained from the surface waters within the approximate 3 and 2°F isotherms of the plume (2 and 3°F lake samples) with a Van Dorn

TABLE V-6

PLANT LOAD AND TEMPERATURE RISE AT TIME OF SAMPLING

JAMES A. FITZPATRICK NUCLEAR POWER PLANT - 1976

DATE	HOUR	AVERAGE LOAD/DAY (MWe)	ΔT (°C) AT TIME OF INTAKE OF SAMPLE
12 MAY	0958	737	14.4
26 MAY	1012	781	15.5
9 JUN	1021	693	12.9
23 JUN	1018	446	15.8
20 JUL	1019	721	14.2
29 JUL	1016	543	13.6
11 AUG	0951	771	15.1
25 AUG	0950	789	15.0
8 SEP	1000	785	15.8
22 SEP	1038	730	14.4

*Samples for chlorophyll a analysis were taken at night under similar ΔT conditions on each date, except that the June night sample was taken on 28 June.

water sampler or were simulated by dilution of discharge samples, obtained from the discharge aftbay, with intake sample water to represent both plant and plume entrainment to the 3 and 2°F isotherms. During the period May through June the dilution ratios used in the simulations were designed to reduce the measured temperature difference between intake and discharge to 3 and 2°F, depending on the plume effect being simulated. The dilution during this period was done with a single instantaneous addition of intake water to the discharge sample. For the period July through September, the dilution scheme was changed to a time series of dilutions, designed to simulate the time-temperature regime of plume organisms. The times of travel to the temperature rises above 2°F were doubled (see Chapter IV), to insure maximum exposure of the organisms. Due to the length of the estimated time interval to the 2°F isotherm, a time period of 5 minutes was allowed between the 3 and 2°F simulated temperature rises.

After simulation on lake collection, samples were transported back to the laboratory where they were incubated at 1000 ft/candles for four hours. Primary production rates and chalorophyll a concentrations at the experimental locations (3 and 2° isotherms) were divided by the control (intake forebay) rates to provide an index of entrainment effects. When the index equals one, no effects are noted and rates in excess of one suggests a stimulatory effect.

Since all discharge samples used in the simulations were held at discharge temperature for the travel time from the discharge bay to the lake discharge, the only possible effects that are not simulated are those effects, if any, caused by pressure change and mechanical damage in the discharge tunnel system.

With one exception, primary production rates in the plume were greater than at the intake (Figure V-4) for both actual and simulation experiments, indicating that during the warmer months of the year the net effect of phytoplankton entrainment is stimulation of primary production. The mean stimulation factors were similar (between 1.5 and 1.8) among the four treatments over comparable months, suggesting that the variation in ΔT's and ambient had little influence on the results. Lake samples exhibited more variability and increased stimulation than simulated samples which suggests that there may be natural differences between intake and surface samples, since intake water is withdrawn from near the bottom in 25 ft of water. This implies that the simulation studies may be more representative of plume entrainment effects.

Chlorophyll a values tended to be equal or greater at the 2°F isotherm in the lake than at the intake, but lower at the 3°F than at the intake (Figure V-5). The magnitudes, of difference were,

RATIO OF PLUME VS. INTAKE PRIMARY PRODUCTION
JAMES A. FITZPATRICK NUCLEAR POWER PLANT — MAY-SEPTEMBER 1976

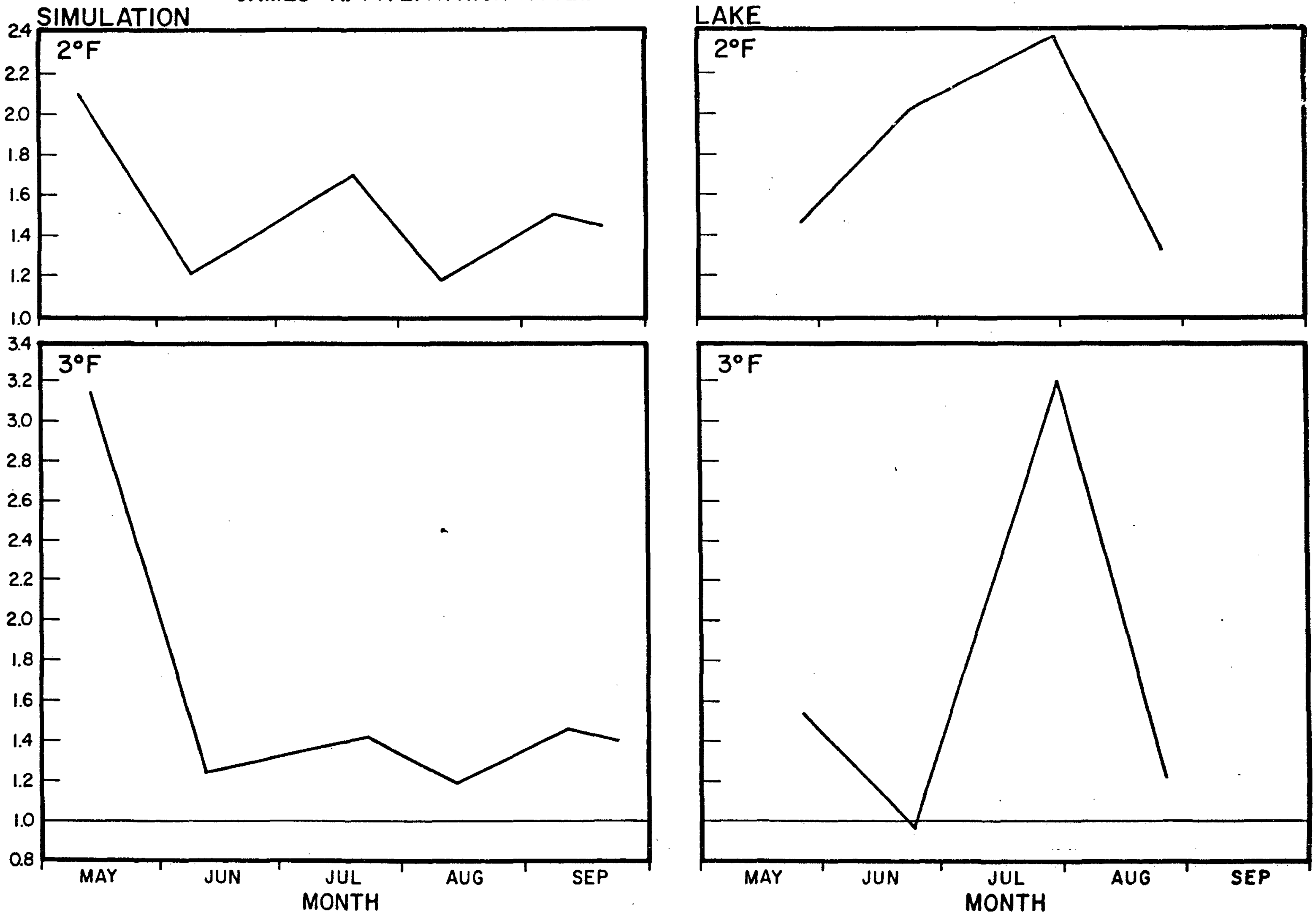
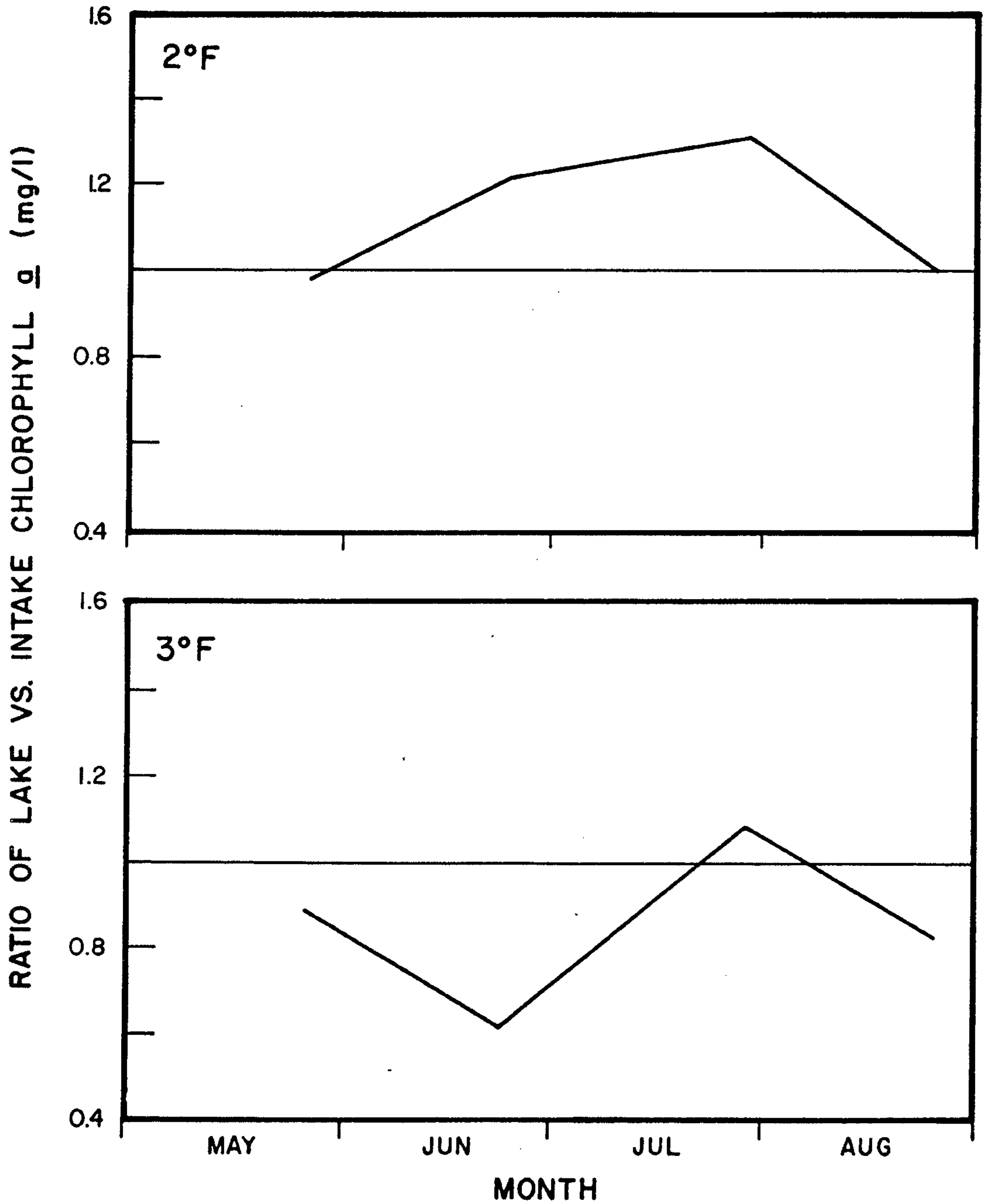


FIGURE V-4

RATIO OF LAKE VS. INTAKE CHLOROPHYLL a

JAMES A. FITZPATRICK NUCLEAR POWER PLANT — MAY-AUGUST 1976



however, generally less than ±20%. The simulation experiments showed similar results except there was no consistent trend in plume to intake ratios (Figure V-6).

Overall, then the data indicate net stimulation of primary production, primarily in the plume. No consistent change in standing stock was noted along with no substantive mortality during the warmer months of the year. Chlorophyll a concentrations suggest that it will not be possible to detect differences in standing crop outside the immediate discharge area.

Conclusion

The preceding analyses yielded no evidence of plant-induced depression or enhancement of total phytoplankton, diatoms, green algae or blue-green algae in 1975. Results of the entrainment studies support this conclusion in that it was determined that it will probably not be possible to detect changes in chlorophyll a outside the immediate discharge area. There is, however, an increase in primary production in the plume.

7. Zooplankton

For the purposes of this study the zooplankton community is divided into two subcategories according to the size of the organisms. Those collected by and retained in a 76µ mesh net are microzooplankton, while macrozooplankton are defined as those zooplanktonic organisms retained by a 571µ mesh net. Two different mesh sizes were used to facilitate the collection of organisms of different sizes.

a. Microzooplankton

The species constituting the microzooplankton assemblage in the vicinity of JAF in 1974 and 1975 are listed in Table V-7. Four major taxonomic groups - rotifers, cladocerans, copepods and protozoans - made up the bulk of the microzooplankton community in the study area in both 1974 and 1975 (LMS, 1975; LMS, 1976).

Total abundance, species composition and patterns of distribution of the four major groups followed a seasonal cycle that was most influenced by meteorological parameters. The highest densities of total microzooplankton were observed during the June-July period, with a maximum concentration of 1,000,000 organisms/m^3 reached on 8 July 1975 (Table V-8).

Rotifers were abundant at all depth contours, increasing from 20,000 organism/m^3 in May 1975 to 700,000 organism/m^3 in July

RATIO OF PLUME VS. INTAKE CHLOROPHYLL a

JAMES A. FITZPATRICK NUCLEAR POWER PLANT — MAY-SEPTEMBER 1976

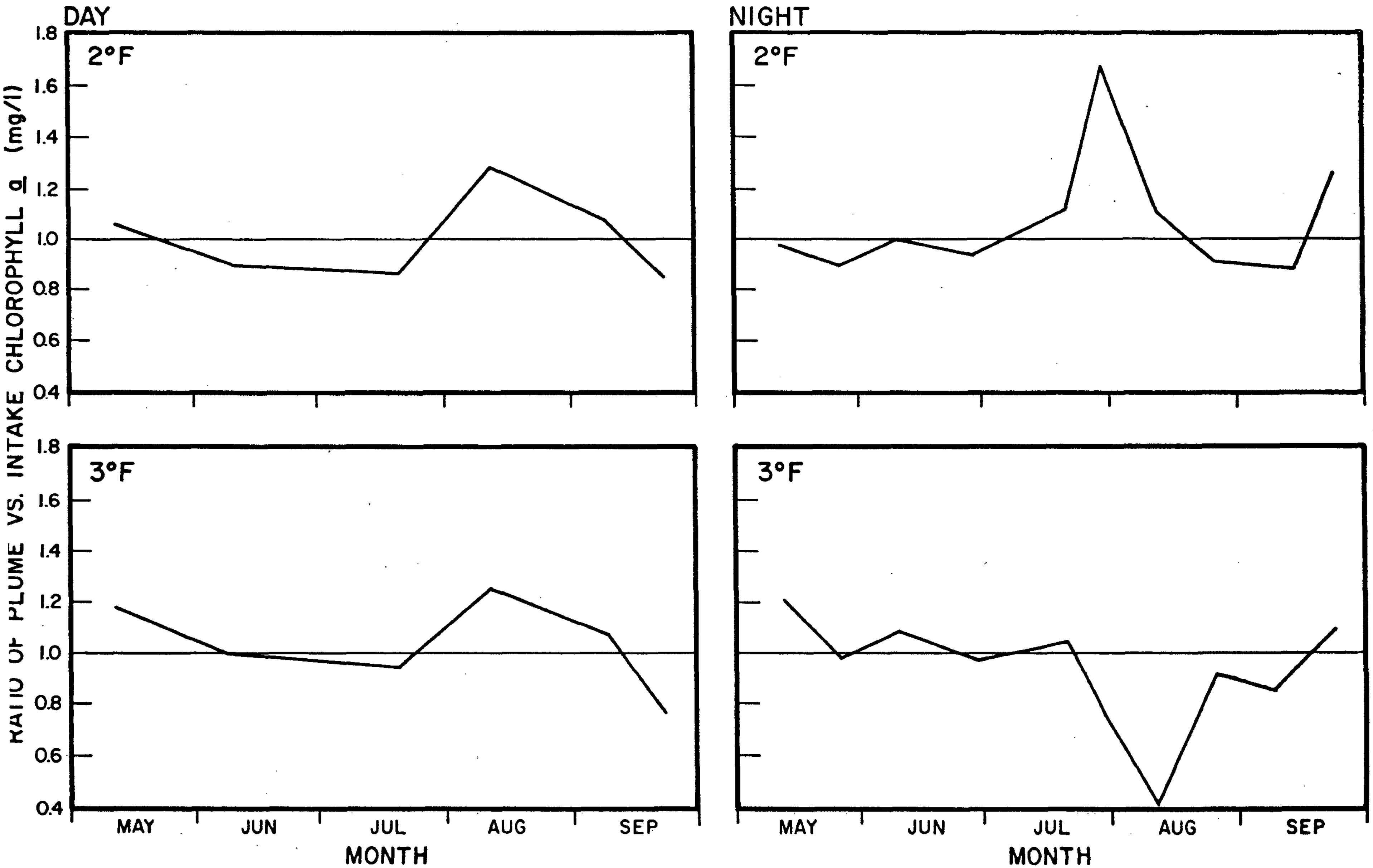


FIGURE V-6

TABLE V-7

MICROZOOPLANKTON SPECIES INVENTORY [a]

NINE MILE POINT VICINITY - 1974-1975

PROTOZOA
Lobosa
Testacealobosa
Difflugiidae
Difflugia sp.
Suctoria
Tentaculiferida
Acinetidae
Acineta sp.
Thecacineta sp.
Tokophyra sp.
Dendrosomidae
Staurophyra elegans
Podophryidae
Paracineta sp.
Ciliata
Spirotrichida
Tintinnidae
Codonella cratera
Peritrichida
Epistylidae
Epistylis sp.
Vaginocolidae
Vorticellidae
Vorticella sp.
Holotrichida
Gymnostomina [b]

ROTIFERA
Bdelloidea
Monogononta
Ploima
Brachionidae
Brachionus sp.
B. angularis
B. budapestinensis
B. calyciflorus
B. caudatus
B. havanaenis
B. quadridentatus
B. urceolaris
Euchlanis sp.
E. dilatata
Kellicottia bostoniensis
K. longispina
Keratella sp.

ROTIFERA (Continued)
K. cochlearis
K. crassa
K. earlinae
K. quadrata
K. valga
Lepadella sp.
Notholca sp.
N. acuminata
N. squamula
N. striata
Platyas patulus
Trichotria sp.
Lecanidae
Lecane sp.
Notommatidae
Cephalodella sp.
Monostyla sp.
Trichocercidae
Ascomorpha sp.
A. eucaudis
Trichocerca sp.
T. cylindrica
T. multicrinis
T. porcellus
T. similis
Gastropidae
Chromogaster ovalis
Asplanchnidae
Asplanchna sp.
A. priodonta
Synchaetidae
Ploesoma sp.
P. hudsoni
P. lenticulare
P. truncatum
Polyarthra sp.
P. dolichoptera
P. euryptera
P. major
P. remata
P. vulgaris
Synchaeta lackowitziana
S. pectinata
S. stylata
S. tremula

TABLE V-7 (Continued)

MICROZOOPLANKTON SPECIES INVENTORY [a]

ROTIFERA (Continued)
Testudinellidae
Filinia longiseta
Hexarthridae
Hexarthra sp.
Conochilidae
Conochiloides sp.
Conochilus sp.
C. unicornis
Collothecidae
Collotheca mutabilis

ARTHROPODA
Crustacea
Cladocera
Bosminidae
Bosmina sp.
B. coregoni
B. longirostris
Chydoridae
Alona affinis
Chydorus sphaericus
Daphnidae
Ceriodaphnia lacustris
C. quadrangula
Daphnia sp.
D. galeata mendotae
D. longiremus
D. retrocurva
Holopedidae
Holopedium gibberum
Sididae
Diaphanosoma leuchtenbergianum
Copepoda[c]
Copepoda nauplii
Calanoida
Diaptomidae
Diaptomus sp.
D. minutus
Centropagidae
Limnocalanus macrurus
Temoridae
Eurytemora affinis

ROTIFERA (Continued)
Calanoida juvenile
Cyclopoida
Cyclopidae
Acanthocyclops vernalis
Diacyclops bicuspidatus thomasi
Mesocyclops edax
Tropocyclops prasinus mexicanus
Cyclopoida juvenile
Harpacticoida
Harpacticoida juvenile

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[a] Subject to corrections
[b] Suborder
[c] Subclass

TABLE V-8

ABUNDANCE* OF MICROZOOPLANKTON AT FITZ-40 FT STATION

JAMES A FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1973-1975

I. TOTAL MICROZOOPLANKTON

1973		1974		1975	
DATE	No./m^3	DATE	No./m^3	DATE	No./m^3
		26 APR	76170	29 APR	NS
		11 MAY	272470	6 MAY	81304
16 MAY	3165	22 MAY	NS	20 MAY	704490
		6 JUN	380900	10 JUN	1261076
15 JUN	631	28 JUN	322930	24 JUN	478066
20 JUL	1489338	15 JUL	1285810	8 JUL	1488990
26 JUL	1792795	29 JUL	421770	29 JUL	232052
13 AUG	290541	8 AUG	583880	4 AUG	906602
23 AUG	428819	22 AUG	476790	24 AUG	48032
20 SEP	189843	27 SEP	99410	18 SEP	225810
25 OCT	348154	24 OCT	266550	27 OCT	157612
20 NOV	200273	27 NOV	78790	17 NOV	110064
		12 DEC	72320	12 DEC	NS
MEAN	527062		361483		517646

II. ROTIFERA

1973		1974		1975	
DATE	No./m^3	DATE	No./m^3	DATE	No./m^3
		26 APR	65960	29 APR	NS
		11 MAY	180260	6 MAY	26372
16 MAY	3165	22 MAY	NS	20 MAY	600458
		6 JUN	250915	10 JUN	1157090
15 JUN	631	28 JUN	291685	24 JUN	406878
20 JUL	886510	15 JUL	887000	8 JUL	1131100
26 JUL	50686	29 JUL	503650	29 JUL	100406
13 AUG	147271	8 AUG	446050	4 AUG	374318
23 AUG	316752	22 AUG	239600	24 AUG	37232
20 SEP	123909	27 SEP	15585	18 SEP	50216
25 OCT	87685	24 OCT	194550	27 OCT	101496
20 NOV	40202	27 NOV	49485	17 NOV	34456
		12 DEC	46800	12 DEC	NS
MEAN	184090		264295		365456

III. CLADOCERA

1973		1974		1975	
DATE	No./m^3	DATE	No./m^3	DATE	No./m^3
		26 APR	310	29 APR	NS
		11 MAY	355	6 MAY	0
16 MAY	0	22 MAY	NS	20 MAY	0
		6 JUN	3130	10 JUN	6732
15 JUN	0	28 JUN	10540	24 JUN	20490
20 JUL	330509	15 JUL	147800	8 JUL	260028
26 JUL	983561	29 JUL	42865	29 JUL	30634
13 AUG	36281	8 AUG	144250	4 AUG	183360
23 AUG	59350	22 AUG	13165	24 AUG	2418
20 SEP	3828	27 SEP	26190	18 SEP	95954
25 OCT	214539	24 OCT	35350	27 OCT	28830
20 NOV	116817	27 NOV	10960	17 NOV	35236
		12 DEC	2495	12 DEC	NS
MEAN	249269		36451		60334

*Mean of original and replicate samples
NS - No sample

TABLE V-8 (Continued)

ABUNDANCE* OF MICROZOOPLANKTON AT FITZ-40 FT STATION

IV. COPEPODA

1973		1974		1975	
DATE	No./m^{3}	DATE	No./m^{3}	DATE	No./m^{3}
		26 APR	8970	29 APR	NS
		11 MAY	1185	6 MAY	2824
16 MAY	0	22 MAY	NS	20 MAY	10564
		6 JUN	40705	10 JUN	23768
15 JUN	0	28 JUN	9640	24 JUN	26772
20 JUL	113504	15 JUL	37880	8 JUL	49584
26 JUL	302449	29 JUL	59275	29 JUL	75152
13 AUG	106990	8 AUG	58290	4 AUG	226704
23 AUG	52717	22 AUG	129900	24 AUG	8382
20 SEP	62107	27 SEP	54255	18 SEP	58736
25 OCT	45931	24 OCT	48840	27 OCT	18872
20 NOV	43279	27 NOV	17420	17 NOV	36282
		12 DEC	14330	12 DEC	NS
MEAN	103854		40058		48876

*Mean of original and replicate samples
NS - No sample

of the same year before they declined throughout the rest of the year. Copepod abundance increased from less than 10,000 organisms/m^3 in May 1975 to more than 50,000 organisms/m^3 in August 1975. Cladocerans, represented primarily by Bosmina longirostris, increased in abundance at all depths from 1,000 organism/m^3 in April and May to 100,000 organism/m^3 in July 1975 (Table V-8).

Of the four major taxonomic groups rotifers, composed the largest portion of the microzooplankton community in the area in 1974 and 1975. The same observation was made during the studies conducted in 1973 (QLM, 1974). Rotifer abundance varied from 6 to 97% of the total organisms collected on a given sampling date and they were represented by as many as 50 species (LMS, 1976). Keratella, Polyarthra and Synchaeta were the most abundant rotifer genera, and rotifer species occurring throughout the 1975 sampling period were Brachionus angularis and Kellicottia longispina. Seasonal shifts in the dominant rotifer taxa were evident, however; for example, from April through May 1975, Synchaeta tremula was dominant, while from 10 June through 8 July Keratella quadrata, Asplanchna priodonta and Ploesoma truncatum were dominant.

Cladocerans made up the second highest percentage of the total microzooplankton community present in the study area, being represented by 9 genera in 1974 and 8 genera in 1975 (9 genera in 1973). A species which occurred throughout the 1975 sampling program was Bosmina longirostris. The seasonal pattern of cladoceran abundance was bimodal, the first mode occurring in July while the second was observed in the October-November period (LMS, 1975). Bosmina longirostris was dominant between 10 June and 8 July 1975, and from 29 July through 18 September 1975. Storr (1971) found B. longirostris to be the dominant cladoceran in Lake Ontario with peak abundance in the late summer/early fall period. Daphnia was the most abundant cladoceran during the spring of 1974 in the Nine Mile Point vicinity.

Copepods, adult forms and nauplii were abundant in spring and late summer, respectively. Copepods in the study area exhibited a cyclic distributional pattern similar to that reported for cladocerans (LMS, 1975). Copepods made up 10-20% of total microzooplankton community abundance (LMS, 1975). The copepod Diacyclops bicuspidatus was collected throughout the sampling period in 1975.

Protozoa, represented by 8-10 genera in 1974-1975, showed higher variability in abundance and species composition than the other three major groups found in the vicinity of JAF. Protozoa were present in highest abundance in summer and lowest abundance in winter (LMS, 1975); the protozoan Codonella cratera was collected throughout the 1975 sampling program (LMS, 1976) while Staurophyra *elegans* showed a seasonal cycle, being abundant in spring/early summer.

The abundance and distribution of rotifers, copepods, cladocerans and protozoans is largely dependant on seasonal meteorological factors, particularly wind as it effects lake currents and upwellings. The seasonal patterns of abundance of microzooplankton in the Nine Mile Point vicinity were similar to those described by Gachter et al. (1974) and Glooschenko et al. (1972) for Lake Ontario communities. There was no apparent changes in the microzooplankton community composition between 1973 and 1975 in the study area.

Because of the elevated water temperature induced by JAF discharge, the major components of the microzooplankton community collected at the 40-ft stations were analyzed for differences within 1975 and at the FITZ 40-ft location only for differences between years (1973-1975). Differences in collection techniques occurred over the years. However, net size remained constant and thus differences were not considered to be as significant as for phytoplankton where similar analyses were not undertaken.

(i) Total Microzooplankton

Strong similarities existed in total microzooplankton abundance (number/m^3) among years (Table V-8). Peak abundance occurred in July of all three years, and the mean annual abundance of total microzooplankton was similar among years, although there was some seasonal variability. The maximum abundance of microzooplankton reported in 1973 occurred on 20-26 July (Table V-8). The peak abundance observed for microzooplankton in 1975 occurred on 8 July at NMPW, NMPP and FITZ 40-ft stations and on 24 June at NMPE transect (Table V-9). The magnitudes of the maxima at NMPW, NMPP and NMPE in 1975 were similar but greater than that of FITZ transect. However, an analysis of variance (ANOVA) indicated that there was no significant difference in the average abundance of microzooplankton among transects (Table V-10).

(ii) Rotifera

Annual peaks in rotifer density (number/m^3) at the FITZ 40-ft station occurred in July of 1973, 1974 and 1975 (Table V-8), although they were observed on slightly different dates among years (20, 15 and 8 July in 1973, 1974 and 1975, respectively). The magnitude of the 1973 peak was greater than that of 1974 but lower than that of 1975. Mean annual rotifer densities in 1973 and 1974 were smaller than those found in

TABLE V-9

ABUNDANCE OF MICROZOOPLANKTON* AT 40-FT DEPTH CONTOUR BY TRANSECT

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. TOTAL MICROZOOPLANKTON

DATE	NMPW No./m³	NMPP No./m³	FITZ No./m³	NMPE No./m³
29 APR	46958	49176	NS	88685
6 MAY	50867	45393	40652	34501
20 MAY	254598	180016	352245	384163
10 JUN	341774	416761	630538	320418
24 JUN	380295	337113	239033	1041265
8 JUL	1128360	1386429	744495	599855
29 JUL	250015	180853	116026	239986
4 AUG	545086	915776	453301	324883
24 AUG	115773	63442	24016	56120
18 SEP	65782	83720	112905	132598
27 OCT	54015	116253	78806	94017
17 NOV	57001	72055	55032	52874
12 DEC	NS	NS	NS	24445
MEAN	274210	320582	258823	261062

II. ROTIFERA

DATE	NMPW No./m³	NMPP No./m³	FITZ No./m³	NMPE No./m³
29 APR	8484	10780	NS	28171
6 MAY	15777	19297	13186	17101
20 MAY	190744	125204	300229	299320
10 JUN	306735	405049	578545	311705
24 JUN	311868	304766	203439	906712
8 JUL	914138	1103426	565550	451162
29 JUL	61898	81325	50203	108435
4 AUG	309432	460621	187159	126110
24 AUG	94431	43706	18616	39122
18 SEP	12542	19782	25108	43662
27 OCT	32161	66247	50748	42896
17 NOV	24157	23800	17228	16005
12 DEC	NS	NS	NS	7853
MEAN	190197	222000	182728	184481

*Mean of original and replicate samples; multiply each number by 2 for correction factor

NS - No sample

TABLE V-9 (Continued)

ABUNDANCE OF MICROZOOPLANKTON* AT 40-FT DEPTH CONTOUR BY TRANSECT

III. CLADOCERA

DATE	NMPW No./m³	NMPP No./m³	FITZ No./m³	NMPE No./m³
29 APR	0	0	NS	690
6 MAY	109	265	0	252
20 MAY	0	0	0	247
10 JUN	2477	519	3366	384
24 JUN	12175	9778	10245	25709
8 JUL	152290	243985	130014	110854
29 JUL	42850	40669	15317	53426
4 AUG	90697	231881	91680	46928
24 AUG	4416	3108	1209	1987
18 SEP	8789	19956	47977	29979
27 OCT	9514	24040	14415	23739
17 NOV	15654	23263	17618	11348
12 DEC	NS	NS	NS	3822
MEAN	28248	49789	30167	23797

IV. COPEPODA

DATE	NMPW No./m³	NMPP No./m³	FITZ No./m³	NMPE No./m³
29 APR	984	2456	NS	8233
6 MAY	1699	2251	1412	4064
20 MAY	6494	1671	5282	11665
10 JUN	8050	5097	11884	6167
24 JUN	15118	13063	13386	39147
8 JUL	49231	35195	24792	14298
29 JUL	31998	41736	37576	45596
4 AUG	106433	161901	113352	71554
24 AUG	16926	14500	4191	10091
18 SEP	36561	30413	29368	34421
27 OCT	9635	19562	9436	18676
17 NOV	15731	19220	18141	19352
12 DEC	NS	NS	NS	12632
MEAN	24905	28922	24438	22761

*Mean of original and replicate samples; multiply each number by 2 for correction factor
NS - No sample

1975 due to the use of Clarke Bumpus nets in 1975 instead of Wisconsin nets in 1973-1974 (Table V-2).

The rotifer abundance at 40-ft stations at all transects in the Nine Mile Point vicinity exhibited a multi-modal distribution in 1975 (Table V-9), with peaks in June, July and August. Analysis of variance (Table V-10) indicated the lack of any significant difference in average abundance of rotifers at 40-ft stations of all transects in 1975.

(iii) Cladocera

Cladocera were abundant during the July-August period of 1973, 1974 and 1975 (Table V-8). These organisms followed the same seasonal pattern of abundance as the rotifers, with July peaks observed during for 1973, 1974 and 1975. This observation is similar to the finding of Murarka (1976) regarding peak abundance of cladocerans in Lake Michigan.

The July maxima in cladoceran abundance among years were not of comparable magnitude; more cladocerans were collected at FITZ 40-ft stations in July 1973 than in July of either 1974 or 1975 (Table V-8). LMS (1976) found that temporal variations in zooplankton distribution were more pronounced than spatial variation.

On the average, there was an increase in the number of cladocerans from 1974 to 1975. This increase in connection with higher abundances in 1973 implies that differences between years is due to natural variation.

Abundance data from 1975 for all 40-ft stations showed that the maximum annual density at all transects occurred on 8 July (Table V-9). The heights of the peaks varied slightly, being greater at NMPW and NMPP than at FITZ and NMPE transects. The difference in the average abundance of cladocerans among transects in 1975 was examined statistically (ANOVA) in order to detect any significant effect that could have resulted from the plant-heated plume. The results indicated that there was no significant difference in cladocera density among the four transects (Table V-10). Thus, any effects induced by the JAF discharge were undetectable statistically. An examination of the data also shows no trends for either the NMPP or FITZ locations in which abundance was consistently high or low. This conclusion supports the previous contention that differences between years is due to natural variation.

TABLE V-10

STATISTICAL ANALYSIS OF MICROZOOPLANKTON ABUNDANCE AT FITZ-40 FT STATION

JAMES A FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. TOTAL MICROZOOPLANKTON

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	10	16.7465	1.6747	27.10**
TRANSECTS	3	0.1243	0.0414	0.67
ERROR	30	1.8534	0.0618	
WITHIN SAMPLES	44	0.0623	0.0014	
TOTAL	87	18.7865		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

Largest: 8 JUL, 4 AUG, 24 JUN, 10 JUN, 20 MAY, 29 JUL, 18 SEP, 27 OCT, 17 NOV, 24 AUG, 6 MAY : Smallest

(Underlined groups: 8 JUL–10 JUN; 4 AUG–20 MAY; 24 JUN–29 JUL; 20 MAY–18 SEP; 18 SEP–6 MAY)

II. ROTIFERA

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	10	27.5752	2.7575	36.05**
TRANSECTS	3	0.1582	0.0527	0.69
ERROR	30	2.2963	0.0765	
WITHIN SAMPLES	44	0.0902	0.0021	
TOTAL	87	30.1199		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

Largest: 8 JUL, 10 JUN, 24 JUN, 4 AUG, 20 MAY, 29 JUL, 27 OCT, 24 AUG, 18 SEP, 17 NOV, 6 MAY : Smallest

(Underlined groups: 8 JUL–4 AUG; 10 JUN–20 MAY; 20 MAY–29 JUL; 29 JUL–24 AUG; 27 OCT–6 MAY)

TABLE V-10 (Continued)

STATISTICAL ANALYSIS OF MICROZOOPLANKTON ABUNDANCE AT FITZ-40 FT STATION

III. CLADOCERA

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	10	188.1013	18.8101	29.24**
TRANSECTS	3	0.4668	0.1556	0.24
ERROR	30	19.3000	0.6433	
WITHIN SAMPLES	44	16.3024	0.3705	
TOTAL	87	224.1705		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

	8	4	29	18	27	17	24	24	10	6	20	
Largest:	JUL	AUG	JUL	SEP	OCT	NOV	JUN	AUG	JUN	MAY	MAY	: Smallest

IV. COPEPODA

NESTED ANALYSIS OF VARIANCE
(Log Transformed)

SOURCE	DF	SS	MS	F
BETWEEN SAMPLES				
DATES	10	17.4566	1.7457	21.45**
TRANSECTS	3	0.2006	0.0669	0.82
ERROR	30	2.4417	0.0814	
WITHIN SAMPLES	44	0.3636	0.0083	
TOTAL	87	20.4625		

**Significant at α = .01

TUKEY T TEST - DATES (α = .05)

	4	29	18	8	24	17	27	24	10	20	6	
Largest:	AUG	JUL	SEP	JUL	JUN	NOV	OCT	AUG	JUN	MAY	MAY:	Smallest

(iv) Copepoda

Copepoda (adults and nauplii) made up a sizable portion of the zooplankton community at the 40-ft stations of FITZ transect in 1973, 1974 and 1975. A July abundance maximum can be seen in 1973, but not in 1974-1975 (Table V-8). In the latter two years, maximum abundance occurred in August (22 and 4 August in 1974 and 1975, respectively); however, in both 1974 and 1975, copepod density (number/m^3) increased sharply in late July (on 29 July). The fall peak, which was smaller in magnitude, was observed in 1973 (20 November), 1974 (27 November) and 1975 (17 November). It follows that there was no apparent shift in the time of occurrence of the fall peak between preoperational and operational periods for JAF.

Maximum copepod density occurred on 4 August 1975 at the plants transects (NMPP and FITZ), as well as at the control transects (NMPW and NMPE) (Table V-9). No significant differences were found in mean copepod density (Table V-10).

b. Cluster Analysis of Microzooplankton Distribution

The spatial and temporal distribution of selected taxa including total copepods, total rotifers, Bosmina longirostris (a cladoceran), as well as, total microzooplankton was examined using cluster analysis to determine if their distributions among sampling stations reflects the influence of the thermal plume. The stations near the power plant discharge variously had higher, lower and similar abundances with stations distant from the discharge. There was no consistently recurring distribution pattern which might suggest plant effects. The variations in abundance were attributed primarily to seasonal factors and meteorological conditions (LMS, 1976).

c. Effect of Plume Entrainment on Microzooplankton Survival

Microzooplankton mortality was measured for intake forebay samples, and discharge aftbay samples collected with a pump (1.26 liter/sec capacity at a 6.4 m head) discharged into a 1/2 meter 76μ mesh net. Pumping time ranged from 5 to 15 minutes per sample. From May through June 1976 some microzooplankton samples collected at the discharge were immediately diluted to 2 or 3°F above intake temperature with intake forebay water after a holding time representing discharge tunnel transit time. Microzooplankton samples were also collected monthly in the lake at the approximate 3 and 2°F isotherms. Beginning in July this procedure was changed and intake samples were added to filtered discharge water by means of several serial dilutions to represent only plume entrainment mortality. The dilution occurred over an interval that was twice the predicted time of entrainment in case the model did not correctly estimate the actual time-temperature relationship. This change in procedure was necessary because in the original experimental design concentrated microzooplankton discharge samples were diluted with unconcentrated intake water. This technique resulted in high densities of plant entrained organisms in comparison to simulated plume entrained organisms which effectively precluded any evaluation of plume entrainment.

The percent mortality for the various sampling collections and simulations were plotted for the study period for total zooplankton and protozoa, rotifera, total copepods and cladoceran. Day and night collections and simulations were plotted separately. A comparison of the percent mortality for the intake samples with various simulation and lake conditions provides a measure of the affect of plume and plume plus plant entrainment. One would expect that if there were significant mortality due to plume or plant entrainment, the percent mortality for the simulations and lake collections would exceed the percent mortality in the intake collections.

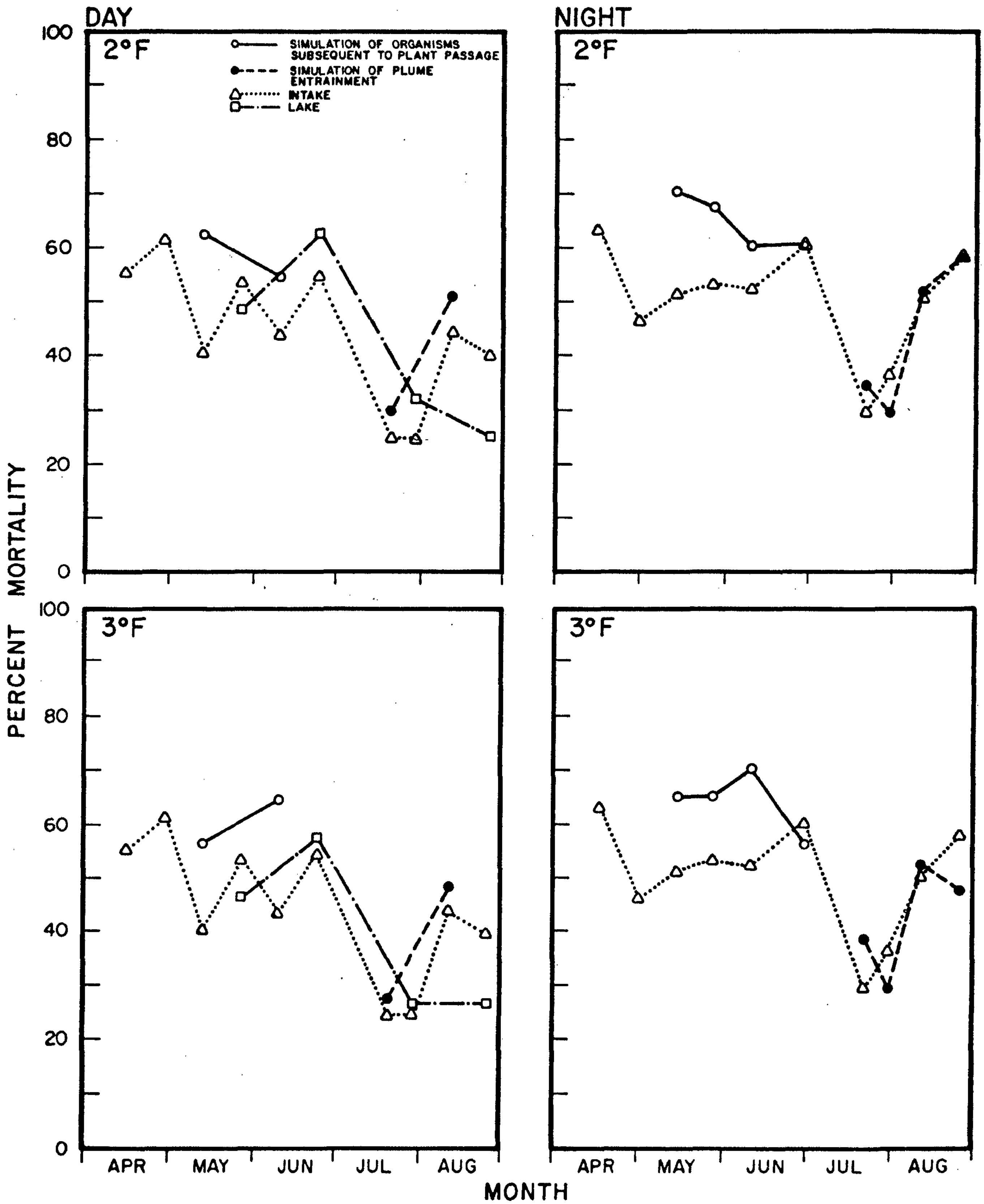
The percent mortality for total microzooplankton in the intake sample was quite varied throughout the study period (April through August) (Figure V-7). The percent mortality for simulations without plant passage and the lake collections show a similar variability and are generally close to intake values. This indicates that plume entrainment does not inflict any substantial mortality on zooplankton. The percent mortality in simulations following plant passage tended to be slightly greater than corresponding intake percentages. This suggests that the additional stresses of plant entrainment are killing a small percentage of the microzooplankton passing through the plant.

In the plots of major microzooplankton groups (Figures V-8 through V-11), the pattern observed for total microzooplankton was less distinct, but there was a tendency for the percent mortalities in the simulations and lake collections to follow the magnitude and direction of change in the intake sample percentages. There were many instances, however, when corresponding values were quite far apart, but no consistent pattern in the difference between intake and simulation or lake collection percentages was evident. The differences are thus attributed to the experimental techniques and it is clear that plume entrainment has no obvious effect on microzooplankton viability.

FIGURE V-7

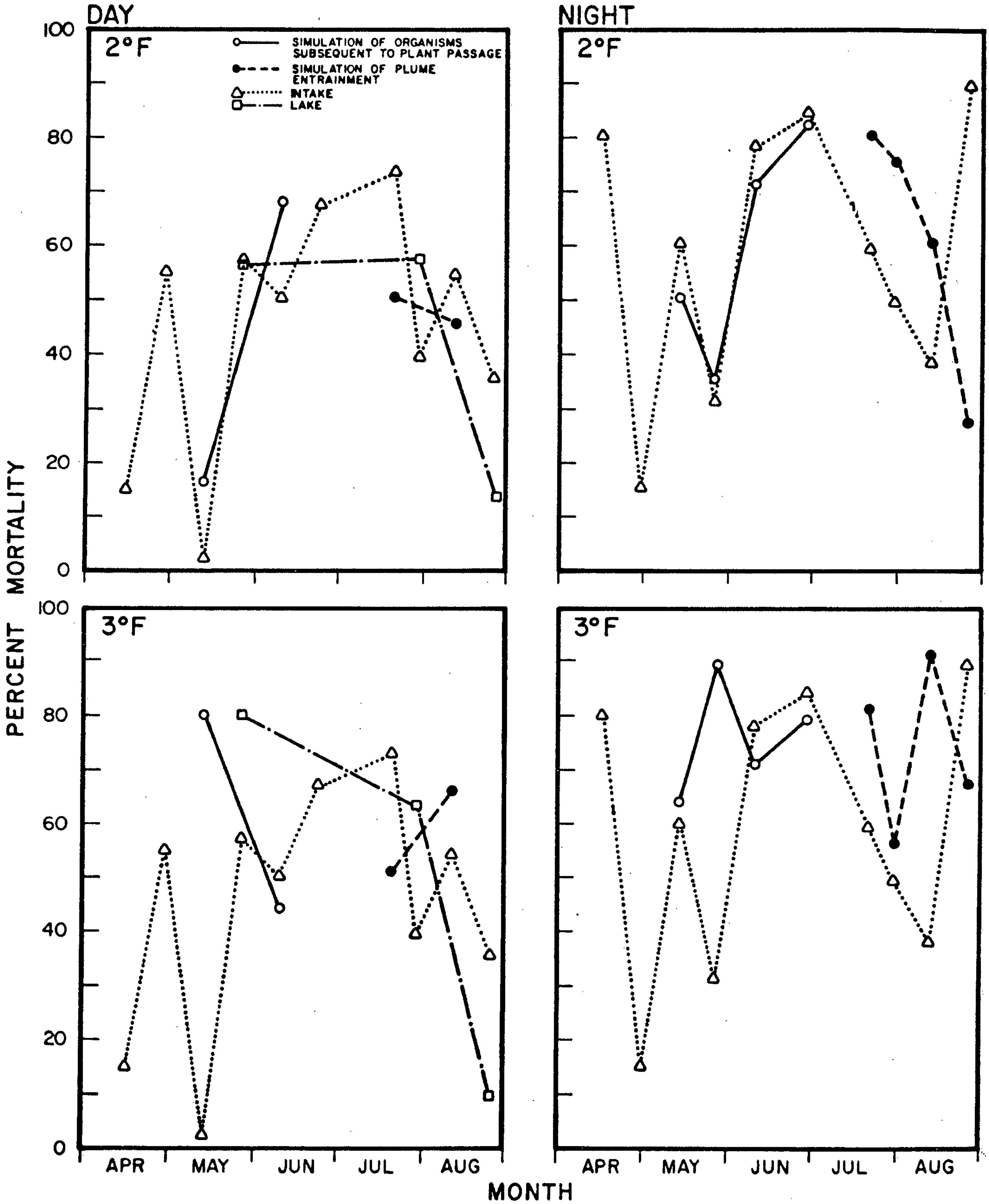
INTAKE AND PLUME SIMULATION MORTALITY OF TOTAL MICROZOOPLANKTON

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1976



INTAKE AND PLUME SIMULATION MORTALITY OF PROTOZOA

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1976



INTAKE AND PLUME SIMULATION MORTALITY OF ROTIFERA

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1976

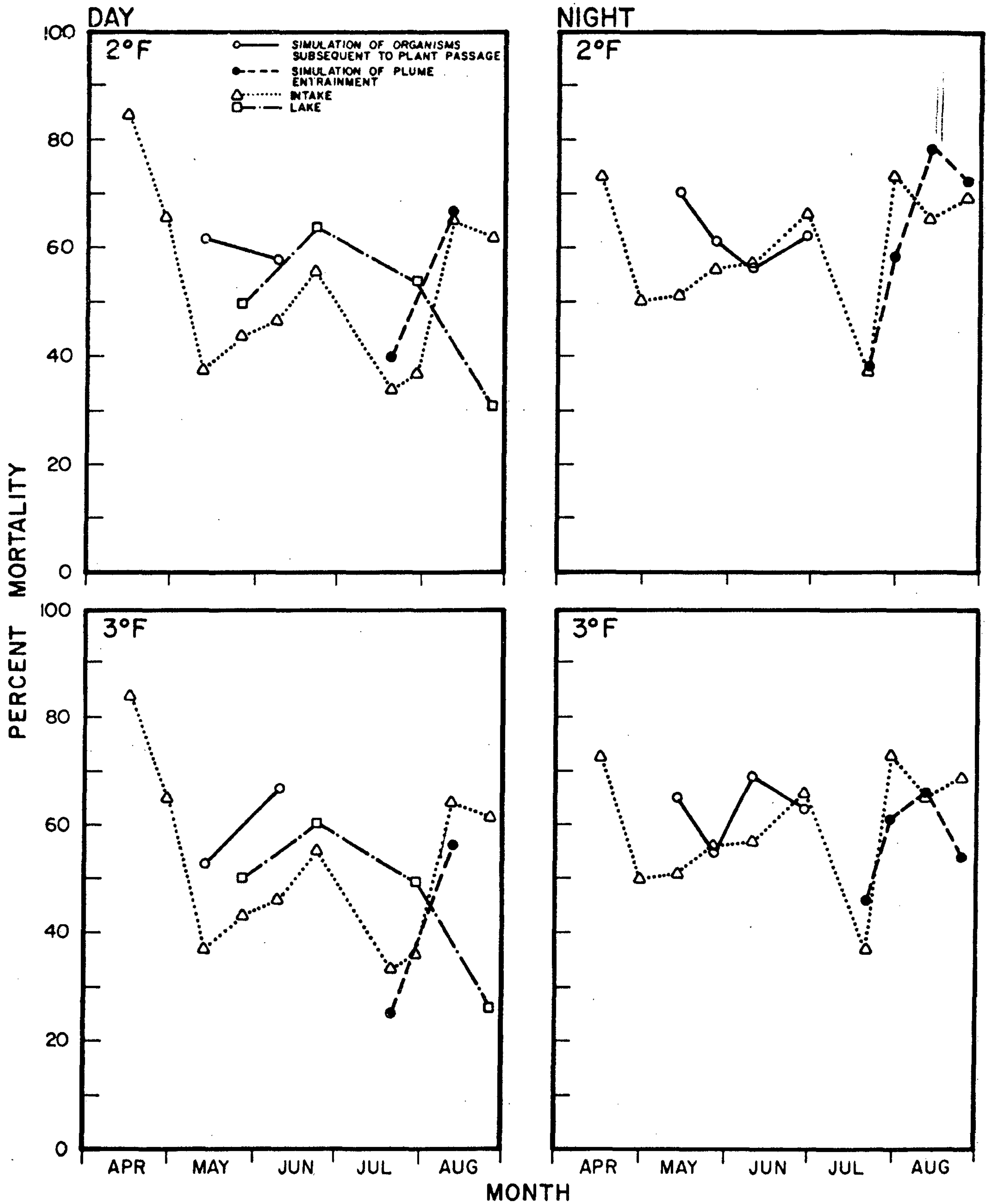


FIGURE V-10

INTAKE AND PLUME SIMULATION MORTALITY OF TOTAL COPEPODA

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY – 1976

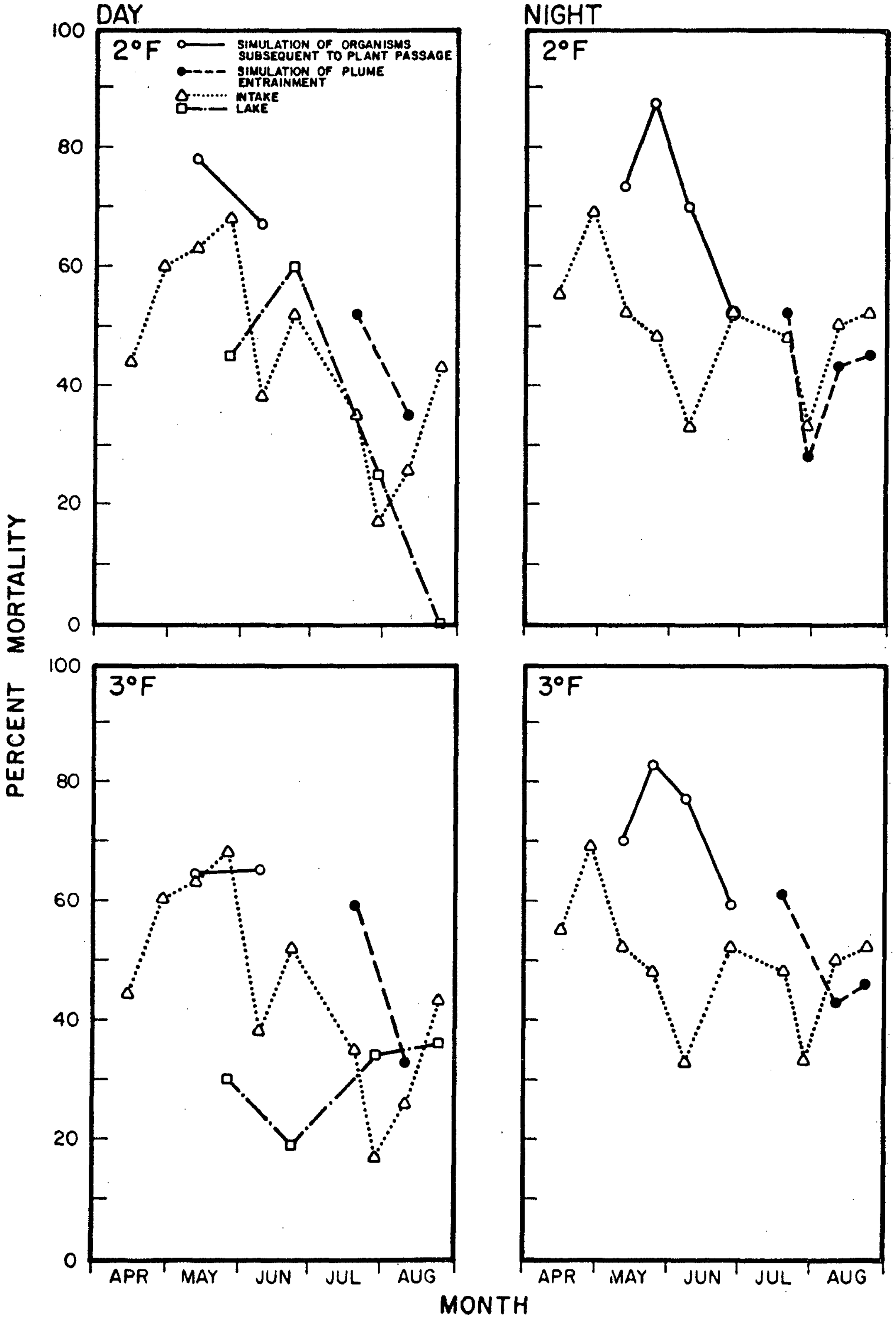
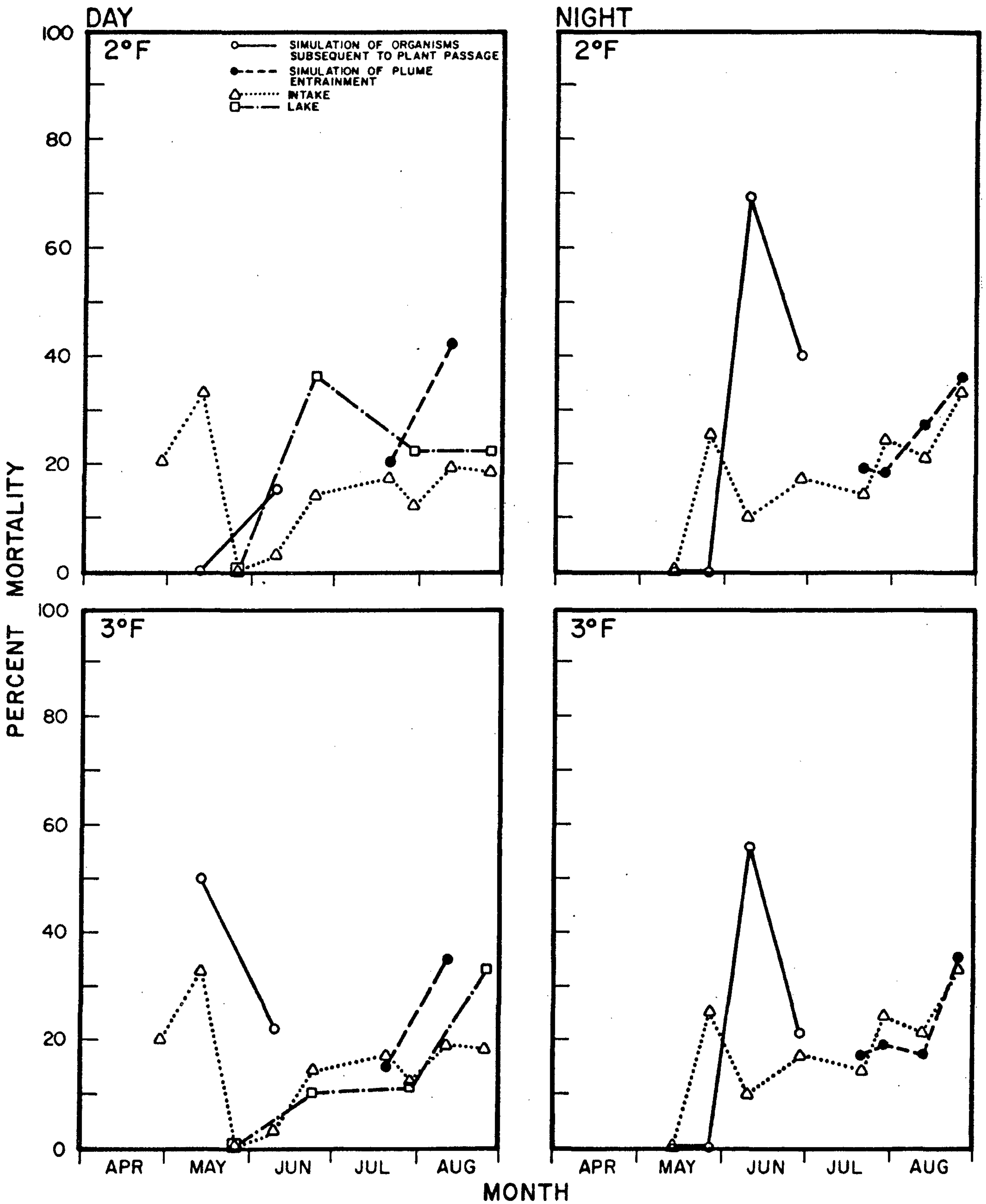


FIGURE V-11

INTAKE AND PLUME SIMULATION MORTALITY OF CLADOCERA

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1976



Conclusion

The analyses presented above do not show any significant impact that can be attributed to the operation of the JAF in conjunction with operation of NMP-1 in 1975. Comparisons between transects (plants vs. control) in the same year (1975) indicated no statistical or empirical difference in the abundance of planktonic organisms among transects.

It is recognized that the conclusions reached here were based on analyses of data collected in 1973, 1974 and 1975 even though some collection (and analysis) procedures may have been changed. This may have influenced the magnitude of abundances among years, but did not affect the timing of peaks. The mortality data for microzooplankton collected at the plant intake, from the plume and exposed to simulated plume conditions did not show an increase in mortality attributable to temperature increases encountered during plume entrainment.

c. Macrozooplankton

Macrozooplankton are defined as those invertebrate zooplankters retained in a 571μ mesh plankton net. However, invertebrate crustaceans of the same species may be found in both the macrozooplankton and the microzooplankton groups due to wide range of sizes encompassed by the developmental stages of these organisms.

Cladocerans, copepods and amphipods were the dominant macrozooplankters encountered in 1973 and 1974 collections. The cladoceran *Leptodora kindtii* and the amphipod *Gammarus fasciatus* (*G. fasciatus* is the most abundant of two *Gammarus* species present) were the two dominant species in 1975, while other zooplankters, including *Mysis relicta*, dipteran larvae and pupae, hydroids, hydracarinids, and isopods, occurred in small numbers throughout the sampling program. Members of the Nematoda and Gastropoda were occasionally observed in the macrozooplankton collections.

The species of macrozooplankton identified in the vicinity of JAF during 1974 and 1975 are shown in Table V-11. The cladoceran *Leptodora kindtii* was the numerically dominant macrozooplankter enumerated in 1974; the amphipod *Gammarus fasciatus* was the second most abundant species followed by members of Hydroida and Diptera, mostly larvae and pupae (LMS, 1975). *Pontoporeia affinis* (Amphipoda) and *Mysis oculata relicta* (Mysidacea) were less abundant,

TABLE V-11

MACROZOOPLANKTON SPECIES INVENTORY*

NINE MILE POINT VICINITY - 1974-1975

COELENTERATE
- Hydrozoa
  - Athecata
    - Cordylophora lacustris
    - Hydra americana

PLATYHELMINTHES
- Turbellaria

ASCHELMINTHES
- Nematoda

MOLLUSCA
- Gastropoda
- Bivalvia (Pelecypoda)

ANNELIDA
- Polychaeta
  - Sabellida
    - Manayunkia speciosa
- Oligochaeta
- Hirudinea

ARTHROPODA
- Arachnida
  - Acari
    - Limnesiidae
      - Limnesia sp.
    - Hygrobatidae
      - Hygrobates sp. A
      - Hygrobates sp. B
    - Unionicolidae
      - Huitfeldtia rectipes
      - Unionicola sp. A
      - Unionicola sp. B
    - Pionidae
      - Forelia sp.
      - Piona sp.
    - Lebertiidae
      - Lebertia sp.
- Insecta
  - Odonata
  - Ephemeroptera
  - Hemiptera
  - Trichoptera
  - Diptera

ARTHROPODA (Diptera Continued)
- Culicidae
  - Chaoborus albipes
- Simuliidae
- Chironomidae
  - Chironomus sp.
  - Cricotopus sp.
  - Cryptochironomus sp.
  - Demicryptochironomus sp.
  - Dicrotendipes sp.
  - Endochironomus sp.
  - Glytotendipes sp.
  - Micropsectra sp.
  - Orthocladius sp.
  - Parachironomus sp.
  - Paracladopelma sp.
  - Paratendipes sp.
  - Phaenopsectra sp.
  - Polypedilum sp.
  - Potthastia sp.
  - Procladius sp.
  - Psectrocladius sp.
  - Pseudochironomus sp.
  - Rheotanytarsus sp.
  - Tanytarsus sp.
- Coleoptera
- Lepidoptera
- Neuroptera
- Crustacea
  - Cladocera
    - Leptodora kindtii
  - Branchiura
    - Argulus sp.
  - Isopoda
  - Amphipoda
    - Gammaridae
      - Crangonyx sp.
      - Gammarus fasciatus
    - Haustoridae
      - Pontoporeia affinis
  - Mysidacea
    - Mysidae
      - Mysis oculata relicta
  - Ostracoda
  - Podocopa

*Subject to corrections

each composing less than 1% by number of all macrozooplankters analyzed. These two species are cold-water inhabitants and were observed primarily during periods of cold-water upwelling. *L. kindtii*, *G. fasciatus* and dipterans exhibited a diel pattern of movement, being more abundant at night and in the subsurface areas.

The macrozooplankton *L. kindtii*, *G. fasciatus*, and dipterans were abundant in both day and night collections during 1975 (LMS, 1976). More organisms were collected at night at surface and mid-depths than near the bottom, but there was no consistant pattern. On the other hand, more organisms were collected near the bottom during daylight hours.

(i) *Leptodora kindtii*

The seasonal distribution of *Leptodora* was characterized as exhibiting an upward trend from April and May, when it was absent or scarce at all transects, to August 1975, when it reached its maximum; a sharp decline was then noted through December. Generally there was no persistent pattern of abundance in either longshore direction: west-east or east-west direction.

The distribution of *Leptodora* at the 40-ft depth contour was scarce to absent in April-May, increasing gradually toward midsummer, reaching a peak in August and then declining sharply toward December. The annual average (number/1,000 m^3) density of *Leptodora* was similar among the five transects (3-NMPW, 1-NMPW, .5 NMPW, 1-NMPE and 3-NMPE) but was drastically lower than that of FITZ transect (.5-NMPE); due to a single high monthly value (Table V-12). There is thus no consistent differences in *Leptodora* abundances due to operation of JAF.

(ii) *Gammarus fasciatus*

Gammarus collected in the 1975 study were much more abundant at night than during the daylight hours (LMS, 1976), similar to the pattern reported for *Gammarus* in 1974 (LMS, 1975). As was the case in 1974, *Gammarus* appeared first in April collections but was represented by very few organisms. Seasonal trends were not evident in either year due to large fluctuations among sampling dates and stations. The 1975 collections indicated that *Gammarus* were relatively abundant at night in July and August at all transects, but were abundant in August in day collections at the western transects (3-NMPW, 1-NMPW and .5-NMPW) only.

TABLE V-12

ABUNDANCE[a] OF SELECTED MACROZOOPLANKTON AT 40-FT DEPTH CONTOUR[b]

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. LEPTODORA KINDTII

MONTH	3-NMPW	1-NMPW	.5-NMPW	FITZ[c]	1-NMPE	3-NMPE
APR[d]	0	0	0	0	0	0
MAY[d]	5	15	0	6	16	6
JUN	1075	925	1934	880	3350	3102
JUL	37146	40305	31810	30383	19079	22447
AUG	246476	160877	172128	436800	164747	144933
SEP[d]	76731	83285	79356	133614	85524	106214
OCT[d]	9556[f]	7761	6964	6673	7023	9138
NOV[d]	839	889	2321	2219	2098	1940
DEC[d]	67	40	38	87	37	47
MEAN[e]	54451	41350	41702	89894	39088	38192

II. GAMMARUS FASCIATUS

MONTH	3-NMPW	1-NMPW	.5-NMPW	FITZ[c]	1-NMPE	3-NMPE
APR[d]	0	0	0	1	0	0
MAY[d]	0	0	0	4	0	4
JUN	174	150	202	40	243	208
JUL	330	302	1135	1168	716	1044
AUG	120	179	3172	196	352	566
SEP[d]	43	16	4	2	2	0
OCT[d]	0[f]	0	0	45	0	0
NOV[d]	0	0	1	0	0	0
DEC[d]	0	0	2	11	0	0
MEAN[e]	108	106	752	239	219	303

[a] Number of organisms/1000 m^3; mean of sample depths; mean of day and night collections
[b] NMPP transect is not included (not sampled at 40-ft depth contour)
[c] Same as .5-NMPE
[d] Day sample only
[e] Weighted mean
[f] Surface and bottom sample only

Moreover, Gammarus were found only near the bottom in July and in mid-depths in August at FITZ, 1-NMPE and 3-NMPE (LMS, 1976).

The seasonal distributional pattern of Gammarus in 1975 at the 40-ft depth contour of all transects (no samples were taken at NMPP) is shown in Table V-12. The maximum abundance was reached in July at all transects except at .5-NMPW, which exhibited a maximum density in August. However, the abundance of Gammarus at the .5-NMPW transect in July was also characterized as similar to or greater than the maxima shown by the rest of the transects (Table V-12). The data in Table V-12 indicates that JAF is not affecting water column Gammarus abundance in that abundance at FITZ in July, August, September, October and November when JAF was operating at greater than 50% capacity indicates no differences that are indicative of trends, either high or low, exist.

d. Ichthyoplankton

Fish eggs and larvae were collected from the vicinity of JAF in 1974 and 1975. A species inventory of ichthyoplankton collected during the two-year period is presented in Table V-13. Eighteen, 17 and 20 species of fish larvae were collected in 1973, 1974 and 1975, respectively. Fish larvae were generally collected from April through September, and were most abundant in June and July, declining in number toward the end of September.

Of all larval species identified during the study period, alewives were the most abundant. Larvae of johnny darter and white perch were collected in smaller numbers, and a very few yellow perch larvae and a number of other species were occasionally caught.

Differences in species composition of fish larvae among years were attributed to the scattered distribution of the larvae in the study area. Moreover, the area of larval sampling is characterized as having sandy to bedrock/rubble substrata and lacking extensive vegetation, conditions which make it undesirable for spawning by many fish species collected from the area.

Larval alewives were found from June through early September in the Nine Mile Point area (LMS, 1975). Seasonal abundance patterns for alewife larvae reflected a late spring abundance peak followed by a second higher peak in August. Length frequency data and abundance

TABLE V-13

ICHTHYOPLANKTON SPECIES INVENTORY

NINE MILE POINT VICINITY - 1974-1975

FAMILY	SCIENTIFIC NAME	COMMON NAME
Clupeidae	Alosa pseudoharengus	Alewife
	Dorosoma cepedianum	Gizzard shad*
Salmonidae	Coregonus artedii	Cisco or Lake herring
Osmeridae	Osmerus mordax	Rainbow smelt
Cyprinidae	Carassius auratus	Goldfish
	Cyprinus carpio	Carp
	Notropis sp.	UID shiner
	N. atherinoides	Emerald shiner
	N. cornutus	Common shiner
	N. hudsonius	Spottail shiner
	Pimephales notatus	Bluntnose minnow
	UID Cyprinidae	-
Percopsidae	Percopsis omiscomaycus	Trout-perch
Gadidae	Lota lota	Burbot
Gasterosteidae	Gasterosteus aculeatus	Threespine stickleback
Percichthyidae	Morone americana	White perch
Centrarchidae	Lepomis sp.	UID sunfish
	L. gibbosus	Pumpkinseed
	Micropterus dolomieui	Smallmouth bass
	UID Centrarchidae	-
Percidae	Etheostoma sp.	UID darter
	E. nigrum	Johnny darter
	Perca flavescens	Yellow perch
	Stizostedion vitreum vitreum	Walleye*
Cottidae	Cottus bairdi	Mottled sculpin

*Eggs only
- Not applicable

of eggs suggest that alewife spawning reached peak levels during the first half of July. The abundance of alewife larvae in night collections from late June through early August was usually an order of magnitude greater than the abundance of these fish larvae in day collections. Norden (1968) and Scott and Crossman (1973) point to a nocturnal behavior pattern for this species.

The seasonal patterns of total larval abundance reflected the seasonal patterns of larval alewife abundance at most stations (LMS, 1974).

Rainbow smelt, johnny darter, carp, and mottled sculpin formed small percentages of the total fish larvae population during the early summer, along with the larvae of white perch, common shiner, yellow perch, emerald shiner, and pumpkinseed. Spottail shiner larvae and unidentified shiner larvae were also collected on at least one sampling date (LMS, 1974). Larvae of yellow perch were present in two collections in 1975 (4 June and 25-28 June), but were very few in numbers (LMS, 1976).

Most fish larvae were found in samples collected between late June and late August; however, rainbow smelt larvae were collected during mid-May, and mottled sculpin and rainbow smelt larvae were found in early November collections in 1974.

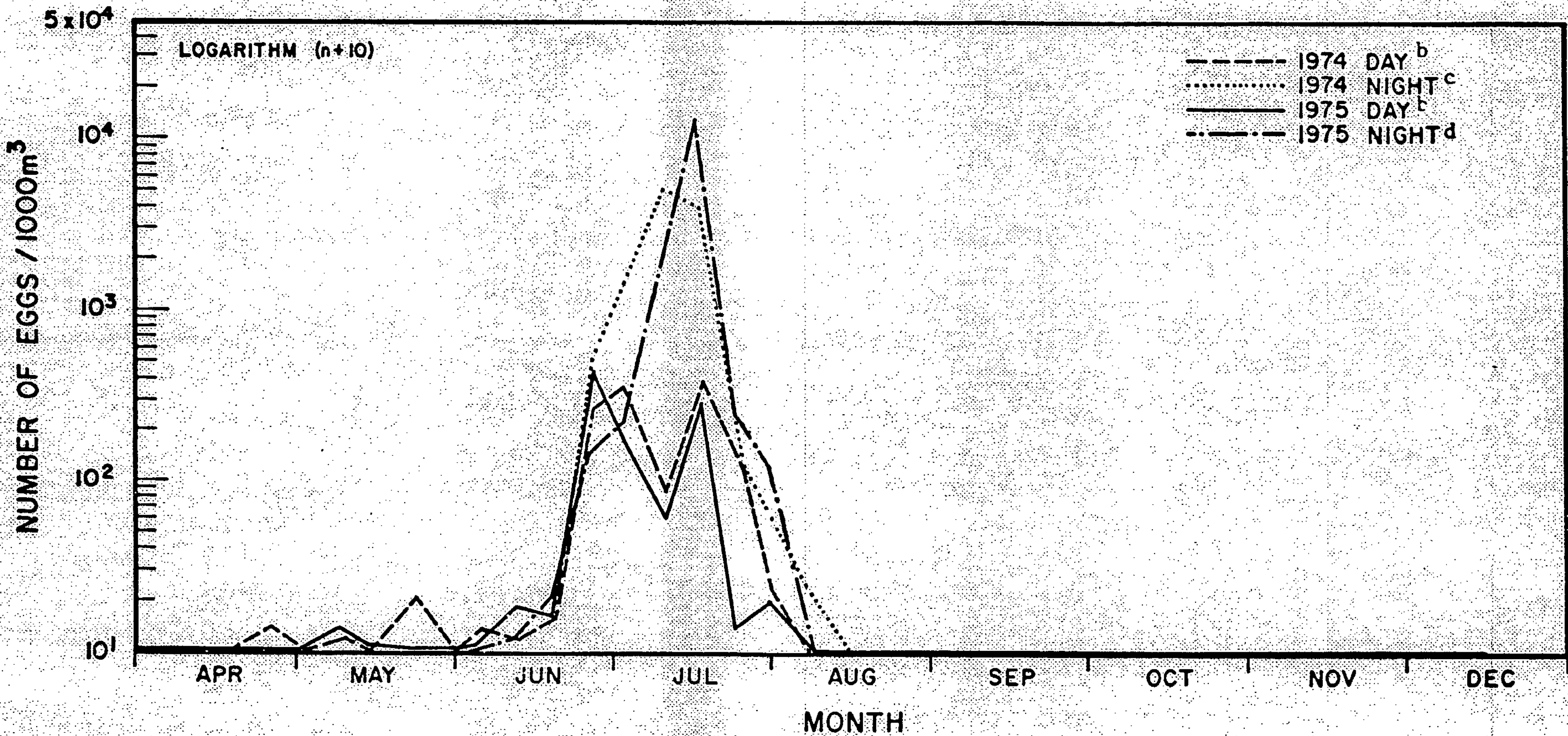
Larvae of the burbot and Coregonus sp. were collected during the earliest sampling dates in 1974, reflecting the cold-water spawning of the burbot and late fall spawning of coregonid species (Scott and Crossman, 1973).

The pattern of fish egg distribution was similar for day and night collections in 1974 and 1975 (Figure 12). Daytime egg collections in the Nine Mile Point vicinity exhibited a bimodal pattern in both years, with maxima occurring in mid-June and mid-July. Night collections showed a single mode, with the peak occurring in July of both years. Magnitudes of both day and night abundance peaks were similar between years.

By contrast to egg abundance, diel distributions of larvae in 1974 and 1975 were different; more larvae were collected at night in 1974 than in 1975 (Figure V-13).

In general, the ichthyoplankton community in the vicinity of JAF is characterized as having low larval abundance except for alewife larvae. The low concentrations of most larval species, combined with the type of bottom habitats, indicate that the area is not a major spawning ground.

ABUNDANCE OF FISH EGGS[a]
NINE MILE POINT VICINITY – 1974-1975



[a]Mean of all stations and sample depths; number of eggs/m^3

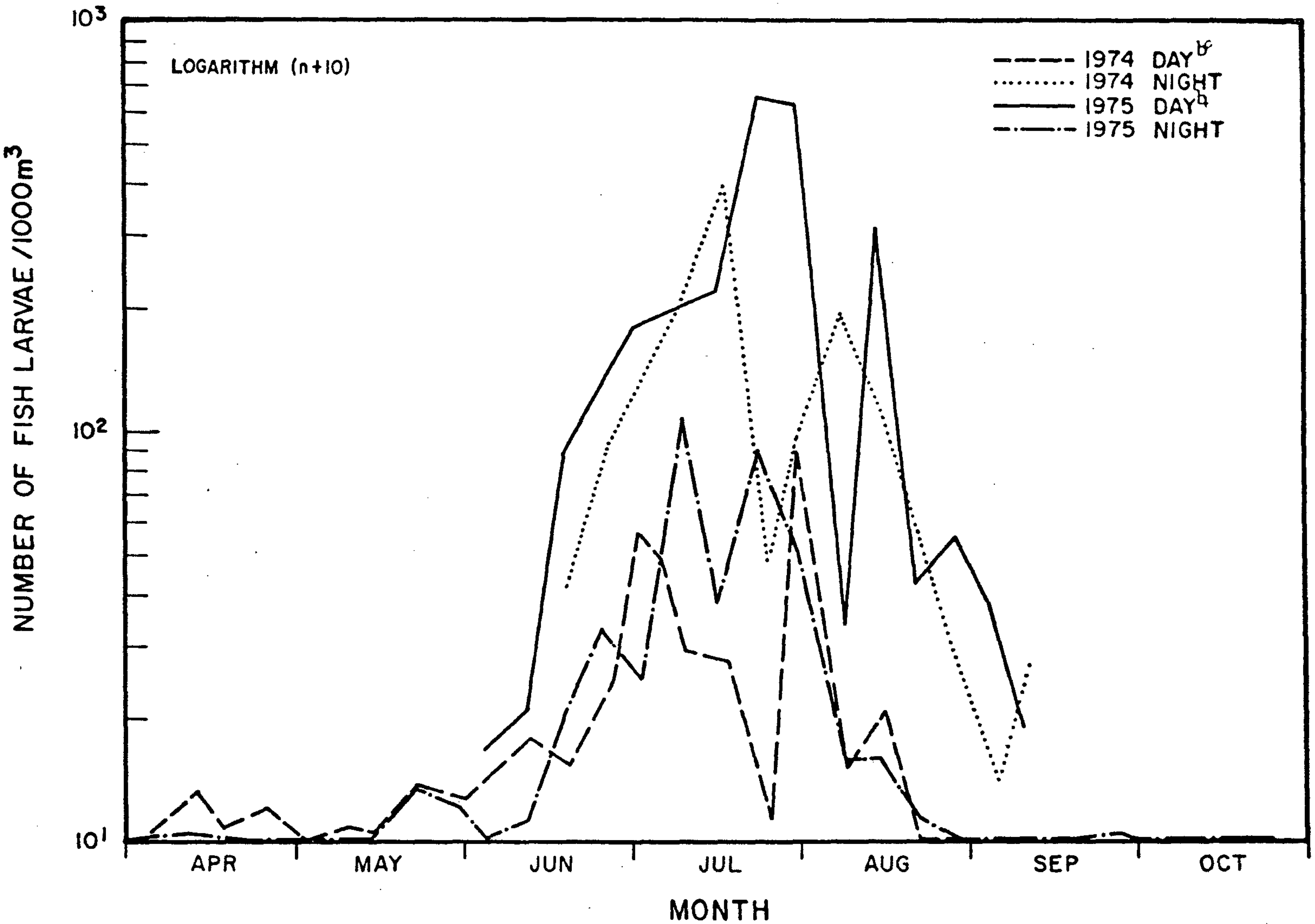
[b]Sampling continued until 13 Dec, no eggs were collected after Aug.

[c]Sampling continued until 11 Sep, no eggs were collected after Aug.

[d]Sampling continued until 10 Sep, no eggs were collected after Aug.

FIGURE V-12

ABUNDANCE[a] OF TOTAL FISH LARVAE
NINE MILE POINT VICINITY — 1974-1975



[a]Mean of all stations and sample depths; number of larvae/1000 m^3
[b]Sampling continued unitl 13 Dec, no larvae were collected after Sep.

FIGURE V-13

8. Benthos

a. Introduction

Substrate structure and currents are among the important factors influencing diversity in benthic communities and which are of particular importance in this analysis. Certain species are strictly confined to well-defined types of substrata and exist at a certain current velocity. Moreover, the species composition and abundance of benthic macroinvertebrates has been shown to vary with depth in Lake Ontario. For example, the benthic fauna was reported to increase in abundance and diversity with increasing depth (Judd and Gemmel, 1971) and Brinkhurst (1969) reported the presence of eutrophic species in the inshore area of the lake.

b. Bottom Structure

During the study program, visual observation of the type of substratum in the vicinity of the Nine Mile Point was determined along the four transects (NMPW, NMPP, FITZ and NMPE) by divers following defined criteria (LMS, 1976). The divers' observations indicated that two transects (NMPW and NMPP) were dominated by more bedrock and rubble than sand and silt. The FITZ and NMPE transects were characterized as having bedrock and rubble in the inshore areas with sand and silt prevalent beyond the 20-ft depth contour. In general, finer particles are dominant in the offshore areas.

Results of 1975 diver observations (LMS, 1976) indicated little or no sedimentation at NMPW or NMPP/FITZ transects. At NMPE, both sedimentation and scouring alternately occurred, indicating sediment instability in that area. Scouring was also confirmed by LMS special study conducted in 1976 at the FITZ transect in the area near the diffuser (40 ft station).

c. Community Structure

Species of seven phyla - Nematoda, Mollusca, Platyhelminthes, Arthropoda, Annelida, Coelenterata and Nemertea - constituted the benthic community in the Nine Mile Point vicinity (Table V-14). These phyla included 81-85 genera identified during the 1973-1975 period. Species of Nemertea and Coelenterata (Hydra and Cordylophora) were collected in 1973 but recorded in the years that followed.

Phylum Arthropoda, represented by 33-45 species, included the most abundant organisms in the area, including Gammarus fasciatus, which was the most single dominant species collected. Members of the order Oligochaeta were relatively abundant in the April-December

TABLE V-14

BENTHOS SPECIES INVENTORY*

NINE MILE POINT VICINITY - 1974-1975

COELENTERATA
- Hydrozoa
  - *Cordylophora caspia*
  - *Hydra* sp.
  - *H. americana*

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

NEMERTEA

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

BRYOZOA

ANNELIDA
- Polychaeta
  - Sabellidae
    - *Manuyunkia speciosa*
- Oliochaeta
  - Prosopora
    - Lumbriculidae
      - *Stylodrilus heringianus*
  - Plesiopora
    - Tubificidae
      - IWOC-immature without chaetae
      - IWC-immature with chaetae
      - *Aulodrilus americanus*
      - *A. limnobius*

ANNELIDA (Cont)
- *A. piqueti*
- *A. pluriseta*
- *Ilyodrilus templetoni*
- *Limnodrilus claparedianus*
- *L. hoffmeisteri*
- *L. profundicola*
- *L. spiralis*
- *L. udekemianus*
- *Peloscolex ferox*
- *P. freyi*
- *P. multisetosus multisetosus*
- *P. m. longidentus*
- *Potamothrix moldaviensis*
- *P. vejdovskyi*
- *Tubifex newaensis*
- *T. tubifex*
- Enchytraeidae
- Naididae
  - *Areteonais lomondi*
  - *Chaetogaster diaphanus*
  - *C. limnaei*
  - *Nais barbata*
  - *N. bretscheri*
  - *N. communis*
  - *N. elinquis*
  - *N. pseudobtusa*
  - *N. simplex*
  - *Ophidonais serpentina*
  - *Paranais littoralis*
  - *P. simplex*
  - *Piquetiella michiganensis*
  - *Pristina* sp.
  - *Specaria josinae*
  - *Stylaria fossularis*
  - *S. lacustris*
  - *Uncinais uncinata*
  - *Vejdovskyella* sp.
  - *V. comata*
  - *V. intermedia*
- Hirudinea

TABLE V-14 (Continued)

BENTHOS SPECIES INVENTORY *

ANNELIDA (Continued)
Rhynchobdellida
Piscicolidae
Piscicola sp.

ARTHROPODA
Arachnoidea
Hydracarina
Hygrobatidae
Hygrobates sp. 1
Hygrobates sp. 2
Hygrobates sp. 3
Hygrobates sp. 4
Limnesiidae
Limnesia sp.
Unionicolidae
Huitfeldtia rectipes
Koenikia sp.
Neumania sp.
Unionicola sp.
Unionicola sp. 1
Unionicola sp. 4
Lebertiidae
Lebertia sp.
Torrenticollidae
Pionidae
Forelia sp.
Piona sp.
Crustacea
Ostracoda[b]
Podocopa-UID[b]
Malacostraca
Mysidacea
Mysis oculata relicta
Isopoda
Asellidae
Asellus sp.
Amphipoda
Gammaridae
Gammarus fasciatus
Crangonycidae
Crangonyx sp.
Haustoriidae
Pontoporeia affinis
Decapoda
Astacidae
Cambarinae[c]

ARTHROPODA (Cont)
Cambarus bartoni
C. robustus
Orconectes propinquus
Insecta
Ephemeroptera
Heptageniidae
Stenonema sp.
Baetidae-UID
Hemiptera-UID
Neuroptera
Sisyridae
Climacia areolaris
Trichoptera
Hydroptilidae
Agraylea sp.
Leptoceridae
Athripsodes sp.
Oecetis sp.
Psychomyiidae
UID pupa
Lepidoptera-UID
Diptera
Chironomidae
Chironomini[d]
Chironomus sp.
Cryptochironomus sp.
Cryptocladopelma sp.
Demicryptochironomus sp.
Dicrotendiptes sp.
Glyptotendiptes sp.
Microtendiptes sp.
Parachironomus sp.
Paracladopelma sp.
Paralauterborniella sp.
Paratendiptes sp.
Phaenopsectra sp.
Pseudochironomus sp.
Polypedilum sp.
Stictochironomus sp.
Xenochironomus sp.
Tanytarsini[d]
Calopsectra sp.
Cladotanytarsus sp.[e]
Microsectra sp.
Paratanytarsus sp.
Rheotanytarsus sp.

TABLE V-14 (Continued)

BENTHOS SPECIES INVENTORY*

ANNELIDA (Continued)

- *Tanytarsus* sp.[e]
- Tanypodinae[c]
  - *Anatopynis* sp.
  - *Procladius* sp.
  - *Psectrocladius* sp.
- Orthocladinae
  - *Cardiocladius* sp.
  - *Cricotopus* spp.
  - *Heterotrissocladius* sp.
  - *Orthocladius* sp.
  - *Trichocladius* sp.
  - *Trissocladius* sp.
  - UID pupae
- Diamesinae[c]
  - *Potthastia* sp.
- Ceratopogonidae-UID
- Empididae-UID
- Stratomyidae-UID

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*Subject to corrections

[a]Only Genera are listed; taxonomy is under revision.

UID = Unidentified form.

[b]Subclass

[c]Subfamily

[d]Tribe

[e]Genera identification tentative

period; tubificid worms (Family Tubificidae) were abundant in all seasons and at most transects.

Differences observed in the distribution and species abundance of benthic invertebrates between stations and transects are attributed to animal-substrate relationships. For example, Gammarus and Manayunkia were dominant and associated with bedrock substrata while the nematode Dorylaimus, tubificids and the dipteran Cryptochironomus were abundant where substrata were mostly sand and silt. In general, more organisms were found in deep areas in association with Cladophora beds, and abundance and biomass increased eastwards, i.e., at FITZ and NMPE.

Benthic invertebrates in the Nine Mile Point vicinity have a seasonal growth and reproduction pattern similar to that reported by Fretwell (1972) and Odum (1971) for temperate zones (LMS, 1975). Seasonally the abundance of macroinvertebrates was as follows: the polychaete Manayunkia and the gastropods Valvata perdepressa and Amnicola limosa were dominant in April, the oligochaetes (in particular Nais bretscheri) and the ostracods in June, the amphipod Gammarus fasciatus and the polychaete Manayunkia in August, Gammarus fasciatus and oligochaetes in October, and Gammarus fasciatus in December. Benthic organisms were most abundant in June 1973, 1974 and in June-August 1975.

The trend of greater benthic invertebrate abundance during the spring and fall periods is mainly due to the presence of actively growing Cladophora, a filamentous green alga which provides food and refuge for many invertebrate populations. Cladophora exhibited a maximum seasonal abundance in June of 1974 and 1975 (LMS, 1976). Cladophora biomass decreased rapidly with depth, and was either scarce or nonexistent at depths of 30 and 40 ft. This was previously noted by Neil and Owen (1964). Christie (1974) attributes the increased productivity observed in Lake Ontario during recent years to the growth of Cladophora and its associated fauna. This was confirmed by the studies at Nine Mile Point in which the greatest abundance and biomass of benthic invertebrates were found at the shallow 10 ft stations, while both these parameters generally decreased with increasing depth.

(i) Phylum Platyhelminthes (Order Tricladida)

Abundance and biomass of Tricladida collected at the 40-ft depth contour at the four transects were low in April, June and August 1975 (Table V-15). In October, their numbers (and biomass) increased to a maximum of 95 and 45 organism/m^2 at NMPW and NMPP, respectively, however, remained relatively unchanged at FITZ and NMPE transects.

TABLE V- 15

ABUNDANCE[a] AND BIOMASS[b] OF SELECTED MACROINVERTEBRATES AT 40-FT DEPTH CONTOUR BY TRANSECT[c]

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. TRICLADIDA

TRANSECT	APRIL		JUNE		AUGUST		OCTOBER	
	No./m^2	mg/m^2	No./m^2	mg/m^2	No./m^2	mg/m^2	No./m^2	mg/m^2
NMPW	0	0.000	2	0.001	0	0.000	50	0.027
NMPP	4	0.011	0	0.000	2	<0.001	24	0.009
FITZ	0	0.000	10	0.002	0	0.000	4	0.005
NMPE	0	0.000	3	0.002	0	0.000	6	0.004
MEAN	1.0	0.003	3.8	0.001	0.5	-	21.0	0.011

II. NEMATODA

NMPW	0	0.000	4	<0.001	0	0.000	0	0.000
NMPP	0	0.000	0	0.000	2	<0.001	3	<0.001
FITZ	7	<0.001	411	0.016	77	0.003	2	<0.001
NMPE	32	0.002	335	0.013	127	0.005	46	0.002
MEAN	9.8	-	187.5	-	51.5	-	12.8	-

III. GASTROPODA

NMPW	0	0.000	0	0.000	4	0.100	141	0.320
NMPP	0	0.000	2	0.085	105	0.458	10	0.004
FITZ	17	0.079	140	0.717	141	0.526	98	0.263
NMPE	404	1.091	490	1.177	1303	1.412	773	2.328
MEAN	105.2	0.292	158.0	0.495	388.2	0.624	255.5	0.729

IV. BIVALVA (PELECYPODA)

NMPW	0	0.000	0	0.000	2	0.001	3	0.002
NMPP	0	0.000	0	0.000	17	0.002	4	0.002
FITZ	23	0.021	26	0.014	66	0.030	115	0.049
NMPE	356	0.168	574	0.309	729	0.435	1058	1.224
MEAN	94.8	0.047	150.0	0.081	203.5	0.117	295.0	0.319

[a] For total number multiply by 1.89
[b] For total biomass multiply by 5.09
[c] Based on subsamples
- Averages were not calculated where abundance values were <0.0001.

TABLE V-15 (Continued)

ABUNDANCE[a] AND BIOMASS[b] OF SELECTED MACROINVERTEBRATES AT 40-FT DEPTH CONTOUR BY TRANSECT[c]

TRANSECT	APRIL No./m^2	APRIL mg/m^2	JUNE No./m^2	JUNE mg/m^2	AUGUST No./m^2	AUGUST mg/m^2	OCTOBER No./m^2	OCTOBER mg/m^2
V. POLYCHAETA								
NMPW	0	0.000	6	<0.001	3	<0.001	2	<0.001
NMPP	2	<0.001	0	0.000	0	0.000	171	0.006
FITZ	0	0.000	11	<0.001	0	0.000	0	0.000
NMPE	0	0.000	11	0.001	7	<0.001	11	0.001
MEAN	0.5	-	7.0	-	2.5	-	46.0	-
VI. OLIGOCHAETA								
NMPW	4	<0.001	5	0.002	0	0.000	9	0.007
NMPP	0	0.000	0	0.000	8	0.006	5	0.004
FITZ	552	0.387	1223	1.306	438	0.498	268	0.234
NMPE	686	0.742	849	0.931	34	0.024	260	0.229
MEAN	310.5	-	519.2	0.560	120.0	0.132	135.5	0.118
VII. ACARI								
NMPW	20	0.002	326	0.036	55	0.006	311	0.035
NMPP	10	0.001	418	0.047	52	0.006	634	0.071
FITZ	0	0.000	58	0.007	14	0.002	2	<0.001
NMPE	0	0.000	15	0.002	83	0.010	50	0.005
MEAN	7.5	0.001	204.2	0.023	51.0	0.006	249.2	0.028
VIII. DIPTERA								
NMPW	6	0.001	37	0.006	13	0.006	2	0.001
NMPP	2	<0.001	46	0.026	20	0.004	6	0.001
FITZ	31	0.012	170	0.049	29	0.013	58	0.026
NMPE	92	0.047	147	0.024	80	0.037	96	0.039
MEAN	32.8	-	100.0	0.026	35.5	0.015	40.5	0.017

[a] For total number multiply by 1.89

[b] For total biomass multiply by 5.09

[c] Based on subsamples

\- Averages were not calculated where abundance values were <0.0001.

TABLE V-15 (Continued)

ABUNDANCE[a] AND BIOMASS[b] OF SELECTED MACROINVERTEBRATES AT 40-FT DEPTH CONTOUR BY TRANSECT[c]

IX. AMPHIPODA

TRANSECT	APRIL No./m^2	APRIL mg/m^2	JUNE No./m^2	JUNE mg/m^2	AUGUST No./m^2	AUGUST mg/m^2	OCTOBER No./m^2	OCTOBER mg/m^2
NMPW	7	0.006	20	0.010	24	0.019	228	0.045
NMPP	6	0.023	0	0.000	10	0.008	1079	0.186
FITZ	53	0.027	885	0.265	335	0.117	737	0.238
NMPE	136	0.087	613	0.122	632	0.309	749	0.284
MEAN	50.5	0.036	379.5	0.099	250.2	0.113	698.2	0.188

X. OSTRACODA

TRANSECT	APRIL No./m^2	APRIL mg/m^2	JUNE No./m^2	JUNE mg/m^2	AUGUST No./m^2	AUGUST mg/m^2	OCTOBER No./m^2	OCTOBER mg/m^2
NMPW	8	0.001	71	0.006	54	0.004	221	0.017
NMPP	2	<0.001	76	0.006	72	0.006	8	0.001
FITZ	4	<0.001	5913	0.440	127	0.010	22	0.002
NMPE	43	0.003	2590	0.076	61	0.005	167	0.013
MEAN	14.2	-	2162.5	0.132	78.5	0.006	104.5	0.008

[a] For total number multiply by 1.89
[b] For total biomass multiply by 5.09
[c] Based on subsamples
- Averages were not calculated where abundance values were <0.0001.

Tricladida, in general, declined in abundance from 1973 to 1974 in all Nine Mile Point benthic collections (LMS, 1975). However, collections at NMPW had a substantially increased percentage of triclads in 1974 (36%) compared to 1973 (8%); the percentage at NMPE and FITZ decreased in 1974, but remained unchanged at NMPP. The NMPP and FITZ transects did not consistently show higher or lower abundance of triclads than the other two transects during the sampling period (LMS, 1975).

(ii) Phylum Nematoda

In 1975, nematodes were abundant at the 40-ft depth contour of FITZ and NMPE transects, but scarce to absent at NMPW and NMPP transects (Table V-15). They were most abundant in June, after which their numbers and biomass continued to decline toward the end of the summer.

In 1974 nematodes were abundant throughout the sampling period at both FITZ and NMPE (LMS, 1975), and also at NMPP in April due probably to the abundance of the genus Dorylaimus (LMS, 1975); their numbers then declined in June, August and October. Nematode abundance is attributed essentially to two genera, Alaimus and Dorylaimus, which alternately dominated the collections; i.e., Dorylaimus was dominant in April and August while Alaimus was abundant in June (LMS, 1975).

(iii) Phylum Mollusca (Class Gastropoda)

The gastropods collected from Nine Mile Point vicinity were dominated by pulmonates and prosobranchs. The prosobranchs Valvata perdepressa and Amnicola limosa were dense at NMPE in 1974 and 1975, scattered at NMPP and NMPW, and present in moderate abundance at FITZ transect. In general, gastropods were most abundant in August and October in 1974-1975 and least abundant in December 1974.

The seasonal distribution of gastropods at the 40-ft depth contour in 1975 was in agreement with the above observations; average numbers and biomass exhibited an upward trend from April to August (Table V-15) and the organisms remained relatively abundant in October. Abundance and biomass of gastropods at the two eastern transects FITZ and NMPE were greater on the average than those at the same sampling depth of NMPW and NMPP. Except for NMPP in August and NMPW in October, gastropods were scarce or not present at the NMPW and NMPP 40-ft depth contour.

(iv) Phylum Mollusca (Class Pelecypoda)

Pelecypods (Bivalvia) in the Nine Mile Point vicinity are represented primarily by members of two families: Sphaeriidae, the most abundant bivalves dominated by the genera Sphaerium and Pisidium, and Unioniidae, which was seldom represented in the study area. Bivalves were abundant in midsummer (LMS, 1975, 1976) and increased in numbers in the west-to-east direction.

The occurrence of maximum bivalve abundance at NMPE was related to the type of substratum at that transect. Bivalved molluscs are known to be associated with sand or to live attached to rocks and submerged objects.

Bivalve distribution at the 40-ft depth contour was generally similar to the distribution found along the transects in 1974 and 1975: more organisms at FITZ and NMPE than at NMPW and NMPP (Table V-15), with the highest average numbers and biomass at the NMPE transect. The general pattern of west-to-east increase in density (number/m^2) found in 1974 was also evident here (Table V-15); the maximum density of organisms occurred in October at both FITZ and NMPE transects.

(v) Phylum Annelida (Class Polychaeta)

Only one species of polychaete, Manayunkia speciosa (Family Sapellidae), was observed in any collection during 1973, 1974 and 1975. This species is a domiculous species (Pennak, 1953) living in tubes constructed from mud, detritus or mucus secretion. Polychaetes reached their maximum abundance in August 1974 and were equally abundant in August and October 1975. They declined in numbers toward the end of the year.

Polychaetes were abundant at NMPW and NMPP (LMS, 1975); they were abundant at NMPE in 1973, but numbers there dropped off sharply in 1974, unlike NMPP transect, where they were more numerous in 1974. This pattern seems to change with the month of collection. Samples taken at 40-ft depth contour in 1975 indicated that polychaetes were more abundant at NMPE than NMPW in June, August and October (Table V-15); they were found at FITZ transect only in June, while they were numerous at NMPP transect in October.

(vi) Phylum Annelida (Class Oligochaeta)

In contrast to polychaetes, the oligochaetes were represented by as many as 33 species in 1974 and were abundant at NMPP and NMPW

(LMS, 1975). Tubificid worms, whose presence has been used as an indicator of organic pollution (Howmiller and Beeton, 1970; Goodnight, 1973), were abundant in the area.

Oligochaetes were highly abundant at the 40-ft depth contour at FITZ and NMPE transects in 1975 (Table V-15), reaching a maximum there in June. These organisms were scarce to absent at the 40-ft depth contour of NMPW and NMPP (Table V-15).

(vii) Phylum Arthropoda (Order Acari)

A comparison of the relative abundance of Acari (water mites) between 1973 and 1974 indicated a shift in the period of peak water mite abundance from August in 1973 to June in 1974. NMPW transect contributed the greatest percentage of Hydracarina for both years (44% in 1973; 46.1% in 1974). The abundance at FITZ transect was relatively low for both years; however, the proportion of total abundance at NMPE transect dropped from 20% in 1973 to 9.2% of the Hydracarina population in 1974.

In 1975, water mites were least abundant at the 40-ft depth contour of the FITZ and NMPE transects (Table V-15), and most abundant at both NMPW and NMPP. Their numbers were greater in June and October, but declined in April and August (Table V-15), following a bimodal pattern.

(viii) Phylum Arthropoda (Order Diptera)

Dipterans were abundant and diversified in the study area, as shown in 1973, 1974 and 1975 studies. Dominant genera were Chironomus, Cryptochironomus and Cricotopus. There was an upward trend in abundance of dipterans among years, and distribution generally followed a west-east pattern of increase in abundance.

Dipterans are abundant in the early midsummer period, and they decline in number and biomass in late summer/early fall as a result primarily of emergence, which is temperature-dependent, and also of cropping by fish. In 1974, dipterans reached a peak in August, with NMPE exhibiting the greatest abundance (LMS, 1975). Abundance then declined toward October, particularly populations in shallow areas. For example, Chironomus sp. larvae were abundant at the 60-ft depth contour of FITZ and NMPW transects in October, at the same time as a decline in standing crop was noted at the 10, 20 and 30-ft depth contours.

The seasonal abundance and biomass of dipterans collected at the 40-ft depth contour in 1975 are shown in Table V-15. These indicate the presence of a west-to-east trend of increased abundance during the April-October period. Average number and biomass of dipterans reached a maximum in June and then drastically declined in August and October. These organisms were more abundant at both FITZ and NMPE than at NMPW and NMPP transects during all 1975 collections.

(ix) Phylum Arthropoda (Order Amphipoda)

Two species of amphipods were collected from the Nine Mile Point area in 1973, 1974 and 1975: Gammarus fasciatus and Pontoporeia affinis. G. fasciatus is generally considered a littoral species, although it has been recorded from depths up to 33 m in Lake Ontario (Hiltunen, 1964). G. fasciatus was more abundant than P. affinis and played a major role in the food chain of the representative important species in the area (LMS, 1975, 1976).

G. fasciatus was abundant in August (its peak) and October in 1975 (LMS, 1976); its abundance in 1974 was characterized by a minor peak in August followed by a major peak in December (December collections were not available for 1975). In 1973, the peak abundance occurred in June and numbers declined toward October (QLM, 1974). In general, the distribution of Gammarus did not follow a definite pattern among transects, but the littoral habit of the species was evident in that more organisms were collected from the 10 and 20-ft depth contours in 1974 and 1975.

Pontoporeia affinis was less abundant than Gammarus and was encountered at the 40 and 60-ft depth contours. This was substantiated by 1973 (QLM, 1974) and 1974 (LMS, 1975) data which indicated the presence of 90% of the species at these two depths.

The density distribution of amphipods at the 40-ft depth contour at the four transects in 1975 is shown in Table V-15. These data indicated that amphipods were abundant at FITZ and NMPE transects in April, June and August. In October, however, all transects displayed high values in both number and biomass.

(x) Phylum Arthropoda (Order Ostracoda)

Seasonal distribution of ostracods was similar in 1973 (QLM, 1974), 1974 (LMS, 1975) and in 1975 (LMS, 1976). The abundance at all transects increased from relatively low numbers in April to a maximum in June, followed by a sharp decline through December 1973-1974 and through October 1973.

NMPE provided the maximum contribution to ostracod abundance in the 1973-1975 period, followed by FITZ transect, where abundance was unchanged between 1973 and 1974. Ostracod abundance declined at NMPP transect in 1974, where it was least in 1975. In general, NMPW and NMPP had fewer ostracods than FITZ and NMPE throughout the study period.

Ostracod distribution at the 40-ft depth contour (Table V-15) was similar to that described above, reaching maximum abundance in June and declining in abundance toward October. FITZ and NMPE had more ostracods, on the average, than NMPW and NMPP, especially in June when ostracods were abundant.

9. Scouring

The high-velocity jet discharge at JAF has created a depression 3-9 ft deep near the center of the diffuser. The scouring in the vicinity of the discharge caused sand and bottom substratum to be transported from an area approximately 50 ft from the center of the diffuser and extending to about 180 ft lakeward. The scouring of this area has also created a "mound" north of it as a result of the deposition of the transferred materials as the plume velocity declines. It is thus most likely that this scouring process has displaced part of the benthic community occupying an area roughly 488 x 92 m and some damage may have occurred. The deposition area, even though it is expected to be recolonized, is included in the area of impact of the scouring.

10. Nekton

The fish community in the plant vicinity was sampled from March through December 1973, and from April through December of 1974 and 1975 by gill nets, trawls, and seines. Samples were collected from the shoreline to the 60-ft depth contour along four transects - NMPW, NMPP, FITZ, and NMPE. The two transects, NMPW and NMPE, served as control transects because, for the most part, they were not influenced by the heated discharge from the two plants. It should be noted, however, that on very few occasions the 2°C isotherm may have occurred at either transect. Description of the gears used and methods of sampling are in QLM (1974) and LMS (1976).

An ascending trend in the number of species collected was noted during the period 1973-1975. The number varied from 37 species in 1973 to 42 species in 1974 and 53 species in 1975 (Table V-16).

The alewife was the dominant species collected, making up 73, 74 and 75% of the total number of fish collected in 1973, 1974, and 1975, respectively. Rainbow smelt was the second most abundant species in 1974

TABLE V-16

FISH SPECIES INVENTORY

NINE MILE POINT VICINITY - 1974-1975

FAMILY	SCIENTIFIC NAME	COMMON NAME
Petromyzontidae	Petromyzon marinns	Sea Lamprey
Lepisosteidae	Lepisosteus osseus	Longnose gar
Amiidae	Amia calva	Bowfin
Anguillidae	Anguilla rostrata	American eel
Clupeidae	Alosa pseudoharengus	Alewife
	Dorosoma cepedianum	Gizzard shad
Salmonidae	Coregonus artedii	Cisco or Lake herring
	Oncorhynchus kisutch	Coho salmon
	O. tshawytscha	Chinook salmon
	Salmo gairdneri	Rainbow trout
	S. trutta	Brown trout
	Salvelinus fontinalis	Brook trout
	S. namaycush	Lake trout
	S. namaycush x fontinalis	Splake trout
Osmeridae	Osmerus mordax	Rainbow smelt
Esocidae	Esox americanus americanus	Redfin pickerel
	E. lucius	Northern pike
Cyprinidae	Corassius auratus	Goldfish
	Conesius plumbens	Lake chub
	Cyprinus carpio	Carp
	Hybognathus nuchalis	Silvery minnow
	Notemigonus crysolencas	Golden shiner
	Notropis atherinoides	Emerald shiner
	N. bifrenatus	Bridle shiner
	N. cornutus	Common shiner
	N. hudsonius	Spottail shiner
	Pimephales promelas	Fathead minnow
	Rhinichthys cataractae	Longnose dace
Catostomidae	Catostomus catostomus nannonyzon	Dwarf longnose sucker
	C. commersoni	White sucker
	Erimyzon sucetta	Lake chubsucker
	Hypentelium nigricans	Northern hogsucker

TABLE V-16 (Continued)

FISH SPECIES INVENTORY

FAMILY	SCIENTIFIC NAME	COMMON NAME
Ictaluridae	Ictalurus nebulosus	Brown bullhead
	I. puntatus	Channel catfish
	Notarus flavus	Stonecat
	N. gyrinus	Tadpole madtom
Percopsidae	Percopsis omiscomaycus	Trout-perch
Gadidae	Lota lota	Burbot
Cyprinodontidae	Fundulus diaphanus	Banded killifish
Atherinidae	Labidesthes sicculus	Brook silverside
Gasterosteidae	Culaea inconstans	Brook stickleback
	Gasterosteus aculeateus	Threespine stickleback
Percichthyidae	Morone americana	White perch
	M. chrysops	White bass
	M. mississippiensis	Yellow bass
Centrarchidae	Ambloplites rupestris	Rock bass
	Lepomis gibbosus	Pumpkinseed
	L. macrochirus	Bluegill sunfish
	Micropterus dolomieni	Smallmouth bass
	M. salmoides	Largemouth bass
	Pomoxis nigramaculatus	Black crappie
Percidae	Etheostoma nigrum	Johnny darter
	Perca flavescens	Yellow perch
	Percina caprodes	Logperch
	Stizostedian vitreum vitreum	Walleye
Sciaenidae	Aplodinotus grunniens	Freshwater drum
Cottidae	Cottus bairdi	Mottled sculpin

(11.7% of the total catch), but represented only 2% in 1973 and 2.5% in 1975. The latter difference is attributed to variations in April fishing efforts between 1974 and 1975 (April is the spawning time for rainbow smelt). Spottail shiner (the second most abundant species in 1975), threespine stickleback, yellow perch, white perch and gizzard shad were relatively abundant at one time or another during the collection periods. White perch was the second most abundant species in 1973 (7% of all fish collected).

The catch per unit effort for salmonids probably reflects the rate of stocking in Lake Ontario and growth to catchable size of these species. Both the brown trout and the coho salmon were caught in greater numbers in 1975 than in either 1973 or 1974. The brown trout was represented by 182 specimens in 1975 as compared to 75 in 1974; and the coho salmon by 57 individuals in 1975 and by 13 in 1974. Lake trout catch increased from 4 in 1974 to 28 in 1975. Other salmonids were captured in similar low numbers over the last two years.

Fluctuations in the seasonal abundances of various species are evident (LMS, 1975, 1976). The greatest number of fish were collected in the spring months, corresponding to the spawning of rainbow smelt and the inshore migration of alewife. The fish abundance then declined during the summer months due to the lakeward (post spawning) migration of these two abundant species (LMS, 1975).

The Shannon-Weaver diversity index (H), applied to bottom gill net collections (few fish were caught in surface gill nets) in 1974, indicated higher diversity at FITZ and NMPE transects and lowest diversity at NMPW transect, which with NMPP, generally had lower diversity values throughout the year (LMS, 1975). The fairly distinct west-to-east increase in diversity that occurred in 1974 was not found in 1975 when JAF was operating. Averages (and ranges) of diversity values based on 1975 bottom gill nets data were similar for the four transects.

Monthly station data for bottom gill nets were subjected to a clustering regime using group-average strategy in an attempt to discern patterns in the spatial and temporal distribution indicative of effects of the thermal plume (LMS, 1976). The transects were found not to differ among themselves, thus there is no apparent differences between stations close to and distant from the discharge. There was an apparent difference between inshore and offshore stations that was not the result of the presence of the thermal discharge.

The relative abundance and species composition of fish collected in surface and bottom gill nets in 1975 was different from that found in 1974. More alewife were collected near the surface in 1975 than in 1974 and fewer alewife were caught in the bottom gill nets in 1975 than in 1974. Moreover, 13 more species were collected in bottom gill nets than in surface gill nets in 1975. These two factors may have contributed to the changes in the diversity which is illustrated as follows: when 1974 data for species diversity were calculated, excluding alewife, the west-to-east assending trend was absent, i.e., more alewife inhabitated the western part of the study area in terms of their relative contribution to the nekton community.

The distribution and relative abundance of fishes observed in the Nine Mile Point vicinity is similar to the general pattern for the entire lake. The seasonal occurrence of fishes in the Nine Mile Point area follows the known seasonal behavior of the abundant species and no unusual concentrations or depletions in the vicinity of the discharge have been observed. A comparison of the life history data for the representative important species collected at Nine Mile Point is compared with the literature on each species in Chapter VI.

This conclusion is verified by the work of Storr (1974) who conducted tagging studies in the vicinity of NMP-1 and found that normal seasonal movements were not effected by operation of NMP-1. Preliminary results from 1976 indicate that this conclusion can be extended to JAF.

11. Conclusions

The biological community in the vicinity of Nine Mile Point shows high diversity at all trophic levels. The distribution, abundance and seasonal changes in groups and individual species are typical of Lake Ontario and follow the expected values and patterns found in the literature. There is a normal seasonal cycle of changing species composition and abundance in phytoplankton and zooplankton.

Phytoplankton zooplankton species abundance was found not to be affected by combined operation of NMP-1 and JAF. Measurement of photosynthetic rate suggested a stimulatory effect by the heated water, however, the increase is probably insignificant in terms of phytoplankton population dynamics due to the short period of stimulation. Microzooplankton samples from the plume and simulations of plume entrainment indicate percentage mortalities similar to simultaneous intake samples. There was no indication in these data of thermal induced mortality.

for all groups? I doubt

The high velocity discharge of the JAF has scoured an area of the lake bottom immediately north the discharge ports and created an area of deposition beyond the area of scour. In both areas the benthic invertebrate community has been disturbed and a loss of productive benthic habitat has probably occurred in the scour area; productivity can be expected in the depositioned area when it becomes stabilized. The loss of benthic productivity is restricted to a small area and is unimportant in relation to benthic production in the Nine Mile Point Area.

The fish community at Nine Mile Point has a species composition typical of Lake Ontario and a seasonal pattern of distribution and abundance that is not influenced by the presence of the thermal discharge. The information on representative important species presented in Chapters VI and VII provides details on the effects of the thermal discharge on fishes.

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VI. SELECTION OF IMPORTANT REPRESENTATIVE SPECIES

A. RATIONALE

The purpose of selecting important representative species is to permit an assessment of plant effects on the ecosystem without resorting to a study of numerous species at each trophic level. The species selected are considered characteristic of the ecosystem, and therefore, an assessment of plants effects on these species provides an assessment of ecosystem effects.

The Regional Administrator, after consulting with the Commissioner of New York State Department of Environmental Conservation, the Secretary of Commerce and the Secretary of Interior, selected the following species as Representative Important Species for the James A. FitzPatrick Nuclear Power Plant (letter from Mr. Gerald Hansler to Mr. George Berry dated August 11, 1975).

1.	Alewife	Alosa pseudoharengus
2.	Brown trout	Salmo trutta
3.	Coho salmon	Oncorhynchus kisutch
4.	Rainbow smelt	Osmerus mordax
5.	Smallmouth bass	Micropterus dolomieui
6.	Threespine stickleback	Gasterosteus aculeatus
7.	Yellow perch	Perca flavescens
8.	Gammarus fasciatus	

Four criteria were used to aid in the selection of important representative species as required for the 316(a) demonstration for the James A. FitzPatrick Plant. The criteria were: (1) the species is important for a recreational or commercial fishery, (2) the species is numerically abundant or represents a major portion of the biomass of its trophic level, (3) the species is important because its existence in the lake is endangered or it is a nuisance, (4) the species has an important functional role in the ecosystem.

The sources of information which were used include: (1) published literature regarding the biology of a given species; (2) determinations of importance to the ecosystem based on biological and plant monitoring programs which have been conducted in the Nine Mile Point/ Oswego area since 1963; and (3) design features, location, and predicted plumes of the thermal discharge which may impact on the distribution and abundance of the selected species. The important representative species are listed below with the rationale for inclusion of each species in the list.

1. Alewife

The alewife was selected as a representative species because it is numerically abundant, a major portion of the total fish biomass, an important forage species for valuable recreational fishes, at times a nuisance, and a potentially important commercial species. Alewife was the dominant species in the vicinity of Nine Mile Point and in impingement sampling from 1973 to 1975. In 1975, it made up 75% of the annual lake catch (all gears combined) and 79.6% of the total number of fish collected during annual impingment monitoring. This species is the forage base for a number of recently introduced salmonids and constitutes a portion of the diet of all large piscivorous fishes in Lake Ontario. Annual spring and summer die-offs of alewives have clogged water intake systems and fouled shoreline areas with rotting carcasses. The alewife is not commercially exploited in Lake Ontario.

2. Brown Trout and Coho Salmon

The brown trout and coho salmon were selected because they are important recreational species, and are among several salmonids being stocked in large numbers by the State of New York and the Province of Ontario. These two species, along with other salmonids, feed heavily on alewives and thereby convert a nuisance species into a useful resource. In addition, salmonids are "coldwater" species that could be impacted by thermal discharges. Although salmonids are presently collected in low numbers in lake and impingement sampling, their recreational value, as well as their relationship to the alewife, has led to their inclusion as representative species.

