UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

ENVIRONMENTAL IMPACT APPRAISAL BY THE OFFICE OF NUCLEAR REACTOR REGULATION SUPPORTING AMENDMENT NO. 26 TO FACILITY OPERATING LICENSE NO. NPF-3 THE TOLEDO EDISON COMPANY AND THE CLEVELAND ELECTRIC ILLUMINATING COMPANY DAVIS-BESSE NUCLEAR POWER STATION, UNIT NO. 1 DOCKET NO. 50-346

Description of Proposed Action

Appendix B to Facility Operating License No. NPF-3 for Davis-Besse Nuclear Power Station, Unit No. 1 (dated April 22, 1977) requires that a study be undertaken to describe the number and species of fish impinged on the traveling screens. The study (included as Section 4.2 of Appendix B) is divided into three phases, as follows:

Phase I - To be conducted for the first year of commercial operation to determine if the fish being impinged, as a result of unit operation, are of significant number and value to adversely affect the fish population in the vicinity of the site and the lake as a whole.

Phase II - To be conducted during the second year of commercial operation if the Phase I study indicates that impingement losses are higher than anticipated; the Phase II study is designed to determine if the fish being impinged originate from the lake proper or from a resident population in the intake canal; if Phase II reveals that the majority of impinged fish are from a resident population of the intake canal, the impingement program could be terminated, pending NRC approval.

Phase III - To be conducted during the third year of commercial operation if the Phase II study shows that a significant portion of the impinged fish are from the lake proper; the Phase III study is designed to evaluate the effectiveness of a bubble screen around the offshore intake crib as a mitigative measure in preventing entrapment (and thus impingement) of fish from the lake.

If the Phase I study determines that impingement is minimal and not of a level significantly high enough to cause adverse impact, Phases II and III need not be initiated, upon approval by NRC after the receipt of the Phase I results. Decision criteria for determining whether or not to proceed from one phase to the next are required to be developed during each phase of study.

In fulfillment of the Phase I requirements of Appendix _, The Toledo Edison Company (TECO or the licensee) submitted to NRC the proposed decision criteria in November 1978[1] and the results of the Phase I impingement study in March 1979[2] which is based upon a study prepared for the licensee by his consultant.[3] With the Phase I submittal, the licensee requested a termination of the impingement program, indicating that impingement is minimal with an insignificant impact on lake populations.[2]

Appendix B (Section 3.1.2.a.5) to the Davis-Besse Operating License also requires that a 2-year study be undertaken to investigate the number and species of fish eggs and larvae entrained as a result of operation of Unit No. 1. Study requirements include sampling for fish eggs and larvae once every ten days during the anticipated spawning season (April through August) in the vicinity of the intake crib and at two control stations. In addition, Appendix B, Section 3.1.2.a.4, requires ichthyoplankton sampling during the spawning season in the area of the thermal plume and at the Toussaint Reef offshore of Davis-Besse.

In fulfillment of this Appendix B requirement, the licensee submitted the results of fish egg and larvae farfield[4] and entrainment studies conducted during 1978.[5] Additionally, the licensee has prepared an impingement and entrainment demonstration for the State of Ohio under Section 316(b) of the Clean Water Act.[6] The data contained in the demonstration are the same as those contained in the submittals to NRC[2,3,4,5] under Appendix B of the Operating License.

Environmental Impact of Proposed Action

I. Final Environmental Statement (FES) Assessments of Impacts

A. Impingement of Fishes

The FES related to construction (FES-CP) of Davis-Besse Nuclear Power Station[7] discussed potential environmental impacts of fish impingement during station operation (Section 5.5.1, pages 5-12, 5-13, and 5-15). It was stated that major adverse biological effects due to the intake of lake water were unlikely. Further, it was noted that:

(1) Adult fish should be able to avoid being drawn into the intake, although young fish or weak adults swimming too near the intake probably will be entrained.

(2) Most fish that are entrained in the intake water will be impinged on the traveling screens located in the intake structure at the end of the intake canal

(3) Studies indicated that gizzard shad, alewife, freshwater drum, white bass, and shiners are likely to be the most abundant young fish near the intake crib, and thus potentially subject to impingement.

The FES related to operation (FES-OL) of Davis-Besse[8] also discussed potential impacts of fish impingement (Section 5.5.1, page 5-5; and Section 12.2.2, pages 12-2 and 12-3). It was concluded that the intake design represents a practical balance between technological and ecological considerations and will have a minimal environmental impact. Further, it found the following:

(1) Emerald shiner, spottail shiner, gizzard shad and alewife will be impinged in greatest numbers.

(2) Survival of fishes washed from the traveling screens and sluiced through a trough to the holding basin is not expected to be high.

(3) Impingement losses are not expected to significantly affect the fisheries of Lake Erie.

To insure that unacceptable impingement losses were not occurring, the FES-OL required operational monitoring at the traveling screens and in the intake canal, as follows:

(1) Fish impingement should be monitored no less than three times each week to determine the number and size-distribution of each species impinged, and to assess local and regional impacts.

(2) A special study should be undertaken to determine the extent to which the intake canal supports a fish population and thus contributes to impingement losses.

(3) A special study should be undertaken to investigate entrainment of adult and juvenile fishes at the intake crib and the effectiveness of the bubble screen in reducing impingement.

B. Entrainment of Ichthyoplankton

The FES-OL for Davis Besse[8] discussed the potential for impact to Lake Erie fishes from entrainment and station passage of planktonic fish eggs and larvae (Section 5.5.2, page 5-8; and Section 12.2.2, pages 12-2 and 12-3). The FES assumed that all organisms entrained within the cooling system would be killed by a combination of mechanical, thermal, and biocidal effects. It was concluded, however, that entrainment losses were not expected to significantly alter local fish populations. That conclusion was based on:

(1) The low fish egg and larval densities at the site which indicate that it is not a major spawning area;

(2) The distribution of known spawning areas along the southwest shore of Lake Erie;

(3) The offshore location of the intake crib; and

(4) The relatively small volume of water withdrawn from the lake by the plant.

To ensure that unacceptable entrainment losses were not occurring, the FES-OL required operational monitoring of ichthyoplankton near the offshore intake and at control stations.

II. Site and Station Description

A. The Site

The Davis-Besse Nuclear Power Station is located on the southwest shore of Lake Erie in Ohio approximately 21 miles (~34 km) southeast of Toledo and 21 miles northwest of Sandusky in Ottawa County (Figure 1). The 954 acre (386 ha) site borders the north side of the Toussaint River and has a lake frontage of 7,250 feet (2210 m). This section of the shoreline is flat and marshy with maximum elevations only a few feet above the lake level. The site includes a tract known as Navarre Marsh, as well as upland where the main station structures are located. The graded and fenced station area, exclusive of the cooling tower, occupies about 56 acres (23 ha). The station buildings are about 3000 feet (914 m) from the lakeshore and at least 2400 feet (732 m) from any point on the site boundary (Figure 2).

