CLEAR TECHNICAL REPORT NO. 164

FISH EGG AND LARVAE ENTRAINMENT AT THE DAVIS-BESSE NUCLEAR POWER STATION DURING 1979

Environmental Technical Specifications
Sec. 3.1.2.a.5 Fish Egg and Larvae Entrainment

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3.1.2.a.5 Fish Egg and Larvae Entrainment

Procedures

Fish egg and larvae (ichthyoplankton) entrainment at the Davis-Besse Nuclear Power Station was computed by multiplying the ichthyoplankton concentration observed at Station 8 (intake) by the intake volume (Figure 1). Ichthyoplankton densities were determined on 9 occasions between 1 May and 15 August from four 3-minute, oblique (bottom to surface) tows at 3-4 knots made at night on each date (Table 1) with a 0.75 meter diameter heavy-duty oceanographic plankton net (N. 00, 0.75 mm mesh) equipped with a calibrated General Oceanics flow meter. Oblique tows were selected as this is the technique required at intakes on Lake Erie by U.S. Environmental Protection Agency and U.S. Fish and Wildlife Service. Night sampling is also required by these agencies to minimize net avoidance by larvae and to more accurately assess densities of species which may cling to the bottom during daylight. Samples were preserved in 5% formalin and returned to the laboratory for sorting and analysis. All specimens were identified and enumerated using the works of Fish (1932), Norden (1961a and b), Nelson and Cole (1975). Densities were presented as number of ichthyoplankters per 100 m^3 of water.

From the above estimates it was possible to determine an approximate period of occurrence for each species and a mean density during that period. For example, yellow perch were not found on 1 May or on 5 July or later (Table 1). They were present in samples from 31 May, 5 June, and 21 June. Therefore, the period of occurrence was estimated to have been from 16 May (the midpoint between 1 May and 31 May) to 28 June (the midpoint between 21 June and 5 July) (Table 2). The mean density of yellow perch during this period was estimated to have been 34.13/100 m^3, computed from the concentration of 77.2/100 m^3 observed on 31 May, the concentration of 25.0/100 m^3 observed on 5 June, and the concentration of 0.2/100 m^3 observed on 21 June. It was this concentration, 34.13/100 m^3, which was multiplied by the volume of water drawn through the plant from 16 May to 28 June.

The daily intake volume was computed by multiplying the daily discharge volume by 1.3. The daily intake volumes were then added for all days within the period of occurrence of the species in question to determine the total intake volume during the period. All specimens were vouchered and all data were keypunched and stored at The Ohio State University's Center for Lake Erie Area Research, Columbus, Ohio.

Results

Ichthyoplankton densities observed at Station 8 (intake) during 1979 indicated that ichthyoplankters were entrained at the Davis-Besse Nuclear Power Station from 26 April to 9 August (Table 1). April 26 was selected as the first day because several walleye were collected on the first sampling date (1 May) and 26 April is half of one sampling interval (10 days) ahead of this first collection. It should also be noted that in 1978 no ichthyoplankters were collected prior to 11 May (Reutter, 1979). August 9 was selected as the last