3. Rainbow Smelt

The rainbow smelt was selected for the representative species list because it is numerically abundant and represents a major portion of the total fish biomass of the lake. Smelt are harvested commercially in Lake Ontario and formerly supported a sport fishery on the Canadian side of the lake. The rainbow smelt increased in abundance dramatically in the late 1940's and may have important ecological relationships with other lake species. It is collected in substantial numbers in lake and impingement sampling at Nine Mile Point.

4. Smallmouth Bass

The smallmouth bass in an important sport fish and an important piscivore in the nearshore area of the lake. Smallmouth bass were collected in small numbers compared to alewife, although they are found in the nearshore area and in impingement collections.

5. Threespine Stickleback

The threespine stickleback is listed as a representative species because it is important as forage for many piscivores, very abundant in the nearshore area, and collected in relatively large numbers in impingement collections at Nine Mile Point. Threespine stickleback spawn in the Nine Mile Point area.

6. Yellow Perch

The yellow perch was chosen as a representative species because it is important for sport and commercial fisheries and abundant in the nearshore area. Christie (1973) felt that the increased commercial catch of this species indicates a substantial increase in its abundance in the eastern end of Lake Ontario. It is collected in substantial numbers in lake and impingement sampling at Nine Mile Point, and there is evidence of a minimal amount of spawning in the Nine Mile Point area.

7. *Gammarus* sp.

Gammarus sp., an amphipod, is considered representative of the benthic invertebrates that are important forage for the young and adults of many fish species. Several species of *Gammarus* are found in Lake Ontario with *Gammarus fasciatus* the most abundant. Unlike most benthic invertebrates, *Gammarus* is quite mobile and migrates upward away from the bottom. It is thus entrained into the cooling system of the Nine Mile Point plant (LMS, 1975) and into the discharge plume.

8. Threatened and Endangered Species

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

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

None of these fishes 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 four years (1972 to 1975). A discussion of the decline in abundance of the species listed above may be found in Christie (1973).

B. LIFE HISTORIES OF REPRESENTATIVE SPECIES

1. Alewife (*Alosa pseudoharengus*)

The alewife is an anadromous species that spends most of its adult life in marine waters and returns to fresh water to spawn. It occurs from Newfoundland to North Carolina (Scott and Crossman, 1973), and, in addition, is landlocked in many lakes along its range, including Lake Ontario.

- Abundance and Seasonal Distribution

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

Alewife from Lake Michigan occupy all depths along the bottom as well as all vertical depths, depending on life stage and time of year (Wells, 1968). The inshore spawning migration of adults was reported to occur as early as March 11, and by April 15, the largest concentration of adult alewife was observed in the shallow areas of Lake Michigan (Wells, 1968). In the Bay of Quinte, Lake Ontario, the inshore migration of alewife reached a maximum in late June and ended in late July (Graham, 1956). The inshore movement of adult alewife in the FitzPatrick vicinity was observed to take place during April (LMS, 1975). Spawning activity began shortly after arrival, reaching a peak during the first half of July. Like the adults, juvenile alewife initiated their inshore movements in the spring; they tended to group in shallow areas at dark and to remain on the bottom, at 6 to 10 ft depth, during daylight hours.

The majority of alewife collected from the Nine Mile Point study area during the period 1973-1975 were caught by gill nets. In 1974, more alewife were caught in bottom gill nets than in surface gill nets; this trend, however, was reversed in 1975 (LMS, 1976). The 1974 gill net collections indicated that alewife abundance was not significantly different (based on catch/12 hours) at the FITZ transect than at the other three transects (LMS, 1975).

Alewife in the Nine Mile Point area exhibited seasonal as well as diel variations in behavior. A three-way analysis of variance of 1974 gill net data (catch/12 hours) by sample depth among three seasons (Spring: April-June; Summer: July-September; and Fall: October-December) revealed that alewife were significantly more abundant in the evening and during the spring and summer periods than during fall (LMS, 1975). This is in agreement with observations of Graham (1956) and Scott and Crossman (1973) that alewife return to deep water after spawning, and was also confirmed by Wells (1968) for Lake Michigan alewife. More alewife were caught near the bottom during the daytime than near the surface, and conversely, near the surface at night.

Catch per effort (number/12 hrs) of alewives collected by surface and bottom gill nets at the 40 ft depth contour were estimated from April through December 1975 and compared among transects (Table VI-1). The 40 ft depth contour was chosen because it was most influenced by the thermal plume of the FitzPatrick plant. Surface gill net collections yielded significantly more alewives than bottom gill net collections, and the average catch per effort in April, May and July 1975 was significantly higher for collections during the rest of the sampling period (Table VI-2). The average catch per effort for surface gill nets at FITZ transect was similar to that of NMPW and NMPP, but higher than that of NMPE (Table VI-1). Catch per effort estimated from bottom gill net collections was higher at FITZ transect than the other three transects, primarily because of the large collection during July (Table VI-1). No significant difference existed in catch per effort among transects throughout the sampling period, and the difference between surface and bottom alewife abundance was significant in one month only, May, 1975 (Table VI-2).

- Age and Growth

The average calculated lengths at each annulus for male and female alewives are summarized in Table VI-3 and compared with these for fish collected in 1973 (QLM, 1974) and other populations from Lake Ontario and its vicinity (Table VI-4). Growth rate of alewife is characterized as rapid during the first two years of life. After the first and second years of life, alewife were 54 and 67%, respectively, of the length achieved after six years of growth. In a study of alewife growth in Lake Ontario, Graham (1956) noted that alewives experience an early period of rapid growth, the rate of which decreases with the onset of sexual maturity at age 2 for males and age 3 for females. Growth rates of male and female alewives were similar for age groups I and II, after which females exhibited a relatively faster growth rate than did males (Table VI-3). This is in agreement with Pritchard (1929) who reported that female alewives grow faster than males and attain a greater size.

The calculated growth of male and female alewife was plotted by age class (i.e., year spawned) so that differences or similarities among age classes could be observed (Figures VI-1 and VI-2). These graphs show (where comparisons are possible) that for fish spawned from 1969 to 1973, growth was similar for ages I, II, III, and IV. However, fish spawned in 1968 appeared to grow faster from ages III to VI. This

TABLE VI-1

CATCH PER EFFORT* OF SELECTED FISH SPECIES IN GILL NET COLLECTIONS AT 40-FT DEPTH CONTOUR

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

I. ALEWIFE

	SURFACE GILL NETS				BOTTOM GILL NETS			
MONTH	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE
APR	45.1	127.9	88.8	16.8	27.0	14.5	26.3	3.0
MAY	202.7	133.3	90.4	60.5	4.6	4.9	2.2	1.6
JUN	67.3	24.5	57.4	42.4	1.4	3.4	6.0	12.0
JUL	154.0	85.7	91.9	68.0	19.0	49.1	188.9	8.6
AUG	16.9	27.0	2.4	4.0	4.4	1.9	9.1	24.5
SEP	2.8	17.3	7.7	2.6	8.0	10.7	18.8	6.8
OCT	10.8	17.5	NS	1.6	5.3	4.0	8.3	3.4
NOV	17.2	25.0	30.5	11.9	24.7	1.6	6.7	3.7
DEC	11.4	16.6	7.8	3.0	1.8	3.8	9.6	10.0
MEAN	58.7	52.8	47.1	23.4	10.7	10.4	30.7	7.2

II. RAINBOW SMELT

APR	1.6	3.6	26.2	8.6	4.3	1.9	15.0	5.3
MAY	0.0	0.1	0.1	0.1	0.4	0.0	0.1	0.1
JUN	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
JUL	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
AUG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEP	0.4	0.5	0.2	0.1	0.0	0.2	0.2	0.0
OCT	1.1	1.8	NS	0.1	0.4	0.2	1.6	0.4
NOV	0.8	1.3	0.5	0.6	1.3	0.6	2.2	2.6
DEC	0.2	1.3	0.7	0.0	0.4	0.0	1.2	0.0
MEAN	0.5	1.0	3.5	1.1	0.8	0.3	2.3	0.9

*Mean number of fish collected/12 hours
NS = No sample

TABLE VI-1 (Continued)

CATCH PER EFFORT* OF SELECTED FISH SPECIES IN GILL NET COLLECTIONS AT 40-FT DEPTH CONTOUR

III. YELLOW PERCH

MONTH	SURFACE GILL NETS				BOTTOM GILL NETS			
	NMPW	NMPP	FITZ	NMPE	NMPW	NMPP	FITZ	NMPE
APR	0	0.0	0.0	0	0.0	0.1	0.4	0.0
MAY	0	0.0	0.0	0	0.0	0.1	0.0	0.2
JUN	0	0.0	0.2	0	0.8	0.5	0.2	0.8
JUL	0	0.0	0.2	0	0.7	0.5	1.7	0.1
AUG	0	0.1	0.0	0	0.2	0.1	1.3	0.4
SEP	0	0.2	0.0	0	0.7	0.5	1.0	0.6
OCT	0	0.0	NS	0	1.0	0.2	2.0	1.1
NOV	0	0.0	0.0	0	0.5	0.2	0.4	0.2
DEC	0	0.0	0.0	0	0.4	0.0	0.0	0.0
MEAN	0	0.0	0.1	0	0.5	0.2	0.8	0.4

IV. SMALLMOUTH BASS

APR	0	0.0	0	0	0.0	0.0	0.6	0.2
MAY	0	0.0	0	0	0.2	0.1	0.2	0.0
JUN	0	0.0	0	0	0.0	0.0	0.0	0.0
JUL	0	0.0	0	0	0.1	0.5	0.7	0.7
AUG	0	0.0	0	0	1.9	1.8	0.7	1.6
SEP	0	0.5	0	0	0.8	1.8	3.4	0.4
OCT	0	0.0	0	0	0.1	0.0	0.0	0.0
NOV	0	0.0	0	0	0.5	0.0	0.1	0.0
DEC	0	0.0	0	0	0.0	0.0	0.0	0.0
MEAN	0	0.1	0	0	0.4	0.5	0.6	0.3

*Mean number of fish collected/12 hours
NS = No sample

TABLE VI-2

STATISTICAL ANALYSIS OF SELECTED FISH SPECIES IN GILL NET COLLECTIONS AT 40-FT DEPTH CONTOUR

JAMES A FITZPATRICK NUCLEAR POWER PLANT - 1975

ALEWIFE

THREE-WAY ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
MONTHS	7	44097.07	6299.58	6.72**
TRANSECTS	3	5120.33	1706.78	1.82
SAMPLE DEPTHS	1	16971.58	16971.58	18.10**
MONTH X TRANSECT	21	17216.77	819.85	0.87
MONTH X SAMPLE DEPTH	7	22616.92	3230.99	3.45*
TRANSECT X SAMPLE DEPTH	3	4787.95	1595.98	1.70
ERROR	21	19687.11	937.48	
TOTAL	63	130497.73		

*Significant at $\alpha = .05$
**Significant at $\alpha = .01$

ESTIMATED MEANS FOR MONTHS

MONTH	ESTIMATED MEAN
APR	43.7
MAY	62.5
JUN	26.8
JUL	83.2
AUG	11.3
SEP	9.3
NOV	15.2
DEC	8.0

TUKEY T TEST - MONTHS ($\alpha = .05$)

Largest: JUL MAY APR JUN NOV AUG SEP DEC: Smallest

ESTIMATED MEANS FOR SAMPLE DEPTHS

SAMPLE DEPTH	ESTIMATED MEAN
SURFACE	48.8
BOTTOM	16.2

ESTIMATED MEANS FOR MONTHS AND DEPTHS

	DEPTH		
MONTH	SURFACE	BOTTOM	SIGNIFICANT DIFFERENCE[a]
APR	69.7	17.7	NO
MAY	121.7	3.3	YES
JUN	47.9	5.7	NO
JUL	99.9	66.4	NO
AUG	12.6	10.0	NO
SEP	7.6	11.1	NO
NOV	21.2	9.2	NO
DEC	9.7	6.3	NO

[a]Simultaneous tests using Bonferroni procedures ($\alpha = .05$)

TABLE VI-3

AVERAGE CALCULATED TOTAL LENGTH
AND STANDARD ERROR AT ANNULUS FORMATION
OF ALEWIVES

NINE MILE POINT - 1974

YEAR CLASS	NUMBER OF FISH	AGE GROUP	I	II	III	IV	V	VI
			AVERAGE CALCULATED TOTAL LENGTH (mm) AND STANDARD ERROR AT ANNULUS FORMATION					
			MALES					
1973	44	I	98.40 ±2.02					
1972	13	II	81.63 ±3.83	138.42 ±3.65				
1971	18	III	86.14 ±3.25	139.17 ±3.01	155.42 ±3.28			
1970	48	IV	80.37 ±1.58	133.33 ±1.45	148.92 ±1.36	157.34 ±1.48		
1969	22	V	77.53 ±2.26	129.94 ±2.53	145.20 ±2.09	154.59 ±2.23	160.10 ±2.50	
1968	5	VI	76.33 ±7.35	131.08 ±10.59	164.60 ±7.79	179.87 ±9.88	190.49 ±10.42	198.80 ±11.53
		Grand average calculated length (weighted)	85.91	134.14	150.14	158.04	165.73	198.80
		Grand average increment of length (weighted)	85.91	53.41	16.60	9.16	6.46	8.31
		Sum of grand average increments	85.91	139.32	155.92	165.08	171.54	179.85
		Confidence interval of (α=0.05) grand calculated lengths	83.83 87.99	131.67 136.61	147.75 152.53	155.29 160.79	161.18 170.28	157.40 240.20
			FEMALES					
1973	44	I	98.40 ±2.02					
1972	8	II	82.00 ±5.84	140.38 ±3.94				
1971	28	III	88.54 ±2.98	142.26 ±2.80	160.38 ±2.27			
1970	48	IV	82.97 ±1.89	140.08 ±2.05	157.53 ±1.68	167.12 ±1.54		
1969	37	V	74.26 ±1.98	125.37 ±2.39	143.35 ±1.65	156.89 ±1.64	165.54 ±2.18	
1968	10	VI	74.23 ±4.56	129.80 ±10.22	160.20 ±8.91	170.53 ±8.53	182.67 ±8.45	198.20 ±9.79
		Grand average calculated length (weighted)	85.36	135.62	154.13	163.49	169.18	198.20
		Grand average increment of length (weighted)	85.36	54.65	18.82	11.21	9.39	5.53
		Sum of grand average increment	85.36	140.01	158.83	170.04	179.43	184.96
		Confidence interval of (α=0.05) grand calculated lengths	83.26 87.46	132.68 138.56	151.65 156.61	160.73 166.25	163.95 174.41	186.67 209.73

TABLE VI-4

COMPARISON OF GROWTH RATE OF ALEWIFE FROM LAKE ONTARIO AND ITS VICINITY[a]

NINE MILE POINT (LMS, 1975) LENGTH (mm)	NINE MILE POINT (QLM, 1974) LENGTH (mm)	PORT CREDIT LAKE ONTARIO (PRICHARD, 1929) LENGTH (mm)	BAY OF QUINTE LAKE ONTARIO (PRICHARD, 1929) LENGTH (mm)	LAKE MICHIGAN (NORDEN, 1967) LENGTH (mm)	SENACA LAKE, N.Y. (ODELL, 1934)[b] LENGTH (mm)
86 (44)	110 (2)	99 (7)		94 (147)	70 (113)
135 (21)	145 (28)	128 (5)	140 (1)	140 (177)	145 (89)
152 (46)	157 (83)	143 (11)	143 (2)	159 (1028)	154 (284)
		153 (34)	148 (14)	173 (502)	171 (49)
161 (96)	165 (145)	162 (35)	157 (17)		174 (15)
168 (59)	183 (31)	180 (3)	179 (9)		
198 (15)	204 (7)		187 (1)		
	217 (1)				

[a]Numbers which appear in parentheses represent the number of fish measured in determining average length.

[b]To convert standard length to total length multiply by 1.2513, based on Nine Mile Point alewives total length/standard length ratio.

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

NINE MILE POINT-1974

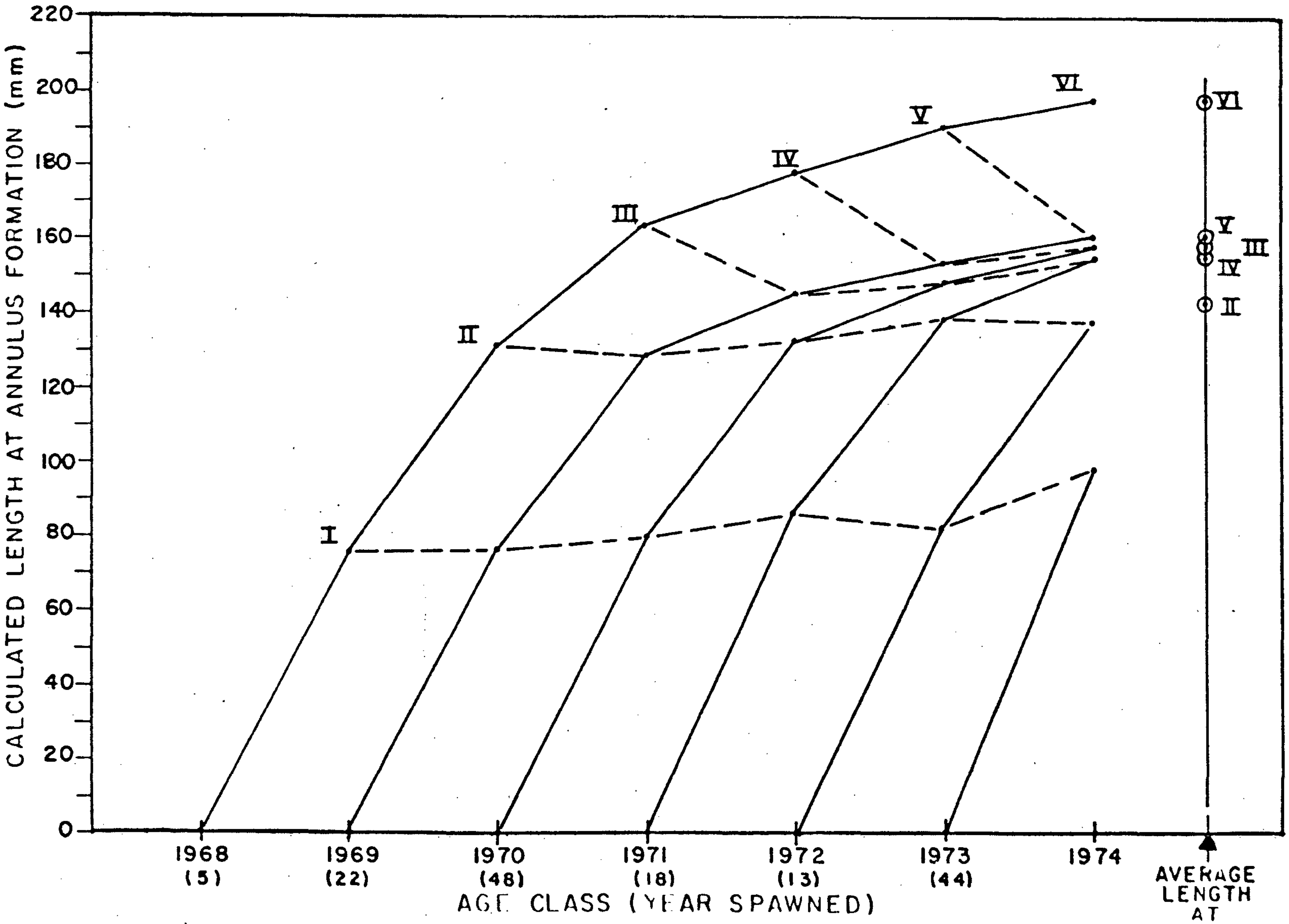


FIGURE VI-1

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

NINE MILE POINT - 1974

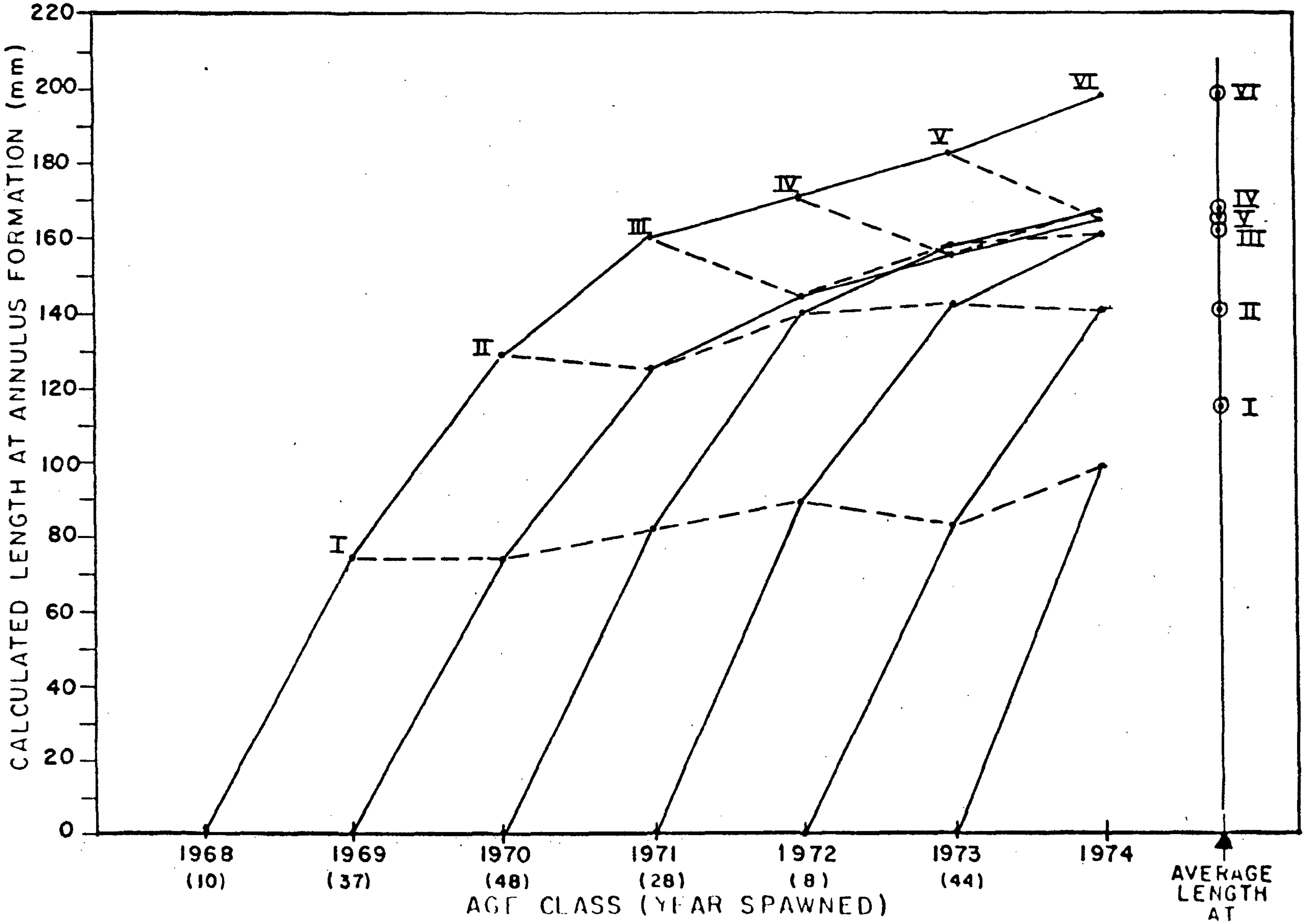


FIGURE VI-2

phenomenon may be attributed to the small sample size or the fact that only larger, faster growing individuals survive for six years and are then available for capture.

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

Alewives from the Nine Mile Point vicinity of Lake Ontario generally appeared to grow more rapidly after the first year of life than fish from Port Credit and the Bay of Quinte, Lake Ontario (Pritchard, 1929) (Table VI-4). Graham (1956) reported that Atlantic alewife of both sexes mature one year later than landlocked Lake Ontario alewife, grow more quickly throughout their life, and attain a larger size than Lake Ontario alewife. He suggested that the freshwater environment hastens the onset of sexual maturity and that this results in an inhibition of growth.

- Reproduction

Landlocked alewives spend most of the year in deeper lake waters and move to shallow areas in spring for spawning. The inshore spawning migration is related to water temperature. The average water temperatures recorded in the Nine Mile Point vicinity at the onset of spawning were similar to those reported by Threinen (1958)(13-16°C) and Gross (1959)(17-19°C).

Alewives in the Nine Mile Point vicinity began spawning in late May/ early June and reach a peak spawning during the first two weeks of July when the water temperature is about 13.5-22°C.

Graham (1956) noted that peak spawning activity for alewives in the Bay of Quinte, on the north shore of eastern Lake Ontario, was near the end of July. Larvae were observed to remain in the shallow shore zone at least until late larval stages had been reached during the early fall period. Wells (1968) studied alewife distribution in Lake Michigan and found the greatest concentration located near the surface, with individuals gradually assuming a mid-depth to bottom preference with increased age.

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

Total egg counts for fish in the 1974 study ranged from 8,981 to 50,274 eggs with a mean of 31,613 eggs. In 1973 (QLM, 1974), the total egg counts for 11 alewives from the Nine Mile Point vicinity of Lake Ontario ranged from 25,797 to 67,739 eggs, with a mean of 46,821 eggs.

A range in total egg production of 11,147 to 22,407 eggs per female was reported for alewives of similar size in Lake Michigan (Norden, 1967). Since only mature eggs are spawned during a season, total egg count may overestimate the actual fecundity of freshwater alewives.

Fecundity of alewives does not seem to be correlated with age, fish weight, ovary weight, or even fish length (LMS, 1975). Each of these parameters exhibited a poor correlation (r varied from 0.02 to 0.21 with fecundity). The fecundity estimates varied from 7,364 to 36,574 eggs (average 21,378 for 153-177 mm female alewives).

Alewife eggs were first observed in samples collected at Nine Mile Point on 19-20 June, and peak egg abundance was found during the second and third week of July, 1974 (LMS, 1975). This corresponds very closely to the observed time of spawning reported by Graham (1956). As expected, egg concentrations were higher in bottom samples since the alewife has demersal eggs which are broadcast at random (Mansueti and Hardy, 1967). The greatest concentration of alewife eggs was at the 20 ft depth contour stations of NMPP and the lowest numbers were observed at NMPE and at the deeper depth contour stations north of the point.

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

The time required for egg hatching was cited (Scott and Crossman, 1973) to be six days at 15.6°C or three days at 22.2°C.

- <u>Feeding</u>

Alewives are size-selective zooplankton feeders preferring larger

- Feeding

Alewives are size-selective zooplankton feeders preferring larger cladocerans, calanoid and cylopoid copepods (Wells, 1970). Norden (1968) found that larval alewives in Lake Michigan had a definite food preference for cladocerans and copepods with incidental occurrences of diatoms and plant material in stomachs analyzed. Adult alewives from Lake Michigan, like the larvae, fed primarily on copepods and cladocerans (Rhodes and McCormish, 1975); however, during the summer, dipteran larvae were a preferred item and the deep-water amphipod, Pontoporeia affinis, was heavily utilized during the early fall. Wells (1970) noted heavy feeding pressure on Leptodora kindtii, which is one of the predominant macrozooplankters in the vicinity of Nine Mile Point.

Information on the feeding habits of alewives in the vicinity of Nine Mile Point is not currently available. All of the food items reported for alewives are abundant in the Nine Mile Point area (LMS, 1975).

2. Rainbow smelt (Osmerus mordax)

The original range of the rainbow smelt in eastern North America was the Atlantic coastal drainage from New Jersey to Labrador. Whether or not the smelt is native to Lake Ontario is uncertain; Hubbs and Lagler (1958) believe that it is, whereas Scott and Crossman (1973) are of the opposite opinion. In either case, the first report of rainbow smelt taken from Lake Ontario was in 1931 by Mason (1933), although they now occur in all of the Great Lakes and in many other Canadian and United States lakes. The smelt is an anadromous species, leaving the sea or large lakes in spring to spawn in freshwater streams.

- Abundance and Seasonal Distribution

The vast majority of rainbow smelt sampled from the Nine Mile Point area were collected by surface and bottom gill nets in both 1974 and 1975. Their representation declined from 1974, when rainbow smelt made up 11.7% of the total fish collected, to 1975, when they were only 2.5% of the total. The average catch per effort declined between years for both surface and bottom gill nets, dropping from 4.32 in 1974 to 1.06 in 1975 and from 3.63 in 1974 to 0.80 in 1975 for surface and bottom gill nets, respectively.

Trawl and seine nets produced little data on rainbow smelt in either 1974 or 1975. The absence of this species from the seine collections may indicate that spawning is not occurring in the littoral area. Scott and Crossman (1973) reported that rainbow smelt in the Great Lakes spawn in streams or, under adverse weather conditions, in the offshore areas on gravel shoals.

In 1974, the highest catch per effort was recorded at all transects in April, the reported time of the smelt spawning migration (LMS, 1975). The eastern transect, NMPE, yielded the greatest catch per effort, (40) while it was intermediate (39.8) at FITZ, and lower at NMPW (19.8) and NMPP (22.6).

In 1975, the number of rainbow smelt collected in April declined because of a reduction in the fishing efforts. Smelt were sampled on only three days in April 1975 compared to nine days in 1974. This explains the reduction in the percentage of the total for the two years since April is the time of peak abundance. Percent composition of rainbow smelt collected in bottom gill nets is summarized by season; Spring, Summer, and Fall 1975 (Table VI-5).

The catch per effort of rainbow smelt in surface and bottom gill nets in 1975 at the 40 ft depth contour was estimated and compared for all transects (Table VI-1). The average catch per effort during April-December 1975 was significantly higher at FITZ transect (= .01) than at the other three transects (Table VI-6). There was no significant difference between surface and bottom catch within transects, but the difference among transects was significant in April, with the FITZ catch exceeding that at all other transects combined, for both surface and bottom collections. Catch per effort in April, when JAF was not operating, was significantly higher than during the rest of the sampling period.

The larger number of rainbow smelt present at the FITZ 40 ft depth contour in April may be subject to the thermal discharge if the trend continues in the future. The majority of the fish are present in April when the average water temperature is about 6°C. The preferred temperature for smelt is about 7.0-7.2°C but they may enter waters as warm as 15.6°C for brief periods (Scott and Crossman, 1973). Catch per effort in October, November, and December was not significantly different at Fitz 40. Since smelt were present in the area, this implies that there is no attraction to the JAF discharge.

- <u>Age and Growth</u>

The growth history of rainbow smelt was based on the analyses of 101 male and 206 females (Table VI-7) collected in 1974 ranging in total length from 125 to 244 mm. Average back calculated lengths at each annulus, together with the standard error for each year of life, are summarized in Table VI-7.

Both male and female rainbow smelt grew faster in their early years of life, and growth increments declined with age. Both sexes exhibited similar growth rates during the first year of life, after which (i.e., at age two and older) female smelt grew significantly ($P = 0.5$, t-test)

TABLE VI-5

PERCENT COMPOSITION OF RAINBOW SMELT IN BOTTOM GILL NETS COLLECTIONS BY SEASON

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY - 1975

	TRANSECT			
SEASON	NMPW	NMPP	FITZ	NMPE
SPRING	2.47	2.70	9.41	3.71
SUMMER	0.48	1.02	0.24	0.08
FALL	6.47	2.54	5.14	5.05

TABLE VI-6

STATISTICAL ANALYSIS OF SELECTED FISH SPECIES IN GILL NET COLLECTIONS AT 40-FT DEPTH CONTOUR

RAINBOW SMELT

THREE-WAY ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
MONTHS	7	459.8798	65.6971	28.31**
TRANSECTS	3	57.9642	19.3214	8.33**
DEPTHS	1	1.9252	1.9252	0.83
MONTH X TRANSECT	21	368.7796	17.5609	7.57**
MONTH X DEPTH	7	22.5261	3.2180	1.39
TRANSECT X DEPTH	3	5.0954	1.6985	0.73
ERROR	21	48.7383	2.3209	
TOTAL	63	964.9086		

**Significant at $\alpha = .01$

ESTIMATED MEANS FOR TRANSECTS

TRANSECTS	ESTIMATED MEAN
NMPW	0.6
NMPP	0.6
FITZ	2.9
NMPE	1.1

TUKEY T TEST - TRANSECTS ($\alpha = .05$)

Largest: FITZ NMPE NMPP NMPW: Smallest

ESTIMATED MEANS FOR MONTHS

MONTH	ESTIMATED MEAN
APR	3.3
MAY	0.1
JUN	0.0
JUL	0.0
AUG	0.0
SEP	0.1
NOV	0.8
DEC	0.2

TUKEY T TEST - MONTHS ($\alpha = .05$)

Largest: APR NOV DEC MAY SEP JUL JUN AUG: Smallest

ESTIMATED MEANS FOR MONTHS AND DEPTHS

MONTH	DEPTH		SIGNIFICANT DIFFERENCE[a]
	SURFACE	BOTTOM	
APR	10.0	6.6	YES
MAY	0.1	0.2	NO
JUN	0.0	0.0	NO
JUL	0.0	0.0	NO
AUG	0.0	0.0	NO
SEP	0.3	0.1	NO
NOV	0.8	1.7	NO
DEC	0.6	0.4	NO

[a]Simultaneous tests using Bonferroni procedures ($\alpha = .05$)

TABLE VI-7

AVERAGE CALCULATED TOTAL LENGTH AND STANDARD ERROR AT ANNULUS FORMATION OF RAINBOW SMELT

NINE MILE POINT - 1974

YEAR CLASS	NUMBER OF FISH	AGE GROUP	I	II	III	IV	V	VI	VII
			AVERAGE CALCULATED TOTAL LENGTH (mm) AND STANDARD ERROR ANNULUS FORMATION						
			MALES						
1972	29	II	79.35 ±2.25	128.56 ±2.41					
1971	67	III	75.97 ±1.19	118.69 ±1.42	147.72 ±1.47				
1970	3	IV	87.84 ±13.85	126.68 ±14.83	155.17 ±14.36	179.00 ±12.58			
1969	2	V	68.12 ±2.40	116.28 ±15.98	144.28 ±16.26	169.63 ±19.09	189.00 ±28.00		
		Grand average calculated length (weighted)	77.14	121.72	147.93	175.25	189.00		
		Grand average increment of length (weighted)	77.14	44.58	28.98	24.44	19.37		
		Sum of grand average increments	77.14	121.72	150.70	175.14	194.51		
		Confidence interval (α=0.05) grand average calculated lengths	74.95 79.33	119.16 124.26	144.85 151.00	124.38 226.12	166.76 544.17		
			FEMALES						
1972	8	II	85.70 ±2.87	145.27 ±3.88					
1971	107	III	80.69 ±1.03	128.48 ±1.20	157.47 ±1.49				
1970	49	IV	74.91 ±1.84	121.35 ±2.71	158.20 ±2.82	185.44 ±3.62			
1969	31	V	75.28 ±2.01	127.41 ±3.20	159.37 ±2.95	185.92 ±3.45	208.86 ±4.13		
1968	10	VI	73.25 ±3.10	132.07 ±3.07	160.24 ±3.26	183.73 ±4.47	199.26 ±5.25	217.09 ±4.72	
1967	1	VII	75.38	144.11	146.69	171.21	189.50	207.86	220.08
		Grand average calculated length (weighted)	78.31	127.38	158.03	185.26	206.11	216.25	220.08
		Grand average increment of length (weighted)	78.31	49.07	31.38	26.56	21.07	17.88	12.22
		Sum of grand average increment	78.31	127.38	158.76	185.32	206.39	224.27	236.49
		Confidence interval (α=0.05) grand average calculated lengths	76.76 79.86	125.30 129.46	155.69 160.36	180.26 190.06	199.09 213.13	204.93 227.56	

faster than males. This characteristic has been observed for female rainbow smelt in other waters.

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

The growth by each age class for males and females is plotted as a function of age in Figures VI-3 and VI-4. which show that growth has been uniform for fish spawned in the years 1967-1972.

The growth rate of rainbow smelt from the Nine Mile Point vicinity is greater than or similar to that of smelt collected from other areas in the vicinity of Lake Ontario (Table VI-8). The growth rate of Nine Mile Point smelt in the first year of life was greater than that of smelt from Lake Superior (Bailey, 1964) and Gull Lake, Michigan (Burbidge, 1969) and was comparable to the rate for smelt in Crystal Lake, Michigan (Beckman, 1942) (Table VI-8). Growth for the second through the seventh year of life for Nine Mile Point smelt appears lower than that for fish reported above (except age IV-VI for Gull Lake smelt). It should be noted that these analyses represent fewer smelt than those recorded in other studies.

- Reproduction

In Lake Ontario, spawning often occurs along the lake edge in shallow water on gravel shoals; Rupp (1965) believes that shore spawning may be as successful as stream spawning. Spawning runs of ripe smelt begin in March and continue through May (McKenzie, 1964).

Rainbow smelt spawning occurred in April in the Nine Mile Point area, as indicated by coefficient of maturity and the appearance of smelt eggs in the ichthyoplankton collections. The fecundity of rainbow smelt in the Nine Mile Point vicinity varied with fish length from 6,212 to 29,050 eggs, with a mean of 17,002 eggs. When allowance is made for the size of the fish, the estimates of Baldwin (1950) and Van Oosten (1940) are most nearly comparable to those of this study.

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

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

NINE MILE POINT-1974

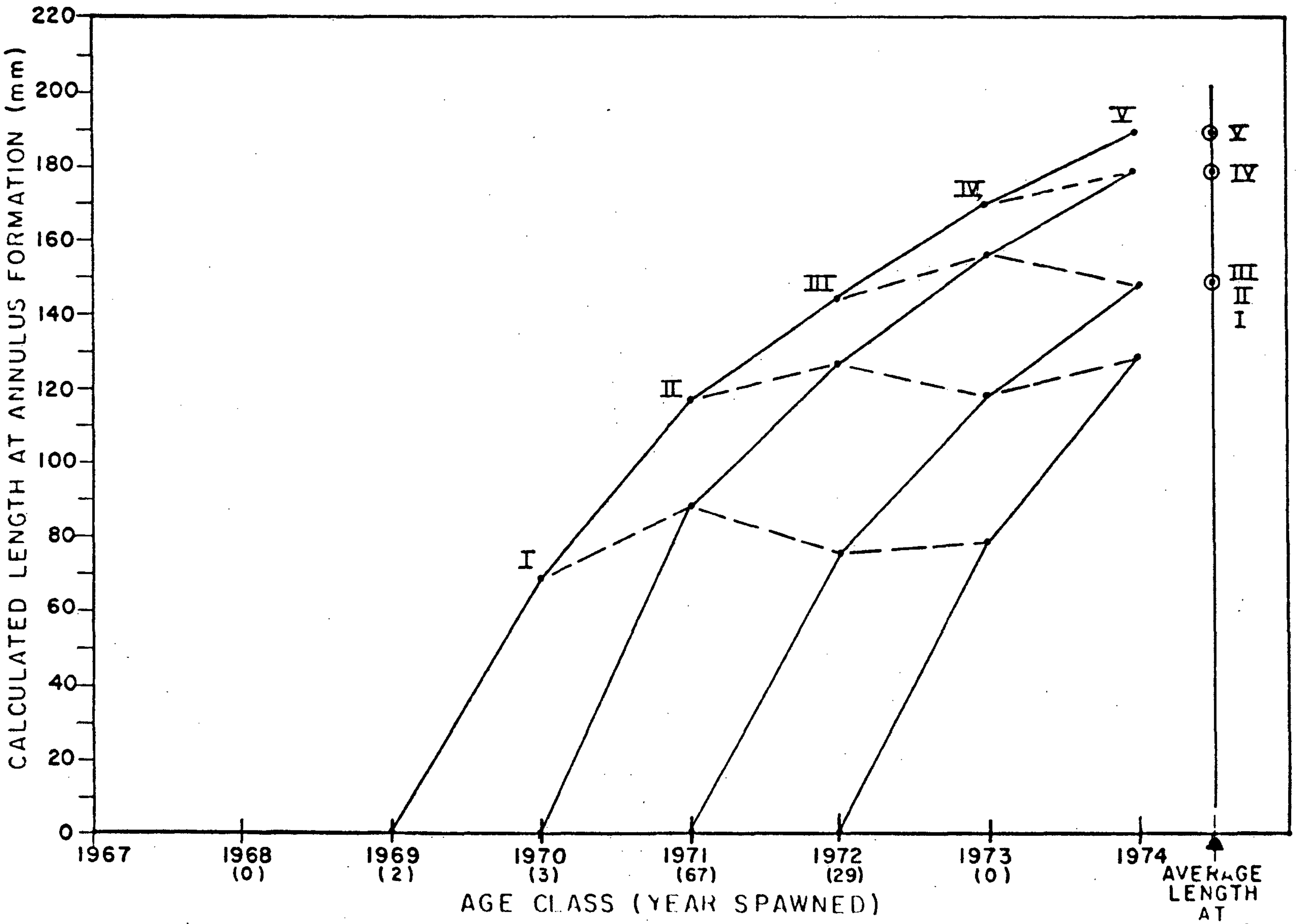


FIGURE VI-3

TABLE VI-8

COMPARISON OF GROWTH RATE OF RAINBOW SMELT FROM LAKE ONTARIO AND ITS VICINITY*

LAKE ONTARIO NINE MILE POINT (LMS, 1975) LENGTH (mm)	LAKE ONTARIO NINE MILE POINT (QLM, 1974) LENGTH (mm)	GULL LAKE, MICHIGAN (BURBRIDGE, 1969) LENGTH (mm)	LAKE SUPERIOR (BAILEY, 1964) LENGTH (mm)	CRYSTAL LAKE, MICHIGAN (BECKMAN, 1942) LENGTH (mm)	LAKE MICHIGAN GREEN BAY (SCHNEBERGER, 1937) LENGTH (mm)
78	103	60 (11)	66	112 (12)	
126 (37)	137	150 (141)	152 (307)	178 (92)	178
155 (174)	157	163 (123)	187 (256)	196 (100)	254
185 (52)	183	180 (24)	219 (121)	208 (35)	305
205 (33)	207	198 (7)	237 (39)	210	356
216 (10)	228	187 (2)	251 (10)		
220 (1)			309 (1)		

*Numbers which appear in parentheses represent the number of fish measured in determining average length.

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

NINE MILE POINT-1974

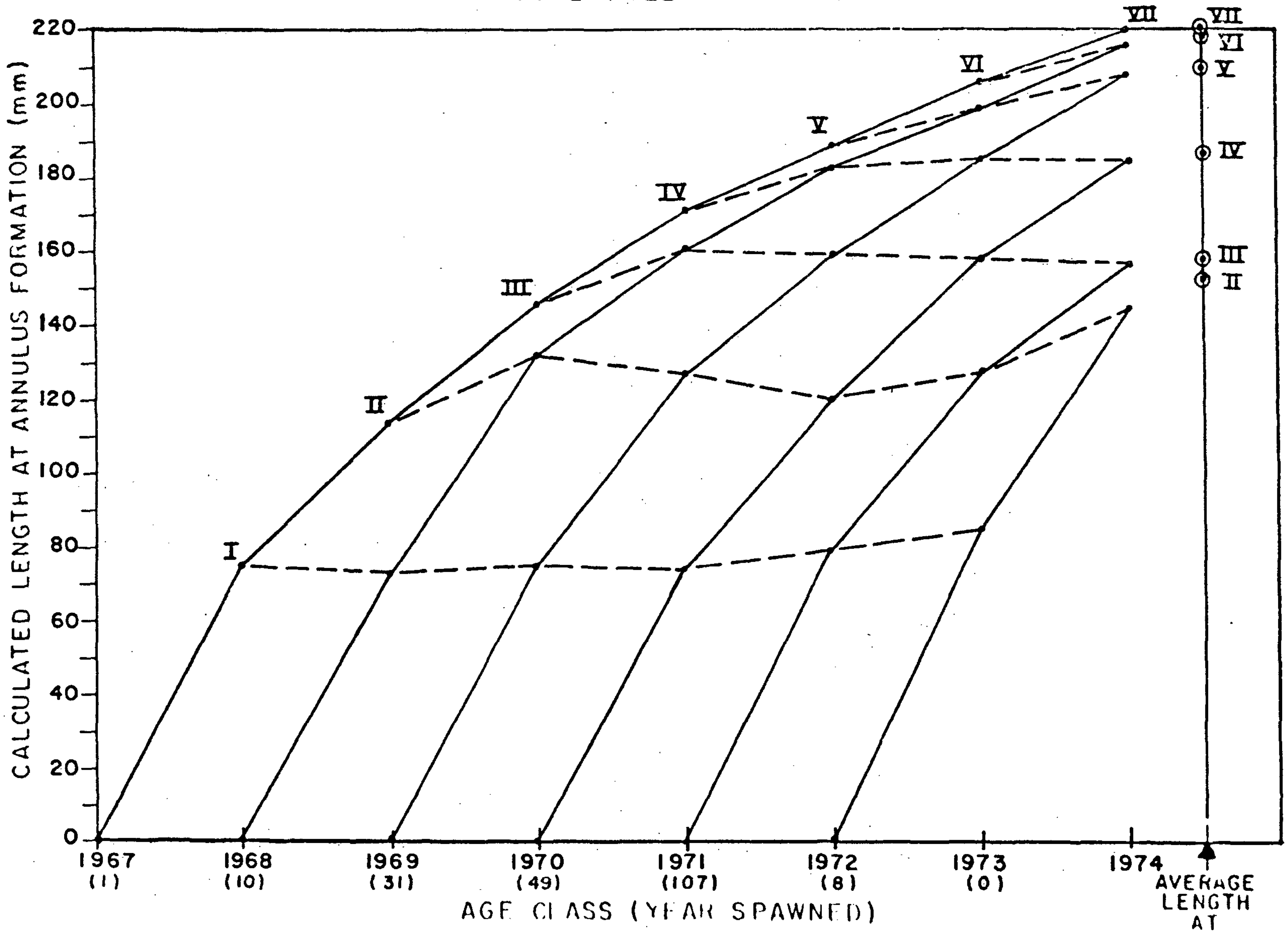


FIGURE VI-4

Reference	Location	Size of Females	Number of Females	Mean No. of Eggs Per Female
Bailey (1964)	Lake Superior	188-224 mm	10	31,338
Baldwin (1950)	Lake Huron	140-224 mm	5	20,500
Van Oosten (1940)	Lake Michigan	185-196 mm	-	25,000
LMS (1975)	Lake Ontario	138-213 mm	24	17,002

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

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

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

Rainbow smelt larvae were collected from 22 May to 25 July with the greatest concentration occurring in samples from 19-20 June. More larvae were collected at night, corresponding to the nocturnal activity of the species (Scott and Crossman, 1973). Generally, the shallower stations (20 ft depth contour) experienced the greatest abundance of rainbow smelt larvae during the spring and the average larval concentration then decreased with distance from shore. As the larvae matured, the deeper water stations became the preferred depth contour, corresponding to the offshore migratory pattern observed for the species (Wells, 1968).

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

The correlation coefficients were determined for fecundity and age (r = .26), length (r = .76), body weight (r = .83) and weight of ovaries (r = .79). A positive correlation was found between fecundity and each of the above parameters. The low correlation between age and fecundity indicates that age is not a reliable indicator of fecundity.

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

- Feeding

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

Rainbow smelt are reported by Christie (1974) to feed on invertebrates when they are small, and to change to a piscivorous diet as they mature. Burbidge (1969) reported a seasonally varying diet with the dominant food item corresponding to the most abundant invertebrate, suggesting an opportunistic feeding pattern. O'Gorman (1974) reported definite predation by rainbow smelt on young alewives in the fall when both populations are located in the deeper offshore waters; however, Burbidge (1969) observed only the remains of young smelt in the stomachs of larger rainbow smelt. The common invertebrate organisms observed in smelt stomachs were dipterans, primarily *Chaoborus*, copepods, and cladocerans, all of which are abundant in the Nine Mile Point area.

3. Yellow perch (*Perca flavescens*)

Yellow perch have a circumpolar distribution in fresh water. In North America, the yellow perch occurs from Nova Scotia south along the Atlantic Coast, previously to South Carolina, but now apparently to Florida and Alabama.

The yellow perch is a commercially valuable species throughout its range, and consequently there is considerable literature on various aspects of its life history. These fish are considered very adaptable because of the wide range of habitats in which they are found, including warm to cooler areas from large lakes to ponds or quiet rivers. They are most abundant in the open water of large lakes with moderate vegetation (Scott and Crossman, 1973). Yellow perch are usually considered shallow water fish and are seldom collected in water depths below 9.2 m (30 ft).

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

- Abundance and Seasonal Distribution

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

Bottom gill net data indicated that more yellow perch were caught at NMPE and FITZ transects than at NMPW transect. The catch per effort data on yellow perch collected in surface and bottom gill nets at 40-ft stations in 1975 (operational year) are summarized in Table VI-8. Data of Table VI-1 indicated a greater catch per effort of yellow perch in bottom gill nets than in surface gill nets. Moreover, there was a significant difference (= .01) in bottom gill net catches among transects (Table VI-9), with more fish collected at the FITZ transect.

Neill (1971) concluded that yellow perch (among other fish) avoided the outfall area of a steam electric power plant at Lake Monona, Wisconsin. In his laboratory experiments, Neill also found that yellow perch were attracted to a food-rich environment and suggested that this attraction did not override the species' behavioral thermoregulation.

In contrast to Neill's findings, Everest (1973) found that at the Hearn Generating Station in northern Lake Ontario, yellow perch, which were found only from June to November, were concentrated in the plume area as compared to a control area. This occurred especially during October, when these fish were collected at temperatures between 12-22°C, but when ambient temperatures were around 9-11°C.

- Age and Growth

The body length-scale length relationship for yellow perch was based on analyses of scales taken from 237 male and female fish ranging in total length from 81 to 323 mm (LMS, 1975). The back calculated lengths at previous ages and the standard error for each year of life are summarized in Table VI-10 for 102 male and 124 female yellow perch.

TABLE VI-9

STATISTICAL ANALYSIS OF SELECTED FISH SPECIES IN GILL NET COLLECTIONS AT 40-FT DEPTH CONTOUR

YELLOW PERCH

TWO-WAY ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
MONTHS	8	3.7689	0.4711	3.49**
TRANSECTS	3	1.3872	0.4624	3.42*
ERROR	24	3.2403	0.1350	
TOTAL	35	8.3964		

*Significant at $\alpha = .05$
**Significant at $\alpha = .01$

ESTIMATED MEANS FOR TRANSECTS

TRANSECTS	ESTIMATED MEAN
NMPW	0.5
NMPP	0.2
FITZ	0.8
NMPE	0.4

TUKEY T TEST - TRANSECTS ($\alpha = .05$)

Largest: FITZ NMPW NMPE NMPP: Smallest

ESTIMATED MEANS FOR MONTHS

MONTH	ESTIMATED MEAN
APR	0.1
MAY	0.1
JUN	0.6
JUL	0.8
AUG	0.5
SEP	0.7
OCT	1.1
NOV	0.3
DEC	0.1

TUKEY T TEST - MONTHS ($\alpha = .05$)

Largest: OCT JUL SEP JUN AUG NOV APR DEC MAY: Smallest

TABLE VI-10

AVERAGE CALCULATED TOTAL LENGTH AND STANDARD ERROR AT ANNULUS FORMATION OF YELLOW PERCH

NINE MILE POINT - 1974

YEAR CLASS	No. of FISH	AGE GROUP	I	II	III	IV	V	VI	VII	VIII	IX
			MALES								
1972	19	II	68.60 ±2.05	132.42 ±3.54							
1971	22	III	64.29 ±1.78	117.37 ±2.56	158.98 ±4.13						
1970	33	IV	63.71 ±2.06	112.46 ±2.74	150.68 ±3.04	184.77 ±2.94					
1969	18	V	61.12 ±1.66	114.66 ±4.18	161.05 ±4.71	191.94 ±4.18	215.93 ±3.96				
1968	10	VI	62.90 ±4.06	112.32 ±8.85	157.86 ±7.84	185.40 ±8.77	205.77 ±9.38	224.26 ±8.76			
		Grand average calculated length (weighted)	64.25	117.61	155.99	186.99	212.30	224.26			
		Grand average increment of length (weighted)	64.25	53.36	41.77	32.07	22.70	18.49			
		Sum of grand average increments	64.25	117.61	159.38	191.45	214.15	232.64			
		Confidence interval of (α=0.05) grand average calculated lengths[a]	62.23- 66.27	114.21- 121.01	151.62- 160.37	181.94- 192.04	203.38- 221.22	204.44- 244.08			
			FEMALES								
1973	4	I	77.54 ±4.00								
1972	32	II	68.27 ±2.27	130.12 ±2.84							
1971	32	III	69.43 ±1.75	118.37 ±2.21	150.15 ±2.10						
1970	23	IV	61.91 ±3.12	113.18 ±3.84	150.00 ±4.24	180.13 ±3.91					
1969	15	V	65.46 ±2.93	118.44 ±6.32	163.36 ±7.53	201.60 ±7.87	230.68 ±7.19				
1968	8	VI	65.49 ±3.09	113.12 ±4.00	155.04 ±8.66	184.44 ±10.93	212.21 ±12.76	232.24 ±12.79			
1967	7	VII	67.87 ±6.16	122.40 ±9.62	164.97 ±10.08	194.99 ±6.72	220.83 ±8.58	237.37 ±7.77	249.20 ±7.06		
1966	2	VIII	66.38 ±1.82	107.62 ±3.44	168.29 ±0.86	204.87 ±4.69	230.18 ±4.19	246.65 ±2.60	266.38 ±3.49	279.17 ±10.08	
1965	1	IX	56.24	101.49	169.99	233.58	256.83	272.73	286.18	303.28	317.[illegible]8
		Grand average calculated length (weighted)	67.02	120.08	154.62	190.19	224.88	238.83	256.33	287.21	317.0[illegible]
		Grand average increment of length (weighted)	67.02	53.41	38.19	33.01	27.67	18.05	13.57	14.23	14.70
		Sum of grand average increments	67.02	120.43	158.62	191.63	219.30	237.35	250.92	265.15	279.35
		Confidence intervals of (α=0.05) grand average calculated lengths	64.75 69.29	116.84 123.32	150.09 159.15	183.29 197.09	213.68 236.08	222.05 255.60	240.51 272.15	159.29 415.13	

The growth patterns for male and female yellow perch are similar; females appeared to be larger than males, but the differences in annual mean calculated lengths were not statistically significant (t-test, $p>0.05$). Female yellow perch are reported to grow faster than males and reach a greater ultimate size (Scott and Crossman, 1973). The growth rate of both male and female yellow perch from the Nine Mile Point vicinity is characterized as being rapid through the fourth year of life, after which it slows (Table VI-10).

Calculated growth of male and female yellow perch was plotted as a function of age (Figures VI-5 and VI-6). These graphs show that female yellow perch growth for the first three years of life has been similar for the past 9 years. After age four, females that spawned between 1966 and 1968 exhibited a progressively slower growth rate, while those which spawned in 1969 showed an increased rate of growth after four years of age. Male yellow perch appear to have grown uniformly from 1968 to 1972. No 1973 year class fish were collected during 1974, perhaps due to the selectivity of gill nets for larger fish. While statistical comparisons of Nine Mile Point yellow perch growth with that of other populations were not possible, a more general comparison (Table VI-11) indicates a great deal of variability between Nine Mile Point yellow perch and those from water bodies. However, the Nine Mile Point population does not appear to differ greatly from those in other collections.

- Reproduction

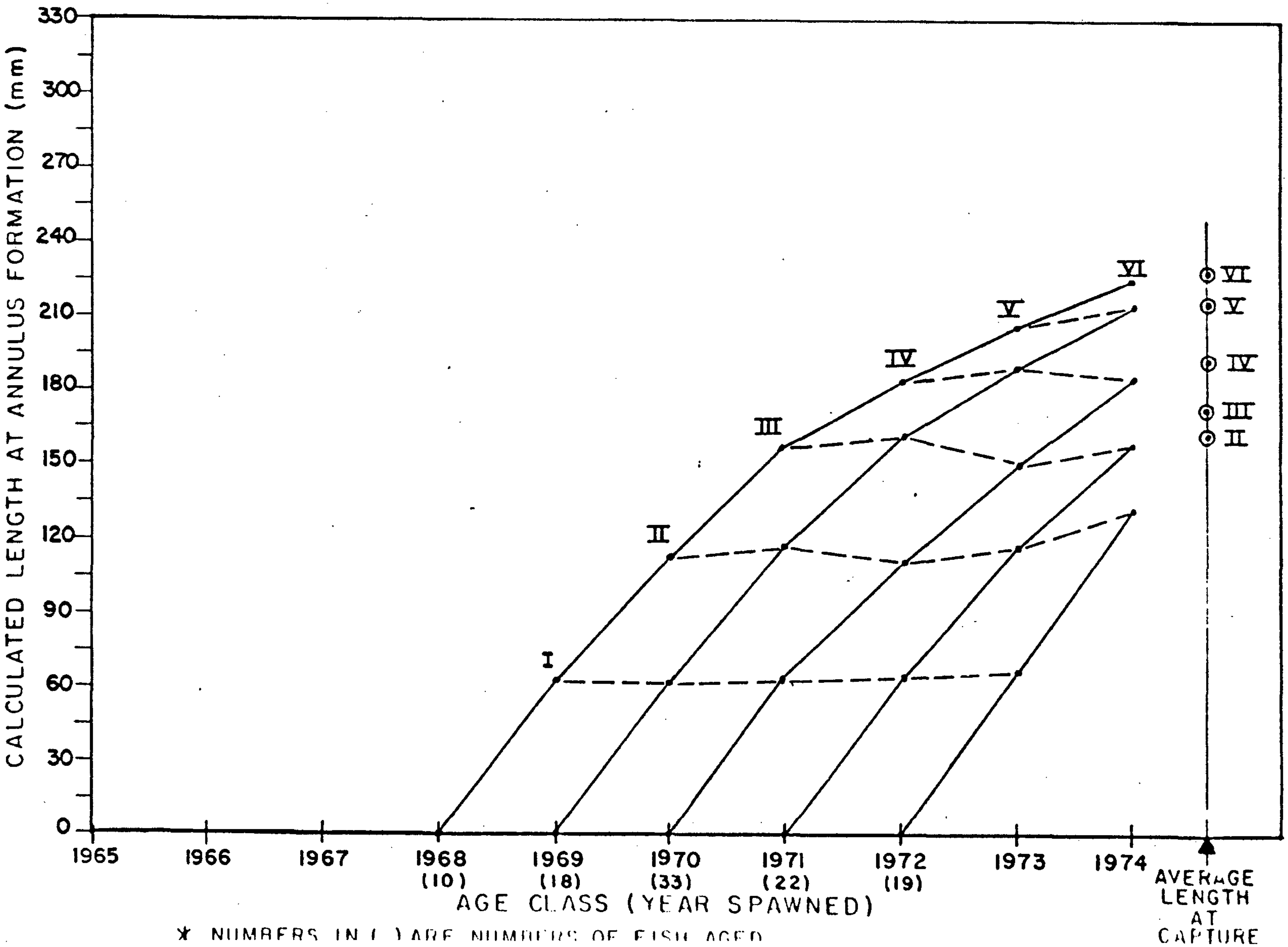
Muncy (1962) reported yellow perch movement to the spawning grounds in the Severn River, Maryland, from late February to early March, a period when water temperatures were 3.98-6.7°C (39-44°F). The time of spawning for yellow perch in the vicinity of Nine Mile Point was determined by examining the coefficient of maturity data for 351 males and 537 females collected from January through December 1974 (LMS, 1975). These data reveal that peak spawning occurred during the first two weeks in April, when water temperatures were 0.7-6.2°C (33.3-43.2°F) with a mean of 3.3°C (37.9°F). This observation corresponds very closely to that found by Muncy (1962).

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

The ovaries of 18 sexually mature females (collected in the vicinity of Nine Mile Point) contained eggs ranging in diameter from 0.6 to 1.5

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

NINE MILE POINT-1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-5

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

NINE MILE POINT-1974

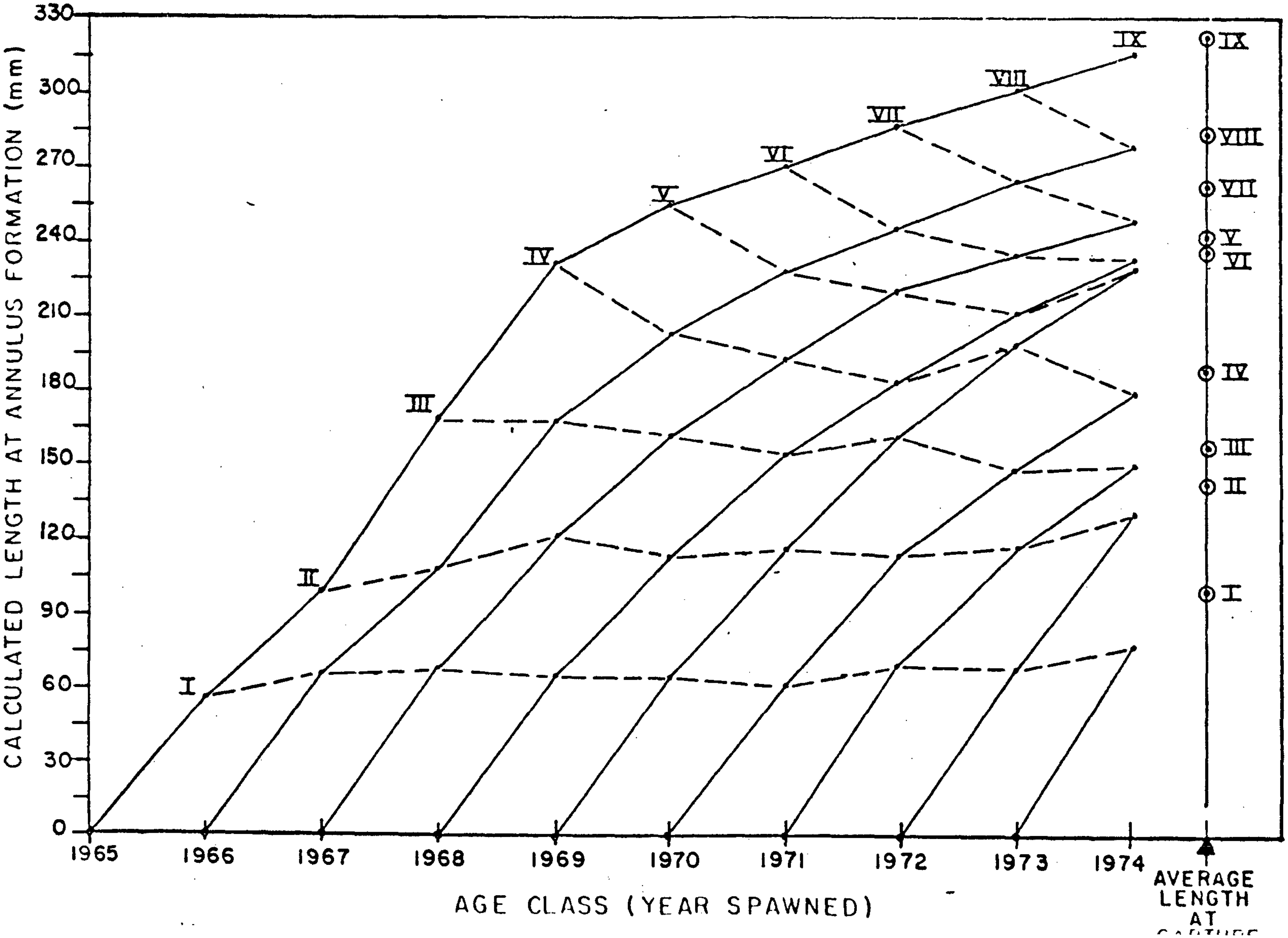


FIGURE VI-6

TABLE VI-11

COMPARISON OF GROWTH RATE OF YELLOW PERCH FROM LAKE ONTARIO AND ITS VICINITY*

LAKE ONTARIO NINE MILE POINT (LMS, 1975)	LAKE ONTARIO NINE MILE POINT (QLM, 1973)	GREEN BAY LAKE MICHIGAN (HILE AND JOBES, 1942)	SAGINAW BAY LAKE HURON (HILE AND JOBES, 1941)	LAKE ERIE (JOBES, 1952)	SAGINAW BAY LAKE HURON (EL-ZARKA, 1959)	THREE IOWA LAKES (PARSONS)	THREE WISCONSIN LAKES (SCHNEBERGER, 1935)		
							NEBISH LAKE	WEBER LAKE	SILVER LAKE
66 (4)	110	73 (2)	77	92	66 (18)	68 (74)	66 (159)	58 (3)	44
117 (51)	149	118 (58)	137 (20)	174	107 (565)	177 (86)	136 (306)	113 (389)	80 (148)
155 (54)	182	160 (128)	202 (308)	219	142 (1623)	235 (346)	175 (114)	145 (81)	113 (558)
189 (56)	211	198 (241)	248 (170)	248	178 (1006)	280 (16)	213 (39)	175 (278)	133 (239)
219 (48)	241	227 (212)	279 (137)	271	193 (173)	302 (39)		199 (248)	149 (93)
234 (18)	254	262 (98)	315 (17)	288	239 (12)			215 (69)	169 (21)
256 (7)	270	285 (8)	338 (5)		315 (3)			231 (13)	202 (2)
287 (2)		319 (4)			356 (1)			245 (3)	
318 (1)		360 (1)							

*Numbers which appear in parentheses represent the number of fish measured in determining average length.

mm with a mean of 0.93 mm. The fecundity estimates, based on total egg counts, ranged from 4,840 eggs (fish body length 150 mm, weight 42.2 g) to 50,000 eggs (290 mm length, 429.3 g weight), with a mean of 25,077 eggs (LMS, 1975).

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

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

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

- Feeding

The larvae feed on zooplankton and insect larvae, and when they grow to a length of 5.0 - 7.5 cm, their diet changes to larger zooplankton, insects, crayfish, snails, and small fish, including their own species (McClane, 1964). Tharatt (1959) found that alewives were the principal food of yellow perch in Saginaw Bay.

Stomach contents of yellow perch analyzed in 1975 indicated that perch consumed mostly fishes (54% of the diet by weight) and decapods (45% by weight). Dipterans (Family Chironomidae) were the only insects recovered from stomachs of yellow perch in 1975; other species found in yellow perch stomachs included Gammarus and oligochaetes. A mass of sculpin eggs was also found in the gut of a single perch, thus confirming the observation of Scott and Crossman (1973). Adult sculpins were also preferred food items for yellow perch analyzed in 1975.

The fish collected during the spring of 1974 (LMS, 1975) contained a greater variety of food items in their stomachs than did those recorded during the fall collection. Of the stomachs examined, 53.7% contained fish eggs and *Gammarus fasciatus*. During the fall sampling period, fish (alewife identified) and amphipods were the only identifiable materials in the stomachs of yellow perch. The results of the 1974 stomach content analysis agreed with results from a study conducted on fish collected during 1972 (Williams and Miller, 1973) and with those reported by Scott and Crossman (1973).

4. Smallmouth bass (*Micropterus dolomieui*)

The smallmouth bass is an important sport fish and an important piscivore in the nearshore area of Lake Ontario. Smallmouth bass were collected in small numbers compared to alewife, although they were found in the nearshore area and in impingement collections. Eggs and larvae of smallmouth bass were not represented in the 1975 ichthyoplankton collections. These eggs and larvae were not among the Nine Mile Point plant entrainment collections and thus the possibility of the lack of spawning grounds for smallmouth bass in the area exists. However, the lack of eggs in the collections could be partially attributed to the nesting habits of the species. Smallmouth bass eggs are demersal, adhesive, and attach to stones in the nest. Thus the presence or absence of smallmouth bass spawning grounds in the area could not be evidenced based on the current data. However the lack of eggs and larvae in the entrainment samples implies that large numbers of either life history stage will not be subjected to plume entrainment.

- Abundance and Seasonal Distribution

A total of 432 (0.54% of all collections) smallmouth bass were collected during 1975 in the Nine Mile Point vicinity. The vast majority (N = 413) were collected by bottom gill nets while only 15 specimens were collected from the surface. Like yellow perch, smallmouth bass seem to avoid the discharge area except perhaps during feeding runs (LMS, 1975). In 1975, catch per effort of smallmouth bass at NMPP transect reached a maximum (average of 4.83 fish/12 hrs) during the summer. Catch per effort at the FITZ transect varied from an average of 2.45 in the summer to 0.07 in the fall of 1975; the NMPE and NMPW values did not differ significantly from those at the FITZ transect (LMS, 1976). Catch per effort was as high as 2.03 fish/12 hrs at NMPE in summer of 1975. The lowest catch per effort at all transects was recorded in the fall of 1975.

Only 271 smallmouth bass were collected in 1974 (0.28% of the total annual catch) and these were collected exclusively in the bottom gill nets (N = 21), as occurred in 1975. The ANOVA comparing day-night differences indicated no significant differences among transects, probably because of the small sample size of the smallmouth bass collected.

The catch per effort of smallmouth bass collected in 1975 by surface and bottom gill nets at the 40 ft depth contours was estimated and compared among the transects by month (Table VI-1). The average catch per effort at NMPP and FITZ transects was slightly higher than at NMPW and NMPE; however, the differences were not statistically significant (Table VI-12).

- Age and Growth

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

The back calculated lengths were estimated for male (N = 59) and female (N = 71) smallmouth bass and are summarized in Table VI-13. The growth pattern for both male and female smallmouth bass was similar, but males appeared larger at all ages. A t-test of the differences between the grand average calculated lengths of male and female smallmouth bass for each year of life revealed that males were significantly larger at ages 1, 3, 5, 6, 8 and 9 ($p < 0.05$). In 1973, QLM (1974) reported that only five-year-old males were significantly larger than females. Stone et al. (1954) reported little difference in the growth of male and female smallmouth bass in the St. Lawrence region of Lake Ontario; Suttkus (1955) also found no difference in the growth between the sexes for smallmouth bass in Fall Creek, New York.

Calculated growth of male and female smallmouth bass was plotted as a function of age (Figures VI-7 and VI-8). These plots show that first-year growth was not uniform, with a 40 - 100% change occurring between any two year classes. In addition, there are year classes missing (not collected) for both sexes indicating a low abundance of these years' representatives. Female growth appears to be more regular than male growth, at least for age class I.

Based on the limitations of comparing data among growth studies described in LMS (1975), the following points are apparent. The difference between the estimated growth of smallmouth bass at Nine Mile Point for 1973 and 1974 was the greatest at ages 1 and 2, but decreased with increasing age; estimates of growth were similar at ages 6 to 8. The growth estimates at Nine Mile Point were similar to those at Tadenac

TABLE VI-12

STATISTICAL ANALYSIS OF SELECTED FISH SPECIES IN GILL NET COLLECTIONS AT 40-FT DEPTH CONTOUR

IV. SMALLMOUTH BASS

TWO-WAY ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
MONTHS	8	13.0839	1.6355	6.07**
TRANSECTS	3	0.4733	0.1578	0.59*
ERROR	24	6.4717	0.2697	
TOTAL	35	20.0289		

**Significant at $\alpha = .01$

ESTIMATED MEANS FOR MONTHS

MONTH	ESTIMATED MEAN
APR	0.2
MAY	0.1
JUN	0.0
JUL	0.5
AUG	1.5
SEP	1.6
OCT	0.0
NOV	0.2
DEC	0.0

TUKEY T TEST - MONTHS ($\alpha = .05$)

Largest: SEP AUG JUL APR NOV MAY OCT JUN DEC: Smallest

TABLE VI-13

AVERAGE CALCULATED TOTAL LENGTH AND STANDARD ERROR
AT ANNULUS FORMATION OF SMALLMOUTH BASS

NINE MILE POINT - 1974

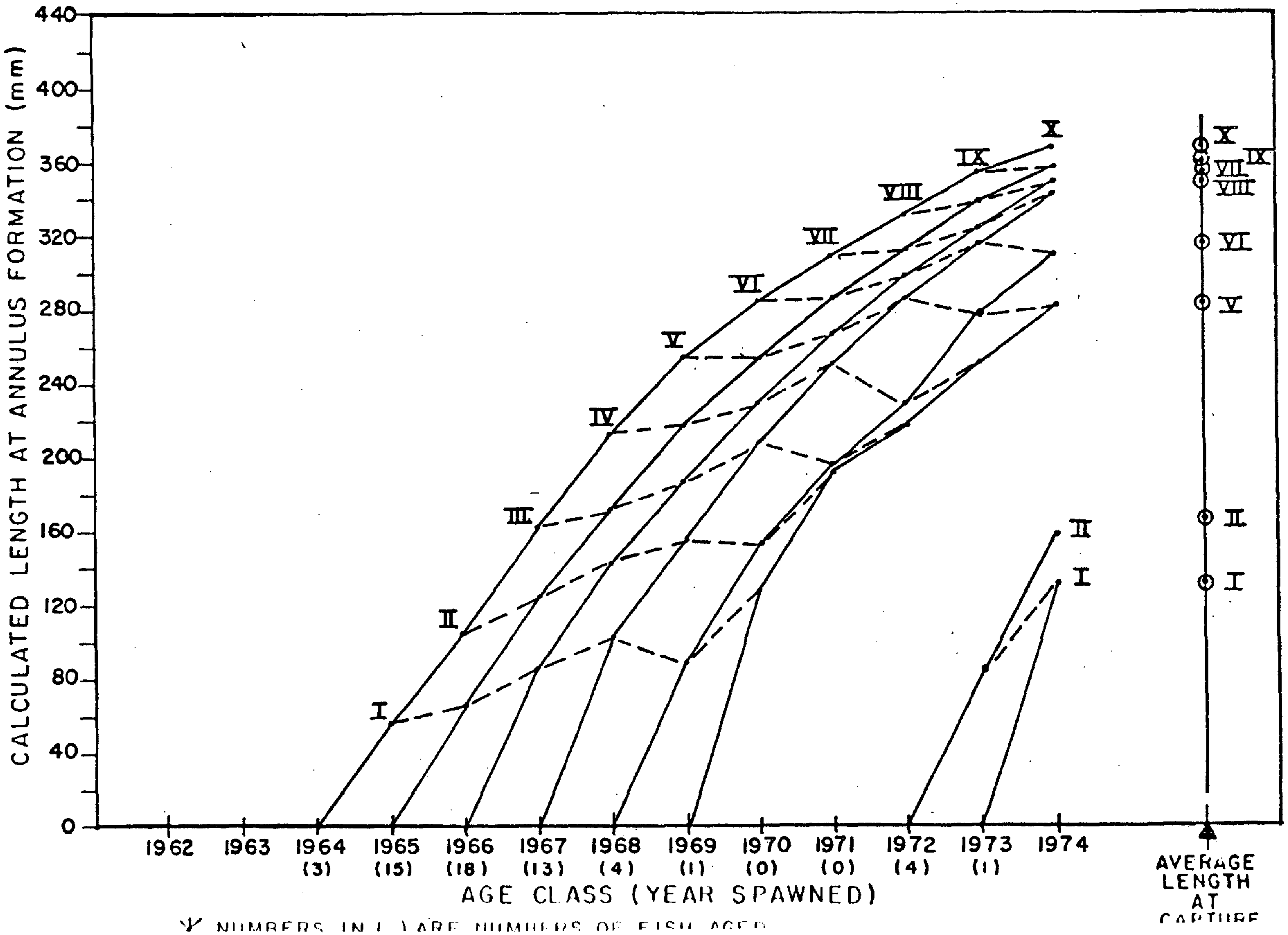
YEAR CLASS	No. of FISH	AGE GROUP	I	II	III	IV	V	VI	VII	VIII	IX	X	
			FEMALE										
1973		I											
1972	2	II	89.60 ±6.52	148.95 ±10.95									
1971		III											
1970	5	IV	78.19 ±3.81	151.91 ± 8.33	220.33 ± 6.82	260.03 ± 9.44							
1969	3	V	62.33 ±5.29	124.07 ± 4.08	177.02 ± 3.48	238.24 ± 7.93	282.54 ± 5.25						
1968	2	VI	62.6 ± .21	118.55 ± 6.2	160.59 ± 2.56	198.20 ± 9.76	239. ± .99	264.5 ± 7.5					
1967	13	VII	80.47 ±6.83	145.32 ± 7.44	195.58 ± 7.32	236.54 ± 8.65	274.34 ± 9.3	309.6 ± 9.96	340.61 ± 9.66				
1966	14	VIII	75.95 ±5.7	130.91 ± 6.77	178.66 ± 7.38	220.93 ± 8.33	258.82 ± 8.49	288.6 ± 9.07	317.53 ± 7.78	341.06 ± 6.44			
1965	18	IX	73.66 ±3.62	128.14 ± 3.34	177.68 ± 5.91	219.29 ± 6.51	256.82 ± 7.09	283.31 ± 6.72	306.06 ± 6.56	329.55 ± 5.28	346.1 ± 4.17		
1964	11	X	77.49 ±5.23	140.06 ± 5.16	180.89 ± 5.08	216.27 ± 4.64	248.00 ± 3.83	276.52 ± 3.65	302.33 ± 5.17	323.50 ± 4.73	344.08 ± 4.57	337.45 ± 4.47	
1963	3	XI	62.44 ±2.89	109.37 ± 3.97	156.30 ± 7.22	194.54 ± 7.67	234.73 ± 5.89	269.21 ± 3.68	297.37 ± 5.37	326.90 ± 4.34	348.95 ± 3.14	364.52 ± 3.76	372.57 ± 2.9
1962		XII											
		Grand average calculated length (weighted)	75.44	134.703	199.365	224.48	275.892	287.592	315.257	331.433	345.672	358.965	372.57
		Grand average increment of length (weighted)	75.44	59.248	49.109	41.08	37.21	29.84	26.882	23.341	18.45	13.841	8.05
		Sum of grand average increments	75.44	134.588	183.797	224.877	262.87	291.927	318.809	342.15	360.6	374.441	382.491
		Confidence interval of (α=0.05) Grand average calculated lengths	74.14 76.75	133.24 136.16	193.74 204.99	218.231 230.729	268.525 283.259	280.18 295.00	308.005 322.51	325.17 331.43	344.06 347.3	350.94 366.99	357.89 387.89

TABLE VI-13
(CONTINUED)

YEAR CLASS	No. of FISH	AGE GROUP	I	II	III	IV	V	VI	VII	VIII	IX	X
			MALES									
1973	1	I	131									
1972	4	II	85.95 +5.19	158.17 +4.92								
1971		III										
1970		IV										
1969	1	V	128.51	191.72	219.36	251.87	281.0					
1968	4	VI	93.28 +20.72	153.99 +31.44	193.11 +30.30	229.54 +28.32	279.51 +21.29	309.22 +18.08				
1967	13	VII	102.8 +7.51	156.18 +7.66	207.35 +7.32	250.87 +8.37	285.99 +6.54	315.77 +6.93	343.50 +8.52			
1966	18	VIII	85.25 +6.72	141.17 +7.37	186.94 +7.75	230.75 +8.06	267.73 +6.75	294.53 +6.73	323.23 +6.44	345.53 +6.36		
1965	15	IX	66.43 +2.22	124.89 +3.55	173.69 +4.8	219.36 +5.79	255.03 +6.13	285.74 +6.50	311.48 +6.04	337.06 +4.33	355.64 +4.64	
1964	3	X	57.99 +3.49	114.85 +7.48	163.37 +11.69	215.45 +18.37	255.77 +13.73	283.90 +12.62	308.58 +11.76	331.64 +8.77	353.61 +7.05	366.00 +5.69
1963		XI										
1962		XII										
		Grand average calculated length (weighted)	85.046	141.894	187.92	231.881	250.533	297.759	324.113	340.843	355.301	366
		Grand average increment of length (weighted)	85.046	56.662	47.176	43.96	37.17	28.932	27.29	23.73	19.145	12.39
		Sum of grand average increments	85.046	141.708	188.884	232.844	270.014	298.946	326.236	349.966	369.111	381.501
		Confidence interval of (α=0.05) grand average calculated lengths	78.70 91.38	134.39 149.39	179.63 196.21	223.01 240.75	243.067 258	290.289 305.229	316.36 331.87	333.21 348.47	346.67 363.92	341.5 390.5

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

NINE MILE POINT-1974



* NUMBERS IN ( ) ARE NUMBERS OF FISH AGED

FIGURE VI-7

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

NINE MILE POINT-1974

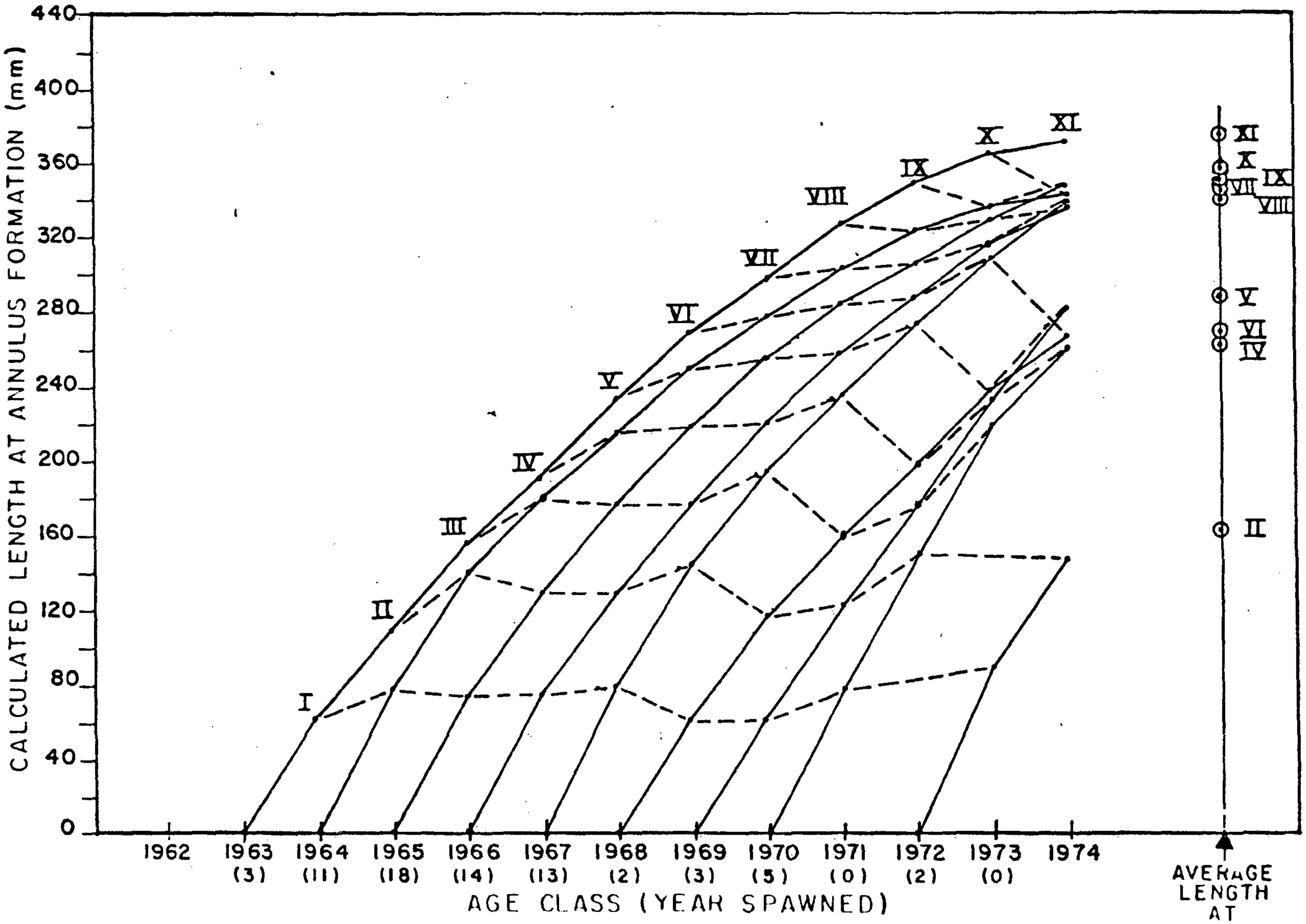


FIGURE VI-8

Lake, Ontario, for ages 1 to 4 and to the St. Lawrence River (Lake Ontario area) for ages 5 to 7. The growth estimates for fish in these two studies were greater than Nine Mile Point estimates for the remaining years of life. Smallmouth bass in Cayuga Lake, Lake Michigan, and the Des Moines River, Iowa appear to grow faster than smallmouth bass in the Nine Mile Point vicinity.

- Reproduction

Fecundity measurements were not performed on smallmouth bass because these fish were not present in collections during the spring, which was the expected time of spawning (Scott and Crossman, 1973). Male and female smallmouth bass were equally represented in gill net collections in the vicinity of Nine Mile Point during 1974 (LMS, 1975). Smallmouth bass spawn as pairs, and, therefore, it should be expected that in a spawning area individuals would be distributed equally between the sexes.

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

- Feeding

The diet of smallmouth bass varies with age. Young bass prey upon plankton and immature insects, whereas adult bass include crayfish and a variety of fish in their dietary spectrum. The food items consumed by individuals >301 mm (IV) in length are listed in Table VI-14. Rather than ingesting a wide variety of organisms from their habitat, larger bass apparently limit their feeding to essentially two types of prey: small fishes and decapod crustaceans. Although 25 specimens (one stomach was empty) is a small sample, previous studies support these results. Scott and Crossman (1973) describe the diet of smallmouth bass as including crayfish, fish, insects, and occasional frogs. Fish are believed to be the most important component, and in this study, they constituted 70% (by weight) of the gut contents.

Fish were present in the guts of 73% of the bass, whereas comparable values for crayfish were 30% by weight and 30% by occurrence. Two genera of crayfish were taken, *Orconectes* and *Cambarus*, with the former occurring in greater numbers (Table VI-14).

TABLE VI-14

GUT CONTENTS[a] OF SMALLMOUTH BASS

NINE MILE POINT VICINITY - 1975

LENGTH INTERVAL: >301 mm

TAXON	NO. PRESENT	DRY WT. (mg)	OCCURRENCE NO. OF GUTS[b]	OCCURRENCE % OF GUTS[b]	% OF TOTAL ORGANISMS CONSUMED	% OF TOTAL DRY WT.
PISCES						
Etheostoma nigrum	3	432.8	2	7.6	8.1	2.6
Alosa pseudoharengus	2	4068.3	2	7.6	5.4	24.2
Notropis hudsonius	1	101.8	1	3.8	2.7	0.6
Notropis sp.	2	109.9	3	7.6	5.4	0.7
Cottus bairdi	1	43.0	1	3.8	2.7	0.3
Osmerus mordax	3	4562.2	3	11.5	8.1	27.1
UID Pisces	11	2455.3	9	34.6	29.7	14.6
TOTAL (Pisces)	23	11773.3	19	73.1	62.2	70.0
ARTHROPODA						
Crustacea						
Decapoda						
Orconectes sp.	6	3063.5	5	19.2	16.2	18.2
O. propinguus	1	87.0	1	3.8	2.7	0.5
Cambarus sp.	1	1027.7	1	3.8	2.7	6.1
UID crayfish	3	802.2	3	7.7	8.1	4.8
TOTAL (Decapoda)	11	4980.1	7	26.9	29.7	29.6
Insecta						
Orthoptera	3	63.0	1	3.8	8.1	0.4
TOTAL (All Prey Items)	37		-	-	100.0	100.0
Miscellaneous						
Oligochaete (setae)	-	-	1	3.8	-	-

[a] N = 25; does not include 1 additional gut containing oligochaete setae; empty = 10

[b] Includes those guts containing oligochaete setae; N = 26

5. Threespine stickleback (Gasterosteus aculeatus)

- Abundance and Seasonal Distribution

Although threespine stickleback are relatively abundant in impingement samples, they are not collected in large numbers with the fishing gear employed at Nine Mile Point; therefore, there is very limited life history data available for the FitzPatrick vicinity. During the 1973 sampling period, 78 threespine stickleback were collected, 50 specimens by surface trawl and 23 by seines. Threespine stickleback were most abundant in May and June at the NMPP and NMPE transects. The largest seine collection (N = 20) occurred in June at FITZ (N = 10) and NMPE (N = 10) transects (QLM, 1973).

The majority of threespine stickleback was collected by surface and bottom trawls in 1974 (21 out of a total of 29) and 1975. Seine collections were comparable to trawl collections in 1975, and in 1974, only two fish were gill netted.

More threespine stickleback were collected in 1975 than in 1973 and 1974 (LMS, 1976). Of the 160 specimens collected in 1975, 60% were collected by surface (N = 46) and bottom (N = 48) trawls, and 65 fish were collected by seines, as opposed to 6 fish in the preceding year. In general, however, the number of threespine stickleback collected in 1973-1975 from the Nine Mile Point vicinity was too small to permit drawing any definitive conclusions regarding differences among transects.

- Age and Growth

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

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

No data are available on the time of spawning or the fecundity of the threespine sticklebacks in the vicinity of Nine Mile Point. Eggs and larvae of the threespine sticklebacks were among the ichthyoplankton collections in 1975 but were few in number. Eggs were not collected in either 1973 or 1974, and very few larvae were found in 1973 collections. The threespine stickleback spawns during the summer (June - July) in fresh water, building its nest in shallow, sandy areas (Scott and Crossman, 1973). The male entices the female to the nest by a distinctive courtship display; eggs are then laid in clusters and are adhesive to each other. Breder and Rosen (1966) stated that hatching occurs in 7 days at 19°C (66.2°F). The males tend the eggs and the young for several days after hatching.

- Feeding

A voracious feeder, the threespine stickleback consumes various annelids, crustaceans, insects, and eggs and larvae of fish. They, in turn, are preyed upon by fish-eating birds as well as by larger fish including trout and salmon. The threespine stickleback, therefore, serves as an important forage species. Information on feeding habits of that species in the Nine Mile Point area is not available.

6. Coho salmon (*Oncorhynchus kitsutch*)

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

- Abundance and Seasonal Distribution

Coho salmon were caught in greater numbers in 1975 (57 fish) than in 1974 (13 fish); none was caught in 1973. The majority were collected by gill nets in both years, and no differences were noted in coho salmon distribution among transects due to the small sample size. The increase in the coho salmon abundance in the lake collections is attributed to the success of the salmonid stocking program in Lake Ontario.

- Age and Growth

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

- Reproduction

The spawning runs of the coho in the Great Lakes take place from September to early October, although actual time of the spawning occurs from October to January, depending upon the spawning run (Scott and Crossman, 1973). Swift-running tributaries with gravel bottoms are selected as the spawning site. Populations of salmon in the Lake Ontario are maintained through stocking of hatchery-reared fingerlings.

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

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

- Feeding

In fresh water, the young cohos feed upon aquatic insects and oligochaetes. Schools of salmon migrate to the ocean or lake during the spring of the year following emergence. The majority of the migratory population spends about 18 months in the lake or at sea, and returning to spawn at age 3 or age 4 during the fall (Scott and Crossman, 1973). Large coho salmon prey primarily upon rainbow smelt and alewives. Information on coho salmon feeding in the Nine Mile Point vicinity is not presently available.

7. Brown trout (Salmo trutta)

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

- Abundance and Seasonal Distribution

As in the case of other salmonids, brown trout were caught in greater numbers in 1975 than in either of the two previous years, due to stocking. The brown trout was represented by 182 specimens in 1975 as compared to 75 in 1974 and 31 fish in 1973. All of the brown trout caught in 1975 were collected by surface (N = 116) and bottom (N = 66) gill nets. No differences were found among transects.

- Age and Growth

Age and growth studies of Lake Ontario brown trout indicated that individuals of this species may live for 13 years (Marshall and MacCrimmon, 1970); brown trout have been reported to reach a length of 427 mm at age 4 (Mansell, 1966).

No data are available on age and growth of brown trout from the Nine Mile Point vicinity.

- Reproduction

Brown trout usually spawn during late autumn/early winter; in one study, Mansell (1966) noted that brown trout spawned during mid-October through early November in Ontario Province when water temperatures ranged from 6.7-8.9°C (44.1-48.0°F). Spawning usually takes place in the shallow headwaters of streams over a gravel bottom, although Eddy and Surber (1960) observed that many trout spawned on rocky reefs along the shore of Lake Superior. The number of eggs deposited by a spawning female brown trout is proportional to her size: the larger females deposit more eggs.

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

- Feeding

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

8. *Gammarus fasciatus*

Gammarus was among the most abundant species in both macrozooplankton (>571) and benthic collections in the 1973-1975 period. Abundance and distribution of *Gammarus* in the study area have been discussed earlier in the plankton and benthos sections.

Summary

The population parameters including abundance and distribution, age and growth, reproduction and feeding of the representative important species in the vicinity of Nine Mile Point have been discussed in this section. In addition, distributional trends among years (1973-1975) and within years (1975) encompassing preoperational (1973-1974) and post operational (1975).

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VII. IMPACT OF THE THERMAL DISCHARGE

A. INTRODUCTION

In this Chapter, the potential direct and indirect effects of JAF thermal discharge are discussed and then followed by an assessment of these effects on the representative species. Although emphasis is placed on the thermal component of the discharge, physical and chemical components of the discharge are also discussed. For the purpose of this discussion, direct effects are defined as those resulting from contact by individual organisms with a potentially injurious component of the discharge. Indirect effects are those which result from an interaction of the discharge with other potentially stressful conditions in the environment or an ecosystem imbalance initiated through direct effects.

Ecosystem effects are initiated at the individual organism level and become important when a substantial proportion of the individuals experience deleterious effects of the discharge. This chapter evaluates potential effects on individual organisms and the subsequent ecosystem effects that may occur.

B. POTENTIAL EFFECTS

1. Thermal Effects Conceptual Framework

The behavioral and physiological capabilities of fish and the temporal and spatial gradients of temperature within thermal plumes allow for a range of response to thermal exposure from death to no effect. In order to evaluate the effects of the exposure of organisms to changes in temperature, a conceptual framework has been developed within which organism response can be tested in the laboratory for specific thermal regimes, and extrapolated to the multi-dimensional thermal regimes of an actual discharge. This conceptual framework is briefly discussed to provide a background for a subsequent discussion of the thermal characteristics of the representative important species. (For a detailed exposition of the following concepts see Coutant, 1970 and Warren, 1971.)

The response of an organism to temperature is divided into two zones: the zone of tolerance and the zone of resistance. An organism may live indefinitely in the zone of tolerance because the temperature level does not exceed the incipient lethal level (lethal threshold) for that species. The incipient lethal temperature is the highest (or lowest) temperature at which a given percentage of test individuals (usually 50%) will survive indefinitely for a given acclimation temperature. The higher the acclimation temperature, the higher the incipient lethal level until the ultimate incipient lethal level is reached. At this level, an increase in acclimation temperature will not raise the incipient lethal level.

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

Another important concept related to the thermal responses of fish is that of the Critical Thermal Maximum (CTM). The CTM is the thermal point at which the locomotor activity becomes disorganized and the fish loses its ability to escape from conditions that may cause death. The point of equilibrium loss is of particular importance in the evaluation of effects of exposure to thermal plumes in the natural environment. Standard thermal bioassays, while providing a rather precise demarcation of lethal temperatures, do not permit evaluation of sub-lethal effects on behavior which can culminate in death. Coutant (1970) has shown that sub-lethal exposures to lethal temperatures resulted in increased predation on juvenile salmonids in controlled laboratory experiments. Increases in predation rate occurred at thermal doses well below those causing equilibrium loss visible to the experimenter.

The thermal history of an organism, or its acclimation temperature, has a profound influence on the physiological and behavioral response of fish to a change in temperature. The ability of a fish to tolerate and adjust to a change in temperature varies with its acclimation temperature.

In addition to the physiological response of death and loss of equilibrium, fish can respond behaviorally to temperature changes by avoiding or gravitating to the change. For example, when presented with a gradient of temperature in the laboratory, fish will show a preference for a temperature regime. When presented with a series of choices between two temperatures, fish will show an avoidance response when an unsuitable temperature is presented. A series of experiments can be conducted which will produce preferred and avoidance temperatures over a broad range of acclimation temperatures. Preferred and avoidance temperatures are important in the assessment of thermal plume effects in that they permit an evaluation of fish behavior in relation to the thermal gradient of the plume.

Laboratory determinations of preferred and avoidance temperatures eliminate the influence of other factors on fish behavior. In a natural situation fish may respond to many factors, and therefore, the prediction of fish behavior from laboratory results must be approached with caution.

C. EVALUATION OF POTENTIAL EFFECTS ON REPRESENTATIVE IMPORTANT SPECIES

1. Direct Thermal Effects

The evaluation of potential effects is based on thermal data for each species, field data collected in the vicinity of the JAF, and literature on the effect of thermal discharges. The tabulated data of thermal characteristics includes selected representative species as well as other Great Lakes species. The thermal characteristics of the other species are presented to show that the selected species are representative in regard to the analysis of thermal effects. Thermal data of Otto et al. (1973), for specimens collected in Lake Michigan, are particularly useful because they provide thermal characteristics relative to an acclimation temperature in each case.

The assessment of the effect of the JAF discharge on representative important species and closely related species draws together and evaluates evaluates the factors that determine the likelihood of exposure, duration of exposure, and consequences of exposure to the plume for each species. The probable ecological consequences of the projected lethal and sub-lethal effects are discussed in terms of the representative species and the overall biological community data presented in Chapter V.

a. Lethal Effects

The thermal plume can be potentially lethal in two ways: fish can voluntarily swim into an increasing temperature gradient until lethal conditions are met and organisms can be entrained into the plume at temperatures that are lethal. The temperature distributions in the plume, described in Chapter IV, indicate a very sharp gradient of temperature due to the rapid dilution produced by the high velocity discharge. Although the temperature at the point of discharge exceeds the upper incipient lethal temperature (Tables VII-1 and VII-2) for all the representative species, the likelihood of a fish intentionally experiencing the full temperature increase is very remote.

Otto et al. (1973) studied the swimming ability of yellow perch, rainbow smelt and other species from Lake Michigan(Figure VII-1). The maximum sustained swimming speeds (speeds which a fish can maintain for time intervals up to 45 minutes) over a range of acclimation temperatures from 5 to 20°C were 14-28 cm/sec for yellow perch and 34-45 cm/sec for rainbow smelt. Their ranges of sustained swim speeds probably encompass the capabilities of the other species on the representative list.

TABLE VII-1

SUMMER LETHAL THRESHOLD TEMPERATURES FOR REPRESENTATIVE IMPORTANT SPECIES

JAMES A. FITZPATRICK NUCLEAR POWER PLANT AND VICINITY

SPECIES	SUMMER LETHAL THRESHOLD*
Alewife	23.0-32.2°C
Brown trout	23.5-25.0°C
Coho salmon	24.0-25.0°C
Rainbow smelt	21.5-28.5°C
Smallmouth bass	35.0°C
Threespine stickleback	25.8-33.0°C
Yellow perch	29.0-32.0°C
Gammarus fasciatus	34.0-37.0°C

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

TABLE VII-2

A SUMMARY OF UPPER INCIPIENT LETHAL TEMPERATURES (°C) FOR FISH[a]

LAKE MICHIGAN

SPECIES	ACCLIMATION TEMPERATURE (°C)				
	5	10	15	20	25
Alewife (Adult)*	-	23.3	23.8	24.5	-
Alewife (Young-of-the-Year)*		26.3	-	30.3	32.1
Bloater[b]	22.6	23.8	24.8	26.6	27.0
Brook Trout[c]	23.7	24.4	25.0	25.3	25.3
Chinook Salmon[b]	21.5	24.3	25.0	25.1	-
Cisco[c]	21.6	24.3	-	26.6	26.0
Coho Salmon[d]*	21.3	22.5	23.1	23.9	-
Emerald Shiner[f]	23.2	26.7	28.9	30.7	30.7
Fathead Minnow[f]	-	28.2	-	31.7	33.2
Golden Shiner[g]	-	29.3	30.5	31.8	32.2
Largemouth Bass[g]	-	-	-	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] Otto et al., 1973

[b] Edsall et al., 1970

[c] Fry et al., 1946

[d] Brett, 1952

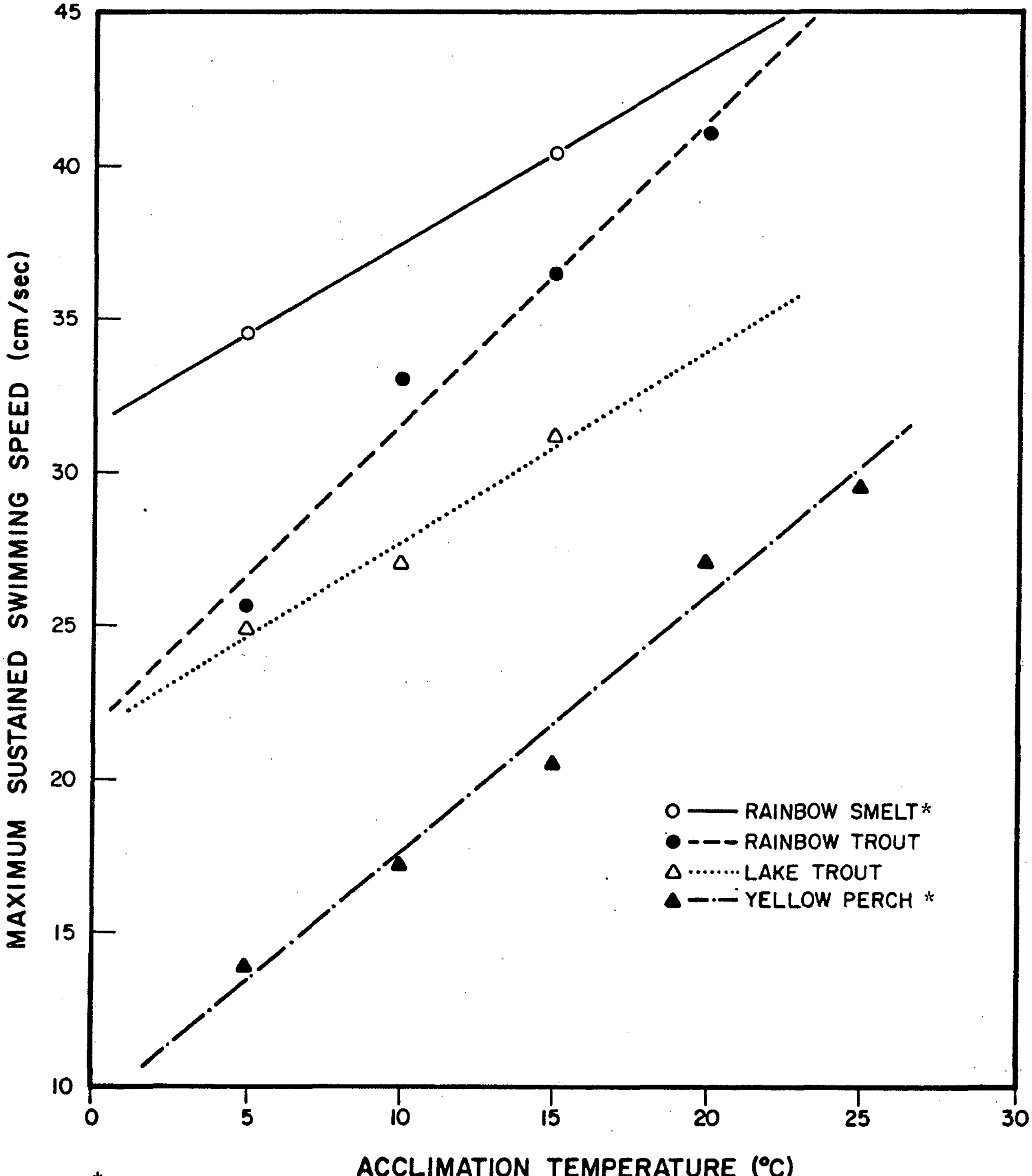
[e] Edsall and Colby, 1970

[f] Hart, 1947

[g] Hart, 1952

*Representative Important Species

MAXIMUM SUSTAINED SWIMMING SPEEDS OF FISH[a] ACCLIMATED TO CONSTANT TEMPERATURES[b] LAKE MICHIGAN



*Representative Important Species

[a]Mean standard lengths of test fish (cm): rainbow smelt, 13.4 cm; lake

The velocity of water exiting from the discharge ports is 426.7 cm/sec and decreases to 30.48 cm/sec at a distance of 91.4 m from the ports. Over this same distance dilution of the discharge water has reduced the temperature increase from 17.5°C to temperatures of 1.7-2.8°C above ambient. It is clear from a comparison of discharge velocities and maximum sustained swim speeds that it is impossible for any of the representative species to swim against the discharge flow and maintain themselves in the hottest portion of the plume. Therefore, the evaluation of lethal effects resulting from voluntary exposure to the plume should be based on the temperatures which exist in the area of the velocity field where a fish could theoretically maintain itself.

Most of the representative species could maintain themselves in the area of water velocity of 30.5 cm/sec during the summer months when their swimming ability is at a maximum, particularly for specimens larger than those tested. Temperature increases of 1.7-2.8°C are expected in the area where plume velocities are approximately 30.5 cm/sec. Upper incipient lethal levels for all representative species at low to moderate ambient lake temperatures are well above temperatures in the 30.5 cm/sec area of the plume. During high ambient conditions the upper incipient lethal levels for five of the representative species - adult alewife, brown trout, coho salmon, rainbow smelt and threespine stickleback - are exceeded or very close to temperatures in the area of 30.5 ft/sec velocities. Summer lethal thresholds for remaining representative important species, smallmouth bass, yellow perch and Gammarus sp., are above the plume temperatures under consideration.

Brown trout, coho salmon, and rainbow smelt are cold-water species which normally leave the warm surface waters of the lake during the summer months and reside in the cool waters in the depths of the lake. This distribution pattern, an expression of their avoidance of warm water, effectively removes them from contact with the plume during the period of high ambient temperatures.

Adult alewives are less tolerant of high temperatures than young-of-the-year alewives. While the upper incipient lethal level may be exceeded for adult alewives during the summer, young-of-the-year alewives can apparently tolerate the same conditions. Adult alewives move to the cool depths of Lake Ontario following spawning in the spring. This movement would remove them from contact with the plume.

The threespine stickleback is an inshore species throughout the year and is, therefore, susceptible to lethal conditions. The area of the plume under consideration is restricted to the surface during the summer. The stickleback nests on the bottom in late spring and early summer, which would isolate it from the thermal plume, but at other times during the summer it could be exposed to lethal conditions.

The above considerations preclude mortality to fish due to their voluntary contact with the plume. Plume temperatures in an area where a species maintains itself never exceed the upper incipient lethal temperature when that species can be expected to be in the vicinity of the discharge. There is, however, another consideration which supports the conclusion that voluntary excursion into the plume cannot result in mortality.

Avoidance of potentially harmful temperatures by fish has been demonstrated in the laboratory many times and is observable in nature in the seasonal changes in distribution made by salmonids. Table VII-3 lists laboratory-determined avoidance temperatures for some Lake Michigan fishes, which include four of the representative species (Otto et al., 1973). Except for yellow perch, there is a trend through the range of acclimation temperatures available which shows the avoidance temperature to be below the critical thermal maximum (Table VII-4) at each acclimation temperature. The CTM's which are substantially greater than upper incipient lethal temperatures, permit a greater excursion into the plume and thus a fish has a substantial temperature differential which permits avoidance of the plume.

These data demonstrate that the representative species, with the exception of yellow perch, have avoidance behavior of potentially harmful conditions. Yellow perch may not avoid conditions which would ultimately be lethal. However, this condition will not occur because the upper incipient lethal level is not exceeded in the area of the plume to which yellow perch have access.

The foregoing discussion was directed to potential mortalities when an organism moves under its own power into the thermal plume. A second mode of contact with the thermal plume is through entrainment with the surrounding water mass. As the condenser water exits from the discharge ports at high speed, surrounding lake water is drawn into the jet stream and mixed with the condenser water. The velocity of the surrounding water entering the jet stream near a discharge nozzle was estimated to be 15.24 cm/sec (0.5 ft/sec) in the hydraulic model. Organisms with limited motility will be entrained with the water mass, and actively swimming organisms will be entrained if they do not resist the flow.

Figure IV-4 shows the decay of temperature with time in the JAF plume. Because of the complex hydraulics associated with the mixing of the jet and the surrounding water it is difficult to define the

TABLE VII-3

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

LAKE MICHIGAN

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

[a]Otto et al., 1973
*Representative Important Species

TABLE VII-4

A SUMMARY OF CRITICAL THERMAL MAXIMA (°C) FOR FISH ACCLIMATED TO CONSTANT TEMPERATURES[a]

LAKE MICHIGAN

SPECIES	ACCLIMATION TEMPERATURE (°C)					
	5	10	15	20	25	30
Alewife (Adult)*	24.7	28.7	29.9	31.9	32.8	-
Alewife (Young-of-the-Year)*	24.7	26.7	29.5	31.9	34.3	36.7
Brook Trout (Yearling)	27.5	28.8	30.0	-	-	-
Brown Trout (Yearling)*	-	27.8	-	-	-	-
Chinook Salmon (Yearling)	26.4	28.5	29.5	30.2	-	-
Coho Salmon (Yearling)*	26.1	27.3	28.2	29.9	-	-
Fathead Minnow	28.5	31.9	32.7	35.7	36.7	38.5
Golden Shiner	27.9	30.3	33.0	35.0	37.6	39.0
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-the-Year)*	27.5	28.6	30.3	32.6	35.1	-

[a]Otto et al., 1973
*Representative Important Species

thermal regime that a plume-entrained organism might experience. If an organism were entrained next to the discharge nozzle and entered the core of the jet it would theoretically experience the time/temperature relationship of a water particle exiting from the discharge ports. This would represent the worst situation for an entrained organism.

The other extreme would be for organisms which briefly encounter the periphery of the plume and only experience a small temperature increase for a short time. Therefore, plume entrainment results in a broad spectrum of time/temperature exposures. For this analysis the worst-case conditions will be emphasized which consist of entrainment into the plume at the point of discharge and exposure to temperatures diminishing from 17.5°C above ambient to surface ambient. The effect of plume entrainment on representative species will be assessed separately for larvae and early life stages and for older life stages.

An attempt to simulate the time/temperature regime of the FitzPatrick plume on larvae collected in the intake was conducted from June through August 1976. Because of initial high mortality in the intake samples, apparently due to the collection process, and very low numbers of larvae available for testing, no substantive results were obtained. On a few occasions live larvae were obtained and survived the simulation process. This demonstrates that larvae can survive plume entrainment. However, it is not possible to quantify survival percentages and this requires extrapolation from other sources.

Laboratory studies simulating the temperature effects of condenser entrainment are useful for evaluating plume entrainment of larvae and early life stages of fish because the time/temperature exposures incurred during passage through a cooling system are considerably more severe than the worst case of time/temperature exposures in the JAF plume. Although data are not available on the representative species, data from a few closely related species are available, while the data from a variety of species provide a general picture of the effect of thermal shock on early life stages of fish.

Schubel et al. (1975) exposed larvae of blueback herring (Alosa aestivalis), American shad (Alosa sapidissima) and striped bass (Morone saxatilis) to time/temperature histories typical of currently operating power plants for acclimation temperatures of 20°C.

The study of Schubel et al. consisted of exposing eggs and larvae of various sizes to temperature increases for periods of time representing plant passage and then decreasing temperature over several different time intervals to represent various time/temperature histories in the plume. LMS restricted their comment to the holding times representing plant passage, since time temperature histories of Schubel et al (1975) are longer than those at JAF and are thus conservative. The holding times representing plant passage are also extreme in that the shortest time of exposure to maximum temperature increases are substantially longer than time of exposure to the near field temperature increase at JAF.

For eggs of the three selected species, Schubel et al. found no significant increase in mortality for temperature increases of 10°C for 20 minute exposure. Eggs of striped bass survived temperature increases of 15°C for 3 minutes exposures, but eggs of the other two species exhibited a significant increase in mortality for the same temperature increase and exposure. Schubel et al (1975) did not indicate the percentage increase in mortality for Alosa eggs at 15°C exposures.

Similar results were found for larvae in that no significant increase in mortality occurred for increased temperatures of 10°C for 20 minutes exposure for striped bass and blueback herring. There was a significant increase in mortality for American shad but the increase was only 3% (average of difference in control and D1 mortalities; Table 6 of Schubel et al.). For a 15°C increase at a 3 minute exposure, there was no significant increase in mortality for blueback herring, but there was for the other two species. The increase in mortality was, however, less than 50% (average of difference in mortality between control and experiment classification E in Tables 5 and 6 of Schubel et al.).

Hoss et al. (1973) exposed larvae of Atlantic menhaden (Brevoortia tyrannus), spot (Leiostomus xanthurus), pinfish (Lagodon rhomboides) and three species of flounder (Paralicthys albigutta, P. lethostigma and P. dentatus) to thermal shocks simulating the time/temperature exposures that could be encountered in the cooling systems of operating power plants. Each species was maintained at a range of acclimation temperatures and exposed to temperature increases of 12, 15 and 18°C for 10, 20, 30 and 40 minutes. With the exception of menhaden, no significant increased mortality was observed for the 12°C increase over a 40-minute exposure at maximum ambient (15 or 20°C depending on the species). Menhaden exhibited increased mortality with a temperature increase of 12°C at a 15°C acclimation temperature, but no increased mortality with an increase of 10°C at the same acclimation temperature. Increased mortality was observed for temperature increases above 12°C for all species, particularly at the high acclimation temperatures.

Hoss et al. (1973) did not find persistent (long-term) effects of thermal shock on oxygen consumption and growth rate. In addition, exposure of larvae to a 12°C increase in temperature did not cause visible signs of distress in most cases. Subtle changes in behavior, however, may be difficult for an observer to see in these small specimens.

Chadwick (1974) obtained high survival of striped bass larvae after exposure to 10°C temperature shocks for up to 6 minutes at acclimation temperatures of 15.5 and 21.1°C. Temperature increases which brought the maximum to 32°C or above resulted in significant mortality, regardless of exposure time for this species.

The foregoing results of larval entrainment simulations indicate that the worst case of plume entrainment at JAF is far less severe than the time/temperature regimes for which there was substantial survival for a variety of species. These studies exposed eggs and larvae to temperature increases for a minimum of 3 minutes. At JAF an organism entrained exactly at the point of discharge is down to 5°C above ambient in less than 2 seconds for the worst case condition. In general, these other studies found that a 10°C increase did not affect survival while a 15°C increase resulted in some mortality, less than 50%. Since these studies were done for exposure periods that were substantially longer than comparable exposure at JAF, it is expected that plume entrainment of JAF will have a minimal effect on survival of eggs and larvae.

The analysis of plume entrainment of juvenile and adult fish presents a more complex situation because these life stages have the ability to resist entrainment into the plume or to leave the plume if they encounter unsuitable temperatures. The velocity component of the discharge will assist entrained organisms to escape potentially harmful temperatures because the plume momentum is carrying organisms away from the warmest temperatures. This analysis will be based on the worst case entrainment situation described for larval life stages. The evaluation will be based almost entirely on contents of Otto et al. (1973). However, unlike the larval evaluation, the Otto et al. report addressed all of the representative important species except smallmouth bass and threespine stickleback. All of the Lake Michigan species they studied are found in Lake Ontario.

At the beginning of this section it was indicated that the upper incipient lethal level was exceeded during summer for five species in the area of the plume velocities of 30.48 cm/sec. It was also shown that these species are distributed in cooler waters when exposure to lethal temperatures in the plume would be possible. The other representative species could be entrained in the plume during the summer months, while all species could be entrained at one or all of the other seasons.

When the 17.5°C temperature increase at the point of discharge is added to the acclimation temperatures shown in Table VII-2, the upper incipient lethal levels generally approximate the maximum discharge temperature for 5°C acclimation and exceed the upper incipient lethal temperatures for all other acclimation temperatures. In other words, at acclimation temperatures of 5°C and above, fish in the worst-case entrainment situation have entered the zone of resistance and their survival is dependent on the time of exposure.