The site is located on Locust Point, a gently curving headland of the western basin of Lake Erie. The lake bottom is gently sloping from shore out to a distance of at least 4000 feet (1219 m), with a ten foot depth at a distance of 2000 feet offshore and a 12 foot depth at 4000 feet offshore. Bottom sediments vary with distance offshore and are predominantly sand, gravel and clay. A series of shallow rocky reefs occur offshore of Locust Point at distances between about 3-7 miles. The most nearshore are the Locust Point and Toussaint Reefs (Figures 1 and 3). More complete descriptions of the site and vicinity are to be found in the FES-CP[7] and the 316(b) Demonstration[6] and in several of the other documents referred to in this report.

B. The Station

Davis-Besse Nuclear Power Station is rated at 906 MWe and consists of a single unit utilizing a closed-cycle cooling heat dissipation system. The operating license was issued in April 1977. Initial reactor criticality was achieved on August 8, 1977,[9] but the station never operated at full capacity in 1977 and only achieved ~ 75 percent capacity in December.[10] One hundred percent operating capacity was attained on April 4, 1978.[34] A 493 foot (150 m) high natural draft cooling tower is used to dissipate 98 percent of the total heat from the condenser to the atmosphere. The remaining 2 percent of the heat is discharged to Lake Erie in the cooling tower blowdown. Cooling water is withdrawn from the lake via a submerged intake crib located about 3000 feet (914 m) offshore at the 11 foot depth contour (Figures 2 and 4). The crib is a cross-shaped structure rising 3-10 feet above the lake bottom with intake ports located at the ends of each of the four arms. Water enters the crib by gravity in a downward direction through the ports at a velocity of 0.25 fps (7.6 cm/sec) at the maximum intake flow rate of 42,000 gpm (94 cfs; 2.66 cms).

An eight foot diameter conduit buried beneath the lake bottom connects the offshore crib with an onshore intake canal. The intake canal is a 2950 foot (899 m) long open channel which conveys water from the intake conduit to the pumphouse (Figure 2). The canal has earthen embankments and is separated from the lake by a sand beach and beachfront dike constructed of large limestone rip-rap. The canal is approximately 40-45 feet wide at the bottom, with 3:1 side slopes and a depth of 13-14 feet, except in the vicinity of the pumphouse where it widens to form a forebay approximately 800 feet long, 200 feet wide at the bottom, and 16-17 feet deep. At an intake flow rate of 42,000 gpm, the calculated velocity in the canal is about 0.11 fps (3.4 cm/sec). The pumphouse intake structure is located at the extreme western end of the canal forebay where water enters through fixed trash racks (8 inch x 26 inch openings; ~ 20 cm x 66 cm) and one-quarter inch (6 mm) mesh traveling screens, which are automatically cleaned either on a pre-set time interval or by pressure differential across the screens.

All station effluents (most of which is cooling tower blowdown) flow through a six foot diameter buried pipe to a slot-type jet discharge structure (4.5 feet wide x 1.5 feet high; 1.4 x 0.5 m) located on the lake bottom 1200 feet offshore (Figures 2 and 4). The discharge exit velocity is about 6.5 fps (198 cm/sec) at the design maximum flow rate of 20,000 gpm (44.6 cfs; 1.26 cms). The thermal discharge produces a plume in Lake Erie with a calculated surface area of 0.7 acres. The discharge temperature of station effluents in the lake never exceeds 20°F (11.1°C) above ambient lake water temperature.

This summary of station design features was extracted from the FES-CP,[7] the FES-OL,[8] and the 316(b) Demonstration,[6] where more details may be found.

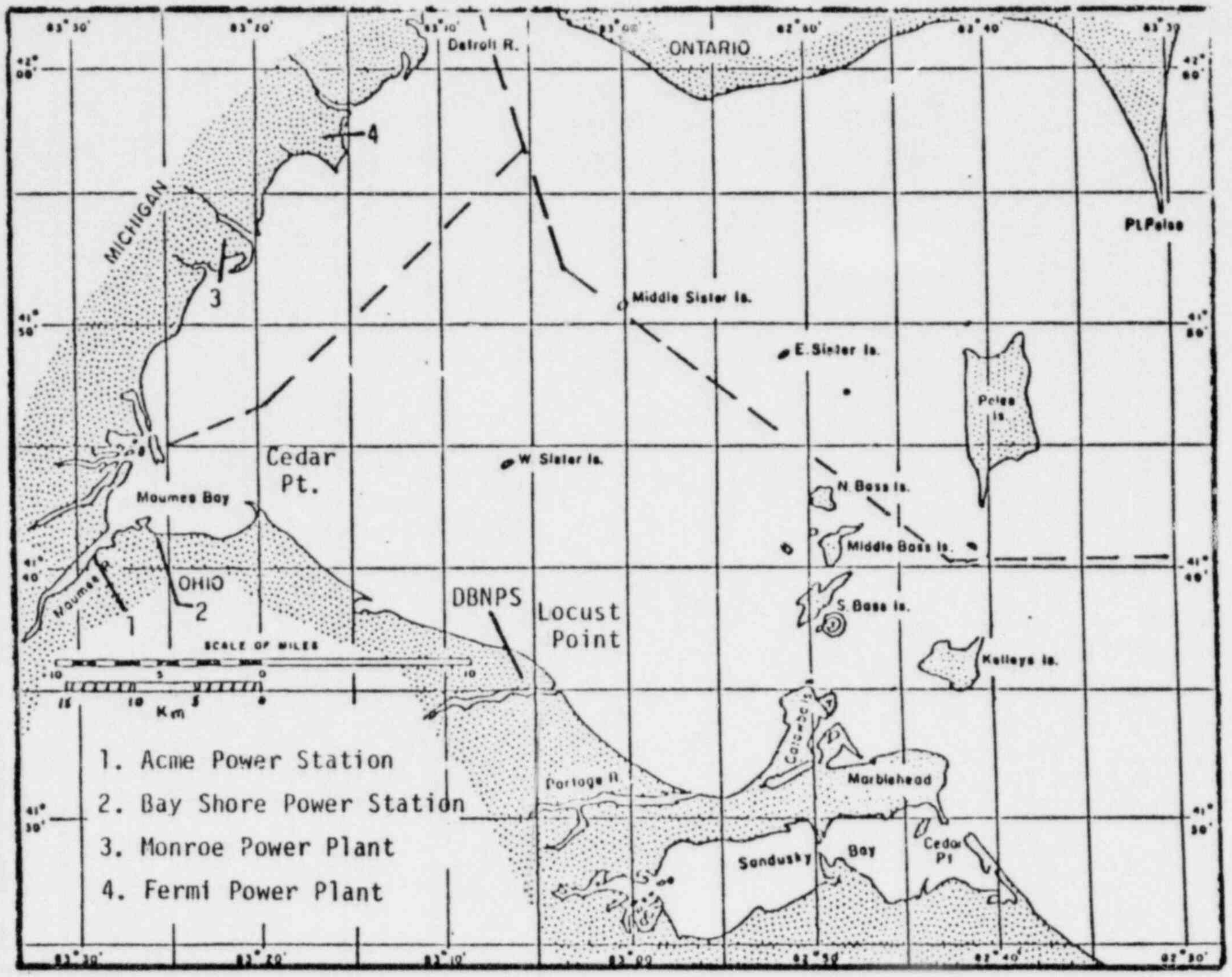

FIGURE 1. Location of Davis-Besse Nuclear Power Station (DBNPS) at Locust Point in the western basin of Lake Erie. Also shown are the locations of the Acme and Bay Shore Power Stations, Ohio; and Monroe and Fermi Power Plants, Michigan. (From Reference No. 18)