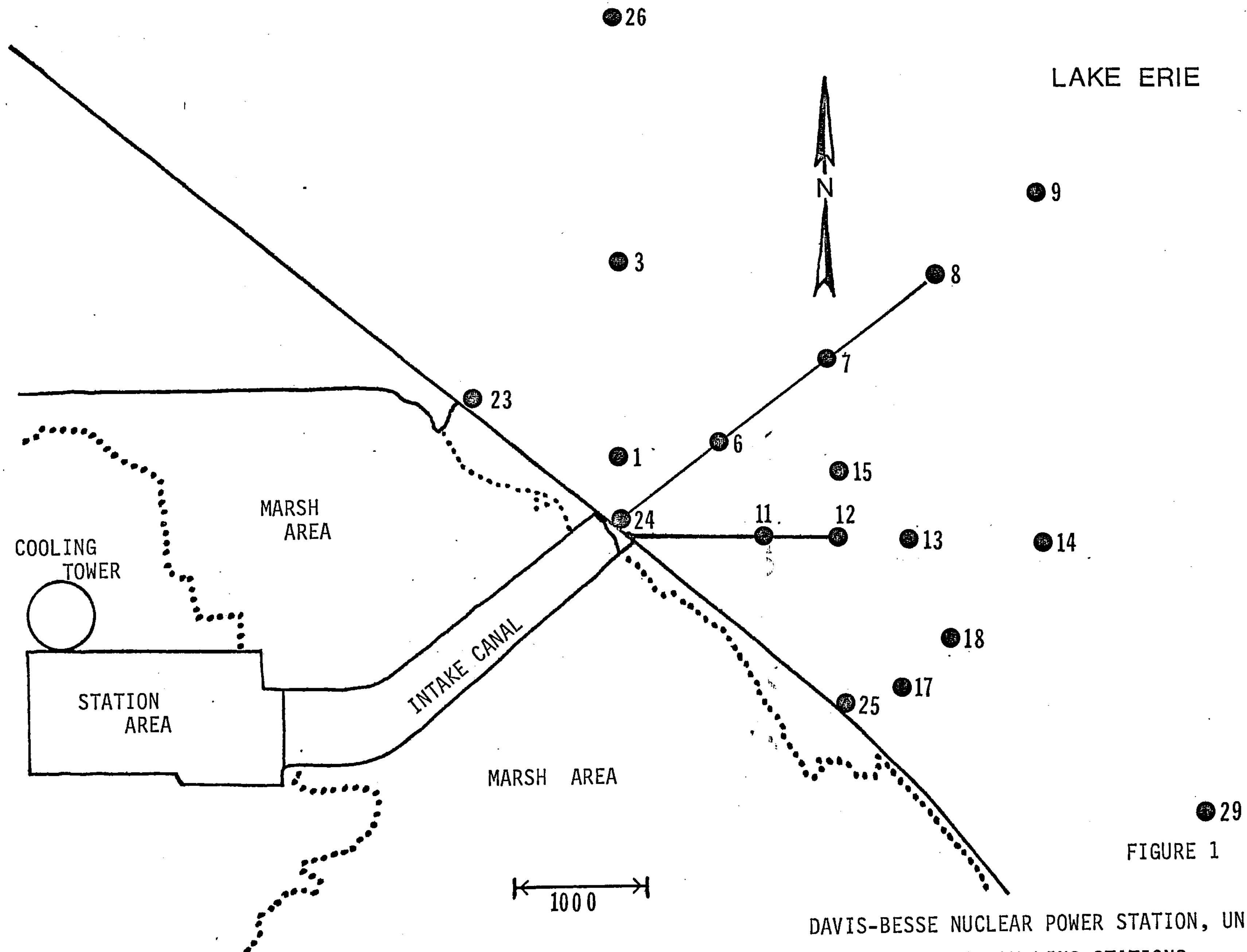

FIGURE 1

DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1
AQUATIC SAMPLING STATIONS

TABLE 1

ICHTHYOPLANKTON DENSITIES IN THE VICINITY OF THE INTAKE OF THE DAVIS-BESSE NUCLEAR POWER STATION - 1979*

SPECIES	LARVAL STAGES** \ DATE	May 1	May 31	June 5	June 21	July 5	July 11	July 19	August 2	August 15	MEAN
Carp	Stage 1				0.2	2.9	0.2				0.37
	Stage 2				0.1						0.01
	Stage 3										
	Subtotal				0.3	2.9	0.2				0.38
Emerald Shiner	Stage 1				10.5	144.2	1.6	0.5	0.2		17.44
	Stage 2				23.8	86.4	38.3	10.5			17.67
	Stage 3					43.3	7.9	38.3			9.94
	Subtotal				34.3	273.9	47.8	49.3	0.2		45.06
Freshwater Drum	Stage 1				3.1	7.7	38.3		0.2		5.48
	Stage 2					4.8			0.5		0.59
	Stage 3						1.0		4.8		0.64
	Subtotal				3.1	12.4	39.3		5.5		6.70
Gizzard Shad	Stage 1		33.3	82.5	61.8	91.8	25.2	8.7	0.3		33.73
	Stage 2		8.7	15.5	82.6	69.5	64.4	15.1	2.8		28.73
	Stage 3				7.8	39.4	22.1	9.5	5.5		9.37
	Subtotal		42.0	98.0	152.1	200.7	111.7	33.3	8.6		71.82
Logperch	Stage 1			3.6							0.40
	Stage 2					0.1					0.01
	Stage 3				0.1	0.1					0.02
	Subtotal			3.6	0.1	0.2					0.43
Rainbow Smelt	Stage 1		0.2	33.5				0.6			3.81
	Stage 2		9.0		0.1			2.8	1.3		1.47
	Stage 3				0.5	0.4					0.10
	Subtotal		9.2	33.5	0.6	0.4		3.4	1.3		5.38
Spottail Shiner	Stage 1					1.9					0.21
	Stage 2				0.5						0.06
	Stage 3										
	Subtotal				0.5	1.9					0.27
Unidentified	Stage 1				0.1						0.01
	Stage 2										
	Stage 3										
	Subtotal				0.1						0.01
Unidentified Percid	Stage 1										
	Stage 2		0.2								0.02
	Stage 3										
	Subtotal		0.2								0.02
Unidentified Shiner	Stage 1				0.1						0.01
	Stage 2					0.1					0.01
	Stage 3										
	Subtotal				0.1	0.1					0.02
Unidentified Sucker	Stage 1										
	Stage 2					0.1					0.01
	Stage 3										
	Subtotal					0.1					0.01
Walleye	Stage 1	0.7	0.2								0.10
	Stage 2		1.2								0.13
	Stage		0.3								0.03
	Subtotal	0.7	1.7								0.27
White Bass	Stage 1				0.1		0.3	0.3			0.08
	Stage 2		0.2		0.3	0.3	0.1	0.6			0.17
	Stage 3					0.8		0.1	0.2		0.12
	Subtotal		0.2		0.4	1.1	0.4	1.0	0.2		0.37
White Sucker	Stage 1						0.2				0.02
	Stage 2										
	Stage 3										
	Subtotal						0.2				0.02
Yellow Perch	Stage 1		7.0	16.4							2.60
	Stage 2		55.5	3.6							6.57
	Stage 3		14.7	5.0	0.2						2.21
	Subtotal		77.2	25.0	0.2						11.38
Freshwater Drum Egg					0.3	1.0	6.0				0.81
Total Ichthyoplankton	Stage 1	0.7	40.8	135.9	75.8	246.6	65.7	10.1	0.7		64.03
	Stage 2		75.0	19.1	107.4	163.2	102.8	29.1	4.5		55.68
	Stage 3		14.9	5.0	8.6	84.1	31.0	48.0	10.5		22.47
	Egg				0.3	1.0	6.0				0.81
	Subtotal	0.7	130.7	160.0	192.0	494.9	205.5	87.1	15.8		142.97