There are no data available on the effect of extremely short exposures to temperature increases such as would occur in the Fitz-Patrick plume. A thermal bioassay was conducted in which juvenile yellow perch acclimated to 25°C (maximum intake temperature recorded at JAF in summer, 1976) were exposed to temperature increases of 4.4, 8.8, 13.2, and 17.5°C for 6 seconds. A median tolerance limit of 38.5°C was established. Behavior was, however, noticeably altered for the lowest test temperature. There was no equilibrium loss at an increase of 4.4°C, but there was a depression of activity which lasted up to 15 minutes. Because no other temperature tolerance information exists for very short exposure times, CTM temperatures will be used as an indication of survival in JAF's discharge for plume entrained nekton.

CTM's as pointed out previously, are determined by exposing a fish to gradually increasing temperatures until there is an equilibrium loss. Otto et al. used 1°C increase per minute. Determination of an upper incipient lethal temperature takes a minimum of several hours exposure. The Critical Thermal Maximum (CTM) temperatures in Table VII-4 are in the zone of resistence and can be used as an indication of the temperature increase that a species can survive for very short exposure periods. This can be verified by comparing the CTM and upper incipient lethal temperature for yellow perch as determined by Otto et al., and the 6 second exposure lethal temperature determined as part of this study. Juvenile yellow perch have an upper incipient lethal temperature of 31.2, a CTM 35.1 and a 6 sec lethal temperature of 38.5°C. Using the 2°C safety factor advocated by EPA (1973), the 6 sec exposure safe temperature is 36.5°C or approximately 1.5°C higher than the CTM.

Use of the CTM rather than the upper incipient lethal temperature indicated that the 17.5°C temperature increase will be at or near the lethal level for a few species at 10°C acclimation, while some limited mortality may occur at 15°C. At a water temperature of 20°C, it is expected that the salmonids and rainbow smelt would have migrated and only the warm water nekton species would be exposed to potentially lethal temperatures. At 20°C plume temperatures, 12°C above ambient would be potentially lethal while at 25°C, plume temperatures above 10°C could be potentially lethal. At 25°C, it is expected that adult alewives have left the area since this temperature exceeds their upper incipient lethal temperature. This analysis does not address smallmouth bass and threespine stickleback. Since the smallmouth bass is the most temperature tolerant of all representative important species, it is expected that no plume related mortality will occur for this species (Table VII-1). Since yellow perch and threespine stickleback have similar temperature tolerances (Table VII-1), the conclusion made above for yellow perch would be appropriate for threespine stickleback.

While the above analysis suggests that some mortality may occur for the worst case condition, particularly at 20 and 25°C acclimation temperatures, it needs to be emphasized that the bioassay studies which support this conclusion are atypical of the conditions which exist for plume entrainment. Bioassays exposed fish to gradually increasing temperatures for CTM's or to a sudden increase in temperature for upper lethal temperatures. At JAF the worst case condition occurs at 25°C acclimation; which is the maximum intake temperature recorded in 1976. For this case, fish are down to 10°C above ambient in less than 1 second. It takes 1 sec to traverse to the 7.5°C isotherm, a drop of 10°C. After this point, plume related mortality cannot occur.

In summary, it appears that any plume entrained mortality will be minimal, if it occurs at all, and this is predicated on the assumption that fish will not avoid the highest velocity component of the discharge. Observations in the discharge area support this contention in that dead fish have been seen despite the fact that studies around the discharge are conducted several times a month.

The Critical Thermal Maximum is defined in terms of equilibrium loss, a readily observable effect. However, as Coutant showed, increased predation occurred at shock temperatures less than those producing observable changes in behavior. Therefore, although plume entrainment probably will not cause mortality to juvenile and adult fish even at the worst case condition of highest lake ambient and maximum temperature exposure in the plume, fishes so exposed could be susceptible to increased predation.

Mortality of fish due to "cold shock," i.e., abrupt exposure of organisms acclimated to a warm effluent to very low ambient temperatures, has occurred at a number of power plants. Acclimation to warmer than ambient temperatures is a precondition for cold shock mortality and the diffuser at JAF will preclude acclimation to high temperature increases. Otto et al. (1973) reported that it takes approximately 6 days for alewife and yellow perch to acclimate to 90% of a 10°C increase in temperature.

Maximum sustained swim speeds for low acclimation temperatures presented by Otto et al. (1973) indicate that strong swimmers such as salmonids could not maintain themselves in plume velocities above 35 cm/sec. Plume temperature rises corresponding to this velocity are in the range of 1.7 to 2.8°C. Maximum sustained swim speeds are defined as the speed a fish can maintain for a moderate length of time, generally less than 45 minutes. Maximum sustained speeds are greater than speeds that can be maintained for extended periods (days). Therefore, a velocity field in which representative species could maintain themselves for extended periods, the time these organisms would require to become thermally acclimated would have temperature increases on the order of 1°C. The velocity field of the FitzPatrick plume is such that the representative species will be unable to maintain themselves in a temperature sufficiently above ambient to produce a shock effect if it were removed by a plant shutdown. Because fish are effectively excluded from the plume by the velocity field, cold shock cannot occur at FitzPatrick.

In regard to plume entrainment of Gammarus sp. at JAF, Lauer et al. (1974) found that individuals from an estuarine population of Gammarus sp. could tolerate a 10°C temperature increase for 60 minutes at an ambient temperature of 25°C and 15 minute exposures of 12°C at the same acclimation temperature. At absolute temperatures above 37°C mortality after 24 hr increased significantly. Alterations in behavior indicating stress were not observed at temperature shocks of 10°C or less for exposure times of 60 minutes.

Simulations of plume entrainment of Gammarus sp. at JAF conducted in the summer of 1976 are in agreement with Lauer's results. In these simulations, Gammarus collected in the intake were placed in full plant ΔT and 1/2ΔT discharge water and then serially diluted with intake water to simulate the rate of cooling in the plume. Individuals exposed to the full ΔT were diluted to a final temperature of 3°C above ambient and 1/2ΔT exposures were diluted to 2°C above ambient. The mean percentage dead (of two replicates) did not exceed two on four test dates and was similar to the mean percentage dead in the intake samples on the same date.

The simulations conducted at JAF and by Lauer indicate that Gammarus sp. can tolerate the worst time/temperature regimes in the plume, and that therefore, there will be no mortality to Gammarus sp. due to plume entrainment.

b. Sub-lethal Effects

Sub-lethal effects may manifest themselves as a change in behavior or physiology of the organism. Behavioral changes involve almost immediate responses by fish, while physiological changes require an extended period of exposure to increased water temperatures. Life history data on selected representative species are presented in this section to show that the utilization of the NMP-1 area by these species has not resulted in altered reproductive or feeding behavior and physiology.

The velocity field of the JAF plume is such that fishes are excluded from all but the lowest temperatures above ambient. Based on the preferred temperatures of Table VII-5, fish are excluded from areas where they may concentrate at various seasons if they had access. Therefore, the velocity field of the FitzPatrick plume is the factor which establishes the area of exclusion in the vicinity of the discharge. The area of exclusion, the estimated 2 to 3 surface acres inside the 30-48 cm/sec velocity isopleth, is extremely small in relation to the water body segment discussed in Chapter IV and is not a crucial area for the life history of any representative species or other species in Lake Ontario.

Sub-lethal effects involving a physiological response are precluded due to the exclusionary effect of the plume velocity. The time required for a fish to acclimate to a change in water temperature is days or weeks, depending on the magniture of change. Based on maximum sustained swim speeds, fish can maintain themselves only on the periphery of the plume and then only for short periods of time.

The potential for a sub-lethal effect due to a brief exposure to an elevated temperature, such as would occur in the worst case entrainment situation, has not been studied exclusively. The results of Hoss et al. (1973) cited earlier indicated no persistent effects on oxygen consumption or growth rate for thermally shocked fish lavae.

There was no increased mortality after 10 days to Gammarus spp. exposed to a 8.3°C temperature increase over an ambient of 25.5°C for 60 minutes (Ginn et al., 1976). An 11.1°C increase caused significant mortality after ten days for the same ambient temperature and exposure time, while a five minute exposure to an 11.1°C increase did not cause increased mortality. The 8.3°C, 60 minute exposure did not effect subsequent reproductive behavior, nor the release of young from ovigerous females.

There are many physiological mechanisms which could be affected by brief sub-lethal exposure to elevated temperature. While only a few of these physiological responses have been examined in a few species, it appears that the sub-lethal exposures that organisms could experience in the FitzPatrick plume will not cause latent effects that are debilitating or ultimately fatal to the organism.

TABLE VII-5

A SUMMARY OF PREFERRED TEMPERATURES FOR FISH ACCLIMATED TO CONSTANT TEMPERATURES[a]

LAKE MICHIGAN

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

[a]Otto et al., 1973

The ecological studies in the vicinity of Nine Mile Point and Oswego, which have been in progress for several years, provide a data base of information on the representative important species. While the foregoing analyses indicate little potential effect of the plume on the representative species, life history data on alewife, rainbow smelt, yellow perch and smallmouth bass are summarized below to indicate observed effects compared to the theoretical considerations of the preceding analyses. These four species were chosen for detailed discussion because of the large amount of data available on them. The majority of these studies were conducted prior to JAF operation. However, both the Oswego and NMP-1 stations were operating and, thus, the results can be used to evaluate potential JAF impacts. Also, before continuing, it should be pointed out that concerns related to long term sublethal effects assume that some portion of a population is residing for long periods in the discharge area.

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

There was a continuous dispersal of fish from the tagging area which suggests that there may not be long term residence in the discharge area. Tagged fish were recovered from a wide area, indicating on approximate 70 mile range of movement around Nine Mile Point. There was a general pattern of movement to the east of Nine Mile Point during the summer and fall and westward movement in the spring. Storr's findings are supported by the results of LMS's studies (cited throughout this document) that normal onshore-offshore seasonal migrations have been found not to be effected by the presence of the thermal discharges.

(i) Fecundity and Time of Spawning

Spawning of alewife, rainbow smelt and yellow perch was determined by examining the coefficient of maturity (LMS, 1975) of the males and females of these species. The period of maximum spawning for alewife in the study area occurred during the first half of July (LMS, 1975) at a time when the average surface and bottom water temperatures were 20.6 (range of 13.5-22°C) and 16.8°C, respectively. Similar spawning temperatures have been reported for freshwater alewife in Maine (13-21°C; Rounsefell and Stringer, 1943) and in New Jersey (17-19°C; Gross, 1959). Scott and Crossman (1973) cited hatching temperatures for alewife eggs as 15.6-22.2°C. These water temperatures are not exceeded in the area during the period of alewife spawning.

Fecundity of alewife studied in 1973 (QLM, 1974) in the area varied from 25,798 to 67,739 eggs (average of 46,821) per female, for females ranging from 156 to 181 mm in total length. The total egg counts conducted in 1974 (LMS, 1975) varied from 8,981 to 50,274 eggs (average of 31,613) per female, for females ranging from 153 to 177 mm in total length. Fecundity did not differ significantly for different age classes. The total egg production for alewife taken from Lake Michigan (in July 1965) varied from 11,147 to 22,407 eggs per female of a size similar to those analyzed in this study (Norden, 1967). The number of eggs per female alewife cited by Scott and Crossman (1973) varied from 10,000 to 12,000. The values reported in this study seem to be relatively high, which is attributed to the fact that total egg count overestimates the actual number of eggs to be spawned in one season. Therefore, these figures clearly show that the alewife fecundity in the area varied from 25,798 to 67,739 eggs (average of 46,821) per female, for females ranging from 156 to 181 mm in total length. The total egg counts conducted in 1974 (LMS, 1975) varied from 8,981 to 50,274 eggs (average of 31,613) per female, for females ranging from 153 to 177 mm in total length. Fecundity did not differ significantly for different age classes. The total egg production for alewife taken from Lake Michigan (in July 1965) varied from 11,147 to 22,407 eggs per female of a size similar to those analyzed in this study (Norden, 1967). The number of eggs per female alewife cited by Scott and Crossman (1973) varied from 10,000 to 12,000. The values reported in this study seem to be relatively high, which is attributed to the fact that total egg count overestimates the actual number of eggs to be spawned in one season. Therefore, these figures clearly show that alewife fecundity in the area is not depressed and it is similar to that of other alewife populations reported elsewhere.

Rainbow smelt spawning migration begins in March when water temperature is 13.5°C and continues through May when water temperature is 18.3°C (McKenzie, 1964). During this study, maximum spawning for rainbow smelt was observed during April, when water temperature in the Nine Mile Point vicinity varied from 0.7-6.2°C (LMS, 1975). Trawl collections in April contained mature females, while smelt eggs and larvae were present in ichthyoplankton collections during the same month. This may indicate that appropriate spawning conditions for rainbow smelt occurred during the March-May period at temperatures from less than 10°C. McKenzie recognized two spawning populations of smelts in the Miramichi River system. One group of smelt spawned at temperatures less than 10°C (early spawners) and a second group spawned at temperatures 15°C or less (late spawners).

Rainbow smelt collected from the area during 1974 exhibited a fecundity of 6,212 to 29,050 eggs for females 138 to 213 mm, respectively, in total length (average 17,002 eggs)(LMS, 1975).

Fecundity was not dependent on fish age, but showed good correlations to length ($r = .76$), body weight ($r = .83$) and weight of ovaries ($r = .79$). The fecundity of smelt from Lake Ontario, as reported by Bailey (1964), averaged 31,338 eggs for females ranging in length from 188 to 224 mm. Lake Michigan (Van Oosten, 1940) and Lake Huron (Baldwin, 1950) female rainbow smelt showed comparable values. It is evident that maturity coefficient, time of spawning and fecundity of smelt collected from the vicinity of the JAF are similar to those exhibited by smelt in other natural bodies of water.

As in the case of alewife and rainbow smelt, yellow perch in the study area showed a coefficient of maturity, time of spawning, and spawning temperature, similar to those cited in the literature. Coefficient of maturity of yellow perch from Nine Mile Point area revealed a peak spawning activity during the first half of April (LMS, 1975) when water temperature ranged from 0.7 to 6.2°C (average 3.3°C). A temperature range of 3.9-6.7°C was reported by Muncy (1962) for spawning yellow perch in the Severn River, Maryland. In 1973 (QLM, 1974) yellow perch from Nine Mile Point spawned earlier, in mid-March, but at a similar water temperature, 3.3-6.8°C.

Yellow perch from the vicinity of the plant showed fecundity values of 4,840-5,000 eggs per female ranging 150-290 mm in total length and an average of 25,077 eggs per female (LMS, 1975). Sheri and Power (1969) estimated the fecundity of yellow perch in the Bay of Quinte, Lake Ontario as 3,035-61,465 eggs per female ranging in total length from 131 to 257 mm. Muncy (1962) reported that fecundity values for female yellow perch in Maryland (173-295 mm) were similar to those found in this study.

Alewife, rainbow smelt and yellow perch, as representative of the important species, showed that reproduct activity proceeds normally and is similar to the same parameters in fish studied in other natural environments.

(ii) Time of Annulus Formation

The time of annulus formation is the result of simultaneous processes, both internal and external (Nikolsky, 1963), and is more or less similar among years, i.e., rings, or annuli, are formed at the same time every year in a given species. This process takes place presumably when the natural environmental factors do not alter. It should be noted that the annuli are not formed directly as a result of water temperature (Nikolsky, 1963), but that water temperature can influence other factors (e.g., food abundance) which in turn influence the formation of annuli.

For fish observed from the study area, annuli were formed on scales of 36% of the alewife captured in June, 43% in July, and 100% in August 1974 (LMS, 1975). At Nine Mile Point during 1973, annulus formation began in April, reached 29 and 42% for the alewife collected in May and June, respectively, and peaked in July and August with 66 and 65%, respectively (QLM, 1974). Norden (1967) reported that 15% of alewife collected from Lake Michigan had formed annuli in June while the remainder showed annuli in July. These results are similar to the time of annulus formation for alewife collected from the vicinity of Nine Mile Point.

Fourteen percent of rainbow smelt collected in this study area during April 1974 (LMS, 1975) showed annuli on their scales; the proportion in May was 12%, and increased to 72% in June 1974, after which all smelt sampled had formed annuli. Similar results were found in 1973 (QLM, 1974), when 89% of the rainbow smelt sampled in July and 100% of those in August had formed annuli. This is in agreement with data for older smelt collected from Lake Superior (Bailey, 1964); annuli were formed earlier in younger fish. Annulus formation was complete in some yellow perch collected in this study area in April and May 1974, peaked in June and was complete for all fish examined in July (LMS, 1975). Yellow perch collected in 1973 (QLM, 1974) exhibited a similar pattern. These data are also in agreement with those of Jobes (1952), who reported the formation of annuli in yellow perch from Lake Erie in early April to mid-July.

Annulus formation for smallmouth bass collected from Nine Mile Point in 1974 (LMS, 1975) started in May, peaked in July and was essentially complete by August. Reynolds (1965) reported that annulus formation in smallmouth bass occurred in late May in the Des Moines River, Iowa; Suttkus (1955) found that annulus formation for smallmouth bass was completed in May-June for a small stream population in Falls Creek, New York. A slightly later time of annulus formation would be expected in the more northerly population of Lake Ontario.

The above discussion indicates that for alewife, rainbow smelt, yellow perch and smallmouth bass collected from Nine Mile Point area the time of annulus formation which is indirectly dependent on water temperature was similar to times observed for the same species collected from other waters. Additionally, the annuli for the above species were formed at comparable times in both years, 1973 and 1974.

(iii) Feeding

Feeding behavior of fish is governed by many factors including relative abundance of prey, behavior of predator and prey, spatial and temporal distribution of food items, and intensity of competition. These factors are directly or indirectly affected by increased (or decreased) water temperature. The influence of temperature is evident as altered predator-prey relationships.

This section describes the predator-prey relationship of representative important species in the study area. Such feeding relationships will be compared to those of the same species inhabiting natural waters which receive no heated discharges.

Smallmouth bass and yellow perch, two of the representative important species, were considered for studies of food habits. Stomach contents of these two species were analyzed in 1973 (QLM, 1974) and in 1975 (LMS, 1976). Additionally, stomach contents of yellow perch were also analyzed in 1974 (LMS, 1975).

- Yellow Perch

A total of 114 yellow perch varying in length from 130 to 275 mm and collected mostly during morning hours in August-November 1973 were examined for food preference. At the JAF 15-ft station, *Gammarus fasciatus* contributed more than 70% (by volume) of the total food ingested of all fish averaging in length from less than 84 to 279 mm. *Pontoporeia* made up only 1.3% of the stomach contents (QLM, 1974). In addition, small yellow perch (84 mm) fed on dipterans to a large degree (12.8% of their diet) while larger fish (141-186 mm) showed a tendency to consume the gastropod *Physa* sp. and preyed intensively on *Gammarus*.

Yellow perch (141-186 mm) collected at the 15-ft depth contour of NMPP transect tended to show great preferences for the amphipod Pontoporeia sp. (abundant in benthic collections), while dipterans made up a small part of their diet. Amphipods and fish were the major part of the diet of yellow perch (141-236 mm) collected at the end of August, while older fish (237-279 mm) preferred the gastropods Valvata sp. and Amnicola sp. Fish items also composed a sizable portion of their diet (QLM, 1974). At the NMPE 15-ft station yellow perch (141-186 mm) fed exclusively on Gammarus in September (QLM, 1974), whereas, the diet of those collected at NMPW 15 and 30-ft stations in October consisted mainly of fish.

Stomach contents of 48 yellow perch collected in bottom gill nets at the 15-ft depth contour (all transects combined) were examined in 1974 (LMS, 1975). These fish ranged in size from 160 to 268 mm during the spring and from 186 to 274 mm during the fall. The fish collected during the spring contained a greater variety of food items in their stomachs than those recorded from the fall collection. Of the stomachs examined, 53.7% contained fish (mottled sculpin and alewife) and 26.8% contained fish eggs and Gammarus fasciatus (LMS, 1975).

Scott and Crossman (1973) report that in general large yellow perch (>150 mm) feed primarily on decapod crustaceans, small fish and Odonata nymphs. In addition, they frequently ingest the eggs of a wide variety of fishes. McClane (1964) reported that larvae feed on zooplankton and insect larvae, and when they grow to a length of 50 to 75 mm, their diet changes to larger zooplankton, insects, crayfish, snails and small fish, including those of their own species.

Seaburg and Moyle (1964) studied summer food preference of yellow perch in Minnesota, and concluded that 66% (by volume) of stomach contents of fish larger than 127 mm was made up of fish.

Muncy (1962) examined the stomach contents of 209 yellow perch and found the major food items to be small crustaceans and insects, especially chironomid larvae. Stomachs of larger fish (89-92 mm total length) contained fish.

Yellow perch in the Nine Mile Point vicinity have a basic diet of fish and crustaceans (particularly amphipods), in addition to gastropods and dipterans, with the amount and types of food consumed depending on available food items and feeding location. The food items selected by yellow perch in the vicinity of Nine Mile Point are typical of the food preferences reported for this species in the literature. The Nine Mile Point food habit studies indicate that a diverse food base is available to yellow perch and that their food habits and feeding behavior is probably unaltered in the vicinity of the thermal discharge.

- Smallmouth Bass

In all smallmouth bass stomachs collected from August through October 1973 in the Nine Mile Point vicinity, for fish ranging in size from 167 to 415 mm total length, fish and decapod crustaceans (crayfish) were the bulk of all food present. Twenty five adult smallmouth bass over 301 mm total length analyzed in 1975 fed almost exclusively on fish and crayfish. In the 1975 samples fish were present in 73% of the stomachs and were 70% of the weight of stomach contents, while crayfish were 30% by occurrence and 30% by weight in the stomachs.

Dendy (1946) concluded that crayfish and fish are the most significant foods for smallmouth bass, and Scott and Crossman (1973) described the diet of smallmouth bass as including fish, crayfish, insects and occasionally frogs, with fish believed to be the most important component.

As with yellow perch, it is evident that the presence of JAF has neither resulted in adverse effects on food habits nor altered the normal predator-prey relationships of smallmouth bass.

c. Indirect Thermal Effects

Indirect effects are those which are secondary to contact of the thermal component of the discharges by individual organisms.

The JAF does not treat the cooling system piping to control biological growth; therefore, there are no biocides present to interact with the thermal component of the discharge.

Studies have been conducted at NMP-1 to quantify the reduction in DO after passage of the cooling water through the power plant. Analyses of the 1973 data indicated that the reduction averaged 0.3 mg/l when the inlet water was supersaturated. The mean percent DO saturation value recorded in 1975 was 108% in surface water and 104% in bottom waters; it was never below 74% and occasionally reached as high as 144%.

DO concentrations in the study area remained relatively unchanged throughout the 1973-1975 period and were consistently above the minimum value necessary for growth and development of even the most sensitive species (5.0 mg/l for salmonids). Despite spring-summer fluctuation in DO, the lowest mean DO concentration, 7.1 mg/l recorded in bottom waters in 1975 (LMS, 1976), is well above the minimum criterion for the protection of aquatic life (USEPA, 1973).

Coutant (1970) reviewed the theoretical aspects and field studies of the change in dissolved oxygen levels in water passing through power plant condensers. He presented abundant evidence to show that reductions in dissolved oxygen below saturation values do not occur when water is passed through power plant cooling systems.

The studies at NMP-1, field studies in the vicinity of Nine Mile Point and the literature indicate that there will be no significant change in dissolved oxygen levels due to passage through the JAF cooling system. Therefore, there will be no interaction of the thermal component of the discharge and reduced dissolved oxygen levels.

d. <u>Other Effects</u>

(i) Shear Forces

Shear forces produced by the differential current movements may result in an additional stress on fish eggs and larvae. The maximum shear force expected to occur between the 2.5°C isotherm and the ambient temperature water is about 1.33 dynes/cm^2. The shear between the 0.3°C isotherm and the ambient water is 0.09 dynes/cm^2. Morgan et al. (1973) have reported that striped bass larvae could withstand shear of 3.4 dynes/cm^2 for 1 minute in a specialized apparatus with laminar flow. Although this species is not present in Lake Ontario, the shear stress it can withstand before injury is applicable to the species in the vicinity of JAF. Therefore, it appears that little or no adverse impact can be expected to occur as a result of shear forces within the thermal plume.

(ii) Pressure Change

At the JAF discharge, as the heated water rises to the surface, carrying with it plankton and possibly eggs and larvae, a sudden drop in pressure is expected, from 2 atmospheres at 34 ft to one atmosphere near the surface. This process, which takes place in about 30 seconds, subjects the entrained organisms to an abrupt change in pressure without sufficient time for gradual adjustment at a rate of 0.03 atmos/sec.

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

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

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

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

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

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

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

Tsvetkov et al. (1972) exposed both physostomous and physoclistous fishes to modeled changes in the magnitude and rates of change of hydrostatic pressure during passage through turbines. Pressures from 1-6 atmospheres were applied by air pressure to the surface of the water in order to acclimate the fish, which were allowed to adapt to neutral buoyancy. The perch (Perca fluviatilis), a physoclist, required 23-27 hours to acclimate to neutral buoyancy at one atmosphere, and at least 72 hours at 3 atmospheres. The physostomous fishes were unable to acclimate, when access to an air-water interface was restricted. To observe possible delayed mortalities, all surviving fish were maintained up to four days.

Swim bladder injury and gas disease were the causes of pressure-induced mortalities. Death occurred within 10 seconds to 15 minutes after rapid release from the acclimation pressure, when rupturing of the swim bladder wall occurred. In the physostomous fishes, no swim bladder damage was observed when the rate of pressure release was retarded, but rupturing of other internal organs did occur as the swim bladder expanded, compressing the other organs. Fingerlings of the roach, Rutilus rutilus

(L.), [a physostome] displayed 100% mortality at a pressure release rate of 3 atm/sec, 40-72% mortality at 0.1-0.5 atm/sec, and 10% mortality when the rate was below 0.1 atm/sec.

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

(iii) Effects of Turbulence on Benthos

The high velocity discharge of JAF creates turbulence near the point of discharge which has disturbed bottom sediments. The analysis of the effect of scouring on benthic life, including Gammarus spp., was discussed in Chapter V.

(iv) Multiplant Effects in the Water Body Segment

Within the water body segment (defined in Chapter IV) there are seven operating generating units and one unit under construction. Oswego Units 1-4 discharge into Oswego harbor, therefore Oswego Unit 5, NMP-1, and the JAF discharges are the major sources of artificial heat into the water body segment. The contribution of heat from Oswego Units 1-4 to the Oswego River varies seasonally depending on river flow, but generally has a small effect on the temperature differential between the river and lake.

Previous analyses of the impact of the thermal component of the discharge of Oswego Units 5 and 6 and NMP-1 (see 316(a) Demonstrations for these units) have indicated that potential effects on representative species (including the same representative species discussed here) were minimal. Many of the basic considerations which limit the probability of effects discussed previously in this document were found to limit potential effects at the other discharges.

In regard to long term effects on representative species, the temperature distributions of the existing thermal plumes are fixed by design, therefore, the impact on representative species and the biological community, which is currently assessed as minimal should not change. The thermal component of the discharge does not alter the physical habitat of the lake and because heat is not retained in the lake, there is no progressive decline in water quality. These characteristics of the thermal plumes preclude the possibility of long term effects on representative important species.

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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			
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 [range[2/]]	28-29(2)	26 (3)		2, 3

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 Dittmer, 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)

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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.

*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 ^{o}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
$25^{o}C$	0	28	0	0	0	0	0	0	0
$25^{o}C$	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

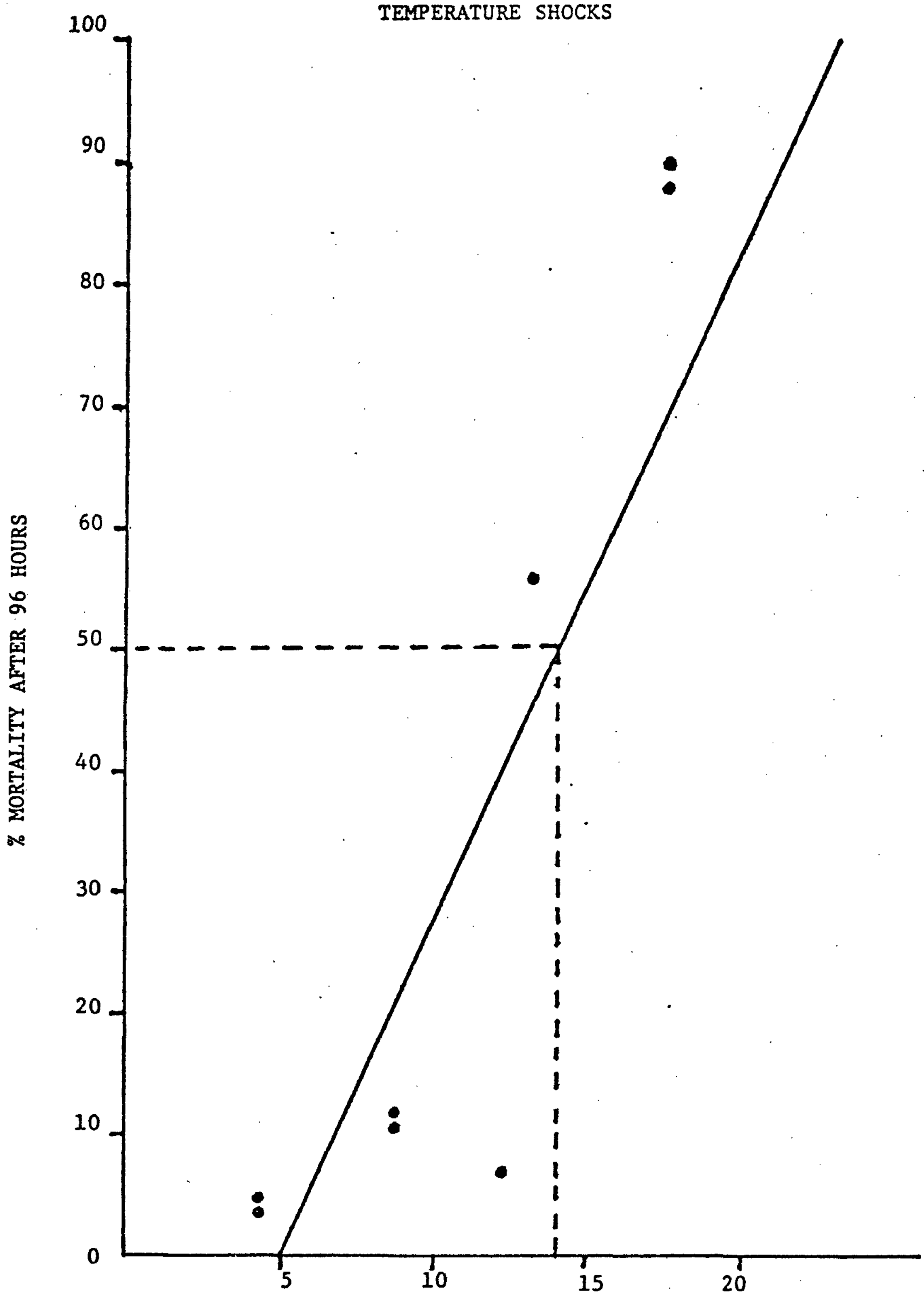
The gills of these fish were brilliant red and the operculum was greatly distended. Of the fish that survived this treatment, all locomotion initially stopped or was severly limited. All of these fish were disoriented for 30 to 90 minutes.

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



Temperature (°C) above
ambient

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. Howe

F.-EL-SHAMY

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

TEMPERATURE EFFECTS ON FISH
JUNE 1972-JUNE 1973

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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:

$$\text{Max. sust. speed} = \text{Last recorded speed} + \frac{\text{time at new increment}}{} \times \text{increment of speed}$$

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

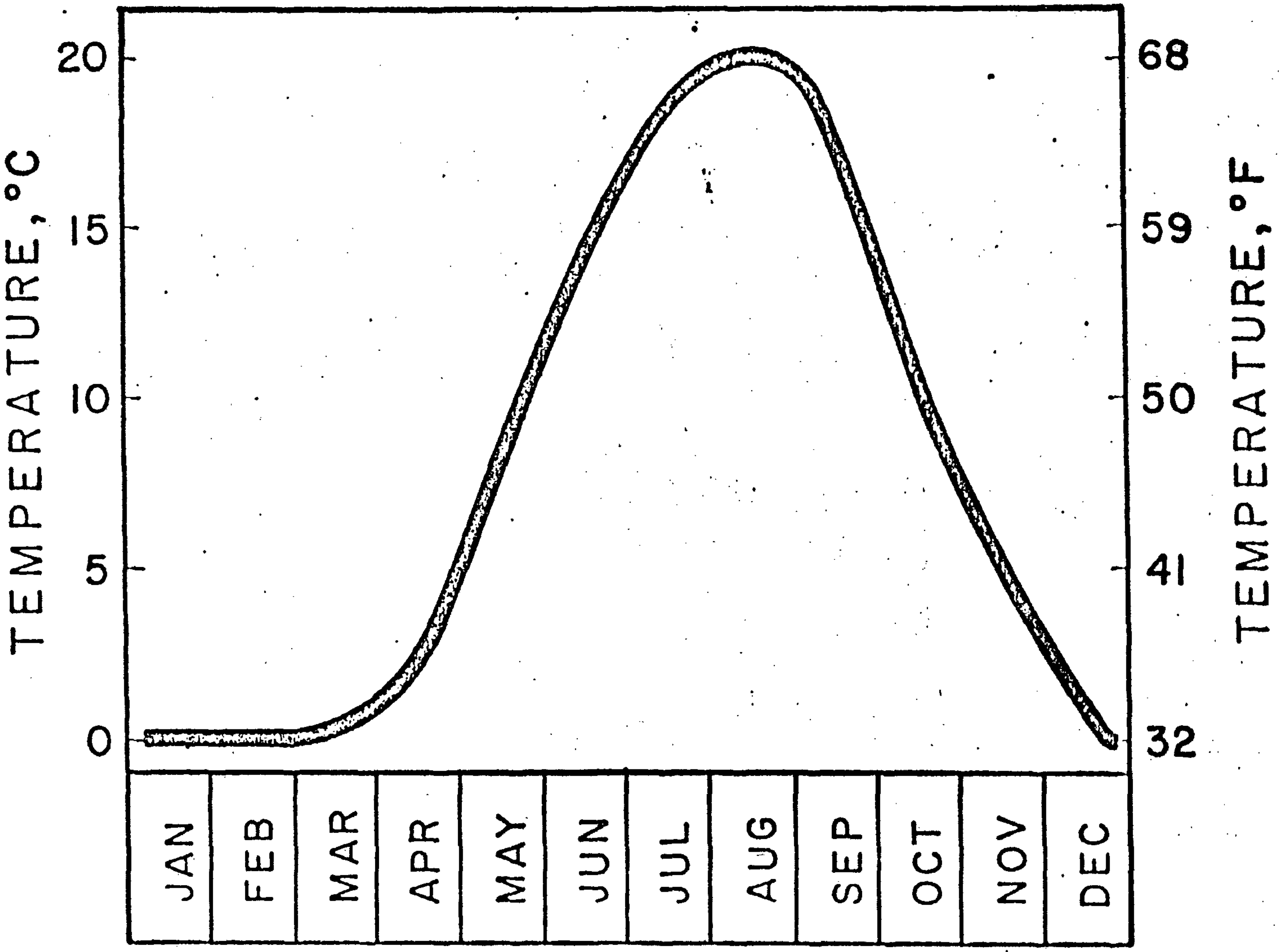

Figure 2. Annual water temperature cycle for the Waukegan-Zion region of Lake Michigan

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:

Swim Speed = 0.62 (Acclimation Temperature) + 21.36
and $r = 0.983$

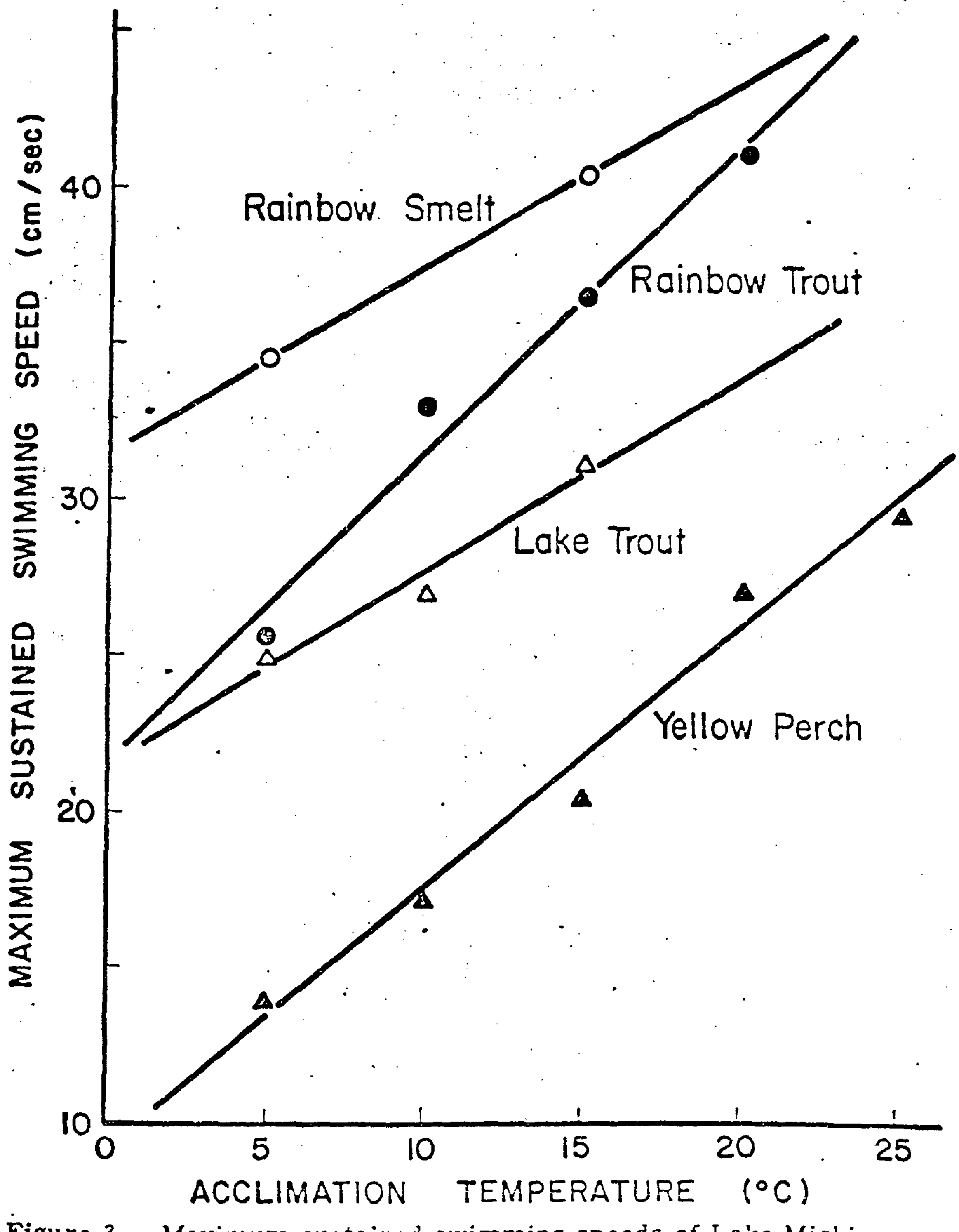

Figure 3. Maximum sustained swimming speeds of Lake Michigan fishes acclimated to constant temperatures. Mean standard lengths of test fish (cm): rainbow smelt, 13.4 cm; lake trout, 14.5 cm; rainbow trout, 10.3 cm; yellow perch, 10.2 cm.

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.

<u>Effects of size:</u> 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

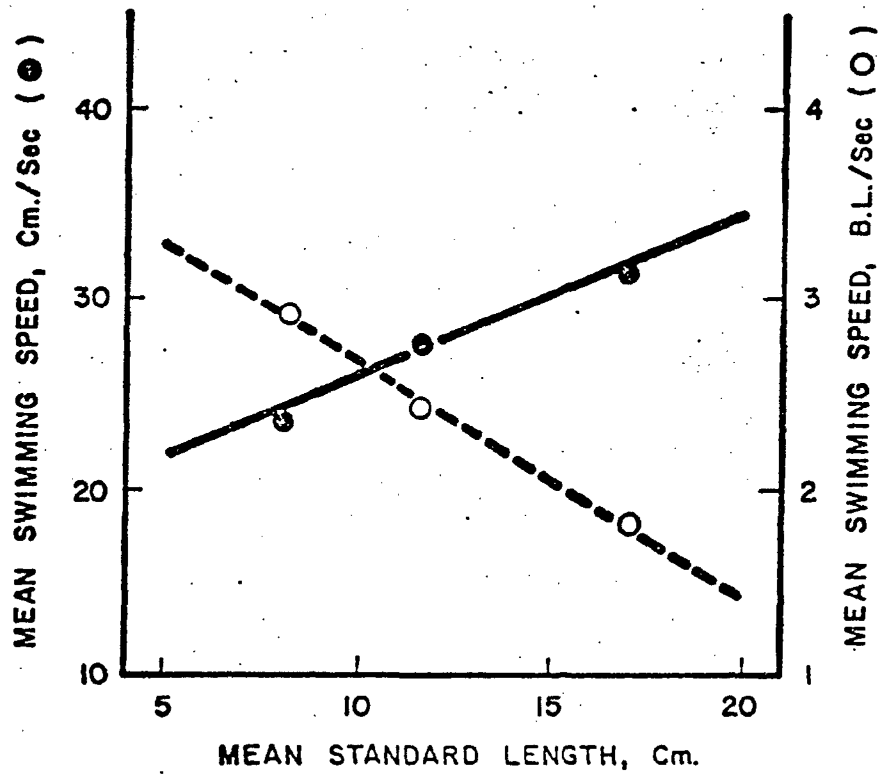

Figure 4. Effects of size on swimming capability of the rainbow trout. Fish were acclimated to 2 C and tested at 4 to 5 C.

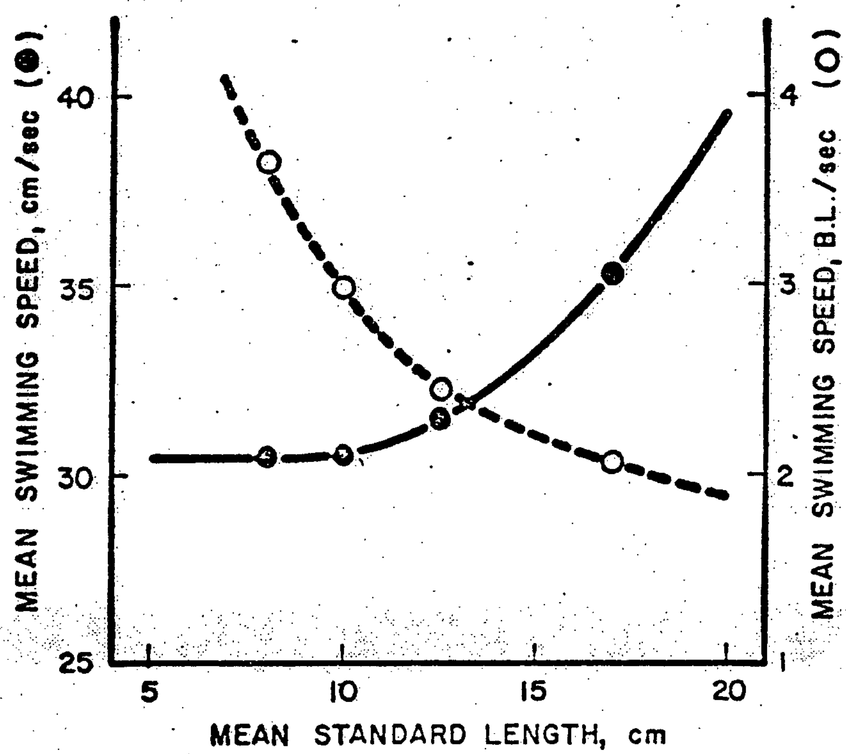

Figure 5. Effects of size on the swimming capability of the yellow perch. Fish were acclimated and tested at 20 C.

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

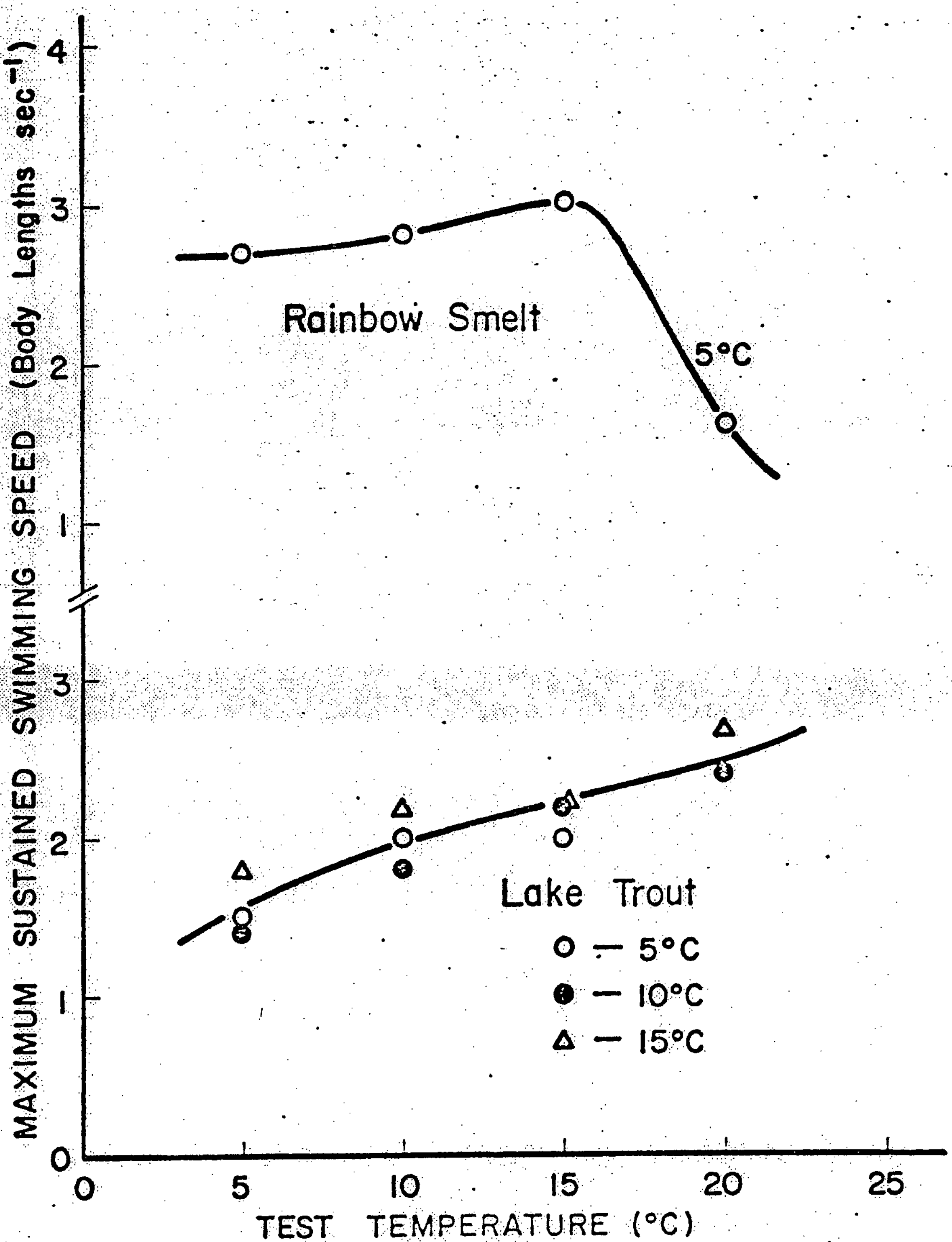

Figure 6. Maximum sustained swimming speeds of rainbow smelt and lake trout following acute changes in temperature. Acclimation temperatures are indicated.

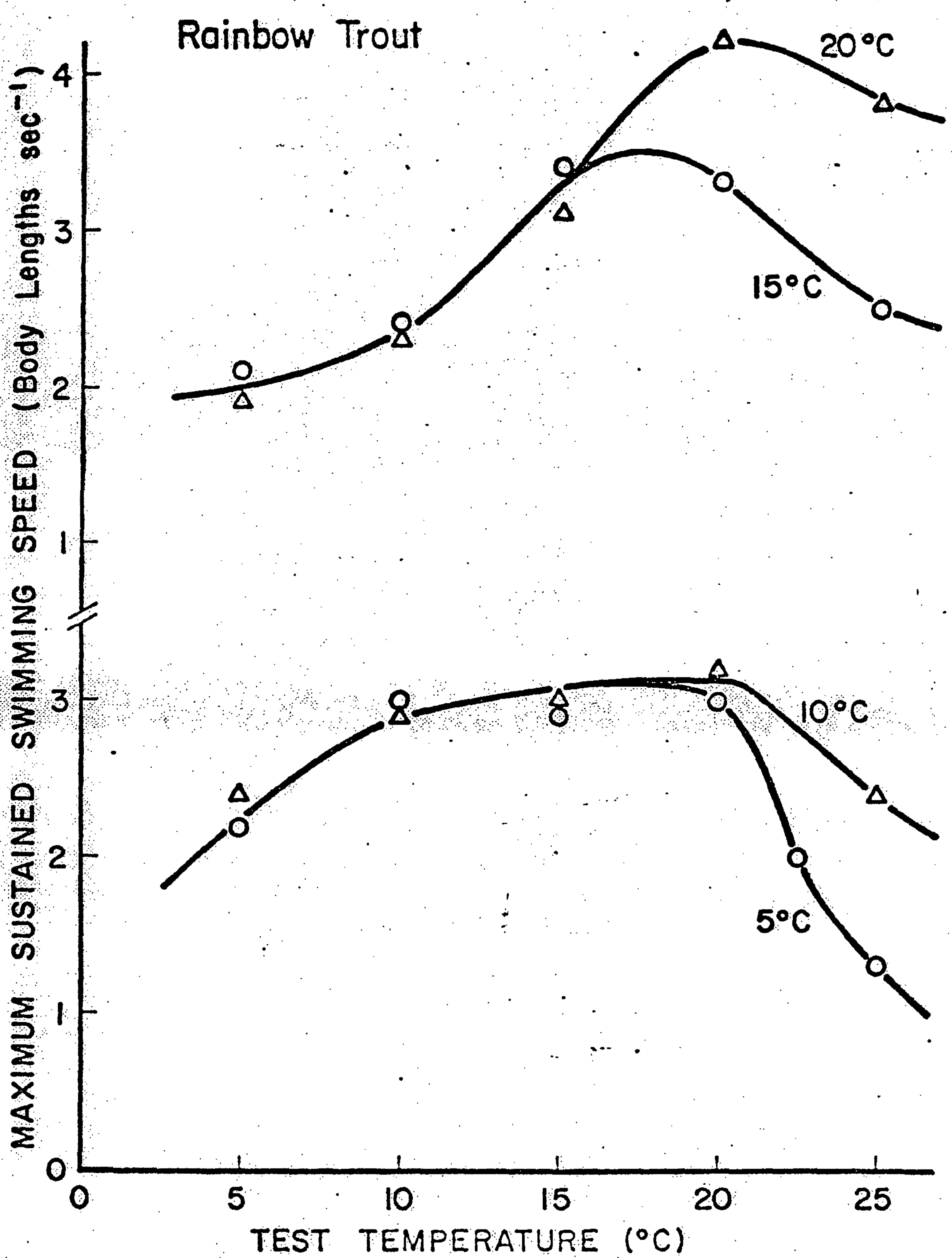

Figure 7. Maximum sustained swimming speeds of rainbow trout following acute changes in temperature. Acclimation temperatures are indicated.

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

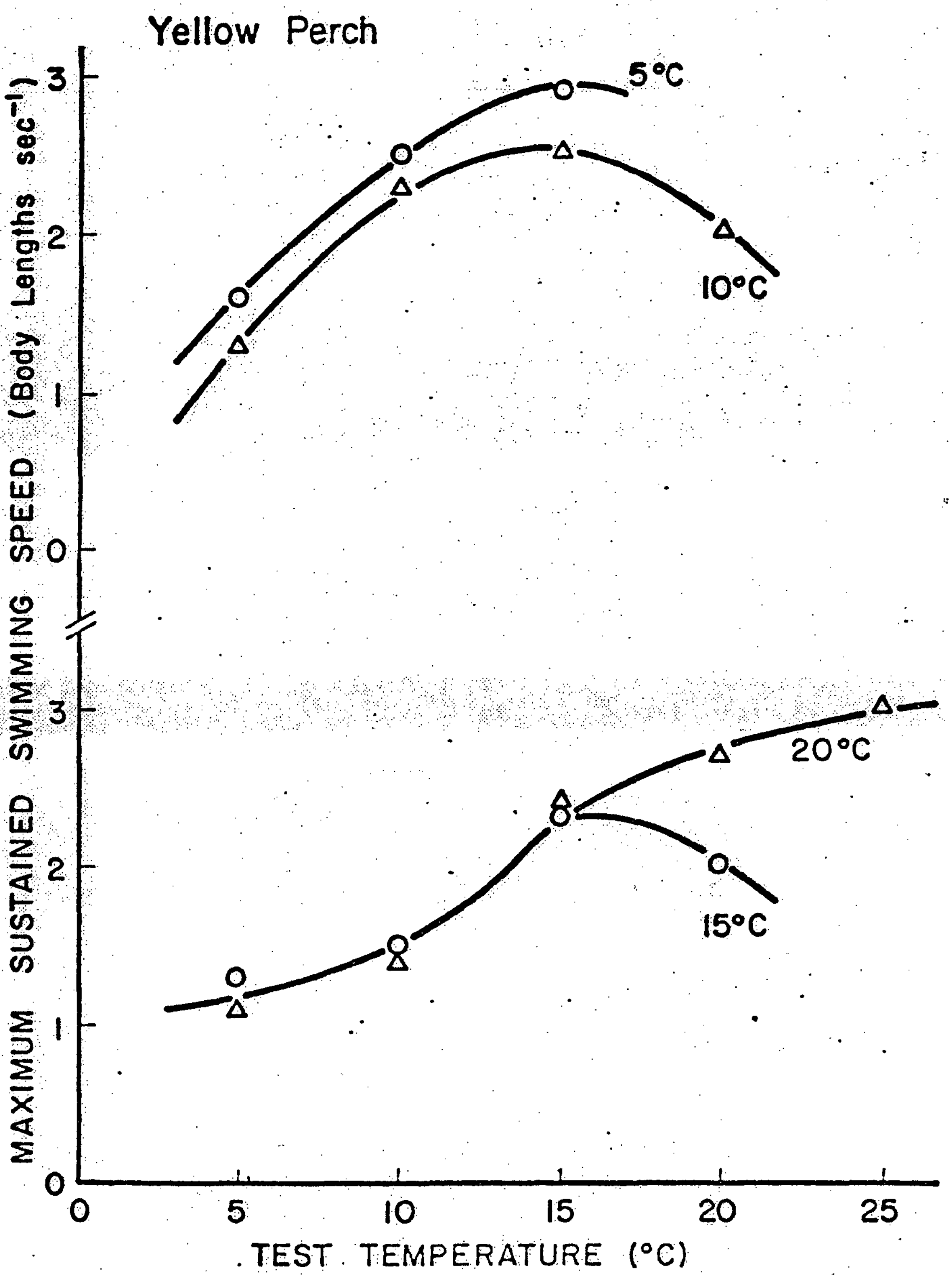

Figure 8. Maximum sustained swimming speeds of yellow perch following acute changes in temperature. Acclimation temperatures are indicated.

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

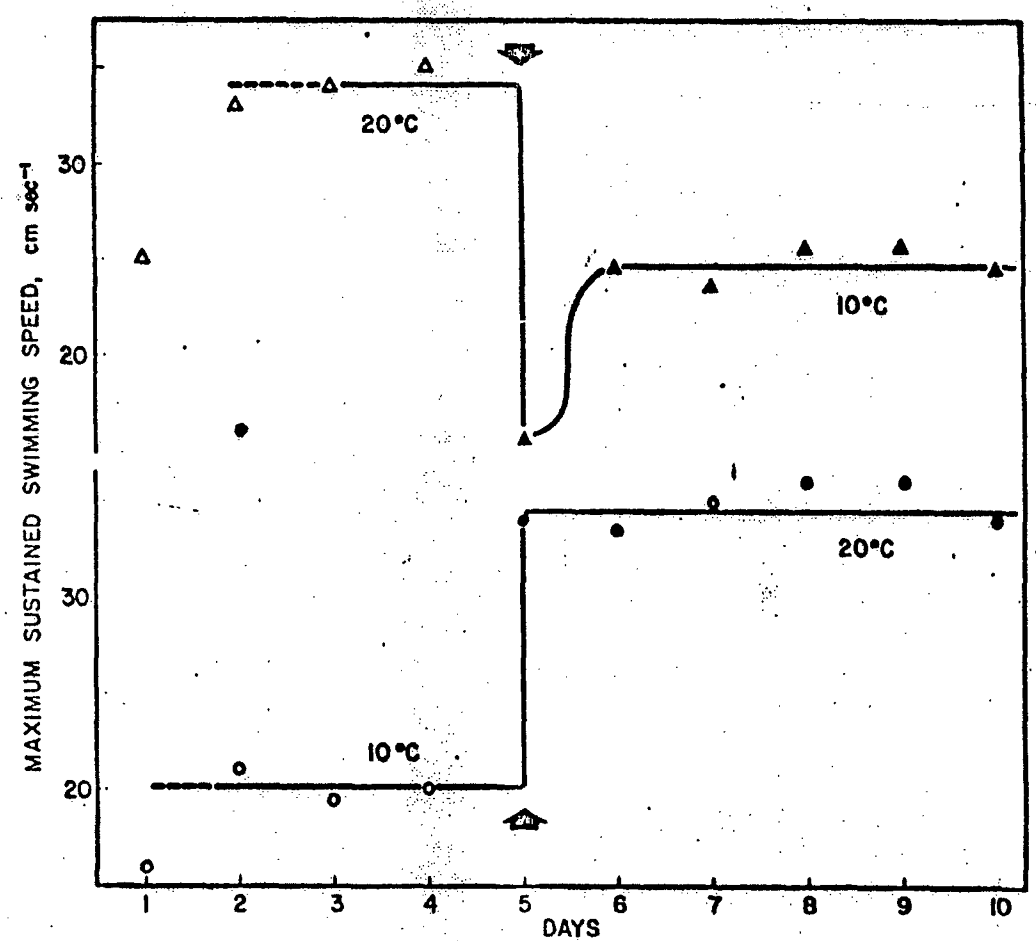

Figure 9. The effects of an abrupt change in temperature on the maximum sustained swimming speed of the yellow perch. The time of temperature change is indicated by arrows.

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

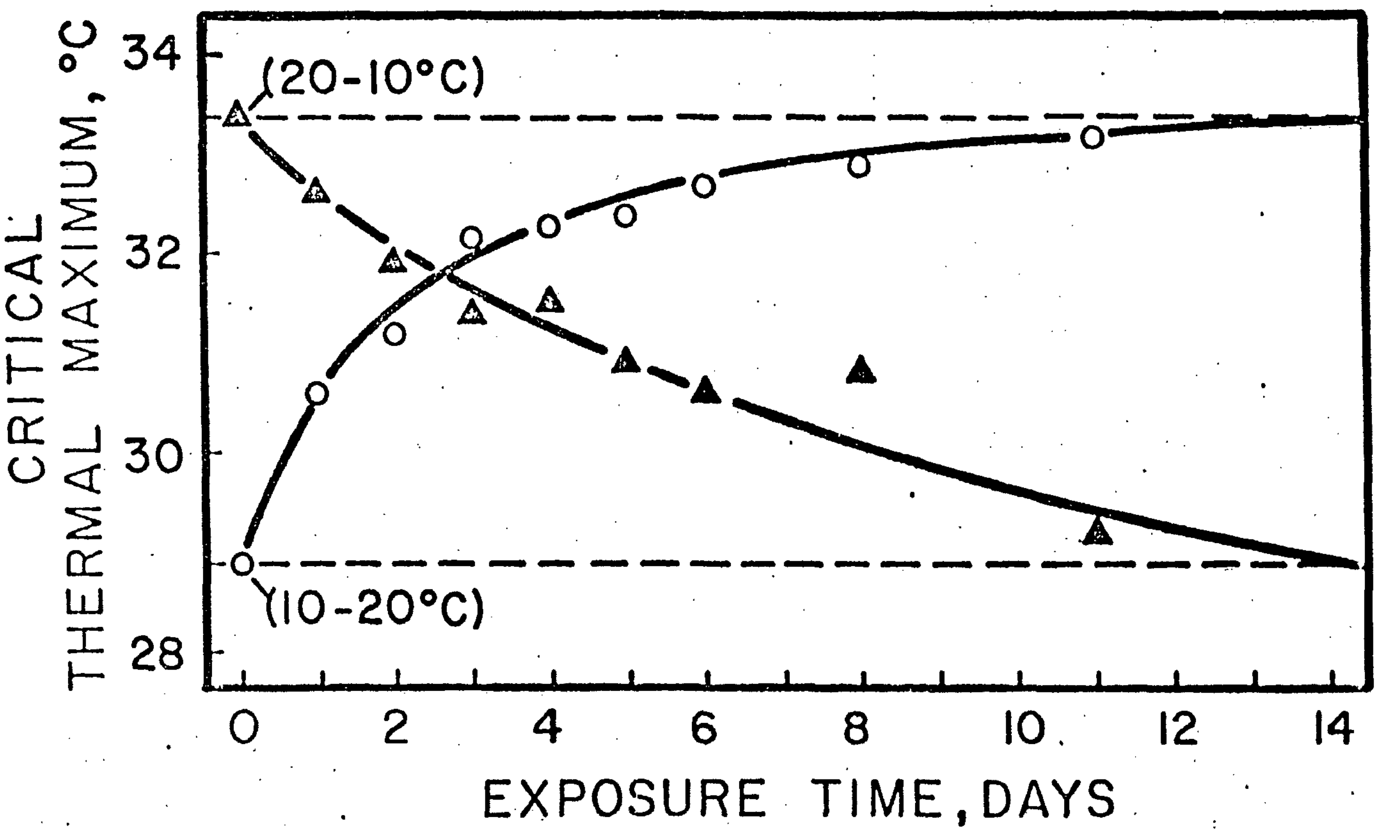

Figure 10. Critical thermal maxima (CTMs) for mature alewives subjected to a 10 C change in temperature.

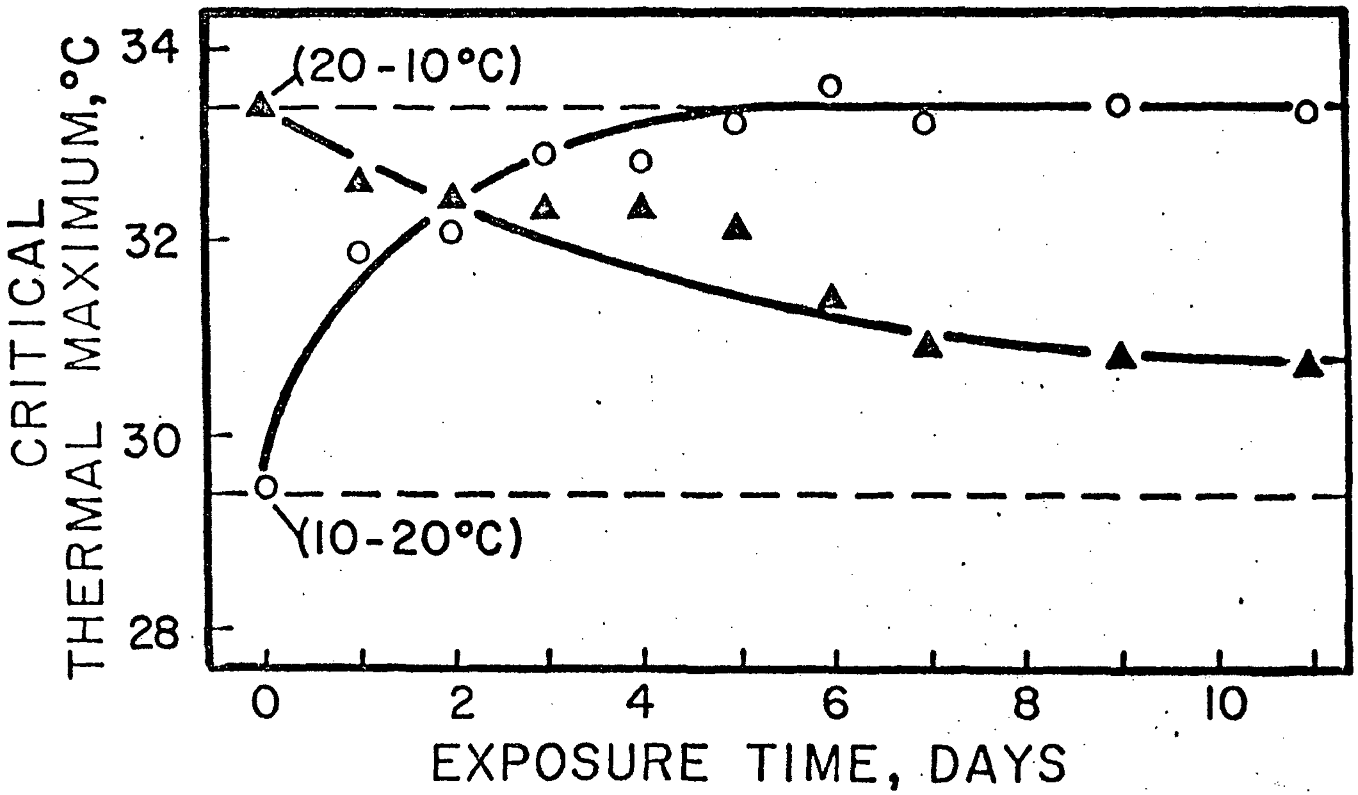

Figure 11. Critical thermal maxima (CTMs) for yellow perch subjected to a 10 C change in temperature.

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

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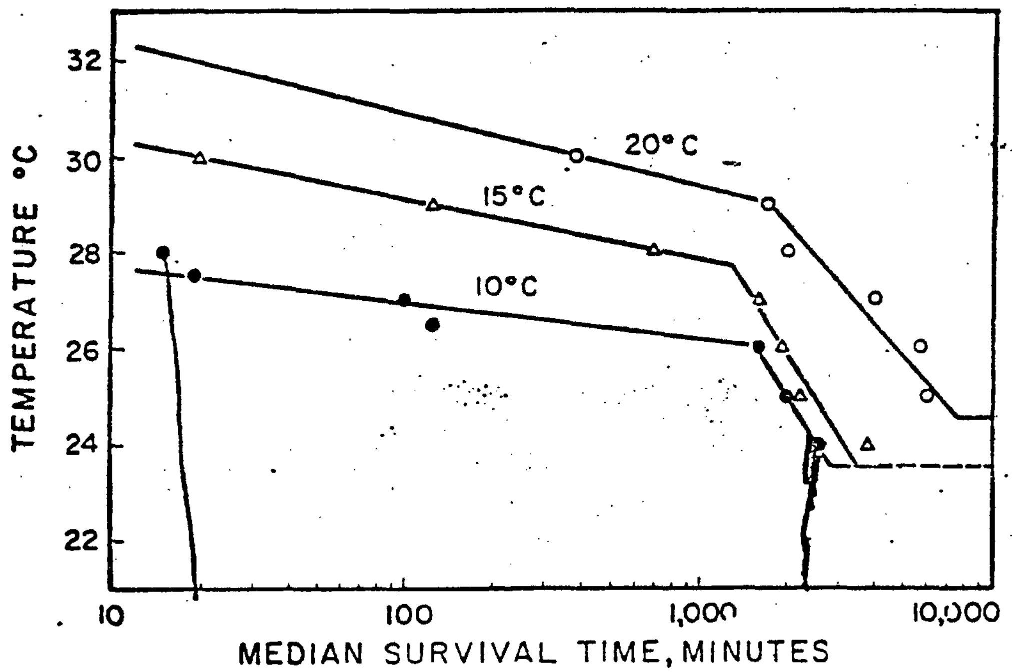

Figure 12. Median survival times for mature alewives subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

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

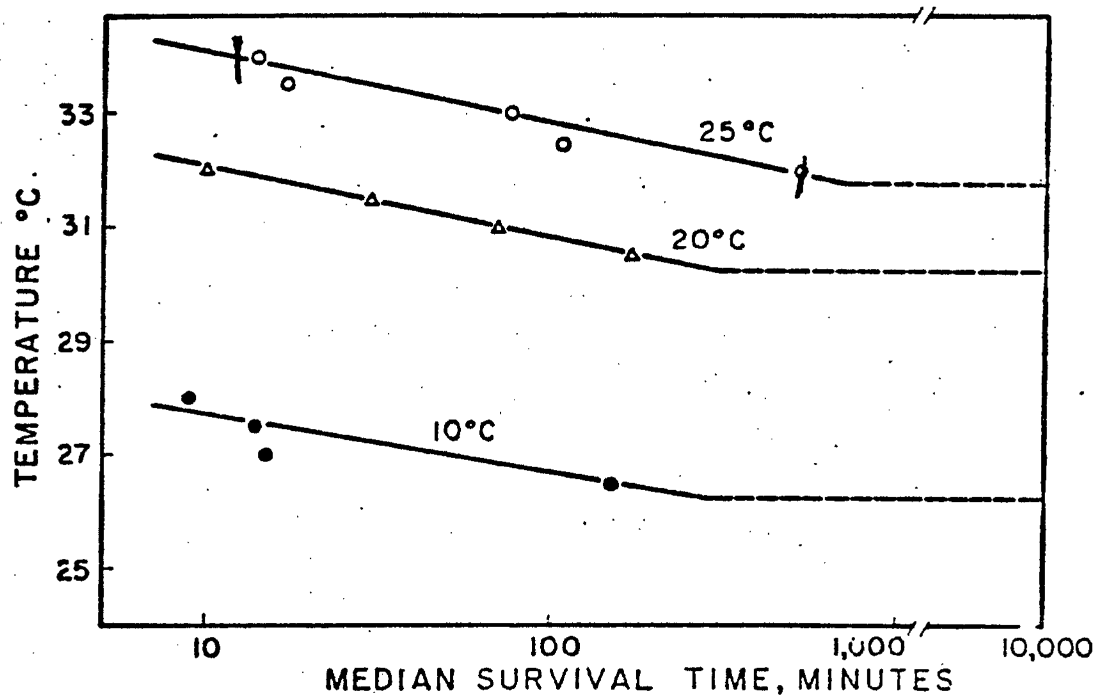

Figure 13. Median survival times for young of year alewives subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

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

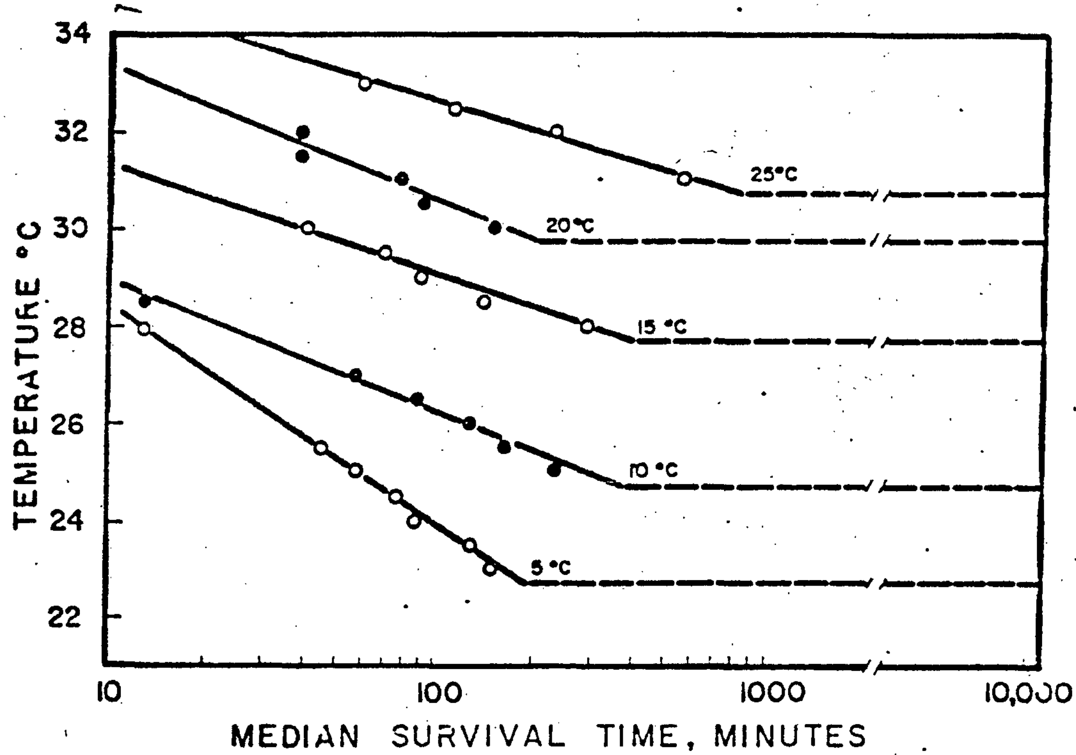

Figure 14. Mean survival times for yellow perch subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

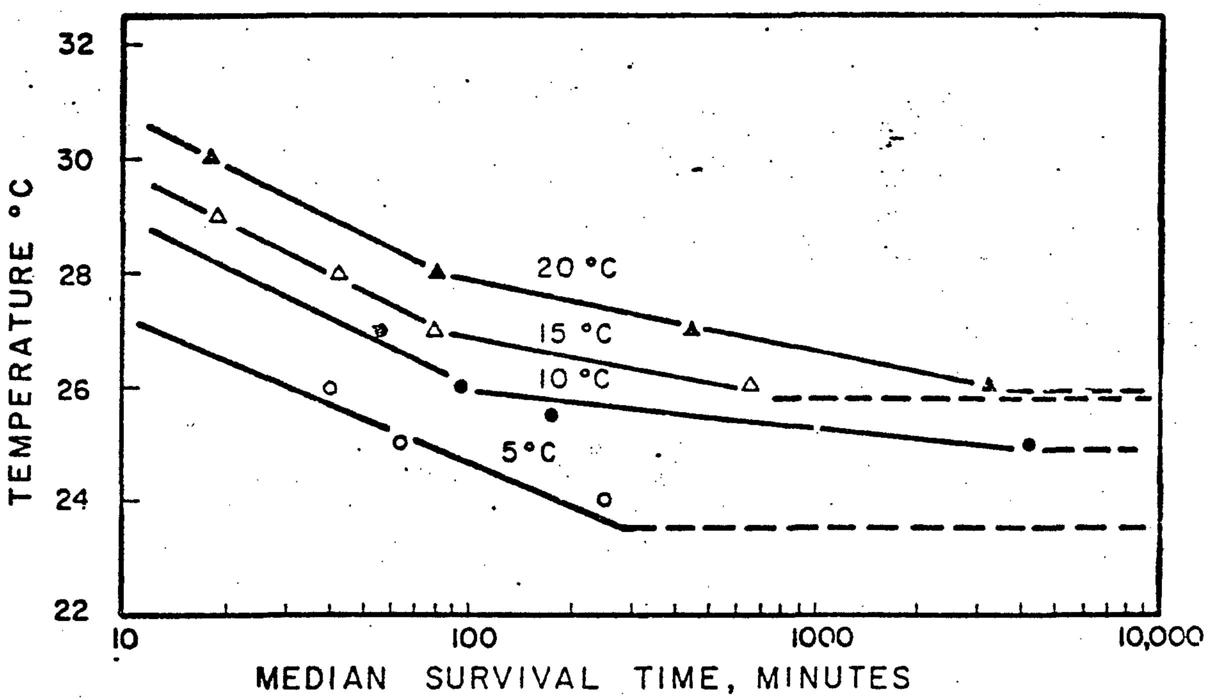

Figure 15. Median survival times for rainbow trout subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

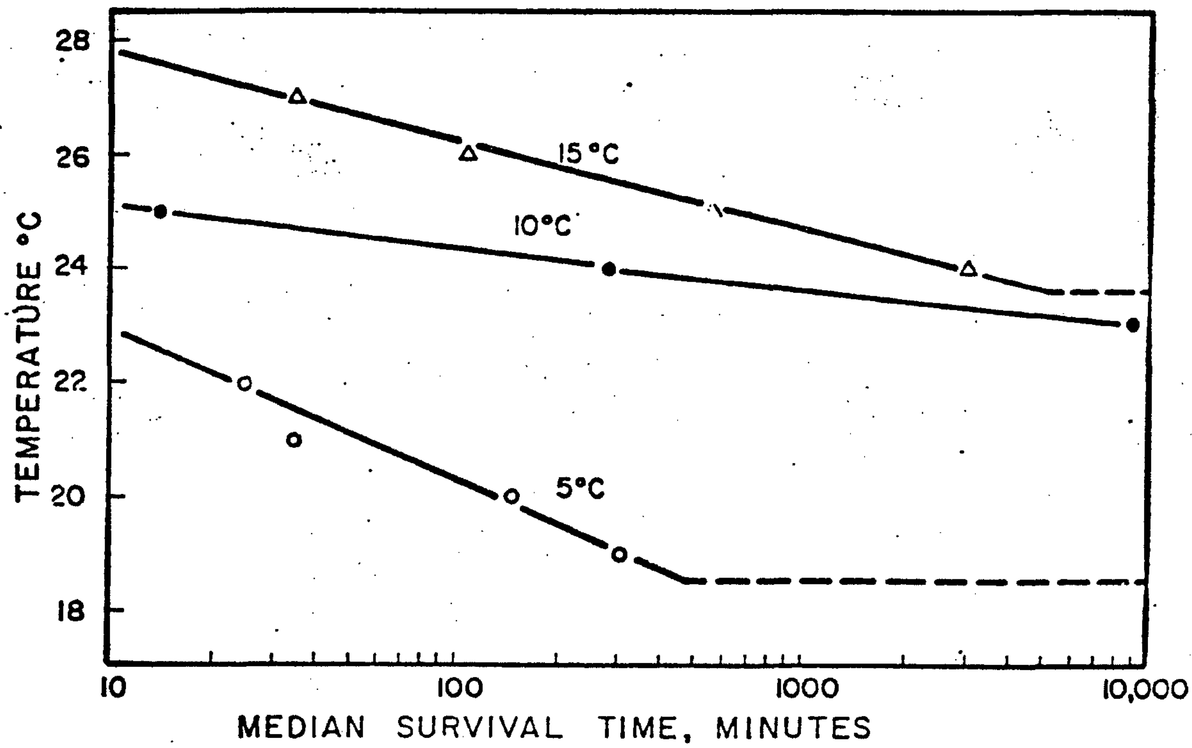

Figure 16. Median survival times for slimy sculpin subjected to an abrupt increase in temperature. Acclimation temperatures are indicated.

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 5-0510

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April 15, 1970

1122-5

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; 4/3/70)

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 Facility Section

TEQ:SG
cc: PASNY: Mr. George
Syracuse Regional Office
Watertown District Office

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

PASNY: Mr. George

April 10, 1970

Mr. R. W. Cumwaldson
Chief Hydraulic Engineer
Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, Mass. 02107

Dear Mr. Cumwaldson:

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.

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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

...NGRAHAM, M.D.
...MISSIONER

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

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. E-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

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

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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.

.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.

COPY

POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N.Y. 10019
212—CO 5-6510

WILLIAM S. CHAPIN
GENERAL MANAGER
THOMAS F. MOORE JR.
GENERAL COUNSEL
ASA GEORGE
CHIEF ENGINEER
GEORGE T. BERRY
DIRECTOR OF
POWER UTILIZATION
JOHN J. GEOGHAN
CONTROLLER

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.

oject Description:

T[illegible] of Ownership:

☐ Municipal	☐ Commercial	☐ 68 Private-Other	☒ 1 Authority	☐ 30 Interstate
☐ Industrial	☐ 6 Sewage Works Corp.	☐ Private-Institutional	☐ 19 Federal	☐ 40 International
	☐ 67 Private-Home	☐ 26 Board of Education	☐ 20 State	☐ 18 Indian Reservation

[illegible]. Type & Nature of Construction:

	Collection	Treatment and/or Disposal
	☐ 1 New	☒ 1 New
	☐ 2 Additions or Alterations	☐ 2 Additions or Alterations

7. E[illegible]imated Cost of Construction:

Collection System N/A Treatment and/or Disposal $6,000,000

8. T[illegible] of Waste: ☐ 1 Sewage ☐ Industrial Specify ☒ Other Specify Thermal

9. Degree of Treatment:

☐ 1 None	☐ 3 Primary	☐ 5 Secondary	☐ 7 Complete
☐ 2 Septic Tank	☐ 4 Intermediate	☐ 6 Tertiary	☒ 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:
James A. Fitzpatrick Nuclear Power Plant	N/A	☐ 1 Continuous ☐ 2 Seasonal ☒ 3 None
14. Design Flow (Gals./day):	**15. Design Equivalent Population (BOD Basis):**	**16. Design Plant Efficiency (% BOD Removal):**
534,000,000	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

6 - diffuser heads - consisting of two nozzles each 2.5 feet in diameter

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.

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)

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.

* 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:

31 Oct 1978

RAY S. HANSEN — Date
Colonel, Corps of Engineers
District Engineer

Permittee hereby accepts the terms and conditions of this permit.

Signature ______ 7-23-78
Permittee — Date

(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.

(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.

(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.

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.

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

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

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.

the discharge structures. 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 curing 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, 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

JOHN F. STORR, Ph.D.
Consultant in Oceanography and Limnology
51 Meadow Lea Drive
Buffalo, New York 14226

Job 3000 N.Y. State License

December 8, 1969

Stone and Webster Engineering Corporation
225 Franklin Street
Boston, Massachusetts, 02107

File in Job Book 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

STONE & WEBSTER ENGINEERING CORPORATIO
225 FRANKLIN STR   BOSTON, MASSACHUSETTS 02107

DATE January 2, 19
J.O. NO. 11825
P.O. NO. PAS - 1611
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 100

DEAR SIRS:

THE FOLLOWING ARE ☒ ATTACHED; ☐ SENT SEPARATELY:

1 COPIES ____ PRINTS ____ REPRODUCIBLES
EACH OF
☐ DRAWINGS ☐ SPECIFICATIONS
☒ 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	☒ INFORMATION
☐ NOTED	☐ NOTED AS REVISED	☐ PRELIMINARY	☐ ADDITIONS	☐ CORRECTIONS	☒ 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,

JW

J. Wainrib

Copies to:
George

GEGoodman
Wainrib
BSMaciejewski
JRPPerry - 3
MStein/Job Book
CCarter (Encl.)

TSForslind/MAG

NOTED DEC 31 1969
NOTED JAN 2, 1970

January 23, 1976

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,

Boyce A. Blac[illegible], Director
Bureau of Industrial Wastes

cc: Syracuse Regional Office
Watertown District Office
Stone & Webster Eng. Corp.

Copy to AGeorge CSGoodman
RDShillady
ABleiweis
JPBurris
HELesser
EEForslind
RCMiller
BBrodfeld
JWainrib

DMStein/Job Bo...
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

B. Pk dfeld   Dick Gilliat   7.6
J.O.No. 11825 L.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.	WEINBERG		

TOPIC: N.Y State Permit

DISCUSSION:

1. Conservation Dept wants to see 1 ft/sec. velocity. (we now have 1.4 ft/s)
   Bentley - Boaners are interested.
   ~~Stream~~
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° cut above. That one should be a in final form.
4. We want details of the design of the intake & the screen.

ACTION REQUIRED:

5. Dr. Shorr - Heckner...?
6. Meeting on SEIR should be expedited.

Donovan's memo ... Dick Gilliat ... their ...

STONE & WEBSTER ENGINEERING CORPORATION

N.Y. State License 7.6

Copy to
ACeorge (2 encs.)
LCNeale (enc.)
LRBurr
WOChatfield (enc.)
NBCleveland (enc.)
CRClaxton
DKFeldtmose
WSRoberts, Jr.
JWaldrib (enc.)
LSMaciejowski
CEGoodman
RDShillady
ABleiweis
JPBurris
HELesser
IEForslind
RCMiller (enc.)
BBrodfeld
DHStein/Jo
Book
General Fi
GEHecker

Mr. Thomas E. Quinn
Acting Chief Industrial Facilities Section
New York State Health Department
84 Holland Avenue
Albany, New York

March 23, 1970
J.O.No. 11825

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

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

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

NOTED MAR 31 1970 R.W.G.

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.

Effluent Characteristics

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?

Construction Discharges

What provisions have been made to protect the receiving water from chemical compounds used during construction of the

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. Gunwaldsen
Stone and Webster Eng. Corp.

ALDEN RESEARCH LABORATORIES
WORCESTER POLYTECHNIC INSTITUTE

30 SHREWSBURY STREET, HOLDEN, MASSACHUSETTS 01520
TELEPHONE: 617 829-4323

NOTED MAR 31 1970 R.W.B.

NOTED APR 1 1970 D.S.H.

March 27, 1970

NOTED APR 2 1970 R.A.B.

Mr. Thomas E. Quinn
[illegible] 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 Corporation 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 forward 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 Reynolds 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 theoretically 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 temperature or % change in temperature should be assigned and that the expected improvement 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 [illegible]-4323

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.

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

to:

CEGoodman
RDShillady
ABleiweis
JFBurris
HELesser
EEForslind

RCMiller
BBredfeld
JWainrib
D.Stein/Job Book
General Files
ISMaciejewski

7.6

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. Weinrib
Project Engineer

ISM:krs

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[illegible]

TEQ:SG
cc: PASNY: Mr. George
Syracuse Regional Office
Watertown District Office

STONE & WEBSTER ENGINEERING CORPORATION

TO:

NECLEVELAND	HELESSER	GAGERRIDGE	AFSHARRY, JR.-3
CRCLAXTON	JPBURRIS	JRGEURTS	CLWHITFORD
DKFELDTHOSE	EEFCASLINO	LRBURR	PD
WSROBERTS, JR.	JPALLEN	RCMILLER	AASMITH
LSMACIEJEWSKI	BERCOFELD	LPWALKER	LBSTEIN/JOB BOOK
CEGOODMAN	JFCAMPELLO	LJPIERCE	GENERAL FILES
RDSHILLADY	RCCARTER	APSTAKUTIS	JWAINRIB
ABLEIWEIS			

BOSTON, MASSACHUSETTS

APRIL 27, 1970

ASA GEORGE, CHIEF ENGINEER
POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE
NEW YORK, N. Y. 10019

File in Job Book 7.6

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

Commercial | 65 Private-Other | |
Sewage Works Corp. | Private-Institutional | 19 Federal |
Home | 25 Board of Education | 20 State | 18 Indian Reservation

Collection: [ ] 1 New [ ] 2 Additions or Alterations
Treatment and/or Disposal: [X] 1 New [ ] 2 Additions or Alterations

Collection System N/A Treatment and/or Disposal $6,000,000

Sewage [ ] Industrial Specify ______ [X] Other Specify Thermal

[ ] 1 None [ ] 3 Primary [ ] 5 Secondary [ ] 7 Complete
[ ] 2 Septic Tank [ ] 4 Intermediate [ ] 6 Tertiary [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

(GPD): ,000,000

15. Design Equivalent Population (BOD Basis): N/A

16. Design Plant Efficiency (% BOD Removal): N/A

such as number, name and capacity of units:

Discharge tunnel - 1,367 feet long
approximately 14 feet x 14 feet in X-sec.

Diffuser tunnel - 774 feet long with 6 diffuser heads

Diffuser heads - consisting of two nozzles each 2.5 feet in diameter

PERMIT TO CONSTRUCT A WASTE DISPOSAL SYSTEM

...nder 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 ... 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:

... construction permit shall be maintained on file by the permittee.

... permit is revocable or subject to modification or change pursuant to Article 12 of the Public Health Law.

THAT the facilities shall be fully constructed and completed in compliance with the engineering report, plans and specifications as approved.

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.

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

[signature]

Designated Representative

DATE 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)

STATE OF N...

DEPARTMENT OF HEALTH

84 HOLLAND AVENUE
ALBANY, NEW YORK 12203

DEPUTY ...

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.

13640

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POWER AUTHORITY OF THE STATE OF NEW YORK
10 COLUMBUS CIRCLE NEW YORK, N.Y. 10019
212—CO 5-6510

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.

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 accuracy, 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

DPH:GMS

CRClaxton
DKFeldtrose
WSRoberts, Jr.
JWainrib
LSMaciejewski
CLWhitford
CEGoodman
ABleiweis
HELesser
EEForslind
DMStein/Job Book
General Files
DPMcKittrick

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

July 15, 1970

J.O.No. 11825
PAS-2774

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."

...that a study proposed by Dr. J. J. Storr for the summer of 19.. 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] No. 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

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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,

CEGoodman
DStein/Job Book
General Files
BBrodfeld

Mr. W. S. Chapin
General Manager
Power Authority of the State of New York
10 Columbus Circle
New York, N.Y. 10019

February 6, 1969

J.O.No. 11825
PAS Nos. 241
242

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. Weinrib
Project Engineer

Enclosures

BB:MLS

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.

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.

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 G. Burdick
Stone & Webster Engineering Corporation	Messrs.	B. Brodfeld G.E. Hecker

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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.

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.

?.No. 11825
? 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

TWPhilbin (1 enc.)

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

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

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.

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.

Mr. 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.

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.

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

WBAllred
NBCleveland
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

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.

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.

J.O. No. 11829
PAS No. 2151

Cont
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

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.

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 latters request. Items covered were Hydrothermal 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.

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

DATE March 29, 1971
J.O. NO. 11325
P.O. NO.
LETTER NO. PXS-2579
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:

THE FOLLOWING ARE ☐ ATTACHED ☐ SENT SEPARATELY

1 COPIES ___ PRINTS ___ REPRODUCIBLES

EACH OF
☐ DRAWINGS ☐ SPECIFICATIONS
☒ 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	☐ INFORMATION
☐ NOTED	☐ NOTED AS REVISED	☐ PRELIMINARY	☐ ADDITIONS	☐ CORRECTIONS	☐ 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.

IMPORTANT SHOULD ANY REVISION TO DRAWING(S) RETURNED HEREWITH INVOLVE A PRICE INCREASE, THE SUPPLIER MUST NOTIFY STONE & WEBSTER PURCHASING DEPARTMENT WITHIN TEN (10) DAYS EVEN THOUGH A DEFINITE ESTIMATE CAN NOT BE GIVEN AT THIS TIME, OTHERWISE, THE PURCHASER WILL CONSIDER THE REVISIONS MADE WITHOUT COST.

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

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 Plai

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) — Major Drainage Basin: Lake Ontario
Surface water: Class A — Name of Receiving Water: Lake Ontario
Ground water: Class — 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

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, P.E.
Chief
Industrial Works Section

AA/dt
Attachment

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)

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;

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.

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.

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:

Detergent Drainage (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.

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.

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.

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 2

Chemical Discharge Associated With Cation-Anion Demineralizer Regeneration Wastes*

onstituent	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% H_2SO_4 added for neutralization - Based on average makeup water requirement of 50 gpm.

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.

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

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.

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 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.

REPORT ON LIQUID WASTE SYSTEMS

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

POWER AUTHORITY OF THE STATE OF NEW YORK

APRIL 20, 1973

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

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

Atts. 2

bcc. w/att. - Messrs. Cleveland, Wahrib, Goodman, Burt, Clancy
PASNY- Messrs. George, DeCarolis, Cicolo, Chilasi, Cla[illegible]
Hausmann, Leopold, Lilly, Davison, Wi[illegible]

PROJECT MANAG[illegible]
APR [illegible]

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

[Ne]w York State Department of Environmental Conservation
[illegible] 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.

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.

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:

FISH KILL CONTINGENCY PLAN

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

SCRIBA, NEW YORK

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 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 3, 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.

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 8

Condition 8 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)

(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.

(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.

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.

"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.

(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:

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.

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

(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.

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).

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

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)

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

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.

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.

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

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 overpopulated 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

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.

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

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:

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

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

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

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

COPY

POWER AUTHORITY OF THE STATE OF NEW YORK

10 COLUMBUS CIRCLE NEW YORK, N. Y. 10019

(212) 265-6310

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. Toomis/NMPC, J. Helland/Eng. Files

CONCURRENCES (INITIAL & DATE)

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.

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

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

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
<u>316(a) and 316(b) Study Plans</u>

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				

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

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

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

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:

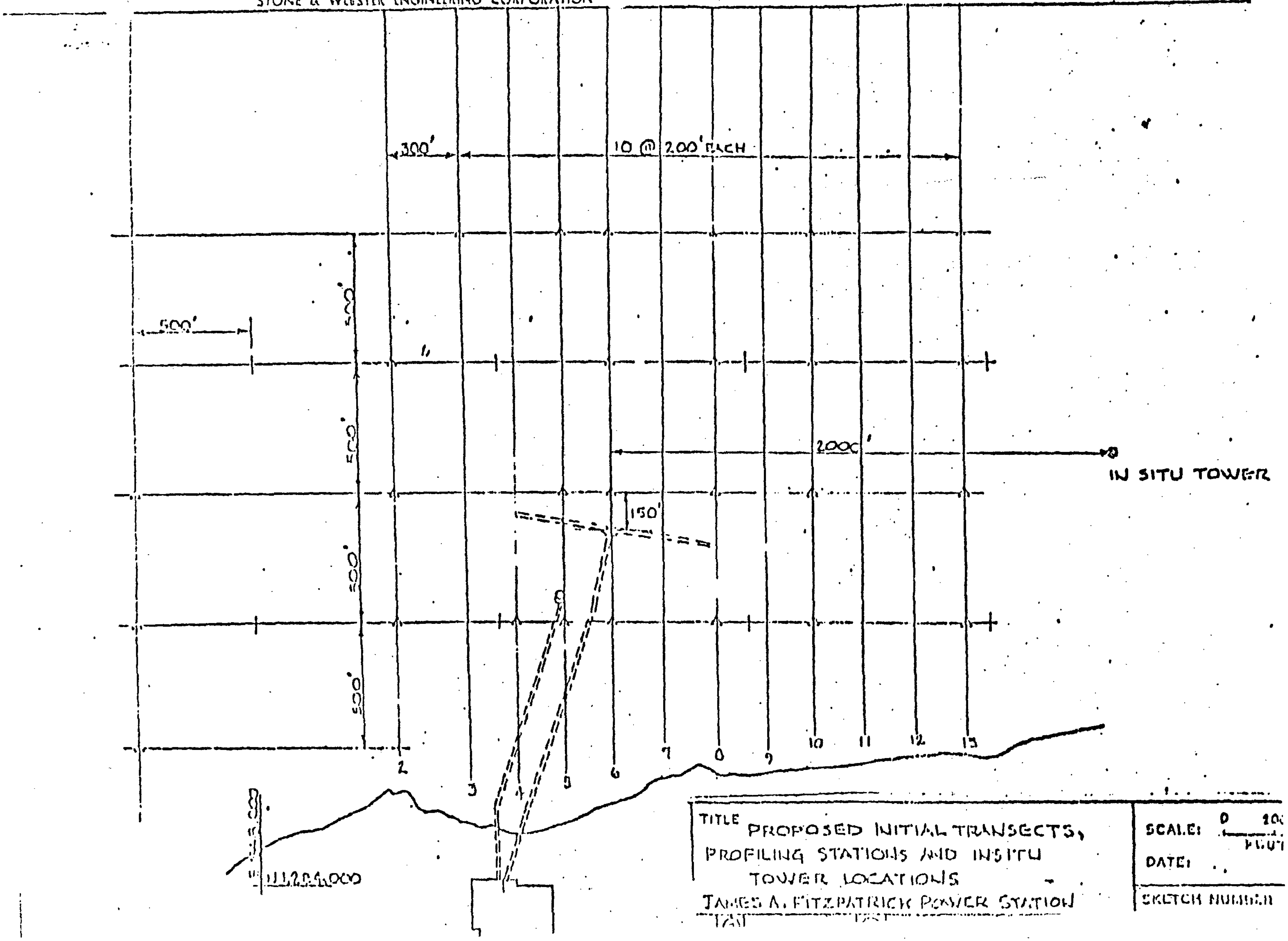
As a follow up to our meeting with your staff on December 8, 1975, we are submitting the following information:

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.



TITLE PROPOSED INITIAL TRANSECTS, PROFILING STATIONS AND INSITU TOWER LOCATIONS

JAMES A. FITZPATRICK POWER STATION

SCALE: 0 100 FEET

DATE:

SKETCH NUMBER

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.

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.

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.

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:

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

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 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.

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 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.

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

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.

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 Screenwall

7.4 Survey Log

8.0 REPORTS

3.2 Temperature

4.0 SURVEYS

4.1 Transects

4.2 Temperature Measurements

4.3 Dye Measurements

4.3.1 Background Flourescence

4.3.2 Dye Release

4.3.3 Dye Studies

5.0 STONE & WEBSTER COORDINATION

6.0 INSTRUMENT CALIBRATION AND ACCURACY

6.1 Accuracies

6.2 Calibration

7.0 DATA REDUCTION

7.1 General

7.2 In Situ Station Data

J.O.No. 11825

SCOPE OF HYDROTHERMAL FIELD SURVEYS

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

POWER AUTHORITY OF THE STATE OF NEW YORK

1.0 INTRODUCTION

2.0 GENERAL SCOPE OF WORK

2.1 Conduct of Field Surveys

2.1.1 In Situ Station

2.1.2 Surveys

2.2 Contractor Responsibility

2.3 Periods of Investigation

3.0 MEASUREMENTS AT THE IN SITU STATION

3.1 Current

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)					

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) | 3/31/76 | 3/31/76 | | |

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

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

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]			

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, Ph.D.
Deputy Commissioner for
Programs and Research

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.

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).

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.

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.

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

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

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.E., Chief
Energy and Thermal Wastes Section
Water Facilities Branch

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;

APPENDIX D

WATER QUALITY RELATED COMMUNICATIONS

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

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: 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	Nine Mile Pt E-6	7/ 5/74	3	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: 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: 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: 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
[+ 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: 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: 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

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 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

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: 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: 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: 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: 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
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
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
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
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
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
[+ 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: 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: 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
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
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
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
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
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
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
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
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
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
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
[+ 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: 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: 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
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
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
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
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
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
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
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
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
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
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

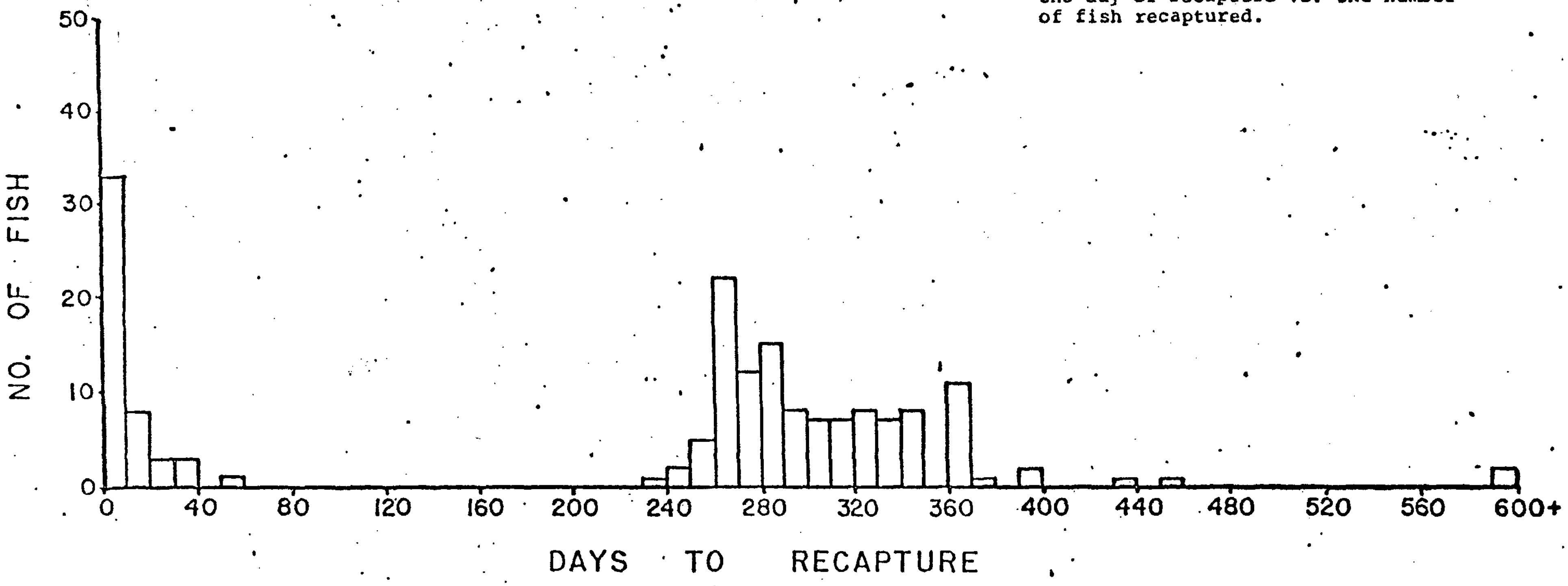
APPENDIX 1

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

APPENDICES

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



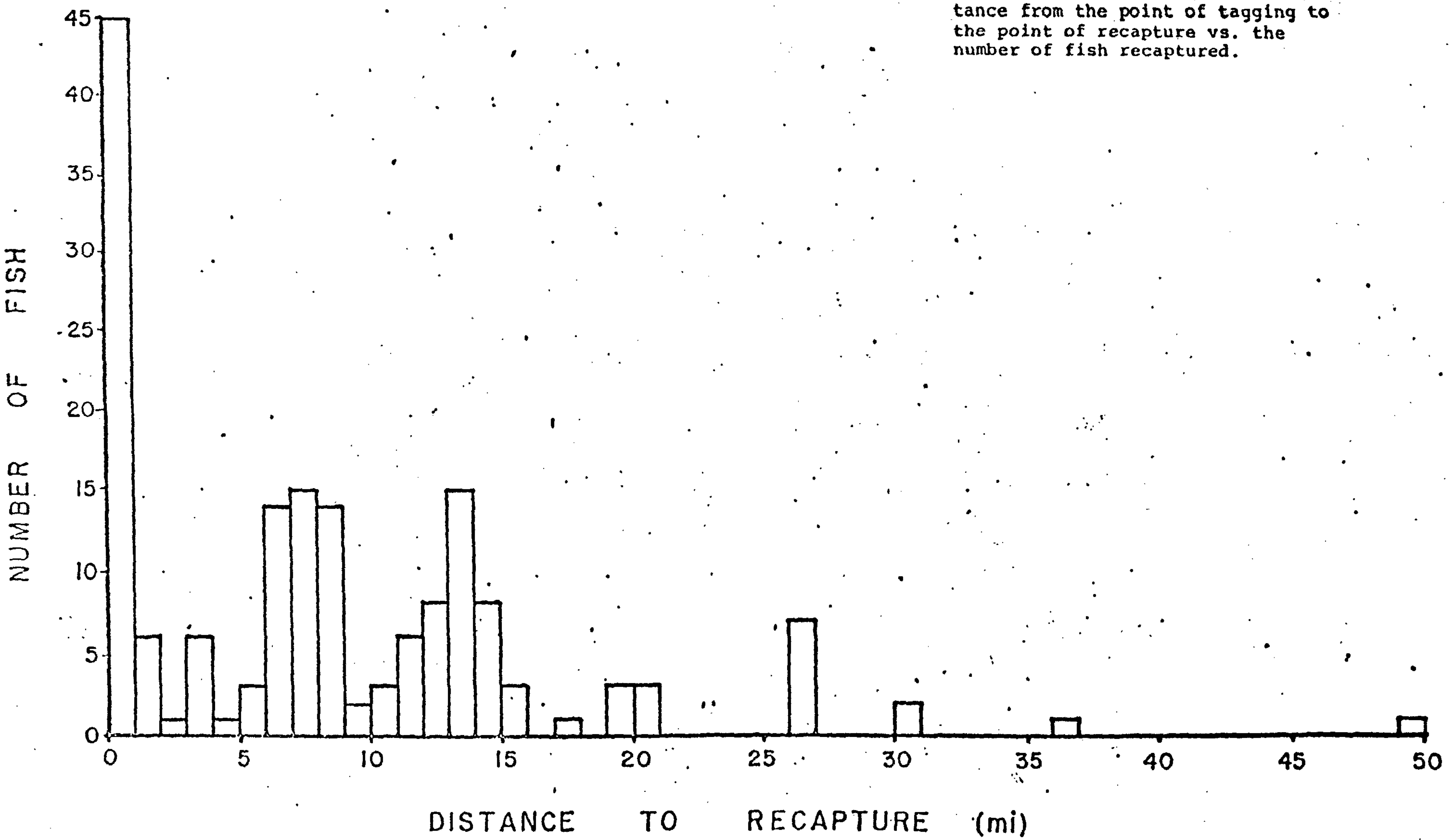


FIGURE 8 - Brown bullhead: The distance from the point of tagging to the point of recapture vs. the number of fish recaptured.

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

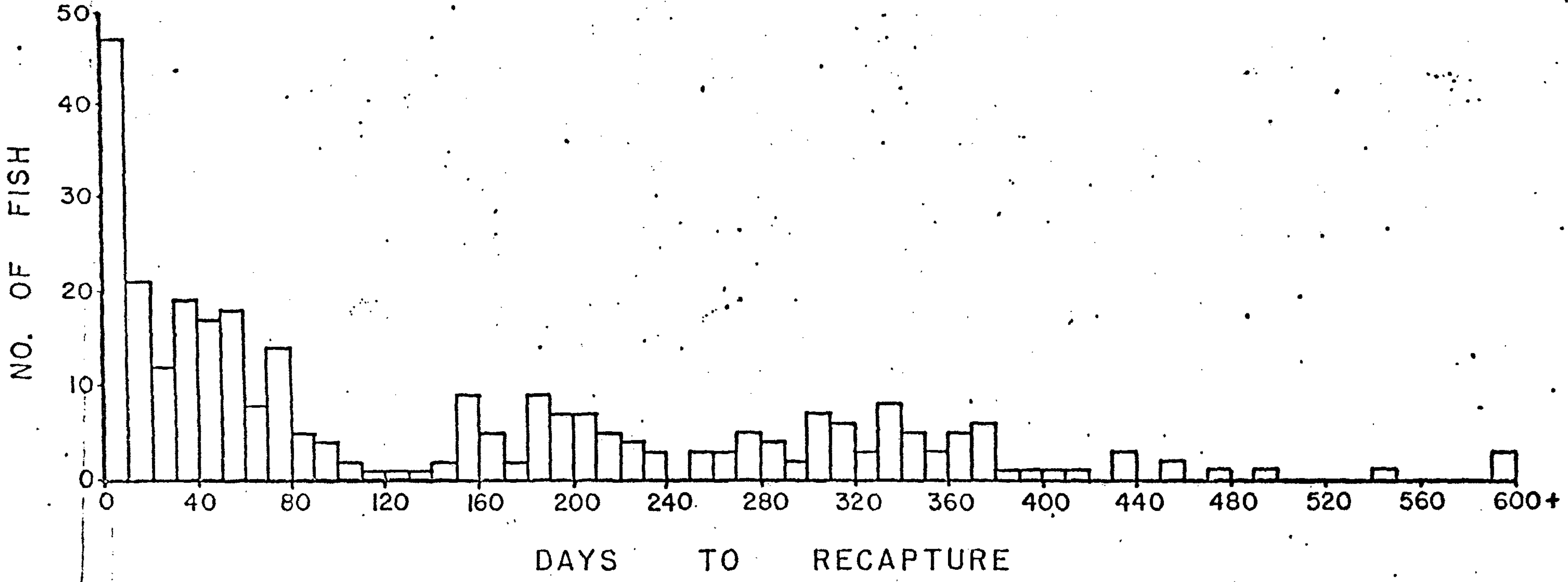
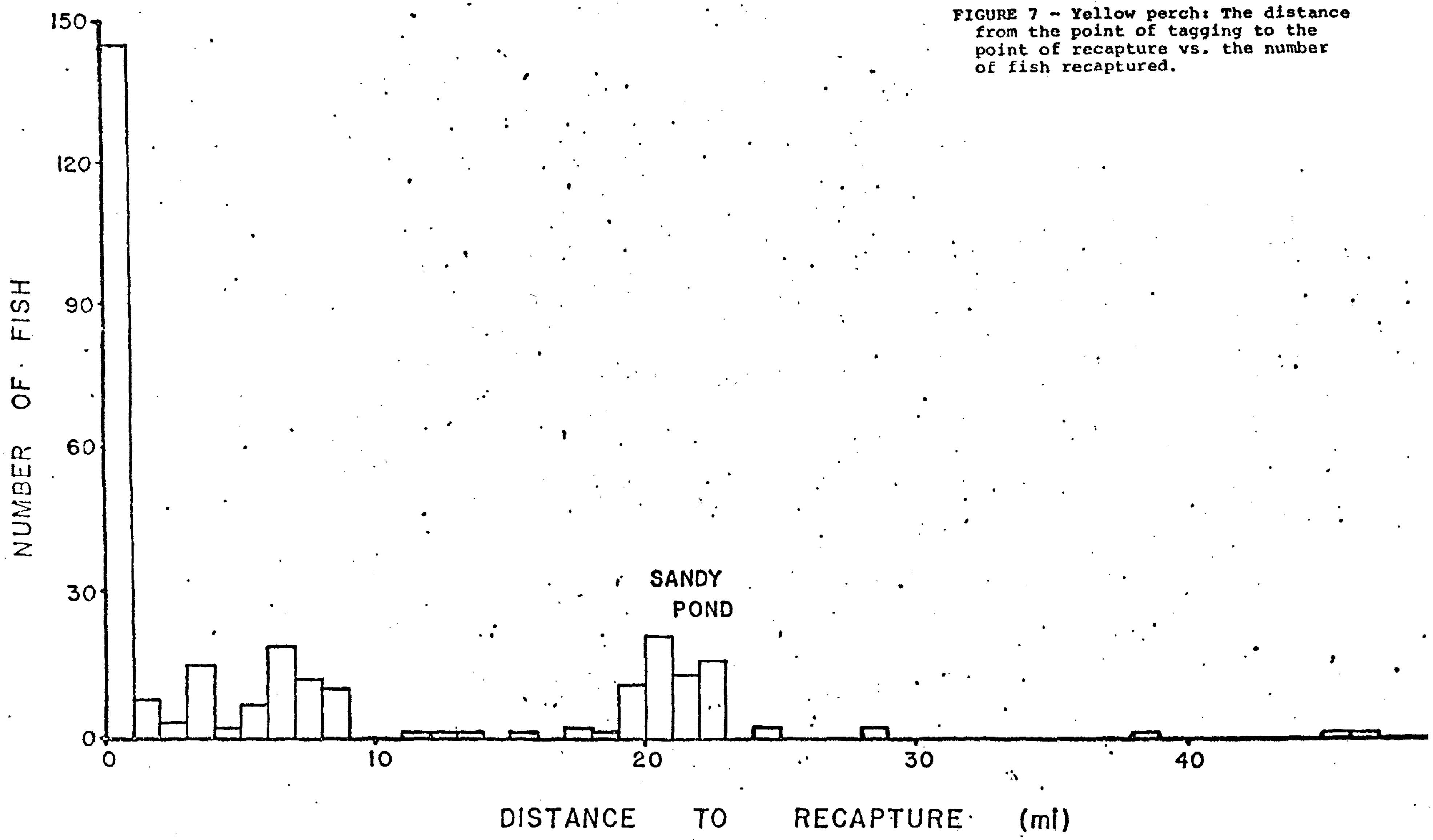
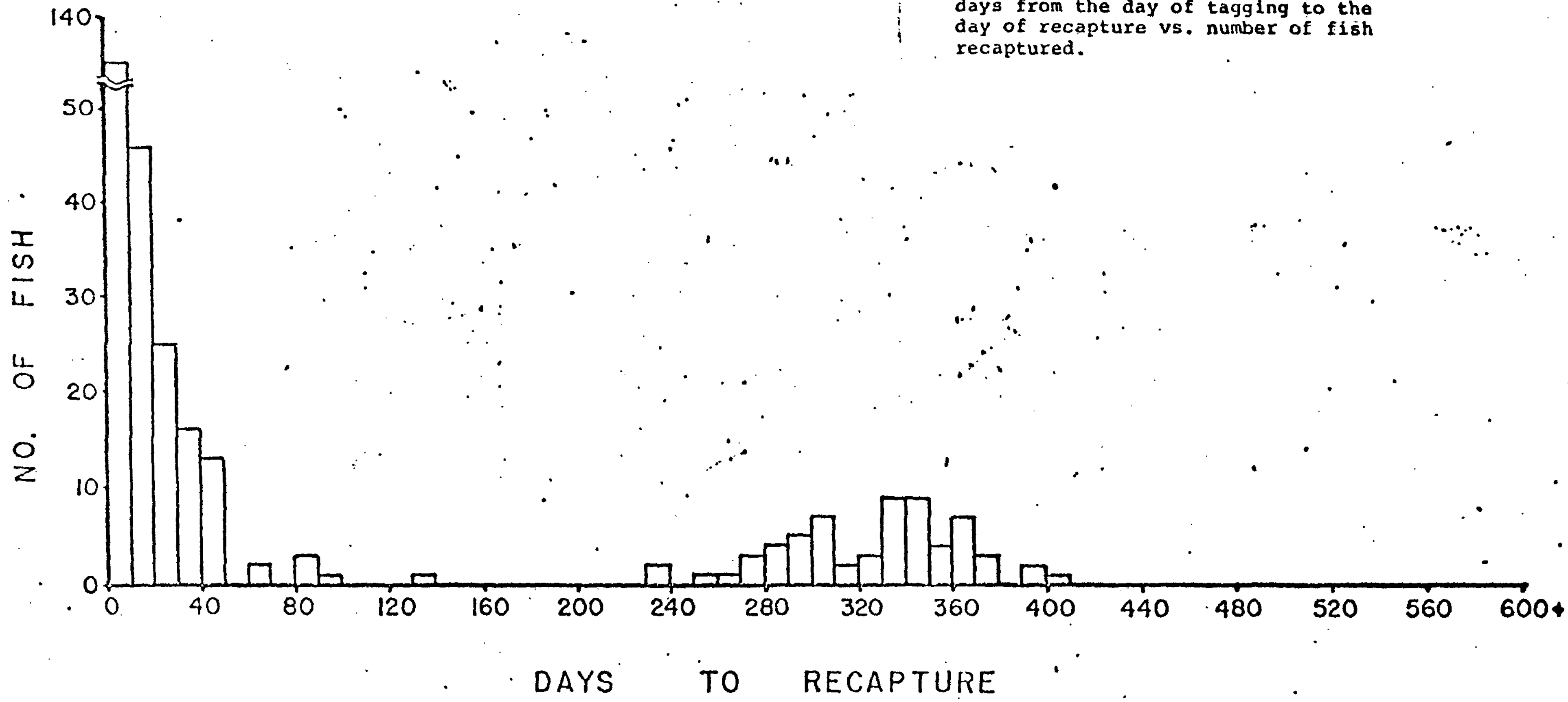


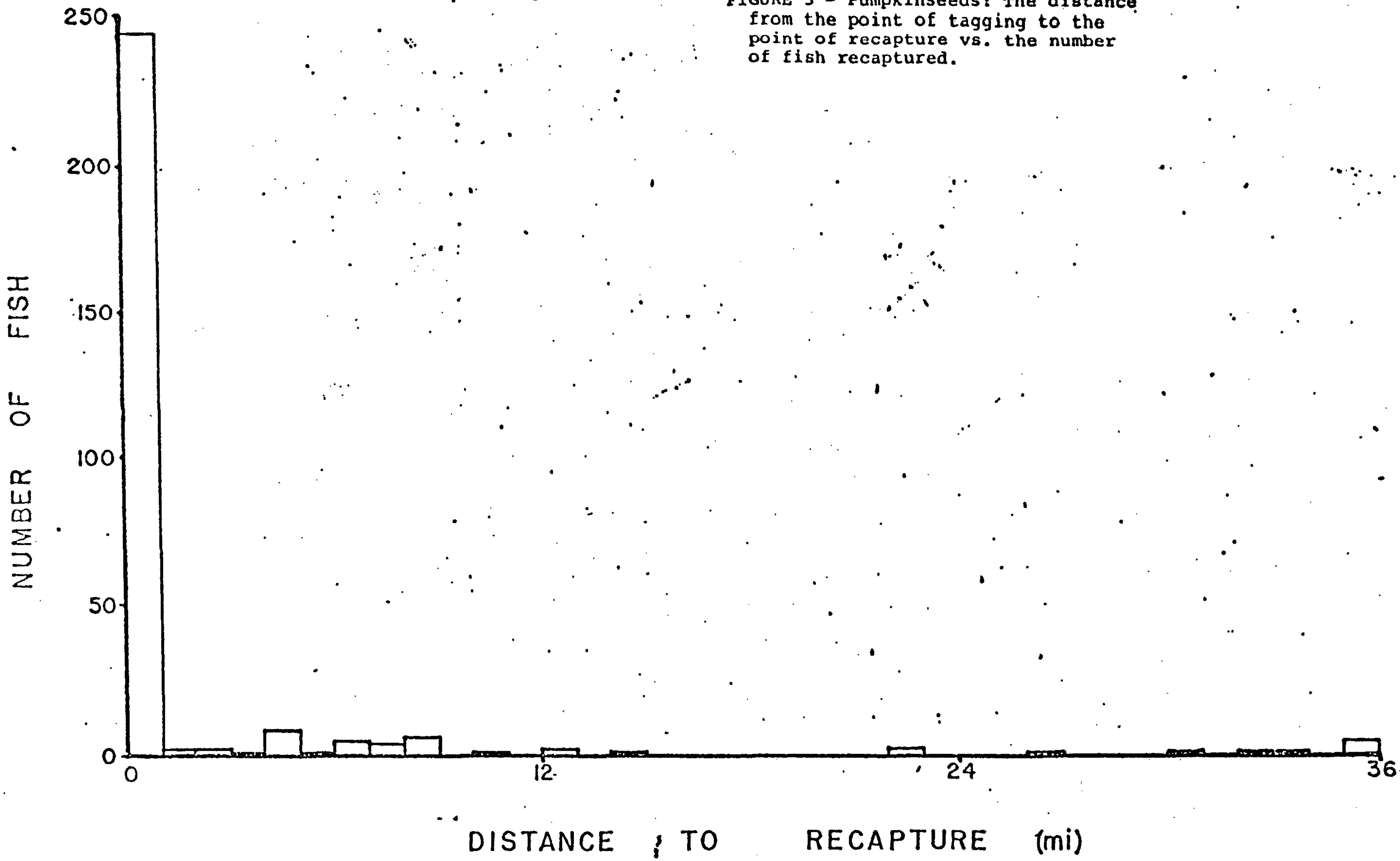
FIGURE 7 - Yellow perch: The distance from the point of tagging to the point of recapture vs. the number of fish recaptured.