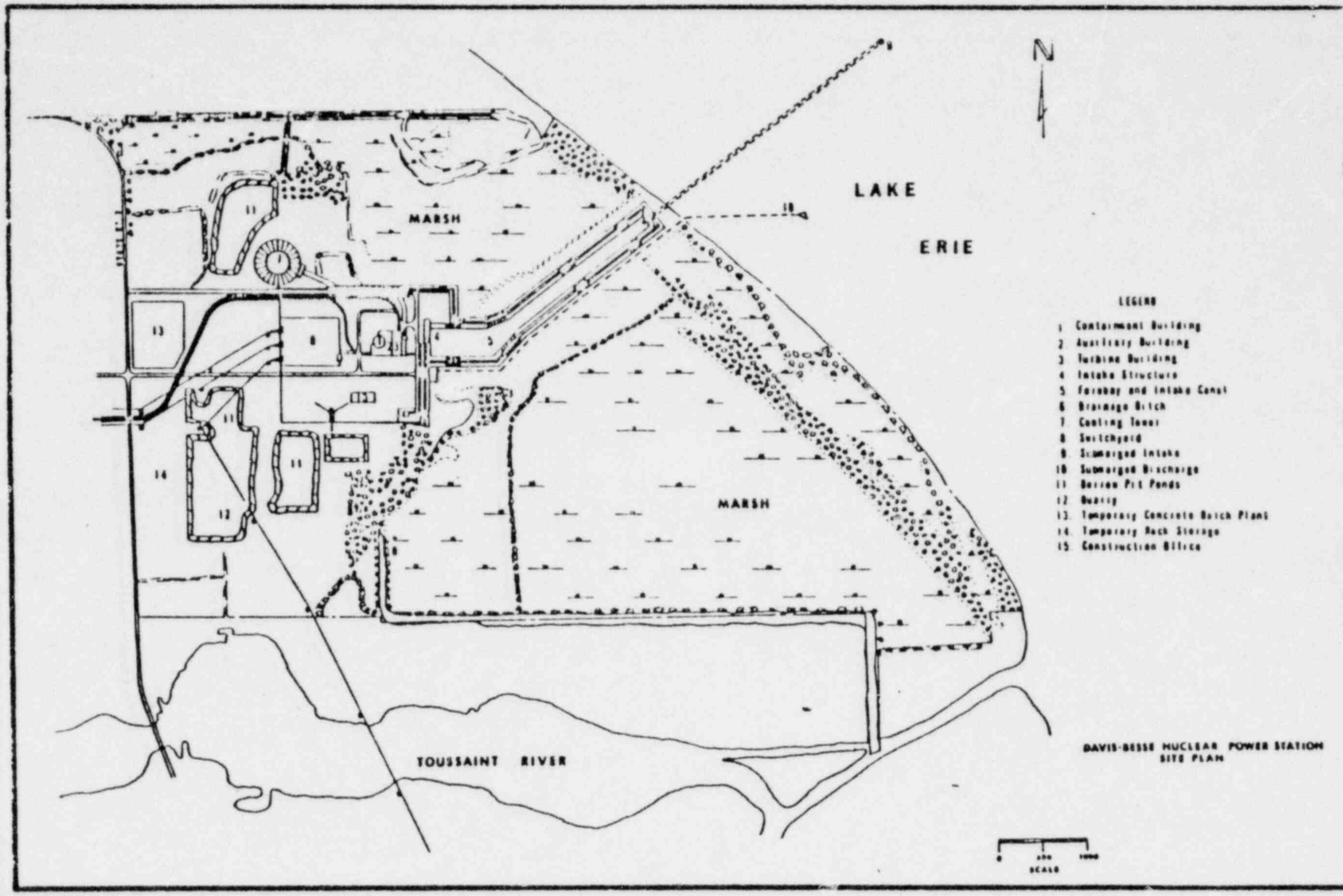

FIGURE 2. Davis-Besse Nuclear Power Station site plan, showing the offshore intake and discharge structures and the onshore intake canal and forebay. (From Reference No. 7)

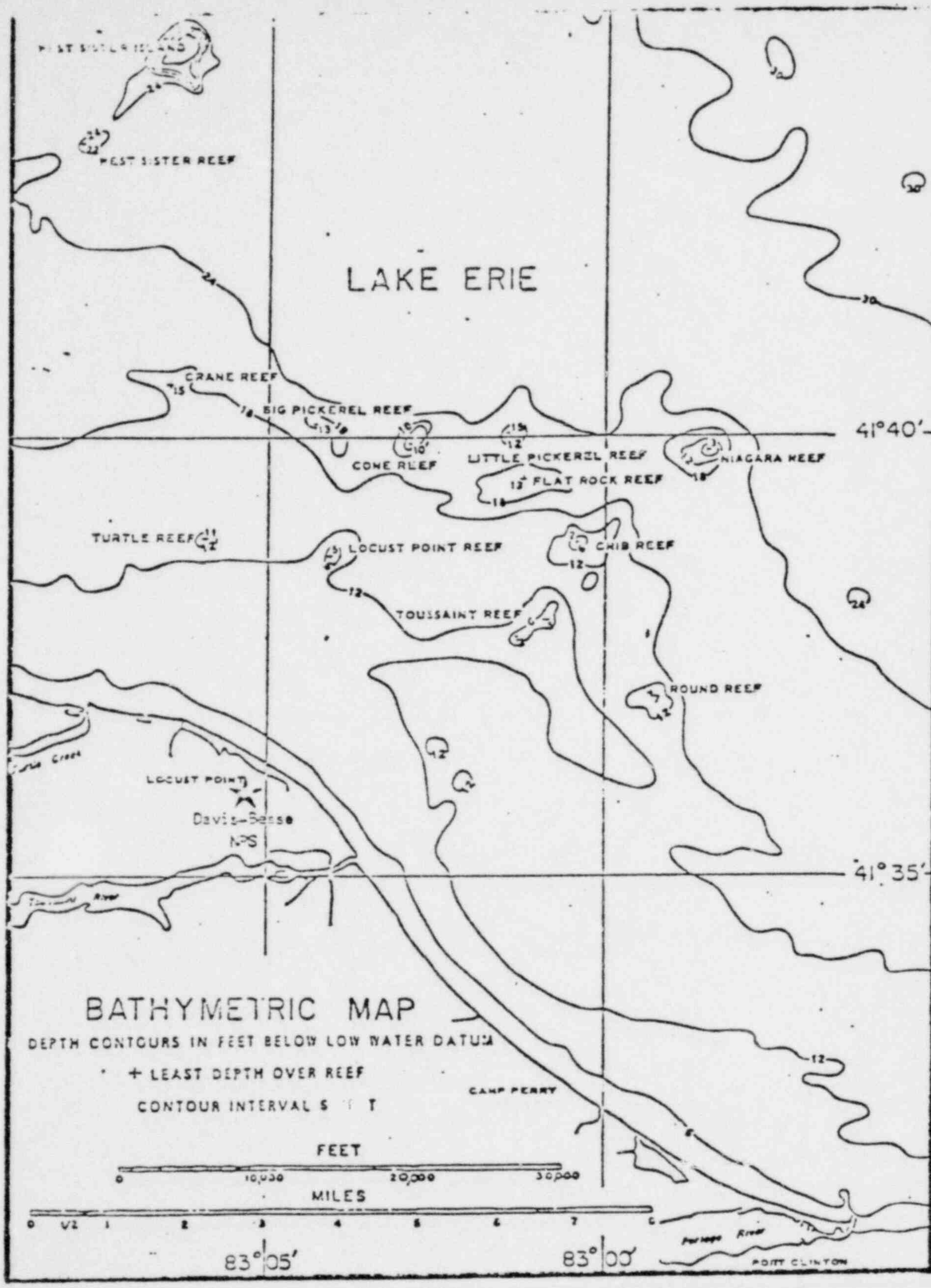

FIGURE 3. Bathymetric map of Lake Erie in the vicinity of Davis-Besse Nuclear Power Station, showing the location of the offshore reefs. (From Reference No. 33)