*Data presented as number of individuals per 100m^3 and computed from 4 oblique tows (bottom and surface) collected at night.

**This is the subtotal of the larval stages. It is the mean of the surface and bottom densities. Stage 1 = proto-larvae, no rays in fin/finfold. Stage 2 = meso-larvae, first ray seen in median fins. Stage 3 = meta-larvae, pelvic fin bud is visible.

day since it is midway between 3 August, the last sampling date on which larvae were present, and 15 August, a sampling date on which no ichthyoplankters were collected.

The mean larvae density from all night samples at Station 8 (142.97/100 m^3) was 2.9 times greater than the mean density from all day samples collected at Station 8 (36.7/100 m^3). Gizzard shad constituted 50 percent of the night ichthyoplankton population followed by emerald shiners at 32 percent, yellow perch at 8 percent, freshwater drum at 5 percent, and smelt at 4 percent (Table 1).

Based on the results in Table 1, it is estimated that 20,620,799 larvae and 101,405 eggs were entrained at the Davis-Besse Nuclear Power Station during 1979 (Table 2). Of this total, gizzard shad constituted 49 percent, emerald shiners 33 percent, yellow perch 8 percent, freshwater drum 5 percent and rainbow smelt 4 percent.

Analysis

Ichthyoplankton entrainment at the Davis-Besse Nuclear Power Station during 1979 was typical for an intake on the south shore of the Western Basin of Lake Erie--it was strongly dominated by gizzard shad. As explained in the ichthyoplankton section of this report (Section 3.1.2.a.4), gizzard shad are on the increase and, consequently, it would not be surprising if they represented even a greater portion of the entrainment next year.

It appears that walleye and yellow perch densities are fluctuating greatly from year to year. Walleye constituted 0.02 percent of the 1976 population, 11 percent of the 1977 population, 22 percent of the 1978 population and 0.2 percent of the 1979 population. Yellow perch constituted 5 percent of the 1974 larvae, 70 percent of the 1975 larvae, 4 percent of the 1976 larvae, 26 percent of the 1977 larvae, 2 percent of the 1978 larvae, ad 11 percent of the 1979 larvae (see Section 3.1.2.a.4 Ichthyoplankton). Entrainment of these species can be expected to fluctuate with their larval densities.

One way to put entrainment losses into perspective is to look at fecundity. Based on an average of 300,000 eggs/female gizzard shad (Hartley and Herdendorf, 1977), the 10,186,841 larvae could have been produced by 34 females; based on an average of 331,000 eggs/female walleye (Hartley and Herdendorf, 1977), the 41,648 entrained larvae could have been produced by 1 female; and based on 44,000 eggs/female yellow perch (Hartley and Herdendorf, 1977) the 1,595,066 entrained larvae could have been produced by 36 females. In actuality, the above estimates of the number of females required to produce the entrained larvae are quite low since they do not take mortality from egg to larvae into account. If we assume 99 percent mortality from eggs to larvae to be safe (90 percent is probably more reasonable) then the entrained larvae could have been produced by 3400 gizzard shad, 100 walleyes, and 3600 perch. These values are less than 0.1 percent of the number of perch and walleye captured by Ohio sport fishermen in 1978 (Scholl, 1979).