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

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



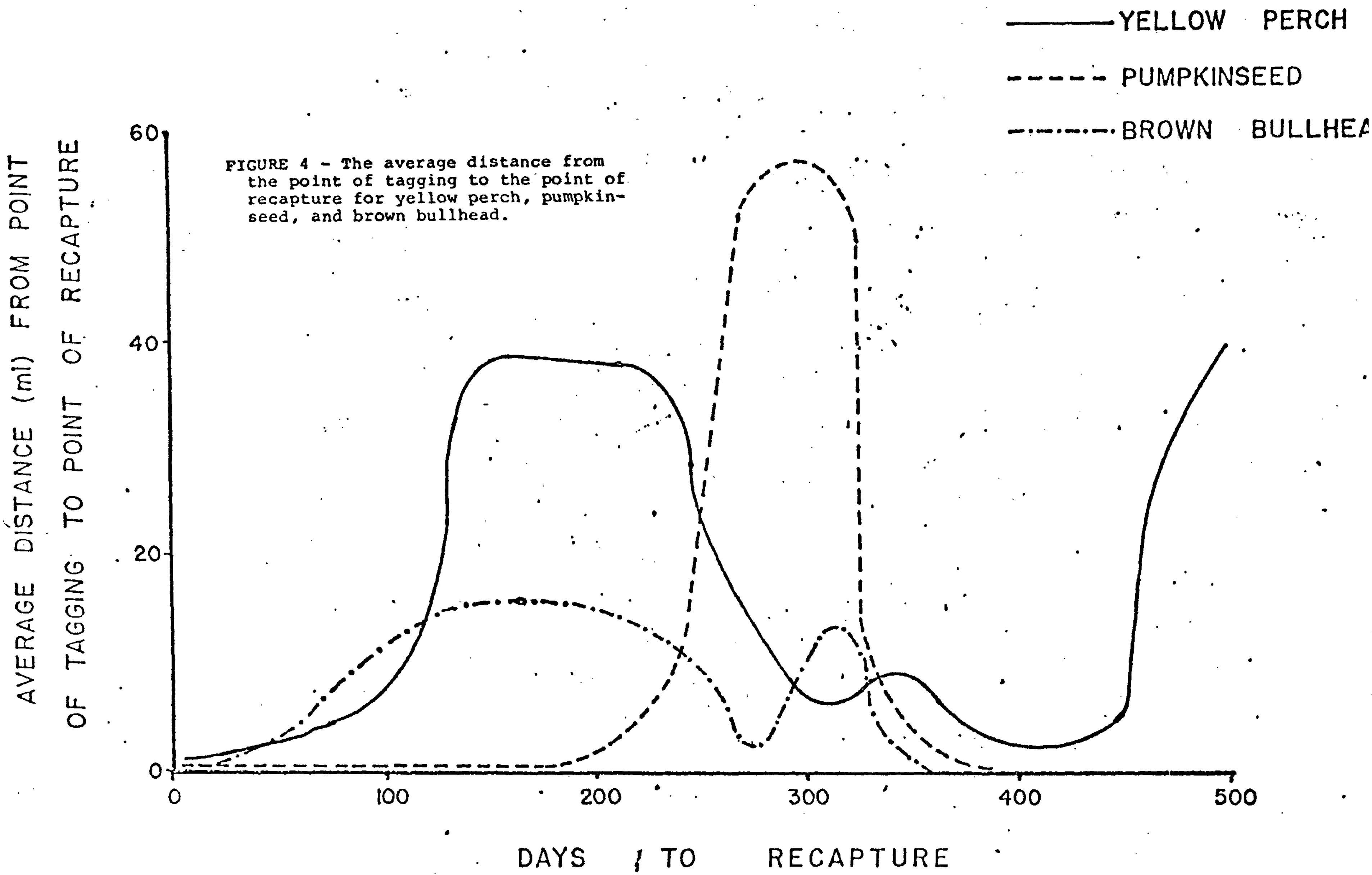
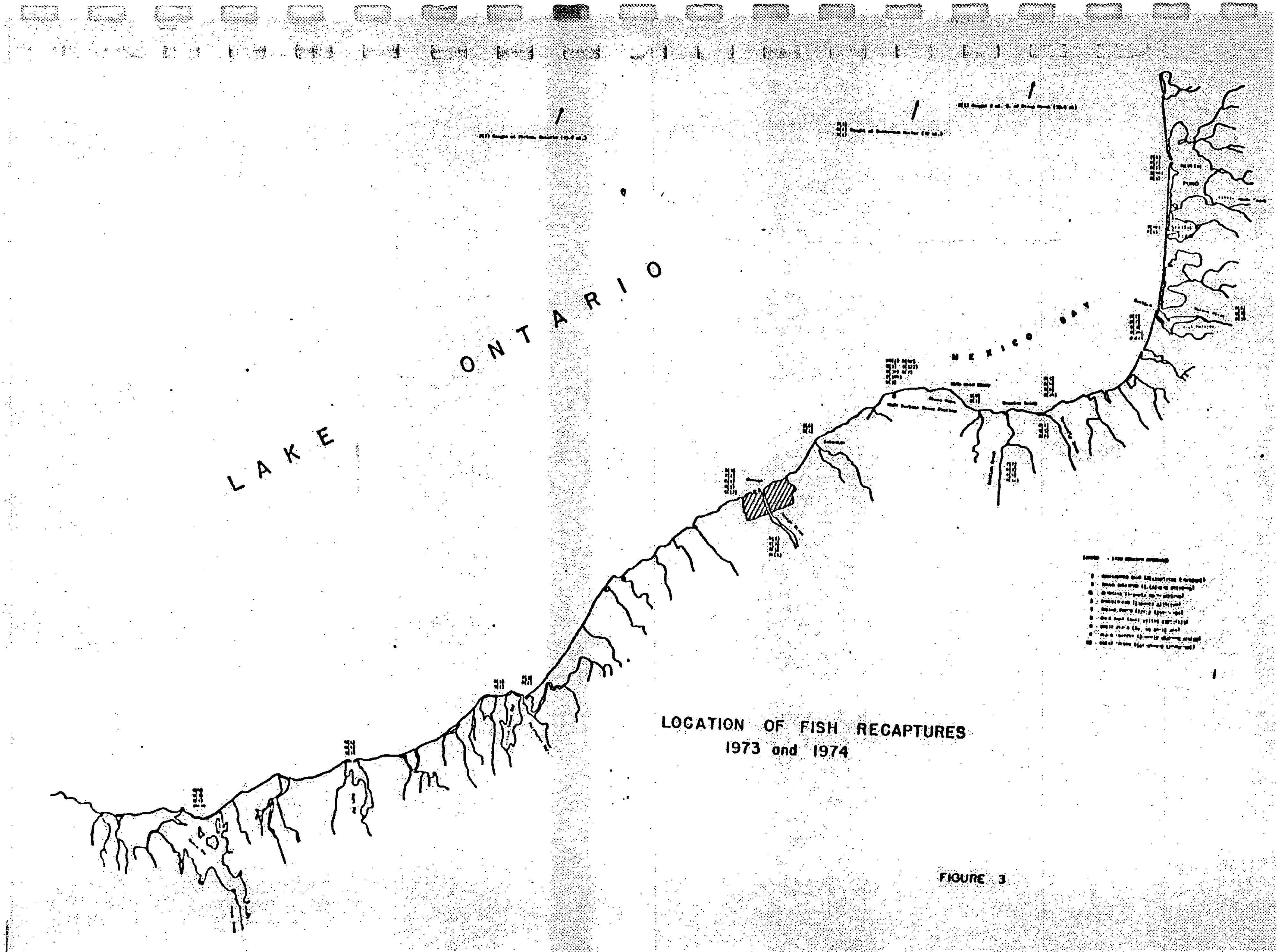


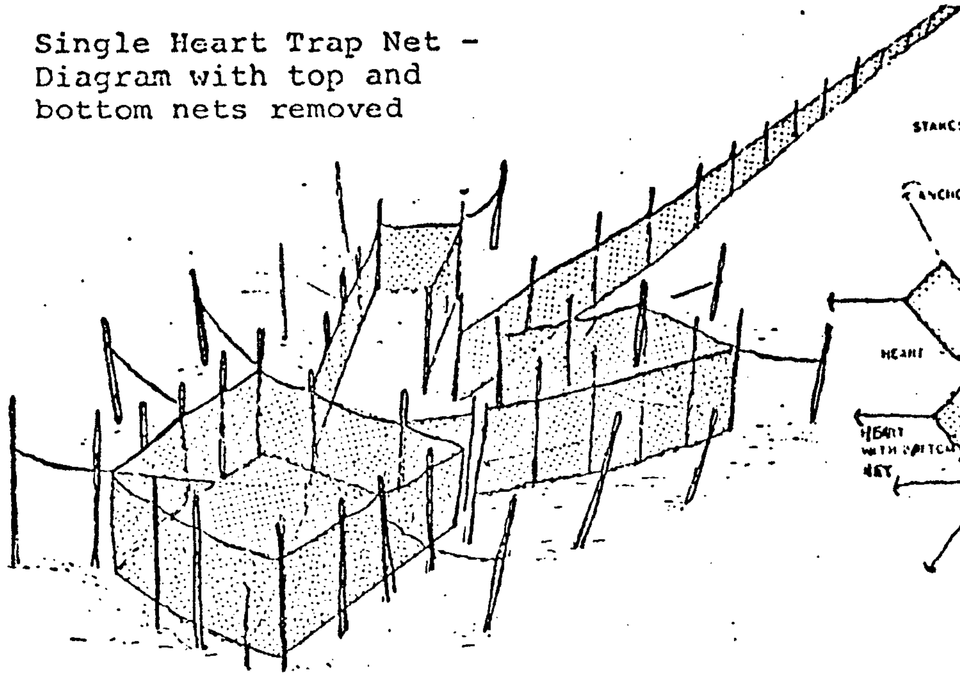
FIGURE 4 - The average distance from the point of tagging to the point of recapture for yellow perch, pumpkinseed, and brown bullhead.

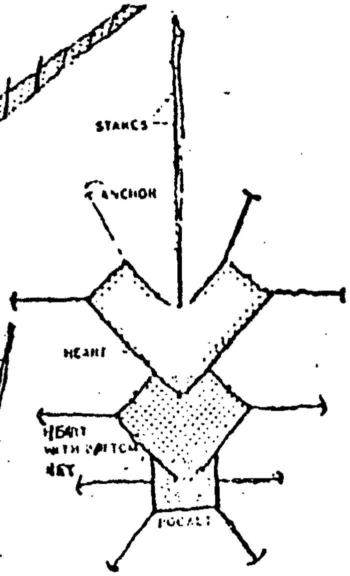


LOCATION OF FISH RECAPTURES
1973 and 1974

FIGURE 3

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

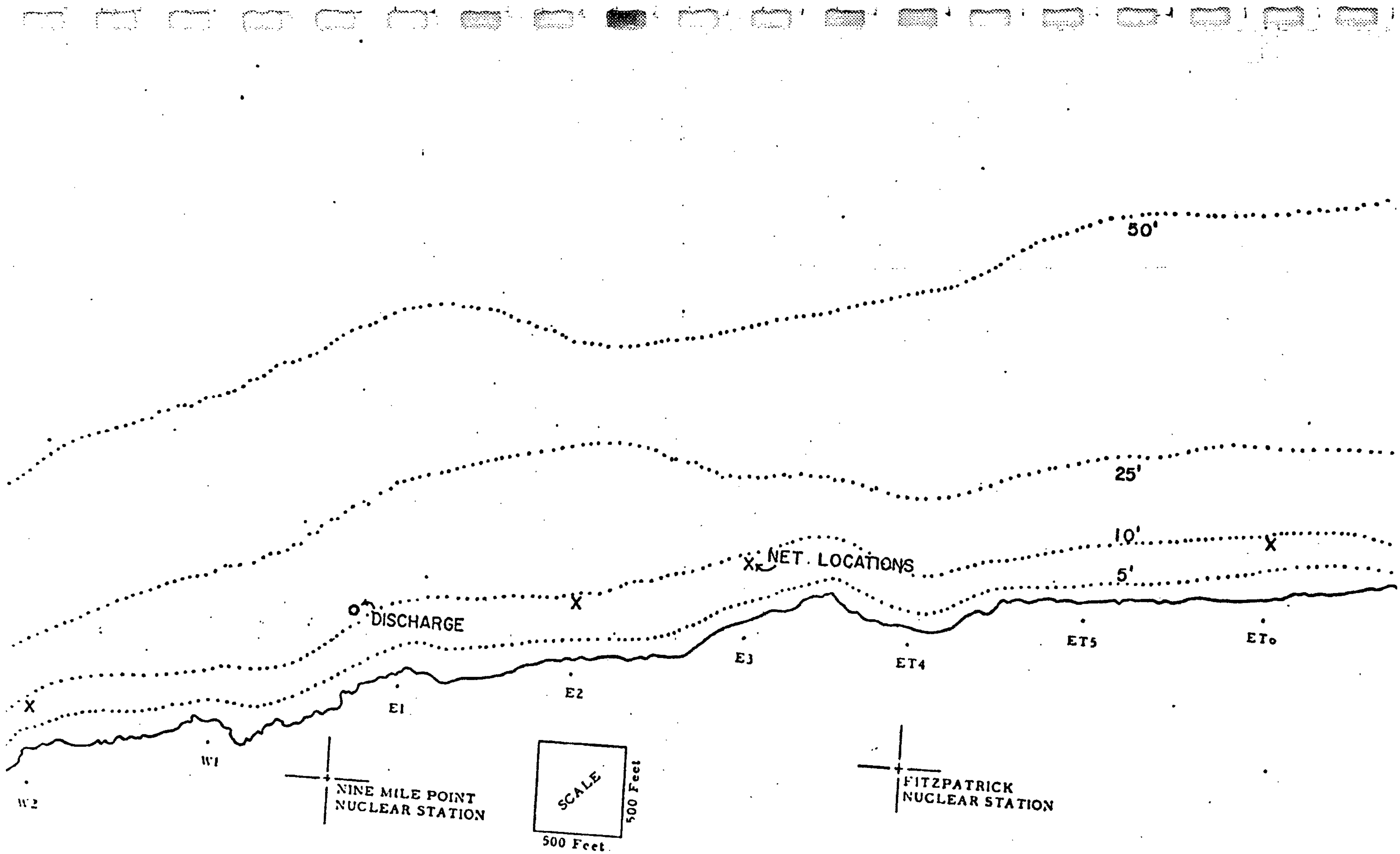

50'
25'
10'
5'
NET. LOCATIONS
DISCHARGE
X
E1
E2
E3
ET4
ET5
ETo
W1
W2
NINE MILE POINT
NUCLEAR STATION
SCALE
500 Feet
500 Feet
FITZPATRICK
NUCLEAR STATION

FIGURE 1

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)831-2833

SAMPLE FORM LETTER SENT TO ANGLERS RETURNING FISH TAGS

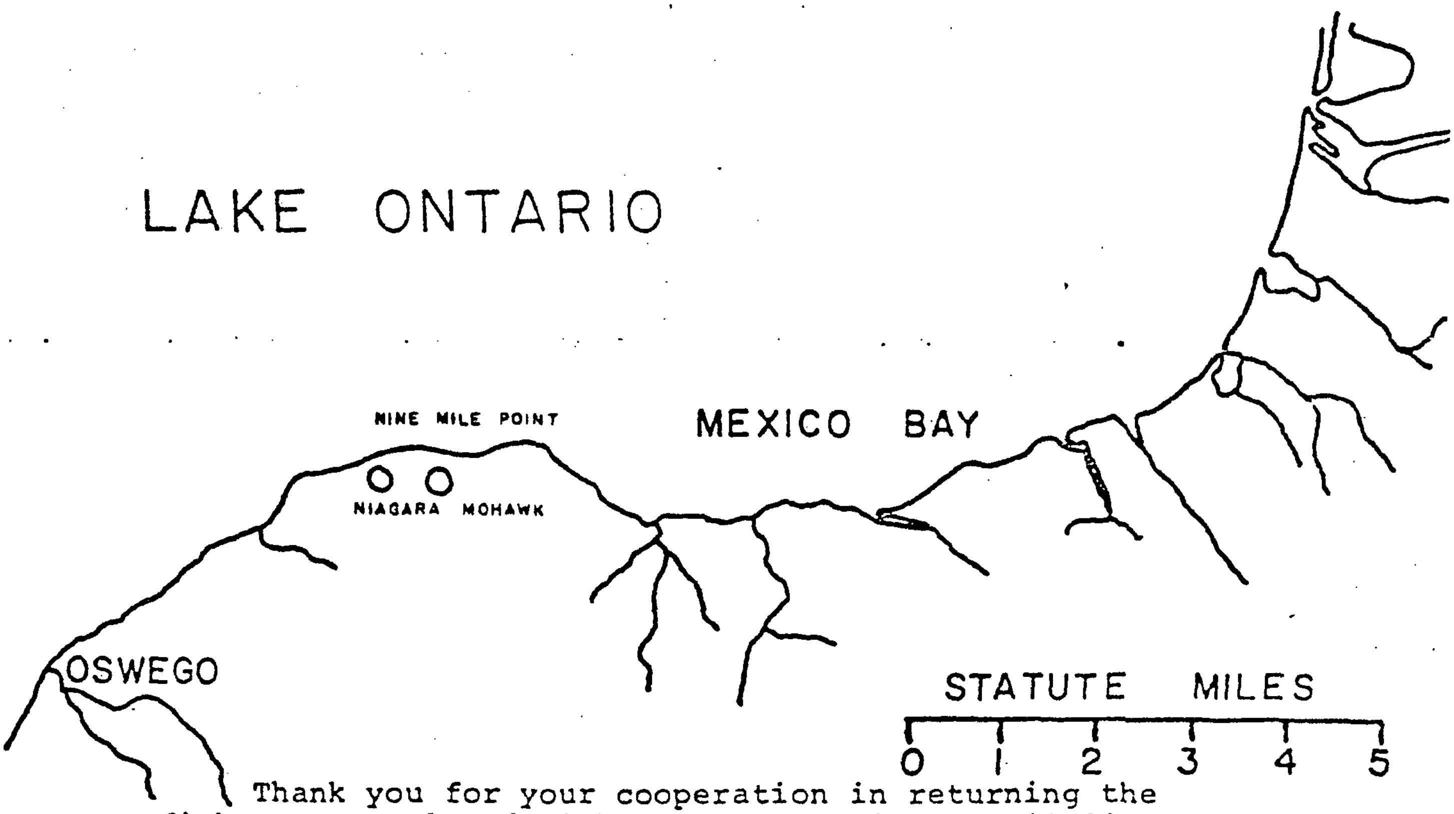
State University of New York at Buffalo

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

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

TABLE 3 (Continued)

Species	Tag Returns by Year for Fish Tagged in 1973							Tag Returns for Fish Tagged in 1974		
	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: Summary of Fish Tagging 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 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	5.59	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 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: Summary of Fish Taggings and Recaptures by Location

Species	Tagging Locations: NMP	Tagging Locations: Sandy Pond	Tagging Locations: Oswego Harbor	Tagging Locations: TOTAL	Fish Recaptured in Trap Nets: Total # Returned in Nets	Fish Recaptured in Trap Nets: % of Total Tagged	Recapture Locations: Fish Recaptured by Anglers: 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 1: Summary of Fish Taggings by Date and Location for 1972-1974

	TAGGING PERIOD																	
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
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:

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.

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 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.

3.3.3 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

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.

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 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

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 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.

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. Patterns 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, 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 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

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

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.

tured 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.

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 cap-where is this

mary 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.

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 sum-

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

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:

- 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

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.

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.

- 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.

- 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.

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.

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NINE MILE POINT FISH TAGGING PROGRAM

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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.

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

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	-

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.

<u>Temperature preference</u>: 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 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

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 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

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]	-	-	-	-	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]	< 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.

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

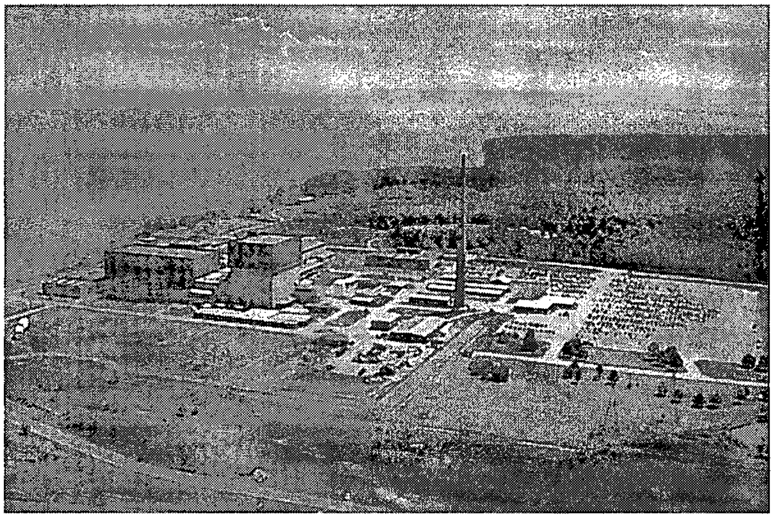
Attachment 2

James A. FitzPatrick Nuclear Power Plant

License Renewal Application – Amendment 1

Reference for RAI E-1-j-1

2004 SPDES
Biological Monitoring Report
James A. FitzPatrick Nuclear Power Plant
(Permit No. NY 0020109, Section 10, CP-04.03)



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April 2005
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EXECUTIVE SUMMARY

This report presents the results of impingement abundance studies conducted during 2004 as required by the State Pollution Discharge Elimination System Permit No. NY 0020109, Section 10 for the James A. FitzPatrick Nuclear Power Plant (JAFNPP).

In 2004, the estimated (based on total cooling water flow volume) impingement at JAFNPP was 230,534 organisms (including fish fragments and crayfish). Alewife (16,796) comprised 7 percent of the annual total of organisms impinged. Estimates of impingement numbers for the remaining species of special interest are: rainbow smelt, 1,527; white perch, 481; yellow perch, 403; smallmouth bass, 1,106; lake trout, 115; chinook salmon, 18; brown trout, 8; and rainbow trout, 5. All species of special interest combined (20,459) comprised 9 percent of the annual estimated number of organisms impinged at JAFNPP during 2004. Similar to monitoring results during the 1990s, threespine stickleback continues to be the most abundant species in JAFNPP impingement collections at 201,563, comprising 87 percent of the annual estimated impingement for 2004. No, rare, threatened, or endangered species were collected at JAFNPP in 2004.

1. INTRODUCTION

The James A. FitzPatrick Nuclear Power Plant (JAFNPP) is operated by Entergy Nuclear Operations, Inc. and is located on the shore of Lake Ontario approximately 11 km (7 mi) northeast of the City of Oswego, New York. JAFNPP is an 886-MWe (gross) boiling water reactor. With all three circulating water pumps and all three service water pumps operating, JAFNPP requires up to 922 ft^3/sec cooling water volume. JAFNPP has a once-through cooling system with an offshore, submerged intake and discharge. The intake structure is located 274 m (900 ft) offshore in approximately 7.3 m (24 ft) of water (Figure 1-1). The intake openings face toward shore. Water enters the cooling water system through the intake structure (Figure 1-2), and then proceeds into the screenwell area within the plant. Once in the screenwell, the cooling water passes through trash racks, with bars spaced approximately 7.5 cm (3 in.) apart used for removing large items such as logs, and then through 9.5-mm (3/8-in.) mesh traveling screens, used to prevent smaller materials from entering the cooling water system (Figure 1-3). Periodically, the traveling screens are rotated and washed to remove any accumulation of impinged organisms and other debris, which are washed into a sluiceway and then into an impingement collection basket. The cooling water is returned to Lake Ontario through a high-velocity, submerged diffuser-type discharge (Figure 1-4). The discharge, with a 236-m (774-ft) diffuser, is located 334 m (1,100 ft) offshore in approximately 9.1 m (30 ft) of water (Figure 1-1).

The impingement of aquatic organisms at JAFNPP has been monitored annually from 1975 to 1997 and 2004 in order to estimate species abundance and composition. The composition of the impingement collections has ranged from 26 to 54 fish species per year. Alewife, threespine stickleback, and rainbow smelt generally have been the most abundant fishes in the impingement collections. Other fish species, which have been relatively abundant in the impingement collections, include white perch, gizzard shad, trout perch, spottail shiner, tessellated darter, and sculpins.

This report presents the results of impingement collections made during 2004 as stipulated by Additional Requirement 10 of the State Pollutant Discharge Elimination System (SPDES) Permit No. NY 0020109) for JAFNPP. The monthly frequency of impingement monitoring ranged from 4 to 20 days per month, for a total of 78 samples in 2004.

Zebra mussels (*Dreissena polymorpha*) were identified in the JAFNPP area in late 1990. Zebra mussels were first noted in impingement sample collections in 1991, and their presence (by volume) has been recorded on applicable data sheets as part of the regular analysis procedure since that time. As required by correspondence from JAFNPP to the Nuclear Regulatory Commission, all impingement samples are checked for the presence of the Asiatic clam (*Corbicula* sp.). No *Corbicula* sp. mollusks were found in 2004 impingement collections at JAFNPP.

At the end of 1997, impingement collections were discontinued at JAFNPP due to a SPDES permit change that required operation of a newly installed high frequency fish deterrence system in conjunction with transition to a long-term monitoring program at a less intensive level of effort. The specified condition in the 2001 SPDES permit renewal required that JAFNPP complete a 1-year impingement study during each 5-year permitting cycle. In 2004, impingement collections were conducted for the first time since 1997.

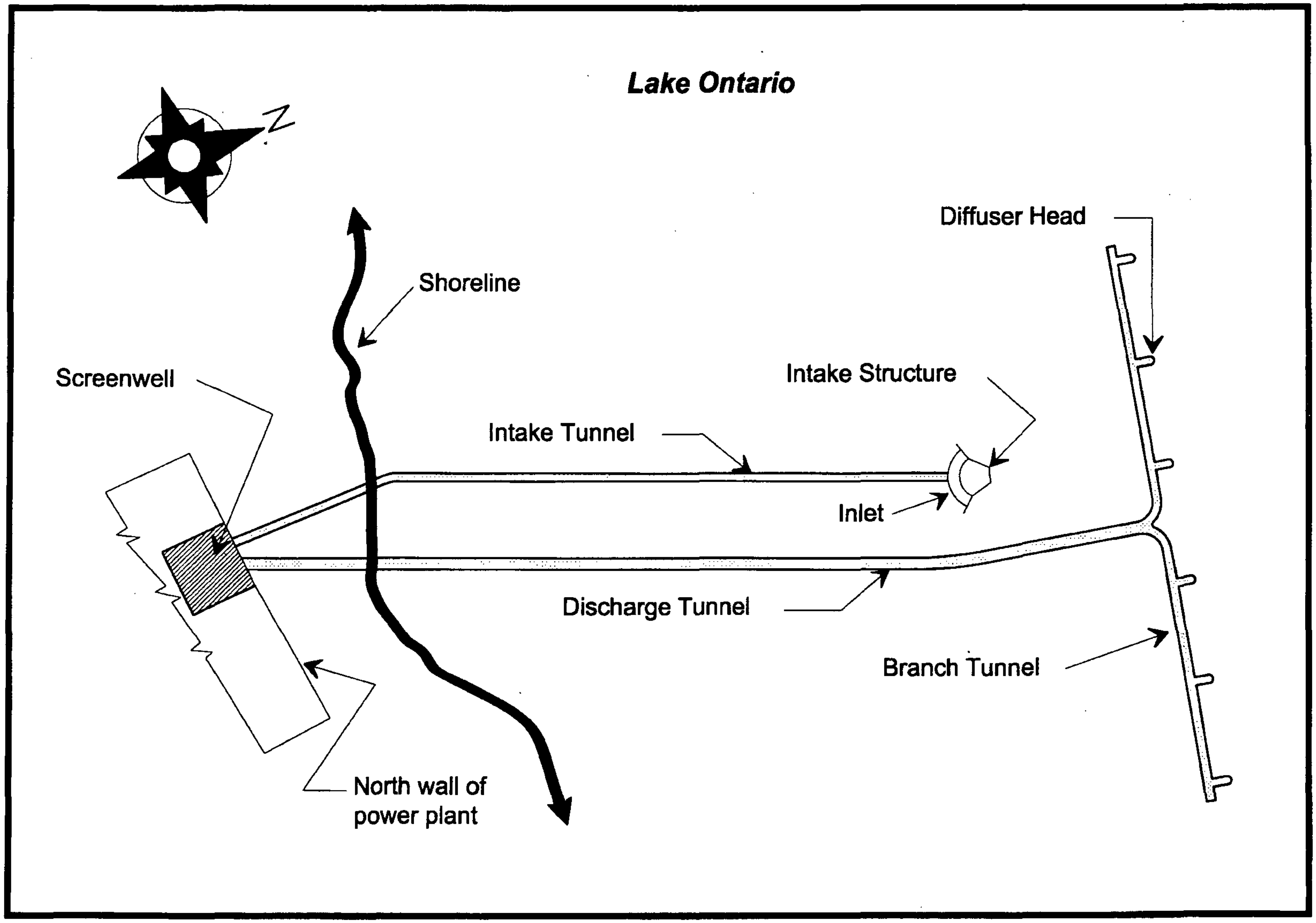

Figure 1-1. Configuration of the cooling water intake and discharge facilities at the James A. FitzPatrick Nuclear Power Plant.

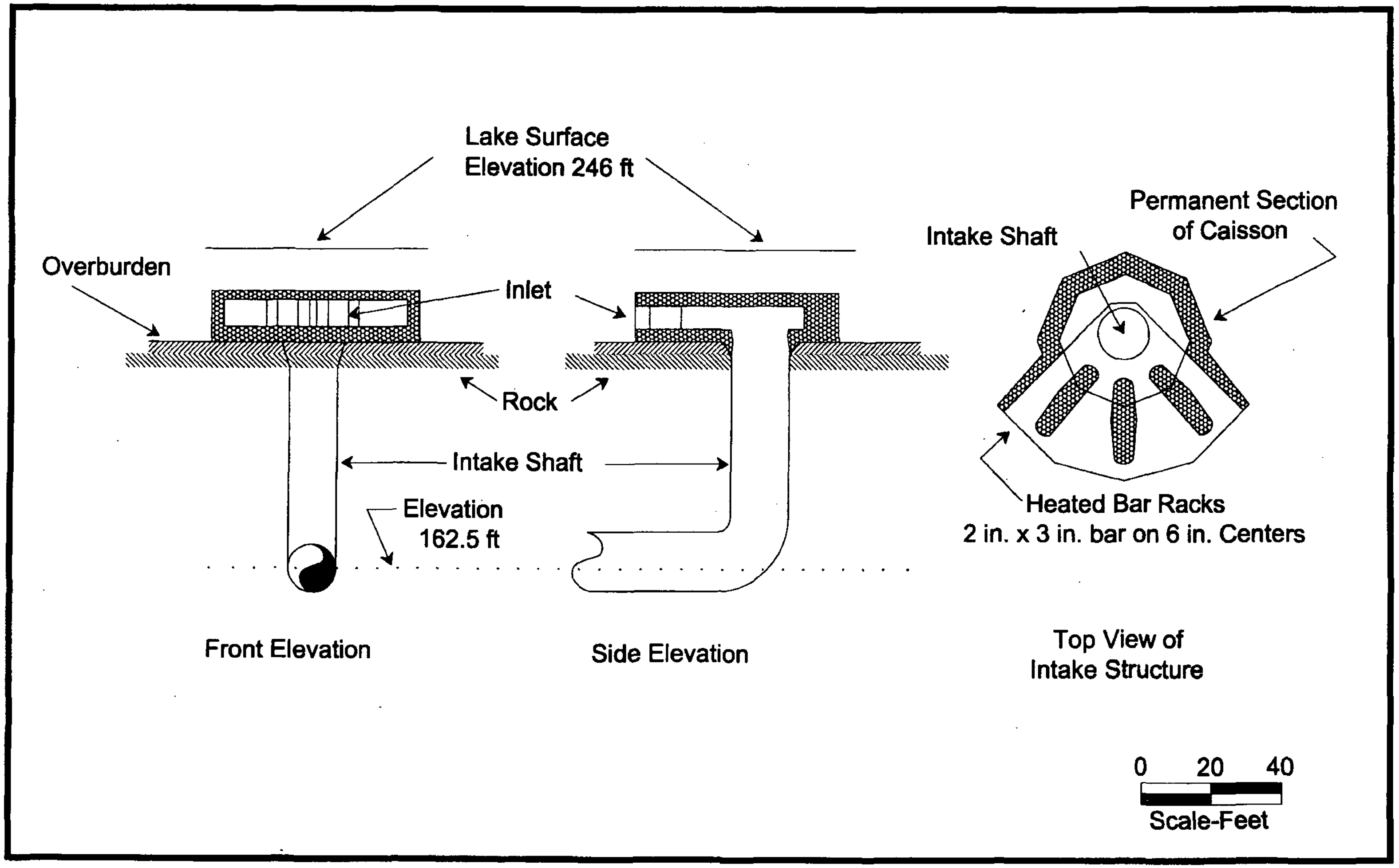

Figure 1-2. Intake structure at the James A. FitzPatrick Nuclear Power Plant.

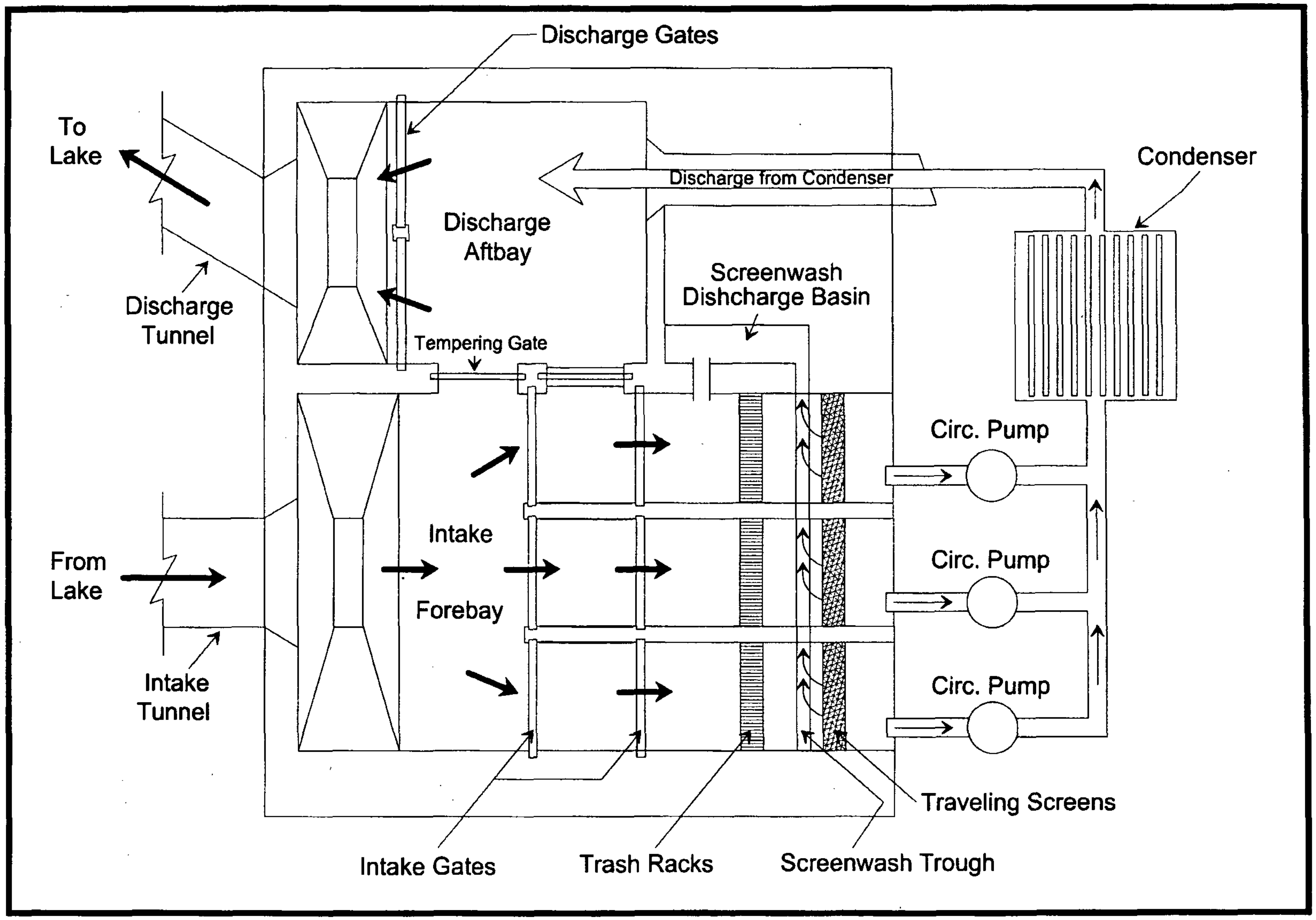

Figure 1-3. Schematic diagram of intake and discharge bays at James A. FitzPatrick Nuclear Power Plant.

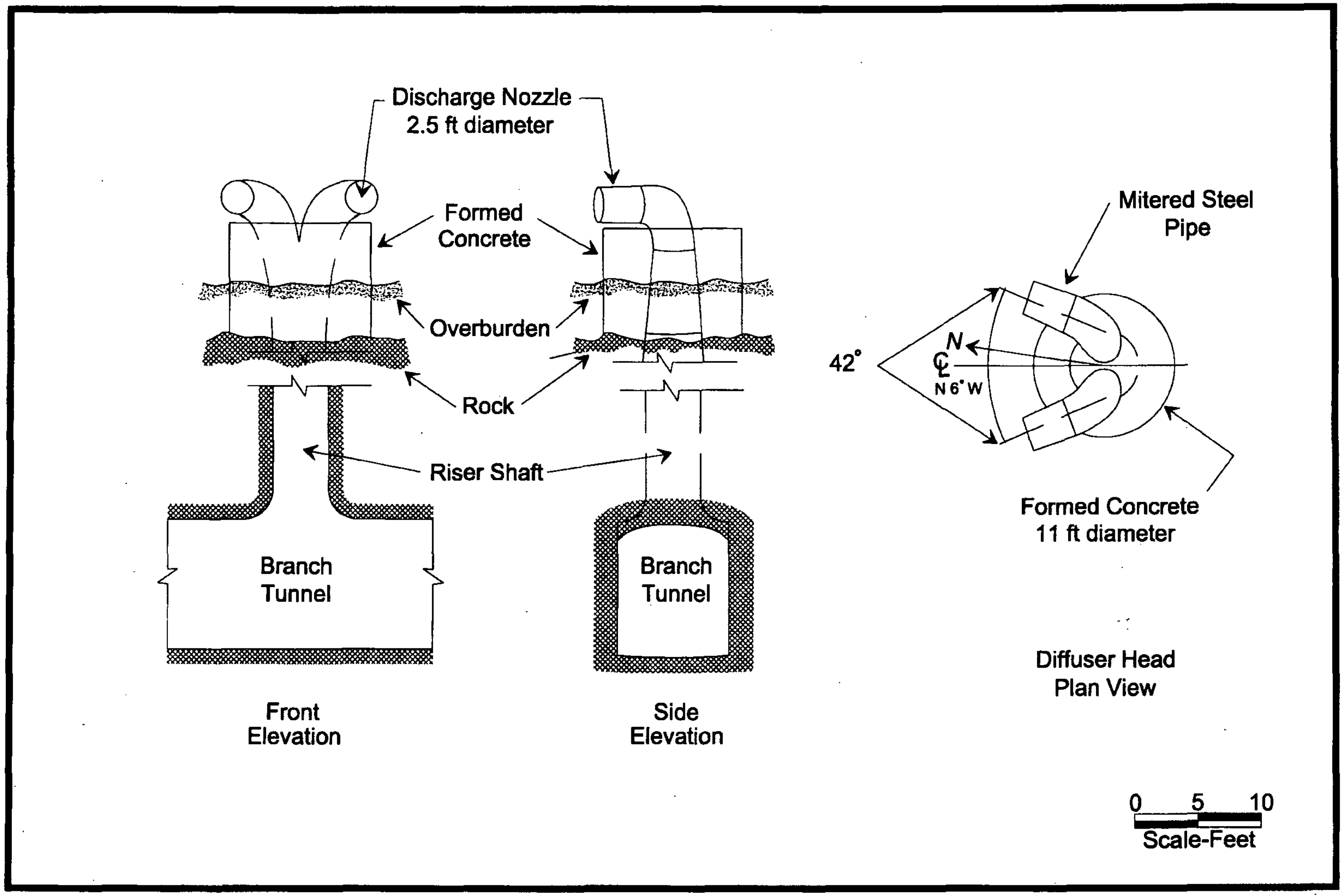

Figure 1-4. Discharge structure and typical diffuser head at the James A. FitzPatrick Nuclear Power Plant.

2. METHODS AND MATERIALS

2.1 SCHEDULE (PERMIT SECTION 10.a)

In accordance with Permit Section 10.a, impingement collections were scheduled for 78 days between 1 January and 31 December 2004 as listed below:

Month	Number of Days[a]
January	4
February	4
March	4
April	16
May	20
June	4
July	4
August	6
September	4
October	4
November	4
December	4
TOTAL	78

(a) Days assigned within each month were selected randomly using the formula Δ to: = INT (RAND ()*31) +1 from Microsoft Excel Version 9.0.

Stratified random samples were collected over a 24-hour period. Sample dates were scheduled such that no more than 10 days occurred between samples. Samples were collected so that the sample collection basket was set for a minimum of 24 hours but not greater than 26 hours. Table 2-1 lists the scheduled sampling dates. A total of 10 impingement samples during 2004 were declared void. Of these 10 samples, 3 were declared void when cooling water condensers were backwashed during the sampling period. When backwashing occurs, fish fragments and debris flushed from the condenser tubes is discharged to the impingement collection basket biasing the ongoing impingement sampling event. One sample was declared void due to a high volume of debris loading in which the collection basket had to be removed prior to the scheduled collection end time; 4 samples were declared void due to a plant outage which produced zero flow; and the remaining 2 samples were declared void due to maintenance work on the overhead crane which is used to remove the collection basket. All voided samples were rescheduled and successfully collected. Details of the voided samples are provided in Appendix A.

2.2 SAMPLING PROCEDURES (PERMIT SECTIONS 10.b,c)

All sampling procedures were conducted according to Contractor Procedure for Impingement Monitoring DVP-04.12 (Rev. 3). Samples were initiated at approximately 1000 hours unless maintenance and/or availability of facility operators delayed the start time. Before sample collection, the traveling screens were rotated and washed for a minimum of 15 minutes, after which the collection basket, with a 9.5-mm (3/8-in.) stretch mesh liner, was positioned at the end of the sluiceway. The collection basket remained in place for a minimum of 24 hours, unless high impingement or debris loads required that it be emptied; in which case it was removed, emptied, and repositioned.

A subsampling routine was utilized for occasions when high impingement rates or high debris loads were encountered. The subsampling technique was based on volume, and the total 24-hour catch was estimated using the following formula:

$$\textit{Estimated No. of Fish in Total Sample} = \frac{\textit{Volume of Total Sample} \times \textit{No. of Fish in Aliquot}}{\textit{Volume of Subsample}}$$

The volume of the total sample was determined by repeatedly filling a volumetrically graduated container, recording the values, and adding them. The total volume was thoroughly mixed by hand or with a shovel and spread out evenly over a flat surface. An aliquot(s) of the total sample was randomly selected, and this portion of the sample was removed and measured to determine its volume. During 2004, subsamples constituted at least 10 percent by volume of the total sample. The fish in the subsample were then processed according to regular laboratory procedures (Section 2.3). A total of 4 samples during 2004 were processed for subsampling due to heavy debris loading. Dates for those samples are as follows: 8 January, 19 March, and 11 and 12 May 2004. Debris loading ranged from 22 to 406 gal.

An extrapolation routine was employed on occasions when one of the three rotating screens that was initially cycled at the onset of the sample became immobilized due to maintenance and/or other reason before the completion of the sample. The total numbers of impinged organisms were extrapolated for the remaining screen using the following formula:

$$\textit{Estimated No. of Fish in Total Sample} = \frac{\textit{Number of Fish in Sample} \times \textit{Number of Screens Rotated at Start of Sample}}{\textit{Number of Screens Rotated at End of Sample}}$$

A total of 3 samples in 2004 were extrapolated using the above formula. Those dates were as follows: 12 and 25 May, and 16 December 2004.

Pump regimes and cooling water flow rates, intake and discharge temperatures, and power production were obtained for each day of 2004 and are presented in Appendix B.

2.3 LABORATORY PROCESSING (PERMIT SECTION 10.d)

Each impingement sample was returned to the laboratory where all organisms were sorted, identified, and enumerated. Identification was made to the lowest possible taxonomic level, in most cases, down to species. A list of common names and their associated scientific names is included in Appendix C (AFS 1980).

A maximum of 25 individuals of the following species were weighed and measured: white perch, alewife, and rainbow smelt. All individuals collected of yellow perch, smallmouth bass, and salmonids collected were individually weighed and measured. Other fish were enumerated and weighed to obtain a total count and total weight for each species or taxonomic group. Total lengths were measured to the nearest millimeter (mm). Age analysis is not a requirement of this report except in a general sense. Length data in Scott and Crossman (1973) indicate that at the end of the first year growth, the species of special interest attain a total length between 65 and 102 mm. Young-of-year (YOY) are considered those individuals of species of special interest whose lengths are less than 100 mm and which are generally collected from late summer through winter. Young fish collected in spring impingement samples are considered yearlings even if they not have attained a length greater than 100 mm, they have completed a full year of growth, and are not classified as YOY.

Weights were measured and recorded to the nearest 0.1 g (0.0002 lb) for specimens weighing less than 1,000 g (2.20 lb), 1 g (0.002 lb) for specimens weighing between 1,000 g (2.20 lb) and 2,000 g (4.41 lb), and 5 g (0.011 lb) for specimens weighing greater than 2,000 g (4.41 lb). Specimens with any unusual conditions, abnormalities, or presence of fish tags were noted on the data sheets. Zebra mussel volumes for each sample were also noted on the data sheets.

2.4 WATER QUALITY DETERMINATIONS ((JAFNPP 2004, DVP-04.12, Rev. 3)

Intake and discharge temperatures were recorded at the beginning and end of each impingement sample. Intake and discharge temperatures were obtained from the screenwell operations area computer via plant parameters, communication with the control room during times the screenwell computer was unavailable, or by contacting the JAFNPP onsite Environmental Engineer. Intake and discharge temperatures are presented in Appendix B.

2.5 DATA PRESENTATION (PERMIT SECTION 10.e.f)

The following data are presented in Chapter 3 according to the requirements set forth in the SPDES permit:

a. Monthly and annual total of impingement by species and grand total over all species.

b. Monthly "mean" impingement rate is equal to the total number of fish impinged by species on all sampling days in a given month divided by the total volume of water pumped on sampling days.

c. Total estimated impingement for each month was calculated using the following formula:

$$D = \frac{c}{v} * x$$

where

D = Total estimated impingement.
c = Number of fish collected during the sampling period.
v = Volume of cooling water used during the sampling period.
x = Total monthly volume of cooling water used.

The annual impingement estimate was then calculated by adding the 12 monthly impingement estimates.

d. Mean and total impingement numbers were also estimated based on daily counts rather than cooling water volume for comparison of summary statistical methods and for historical continuity with past data reports.

e. Mean daily impingement counts were calculated by month (total number of fish impinged by species on all sampling days in a month divided by the total number of sampling days); monthly impingement was estimated based on the mean daily counts (mean daily impingement count multiplied by the total number of days in a particular month).

f. Length frequency tables for the species of special interest.

g. Monthly and annual totals of biomass (grams) by species and grand totals over all species.

h. Total estimated biomass (adjusted for flow) was calculated in the same manner as estimated impingement numbers.

TABLE 2-1 SCHEDULED AND COMPLETED IMPINGEMENT SAMPLES BY DATE, 2004

Scheduled Sampling Date	Completed Sample Date	Scheduled Sampling Date	Completed Sample Date	Scheduled Sampling Date	Completed Sample Date
07 JAN	08 JAN[(a)]	02 MAY	02 MAY	05 AUG	05 AUG
15 JAN	15 JAN	03 MAY	03 MAY	06 AUG	06 AUG
23 JAN	23 JAN	04 MAY	04 MAY	11 AUG	11 AUG
28 JAN	28 JAN	05 MAY	05 MAY	18 AUG	18 AUG
		06 MAY	06 MAY	26 AUG	26 AUG
06 FEB	06 FEB	07 MAY	07 MAY	31 AUG	31 AUG
10 FEB	10 FEB	10 MAY	10 MAY		
19 FEB	19 FEB	11 MAY	11 MAY	10 SEP	15 SEP[(a)]
25 FEB	25 FEB	12 MAY	12 MAY	14 SEP	16 SEP[(a)]
		13 MAY	15 MAY[(a)]	24 SEP	03 SEP[(a)]
02 MAR	02 MAR	14 MAY	14 MAY	29 SEP	09 SEP[(a)]
11 MAR	11 MAR	17 MAY	17 MAY		
19 MAR	19 MAR	18 MAY	18 MAY	08 OCT	21 OCT[(a)]
25 MAR	25 MAR	19 MAY	19 MAY	12 OCT	28 OCT[(a)]
		20 MAY	20 MAY	22 OCT	22 OCT
02 APR	02 APR	21 MAY	21 MAY	26 OCT	26 OCT
05 APR	05 APR	25 MAY	25 MAY		
06 APR	06 APR	26 MAY	26 MAY	05 NOV	03 NOV[(a)]
07 APR	07 APR	27 MAY	27 MAY	09 NOV	09 NOV
08 APR	08 APR	28 MAY	28 MAY	17 NOV	17 NOV
09 APR	09 APR			23 NOV	23 NOV
13 APR	13 APR	04 JUN	04 JUN		
14 APR	14 APR	09 JUN	09 JUN	02 DEC	02 DEC
15 APR	15 APR	15 JUN	15 JUN	10 DEC	10 DEC
16 APR	16 APR	25 JUN	25 JUN	16 DEC	16 DEC
20 APR	20 APR			21 DEC	21 DEC
21 APR	21 APR	02 JUL	02 JUL		
22 APR	22 APR	08 JUL	08 JUL		
23 APR	23 APR	16 JUL	16 JUL		
28 APR	28 APR	26 JUL	26 JUL		
27 APR	29 APR[(a)]				

(a) Rescheduled sample (see Appendix A).

3. RESULTS AND DISCUSSION

3.1 IMPINGEMENT ABUNDANCE AND COMPOSITION (PERMIT SECTIONS 10.d,e,f)

In 1998, a high frequency fish deterrence system (FDS) was placed into long-term operation at JAFNPP. As a result, a permitting change allowed JAFNPP to operate the FDS and implement a long-term monitoring program at a less frequent interval. The SPDES permitting change requires that JAFNPP complete a 1-year impingement study during each 5-year permitting cycle. In 2004, impingement collections were conducted for the first time since 1997.

Results from FDS tests demonstrated that the system reduced alewife impingement by an average of 87 percent for the test periods (Ross et al. 1993, 1996). Since 1998, the FDS has operated from April to October of every year because historical data, before the deterrence system was installed, demonstrated that approximately 97 percent of the total annual alewife impingement occurred during these months (EA 1998).

Impingement abundance at JAFNPP was influenced by many factors during the 2004 sampling year. Over the last decade, the lake ecosystem has undergone many changes. Primarily due to the introduction of the zebra mussel (*Dreissena polymorpha*) in the early 1990s, the behavioral and physiological biology of fish species have changed in response to food web changes, water clarity increases, and thermal life history regimes. Shifts in temporal distributions of important forage fish species, notable changes in the size distribution of fish species, and changes in spawning behavior have been documented by teams researching the effects of the invasive zebra mussel. Changes in nutrient loading to the lake have also been considered as a contributor to the changing lake ecosystem. Due to new regulations, more efficient sewage treatment facilities, and lakeside farming best management practices, nutrient loading has decreased considerably over the last decade. Nutrients that used to supply a food source for the forage base have all but disappeared (Grant et al. 2005). Also affecting 2004 impingement numbers was the continued presence of high numbers of threespine stickleback. For the third consecutive annual impingement monitoring program (including 1997 and 1996), threespine stickleback are the most abundant fish collected (32,543) comprising 73 percent of the total actual annual 2004 impingement collection (Table 3-1). Typically, prior to the mid-1990s, alewives comprised the majority of the total impingement collection. The estimated abundance of impinged threespine stickleback (based on total volume of water pumped) increased to 87.4 percent of the total annual impingement (Figure 3-1). The continued use of the FDS appears to have also contributed to the lower number of alewives observed in the 2004 impingement samples compared to monitoring programs prior to 1997.

Impingement sampling at JAFNPP in 2004 resulted in the collection of 44,593 organisms (including damaged individuals) composed of 35 species of fish (Table 3-1) (Appendix C) (AFS 1980). Invertebrates collected in the 2004 impingement samples included crayfish and zebra mussels. Alewife (9,203), a species of special interest, was second in abundance and comprised 21 percent of the annual total. Rainbow smelt (315), another species of special interest, which has been ranked among the three most abundant species since the onset of biological monitoring in the mid-1970s at JAFNPP, was ranked fifth in abundance in 2004. Other species found in relatively high abundance included sculpins, smallmouth bass, and trout perch. Sculpins (*Cottus*) were identified to genus. Other species of special interest were collected in the following abundance: smallmouth bass, 309; white perch, 71; yellow perch, 58; lake trout, 17; chinook salmon, 4; brown trout, 1; and rainbow trout, 1. Complete impingement collection results are presented in Table 3-1 and Appendix D.

Historically, impingement samples collected in the spring (April, May, and June) contain the highest abundance as fish, particularly when alewives and rainbow smelt move inshore to spawn. In 2004, April-June accounted for 94 percent of the total annual catch of alewives and rainbow smelt. The movement of fish and the corresponding increase in impingement abundance is primarily influenced by an increase in water temperature. The seasonal increase in abundance may deviate temporally from year to year in response to meteorological conditions. In 2004, the seasonal increases for all fish species combined are provided in Table 3-1. April, May, and June accounted for almost half of the year's total impingement abundance; however, excluding threespine stickleback from that calculation, the proportion collected during these 3 months increased from approximately half to 87 percent.

Generally, impingement decreases after the spawning season ends and fish return to the cooler offshore waters. The summer impingement often results in fewer fish collected as demonstrated for the months of July (288) and August (98). As summer wanes and YOY grow to an impingeable size, impingement abundance often increases, particularly in conjunction with storms and associated rough water. During 2004, a quiet weather pattern during the summer and fall reduced storm-influenced impingement collections to a minimum. Detailed information on weather-related impingement collections is discussed below.

Fish species diversity varied with seasonal abundances associated with behavioral and/or meteorological influences. The highest species diversity occurred in December (22 species) and May (20 species). Lowest species diversity occurred in October (6 species) and February (9 species). The only two species of special interest that were collected in every month of the year were rainbow smelt and smallmouth bass.

Species of special interest (JAFNPP SPDES Permit No. NY 0020109) were found in collections as follows: alewives (9 months), rainbow smelt (12 months), yellow perch (9 months), white perch (5 months), lake trout (6 months), chinook salmon (2 months), rainbow trout (1 month), smallmouth bass (12 months), and brown trout (1 month).

In addition to the seasonal influx of fish in late spring, high rates of impingement can occur at JAFNPP when strong winds from the west or northwest result in heavy wave action. Lifton and Storr (1977) statistically correlated wave height, water temperature, and wind action with impingement at power plants on Lake Erie and Lake Ontario. Wave height was found to be the most significant factor contributing to the correlation. They hypothesized that wave-induced turbulence and possibly turbidity interfere with a fish's normal ability to detect and avoid an intake structure, resulting in a higher rate of impingement. YOY of most species of fish appear to be most susceptible to meteorological influences (Lifton and Storr 1977). There were only a few significant storms to influence impingement in 2004. These examples of storm conditions and impingement collections are discussed below:

- Increased wind and wave height during the first sample of the year (period 7-8 January 2004) produced 33 percent of the month's total impingement abundance. This collection also accounted for the collection of 13 different species. During the sample period, the wind velocities reached in excess of 33 mph from the west-southwest direction. Wind speeds of this velocity and from the westerly direction can be associated with very high wave height.

- High winds (20-30+ mph) were recorded during the sample period 22-23 January 2004, resulting in the collection of nearly 50 percent of the month's total impingement abundance. Winds on the set date were recorded at a southwest direction of 229 degrees and shifted to a northwest direction of 326 degrees with sustained wind speeds between 20 and 35 mph. This is the typical wind direction resulting in high impingement abundance, usually when winds are strong enough to induce considerable wave height. Threespine stickleback was the primary species collected (98 percent of the 24-hour sample total and 95 percent of the monthly total).

- Increased wind and wave height during the sample period 1-2 December 2004 produced 32 percent of the month's total impingement abundance. This collection also accounted for the collection of 22 different species. During the sample, the lake experienced wave heights in excess of 10 ft and winds from the northwest.

Rates of impingement were calculated using two different methods for comparison. The monthly mean daily impingement (Table 3-2) is defined as the average number of fish collected per sample day for each month. The monthly impingement rate based on flow (Table 3-3) is defined as the total number of fish by species impinged on sampling days in the month divided by the total volume of water pumped through the intake on those days. Each table reports the total rate and rate per species by month.

Rates of impingement, whether calculated by sample day (Table 3-2) or volume (Table 3-3), generally demonstrate the same trends as the impingement counts (Table 3-1). The trend of continued increased threespine stickleback abundance during 2004 is evident in the rate of impingement (calculated by both methods) as they were the most numerous species in 54 of the total 78 (nearly 70 percent) samples completed in 2004. Seasonal trends for select species (alewife, trout perch, and spottail shiner) can also be discerned. The influence of short-term meteorological occurrences, as previously discussed for January and December, is also apparent. JAFNPP experienced only one plant outage during 2004, and was classified as Refueling Outage 16. Only one outage occurred during 2004 and was completed over the period 25 September through 24 October, resulting in only 19 percent of normal water volume being pumped during that time. The impingement samples that were originally scheduled during Refueling Outage 16 were rescheduled and completed during September and October at times when at least two circulating water pumps were in operation (Table 2-1; Appendix B). The volume of cooling water pumped for the month in million cubic meters (MCM) is indicated at the top of the columns for monthly volumetric rates (Table 3-3). Pump operating regimes and flows are presented in Appendix B.

Rates of impingement per MCM are highest when the plant is at full power (i.e., when all three circulating water pumps are in operation) and during times when fish are in the vicinity of the intake structure due to behavioral, seasonal, or meteorological influences. The mean rate of impingement was highest in January (1,019 fish/MCM) and March (1,926 fish/MCM), associated with the sustained high impingement rates of threespine stickleback (Table 3-3); monthly mean impingement rates were 1-2 orders of magnitude lower during most other months.

Species-specific patterns of abundance during the year are generally associated with behavioral and meteorological controls discussed above. Alewife impingement rates were highest in May (224 fish/MCM) and increased slightly again in October (13 fish/MCM) and November (38 fish/MCM) due to spawning behavior and juvenile recruitment to inshore areas of the lake. Alewives may have been absent from impingement samples for the first 3 months of 2004 due to behavioral adaptations that place them in deeper waters where food is more plentiful for longer periods of time. Historically, high impingement rates (much above numbers observed during 2004) of alewives typically occur during the months of April-June, and again late in the year as YOY move out to deeper water. Alewife impingement rates are notably lower than observed in the 1980s and early 1990s and are unlikely to return to those conditions due to ecosystem changes discussed earlier in this report (O'Gorman 2005). Numbers of alewives and rainbow smelt have declined over the years due to a combination of factors. The nutrients received by the lake have decreased in recent decades due to improved land use and sewage treatment practices. Also, in the early 1990s, the colonization of the exotic zebra mussel played an important role in changing plankton communities and the forage available for both alewives and rainbow smelt (Schaner et al. 2002). These factors, coupled with the installation of a high frequency FDS in 1997, have reduced impingement rates as proven by the 2004 data. Rainbow smelt impingement rates were highest in January (9 fish/MCM), May (4 fish/MCM), and June/December (3 fish/MCM), and remained consistently low for the remainder of the year (approximately 1 fish/MCM). The slight increase in the rate of impingement for rainbow smelt that occurred in May and June is likely a result of migration inshore during the spawning season. The increase in January is most likely due to the two storm events mentioned earlier in this report that increased the total number of organisms impinged, resulting in nearly 20 percent of the annual collection of rainbow smelt in that one month. Although the impingement rate of rainbow smelt is very low for the 2004 impingement year, there are indications that the lake population of rainbow smelt is increasing. In late 2004, reports from the U.S. Geological Survey's (USGS) Biological Field Station in Oswego indicated one of the highest indexes for smelt since 1999 (O' Gorman 2004).

Other species of special interest (white perch, yellow perch, smallmouth bass, and salmonids) were generally collected in low numbers throughout the year. The higher impingement rates for these species in January 2004 appear to be due to the two storm events that occurred during the month. The yellow perch impingement rate increased in December (4 fish/MCM), also due to a storm event that occurred during the period 1-2 December 2004.

To assess the loss of fish in the cooling water system as a result of settling out, carryover of the screens, or passage through the seals around the screens, EA conducted a collection efficiency study of selected species during 1988 and 1989 at JAFNPP. Individuals of alewife, rainbow smelt, smallmouth bass, white perch, and yellow perch were collected and frozen from preceding impingement collection years. The study began by thawing a selected group of fish, removing the dorsal fin, measuring and weighing each individual, and marking them with a visible dye (rose bengal), and then releasing them into the intake screenwell area downstream of the bar racks and upstream of the traveling screens. The collection basket was removed hourly during the study period until a period of 6 hours elapsed, during which no stained fish were recovered. Recaptured fish were again measured, weighed, and enumerated. Collection efficiencies were then calculated based on fish recapture/loss. In 2004, annual and monthly estimates of total impingement for alewives, rainbow smelt, smallmouth bass, yellow perch, and white perch were adjusted for their respective collection efficiencies as determined from the results of the individual species' screen efficiency studies. From the screen efficiency tests, the impingement collection efficiency for alewives was found to be 99 percent (1 percent of impinged individuals were not collected during sampling events); for rainbow smelt, the estimate was 92 percent (8 percent not collected); for smallmouth bass, the efficiency estimate was 97 percent (3 percent not collected); for yellow perch, the estimate was 98 percent (2 percent not collected); and for white perch, the estimate was 87 percent (13 percent not collected). When these collection efficiencies are applied as correction factors to the number of individuals collected (Table 3-1) in 2004, the corrected impingement collection total is estimated to increase by 142 individuals (all species combined). The results of the traveling screen efficiency studies conducted appear to demonstrate that the equipment and process for removing fish and debris from the cooling water intake at the JAFNPP screenhouse is highly efficient.

Calculations of the estimated number of organisms impinged at JAFNPP during 2004 were based on the mean daily impingement rate (Table 3-4) and on the monthly flow weighted impingement rate (Table 3-5). Because the daily rate of impingement of organisms is affected by cooling water flow, which varies due to the number of operating circulating water pumps and duration of operation each day, volume-based estimates of total impingement are more accurate than estimates based on mean daily counts. Estimates of impingement mortality based on mean counts from daily collections (Table 3-4) have been calculated for comparison to historic impingement data summaries, but are not reliable estimates of total impingement. Impingement estimates for alewives, rainbow smelt, smallmouth bass, yellow perch, and white perch are additionally adjusted for collection efficiency on Table 3-5. Based on volume, the estimated total number of aquatic organisms impinged at JAFNPP in 2004 was 230,534. Of those, 16,796 were estimated to be alewives, equivalent to 7 percent of the total annual estimated impingement. The number of rainbow smelt estimated impinged in 2004 was 1,527; <1 percent of the total annual impingement estimate for all species. The remaining species of special interest were estimated to have been impinged in the following numbers: white perch, 481; yellow perch, 403; smallmouth bass, 1,106; lake trout, 115; chinook salmon, 18; rainbow trout, 5; and brown trout, 8. All species of special interest combined (20,459) comprised 9 percent of the annual estimated total impingement. Threespine stickleback (201,563) comprised 87 percent of the total estimated impingement for 2004 (Table 3-5, Figure 3-1). Estimated impingement by month during 2004 followed the seasonal, behavioral, and meteorological patterns previously discussed. The most influential factor on the impingement estimates appear to be the presence of large numbers of threespine stickleback in eastern Lake Ontario and meteorological events that occurred in conjunction with the 24-hour impingement collections in January and December.

3.2 LENGTH DISTRIBUTIONS (PERMIT SECTION 10.d)

Length frequency distributions are presented in Tables 3-6a through 3-6f for alewife, rainbow smelt, white perch, yellow perch, smallmouth bass, and the salmonids. Length frequency for species such as alewives and rainbow smelt, which are collected throughout the year, generally follow a seasonal pattern. Adults and subadults of both species are most often impinged during spring spawning migrations when fish move into inshore waters. Late summer and fall collections typically consist of YOY (<100 mm; <4 in.) as they reach a size susceptible to impingement while in shallow inshore nursery areas. Scott and Crossman (1973) noted the late summer length attained by alewives as 51-75 mm (2-3 in.) and that of rainbow smelt as 51 mm (2 in.).

Collections of alewives typically follow the seasonal length distribution pattern as described above, however, low numbers of alewives impinged during 2004 limit the comparability of these data to historical trends. It is suggested that cold winter water inhibits the YOY growth and, therefore, a 90-mm (YOY) fish in December would remain at 90 mm until the lake warms after June (yearling) when zooplankton blooms occur, providing sufficient food for growth (O'Gorman 2005). The data presented in Table 3-6a are representative of this growth pattern during April and May in which 73 percent of the total alewives collected for those 2 months were yearlings that have not been through a second growing season to achieve an adult length. Consequently, the alewives collected as YOYs in October-December at age 5 months have obtained the same size as the yearlings in April and May that have almost a year's growth, primarily due to very cold water temperatures found over winter in Lake Ontario. From October through December, most alewives were YOY, comprising 99 percent of the total alewives measured for those 3 months. Overall, 22 percent of all alewives measured (543 individuals) from samples collected in 2004 were adults and subadults and 78 percent were YOY and yearlings. At times, alewives of yearling size could not be accurately measured due to their condition upon collection; for example, 300 damaged yearlings were collected in impingement samples (Table 3-1) during May. Accounting for these damaged yearlings in Table 3-6a would have increased the YOY/yearling count from 73 percent to 85 percent during April and May. The minimum alewife length measured was 3.5 cm (1.4 in.) in September; the maximum was 18.5 cm (7.3 in.) in May.

The majority of rainbow smelt measured (230 individuals) in 2004 impingement collections (Table 3-6b) were YOY and yearling fish (74 percent), with adults and subadults representing 26 percent. Rainbow smelt have ranked in the top three in species abundance from 1976 (when impingement collections began) to 1997 (Table 3-1, Table E-2). In 2004, rainbow smelt fell in rank to fifth after sculpins and alewife fragments. USGS trawls from 2002 to 2003 showed record low numbers of rainbow smelt in their collections. The low numbers of rainbow smelt collected by the USGS for 2002 and 2003 are indicative of low abundance in EA's 2004

JAFNPP impingement collections. In spite of indications of recovering numbers based on 2004 USGS trawl surveys, JAFNPP experienced record low numbers of smelt impingement. USGS biologists state that, although the smelt population is unlikely to return to that of earlier years, latest trawls indicate that the population may be rebounding (O'Gorman 2005). The minimum length measured for rainbow smelt collected in 2004 was 3.2 cm (1.3 in.); the maximum length recorded was 16.7 cm (6.6 in).

White perch measured from the 2004 impingement samples were predominately YOY and yearlings (Table 3-6c). YOY fish represented 95 percent of the white perch measured (64 individuals). The minimum length recorded for white perch was 5.5 cm (2.2 in.); the maximum length recorded was 21.8 cm (8.6 in).

Yellow perch collected in 2004 were recorded as YOY, subadults, and adults (Table 3-6d). In 2004, subadult and adult yellow perch accounted for 83 percent of all yellow perch measured (54 individuals). Yellow perch collected in January and December represented 78 percent of the annual total, and were collected at the time of storm events during those months (Table 3-1). The minimum length recorded for the yellow perch measured in 2004 was 7.0 cm (2.8 in.); the maximum length was 40.0 cm (15.7 in.).

Smallmouth bass (Table 3-6e) were collected as adults, subadults, and YOY throughout 2004. The smallmouth bass collected and measured (280 individuals) were primarily subadult/adults (86 percent). Seasonally, 65 percent of all subadult/adult smallmouth bass measured in 2004 were collected in April and May, corresponding to spawning movements inshore. The minimum length for smallmouth bass collected in 2004 was 5.1 cm (2.0 in.); the maximum length was 50.6 cm (19.9 in.).

Salmonids collected in 2004 included lake trout, chinook salmon, brown trout, and rainbow trout. All salmonids collected were adults except for chinook salmon, where all specimens were parr-marked individuals (juvenile). The individual length data for each species are recorded on Table 3-6f. Lake trout accounted for 15 of 20 salmonids individuals measured during 2004.

3.3 BIOMASS (PERMIT SECTION 10.d)

Total biomass (Table 3-7) of the 2004 impingement samples at JAFNPP was 352,493 g (352 kg, 777 lb). Alewives (41,116 g, 41 kg, 91 lb) accounted for only 12 percent of the total biomass collected in 2004. The annual total biomass collected for the remaining species of special interest was as follows: rainbow smelt, 1,187g (2.6 lb); yellow perch, 2,183 g (4.8 lb); smallmouth bass, 138,565 g (306 lb); white perch, 499 g (1.1 lb); lake trout, 53,745 g (119 lb); chinook salmon, 56 g (0.1 lb); rainbow trout, 1,009 g (2.2 lb); and brown trout, 1,019 g (2.2 lb). The biomass of smallmouth bass comprised 39 percent of the total combined biomass collected for 2004, due to relatively high numbers impinged and large size of those individuals collected. The biomass of all species of special interest combined constituted 68 percent of the total biomass for 2004. Threespine stickleback comprised only 9 percent of the total annual biomass in 2004 as compared to 46 percent in 1997.

USGS biologists have found that alewife densities were relatively unchanged in 2002 and 2003. However, they have also found that the biomass in 2004 of adult alewives was higher, translating into fatter, more robust fish. They attribute the healthier condition of the alewives to the heavy predation by lake trout and salmon. Thus, the relatively improved availability of food resources to a reduced alewife population in Lake Ontario has resulted in healthier fish (O'Gorman 2004).

The estimated biomass (Table 3-8) calculated based on intake water volume was 1,505,086 g (1,505 kg, 3,319 lb) of which alewives (71,597g, 158 lb) constituted 5 percent. The estimated biomass combined (887,170 g, 1956 lb) for all species of special interest (alewives, rainbow smelt, yellow perch, white perch, smallmouth bass, and all salmonids) impinged in 2004 accounted for 59 percent of the annual estimated biomass of impinged organisms at JAFNPP. The estimated biomass for impinged threespine stickleback was 203,112 g (448 lb) and 13 percent of the total estimated biomass for 2004.

3.4 WATER QUALITY (JAFNPP 2004, DVP-04.12, REV. 3)

Intake temperatures recorded in monthly SPDES 401 reports during 2004 at JAFNPP ranged from a minimum of 0.6°C (33.0°F) on 9 January to a maximum of 23.7°C (74.7°F) on 5 October. Discharge temperatures ranged from a minimum of 6.6°C (43.9°F) on 17 February to a maximum of 38.8°C (101.9°F) on 23 July 2004 (Appendix B).

3.5 HISTORICAL IMPINGEMENT COMPARISONS (PERMIT SECTION 10.e)

Impinged fish have been collected annually at JAFNPP from 1975 to 1997 and again in 2004. Historical impingement abundances from 1976 to 1997 and 2004 are provided in Appendix E (estimated impingement numbers have been corrected for screen efficiency where applicable [i.e., alewives, rainbow smelt, smallmouth bass, white perch, and yellow perch]). Impingement abundance is highest in the spring and peaks in May when approximately 35 percent of impingement occurs. The high abundance in spring coincides with the movement of fish to the shallow inshore areas to spawn. Migration inshore occurs when lake temperatures warm in spring to preferred species-specific spawning temperature ranges; the timing may vary slightly each year with meteorological conditions. Impingement abundance begins to decrease in June as adult fish move offshore after spawning. Fish impingement then increases in the fall (October, November, and December) when 21 percent of impingement occurs as YOY fish, particularly alewives and rainbow smelt, attain a size susceptible to the impingement on cooling water intake screens (Figure 3-2, Table E-1). Generally associated with the increase in impingement of fish in the fall and winter are specific meteorological conditions to which YOY seem particularly susceptible. Historically, strong winds from the west or northwest that cause strong wave action have resulted in short-term increases in impingement abundance at JAFNPP. Lifton and Storr

(1977) found statistically significant correlations between environmental factors (wave height, water temperature, and wind action) and impingement at power plants on Lake Erie and Lake Ontario. Wave height had a higher correlation than either of the other factors. They hypothesized that wave-induced turbulence and possibly turbidity interfere with a fish's normal ability to detect and avoid an intake structure.

Historically, the timing and duration of station outages for refueling and maintenance have a major influence on impingement abundance and species composition. During extended maintenance and/or refueling outages, the operation of the main circulating water pumps is generally reduced to one or two of the three existing pumps; occasionally none are in operation. The reduced flow through the intake generally results in a reduction in impingement abundance and species diversity during the outage. Years in which extended outages resulted in the reduction of fish impingement are visible on Figure 3-3. The timing of refueling outages during spring spawning migrations of alewives and rainbow smelt occurred in 1979, 1980, 1985, 1987, 1990, 1991, 1992, and April 1994. Outages that occurred in the late summer and fall when YOY are susceptible to impingement occurred in 1977, 1978, 1981, 1983, 1984, 1988, 1991, 1992, 1994, and 1996. The influence of station outages should be considered when interpreting patterns of historical impingement abundance, particularly when outages occur at times of seasonal movements of both alewife and rainbow smelt. Privatization, competition, and deregulation of nuclear power of today compared to that of the 1980s and 1990s are all influences that have led to an increase in plant efficiency which has led to improved generation output by concentrating on reducing unplanned losses, minimizing the duration of planned outages, and exploring options to improve station output capability. These practices have minimized influences of reduced flow during outages on impingement studies. Only one outage occurred during 2004 (Refueling Outage 16) and was completed over the period 25 September through 24 October that resulted in only 19 percent of normal water volume pumped during that time. The impingement samples that were originally scheduled during this outage were rescheduled and completed during September and October at times when at least two circulating water pumps were in operation (Table 2-1; Appendix B).

Meteorological conditions cause changes in populations that may also be reflected in the impingement collections. Alewives have exhibited significant year-to-year fluctuations in population size (Christie 1974; Elrod et al. 1979; O'Gorman and Schneider 1986; O'Gorman et al. 1988; Scott and Crossman 1973). Christie (1974) hypothesized that periodic die-offs of alewives in the spring might occur due to some combination of climatic conditions and the physical condition of individuals in the population. Impingement has been monitored at JAFNPP since 1976 (Figures 3-4a and 3-4b, Table 3-9) (Appendix E). Data from impingement collections during 1976, the year prior to a severe winter mass alewife die-off, were extremely high compared to data collected since that time. During Winter/Spring 1977, Lake Ontario experienced a 60-75 percent loss of the adult alewife population, resulting in the virtual elimination of the 1976 year class. This event was reflected in impingement data when a 20-fold decrease was observed between 1976 and 1977. The estimated number of alewives impinged in 1976 (3,916,717, adjusted for screen efficiency) (LMS 1977) accounted for 52 percent of the total estimated alewife catch from 1976 to 1997 and 2004. The exceptionally high alewife abundance during 1976, as compared to abundance since then, may be construed as an anomaly in a statistical sense. The interpretation of historical alewife abundance as a percent of all data should take these differences into consideration. Alewife abundance data from 1977 to 1997 and 2004 are more representative of abundance observed during the past two decades than data from 1976. Therefore, for purposes of comparing historical data, references to both the inclusion and omission of the 1976 data are made in Figures 3-4a and 3-4b. With the inclusion of 1976 data, alewives have accounted for 59 percent (Figure 3-4a) of total impingement (based on dominant species) from JAFNPP compared to 43 percent (Figure 3-4b) when omitting 1976 data. Alewife impingement abundance has never approached the same level experienced in 1976. Since then, Lake Ontario winters resulted in no catastrophic die-offs of the magnitude recorded in 1976. Several smaller die-off events have been noted, e.g., 1983 and 1986 (O'Gorman et al. 1988).

High frequency FDS tests in Spring 1991 (April-June) and 1993 (April-July) should also be taken into account when interpreting historical trends in impingement in Table 3-9. The impingement of alewives at JAFNPP was reduced by over 87 percent, due to the deployment of the acoustic fish deterrence system at the JAFNPP intake (Ross et al. 1993, 1996). Another deterrence system test in 1997 directly affected impingement abundance from April through mid-July so that 1997 data are not directly comparable except for general seasonal trends. Preliminary results suggested that the system effectively reduced alewife impingement by 87 percent (Dunning 1998).

USGS data show that alewife numbers continue to remain moderate in 2004 and have been relatively stable for the last several years. Although abundance is considerably less than in the mid-1980s, the population seems to be stabilizing as their diet has shifted from the amphipod, *Diporeia*, to possum shrimp, *Mysis,* and is associated with dispersal of alewives to deeper areas of the lake. The shift in diet seems to result in healthier, more robust fish due to lower alewife numbers, which provide more food for the fish that do survive. USGS personnel believe that *Diporeia*, which was the major food source of the alewife, have been almost completely depleted following the introduction and increase of the zebra mussel population over the last decade (O'Gorman 2004).

Rainbow smelt impingement abundance has been subject to fluctuations resulting from a variety of factors. As previously discussed, strong west or northwest winds with an associated increase in wave action result in short-term increases in impingement abundance. These conditions occur on Lake Ontario particularly in January, November, and December, and cause an increase in impingement of YOY rainbow smelt. In addition, rainbow smelt are subject to lake-wide population fluctuations, which appear to be caused in part by cannibalism of young smelt by adult smelt and by predation by the stocked salmonids on adult smelt (O'Gorman et al. 1990). When interpreting impingement data on rainbow smelt, lake-wide patterns in population fluctuations are difficult to ascertain due to the strong influence of meteorological conditions and plant outages which have occurred during sample collections. In impingement years 1995-1997, rainbow smelt numbers appeared to be fairly stable, however, estimated numbers of rainbow smelt impinged (based on total cooling water flow) for 2004 are the lowest on record since inception of impingement monitoring at JAFNPP. Factors including the introduction of the zebra mussel in the early 1990s and nutrient reductions in near shore areas of the lake due to improved land use and sewage treatment practices have reduced lake productivity, affected associated reductions in smelt populations, and caused a shift in the distribution of smelt into deeper waters similar to that of the alewife, where food is more prevalent, thus avoiding the JAFNPP intake structure altogether. The USGS has also noted that the year classes for rainbow smelt in 2002 and 2003 were so low that no studies could be done on them. Although rainbow smelt impingement numbers were very low for 2004, trawls performed by the USGS in the same year showed the highest population index number for smelt since 1999 (O'Gorman 2005), indicating a strong recruitment year class for 2005. USGS biologists are uncertain of what factors have influenced the improved index for rainbow smelt in 2005.

The estimated impingement of alewives, rainbow smelt, white perch, yellow perch, smallmouth bass, and salmonids, species of interest due to their significance as forage or sport fish, are shown for 1976-1997 (Figure 3-3). Fluctuations in their abundance appear to be attributable primarily to natural fluctuations of individual populations and localized meteorological occurrences influencing the impingement process. Increases in smallmouth bass and white perch impingement abundance are most often influenced by short-term meteorological conditions previously described. Late fall and winter storms often cause large numbers of YOY of both species to be collected in the impingement samples. Impingement of smallmouth bass during 1988, 1990, 1993, and 1994 was influenced by such factors; storms in 1977, 1983, 1993, and 1996 affected white perch impingement (EA 1984, 1989, 1991, 1994; TI 1978). Increases in 2004 for white perch and yellow perch in January and December can be attributed to meteorological conditions. The January and December combined numbers for white perch accounted for 50 of the total 71 specimens collected (70 percent), and yellow perch for those months accounted for 45 of the total 58 specimens collected (78 percent).

The population of yellow perch in Lake Ontario declined from the late 1970s through 1990, with only 1978 and 1985 assessment data indicating high abundance of yellow perch (O'Gorman et al. 1990). For those years, yellow perch impingement abundance estimates were highest in 1978; the JAFNPP outage in 1985 could have obscured any increase in yellow perch due to reduced impingement during the outage. Historically, yellow perch impingement abundance has demonstrated small fluctuations most likely influenced by meteorological events and extended outages.

Natural biological factors such as population size, migration patterns, schooling, and spawning behaviors, in conjunction with external environmental factors such as water temperatures, currents, and localized meteorological conditions, can play an important role in seasonal variations in species occurrence or absence in the near shore zone of Lake Ontario. Species composition has ranged from 26 to 54 species per year in the impingement collections at JAFNPP. The 35 species collected in 2004 are within the average range of historical diversity. It is conceivable that the reduction in population of alewives and the presence of zebra mussels may be affecting species composition and abundance in Lake Ontario and may be a few of the factors influencing the exponential increase in threespine stickleback lake-wide and as reflected in the impingement samples for 2004 and in the mid-1990s.

Historically, changes in fish populations in the vicinity of JAFNPP are the result of natural fluctuations. When changes are of a greater magnitude (as in a die-off of alewives), they can be detected in the annual estimates of fish impinged at JAFNPP. When fluctuations occur over long periods of time and are relatively small, they are difficult to differentiate from the influences of daily plant operations and meteorological occurrences, the two main influences upon the impingement process. No long-term trends in fish population abundance due to the impingement process at JAFNPP have been apparent.

A new forage feeder in Lake Ontario, the round goby (*Neogobius melanostomus*), is rapidly spreading eastward across the lake. Gobies, which are native to Eastern Europe, were introduced into the St. Claire River in 1990, probably via contaminated ballast water of transoceanic ships. The goby is a bottom-dwelling fish that has great potential for causing impacts on Great Lakes fisheries. Round gobies are thriving in the Great Lakes Basin because they are aggressive, voracious feeders that can forage in total darkness. The round goby takes over prime spawning sites traditionally used by native species, competing with native fish for habitat and changing the balance of the ecosystem. The round goby is already causing problems for other bottom-dwelling Great Lakes native fish like mottled sculpin, logperch, and darters. Goby spawn more often and over a longer period than native fish. Unfortunately, they have shown a rapid expansion of their range through the Great Lakes (Marsden and Dude 2003). No round gobies were collected in impingement samples in 2004 or in previous years at JAFNPP.

Another species that resource managers are watching is the invasive species ruffe (*Gymnocephalus cernuus*). Although the ruffe has yet to be found in Lake Ontario, they are rapidly moving east from the Upper Great Lakes and appear to compete with the walleye and yellow perch (McLean 1994). The goby and ruffe do not appear to have reached this area of the Great Lakes based on extensive impingement monitoring at JAFNPP.

3.6 SCREENWASH EFFLUENT DEBRIS VOLUME (PERMIT SECTION 10.f)

The volume of debris from the screenwash effluent for each 24-hour impingement sample is listed in Table 3-10. Debris mainly consisted of zebra mussel shells, aquatic vegetation, fish, silt, sticks, and other miscellaneous items. The total volume of debris removed from the collection basket for 2004 was 1,326 gal (7.58 yd^3). Storm events, such as those experienced on 8, 15, and 25 January and 2 December, were a significant factor in volume of debris loading. Large quantities of debris have historically been associated with periods of high winds and rough water surface conditions. Another factor that significantly increased the volume of debris loading was maintenance of the intake canal on 11 and 12 May. The maintenance involved divers vacuuming the bottom of the canal to remove a buildup of zebra mussel shells. The "stirring up" of the bottom of the canal released a considerable number of zebra mussel shells into the collection basket. Debris loading for these 2 days of canal maintenance accounted for 51 percent of the total annual volume. The average total effluent debris, excluding the storm and maintenance events listed above, was approximately 7 gal (0.04 yd^3) per sample.

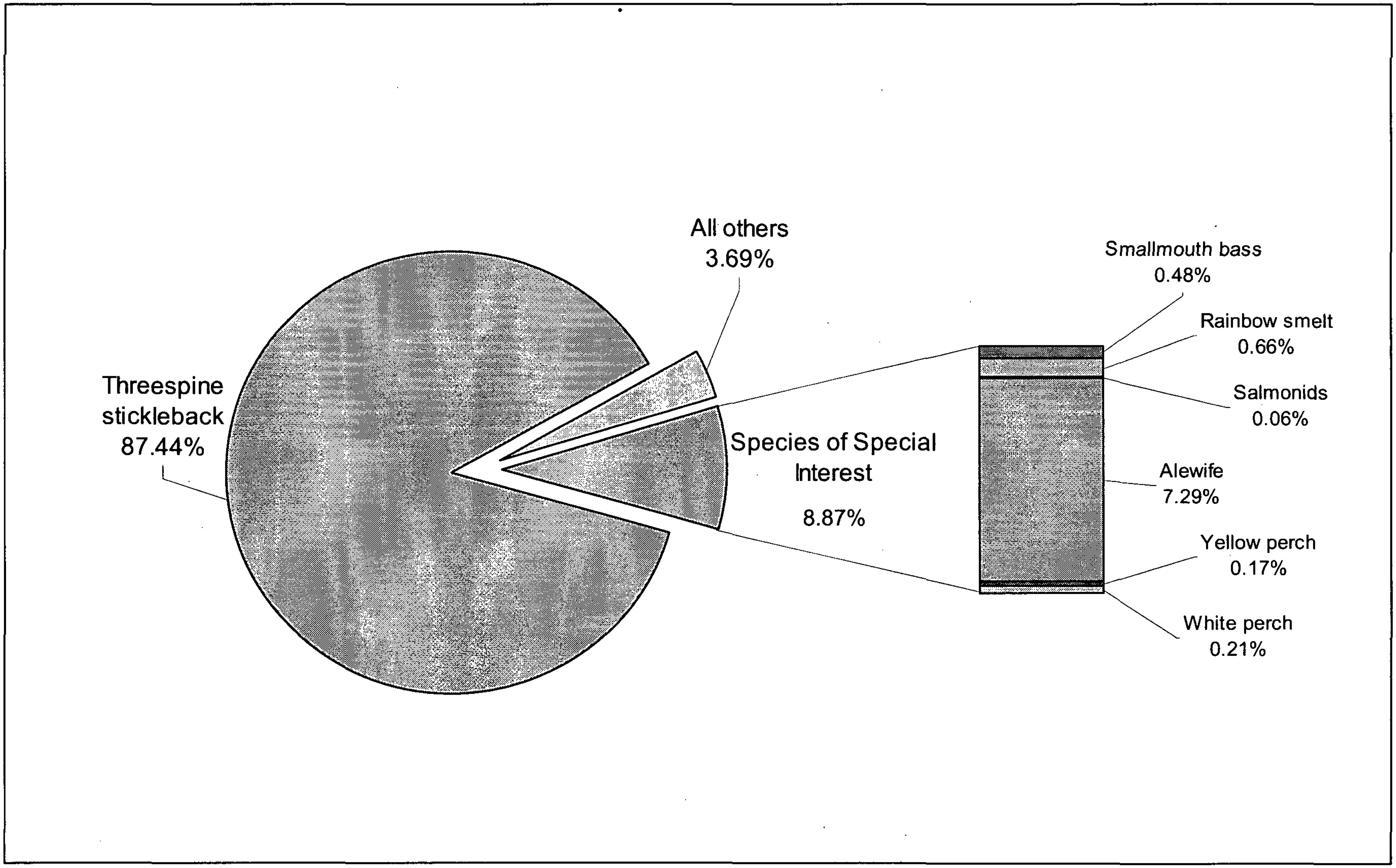

Figure 3-1. Relative proportions of the impingement collections for all species at the James A. Fitzpatrick Nuclear Power Plant, 2004.

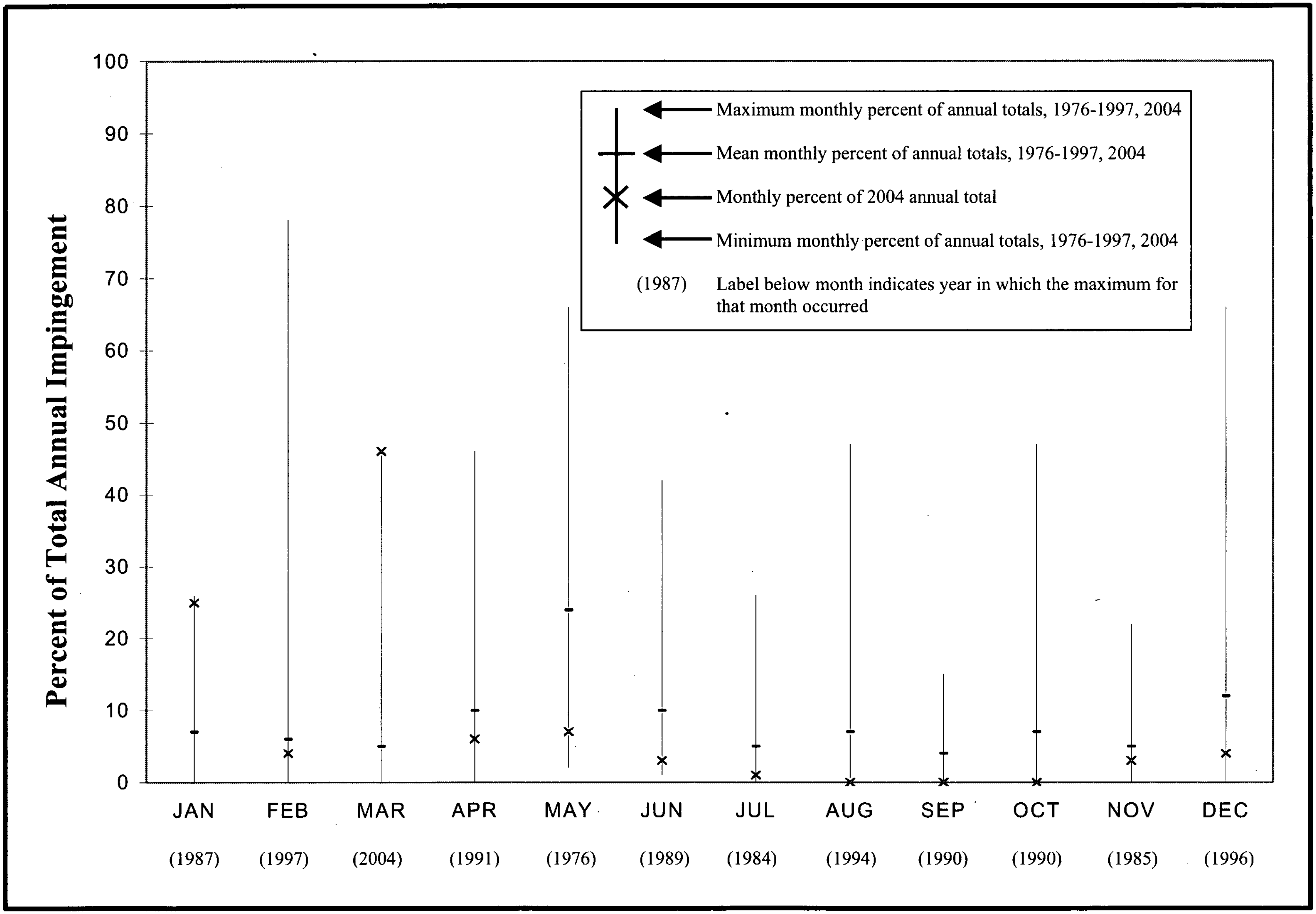

Figure 3-2. Range and mean of monthly impingement estimates as percents of annual totals (1976-1997 and 2004) at the James A. FitzPatrick Nuclear Power Plant.

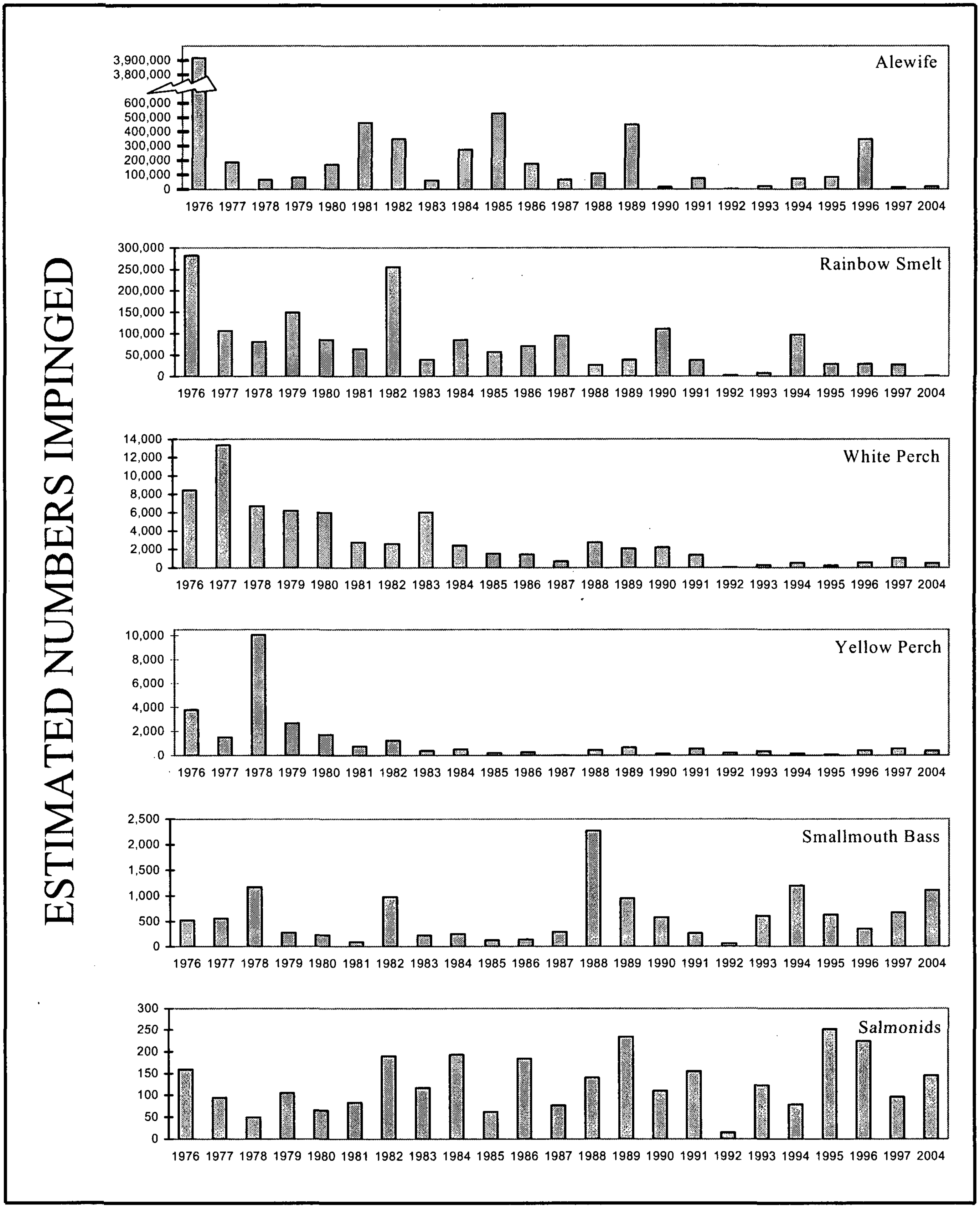

Figure 3-3. Estimated impingement of selected species calculated based on total cooling water flow at the James A. FitzPatrick Nuclear Power Plant. Note difference in vertical scale.

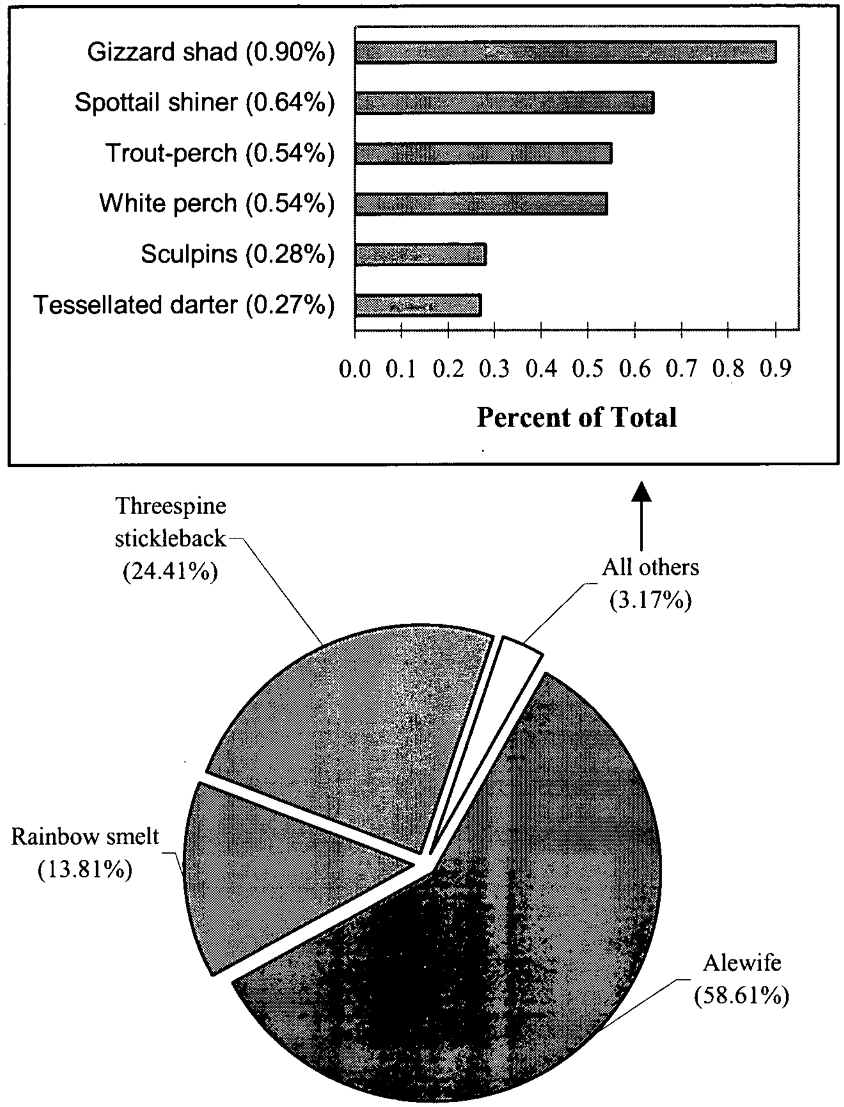

Figure 3-4a. Relative proportions of impingement collections composed of dominant species, 1976-1997 and 2004 (inclusion of 1976 data [Table E-2]), at the James A. FitzPatrick Nuclear Power Plant.

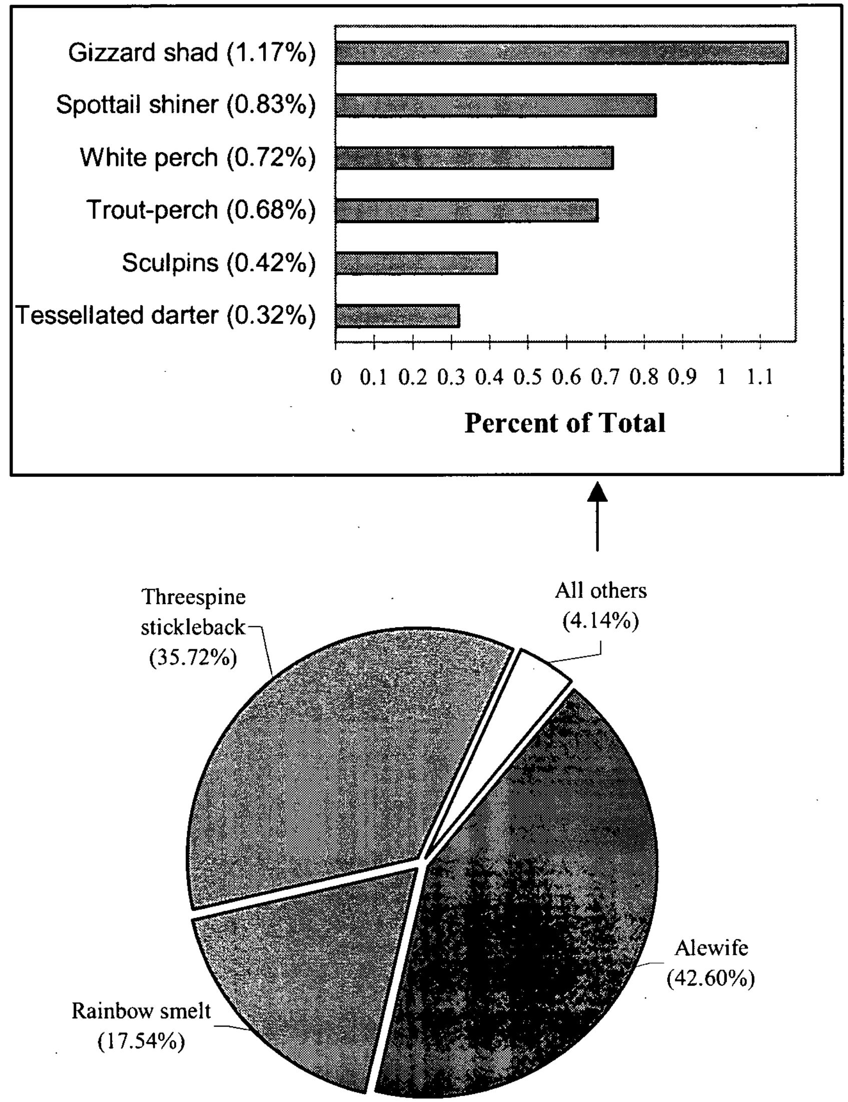

Figure 3-4b. Relative proportions of impingement collections composed of dominant species, 1977-1997 and 2004 (omission of 1976 data [Table E-2]), at the James A. FitzPatrick Nuclear Power Plant.

TABLE 3-1 MONTHLY IMPINGEMENT COLLECTIONS[(a)], 2004

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Threespine stickleback	6,900	1,285	13,719	7,459	814	697	196	48	3	4	368	1,050	32,543
Alewife	---	---	---	45	8,684	12	3	2	10	89	329	29	9,203
Sculpins	14	8	12	204	109	16	3	12	23	---	3	28	432
Alewife (damaged)	---	---	---	---	300	---	---	---	---	34	34	2	370
Rainbow smelt	62	8	13	21	141	28	6	1	8	1	4	22	315
Smallmouth bass	29	4	3	24	181	26	13	6	11	2	3	7	309
Trout perch	1	1	---	8	183	54	22	1	2	---	---	3	275
Rock bass	53	6	---	7	49	16	8	2	11	---	3	16	171
Rainbow smelt (damaged)	2	3	8	5	117	21	4	1	2	---	---	7	170
Stonecat	26	4	9	31	44	19	8	2	2	4	2	19	170
Spottail shiner	11	10	11	35	26	6	8	---	2	---	---	9	118
Threespine stickleback (damaged)	50	---	---	---	---	---	---	2	---	---	9	38	99
White perch	16	---	---	17	3	---	---	---	---	---	1	34	71
Crayfish	28	---	---	2	2	3	2	1	---	---	4	16	58
Yellow perch	14	---	---	3	2	---	1	4	1	1	1	31	58
Crayfish (damaged)	12	---	1	3	---	---	---	10	8	---	---	1	35
Gizzard shad	6	---	1	---	---	---	---	---	---	---	15	13	35
White sucker	---	1	---	---	3	5	11	3	---	---	1	---	24
Bluegill	---	---	---	1	1	---	---	---	---	---	8	10	20
Tessellated darter	---	---	---	---	11	5	---	---	---	---	1	1	18
Lake trout	4	---	2	---	2	3	---	---	---	---	3	3	17
Emerald shiner	8	---	---	---	---	---	---	---	---	---	---	6	14
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	6	6
Pumpkinseed	---	---	---	1	---	---	---	---	---	---	---	5	6

(a) Total number of organisms collected per month.

NOTE: Dashes (---) indicate no catch.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Spottail shiner (damaged)	1	---	2	1	---	1	---	---	---	---	---	---	5
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	4	---	4
Chinook salmon	---	---	---	---	2	---	2	---	---	---	---	---	4
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	4	4
Sea lamprey	---	---	---	1	2	---	---	---	---	---	1	---	4
Central mudminnow	---	---	1	---	---	---	---	---	---	---	---	2	3
Sculpins (damaged)	---	---	---	---	---	---	---	---	1	---	---	2	3
Brook stickleback (damaged)	---	---	---	2	---	---	---	---	---	---	---	---	2
Brown bullhead	---	---	---	---	2	---	---	---	---	---	---	---	2
Burbot	---	---	---	1	---	---	1	---	---	---	---	---	2
Channel catfish	2	---	---	---	---	---	---	---	---	---	---	---	2
Freshwater drum	1	---	1	---	---	---	---	---	---	---	---	---	2
Shorthead redhorse sucker	---	---	---	1	---	---	---	---	1	---	---	---	2
Silver redhorse sucker	---	---	2	---	---	---	---	---	---	---	---	---	2
Smallmouth bass (damaged)	---	---	1	---	---	---	---	---	---	---	---	1	2
Stonecat (damaged)	---	1	---	1	---	---	---	---	---	---	---	---	2
Trout perch (damaged)	---	---	---	---	1	---	---	1	---	---	---	---	2
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	1	1
Brook stickleback	---	---	---	---	1	---	---	---	---	---	---	---	1
Brown trout	1	---	---	---	---	---	---	---	---	---	---	---	1
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	1	1
Rainbow trout	---	---	---	---	---	---	---	1	---	---	---	---	1
Sea lamprey (damaged)	---	---	---	1	---	---	---	---	---	---	---	---	1
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	1	1
Walleye	---	---	---	---	---	1	---	---	---	---	---	---	1
Yellow perch (damaged)	---	---	---	---	---	---	---	1	---	---	---	---	1
TOTAL	7,241	1,331	13,786	7,874	10,680	913	288	98	85	135	794	1,368	44,593

TABLE 3-2 MEAN DAILY IMPINGEMENT RATE[(a)] BY SPECIES, 2004

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Threespine stickleback	1,725.00	321.25	3,429.75	466.19	40.70	174.25	49.00	8.00	0.75	1.00	92.00	262.50	417.22
Alewife	---	---	---	2.81	434.20	3.00	0.75	0.33	2.50	22.25	82.25	7.25	117.99
Sculpins	3.50	2.00	3.00	12.75	5.45	4.00	0.75	2.00	5.75	---	0.75	7.00	5.54
Alewife (damaged)	---	---	---	---	15.00	---	---	---	---	8.50	8.50	0.50	4.74
Rainbow smelt	15.50	2.00	3.25	1.31	7.05	7.00	1.50	0.17	2.00	0.25	1.00	5.50	4.04
Smallmouth bass	7.25	1.00	0.75	1.50	9.05	6.50	3.25	1.00	2.75	0.50	0.75	1.75	3.96
Trout perch	0.25	0.25	---	0.50	9.15	13.50	5.50	0.17	0.50	---	---	0.75	3.53
Rock bass	13.25	1.50	---	0.44	2.45	4.00	2.00	0.33	2.75	---	0.75	4.00	2.19
Rainbow smelt (damaged)	0.50	0.75	2.00	0.31	5.85	5.25	1.00	0.17	0.50	---	---	1.75	2.18
Stonecat	6.50	1.00	2.25	1.94	2.20	4.75	2.00	0.33	0.50	1.00	0.50	4.75	2.18
Spottail shiner	2.75	2.50	2.75	2.19	1.30	1.50	2.00	---	0.50	---	---	2.25	1.51
Threespine stickleback (damaged)	12.50	---	---	---	---	---	---	0.33	---	---	2.25	9.50	1.27
White perch	4.00	---	---	1.06	0.15	---	---	---	---	---	0.25	8.50	0.91
Crayfish	7.00	---	---	0.12	0.10	0.75	0.50	0.17	---	---	1.00	4.00	0.74
Yellow perch	3.50	---	---	0.19	0.10	---	0.25	0.67	0.25	0.25	0.25	7.75	0.74
Crayfish (damaged)	3.00	---	0.25	0.19	---	---	---	1.67	2.00	---	---	0.25	0.45
Gizzard shad	1.50	---	0.25	---	---	---	---	---	---	---	3.75	3.25	0.45
White sucker	---	0.25	---	---	0.15	1.25	2.75	0.50	---	---	0.25	---	0.31
Bluegill	---	---	---	0.06	0.05	---	---	---	---	---	2.00	2.50	0.26
Tessellated darter	---	---	---	---	0.55	1.25	---	---	---	---	0.25	0.25	0.23
Lake trout	1.00	---	0.50	---	0.10	0.75	---	---	---	---	0.75	0.75	0.22
Emerald shiner	2.00	---	---	---	---	---	---	---	---	---	---	1.50	0.18
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	1.50	0.08
Pumpkinseed	---	---	---	0.06	---	---	---	---	---	---	---	1.25	0.08

(a) Number of organisms impinged per sample.

NOTE: Dashes (---) indicate no catch.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Spottail shiner (damaged)	0.25	---	0.50	0.06	---	0.25	---	---	---	---	---	---	0.06
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	1.00	---	0.05
Chinook salmon	---	---	---	---	0.10	---	0.50	---	---	---	---	---	0.05
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	1.00	0.05
Sea lamprey	---	---	---	0.06	0.10	---	---	---	---	---	0.25	---	0.05
Central mudminnow	---	---	0.25	---	---	---	---	---	---	---	---	0.50	0.04
Sculpins (damaged)	---	---	---	---	---	---	---	---	0.25	---	---	0.50	0.04
Brook stickleback (damaged)	---	---	---	0.12	---	---	---	---	---	---	---	---	0.03
Brown bullhead	---	---	---	---	0.10	---	---	---	---	---	---	---	0.03
Burbot	---	---	---	0.06	---	---	0.25	---	---	---	---	---	0.03
Channel catfish	0.50	---	---	---	---	---	---	---	---	---	---	---	0.03
Freshwater drum	0.25	---	0.25	---	---	---	---	---	---	---	---	---	0.03
Shorthead redhorse sucker	---	---	---	0.06	---	---	---	---	0.25	---	---	---	0.03
Silver redhorse sucker	---	---	0.50	---	---	---	---	---	---	---	---	---	0.03
Smallmouth bass (damaged)	---	---	0.25	---	---	---	---	---	---	---	---	0.25	0.03
Stonecat (damaged)	---	0.25	---	0.06	---	---	---	---	---	---	---	---	0.03
Trout perch (damaged)	---	---	---	---	0.05	---	---	0.17	---	---	---	---	0.03
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	0.25	0.01
Brook stickleback	---	---	---	---	0.05	---	---	---	---	---	---	---	0.01
Brown trout	0.25	---	---	---	---	---	---	---	---	---	---	---	0.01
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	0.25	0.01
Rainbow trout	---	---	---	---	---	---	---	0.17	---	---	---	---	0.01
Sea lamprey (damaged)	---	---	---	0.06	---	---	---	---	---	---	---	---	0.01
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	0.25	0.01
Walleye	---	---	---	---	---	0.25	---	---	---	---	---	---	0.01
Yellow perch (damaged)	---	---	---	---	---	---	---	0.17	---	---	---	---	0.01
TOTAL	1,810.25	332.75	3,446.50	492.10	534.00	228.25	72.00	16.35	21.25	33.75	198.50	342.00	571.73

TABLE 3-3 MONTHLY IMPINGEMENT RATE[(a)] (NUMBER/MCM), 2004

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4
Sample Volume (MCM)	7.104	6.803	7.156	30.810	38.848	8.201	8.373	12.043	8.734	6.741	8.721	8.484
Threespine stickleback	971.28	188.89	1,917.13	242.10	20.95	84.99	23.41	3.99	0.34	0.59	42.20	123.76
Alewife	---	---	---	1.46	223.54	1.46	0.36	0.17	1.14	13.20	37.72	3.42
Sculpins	1.97	1.18	1.68	6.62	2.81	1.95	0.36	1.00	2.63	---	0.34	3.30
Alewife (damaged)	---	---	---	---	7.72	---	---	---	---	5.04	3.90	0.24
Rainbow smelt	8.73	1.18	1.82	0.68	3.63	3.41	0.72	0.08	0.92	0.15	0.46	2.59
Smallmouth bass	4.08	0.59	0.42	0.78	4.66	3.17	1.55	0.50	1.26	0.30	0.34	0.82
Trout perch	0.14	0.15	---	0.26	4.71	6.58	2.63	0.08	0.23	---	---	0.35
Rock bass	7.46	0.88	---	0.23	1.26	1.95	0.96	0.17	1.26	---	0.34	1.89
Rainbow smelt (damaged)	0.28	0.44	1.12	0.16	3.01	2.56	0.48	0.08	0.23	---	---	0.82
Stonecat	3.66	0.59	1.26	1.01	1.13	2.32	0.96	0.17	0.23	0.59	0.23	2.24
Spottail shiner	1.55	1.47	1.54	1.14	0.67	0.73	0.96	---	0.23	---	---	1.06
Threespine stickleback (damaged)	7.04	---	---	---	---	---	---	0.17	---	---	1.03	4.48
White perch	2.25	---	---	0.55	0.08	---	---	---	---	---	0.12	4.01
Crayfish	3.94	---	---	0.06	0.05	0.37	0.24	0.08	---	---	0.46	1.89
Yellow perch	1.97	---	---	0.10	0.05	---	0.12	0.33	0.11	0.15	0.12	3.65
Crayfish (damaged)	1.69	---	0.14	0.10	---	---	---	0.83	0.92	---	---	0.12
Gizzard shad	0.84	---	0.14	---	---	---	---	---	---	---	1.72	1.53
White sucker	---	0.15	---	---	0.08	0.61	1.31	0.25	---	---	0.12	---
Bluegill	---	---	---	0.03	0.03	---	---	---	---	---	0.92	1.18
Tessellated darter	---	---	---	---	0.28	0.61	---	---	---	---	0.12	0.12
Lake trout	0.56	---	0.28	---	0.05	0.37	---	---	---	---	0.34	0.35
Emerald shiner	1.13	---	---	---	---	---	---	---	---	---	---	0.71
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	0.71
Pumpkinseed	---	---	---	0.03	---	---	---	---	---	---	---	0.59

(a) Rate = Mean number of organisms impinged per MCM (based on sample flow).