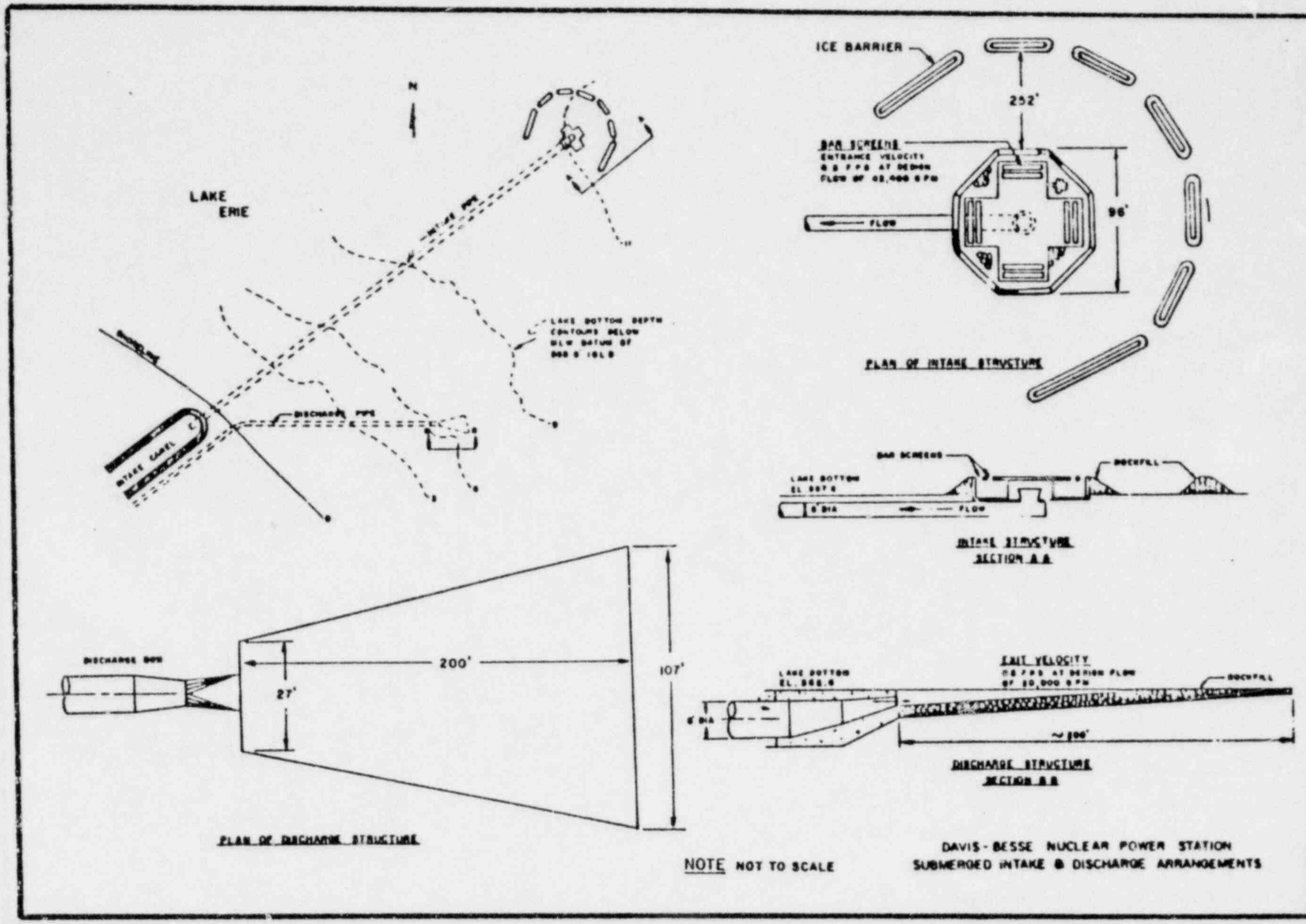

FIGURE 4. Designs and locations of the offshore intake and discharge structures of the Davis-Besse Nuclear Power Station. (From Reference No. 7)

III. Evaluation of Observed Impacts

A. Impingement of Fishes

The Phase I fish impingement study was conducted between January 1 and December 31, 1978.[2] Appendix B requires that 24 hour samples be collected three days per week. During 1978, sampling occurred on 144 days, or about 39.5 percent of the days. Collections of impinged fish were made by placing a 1/4 inch mesh screening device into the traveling screen backwash sluiceway. The screening device had the same mesh size as the traveling screens at the intake structure. Number and weights of impinged fishes were recorded and expanded monthly and annual estimates of total impingement losses were developed based upon fishes impinged per hour of station operation during the times of sampling. Additionally, impinged fishes were collected using the above methods on 45 days during the period August 17 to December 31, 1977,[10] or about 33 percent of the days.

Impingement sampling during 1977[10] and 1978[2] documented the occurrences of 15 and 20 species of fishes respectively on the screens, or a total of 23 species for both years combined (Table 1). During 1977, the principal species impinged were gizzard shad, freshwater drum, white crappie, yellow perch, emerald shiner and goldfish. The 4 1/2 month total for impingement was estimated to be 1,936 fishes weighing 25.8 kg (56.8 pounds). Greater than 93 percent of the total impingement occurred during the period November 22-December 19, 1977.