Another way to determine the impact of entrainment losses is to estimate the number of adults the entrained larvae would have produced had they lived. This technique requires some knowledge of the mortality between larval stages

TABLE 2

ICHTHYOPLANKTON ENTRAINMENT AT THE
DAVIS-BESSE NUCLEAR POWER STATION - 1979

Species	Period During Which Entrainment Occurred[a]	Volume of Water ($100m^3$) Withdrawn During Period[b]	Larvae/$100m^3$ [c]			Number of Larvae Entrained		
			Mean	95% Confidence Interval		Mean	95% Confidence Interval	
				Lower Limit	Upper Limit		Lower Limit	Upper Limit
Carp	13 June-15 July	41,903	1.13	0.20	2.06	47,350	8,381	86,320
Emerald Shiner	13 June-9 August	84,023	81.11	33.83	128.39	6,815,106	2,842,498	10,787,713
Freshwater Drum	13 June-9 August	84,023	12.07	6.84	17.30	1,014,158	574,717	1,453,598
Gizzard Shad	16 May-9 August	110,283	92.37	62.66	122.08	10,186,841	6,910,333	13,463,349
Logperch	2 June-8 July	43,542	1.30	0.36	2.24	56,605	15,675	97,534
Rainbow Smelt	16 May-9 August	110,283	6.92	4.27	9.57	763,158	470,908	1,055,408
Spottail Shiner	13 June-8 July	32,771	1.17	-1.01	3.35	38,342	0	109,783
Unidentified	13 June-28 June	20,474	0.05	-0.10	0.20	1,024	0	4,095
Unidentified Percid	16 May-2 June	16,302	0.24	-0.52	1.00	3,912	0	16,302
Unidentified Shiner	13 June-8 July	32,771	0.08	- .05	0.21	2,622	0	6,882
Unidentified Sucker	28 June-8 July	13,477	0.12	-0.26	0.50	1,617	0	6,739
Walleye	26 April-2 June	34,138	1.22	0.64	1.80	41,648	21,848	61,448
White Bass	16 May-9 August	110,283	0.47	0.22	0.72	51,833	24,262	79,404
White Sucker	8 July-15 July	10,112	0.15	-0.33	0.64	1,517	0	6,472
Yellow Perch	16 May-28 June	46,735	34.13	27.67	40.59	1,595,066	1,293,157	1,896,974
TOTAL LARVAE						20,620,799		
F. Drum Eggs	13 June-15 July	41,903	2.42	0.85	3.99	101,405	35,618	167,193
TOTAL ICHTHYOPLANKTON						20,722,204		

[a]Estimated from Table 1. See discussion on page 1.

[b]Estimated by multiplying daily discharge rate by 1.3 and adding all daily estimates for the specified period.

[c]Average concentration during their period of occurrence.

[d]Values which would have been less than zero were rounded back to zero.

and between year classes. Patterson (1976) has developed such estimates for yellow perch, and, since it is in the same family, the estimates will also be used here for walleye. Several assumptions are involved.

I. All entrained larvae are killed.

II. All larvae lost by entrainment are in their late larval stage. This provides a conservative or high estimate because it does not account for early larval mortality which may range from 83-96 percent (Patterson, 1976).

III. Yellow perch become vulnerable to commercial capture, and reach sexual maturity at age class III.

IV. A one percent survival rate from late larvae to age III adults is assumed. Again, this is conservative since survival rates from:

late larvae to YOY = 4 to 17 percent;
YOY to age class I = 12 to 33 percent;
age class I to age class II = 38 percent;
age class II to age class III = 38 percent (Patterson, 1976, and Brazo, et al., 1975).

This trend translates to a survivorship ranging from 0.1 percent to one percent over the period from the late larval stage to age class III.

Based on the above assumptions, the 41,648 entrained walleye larvae could have produced 42-416 age class III adults and the 1,595,066 entrained yellow perch larvae could have produced 1,595-15,951 age class III adults. It should also be noted that due to natural variation in populations these estimates are virtually the reverse of those obtained in 1978 (Reutter, 1979).

The author feels little weight should be placed on the above impact assessments since they are based on the number of entrained larvae which can vary greatly from year to year depending on the success of the hatch which in turn is dependent upon the size of the brood stock and weather conditions during spawning and incubation. In the case of Davis-Besse, the off-shore intake, where larvae densities are lower (see Section 3.1.2.a.4), and the low volume intake due to the cooling tower and closed cooling system, necessitate a very low-level impact on Western Basin fish populations.

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