NOTE: MCM = Million cubic meters.
Dashes (---) indicate no catch.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4
Sample Volume (MCM)	7.104	6.803	7.156	30.810	38.848	8.201	8.373	12.043	8.734	6.741	8.721	8.484
Spottail shiner (damaged)	0.14	---	0.28	0.03	---	0.12	---	---	---	---	---	---
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	0.46	---
Chinook salmon	---	---	---	---	0.05	---	0.24	---	---	---	---	---
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	0.47
Sea lamprey	---	---	---	0.03	0.05	---	---	---	---	---	0.12	---
Central mudminnow	---	---	0.14	---	---	---	---	---	---	---	---	0.24
Sculpins (damaged)	---	---	---	---	---	---	---	---	0.11	---	---	0.24
Brook stickleback (damaged)	---	---	---	0.06	---	---	---	---	---	---	---	---
Brown bullhead	---	---	---	---	0.05	---	---	---	---	---	---	---
Burbot	---	---	---	0.03	---	---	0.12	---	---	---	---	---
Channel catfish	0.28	---	---	---	---	---	---	---	---	---	---	---
Freshwater drum	0.14	---	0.14	---	---	---	---	---	---	---	---	---
Shorthead redhorse sucker	---	---	---	0.03	---	---	---	---	0.11	---	---	---
Silver redhorse sucker	---	---	0.28	---	---	---	---	---	---	---	---	---
Smallmouth bass (damaged)	---	---	0.14	---	---	---	---	---	---	---	---	0.12
Stonecat (damaged)	---	0.15	---	0.03	---	---	---	---	---	---	---	---
Trout perch (damaged)	---	---	---	---	0.03	---	---	0.08	---	---	---	---
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	0.12
Brook stickleback	---	---	---	---	0.03	---	---	---	---	---	---	---
Brown trout	0.14	---	---	---	---	---	---	---	---	---	---	---
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	0.12
Rainbow trout	---	---	---	---	---	---	---	0.08	---	---	---	---
Sea lamprey (damaged)	---	---	---	0.03	---	---	---	---	---	---	---	---
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	0.12
Walleye	---	---	---	---	---	0.12	---	---	---	---	---	---
Yellow perch (damaged)	---	---	---	---	---	---	---	0.08	---	---	---	---
TOTAL	1,019.28	195.65	1,926.50	255.57	274.92	111.33	34.40	8.14	9.73	20.03	91.04	161.24

TABLE 3-4 ESTIMATED[(a)] TOTAL MONTHLY IMPINGEMENT (BASED ON MEAN DAILY IMPINGEMENT COUNT), 2004

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Threespine stickleback	53,475	9,316	106,322	13,986	1,262	5,228	1,519	248	22	31	2,760	8,138	202,307
Alewife	---	---	---	84	13,460	90	23	10	75	690	2,468	225	17,125
Sculpins	108	58	93	382	169	120	23	62	172	---	22	217	1,426
Alewife (damaged)	---	---	---	---	465	---	---	---	---	264	255	16	1,000
Rainbow smelt	480	58	101	39	219	210	46	5	60	8	30	170	1,426
Smallmouth bass	225	29	23	45	281	195	101	31	82	16	22	54	1,104
Trout perch	8	7	---	15	284	405	170	5	15	---	---	23	932
Rock bass	411	44	---	13	76	120	62	10	82	---	22	124	964
Rainbow smelt (damaged)	16	22	62	9	181	158	31	5	15	---	---	54	553
Stonecat	202	29	70	58	68	142	62	10	15	31	15	147	849
Spottail shiner	85	72	85	66	40	45	62	---	15	---	---	70	540
Threespine stickleback (damaged)	388	---	---	---	---	---	---	10	---	---	68	294	760
White perch	124	---	---	32	5	---	---	---	---	---	8	264	433
Crayfish	217	---	---	4	3	22	16	5	---	---	30	124	421
Yellow perch	108	---	---	6	3	---	8	21	8	8	8	240	410
Crayfish (damaged)	93	---	8	6	---	---	---	52	60	---	---	8	227
Gizzard shad	46	---	8	---	---	---	---	---	---	---	112	101	267
White sucker	---	7	---	---	5	38	85	16	---	---	8	---	159
Bluegill	---	---	---	2	2	---	---	---	---	---	60	78	142
Tessellated darter	---	---	---	---	17	38	---	---	---	---	8	8	71
Lake trout	31	---	16	---	3	22	---	---	---	---	22	23	117
Emerald shiner	62	---	---	---	---	---	---	---	---	---	---	46	108
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	46	46
Pumpkinseed	---	---	---	2	---	---	---	---	---	---	---	39	41

(a) Estimate total = Mean number of organisms impinged per sample (Table 3-2) multiplied by the number of days in month.

NOTE: Dashes (---) indicate no catch.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Spottail shiner (damaged)	8	---	16	2	---	8	---	---	---	---	---	---	34
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	30	---	30
Chinook salmon	---	---	---	---	3	---	16	---	---	---	---	---	19
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	31	31
Sea lamprey	---	---	---	2	3	---	---	---	---	---	8	---	13
Central mudminnow	---	---	8	---	---	---	---	---	---	---	---	16	24
Sculpins (damaged)	---	---	---	---	---	---	---	---	8	---	---	16	24
Brook stickleback (damaged)	---	---	---	4	---	---	---	---	---	---	---	---	4
Brown bullhead	---	---	---	---	3	---	---	---	---	---	---	---	3
Burbot	---	---	---	2	---	---	8	---	---	---	---	---	10
Channel catfish	16	---	---	---	---	---	---	---	---	---	---	---	16
Freshwater drum	8	---	8	---	---	---	---	---	---	---	---	---	16
Shorthead redhorse sucker	---	---	---	2	---	---	---	---	8	---	---	---	10
Silver redhorse sucker	---	---	16	---	---	---	---	---	---	---	---	---	16
Smallmouth bass (damaged)	---	---	8	---	---	---	---	---	---	---	---	8	16
Stonecat (damaged)	---	7	---	2	---	---	---	---	---	---	---	---	9
Trout perch (damaged)	---	---	---	---	2	---	---	5	---	---	---	---	7
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	8	8
Brook stickleback	---	---	---	---	2	---	---	---	---	---	---	---	2
Brown trout	8	---	---	---	---	---	---	---	---	---	---	---	8
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	8	8
Rainbow trout	---	---	---	---	---	---	---	5	---	---	---	---	5
Sea lamprey (damaged)	---	---	---	2	---	---	---	---	---	---	---	---	2
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	8	8
Walleye	---	---	---	---	---	8	---	---	---	---	---	---	8
Yellow perch (damaged)	---	---	---	---	---	---	---	5	---	---	---	---	5
TOTAL	56,119	9,649	106,844	14,765	16,556	6,849	2,232	505	637	1,048	5,956	10,604	231,764

TABLE 3-5 ESTIMATED[a] TOTAL MONTHLY IMPINGEMENT (BASED ON TOTAL MONTHLY FLOW), 2004

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Total Sample Flow (MCM)	7.104	6.803	7.156	30.810	38.848	8.201	8.373	12.043	8.734	6.741	8.721	8.484	152.018
Total Monthly Flow (MCM)	55.485	48.962	55.129	57.469	59.938	61.203	64.071	65.354	55.644	23.172	64.745	63.323	674.495
Threespine stickleback	53,892	9,248	105,690	13,913	1,256	5,202	1,500	260	19	14	2,732	7,837	201,563
Alewife[b]	---	---	---	84	13,534	90	23	11	64	309	2,465	216	16,796
Sculpins	109	58	92	381	168	119	23	65	147	---	22	209	1,393
Alewife (damaged)	---	---	---	---	463	---	---	---	---	117	252	15	847
Rainbow smelt[b]	523	65	108	43	236	224	54	5	57	3	30	179	1,527
Smallmouth bass[b]	234	29	23	47	289	201	99	33	70	7	22	52	1,106
Trout perch	8	7	---	15	282	403	168	5	13	---	---	22	923
Rock bass	414	43	---	13	76	119	61	11	70	---	22	119	948
Rainbow smelt (damaged)	16	22	62	9	181	157	31	5	13	---	---	52	548
Stonecat	203	29	69	58	68	142	61	11	13	14	15	142	825
Spottail shiner	86	72	85	65	40	45	61	---	13	---	---	67	534
Threespine stickleback (damaged)	391	---	---	---	---	---	---	11	---	---	67	284	753
White perch[b]	141	---	---	37	5	---	---	---	---	---	7	291	481
Crayfish	219	---	---	4	3	22	15	5	---	---	30	119	417
Yellow perch[b]	109	---	---	6	3	---	8	22	6	3	7	239	403
Crayfish (damaged)	94	---	8	6	---	---	---	54	51	---	---	7	220
Gizzard shad	47	---	8	---	---	---	---	---	---	---	111	97	263
White sucker	---	7	---	---	5	37	84	16	---	---	7	---	156
Bluegill	---	---	---	2	2	---	---	---	---	---	59	75	138
Tessellated darter	---	---	---	---	17	37	---	---	---	---	7	7	68
Lake trout	31	---	15	---	3	22	---	---	---	---	22	22	115
Emerald shiner	62	---	---	---	---	---	---	---	---	---	---	45	107

(a) Estimate total = number of organisms impinged per MCM (based on sample flow) multiplied by the total volume of cooling water pumped per month.
(b) Species totals corrected for traveling screen efficiency.

NOTE: MCM = Million cubic meters.
Dashes (---) indicate no catch.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Total Sample Flow (MCM)	7.104	6.803	7.156	30.810	38.848	8.201	8.373	12.043	8.734	6.741	8.721	8.484	152.018
Total Monthly Flow (MCM)	55.485	48.962	55.129	57.469	59.938	61.203	64.071	65.354	55.644	23.172	64.745	63.323	674.495
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	45	45
Pumpkinseed	---	---	---	2	---	---	---	---	---	---	---	37	39
Spottail shiner (damaged)	8	---	15	2	---	7	---	---	---	---	---	---	32
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	30	---	30
Chinook salmon	---	---	---	---	3	---	15	---	---	---	---	---	18
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	30	30
Sea lamprey	---	---	---	2	3	---	---	---	---	---	7	---	12
Central mudminnow	---	---	8	---	---	---	---	---	---	---	---	15	23
Sculpins (damaged)	---	---	---	---	---	---	---	---	6	---	---	15	21
Brook stickleback (damaged)	---	---	---	4	---	---	---	---	---	---	---	---	4
Brown bullhead	---	---	---	---	3	---	---	---	---	---	---	---	3
Burbot	---	---	---	2	---	---	8	---	---	---	---	---	10
Channel catfish	16	---	---	---	---	---	---	---	---	---	---	---	16
Freshwater drum	8	---	8	---	---	---	---	---	---	---	---	---	16
Shorthead redhorse sucker	---	---	---	2	---	---	---	---	6	---	---	---	8
Silver redhorse sucker	---	---	15	---	---	---	---	---	---	---	---	---	15
Smallmouth bass (damaged)	---	---	8	---	---	---	---	---	---	---	---	7	15
Stonecat (damaged)	---	7	---	2	---	---	---	---	---	---	---	---	9
Trout perch (damaged)	---	---	---	---	2	---	---	5	---	---	---	---	7
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	7	7
Brook stickleback	---	---	---	---	2	---	---	---	---	---	---	---	2
Brown trout	8	---	---	---	---	---	---	---	---	---	---	---	8
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	7	7
Rainbow trout	---	---	---	---	---	---	---	5	---	---	---	---	5
Sea lamprey (damaged)	---	---	---	2	---	---	---	---	---	---	---	---	2
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	7	7
Walleye	---	---	---	---	---	7	---	---	---	---	---	---	7
Yellow perch (damaged)	---	---	---	---	---	---	---	5	---	---	---	---	5
TOTAL	56,619	9,587	106,214	14,701	16,644	6,834	2,211	529	548	467	5,914	10,266	230,534

TABLE 3-6a LENGTH DISTRIBUTION OF SELECT SPECIES OF SPECIAL INTEREST IMPINGED, 2004

ALEWIFE													
Length Interval (cm)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Interval Total
2.0-3.9	0	0	0	0	0	0	0	0	2	0	0	0	2
4.0-5.9	0	0	0	0	0	0	0	0	2	4	1	0	7
6.0-7.9	0	0	0	11	41	2	0	0	1	40	51	22	168
8.0-9.9	0	0	0	25	204	4	1	0	0	1	9	4	248
10.0-11.9	0	0	0	0	7	0	0	0	0	0	0	0	7
12.0-13.9	0	0	0	0	7	0	0	0	0	0	0	0	7
14.0-15.9	0	0	0	6	44	0	1	0	0	0	0	0	51
16.0-17.9	0	0	0	2	34	6	1	2	4	0	0	1	50
18.0-19.9	0	0	0	1	2	0	0	0	0	0	0	0	3
Total Measured	0	0	0	45	339	12	3	2	9	45	61	27	543
Mean Length	0.0	0.0	0.0	9.6	10.4	12.5	13.9	16.6	10.2	6.7	7.2	7.7	9.6
Length Range (Minimum)	0.0	0.0	0.0	6.8	7.0	6.8	8.8	16.4	3.5	5.0	5.1	6.5	3.5
Length Range (Maximum)	0.0	0.0	0.0	18.0	18.5	17.6	17.1	16.7	17.7	8.0	9.3	16.7	18.5

TABLE 3-6b LENGTH DISTRIBUTION OF SELECT SPECIES OF SPECIAL INTEREST IMPINGED, 2004

RAINBOW SMELT													
Length Interval (cm)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Interval Total
2.0-3.9	0	0	0	0	0	0	0	1	0	0	0	0	1
4.0-5.9	4	0	0	1	3	1	0	0	0	0	0	1	10
6.0-7.9	8	0	2	4	30	11	0	0	0	0	0	2	57
8.0-9.9	7	2	5	11	55	11	6	0	0	0	0	5	102
10.0-11.9	10	4	0	3	7	2	0	0	3	0	1	9	39
12.0-13.9	6	1	0	0	0	0	0	0	2	1	1	2	13
14.0-15.9	1	0	0	1	2	0	0	0	0	0	0	2	6
16.0-17.9	0	0	0	0	0	0	0	0	1	0	1	0	2
Total Measured	36	7	7	20	97	25	6	1	6	1	3	21	230
Mean Length	9.4	10.7	8.0	9.1	8.5	8.0	8.6	3.2	12.2	13.0	14.1	10.3	9.0
Length Range (Minimum)	4.6	8.1	6.5	5.5	5.3	5.9	8.0	3.2	10.3	13.0	11.9	4.8	3.2
Length Range (Maximum)	14.2	12.1	9.0	15.5	15.0	11.9	9.2	3.2	16.6	13.0	16.7	15.3	16.7

TABLE 3-6c LENGTH DISTRIBUTION OF SELECT SPECIES OF SPECIAL INTEREST IMPINGED, 2004

WHITE PERCH													
Length Interval (cm)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Interval Total
4.0-5.9	2	0	0	0	0	0	0	0	0	0	0	1	3
6.0-7.9	11	0	0	9	1	0	0	0	0	0	0	15	36
8.0-9.9	0	0	0	6	2	0	0	0	0	0	1	13	22
10.0-11.9	0	0	0	0	0	0	0	0	0	0	0	1	1
14.0-15.9	0	0	0	1	0	0	0	0	0	0	0	0	1
20.0-21.9	0	0	0	1	0	0	0	0	0	0	0	0	1
Total Measured	13	0	0	17	3	0	0	0	0	0	1	30	64
Mean Length	6.5	0.0	0.0	9.1	8.2	0.0	0.0	0.0	0.0	0.0	9.4	7.9	7.9
Length Range (Minimum)	5.5	0.0	0.0	6.2	7.7	0.0	0.0	0.0	0.0	0.0	9.4	5.7	5.5
Length Range (Maximum)	7.4	0.0	0.0	21.8	8.6	0.0	0.0	0.0	0.0	0.0	9.4	11.0	21.8

TABLE 3-6d LENGTH DISTRIBUTION OF SELECT SPECIES OF SPECIAL INTEREST IMPINGED, 2004

YELLOW PERCH													
Length Interval (cm)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Interval Total
6.0-7.9	2	0	0	1	0	0	0	0	0	0	0	0	3
8.0-9.9	3	0	0	1	0	0	1	0	0	0	0	1	6
10.0-11.9	0	0	0	0	1	0	0	2	0	0	0	6	9
12.0-13.9	3	0	0	1	0	0	0	1	0	0	1	15	21
14.0-15.9	0	0	0	0	0	0	0	1	0	0	0	8	9
16.0-17.9	0	0	0	0	1	0	0	0	0	1	0	1	3
18.0-19.9	0	0	0	0	0	0	0	0	1	0	0	0	1
22.0-23.9	1	0	0	0	0	0	0	0	0	0	0	0	1
40.0-41.9	1	0	0	0	0	0	0	0	0	0	0	0	1
Total Measured	10	0	0	3	2	0	1	4	1	1	1	31	54
Mean Length	14.3	0.0	0.0	9.8	13.4	0.0	8.2	12.3	19.2	16.8	12.9	13.1	13.2
Length Range (Minimum)	7.0	0.0	0.0	7.5	10.0	0.0	8.2	10.9	19.2	16.8	12.9	9.2	7.0
Length Range (Maximum)	40.0	0.0	0.0	12.1	16.8	0.0	8.2	14.1	19.2	16.8	12.9	17.2	40.0

TABLE 3-6e LENGTH DISTRIBUTION OF SELECT SPECIES OF SPECIAL INTEREST IMPINGED, 2004

SMALLMOUTH BASS													
Length Interval (cm)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Interval Total
4.0-5.9	1	0	0	0	0	0	0	0	1	1	0	0	3
6.0-7.9	10	1	0	3	1	0	0	0	3	1	0	4	23
8.0-9.9	3	0	0	1	3	1	1	0	0	0	2	1	12
10.0-11.9	1	0	0	0	0	0	0	0	0	0	0	1	2
14.0-15.9	1	0	0	0	0	0	0	0	0	0	0	0	1
18.0-19.9	0	0	0	0	1	0	1	1	1	0	0	0	4
20.0-21.9	0	0	0	0	1	0	1	0	0	0	0	0	2
22.0-23.9	0	0	0	0	0	0	0	0	1	0	0	0	1
24.0-25.9	0	1	0	0	3	0	0	0	1	0	0	0	5
26.0-27.9	0	0	1	3	5	0	1	0	0	0	0	0	10
28.0-29.9	0	0	0	0	11	0	3	0	1	0	0	0	15
30.0-31.9	0	0	0	3	29	4	2	0	1	0	0	0	39
32.0-33.9	0	0	0	1	33	4	2	1	1	0	0	0	42
34.0-35.9	0	0	0	2	25	6	0	1	0	0	1	0	35
36.0-37.9	0	0	0	3	16	6	1	1	0	0	0	0	27
38.0-39.9	0	0	0	1	10	4	0	1	0	0	0	0	16
40.0-41.9	1	1	1	1	11	0	0	0	0	0	0	0	15
42.0-43.9	0	0	0	3	8	1	0	0	0	0	0	0	12
44.0-45.9	0	0	0	2	8	0	0	0	1	0	0	0	11
46.0-47.9	0	1	0	0	2	0	0	0	0	0	0	0	3
48.0-49.9	0	0	0	0	0	0	0	1	0	0	0	0	1
50.0-51.9	0	0	0	1	0	0	0	0	0	0	0	0	1
Total Measured	17	4	2	24	167	26	12	6	11	2	3	6	280
Mean Length	10.1	30.2	33.1	31.8	34.0	34.3	27.4	34.9	20.9	6.4	17.0	8.2	30.6
Length Range (Minimum)	5.7	7.4	26.0	7.1	7.5	9.8	8.9	18.8	5.1	5.6	8.3	6.7	5.1
Length Range (Maximum)	40.8	46.8	40.2	50.6	46.4	42.1	37.2	48.0	45.3	7.3	34.5	10.8	50.6

TABLE 3-6f LENGTH DISTRIBUTION OF SELECT SPECIES OF SPECIAL INTEREST IMPINGED, 2004

Length Interval (cm)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Interval Total
SALMONIDS – LAKE TROUT													
66.0-67.9	0	0	0	0	0	0	0	0	0	0	1	0	1
68.0-69.9	0	0	0	0	0	1	0	0	0	0	0	0	1
70.0-71.9	1	0	0	0	0	1	0	0	0	0	0	0	2
72.0-73.9	0	0	0	0	1	0	0	0	0	0	1	0	2
74.0-75.9	2	0	2	0	1	1	0	0	0	0	1	0	7
80.0-81.9	0	0	0	0	0	0	0	0	0	0	0	1	1
82.0-83.9	0	0	0	0	0	0	0	0	0	0	0	1	1
Total Measured	3	0	2	0	2	3	0	0	0	0	3	2	15
Mean Length	73.4	0.0	74.0	0.0	73.9	71.8	0.0	0.0	0.0	0.0	71.6	81.5	74.0
Length Range (Minimum)	70.0	0.0	74.0	0.0	72.2	69.5	0.0	0.0	0.0	0.0	67.3	80.0	67.3
Length Range (Maximum)	75.1	0.0	74.1	0.0	75.6	74.5	0.0	0.0	0.0	0.0	75.1	83.0	83.0
SALMONIDS – RAINBOW TROUT													
54.0-55.9	0	0	0	0	0	0	0	1	0	0	0	0	1
Total Measured	0	0	0	0	0	0	0	1	0	0	0	0	1
Mean Length	0	0	0	0	0	0	0	54.4	0	0	0	0	54.4
Length Range (Minimum)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.4	0.0	0.0	0.0	0.0	54.4
Length Range (Maximum)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.4	0.0	0.0	0.0	0.0	54.4
SALMONIDS – CHINOOK SALMON													
10.0-11.9	0	0	0	0	0	0	1	0	0	0	0	0	1
12.0-13.9	0	0	0	0	1	0	0	0	0	0	0	0	1
14.0-15.9	0	0	0	0	0	0	1	0	0	0	0	0	1
Total Measured	0	0	0	0	1	0	2	0	0	0	0	0	3
Mean Length	0.0	0.0	0.0	0.0	13.0	0.0	12.6	0.0	0.0	0.0	0.0	0.0	12.7
Length Range (Minimum)	0.0	0.0	0.0	0.0	13.0	0.0	10.3	0.0	0.0	0.0	0.0	0.0	10.3
Length Range (Maximum)	0.0	0.0	0.0	0.0	13.0	0.0	14.8	0.0	0.0	0.0	0.0	0.0	14.8
SALMONIDS – BROWN TROUT													
42.0-43.9	1	0	0	0	0	0	0	0	0	0	0	0	1
Total Measured	1	0	0	0	0	0	0	0	0	0	0	0	1
Mean Length	42.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.1
Length Range (Minimum)	42.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.1
Length Range (Maximum)	42.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.1

TABLE 3-7 TOTAL BIOMASS (a) OF IMPINGED ORGANISMS COLLECTED, 2004

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Threespine stickleback	7,158	1,276	13,406	7,034	1,237	1,161	275	18	3	3	280	903	32,754
Alewife	---	---	---	292	39,432	157	57	58	132	153	735	100	41,116
Sculpins	93	33	73	1,054	388	50	11	39	68	---	16	140	1,965
Alewife (damaged)	---	---	---	---	979	---	---	---	---	15	36	1	1,031
Rainbow smelt	189	38	26	72	570	55	16	<1	51	11	45	114	1,187
Smallmouth bass	1,420	2,216	1,093	11,986	95,904	14,888	3,774	4,190	2,539	7	500	48	138,565
Trout perch	6	3	---	48	1,032	263	109	3	4	---	---	18	1,486
Rock bass	942	417	---	1,687	13,923	3,887	1,587	386	1,602	---	6	94	24,531
Rainbow smelt (damaged)	1	2	6	2	126	14	3	<1	<1	---	---	3	157
Stonecat	381	55	408	1,376	2,002	1,051	363	42	72	240	56	536	6,582
Spottail shiner	46	47	43	182	122	40	46	---	4	---	---	56	586
Threespine stickleback (damaged)	4	---	---	---	---	---	---	<1	---	---	2	14	20
White perch	42	---	---	244	14	---	---	---	---	---	8	191	499
Crayfish	37	---	---	6	7	31	19	2	---	---	5	37	144
Yellow perch	1,122	---	---	29	51	---	6	86	97	44	24	724	2,183
Crayfish (damaged)	8	---	1	2	---	---	---	2	2	---	---	<1	15
Gizzard shad	2,206	---	1,044	---	---	---	---	---	---	---	161	116	3,527
White sucker	---	831	---	---	3,258	3,214	10,134	2,417	---	---	140	---	19,994
Bluegill	---	---	---	38	4	---	---	---	---	---	11	19	72
Tessellated darter	---	---	---	---	28	8	---	---	---	---	4	4	44
Lake trout	12,395	---	6,870	---	5,035	8,150	---	---	---	---	10,925	10,370	53,745
Emerald shiner	13	---	---	---	---	---	---	---	---	---	---	23	36
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	30	30
Pumpkinseed	---	---	---	1	---	---	---	---	---	---	---	8	9

(a) Units of biomass expressed in grams. If the weight is designated as <1, and is less than 0.5 grams, it was not added into the total.

NOTE: Dashes (---) indicate no catch.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Spottail shiner (damaged)	1	---	2	1	---	1	---	---	---	---	---	---	5
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	1	---	1
Chinook salmon	---	---	---	---	19	---	37	---	---	---	---	---	56
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	54	54
Sea lamprey	---	---	---	329	98	---	---	---	---	---	186	---	613
Central mudminnow	---	---	5	---	---	---	---	---	---	---	---	11	16
Sculpins (damaged)	---	---	---	---	---	---	---	---	<1	---	---	4	4
Brook stickleback (damaged)	---	---	---	1	---	---	---	---	---	---	---	---	1
Brown bullhead	---	---	---	---	129	---	---	---	---	---	---	---	129
Burbot	---	---	---	2,630	---	---	1,120	---	---	---	---	---	3,750
Channel catfish	4	---	---	---	---	---	---	---	---	---	---	---	4
Freshwater drum	27	---	1,239	---	---	---	---	---	---	---	---	---	1,266
Shorthead redhorse sucker	---	---	---	1,355	---	---	---	---	1,593	---	---	---	2,948
Silver redhorse sucker	---	---	7,240	---	---	---	---	---	---	---	---	---	7,240
Smallmouth bass (damaged)	---	---	22	---	---	---	---	---	---	---	---	4	26
Stonecat (damaged)	---	22	---	6	---	---	---	---	---	---	---	---	28
Trout perch (damaged)	---	---	---	---	2	---	---	<1	---	---	---	---	2
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	10	10
Brook stickleback	---	---	---	---	<1	---	---	---	---	---	---	---	0
Brown trout	1,019	---	---	---	---	---	---	---	---	---	---	---	1,019
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	1	1
Rainbow trout	---	---	---	---	---	---	---	1,009	---	---	---	---	1,009
Sea lamprey (damaged)	---	---	---	108	---	---	---	---	---	---	---	---	108
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	1	1
Walleye	---	---	---	---	---	3,920	---	---	---	---	---	---	3,920
Yellow perch (damaged)	---	---	---	---	---	---	---	4	---	---	---	---	4
TOTAL	27,114	4,940	31,478	28,483	164,360	36,890	17,557	8,256	6,167	473	13,141	13,634	352,493

TABLE 3-8 ESTIMATED[a] MONTHLY BIOMASS (BASED ON TOTAL MONTHLY FLOW) OF IMPINGED ORGANISMS, 2004

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Sample Flow (MCM)	7.104	6.803	7.156	30.810	38.848	8.201	8.373	12.043	8.734	6.741	8.721	8.484	152.018
Total Monthly Flow (MCM)	55.485	48.962	55.129	57.469	59.938	61.203	64.071	65.354	55.644	23.172	64.745	63.323	674.495
Threespine stickleback	55,907	9,184	103,278	13,120	1,909	8,664	2,104	98	19	10	2,079	6,740	203,112
Alewife[b]	---	---	---	550	61,453	1,187	444	320	847	533	5,509	754	71,597
Sculpins	726	238	562	1,966	599	373	84	212	433	---	119	1,045	6,357
Alewife (damaged)	---	---	---	---	1,510	---	---	---	---	52	267	7	1,836
Rainbow smelt[b]	1,601	295	216	145	957	448	130	1	350	41	364	926	5,474
Smallmouth bass[b]	11,434	16,445	8,682	23,049	152,545	114,540	29,774	23,443	16,679	24	3,823	366	400,804
Trout perch	47	22	---	90	1,592	1,963	834	16	25	---	---	134	4,723
Rock bass	7,357	3,001	---	3,147	21,482	29,008	12,144	2,095	10,206	---	45	702	89,187
Rainbow smelt (damaged)	8	14	46	4	194	104	23	1	3	---	---	22	419
Stonecat	2,976	396	3,143	2,567	3,089	7,843	2,778	228	459	825	416	4,001	28,721
Spottail shiner	359	338	331	339	188	299	352	---	25	---	---	418	2,649
Threespine stickleback (damaged)	31	---	---	---	---	---	---	1	---	---	15	104	151
White perch[b]	375	---	---	522	25	---	---	---	---	---	67	1,642	2,631
Crayfish	289	---	---	11	11	231	145	11	---	---	37	276	1,011
Yellow perch[b]	8,943	---	---	56	80	---	46	478	631	155	178	5,516	16,083
Crayfish (damaged)	62	---	8	4	---	---	---	11	13	---	---	2	100
Gizzard shad	17,230	---	8,043	---	---	---	---	---	---	---	1,195	866	27,334
White sucker	---	5,981	---	---	5,027	23,986	77,546	13,116	---	---	1,039	---	126,695
Bluegill	---	---	---	71	6	---	---	---	---	---	82	142	301
Tessellated darter	---	---	---	---	43	60	---	---	---	---	30	30	163
Lake trout	96,810	---	52,926	---	7,768	60,822	---	---	---	---	81,108	77,400	376,834
Emerald shiner	102	---	---	---	---	---	---	---	---	---	---	172	274
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	224	224
Pumpkinseed	---	---	---	2	---	---	---	---	---	---	---	60	62

(a) Estimate total = Grams of organisms per million cubic meters per (MCM) (based on sample flow) multiplied by the total volume of water pumped per month.
(b) Species totals corrected for traveling screen efficiency.

NOTE: Dashes (---) indicate no catch.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total
No. of Samples	4	4	4	16	20	4	4	6	4	4	4	4	78
Sample Flow (MCM)	7.104	6.803	7.156	30.810	38.848	8.201	8.373	12.043	8.734	6.741	8.721	8.484	152.018
Total Monthly Flow (MCM)	55.485	48.962	55.129	57.469	59.938	61.203	64.071	65.354	55.644	23.172	64.745	63.323	674.495
Spottail shiner (damaged)	8	---	15	2	---	7	---	---	---	---	---	---	32
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	7	---	7
Chinook salmon	---	---	---	---	29	---	283	---	---	---	---	---	312
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	403	403
Sea lamprey	---	---	---	614	151	---	---	---	---	---	1,381	---	2,146
Central mudminnow	---	---	39	---	---	---	---	---	---	---	---	82	121
Sculpins (damaged)	---	---	---	---	---	---	---	---	2	---	---	30	32
Brook stickleback (damaged)	---	---	---	2	---	---	---	---	---	---	---	---	2
Brown bullhead	---	---	---	---	199	---	---	---	---	---	---	---	199
Burbot	---	---	---	4,906	---	---	8,570	---	---	---	---	---	13,476
Channel catfish	31	---	---	---	---	---	---	---	---	---	---	---	31
Freshwater drum	211	---	9,545	---	---	---	---	---	---	---	---	---	9,756
Shorthead redhorse sucker	---	---	---	2,527	---	---	---	---	10,149	---	---	---	12,676
Silver redhorse sucker	---	---	55,776	---	---	---	---	---	---	---	---	---	55,776
Smallmouth bass (damaged)	---	---	169	---	---	---	---	---	---	---	---	30	199
Stonecat (damaged)	---	158	---	11	---	---	---	---	---	---	---	---	169
Trout perch (damaged)	---	---	---	---	3	---	---	2	---	---	---	---	5
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	75	75
Brook stickleback	---	---	---	---	1	---	---	---	---	---	---	---	1
Brown trout	7,959	---	---	---	---	---	---	---	---	---	---	---	7,959
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	7	7
Rainbow trout	---	---	---	---	---	---	---	5,476	---	---	---	---	5,476
Sea lamprey (damaged)	---	---	---	201	---	---	---	---	---	---	---	---	201
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	7	7
Walleye	---	---	---	---	---	29,254	---	---	---	---	---	---	29,254
Yellow perch (damaged)	---	---	---	---	---	---	---	22	---	---	---	---	22
TOTAL	212,466	36,072	242,779	53,906	258,861	278,789	135,257	45,531	39,841	1,640	97,761	102,183	1,505,086

TABLE 3-9 ESTIMATED IMPINGEMENT (BASED ON FLOW), 1976-1997 AND 2004

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1976	12,208	1,300	50,037	689,466	2,850,935	304,206	160,379	5,147	6,524	8,178	188,928	36,254	4,313,562
1977	19,526	5,068	13,813	50,490	119,725	15,910	152	223	15,560	32,428	29,711	30,837	333,443
1978	41,595	16,646	87,854	25,014	88,712	42,847	13,392	33,708	31,570	246	558	42,051	424,193
1979	13,436	9,115	8,362	5,629	14,453	1,675	219	227	18,132	30,649	46,209	96,123	244,229
1980	45,794	10,197	2,998	27,371	13,854	59,916	19,690	5,966	4,072	42,751	40,026	23,632	296,267
1981	6,169	8,046	17,572	44,405	34,936	35,879	55,165	116,356	49,081	153,223	2,378	4,050	527,260
1982	47,283	3,533	14,095	91,148	110,301	38,996	142,100	22,753	11,453	877	2,205	118,508	603,252
1983	4,826	1,421	3,945	9,832	51,562	2,739	832	4,945	15,071	2,870	1,277	16,674	115,994
1984	1,441	1,538	2,539	3,332	140,421	43,211	95,471	6,958	3,616	101	2,788	71,168	372,584
1985	16,065	6,486	0	20,715	186,113	117,628	53,100	22,900	31,458	2,716	128,768	10,020	595,969
1986	17,752	1,974	3,100	47,935	96,718	11,692	16,993	22,685	18,854	6,879	7,065	8,422	260,069
1987	42,959	912	103	5,775	55,500	7,494	8,936	9,127	3,437	6,570	4,349	19,220	164,382
1988	15,618	4,713	3,174	56,707	53,127	7,831	913	5,685	108	119	5,856	13,218	167,069
1989	8,521	3,732	1,136	32,120	196,640	217,552	17,628	735	985	22,166	11,122	2,699	515,036
1990	931	1,674	6,232	436	2,781	3,168	428	17,933	24,202	73,971	8,386	17,774	157,916
1991	7,597	2,183	2,022	60,703	27,755	12,887	1,993	1,296	521	565	13,097	2,675	133,294
1992	665	40	72	25	352	1,008	58	1,268	487	328	660	2,242	7,205
1993	2,120	7,271	883	5,760	7,668	4,885	1,663	1,148	1,117	6,121	379	2,074	41,089
1994	3,313	566	317	238	77,550	6,303	877	91,079	2,943	1,335	9,544	328	194,393
1995	16	0	2,550	31,134	26,918	51,889	7,516	10,212	253	2,361	2,635	22,468	157,952
1996	6,036	29,520	25,732	6,119	264,983	202,224	38,224	208	257	30,278	931	1,183,288	1,787,800
1997[(a)]	127,004	955,468	81,274	22,849	29,410	8,968	439	526	612	490	2,337	692	1,230,069
2004[(a)]	56,619	9,587	106,214	14,701	16,644	6,834	2,211	529	548	467	5,914	10,266	230,534
Total	**497,494**	**1,080,990**	**434,024**	**1,251,904**	**4,467,058**	**1,205,742**	**638,379**	**381,614**	**240,861**	**425,689**	**515,123**	**1,734,683**	**12,873,561**

OUTAGES:
1976 – No plant operating data.
1977 – 22 JUN – 23 SEP
1978 – 17 SEP – 06 DEC
1979 – 16 MAR – 07 SEP
1980 – 07 MAY – 13 AUG
1981 – 30 OCT – 31 DEC
1982 – 01 JAN – 09 MAR
1983 – 04 JUN – 02 SEP
1984 – 16 SEP – 05 NOV
1985 – 16 FEB – 01 JUN
1986 – 15 MAR – 30 MAR; 29 SEP – 08 OCT
1987 – 16 JAN – 28 APR
1988 – 28 AUG – 23 NOV
1989 – 16 SEP – 06 OCT
1990 – 01 APR – 27 JUN
1991 – 09 MAR – 14 APR; 08 MAY – 19 AUG; 28 NOV – 31 DEC
1992 – 01 JAN – 31 DEC
1993 – Several short duration outages
1994 – 03 APR – 04 MAY; 01 – 31 DEC
1995 – 01 JAN – 26 MAR; 31 MAY – 08 JUN; 06–12 SEP
1996 – 22 FEB – 06 MAR; 27 OCT – 11 DEC
1997 – Several short duration outages
2004 – 25 SEP – 24 OCT (Refueling Outage 16)

(a) A full-scale fish deterrence system ran in its entirety for 1997 and 2004.

NOTE: Totals for 1991-1997 and 2004 include screen efficiency corrections.

TABLE 3-10 VOLUME OF EFFLUENT SCREENS REMOVED AND DISPOSED OF DURING 24-HOUR IMPINGEMENT SAMPLES, 2004

Impingement Sample Date	Effluent Screens Volume (gal)	Impingement Sample Date	Effluent Screens Volume (gal)	Impingement Sample Date	Effluent Screens Volume (gal)
08 JAN	68	02 MAY	8	05 AUG	6
15 JAN	34	03 MAY	7	06 AUG	4
23 JAN	25	04 MAY	7.5	11 AUG	1.5
28 JAN	12	05 MAY	5.5	18 AUG	2
06 FEB	6	06 MAY	6.5	26 AUG	4.5
10 FEB	13	07 MAY	8	31 AUG	3
19 FEB	14	10 MAY	6.5	03 SEP	3
25 FEB	9	11 MAY	275[a]	09 SEP	7.5
02 MAR	10	12 MAY	406[a]	15 SEP	3
11 MAR	16	14 MAY	3.5	16 SEP	3
19 MAR	22	15 MAY	6.5	21 OCT	1
25 MAR	5	17 MAY	7	22 OCT	0.5
02 APR	8.5	18 MAY	10	26 OCT	17
05 APR	15	19 MAY	7	28 OCT	10
06 APR	10.5	20 MAY	8	03 NOV	1
07 APR	9.5	21 MAY	8	09 NOV	1.5
08 APR	10	25 MAY	7	17 NOV	2
09 APR	16	26 MAY	7	23 NOV	3
13 APR	11	27 MAY	6	02 DEC	20.5
14 APR	10	28 MAY	4.5	10 DEC	2.5
15 APR	6	04 JUN	6.5	16 DEC	8
16 APR	8	09 JUN	4.5	21 DEC	2
20 APR	6	15 JUN	4		
21 APR	5	25 JUN	2.5		
22 APR	5.5	02 JUL	4		
23 APR	5.5	08 JUL	3.5		
28 APR	7.5	16 JUL	10.5		
29 APR	6	26 JUL	4		

(a) An increase in effluent, consisting mostly of zebra mussel shells, is a result of divers vacuuming in Intake Canal C as part of scheduled maintenance.

4. CONCLUSIONS

The species composition of fish impinged at JAFNPP in 2004 was similar to that in past years. However, overall abundance was considerably lower than during the most recent impingement monitoring in the 1990s. Changes and variability in the abundance of fish collected at JAFNPP over the years can be related to one or more of the following factors:

- Biology of individual species involved (behavioral and physiological)
- Effects of variable meteorological conditions
- Operational schedule of the plant
- Changes in the Lake Ontario ecosystem.

Behavioral adaptations and changes in fish abundances in Lake Ontario over the past several years have been associated with the introduction and colonization of the zebra mussel in the early 1990s. Documented changes associated with this introduction include major alterations in the benthic macroinvertebrate community and decreases in particulates and phytoplankton with an associated increased water clarity. These system changes have resulted in several behavioral changes in fish, and have ultimately altered the structure of the lake-wide food web. In the mid-1990s, USGS biologists found alewives, rainbow smelt, and juvenile lake trout at greater depths than in the mid-1980s. They have linked the colonization of the zebra mussel to the shifts in depth. Although temperature was not a factor in the shift, it is believed that this change in depth distribution has altered growth and reproductive dynamics by exposing fish populations to colder overall temperature regimes (O'Gorman et al. 2000). This may induce later and shorter spawning times and may account for lower alewife impingement numbers. The diet of alewives has dramatically changed as well. The main food source of alewives up until a few years ago was primarily *Diporeia*. Biologists concluded that the introduction of the zebra mussel is responsible to the demise of *Diporeia* (O'Gorman 2005). Since *Diporeia* have all but vanished from the lake, shifts in the diet of alewife to the more prevalent *Mysis* (possum shrimp) may have also contributed to shifts in depth.

Shifts in depths, shorter/later spawning times of alewives, and the installation and use of the FDS all appear to have contributed to the reduction in JAFNPP impingement abundance as compared to earlier years.

No rare, threatened, or endangered fish species were collected during 2004. No *Corbicula* sp. mollusks were found in the 2004 impingement collections. No specimens of the round goby (*Neogobius melanostomus*) or ruffe (*Gymnocephalus cernuus*) were observed in 2004 collections.

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Appendix A

Exceptions to Standard Operating Procedures for Impingement, 2004

APPENDIX A

EXCEPTIONS TO STANDARD OPERATING PROCEDURES FOR IMPINGEMENT, 2004

6 JAN The impingement sample scheduled for collection over the period 6-7 January 2004 could not be collected as planned. A condenser backwashing event introduced an unknown amount of debris into the collection basket and, therefore, prevented the sample initiation. The sample was rescheduled and successfully collected on 7-8 January 2004.

26 APR The impingement sample scheduled for collection over the period 26-27 April 2004 could not be collected as planned. A condenser backwashing event introduced an unknown amount of debris into the collection basket and, consequently, prevented the sample initiation. The sample was rescheduled and successfully collected on 28-29 April 2004.

12 MAY The impingement sample scheduled for collection over the period 12-13 May 2004 could not be collected as planned. A condenser backwashing event introduced an unknown amount of debris into the collection basket and, as a result, prevented the sample initiation. The sample was rescheduled and successfully collected on 14-15 May 2004.

9 SEP The impingement sample scheduled for collection over the period 9-10 September 2004 was considered void due to a high influx of debris into the impingement sample basket overnight during which operations personnel removed the basket and discarded the contents prior to the scheduled sample collection time. The sample was rescheduled and successfully collected on 14-15 September 2004.

13 SEP The impingement sample scheduled for collection over the period 13-14 September 2004 could not be collected as planned. A malfunction on the overhead crane used for placement and removal of the impingement sample collection basket prevented the basket from being placed in the collection position. The sample was rescheduled and successfully collected on 15-16 September 2004.

23 SEP The impingement sample scheduled for collection over the period 23-24 September 2004 could not be collected as planned. Zero flow due to a refueling outage was the reason for the voiding of this sample. The sample was rescheduled and successfully collected over the period 2-3 September 2004.

28 SEP The impingement sample scheduled for collection over the period 28-29 September 2004 could not be collected as planned. The sample was voided on account of zero flow during this period as a result of a refueling outage. The sample was rescheduled and successfully collected over the period 8-9 September 2004.

7 OCT The impingement sample scheduled for collection over the period 7-8 October 2004 could not be collected as planned. Due to a refueling outage during this period of time, there was zero flow. The sample was rescheduled and successfully collected over the period 20-21 October 2004.

11 OCT The impingement sample scheduled for collection over the period 11-12 October 2004 could not be collected as planned. The sample was considered void because of zero flow due to a refueling outage. The sample was rescheduled and successfully collected over the period 27-28 October 2004.

4 NOV The impingement sample scheduled for collection over the period 4-5 November 2004 could not be collected as planned. The sample was declared void due to a scheduling conflict with the crane used to place the sample basket in the sampling position. The sample was rescheduled and successfully collected over the period 2-3 November 2004.

Appendix B

Station Operating Conditions, 2004

TABLE B-1 STATION OPERATING CONDITIONS, 2004

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
JANUARY (Flows obtained from JAF 401 Report for this month)						
1	3	1	1,840,816.9	874	3.0	21.4
2	3	1	1,841,365.0	874	4.1	22.5
3	3	1	1,842,684.8	873	4.7	23.2
4	3	1	1,843,096.3	874	4.2	22.7
5	3	1	1,842,532.3	874	4.4	22.9
6	3	1	1,845,674.4	736	3.8	19.8
7	3	1	1,838,778.2	870	1.3	19.9
8	3	1	1,831,111.5	873	1.8	20.6
9	3	1	1,818,862.8	873	0.6	19.6
10	3	1	1,787,589.6	873	2.1	21.3
11	3	1	1,782,631.3	873	2.7	22.1
12	3	1	1,780,380.3	874	2.1	21.6
13	3	1	1,787,448.7	873	1.6	21.1
14	3	1	1,778,459.7	873	1.4	20.9
15	3	1	1,777,090.9	873	1.5	20.9
16	3	1	1,782,394.4	873	1.0	20.4
17	3	1	1,775,597.3	873	1.3	20.8
18	3	1	1,766,512.3	873	1.4	21.0
19	3	1	1,770,680.1	874	1.3	20.9
20	3	1	1,765,142.7	873	1.3	20.9
21	3	1	1,762,226.0	873	1.3	21.0
22	3	1	1,767,818.2	873	1.7	21.3
23	3	1	1,763,320.9	873	1.3	21.1
24	3	1	1,763,337.1	874	1.3	21.1
25	3	1	1,761,987.7	873	1.4	21.1
26	3	1	1,751,554.3	873	1.6	21.3
27	3	1	1,758,590.8	874	1.9	21.7
28	3	1	1,766,706.4	875	2.2	21.9
29	3	1	1,763,589.3	875	1.4	21.3
30	3	1	1,761,921.0	876	1.3	21.2
31	3	1	1,764,988.4	876	1.3	21.2

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
FEBRUARY (Flows obtained from JAF 401 Report for this month)						
1	3	1	1,769,168.1	876	1.7	21.4
2	3	1	1,755,834.7	876	1.7	21.5
3	3	1	1,762,890.0	876	2.2	21.9
4	3	1	1,767,608.7	876	1.9	21.6
5	3	1	1,761,753.9	876	1.5	21.4
6	3	1	1,771,342.9	876	2.2	21.9
7	3	1	1,780,304.1	876	3.1	22.7
8	3	1	1,774,155.0	876	2.7	22.4
9	3	1	1,773,639.9	875	2.9	22.7
10	3	1	1,762,984.9	876	2.7	22.6
11	3	1	1,760,690.7	876	2.4	22.3
12	3	1	1,761,519.7	875	2.7	22.7
13	3	1	1,761,370.1	876	2.3	22.3
14	3	1	1,758,308.8	876	2.2	22.4
15	3/2/1/3	1	1,150,675.5	370	3.1	16.2
16	3/2	1	1,219,158.4	146	1.6	8.5
17	2	1	1,212,571.4	0	1.8	6.6
18	2	1	1,203,231.2	55	2.0	7.2
19	2/3	1	1,772,714.8	471	2.2	12.9
20	3	1	1,767,589.0	824	2.7	20.6
21	3	1	1,776,120.7	876	3.5	22.4
22	3	1	1,773,483.0	876	3.1	22.2
23	3	1	1,766,304.6	875	2.9	22.1
24	3	1	1,766,996.7	876	2.9	22.1
25	3	1	1,765,409.4	876	2.7	21.9
26	3	1	1,765,845.4	875	2.8	22.0
27	3	1	1,765,387.0	876	2.7	21.9
28	3	1	1,768,769.9	875	3.6	22.7
29	3	1	1,766,253.7	857	3.7	22.6

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
MARCH (Flows obtained from JAF 401 Report for this month)						
1	3	1	1,762,192.4	874	3.8	23.1
2	3	1	1,760,793.5	872	4.1	23.3
3	3	1	1,758,210.6	872	4.3	23.5
4	3	1	1,764,076.3	637	3.9	18.3
5	3	1	1,763,989.0	521	3.6	15.5
6	3	1	1,766,981.2	537	4.3	16.7
7	3	1	1,776,200.2	730	4.2	19.9
8	3	1	1,780,636.6	795	4.2	21.1
9	3	1	1,773,246.1	822	4.6	21.7
10	3	1	1,780,974.2	874	5.7	24.0
11	3	1	1,784,169.5	871	5.1	23.6
12	3	1	1,790,443.0	866	4.7	23.1
13	3	1	1,787,433.8	849	4.6	22.7
14	3	1	1,784,149.5	870	4.9	23.4
15	3	1	1,817,670.7	875	2.6	21.1
16	3	1	1,779,516.7	875	2.7	21.4
17	3	1	1,780,025.2	874	2.3	21.1
18	3	1	1,778,357.9	873	2.6	21.4
19	3	1	1,776,928.1	872	2.8	21.7
20	3	1	1,778,965.2	866	3.8	22.6
21	3	1	1,773,464.6	870	3.3	22.2
22	3	1	1,759,875.0	873	3.1	21.7
23	3	1	1,771,229.2	871	3.9	22.8
24	3	1	1,764,070.2	869	3.6	22.6
25	3	1	1,769,138.8	867	4.1	22.9
26	3	1	1,800,889.9	869	3.3	22.0
27	3	1	1,805,769.4	868	2.8	21.6
28	3	1	1,793,573.7	854	2.9	21.4
29	3	1	1,781,116.6	875	3.9	23.1
30	3	1	1,781,718.0	875	4.8	23.9
31	3	1	1,783,410.8	875	4.8	23.9

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
APRIL (Flows obtained from JAF 401 Report for this month)						
1	3	1	1,785,328.6	874	4.9	23.9
2	3	1	1,812,272.4	873	5.4	24.3
3	3	1	1,932,766.9	872	4.5	22.2
4	3	1	1,936,759.3	851	4.2	21.5
5	3	1	1,931,177.7	875	3.2	21.1
6	3	1	1,931,069.2	875	3.8	21.6
7	3	1	1,934,600.9	875	4.4	22.2
8	3	1	1,929,587.9	875	4.0	21.8
9	3	1	1,925,404.1	876	4.3	22.1
10	3	1	1,926,489.8	875	4.4	22.3
11	3	1	1,929,684.6	853	4.1	21.4
12	3	1	1,923,652.0	875	4.5	22.3
13	3	1	1,920,324.3	875	5.1	22.9
14	3	1	1,918,257.5	875	5.6	23.5
15	3	1	1,915,843.0	875	5.2	23.2
16	3	1	1,913,428.7	875	5.1	23.1
17	3	1	1,914,919.7	875	4.4	22.4
18	3	1	1,918,222.0	837	4.9	22.1
19	3	1	1,922,978.8	874	6.2	24.1
20	3	1	1,921,019.6	875	5.9	23.9
21	3	1	1,921,854.1	875	4.6	22.4
22	3	1	1,924,339.5	875	6.9	24.8
23	3	1	1,922,661.2	874	7.6	25.4
24	3	1	1,923,764.8	873	7.1	24.9
25	3	1	1,922,841.9	871	7.1	24.9
26	3	1	1,926,079.4	706	6.5	21.3
27	3	1	1,926,718.8	827	7.9	24.5
28	3	1	1,925,337.0	842	8.9	25.7
29	3	1/0/1	1,907,802.2	875	6.6	24.2
30	3	1	1,923,382.7	875	7.9	25.4

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
MAY (Flows obtained from JAF 401 Report for this month)						
1	3	1	1,925,334.5	873	9.1	26.6
2	3	1	1,925,294.8	820	8.3	24.7
3	3	1	1,924,604.6	871	9.8	27.3
4	3	1	1,924,202.8	874	9.3	26.8
5	3	1	1,923,622.2	873	8.1	25.6
6	3	1	1,922,996.8	871	8.8	26.3
7	3	1	1,923,740.7	870	9.5	26.9
8	3	1	1,920,353.1	869	8.4	25.9
9	3	1	1,921,528.2	833	7.2	23.9
10	3	1	1,921,896.1	874	7.4	25.1
11	3	1	1,924,482.2	872	10.1	27.8
12	3	1	1,928,477.9	766	10.6	27.4
13	3	1	1,926,707.0	858	11.7	28.9
14	3	1	1,931,907.1	870	10.8	28.3
15	3	1	1,933,058.3	866	11.4	28.8
16	3	1	1,932,340.4	864	10.9	28.2
17	3	1	1,933,280.5	862	11.0	28.3
18	3	1	1,933,607.2	861	10.9	28.2
19	3	1	1,937,019.9	858	11.9	29.2
20	3	1	1,934,999.1	853	11.1	28.2
21	3	1	1,933,119.8	872	12.2	29.9
22	3	1	1,933,103.7	873	11.2	28.8
23	3	1	1,935,105.6	873	11.3	28.9
24	3	1	1,936,602.4	869	10.6	28.1
25	3	1	1,940,903.2	869	12.3	29.8
26	3	1	1,935,981.1	867	12.6	30.0
27	3	1	1,937,752.1	864	13.8	31.3
28	3	1	1,939,275.9	847	13.1	30.1
29	3	1	1,940,179.4	870	12.7	30.2
30	3	1	1,942,042.1	868	12.7	30.1
31	3	1/2	2,014,916.0	867	10.8	27.8

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
JUNE (Flows obtained from JAF 401 Report for this month)						
1	3	2	2,035,831.7	865	10.4	27.3
2	3	2	2,036,674.2	861	12.9	29.6
3	3	2	2,036,291.3	860	12.9	29.6
4	3	2	2,038,661.8	857	13.3	29.9
5	3	2	2,037,797.6	856	13.0	29.6
6	3	2	2,038,907.2	872	13.6	30.6
7	3	2	2,034,851.7	870	13.4	30.3
8	3	2	2,039,722.1	866	14.7	31.6
9	3	2	2,038,927.7	864	15.9	32.6
10	3	2	2,030,964.4	863	14.9	31.6
11	3	2	2,031,400.5	864	12.5	29.2
12	3	2	2,036,207.7	860	14.2	30.8
13	3	2	2,037,182.3	831	13.8	29.9
14	3	2	2,034,613.7	871	14.3	31.2
15	3	2	2,041,937.1	865	16.2	32.9
16	3	2	2,038,617.4	860	17.4	34.1
17	3	2	2,031,177.5	859	16.9	33.5
18	3	2	2,040,115.2	858	16.0	32.6
19	3	2	2,043,285.9	856	16.7	33.2
20	3	2	2,047,549.0	752	15.1	29.7
21	3	2	2,046,870.1	827	15.9	31.9
22	3	2	2,044,070.0	866	16.2	32.9
23	3	2	2,045,497.6	861	16.3	32.8
24	3	2	2,046,133.5	861	16.3	32.8
25	3	2	2,045,142.7	858	17.2	33.8
26	3	2	2,044,726.9	855	17.2	33.7
27	3	2	2,045,626.7	851	17.6	34.1
28	3	2	2,044,160.6	866	17.7	34.4
29	3	2	2,044,174.0	865	17.7	34.4
30	3	2	2,045,993.2	862	18.2	34.9

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
JULY (Flows obtained from JAF 401 Report for this month)						
1	3	2	2,044,862.0	859	18.1	34.7
2	3	2	2,045,165.6	856	18.6	35.2
3	3	2	2,045,895.4	853	19.1	35.6
4	3	2	2,045,228.1	851	18.3	34.8
5	3	2	2,053,350.9	699	19.0	32.8
6	3	2	2,054,641.8	679	19.6	32.9
7	3	2	2,053,500.5	793	19.5	34.8
8	3	2	2,043,980.1	846	20.1	36.5
9	3	2	2,047,544.8	840	19.8	36.1
10	3	2	2,047,835.8	839	19.6	35.8
11	3	2	2,048,763.6	830	20.2	36.3
12	3	2	2,046,212.0	862	19.3	36.1
13	3	2	2,047,897.1	859	18.8	35.5
14	3	2	2,047,167.2	858	18.2	34.8
15	3	2	2,048,453.3	853	19.3	35.8
16	3	2	2,048,357.0	850	19.6	36.1
17	3	2	2,049,041.7	847	19.9	36.4
18	3	2	2,049,012.3	828	20.0	36.1
19	3	2	2,049,031.9	851	20.3	36.9
20	3	2	2,051,003.2	841	21.9	38.4
21	3	2	2,046,998.7	837	22.3	38.7
22	3	2/3	2,133,082.6	835	22.2	38.2
23	3	3	2,140,429.9	831	23.0	38.8
24	3	3	2,137,785.2	830	22.2	37.9
25	3	3	2,141,310.2	787	19.8	34.7
26	3	3	2,142,305.5	774	20.2	34.9
27	3	3	2,138,802.9	796	17.5	32.6
28	3	3/2	2,066,494.5	831	15.8	31.7
29	3	2	2,051,032.9	814	19.9	35.7
30	3	2	2,049,283.0	815	18.9	34.7
31	3	2	2,056,656.3	812	20.4	36.2

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
AUGUST (Flows obtained from JAF 401 Report for this month)						
1	3	2	2,058,423.3	795	21.7	37.2
2	3	2	2,056,311.6	825	22.2	38.2
3	3	2	2,057,269.5	822	21.7	37.6
4	3/2/3/2	2	1,749,578.4	201	20.7	25.6
5	2	2	1,477,541.7	27	21.2	23.1
6	2/3	2	1,994,846.4	523	20.6	31.1
7	3	2	2,158,358.4	632	20.4	32.4
8	3	2	2,158,358.4	614	20.9	32.6
9	3	2	2,158,358.4	793	21.4	36.2
10	3	2	2,158,358.4	784	21.2	35.8
11	3	2	2,158,373.9	779	21.6	36.0
12	3	2	2,158,367.4	676	21.8	34.6
13	3	2	2,158,486.2	805	22.1	37.1
14	3	2	2,158,358.4	827	22.6	37.9
15	3	2	2,158,358.4	819	22.7	38.0
16	3	2	2,158,358.4	815	23.2	38.4
17	3	2	2,158,358.4	812	23.3	38.4
18	3	2	2,158,358.4	808	23.3	38.4
19	3	2	2,158,368.4	799	23.0	37.8
20	3	2	2,158,476.4	803	22.9	37.8
21	3	2	2,158,358.4	801	22.5	37.4
22	3	2	2,158,358.4	798	22.4	37.2
23	3	2	2,158,358.4	796	22.1	36.8
24	3	2	2,158,358.4	789	21.8	36.4
25	3	2	2,158,371.5	782	20.7	35.2
26	3	2	2,158,561.3	786	21.7	36.2
27	3	2	2,158,368.0	781	22.4	37.0
28	3	2	2,158,358.4	777	22.9	37.4
29	3	2	2,158,358.4	775	22.4	36.9
30	3	2	2,158,358.4	765	23.4	37.8
31	3	2	2,158,582.1	758	22.8	36.9

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
SEPTEMBER (Flows obtained from JAF 401 Report for this month)						
1	3	2	2,158,641.4	769	22.8	37.2
2	3	2	2,158,474.9	765	22.6	36.8
3	3	2	2,158,472.6	763	22.3	36.6
4	3	2	2,158,358.4	758	22.8	37.1
5	3	2	2,158,358.4	756	22.3	36.4
6	3	2	2,158,489.6	753	21.8	35.8
7	3	2	2,158,358.4	733	22.2	36.0
8	3	2	2,158,358.4	752	20.8	34.9
9	3	2	2,158,080.8	761	7.5	21.8
10	3	2	2,158,367.6	758	10.3	24.5
11	3	2	2,158,358.4	754	13.9	27.9
12	3	2	2,158,358.4	752	11.7	25.6
13	3	2	2,158,358.4	749	14.0	27.8
14	3	2	2,158,358.4	726	16.7	30.2
15	3	2	2,158,358.4	739	18.2	31.9
16	3	2	2,158,360.0	734	18.9	32.6
17	3	2	2,158,358.4	730	19.9	33.6
18	3	2	2,158,359.4	729	19.0	32.6
19	3	2	2,158,371.7	730	16.4	30.0
20	3	2	2,158,358.4	726	17.1	30.6
21	3	2	2,158,358.4	715	17.3	30.6
22	3	2	2,158,367.1	719	18.2	31.6
23	3	2	2,158,545.0	715	18.8	32.1
24	3	2	2,154,353.8	645	19.2	31.5
25	3/2	2	1,504,449.0	1	19.3	18.9
26	2/1/2	2	932,310.8	0	19.7	19.3
27	2	2/1	842,375.2	0	19.6	19.2
28	2/1/2	1	370,949.3	0	19.6	20.6
29	2/1	1	98,496.1	0	18.7	19.6
30	1	1	98,130.8	0	16.2	16.1

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
OCTOBER (Flows obtained from JAF 401 Report for this month)						
1	1	1	98,107.3	0	16.2	16.2
2	1	1	98,107.2	0	17.1	17.1
3	1	1	98,107.2	0	17.8	17.6
4	1	1	98,126.5	0	22.4	17.9
5	1	1	98,135.3	0	23.7	18.7
6	1	1	98,162.5	0	17.2	17.2
7	1	1	98,124.9	0	17.3	17.0
8	1	1/0	4,097.6	0	17.7	17.0
9	1	0	5.5	0	18.3	16.8
10	1	0	0.0	0	18.7	16.7
11	1	0	1.6	0	18.8	16.7
12	1	0	71.2	0	18.9	18.3
13	1	0	0.0	0	19.4	16.7
14	1	0	34.1	0	19.7	18.7
15	1/0/1	0/1	140,391.6	0	16.8	16.8
16	1/0	1	98,141.2	0	16.4	16.3
17	0	1	98,326.2	0	15.5	15.9
18	0	1	98,363.9	0	14.9	15.3
19	0/1/0	1	561,590.9	0	14.9	14.5
20	0/2	1	1,406,300.2	0	14.6	13.9
21	2	1	1,406,508.3	0	14.2	13.6
22	2	1	1,406,425.7	0	13.6	13.0
23	2	1/2	1,414,551.1	0	13.4	12.9
24	2	2	1,504,370.0	12	13.1	15.4
25	2	2	1,504,310.4	241	13.2	19.9
26	2/3/2	2	2,049,350.4	713	14.4	27.3
27	2/3	2	2,158,358.4	856	14.4	29.4
28	3	2	2,158,360.4	770	13.6	27.0
29	3	2	2,158,385.2	860	13.4	28.6
30	3	2	2,158,358.4	882	13.3	29.1
31	3	2	2,158,358.4	883	13.1	28.9

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
NOVEMBER (Flows obtained from JAF 401 Report for this month)						
1	3	2	2,158,358.4	868	13.1	28.6
2	3	2	2,154,271.3	883	12.4	28.2
3	3	2	2,158,358.4	883	12.8	28.6
4	3	2	2,158,368.8	883	12.2	28.0
5	3	2	2,158,372.7	885	10.3	26.2
6	3	2	2,158,360.2	884	10.3	26.2
7	3	2	2,158,358.4	884	11.2	26.9
8	3	2	2,158,358.4	884	10.9	26.7
9	3	2	2,158,358.4	884	11.3	27.0
10	3	2	2,158,358.4	884	10.8	26.6
11	3	2	2,158,358.4	883	11.3	27.1
12	3	2	2,158,358.4	882	9.8	25.6
13	3	2	2,158,358.4	885	8.6	24.3
14	3	2	2,158,358.4	885	9.4	25.2
15	3	2	2,158,360.4	885	9.7	25.5
16	3	2	2,158,376.5	747	10.0	23.4
17	3	2	2,158,358.5	858	10.2	25.4
18	3	2	2,158,367.1	883	10.6	26.3
19	3	2	2,158,358.4	883	11.2	26.9
20	3	2	2,158,358.4	885	9.9	25.7
21	3	2	2,158,358.4	885	10.4	26.2
22	3	2	2,158,358.4	885	10.3	26.0
23	3	2	2,158,358.4	885	9.9	25.7
24	3	2	2,158,358.4	885	9.9	25.7
25	3	2	2,158,358.4	885	9.7	25.4
26	3	2	2,158,358.4	885	9.2	24.9
27	3	2	2,158,358.4	885	9.1	24.9
28	3	2	2,158,358.4	885	9.1	24.9
29	3	2	2,157,849.4	884	8.5	24.2
30	3	2	2,157,592.4	885	8.8	24.6

Date	No. of Circulating Water Pumps	No. of Service Water Pumps	Total Volume of Water Pumped (m^3)	Mean Electrical Output (MWe)	Temperature (°C)	
					Intake	Discharge
DECEMBER (Flows obtained from JAF 401 Report for this month)						
1	3	2	2,157,061.4	885	8.1	23.9
2	3	2	2,157,137.0	885	7.4	23.3
3	3	2	2,155,581.3	885	7.4	23.3
4	3	2	2,156,197.6	885	7.7	23.6
5	3	2	2,157,886.2	885	6.5	22.4
6	3	2	2,156,737.2	885	7.4	23.2
7	3	2	2,155,364.6	885	6.6	22.4
8	3	2	2,155,098.0	885	6.2	22.2
9	3	2	2,155,993.6	885	7.3	23.3
10	3	2	2,156,481.2	885	6.9	22.8
11	3	2	2,158,358.4	885	6.9	22.8
12	3	2	2,158,358.4	885	7.3	23.2
13	3	2	2,155,366.7	885	6.4	22.3
14	3	2	2,154,193.6	885	6.8	22.7
15	3	2	2,153,038.1	885	6.6	22.6
16	3	2	2,151,467.0	885	5.9	21.8
17	3	2	2,100,295.8	885	3.8	20.1
18	3	2	2,018,189.5	885	5.6	22.4
19	3	2	2,006,191.7	885	4.3	21.3
20	3	2	1,937,962.8	885	3.9	21.4
21	3	2	1,911,443.5	881	3.9	21.5
22	3	2	1,915,882.0	885	4.4	22.1
23	3	2	1,918,551.4	885	4.1	21.8
24	3	2	1,903,390.0	885	2.5	20.3
25	3	2	1,851,559.7	884	2.8	21.0
26	3	2	1,839,208.9	884	3.2	21.4
27	3	2	1,875,229.8	885	3.9	21.7
28	3	2	1,915,087.1	885	6.5	23.9
29	3	2	1,855,764.2	885	4.3	22.4
30	3	2	1,882,581.7	884	5.2	22.9
31	3	2	1,897,323.5	884	7.0	24.6

Appendix C

Scientific and Common Names of Taxa Collected in 2004

TABLE C-1 SCIENTIFIC AND COMMON NAMES OF TAXA COLLECTED IN 2004

Scientific Name	Common Name
Alosa pseudoharengus	Alewife
Ambloplites rupestris	Rock bass
Aplodinotus grunniens	Freshwater drum
Cambaridae	Crayfish Family
Catostomus commersoni	White sucker
Cottus spp.	Sculpins
Culaea inconstans	Brook stickleback
Dorosoma cepedianum	Gizzard shad
Etheostoma olmstedi	Tessellated darter
Gasterosteus aculeatus	Threespine stickleback
Ictalurus nebulosus	Brown bullhead
Ictalurus punctatus	Channel catfish
Lepomis cyanellus	Green sunfish
Lepomis gibbosus	Pumpkinseed
Lepomis macrochirus	Bluegill
Lota lota	Burbot
Micropterus dolomieui	Smallmouth bass
Micropterus salmoides	Largemouth bass
Morone americana	White perch
Moxostoma anisurum	Silver redhorse sucker
Moxostoma macrolepidotum	Shorthead redhorse sucker
Notropis atherinoides	Emerald shiner
Notropis hudsonius	Spottail shiner
Noturus flavus	Stonecat
Oncorhynchus mykiss	Rainbow trout
Oncorhynchus tshawytscha	Chinook salmon
Osmerus mordax	Rainbow smelt
Perca flavescens	Yellow perch
Percopsis omiscomaycus	Trout perch
Petromyzon marinus	Sea lamprey
Pimephales notatus	Bluntnose minnow
Salmo trutta	Brown trout
Salvelinus namaycush	Lake trout
Stizostedion vitreum	Walleye
Umbra limi	Central mudminnow

Appendix D

Daily Impingement Collection Totals, 2004

TABLE D-1 DAILY IMPINGEMENT COLLECTION TOTALS, 2004

	JANUARY				FEBRUARY				MARCH			
Species	8	15	23	28	6	10	19	25	2	11	19	25
Threespine stickleback	2,174	651	3,156	919	106	177	704	298	2,852	8,813	1,618	436
Alewife	---	---	---	---	---	---	---	---	---	---	---	---
Sculpins	8	2	4	---	1	2	1	4	4	4	2	2
Alewife (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Rainbow smelt	30	7	10	15	3	1	2	2	---	1	12	---
Smallmouth bass	20	1	8	---	---	3	1	---	1	---	2	---
Trout-perch	---	1	---	---	1	---	---	---	---	---	---	---
Rock bass	44	---	8	1	---	2	4	---	---	---	---	---
Rainbow smelt (damaged)	2	---	---	---	---	1	2	---	---	---	8	---
Stonecat	18	1	7	---	1	1	2	---	---	2	6	1
Spottail shiner	2	---	1	8	7	---	1	2	---	---	10	1
Threespine stickleback (damaged)	50	---	---	---	---	---	---	---	---	---	---	---
White perch	4	---	11	1	---	---	---	---	---	---	---	---
Crayfish	24	---	4	---	---	---	---	---	---	---	---	---
Yellow perch	6	---	8	---	---	---	---	---	---	---	---	---
Crayfish (damaged)	12	---	---	---	---	---	---	---	1	---	---	---
Gizzard shad	6	---	---	---	---	---	---	---	---	---	---	1
White sucker	---	---	---	---	---	---	1	---	---	---	---	---
Bluegill	---	---	---	---	---	---	---	---	---	---	---	---
Tessellated darter	---	---	---	---	---	---	---	---	---	---	---	---
Lake trout	2	---	2	---	---	---	---	---	1	1	---	---
Emerald shiner	2	2	3	1	---	---	---	---	---	---	---	---
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	---
Pumpkinseed	---	---	---	---	---	---	---	---	---	---	---	---
Spottail shiner (damaged)	---	---	---	1	---	---	---	---	---	---	2	---
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Chinook salmon	---	---	---	---	---	---	---	---	---	---	---	---
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	---
Sea lamprey	---	---	---	---	---	---	---	---	---	---	---	---

NOTE: Dashes (---) indicate no catch.

Species	JANUARY				FEBRUARY				MARCH			
	8	15	23	28	6	10	19	25	2	11	19	25
Central mudminnow	---	---	---	---	---	---	---	---	---	---	---	1
Sculpins (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Brook stickleback (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Brown bullhead	---	---	---	---	---	---	---	---	---	---	---	---
Burbot	---	---	---	---	---	---	---	---	---	---	---	---
Channel catfish	---	---	2	---	---	---	---	---	---	---	---	---
Freshwater drum	---	---	1	---	---	---	---	---	---	1	---	---
Shorthead redhorse sucker	---	---	---	---	---	---	---	---	---	---	---	---
Silver redhorse sucker	---	---	---	---	---	---	---	---	---	---	2	---
Smallmouth bass (damaged)	---	---	---	---	---	---	---	---	---	1	---	---
Stonecat (damaged)	---	---	---	---	1	---	---	---	---	---	---	---
Trout-perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	---
Brook stickleback	---	---	---	---	---	---	---	---	---	---	---	---
Brown trout	---	1	---	---	---	---	---	---	---	---	---	---
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Rainbow trout	---	---	---	---	---	---	---	---	---	---	---	---
Sea lamprey (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
Walleye	---	---	---	---	---	---	---	---	---	---	---	---
Yellow perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	2,404	666	3,225	946	120	187	718	306	2,859	8,823	1,662	442

Species	APRIL															
	2	5	6	7	8	9	13	14	15	16	20	21	22	23	28	29
Threespine stickleback	309	76	214	1,155	692	388	3,427	482	159	71	258	92	34	30	51	21
Alewife	---	1	2	10	10	3	---	---	---	3	1	---	1	5	5	4
Sculpins	5	6	4	7	12	8	9	14	10	12	37	16	13	16	28	7
Alewife (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Rainbow smelt	---	1	3	2	3	3	---	1	---	---	---	2	2	---	---	4
Smallmouth bass	1	2	1	---	1	1	3	---	3	---	1	1	2	---	6	2
Trout-perch	---	---	1	---	---	---	---	---	1	---	---	2	---	1	---	3
Rock bass	---	1	---	1	---	---	1	2	---	---	---	1	---	1	---	---
Rainbow smelt (damaged)	---	---	---	---	---	2	---	---	---	---	1	---	---	2	---	---
Stonecat	---	2	1	---	1	1	---	2	2	---	8	3	---	5	4	2
Spottail shiner	4	4	2	1	---	3	1	2	---	2	6	3	2	---	3	2
Threespine stickleback (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
White perch	---	---	---	4	2	1	---	---	---	---	1	5	1	---	3	---
Crayfish	---	1	---	---	---	---	---	1	---	---	---	---	---	---	---	---
Yellow perch	---	---	2	1	---	---	---	---	---	---	---	---	---	---	---	---
Crayfish (damaged)	---	3	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Gizzard shad	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
White sucker	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bluegill	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
Tessellated darter	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Lake trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Emerald shiner	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pumpkinseed	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---
Spottail shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chinook salmon	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sea lamprey	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
Central mudminnow	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sculpins (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Species	APRIL															
	2	5	6	7	8	9	13	14	15	16	20	21	22	23	28	29
Brook stickleback (damaged)	---	---	---	---	---	---	---	---	2	---	---	---	---	---	---	---
Brown bullhead	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Burbot	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---
Channel catfish	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Freshwater drum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Shorthead redhorse sucker	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Silver redhorse sucker	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Smallmouth bass (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Stonecat (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
Trout-perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brook stickleback	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brown trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Rainbow trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sea lamprey (damaged)	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Walleye	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Yellow perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	320	97	231	1,181	721	410	3,442	505	177	89	313	125	57	60	101	45

Species	MAY																			
	2	3	4	5	6	7	10	11	12	14	15	17	18	19	20	21	25	26	27	28
Threespine stickleback	8	50	44	33	18	6	10	30	105	10	9	10	11	24	27	36	64	174	37	108
Alewife	1	7	6	11	10	7	12	20	465	57	1,099	2,775	2,430	562	328	571	244	43	25	11
Sculpins	4	19	10	6	2	3	3	---	15	4	4	7	12	5	5	4	4	1	---	1
Alewife (damaged)	---	---	---	---	---	2	---	10	120	---	11	54	42	20	6	18	9	3	---	5
Rainbow smelt	---	6	5	---	2	---	---	---	30	2	4	4	6	4	5	4	26	17	17	9
Smallmouth bass	4	16	4	4	6	4	6	10	---	5	15	18	5	15	16	10	12	7	12	12
Trout-perch	---	2	2	2	---	1	1	---	45	5	14	15	22	15	13	17	14	5	7	3
Rock bass	---	---	2	---	---	1	---	---	---	1	1	2	1	1	3	3	10	11	5	8
Rainbow smelt (damaged)	---	1	3	---	---	1	1	---	30	5	6	---	---	2	---	---	20	8	12	28
Stonecat	2	4	2	3	1	1	3	---	15	---	---	2	1	1	---	4	2	3	---	---
Spottail shiner	1	2	---	---	1	2	---	---	15	---	---	2	---	---	---	---	3	---	---	---
Threespine stickleback (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
White perch	---	1	2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Crayfish	---	2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Yellow perch	---	1	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
Crayfish (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Gizzard shad	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
White sucker	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	2	---	---	---
Bluegill	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tessellated darter	1	1	1	---	---	1	---	---	---	---	1	---	1	---	---	2	---	2	1	---
Lake trout	---	---	---	---	---	---	1	---	---	---	---	---	---	---	1	---	---	---	---	---
Emerald shiner	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pumpkinseed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Spottail shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chinook salmon	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sea lamprey	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---	1	---	---
Central mudminnow	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sculpins (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Species	MAY																			
	2	3	4	5	6	7	10	11	12	14	15	17	18	19	20	21	25	26	27	28
Brook stickleback (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brown bullhead	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	1
Burbot	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Channel catfish	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Freshwater drum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Shorthead redhorse sucker	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Silver redhorse sucker	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Smallmouth bass (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Stonecat (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Trout-perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brook stickleback	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brown trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Rainbow trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sea lamprey (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Walleye	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Yellow perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	21	114	81	59	40	31	37	70	840	90	1,164	2,889	2,532	650	404	669	412	275	116	186

Species	JUNE				JULY				AUGUST					
	4	9	15	25	2	8	16	26	5	6	11	18	26	31
Threespine stickleback	243	177	76	201	34	34	127	1	39	4	2	3	---	---
Alewife	3	4	2	3	1	---	2	---	---	1	1	---	---	---
Sculpins	1	4	2	9	---	1	2	---	3	2	1	1	3	2
Alewife (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Rainbow smelt	6	11	7	4	6	---	---	---	1	---	---	---	---	---
Smallmouth bass	13	7	4	2	5	4	2	2	1	1	2	1	1	---
Trout-perch	5	9	5	35	12	5	5	---	---	1	---	---	---	---
Rock bass	7	5	2	2	---	2	4	2	1	---	---	1	---	---
Rainbow smelt (damaged)	12	7	1	1	3	1	---	---	---	1	---	---	---	---
Stonecat	6	5	4	4	---	2	6	---	---	---	1	---	1	---
Spottail shiner	2	---	3	1	5	3	---	---	---	---	---	---	---	---
Threespine stickleback (damaged)	---	---	---	---	---	---	---	---	---	2	---	---	---	---
White perch	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Crayfish	---	---	1	2	1	---	---	1	1	---	---	---	---	---
Yellow perch	---	---	---	---	---	1	---	---	---	3	---	1	---	---
Crayfish (damaged)	---	---	---	---	---	---	---	---	---	3	1	4	---	2
Gizzard shad	---	---	---	---	---	---	---	---	---	---	---	---	---	---
White sucker	---	---	1	4	8	1	2	---	1	---	---	---	1	1
Bluegill	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tessellated darter	---	1	2	2	---	---	---	---	---	---	---	---	---	---
Lake trout	2	1	---	---	---	---	---	---	---	---	---	---	---	---
Emerald shiner	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pumpkinseed	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Spottail shiner (damaged)	---	---	1	---	---	---	---	---	---	---	---	---	---	---
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chinook salmon	---	---	---	---	---	1	1	---	---	---	---	---	---	---
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sea lamprey	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Central mudminnow	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Species	JUNE				JULY				AUGUST					
	4	9	15	25	2	8	16	26	5	6	11	18	26	31
Sculpins (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brook stickleback (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brown bullhead	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Burbot	---	---	---	---	---	1	---	---	---	---	---	---	---	---
Channel catfish	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Freshwater drum	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Shorthead redhorse sucker	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Silver redhorse sucker	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Smallmouth bass (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Stonecat (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Trout-perch (damaged)	---	---	---	---	---	---	---	---	---	1	---	---	---	---
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brook stickleback	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Brown trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Rainbow trout	---	---	---	---	---	---	---	---	---	---	---	---	1	---
Sea lamprey (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Walleye	1	---	---	---	---	---	---	---	---	---	---	---	---	---
Yellow perch (damaged)	---	---	---	---	---	---	---	---	---	1	---	---	---	---
TOTAL	301	231	111	270	75	56	151	6	47	20	8	11	7	5

Species	SEPTEMBER				OCTOBER				NOVEMBER				DECEMBER				TOTAL
	3	9	15	16	21	22	26	28	3	9	17	23	2	10	16	21	
Threespine stickleback	---	1	1	1	---	---	---	4	1	210	84	73	225	168	399	258	32,543
Alewife	---	7	1	2	1	3	16	69	35	9	2	283	22	3	3	1	9,203
Sculpins	2	19	1	1	---	---	---	---	---	---	3	---	22	4	2	---	432
Alewife (damaged)	---	---	---	---	1	---	25	8	3	3	4	24	2	---	---	---	370
Rainbow smelt	---	6	1	1	---	---	---	1	---	2	1	1	15	4	2	1	315
Smallmouth bass	---	11	---	---	---	1	1	---	1	1	---	1	5	---	2	---	309
Trout-perch	---	2	---	---	---	---	---	---	---	---	---	---	3	---	---	---	275
Rock bass	---	11	---	---	---	---	---	---	---	3	---	---	13	---	3	---	171
Rainbow smelt (damaged)	---	2	---	---	---	---	---	---	---	---	---	---	4	---	2	1	170
Stonecat	---	---	1	1	---	1	---	3	---	---	---	2	17	---	2	---	170
Spottail shiner	---	2	---	---	---	---	---	---	---	---	---	---	9	---	---	---	118
Threespine stickleback (damaged)	---	---	---	---	---	---	---	---	---	9	---	---	1	7	3	27	99
White perch	---	---	---	---	---	---	---	---	---	1	---	---	27	---	6	1	71
Crayfish	---	---	---	---	---	---	---	---	---	1	1	2	6	3	4	3	58
Yellow perch	---	1	---	---	---	1	---	---	1	---	---	---	30	---	---	1	58
Crayfish (damaged)	---	8	---	---	---	---	---	---	---	---	---	---	1	---	---	---	35
Gizzard shad	---	---	---	---	---	---	---	---	---	6	5	4	12	---	---	1	35
White sucker	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	24
Bluegill	---	---	---	---	---	---	---	---	---	8	---	---	10	---	---	---	20
Tessellated darter	---	---	---	---	---	---	---	---	---	1	---	---	1	---	---	---	18
Lake trout	---	---	---	---	---	---	---	---	---	2	1	---	1	---	2	---	17
Emerald shiner	---	---	---	---	---	---	---	---	---	---	---	---	2	1	---	3	14
Largemouth bass	---	---	---	---	---	---	---	---	---	---	---	---	6	---	---	---	6
Pumpkinseed	---	---	---	---	---	---	---	---	---	---	---	---	5	---	---	---	6
Spottail shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5
Bluegill (damaged)	---	---	---	---	---	---	---	---	---	4	---	---	---	---	---	---	4
Chinook salmon	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4
Green sunfish	---	---	---	---	---	---	---	---	---	---	---	---	1	1	2	---	4
Sea lamprey	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	4
Central mudminnow	---	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---	3

Species	SEPTEMBER				OCTOBER				NOVEMBER				DECEMBER				TOTAL
	3	9	15	16	21	22	26	28	3	9	17	23	2	10	16	21	
Sculpins (damaged)	---	1	---	---	---	---	---	---	---	---	---	---	---	---	2	---	3
Brook stickleback (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Brown bullhead	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Burbot	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Channel catfish	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Freshwater drum	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Shorthead redhorse sucker	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Silver redhorse sucker	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Smallmouth bass (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	2
Stonecat (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Trout-perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2
Bluntnose minnow	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	1
Brook stickleback	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
Brown trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
Emerald shiner (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	1
Rainbow trout	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
Sea lamprey (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
Unidentified (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	1
Walleye	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
Yellow perch (damaged)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
TOTAL	2	72	5	6	2	6	42	85	41	261	101	391	444	191	434	299	44,593

Appendix E

Historical Impingement
1976-1997 and 2004

TABLE E-1 ESTIMATED TOTAL IMPINGEMENT (BASED ON FLOW) AT THE JAMES A. FITZPATRICK NUCLEAR POWER PLANT, 1976-1997 AND 2004

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1976	12,208	1,300	50,037	689,466	2,850,935	304,206	160,379	5,147	6,524	8,178	188,928	36,254	4,313,562
1977	19,526	5,068	13,813	50,490	119,725	15,910	152	223	15,560	32,428	29,711	30,837	333,443
1978	41,595	16,646	87,854	25,014	88,712	42,847	13,392	33,708	31,570	246	558	42,051	424,193
1979	13,436	9,115	8,362	5,629	14,453	1,675	219	227	18,132	30,649	46,209	96,123	244,229
1980	45,794	10,197	2,998	27,371	13,854	59,916	19,690	5,966	4,072	42,751	40,026	23,632	296,267
1981	6,169	8,046	17,572	44,405	34,936	35,879	55,165	116,356	49,081	153,223	2,378	4,050	527,260
1982	47,283	3,533	14,095	91,148	110,301	38,996	142,100	22,753	11,453	877	2,205	118,508	603,252
1983	4,826	1,421	3,945	9,832	51,562	2,739	832	4,945	15,071	2,870	1,277	16,674	115,994
1984	1,441	1,538	2,539	3,332	140,421	43,211	95,471	6,958	3,616	101	2,788	71,168	372,584
1985	16,065	6,486	0	20,715	186,113	117,628	53,100	22,900	31,458	2,716	128,768	10,020	595,969
1986	17,752	1,974	3,100	47,935	96,718	11,692	16,993	22,685	18,854	6,879	7,065	8,422	260,069
1987	42,959	912	103	5,775	55,500	7,494	8,936	9,127	3,437	6,570	4,349	19,220	164,382
1988	15,618	4,713	3,174	56,707	53,127	7,831	913	5,685	108	119	5,856	13,218	167,069
1989	8,521	3,732	1,136	32,120	196,640	217,552	17,628	735	985	22,166	11,122	2,699	515,036
1990	931	1,674	6,232	436	2,781	3,168	428	17,933	24,202	73,971	8,386	17,774	157,916
1991	7,597	2,183	2,022	60,703	27,755	12,887	1,993	1,296	521	565	13,097	2,675	133,294
1992	665	40	72	25	352	1,008	58	1,268	487	328	660	2,242	7,205
1993	2,120	7,271	883	5,760	7,668	4,885	1,663	1,148	1,117	6,121	379	2,074	41,089
1994	3,313	566	317	238	77,550	6,303	877	91,079	2,943	1,335	9,544	328	194,393
1995	16	0	2,550	31,134	26,918	51,889	7,516	10,212	253	2,361	2,635	22,468	157,952
1996	6,036	29,520	25,732	6,119	264,983	202,224	38,224	208	257	30,278	931	1,183,288	1,787,800
1997[(a)]	127,004	955,468	81,274	22,849	29,410	8,968	439	526	612	490	2,337	692	1,230,069
2004[(a)]	56,619	9,587	106,214	14,701	16,644	6,834	2,211	529	548	467	5,914	10,266	230,534
Total	**497,494**	**1,080,990**	**434,024**	**1,251,904**	**4,467,058**	**1,205,742**	**638,379**	**381,614**	**240,861**	**425,689**	**515,123**	**1,734,683**	**12,873,561**

OUTAGES:
1976 – No plant operating data.
1977 – 22 JUN – 23 SEP 1977
1978 – 17 SEP – 06 DEC 1978
1979 – 16 MAR – 07 SEP 1979
1980 – 07 MAY – 13 AUG 1980
1981 – 30 OCT – 31 DEC 1981
1982 – 01 JAN – 09 MAR 1982
1983 – 04 JUN – 02 SEP 1983
1984 – 16 SEP – 05 NOV 1984
1985 – 16 FEB – 01 JUN 1985
1986 – 15 MAR – 30 MAR; 29 SEP – 08 OCT 1986
1987 – 16 JAN – 28 APR 1987
1988 – 28 AUG – 23 NOV 1988
1989 – 16 SEP – 06 OCT 1989
1990 – 01 APR – 27 JUN 1990
1991 – 09 MAR – 14 APR; 08 MAY – 19 AUG; 28 NOV – 31 DEC 1991
1992 – 01 JAN – 31 DEC 1992
1993 – Several short duration outages
1994 – 03 APR – 04 MAY; 01 – 31 DEC 1994
1995 – 01 JAN – 26 MAR; 31 MAY – 08 JUN; 06–12 SEP 1995
1996 – 22 FEB – 06 MAR; 27 OCT – 11 DEC 1996
1997 – Several short duration outages
2004 – 25 SEP – 24 OCT 2004 (Refueling Outage 16)

(a) A full-scale fish deterrence system ran in its entirety for 1997 and 2004.

NOTE: Totals for 1991-1997 and 2004 include screen efficiency corrections.

TABLE E-2 TOTAL ESTIMATED IMPINGEMENT ABUNDANCE (BASED ON FLOW) FOR DOMINANT SPECIES, 1976-1997 AND 2004

Year	Alewife[a]	Rainbow Smelt[a]	Threespine Stickleback	White Perch[a]	Spottail Shiner	Gizzard Shad	Trout Perch	Tessellated Darter	Sculpins
1976	**3,916,717**	**282,373**	**95,883**	8,436	11,683	16,732	12,183	6,708	---
1977	**187,305**	**107,134**	4,442	**13,353**	5,970	10,931	1,550	953	---
1978	**67,991**	**81,480**	**222,837**	6,739	6,459	15,468	3,479	2,157	3,425
1979	**81,931**	**148,611**	190	**6,214**	6,296	4,416	496	305	2,059
1980	**171,465**	**85,049**	85	6,019	2,077	**14,017**	2,545	1,539	2,893
1981	**463,542**	**64,105**	535	2,762	1,462	5,512	**2,565**	618	1,503
1982	**350,003**	**255,749**	792	**2,590**	3,440	1,055	1,600	420	2,417
1983	**62,026**	**39,407**	2,880	6,046	1,034	2,735	**1,778**	595	1,196
1984	**273,931**	**85,708**	1,373	2,384	2,953	4,058	2,794	**4,496**	1,327
1985	**527,952**	**57,379**	3,908	1,522	1,158	**5,658**	1,032	424	1,081
1986	**176,972**	**71,039**	1,880	1,453	**3,172**	1,346	2,144	460	1,556
1987	**66,625**	**95,067**	2,187	664	**2,366**	471	1,061	640	881
1988	**111,468**	**26,351**	2,288	2,759	3,977	3,712	1,221	1,668	**4,916**
1989	**449,017**	**38,154**	2,124	2,075	5,413	927	**8,818**	4,749	2,656
1990	**15,156**	**110,848**	845	2,210	3,809	**26,173**	524	2,738	1,117
1991	**75,741**	**37,343**	2,947	1,343	**3,578**	1,031	2,482	1,332	917
1992	**1,312**	**2,179**	78	53	282	40	180	986	**1,043**
1993	**21,425**	**7,611**	520	278	**2,277**	668	1,636	323	747
1994	**74,552**	**97,643**	3,209	517	5,569	42	**7,755**	652	1,076
1995	**83,567**	**29,199**	**34,469**	247	929	753	3,424	1,121	1,515
1996	**346,593**	**29,436**	**1,392,763**	559	4,662	26	6,923	916	948
1997[b]	**13,755**	**27,311**	**1,169,567**	1,036	3,263	240	3,282	573	998
2004[b]	**16,796**	1,527	**201,563**	481	534	263	923	68	**1,393**
TOTAL	7,555,842	1,780,703	3,147,365	69,740	82,363	116,274	70,395	34,441	35,664

(a) Corrected for traveling screen efficiencies.
(b) A full-scale fish deterrence system ran in its entirety for 1997 and 2004.

NOTE: Numbers in bold represent the three most abundant species collected in samples for that year. Dashes (---) indicate no catch made for that year.

TABLE E-3 ESTIMATED TOTAL IMPINGEMENT ABUNDANCE (BASED ON FLOW) FOR SELECT SPECIES OF SPECIAL INTEREST, 1976-1997 AND 2004

Year	Alewife[a]	Rainbow Smelt[a]	White Perch[a]	Yellow Perch[a]	Smallmouth Bass[a]	Salmonids[b]
1976	3,916,717	282,373	8,436	3,770	521	159
1977	187,305	107,134	13,353	1,526	555	94
1978	67,991	81,480	6,739	10,076	1,170	49
1979	81,931	148,611	6,214	2,668	277	105
1980	171,465	85,049	6,019	1,750	231	65
1981	463,542	64,105	2,762	746	95	83
1982	350,003	255,749	2,590	1,236	980	190
1983	62,026	39,407	6,046	406	224	117
1984	273,931	85,708	2,384	530	253	193
1985	527,952	57,379	1,522	206	132	62
1986	176,972	71,039	1,453	274	141	184
1987	66,625	95,067	664	42	293	76
1988	111,468	26,351	2,759	465	2,268	141
1989	449,017	38,154	2,075	684	948	234
1990	15,156	110,848	2,210	156	576	110
1991	75,741	37,343	1,343	588	266	155
1992	1,312	2,179	53	198	64	14
1993	21,425	7,611	278	354	608	123
1994	74,552	97,643	517	192	1,202	79
1995	83,567	29,199	247	103	631	252
1996	346,593	29,436	559	436	359	224
1997[c]	13,755	27,311	1,036	568	671	96
2004[c]	16,796	1,527	481	403	1,106	146
TOTAL	7,555,842	1,780,703	69,740	27,377	13,571	2,966

(a) Species totals corrected for traveling screen efficiency.
(b) Salmonids are treated as a group; estimates of abundance for all species in one year are tallied. For individual species abundance, refer to the report issued for the year of interest.
(c) A full-scale fish deterrence system ran in its entirety for 1997 and 2004.

Attachment 2

James A. FitzPatrick Nuclear Power Plant

License Renewal Application – Amendment 1

Reference for RAI E-1-j-3

PROPOSAL FOR INFORMATION COLLECTION TO ADDRESS COMPLIANCE WITH THE CLEAN WATER ACT §316(b) PHASE II REGULATIONS AT JAMES A. FITZPATRICK NUCLEAR POWER PLANT (SPDES PERMIT NO. NY 0020109) LYCOMING, NEW YORK

Submitted By

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31 January 2006

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1.0 INTRODUCTION

Entergy Nuclear FitzPatrick, LLC owns and operates the James A. FitzPatrick Nuclear Power Plant ("JAFNPP"). JAFNPP is located on the southeastern shore of Lake Ontario approximately 7 miles (11 km) northeast of the city of Oswego, New York in Lycoming, New York. Lake Ontario is one of the Great Lakes, and the JAFNPP off-shore submerged cooling water intake structure (CWIS) is found in Lake Ontario. The cooling water source is located within the state of New York and considered waters of the United States.

The primary activity of JAFNPP is the generation of electric power. JAFNPP began commercial operation on 28 July 1975, currently generates at a rated capacity of 866 mWe (gross), and withdraws once-through cooling water from an off-shore submerged CWIS. The JAFNPP CWIS has a total design intake flow in excess of 50 million gallons per day ("MGD") and uses at least 25% of the water withdrawn exclusively for cooling purposes. The current expected operating mode for JAFNPP over the next ten years is at a capacity utilization rate in excess of 15%.

The final regulations implementing §316(b) of the Clean Water Act ("CWA") at existing electricity-generating stations (the "Phase II Regulations"), among other things, establish performance standards for the reduction of impingement mortality by 80 to 95 percent and, under certain circumstances, for the reduction of entrainment by 60 to 90 percent. See 69 Fed. Reg. 41576 (July 9, 2004). The applicability of these performance standards is determined by several factors, including the type of water body from which a plant withdraws cooling water and the plant's capacity utilization factor. Under the Phase II Regulations, applicable performance standards can be met by design and construction technologies, operational measures, restoration measures, or some combination of these compliance alternatives.

In a March 14, 2005 letter to Mr. Michael Rodgers of JAFNPP, Mr. Roy A. Jacobson, Jr. Steam Electric Unit Leader for the New York State Department of Environmental Conservation ("NYSDEC"), requested submission of information about JAFNPP consistent with the Phase II Regulation's description of a Proposal for Information Collection ("PIC"), including:

- "identifying information previously submitted to the Department,
- need to update existing information, and
- need to collect new information or conduct monitoring studies."

To the extent that the Phase II Regulations apply to the JAFNPP, this document constitutes the information requested by Mr. Jacobson in his March 14, 2005 letter by format and content of a PIC. This PIC provides general and in some cases specific information regarding the Comprehensive Demonstration Study (CDS):

- Source Water Body Description
- Cooling Water Intake Structure
- Cooling Water Intake System
- Currently Implemented Technologies, Operational and/or Restorative Measures
- Discussion of Appropriate Additional Technologies, Operational and/or Restorative Measures
- Historical Impingement and Entrainment Characterization Studies
- Summary of Relevant Regulatory Consultations
- Proposed Sampling Plans and Quality Assurance Program.

The PIC does not, however, commit JAFNPP to any particular technology, operations, or any other course of action other than the preparation of the Compliance Demonstration Study. JAFNPP reserves its right to supplement or amend this PIC in response to comments from the New York State Department of Environmental Conservation ("NYSDEC"), United States Environmental Protection Agency ("USEPA"), or any other governmental agency, results of the activities proposed in this PIC, or any litigation challenging the Phase II Regulations (including but not limited to 40 C.F.R. §122.21(r), §122.44(b), §123.25(a)(4) and (36), and §124.10, and 40 C.F.R. Part 125, Subpart J and 6NYCRR §704.5). In light of the several pending challenges to federal and state intake structure requirements, JAFNPP must fully reserve its rights to raise any legal or factual argument or challenge, and nothing herein shall be otherwise interpreted to limit those rights.

2.0 SOURCE WATER BODY DESCRIPTION

The source water body type for JAFNPP is a Great Lake for purposes of the Phase II Regulations. JAFNPP is a 700 acre facility located in Lycoming, New York on Nine Mile Point, a slight promontory on the southeastern shore of Lake Ontario adjacent to the Nine Mile Point Nuclear Station (NMPNS). The offshore slope at the plant site is steep (5-10% grade) at the beach, flattening to a 2-3% grade at the 15 foot depth contour, then increasing to a 4% slope lakeward (NMPNS 2004). There is little sediment deposition along the shoreline in the vicinity of JAFNPP, especially in areas where water depth is less than 40 feet (TI 1979). In general, bottom sediments in the nearshore area are composed primarily of bedrock overlain with boulders, cobble, pebbles and coarse sand; finer sediments occur further offshore at the 40 and 60 foot depth contours (TI 1979).

Lake Ontario, the easternmost of the five Great Lakes, is roughly 193 mi (311 km) long and 53 miles (85 km) wide at its maximum dimensions. Although the smallest of the Great Lakes based on volume, Lake Ontario ranks as the twelfth largest lake in the world. Approximately 52% of Lake Ontario's 7,340 mi^2 (18,960 km^2) of surface area lies within the Province of Ontario, and the remainder is in the state of New York. Lake Ontario is relatively deep, with an average depth of 283 ft (86 m) and a maximum depth of 802 ft (244 m). Lake Ontario has a volume of approximately 390 mi^3 (1,626 km^3).

Although the bottom topography of Lake Ontario is relatively smooth, there are two distinct sedimentary basins. The Kingston Basin is located in the northeastern end of the lake. The Kingston basin is separated from the deeper main basin by the Duck-Galoo Sill (Figure 2-1). Within the main basin there are three deep sub-basins from west to east: the Niagara, Mississauga, and Rochester basins. These basins are bordered by a shallow inshore zone that extends along the perimeter of the main basin. The differentiation among the three most westerly sub-basins is relatively subtle while the Duck-Galoo Sill provides a pronounced distinction between the Rochester sub-basin and Kingston Basin (Kerr and LeTendre 1991). Kingston Basin is shallower and has unique water quality characteristics compared to the three westerly basins (Flint and Stevens 1989). The JAFNPP intake structure is located 900 feet (274 m) offshore in approximately 24 feet (7.3m) of water in the inshore zone adjacent to the Rochester sub-basin.

The lake's drainage area of 24,720 mi^2 (64,030 km^2) is dominated by forests (49%) and agriculture (39%). A total of 7% of the basin is urbanized (Stewart et al. 1999). Major urban centers include Hamilton, Toronto, and Rochester. There are approximately 6.6 million people living within the Lake Ontario basin with most of the population concentrated in the western half (including the

Toronto-Hamilton crescent (Stewart et al. 1999)). The New York shore is less urbanized and not as intensively farmed. The Lake Ontario Basin in New York state drains an area of about 3,000 mi^2 (4288 km^2) and is inhabited by approximately 700,000 people (NYSDEC 2000).

Approximately 86% of inflow into Lake Ontario originates from the upper Great Lakes and Lake Erie via the Niagara River (Kerr and LeTendre 1991). The remaining water inflow comes from Lake Ontario basin tributaries and precipitation. The St. Lawrence River is the sole outlet for Lake Ontario and flows northeast in the Gulf of St. Lawrence. Approximately 93 percent of the water in Lake Ontario flows out to the St. Lawrence River; the remaining 7 percent leaves through evaporation. Water retention time is estimated to be approximately 7 years.

Since 1960, Lake water levels have been regulated by a series of dams and locks in the St. Lawrence River under the authority of the International St. Lawrence River Board of Control (ISLRBC). The current plan regulating Lake Ontario outflows is Plan 1958D, which specifies weekly outflows based on the water level of the Lake and water supplies to the Lake and seeks to balance a number of interests including hydropower, commercial navigation, and shoreline property owners. By managing Lake water elevations, the natural range in water level fluctuations has been reduced to a target range from 243.3 feet to 247.3 feet International Great Lakes Datum (IGLD).

The prevailing west-northwest winds combined with the eastward flow of water from the Niagara River are the most important features on lake circulation. In its simplest form, the largest general circulation of Lake Ontario is counterclockwise with flow to the east along the south shore in a relatively narrow band and somewhat less pronounced flow to the west along the north shore (Pickett and Bermick 1977). Circulation of water generally occurs along the eastern shore and within the sub-basins of the main lake; there is little net flow along the north, inshore zone (Kalinauskas 2004).

However, circulation patterns on a shorter temporal scale observed at any given time are more complex and are affected by transient winds, which can alter currents in a matter of hours (TI 1979). During preoperational studies at JAFNPP, currents off Nine Mile Point were measured from May to October 1969 and July 1970 (Gunwaldson et al. 1970, PASNY 1971). Wind speed frequency data averaged over a 6 hour period indicate that winds exceeding 20 miles per hour (32 km/hr) occurred 21.6% of the time over the year. From June through September, winds in excess of 20 miles per hour occurred 13.9% of the time. At the 19 ft. depth contour, the measured current speed of six-hour duration exceeded with comparable frequency is about 0.2 feet per second (USNRC 1985). The predominant direction of currents was alongshore, as dictated by continuity. On the occasions when onshore or offshore currents were observed, their magnitudes were substantially less than those of alongshore currents. During the summer, alongshore currents from either the west or east were equally frequent about 33% of the time. Onshore and offshore currents each accounted for nearly 5% of the observations; the remaining 30% of the observations were below the flowmeter threshold of 0.5 knots (2.5 cm/sec, 0.09 ft/sec). Lake currents were measured at selected locations in the vicinity of the Oswego Steam Station (about 6 miles west of Nine Mile Point) for 5 days between 12 October and 19 November 1970. These surface current velocities were mostly alongshore, with speeds ranging from less than 0.08 feet per second (2.5 cm/sec.) to 0.50 feet per second (15 cm/sec.).

Two other important examples of wind-induced effects on the general circulation pattern in Lake Ontario are upwelling and internal oscillation of thermocline depth (NMPNS 2004). Upwelling is characterized by the rising of colder, denser, bottom water toward the surface. A variety of theories have been proposed to account for the oscillations, which are a common feature of Lake Ontario temperature records (USNRC 1985). The most direct explanation is that an upwelling displaces the thermocline from equilibrium by converting the kinetic energy from wind gusts into potential energy that alters the thermocline position. When the wind stress is removed, internal waves are set in motion and contribute to the dissipation of this energy. Internal waves increase in amplitude after storms. In Lake Ontario, approximately three complete oscillations occur every 2 days (USNRC 1985).

Lake Ontario has a seasonally dependent pattern of both horizontal and vertical stratification (Kalinauskas 2004) which alter circulation patterns. Changes in stratification result from atmospheric heat exchange and wind-induced mixing. In the spring, nearshore waters warm up more quickly than deep offshore waters, creating isotherms relatively parallel to shore. As temperatures continue to warm, the lake becomes vertically stratified between the nearshore and offshore zones with little mixing. This thermal stratification lasts until about the middle of June when offshore waters warm and mixing occurs. As summer progresses the Lake experiences a period of horizontal stratification with little mixing between the warm surface waters and cool deeper waters. Summer stratification is characterized by warmer, less dense water at the surface layers and cooler, denser water in the lower layer. Progressive heating develops stable thermal stratification and a well-defined epilimnion (warm surface water layer), mesolimnion (transition mid-depth temperatures), and hypolimnion (cool deep water layer). This thermal stratification in Lake Ontario, generally extends from late June to October of each year, when the epilimnion averages nearly 70°F (21 °C) and the hypolimnion averages approximately 39 °F (3.9 °C) (NMPNS 2004). Mixing of these thermal strata begins as the thermocline breaks down in the fall as surface waters cool. In late fall after overturn has occurred, the lake is essentially isothermal, thereby permitting a free exchange of water from surface to bottom. The Great Lakes mix from top to bottom (overturn) twice yearly, in the spring and in the fall. The timing of the overturn is closely related to the time when the surface water temperatures fluctuate through the temperature of maximum density of fresh water (i.e. 4°C).

Towards the end of winter, the entire water mass cools down to below 4°C, with the coldest water remaining close to the shore. During winter, ice begins to form in the nearshore waters of the Great Lakes in December and January and in the deeper offshore waters in February and March, reaching its greatest extent in late February or early March. Expected maximum ice cover for Lake Ontario is 24 percent (Assel et al. 1983), however during a severe winter maximum ice cover can exceed 90 percent (Assel et al. 1996). During a mild winter, maximum ice cover is usually limited to the nearshore waters (Assel 1985).

Intake water temperature recorded at JAFNPP in 2004 ranged from a minimum of 0.6 °C (33.0°F) in early January to a maximum of 23.7 °C (74.6°F) in early October (Table 2-1, EA 2005). Intake water temperatures begin to rise in mid-March and peak from mid-July through September (Figure 2-2).

Summer and early winter inshore water temperatures have increased significantly in Lake Ontario over the past several decades, paralleling global warming and temperature extremes, particularly those associated the El Nino and La Nina (Casselman 2002). It is expected that future global warming will lead to increasing water temperatures in Lake Ontario and thereby affect fish community dynamics and their habitat (Mills et al. 2003). Global warming's impact on fish species may be either positive or negative depending on species-specific thermal requirements and changes in thermal habitat.

3.0 COOLING WATER INTAKE STRUCTURE DESCRIPTION

3.1 PHYSICAL DESCRIPTION, LOCATION AND DEPTH OF INTAKE STRUCTURE

The CWIS at JAF is a submerged, shore-facing, remote intake with a total design intake flow of 388,600 gallons per minute (gpm). The CWIS is shared primarily by the Circulating Water (CW) and Service Water (SW) systems, and is located about 990 feet from the shoreline of Lake Ontario at coordinates N43°31'3.7" and E76°23'49". The top of the CWIS is at elevation 232.8 feet, approximately 14 feet beneath the lake surface, which typically varies from elevation 244.0 feet to 248.0 feet. The intake consists of four segmented shore-facing openings, each 22 feet wide and 8 feet high, feeding a 14 foot diameter D-shaped intake tunnel that runs beneath the lake bed approximately 1,150 feet to the offshore screenwell and pumphouse. The base mat of the CWIS is at elevation 222.8 feet, approximately four feet above the lake bottom elevation of 218.8 feet.

Nine acoustical projector housings are symmetrically installed on top of the remote intake structure roof, located at elevation 232.8 feet, to provide for fish deterrence. The projectors are removed for the winter months due to the ice packs possibly defacing the projector faces. The function and effectiveness of this system is discussed in detail in Section 5.1 (below) describing "Currently Implemented Technologies".

3.2 AS-BUILT PLAN AND SECTIONAL VIEWS OF INTAKE STRUCTURE

Refer to Appendix 2, "Drawings with Plan and Sectional Views of Intake Structure". The following JAF plant drawings are included in this Appendix:

FC-42A, Intake & Discharge Tunnels
FC-43B, Intake Structure
FM-7A, Screenwell & Water Treating, Plans & Sections
FM-7C, Screenwell & Water Treating, Sections

Additional applicable plant drawings are listed in the "Literature Cited" section of this report.

3.3 BAR-RACK DESCRIPTION, DIMENSIONS, OPERATION, AND DEBRIS LOADING

There are two sets of bar racks, an internally heated bar rack at the remote intake, and a trash bar rack in the screenwell of the CWIS. The heated bar rack at the remote offshore intake consists of 3 inch by 2 inch rectangular vertical bars on 12 inch centers across each 22 foot by 8 foot intake opening, a total of 88 bars. The primary purpose for this heated bar rack is the prevention of intake clogging due to frazil ice and/or large debris (a potential NRC safety concern). The bar rack heaters are energized anytime water temperature is ≤37°F to prevent/remove ice formation. There are no installed systems to remove large debris from these racks with the plant operating, although original plant design provided "reverse flow" capability to backwash the remote intake racks when the plant is not at power. The design water velocity through the bar rack at the remote intake is 1.2 feet per second with all three circulating water pumps operating (fps; TI 1979).

The trash bar rack in the CWIS consists of three 12 foot wide vertical bar racks, one installed in front of each traveling water screen, retaining debris equal to or greater than 3.125 inches. A movable trash rake is used to clear away debris collected on the screenwell trash racks, capable of being manually traversed to service any of the three racks to remove debris. Permanent instrumentation monitors trash bar rack differential pressure, and Operations manually rakes trash off the racks when high differential pressure, i.e. debris loading, is indicated. If differential pressure is excessively high, >10 inches W.C., an alarm is annunciated in the control room and compensatory actions must be initiated.

3.4 TRAVELING SCREENS DESCRIPTION, DIMENSIONS, OPERATION, AND DEBRIS LOADING

The traveling water screens are furnished by Jeffrey Manufacturing Company of Columbus, Ohio, in accordance with Purchase Specification APO-36. Three 12 foot wide traveling screens, fabricated from No. 10 gauge 304 stainless steel wire with 3/8 inch clear openings, are situated between the trash racks and the pump intake sluice gates. Each screen has a design capacity of 125,000 gpm, is 12'-0" wide and 43'-4" high, and has a design approach velocity of 1.2 fps. Screen rotation speed ranges from 10 fpm to 20 fpm. The traveling screens retain debris ≥3/8 inches and dump it into a collecting trough. The steel trash trough has flanged ends for each screen section designed so that the flanged ends will mate for bolting when the screens are installed in place to form one continuous pitched trash trough mated to a trough extension. The bottom flange of each panel forms a trash shelf extending the entire width of the panel. The shelf design includes a substantial dredging leaf rake extending the width of each panel at the panel midpoint for refuse removal and is designed for minimum reduction of free area. This rake has tines to engage and raise moss and other lake vegetation. The carrying ledge portion of the lip is able to retain fish and is perforated to drain water. The panels are constructed and so attached to the chain that there is no opening larger than the screen cloth opening for debris to get through at the line of articulation along the sides or bottom when they are stationary or moving.

Two 100% capacity (1 running, 1 standby) screen wash pumps take suction from the SW discharge header to provide backwash spray water for the traveling screens. The spray system utilizes non-clogging, wear resistant deflector type nozzles, designed to project overlapping fan shaped jets of spray water across the width of the screen so that all material picked up on the screen, trash shelf, and the special dredging leaf rake will be jetted off when the panels are ascending. Debris is jetted in a direction opposite the direction of flow of water in the intake channel. The design screen wash pumps spray flow rate is 720 gpm/screen, at a minimum of 80 psi gauge pressure. Water is sprayed on all screens simultaneously from two screen wash headers whenever the traveling screens are rotating.

The traveling screens and screen wash pumps are equipped with an automatic differential level control to limit debris loading and can be operated manually or in automatic mode. When in the automatic mode, the screens and pumps will start when the screen wash pump discharge pressure is > 100 psig, and either of two conditions occur:

1. High screen differential level, ≥4 inches W.C., as sensed by level detectors across the screens. or
2. 10-minute daily exercise timer is initiated.

Design debris loading conditions for the traveling screens correspond to 1.6 inches differential W.C. clean, up to 6 inches differential W.C. fully loaded. The traveling screens will automatically stop if the screen differential level is <2 inches W.C. for 10 minutes. An adjustable timer is included to insure that the screen will run for at least 1-1/3 revolutions after minimum level differential is attained to assure that debris is completely removed and not just lifted out of the water and allowed to dry on the panels. If any of the screens runs continuously for 30 minutes or if the differential level across the screens reaches 6 inches W.C., an alarm is sounded in the main control room. Per the CW Operating Procedure OP-4, the traveling screens are operated at least once per shift, either in "automatic" mode, or manually in "continuous" mode.

4.0 COOLING WATER INTAKE SYSTEM DESCRIPTION

4.1 Circulating Water System Intake Pumps Description, Design Parameters, and Operation

The JAFNPP CWIS contains three vertical, mixed flow, dry pit type circulating water pumps. Each single speed intake pump has a rated 27 feet of total dynamic head (TDH), and a rated flow of 120,000 gallons per minute (GPM). The pump drivers are open, drip-proof, induction motors rated at 1,000 HP. During normal plant operation, all three CW pumps are operating with a combined design circulating water intake flow of 360,000 GPM (5.184 x 10^8GPM) measured through the condensers.

4.2 Hydraulic Zone of Influence

A mathematical model of the Hydraulic Zone of influence (HZOI) for the cooling water intake structure (CWIS) will be prepared using computational flow dynamics (CFD) software. Using existing electronic intake drawings and topographic information collected for the site, a three-dimensional model of the CWIS and its immediate vicinity will be constructed and used to estimate the HZOI, approach velocities, and appropriate sampling areas, within the entire water column while providing a graphic representation for these estimates when applied under normal or median atmospheric and operational conditions. Early stage development of the CFD model may be used in later stages of the CDS development as an evaluation tool to predict regulatory performance of the CWIS. Evaluation of appropriate operational or technological modifications may utilize this same modeling process for performance comparison and/or cost benefit analysis.