A comparison of the 1977 impingement catches with trawl and gill net catches near the intake during preoperative studies[11,12] indicates that the majority of impinged fish species were common in the area. Exceptions were white crappie, goldfish, and freshwater drum. The licensee stated that impinged white crappie probably were residents of the intake canal, and the fact that many were young-of-the-year indicates a probable spawning in the canal.[10] Goldfish and drum were relatively more abundant in impingement samples than in gill net and trawl samples in the lake proper. Their presence in the intake canal was indicated by their low abundance there in previous canal netting studies.[11,12] Additionally, a fish toxicant study of the intake canal during September of 1974 collected "25 gallons" of fish numbering 2,327 individuals[13,14] (Table 2), far more than any of the canal trawl studies, which took 414 fishes on the day prior to toxicant use,[11] and 420 fishes during June and September 1975.[12] None of the above canal studies documented significant numbers of goldfish and drum, but crappies were found in higher relative abundance (24-40 percent of 1974 canal trawl studies;[11] 16.5 percent of the 1974 toxicant study; and 81 percent of the 1975 canal trawl study[12]). Comparison of the 1977 impingement data with trawl and gill net catches near the intake during 1977[15] yielded results similar to those above, with crappies and goldfish occurring in very low levels of abundance in the lake. Unfortunately, lake sampling was not performed during December 1977,[15] the time period of high impingement. Trawl catches indicated that fish populations could be slightly larger in the area encompassing the intake and discharge, compared with a control area, possibly due to the "cover" provided for fishes by the rip-rap material at the structures.[15]

During 1978, the principal species impinged were goldfish, yellow perch, emerald shiner, and gizzard shad (Table 1).[2] Impingement estimates for white crappie and freshwater drum were much lower than during 1977, while goldfish estimates were considerably higher during 1978. The estimated total annual impingement for 1978 was 6,607 fishes weighing 30.5 kg (67.2 pounds). Approximately 78 percent of the total impingement occurred during the months of April and December.

Although lake fish sampling did not occur during April and December 1978,[16] a comparison of the 1978 impingement catches[2] with trawl and gill net catches near the intake[16] showed that with the exception of a few species, the fishes impinged were also common in the lake. The most notable exception was goldfish which was far more abundant in impingement samples than in lake samples. White crappie was also somewhat more abundant in impingement samples. Black crappie was captured on the screens and not at all in lake samples. It was suggested that these three species probably are now using the intake canal for permanent residence and for spawning[2] and thereby contributing to the impingement counts.

The spawning of white crappie within the intake canal was indicated during 1975 when ichthyoplankton sampling was performed during the spawning season in both the lake and the canal.[12] Only during the period June 13-16 were white crappie larvae captured and then only in the intake canal. White crappie have not been represented in any of the ichthyoplankton samples thus far collected from the lake during studies at the site,[10,11,12,17,4,5] but crappies (not identified to species) were taken in ichthyoplankton samples collected during 1975 and 1976 in the western basin of Lake Erie near Davis-Besse.[18]

In addition to those fish species living in the canal (and the lake) that contribute to impingement counts, other canal fish might reside principally there. For example, a small number of bluegill have been impinged each year and taken during the canal studies, but bluegill have not been captured during the lake sampling. Similarly, one individual each of blackside darter and bluntnose minnow were impinged during 1978, but these species have not been captured near the site previously.[2] Conversely, black bullhead catfish have constituted significant portions of intake canal samples (especially during 1974), but have not yet been recorded in impingement catches and have been very rare in lake netting samples.

The ability of the canal fish populations to repopulate is demonstrated by the 1974 and 1975 netting and toxicant studies, as tabulated below. Following dewatering of the canal and toxicant application on September 25, 1974, just one individual fish was taken by trawl in the canal. During the following year, the canal fish population increased in both numbers of individuals and species, with white crappie constituting 81 percent of the population on September 16, 1975. Repopulation of the canal must have been via fishes entering through the offshore intake structure.

Date of Sampling	Intake Canal Fishes Caught	
	No. of Individuals	No. of Species
June 18, 1974[a]	31	5
August 27, 1974[a]	33	4
September 24, 1974[b]	414	18
September 25, 1974[c]	2,327	≥ 15
October 23, 1974[a]	1	1
June 13, 1975[d]	20	4
September 16, 1975[d]	400	12
Total	3,226	

[a] Two tows of an 8-foot otter trawl over the entire canal length.[11]

[b] More than 22 trawl tows were made in an effort to remove as many fish as possible prior to the toxicant study which took place the following day.[11]

[c] Toxicant study, see Table 2.

[d] Two 15-minute tows of an 8-foot otter trawl.[12]

It thus appears that the intake canal does provide habitat for several species of fish, some of which contribute to the estimates of impingement losses.

Davis-Besse is the only nuclear generating station now operating on Lake Erie and the only operating station (nuclear or fossil-fueled) on the lake utilizing closed-cycle cooling; thus, a comparative examination of the impingement at Davis-Besse with data from similarly designed stations on Lake Erie is not possible. However, impingement loss estimates are available for several Lake Erie fossil-fueled plants utilizing once-through cooling. Four plants located in the central basin (to the east of Davis-Besse) on the southern shore of Lake Erie were estimated to have impinged between 560,000 and 11,940,000 fishes during 1976 (Table 3).[19] During the period September 1976 to September 1977, impingement studies were conducted at two power stations located on the Maumee River and Maumee Bay to the west of Davis-Besse (Figure 1). At Bay Shore Power Station, 52 species were impinged, with total estimates of 18,316,745 fishes (of which 506,112 occurred during a 12-hour fish run) weighing 173,144 kg (381,713 pounds).[20] Principal species impinged included gizzard shad, emerald shiner, alewife, white bass, yellow perch, freshwater drum, and others (Table 4). At Acme Power Station, 43 species were impinged, with total estimates of 11,753,124 fishes (of which 6,024,060 occurred during seven fish runs of 44.5 total hours) weighing 102,221 kg (225,356 pounds).[21] Principal species impinged included gizzard shad, emerald shiner, freshwater drum, and others (Table 5). Both power plants have shoreline intake channels and larger rated intake volume capacities than Davis-Besse (1149.3 cfs at Bay Shore;[20] 605.7 cfs at Acme[21]). During 1974 and 1975, impingement studies were conducted at six power plants (all with shoreline or channel intakes) located in Michigan waters of Lake Erie, Maumee Bay, and the Detroit River[22] (Figure 1). Gizzard shad comprised between 51 percent and 87 percent of all species impinged at each plant, followed by emerald shiner, alewife, smelt, yellow perch, and others. Total estimated impingement ranged between 84,528 fishes at the Trenton Channel Plant and 1,410,286 fishes at the J. R. Whiting Plant (Table 6).

By comparison, the impingement estimate of 6,607 fishes is 1-3 orders of magnitude less than other Lake Erie power plants. Reasons for this probably are station design (low intake volume, offshore intake location) and site location in a relatively unproductive area of the western basin (discussed below in entrainment analysis). Sustained annual impingement comparable to that within the confidence intervals of the 1978 loss estimates at Davis-Besse should not add measurably to the total impingement impact to fishes resulting from the several power plants operating on Lake Erie.

Comparison of the fish impingement estimates at Davis-Besse with the recreational[23] and commercial harvests[24] for the Ohio waters of Lake Erie shows that the numbers and weights of impinged fishes were small fractions of the 1978 harvests (Tables 7 and 8).

The total number of fishes captured by seine, trawl, and gill net in the lake during preoperative and operative studies is shown below. By comparison with fish catches due to environmental impact studies, the number of fishes estimated to have been impinged (6,607) during 1978 is small. Using strictly numbers (not accounting for species or abundance differences), the total fishes taken by nets equals approximately 16.9 "impingement-years," at an impingement rate of 6,607 fishes per year. During 1978, the netted fishes numbered 2.9 times those estimated to have been impinged. All totaled, the fishes taken during lake, intake canal, and impingement sampling equals 123,534 individuals, or the equivalent of about 18.7 "impingement-years," a time frame approximating one-half of the operating life of the station.

Year	Numbers Caught	Number of Species
1973[12]	5,300	28
1974[12]	31,405	34
1975[12]	41,342	30
1977[15]	14,697	26
1978[16]	19,021	25
Total	111,765	

Even these numbers are lower (by about 75 percent) than the estimated impingement at the Lake Shore fossil power plant during the year 1976 alone (Table 3). An examination of the numbers of netted fishes and the numbers of impinged fishes provides a useful comparison to highlight the relatively low level of impingement losses at Davis-Besse. Netted fishes, however, might undergo less stress with greater overall survival than impinged fishes; thus, the numbers of netted fishes do not represent loss estimates, but only numbers captur

The bounds placed on the impingement estimates at the 95 percent confidence interval[2,10] are narrow (Table 1) and indicate low variability of impingement over time. It also suggests a reliability in the calculated estimates. Recent developments in impingement study design suggest that the sampling frequency should be adjusted based upon the time period or seasonality of abundance of important fish species--high sampling frequency during periods of abundance and low frequency during periods of low abundance.[25,26] Such a scheme is designed to reduce the variability and thus increase the precision in the impingement loss estimates. In the absence of such a stratified sampling design, a simple random sampling program should include a sampling frequency not less than 20 percent (~ 75 days in a year) and need not exceed 50 percent (~ 180 days).[25] The simple random sampling design and sampling frequencies of ~ 33 percent to 40 percent at Davis-Besse during 1977-78, therefore, appear to have been adequate for a reasonable determination of impingement loss estimates. During both years, the 45 (1977) and 144 (1979) sample days most often represented impingement catches by the power station for time periods in excess of 24 hours, and often in excess of 48 hours. Therefore, the total time periods sampled during each year were greater than the 45 and 144 days on which sampling occurred. The low numbers impinged and the low variability indicates that a stratified sampling design was not essential for reliable loss estimation.

Table 1. Estimates of the numbers and weights and percent contributions of impinged fish species to the total estimates for 1977 and 1978 at Davis-Besse Nuclear Power Station. The numbers impinged are those presented by the licensee. The weights are derived from the mean weight (in grams) presented by licensee multiplied by the estimated number impinged.

Species	1977 Number[a]	%	Weight	%	1978 Number[b]	%	Weight	%
Alewife	5.3	0.3	61.0	0.2	4	0.1	16	0.1
Black crappie	10.9	0.6	111.2	0.4	82	1.2	1,394	4.6
Blackside darter	-	-	-	-	1	< 0.1	1	< 0.1
Bluegill sunfish	15.4	0.8	78.5	0.3	5	0.1	50	0.2
Bluntnose minnow	-	-	-	-	1	< 0.1	1	< 0.1
Carp	-	-	-	-	6	0.1	12	< 0.1
Channel catfish	-	-	-	-	3	< 0.1	1.2	< 0.1
Emerald shiner	129.8	6.7	142.8	0.6	991	15.0	991	3.2
Freshwater drum	234.5	12.1	1,055.3	4.1	80	1.2	320	1.0
Gizzard shad	875.1	45.2	11,551.3	44.8	391	5.9	2,737	9.0
Goldfish	135.1	7.0	2,148.1	8.3	3,299	49.9	16,495	54.1
Green sunfish	-	-	-	-	5	0.1	60	0.2
Logperch darter	42.9	2.2	111.5	0.4	12	0.2	24	0.1
Pumpkinseed sunfish	-	-	-	-	9	0.1	99	0.3
Orangespotted sunfish	17.5	0.9	35.0	0.1	-	-	-	-
Rainbow smelt	5.6	0.3	61.6	0.2	69	1.0	69	0.2
Spottail shiner	2.1	0.1	12.6	< 0.1	15	0.2	30	0.1
Stonecat madtom	-	-	-	-	1	< 0.1	1	< 0.1
Trout-perch	-	-	-	-	29	0.4	116	0.4
Walleye	4.6	0.2	17.0	0.1	-	-	-	-
White bass	6.7	0.3	38.9	0.2	-	-	-	-
White crappie	231.1	11.9	9,036.0	35.0	22	0.3	176	0.6
Yellow perch	219.7	11.3	1,340.2	5.2	1,582	23.9	7,910	25.9
Totals	1,936.3	100.0	25,801.0	100.0	6,607	100.0	30,503.2	100.0
95% C.I.	(1316-2848.7)				(5447-8015)			

a. Source: Toledo Edison Company; Reference No. 10.
b. Source: Toledo Edison Company; Reference No. 2.

Table 2. Species composition of fishes collected from the Davis-Besse intake canal using a toxicant for complete removal of fishes on September 25, 1974.

Species or Group	Number Counted	% of Total
Yellow perch	19	0.8
Sunfish species	289	12.4
Bluegill	4	0.2
Goldfish	9	0.4
Minnows (cyprinids)	423	18.2
White bass	2	0.1
Gizzard shad	86	3.7
Smallmouth bass	4	0.2
Crappie species	385	16.5
Bullhead catfishes	812	34.9
Carp	275	11.8
Rock bass	4	0.2
Freshwater drum	5	0.2
Quillback	6	0.3
Channel catfish	4	0.2
Total	2,327	100.0

Source: Ohio Department of Natural Resources; Reference Numbers 13 and 14.

Table 3. Estimated annual impingement of fishes at four fossil-fueled plants on Lake Eria[a]

Fish Species	Avon Lake		Lake Shore		East Lake		Ashtabula A&B	
	Number (millions)	Percent	Number (millions)	Percent	Number (millions)	Percent	Number (millions)	Percent
Gizzard shad	3.90	86.4	0.26	46.5	10.59	88.7	4.75	98.0
Shiners	0.24	5.3	0.10	16.9	0.78	6.5	0.02	0.4
Rainbow smelt	0.35	7.8	0.18	32.6	0.48	4.0	0.04	0.8
White bass	0.02	0.4	0.02	2.6	0.01	0.1	0.01	0.2
Freshwater drum	b	b	b	1.3	0.5	0.4	b	0.1
Carp	b	b	b	b	b	b	b	0.1
Catfish	b	b	b	b	b	b	b	b
Yellow perch[c]	3,504	0.1	b	b	14,366	0.1	4,643	0.1
Trout perch	b		c	b	b	b		
Total	4.51		0.56		11.94		4.83	
Capacity, MWe	1344		514		1372		500	
Intake, m^3/sec(cfs)								
Mean	30(1060)		19(670)		34(1200)		8(300)	
Max	53(1870)		47(1664)		41(1461)		31(1100)	

[a] These rough estimates were calculated from preliminary impingement data. Final estimates must be derived from completed EPA 316b demonstration.

[b] Less than 10,000 and/or 0.1% of total.

[c] Actual number estimated.

Source: Ohio EPA, as presented in Reference No. 19.