The HZOI for the plant's CWIS and subsequent biological sampling areas will be determined by

1. Defining a coarse CFD grid using an existing CAD model of the off-shore intake structure
2. Applying reasonable (non-zero) influence boundaries to the CFD problem definition
3. Mapping existing lake bottom topographic information
4. Incorporating available basic bathymetric data and median water level
5. Running the CFD calculation
6. Generating a graphic representation of the results
7. Determining an estimated Hydraulic Zone Of Influence
8. Report the results for use to support biological sampling boundaries.

This report will be prepared and submitted for review by the permitting authority at least 30 calendar days prior to sampling start.

4.3 Service Water System Pumps Description, Design Parameters, and Operation

Three 50% capacity, vertical wet-pit, 18,000 gpm SW pumps take suction from the same common intake bay as the CW pumps, downstream of the traveling screens. The design SW total flow, with two pumps running and one in standby, is 36,000 gpm.

Water entering the intake and passing through the traveling screens consolidates in a common pre-entry area from which suction is taken for all the CW and SW pumps. The SW pumps support safety related systems within the plant and as such must be available all of the time. Any modification to the intake structure, bar racks and rake, or the traveling water screens must be evaluated and assessed against the design basis monitored and regulated by the NRC.

4.4 Additional Pumps Taking Suction from the Common Intake Bay

Although the primary intake flows are for the CW and SW systems, there are periodic, minor flows to the Emergency Service Water System, the Fire Protection System, RHR Service Water, and the Makeup Demineralizer System.

4.5 Biofouling Control

Biofouling control at JAFNPP is administered by the application of sodium hypochlorite in the service water system and the condenser waterboxes. In both cases, the sodium hypochlorite is injected after the travelling screens. Service water injection occurs continuously not to exceed the SPDES Permit limit of 0.2 ppm TRC as measured in the discharge canal. Waterbox chlorination is limited to less than two hours per day, to less than nine hours total per week, and to daylight hours only to minimize the impact on entrained organisms. Waterbox chlorination also has a SPDES Permit limit of 0.2 ppm TRC as measured in the discharge canal.

4.6 Baseline Maximum Cooling Water Use Based On Pump Nameplates or Design Rated Capacity

The baseline cooling water intake capacity is 360,000 GPM, based on the combined design rated flow of the three circulating water pumps.

4.7 Identification of Reductions In Raw Water Intake from Tempering Flow (Recirculation)

During periods of cold weather, when inlet water temperature is below approximately 45°F, warm discharge water is recirculated via a tempering gate to obtain proper temperature of the CW and SW inlet water. This flow path delivers some of the water in the discharge tunnel to the intake bay, upstream of the traveling screens. The tempering gate can be controlled from 0%-100% open, and all positions in between, from the main control room. The JAF raw water intake from Lake Ontario is effectively reduced by the amount of recirculation flow during this mode of operation. Based on historical data, the tempering recirculation flow effectively reduces the plant cold water intake at extreme (cold) intake water temperatures.

4.8 Calculation of Monthly and Annual Flow Reduction from Baseline

JAFNPP has compiled more than seven years (January 1998 through July 2005) of monthly actual intake flow data for the CWIS that is representative of the current and expected future CWIS operations (Table 4-1). These intake flow data are representative of operating conditions at the CWIS in that they account for the fact that the actual pumping rate historically has been less than the CWIS's design intake flow. As detailed below, the actual pumping rates have been lower than the design flows because these pumps operate at various head differentials between MHW and the MLW design rating, and because the unit's cooling water needs vary in response to reduced generation and periodic maintenance outages, among other factors. The observed actual average monthly cooling water intake flow for the JAFNPP CWIS during the 2001 through 2004 period of available data was 480.7471 million gallons per day (MGD) (Table 4-1). The design flow baseline intake is calculated comparatively at 518.4000 MGD, resulting in an immediate 7.3% average flow reduction.

5.0 DESCRIPTION OF PROPOSED AND/OR IMPLEMENTED TECHNOLOGIES, OPERATIONAL MEASURES AND/OR RESTORATION MEASURES

5.1 Currently Implemented Technologies and Operational Measures

The primary technological design feature currently implemented at JAFNPP CWIS to reduce impingement mortality and entrainment is the offshore, submerged, mid-water, shore-facing intake located 900 feet out in Lake Ontario. JAFNPP also operates a state of the art fish deterrence system (FDS) installed at this offshore intake structure that has been proven to be Best Technology Available (BTA) for reducing impingement mortality (Ross et al. 1993, 1996; Dunning and Ross 1998), and accepted as BTA by NYSDEC (letter from P.Kolakowski NYSDEC to D. Dunning NYPA, 1 March 1996). Operation of this fish deterrence system is required as Additional Requirement 9 of JAFNPP's current SPDES No. NY 002 0109 from the first week in April into October of each year. Operational measures currently implemented at the JAFNPP CWIS to reduce impingement mortality and entrainment are intake flow reductions, including those resulting from pump differentials, maintenance outages, and from recirculation of heated condenser flow that is used for tempering the incoming ambient Lake Ontario water during the winter. The average flow reduction for the JAFNPP CWIS over the most recent period of record was 7.3% based on the observed actual average annual intake flow compared to the maximum annual intake design flow.

5.2 Proposed Technologies and Operational Measures

This Proposal for Information Collection ("PIC") is designed as "a proposal stating what information will be collected to support the Comprehensive Demonstration Study." 69 Fed. Reg. 41634 (July 9, 2004). The document is, however, necessarily iterative to some degree in that the data collected through the sampling plan discussed below may indicate that other alternative technologies, operating procedures, or restoration measures may be suitable for application toward the facility's compliance with section 316(b). Thus, the description of proposed technologies and measures included in this PIC is meant to serve as a frame of reference for the evaluation of the data collection proposed but is not meant either as a commitment to implement specific technologies or measures or as a decision not to pursue other technologies or measures. The decision of what proposed technologies and measures to implement, if required, will be presented in the final Comprehensive Demonstration Study as supported by the data collected through the PIC.

5.2.1 Impingement

JAFNPP presently operates a state of the art fish deterrence system installed at the offshore intake structure that has been proven to be Best Technology Available (BTA) for reducing impingement mortality and accepted as BTA by NYSDEC (Section 5.1 above). Full operation of this fish deterrence system is required as Additional Requirement 9 of JAFNPP's current SPDES No. NY 002 0109 from the first week in April into October of each year. Unforeseen circumstances preventing full operations in April must be documented in a letter to NYSDEC, and if there is a refueling outage in October, the deterrence system may be winterized (turned off) during September of that year.

JAFNPP asserts that the present intake design, flow reductions, and operation of the FDS meet the impingement mortality standard for the 316(b) Phase II Regulations. As part of the Comprehensive Demonstration Study (CDS), JAFNPP may evaluate the efficacy of other technological options to further reduce impingement mortality at JAFNPP, if warranted, by new or additional information. Examples of technologies may include (1) a fish return system for impingement survival, (2) conservation devices such as fine mesh screens and baskets (3) continuously rotating traveling screen, or (4) a low pressure wash water spray header system.

Under the assumption that impingement abundance is directly proportional to CWIS flow (a fundamental assumption upon which the Phase II Regulations are based), JAFNPP may also consider one or more technological / operational flow reduction methods to further reduce impingement mortality achieved by one or more of the following measures: (1) seasonal flow reductions through modifying refueling outage schedules to occur during periods of high impingement mortality, (2) installation and operation of variable speed intake pumps to potentially reduce intake flows during periods of excess cooling capacity within the existing SPDES permit thermal limits, or (3) increasing the SPDES thermal discharge limits and using proposed operational measures 1 and/or 2 (above) to further reduce impingement mortality.

If appropriate, in accordance with 40 C.F.R. §125.94(a)(5), JAFNPP may estimate whether the costs of these technological and/or operational options will be significantly greater than (a) the Appendix A costs established by USEPA for the facility, corrected to the extent necessary to account for errors in USEPA's calculation, or (b) the demonstrable benefits of complying with the applicable performance standards (i.e., demonstrable reductions in impingement mortality that would be obtained by installation of additional technologies and / or implementation of modified operational measures). If appropriate, JAFNPP may request a site-specific determination of best technology available for minimizing adverse environmental impacts in accordance with 40 C.F.R. §125.94(a)(5).

5.2.2 Entrainment

The construction and offshore location of the JAFNPP CWIS minimizes the impacts to shoreline organisms susceptible to entrainment. The 316(b) Phase II Regulations recognize the difference of location and depth of the CWIS as it relates to both impingement and entrainment potential. Sampling plans provided in Section 8.2 outline the gathering of additional data which will include both near shore and intake collection. Near shore data is intended to quantify baseline conditions as defined in the 316(b) Phase II Regulations. Both sets of data will be evaluated and compared during the CDS process. JAFNPP is confident that, through the CDS process, the plant will demonstrate compliance with the entrainment standards when compared to baseline criteria.

If warranted, JAFNPP may consider the addition of passive fine-mesh screen to the existing offshore intake with mesh width of 1.75 mm, which is USEPA's selected technology for its cost calculations presented in Appendix A to the final Phase II Regulations (See 69 Fed. Reg. 41671). The USEPA estimated annualized 316(b) compliance costs comprised of annualized capital and operation and maintenance ("O&M") using a USEPA estimated design intake flow (See 69 Fed. Reg. 41646). USEPA did not, however, estimate the total net revenue losses from net construction down-time for JAFNPP.

Under the assumption that entrainment is directly proportional to CWIS flow (a fundamental assumption upon which the Phase II Regulations are based), JAFNPP may also consider one or more flow reductions options as described in Section 5.2.1. Technological and Operational flow reductions for the purpose of reducing entrainment at JAFNPP are the same as described above in Section 5.2.1 for reducing impingement mortality, although they may be implemented in a different period or periods depending on the seasonal occurrence of entrainment.

If appropriate, in accordance with 40 C.F.R. §125.94(a)(5), JAFNPP may estimate whether the costs of these technological / operational options will be significantly greater than (a) the costs considered by USEPA for a like facility in establishing the applicable performance standards, corrected to the extent necessary to account for errors in USEPA's calculation, or (b) the demonstrable benefits of complying with the applicable performance standards (i.e., demonstrable reductions in impingement mortality that would be obtained by installation of such technology / operations). If appropriate, JAFNPP may request a site-specific determination of best technology available for minimizing adverse environmental impacts in accordance with 40 C.F.R. §125.94(a)(5).

6.0 HISTORICAL STUDIES CHARACTERIZING IMPINGEMENT MORTALITY AND ENTRAINMENT AND/OR PHYSICAL AND BIOLOGICAL CONDITIONS

6.1 WATER QUALITY

A long period of habitat loss and water quality degradation followed European colonization of the Lake Ontario watershed (Smith 1995). Initially, water quality deteriorated slowly from the effects of forest clearance, but deterioration accelerated during 1940-1970 because of increasing urban runoff (Schelske 1991). Historic changes in land use and uncontrolled pollutant discharge into the Great Lakes contributed to eutrophication of the entire lake system, characterized by high phosphorus concentrations and high turbidity up to the late 1970s.

Because of its depth and dilution capacity, adverse eutrophication effects have been minimal in Lake Ontario compared with those for parts of Lake Erie. Oxygen saturation is usually above 80% in the hypolimnion during summer and averages over 90% in the epilimnion throughout the year (TI 1979, 1980). There are no persistent lakewide eutrophication problems at this time, although near shore and major tributary impairments have been noted (NYSDEC 2000).

Changes in selected water quality parameters over the last 30 years are shown in Table 6-1. These data were collected at the Nine Mile Point area in 1972 and 1978, at the City of Oswego water intake located about eight miles southwest of JAFNPP in 1998 and 1999, and at the Monroe County water intake in 2000, approximately 50 miles west of JAFNPP. General reductions in pollutants such as phosphorus and dissolved solids, and in turbidity levels, have been observed over the last 30 years. Water clarity, measured by a Secchi disk, has increased by more than 100% in Lake Ontario during the 1990's (3.1m to 6.7 m, EPA 2005- http://www.epa.gov/glnpo/monitoring/limnology).

The largest source of primary nutrients into Lake Ontario is Lake Erie via the Niagara River. Additional phosphorus and nitrogen enter Lake Ontario from runoff from agricultural lands, urban areas, and sewage outflows. With the intent of preventing further pollution and eutrophication of the Great Lakes system from continuing population growth, resource development, and increasing use of water, the United States and Canada signed the Great Lakes Water Quality Agreement (GLWQA) in 1972. Since the implementation of GLWQA, phosphorus levels in the Great Lakes have been significantly reduced (Stevens and Neilson 1987, Millard et al. 2003) as a result of better sewage treatment and land use practices in the watershed, which has shifted Lake Ontario back towards its historical oligotrophic condition (Mills et al. 2003).

Spring open-lake (offshore) total surface phosphorus levels peaked in 1973 at 25 to 30 ug/l and then declined at an average rate of 1.35 ug/l per year between 1973 and 1986 (NYSDEC 2000). By 1986 the 10 ug/l target for open-lake phosphorus had been achieved (GLWQB 1989). Decreases in phosphorus were accompanied by decreases in Lake Ontario algal biomass. Eutrophic conditions of the 1960s and 1970s resulted in explosive growth of *Cladophora*, a green filamentous algae. After the implementation of phosphorus reduction programs in the early 1970s, Lake Ontario *Cladophora* biomass and growth rate decreased 50% between 1972 and 1982 (Painter and Kamaitis 1985). Similar decreases were seen in phytoplankton biomass over the same time period (Gray 1987).

Nitrogen concentrations in Lake Ontario, although not considered as major a cause of eutrophication in the 1960's and 1970's as phosphorus, have been increasing in all the Great Lakes (Williams 1992, Neilson et al. 1995). The causal factors are not well understood, but agricultural runoff and atmospheric deposition are considered the most likely sources (NYSDEC 2000). Lean (1987) concluded that the increase in nitrate was associated with higher loading from the watershed and was not associated with reduced algal demand because the nitrate increase occurred before implementation of phosphorus control. Millard et al. (2003) showed that the rate of nitrate increase paralleled nitrogen fertilizer use in the Great Lakes basin and mirrored the observed Lake Ontario mid-lake increase up to the mid-1980s.

Nutrient concentrations are greatest in early spring, before algal production begins (Williams et al. 1998). During thermal stratification, nutrients such as orthophosphate, nitrate, and silica generally increase from surface to bottom, reflecting uptake by phytoplankton in the photosynthetic zone and perhaps release from bottom sediments (TI 1979).

Because Lake Ontario is the most downstream of the Great Lakes, it is impacted by human activities occurring throughout the Lake Superior, Michigan, Huron, and Erie basins. Persistent, bioaccumulative toxic chemicals (PBTs), which include mirex, PCBs, dioxins, etc., entered Lake Ontario via tributaries and historically were accumulated in the sediments. Concentrations of toxic chemicals in Lake Ontario led the International Joint Commission (IJC) to designate Lake Ontario as the most contaminated of the Great Lakes. Canada and the United States developed the "Lake Ontario Toxics Management Plan" in 1989 to address PBTs through regulation of toxic chemical manufacture and use (NYSDEC 2000). The reductions have been generally attributed to restrictions placed on the manufacture and use of those chemicals. The downward trend of toxic chemical concentrations has leveled off since the 1980's and may be due, in part, to a sequestering of the chemicals in benthic sediments. Consumption advisories for numerous fish species based on concentrations of PBTs found in fish tissue samples continue to be issued by the NYSDEC (NYSDEC 2000).

Monthly and semimonthly water quality sampling programs conducted in the Nine Mile Point vicinity from 1973 through 1978 included weekly thermal profiles at the 100 foot depth contour (TI 1979). Although many of the parameters analyzed fluctuated monthly and annually, there were no persistent trends (TI 1979). During any given year, there were temporal cycles for many of the parameters, particularly nutrients and water temperatures. Inorganic nitrogen and phosphorus characteristically increased during winter and decreased during summer with a corresponding summer increase in organic nitrogen and organic phosphorus compounds (TI 1979). Data collected from 1973-1978 showed no short term or long term effects from operation of NMPNS or JAFNPP (TI 1979). The Oswego River, west to east longshore currents, and hypolimnetic upwellings of cold, often nutrient rich waters exert the most influence on the physiochemical parameters at Nine Mile Point (TI 1979).

6.2 Planktonic Community

Historical phosphorus loadings from wastewater discharge and runoff from urban and agricultural sources contributed to significant eutrophication of Lake Ontario and accompanying algal community during the 1960s-1970s. The increased phytoplankton and zooplankton productivity contributed to increasing turbidity within Lake Ontario during that period. Nutrient loading reductions that were a result of the United States Clean Water Act and the GLWQA have allowed Lake Ontario's plankton community to shift back to a more balanced, oligotrophic state (NYSDEC 2000, Mills et al. 2003). Net productivity has declined by 18% and late summer zooplankton production had been reduced by 50% since the 1970s (NYSDEC 2000). Comparison of lakewide surveys conducted in 1970 (high phosphorus) and 1990 (low phosphorus) showed an increase of oligotrophic over eutrophic phytoplankton species (Vollenweider et al. 1974, Munawar and Munawar 1996, Munawar et al. 2003). Shifts in phytoplankton community structure indicate improvement in Lake Ontario's trophic status and have closely resembled the changes in the available nutrients. Predominant eutrophic species of diatoms and cyanobacteria have either been replaced by oligotrophic species or occur in very low numbers, and the relative abundance of oligotrophic species of diatoms and chrysophytes has increased. Recently invading *Dreissena* spp. mussels have caused a redistribution of a large portion of Lake Ontario's available planktonic nutrients from the water column to the benthic environment and contributed to decreases in turbidity (Mills et al. 2003).

The impact of alewife on the zooplankton species composition since the early 1970s in Lake Ontario has been significant. Intense planktivory by these fish has structured the community toward small species (Mills et al. 2003). Zooplankton are the principal food of juvenile and adult alewife (Mills et al. 1992, Urban and Brandt 1993), and alewife were responsible for > 96% of the predation on zooplankton by Lake Ontario fish as late as 1990 (Rand et al. 1995). Alewife abundance has declined 42% from the early 1980s to the early 1990s (O'Gorman et al. 2000-cited in Mills 2003), and subtle changes were observed in the zooplankton community coincident with this decline (Mills et al. 2003).

6.3 BENTHIC COMMUNITY

One of the most significant changes in the benthic macrofauna of Lake Ontario has been the establishment of two species of *Dreissena*. The exotic zebra mussel (*Dreissna polymorpha*) and quagga mussel (*Dreissena bugensis*) have amplified the effects of reduced nutrient levels by filtering and clarifying the water column throughout Lake Ontario. The zebra mussel was first detected in Lake Ontario in 1989, and by 1991 the quagga mussel was observed co-existing with the zebra mussel (Mills et al. 1993). These mussels had colonized western Lake Ontario and the south shore by 1991-92 and the eastern outlet basin by 1993. South-shore studies between 1992 and 1995 showed that total *Dreissena* biomass had increased and that areas of lake bottom dominated by zebra mussels in 1992 were dominated by quagga mussels in 1995 (Mills et al. 1999). *Dreissna* mussels are capable of colonizing areas from the waters edge to depths beyond 400 feet, zebra mussels are primarily found in water less than 10 feet deep. Quagga mussel density has increased to over 18,800 mussels/ yd^2 in water 246 feet deep and over 2,000/ yd^2 in water 425 feet deep (NYSDEC 2003).

After 1994, benthic macroinvertebrate populations declined in many areas of Lake Ontario (Lozano et al. 2001, Dermott 2001). Associated with the dramatic increase in *Dreissena* spp. was a collapse of the larger fingernail clams (*Sphaerium* spp.) likely due to competition with *Dreissena* for food and space. Coincident with the ascent of *Dreissena* spp., numbers of the shallow water amphipod *Gammarus fasciatus* increased, perhaps because they benefited from the structural complexity associated with mussel colonies and energy transfer to the benthos through pseudofecal deposition (Stewart and Haynes 1994, Haynes et al. 1999). Colonization of Lake Ontario by the filter-feeding *Dreissena* spp. has likely decreased crustacean zooplankton production, particularly in nearshore (< 30 m depth) areas if the ecological response is similar to that of Lake Erie, where dreissenid mussels depressed zooplankton production through their impact on pelagic primary production (Johannsson et al. 2000). The nearshore macrobenthos community has undergone further change with the replacement of the gastropod snails *Amnicola* spp. and *Valvata* spp. with the exotic New Zealand mud snail (*Potamopyrgus antipodarum*; Zaranko et al. 1997).

The deepwater scud (*Diporeia*) was historically the dominant benthic invertebrate in most offshore areas of Lake Ontario (Nalepa 1991) representing 60-80% of benthic biomass of Lake Ontario (Johannsson et al. 1985). *Diporeia* is an important prey item for alewife, rainbow smelt, slimy sculpin, young lake trout and lake whitefish (Hoyle et al. 2003). In the Kingston Basin, density of *Diporeia* increased between 1983 and 1989 and reached a seasonal average just over 13,000/m^2 in 1988 (Mills et al. 2003). After 1990, *Diporeia* density in the Kingston Basin (at depths <35 m) plummeted to < 4/m^2 by October 1995 and to zero in April 1996 (Dermott 2001). Lozano et al. (2001) also observed a significant decline in *Diporeia* density between 1972 and 1997 at depths of 12-88 m. A zone of low *Diporeia* density (< 4/m^2) encompassing a significant portion of the soft sediment habitat in Lake Ontario currently extends to 26 km offshore and as deep as 160 m (Lozano et al. 2001). The diversion of algal production into *Dreissena* tissue and biodeposits may deprive *Diporeia* of food settling from the water column. This reduction of *Diporeia* is expected to have a significant impact on the fish of Lake Ontario that are dependent on these organisms for their growth and survival (Mills et al. 2003).

6.4 Historical Fish Community in Lake Ontario

The Lake Ontario ecosystem has undergone dramatic change since European colonization, primarily due to human impacts on Lake Ontario and its watershed (Christie 1973, Smith 1995). The native fish community of Lake Ontario comprised a rich forage base that included coregonids (whitefish family) and sculpins. Atlantic salmon (*Salmo salar*), lake trout (*Salvelinus namaycush*), and burbot (*Lota lota*) were the most abundant offshore predators in Lake Ontario. In nearshore waters, warmwater predator species such as yellow perch (*Perca flavescens*), walleye (*Stizostedion vitreum*), northern pike (*Esox lucius*), and lake sturgeon (*Acipenser fulvescens*) were in abundance. Prey species included deepwater ciscoes (*Coregonus* spp.) and sculpins (*Myoxocephalus thompsoni* and *Cottus cognatus*) in offshore areas, and emerald shiner (*Notropis atherinoides*) and spottail shiner (*Notropis hudsonius*) in nearshore areas (Stewart et al. 1999). Coregonids and salmonids constituted the largest components of the fish population in the Great Lakes, which reflected their oligotrophic character (Smith 1995). The earliest records of the Lake Ontario fish community involve the commercial fishery (Baldwin et al. 1979). Historically, the Lake Ontario commercial fishery was based on a variety of species including lake herring, deepwater ciscoes, lake trout, lake whitefish, American eel (*Anguilla rostrata*), walleye, yellow perch, northern pike and bullheads (*Ictalurus spp*).

Habitat and water quality degradation, overfishing and the introduction of exotic species contributed to the decline of the native fish community (Christie 1973, 1974, Smith 1995). By the 1970's, these impacts culminated in the virtual extinction of large piscivores, the reduction or extinction of other native fishes, and proliferation of exotic species. Atlantic salmon, deepwater sculpins, lake trout, burbot, and coregonids had all disappeared or had seriously declined in abundance. Notable changes to the fish community began over 100 years ago with the arrival of several exotic species (Christie 1973, Smith 1995, Kerr and LeTendre 1991, Stewart et al. 1999). Alewife (*Alosa pseudoharengus*), sea lamprey (*Petromyzon marinus*), and rainbow smelt (*Osmerus mordax*) colonized Lake Ontario most likely via migration through the New York State Canal System. Sea Lampreys established a reproducing population, and their parasitic feeding habits decimated native lake trout fish stocks until the 1970s when control measures were implemented. Alewife and rainbow smelt proliferated in the virtual absence of predators and became overabundant by the 1960s. Eutrophic conditions in Lake Ontario and abundant phytoplankton perpetuated the population growth of both alewife and smelt.

Early efforts to stock the Great Lakes with various species of salmon and trout met with little or no success. Renewed stocking efforts began in the 1960's in an attempt to control nuisance levels of alewife and quickly became focused on developing a recreational fishing industry. In the early 1970's, New York State and the Province of Ontario began to establish recreational fisheries and rehabilitate lake trout by accelerating the introductions of lake trout, brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*) and Atlantic salmon. The introductions initially failed to establish fisheries due to high parasitic lamprey induced mortality (Pearce et al. 1980). In the early 1980s sea lamprey were effectively controlled (Christie and Kolenosky 1980) and the survival of stocked salmonids improved. Hatchery programs in both New York and Ontario were expanded and the number of salmonids stocked rapidly increased during the 1970's and 1980's (Stewart and Schaner 2002).

In the following years, activity in the recreational fishery greatly expanded. Total annual expenditures by anglers in Lake Ontario's recreational fisheries were $ 53 million (Canadian) for Ontario in 1995 (Department of Fisheries and Oceans 1997) and $ 71 million (U.S.) for New York in 1996 (Connelly et al. 1997). In the mid-1980s, the state of New York and the province on Ontario agreed to limit stocking to 8 million salmonids annually (Kerr and LeTendre 1991) in response to concerns about the sustainability of the high predator levels, declining alewife, record fishery yields and perceived risks to the burgeoning recreational fishery (Kocik and Jones 1999, O'Gorman and Stewart 1999). Salmonid consumption of alewives was estimated to exceed supply in 1992 (Stewart et al. 1999). To reduce the risk of an alewife collapse and associated adverse impacts on the recreational fishery stocking levels were reduced to 4.5 million salmonids in 1996, and have been maintained at between 4 and 5.5 million annually. In 1999, the percentage of the total salmonid stocked by species was 39.2 % chinook salmon, 18.8% lake trout, 17.2% rainbow trout, 12.2% brown trout, 7.2% coho salmon, and 5.5% Atlantic salmon (Stewart and Schaner 2002).

In the 1970s and early 1980s, Lake Ontario's offshore fish community was dominated by non-native planktivores (alewife and rainbow smelt) and a native benthivore, slimy sculpin (Owens et al. 2003). Data prior to the build-up of predator levels (pre 1985) suggests that alewife and smelt were regulated by intraspecific and interspecific competitive interactions, cannibalism, and weather (Smith 1968, Christie 1973, Christie et al. 1987a, O'Gorman 1974, O'Gorman et al. 1987, Smith 1995, O'Gorman and Stewart 1999). The diet of salmonids in Lake Ontario is comprised almost entirely of smelt and alewife (Brandt 1986, Rand and Stewart 1998). The combination of predation from stocked salmonids and changes in the trophic structure resulting from declines in nutrients and zebra and quagga mussel colonization in Lake Ontario resulted in marked declines in alewife and rainbow smelt by the early 1990's. Compared to the early 1980s, the biomass of prey fish like the alewife and rainbow smelt has been reduced by one-half (Stewart et al. 1999). The results of midwater trawls combined with acoustical transects conducted by NYSDEC and the Ontario Ministry of Natural Resources in Lake Ontario revealed an 80% reduction in the alewife population between October 1991-1994 (Lantry and Schaner 1998). Dreissenid mediated changes in the trophic structure of Lake Ontario toward a more benthic oriented foodweb and resultant decreases in planktonic prey upon which alewife feed also affect the alewife population.

Alewives exert the dominant biotic influence on fish communities in Lake Ontario and are the principal prey of most predatory fish and fish eating birds (Brandt 1986, Jones et al. 1993, Weseloh and Collier, Rand et al. 1994). Chinook salmon, in particular, rely heavily on alewives in their diet even when alewive numbers are low (Stewart and Ibarra 1991). A number of changes have been observed in recent years as alewife abundance has declined: lake trout began to successfully reproduce, threespine stickleback abundance increased, lake whitefish populations have increased, populations of other native fish species (yellow perch, emerald shiner, and lake herring) improved (Stewart et al. 1999). Two native pelagic species, threespine stickleback (*Gasterosteus aculeatus*) and emerald shiner (*Notropis atherinoides*), have recently increased in abundance and may reflect a significant change in the Lake Ontario fish community. Owens et al. (2003) suggested that the seminal event that allowed these fishes to reproduce successfully was a relaxation of predation on their larvae resulting from the shift of alewife to deeper water. Alewives prey on the pelagic larvae of many fish species (Brandt et al. 1987, Eck and Wells 1987, Krueger et al 1995, Mason and Brandt 1996). Male threespine sticklebacks establish and defend territories during breeding season and build nests of submerged aquatic vegetation and sand grains with mucus from kidney secretions (Wooten 1976). Suitable nest sites may be in short supply in some habitats and males nesting in rocky areas had fewer eggs in their nests than males in vegetated areas (Kynard 1979). An additional factor contributing to increasing abundance of threespine stickleback in Lake Ontario may be an increase in nesting habitat quantity and quality due to the increased growth of macrophyte beds in many littoral areas since dreissenid mediated increases in water clarity.

Slimy sculpin are native benthic fish that are important to the diet of lake trout (Elrod and O'Gorman 1991). Numbers of slimy sculpins fell sharply in southern Lake Ontario between 1982 and 1984 due to predation by stocked juvenile lake trout (Owens and Bergstedt 1994). Numbers slowly rose from 1984 to 1991, declined abruptly in 1992, and remained low during 1993-1998 (Owens et al. 2003). Owens et al. (2003) hypothesized that the decline of slimy sculpins was due to reductions in productivity brought on by nutrient abatement and to reductions in *Diporeia,* an important prey item, brought on by dreissenid colonization.

The current Lake Ontario fish community is in a dynamic state, affected by trophic changes triggered by invasive species as well as through manipulation by agency stocking programs. The system is largely composed of a mix of exotic species that have no evolutionary sympatry (Stewart and Schaner 2002). Recruitment of dominant predators, and the associated top-down influence on fish communities is largely controlled through stocking levels (Stewart and Schaner 2002). An imbalance of predators and prey has resulted, with important forage species (alewife and rainbow smelt) at low population levels. As a result, conventional ecological paradigms are difficult to apply, and descriptions of historical fish community structures are not useful for understanding or predicting species interactions or equilibrium states (Christie et al. 1987b, Eshenroder and Burnham-Curtis 1999, cited in Mills 2003).

More recent invasions of exotic fish include the European ruffe (*Gymnocephalus cernuus*), blueback herring (*Alosa aestivalis*), and the round goby (*Neogobius melanostomus*). Blueback herring have not become as abundant as had been expected, although they have been found in the Oswego area (NMPNS 2004). Round goby, a predator of *Dreissena,* are established in Rochester, New York and have spread eastward to the Sodus, New York area, approximately 30 miles west of Nine Mile Point. Round gobies, which are native to Eastern Europe, were introduced into the St. Claire River in 1990, probably via contaminated ballast water of transoceanic ships. The goby is a bottom-dwelling fish that has great potential for causing impacts on Great Lakes fisheries. Round gobies are thriving in the Great Lakes Basin because they are aggressive, voracious feeders that can forage in total darkness. The round goby takes over prime spawning sites traditionally used by native species, competing with native fish for habitat and changing the balance of the ecosystem. The round goby is already causing problems for other bottom-dwelling Great Lakes native fish like mottled sculpin, logperch, and darters. Goby spawn more often and over a longer period than native fish. Unfortunately, they have shown a rapid expansion of their range through the Great Lakes (Marsden and Dude 2003). No round gobies were collected in impingement samples in 2004 or in previous years at JAFNPP or NMPNS (NMPNS 2004, EA 2005). Another species that resource managers are watching is the invasive species ruffe *(Gymnocephalus cernuus).* Although the ruffe has yet to be found in Lake Ontario, they are rapidly moving east from the Upper Great Lakes and appear to compete with the walleye and yellow perch (McLean 1994). The goby and ruffe do not appear to have reached this area of the Great Lakes based on extensive impingement monitoring at JAFNPP (EA 2005).

6.5 NEARSHORE FISH COMMUNITY

With few exceptions, most Lake Ontario fish spend at least part of their life cycle in the nearshore zone. The resident fish community inhabiting the nearshore zone varies with season, the degree of nutrient enrichment, temperature, and available habitat (Stewart et al. 1999). Dominant fish species that spend most of their life cycle in the nearshore zone include walleye, smallmouth bass, largemouth bass, northern pike, freshwater drum, yellow perch, white perch, gizzard shad, trout perch, white sucker, various minnows and several sunfishes (e.g. rock bass, pumpkinseed, bluegill, black crappie: Stewart et al. 1999, Hoyle et al. 2001, Hoyle and Schaner 2002). The American eel is an important nearshore fish predator, but is currently at historically low levels of abundance (Casselman et al. 1997). The lake sturgeon, which inhabits a wide- range of water depths, is a formerly common species showing a moderate resurgence in recent years (Hoyle and Schaner 2002). The alewife, primarily an offshore pelagic species, utilizes the nearshore as spawning and nursery habitat and can be seasonally very abundant in nearshore areas.

The fish community in the coastal nearshore areas surrounding the main body of Lake Ontario is relatively sparse, therefore much of the nearshore fish community production comes from major embayments such as the Bay of Quinte, and Lake Ontario's relatively shallow Outlet Basin (Hoyle et al. 2001, Hoyle and Schaner 2002). Here, several species of management interest have shown dramatic changes in abundance in the past decade. The Bay of Quinte and eastern Lake Ontario ecosystems have undergone tremendous change, both gradually since water quality clean up efforts initiated in the late 1970s, and rapidly following the invasion and proliferation of dreissenid mussels in the early to mid 1990s (Hoyle et al. 2001). The ecosystem change has included increased water clarity, increased levels of submerged aquatic vegetation, and a modified fish community. Smallmouth bass, abundant throughout the 1980s, declined dramatically in the Outlet Basin of Lake Ontario after 1992 (Hoyle et al. 2001). The decline appears to be largely due to unfavorable summer water temperatures during the exceptionally cool years of the early 1990s (Hoyle et al. 1999). Howerver, recruitment conditions were especially good in the late 1990s, particularly the warm summers of 1995 and 1998, and smallmouth bass abundance has not shown any significant resurgence (Mills et al. 2003). Recent smallmouth bass decline has also been attributed to increased predation by double-crested cormorant (Lantry et al. 2002).

Walleye are an important keystone predator of the inshore fish community of eastern Lake Ontario. Walleye have resurged from low levels in the early 1970s and reached record setting high levels in the Bay of Quinte in the early 1990s. The resurgence began as a result of an extremely large year-class in 1978 after the winterkill of its larval predators, alewife and white perch, which occurred after the severe winters of 1976-1977 and 1977-1978 (Casselman and Scott 2003). In the late 1980s and early 1990s, the walleye population of the Bay of Quinte moved down the bay as spawning runs of alewife, an important prey species for walleye, diminished (Mills et al. 2003). Although large walleye have seasonal migrations between the Bay of Quinte and eastern Lake Ontario, this shift, along with the increased abundance of walleye, initiated their dispersion out of the lower Bay of Quinte into eastern Lake Ontario. This was accelerated in the early 1990s by increasing water transparency caused by dreissenid colonization (Cassleman and Scott 2003). In the mid-1990s, walleye abundance increased in New York waters of Lake Ontario's eastern basin. This increase, which was also seen in the upper St. Lawrence River, likely reflected the dispersion of the Bay of Quinte stock (Mills et al. 2003). Coincident with this decrease, yellow perch abundance increased substantially throughout the Bay of Quinte at a time when the species was decreasing in the eastern basin of Lake Ontario (Mills et al. 2003).

Another important inshore species, yellow perch, were at record-setting high levels in north-eastern Lake Ontario in the late 1970s and early 1980s but declined precipitously in the mid-1980s (Mills et al. 2003). Among the many factors associated with these dynamics was a massive winter kill of alewives, significant predators of yellow perch larvae (Mason and Brandt 1996), in the late 1970s followed by a strong rebound in the 1980s. A shift in alewife distribution in the early 1990s boosted yellow perch reproductive success, but it was followed by increased predation by double-crested cormorant that appears responsible for decreasing yellow perch abundance in eastern Lake Ontario in recent years (Burnett et al. 2002).

6.6 Nearshore Fish Community in the Vicinity of Nine Mile Point

The temporal and spatial distribution of fishes in the vicinity of Nine Mile Point was monitored at varying levels of effort from 1969 through 1978 (TI 1979) using a variety of gear types, including gill nets, trawls, seines, and trap nets. Fish community structure varied seasonally during any given year, changing from a simple system in winter and early spring to a more complex and diverse community in late spring through the fall (TI 1979). Data indicated that the fish community in the Nine Mile Point vicinity was dominated by one or two species with a small number of other species in reduced numbers (TI 1979). Species diversity was highest in the spring due to an inshore movement of a number of species. During summer when alewives were most abundant, diversity was low. Diversity usually increased again in the fall, coinciding with the offshore movement of alewives (TI 1979).

Seventy-two fish species were collected from 1969 to 1978 in the vicinity of Nine Mile Point (TI 1979). During a typical year, alewives comprised a majority of the total catch, with rainbow smelt, spottail shiners, emerald shiners, centrarchids, yellow perch, and white perch accounting for the majority of the remaining catch (TI 1979). Seasonally, fish were collected in greatest numbers during the spring, coinciding with the shoreward migration of the two most abundant species, alewife and rainbow smelt. Abundances typically decline during the warmer summer months and rise during the fall, corresponding to increased catches of young of the year fish. Abundance patterns based on gill net data generally mimicked the patterns displayed for impingement catches at JAFNPP and NMPNS (TI 1979).

Yearly gill net catch data for rainbow smelt, white perch, and smallmouth bass in the Nine Mile Point vicinity displayed no significant changes among years (1969-1978: TI 1979). Alewife abundance oscillated, displaying highest numbers in 1974 and 1976 and declining through 1977 and 1978 (TI 1979). The yellow perch population declined slightly from 1977 through 1978. Data on gizzard shad indicated a generally increasing population in the Nine Mile Point vicinity through 1975 and a decline during 1977 and 1978, greatest concentrations were in the vicinity of plant thermal discharges during the fall . Salmonids appeared infrequently in gill net catches through the years and typically reflected stocking intensity for any given year (TI 1979).

No incidents of cold shock mortality due to plant shutdown at either JAFNPP or NMPNS were reported, nor were any rare, endangered, or threatened fish species collected (TI 1979). Comparison of temporal and spatial abundance based on catch per unit effort data as well as length-frequency distribution, age and growth, fecundity, gonad maturity, and diet analysis between experimental and control areas in the Nine Mile Point vicinity for 1969-1978 revealed no distinct alteration to the normal seasonal life cycle patterns of the nearfield fish community directly attributable to operations at JAFNPP or NMPNS (TI 1979).

6.7 Entrainment at or Near JAFNPP

The Power Authority of the State of New York (PASNY, now called the New York Power Authority, NYPA) and Niagara Mohawk Power Corporation (NMPC) began ecological studies in the vicinity of

Nine Mile Point in the late 1960s to evaluate potential effects of power station operations at Nine Mile Point (JAFNPP and NMPNS) on the near field aquatic ecosystems. The nearfield distribution of fish eggs and larvae was monitored weekly at depths ranging from 20 to 100 feet in the Nine Mile Point vicinity during April-December 1973-1979 (LMS 1983). Thermally influenced and control areas were sampled over a range of depths in order to characterize the temporal and spatial distribution of the ichthyofaunal community in the Nine Mile Point vicinity.

Egg collections, which included up to six species during any one year, were consistently dominated by alewife and rainbow smelt (TI 1979). Larval samples, also dominated by alewife, included up to 22 species in a given year. Alewife consistently dominated the ichthyoplankton community, other abundant species included rainbow smelt, white perch, sculpin, and tessellated darter (LMS 1977a, LMS 1977b, TI 1979). Although yellow perch, rainbow smelt, and *Morone* spp. (white bass and white perch) larvae were consistently present over the years, they and other species generally occurred either in low numbers or were collected infrequently during each year (TI 1979). These data indicate that significant spawning in the study area was limited to alewife and rainbow smelt, and that the Nine Mile Point area is not a major spawning habitat for the majority of the Lake Ontario fish community (TI 1979). During a review of Nine Mile Point studies, Williams et al. (1975, cited in TI 1979) indicated that the area does not contain desirable spawning and nursery sites because of extensive nearshore wave action and bedrock/rubble substrate.

The temporal distribution of eggs and larvae in the Nine Mile Point area is characterized by two basic spawning groups: Species typically spawning in the winter and early spring (e.g. burbot, *Coregonus* spp., rainbow smelt, yellow perch), and late spring and summer spawning species (e.g. alewife, white perch, carp; TI 1979). Eggs and larvae of the first group are most abundant during April through early June and larvae of the second group are most abundant in July and August.

Eggs and larvae were more abundant along the 20 foot than along the 40 foot depth contour and densities were usually lowest at the deeper (60, 80, 100 foot) stations (TI 1979). Older larvae consistently displayed a pattern of offshore migration to deeper waters. From June through August, when larvae were most abundant, both prolarvae and post yolk sac larvae were usually more abundant in surface than in mid-depth and bottom samples (TI 1979). Alewives usually accounted for more than 90 percent of the catches during this period. Alewife eggs were more abundant in night samples (generally near the bottom) while alewife larvae were more abundant during the night generally near the surface (TI 1979). Prior to the influx of alewives, rainbow smelt larvae were usually most abundant at night in the bottom strata (TI 1979). The vertical distribution pattern of rainbow smelt eggs was not consistent from year to year. No pattern was observed in the vertical distribution of yellow perch larvae (TI 1979).

Abundance of ichthyoplankton larvae and eggs from sampling conducted directly in the intake forebay at NMPNS Unit 1 was determined either weekly or twice per month from 1973-1978 (TI 1979). Generally, the species from the intake forebay reflected the Lake Ontario species composition, except that species occurring infrequently or on low numbers were often not observed in the intake forebay. The temporal abundance of eggs and larvae in intake samples was generally similar to temporal patterns observed in Lake Ontario samples. However, densities in intake samples were sometimes lower than corresponding densities in Lake Ontario nearfield samples, particularly larval densities in 1977 and 1978 (TI 1979). Also, the diversity of eggs and larvae was frequently lower in intake samples than in the nearshore Lake Ontario samples. Although 100% mortality of entrained ichthyoplankton in the intake samples was assumed for the purposes of impact evaluation, station operation from 1973 to 1979 had a minimal impact on ichthyoplankton populations in the vicinity of Nine Mile Point (TI 1979). For example, cropping estimates for larvae indicated that only about 0.26% of the alewives and rainbow smelt in Lake Ontario that were available for entrainment during 1976 were actually entrained, assuming both NMPNS and JAFNPP were operating at full intake flow (TI 1979).

Initial studies of entrainment at Unit 1 of NMPNS conducted in the mid-1970s were summarized in (LMS 1983). The purpose of that summary was to use data from Unit 1 and JAFNPP to project potential impacts for Unit 2. For entrainment, the summary focused on the 1976 data, the first year that NMPNS Unit 1 and JAFNPP were both operational. The 1976 entrainment program at Unit 1 yielded a number of species, typified by burbot and *Coregonus* spp. in early spring, rainbow smelt in mid-spring, and alewife in late spring/summer. Abundance was highest during summer, attributable to a large alewife population. Rainbow smelt was the second most abundant fish entrained. Weekly average densities ranged from 0 to 34.4 eggs per cubic meter and 0 to 0.5 larvae per cubic meter for alewife. Corresponding densities for rainbow smelt were 0 to 0.15 eggs per cubic meter and 0 to 0.02 larvae per cubic meter (LMS 1983). Assuming full load and a maximum cooling-water flow rate at Unit 1 during the 1976 entrainment sampling program (i.e. 268,000 gallons per minute) up to 350 million alewife eggs and 4.9 million larvae would have been entrained during the respective periods of maximum weekly density. Maximum weekly numbers of entrained rainbow smelt would have been 1.5 million eggs and 205,000 larvae (NMPNS 2004).

LMS (1983) placed their predicted entrainment losses at the future Unit 2 plant in perspective by comparing them to populations in Lake Ontario. LMS (1983) estimated the standing stock of alewife in the U.S. waters of Lake Ontario in 1976 at 12.56 billion. Assuming a 1:1 sex ratio, this equates to 6.28 billion females. When the maximum weekly entrainment total of alewife eggs of 350 million is divided by the fecundity of alewife (26,272 eggs) the result is 13,322 females, which represents lost spawning capacity. When this number is divided by the Lake Ontario population of 6.28 billion female alewives, the estimated loss of the population females equates to 0.0002%. For alewife larvae, the peak weekly estimated number entrained of 4.9 million was compared to the estimated peak standing stock in Lake Ontario of 35 billion larvae and the entrainment loss represented 0.014%. Similar calculations for rainbow smelt yielded a loss of female standing stock due to egg entrainment of 0.00001% and a loss of larval standing stock of 0.025%. These calculations were based on the peak weekly entrainment during 1976, but even if all weeks were included, the proportional losses to standing stocks in Lake Ontario would be extremely small (NMPNS 2004).

Entrainment sampling at NMPNS was also conducted in 1997. Weekly day and night samples were collected from April through August (EA 1998). Seven species and two additional family groups were represented in the collection of eggs and larvae, however abundance was overwhelmingly dominated by alewife (EA 1998). Most alewife eggs and larvae were collected in July; larvae were more abundant than eggs in August. Total numbers of ichthyoplankton entrained at Unit 1 in 1997 were related to cooling water flow. It was estimated that 86.6 million ichthyoplankton were entrained during the April-August period, of which 77.9 million (90.7%) were alewife eggs and larvae, and a relatively few juveniles (EA 1998). Tessellated darter was second most abundant, with 3.6 million estimated entrained (4.2%), followed by threespine stickleback (2.4 million, 2.8%). Rainbow smelt, the second most entrained fish in the 1970s, was rare in the 1997 collections, representing only 0.1% of the total (EA 1998).

Entrainment of ichthyoplankton at NMPNS in 1997 was much reduced relative to the 1970s. As noted above, an estimated 350 million alewife eggs and 4.9 million larvae were entrained during their respective peak weeks in 1976. In contrast, 77.9 million alewife eggs and larvae were entrained during the entire season in 1997 (NMPNS 2004). Millions of rainbow smelt eggs and larvae were entrained in 1976, but they were rare in 1997. The principal reason for the difference in entrainment between 1976 and 1997 was the difference in lakewide abundance of alewife and rainbow smelt. The biomass of alewife and rainbow smelt in Lake Ontario is about one-half that estimated in the early 1980s (Stewart et al. 1999). These reductions are attributed to predation by stocked salmonids as well as changes in nutrient cycling brought about by invasive *Dreissena* mussels as discussed previously.

6.8 IMPINGEMENT AT JAFNPP

Impingement collections have been made annually at JAFNPP from 1975 through 1997 and again in 2004 (EA 2005). Impingement abundance is highest in the spring and peaks in May when approximately 35% of annual impingement occurs (EA 2005). The high abundance in spring coincides with the movement of fish to the shallow inshore areas to spawn. Migration inshore occurs when Lake Ontario temperatures warm in the spring to preferred species-specific spawning temperature ranges. Impingement begins to decrease in June as adult fish move offshore after spawning. Fish impingement increases again in the fall (Oct-Dec) when 21% of impingement occurs as YOY fish, particularly alewives and rainbow smelt, attain a size susceptible to impingement in the intake screens (EA 2005). The strong west and northwest winds typically encountered in fall and winter cause wave action that have resulted in short-term increases in impingement abundance at JAFNPP. Lifton and Storr (1977) found correlations between wind action and wave height and impingement at power plants in Lake Erie and Lake Ontario and hypothesized that wave induced turbulence and turbidity interfere with fish's ability to detect and avoid an intake structure.

Historically, the timing and duration of station outages for refueling and maintenance have a major influence on impingement abundance and species composition (EA 2005). During extended maintenance and/or refueling outages, the operation of the main circulating water pumps is generally reduced to one or two of the three existing pumps; occasionally none are in operation. The reduced flow through the intake generally results in a reduction in impingement during the outage. The timing of refueling outages during spring spawning migrations of alewives and rainbow smelt occurred in 1979, 1980, 1985, 1987, 1990, 1991, 1992, and April 1994. Outages that occurred in the late summer and fall when YOY are susceptible to impingement occurred in 1977, 1978, 1981, 1983, 1984, 1988, 1991, 1992, 1994, and 1996. The influence of station outages should be considered when interpreting patterns of historical impingement abundance (Table 6.2, 6.3), particularly when outages occur at times of seasonal movements of both alewife and rainbow smelt. Privatization, competition, and deregulation of nuclear power today compared to that of the 1980s and 1990s have led to an increase in plant efficiency and improved generation output by concentrating on reducing unplanned losses, minimizing the duration of planned outages, and exploring options to improve station output capability (EA 2005). These practices have minimized influences of reduced flow during outages on impingement studies. Only one outage occurred during 2004 (Refueling Outage 16) and was completed over the period 25 September through 24 October that resulted in only 19 percent of normal water volume pumped during that time.

Meteorological conditions cause changes in populations that may also be reflected in the impingement collections (EA 2005). Alewives have exhibited significant year-to-year fluctuations in population size (Christie 1973, 1974, Scott and Crossman 1973, Elrod et al. 1979; O'Gorman and Schneider 1986, O'Gorman and Stewart 1999, Owens et al. 2003). Christie (1974) hypothesized that periodic die-offs of alewives in the spring might occur due to some combination of climatic conditions and the physical condition of individuals in the population. Data from impingement collections during 1976, the year prior to a severe winter mass alewife die-off, were extremely high compared to data collected since that time. During Winter/Spring 1977, Lake Ontario experienced a 60-75 percent loss of the adult alewife population, resulting in the virtual elimination of the 1976 year class. This event was reflected in impingement data when a 20-fold decrease was observed between 1976 and 1977 (Table 6.3). The estimated number of alewives impinged in 1976 (3,916,717, adjusted for screen efficiency) (LMS 1977b) accounted for 52 percent of the total estimated alewife catch from 1976 to 1997 and 2004. The exceptionally high alewife abundance during 1976, as compared to abundance since then, may be construed as an anomaly in a statistical sense. The interpretation of historical alewife abundance as a percent of all data should take these differences into consideration. Alewife abundance data from 1977 to 1997 and 2004 are more representative of abundance observed during the past two decades than data from 1976. With the inclusion of 1976 data, alewives have accounted for 59 percent of total impingement (based on dominant species) from JAFNPP compared to 43 percent when omitting 1976 data (EA 2005). Alewife impingement abundance has never approached the same level experienced in 1976. Since then, Lake Ontario winters resulted in no catastrophic die-offs of the magnitude recorded in 1976. Several smaller die-off events have been noted, e.g., 1983 and 1986 (O'Gorman et al. 1987).

Ross et al. (1993) demonstrated that a fish deterrence system (FDS) using high frequency broadband sound (122-128 kHz) at a source level of 190 decibels could reduce impingement of alewives at JAFNPP by as much as 87% when operating at full power and using the maximum cooling water flow rate. Ross et al. (1996) confirmed these results and estimated that the reduction in impingement of alewives over the period from April through July was 81%. These deterrent tests in spring 1991 (April-June) and 1993 (April-July) should be taken into account when interpreting historical trends in impingement. Another test using a reconfigured fish deterrence system in 1997 directly affected impingement abundance from April through mid-July so that 1997 data are not directly comparable except for general seasonal trends. Results suggested that the reconfigured system with eight integrated projector assemblies (IPAs) operating at 187 decibels measured at 1 meter from the source provided protection for alewives equivalent to the systems tested by Ross et al. (1993) with 20 transducers operating at 190 decibels at 1 meter from the source, and Ross et al. (1996) with 25 transducers operating at 190 decibels at 1 meter from the source (Dunning and Ross 1998). The FDS was in use during the 2004 impingement sampling program as well (EA 2005).

USGS and NYSDEC data from the Lake Ontario Forage Base Assessment Program show that adult alewife numbers continue to remain moderate in 2004 and have been relatively stable for the last several years (O'Gorman et al. 2005). Although abundance is considerably less than in the mid-1980s and early 1990s, the population seems to be stabilizing at a lower level as the carrying capacity of Lake Ontario has reduced. The process of food web disruption, mediated by dreissenid mussel invasion, may well have eroded lower trophic level support for the Lake Ontario alewife population to below that of the early 1990s (Mills et al. 2003, O'Gorman et al. 2005). The diet of alewives has shifted from the amphipod, *Diporeia, to* possum shrimp, *Mysis*, and is associated with dispersal of alewives to deeper areas of Lake Ontario (O'Gorman et al. 2000). The shift in diet seems to result in healthier, more robust fish due to lower alewife numbers, which provide more food for the fish that do survive. *Diporeia*, which was a major food source for alewife, has been almost completely depleted following the proliferation of zebra and quagga mussels over the last decade as previously discussed. The R.E. Ginna Nuclear Power Plant and Nine Mile Point Nuclear Station (NMPNS) also report reduced impingement catches of alewife and rainbow smelt in recent years concurrent with reduced numbers in the Eastern Basin of Lake Ontario (NMPNS 2004).

Rainbow smelt are the second most abundant open water fish in Lake Ontario (Casselman and Scott 2003). Numbers and biomass of rainbow smelt fluctuated widely and without trend in U.S. waters of Lake Ontario during 1978-1998 (Mills et al. 2003). Rainbow smelt impingement abundance has been subject to fluctuations resulting from a variety of factors. As previously discussed, strong west or northwest winds with an associated increase in wave action result in short-term increases in impingement abundance (EA 2005). These conditions occur on Lake Ontario particularly in January, November, and December, and cause an increase in impingement of YOY rainbow smelt. In addition, rainbow smelt are subject to lake-wide population fluctuations, which appear to be caused in part by cannibalism of young smelt by adult smelt and by predation by the stocked salmonids on adult smelt (O'Gorman et al. 1990). When interpreting impingement data on rainbow smelt, lake-wide patterns in population fluctuations are difficult to ascertain due to the strong influence of meteorological conditions and plant outages which have occurred during sample collections. In impingement years 1995-1997, rainbow smelt numbers appeared to be fairly stable, however, estimated numbers of rainbow smelt impinged (based on total cooling water flow) for 2004 are the lowest on record since inception of impingement monitoring at JAFNPP (Table 6.3). Factors including the introduction of dreissenid mussels in the early 1990s and nutrient reductions in nearshore areas of Lake Ontario due to improved land use and sewage treatment practices have reduced lake productivity, affected associated reductions in smelt populations, and caused a shift in the distribution of smelt into deeper waters similar to that of the alewife (O'Gorman et al. 2000), where food is more prevalent, thus avoiding the JAFNPP intake structure altogether (EA 2005). Although rainbow smelt impingement numbers were very low for 2004, trawls performed by the USGS and NYSDEC in the same year showed the highest population index number for smelt since 1997 and 1998 (O'Gorman et al. 2005), indicating a strong recruitment year class for 2005.

Lakewide population estimates (U.S. waters) of alewife and rainbow smelt for 1982-1997 provided by Rochester Gas & Electric (2003) as presented in (NMPNS 2004) demonstrate that the proportion of the population lost to impingement at JAFNPP was quite low (Table 6.4). The greatest proportional impingement in any year for alewives was 0.018% in 1984, and for rainbow smelt was 0.027% in 1994.

The estimated impingement of alewives, rainbow smelt, threespine stickleback, white perch, yellow perch, smallmouth bass, salmonids, spottail shiner, gizzard shad, trout perch, tessellated darter, and sculpins, species of interest due to their significance as forage or sport fish, are shown for 1976-1997 (Table 6.3). Fluctuations in their abundance appear to be attributable primarily to natural fluctuations of individual populations and localized meteorological occurrences influencing the impingement process (EA 2005). Increases in smallmouth bass and white perch impingement abundance are most often influenced by short-term meteorological conditions previously described. Late fall and winter storms often cause large numbers of YOY of both species to be collected in the impingement samples. Impingement of smallmouth bass during 1988, 1990, 1993, and 1994 was influenced by such factors; storms in 1977, 1983, 1993, and 1996 affected white perch impingement (EA 1984, 1989, 1991, 1994; TI 1978). Increases in 2004 for white perch and yellow perch in January and December can be attributed to meteorological conditions. The January and December combined numbers for white perch accounted for 50 of the total 71 specimens collected (70 percent), and yellow perch for those months accounted for 45 of the total 58 specimens collected (78 percent, EA 2005).

The population of yellow perch in Lake Ontario declined from the late 1970s through 1990, with only 1978 and 1985 assessment data indicating high abundance of yellow perch (O'Gorman et al. 1990). For those years, yellow perch impingement abundance estimates were highest in 1978; the JAFNPP outage in 1985 could have obscured any increase in yellow perch due to reduced impingement during the outage (EA 2005). Historically, yellow perch impingement abundance has demonstrated small fluctuations most likely influenced by meteorological events and extended outages.

Natural biological factors such as population size, migration patterns, schooling, and spawning behaviors, in conjunction with external environmental factors such as water temperatures, currents, and localized meteorological conditions, can play an important role in seasonal variations in species occurrence or absence in the near shore zone of Lake Ontario (EA 2005). Species composition has ranged from 26 to 54 species per year in the impingement collections at JAFNPP. The 35 species collected in 2004 are within the average range of historical diversity. It is conceivable that the reduction in population of alewives and the presence of dreissenid mussels may be affecting species composition and abundance in Lake Ontario and may be a few of the factors influencing the previously discussed lake-wide exponential increase in threespine stickleback as reflected in the impingement samples for 2004 and in the mid-1990s.

Historically, changes in fish populations in the vicinity of JAFNPP are the result of natural fluctuations (EA 2005). When changes are of a greater magnitude (as in a die-off of alewives), they can be detected in the annual estimates of fish impinged at JAFNPP. When fluctuations occur over long periods of time and are relatively small, they are difficult to differentiate from the influences of daily plant operations and meteorological occurrences, the two main influences upon the impingement process. No long-term trends in fish population abundance due to the impingement process at JAFNPP have been apparent (EA 2005)

Trends in impingement at the adjacent NMPNS Unit 1 are similar and dominated by one or more of three species: alewife, rainbow smelt, and threespine stickleback (NMPNS 2004). During 1972 to 1997 alewife dominated the impingement catch in most years. Rainbow smelt were most abundant in 1979, 1982, and 1989 and threespine stickleback dominated the impingement catch in 1978 and 1997 (NMPNS 2004) similar to trends observed at JAFNPP (Table 6.3). At NMPNS, highest impingement rates are usually evident during spring when alewife and rainbow smelt move inshore to spawn.

Although less abundant, a variety of other species have been impinged at NMPNS Unit 1 over the years including species of minnows (Cyprinidae), sculpins (*Cottus* sp.), catfish (Ictaluridae), trout perch and gizzard shad. Game fish such as smallmouth bass, white bass, yellow perch, white perch, lake trout, and walleye were also impinged, although in low numbers compared to alewife and rainbow smelt (NMPNS 2004).

6.9 Benefits of "Offshore" Intake vs Shoreline

Nearshore areas in Lake Ontario (defined as < 15 m by Stewart et al. 1999 and < 27 m by Edsall and Charlton 1997) provide areas of permanent residence for some fishes, migratory pathways for anadromous fishes, and temporary feeding or nursery grounds for other species from the offshore waters. The nearshore areas of the Great Lakes are diverse physical habitats, exhibiting a range of morphometric features, current velocities, substrates, and aquatic vegetation (Edsall and Charlton 1997). These features, combined with seasonal fluctuations in temperature, provide conditions optimum to most species of fish in the Great Lakes for at least a portion of their life cycle. Of 139 Great Lakes fish species reviewed by Lane et al. (1996a), all but six species-the deepwater ciscoes (*Coregonus hoyi*, *C. johannae*, *C. nigripinnis*, *C. reighardi*, *C. zenithicus*) and deepwater sculpin (*Myxocephalus thompsoni*) typically use waters less than 10 m deep as nursery habitat; and even the latter has been captured from shallows in the St. Clair River delta (Leslie and Timmins 1991). Adults of many species occur over a range of depths, but 80 percent of fish species in the Great Lakes use nearshore areas for at least part of the year (Lane et al. 1996b). The resident fish community inhabiting nearshore zone varies with season. Dominant species that spend most of their life cycle in the nearshore zone include walleye, perch, white perch, gizzard shad, minnow species and sunfishes and American eel.

Fish species diversity and production in the nearshore waters are higher than in offshore waters (Edsall and Charlton 1997). Icthyoplankton monitoring in the vicinity of the JAFNPP and NMPNS intake structures in the mid 1970's found higher fish egg and larval density along the shallowest (20 ft) depth contours than in deeper waters (40, 60, 80, and 100 foot contours TI 1979). Older, more developed post-yolk sac larvae were equally distributed over all five depth contours suggesting offshore movement as the larvae develop (TI 1979). Larvae of several species the study area, including rainbow smelt and alewife, move offshore as they mature (LMS 1975, TI 1978, TI 1979). Gill net sampling of adult fish in the Nine Mile Point area also found higher abundance at the shallowest (15 ft.) depth contour than in deeper sites (30, 40, 60 ft. depth contours, TI 1979).

The reduction in available nutrients over the past two decades, combined with the increased penetration of light has resulted in the return and increased growth of macrophyte beds in many littoral areas. Water clarity, measured by a Secchi disk, has increased by nearly 100% in Lake Ontario during the 1990's (3.1m to 6.7 m in summer, EPA 2003). Concurrently, submerged aquatic vegetation (SAV) in Lake Ontario has proliferated (Ontario Ministry of Environment and Energy 1995, Bin et al. 2004). SAV stabilizes sediments, reduces turbidity, and provides nursery habitat for numerous fish species (Nichols 1991). The abundance of young-of-the-year fishes is often higher in vegetated than in non-vegetated habitats (Keast et al. 1978, Holland and Huston 1984, Chubb and Liston 1986, Leslie and Timmins 1994;). Chubb and Liston (1986) reported that larval fish densities were usually 10 times to 100 times more abundant in the vegetated bayou of Pentwater Marsh, Lake Michigan, than in adjacent unvegetated bayou mouths or river channels. Of the 133 species examined by Lane et al. (1996a), the young-of-the-year of 77 species are moderately to strongly associated with aquatic vegetation. Vegetation is also an important component of adult habitat. Adults of nearly one-third of the fish species in the Great Lakes are strongly associated with SAV, while adults of one-quarter of the species are strongly associated with nearshore emergent vegetation (Lane et al. 1996b, Edsall and Charlton 1997).

The JAFNPP cooling water intake structure is located 900 feet offshore in approximately 7.3m (24 ft.) of water. Chambers and Kalff (1985) related the maximum depth of angiosperm growth (Z) in lakes worldwide to Secchi Depth (SD) with the following equation: $Z^{0.5} = 1.33 \log (SD) + 1.40$. Based on an average Secchi depth of approximately 6.0 m in nearshore portions of Lake Ontario that are exposed to the main lake (Hall et al. 2003), the maximum depth that SAV would grow in near Nine Mile Point is 5.9 m (19 ft). Therefore, the offshore location of the JAFNPP cooling water intake in 7.3 m of water is outside the likely depth range of SAV habitat in Lake Ontario. The maximum depth of growth of 7.3 m estimated above corresponds with the maximum depth of SAV colonization observed by Bin et al. (2004).

6.9.1 Analysis of Ichthyoplankton and Fish Distributions Near the JAFNPP Intake

An analysis of historical ichthyoplankton, gill net, and bottom trawl data was used to evaluate whether fish abundances vary significantly with respect to distance from shore near Nine Mile Point, where the JAFNPP intake structure is located. The data examined were from sampling conducted in 1978, as presented in the report dated May 1979, prepared by TI (1979). The general approach was to apply analysis of variance ("ANOVA") to compare catch per unit of effort among depth contours, since depth increases with increasing distance from shore.

Ichthyoplankton

Ichthyoplankton sampling in 1978 was conducted weekly during April through November and twice per month during December. Sampling stations were located along seven inshore-offshore transects, between 2.5 miles west of JAFNPP and 1.5 miles east of JAFNPP. Along each transect, stations were located at two or three depth contours ranging from 20 feet deep to 100 feet deep. Sampling during June through mid-September was conducted during two diel periods (daytime and nighttime), while sampling during April through May and mid-September through December was conducted only during the daytime. A total of 780 sets of three samples (near surface, mid-depth, and near bottom) were collected as shown in the following table.

Transect distance east or west of JAFNPP (miles, approx.)	Number of sets of 3 samples; by season, diel period, and depth contour (feet)														
	Apr-May, mid Sep - Dec					Jun - mid Sep					Jun - mid Sep				
	Day					Day					Night				
	20	40	60	80	100	20	40	60	80	100	20	40	60	80	100
2.5 west	22	22				15	15				15	15			
1.5 west	22	22				15	15				15	15			
1.0 west	22	22				15	15				15	15			
0.5 west			22	22	22			15	15	15			15	15	15
zero	22	22				15	15				15	15			
0.5 east	22	22				15	15				15	15			
1.5 east	22	22				15	15				15	15			

For the depth contour analysis JAFNPP used the mean densities (number per 1000 cubic meters) by sampling week, diel period, and depth contour from Appendix Tables E-1 and E-2 (total eggs), E-5 and E-6 (total yolk-sac larvae), and E-13 and E-14 (total post yolk-sac larvae) in TI (1978). This provided 260 values each for eggs, yolk-sac larvae, and post yolk-sac larvae (52 day or night periods for each of 5 depth contours).

Since the sampling design was unbalanced in that nighttime samples were only collected during part of the sampling year, the data were analyzed in two ways. The first design for the ichthyoplankton analyses used only June through mid-September data, so that every sampling week analyzed included both daytime and nighttime data. The data were log(x+1) transformed to better satisfy the normality requirements for ANOVA. A three-way ANOVA was used (15 weeks * 2 diel periods * 5 depth contours) for each of the three early life stages.

The second design for the ichthyoplankton analyses used only daytime samples, but from the entire sampling season. The data were log(x+1) transformed to better satisfy the normality requirements for ANOVA. A two-way ANOVA was used (37 weeks * 5 depth contours) for each of the three early life stages.

Eggs exhibited a significant difference among depth contours in both the summer day-night ANOVA and the 9-month day-only ANOVA (Table 6-5). The highest egg densities were at the shallower (near-shore) depth contours. For the summer data, the average nighttime density at the 20-foot contour was by far the highest, while in the 9-month data, average densities were much higher at both the 20-foot contour and the 40-foot contour than at the three deeper contours (Figure 6-1).

Yolk-sac larvae showed a distinct and highly statistically significant depth gradient in both the summer day-night ANOVA and the nine-month day-only ANOVA (Table 6-5). The average density was highest inshore at the 20-foot depth contour and decreased with increasing depth and distance from shore (Figure 6-2).

Post yolk-sac larvae densities also varied significantly among depths (Table 6-5), but the pattern was not a distinct inshore-offshore difference as seen for eggs and yolk-sac larvae. The highest average post yolk-sac larvae densities were at shallow and deep contours, while the lowest averages were at intermediate depths (Figure 6-3).

Gill Nets

Gill net sampling in 1978 was conducted in two weeks per month during April through mid-December. Sampling stations were located along four inshore-offshore transects, between 1.5 miles west of JAFNPP and 1.5 miles east of JAFNPP. At all four transects, stations were located at the 15-foot, 30-foot, 40-foot, and 60-foot depth contours. A fifth depth contour (20 feet) was sampled at three of the four transects, but only on half the days and since the 20-foot data were not tabulated in the report appendix we did not analyze them. Gill nets were set during two diel periods in all sampling weeks, with two 12-hour daytime sets and two 12-hour nighttime sets in each sampling week. A total of 1,085 of 1,088 scheduled 12-hour sets were collected (excluding the 20-foot depth contour), as shown in the following table.

Transect distance east or west of FitzPatrick (miles, approx.)	Number of 12-hour sets, by diel period and depth contour (feet)							
	Day				Night			
	15	30	40	60	15	30	40	60
1.5 west	34	34	34	34	33	34	34	34
0.5 west	34	34	34	34	34	34	34	34
zero	34	34	34	34	34	34	33	34
1.5 east	34	34	34	34	34	34	33	34

The data used for the depth contour analysis for gill nets were the monthly average values of catch per unit of effort (CPUE=catch per 12-hour set) by transect and depth contour in Appendix Tables F-11 through F-15 of TI (1978). Those tables provided monthly average CPUE data combined across the day and night sets for alewife, rainbow smelt, white perch, yellow perch, and smallmouth bass, which included four of the five most abundant species in gill net catches. Total catch was not tabulated in detail in TI (1978), so we used the CPUE for these five species combined for the analysis, a total of 144 values (9 months at 4 transects and 4 depth contours per transect). The data were log(x+1) transformed to better satisfy the normality requirements for ANOVA. A two-way ANOVA with replication was used (9 months * 4 depth contours, with the four transects serving as replication within each month/depth combination).

Gill net catches varied significantly among depth contours (Table 6-5). Catches were about three times higher at the 15-foot contour than at the other three depths sampled (Figure 6-4). The gill net catches at the 15-foot contour were significantly higher than at all of the three other depth contours. Catches at the 30-foot and 40-foot contours were not significantly different from each other.

Bottom Trawls

Bottom trawl sampling in 1978 was conducted in two weeks per month during April through December. Sampling stations were located along three inshore-offshore transects, between 1.5 miles west of JAFNPP and 1.5 miles east of JAFNPP. At each of the three transects, stations were located at the 20-foot, 40-foot, and 60-foot depth contours. Bottom trawls were taken during two diel periods (daytime and nighttime) in all sampling weeks, with the exception that all daytime trawling in the second December sampling week was cancelled due to weather. A total of 315 of 324 scheduled 15-minute tows were taken, as shown in the following table.

Transect distance east or west of FitzPatric (miles, approx.)	Number of 15-minute tows, by diel period and depth contour (feet)					
	Day			Night		
	20	40	60	20	40	60
1.5 west	17	17	17	18	18	18
0.25 west	17	17	17	18	18	18
1.5 east	17	17	17	18	18	18

The data used for the depth contour analysis for bottom trawls were the average values of catch per unit of effort (CPUE=catch per 15-minute tow) by sampling week, diel period, and depth contour for all species combined in Appendix Table F-16 of the 1978 report. The second week of December was excluded from the analysis due to the missing daytime data for that week. The data were log(x+1) transformed to better satisfy the normality requirements for ANOVA. The analysis was a three-way ANOVA without replication (17 sampling weeks * 2 diel periods * 3 depth contours).

The average catch rate in bottom trawls was higher at the 60-foot depth contour than at the 20-foot and 40-foot contours (Figure 6-5), but the differences among the depths were not found to be significant (Table 6-5).

Comparisons Among Depths

After finding that ichthyoplankton densities and gill net CPUE were significantly related to depth, the pattern of decreasing abundance with increasing depth that was apparent in the graphs was further explored by multiple comparison tests comparing mean abundances among the depth contours.

Tukey's studentized range test was used to determine which depth contours were significantly different from each other (Table 6-6). For example, the mean density of yolk-sac larvae during the summer at the 20-foot depth contour was not significantly different from the mean at the 40-foot contour (Group A), but it was significantly higher than the mean densities at the 60-foot, 80-foot, and 100-foot contours. Mean density at 40 feet was not significantly higher than the 60-foot mean (Group B), but it was significantly higher than means at 80 feet and 100 feet. The means in Table 6-6 are expressed as geometric means because the ANOVAs and Tukey's tests were performed on log(x+1) transformed data.

In all seven data sets where Depth was a significant factor in the ANOVAs, the multiple comparisons tests showed that abundances were highest at the shallowest depth contour and were significantly higher than at least one of the deeper contours (Table 6-6). In summer, when ichthyoplankton densities were highest, all three life stages were significantly more abundant at 20 feet than at 60 feet, 80 feet, or 100 feet. Only at 40 feet were the summer ichthyoplankton densities close enough to the 20-foot densities to be statistically equal. The mean gill net log(x+1) CPUE was significantly higher at 15 feet than at all three of the deeper contours (Table 6-6).

The relationship between the shallowest contour and the deeper contours is summarized in Table 6-7 by comparing the abundance means calculated from the original untransformed densities and CPUEs. The largest percentage difference was for eggs in the summer, which were 95% less abundant at the deeper contours than at the 20-foot contour. The smallest percentage difference was for post yolk-sac larvae in summer samples, where the average density for the deeper contours was 19% less than the density at the 20-foot contour.

7.0 SUMMARY OF RELEVANT CONSULTATIONS WITH FEDERAL, STATE, AND TRIBAL FISH AND WILDLIFE AGENCIES

JAFNPP operates as described above pursuant to NYSDEC's 1996 determination, which remains effective, that JAFNPP's current configuration and operation comply with the BTA requirements of § 316(b). This determination was confirmed in a letter dated 1 March 1996 from P.Kolakowski NYSDEC to D. Dunning NYPA (former owner of JAFNPP).

JAFNPP's consultations with Federal and State fish and wildlife agencies, and consultations between these agencies addressing § 316(b), contributed to this conclusion. Documents relevant to these consultations are summarized in Section 6.0 (above) and in Appendix 1 (below).

8.0 SAMPLING PLAN FOR NEW FIELD STUDIES

8.1 IMPINGEMENT

JAFNPP proposes to obtain no new impingement data for JAFNPP. A recent annual impingement program was performed during January through December 2004, and the results were reported to NYSDEC as required by SPDES Permit No. NY 0020109 Section 10, CP-04.03 (EA 2005). Results from this 2004 impingement program will be used to assess compliance with the impingement mortality performance standard of the Phase II Regulations.

8.2 ENTRAINMENT

JAFNPP proposes a one-year entrainment sampling program for JAFNPP beginning in April and continuing through March 2007 designed to supplement comprehensive annual entrainment data obtained during the 1973-1979 studies described in Section 6.1 (above). JAFNPP may undertake a second year of entrainment sampling in 2007 to verify the results observed during 2006, if appropriate. An entrainment survival study may also be included in one or both years of planned work at JAFNPP if preliminary field observations during the first year suggest high survival of entrained ichthyoplankton. The goal of the proposed entrainment program is to estimate the seasonal and annual total abundance of fish eggs and larvae that become drawn into the offshore intake at JAFNPP and flow into the CWIS. The entrainment program will be documented in a project-specific Quality Assurance Plan (QAP) consistent with USEPA protocols (USEPA 2001). The QAP will describe the Standard Operating Procedures to be used for the field, laboratory, and data file preparation activities, and is included with this PIC as Appendix 3. The goal of the survival study would be to identify and delimit the actual effect of the operation of JAFNPP's CWIS on entrainable organisms and the benefit, if any, of application of these data to entrainment reductions.

The abundance of entrained fish eggs and larvae will be determined by sampling the intake flow in the JAFNPP CWIS. Sampling will begin in April 2006 and continue weekly through October 2006 for a total of 30 sampling weeks. Sampling will continue twice per month during November 2006 through March 2007 for an additional 10 sampling weeks. Continuing sampling during the late fall and winter periods when few or no entrainment of fish eggs or larvae are expected to be present is intended to define the beginning and end of the annual entrainment period. Entrainment sampling will be conducted on each sampling date as long as at least one CW pump is operating at the JAFNPP CWIS. Each weekly collection will occur on the same day in the week (e.g. Wednesday) and consist of one daytime sample and one nighttime sample. The intention is to separate the collection of daytime and nighttime entrainment samples symmetrically within the daytime and nighttime periods of each sampling date. Daytime is defined as occurring between one hour after meteorological sunrise and one hour before meteorological sunset as observed at the plant site. Nighttime is defined as occurring between one hour after meteorological sunset and one hour before meteorological sunrise as observed at the plant site.

Entrainment samples from the JAFNPP CWIS will be collected from two depths in the center of the common forebay: 14 feet below the water elevation and 20 feet below the water elevation, which is consistent with the depths sampled in the earlier studies (TI 1980). Therefore, the total number of entrainment samples for the 2006-2007 entrainment program at the JAFNPP CWIS will be 160 (2 depths x 2 diel periods x 40 dates), unless some samples cannot be collected due to plant outages.

Entrainment sampling at the JAFNPP CWIS will be conducted using an electric-powered "trash" pump with 3-inch intake and discharge hoses and a plankton net suspended in a tank. The net mesh is 0.500 mm Nitex. Earlier studies (TI 1980) deployed a 0.571 mm mesh net in the forebay of the JAFNPP CWIS for entrainment sampling, but this mesh size is no longer manufactured and recent nuclear safety standards preclude deploying nets in the forebay. Each entrainment pump sample will have a sample volume of at least 100 m^3, as measured by a calibrated, in-line flow meter. The first entrainment sample will be randomly drawn from either 14 feet or from 20 feet below the water surface in the CWIS forebay, followed by the second sample drawn from the remaining unsampled depth. Pumping time is expected to be about 100 minutes to insure that the volume of each sample is at least 100 m^3. Therefore, the total number of entrainment samples for the 2006 entrainment program at the JAFNPP CWIS will be 160 (2 depths x 2 diel periods x 40 dates), unless some samples cannot be collected due to plant outages. All samples will be fixed at the time of collection in 4% buffered formalin and changed over to 80% ethanol within 24 hours. Rose Bengal will be added to stain the fish eggs and larvae and facilitate separating them from other material by sorting in the laboratory. Each sample jar will be labeled with a unique inventory number along with the date, time, and depth of collection.

In the laboratory, the two depth samples from each day or night collection on each sampling date will be combined into one composite sample for processing. Therefore, 60 composite samples will be processed in the laboratory for the 2006-2007 entrainment program at the JAFNPP CWIS, unless some samples cannot be collected due to plant outages. All fish eggs and larvae will be removed (sorted) from the total material collected in each composite sample, identified to the lowest possible taxonomic category (generally genus and species), and enumerated by life stage. Life stages will be defined as egg, yolk sac larvae, post yolk sac larvae, and juvenile. Samples with extremely high numbers of ichthyoplankton will be subsampled in the lab with Motoda plankton splitters according to established and statistically reliable protocols. In such cases, a minimum of 200 eggs and larvae will be sorted and identified from the subsample. For subsampling due to high detrital load when ichthyoplankton densities are low, high detrital load will be defined as more than 400 milliliters of settled volume of solids in the sample (detritus and plankton). If this occurs, a maximum of one-half of the sample will be sorted. A reference collection will be made for the species and life stages collected.

All laboratory sorting, fish identification, and enumeration will be subject to a standard and appropriate quality assurance/quality control review based on a Military Inspection Standard (MIL-STD) inspection plan derived from MIL-STD 1235 Single and Multiple Level Continuous Sampling Procedures and Tables for Inspection by Attributes to achieve a 10% Average Outgoing Quality Limit (AOQL), and a 1% AOQL for all data files, computations and reports. Please note that, for example, an AOQL of 1% means that the final data files will be certified through statistical inspection to document that less than one record (line of data) out of every 100 records will be in error. This level of quality meets or exceeds industry standards for impingement and entrainment studies. Computerized operational data files from JAFNPP will be obtained and used to extrapolate entrainment abundance (numbers per 100 m^3) for each taxon and life stage up to diel, daily, weekly, monthly and total annual abundance based on the actual total circulating water flow for each sampling period.

8.3 Lake Ontario Sampling to Determine intake baseline conditions

In a letter from Mr. Roy A. Jacobson of NYSDEC to Mr. T.A. Sullivan of JAFNPP dated 22 June 2005, NYSDEC recognized that JAFNPP's offshore intake is different than the shoreline bulkhead intake used by USEPA to establish the Phase II Rule calculation baseline. Mr. Jacobson recommended that two years of studies commencing in 2006 would be required by NYSCEC to estimate the baseline impingement mortality and entrainment abundance for a hypothetical shoreline intake in the vicinity of Nine Mile Point. Accordingly, JAFNPP proposes a two-year program of Lake Ontario nearfield studies for JAFNPP beginning in April 2006 and continuing through October 2006. A second year of Lake Ontario sampling will be scheduled beginning in April 2007 and continuing through October 2007. Lake Ontario sampling will not be scheduled during the late fall and winter period of November through March due to unsafe conditions for small boats in the nine

Mile Point area of Lake Ontario. Data from April and October of each year will be extrapolated to these unsampled months.

The objective of this Lake Ontario sampling will be to obtain the data necessary to calculate the percentage reduction in impingement mortality and entrainment abundance due to the JAFNPP cooling water intake being located 900 feet offshore instead of being a shoreline bulkhead intake. The percentage reduction due to intake location will be defined as the ratio between the abundance, catch per unit of effort (CPUE), or density of fish from pairs of samples taken by the same gear and collection methods in the shoreline area of Nine Mile Point and in the vicinity of the JAFNPP intake. Calculating ratios from the fish samples taken by the same gear deployed at two different locations will eliminate the need to adjust the ratio for differences in gear efficiency, as would be the case if different gear were used in each location.

Sampling design, gear, and procedures for the Lake Ontario program will be consistent with the gear and procedures used in the earlier studies (TI 1980), except that hydroacoustic techniques will be added to the present study. Two transects perpendicular to shore will be established to coincide with two of the four transects established by TI (1980). Transect FITZ will be centered on the intake structure of JAFNPP, and is the same transect FITZ used by TI during the earlier studies. Transect FITZ-E will be located approximately 2000 ft. east of the JAFNPP intake. Transect FITZ represents the intake area, while transect FITZ-E is a nearfield control for the JAFNPP intake area that is not exposed to operation of the existing and permit-required fish deterrence system. Samples representative of the shoreline area of Nine Mile Point will be taken in Lake Ontario waters less than 10 feet of depth along each transect. Samples from the JAFNPP intake area of Nine Mile Point will be taken in Lake Ontario waters along the 25 foot depth contour along each transect, which is the depth contour where the JAFNPP intake is located. Therefore the following sampling stations will be designated for Lake Ontario studies to determine the impingement mortality calculation baseline:

A mathematical model will be developed and used to define the three-dimensional shape and boundaries of Hydraulic Zone of Influence (HZOI) or 'withdrawal zone" for the JAFNPP cooling water intake structure in Lake Ontario near Nine Mile Point. Once defined, the HOZI will be used to delimit a sampling station in Lake Ontario that is representative of the fish populations directly exposed to entrainment and impingement mortality at the JAFNPP CWIS. The HZOI determination will be made at east 30 calendar days prior to the onset of field sampling activities in April 2006 to allow the sufficient time to accommodate any sampling design or gear changes required to insure that fish are sampled within the HZOI.

8.3.1 Impingement Mortality Baseline

Hydroacoustics will be the primary sampling technique used to calculate the baseline adjustment ratio for impingement mortality at the JAFNPP CWIS. Arrays of digital, dual beam, elliptical transducers (facing 0°, 90°, 180, and 270° to each transect, or one continuously rotating transducer covering 360° in the horizontal plane) will be installed at fixed locations at the 10-foot and 25-foot contours along each of the two transects in the Nine Mile Point study area of Lake Ontario and used to provide continuous enumeration of fish abundance measured by signal (acoustic target) counting and fish biomass measured by echo integration during the April through October monitoring period of each year.

Species composition of adult and juvenile fishes quantified by hydroacoustics will be determined by sampling with sinking experimental gill nets deployed parallel to each contour as bottom sets at each station, but away from the transducer beams. Experimental gill nets will be 8 ft deep and consist of six 25-foot long panels of different mesh sizes randomly arranged in a linear sequence into one net 150 feet long. The gill nets will be made from treated multifilament mesh ranging in 0.5 inch increments from 0.5 up to 3.0 inches bar mesh. Gill net sets will be made twice per month from April through October of each year. Soak time will be 24 hours, with each gill net set deployed near sunset, tended approximately 12 hours later after sunrise, and retrieved near sunset on the following day. Therefore, for each month a total of 16 gill net samples will be collected (2 transects x 2 depth contours x 2 diel periods x 2 events per month), and there will be 112 total gill net samples (7 months x 16 samples per month) scheduled for completion during each year. All fish collected in each gill net sample will be identified to species, and total length (nearest millimeter) and wet weight (grams, $\pm$1%) will be recorded for a maximum of 50 individuals per species per sample. A project-specific reference collection will be made for each species and life stages collected, and all sampling activities will be performed under an approved Scientific Collector's Permit issued by NYSDEC for this study.

8.3.2 Entrainment Baseline

The baseline adjustment ratio for entrainment at the JAFNPP CWIS will be determined by comparing the density of ichthyoplankton in pairs of near-shore and near-intake samples collected with towed nets consistent with the gear and procedures used in earlier studies (TI 1979). If the HZOI is determined to be sufficiently small so that a 300 m^3 plankton net tow cannot be taken primarily within the HZOI at the 25 ft. depth contour along transect FITZ, then Lake Ontario ichthyoplankton sampling will be performed by pump sampling using a 4-inch trash pump with a recessed impeller design capable of pumping at a rate of 250-300 gallons per minute (GPM) to collect 100 m^3 samples.

Ichthyoplankton tows will be taken in the Nine Mile Point study area of Lake Ontario twice per month from April through October at each of the two transects and two depth contours sampled by gill nets. Surface tows will be taken at the 10-foot contour stations. Surface and mid-depth tows will be taken at the 25-foot contour stations during the daytime, and again during nighttime on the scheduled sampling dates. Daytime and nighttime will be defined as specified above (Section 8.2) for entrainment sampling. Ichthyoplankton tows will be taken with a 1m^2 Tucker trawl towed at a speed of 1 meter per second through the water. The Tucker trawl has a 1.0 m^2 net mouth opening and a 5:1 length to mouth ratio with a 0.500 mm mesh Nitex net. Earlier studies (TI 1980) deployed a 1.0 m diameter Hensen net with 0.571 mm Nitex mesh and a 6:1 length to mouth ratio for Lake Ontario ichthyoplankton sampling. The Tucker trawl proposed for this study has the advantage of a closing mechanism to collect discrete depth samples, and as discussed above for the entrainment net, the 0.571 mm Nitex mesh is no longer manufactured. The Tucker trawl has a closing device that uses a messenger to trigger a double-trip release mechanism that releases a weighted lead bar to close the mouth of the net and insure that each sample will be collected in each of the discrete depth strata. The closing mechanism will not be used when the Tucker trawl is deployed for a surface tow. Towing speed will be 1.0 m/sec for a duration of 5 minutes to insure an approximate 300 m^3 sample, and tows will be made along each of the two depth contours parallel to shore. A flume-calibrated digital flowmeter (GO Model 2030R) will be placed slightly off-center in the mouth of the Tucker trawl to measure the distance (volume) of each tow. Tow depth will be determined in the field using a cosine function relating wire length and wire angle to sampling depth. The start and end of each towpath will be recorded using GPS. Samples will be fixed at the time of collection in 4% buffered formalin and changed over to 80% ethanol within 24 hours. Rose Bengal will be added to stain the fish eggs and larvae and facilitate separating them from other material by sorting in the laboratory. Each sample jar will be labeled with a unique inventory number along with the date, time, and depth of collection. Therefore, for each month a total of 24 Tucker trawl samples will be collected (2 transects x 3 tows per transect x 2 events per month x 2 diel periods), resulting in a total of 168 ichthyoplankton samples collected during the 7-month period of April through October.

In the laboratory, each Lake Ontario ichthyoplankton sample will be processed separately from each depth and station. Therefore, 168 individual Tucker samples will be processed in the laboratory for the 2006 Lake Ontario ichthyoplankton sampling program at the JAFNPP CWIS, unless some samples cannot be collected due to inclement weather. The same number of samples will be scheduled for collected during 2007. Each Lake Ontario ichthyoplankton sample will be processed in the laboratory as described above in Section 8.2 for entrainment samples, and subjected to the same quality control standards and procedures.

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6. Operating Procedures (OP) and Abnormal Operating Procedures (AOP)
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8. OP-42, Service Water System
9. AOP-56, Traveling Screen and Trash Rack Differential Level
10. Drawings
11. FM-7A, -7C, Screenwell & Water Treating
12. FM-36A, Flow Diagram Circulating Water, System 36
13. FC-40D, -40E, -40F, -40H, -40J, Pumphouse & Screenwell Concrete Details
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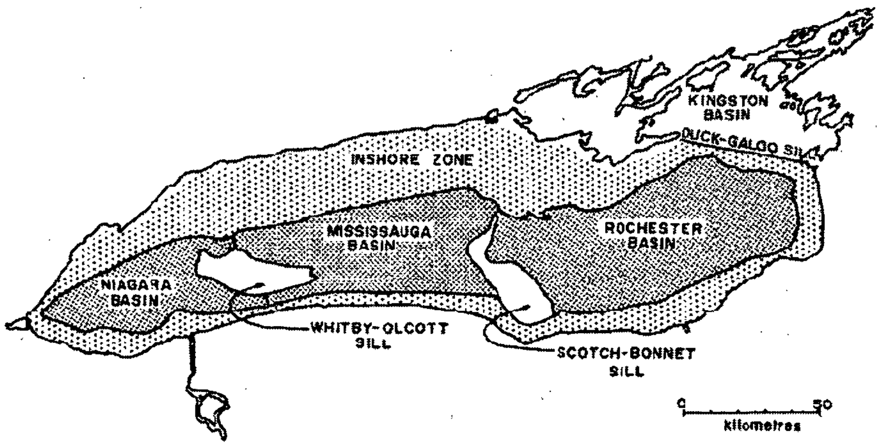


Figure 2-1. Major sedimentation basins of Lake Ontario (Flint and Stevens 1989).

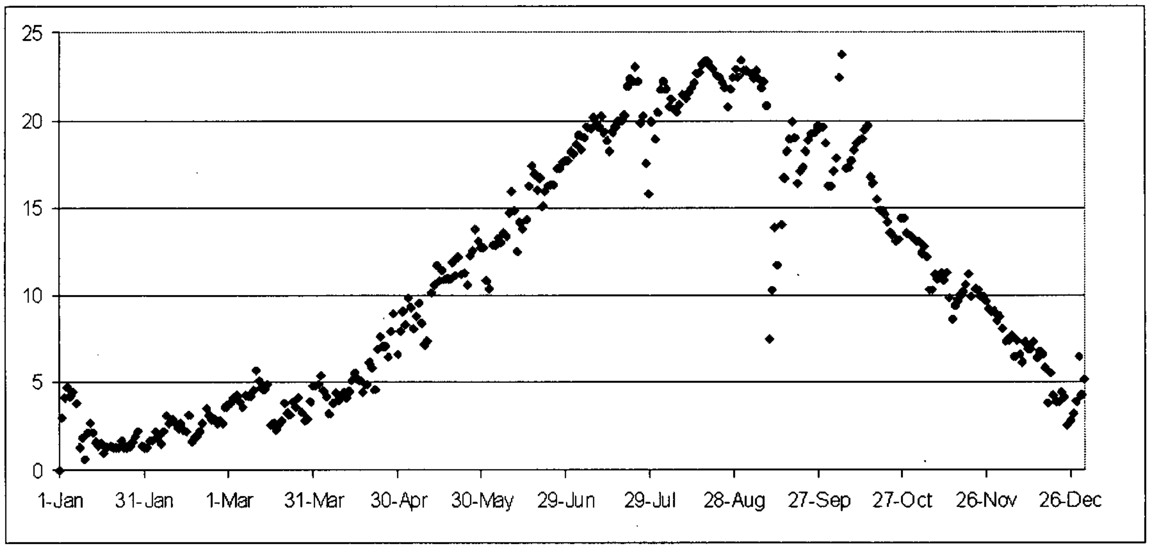


Figure 2-2. Lake Ontario daily water temperature (°C) measured in the circulating water intake flow from the James A. FitzPatrick Nuclear Power Plant, January through December 2004 (data from EA 2005).

Table 2-1. Monthly average intake water temperature (°C) at JAFNPP during 2004. Data from EA 2005.

Month	Average Temperature (°C)	Standard Deviation
Jan	2.0	1.1
Feb	2.5	0.6
Mar	3.8	0.9
Apr	5.5	1.4
May	10.6	1.7
Jun	15.3	2.0
Jul	19.7	1.5
Aug	22.1	0.9
Sep	18.3	3.8
Oct	16.3	2.8
Nov	10.4	1.2
Dec	5.7	1.6

Table 4-1. FitzPatrick Nuclear Power Plant Monthly Average Condenser Cooling Water MGD for Jan 1998 through July 2005. Calculation of Flow Reduction against baseline condition of continuous CWIS operations (service water excluded).

	1998	1999	2000	2001	2002	2003	2004	2005	Average
January	495.6900	504.6000	506.4901	454.2921	493.0625	488.2720	447.0755	453.9835	480.4332
February	502.7000	512.7000	479.3599	453.8208	493.9866	452.0099	420.2277	456.3632	471.3960
March	513.0700	500.3200	538.3113	425.9037	485.2238	478.4039	444.0382	453.2311	479.8128
April	517.6000	545.6500	513.0458	518.3680	497.1974	518.3486	480.2595	460.1382	506.3259
May	499.4700	544.3200	544.3354	518.2845	497.6064	518.2023	484.1558	490.4343	512.1011
June	545.2900	570.2500	555.1464	518.2278	480.3366	518.3383	487.2176	518.3059	524.1391
July	583.4600	541.3900	570.4862	518.2109	500.8666	519.1052	488.7401	323.3892	505.7060
August	472.9000	596.2200	547.7166	518.1594	501.4326	489.8796	504.7053		518.7162
September	570.6200	586.2400	558.7290	518.0555	501.8552	518.1353	439.7184		527.6219
October	370.6600	490.7300	153.8457	518.2260	179.7645	518.1428	169.2936		342.9518
November	10.1300	488.2000	465.6749	518.2778	518.3568	518.2000	518.2936		433.8762
December	301.2100	533.4900	548.2760	518.2215	518.3007	501.2263	487.8342		486.9370
Yearly Average	448.5667	534.5092	498.4514	499.8373	472.3325	503.1887	447.6300	450.8351	480.7471
							Baseline Flow =		518.4
						Reduction from Baseline (2001-2004) =			7.3%

RED TEXT Flows include Service Water

Table 6-1. Selected water quality parameters of Lake Ontario, 1972-2000. Source: NMPNS 2004.

Parameter	1972[a]	1978[b]	1998-99[c]	2000[d]
pH	8.0	8.4	8.0	7.6
Total Alkalinity (mg/L)	72-90	94	92	83
Total Phosphorus (mg/L)	.01-.28	0.03	ND	ND
Total Dissolved Solids (mg/L)	107-186	202	ND	160
Total Nitrates (mg/L)	0.04-0.40	<0.18	ND	0.34
Turbidity	2-6 (JTU)	3.0 (NTU)	0.5 (NTU)	0.09 (NTU)

[a] Source: U.S. Atomic Energy Commission. 1974
[b] Source: Niagra Mohawk Power Corporation. 1985
[c] Source: Heritage Power, LLC. 2000.
[d] Source: Monroe County Water Authority 2001.

JTU= Jackson Turbidity Units
NTU= Nephelometric Turbidity Units
ND= no data available

Table 6-2. Estimated impingement (based on flow), 1976-1997 and 2004. Estimated impingement numbers have been corrected for screen efficiency where applicable [i.e. Alewives, rainbow smelt, smallmouth bass, white perch, and yellow perch]). Source: EA 2005.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
1976	12,208	1,300	50,037	689,466	2,850,935	304,206	160,379	5,147	6,524	8,178	188,928	36,254	4,313,562
1977	19,526	5,068	13,813	50,490	119,725	15,910	152	223	15,560	32,428	29,711	30,837	333,443
1978	41,595	16,646	87,854	25,014	88,712	42,847	13,392	33,708	31,570	246	558	42,051	424,193
1979	13,436	9,115	8,362	5,629	14,453	1,675	219	227	18,132	30,649	46,209	96,123	244,229
1980	45,794	10,197	2,998	27,371	13,854	59,916	19,690	5,966	4,072	42,751	40,026	23,632	296,267
1981	6,169	8,046	17,572	44,405	34,936	35,879	55,165	116,356	49,081	153,223	2,378	4,050	527,260
1982	47,283	3,533	14,095	91,148	110,301	38,996	142,100	22,753	11,453	877	2,205	118,508	603,252
1983	4,826	1,421	3,945	9,832	51,562	2,739	832	4,945	15,071	2,870	1,277	16,674	115,994
1984	1,441	1,538	2,539	3,332	140,421	43,211	95,471	6,958	3,616	101	2,788	71,168	372,584
1985	16,065	6,486	0	20,715	186,113	117,628	53,100	22,900	31,458	2,716	128,768	10,020	595,969
1986	17,752	1,974	3,100	47,935	96,718	11,692	16,993	22,685	18,854	6,879	7,065	8,422	260,069
1987	42,959	912	103	5,775	55,500	7,494	8,936	9,127	3,437	6,570	4,349	19,220	164,382
1988	15,618	4,713	3,174	56,707	53,127	7,831	913	5,685	108	119	5,856	13,218	167,069
1989	8,521	3,732	1,136	32,120	196,640	217,552	17,628	735	985	22,166	11,122	2,699	515,036
1990	931	1,674	6,232	436	2,781	3,168	428	17,933	24,202	73,971	8,386	17,774	157,916
1991	7,597	2,183	2,022	60,703	27,755	12,887	1,993	1,296	521	565	13,097	2,675	133,294
1992	665	40	72	25	352	1,008	58	1,268	487	328	660	2,242	7,205
1993	2,120	7,271	883	5,760	7,668	4,885	1,663	1,148	1,117	6,121	379	2,074	41,089
1994	3,313	566	317	238	77,550	6,303	877	91,079	2,943	1,335	9,544	328	194,393
1995	16	0	2,550	31,134	26,918	51,889	7,516	10,212	253	2,361	2,635	22,468	157,952
1996	6,036	29,520	25,732	6,119	264,983	202,224	38,224	208	257	30,278	931	1,183,288	1,787,800
1997[a]	127,004	955,468	81,274	22,849	29,410	8,968	439	526	612	490	2,337	692	1,230,069
2004[a]	55,619	9,587	106,214	14,701	16,644	6,834	2,211	529	548	467	5,914	10,266	229,534
TOTAL	**496,494**	**1,080,990**	**434,024**	**1,251,904**	**4,467,058**	**1,205,742**	**638,379**	**381,614**	**240,861**	**425,689**	**515,123**	**1,734,683**	**12,872,561**

[a] A full-scale fish deterrence system ran in its entirety for 1997 and 2004

Outages:
1976- No plant operating data
1977- 22 Jun - 23 Sep
1978- 17 Sep - 06 Dec
1979- 16 Mar - 07Sep
1980- 07 May - 13 Aug
1981- 30 Oct - 31 Dec
1982- 01 Jan - 09 Mar
1983- 04 Jun - 02 Sep
1984- 16 Sep - 05 Nov
1985- 16 Feb - 01 Jun
1986- 15 Mar - 30 Mar; 29 Sep - 08 Oct
1987- 16 Jan - 28 Apr
1988- 28 Aug - 23 Nov
1989- 16 Sep - 06 Oct
1990- 01 Apr - 27 Jun
1991- 09 Mar - 14 Apr; 08 May - 19 Aug; 28 Nov - 31 Dec
1993- Several short duration outages
1994- 03 Apr - 04 May; 01 - 31 Dec
1995- 01 Jan - 26 Mar; 31 May - 08 Jun; 06-12 Sep
1996- 22 Feb - 06 Mar; 27 Oct - 11 Dec
1997- Several short duration outages
2004- 25 Sep - 24 Oct (Refueling Outage 16)

Table 6-3. Total estimated impingement abundance (based on flow) for species of interest, 1976-1997. Source: EA 2005.

Year	Alewife[a]	Rainbow smelt[a]	Threespine stickleback	White perch[a]	Yellow perch[a]	Smallmouth bass[a]	Salmonids[b]	Spottail shiner	Gizzard shad	Trout perch	Tessellated darter	Sculpins
1976	3,916,717	282,373	95,883	8,436	3,770	521	159	11,683	16,732	12,183	6,708	
1977	187,305	107,134	4,442	13,353	1,526	555	94	5,970	10,931	1,550	953	
1978	67,991	81,480	222,837	6,739	10,076	1,170	49	6,459	15,468	3,479	2,157	3,425
1979	81,931	148,611	190	6,214	2,668	277	105	6,296	4,416	496	305	2,059
1980	171,465	85,049	85	6,019	1,750	231	65	2,077	14,017	2,545	1,539	2,893
1981	463,542	64,105	535	2,762	746	95	83	1,462	5,512	2,565	618	1,503
1982	350,003	255,749	792	2,590	1,236	980	190	3,440	1,055	1,600	420	2,417
1983	62,026	39,407	2,880	6,046	406	224	117	1,034	2,735	1,778	595	1,196
1984	273,931	85,708	1,373	2,384	530	253	193	2,953	4,058	2,794	4,496	1,327
1985	527,952	57,379	3,908	1,522	206	132	62	1,158	5,658	1,032	424	1,081
1986	176,972	71,039	1,880	1,453	274	141	184	3,172	1,346	2,144	460	1,556
1987	66,625	95,067	2,187	664	42	293	76	2,366	471	1,061	640	881
1988	111,468	26,351	2,288	2,759	465	2,268	141	3,977	3,712	1,221	1,668	4,916
1989	449,017	38,154	2,124	2,075	684	948	234	5,413	927	8,818	4,749	2,656
1990	15,156	110,848	845	2,210	156	576	110	3,809	26,173	524	2,738	1,117
1991	75,741	37,343	2,947	1,343	588	266	155	3,578	1,031	2,482	1,332	917
1992	1,312	2,179	78	53	198	64	14	282	40	180	986	1,043
1993	21,425	7,611	520	278	354	608	123	2,277	668	1,636	323	747
1994	74,552	97,643	3,209	517	192	1,202	79	5,569	42	7,755	652	1,076
1995	83,567	29,199	34,469	247	103	631	252	929	753	3,424	1,121	1,515
1996	346,593	29,436	1,392,763	559	436	359	224	4,662	26	6,923	916	948
1997[a]	13,755	27,311	1,169,567	1,036	568	671	96	3,263	240	3,282	573	998
2004[a]	16,796	1,527	201,563	481	403	1,106	146	534	263	923	68	1,393
TOTAL	7,555,842	1,780,703	3,147,365	69,740	27,377	13,571	2,966	82,363	116,274	70,395	34,441	35,664

[a] Corrected for traveling screen efficiencies
[b] A full scale fish deterrence system rain in its entirety for 1997 and 2004

Table 6-4. Annual percentages of Lake Ontario alewife and rainbow smelt impinged at JAFNPP.

Year	No. Impinged at JAFNPP		Lakewide Population*		Percent Impinged	
	Alewife	Rainbow smelt	Alewife	Rainbow smelt	Alewife	Rainbow smelt
1982	350,003	255,749	3,737,000,000	1,126,000,000	0.0094	0.0227
1983	62,026	39,407	4,484,000,000	1,188,000,000	0.0014	0.0033
1984	273,931	85,708	1,505,000,000	330,000,000	0.0182	0.0260
1985	527,952	57,379	3,150,000,000	2,080,000,000	0.0168	0.0028
1986	176,972	71,039	3,740,000,000	800,000,000	0.0047	0.0089
1987	66,625	95,067	1,860,000,000	4,370,000,000	0.0036	0.0022
1988	111,468	26,351	2,560,000,000	1,000,000,000	0.0044	0.0026
1989	449,017	38,154	3,514,000,000	2,095,000,000	0.0128	0.0018
1990	15,156	110,848	1,396,300,000	620,000,000	0.0011	0.0179
1991	75,741	37,343	2,723,000,000	1,066,000,000	0.0028	0.0035
1992	1,312	2,179	1,926,000,000	456,000,000	0.0001	0.0005
1993	21,425	7,611	2,888,800,000	1,383,000,000	0.0007	0.0006
1994	74,552	97,643	2,230,000,000	361,600,000	0.0033	0.0270
1995	83,567	29,199	2,293,000,000	2,650,000,000	0.0036	0.0011
1997	13,755	27,311	941,300,000	2,330,000,000	0.0015	0.0012

*Lakewide population estimates for U.S. Waters (Rochester Gas & Electric Corporation Unpublished) from NMPNS 2004.

Table 6-5. Analysis of variance tests of whether ichthyoplankton and fish abundances varied significantly among depth contours in the vicinity of Nine Mile Point in 1978.

Data Set	ANOVA Design	*Significance*[a]	
		Main Effects	**Interactions**
Eggs (day & night, summer only)	3-way	Depths *** Weeks *** Diel NS	Depth-Week NS Depth-Diel * Week-Diel NS
Eggs (day only, all 9 months)	2-way	Depths ** Weeks ***	None[b]
Yolk-sac larvae (day & night, summer only)	3-way	Depths *** Weeks *** Diel *	Depth-Week ** Depth-Diel * Week-Diel ***
Yolk-sac larvae (day only, all 9 months)	2-way	Depths *** Weeks ***	None[b]
Post yolk-sac larvae (day & night, summer only)	3-way	Depths *** Weeks *** Diel ***	Depth-Week * Depth-Diel NS Week-Diel ***
Post yolk-sac larvae (day only, all 9 months)	2-way	Depths *** Weeks ***	None[b]
Gill nets	2-way	Depths *** Months ***	Depth-Month**
Bottom trawls	3-way	Depths NS Weeks *** Diel ***	Depth-Week NS Depth-Diel NS Week-Diel **

[a] NS = not significant ($p>0.05$)
* = significant ($p\leq0.05$)
** = highly significant ($p\leq0.01$)
*** = very highly significant ($p\leq0.001$)

[b] There was assumed to be no Depth-Week interaction for the 2-way ichthyoplankton ANOVAs, where there was no replication within each Depth-Week cell of the design

Table 6-6. Multiple comparison tests among depth contours for ANOVAs in which the main effect of depth was significant.

Data Set	ANOVA Design	Depth Contour	Tukey Grouping			Geometric Mean
Eggs	3-way	20	A			2.10
(day & night, summer only)			A			
		40	A	B		0.94
				B		
		80	C	B		0.19
			C	B		
		60	C	B		0.16
			C			
		100	C			0.03
Eggs	2-way	20	A			0.34
(day only, all 9 months)			A			
		40	A	B		0.29
			A	B		
		60	A	B		0.11
			A	B		
		80	A	B		0.07
				B		
		100		B		0.00
Yolk-sac larvae	3-way	20	A			7.46
(day & night, summer only)			A			
		40	A	B		4.92
				B		
		60	C	B		2.76
			C			
		80	C	D		1.63
				D		
		100		D		0.90
Yolk-sac larvae	2-way	20	A			1.37
(Day only, all 9 months)			A			
		40	A	B		1.00
			A	B		
		60	A	B	C	0.69
				B	C	
		80		B	C	0.56
					C	
		100			C	0.34

(continued)

Table 6-6. (Continued)

Data Set	ANOVA Design	Depth Contour	Tukey Grouping		Geometric Mean
Post yolk-sac larvae	**3-way**				
(day & night, summer only)		20	A		70.2
			A		
		40	A		63.5
		80	B		31.7
			B		
		60	B		29.2
			B		
		100	B		25.9
Post yolk-sac larvae	**2-way**	20	A		6.66
(day only, all 9 months)			A		
		40	A		5.85
		60	B		3.06
			B		
		80	B		3.03
			B		
		100	B		2.51
Gill nets	**2-way**	15	A		10.85
		40	B		4.31
			B		
		30	B	C	4.03
				C	
		60		C	2.84

Means with the same letter in the "Tukey Grouping" column are not significantly different from each other at the $\alpha = 0.05$ level of significance.

Table 6-7. Percentage differences of ichthyoplankton and gill net abundances for the mean of all deeper contours compared to the mean abundances for the shallowest depth contour.

Data Set	Shallowest Contour		Deeper Contours		Percent Difference
	Depth	Mean	Depths	Mean	
Eggs (day & night, summer only)	20	20.8	40, 60, 80, & 100	1.0	-95%
Eggs (day only, all 9 months)	20	1.1	40, 60, 80, & 100	0.4	-67%
Yolk-sac larvae (day & night, summer only)	20	31.3	40, 60, 80, & 100	8.6	-73%
Yolk-sac larvae (day only, all 9 months)	20	11.7	40, 60, 80, & 100	4.0	-66%
Post yolk-sac larvae (day & night, summer only)	20	178	40, 60, 80, & 100	145	-19%
Post yolk-sac larvae (day only, all 9 months)	20	60	40, 60, 80, & 100	41	-32%
Gill nets	15	17.1	30, 40, & 60	4.5	-74%

Contour depths are in feet. Mean abundances are number per 1000 cubic meters for ichthyoplankton and number per 12-hour set for gill nets. Percent difference = 100 * [(D – S) / S], where S = mean abundance at shallowest contour and D = mean abundance for all other depth contours combined.

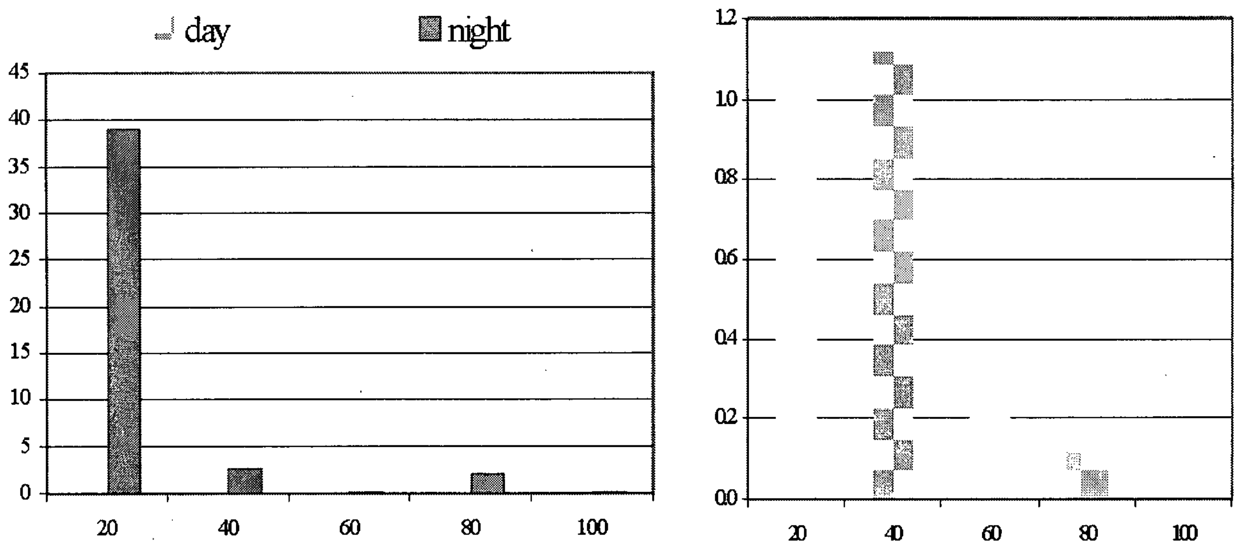


Figure 6-1. Average number of fish eggs per 1000 cubic meters near Nine Mile Point in 1978 at the 20-foot, 40-foot, 60-foot, 80-foot, and 100-foot depth contours (all species combined). Left graph: daytime and nighttime sampling, June through mid-September. Right graph: daytime sampling only, April-December.

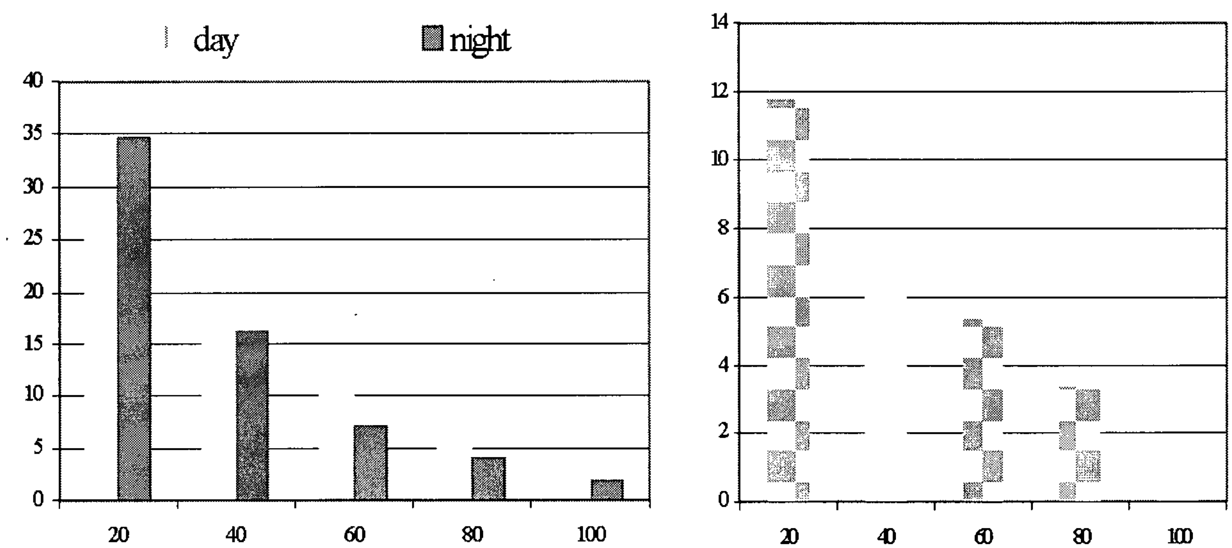


Figure 6-2. Average number of yolk-sac larvae per 1000 cubic meters near Nine Mile Point in 1978 at the 20-foot, 40-foot, 60-foot, 80-foot, and 100-foot depth contours (all species combined). Left graph: daytime and nighttime sampling, June through mid-September. Right graph: daytime sampling only, April-December.

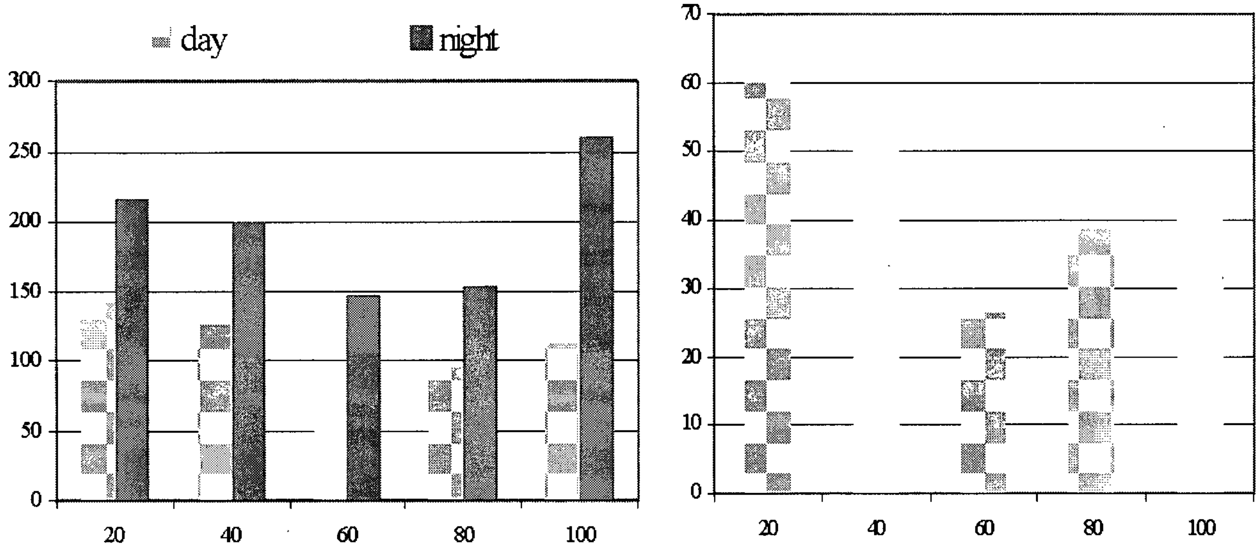


Figure 6-3. Average number of post yolk-sac larvae per 1000 cubic meters near Nine Mile Point in 1978 at the 20-foot, 40-foot, 60-foot, 80-foot, and 100-foot depth contours (all species combined). Left graph: daytime and nighttime sampling, June through mid-September. Right graph: daytime sampling only, April-December.