Table 4. Summary of Fish Impingement by Number and Weight at the Bay Shore Power Station from September 15, 1976 to September 15, 1977

Species*	No. of Individuals		Weight	
	Number	% of Total	Kilograms	% of Total
Gizzard shad	11,347,255	63.7	122,358	71.8
Emerald shiner	3,282,597	18.4	8,098	4.7
Alewife	1,375,911	7.7	10,741	6.3
White bass	624,078	3.5	2,766	1.6
Yellow perch	437,260	2.4	15,311	8.9
Freshwater drum	365,779	2.1	5,807	3.4
Spottail shiner	212,515	1.2	1,661	1.0
Rainbow smelt	87,374	0.5	352	0.2
Walleye	12,187	0.1	1,220	0.7
Channel catfish	20,995	0.1	1,037	0.6
Others	44,682	0.3	1,357	0.8
Total	17,810,663	100.0	170,708	100.0

*Ten most prominent species. To be listed a species represented at least 0.1% of the total number and 0.2% of the total weight. These are estimates. Does not include impingement during fish runs.

Source: J. M. Reutter, et al., The Ohio State University; Reference No. 20.

Table 5. Summary of Fish Impingement by Number and Weight at the Acme Power Station from September 1, 1976 to September 15, 1977

Species*	No. of Individuals		Weight	
	Number	% of Total	Kilograms	% of Total
Gizzard shad	4,709,444	82.1	39,261	90.1
Emerald shiner	823,791	14.4	1,702	3.9
Freshwater drum	114,152	2.0	1,285	3.0
White bass	21,549	0.4	427	1.0
Alewife	21,412	0.4	170	0.4
Spottail shiner	15,789	0.3	105	0.2
Yellow perch	6,063	0.1	216	0.5
Channel catfish	3,225	0.1	32	0.1
Walleye	454	<0.1	131	0.3
Goldfish	746	<0.1	66	0.2
Others	12,439	0.2	140	0.3
Total	5,729,064	100.0	43,535	100.0

*Ten most prominent species. To be listed a species represented at least 0.1% of the total weight. This data does not include fish runs. These are estimates.

Source: J. M. Reutter, et al., The Ohio State University; Reference No. 21.

Table 6. Total Estimated Numbers of Fishes Impinged at Six Power Plants (Along with Their Design Intake Volume Flows) Located in Michigan Waters of Lake Erie, the Detroit River, and Maumee Bay During 1974 and 1975.

Plant Name (location)	Design Intake Flow, gpm (cfs)	Total Estimated Number of Fishes Impinged	Time Period Sampled
Enrico Fermi I (Lake Erie)	130,152 (291)	223,575	June 1974 - August 1975
Trenton Channel (Detroit River)	956,842 (2136)	84,528	June 1974 - August 1975
River Rouge (Detroit River)	450,595 (1006)	271,041	June 1974 - August 1975
Delray (Detroit River)	767,472 (1713)	453,831'	June 1974 - August 1975
Connors Creek (Detroit River)	489,192 (1092)	484,422	June 1974 - August 1975
J. R. Whiting (Maumee Bay)	107,000 (239)	1,410,286	January 1974 - March 1975

Source: R. S. Benda and W. C. Houtcooper; Third National Workshop on Entrainment and Impingement; Reference No. 22.

Table 7. 1978 Recreational Harvest of Fishes From the Ohio Waters of Lake Erie

Species	Numbers	Pounds (kg)
Yellow perch	11,483,000	2,459,000 (1,115,395)
Walleye	1,652,000	3,339,000 (1,514,560)
White bass	1,533,000	737,500 (334,528)
Freshwater drum	668,000	800,000 (362,878)
Channel catfish	218,000	189,500 (85,957)
Smallmouth bass	32,000	44,500 (20,185)
Total	15,586,000	7,649,500

Source: Ohio Department of Natural Resources; Reference No. 23.

Table 8. 1978 Commercial Harvest of Fishes in Ohio Waters of Lake Erie and in Ohio Statistical District 1 which have been Recorded in Impingement Samples at Davis-Besse During 1977 or 1978.

Species	Lake Erie, Ohio Total Pounds (kg)	DISTRICT 1* Pounds (kg)	DISTRICT 1* % of Total
Carp	1,545,925 (701,227)	726,490 (329,534)	47.0
Channel catfish	204,844 (92,617)	119,200 (54,069)	58.2
Freshwater drum	1,189,315 (539,470)	219,596 (99,608)	18.5
Gizzard shad	1,557,104 (706,298)	137,429 (62,337)	8.8
Goldfish	757,162 (343,446)	113,500 (51,483)	15.0
Smelt	13,690 (6,210)	0 -	0
White bass	1,687,345 (765,375)	1,422,485 (645,235)	84.3
Yellow perch	2,110,859 (957,479)	161,[illegible]1 (73,143)	7.6
Total all species	9,312,528 (4,224,135)	3,060,534 (1,388,249)	32.9

*State of Ohio Fishery Statistical District 1 encompasses the Ohio waters of Lake Erie from Toledo to Huron, which includes Maumee Bay, Sandusky Bay, the offshore island and reefs, and the Davis-Besse site.

Source: Ohio Department of Natural Resources; Reference No. 24.

B. Entrainment of Ichthyoplankton

During 1978, fish eggs and larvae were sampled in Lake Erie in the vicinity of Davis-Besse on ten occasions between April 30 and September 1.[4] Sampling was to be conducted approximately once every two weeks (weather permitting) using 0.75 meter diameter plankton net (No. 00, 0.75 mm mesh) equipped with a calibrated flow meter. Samples were collected in duplicate from surface and bottom via a 5 minute circular tow (at a speed of 3-4 knots) at five stations: the intake (sta. 8); the discharge (sta. 12); two control areas, one northwest (sta. 3) and one southwest (sta. 29) of the intake and discharge area; and at Toussaint Reef offshore of Locust Point (Figures 2 and 3).[4] Similar studies were conducted in 1977 between April 20 and September 2.

Densities of ichthyoplankton for entrainment loss estimates were obtained using the above techniques, except that samples were collected at the offshore intake in quadruplicate via oblique (bottom-to-surface) plankton tows made at night.[5,6] Oblique tows were used due to requirements for sampling at Lake Erie water intakes by the U.S. Environmental Protection Agency (USEPA) and the US Fish and Wildlife Service. Night sampling was also required by those agencies for minimization of net avoidance by larvae and to more accurately assess populations of species which reside near the bottom during daylight.[5,6] Density estimates were computed and presented as the number of ichthyoplankters per 100 m^3 of water for each sampling date and a mean density was computed for the time period during which each species was captured. The mean value was then multiplied by the volume of cooling water withdrawn by the power station during the period of plankton occurrence to estimate the numbers entrained. This method assumed that all ichthyoplankters observed at the intake were entrained and also that all entrained plankters were killed.

During 1977, 13 taxa of ichthyoplankters were collected during lake samplings.[17] The most abundant larval species were: gizzard shad (55.9 percent of the total larvae collected); yellow perch (25.5 percent); walleye (11.1 percent); and emerald shiner (3.0 percent). Overall, maximum larval densities occurred on June 2, with the period of greatest abundance between April 29 and June 25. Control station No. 3 exhibited the greatest mean larval density (57.4/100m^3), while control station No. 29 showed the lowest mean density (15.8/100m^3) of those stations near the power plant. Overall, the Toussaint Reef station exhibited the lowest mean larval density (11.6/100m^3). No eggs were collected on any of the sampling dates.