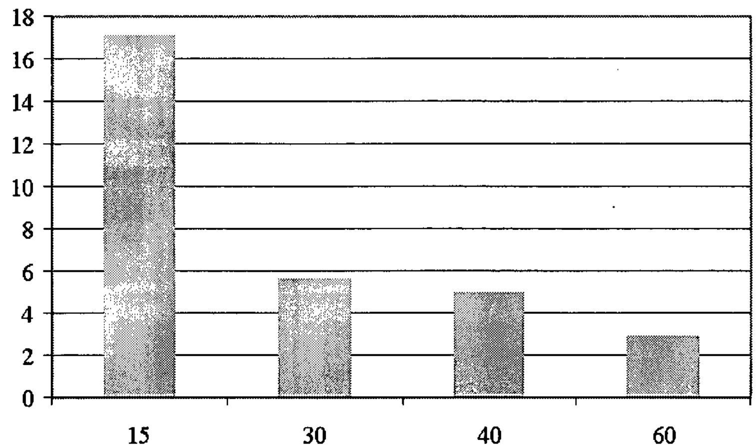


Figure 6-4. Average gill net catch per 12-hour set near Nine Mile Point in April through mid-December 1978 at the 15-foot, 30-foot, 40-foot, and 60-foot depth contours (dominant taxa of alewife, rainbow smelt, white perch, yellow perch, and smallmouth bass combined).

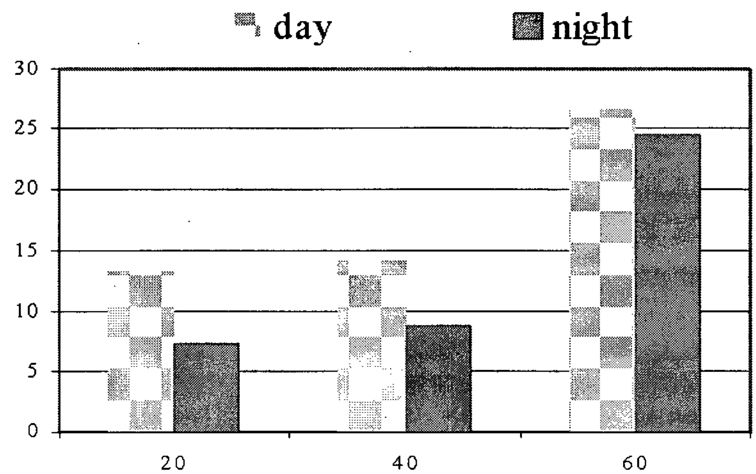


Figure 6-5. Average daytime and nighttime bottom trawl catch per 15-minute tow near Nine Mile Point in April through mid-December 1978 at the 20-foot, 40-foot, and 60-foot depth contours (all fish species combined).

APPENDIX 1

Reports and Relevant Agency Correspondence Regarding §316(b) at James A. Fitzpatrick Nuclear Power Plant (JAFNPP)

Reports
Relevant Agency Correspondence

Letter from P.Kolakowski NYSDEC to D. Dunning NYPA, 1 March 1996

State Pollutant Discharge Elimination System (SPDES) Permit CP-04.03 for Entergy Nuclear Operations, Inc. James a. FitzPatrick Nuclear Power Plant, SPDES No. NY 002 0109, expiration date August 1, 2006.

January 24, 2005 Letter from Lynette M. Stark, Deputy Commissioner, New York Department of Environmental Conservation to Benjamin H. Grumbles, Assistant Administrator, USEPA , regarding determination of Best Technology Available for "existing facilities" in New York.

January 31, 2005 Letter from Denise Sheehan, Executive Deputy Commissioner, New York Department of Environmental Conservation to Mr. John G. Holsapple, Director of Environmental Energy Alliance of New York, regarding determination of Best Technology Available for "existing facilities" in New York.

March 14, 2005 Letter from Roy A. Jacobson, Unit Leader Steam Electric Unit, New York Department of Environmental Conservation to Mr. Michael Rodgers of Entergy Nuclear, regarding determination of Best Technology Available (BTA) 6 NYCRR §704.5 and 40 CFR §125-Subpart J (Phase II Rule) at FitzPatrick Nuclear Power Station.

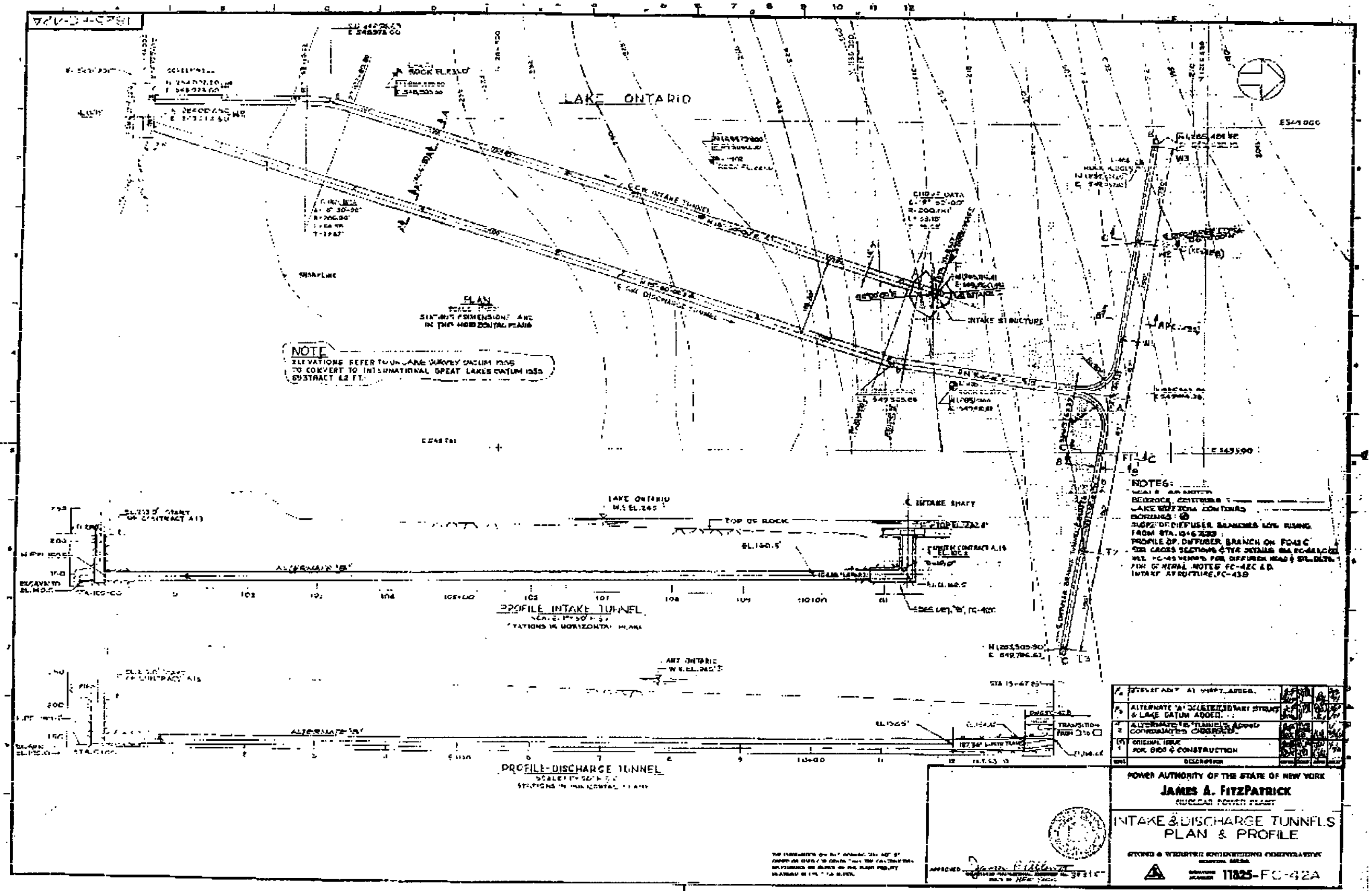
April 19, 2005 Letter from Mr. T.A. Sullivan, Site Vice President - JAF to Roy A. Jacobsen, Unit Leader Steam Electric Unit, New York Department of Environmental Conservation, regarding implementation of 6 NYCRR §704.5 and 40 CFR §125-Subpart J (Phase II Rule) at FitzPatrick Nuclear Power Station.

12 May 2005 Letter from Roy A. Jacobson, Unit Leader Steam Electric Unit, New York Department of Environmental Conservation to Mr. T.A. Sullivan, Site Vice President - JAF, regarding Best Technology Available (BTA) at FitzPatrick Nuclear Power Station.

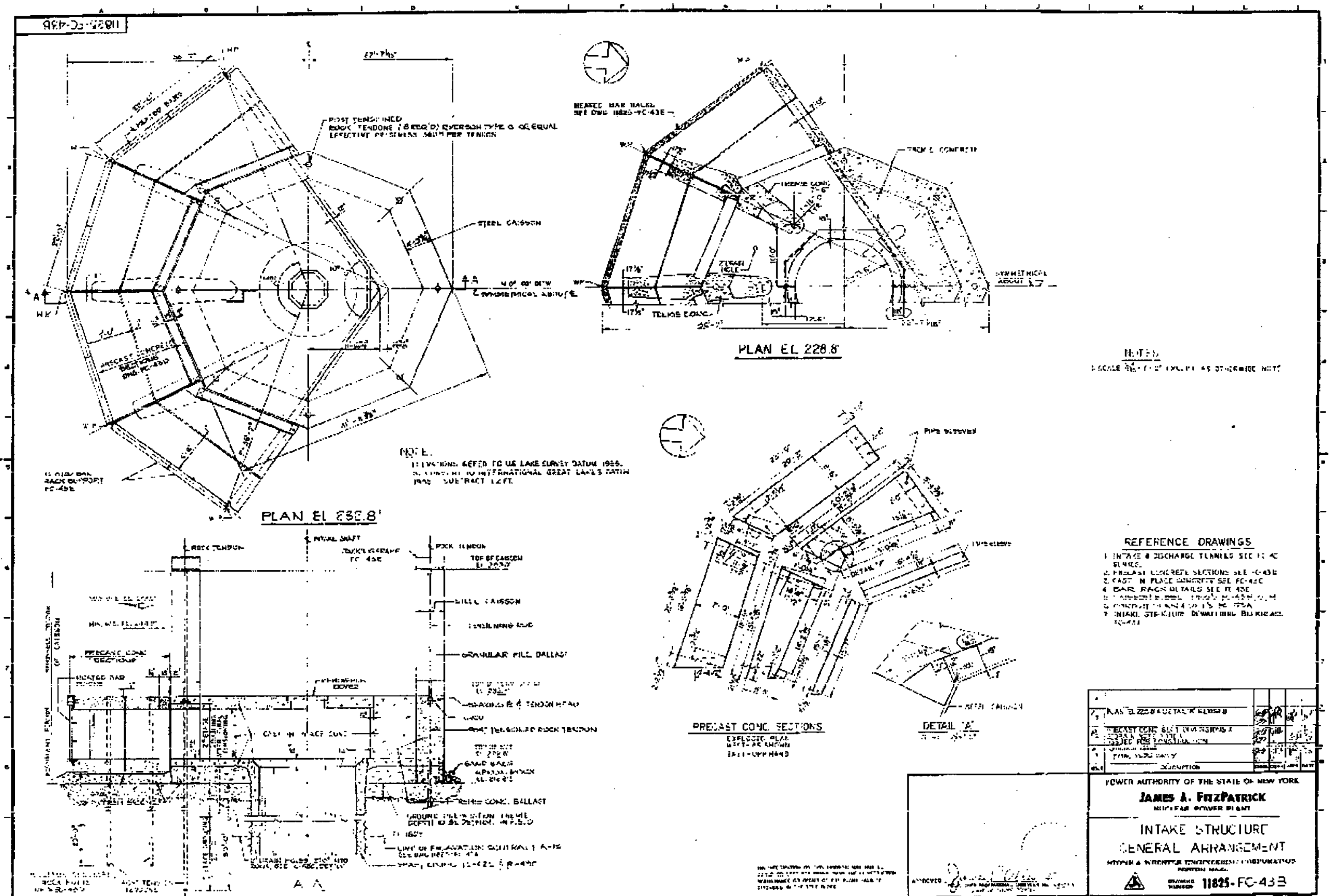
22 June 2005 Letter from Roy A. Jacobson, Unit Leader Steam Electric Unit, New York Department of Environmental Conservation to Mr. T.A. Sullivan, Site Vice President - JAF, regarding implementation of 6 NYCRR §704.5 and 40 CFR §125-Subpart J (Phase II Rule) at FitzPatrick Nuclear Power Station.

APPENDIX 2

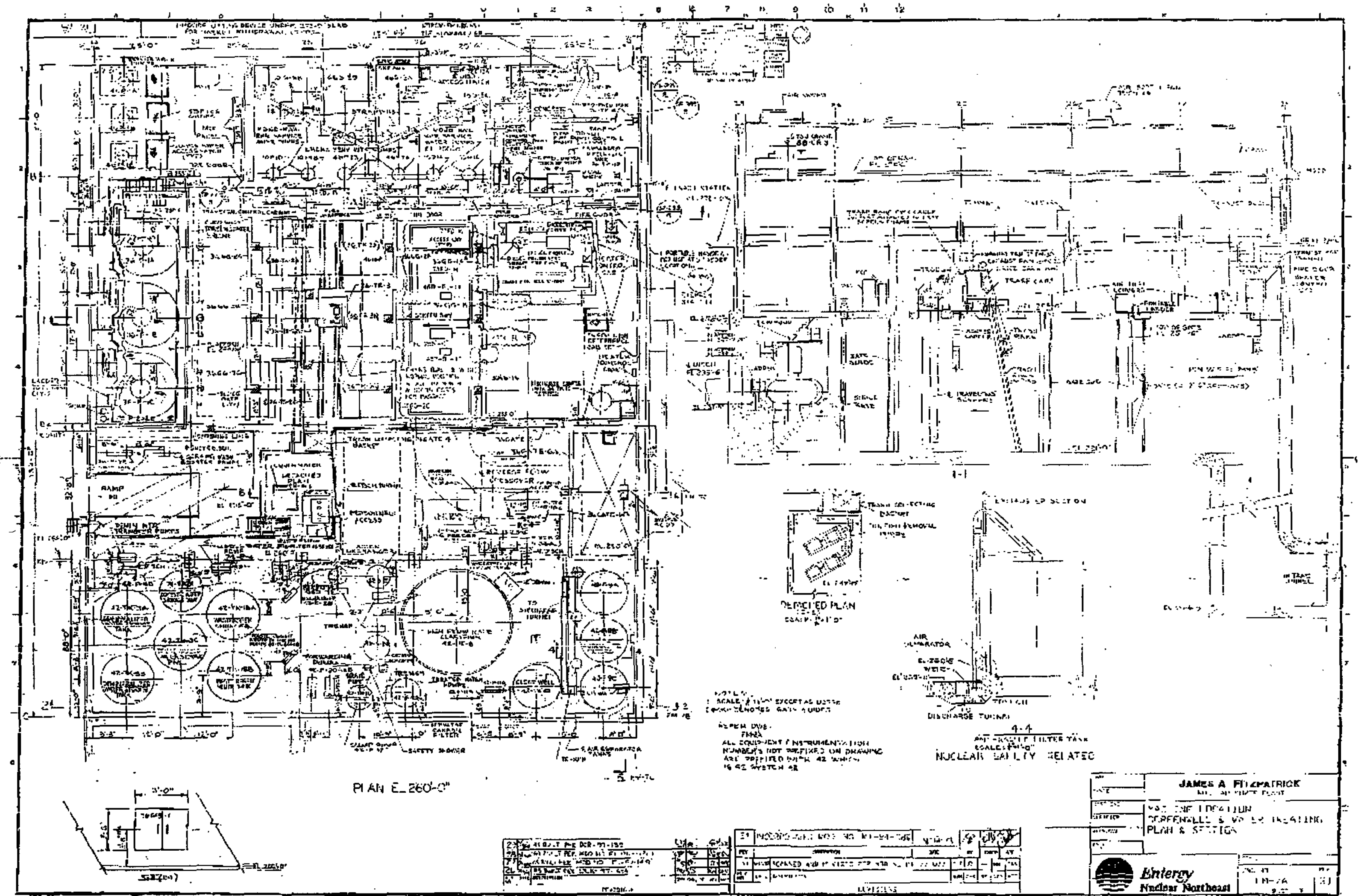
Drawings with Plan and Sectional Views of Intake Structure

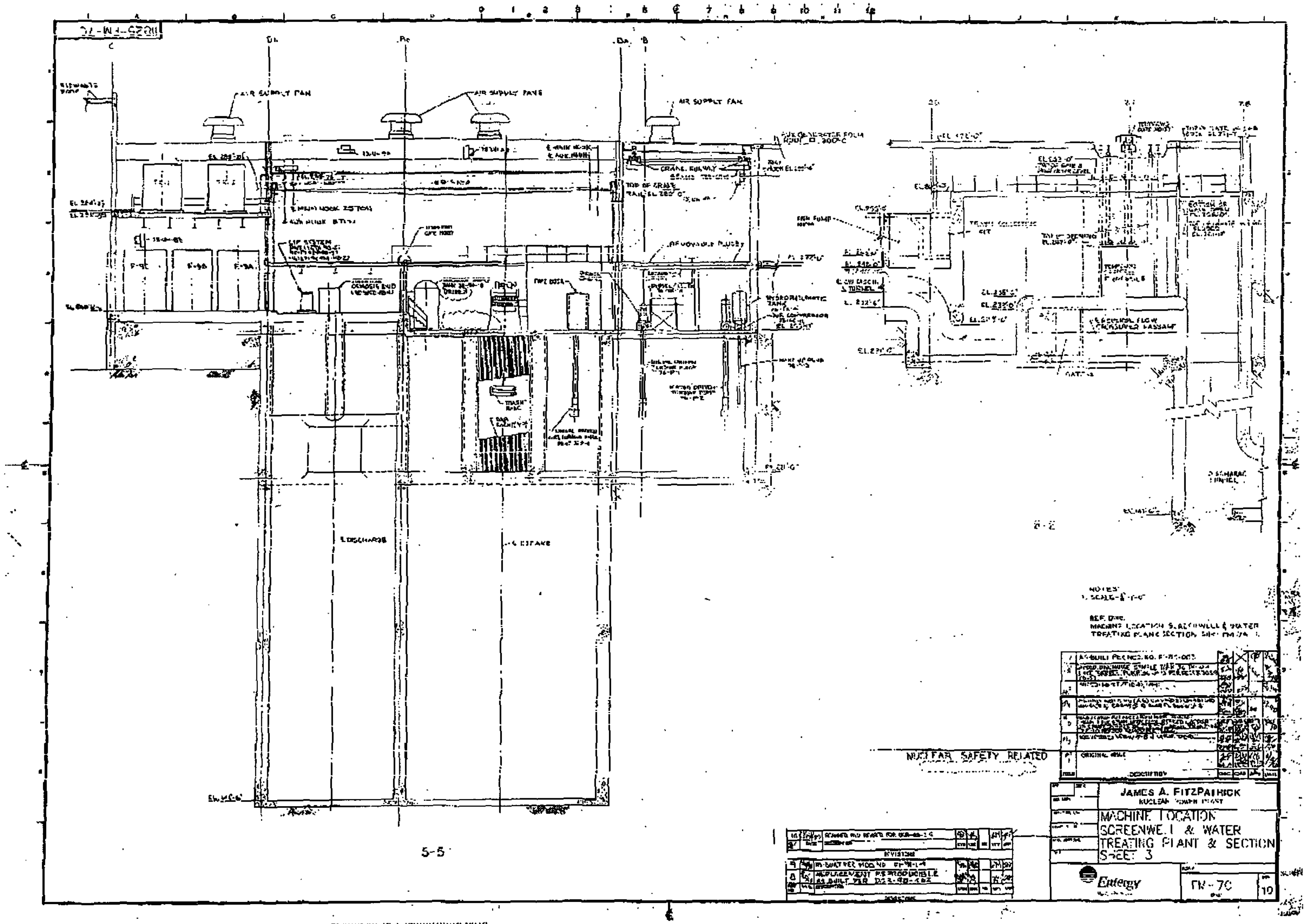


LAKE ONTARIO
PLAN
NOTE
INTAKE STRUCTURE
INTAKE SHAFT
TOP OF ROCK
NOTES:
PROFILE INTAKE TUNNEL
PROFILE-DISCHARGE TUNNEL
POWER AUTHORITY OF THE STATE OF NEW YORK
JAMES A. FITZPATRICK
INTAKE & DISCHARGE TUNNELS
PLAN & PROFILE
11825-FC-42A



PLAN EL 228.8'
PRECAST CONC. SECTIONS
DETAIL "A"
REFERENCE DRAWINGS
STEEL CAISSON
GRANULAR FILL BALLAST
SYMMETRICAL ABOUT
A-A
POWER AUTHORITY OF THE STATE OF NEW YORK
JAMES A. FITZPATRICK
NUCLEAR POWER PLANT
INTAKE STRUCTURE
GENERAL ARRANGEMENT
11825-FC-43B


PLAN E_260-0"
DETAILED PLAN
DISCHARGE TUNNEL
NUCLEAR SAFETY RELATED
JAMES A FITZPATRICK
Entergy
Nuclear Northeast


AIR SUPPLY FAN
AIR SUPPLY FANS
AIR SUPPLY FAN
NUCLEAR SAFETY RELATED
JAMES A. FITZPATRICK
MACHINE LOCATION
SCREENWELL & WATER
TREATING PLANT & SECTION
SHEET 3
Entergy
FM-7C
10

APPENDIX 3

JAFNPP 2006 Entrainment Monitoring

Quality Assurance Plan
and Standard Operating Procedures

January 2006

APPENDIX 3

QUALITY ASSURANCE PLAN AND STANDARD OPERATING PROCEDURES FOR ENTRAINMENT SAMPLING AT JAMES A. FITZPATRICK NUCLEAR POWER PLANT LYCOMING, NEW YORK

(SPDES PERMIT NO. NY 0020109)

ENTERGY NUCLEAR FITZPATRICK, LLC
James A FitzPatrick Nuclear Power Plant
277 Lake Road East
Oswego, New York 13126

Prepared In Consultation with

Enercon Services, Inc.
and
Normandeau and Associates, Inc.

R-20271.001

31 January 2006

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Entrainment Sampling Quality Assurance Plan

1.0 INTRODUCTION

Entergy Nuclear FitzPatrick, LLC ("Entergy") owns and operates the James A. FitzPatrick Nuclear Power Plant ("JAFNPP"). JAFNPP is located on the southeastern shore of Lake Ontario approximately 7 miles (11 km) northeast of the city of Oswego, New York in Lycoming, New York. A one-year entrainment sampling program is proposed for JAFNPP beginning in April and continuing through October 2006 because the most recent and comprehensive annual entrainment data were obtained during the 1973-1979 studies described in the Proposal for information collection (PIC), and because the present fish community in the Nine Mile Point area of Lake Ontario may have changed since then. JAFNPP may undertake a second year of entrainment sampling in 2007 to verify the results observed during 2006 if appropriate. The goal of the proposed program is to estimate the seasonal and annual total abundance of fish eggs and larvae that become drawn into the offshore intake at JAFNPP and flow into the CWIS. This document is a project-specific Quality Assurance Plan (QAP) consistent with USEPA protocols (USEPA 2001) that describes the Standard Operating Procedures to be used for the field, laboratory, and data file preparation activities, and is included with the PIC as Appendix 3.

1.1 ORGANIZATION OF THIS DOCUMENT

Following a narrative description of the cooling water intake structure (CWIS) at JAFNPP (Section 2.0) are separate stand-alone Standard Operating Procedures (SOPs) for entrainment field (Section 3.0), and entrainment laboratory activities (Section 4.0). Within each of the two SOPs, subsections from the following list that are applicable to that SOP are included: sampling schedule and location, equipment, procedures, sample handling, data handling, quality control, reference collection, and instrument calibration and maintenance. Procedures for data processing, from receipt of completed data sheets to the final data files, are described in Section 5.0. A system for providing the appropriate training for project personnel is described in Section 6.0. Quality Assurance procedures are described in Section 7.0.

2.0 COOLING WATER INTAKE STRUCTURE DESCRIPTION

The CWIS at JAF is a submerged, shore-facing, remote intake with a total design intake flow of 388,600 gallons per minute (gpm). The CWIS is shared primarily by the Circulating Water (CW) and Service Water (SW) systems, and is located about 990 feet inland from the shoreline of Lake Ontario at coordinates N 43°31'37" and E76°23'49". The top of the CWIS is at elevation 232.8 feet, approximately 14 feet beneath the lake surface, which typically varies from elevation 244.0 feet to 248.0 feet. The intake consists of four segmented shore-facing openings, each 22 feet wide and 8 feet high, feeding a 14 foot diameter D-shaped intake tunnel that runs beneath the lake bed approximately 1,150 feet to the offshore screenwell and pumphouse. The base mat of the CWIS is at elevation 222.8 feet, approximately four feet above the lake bottom elevation of 218.8 feet.

Entrainment Sampling Quality Assurance Plan

Nine acoustical projector housings are symmetrically installed on top of the remote intake structure roof, located at elevation 232.8 feet, to provide for fish deterrence. The projectors can be removed for the winter months due to the ice packs possibly defacing the projector faces. The function and effectiveness of this system is discussed in detail in Section 5.1 (below) describing "Currently Implemented Technologies".

There are two sets of bar racks, an internally heated bar rack at the remote intake, and a trash bar rack in the screenwell of the CWIS. The heated bar rack at the remote offshore intake consists of 3 inch by 2 inch rectangular vertical bars on 12 inch centers across each 22 foot by 8 foot intake opening, a total of 88 bars. The primary purpose for this heated bar rack is the prevention of intake clogging due to frazil ice and/or large debris. The bar rack heaters are energized anytime water temperature is ≤37°F to prevent/remove ice formation. There are no installed systems to remove large debris from these racks with the plant operating, although original plant design provided "reverse flow" capability to backwash the remote intake racks when the plant is not at power. The design water velocity through the bar rack at the remote intake is 1.2 feet per second with all three circulating water pumps operating (fps; TI 1979).

The trash bar rack in the CWIS consists of three 12 foot wide vertical bar racks, one installed in front of each traveling water screen, retaining debris equal to or greater than 3.125 inches. A movable trash rake is used to clear away debris collected on the screenwell trash racks, capable of being manually traversed to service any of the three racks to remove debris. Permanent instrumentation monitors trash bar rack differential pressure, and Operations manually rakes trash off the racks when high differential pressure, i.e. debris loading, is indicated. If differential pressure is excessively high, ≥12 inches W.C., an alarm is annunciated in the control room and compensatory actions must be initiated.

The traveling water screens are furnished by Jeffrey Manufacturing Company of Columbus, Ohio, in accordance with Purchase Specification APO-36. Three 12 foot wide traveling screens, fabricated from No. 10 gauge semi-hard drawn copper wire with 3/8 inch clear openings, are situated between the trash racks and the pump intake sluice gates. Each screen has a design capacity of 125,000 gpm, is 12'-0" wide and 43'-4" high, and has a design approach velocity of 1.2 fps. The four speed, ranging from 10 fpm to 20 fpm, traveling screens retain debris 3/8 inches and dump it into a collecting trough. The steel trash trough has flanged ends for each screen section designed so that the flanged ends will mate for bolting when the screens are installed in place to form one continuous pitched trash trough mated to a trough extension. The bottom flange of each panel forms a trash shelf extending the entire width of the panel. The shelf design includes a substantial dredging leaf rake extending the width of each panel at the panel midpoint for refuse removal and is designed for minimum reduction of free area. This rake has tines to engage and raise moss and other lake vegetation. The carrying ledge portion of the lip is able to retain fish and is perforated to drain water. The panels are constructed and so attached to the chain that there is no opening larger than the screen cloth opening for debris to get through at the line of articulation along the sides or bottom when they are stationary or moving.

Two 100% capacity (1 running, 1 standby) screen wash pumps take suction from the SW discharge header to provide backwash spray water for the traveling screens. The spray system utilizes non-clogging, wear resistant deflector type nozzles, designed to project overlapping fan shaped jets of spray water across the width of the screen so that all material picked up on the screen, trash shelf, and the special dredging leaf rake will be jetted off when the panels are ascending. Debris is jetted in a direction opposite the direction of flow of water in the intake channel. The design screen wash pumps spray flow rate is 720 gpm/screen, at a minimum of 80 psi gauge pressure. Water is sprayed on all screens simultaneously from two screen wash headers whenever the traveling screens are rotating.

The traveling screens and screen wash pumps are equipped with an automatic differential level control and can be operated manually or in automatic mode. When in the automatic mode, the screens and pumps will start when the screen wash pump discharge pressure is > 100 psig, and either of two conditions occur:

1. High screen differential level, 4 inches W.C., as sensed by level detectors across the screens.
2. 10-minute daily exercise timer is initiated.

Design debris loading conditions for the traveling screens correspond to 1.6 inches differential W.C. clean, up to 6 inches differential W.C. fully loaded. The traveling screens will automatically stop if the screen differential level is <2 inches W.C. for 10 minutes. An adjustable timer is included to insure that the screen will run for at least 1-1/3 revolutions after minimum level differential is attained to assure that debris is completely removed and not just lifted out of the water and allowed to dry on the panels. If any of the screens runs continuously for 30 minutes or if the differential level across the screens reaches 6 inches W.C., an alarm is sounded in the main control room. Per the CW Operating Procedure, OP-4, at least once per shift the traveling screens are operated, either in "automatic" mode, or manually in "continuous" mode.

The JAFNPP CWIS contains three vertical, mixed flow, dry pit type circulating water pumps. Each single speed intake pump has a rated 27 feet of total dynamic head (TDH), and a rated flow of 120,000 gallons per minute (GPM). The pump drivers are open, drip-proof, induction motors rated at 1,000 HP. During normal plant operation, all three CW pumps are operating with a combined design circulating water intake flow of 360,000 GPM (5.1×10^8) measured through the condensers.

3.0 ENTRAINMENT FIELD SOP

3.1 SAMPLING SCHEDULE AND LOCATION

Entrainment sampling at JAFNPP during 2006 is scheduled weekly during April through October and twice per month from November 2006 through March 2007 for a total of 40 sampling weeks. Each weekly collection consists of one daytime sample and one nighttime sample. The abundance of entrained fish eggs and larvae will be determined by sampling the intake flow in the JAFNPP CWIS. Sampling will begin in April 2006 and continue weekly through October 2006 for a total of 30 sampling weeks. Sampling will continue twice per month during November 2006 through March 2007 for an additional 10 sampling weeks. Entrainment sampling will be conducted on each sampling date as long as at least one CW pump is operating at the JAFNPP CWIS. Each weekly collection will occur on the same day in the week (e.g. Wednesday) and consist of one daytime sample and one nighttime sample. The intention is to separate the collection of daytime and nighttime entrainment samples symmetrically within the corresponding periods of each sampling date. Daytime is defined as occurring between one hour after meteorological sunrise and one hour before meteorological sunset as observed at the plant site. Nighttime is defined as occurring between one hour after meteorological sunset and one hour before meteorological sunrise as observed at the plant site. Entrainment samples from the JAFNPP CWIS will be collected from two depths in the center of the common forebay: 14 feet below the water elevation and 20 feet below the water elevation, which is consistent with the depths sampled in the earlier studies (TI 1980). Therefore, the total number of entrainment samples for the 2006 entrainment program at the JAFNPP CWIS will be 160 (2 depths x 2 diel periods x 40 dates), unless some samples cannot be collected due to plant outages.

3.2 EQUIPMENT

Collection gear for JAFNPP entrainment sampling consists of an electric-powered "trash" pump with 3-inch intake and discharge hoses and a plankton net suspended in a tank. The net mesh is 0.500 mm. The following additional equipment is required for entrainment field sampling:

- copy of SOP and copy of Health & Safety Plan
- flowmeter,
- data sheets, clipboard, and pencils,
- watch,
- flashlight,
- net washdown pump,
- sieve, plastic basin, and funnel,
- sample jars,
- formalin,
- rose bengal, and
- labels and waterproof markers.

3.3 PROCEDURES

3.3.1 Operation of the Electric Entrainment Sampling Pump

1. Check to insure the pump is connected to a power supply.
2. Remove the fill cap from the pump housing and fill the chamber with water to prime it.
3. Replace the fill cap.
4. Turn the power switch to on.

5. Monitor the entrainment tank for water flow. If there is no flow within 90 seconds stop the pump, check for air leaks, re-prime, and repeat steps 2-5.
6. Once a continuous flow is obtained, observe the flow rate at the flow meter to verify that the flow rate is 250 gallons per minute (±10%).
7. Check the flow meter calibration as described in Section 3.3.2 below.
8. Install the sampling net and begin collecting the sample as described in Section 3.3.3 below.

To stop and secure the pump:

1. Turn the power switch to off.
2. Drain the pump hosing using the drain located at the bottom of the housing.
3. Leave the valve open.
4. Wipe off any water that is on the pump motor.
5. Drain the sampling tank and secure the flow meter.

3.3.2 Flow Meter Calibration

Prior to the first sample each month, measure the flow rate delivered by the sampling pump by filling to overflowing a calibration vessel of known volume (the sampling tank, which holds 268 gallons) and noting the time required to the nearest 0.1 second. During this test, the pump should be operating in the typical RPM range used for sampling. Record the flow rate (gpm) indicated on the flowmeter gauge during the calibration test. Calculate the observed flow rate as follows:

calibration gpm = calibration gallons / (calibration seconds/60)

Then calculate the percent error indicated by the calibration trial as follows:

percent error = 100 x (gauge gpm – calibration gpm) / calibration gpm

The percent error can be positive or negative depending on whether the gauge gpm was larger or smaller than the calibration gpm. Record the results on the Entrainment Field Data Sheet, *including the minus sign* if the percent error was negative. If the absolute value of the percent error is less than 3% then no further action is necessary.

If the absolute value of the percent error is more than 3% then repeat the calibration trial two more times and average the three results, recording the results on the Entrainment Field Data Sheet. Keep the minus signs, if any, in calculating the average (if there are both positive and negative percent errors, they will partially cancel each other out). If the absolute value of the average percent error is less than 10% then no further action is necessary.

If the absolute value of the average percent error is more than 10% then replace the flowmeter and return it to the manufacturer for servicing. If there is no replacement flowmeter available immediately, continue to collect samples with the one that failed calibration, but enter the code for "flowmeter problem" in the sample status box on the Entrainment Field Data Sheet. (It may be feasible to estimate the sample volume by comparing the duration to durations of samples with known volumes collected during similar tidal conditions.)

3.3.3 Sample Collection

Shortly before the scheduled start of the first (daytime) sampling period, randomly select the first sampling depth (either 14 feet or 20 feet) and lower the sampling pipe into position, check the entire entrainment sampling system, connect all piping, prime the pump, and set collection nets next to the tank. Install the Signet probe in the T valve and secure it in place, taking care to protect the sensor cables.

Start the pump and adjust the flow rate to approximately 250 gallons per minute (gpm).

Record the time that water begins to enter the sampling net and record the totalizer reading. Fill out the sample identification information at the top of the Entrainment Field Data Sheet (Section 3.5.1).

Check the flowmeter gauge periodically and adjust the pump throttle if necessary to maintain a pumping rate of about 250 gpm.

At times, clogging of the net mesh may make it necessary to switch to a clean net during a sample (possibly as frequently as every 20 minutes). To switch nets, move one net to the side, placing the other net under the flow, and remove the original net to collect a subsample without interrupting sample collection. If subsamples are collected in this way before the sample is completed, concentrate and preserve the sample material after each net switch in the same manner as described below for the completed sample. More than one subsample may be preserved in the same jar, but if multiple jars are used, label each one with the same sample number and indicate that multiple jars were used (e.g. "1 of __").

Wait until the totalizer indicates 27,000 gallons to make sure that at least 100 cubic meters of water has been sampled before ending the sample. After the volume has reached at least 27,000 gallons, turn off the pump, and record the time and totalizer reading. At a pumping rate of 250 gpm, a sample will take a little over 1 hour and 45 minutes to complete.

When the sample is completed (and any time plankton nets are exchanged during a sample due to clogging), wash the sample (or subsample) into the cod end bucket using a washdown pump. Collect the sample material from the cod end bucket and place it in a labeled sample container. A 0.500 mm or finer sieve may be used to remove excess water from the sample before transferring it to the sample jar. Take care that none of the sample is spilled, and that the contents of the net and cod end bucket are completely rinsed into the sample container or sieve. Pouring the sample into the jar should always be done over a larger container in case some sample is spilled. Sample containers and cod end buckets that are open should be set down only in a container or bucket, just in case the sample is spilled. Preserve the sample by adding sufficient formalin to make the final concentration 5% (50 mm of full-strength formalin per liter of sample).

Repeat the above procedures for three additional diel samples within the 24-hr collection period. The starting times of the four diel samples should be six hours apart. Reset the totalizer reading on the flowmeter to zero in between samples.

Before leaving the site, disconnect and drain the system (and drain the pump housing to prevent freezing during colder months).

3.4 SAMPLE HANDLING

Fill entrainment sample jars completely by addition of 5% formalin. Sample jars should be no more than 25% full of organisms and debris for adequate preservation. Label the jars externally with the sample number and the number of jars (e.g., 1 of 4, 2 of 4, etc.). Place an internal label in each jar giving the sample number.

3.5 DATA HANDLING

3.5.1 Data Sheets and Coding Instructions

A unique sample number is assigned to each JAFNPP entrainment collection. The sample number is a four-digit number that is a composite of sample type (2 for entrainment), week number (two digits), and diel period (one digit). Record the sample identification and status, collection times, flowmeter readings, and flowmeter calibration data on the Entrainment Field Data Sheet (Appendix A) according to the instructions below. Use the space for comments at the bottom of the data sheet to explain any problems or unusual circumstances. Use a separate data sheet for each sample.

Use the flowmeter calibration section of the Entrainment Field Data Sheet once per month, on the data sheet for the first entrainment sample of the month. Only one calibration trial may be necessary (Section 3.3.2).

VARIABLE	INSTRUCTIONS
Type	Precoded 2 for entrainment
Week	Enter week number within year (1-52). The week number corresponding to each sampling date is shown in Appendix C.
Diel	Enter the code for diel period: 1= daytime 2= nighttime
Status	Enter code for status of sample: 0 = void (no sample) 1 = valid sample

VARIABLE	INSTRUCTIONS
	2 = sample is provisional due to flowmeter problem
Comments	If comments are written at the bottom of the data sheet, enter 1; if not, leave it blank
Start Month	Record the month that the 24-hr sampling event began (should be the same for all samples collected in the 24-hr period)
Start Day	Record the day that the 24-hr sampling event began (should be the same for all samples collected in the 24-hr period)
Start Hour	Record the hour that the 100-cubic-meter diel sample began, using 24-hr clock (0000-2359 hrs)
Start Minute	Record the minute that the 100-cubic-meter diel sample began, using 24-hr clock (0000-2359 hrs)
End Hour	Record the hour that a 100-cubic-meter diel sample (or a subsample) ended, using 24-hr clock (0000-2359 hrs)
End Minute	Record the minute that a 100-cubic-meter diel sample (or a subsample) ended, using 24-hr clock (0000-2359 hrs)
Gallons, end	Record the flowmeter reading for total gallons at the end of the sample
Gallons, start	Record the flowmeter reading for total gallons at the beginning of the sample
Gallons, difference	Subtract the starting flowmeter volume reading from the ending flowmeter volume reading
Gauge gpm	Record the pumping rate indicated by the flowmeter gauge to the nearest gallon per minute
Calibration seconds	Record the time to the nearest 0.1 seconds needed for the sampling pump to fill the calibration tank
Calibration gallons	Enter the calibration tank volume (268 gallons for the aluminum tank)
Calibration gpm	Calculate the observed pumping rate by dividing the calibration time by 60 then dividing that number into the calibration volume (record the result to the nearest gallon per minute)
Percent error	Calculate % error as described in Section 3.3.2 and record the result to the nearest 0.1% (keep the minus sign if it is negative)
Average % error	Calculate average % error as described in Section 3.3.2 and record the result to the nearest 0.1% (keep the minus sign if it is negative)

3.5.2 Storage and Chain of Custody of Data Sheets

Check over all data sheets, to make sure they are completely and correctly filled out, and to be alert to any unusual or unexpected data values. Transport the original data sheets to the field office, file a photocopy of each data sheet there for safe keeping and QA/QC verification, and dispatch the originals to data center.

3.6 HAZARDOUS SUBSTANCES LOG

Maintain a log of the amounts of formalin brought on site. Include in each log entry the date, the name of person making the log entry, and the volume in gallons of formalin brought on site on that date (Appendix A). Make the log available for inspection as requested by JAFNPP's representatives. Provide the log to JAFNPP's Environmental Health and Safety department at the end of the project.

4.0 ENTRAINMENT LABORATORY SOP

4.1 SAMPLES TO BE ANALYZED

Entrainment sampling at JAFNPP during 2006 is scheduled weekly during April through October for a total of 30 sampling weeks. Sampling will continue twice per month during November 2006 through March 2007 for an additional 10 sampling weeks. Each weekly collection consists of samples from two depths collected during the daytime and again during nighttime. The total number of entrainment samples delivered to the laboratory for the 2006-2007 program will be up to 160 (2 depths x 2 diel periods x 40 dates), and possibly less if some samples cannot be collected due to plant outages. However, in the laboratory, the two depth samples from each day or night collection on each sampling date will be combined into one composite sample for processing. Therefore, 80 composite samples (40 weeks x 2 diel periods) will be processed in the laboratory for the 2006-2007 entrainment program at the JAFNPP CWIS, unless some samples cannot be collected due to plant outages.

4.2 EQUIPMENT

The following items are required for laboratory analysis of ichthyoplankton in entrainment samples:

- Sorting pans
- Lights
- Magnifiers
- Dissecting microscopes
- Motoda plankton splitter
- Sieves
- Rose bengal
- Gridded Petri dishes
- Divided Petri dishes
- Jars, with lids

- Forceps
- Pipettes
- Multitally counters
- Squirt bottles
- Lab data sheets
- Pencils
- Vials, with caps
- Vial labels
- Taxonomic literature
- Copy of SOP
- Ocular micrometers
- Millimeter rulers
- Masking tape
- Rubber bands
- Random number table

4.3 PROCEDURES

4.3.1 Sample Preparation

Two diel periods (daytime and nighttime) will be sampled on each sampling day in each of 30 consecutive weeks (April through October) plus an additional 10 weeks (November through March), and two depths (14 ft and 20 ft) will be sampled during each diel period. Once the entrainment samples have been received by the laboratory, the two depths sampled for each day and diel period should be paired up and combined to represent one depth-integrated sample. Each depth-integrated or composite sample will be analyzed as representative of the entrainment collection for the corresponding diel period. Therefore, 160 entrainment samples will be collected (40 weeks x 2 diel periods x 2 depths) and 80 composite samples (40 weeks x 2 diel periods) will be processed in the laboratory for the 2006-2007 entrainment program for the JAFNPP CWIS, unless some samples cannot be collected due to plant outages. All subsequent analysis described in this laboratory SOP will be of these depth-integrated or composite samples.

4.3.1.1 Subsampling Restrictions and Quotas

Samples with high abundances may be subsampled in the laboratory, with a minimum of 200 eggs and larvae to be analyzed. This quota applies to the total count of all species combined, not to individual species.

For each sample with a low ichthyoplankton concentration and a high total volume of detritus and other plankton (more than 400 ml settled volume), sort a maximum of one-half of the sample for eggs and larvae.

4.3.1.2 Sample Splitting Sequence

Use the following sequence of procedures in processing a sample that is subsampled by splitting. To eliminate any chance of bias, some steps in the procedure are to be performed by an assistant, as indicated below, so that the sorter has no prior knowledge of which samples are to be subjected to quality control inspection.

This procedure also applies when a previously split sample is further subsampled, such as an "id. split" performed because the fraction sorted was larger than necessary to meet the quota. In this situation the term "sample" in the following procedure refers to the part of the original sample that is to be further subsampled, and the selected fraction(s) are "analyzed" rather than "sorted."

1. Examine the sample to estimate the smallest size fraction that is likely to contain at least 200 eggs and larvae.
2. Divide the sample material into two equal parts using the techniques in Section 4.3.1.3.
3. Randomly select one of the two divisions for processing (or for further subsampling, if a smaller fraction is needed). Selection should be done using a random number table or a coin toss, so that each of the two divisions has an equal chance of being selected. The person performing the division must not know which of the two divisions will be analyzed before the division is completed (it is not acceptable to always select the division from the same chamber of the splitter).
4. Set aside the fraction not selected for further processing and label it to identify the sample number and fractional size.
5. If the fraction that was selected for further processing needs to be subsampled further, repeat steps 2-4 as many times as necessary to produce the desired fraction for analysis. When the desired fraction is obtained, label it to show the sample number and fractional size.
6. Sort the subsample by the procedures in Section 4.3.2. Organisms must be sorted from the entire subsample even if the quota is reached before finishing the subsample.

4.3.1.3 Sample Splitting Technique

Perform all sample splitting using a Motoda splitter. The presence of filamentous algae or large items (including large juvenile fish, or older age classes) can interfere with the even distribution of material and organisms between the two chambers of the splitter. Therefore, to insure successful results, observe the following techniques: (1) Adjust sample dilution to be great enough to allow free mixing of the sample but not so great as to promote clumping due to over dilution. (2) Remove large fish and excessive amounts of filamentous algae before splitting, returning any adhering ichthyoplankton to the sample. (3) Pull apart remaining clumps of algae before splitting. (4) Scrutinize detritus and organisms during the splitting process to see that they appear equally distributed before making the final division. (5) Remix and split again if the two resulting portions of a division do not appear equal. If a sample has so much algae that it cannot be satisfactorily split, sort the entire sample, and if numbers of ichthyoplankton are high splitting may be performed after sorting. Large juveniles that are removed from the whole sample before splitting must be kept separate from ichthyoplankton sorted from the sample after splitting, and they must be labeled to show they represent the whole sample.

4.3.2 Sorting

Remove fish eggs, larvae, and juveniles from the samples according to the following procedures:

- Samples may be stained with rose bengal to facilitate sorting.
- Pour the sample contents into a sieve with a mesh equivalent to, or finer than, 500 μm and rinse with water to remove the preservative.
- If the sample contains large numbers of eggs and larvae, prepare a subsample following the procedures in Section 4.3.1.
- Carefully wash the sample contents into a container making certain that nothing remains in the sieve. Pour portions of the sample from the container into a pan and examine them under a magnifying lens.
- Remove fish eggs, larvae, and juveniles from the sample using forceps, pipettes, and probes. Remove only those fragments that include the head.
- Maintain a combined total count for eggs and larvae that are removed from the sample (i.e., the combined total of eggs, yolk-sac larvae, post yolk-sac larvae, and juveniles).
- When sorting is completed, recheck the sample for organisms. After the sample has been rechecked, label vials containing the sorted organisms and place them in a box designated for sorted samples. Record the sorting results and date completed in a log.
- Carefully wash back the remaining sample contents into the original sample container, appropriately preserved, and return it to the storage area.
- If a sample is not completed by the end of the work day, it may be left unpreserved overnight if adequate precautions are taken to prevent it from drying out. No sample or part of a sample, however, should remain unpreserved for more than 24 hours.

4.3.3 Identification

Identify, stage, count, and measure the sorted ichthyoplankton according to the following procedures:

- Obtain the sample vials containing the sorted organisms from the storage area and sign them out by initialing a status log.
- Rinse specimens free of preservative and submerge them in water in a Petri dish. Use a binocular microscope with an ocular micrometer to examine the specimens, and identify

them to the lowest practical taxon (usually species) by referring to the literature, the reference collections, and by consulting with fellow identifiers.

- Determine the life stage of each specimen. Pertinent life stages for all larvae are defined and identified as follows:

  Egg: the embryonic developmental stage, from spawning until hatching. Eggs frequently become damaged during collection and sample processing. Damaged eggs are counted as the number of embryos (without regard to how many egg capsules are present). Do not count non-fertilized eggs if they are present.

  Yolk-sac larva: the transition stage from hatching through the development of a complete, functional digestive system (regardless of the degree of yolk and/or oil globule retention)

  Post yolk-sac larva: the transition stage from development of a complete, functional digestive system to transformation to juvenile form (regardless of the degree of yolk and/or oil globule retention), including the leptocephalus stage of eels

  Young-of-the year: the stage from completed transformation to Age 1 (i.e., 12 months after hatching). A young-of-the-year has a full complement of fin rays identical to that of an adult. Eels are classified in this stage until Age 2.

  Yearling or older: a fish at least one year old.

- Count the specimens of each life stage. Record the counts by species and stage on the lab data sheet (refer to Section 4.5.1 for coding instructions).

- From each sample, measure a maximum of 30 larvae of each fish species to the nearest 0.1 mm (total length) and record the measurements on the lab data sheet. If juvenile fish are present in the sample, they will be measured to the nearest 1.0mm (total length). If more than 30 larvae are present, randomize the selection of specimens for measuring by the following procedure. Spread them uniformly in a gridded container, select a starting point in the grid by means of a random number table, and then measure the first 30 measurable specimens encountered in a predetermined pattern commencing at the starting point. Every grid space must have an equal probability of being selected as the starting point, so that every specimen will have an equal probability of being included in the subsample.

- Place identified organisms in vials with an adequate amount of preservative for storage. Specimens may be removed for inclusion in the reference collection. For those removed, list the species, life stage, and numbers on the comments section of the form and note their removal on a tag retained inside the appropriate vial. Label all vials for a single sample, initial them and band them together. Record the number of vials for the sample on the data form. For reference collection procedures refer to Section 4.7.

4.4 SAMPLE HANDLING

4.4.1 Sample Control

Each sample was given a unique sample number at the time of collection. Track each sample by that sample number throughout the laboratory and data processing functions.

4.4.2 Chain of Custody Records

The chain of custody documentation begins with the field office providing a list with the following information for each sample in a shipment delivered to the laboratory facility: sample collection date, sample collection time, sample identification number, and number of jars. Upon receipt of the samples, a laboratory representative verifies that all jars of all samples on the list are present, then signs and dates the chain of custody document.

After samples have been received in the laboratory, track their location and status during all phases of storage and laboratory analysis by means of sample control logs. The function of this system is to provide a paper trail of who performed each step in the analysis of a sample from collection to storage, when each step occurred, what condition the samples were in and where each step took place.

4.4.3 Preservation and Storage

Retain the original preservative (formalin solution) for reuse in preserving the residue of sorted samples, adding 5% formalin as needed to fill the sample jars. Store processed samples (i.e., detritus and organisms not removed from split samples) until sorting quality control checks are completed. Keep sorted ichthyoplankton in vials in a heated storage area until disposal is authorized (up to one year after submittal of data files to JAFNPP). Tape the tops of jars and vials to prevent loss of preservative by evaporation.

4.4.4 Disposal

Disposal of sample residue remaining after sorting (detritus and organisms not removed from split samples) may proceed after sorting quality control has been completed. Disposal of vials of organisms from processed samples may proceed after receiving authorization from JAFNPP. Follow all applicable state and federal regulations for hazardous waste disposal.

4.5 DATA HANDLING

4.5.1 Data Sheets and Coding Instructions

Record ichthyoplankton counts and measurements on Entrainment Lab Count Data Sheets and Entrainment Lab Length Data Sheets (Appendix A). The Entrainment Lab Count Data Sheet is for count data for all taxa. The Entrainment Lab Length Data Sheet is for measurements of all species. Indicate in the upper right-hand corner of each data sheet how many pages there are for the sample (use "1 of 1" for a one-page sample, "1 of 2" and "2 of 2" for a two-page sample, etc.). Record also in the upper right-hand section of the first page the identifier's initials, the date the sample was identified, and the number of vials.

4.5.1.1 Count Data

Record count data in the top ("Card Type L1") section of the data sheet according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the 4-digit sample number. Sample numbers will be in the range 2011 to 2524 (but not every number in that range is used).
CARD TYPE	Preprinted: L1
CATCH_CD	Enter 1 for valid non-empty sample or 2 for valid empty sample (data sheets are not required for void samples)
SPL_FACT	Enter 1.00 if the whole sample is analyzed; if the sample is subsampled record the ratio of the whole sample to the subsample (e.g., 8.00 for a 1/8 split)
TAXON	Enter the TAXON code from the Taxon Code List (Appendix B).
STAGE	Enter one of the following life stage codes: 0 = unknown 1 = eggs 2 = yolk-sac larvae 3 = post yolk-sac larvae 4 = young-of-the-year 5 = yearling or older
COUNT	Record the number of organisms of the indicated taxon and life stage in the sample (or subsample)
SPECIES NAME	Record the common name for the taxon

4.5.1.2 Measurement Data

Record measurement data for fish larvae on one or more Entrainment Lab Length Data Sheets according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the sample number
Card Type	Preprinted: L2
Conversion Factor	Record the number of millimeters per division for the optical micrometer used to measure larvae
TAXON	Enter the taxon codes for other species measured on Entrainment Lab Length Data Sheets.

VARIABLE	INSTRUCTIONS
FISH_ID	Preprinted: 1-30 for fish species
STAGE (or "STG.")	Enter the life stage code for each larva measured (2, 3, 4, or 5 for fish species). Refer to the life stage code definitions used for count data (Section 4.3.3).
SCALE	Enter 6 if measurements are recorded in optical micrometer units; enter 7 if measurements are recorded directly in millimeters. (If optical micrometer units are recorded for a measurement, the actual length in millimeters will be obtained later by multiplying the measurement by the conversion factor.)
MEASUREMENT	Record the total length of larvae to the nearest 0.1 optical micrometer unit or to the nearest 0.1 mm. Juvenile fish are measured to the nearest 1.0 mm total length.

4.5.2 Storage and Chain of Custody of Data Sheets

Maintain all completed data sheets in duplicate. Keep photocopies at the site of origin and transfer the originals as needed from the laboratory to the data center, quality control, and a master project file. Track the custody of data sheets by means of data control logs.

4.6 QUALITY CONTROL

4.6.1 Tasks Subject to Quality Control

The following tasks are subjected to quality control checks consisting of reanalysis of randomly selected samples or measurements:

- sorting
- identification, life stage determination, and enumeration

4.6.2 Inspection Plans

Items are inspected using a quality control (QC) procedure derived from MIL-STD (military-standard) 1235B (single and multiple level continuous sampling procedures and tables for inspection by attributes) to achieve a 10 percent or better AOQL (Average Outgoing Quality Limit). The QC procedure used is the CSP-1 continuous sampling plan, which is conducted in two modes as follows:

- ***Mode 1.*** Reinspect one hundred percent of the samples until "i" consecutive samples pass.
- ***Mode 2.*** After "i" consecutive samples pass QC reinspection, randomly choose (using a random numbers table) the fraction "f" of the samples for reinspection. If any QC sample fails then return to Mode 1.

For this application of CSP-1, **i=8** and **f=1/7**, because the total number of samples analyzed by an individual is less than 500. It is important that QC inspections are performed as soon as possible after the original analysis; work-up of QC samples must not be postponed to be done in batches. Keeping the QC program as current as possible insures that problems are detected and remedied quickly, minimizing the additional number of samples that are analyzed before the problem is addressed.

Select items for reanalysis according to the plan using a random number table. The original analyzer should not know whether a sample is to be checked before the analysis of that sample has been completed. Perform all quality control checks "blindly" (i.e., the individual performing the QC inspection should have no knowledge of the original analyst's results).

Apply the QC plan on an individual processor basis, so that each person's work is subjected to the QC plan independently of others, starting at 100% inspection.

A resolution (third person) value may be determined for any sample found defective. All errors found during the QC check, whether the sample is found to be defective or not, are to be corrected on the data sheets. (A difference between original and QC counts that is within acceptable limits is not considered to be an error). Results of the quality control program are to be presented to all sorters and identifiers and help is to be made available to anyone failing a QC check.

In some cases a QC inspection may be able to determine the taxon or life stage of damaged specimens when the original identifier has recorded them as unknown life stage, unidentified taxon, or a higher level taxon (genus or family). If a more general taxon or life stage used by the original identifier includes the more specific category used by the QC inspector, and that is the only reason for a count discrepancy, then that sample does not fail the QC inspection on the basis of that taxon. For example, damaged specimens recorded as *Morone* sp. by the original identifier and as striped bass by the QC inspector are to be considered in agreement because the category *Morone* sp. includes striped bass. In contrast, an original determination of unidentified gobiid would not be acceptable if the QC determination was striped bass, because striped bass is not included in the family Gobiidae. If substantial differences occur between the original and QC counts as a result of identifying or staging to different levels, then the identifier should be provided with additional guidance or training to minimize such differences in future samples.

4.6.3 Acceptance/Rejection Criteria

4.6.3.1 Sorting

A sample is considered defective if the sorter failed to remove 10 percent of the total organisms in the sample (or subsample). Percent error is calculated as follows (where "QC count" denotes the number missed by the sorter):

% error = 100% x QC count/(sorter's count + QC count)

When the total count (sorter's plus QC) is ≤20, then the sample is considered defective only if the sorter missed more than two organisms.

4.6.3.2 Identification

A sample is considered defective if an error of 10 percent or more is made in identifying, assigning a life stage, or counting any species. In determining whether a sample is defective, analyzer and QC results are compared within each taxon/life stage combination.

For each taxon (or for a life stage within a taxon) the percent error is calculated as follows (except where the QC count is ≤20, the percent error is considered to be zero if analyzer and QC counts differ by no more than two organisms):

$$\% \text{ error} = 100\% \times |\text{analyzer count} - \text{QC count}| / \text{QC count}$$

A sample with a percent error of greater than or equal to 10% for any life stage for any taxon is considered defective.

For each defective sample, a resolution may be determined in which a third person reanalyzes the sample (resolution value). The error for each species and life stage will then be calculated using the resolution counts as the divisor. This will be done for both identification and QC counts:

$$\% \text{ error} = 100\% \times |\text{identifier count} - \text{resolution count}| / \text{resolution count}$$

$$\% \text{ error} = 100\% \times |\text{QC count} - \text{resolution count}| / \text{resolution count}$$

If the resolution vs. identifier error is <10 percent, the sample passes. If they are not, the sample fails and identifier counts are replaced by QC counts for all cases, provided the QC vs. resolution error is <10 percent. If the resolution vs. identifier and the resolution vs. QC errors are both 10 percent or more, the sample will be thoroughly reviewed by all three people and the identifier's sample processing will not continue until agreement can be reached on the identification of the sample. Subsequent samples will be reanalyzed by the QC person until eight consecutive samples pass. Notify the Laboratory Manager of any identifier exceeding two failed samples.

4.6.4 Quality Control Records

Maintain quality control logs, documenting the samples analyzed, the samples selected for reanalysis according to the QC plan, the results of the QC analysis, and any corrective action performed. All QC logs will be 100% inspected monthly by the Laboratory Supervisors. A summary report of quality control results and follow-up corrective action will be submitted to the client upon request.

4.6.5 Quality Control Personnel

The QC of the sorting process is to be conducted under the direct supervision of the Sorting Supervisor. Only the Sorting Supervisor or individuals with a documented sorting QC record of superior performance may provide sort QC.

Regarding identification QC, only the Identification Supervisors will be performing the QC on ichthyoplankton identification.

4.7 REFERENCE COLLECTION

Make sure that each taxon and life stage identified in the JAFNPP entrainment program is represented in a project-specific ichthyoplankton reference collection at the biology laboratory. Develop this reference collection by removing specimens from JAFNPP entrainment samples and storing them in vials in a designated area. If available, include several (e.g., 10) specimens per taxon per stage, displaying a variety of sizes. Label the vials with the scientific name, date of capture, capture location, and a reference collection catalog number. The catalog number identifies a card containing more detailed sampling information, identifier, comments, etc. File the cards alphabetically by family, genus, and species.

4.8 INSTRUMENT CALIBRATION

Calibrate each ocular micrometer periodically (at least weekly) using a stage micrometer. After calibration of ocular micrometers on zoom microscopes, place a calibration mark on the microscope so that measurement accuracy is maintained. Ocular micrometers on microscopes that have been adjusted or moved must be recalibrated before use. Document the calibrations in a log showing the dates and results of the calibrations.

5.0 DATA PROCESSING

5.1 DATA ENTRY VERIFICATION AND DATA SHEET CHAIN OF CUSTODY

Provide a submittal form with each batch of data sheets submitted to the Technical Data Processing (TDP) department for data entry. Information on the submittal form should include names of sender and recipient, date sent, and dates of impingement collections included in the batch.

Key all data twice, resolving discrepancies between the two versions as they are flagged by the data verification program.

After data entry and verification are complete, transfer custody of the data sheets from TDP to the originators, where they are used in the error checking and quality control tasks, and finally stored in a project file. Document the transfer from TDP back to the originator by one or more submittal sheets containing the same information as those used to transfer custody to TDP. TDP is not required to maintain copies of the data sheets. After JAFNPP accepts the data files and final report, the original data sheets and paper copies of them may be discarded.

5.2 SYSTEMATIC ERROR CHECKS

Keyed data are subjected to a series of systematic error checking programs developed specifically for this project. These consist of univariate, bivariate, and multivariate checks specified by project personnel. Univariate range checks identify records for which one or more variables have values outside their valid or expected ranges. Bivariate and multivariate checks compare values of related variables.

Additional checks scan the data for duplicate or missing observations. All records flagged by these programs are resolved, and corrections to both the data files and the data sheets are made as necessary. After error checking is complete, data files are subjected to quality control inspection (refer to Section 5.4).

5.3 DATA FILE FORMAT

Error checked data files are assembled into a SAS, Excel, or Microsoft Access database.

5.4 QUALITY CONTROL OF DATA FILES

Data files that have completed the systematic error checking process undergo a QC inspection to assure a 1% AOQL (Average Outgoing Quality Limit) according to a lot sampling plan (American Society for Quality Control. 1993. Sampling procedures and tables for inspection by attributes. ANSI/ASQC Z1.4-1993.). This procedure insures that ≥99% of the observations in a data file agree with the original data sheets. The number of observations to be checked, and the number of those that must be within tolerance are shown below. If more than the acceptable number of failures are found, then the data set must be inspected 100%.

Lot Sampling Plan for QC Inspection at Less Than 1% AOQL.

		Number of Failures	
Lot Size	**Sample Size**	**Accept If ≤**	**Reject If ≥**
1-32	ALL	0	1
33-500	32	0	1
501-3,200	125	1	2
3,201-10,000	200	2	3
10,001-35,000	315	3	4
35,001-150,000	500	5	6
150,001-500,000	800	7	8
500,001 and over	1,250	10	11

6.0 TRAINING

In order to assure the standardization of field, laboratory, and data processing procedures, a two level system for training technicians is followed: the first level being documented standard operating procedures; the second level being a training program for all new project personnel. At a minimum, this training program consists of the following steps:

- A complete reading and explanation of the project SOP and QA manual. This is documented by a sign-off sheet which is filed in the program file.

- Observation by the Program Manager, Field Site Supervisor or Laboratory Manager of the first two or more times a new procedure is performed. This is documented with a signed checklist.
- Direct supervision by an experienced technician of personnel assigned to unfamiliar tasks for their first two or more attempts.
- 100% quality control checks for at least the first five samples analyzed.
- On tasks requiring identification of fish and ichthyoplankton, the Program Manager will have final approval as to who is qualified to make these identifications. In some cases special training will be required to participate in tasks, as set forth by the Program Manager.

7.0 QUALITY ASSURANCE

7.1 NONCONFORMANCE REPORTS AND CORRECTIVE ACTION

Documentation of problems or unusual events occurring during a program will be accomplished using Extraordinary Event/Nonconformity (EENC) forms. The EENC form (Appendix A) is designed to dispense information to the Program Manager and Quality Assurance department and to obtain necessary action on items that are critical to technical operations and management of programs. The report results from observations such as these:

- deviations from standard operating procedures
- losing a sample
- finding an endangered species in a sample
- noting samples that are grossly different from expected (content, preservation, labels)
- noting a phenomenon that may deserve continued monitoring in the interest of the client and therefore may require a change in the scope of work
- quality control samples that exceed acceptable limits
- unusually high impingement counts.

Items, samples, data, or information not in conformity with specifications or which do not meet preconditions for the next step in processing or use, are set aside until the problem is resolved and documented via the EENC report procedure.

The EENC report is designed for use by any person who identifies a problem or discovers information that is germane to a program scope of work or the improvement or change of contract performance. The originator describes the problem and may make recommendations for its resolution. Two temporary copies are made, and the original is sent to the Program Manager. One of the copies is kept by the originator in a file for "open" EENC reports (corrective action in progress), and the other is sent to the Quality Assurance Supervisor, who periodically checks on the progress of corrective action.

The Program Manager confers with appropriate parties and decides what corrective action will be required. Instructions to the Action Addressee (the person responsible for carrying out the corrective action) are written on the original EENC report. The Program Manger retains the original and sends a copy to the Action Addressee.

The Action Addressee resolves the problem as directed and then signs the EENC copy and returns it to the Program Manager to signify that the corrective action has been completed.

The Program Manager files the signed copy from each Action Addressee (there may be more than one), and when all corrective action is complete signs the original EENC report, keeps a temporary copy, and forwards the original to the QA Supervisor.

The QA Supervisor reviews the EENC report, and signifies acceptance of the resolution by signing and dating the report to "close" it. A copy of the closed EENC report is retained in QA files, the temporary copy received earlier from the originator is discarded, and the original is returned to the Program Manager.

The Program Manager discards the temporary copy and keeps the original on file. A copy of the closed EENC report is sent to the originator, and additional copies are sent to any other affected parties. The originator discards the temporary copy in the file of open EENC reports and files the copy of the closed EENC report.

7.2 QA AUDITS

It is the responsibility of the Quality Assurance organization to verify the achievement of quality through all phases of the project. Once the proposal, program design, and work development phases are complete, these responsibilities will be accomplished primarily by audits, tests, and surveys which will provide objective evidence that the quality control program and technical requirements, methods, and procedures as outlined in the study QA manual are being implemented. All field, laboratory, and data processing tasks will be subject to at least one audit. These audits will be conducted by an audit team of technically qualified personnel familiar with, but independent of and not responsible for, the work or activities under evaluation. The audit team will review the operations, specifications, QC systems, plans, and project objectives and examine the acquisition and transfer of data from field to report.

Observations of nonconformities and program deficiencies will be classified into three categories:

A. Deficiencies that affect the data adversely;

B. Deficiencies that might affect the data adversely; and

C. Deficiencies or procedural changes that cannot affect the data adversely.

Class A deficiencies will be resolved before that portion of the program can proceed. Class B deficiencies must have a determination as to whether they should be changed to Class A or C deficiencies and whether or not corrective action is necessary. If corrective action is necessary, it will be performed within a reasonable time frame agreed to by the program management, the Quality Assurance Department, and JAFNPP. Operations with Class A or B deficiencies will be subject to reaudit to determine the effectiveness of corrective action. Class C deficiencies must have corrective action accomplished before the next scheduled audit or end of the project, whichever comes first.

Audit results will be presented orally to the appropriate project or facility management by the audit team after the audit has been completed. At this time, specific findings will be presented and recommended courses of corrective action developed. Subsequently, the audit results will be documented in a written audit report and reviewed by management having responsibility in the areas audited. These reports will include a summary of audit results, observations made with a listing of non-conformities, recommendations and corrective action taken.

The quality assurance director will maintain a file of all project and facility audits. This file will include copies of the audit checklists, audit reports, written replies, the record of completion of corrective action and follow-up action. A summary report of audit results, and follow-up corrective action will also be made available for JAFNPP review.

APPENDIX A

Forms

FITZPATRICK NUCLEAR POWER PLANT, 2006

Entrainment Lab Count Data Sheet

Sample [ ] Card [L1] Container # [ ] Period [ ] AD [ ] Catch_CD [ ]

Analyzed By: ______
Date: ______
No. Vials: ______

SPL_FACT	TAXON	STAGE	COUNT	SPECIES NAME

Stage Codes

0 = unknown
1 = egg
2 = yolk-sac larvae
3 = post yolk sac larvae
4 = young of year
5 = yearling or older

Sample [ ] Card Type [L2] Conversion Factor [ ] Taxon [ ]

PAGE ___ of ___

Entrainment Sampling Quality Assurance Plan

FITZPATRICK NUCLEAR POWER PLANT, 2006

Entrainment Lab Length Data Sheet

Sample [ ] Card [L2]

Stage Codes: 0 = unknown
2 = yolk sac larvae
3 = post yolk sac larvae
4 = post yolk sac larvae
5 = yearling or older

Page__ of __

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

FITZPATRICK NUCLEAR POWER PLANT, 2006

Hazardous Substances Log, page ___

Amounts of formalin and gasoline brought on site for entrainment sampling

Date	Name	Gallons of Formalin	Gallons of Gasoline

FITZPATRICK NUCLEAR POWER PLANT, 2006

Entrainment Field Data Sheet

CODES

diel	1=0800-1400	
	2=1400-2000	
	3=2000-0200	
	4=0200-0800	
status	0=void, no sample	
	1=valid sample	
	2=flowmeter problem	
comments	1=yes	
	blank=no	

SAMPLE

type	week	diel	status	comments
2				

DATE & TIME

	month	day		hour	min
start			start		
			end		

VOLUME

	gallons
end	
start	
difference	

CALILBRATION

	trial 1	trial 2	trial 3
gauge gpm			
calibration seconds			
calibration gallons			
calibration gpm			
percent error			

average % error

COMMENTS

EXTRAORDINARY EVENT/NONCONFORMITY REPORT

EE/NC Report Number: Date: ____________ From: ____________

Respond by (date): ____________ Project No.: ____________ Title: ____________

Date closed: ____________

ADDRESSEES:
QA: __√__ Project Mgr.: ______ Field Mgr.: ______ Lab Mgr.: ______ Technical Mgr.: ______ Others: ______

PROBLEM DEFINITION (e.g., Sample ID, Activity, Data, Standard, etc. Not in Conformity) :

RECOMMENDATIONS FOR or CORRECTIVE ACTION TAKEN:

Signed:

ACTION ADDRESSEE RESPONSE:

CORRECTIVE ACTION COMPLETED: Date: ____________ Signed: ____________

Distribution: ORIGINAL:QA, COPIES OF ORIGINAL: Originator, Addressees
RESPONSES: QA (responses are to be made on copies)

Appendix B

Fish Taxon Codes

Appendix Table B-1. Taxon codes for fish species.

Taxon Code	Common Name
1	alewife
2	bay anchovy
3	American shad
4	bluefish
5	bluegill
6	brown bullhead
7	pumpkinseed
8	black crappie
9	common carp
10	American eel
11	goldfish
12	golden shiner
13	hogchoker
14	tessellated darter
15	banded killifish
16	emerald shiner
17	largemouth bass
18	mummichog
19	Atlantic menhaden
20	(use 59)
21	chain pickerel
22	blueback herring
23	white sucker
24	Atlantic silverside
25	rainbow smelt
26	smallmouth bass
27	shortnose sturgeon
28	spottail shiner
29	Atlantic sturgeon
30	striped bass
31	fourspine stickleback

Appendix Table B-1 (Continued)

Taxon Code	Common Name
32	Atlantic tomcod
33	to be identified
34	white catfish
35	white perch
36	yellow perch
37	satinfin shiner
38	rock bass
39	northern pipefish
40	redbreast sunfish
41	Atlantic needlefish
42	crevalle jack
43	eastern silvery minnow
44	fallfish
45	weakfish
46	comely shiner
47	common shiner
48	mimic shiner
49	lookdown
50	unidentified clupeid
51	(use 50)
52	(use 60)
53	grass pickerel
54	lined seahorse
55	logperch
56	trout-perch
57	northern hog sucker
58	fathead minnow
59	unidentified cyprinid
60	unidentified *Morone*
61	redfin pickerel
62	tautog
63	fourbeard rockling

Appendix Table B-1 (Continued)

Taxon Code	Common Name
64	striped cusk-eel
65	(use 96)
66	northern kingfish
67	spot
68	Atlantic moonfish
69	brook stickleback
70	unidentified sturgeon
71	scup
72	winter flounder
73	inland silverside
74	sea lamprey
75	gizzard shad
76	silver hake
77	striped mullet
78	threespine stickleback
79	brown trout
80	butterfish
81	white crappie
82	brook trout
83	northern pike
84	green sunfish
85	silver perch
86	northern puffer
87	eastern blacknose dace
88	bridle shiner
90	cutlip minnow
96	unidentified centrarchid
97	spotfin shiner
98	red hake
99	unidentifiable
100	central mudminnow
101	grubby

Entrainment Sampling Quality Assurance Plan

Appendix Table B-1 (Continued)

Taxon Code	Common Name
102	eastern mudminnow
103	white bass
104	rough silverside
105	longear sunfish
106	summer flounder
107	longnose dace
108	creek chub
109	black bullhead
110	striped searobin
111	northern searobin
113	Atlantic croaker
114	longhorn sculpin
115	round herring
116	hickory shad
117	Atlantic herring
118	reef silverside
119	striped anchovy
120	conger eel
121	striped killifish
122	warmouth
123	bluntnose minnow
124	walleye
125	white mullet
126	yellow bullhead
127	channel catfish
128	pollock
129	seaboard goby
130	naked goby
131	yellowtail flounder
132	windowpane
133	spotted hake
134	unidentified searobin

Entrainment Sampling Quality Assurance Plan

Appendix Table B-1 (Continued)

Taxon Code	Common Name
136	northern stargazer
137	American sand lance
138	fat sleeper
139	fourspot flounder
140	Atlantic mackerel
141	black sea bass
142	smallmouth flounder
143	rock gunnel
144	inshore lizardfish
145	unidentified mudminnow
146	silver lamprey
147	rainbow trout
148	rosyface shiner
149	unidentified *Esox*
150	unidentified gobiid
151	unidentified *Fundulus*
152	unidentified cyprinodontid
153	unidentified *Myoxocephalus*
154	unidentified cottid
155	unidentified pleuronectiform
156	unidentified pleuronectid
157	unidentified atherinid
158	unidentified *Menidia*
159	unidentified bothid
160	speckled wormeel
161	unidentified syngnathid
162	mackerel scad
163	unidentified *Ammodytes*
164	cunner
165	unidentified sciaenid
166	unidentified gadid

(continued)

Entrainment Sampling Quality Assurance Plan

Appendix Table B-1 (Continued)

Taxon Code	Common Name
167	flying gurnard
168	shield darter
169	gray snapper
170	Atlantic cod
171	sea raven
172	bigeye scad
173	striped burrfish
174	sheepshead
175	unidentified percid
176	spotfin mojarra
177	spotfin butterflyfish
178	unidentified gasterosteid
179	planehead filefish
180	Atlantic cutlassfish
181	pigfish
182	short bigeye
183	guaguanche
184	freckled blenny
185	unidentified tetraodontid
186	orangespotted filefish
187	margined madtom
188	bluespotted cornetfish
189	black drum
190	northern sennet
191	scamp
192	cobia
193	least darter
194	unidentified percichthyid
195	scrawled cowfish
196	spotfin flyingfish
197	Gulf menhaden

(continued)

Entrainment Sampling Quality Assurance Plan

Appendix Table B-1 (Continued)

Taxon Code	Common Name
198	pugnose shiner
199	redfin shiner
200	sand shiner
201	swallowtail shiner
202	tiger muskellunge
203	goosefish
204	permit
205	freshwater drum
206	king mackerel
207	longnose gar
208	Spanish mackerel
209	highfin goby
210	unidentified sucker
211	unidentified labrid
212	blackcheek tonguefish
213	oyster toadfish
214	feather blenny
215	orange filefish
216	little skate
217	spiny dogfish
218	Atlantic seasnail
219	Gulf Stream flounder
220	spotted goatfish
221	brook silverside
222	harvestfish
223	pinfish
224	witch flounder
225	kokanee
226	ladyfish
227	radiated shanny
228	cusk
229	unidentified *Urophycis*

Appendix Table B-1 (Continued)

Taxon Code	Common Name
230	American plaice
231	slimy sculpin
232	sheepshead minnow
233	unidentified blenny
234	unidentified skate
235	clearnose skate
236	weakfish/scup
237	haddock
238	rudd

Note: Check with the project Technical Director if taxon is not found in this list

APPENDIX 4

JAFNPP 2006 Lake Ontario Sampling

Quality Assurance Plan and Standard Operating Procedures

January 2006

APPENDIX 4

QUALITY ASSURANCE PLAN AND STANDARD OPERATING PROCEDURES FOR LAKE ONTARIO STUDIES AT JAMES A. FITZPATRICK NUCLEAR POWER PLANT LYCOMING, NEW YORK

(SPDES PERMIT NO. NY 0020109)

ENTERGY NUCLEAR FITZPATRICK, LLC

James A FitzPatrick Nuclear Power Plant

277 Lake Road East

Oswego, New York 13126

Prepared In Consultation with

Enercon Services, Inc.

and

Normandeau and Associates, Inc.

R-20271.001

31 January 2006

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Lake Ontario Studies Quality Assurance Plan

1.0 INTRODUCTION

Entergy Nuclear FitzPatrick, LLC ("Entergy") owns and operates the James A. FitzPatrick Nuclear Power Plant ("JAFNPP"). JAFNPP is located on the southeastern shore of Lake Ontario approximately 7 miles (11 km) northeast of the city of Oswego, New York in Lycoming, New York. In a March 14, 2005 letter to Mr. Michael Rodgers of JAFNPP, Mr. Roy A. Jacobson, Jr. Steam Electric Unit Leader for the New York State Department of Environmental Conservation ("NYSDEC"), requested submission of information about JAFNPP consistent with the Phase II Regulations description of a Proposal for Information Collection ("PIC"), including:

- "identifying information previously submitted to the Department,
- need to update existing information, and
- need to collect new information or conduct monitoring studies."

In a letter from Mr. Roy A. Jacobson of the NYSDEC to Mr. T.A. Sullivan of JAFNPP dated 22 June 2005, NYSDEC recognized that JAFNPP's offshore intake is different than the shoreline bulkhead intake used by USEPA to establish the calculation baseline for the purpose compliance with the entrainment and impingement performance standards of the Phase II Regulations. Mr. Jacobson recommended that two years of studies commencing in 2006 would be required by NYSCEC to estimate the baseline impingement mortality and entrainment abundance for a hypothetical shoreline intake in the vicinity of Nine Mile Point.

Accordingly, JAFNPP proposes a two-year program of Lake Ontario nearfield studies for JAFNPP beginning in April 2006 and continuing through October 2007. The objective of this Lake Ontario sampling will be to obtain the data necessary to calculate the percentage reduction in impingement mortality and entrainment abundance due to the JAFNPP cooling water intake being located 900 feet offshore along the 25 foot depth contour instead of being a shoreline bulkhead intake. The percentage reduction due to intake location will be defined as the ratio between the abundance, catch per unit of effort (CPUE), or density of fish from pairs of samples taken by the same gear and collection methods in the shoreline area of Nine Mile Point and in the vicinity of the JAFNPP intake. Calculating ratios from the fish samples taken by the same gear deployed by the same methods at two different locations will eliminate the need to adjust the ratio for differences in gear efficiency, as would be the case if different gear were used in each location.

This document is a project-specific Quality Assurance Plan (QAP) consistent with USEPA protocols (USEPA 2001) that describes the Standard Operating Procedures to be used for the field, laboratory, and data file preparation activities for work to be performed in Lake Ontario in the vicinity of the JAFNPP intake structure, and is included with the PIC as Appendix 4.

1.1 ORGANIZATION OF THIS DOCUMENT

Following a narrative description of the cooling water intake structure (CWIS) at JAFNPP (Section 2.0) are separate stand-alone Standard Operating Procedures (SOPs) for defining the hydraulic zone of influence (Section 3.0), the impingement mortality calculation baseline (Section 4.0), and the entrainment calculation baseline (Section 5.0). Within each of the two sampling SOPs, subsections from the following list that are applicable to that SOP are included: sampling schedule and location, equipment, procedures, sample handling, data handling, quality control, reference collection, and instrument calibration and maintenance. Procedures for data processing, from receipt of completed data sheets to the final data files, are described in Section 6.0. A system for providing the appropriate training for project personnel is described in Section 7.0. Quality Assurance procedures are described in Section 8.0.

2.0 COOLING WATER INTAKE STRUCTURE DESCRIPTION

The CWIS at JAF is a submerged, shore-facing, remote intake with a total design intake flow of 388,600 gallons per minute (gpm). The CWIS is shared primarily by the Circulating Water (CW) and Service Water (SW) systems, and is located about 990 feet inland from the shoreline of Lake Ontario at coordinates N 43°31'37" and E76°23'49". The top of the CWIS is at elevation 232.8 feet, approximately 14 feet beneath the lake surface, which typically varies from elevation 244.0 feet to 248.0 feet. The intake consists of four segmented shore-facing openings, each 22 feet wide and 8 feet high, feeding a 14 foot diameter D-shaped intake tunnel that runs beneath the lake bed approximately 1,150 feet to the offshore screenwell and pumphouse. The base mat of the CWIS is at elevation 222.8 feet, approximately four feet above the lake bottom elevation of 218.8 feet.

Nine acoustical projector housings are symmetrically installed on top of the remote intake structure roof, located at elevation 232.8 feet, to provide for fish deterrence. The projectors can be removed for the winter months due to the ice packs possibly defacing the projector faces. The function and effectiveness of this system is discussed in detail in Section 5.1 (below) describing "Currently Implemented Technologies".

There are two sets of bar racks, an internally heated bar rack at the remote intake, and a trash bar rack in the screenwell of the CWIS. The heated bar rack at the remote offshore intake consists of 3 inch by 2 inch rectangular vertical bars on 12 inch centers across each 22 foot by 8 foot intake opening, a total of 88 bars. The primary purpose for this heated bar rack is the prevention of intake clogging due to frazil ice and/or large debris. The bar rack heaters are energized anytime water temperature is $\leq$37°F to prevent/remove ice formation. There are no installed systems to remove large debris from these racks with the plant operating, although original plant design provided "reverse flow" capability to backwash the remote intake racks when the plant is not at power. The design water velocity through the bar rack at the remote intake is 1.2 feet per second with all three circulating water pumps operating (fps; TI 1979).

The JAFNPP CWIS contains three vertical, mixed flow, dry pit type circulating water pumps. Each single speed intake pump has a rated 27 feet of total dynamic head (TDH), and a rated flow of 120,000 gallons per minute (GPM). The pump drivers are open, drip-proof, induction motors rated at 1,000 HP. During normal plant operation, all three CW pumps are operating with a combined design circulating water intake flow of 360,000 GPM (5.1 x 10^8) measured through the condensers.

3.0 DEFINITION OF THE HYDRAULIC ZONE OF INFLUENCE

3.1 OBJECTIVE

A mathematical model will be developed and used to define the three-dimensional shape and boundaries of Hydraulic Zone of Influence (HZOI) or 'withdrawal zone" for the JAFNPP cooling water intake structure (CWIS) in Lake Ontario near Nine Mile Point. Once defined, the HOZI will be used to delimit a sampling station in Lake Ontario that is representative of the fish populations directly exposed to entrainment and impingement mortality at the JAFNPP CWIS.

3.2 MATHEMATICAL MODELING

A mathematical model of the Hydraulic Zone of Influence (HZOI) for the cooling water intake structure (CWIS) will be prepared using computational flow dynamics (CFD) software, FLOW 3D. This software has been approved and applied as safety related for the Nuclear Regulatory Commission. Using existing electronic intake drawings and topographic information collected for the site, construction of a three-dimensional model of the CWIS and its immediate vicinity will be used estimate the HZOI, approach velocities, and appropriate sampling areas, within the entire water column while providing a graphic representation for these estimates when applied under normal or median atmospheric and operational conditions. Early stage development of the CFD model may be used in later stages of the CDS development as an evaluation tool to predict regulatory performance of the CWIS. Evaluation of appropriate operational or technological modifications may utilize this same modeling process for performance comparison and/or cost benefit analysis.

The HZOI for the plant's CWIS and subsequent biological sampling area will be determined by

1. Defining a coarse CFD grid using an existing CAD model of the off-shore intake structure
2. Applying reasonable (non-zero) influence boundaries to the CFD problem definition
3. Mapping existing lake bottom topographic information
4. Incorporating available basic bathymetric data and median water level
5. Running the CFD calculation
6. Generating a graphic representation of the results
7. Determining an estimated Hydraulic Zone Of Influence

8. Report the results for use to support biological sampling boundaries

This report will be prepared and submitted for review by the permitting authority at least 30 calendar days prior to the start of Lake Ontario sampling (Sections 4.0 and 5.0 below) so that the results can be used to establish the final sampling design.

4.0 IMPINGEMENT MORTALITY CALCULATION BASELINE

4.1 OBJECTIVE

JAFNPP proposes a two-year program of Lake Ontario nearfield studies for JAFNPP beginning in April 2006 and continuing through October 2007 with the objective of obtaining the necessary data describing juvenile and adult fish abundance to calculate the percentage reduction in impingement mortality due to the JAFNPP cooling water intake being located 900 feet offshore along the 25 foot depth contour instead of being a shoreline bulkhead intake. Data from April and October of each year will be extrapolated to the unsampled months. The percentage reduction due to intake location will be defined as the ratio between the abundance, catch per unit of effort (CPUE), or density of fish from pairs of samples taken by the same gear and collection methods in the shoreline area of Nine Mile Point and in the vicinity of the JAFNPP intake. Calculating ratios from the fish samples taken by the same gear deployed at two different locations will eliminate the need to adjust the ratio for differences in gear efficiency, as would be the case if different gear were used in each location.

4.2 SAMPLING DESIGN

Sampling design, gear, and procedures for the Lake Ontario juvenile and adult fish program will be consistent with the gear and procedures used in the earlier studies (TI 1980), except that hydroacoustic techniques will be added to the present study. Two transects perpendicular to shore will be established to coincide with two of the four transects established by TI (1980). Transect FITZ will be centered on the intake structure of JAFNPP, and is the same transect FITZ used by TI during the earlier studies. Transect FITZ-E will be located approximately 2000 ft. east of the JAFNPP intake. Transect FITZ represents the intake area, while transect FITZ-E is a nearfield control for the JAFNPP intake area that is not exposed to operation of the existing and permit-required fish deterrence system. Samples representative of the shoreline area of Nine Mile Point will be taken in Lake Ontario waters less than 10 feet of depth along each transect. Samples from the JAFNPP intake area of Nine Mile Point will be taken in Lake Ontario waters along the 25 foot depth contour along each transect, which is the depth contour where the JAFNPP intake is located. Therefore the following sampling stations will be designated for Lake Ontario studies to determine the impingement mortality calculation baseline:

- ***FITZ-10*** = Lake Ontario near shore water column at the 10 ft. depth contour immediately inshore from the JAFNPP intake,

- ***FITZ-25*** = three dimensional sampling area in the Lake Ontario water column around the JAFNPP intake structure at the 25 ft. depth contour defined as the hydraulic zone of influence (HZOI) according to the criteria and methods specified in Section 3.0 above,
- ***FITZ-E10*** = Lake Ontario near shore water column at the 10 ft. depth contour along a transect established 2000 ft. to the east of the JAFNPP intake and perpendicular to the shoreline, and
- ***FITZ-E25*** = Lake Ontario water column at the 25 ft. contour along a transect established 2000 ft. to the east of the JAFNPP intake and perpendicular to the Lake Ontario shoreline.

Each Lake Ontario sampling station will be designated by GPS coordinates determined in the field prior to the start of sampling.

4.3 Hydroacoustics Fish Enumeration

Hydroacoustics will be the primary sampling technique used to calculate the baseline adjustment ratio for impingement mortality at the JAFNPP CWIS. Arrays of digital, dual beam, elliptical transducers (facing 0°, 90°, 180, and 270° to each transect, or one continuously rotating transducer covering 360° in the horizontal plane) will be installed at fixed locations at the 10-foot and 25-foot contours along each of the two transects in the Nine Mile Point study area of Lake Ontario and used to provide continuous enumeration of fish abundance measured by signal (acoustic target) counting and fish biomass measured by echo integration during the April through October monitoring period of each year.

4.4 Gill Net Sampling to Determine Fish Species Composition

Species composition of adult and juvenile fishes quantified by hydroacoustics will be determined by sampling with sinking experimental gill nets deployed parallel to each contour as bottom sets at each station, but away from the transducer beams. Gill net sets will be made twice per month from April through October of each year. Soak time will be 24 hours, with each gill net set deployed near sunset, tended approximately 12 hours later after sunrise, and retrieved near sunset on the following day. Therefore, for each month a total of 16 gill net samples will be collected (2 transects x 2 depth contours x 2 diel periods x 2 events per month), and there will be 112 total gill net samples (7 months x 16 samples per month) scheduled for completion during each year. All fish collected in each gill net sample will be identified to species, and total length (nearest millimeter) and wet weight (grams, ±1%) will be recorded for a maximum of 50 individuals per species per sample. A project-specific reference collection will be made for each species and life stages collected, and all sampling activities will be performed under an approved Scientific Collector's Permit issued by NYSDEC for this study.

4.4.1 Gill Net Specifications

Experimental gill nets will be 8 ft deep and consist of six 25-foot long panels of different mesh sizes randomly arranged in a linear sequence into one net 150 feet long. The gill nets will be made from treated multifilament mesh ranging in 0.5 inch increments from 0.5 up to 3.0 inches bar mesh. The gill nets (Gear Code = 130) are sinking type constructed of multifilament nylon netting that is double selvage top and bottom. Webbing is pre-shrunk and heat set. The knots must hold without slipping. The float line is 3/8" braided poly foam and the bottom line is be 1/4" lead' core line. Hanging twine is #9 spun nylon and the twine is trimmed to avoid tangling. Panels are seamed together. Brail lines are 8 ft. long. Each hanging knot is double hitched. The thread is white in color. The specifications for mesh in each panel are as follows:

Panel Number	Panel Length Feet	Bar Mesh Netting Size (in.)	Bar Mesh Twine Size
1	25	0.5	#210/2
2	25	1.0	#69
3	25	1.5	#104
4	25	2.0	#104
5	25	2.5	#139
6	25	3.0	#139

4.4.2 Condition and Repair of Nets and Equipment

All nets and equipment are inspected prior to each use and must be found to be operable and in good repair. Any deficiencies or problems that would compromise the sampling effort or the safety of individuals conducting the sampling *must be corrected prior* to deployment or use. Extra and duplicate gear must be available at the site in case the gear are damaged beyond repair or gear are lost.

4.4.3 Invalid Samples

The following conditions invalidate a sample:

- Vandalism of stationary gear such as gill nets.
- Excessive clogging by debris.
- Twisted net due to strong currents, wave action, or improper set,
- failure to retrieve the net after the soak time (± 2 hours) due to weather conditions,
- Hang-downs on bottom structures,
- Improper deployment of net, or
- Excessive damage to net or loss of net.

Should any of these above conditions occur, the collection is invalid. This is noted on the field data sheet by assigning a USE_CODE of 5 (void) and providing a written comment to explain why the sample is considered void. All void samples must be repeated. All valid samples are assigned a USE_CODE of 1.

4.4.4 Field Equipment Checklist

Review the field equipment check list to be sure all of the required boat and sampling equipment is onboard and in good working order prior to leaving the office.

4.4.4.1 Standard Boat Equipment Onboard the Sampling Vessel

- Navigational charts
- Two oars
- Two anchors (one mushroom and one Danforth)
- GPS
- Fathometer
- First-aid kit
- One life jacket per person
- One set of rain gear per person
- Rubber boots
- Fire extinguisher
- 20 m of 1.1-cm nylon rope
- Hand-held or navigational compass
- Hand-held light
- Flares
- 2.5-gal. garbage pail

4.4.4.2 General Sampling Equipment

- Nylon towline or winch cable, metered snapping blocks, messengers, and trip mechanism
- Sampling gear (when using nets have two cups per net)
- Watch or stopwatch
- 30 m of 1.1-cm nylon rope
- Flowmeters (mechanical G.O. Model 2030R for Tucker trawl)
- Safety line (30 m of 1. 1-cm nylon rope with attached float)
- 1-L wide mouth plastic container per net sample
- 25-cm diameter plastic funnel
- 100-ml plastic graduated cylinder
- One data sheet per sample

- One sample label per sample
- One shipping label per sample
- Indelible black marker (Sharpie)
- Pencils
- Field notebook
- 100% formalin buffered with borax. Add 100 ml per 1 liter sample jar for 10% final solution of buffered formalin

4.4.4.3 Water Quality Instrumentation (as needed)

- Dissolved-oxygen/temperature meter
- Pocket thermometer

4.4.5 Gill Net Deployment Procedures

One gill net is deployed at each station, and all stations are fished concurrently. The end of the gill net is attached to a 6' spreader bar to alleviate the problem of net rolling in waves or fast current. A bridle 10' long connects the spreader to the anchor. Nets are set parallel to the shore with adequate floats for the conditions. Soak time will be 24 hours, with each gill net set deployed near sunset, tended approximately 12 hours later after sunrise, and retrieved 24 hours later near sunset on the following day.

Drop one weighted end of the net over the bow of the boat, and when the weighted end is firmly in place on the bottom, back the boat away parallel to shore while feeding out the rest of the net. Straighten and tighten the net as necessary to avoid twists and ensure weighted ends are firmly in place. Document all sampling activities (set time, date, location, gear only) on a field data sheet. Use one data sheet per gear and station. Have a second individual review data sheets for legibility of writing, completeness, and accuracy before proceeding to the next station.

At the end of the first approximately 12 hour period of soak time (set), retrieve each net and transfer the captured fish to a wash tub or live well. Begin retrieving the net at one end removing entangled fish as the net is worked into the boat. Reset the net for the next approximately 12 hour set. After the second set, retrieve the net again and remove the fish as before.

Process all fish caught (identify, count, measure length, measure weight). Document sampling activities (retrieval time, date, location, physical-chemical data, investigators, etc.) on the field data sheet. Have a second individual review the completed data sheets for legibility, completeness and accuracy before proceeding to the next station.

4.4.6 Handling of Fish

Remove all fish from the net as soon as possible. Place fish in a fresh bucket of river water or a live well before processing begins. Work carefully, but quickly to reduce stress to the fish. Release alive fish as soon as possible. Some of the cyprinids and other smaller fish can be difficult to identify in the field. These small specimens may require preservation and closer examination under a laboratory setting. A voucher collection of all fish species will be established. Avoid holding fish longer than needed. All dead fish must be disposed of in accordance with all applicable laws, codes or regulations.

4.4.7 Enumeration

Identify and count all fish from samples to the species level. Measure (total length to the nearest mm) and weigh (to the nearest 1%) all fish from each sample. If there are more than 50 fish of any one species in a sample, then a representative subsample of 50 fish of that species will be measured and weighed.

4.4.8 Rare and Endangered Species

Any rare, threatened, endangered, or species of special concern (Table 4-1) is handled with special care, and returned to the water alive after being identified, measured to the nearest mm, and weighed to the nearest gram. Lake sturgeon is the species most likely to be encountered. Any animals that are dead at the time of capture are transported to the laboratory, frozen, and saved for the New York State Department of Environmental Conservation (NYSDEC) for the duration of the collector's permit. Inform the JAFNPP project manager and NYSDEC of the capture of any rare, threatened, en dangered, or species of special concern.

Table 4-1. Endangered and Threatened Fishes in New York State.

Endangered Species	
Common Name	**Scientific Name**
Round whitefish	*Prosopium cylindraceum*
Pugnose shiner	*Notropis anogenus*
Eastern sand darter	*Ammocrypta pellucida*
Bluebreast darter	*Etheostoma camurum*
Gilt darter	*Percina evides*
Deepwater sculpin	*Myoxocephalus thompsoni*
Threatened Species	
Common Name	**Scientific Name**
Lake Sturgeon	*Acipenser fulvescens*
Mooneye	*Hiodon tergisus*
Lake clubsucker	*Erimyzon sucetta*
Mud sunfish	*Acentharchus pomotis*
Longear sunfish	*Lepomis megalotis*

4.4.9 Postsampling Procedures

- Clean all sampling gear.
- Dismantle all mechanisms (i. e. trip releases, flowmeters, plankton cups, safety line).
- Remove all gear from the boat and place in a storage area or perform necessary preventive maintenance or repairs.
- Remove all samples, aquatic forms, and log books, and transfer them to the laboratory.
- Wash the boat and trailer.
- Inspect the boat hull and trailer and remove any clinging aquatic vegetation to prevent transfer to another water body.
- If sampling in waters with a known zebra mussel population, follow the zebra mussel transfer prevention procedures described in Section 4.4.10 below.
- Arrange the stored samples in order according to gear type, site, station; and date and log them with the appropriate data in the log book.

4.4.10 Zebra Mussel Transfer Prevention Procedures

Normandeau is concerned about the potential of our activities to transport or introduce zebra mussels or other nuisance organisms due to our sampling in numerous water bodies, and we take precautions to help prevent this from occurring. Zebra mussels can be transported by boats by at least two methods. Settled zebra mussels can be transported on the surfaces of boats, trailers and sampling gear. Zebra mussel larvae and juveniles can be transported in bilge water, the outboard motor lower unit and cooling systems or any recessed area that may retain water. The primary method used to decontaminated surfaces that may harbor settled zebra mussels is desiccation. Parking a boat and trailer in full sunlight at temperatures greater than 70°F for 24 hours should be sufficient to decontaminate all exposed surfaces. If the temperature is less than 70°F, the boat and trailer are left in the sunlight for a minimum of five days to desiccate any zebra mussels. If logistic considerations prevent dry storage of the boat and trailer prior to its next use, the boat, trailer and sampling gear are pressure washed with water at temperatures greater than 140°F. This can be accomplished at most self-service car washes using the high pressure rinse setting. All surfaces, including nets and other sampling gear are thoroughly sprayed with the high-pressure hot water to remove settled zebra mussels. All vegetation and debris entangled on vehicles, trailers and boats is removed.

Areas that cannot be reached with the high-pressure water gun, such as bilges, are exposed to a chlorine solution with a concentration of 5 ppm (about 10 ml of Clorox bleach in 5 gallons of water). The chlorine solution is introduced to the bilge for at least ten minutes and then flushed out with clean tap water. Chlorine decontamination is not conducted where the chlorine solution may run directly into a receiving body of water. Sampling gear can be rinsed in the chlorine solution to remove zebra mussels. To prevent settling in outboard motors, or inadvertent transport, outboard motor cooling systems and lower units are decontaminated by flushing with tap water. This procedure not only reduces the risk of inadvertent transport, but also reduces the risk of engine damage caused by entrained mussel larvae that may have metamorphosed and begun to foul the interior parts of the engine. The 5 ppm chlorine solution is used to clean all sample bottles, meter probes and other devices before they are used in a different location.

4.5 DATA CODING INSTRUCTIONS

Coding instructions for each card type are given below. One data sheet is completed for each gill net set or Tucker trawl tow. All entries should be made neatly with only one symbol per data block. The individual whose initials are entered on the data sheet is responsible for assuring the legibility of all entries.

4.5.1 Coding for Header Information

VARIABLE NAME	INSTRUCTIONS
TASK CD	Preprinted 14
SAMPLE	Preprinted
GEAR	Gill Nets = 130; Tucker trawl = 065
YEAR	Record year 2006 or 2007

4.5.2 Source Card Type S1

Source card type S1 is used to record field sampling information.

NOTE: N/A = not applicable, therefore not recorded.

VARIABLE NAME	INSTRUCTIONS
SOURCE CARD TYPE	Preprinted S1
DATE	Record date (Mo/Day) of sample collection. Record set day for gill nets.
TIME	Record set time for gill nets on the first date of deployment or start time for tucker trawl tows using 24-hour clock (HHMM).
LOCATION:	
MILE	N/A
SITE	N/A
STATION	Enter appropriate code for Field Station FITZ-10 = 1 FITZ-25 = 2 FITZ-E10 = 3 FITZ-E25 = 4
N S	N/A
DURATION	For towed net samples record the duration of tow in decimal minutes
PULL TIME	For each gill net record time the gear was removed from water to terminate the fishing effort using 24-hour clock.

VARIABLE NAME	INSTRUCTIONS
SET TIME	For each gill net record time the gear was set in the water to begin the fishing effort using 24-hour clock.
DEPTH_	
SAM	Record sampling depth in feet
RIV	Record lake depth at sampling station in feet
TOW_	
SPD	Record tow speed over bottom for Tucker trawls
DIR	Record tow direction from GPS if Tucker trawl (0 to 360)
WAVE HT	Enter code for estimated wave height: 1 = calm to 1 /2 ft 2 = light chop (>1/2 ft to 1 ft) 3 = heavy chop (>1 ft to 2 ft) 4 = large waves (>2 ft)
BOTM TYP	Enter code for bottom type: 1 = sand 2 = mud 3 = vegetation 4 = debris 5 = brick 6 = gravel less than 3" 8 = mussel/oyster bed 9 = other
VESSEL CD	N/A
BEACH	N/A
USE_CODE	Enter appropriate use code: 1 = no sampling problems 5 = sampling problems, no fish were caught, i.e. void
GEAR NAR	N/A
SAM NAR	N/A
INITIALS	Record employee number of individual responsible for sample collection (crew leader)
COMMENTS	Record any pertinent information not recorded elsewhere on back of sheet. Check comments block if comments may affect data interpretation
ENG RPM	N/A
TOW DIST	Record Tucker trawl tow distance from GPS

4.5.3 Source Card Tvpe Q1

Source card type Q1 is used to record water quality data.

NOTE: N/A = not applicable to present task, therefore not recorded.

VARIABLE NAME	INSTRUCTIONS
SOURCE CARD TYPE	Preprinted Q1
BOTL NO	Record water quality sample bottle number (if used)
H2O TEMP	Record the temperature to the nearest 0.1°C at both surface and bottom
DO	Record the dissolved oxygen to the nearest 0.1 ppm at both surface and bottom
pH	N/A
COND	N/A
DEPTH WQ	Record depth (in feet) at which the water quality measurement was taken
SECCHI DEPTH	N/A
AIR TEMP	Record air temperature to the nearest 1°C at time of sample collection
CLOUD COVER	Enter code for cloud cover at the time of sample collection:

CODE	DESCRIPTION
0	0-9%
1	10-19%
2	20-29%
3	30-39%
4	40-49%
5	50-59%
6	60-69%
7	70-79%
8	80-89%
9	90-100%

PRECIPITATION — Enter code to describe the precipitation status at the time of sample collection:

CODE	DESCRIPTION
0	None
1	Light Rain
2	Heavy Rain
3	Snow

WIND SPEED — Enter code for wind speed based on the Beaufort scale

CODE	MPH	WATER SURFACE	LAND

VARIABLE NAME	INSTRUCTIONS			
	1	0-7	Smooth/small wavelets	Leaves rustle, wind on
	2	8-11	Lg. wavelets, scattered whitecaps	Leaves & twigs in constant motion, flag waving
	3	12-16	Small waves, frequent whitecaps	Raises dust & loose paper, sm. Branches moving
		17-24	Medium crested waves, many whitecaps foam,	Small trees begin to sway
		25-35	Large waves, foam, blown spray	Whole trees in motion, why are you out here???

WIND DIRECTION — Enter code for direction from which the wind is blowing

CODE	DESCRIPTION
0	No wind
1	North
2	South
3	East
4	West

CURRENT SPEED	N/A
INSTRUMENTATION I.D. NUMBERS:	Record the identification numbers for the temperature, dissolved oxygen meter and fish weight scales used to obtain the Source data for this sample. These numbers should cross-reference the QC calibration logs for the instruments.

4.5.4 Source Card Type R1

Source card type R1 is used to record the type and number of jars which contain biological sample(s).

NOTE: N/A = not applicable to present task,

VARIABLE NAME	INSTRUCTIONS
SOURCE CARD TYPE	Preprinted R1
NO. OF JARS SUS RECP	N/A
LW	Record number of jars containing fish for length/weight determination
ID	Record number of jars containing fish for identification and enumeration
NO YRL STOM	N/A

4.5.5 Source Card Type Fl

Source card type F1 is used to record species identification, count, weight and condition data for fish processed in the field.

NOTE: N/A = not applicable to present task, therefore not recorded.

VARIABLE NAME	INSTRUCTIONS
COMMENTS	Record any pertinent information not recorded elsewhere (only check if comments may affect data interpretation)
SOURCE CARD TYPE	Preprinted F1
TAXON	Enter appropriate taxon code from taxon list (Appendix B).
FISH ID	Record consecutive FISH_ID for each fish from which a measurement was taken.
LENGTH	Record total length to the nearest mm for each fish identified.
WEIGHT	Record the weight of each fish measured to the nearest gram.
SEX	Enter the appropriate code for sex of the fish if it can be determined upon external examination (or internal examination if the fish is dead). Blank = not determined 1 = male 2 = female
SEX_COND	Enter the appropriate code for the sexual condition of the fish if it can be determined upon external examination (or internal examination if the fish is dead) Blank = not determined

CODE		DESCRIPTION
1	RIPE:	Adult in spawning condition - gonads well developed, but no milt or eggs extruded upon application of pressure to gonadal area. Will spawn in current season.
2	RIPE & RUNNING:	Adult prepared to spawn immediately; expulsion of eggs or milt from body with little provocation.
3	PARTIALLY SPENT:	Sexual products partially discharged gonads somewhat flaccid as opposed to the firmness of a developing gonad. Genital aperture usually inflamed, some hemorrhaging present.
4	SPENT:	Applied to adult specimens at completion spawning activity. The sexual products have been discharged-genital aperture usually inflamed and hemorrhaging present. The gonads have the appearance of deflated sacs,

VARIABLE NAME	INSTRUCTIONS		
			the ovaries usually containing a few leftover eggs (in a state of re-adsorption) and the testes have some residual sperm. Ovarian wall becomes leathery.
	5	IMMATURE:	A specimen which is either male or female, but too young to spawn (sub-adult). Transparent or pinkish gonads, not developed.
	6	RESTING:	Applies to adult fish with underdeveloped gonads.
	7	DEVELOPING (INDETERMINATE):	Applicable to sub-ripe fish heading into spawning season. Testes are opaque and reddish to reddish-white. Ovaries may appear orange and eggs visible to the naked eye, granular, and whitish to orange-reddish. May or may not spawn.
	8	MATURE.	
	9	NOT REQUIRED; NOT EXAMINED.	

A_D — Enter appropriate alive/dead code for fish at time of capture:

1 = alive
2 = dead

INJURY TYPE — Enter code for type of external injury observed on each fish. Blank = none

1 = gash
2 = crushed
3 = scale loss
4 = hemorrhage
5 = fin rot
6 = body fungus
7 = skeletal deformities
8 = lesions or ulcers
9 = lamprey wound
10 = tumor(s)
11 = blindness
12 = emaciated
13 = parasites
14 = other anomaly
15 = multiple injuries (list in comments)

INJURY LOCATION — Enter code for the location of the predominant external injury on each

VARIABLE NAME	INSTRUCTIONS
	fish. Blank = none 1 = head 2 = opercle(s) 3 = eyes 4=body 5 = caudal peduncle 6 = tail fin 7 = dorsal fin 8 = anal fin 9 = pectoral fin(s) 10 = pelvic fin(s)

4.6 Storage and Chain of Custody of Data Sheets

Check over all data sheets, to make sure they are completely and correctly filled out, and to be alert to any unusual or unexpected data values. Transport the original data sheets to the field office, file a photocopy of each data sheet there for safe keeping and QA/QC verification, and dispatch the originals to data center.

4.7 Reference Collection

Make sure that each taxon and life stage identified in the Lake Ontario juvenile and adult fish program is represented in a project-specific reference collection at the biology laboratory. Develop this reference collection by removing specimens from JAFNPP samples and storing them sample containers in a designated area. If available, include several (up to ten) specimens per taxon, displaying a variety of sizes. Label the sample containers with the scientific name, date of capture, capture location, and a reference collection catalog number. The catalog number identifies a card containing more detailed sampling information, identifier, comments, etc. File the cards alphabetically by family, genus, and species.

5.0 Entrainment Abundance Calculation Baseline

5.1 Objective

The baseline adjustment ratio for entrainment at the JAFNPP CWIS will be determined by comparing the density of ichthyoplankton in pairs of near-shore and near-intake samples collected with towed nets consistent with the gear and procedures used in earlier studies (TI 1979). If the HZOI as defined in Section 3.0 (above) is determined to be sufficiently small so that a 300 m^3 plankton net tow cannot be taken primarily within the HZOI at the 25 ft. depth contour along transect FITZ, then this SOP will be changed to indicate that Lake Ontario ichthyoplankton sampling will be performed by pump sampling using a 4-inch trash pump with a recessed impeller design capable of pumping at a rate of 300 gallons per minute (GPM) to collect 100 m^3 samples. Any modifications to this section of the SOP resulting from the outcome of the HZOI study will be provided to the permitting authority at least 30 calendar days prior to the scheduled start of the ichthyoplankton field sampling.

5.2 Sampling Design

Sampling design, gear, and procedures for the Lake Ontario ichthyoplankton program will be consistent with the gear and procedures used in the earlier studies (TI 1980), except as modified by the outcome of the HZOI evaluation (Section 3.0 above). Two transects perpendicular to shore will be established to coincide with two of the four transects established by TI (1980). Transect FITZ will be centered on the intake structure of JAFNPP, and is the same transect FITZ used by TI during the earlier studies. Transect FITZ-E will be located approximately 2000 ft. east of the JAFNPP intake. Transect FITZ represents the intake area, while transect FITZ-E is a nearfield control for the JAFNPP intake area that is not exposed to operation of the existing and permit-required fish deterrence system. Samples representative of the shoreline area of Nine Mile Point will be taken in Lake Ontario waters less than 10 feet of depth along each transect. Samples from the JAFNPP intake area of Nine Mile Point will be taken in Lake Ontario waters along the 25 foot depth contour along each transect, which is the depth contour where the JAFNPP intake is located. Therefore the following sampling stations will be designated for Lake Ontario studies to determine the entrainment abundance calculation baseline:

- ***FITZ-10*** = Lake Ontario near shore water column at the 10 ft. depth contour immediately inshore from the JAFNPP intake,
- ***FITZ-25*** = three dimensional sampling area in the Lake Ontario water column around the JAFNPP intake structure at the 25 ft. depth contour defined as the hydraulic zone of influence (HZOI) according to the criteria and methods specified in Section 3.0 above,
- ***FITZ-E10*** = Lake Ontario near shore water column at the 10 ft. depth contour along a transect established 2000 ft. to the east of the JAFNPP intake and perpendicular to the shoreline, and
- ***FITZ-E25*** = Lake Ontario water column at the 25 ft. contour along a transect established 2000 ft. to the east of the JAFNPP intake and perpendicular to the Lake Ontario shoreline.

Ichthyoplankton samples will be taken in the Nine Mile Point study area of Lake Ontario twice per month and approximately two weeks apart from April through October at each of the two transects and two depth contours defined above. Both daytime and nighttime samples will be collected, and the intention is to separate the collection of daytime and nighttime ichthyoplankton samples symmetrically within the daytime and nighttime periods of each sampling date. Daytime is defined as occurring between one hour after meteorological sunrise and one hour before meteorological sunset as observed at the plant site. Nighttime is defined as occurring between one hour after meteorological sunset and one hour before meteorological sunrise as observed at the plant site. Surface tows will be taken at the 10-foot contour stations. Surface and mid-depth tows will be taken at the 25-foot contour stations. Therefore, for each month a total of 24 ichthyoplankton samples will be collected (2 transects x 3 samples per transect x 2 diel periods x 2 events per month), and a total of 168 ichthyoplankton samples scheduled for collection during the seven month period of April through October of each year. All sampling activities will be performed under an approved Scientific Collector's Permit issued by NYSDEC for this study.

5.3 SAMPLING GEAR AND DEPLOYMENT

Ichthyoplankton tows will be taken with a $1m^2$ Tucker trawl (GEAR = 065) towed at a speed of 1 meter per second through the water. If the HZOI as defined in Section 3.0 (above) is determined to be sufficiently small so that a 300 m^3 plankton net tow cannot be taken primarily within the HZOI at the 25 ft. depth contour along transect FITZ, then pump sampling will replace towed net samples. The Tucker trawl has a 1.0 m^2 net mouth opening and a 5:1 length to mouth ratio with a 0.500 mm mesh Nitex net. Earlier studies (TI 1980) deployed a 1.0 m diameter Hensen net with 0.571 mm Nitex mesh and a 6:1 length to mouth ratio for Lake Ontario ichthyoplankton sampling. The Tucker trawl proposed for this study has the advantage of a closing mechanism to collect discrete depth samples, and as discussed above, the 0.571 mm Nitex mesh is no longer manufactured.

The Tucker trawl has a closing device that uses a messenger to trigger a double-trip release mechanism that releases a weighted lead bar to close the mouth of the net and insure that each sample will be collected in each of the discrete depth strata. The closing mechanism will not be used when the Tucker trawl is deployed for a surface tow. Towing speed will be 1.0 m/sec for a duration of 5 minutes to insure an approximate 300 m^3 sample, and tows will be made along each of the two depth contours parallel to shore. A flume-calibrated digital flowmeter (GO Model 2030R) will be placed slightly off-center in the mouth of the Tucker trawl to measure the distance (volume) of each tow. Tow depth will be determined in the field using a cosine function relating wire length and wire angle to sampling depth. The start and end of each towpath will be recorded using GPS. Samples will be fixed at the time of collection in 4% buffered formalin and changed over to 80% ethanol within 24 hours. Rose Bengal will be added to stain the fish eggs and larvae and facilitate separating them from other material by sorting in the laboratory. Each sample jar will be labeled with a unique inventory number along with the date, time, and depth of collection.

5.4 SAMPLING PROCEDURES

5.4.1 Equipment Preparation

- Check gear to see if it is damaged or operable, note its condition in the log book, and make repairs if necessary.

- Check the materials list for required materials and check the boat to be sure that all mechanical systems are operable and note in the log book the condition of systems.
- Load in onboard storage areas all sampling materials and forms required.
- Consult the equipment checklist in Section 4.4.4 (above) to insure that all materials have been loaded.

5.4.2 Tucker Trawl Tows

- Establish a position on-station using the GPS.
- Record the appropriate field data in the Header and S1 portion of the field data sheet (Sections 4.5.1 and 4.5.2 above).
- Obtain and record in-situ water quality data in the Q1 portion of the field data sheet (Section 4.5.3 above).
- Secure the tucker trawl to the towing cable and record the flowmeter starting point.
- Attach the plankton collection cup and safety line.
- Read and record bottom depth using a boat fathometer.
- Load the double trip-release mechanism, being certain to operate net with proper release cable.
- Deploy the trawl and safety line with the boom lowered to proper towing position. Maintain sufficient tension (0. 5 m/sec) so the net will not foul.
- When the net is at the proper depth [approximately 3:1 cable length to water; in deep water (>30 m) length of cable x cosine of wire angle = net depth (Kramer et al, 1972)], prepare for tow.
- Attain and maintain a tow speed of 1 in/sec, adjusting the cable length when necessary to keep the net at the desired depth.
- Drop the messenger, opening the net. Start the timer and record the time and velocity.
- Tow the net at 1 m/sec for the prescribed tow duration (5 minutes).
- When the tow is complete, release the messenger to close the net, and retrieve the gear, maintaining a forward direction and sufficient tension to avoid fouling the gear.
- Secure the nets aboard, record flowmeter readings, and wash the net from the outside to concentrate the sample in the collection cup.
- Detach the collection cup and transfer the sample to a 1 liter plastic container. Fix with 10% buffered formalin; for fish eggs and larvae add rose bengal dye.
- Prepare a field label and place inside the container with the sample. Seal the container, affixing the sample number to the exterior.
- Record the number of jars from this sample for delivery to the lab on the R1 portion of the field data sheet (Section 4.5.4 above).
- Transfer the sample container(s) to an onboard storage area.

- Rinse net, cup, and flowmeter and clean the net by towing it through the water without the cup. Repeat all of the preceding steps for each tow.

5.5 DATA CODING INSTRUCTIONS

Data coding for Tucker trawl tows should follow the coding instructions for each card type given in Section 4.5 above. One data sheet is completed for each Tucker trawl tow. The Header, and Card Types S1, Q1, and R1 are completed for each Tucker trawl tow. The F1 card type is not completed for each Tucker trawl tow. All entries should be made neatly with only one symbol per data block. The individual whose initials are entered on the data sheet is responsible for assuring the legibility of all entries.

6.0 ICHTHYOPLANKTON LABORATORY SOP

6.1 SAMPLES TO BE ANALYZED

Ichthyoplankton samples will be taken with a Tucker trawl equipped with 1.0 m^2 net mouth opening and a 5:1 length to mouth ratio with a 0.500 mm mesh Nitex net, providing a sample of approximately 300 m^3. Sampling will occur in the Nine Mile Point study area of Lake Ontario twice per month and approximately two weeks apart from April through October of 2006 and again during 2007 at each of the two transects and two depth contours. Both daytime and nighttime samples will be collected on each scheduled sampling date. Surface tows will be taken at the 10-foot contour stations. Surface and mid-depth tows will be taken at the 25-foot contour stations. Therefore, for each month a total of 24 ichthyoplankton samples will be collected (2 transects x 3 samples per transect x 2 diel periods x 2 events per month), and a total of 168 ichthyoplankton samples scheduled for collection during the seven month period of April through October of each year.

6.2 EQUIPMENT

The following items are required for laboratory analysis of ichthyoplankton in samples:

- Sorting pans
- Lights
- Magnifiers
- Dissecting microscopes
- Motoda plankton splitter
- Sieves
- Rose bengal
- Gridded Petri dishes
- Divided Petri dishes

- Jars, with lids
- Forceps
- Pipettes
- Multitally counters
- Squirt bottles
- Lab data sheets
- Pens
- Vials, with caps
- Vial labels
- Taxonomic literature
- Copy of SOP
- Ocular micrometers
- Millimeter rulers
- Masking tape
- Rubber bands
- Random number table

6.3 PROCEDURES

6.3.1 Sample Preparation

Check the sample container and labels against the field data sheet to be sure the numbers are consistent. Then determine if the sample will be processed completely or if it will require subsampling.

6.3.1.1 Subsampling Restrictions and Quotas

Samples with high abundances may be subsampled in the laboratory, with a minimum of 200 eggs and larvae to be analyzed. This quota applies to the total count of all species combined, not to individual species.

For each sample with a low ichthyoplankton concentration and a high total volume of detritus and other plankton (more than 400 ml settled volume), sort a maximum of one-half of the sample for eggs and larvae.

6.3.1.2 Sample Splitting Sequence

Use the following sequence of procedures in processing a sample that is subsampled by splitting. To eliminate any chance of bias, some steps in the procedure are to be performed by an assistant, as indicated below, so that the sorter has no prior knowledge of which samples are to be subjected to quality control inspection.

This procedure also applies when a previously split sample is further subsampled, such as an "id. split" performed because the fraction sorted was larger than necessary to meet the quota. In this situation the term "sample" in the following procedure refers to the part of the original sample that is to be further subsampled, and the selected fraction(s) are "analyzed" rather than "sorted."

1. Examine the sample to estimate the smallest size fraction that is likely to contain at least 200 eggs and larvae.
2. Divide the sample material into two equal parts using the techniques in Section 4.3.1.3.
3. Randomly select one of the two divisions for processing (or for further subsampling, if a smaller fraction is needed). Selection should be done using a random number table or a coin toss, so that each of the two divisions has an equal chance of being selected. The person performing the division must not know which of the two divisions will be analyzed before the division is completed (it is not acceptable to always select the division from the same chamber of the splitter).
4. Set aside the fraction not selected for further processing and label it to identify the sample number and fractional size.
5. If the fraction that was selected for further processing needs to be subsampled further, repeat steps 2-4 as many times as necessary to produce the desired fraction for analysis. When the desired fraction is obtained, label it to show the sample number and fractional size.
6. Sort the subsample by the procedures in Section 4.3.2. Organisms must be sorted from the entire subsample even if the quota is reached before finishing the subsample.

6.3.1.3 Sample Splitting Technique

Perform all sample splitting using a Motoda splitter. The presence of filamentous algae or large items (including large juvenile fish, or older age classes) can interfere with the even distribution of material and organisms between the two chambers of the splitter. Therefore, to insure successful results, observe the following techniques: (1) Adjust sample dilution to be great enough to allow free mixing of the sample but not so great as to promote clumping due to over dilution. (2) Remove large fish and excessive amounts of filamentous algae before splitting, returning any adhering ichthyoplankton to the sample. (3) Pull apart remaining clumps of algae before splitting. (4) Scrutinize detritus and organisms during the splitting process to see that they appear equally distributed before making the final division. (5) Remix and split again if the two resulting portions of a division do not appear equal. If a sample has so much algae that it cannot be satisfactorily split, sort the entire sample, and if numbers of ichthyoplankton are high splitting may be performed after sorting. Large juveniles that are removed from the whole sample before splitting must be kept separate from ichthyoplankton sorted from the sample after splitting, and they must be labeled to show they represent the whole sample.

6.3.2 Sorting

Remove fish eggs, larvae, and juveniles from the samples according to the following procedures:

- Samples may be stained with rose bengal to facilitate sorting.
- Pour the sample contents into a sieve with a mesh equivalent to, or finer than, 500 μm and rinse with water to remove the preservative.
- If the sample contains large numbers of eggs and larvae, prepare a subsample following the procedures in Section 4.3.1.
- Carefully wash the sample contents into a container making certain that nothing remains in the sieve. Pour portions of the sample from the container into a pan and examine them under a magnifying lens.
- Remove fish eggs, larvae, and juveniles from the sample using forceps, pipettes, and probes. Remove only those fragments that include the head.
- Maintain a combined total count for eggs and larvae that are removed from the sample (i.e., the combined total of eggs, yolk-sac larvae, post yolk-sac larvae, and juveniles).
- When sorting is completed, recheck the sample for organisms. After the sample has been rechecked, label vials containing the sorted organisms and place them in a box designated for sorted samples. Record the sorting results and date completed in a log.
- Carefully wash back the remaining sample contents into the original sample container, appropriately preserved, and return it to the storage area.
- If a sample is not completed by the end of the work day, it may be left unpreserved overnight if adequate precautions are taken to prevent it from drying out. No sample or part of a sample, however, should remain unpreserved for more than 24 hours.

6.3.3 Identification

Identify, stage, count, and measure the sorted ichthyoplankton according to the following procedures:

- Obtain the sample vials containing the sorted organisms from the storage area and sign them out by initialing a status log.
- Rinse specimens free of preservative and submerge them in water in a Petri dish. Use a binocular microscope with an ocular micrometer to examine the specimens, and identify them to the lowest practical taxon (usually species) by referring to the literature, the reference collections, and by consulting with fellow identifiers.
- Determine the life stage of each specimen. Pertinent life stages are defined and identified as follows:

  Egg: the embryonic developmental stage, from spawning until hatching. Eggs frequently become damaged during collection and sample processing. Damaged eggs are counted as the number of embryos (without regard to how many egg capsules are present). Do not count non-fertilized eggs if they are present.

Yolk-sac larva: the transition stage from hatching through the development of a complete, functional digestive system (regardless of the degree of yolk and/or oil globule retention)

Post yolk-sac larva: the transition stage from development of a complete, functional digestive system to transformation to juvenile form (regardless of the degree of yolk and/or oil globule retention), including the leptocephalus stage of eels

Young-of-the year: the stage from completed transformation to Age 1 (i.e., 12 months after hatching). A young-of-the-year has a full complement of fin rays identical to that of an adult. Eels are classified in this stage until Age 2.

Yearling or older: a fish at least one year old.

- Count the specimens of each life stage. Record the counts by species and stage on the lab data sheet (refer to Section 4.5.1 for coding instructions).
- From each sample, measure a maximum of 30 larvae of each fish species to the nearest 0.1 mm (total length) and record the measurements on the lab data sheet. If juvenile fish are present in the sample, they will be measured to the nearest 1.0mm (total length). If more than 30 larvae are present, randomize the selection of specimens for measuring by the following procedure. Spread them uniformly in a gridded container, select a starting point in the grid by means of a random number table, and then measure the first 30 measurable specimens encountered in a predetermined pattern commencing at the starting point. Every grid space must have an equal probability of being selected as the starting point, so that every specimen will have an equal probability of being included in the subsample.
- Place identified organisms in vials with an adequate amount of preservative for storage. Specimens may be removed for inclusion in the reference collection. For those removed, list the species, life stage, and numbers on the comments section of the form and note their removal on a tag retained inside the appropriate vial. Label all vials for a single sample, initial them and band them together. Record the number of vials for the sample on the data form. For reference collection procedures refer to Section 4.7.

6.4 Sample Handling

6.4.1 Sample Control

Each sample was given a unique sample number at the time of collection. Track each sample by that sample number throughout the laboratory and data processing functions.

6.4.2 Chain of Custody Records

The chain of custody documentation begins with the field office providing a list with the following information for each sample in a shipment delivered to the laboratory facility: sample collection date, sample collection time, sample identification number, and number of jars. Upon receipt of the samples, a laboratory representative verifies that all jars of all samples on the list are present, then signs and dates the chain of custody document.

After samples have been received in the laboratory, track their location and status during all phases of storage and laboratory analysis by means of sample control logs. The function of this system is to provide a paper trail of who performed each step in the analysis of a sample from collection to storage, when each step occurred, what condition the samples were in and where each step took place.

6.4.3 Preservation and Storage

Retain the original preservative (formalin solution) for reuse in preserving the residue of sorted samples, adding 5% formalin as needed to fill the sample jars. Store processed samples (i.e., detritus and organisms not removed from split samples) until sorting quality control checks are completed. Keep sorted ichthyoplankton in vials in a heated storage area until disposal is authorized by JAFNPP following acceptance of the Comprehensive Demonstration Study by NYSDEC. Tape the tops of jars and vials to prevent loss of preservative by evaporation.

6.4.4 Disposal

Disposal of sample residue remaining after sorting (detritus and organisms not removed from split samples) may proceed after sorting quality control has been completed. Disposal of vials of organisms from processed samples may proceed after receiving authorization from JAFNPP. Follow all applicable state and federal regulations for hazardous waste disposal.

6.5 Data Handling

6.5.1 Data Sheets and Coding Instructions

Record ichthyoplankton counts and measurements on Lab Count Data Sheets and Lab Length Data Sheets (Appendix A). The Lab Count Data Sheet is for count data for all taxa. The Lab Length Data Sheet is for measurements of all species. Indicate in the upper right-hand corner of each data sheet how many pages there are for the sample (use "1 of 1" for a one-page sample, "1 of 2" and "2 of 2" for a two-page sample, etc.). Record also in the upper right-hand section of the first page the identifier's initials, the date the sample was identified, and the number of vials.

6.5.1.1 Count Data

Record count data in the top ("Card Type L1") section of the data sheet according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the 4-digit sample number. Sample numbers will be in the range 2011 to 2524 (but not every number in that range is used).

VARIABLE	INSTRUCTIONS
CARD TYPE	Preprinted: L1
CATCH_CD	Enter 1 for valid non-empty sample or 2 for valid empty sample (data sheets are not required for void samples)
SPL_FACT	Enter 1.00 if the whole sample is analyzed; if the sample is subsampled record the ratio of the whole sample to the subsample (e.g., 8.00 for a 1/8 split)
TAXON	Enter the TAXON code from the Taxon Code List (Appendix B).
STAGE	Enter one of the following life stage codes: 0 = unknown 1 = eggs 2 = yolk-sac larvae 3 = post yolk-sac larvae 4 = young-of-the-year 5 = yearling or older
COUNT	Record the number of organisms of the indicated taxon and life stage in the sample (or subsample)
SPECIES NAME	Record the common name for the taxon

6.5.1.2 Measurement Data

Record measurement data for all fish species on one or more Lab Length Data Sheets according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the sample number
Card Type	Preprinted: L2
Conversion Factor	Record the number of millimeters per division for the optical micrometer used to measure larvae
TAXON	Enter the taxon codes for each species measured on Lab Length Data Sheets.
FISH_ID	Preprinted: 1-30 for fish species
STAGE (or "STG.")	Enter the life stage code for each larva measured (2, 3, 4, or 5 for fish species). Refer to the life stage code definitions used for count data (Section 6.5.1.1).
SCALE	Enter 6 if measurements are recorded in optical micrometer units; enter 7 if measurements are recorded directly in millimeters. (If optical micrometer units are recorded for a measurement, the actual length in millimeters will be obtained later by multiplying the measurement by the conversion factor.)
MEASUREMENT	Record the total length of larvae to the nearest 0.1 optical micrometer unit or to the nearest 0.1 mm. Juvenile fish are measured to the nearest 1.0mm total length.

6.5.2 Storage and Chain of Custody of Data Sheets

Maintain all completed data sheets in duplicate. Keep photocopies at the site of origin and transfer the originals as needed from the laboratory to the data center, quality control, and a master project file. Track the custody of data sheets by means of data control logs.

6.6 Quality Control

6.6.1 Tasks Subject to Quality Control

The following tasks are subjected to quality control checks consisting of reanalysis of randomly selected samples or measurements:

- sorting
- identification, life stage determination, and enumeration

6.6.2 Inspection Plans

Items are inspected using a quality control (QC) procedure derived from MIL-STD (military-standard) 1235B (single and multiple level continuous sampling procedures and tables for inspection by attributes) to achieve a 10 percent or better AOQL (Average Outgoing Quality Limit). The QC procedure used is the CSP-1 continuous sampling plan, which is conducted in two modes as follows:

- ***Mode 1.*** Reinspect one hundred percent of the samples until "i" consecutive samples pass.
- ***Mode 2.*** After "i" consecutive samples pass QC reinspection, randomly choose (using a random numbers table) the fraction "f" of the samples for reinspection. If any QC sample fails then return to Mode 1.

For this application of CSP-1, **i=8** and **f=1/7**, because the total number of samples analyzed by an individual is less than 500. It is important that QC inspections are performed as soon as possible after the original analysis; work-up of QC samples must not be postponed to be done in batches. Keeping the QC program as current as possible insures that problems are detected and remedied quickly, minimizing the additional number of samples that are analyzed before the problem is addressed.

Select items for reanalysis according to the plan using a random number table. The original analyzer should not know whether a sample is to be checked before the analysis of that sample has been completed. Perform all quality control checks "blindly" (i.e., the individual performing the QC inspection should have no knowledge of the original analyst's results).

Apply the QC plan on an individual processor basis, so that each person's work is subjected to the QC plan independently of others, starting at 100% inspection.

A resolution (third person) value may be determined for any sample found defective. All errors found during the QC check, whether the sample is found to be defective or not, are to be corrected on the data sheets. (A difference between original and QC counts that is within acceptable limits is not considered to be an error). Results of the quality control program are to be presented to all sorters and identifiers and help is to be made available to anyone failing a QC check.

In some cases a QC inspection may be able to determine the taxon or life stage of damaged specimens when the original identifier has recorded them as unknown life stage, unidentified taxon, or a higher level taxon (genus or family). If a more general taxon or life stage used by the original identifier includes the more specific category used by the QC inspector, and that is the only reason for a count discrepancy, then that sample does not fail the QC inspection on the basis of that taxon. For example, damaged specimens recorded as *Morone* sp. by the original identifier and as striped bass by the QC inspector are to be considered in agreement because the category *Morone* sp. includes striped bass. In contrast, an original determination of unidentified gobiid would not be acceptable if the QC determination was striped bass, because striped bass is not included in the family Gobiidae. If substantial differences occur between the original and QC counts as a result of identifying or staging to different levels, then the identifier should be provided with additional guidance or training to minimize such differences in future samples.

6.6.3 Acceptance/Rejection Criteria

6.6.3.1 Sorting

A sample is considered defective if the sorter failed to remove 10 percent of the total organisms in the sample (or subsample). Percent error is calculated as follows (where "QC count" denotes the number missed by the sorter):

% error = 100% x QC count/(sorter's count + QC count)

When the total count (sorter's plus QC) is ≤20, then the sample is considered defective only if the sorter missed more than two organisms.

6.6.3.2 Identification

A sample is considered defective if an error of 10 percent or more is made in identifying, assigning a life stage, or counting any species. In determining whether a sample is defective, analyzer and QC results are compared within each taxon/life stage combination.

For each taxon (or for a life stage within a taxon) the percent error is calculated as follows (except where the QC count is ≤20, the percent error is considered to be zero if analyzer and QC counts differ by no more than two organisms):

% error = 100% x | analyzer count – QC count | /QC count

A sample with a percent error of greater than or equal to 10% for any life stage for any taxon is considered defective.

For each defective sample, a resolution may be determined in which a third person reanalyzes the sample (resolution value). The error for each species and life stage will then be calculated using the resolution counts as the divisor. This will be done for both identification and QC counts:

% error = 100% x | identifier count – resolution count | / resolution count
% error = 100% x | QC count – resolution count | / resolution count

If the resolution vs. identifier error is <10 percent, the sample passes. If they are not, the sample fails and identifier counts are replaced by QC counts for all cases, provided the QC vs. resolution error is <10 percent. If the resolution vs. identifier and the resolution vs. QC errors are both 10 percent or more, the sample will be thoroughly reviewed by all three people and the identifier's sample processing will not continue until agreement can be reached on the identification of the sample. Subsequent samples will be reanalyzed by the QC person until eight consecutive samples pass. Notify the Laboratory Manager of any identifier exceeding two failed samples.

6.6.4 Quality Control Records

Maintain quality control logs, documenting the samples analyzed, the samples selected for reanalysis according to the QC plan, the results of the QC analysis, and any corrective action performed. All QC logs will be 100% inspected monthly by the Laboratory Supervisors. A summary report of quality control results and follow-up corrective action will be submitted to the client upon request.

6.6.5 Quality Control Personnel

The QC of the sorting process is to be conducted under the direct supervision of the Sorting Supervisor. Only the Sorting Supervisor or individuals with a documented sorting QC record of superior performance may provide sort QC.

Regarding identification QC, only the Identification Supervisors will be performing the QC on ichthyoplankton identification.

6.7 Reference Collection

Make sure that each taxon and life stage identified in the JAFNPP ichthyoplankton program is represented in a project-specific ichthyoplankton reference collection at the biology laboratory. Develop this reference collection by removing specimens from JAFNPP samples and storing them in vials in a designated area. If available, include several (e.g., 10) specimens per taxon per stage, displaying a variety of sizes. Label the vials with the scientific name, date of capture, capture location, and a reference collection catalog number. The catalog number identifies a card containing more detailed sampling information, identifier, comments, etc. File the cards alphabetically by family, genus, and species.

6.8 Instrument Calibration

Calibrate each ocular micrometer periodically (at least weekly) using a stage micrometer. After calibration of ocular micrometers on zoom microscopes, place a calibration mark on the microscope so that measurement accuracy is maintained. Ocular micrometers on microscopes that have been adjusted or moved must be recalibrated before use. Document the calibrations in a log showing the dates and results of the calibrations.

7.0 Data Handling

7.1 Data Entry Verification and Data Sheet Chain of Custody

Provide a submittal form with each batch of data sheets submitted to the Technical Data Processing (TDP) department for data entry. Information on the submittal form should include names of sender and recipient, date sent, and dates of impingement collections included in the batch.

Key all data twice, resolving discrepancies between the two versions as they are flagged by the data verification program.

After data entry and verification are complete, transfer custody of the data sheets from TDP to the originators, where they are used in the error checking and quality control tasks, and finally stored in a project file. Document the transfer from TDP back to the originator by one or more submittal sheets containing the same information as those used to transfer custody to TDP. TDP is not required to maintain copies of the data sheets. After JAFNPP accepts the data files and final report, the original data sheets and paper copies of them may be discarded.

7.2 Systematic Error Checks

Keyed data are subjected to a series of systematic error checking programs developed specifically for this project. These consist of univariate, bivariate, and multivariate checks specified by project personnel. Univariate range checks identify records for which one or more variables have values outside their valid or expected ranges. Bivariate and multivariate checks compare values of related variables. Additional checks scan the data for duplicate or missing observations. All records flagged by these programs are resolved, and corrections to both the data files and the data sheets are made as necessary. After error checking is complete, data files are subjected to quality control inspection (refer to Section 7.4 below).

7.3 Data File Format

Error checked data files are assembled into a SAS, Excel, or Microsoft Access database.

7.4 QUALITY CONTROL OF DATA FILES

Data files that have completed the systematic error checking process undergo a QC inspection to assure a 1% AOQL (Average Outgoing Quality Limit) according to a lot sampling plan (American Society for Quality Control. 1993. Sampling procedures and tables for inspection by attributes. ANSI/ASQC Z1.4-1993.). This procedure insures that ≥99% of the observations in a data file agree with the original data sheets. The number of observations to be checked, and the number of those that must be within tolerance are shown below. If more than the acceptable number of failures are found, then the data set must be inspected 100%.

Lot Sampling Plan for QC Inspection at Less Than 1% AOQL.

		Number of Failures	
Lot Size	**Sample Size**	**Accept If ≤**	**Reject If ≥**
1-32	ALL	0	1
33-500	32	0	1
501-3,200	125	1	2
3,201-10,000	200	2	3
10,001-35,000	315	3	4
35,001-150,000	500	5	6
150,001-500,000	800	7	8
500,001 and over	1,250	10	11

8.0 TRAINING

In order to assure the standardization of field, laboratory, and data processing procedures, a two level system for training technicians is followed: the first level being documented standard operating procedures; the second level being a training program for all new project personnel. At a minimum, this training program consists of the following steps:

- A complete reading and explanation of the project SOP and QA manual. This is documented by a sign-off sheet which is filed in the program file.
- Observation by the Program Manager, Field Site Supervisor or Laboratory Manager of the first two or more times a new procedure is performed. This is documented with a signed checklist.
- Direct supervision by an experienced technician of personnel assigned to unfamiliar tasks for their first two or more attempts.
- 100% quality control checks for at least the first five samples analyzed.
- On tasks requiring identification of fish and ichthyoplankton, the Program Manager will have final approval as to who is qualified to make these identifications. In some cases

special training will be required to participate in tasks, as set forth by the Program Manager.

9.0 QUALITY ASSURANCE

9.1 NONCONFORMANCE REPORTS AND CORRECTIVE ACTION

Documentation of problems or unusual events occurring during a program will be accomplished using Extraordinary Event/Nonconformity (EENC) forms. The EENC form (Appendix A) is designed to dispense information to the Program Manager and Quality Assurance department and to obtain necessary action on items that are critical to technical operations and management of programs. The report results from observations such as these:

- deviations from standard operating procedures
- losing a sample
- finding an endangered species in a sample
- noting samples that are grossly different from expected (content, preservation, labels)
- noting a phenomenon that may deserve continued monitoring in the interest of the client and therefore may require a change in the scope of work
- quality control samples that exceed acceptable limits
- unusually high impingement counts.

Items, samples, data, or information not in conformity with specifications or which do not meet preconditions for the next step in processing or use, are set aside until the problem is resolved and documented via the EENC report procedure.

The EENC report is designed for use by any person who identifies a problem or discovers information that is germane to a program scope of work or the improvement or change of contract performance. The originator describes the problem and may make recommendations for its resolution. Two temporary copies are made, and the original is sent to the Program Manager. One of the copies is kept by the originator in a file for "open" EENC reports (corrective action in progress), and the other is sent to the Quality Assurance Supervisor, who periodically checks on the progress of corrective action.

The Program Manager confers with appropriate parties and decides what corrective action will be required. Instructions to the Action Addressee (the person responsible for carrying out the corrective action) are written on the original EENC report. The Program Manger retains the original and sends a copy to the Action Addressee.

The Action Addressee resolves the problem as directed and then signs the EENC copy and returns it to the Program Manager to signify that the corrective action has been completed.

The Program Manager files the signed copy from each Action Addressee (there may be more than one), and when all corrective action is complete signs the original EENC report, keeps a temporary copy, and forwards the original to the QA Supervisor.

The QA Supervisor reviews the EENC report, and signifies acceptance of the resolution by signing and dating the report to "close" it. A copy of the closed EENC report is retained in QA files, the temporary copy received earlier from the originator is discarded, and the original is returned to the Program Manager.

The Program Manager discards the temporary copy and keeps the original on file. A copy of the closed EENC report is sent to the originator, and additional copies are sent to any other affected parties. The originator discards the temporary copy in the file of open EENC reports and files the copy of the closed EENC report.

9.2 QA Audits

It is the responsibility of the Quality Assurance organization to verify the achievement of quality through all phases of the project. Once the proposal, program design, and work development phases are complete, these responsibilities will be accomplished primarily by audits, tests, and surveys which will provide objective evidence that the quality control program and technical requirements, methods, and procedures as outlined in the study QA manual are being implemented. All field, laboratory, and data processing tasks will be subject to at least one audit. These audits will be conducted by an audit team of technically qualified personnel familiar with, but independent of and not responsible for, the work or activities under evaluation. The audit team will review the operations, specifications, QC systems, plans, and project objectives and examine the acquisition and transfer of data from field to report.

Observations of nonconformities and program deficiencies will be classified into three categories:

A. Deficiencies that affect the data adversely;
B. Deficiencies that might affect the data adversely; and
C. Deficiencies or procedural changes that cannot affect the data adversely.

Class A deficiencies will be resolved before that portion of the program can proceed. Class B deficiencies must have a determination as to whether they should be changed to Class A or C deficiencies and whether or not corrective action is necessary. If corrective action is necessary, it will be performed within a reasonable time frame agreed to by the program management, the Quality Assurance Department, and JAFNPP. Operations with Class A or B deficiencies will be subject to reaudit to determine the effectiveness of corrective action. Class C deficiencies must have corrective action accomplished before the next scheduled audit or end of the project, whichever comes first.

Audit results will be presented orally to the appropriate project or facility management by the audit team after the audit has been completed. At this time, specific findings will be presented and recommended courses of corrective action developed. Subsequently, the audit results will be documented in a written audit report and reviewed by management having responsibility in the areas audited. These reports will include a summary of audit results, observations made with a listing of non-conformities, recommendations and corrective action taken.

The quality assurance director will maintain a file of all project and facility audits. This file will include copies of the audit checklists, audit reports, written replies, the record of completion of corrective action and follow-up action. A summary report of audit results, and follow-up corrective action will also be made available for JAFNPP review.

Appendix A

Forms

S1 Page__of __

TASK CD	SAMPLE	GEAR	YEAR
1 4			

DATE MO	DATE DAY	TIME	LOCATION RIV_MILE	LOCATION SITE	LOCATION STAT.	N_S	DURATION

TIME		DEPTH RIV	DEPTH SAM	TOW_ SPD	TOW_ DIR	WAVE_HT	STM_TYP	VESL CD	BEACH	USE CODE	GEAR MAR	SAM MAR	INIT	COMMENTS
PULL														
SET														

ENGINE_RPM

TOW_DIST

Q1 WATER QUALITY

	BOTL_N	H_2O_TEMP	DO	pH	COND	DEPTH_WQ
SURFACE						
BOTTOM						

R1

N_JARS SUS RECP	N_JARS LW	N_JARS ID	N YR_ STOM

SECCHI DEPTH (m)

AIR TEMP (°C)

CLOUD COVER (%)

PRECIPITATION

WIND SPEED

WIND DIRECTION

CURRENT SPEED

INSTRUMENTATION I.D. NUMBERS:

TEMP/D.O. ________

CONDUCTIVITY ________

pH ________

WEIGHT SCALES ________

SLRS.5-94a

COMMENTS: ________ QC ____

Page___ of ___

TASK CD	SAMPLE	GEAR	YEAR
1 4			

COMMENTS: ______________________________

F1

TAXON	FISH_ID	LENGTH	WEIGHT	SEX	SEX COND	A_D	INJURY		COUNT	SS NAR
							TYPE	LOCATION		

SLR8.5-94b

FITZPATRICK NUCLEAR POWER PLANT, 2006
Icthyoplankton Lab Count Data Sheet

Sample [ ] **Card** [L1] **Container #** [ ] **Period** [ ] **AD** [ ] **Catch_CD** [ ] **Analyzed By:** ______

Date: ______
No. Vials: ______

SPL_FACT	TAXON	STAGE	COUNT	SPECIES NAME

Stage Codes

0 = unknown
1 =egg
2 = yolk-sac larvae
3 = post yolk sac larvae
4 = young of year
5 = yearling or older

Sample [| | |] **Card Type** [L2] **Conversion Factor** [ ] **Taxon** [ ]

PAGE ___ of ___

FITZPATRICK NUCLEAR POWER PLANT, 2006

Ichthyoplankton Lab Length Data Sheet

Sample [ ] **Card** [L2]

Stage Codes: 0 = unknown
2 = yolk sac larvae
3 = post yolk sac larvae
4 = post yolk sac larvae
5 = yearling or older

Page ___ **of** ___

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

TAXON [ ] STAGE [ ]

	Scale	Measurement		Scale	Measurement
1		.	16		.
2		.	17		.
3		.	18		.
4		.	19		.
5		.	20		.
6		.	21		.
7		.	22		.
8		.	23		.
9		.	24		.
10		.	25		.
11		.	26		.
12		.	27		.
13		.	28		.
14		.	29		.
15		.	30		.

FITZPATRICK NUCLEAR POWER PLANT, 2006

Hazardous Substances Log, page ___

Amounts of formalin and gasoline brought on site for entrainment sampling

Date	Name	Gallons of Formalin	Gallons of Gasoline

EXTRAORDINARY EVENT/NONCONFORMITY REPORT

EE/NC Report Number: Date:________________ From:________________

Respond by (date): ____________ Project No.: ________________ Title:________________

Date closed: ____________

ADDRESSEES:
QA: __√__ Project Mgr.: ____ Field Mgr.: ____ Lab Mgr.: ____ Technical Mgr.: ____ Others: ____

PROBLEM DEFINITION (e.g.. Sample ID, Activity, Data, Standard, etc. Not in Conformity) :

RECOMMENDATIONS FOR or CORRECTIVE ACTION TAKEN:

Signed:

ACTION ADDRESSEE RESPONSE:

CORRECTIVE ACTION COMPLETED: Date: ____________ Signed:________________

Distribution: ORIGINAL:QA, COPIES OF ORIGINAL: Originator, Addressees
RESPONSES: QA (responses are to be made on copies)

APPENDIX B

Fish Taxon Codes

Appendix Table B-1. Taxon codes for fish species.

Taxon Code	Common Name
1	alewife
2	bay anchovy
3	American shad
4	bluefish
5	bluegill
6	brown bullhead
7	pumpkinseed
8	black crappie
9	common carp
10	American eel
11	goldfish
12	golden shiner
13	hogchoker
14	tessellated darter
15	banded killifish
16	emerald shiner
17	largemouth bass
18	mummichog
19	Atlantic menhaden
20	(use 59)
21	chain pickerel
22	blueback herring
23	white sucker
24	Atlantic silverside
25	rainbow smelt
26	smallmouth bass
27	shortnose sturgeon
28	spottail shiner
29	Atlantic sturgeon
30	striped bass
31	fourspine stickleback

Appendix Table B-1 (Continued)

Taxon Code	Common Name
32	Atlantic tomcod
33	to be identified
34	white catfish
35	white perch
36	yellow perch
37	satinfin shiner
38	rock bass
39	northern pipefish
40	redbreast sunfish
41	Atlantic needlefish
42	crevalle jack
43	eastern silvery minnow
44	fallfish
45	weakfish
46	comely shiner
47	common shiner
48	mimic shiner
49	lookdown
50	unidentified clupeid
51	(use 50)
52	(use 60)
53	grass pickerel
54	lined seahorse
55	logperch
56	trout-perch
57	northern hog sucker
58	fathead minnow
59	unidentified cyprinid
60	unidentified *Morone*
61	redfin pickerel
62	tautog
63	fourbeard rockling

Appendix Table B-1 (Continued)

Taxon Code	Common Name
64	striped cusk-eel
65	(use 96)
66	northern kingfish
67	spot
68	Atlantic moonfish
69	brook stickleback
70	unidentified sturgeon
71	scup
72	winter flounder
73	inland silverside
74	sea lamprey
75	gizzard shad
76	silver hake
77	striped mullet
78	threespine stickleback
79	brown trout
80	butterfish
81	white crappie
82	brook trout
83	northern pike
84	green sunfish
85	silver perch
86	northern puffer
87	eastern blacknose dace
88	bridle shiner
90	cutlip minnow
96	unidentified centrarchid
97	spotfin shiner
98	red hake
99	unidentifiable
100	central mudminnow
101	grubby

Appendix Table B-1 (Continued)

Taxon Code	Common Name
102	eastern mudminnow
103	white bass
104	rough silverside
105	longear sunfish
106	summer flounder
107	longnose dace
108	creek chub
109	black bullhead
110	striped searobin
111	northern searobin
113	Atlantic croaker
114	longhorn sculpin
115	round herring
116	hickory shad
117	Atlantic herring
118	reef silverside
119	striped anchovy
120	conger eel
121	striped killifish
122	warmouth
123	bluntnose minnow
124	walleye
125	white mullet
126	yellow bullhead
127	channel catfish
128	pollock
129	seaboard goby
130	naked goby
131	yellowtail flounder
132	windowpane
133	spotted hake
134	unidentified searobin

Appendix Table B-1 (Continued)

Taxon Code	Common Name
136	northern stargazer
137	American sand lance
138	fat sleeper
139	fourspot flounder
140	Atlantic mackerel
141	black sea bass
142	smallmouth flounder
143	rock gunnel
144	inshore lizardfish
145	unidentified mudminnow
146	silver lamprey
147	rainbow trout
148	rosyface shiner
149	unidentified *Esox*
150	unidentified gobiid
151	unidentified *Fundulus*
152	unidentified cyprinodontid
153	unidentified *Myoxocephalus*
154	unidentified cottid
155	unidentified pleuronectiform
156	unidentified pleuronectid
157	unidentified atherinid
158	unidentified *Menidia*
159	unidentified bothid
160	speckled wormeel
161	unidentified syngnathid
162	mackerel scad
163	unidentified *Ammodytes*
164	cunner
165	unidentified sciaenid
166	unidentified gadid

(continued)

Appendix Table B-1 (Continued)

Taxon Code	Common Name
167	flying gurnard
168	shield darter
169	gray snapper
170	Atlantic cod
171	sea raven
172	bigeye scad
173	striped burrfish
174	sheepshead
175	unidentified percid
176	spotfin mojarra
177	spotfin butterflyfish
178	unidentified gasterosteid
179	planehead filefish
180	Atlantic cutlassfish
181	pigfish
182	short bigeye
183	guaguanche
184	freckled blenny
185	unidentified tetraodontid
186	orangespotted filefish
187	margined madtom
188	bluespotted cornetfish
189	black drum
190	northern sennet
191	scamp
192	cobia
193	least darter
194	unidentified percichthyid
195	scrawled cowfish
196	spotfin flyingfish
197	Gulf menhaden

(continued)

Appendix Table B-1 (Continued)

Taxon Code	Common Name
198	pugnose shiner
199	redfin shiner
200	sand shiner
201	swallowtail shiner
202	tiger muskellunge
203	goosefish
204	permit
205	freshwater drum
206	king mackerel
207	longnose gar
208	Spanish mackerel
209	highfin goby
210	unidentified sucker
211	unidentified labrid
212	blackcheek tonguefish
213	oyster toadfish
214	feather blenny
215	orange filefish
216	little skate
217	spiny dogfish
218	Atlantic seasnail
219	Gulf Stream flounder
220	spotted goatfish
221	brook silverside
222	harvestfish
223	pinfish
224	witch flounder
225	kokanee
226	ladyfish
227	radiated shanny
228	cusk
229	unidentified *Urophycis*

Appendix Table B-1 (Continued)

Taxon Code	Common Name
230	American plaice
231	slimy sculpin
232	sheepshead minnow
233	unidentified blenny
234	unidentified skate
235	clearnose skate
236	weakfish/scup
237	haddock
238	rudd

Note: Check with the project Technical Director if taxon is not found in this list

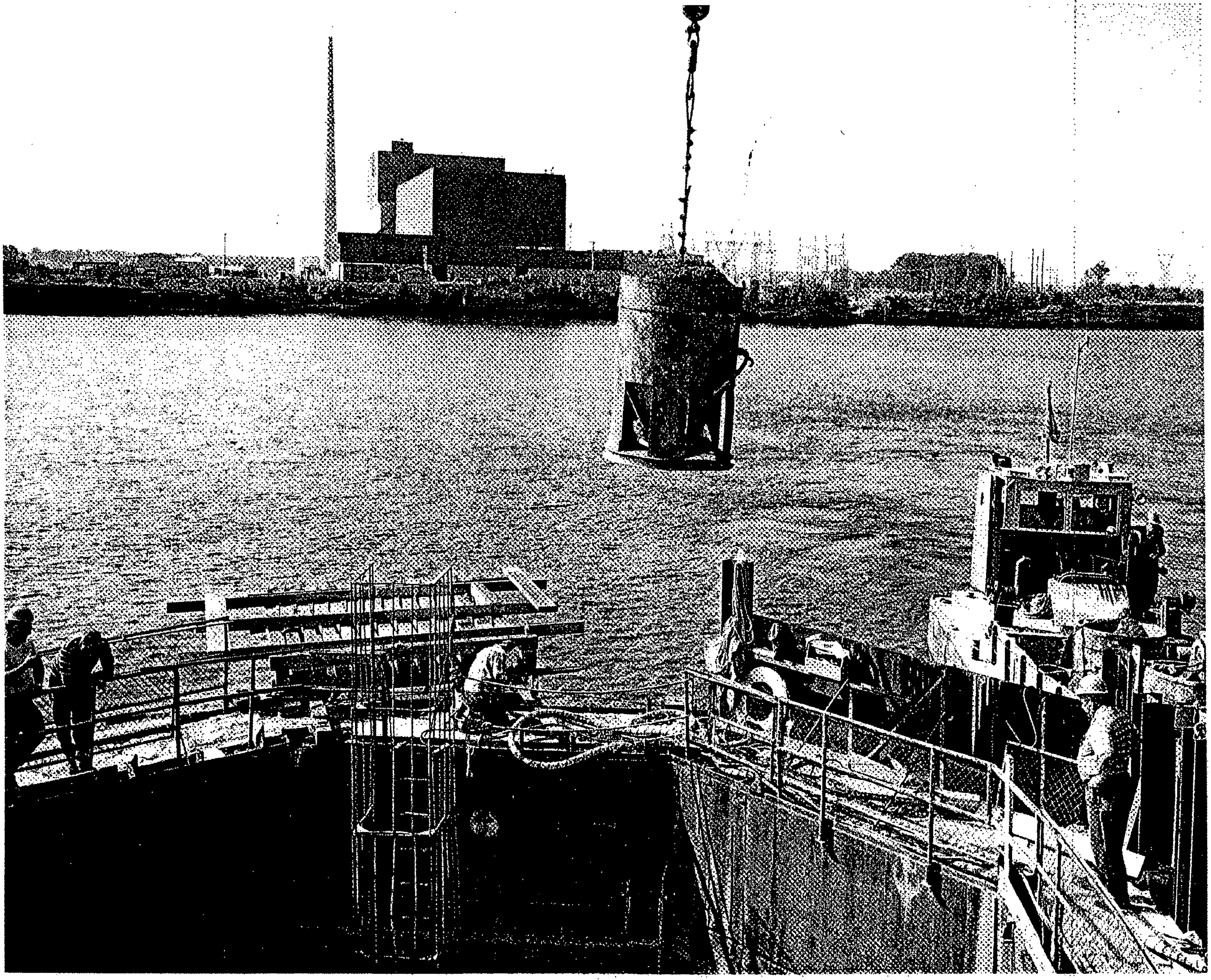
Attachment 2

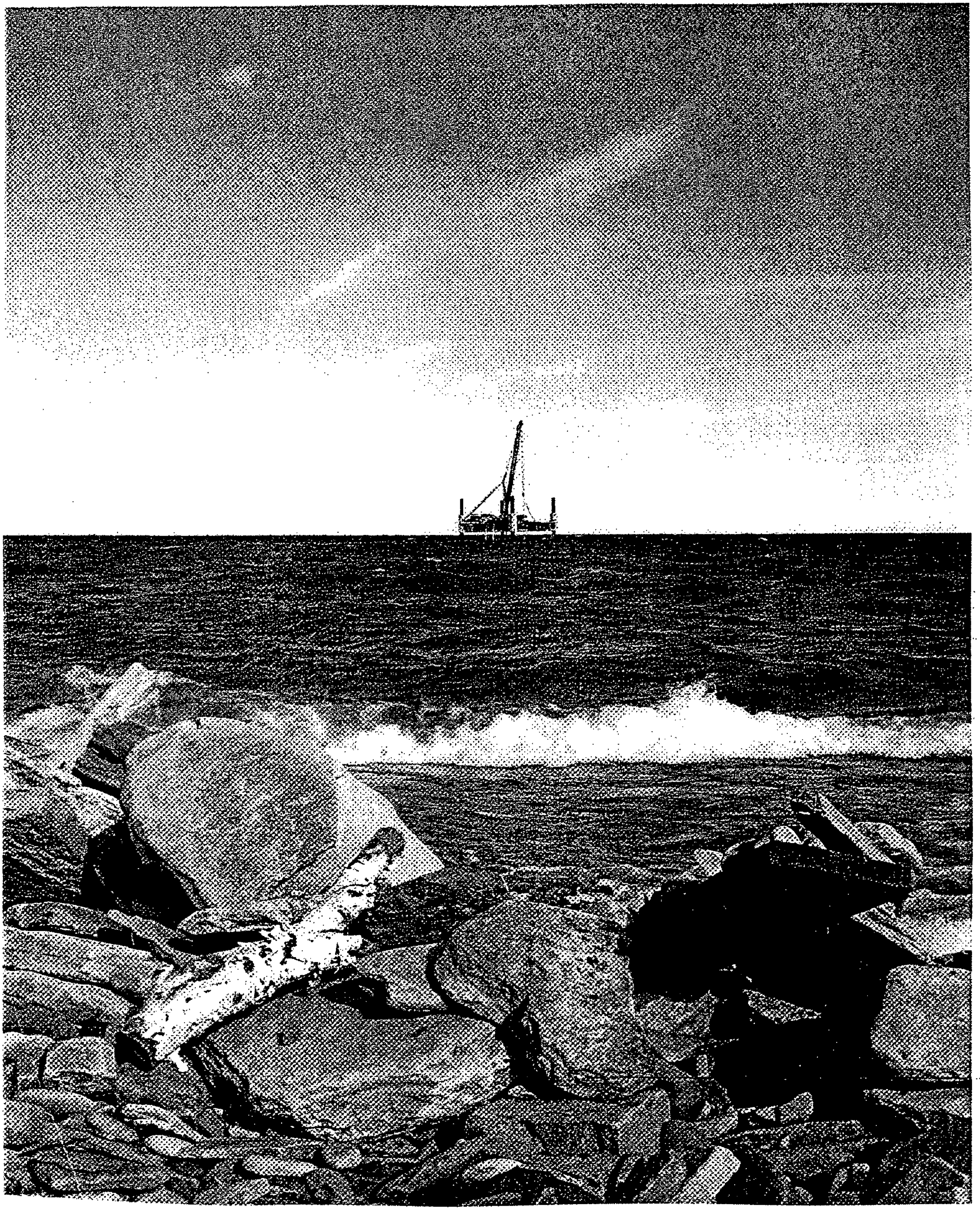
James A. FitzPatrick Nuclear Power Plant

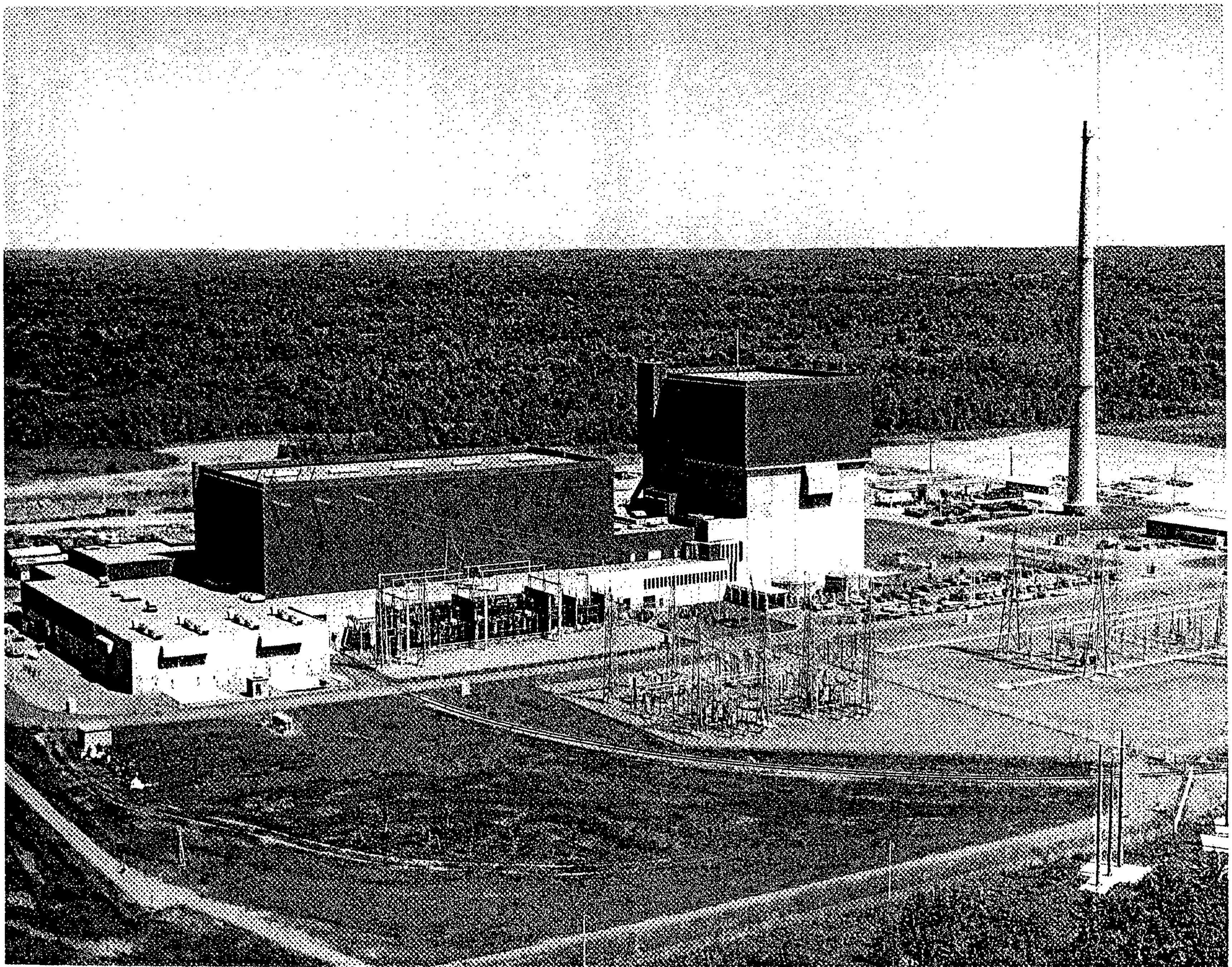
License Renewal Application – Amendment 1

Reference for RAI E-2-a-1

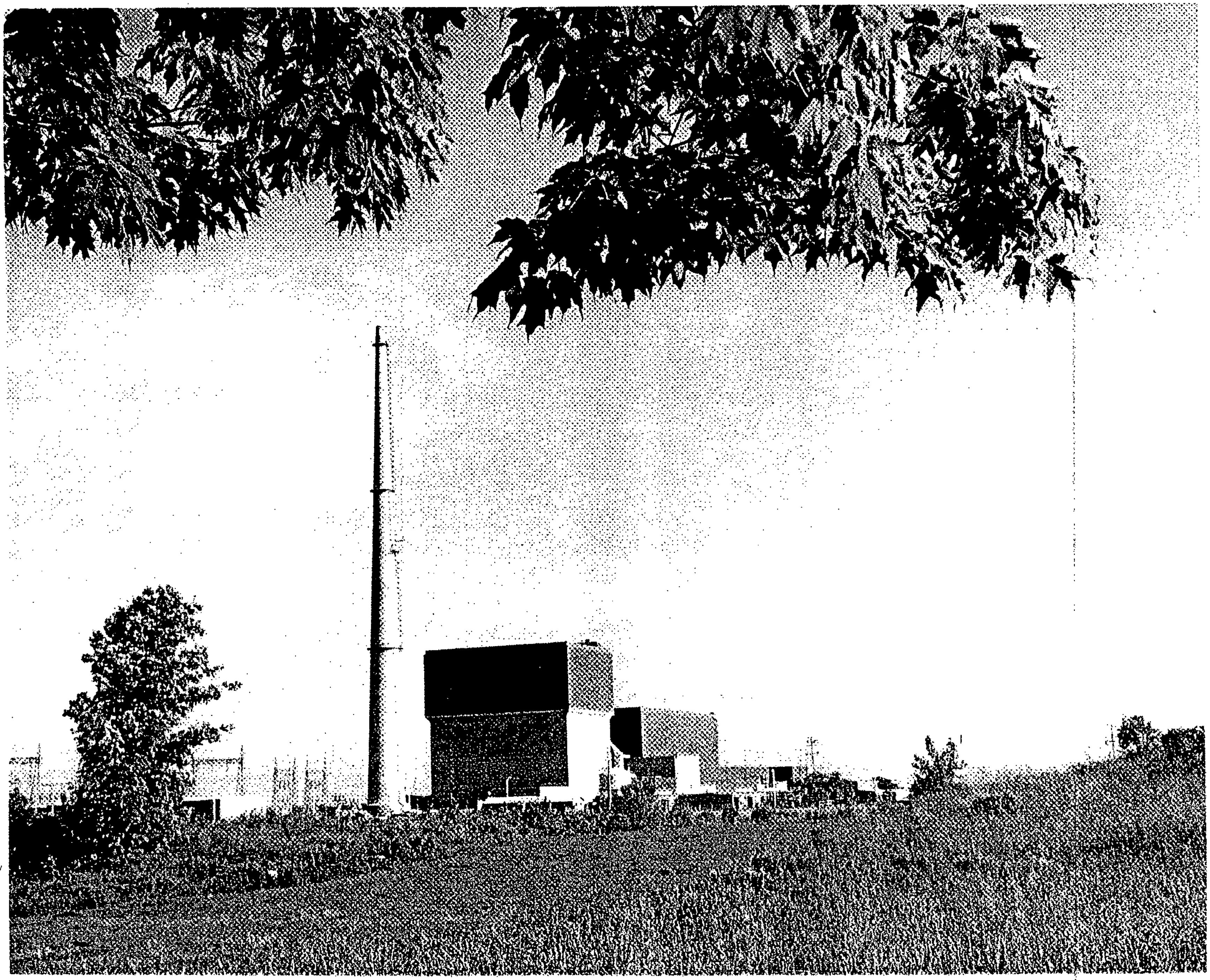

County 29
JAF Site
NMP-#2 Site
NMP-#1 Site
Energy Info Center Site
MET Tower Site
Pre-Nuclear Nine Mile Point

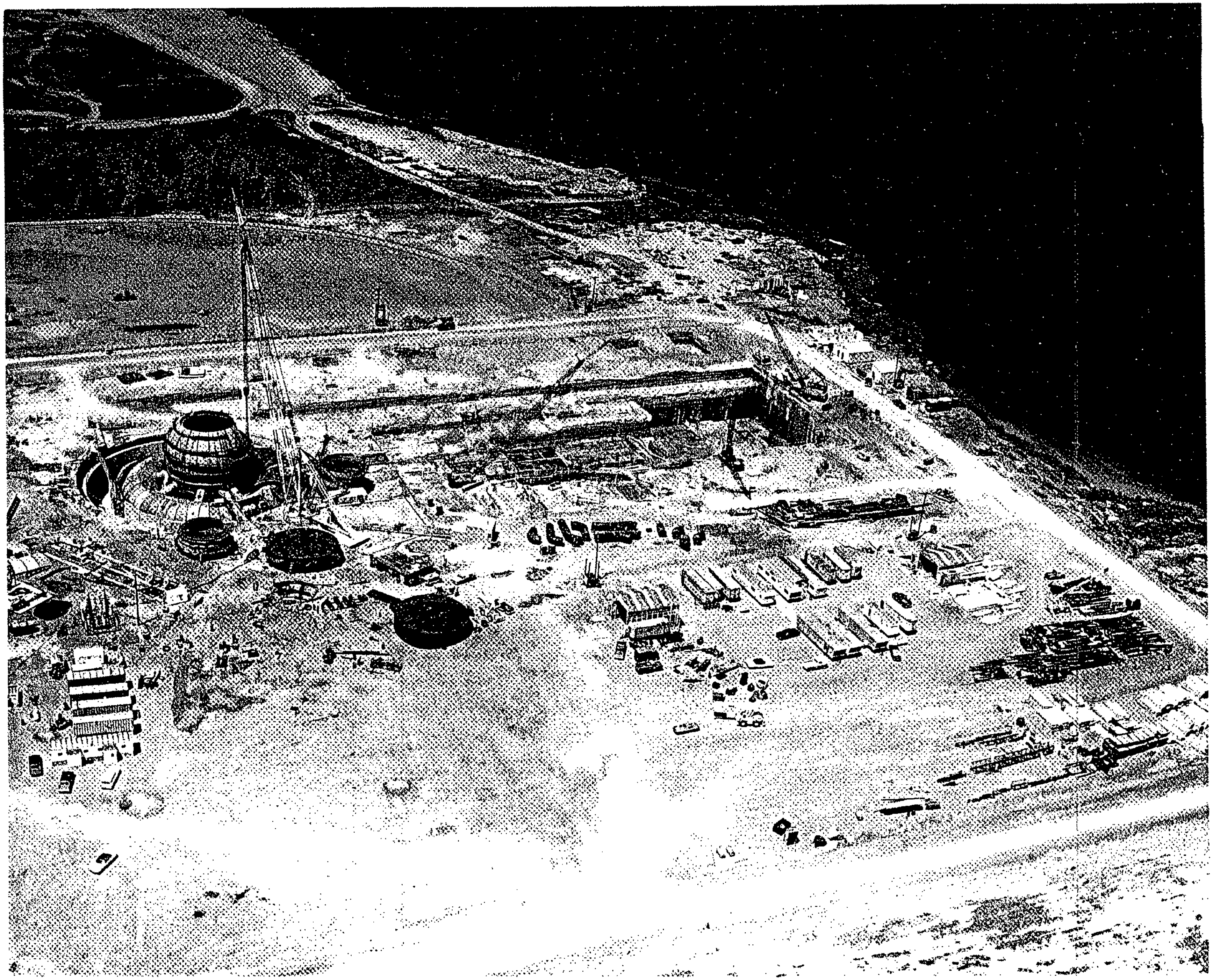


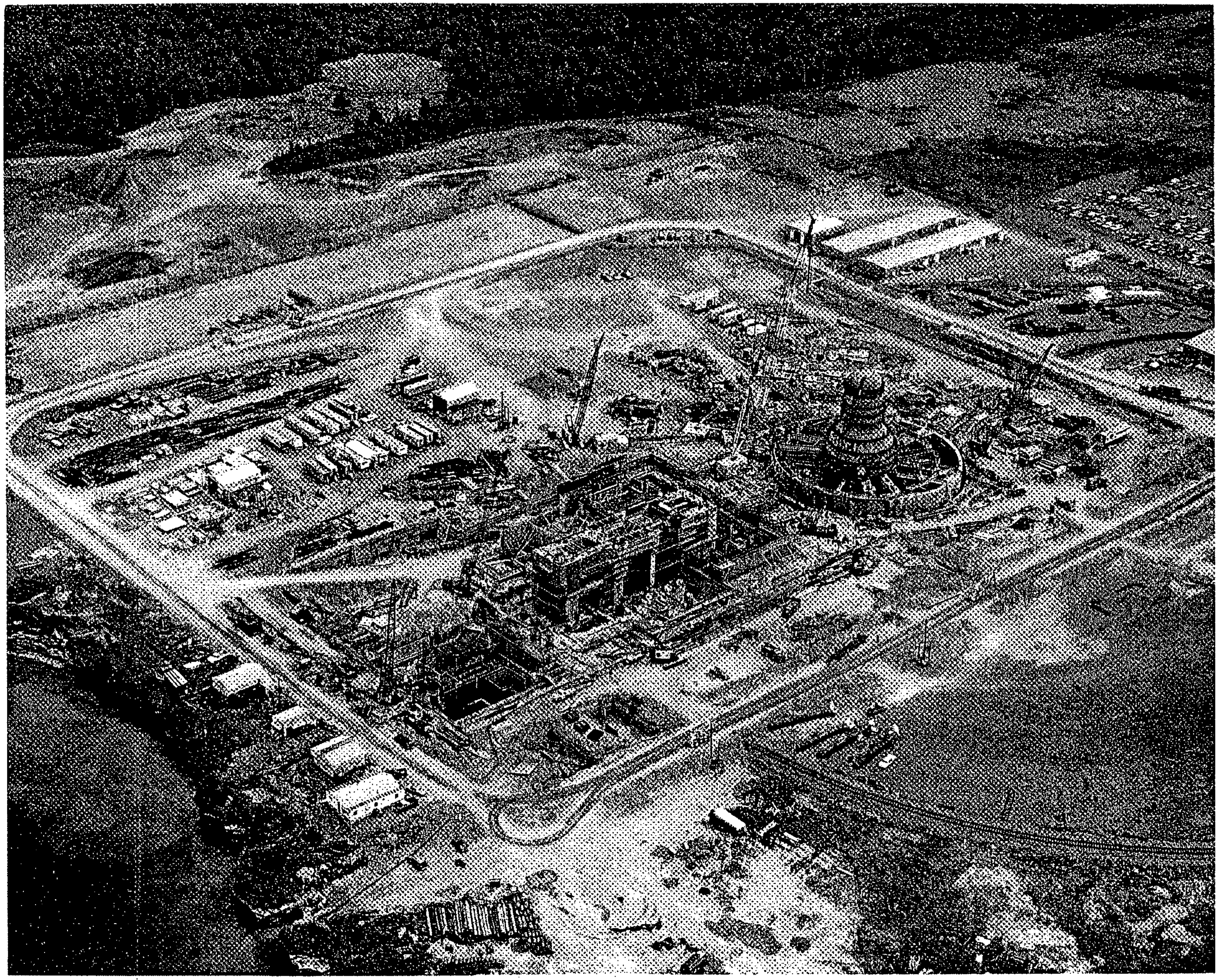


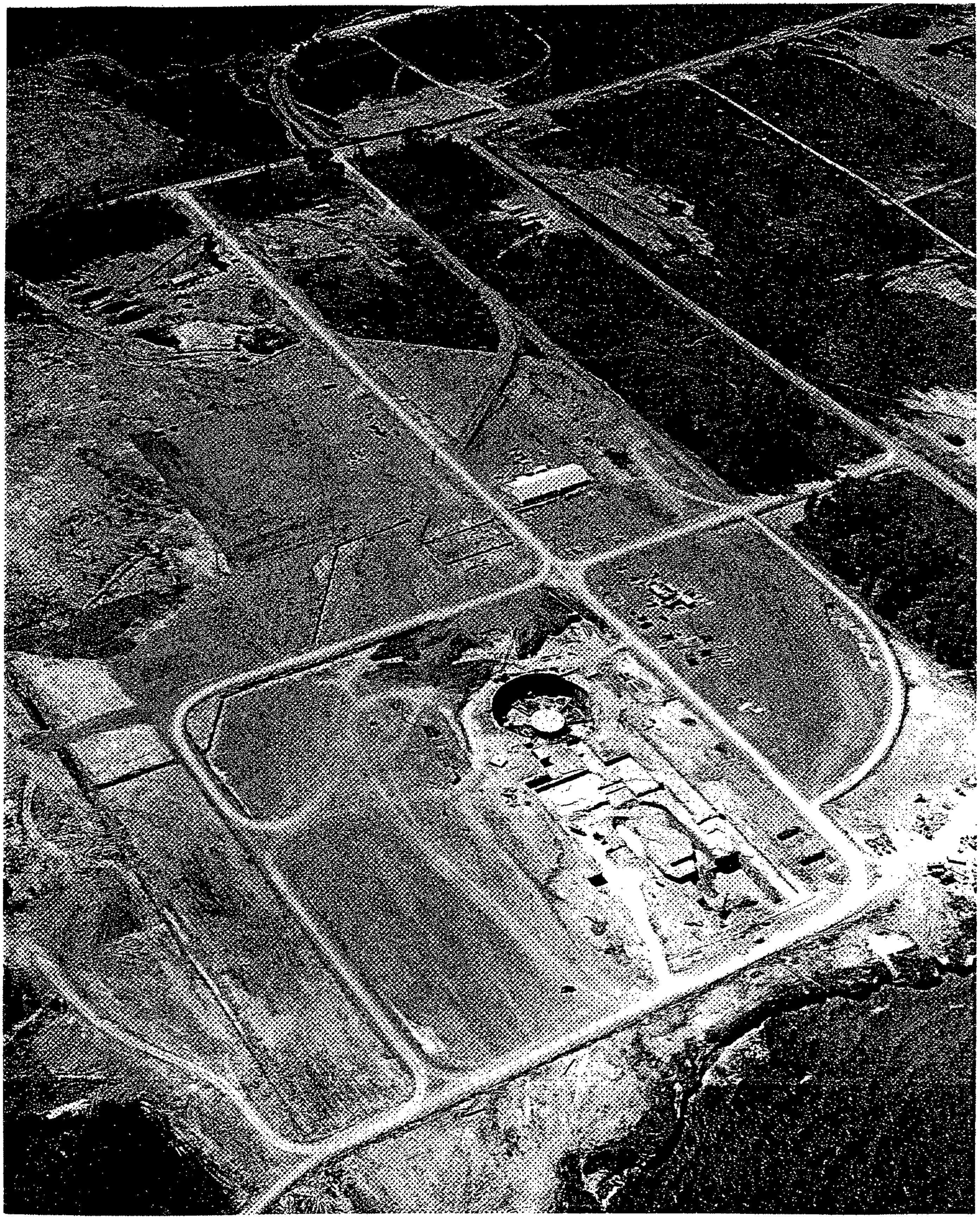


JAMES A. FITZPATRICK NUCLEAR POWER PLANT









Attachment 2

James A. FitzPatrick Nuclear Power Plant

License Renewal Application – Amendment 1

Reference for RAI E-2-b-1

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: "NINE MILE POINT GENERATING SITE NO. C-14332-6."

WITHIN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO. C-14332-6

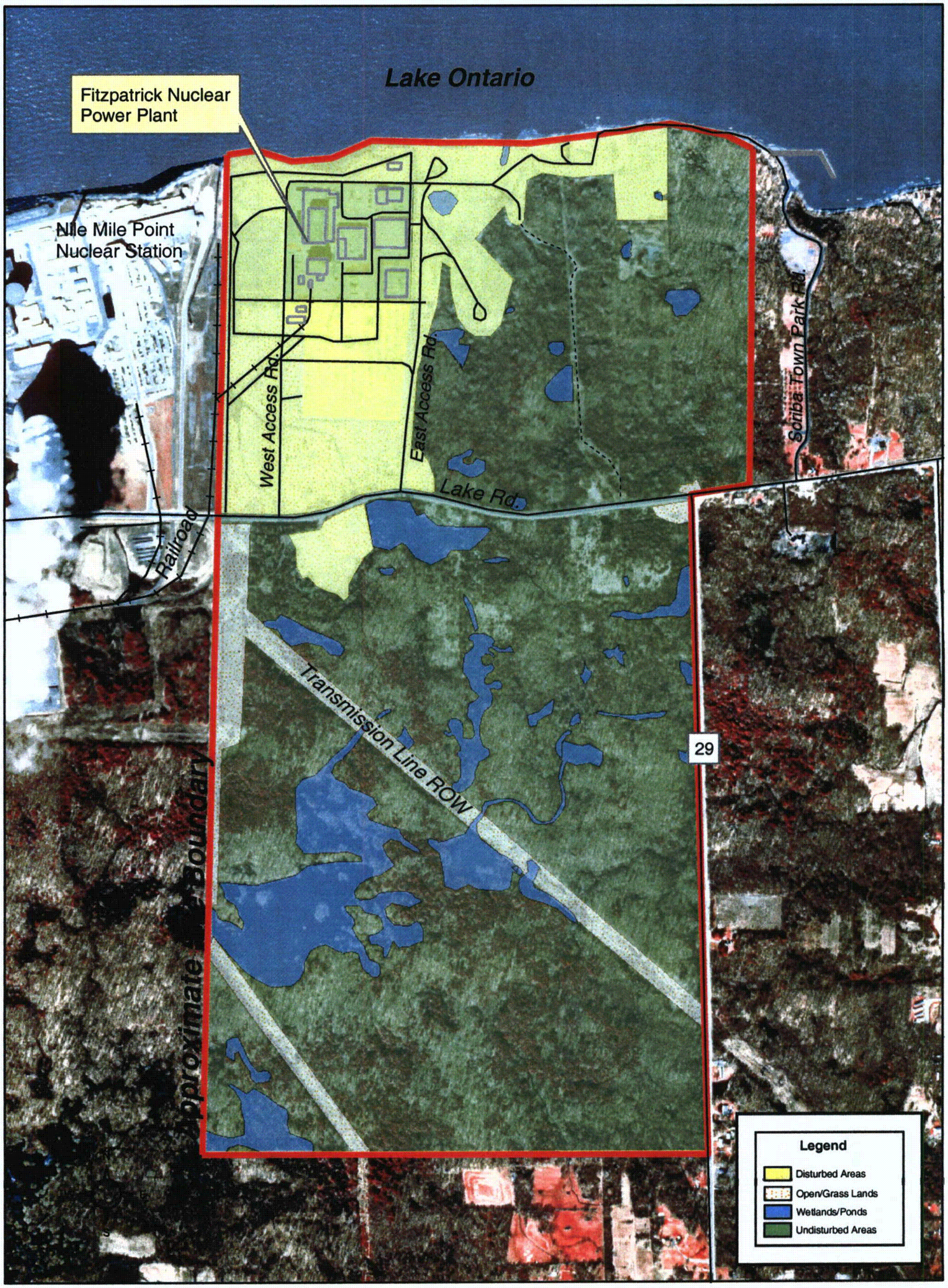
D-01

Attachment 2

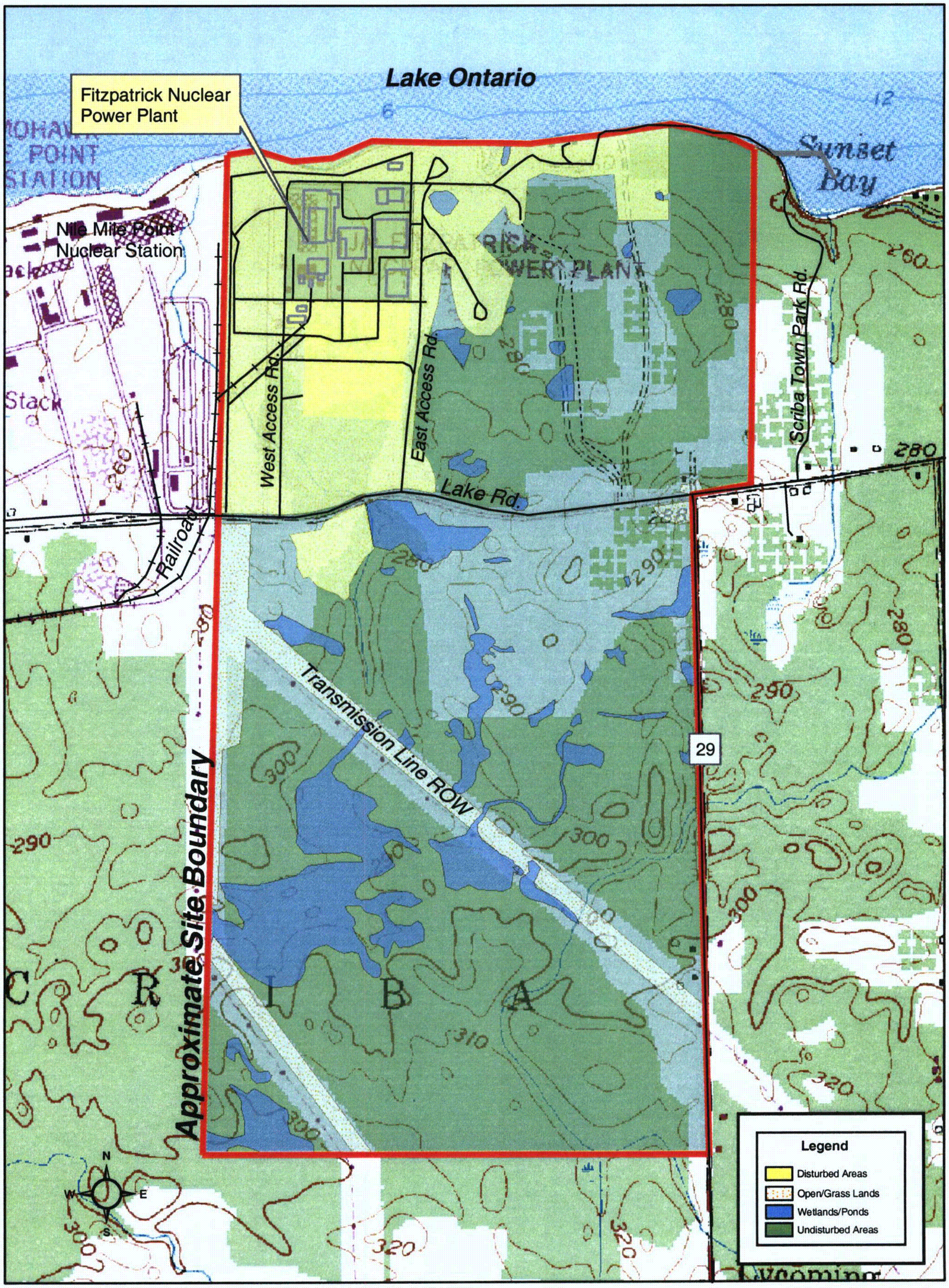
James A. FitzPatrick Nuclear Power Plant

License Renewal Application – Amendment 1

Reference for RAI E-2-c-1



Lake Ontario
Fitzpatrick Nuclear Power Plant
Nine Mile Point Nuclear Station
West Access Rd.
East Access Rd.
Scriba Town Park Rd.
Lake Rd.
Railroad
Transmission Line ROW
29
Boundary
Legend
Disturbed Areas
Open/Grass Lands
Wetlands/Ponds
Undisturbed Areas



Lake Ontario
Fitzpatrick Nuclear Power Plant
Sunset Bay
Nile Mile Point Nuclear Station
West Access Rd.
East Access Rd.
Scriba Town Park Rd.
Lake Rd.
Railroad
Transmission Line ROW
Approximate Site Boundary
29
Legend
Disturbed Areas
Open/Grass Lands
Wetlands/Ponds
Undisturbed Areas

Attachment 2

James A. FitzPatrick Nuclear Power Plant

License Renewal Application – Amendment 1

Reference for RAI E-2-e-1

Title: **Environmental Reviews and Evaluations**

Procedure Owner:	**Rick N. Buckley / Corporate Environmental Chairman**	
	(Print Name / Title)	
Approved:	Ricky N. Buckley	**04/06/06**
	(Procedure Owner Signature)	(Date)

Effective Date	**EN Common**	☒	**04/10/06**	**Effective Date Exception**	**ANO**		**PNPS**	
	ENN	☐			**ECH**		**RBS**	
	ENS	☐			**GGNS**		**VY**	
					IPEC		**W3**	
					JAF		**WPO**	

Procedure Contains NMM REFLIB Forms: YES ☒ NO ☐

Basis Statement

Rev. 4

This revision does not affect the intent of this procedure and is editorial only to:

- Change "greater than one acre" to "equal to or greater than one acre" to correct a typographical error (see Item 1 to Attachment 9.1).
- Clarify that undisturbed areas include "surface or sub-surface" soils (see Item 2 to Attachment 9.1).
- Add language to clarify that land disturbance activities at VY that are less than one acre may require evaluation due to a state-specific requirement (see Item 3 to Attachment 9.1).
- Clarified that Items 1 and 2 under the Environmental Screening Questions to Attachment 9.4 also apply to archaeological, historical or other cultural resources that may be inadvertently uncovered during excavation activities.

Site and NMM Procedures Cancelled or Superseded By This Revision

None

Process Applicability Exclusion (ENN-LI-100) / Programmatic Exclusion (ENS-LI-101)

All Sites: ☐ Specific Sites: ANO ☐ GGNS ☐ IPEC☐ JAF ☐ PNPS☐ RBS ☐ VY ☐ W3 ☐

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1.0 PURPOSE

Prescribes and establishes the nonradiological review and documentation process prior to engaging in additional construction or operational activities that may result in an environmental impact.

2.0 REFERENCES

[1] Regulatory References

(a) 10CFR51.22, "Criterion for Categorical Exclusion; Identification of Licensing and Regulatory Actions Eligible for Categorical Exclusion or Other Wise not Requiring Environmental Review." Specifically 10CFR51.22(c)(9).

(b) NUREG-0575, Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel, 1979

(c) NUREG-1092, Environmental Assessment for 10 CFR Part 72 "Licensing Requirements for the Independent Storage of Spent Fuel and High-Level Radioactive Waste," 1984

(d) NUREG-1437, Generic Environmental Statement for License Renewal of Nuclear Power Plants, Final Report, May 1996 (and Addendum's)

[2] Environmental Protection Agency References

(a) Clean Air Act

(b) Clean Water Act

(c) Endangered Species Act (and amendments)

(d) National Historic Preservation Act (and amendments)

(e) Resource Conservation and Recovery Act

[3] Entergy Nuclear References

(a) NMM Procedure EN-LI-100, Process Applicability Determination

(b) NMM Procedure EN-EV-117, Air Emissions Management Program

2.0 cont

[4] ANO References

(a) Air Permit Number 0090-AR-3

(b) ANO Unit 1 Final Environmental Statement, February 1973

(c) ANO Units 1 and 2 Safety Analysis Report

(d) Arkansas Nuclear One Stormwater Pollution Prevention Plan

(e) Condition 2.E to ANO Unit 2 Operating License NPF-6

(f) Environmental Assessment for Addition of the VSC to the List of Approved Casks in 10CFR72.214, 1993

(g) Environmental Assessment for the Use of a General License for Dry Cask Storage per 10CFR72, Subpart K, 1989

(h) NPDES Permit Number AR0001392

(i) NUREG-0254, ANO Unit 2 Final Environmental Statement, June 1977

(j) NUREG-1437, Supplement 3, Generic Environmental Statement for License Renewal of Nuclear Power Plants Regarding Arkansas Nuclear One, Unit 1

(k) NUREG-1437, Supplement 19, Generic Environmental Statement for License Renewal of Nuclear Power Plants Regarding Arkansas Nuclear One, Unit 2

(l) Procedure 1000.167, ANO Historical and Archaeological Preservation Program

(m) Procedure 1052.030, ANO Spill Prevention Control and Countermeasure Plan

(n) Section 404 Permit 00241-5

(o) Supplementary Information - Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste (51FR19106), 1986

2.0 cont

(p) Waste Confidence Decision (49FR34688), 1984

[5] GGNS References

(a) Baseline Stormwater General NPDES Permit Number MSR000883

(b) GGNS Environmental Protection Plan, Appendix B to Operating License NPF-29

(c) GGNS Synthetic Minor Operating Permit 0420-00023

(d) GGNS Updated Final Safety Analysis Report

(e) Grand Gulf Nuclear Station Spill Prevention Control and Countermeasure Plan

(f) Grand Gulf Nuclear Station Stormwater Pollution Prevention Plan

(g) NPDES Permit Number MS0029521

(h) NUREG-0777, GGNS Final Environmental Statement, September 1981

[6] IP2 References

(a) Environmental Report, Indian Point Unit 2, August 1970

(b) Final Environmental Statement Related to Operation of Indian Point Unit 2, September 1972

(c) IP1, 2 and 3 SPDES Permit Number NY 0004472

(d) IP2 Air Permit Number 3-5522-00011/00026

(e) IP2 Chemical Bulk Storage Registration 3-000107

(f) IP2 Environmental Protection Plan, Appendix B to Operating License DPR-26

(g) IP2 Facility Response Plan

(h) IP2 Hazardous Waste TSDF Permit NYD991304411

(i) IP2 Major Oil Storage Facility License MOSF #3-2140

2.0 cont

(j) IPEC Procedure SMM-EV-101, IPEC Spill /Release Response Plan

(k) IP2 Spill Prevention Control and Countermeasure Plan

(l) IP2 Updated Final Safety Analysis Report

(m) IP2 Vapor Extractor WCDOH Air Permit 52-5682

(n) IP2 WCDOH Boiler Permit 52-4493

(o) IP2 WCDOH GT 1 Air Permit #00021

(p) IP2 WCDOH GT 2 Air Permit #00022

(q) IP WCDOH GT 3 Air Permit #00023

(r) Buchanan GT SPDES Permit Number NY 022 4826

(s) Simulator Transformer Vault SPDES Permit NY 025 0414

(t) Tank Farm SPDES Permit NY 025 1135

[7] IP3 References

(a) Environmental Report, Indian Point Unit 3, June 1971 (and supplements)

(b) Final Environmental Statement Related to Operation of Indian Point Unit 3

(c) IP1, 2 and 3 SPDES Permit Number NY 0004472

(d) IP3 Air Permit Number 3-5522-00105/00009

(e) IP3 Chemical Bulk Storage Registration #3-000071

(f) IP3 Environmental Protection Plan, Appendix B to Operating License DPR-64

(g) IPEC Procedure SMM-EV-101, IPEC Spill/Release Plan

(h) IP3 Spill Prevention Control and Countermeasure Plan

(i) NUREG-75-002/003, IP3 Final Environmental Statement, February 1975

2.0 cont

(j) IP3 Hazardous Waste TSDF Permit NYD085503746

(k) IP3 Petroleum Bulk Storage Registration 3-166367

(l) IP3 Updated Final Safety Analysis Report

(m) IP3 WCDOH Boiler Permit # 52-6497

(n) IP3 WCDOH Training Center Boiler Permit #52-6498

(o) IP3 WCDOH Vapor Extractor Air Permit (awaiting issuance)

[8] JAF References

(a) Certificate to Operate an Air Contamination Source 7-3556-00020/00012

(b) Great Lakes Water Withdrawal Registration 4004

(c) Hazardous Substance Bulk Storage Registration Certificate 7-000117

(d) Final Environmental Statement Related to the Operation of James A. FitzPatrick Nuclear Power Plant, March 1973

(e) JAF Procedure AP-09.03, Oil Spill Prevention Control and Countermeasure Plan

(f) JAF Updated Final Safety Analysis Report

(g) Industrial Waste Transporter and Disposal Permit 7A-041

(h) Mixed Waste Storage Facility Permit NYD000765073

(i) Pesticide Applicator Business Registration 79632

(j) Petroleum Bulk Storage Registration Certificate 7-140600

(k) Section 404 Permit 94-486-10

(l) Sewage Sludge Transporter Permit 34-052

(m) SPDES Permit NY-0020109

2.0 cont

[9] PNPS References

(a) 50% Emission Cap Authorization

(b) Groundwater Discharge Permit Number SE#2-389

(c) NPDES Permit Number MA0003557

(d) PNPS Final Environmental Statement Related to Operation of Pilgrim Nuclear Power Station, May 1972

(e) PNPS Spill Prevention Control and Countermeasures Plan

(f) PNPS Updated Final Safety Analysis Report

(g) Section 404 Permit 199302464

[10] RBS References

(a) Air Permit Number 3160-00009-03

(b) LPDES Permit Number LA0042731

(c) NUREG-1073, RBS Final Environmental Statement, January 1985

(d) RBNP-035, Hazardous Materials Emergency Response

(e) RBS Environmental Protection Plan, Appendix B to Operating License NPF-47

(f) RBS Spill Prevention Control and Countermeasures Plan

(g) RBS Updated Safety Analysis Report

(h) Section 404 General Permit NOD-23

[11] VYNPS References

(a) Air Contaminant Source Registration Certificate WM2335

(b) Stormwater Discharge Permit 3415-9010

2.0 cont

(c) Stormwater Discharge Permit 3653-9015

(d) Dredging Permit 200302129

(e) Final Environmental Statement Related to the Operation of Vermont Yankee Nuclear Power Corporation, July 1972

(f) Indirect Discharge Permit ID-9-0036-1A

(g) NPDES Permit 3-1199

(h) OP 2106, Oil and Hazardous Materials Spill Prevention and Control

(i) Public Water System Permit to Operate (COB Water System) 20559

(j) Solid Waste Management Facility Certification F9906-A1

(k) Stream Alteration Permit SA-1-0655

(l) Underground Storage Permit 806

(m) VY Updated Final Safety Analysis Report

(n) Water System Permit to Operate (Main Plant Water System) 8332

(o) Water System Permit to Operate (NEOB Water System) 20738

[12] W3 References

(a) Air Permit Number 2520-00091-00

(b) LPDES Permit Number LA0007374

(c) NUREG-0779, W3 Final Environmental Statement

(d) W3 Cultural Resources Protection Plan

(e) W3 Environmental Protection Plan, Appendix B to Operating License NPF-38

(f) W3 Final Safety Analysis Report

2.0 cont

(g) W3 Spill Prevention Control and Countermeasures Plan

(h) W3 Stormwater Pollution Prevention Plan

3.0 DEFINITIONS

[1] Environmental Evaluation – Written nonradiological environmental evaluation on the impact of a proposed activity for which an environmental review concluded that an evaluation is required in order to determine if an unreviewed environmental question is involved.

[2] Environmental Review (ER) – Process of determining whether a proposed activity:

- Is regulated by state or federal (other than NRC) regulatory agencies.
- Is within existing environmental reviews (i.e., FES).
- Represents an unreviewed environmental question.

[3] Significant Adverse Environmental Impact – Environmental effects that are clearly noticeable and are sufficient to destabilize important attributes of the environment.

[4] Unreviewed Environmental Question - An unreviewed environmental question exists, if the proposed change, test, or experiment involves a: **[P-29140, P-29141 & P-29142]**

- Matter which may result in a significant increase in any adverse environmental impact previously evaluated in the sites Final Environmental Statement.
- Matter not previously reviewed and evaluated in the sites Final Environmental Statement but which may have a significant adverse environmental impact.

4.0 RESPONSIBILITIES

[1] Environmental Department Lead or Designee is responsible for:

(a) Performing environmental reviews of proposed changes, tests or experiments in accordance with this procedure.

(b) Performing environmental evaluations of proposed changes, tests or experiments that involve an unreviewed environmental question.

(c) Ensuring that reviews and evaluations are placed in plant records in accordance with site procedures.

[2] Contractors are responsible for complying with Section 5.2 of this procedure.

[3] Each Site's Nuclear Safety Assurance Department is responsible for obtaining NRC review and approval prior to the implementation of an activity that involves an unreviewed environmental question.

[4] EN Personnel are responsible for complying with Section 5.2 of this procedure.

[5] Environmental Focus Group is responsible for maintaining this procedure.

5.0 DETAILS

5.1 PRECAUTIONS AND LIMITATIONS

None

5.2 SITE ACTIVITY REVIEWS

NOTE

Activities already reviewed in accordance with the procedures identified in the Section 2.0[3] references, site engineering reviews, or other site administrative procedures which are determined not to have an environmental impact are not subject to Section 5.2 of this procedure.

[1] For those activities listed In Attachment 9.1 to this procedure, contractors and site personnel must complete Attachment 9.1 and obtain approval from the site environmental department lead PRIOR to conducting the activity.

5.2 cont

[2] Contractors and site personnel may refer to Attachment 9.4 of this procedure for a description of the environmental screening regulatory basis for the activities listed in Attachment 9.1.

5.3 QUALIFICATION OF REVIEWERS AND EVALUATORS

[1] Only personnel that are familiar with this procedure and the references identified in Sections 2.0[1] – 2.0[12], as applicable, are qualified to perform environmental reviews and evaluations.

[2] Signature on environmental review or evaluation forms indicates that personnel are familiar with this procedure and the references identified in Sections 2.0[1] – 2.0[12], as applicable, and are qualified to perform environmental reviews and evaluations.

5.4 ENVIRONMENTAL REVIEWS **[P-5452, P-5454, P-5456, P-29138 & P-32396]**

NOTE

Only Sections 5.4[1] and 5.4[2] below of this procedure are applicable to JAF, PNPS and VYNPS since these facilities do not have an Appendix B (Environmental Protection Plan) to their operating license.

[1] Upon receiving a Process Applicability Determination Form described in NMM Procedure EN-LI-100 or a Site Activity Review Form described in Section 5.2 of this procedure, the site environmental department lead must THEN complete the Environmental Review Form shown in Attachment 9.2.

[2] IF the proposed activity is within the scope (i.e., is covered by or could be covered through a modification, revision or approval) of a reference(s) listed in Section 2.0 of this procedure, no unreviewed environmental question exists, and the site environmental department lead must THEN:

(a) Provide a copy of the Environmental Review Form (Attachment 9.2) to the originating department.

(b) Ensure that a copy of the Process Applicability Determination Form or Site Activity Review Form, as applicable, and the Environmental Review Form are placed in plant records in accordance with site procedures.

5.4 cont

[3] IF the proposed activity is not within the scope (i.e., is not covered by or could not be covered through a modification, revision or approval) of a reference(s) listed in Section 2.0 of this procedure, a potential unreviewed environmental question exists, and the site environmental department lead must THEN complete the Environmental Evaluation Form shown in Attachment 9.3.

[4] IF no significant adverse environmental impacts as described in Section 3.0[3] will occur as a result of the activity upon completion of the Environmental Evaluation Form, THEN the site environmental department lead must:

(a) Provide a copy of the Environmental Review Form (Attachment 9.2) to the originating department.

(b) Maintain on file a copy of the Process Applicability Determination Form or Site Activity Review Form, as applicable, Environmental Review Form, and Environmental Evaluation Form.

[5] IF a significant adverse environmental impact as described in Section 3.0[3] will occur as a result of the activity upon completion of the Environmental Evaluation Form, THEN the site environmental department lead must:

(a) Notify the originating department that NRC approval must be obtained prior to implementation.

(b) Unless otherwise specified by the originating department, forward the completed Environmental Evaluation Form shown in Attachment 9.3 to NSA.

(c) Ensure that a copy of the Process Applicability Determination Form or Site Activity Review Form, as applicable, Environmental Review Form and Environmental Evaluation Form are placed in plant records in accordance with site procedures.

5.5 NRC SUBMITTAL OF EVALUATIONS **[P-29139 & P-29143]**

> **NOTE**
>
> Section 5.5 of this procedure is not applicable to JAF, PNPS and VYNPS since these sites do not have an Appendix B (Environmental Protection Plan) to their operating license.

[1] NSA, upon receiving an Environmental Evaluation Form involving an unreviewed environmental question, must THEN:

(a) Submit the environmental evaluation to the NRC for review and approval in accordance with department procedures.

(b) Notify the site environmental department lead upon receipt of NRC approval/disapproval.

6.0 INTERFACES

[1] NMM EN-LI-100, Process Applicability Determination

7.0 RECORDS

[1] Quality Records

(a) Environmental Evaluation Form

[2] Non-Quality Records

(a) Environmental Review Form

8.0 OBLIGATION AND REGULATORY COMMITMENT CROSS-REFERENCES

8.1 OBLIGATIONS AND COMMITMENTS IMPLEMENTED OVERALL

None

8.2 SECTION SPECIFIC OBLIGATIONS AND COMMITMENTS

None

8.3 SITE SPECIFIC COMMITMENTS

Step	Site	Document	Commitment Number or Reference
[1]	GGNS	EPP Section 3.1	P-29138 & P-32396
[2]	GGNS	EPP Section 3.1	P-29139 & P-29143
[3]	GGNS	EPP Section 3.1	P-29140, P-29141 & P-29142
[4]	W3	EPP Section 3.1	P-5452, P-5454 & P-5456

9.0 ATTACHMENTS

9.1 Site Activity Review Form (Typical)

9.2 Environmental Review Form (Typical)

9.3 Environmental Evaluation Form (Typical)

9.4 Environmental Screening Regulatory Basis

ATTACHMENT 9.1 **SITE ACTIVITY REVIEW FORM (TYPICAL)**

SHEET 1 of 1

Check Appropriate Box(es) for Activity Being Performed:
(Attachment 9.4 provides a brief description of the screening regulatory basis for the activities listed below.)

1.	☐	Land disturbance equal to or greater than one acre (i.e., grading activities, construction of buildings, excavations, reforestation, creation or removal of ponds).
2.	☐	Any land disturbance of undisturbed surface or subsurface land areas (i.e., grading activities, construction, excavations, reforestation, creating, or removing ponds).
3.	☐	For Vermont Yankee only, land disturbance involving previously disturbed land that is less than one acre.
4.	☐	Dredging activities in a lake, river, pond, ditches or stream.
5.	☐	Changing the amount of thermal heat being discharged to the river or lake (i.e., associated with once through and closed cycle cooling wastewater discharges).
6.	☐	Changing the concentration or quantity of chemicals being discharged to the river, lake, or air (i.e., associated with wastewater and air emission discharges).
7.	☐	Discharging new or different chemicals that are currently not authorized for use by the state regulatory agency (i.e., associated with wastewater discharges).
8.	☐	Changing the design or operation of the intake or discharge structures (i.e., increase water withdrawal flow at intake structure or discharge flow at discharge structure).
9.	☐	Modifying the design or operation of the cooling tower that will change water or air flow characteristics.
10.	☐	Modifying the design or operation of the plant that will change the path of an existing water discharge or that will result in a new water discharge (i.e., associated with wastewater discharges).
11.	☐	Modifying existing stationary fuel burning equipment that could potentially result in an increase of air emissions (i.e., diesel fuel oil, butane, gasoline, propane, and kerosene).
12.	☐	Installing or removing stationary fuel burning equipment or using portable fuel burning equipment (i.e., diesel fuel oil, butane, gasoline, propane, and kerosene).
13.	☐	Installing or using equipment that will result in an air emission discharge (i.e., ozone, VOC, particulates, sulfur dioxide, carbon monoxide, nitrogen oxide).
14.	☐	Installing or modifying a stationary or mobile tank (i.e., fuel oil, gasoline, kerosene, propane, butane, sulfuric acid).
15.	☐	Using or storing oils or chemicals in containers ≥55 gallons that could be directly released into the environment.
16.	☐	Burying or placing any solid wastes in the site area that may affect runoff, surface water, or groundwater.
17.	☐	Generates a new hazardous waste stream or increases an existing hazardous waste stream.

Prepared By: ______________________________ **Date:** ________________

Approved By: ______________________________ **Date:** ________________

NOTE: Completed form must be reviewed and approved by site environmental department lead prior to starting the activity.

ATTACHMENT 9.2 **ENVIRONMENTAL REVIEW FORM (TYPICAL)**

SHEET 1 of 1

1. Facility: ______________________________

2. Document Number: ______________________________

3. ER Number: ______________________________

4. Activity Reviewed: ______________________________

____

5. Complete Screening Below (as applicable to each site):

Reference	Within Scope	Modification/Revision/ Approval Needed
Section 2.0[1] References	☐ Yes ☐ No ☐ N/A	
Section 2.0[2] References	☐ Yes ☐ No ☐ N/A	
Section 2.0[4] References (ANO)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[5] References (GGNS)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[6] References (IP2)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[7] References (IP3)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[8] References (JAF)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[9] References (PNPS)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[10] References (RBS)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[11] References (VYNPS)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No
Section 2.0[12] References (W3)	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No

6. If within scope, attach cited reference(s) and appropriate section(s) along with a brief discussion:

7. If a modification, revision or approval is needed, attach a brief discussion:

8. Prepared By: ______________________ Date: ______________

ATTACHMENT 9.3 **ENVIRONMENTAL EVALUATION FORM (TYPICAL)**

SHEET 1 OF 1

1. Document Evaluated:

2. Description of proposed change (attach additional sheets if needed):

3. Analysis of environmental impact (attach additional sheets if needed):

4. If applicable, alternatives for reducing environmental impact (attach additional sheets if needed):

5. Summary of basis for conclusions (attach additional sheets if needed):

6. Significant Adverse Environmental Impact Exists: ☐ Yes ☐ No

7. References: (attach additional sheets if needed):

TOT. PGS	PREPARER	DATE	REVIEWER	DATE

Environmental Screening Regulatory Basis:

For sites that implement an Environmental Protection Plan (EPP), it states that the licensee may make changes in station design or operation or perform tests or experiments affecting the environment, provided such activities do not involve an unreviewed environmental question and do not involve a change in the EPP. For ANO, these requirements are described in Condition 2.E to the Unit 2 Operating License.

Changes in plant design or operation or performance of tests or experiments which do not affect the environment are not subject to the requirements of the respective EPP or the ANO Unit 2 Operating License. *However, these changes are still subject to other federal and state regulatory requirements and must be evaluated.*

Before engaging in construction or operation activities which may significantly affect the environment, the licensee shall prepare and record an environmental evaluation of such activity. Although activities are excluded from EPP requirements (or the ANO-2 Operating License 2.E requirement) if all measurable nonradiological effects are confined to the onsite areas previously disturbed during site preparation and plant construction, *other federal and state regulatory requirements still apply.* When the evaluation indicates that such activity involves an unreviewed environmental question, the licensee shall provide a written evaluation of such activity and obtain prior NRC approval. When such activity involves a change in the EPP or the ANO-2 Operating License, such activity and change may be implemented only in accordance with an appropriate license amendment.

The environmental screening fulfills two main purposes:

1. Ensure that no unreviewed environmental question exists as set forth by EPP requirements, and
2. To ensure that activities that may require approvals or permitting activities regulated by the state or federal environmental permitting authority receive due consideration and action, as appropriate.

Each of the environmental screening questions and the regulatory basis for them are provided below.

Environmental Screening Questions:

Will the proposed change being evaluated involve or include.

1. Land disturbance equal to or greater than one acre (i.e., grading activities, construction of buildings, excavations, reforestation, creation or removal of ponds).
   - In accordance with the Clean Water Act, a Construction Stormwater Permit is required for those activities that disturb one acre or greater in order to manage:
     - ★ Sediment runoff and erosion.
     - ★ Potential leakage from oil and chemical containers.
     - ★ Potential leakage from vehicles and equipment.

     A construction stormwater permit is not required for silvicultural activities. However, best management practices must be followed and consideration given to historical locations or endangered species.

- In accordance with the National Historic Preservation Act, any cultural resources in the area must not be disturbed until prior authorization is obtained from the State Historic Preservation Office, and if applicable, the NRC as set forth in the site's Cultural Resource Protection Plan. This would also apply to archaeological, historical or other cultural resources that may be inadvertently uncovered during excavation activities.

2. Any land disturbance of undisturbed surface or sub-surface land areas (i.e., grading activities, construction, excavations, reforestation, creating, or removing ponds).
   - In accordance with the National Historic Preservation Act, any cultural resources in the area must not be disturbed until prior authorization is obtained from the State Historic Preservation Office, and if applicable, the NRC as set forth in the site's Cultural Resource Protection Plan. This would also apply to archaeological, historical or other cultural resources that may be inadvertently uncovered during excavation activities.
   - In accordance with the Clean Water Act, a Construction Stormwater Permit is required for those activities that disturb one acre or greater in order to manage:
     - ★ Sediment runoff and erosion.
     - ★ Potential leakage from oil and chemical containers.
     - ★ Potential leakage from vehicles and equipment.

   A construction stormwater permit is not required for silvicultural activities. However, best management practices must be followed and consideration given to historical locations or endangered species.

   - An activity is excluded from EPP review requirements if all measurable nonradiological effects are confined to the on-site areas previously disturbed during site preparation and plant construction.
3. For Vermont Yankee only, land disturbance involving previously disturbed land that is less than one acre.
   - In accordance with the Vermont Department of Environmental Conservation stormwater management regulations, a Permit may be required to discharge treated stormwater:
4. Dredging activities in a lake, river, pond, ditches or stream.
   - In accordance with the Clean Water Act, a Section 404 Permit is required:
     - ★ For removal of material from a lake, river, pond, ditch or stream.
     - ★ For disturbing any material in a lake, river, pond, ditch or stream.
     - ★ For disturbing areas designated as wetlands.
5. Changing the amount of thermal heat being discharged to the river or lake (i.e., associated with once through and closed cycle cooling wastewater discharges).
   - In accordance with the Clean Water Act, any temperature increase in once through or closed cycle cooling water discharges that would exceed the established limits set in the LPDES/NPDES/SPDES Permit would have to be approved by the regulatory agency and the Permit modified accordingly.

6. Changing the concentration or quantity of chemicals being discharged to the river, lake, or air (i.e., associated with wastewater and air emission discharges).
   - In accordance with the Clean Water Act, increasing the concentration or quantity of a chemical in a wastewater discharge that had already been previously established and defined in a LPDES/NPDES/SPDES Permit application would have to be approved by the regulatory agency prior to the change.
   - In accordance with the Clean Air Act, if air emissions from a source increases in pounds/hour or tons/year from that specified in the site Air Permit or Air Permit application as a result of increasing the concentration or quantity of a chemical, regulatory approval would have to be obtained and the site Air Permit potentially modified.
7. Discharging new or different chemicals that are currently not authorized for use by the state regulatory agency (i.e., associated with wastewater discharges).
   - In accordance with the Clean Water Act, utilizing new or different chemicals that had not been previously defined in a LPDES/NPDES Permit application and that are associated with wastewater discharges would have to be approved by the regulatory agency prior to utilizing the chemical.
8. Changing the design or operation of the intake or discharge structures (i.e., increase water withdrawal flow at intake structure or discharge flow at discharge structure).
   - In accordance with the Clean Water Act, any change in the design that would increase the flow of water at the intake or discharge structures from that previously specified in the LPDES/NPDES application would have to be approved by the state regulatory agency.
9. Modifying the design or operation of the cooling tower that will change water or air flow characteristics.
   - In accordance with the Clean Air Act, if air emissions from a source increases in pounds/hour or tons/year from that specified in the site Air Permit or Air Permit application as a result of modifying the design or operation of the cooling tower, regulatory approval would have to be obtained and the site Air Permit potentially modified.
   - In accordance with the Clean Water Act, any change in the design of the cooling tower that would increase the flow of water being discharged from that previously specified in the LPDES/NPDES application would have to be approved by the state regulatory agency.
10. Modifying the design or operation of the plant that will change the path of an existing water discharge or that will result in a new water discharge (i.e., associated with wastewater discharges).
    - In accordance with the Clean Water Act, changing the path of an existing wastewater discharge or creating a new wastewater discharge that had not been previously defined in a LPDES/NPDES Permit application would have to be approved by the regulatory agency and the Permit modified accordingly.
    - For changes to the site's sanitary sewage system, the introduction of a new source of wastewater that will discharge into a municipal sewage treatment system may require approval from the county or parish sanitarian.

11. Modifying existing stationary fuel burning equipment that could potentially result in an increase of air emissions (i.e., diesel fuel oil, butane, gasoline, propane, and kerosene).
    - In accordance with the Clean Air Act, if air emissions from a source increases in pounds/hour or tons/year from that specified in the site Air Permit or Air Permit application as a result of modifying the fuel burning equipment, regulatory approval would have to be obtained and the site Air Permit modified.
12. Installing or removing stationary fuel burning equipment or using portable fuel burning equipment (i.e., diesel fuel oil, butane, gasoline, propane and kerosene).
    - In accordance with the Clean Air Act, installing stationary fuel burning equipment or bringing portable fuel equipment on-site classified as emission sources that are not listed in the Site Air Permit and that had not been previously defined in the Air Permit application would have to be approved by the regulatory agency and the Permit potentially modified prior to bringing the equipment on-site.
    - In accordance with the Clean Water Act and the sites Spill Prevention, Control and Countermeasures (SPCC) Plan, spill prevention measures have to be established for portable diesel fuel oil, gasoline or kerosene burning equipment and listed in the SPCC Plan if the portable equipment remains permanently.
13. Installing or using equipment that will result in an air emission discharge (i.e., ozone, VOC, particulates, sulfur dioxide, carbon monoxide, nitrogen oxide).
    - In accordance with the Clean Air Act, installing or using equipment that would result in the emission of a regulated air pollutant that is not listed in the Site Air Permit and that had not been previously defined in the Air Permit application would have to be approved by the regulatory agency and the Permit potentially modified prior to bringing the equipment on-site.
14. Installing or modifying a stationary or mobile tank (i.e., fuel oil, gasoline, kerosene, propane, butane, sulfuric acid).
    - In accordance with the Clean Air Act, if air emissions from a source increases in pounds/hour or tons/year from that specified in the site Air Permit or the Air Permit application as a result of installing or modifying a stationary or mobile tank, regulatory approval would have to be obtained and the site Air Permit potentially modified.
    - In an accordance with the Clean Water Act:
        - ★ Stationary diesel fuel oil, gasoline or kerosene tanks are required to have containment/diversionary structures and be listed in the sites Spill Prevention, Control and Countermeasures (SPCC) Plan.
        - ★ Spill prevention measures have to be established for mobile diesel fuel oil, gasoline or kerosene tanks while on-site and listed in the SPCC Plan if the mobile tank remains permanently.
        - ★ State of Louisiana requires that chemical containers ≥55 gallons be listed in the sites SPCC Plan and that containment/diversionary structures be established.

- ★ State of Arkansas and Mississippi require that containers of chemicals and oils be included in the sites Stormwater Pollution Prevention Plan as potential stormwater runoff pollutant sources and that containment/diversionary structures be established.

15. Using or storing oils or chemicals in containers ≥55 gallons that could be directly released into the environment.
    - In accordance with the Clean Water Act:
        - ★ Containers containing oils that are ≥55 gallons in capacity are required to be listed in the sites Spill Prevention, Control and Countermeasures Plan and containment/diversionary structures established.
        - ★ State of Louisiana requires that chemical containers ≥55 gallons be listed in the sites Spill Prevention, Control and Countermeasures Plan and containment/diversionary structures established.
        - ★ State of Arkansas and Mississippi require that containers of chemicals and oils be included in the sites Stormwater Pollution Prevention Plan as potential stormwater runoff pollutant sources and containment/diversionary structures established.
16. Burying or placing any solid wastes in the site area that may affect runoff, surface water, or groundwater.
    - In accordance with the Resource Conservation and Recovery Act, solid waste disposal permits are required to be obtained from the regulatory agency prior to burial of any material on-site.
    - In accordance with the Clean Water Act:
        - ★ Housekeeping measures must be established to minimize the potential of pollutants entering stormwater runoff.
        - ★ State of Arkansas and Mississippi require that areas that could be potential stormwater runoff pollutant source be listed in the sites Stormwater Pollution Prevention Plan.
    - The construction of a surface impoundment or pond will require a permit from the state or federal environmental permitting authority.
17. Generates a new hazardous waste stream or increases an existing hazardous waste stream.
    - In accordance with the Resource Conservation and Recovery Act and/or state-specific hazardous waste management requirements:
        - ★ Hazardous waste streams must be properly managed and accumulated.
        - ★ Hazardous waste streams must be characterized and profiled prior to sending off-site for disposal.
        - ★ Facilities are required to notify the regulatory agency should generator classification change due to an increase in hazardous waste generation.

Title: **Cultural Resources Protection Plan**

Procedure Owner:	**Rick N. Buckley / Corporate Environmental Chairman**	
	(Print Name / Title)	
Approved:	Ricky N. Buckley	**11/01/06**
	(Procedure Owner Signature)	(Date)

Effective Date	**EN Common**	☒	**11/03/06**	**Effective Date Exception**	**ANO**	**01/01/07**	**PNPS**	
	ENN	☐			**ECH**		**RBS**	
	ENS	☐			**GGNS**		**VY**	
					IPEC		**W3**	
					JAF		**WPO**	

Procedure Contains NMM REFLIB Forms: YES ☒ NO ☐

Basis Statement

This procedure provides a mechanism for protecting historical and archaeological areas located on Entergy's nuclear site properties.

Site and NMM Procedures Cancelled or Superseded By This Revision

ANO Procedure 1000.167, ANO Historical and Archaeological Preservation Program will be cancelled.

Process Applicability Exclusion (ENN-LI-100) / Programmatic Exclusion (ENS-LI-101)

All Sites: ☒ Specific Sites: ANO ☐ GGNS ☐ IPEC☐ JAF ☐ PNPS☐ RBS ☐ VY ☐ W3 ☐

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1.0 PURPOSE

[1] Provides a mechanism to protect either existing or potentially existing cultural resources located at the Entergy Nuclear sites.

2.0 REFERENCES

[1] Regulatory References

(a) National Historic Preservation Act (and amendments)

[2] Company References

(a) NMM Procedure EN-EV-115. Environmental Reviews and Evaluations

(b) NMM Procedure EN-IS-112, Trenching, Excavation and Ground Penetrating Activities

[3] ANO References

(a) FTN Letter No. 6045-061, "Cultural Resources Issues, ANO

(b) Commitment 1CAN090005, Reference P-17051, "Develop an administrative level environmental procedure to provide additional control over future land disturbances at ANO site"

[4] JAF References

(a) Letter from Nancy Herter, New York State Office of Parks, Recreation and Historic Preservation, to T. A. Sullivan, James A, Fitzpatrick, dated April 27, 2006 (refer to Attachment C of License Renewal Environmental Report)

[5] PNPS References

(a) Letter from Eric S. Johnson, Massachusetts Historical Commission, to Stephen Bethay, Pilgrim Nuclear Power Station, dated March 14, 2005 (refer to Attachment C of License Renewal Environmental Report)

[6] VYNPS References

(a) 30 V.S.A. § 248, New Gas and Electric Purchases, Investments and Facilities; Certificate of Public Good

2.0 cont

(b) Letter from Jane Lendway, Vermont Division for Historic Preservation, to Gary Tucker, FTN Associates, LTD., dated October 17, 2005 (refer to Attachment C of License Renewal Environmental Report)

[7] W3 References

(a) W3 Cultural Resources Protection Plan

3.0 DEFINITIONS

[1] Disturbed Land Areas – Surface and/or subsurface land areas that were significantly disturbed during the construction phase of the site (i.e., plant's protected area).

[2] Cultural Resources – Resources that include but are not limited to:

(a) Cemeteries, burial sites, funeral monuments, or other sites with human remains

(b) Historic buildings, structures, or building remains

(c) Ancient sites containing cultural artifacts such as pottery, tools, weaponry, and other implements

(d) Ritual artifacts

(e) Discarded materials (i.e. Indian mounds with shells and animal bones)

(f) Sites of historical significance to the community, state, or nation, such as battlegrounds, encampments, villages, etc.

(g) Traditional cultural properties.

[3] Land-Disturbing Activities – Activities that involve grading, construction of buildings, excavations, reforestation, landscaping, placement of any fill or spoil or other terrestrial impact.

[4] Undisturbed Land Areas – Surface and/or subsurface land areas that have not been disturbed either during the construction phase of the site or during current operations, or if there is uncertainty at the site about the degree of disturbance.

4.0 RESPONSIBILITIES

[1] Entergy Nuclear Environmental Focus Group - is responsible for maintaining, reviewing and interpreting this procedure.

[2] Site Environmental Representatives - are responsible for:

(a) Conducting environmental reviews of land disturbance activities in accordance with this procedure to ensure either existing or potentially existing cultural resources are protected to the maximum extent practicable.

(b) Ensuring that the State Historic Preservation Office (SHPO) is notified for activities that may affect existing or potentially existing cultural resources, if required by specific state laws, SHPO, operating license conditions or site reporting procedures.

[3] Site Departments – are responsible for complying with Sections 5.1 through 5.3 of this procedure.

[4] Contract Managers and Contractors – are responsible for complying with Sections 5.1 through 5.3 of this procedure.

5.0 DETAILS

5.1 PRECAUTIONS AND LIMITATIONS

[1] Land disturbing activities must be stopped immediately in the event that there is evidence of a historical or archaeological artifact and the SHPO notified for guidance prior to re-commencing land disturbing activities.

5.2 LAND DISTURBANCE OF UNDISTURBED AREAS

NOTE
If the land disturbance activity is occurring within the Protected Area Fence that encloses the power block area, then no further actions are required regarding this procedure.

[1] Site Departments, Contract Managers and Contractors, for activities involving land disturbance in undisturbed areas are to:

5.2 cont

(a) Complete Section A of Attachment 9.1 to this procedure (Land Disturbance Environmental Review Form) and forward to the Site Environmental Representative for review.

(b) Obtain approval from the Site Environmental Representative prior to the activity commencing.

(c) Adhere to the management requirements identified in Section C of Attachment 9.1 (Land Disturbance Environmental Review Form), as applicable to the land disturbance activity.

[2] Site Environmental Representative, upon receipt of Attachment 9.1 (Land Disturbance Environmental Review Form), is to:

(a) Contact SHPO for activities that may affect existing or potentially existing cultural resources.

(b) Complete Section B of the Form and if applicable Section C.

(c) If approved, return a copy of the completed Form to the requester.

(d) If not approved, notify the requestor of the reasons for denying the approval.

(e) Maintain copies of the required documents on file.

(f) Conduct periodic visual observations of the area to ensure that any management requirements identified in Section C of Attachment 9.1 (Land Disturbance Environmental Review Form) are followed.

(g) Ensure that mitigation measures are implemented as appropriate.

5.3 MODFICATION/REMODELING OF CULTURAL RESOURCE STRUCTURES

[1] Site Departments, Contract Managers and Contractors, for activities involving modifications/remodeling to cultural resource structures are to:

(a) Complete Section A of Attachment 9.2 to this procedure (Cultural Resource Structure Modification/Remodeling Review Form) and forward to the Site Environmental Representative for review.

5.3 cont

(b) Obtain approval from the Site Environmental Representative prior to the activity commencing.

(c) If applicable, adhere to the management requirements identified in Section C of Attachment 9.2 (Cultural Resource Structure Modification/Remodeling Review Form).

[2] Site Environmental Representative, upon receipt of Attachment 9.2 (Cultural Resource Structure Modification/Remodeling Review Form) is to:

(a) Contact SHPO to inform them of the activity.

(b) Complete Section B of the Form and if applicable Section C.

(c) If approved, return a copy of the completed Form to the requester.

(d) If not approved, notify the requestor of the reasons for denying the approval.

(e) Maintain copies of the required documents on file.

(f) Conduct periodic visual observations of the area to ensure that any management requirements imposed by SHPO are followed.

(g) Ensure that mitigation measures are implemented as appropriate.

5.4 ROUTINE SURVEILLANCES

[1] The Site Environmental Representative should:

(a) Conduct periodic environmental rounds to ensure that no unauthorized activities occur that could damage existing or potentially existing culturally protected resources.

(b) Notify the SHPO and the NRC if ground disturbing activities are discovered within an existing or potentially existing culturally protected resource area, if required by operating license conditions, SHPO or site reporting requirements.

(c) Obtain a certified archaeologist to conduct a damage assessment of the affected area, if deemed necessary.

5.5 SPECIAL PROTECTION PROCEDURES

[1] Should the site find it necessary to conduct any activities within a culturally protected area and if required by operating license conditions, SHPO or site procedures, the Environmental Site Representative should notify the SHPO and NRC in writing of the proposed activity. The notification should include, but not limited to:

- A description of the proposed activity.
- Description for the need for the activity.
- A map showing the location of the planned activity in relation the culturally protected areas.
- A demonstration for the need to perform the activity within the culturally protected area.

[2] The NRC, after consultation with the SHPO, will advise the site whether or not a mitigation plan is required.

5.6 RECORDS

NOTE
If the cultural resources review is performed as a result of an EN-EV-115 review, then the forms generated via this procedure should be filed with the EN-EV-15 screening paperwork.

[1] Site Environmental Representative should maintain the following documents on file:

(a) Completed Land Disturbance Environmental Review Forms (Attachment 9.1 to this procedure).

(b) Completed Cultural Resource Structure Modification/Remodeling Review Forms (Attachment 9.2 to this procedure).

(c) Conversation and correspondence records involving the State Historic Preservation Office and/or NRC.

(d) Records of modification/remodeling activities associated with cultural resource structures.

6.0 INTERFACES

[1] NMM Procedure EN-IS-112, Trenching, Excavation and Ground Penetrating Activities

[2] NMM Procedure EN-EV-115, Environmental Reviews and Evaluations

7.0 RECORDS

None

8.0 OBLIGATION AND REGULATORY COMMITMENT CROSS-REFERENCES

8.1 OBLIGATIONS AND COMMITMENTS IMPLEMENTED OVERALL

None

8.2 SECTION SPECIFIC OBLIGATIONS AND COMMITMENTS

None

8.3 SITE SPECIFIC COMMITMENTS

Step	Site	Document	Commitment Number or Reference
[1]	ANO	1CAN090005	P-17051

9.0 ATTACHMENTS

9.1 Land Disturbance Environmental Review Form (Typical)

9.2 Cultural Resource Structure Modification/Remodeling Review Form (Typical)

ATTACHMENT 9.1 **LAND DISTURBANCE ENVIRONMENTAL REVIEW FORM (TYPICAL)**

SHEET 1 of 2

A. Land Disturbance Activity

1. Brief Description of Activity: ______________________________

____

____

2. Amount of Land Involved:

	<1 Acre
	1 – 5 Acres
	>5 Acres

3. Location of Affected Land Area (attach map also): ______________________________

____

4. Expected Duration of Activity: ______________________________

B. Environmental Review

1. Consultation with the State Historic Preservation Office Required: ☐ Yes ☐ No
2. SHPO Protection Measures Imposed: ☐ Yes ☐ No ☐ Not Applicable
3. Existing historical or archaeological sites: ☐ Yes ☐ No
4. Visual Walk-down of Land Area Required: ☐ Yes ☐ No
5. Date(s) of Visual Walk-down: ______________________________
6. Potential historical or archaeological site(s) Identified during Walk-down:

   ☐ Yes ☐ No ☐ Not Applicable

ATTACHMENT 9.1 **LAND DISTURBANCE ENVIRONMENTAL REVIEW FORM (TYPICAL)**

SHEET 2 of 2

C. Required Management Practices

Management Practice(s)	Yes	No	NA
Stop the activity if a potential historical or archaeological site is discovered or if an existing site is damaged.	☐	☐	☐
Notify the Site Environmental Representative immediately in the event that a potential historical or archaeological site is discovered during the land disturbance activity.	☐	☐	☐
In the event that a potential historical or archaeological artifact is discovered, do not resume the land disturbance activity until the Site Environmental Representative has performed an evaluation.	☐	☐	☐
Place a protective barrier around existing historic or archaeological site(s).	☐	☐	☐
Notify the Site Environmental Representative immediately in the event that an existing historical or archaeological site is damaged during the land disturbance activity.	☐	☐	☐

Remarks: Potential evidence that a historical or archaeological site may exist would be the presence of pottery, glass, arrowhead, bones, tools, weaponry, wooden or metal structures, flakes, brick, mortar or plaster.

SHPO Protective Measures: ______________________________

____

____

Approved By: ______________________ / ______________________

Signature Date

ATTACHMENT 9.2 CULTURAL RESOURCE STRUCTURE MODIFICATION/REMODELING REVIEW FORM (TYPICAL)
SHEET 1 of 1

A. Modification/Remodeling Activity

1. Description of Activity: ______________________________

____

____

____

2. Expected Duration of Activity: ______________________________

B. Environmental Review

1. SHPO Contacted: ☐ Yes ☐ No
2. Date SHPO Contacted: ______________________________
3. SHPO Protective Measures Imposed: ☐ Yes ☐ No

C. SHPO Protective Measures (if applicable)

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Approved By: ______________________________ / ______________________________
Signature Date