During 1978, eleven taxa of ichthyoplankters were collected during lake sampling.[4] The most abundant larval species were: gizzard shad (68.7 percent of the total); emerald shiner (14.3 percent); walleye (10.8 percent); freshwater drum (2.5 percent); and yellow perch (2.1 percent). Overall, maximum larval densities occurred on June 5, with the period of greatest abundance between May 22 and July 5. The discharge plume station (No. 13) exhibited the greatest mean larval density (76.1/100m^3), while the intake station (No. 8) showed the lowest mean density (31.9/100m^3) of those stations near the plant. Overall, the Toussaint Reef station exhibited the lowest mean larval density (26.1/100m^3). Fish eggs were collected from the bottom of Station Nos. 3 and 13 and only on June 8, with densities of 8.7/100m^3 and 6.3/100m^3 respectively. The eggs were not speciated. Eggs were not collected near the intake.

During 1977 and 1978, walleye contributed to increasingly greater proportions on the larval catches than during previous years, probably due to noted increases in the adult populations throughout the western basin of the lake.[4,17] Conversely, yellow perch larval densities decreased from 1977 to 1978,[4,17] as did the abundance of young-of-the-year in Ohio Statistical District I.[23]

During the spawning seasons of 1975 and 1976, a study of ichthyoplankton distribution was conducted throughout much of the western basin (Ohio waters) for the USEPA.[18] The study utilized sampling equipment and procedures similar to those used at Davis-Besse during 1977 and 1978, and sampled the waters of Maumee and Sandusky Bays and the lake proper from nearshore to approximately 20 miles (32 Km) offshore. A total of 20 larval species were collected, with the most common being gizzard shad, rainbow smelt, emerald shiners, spottail shiner, carp, freshwater drum, white bass, yellow perch and walleye. The study recommended the use of replicate tows, surface and bottom sampling, and night sampling, as done at Davis-Besse during 1977 and 1978. The study also found that separate surface and bottom tows produced greater larval densities than did oblique tows at the same station. At Davis-Besse during 1978, surface-bottom sampling at the intake yielded lower mean densities (during the periods of occurrence) of gizzard shad, freshwater drum, and walleye, and higher densities of emerald shiner and yellow perch than did oblique sampling.[4,5 6] One result of the study was the identification of areas of the lake used for spawning. It found that nearly all nearshore areas appear to be used by one species or another, and the area where the least amount of spawning and/or nursery activities were taking place was identified to be from Locust Point west to the mouth of Maumee Bay. It was suggested, therefore, that water intakes sited in this area would have the least impact on fish larvae. Intakes placed offshore as far as economically possible were stated as the most desirable, since the fewest larvae were collected offshore.[18]

Entrainment sampling at the intake station (No. 8) during 1978 indicated that ichthyoplankters were entrained by cooling water withdrawal from May 6 through August 17 (Table 9).[5,6] Based upon the densities of plankters caught and the volume of intake water withdraw during the periods of occurrence, an estimated 6,310,890[6] to 6,311,371[5] larvae and 44,278[5,6] eggs were entrained by the power station in 1978 (Table 9). Of the larvae total, gizzard shad constituted 76 percent, walleye 15 percent, and emerald shiner 5 percent. Fish eggs (unspeciated) were captured during entrainment sampling only on June 7 at a density of $2.4/100m^3$.[5,6]

One approach to assessing the impact of entrainment of fish larvae is to estimate the number of adults that the loss represents.[27] Using the simplistic approach, the number of adult fish that would have resulted from the entrained larvae is equal to the survivorship from larva-to-adult multiplied by the number of larvae entrained.[27,28] Based upon survival estimates ranging from 0.1 percent to 1.0 percent during the life stages from late larva to 3-year old adult, the licensee estimated that the 35,259 entrained yellow perch larvae could have produced between 35-353 adult fish. Similar survival estimates for entrained walleye larvae resulted in an estimated loss of 917-9167 adult fish.[5,6] These estimates probably are conservative, however, since the entrained larvae of both species were entirely early stage or pro-larvae (yolk-sac larvae)[5,6] which would have lower survival rates to adulthood than would late stage larvae. For example, survival from early larva to adult (4-year old) for sauger (a species closely related to yellow perch and walleye) in the Mississippi River near the Prairie Island Nuclear Generating Station was estimated to be between 0.023 percent and 0.34 percent, based upon site-specific life history considerations for that species.[29] Other early larva-to-adult survival rates for fishes at Prairie Island which were entrained at Davis-Besse also are estimated to be less than 1 percent: gizzard shad (0.01 percent); carp (0.0006-0.12 percent); and freshwater drum (0.00175-0.01 percent).[29] Comparison of the estimated losses of equivalent adult yellow perch and walleye with the Ohio recreational and commercial fishery harvests for 1978 (tables 7 and 8) shows that they are small proportions of the harvests (which are themselves portions of the total populations). Assuming that compensatory mechanisms are operating within the populations, the numbers of equivalent adults lost could be reduced.

The bounds placed on the entrainment estimates at the 95 percent confidence interval[5,6] are wide (Table 9) and indicate a high variability of larval densities over time. Sampling frequency also could have contributed to the wide intervals. The State of Ohio Environmental Protection Agency (OEPA) guidelines for entrainment sampling[30] suggest that for "low risk" intakes, sampling frequency should be between once-per-7 days and once-per-10 days, with the latter required by OEPA and the USNRC ETS for Davis-Besse. During 1978, entrainment sampling was conducted on eight occasions between April 30 and August 11 at frequencies ranging from 10 to 27 days. During the period of maximum larval abundance (~ May 22 to July 5), the frequencies of entrainment sampling were 15, 17, and 27 days, when indeed, more frequent sampling at the prescribed level would have been desirable. Examination of the far field lake ichthyoplankton data[4] shows that overall peak densities occurred during late May-early June and during early July of 1978, when entrainment sampling did occur. During latter June (when entrainment sampling was not conducted), far field sampling documented the peak in larval abundance of freshwater drum. Densities near the intake, however, were lower than at any other station sampled ($1.7/m^3$) and lower than the concentration used for entrainment estimates ($2.00/m^3$, Table 9) for that species. It thus appears that the sampling frequency and a lack of entrainment sampling from early June (7th) until early July (4th) probably contributed to the wide confidence intervals around the entrainment loss estimates.

Entrainment sampling was conducted for yellow perch larvae during May-August 1975 at the Monroe Power Plant (once-through cooling; with an intake volume of $110m^3/sec$ or 3885 cfs[31]), located in Michigan waters of Lake Erie (Figure 1). Loss estimates of yellow perch larvae were between 85,000,000 and 110,000,000.[32] Entrainment sampling was conducted at Acme and Bay Shore Power Stations during the periods September 1-15, 1976 and from March 16 to September 1, 1977 at both plants.[20,21] Sampling was conducted via submersible pumps at the intakes for a continuous 24-hour period once every seven days during 1976 and from June 16 to September 1, 1977. During the period March 16 to June 16, 1977 sampling occurred once every four days. Entrainment loss estimates for Bay Shore Power Station were 284,717,618 larvae and 426,150,109 eggs (Table 10)[20] and for Acme Power Station were 79,492,563 larvae and 178,048,309 eggs (Table 11).[21] Ninety-five percent confidence intervals around the entrainment losses were relatively narrow and never included zero, probably due to a high frequency of sampling effort and perhaps to an abundant plankton population exhibiting relatively low variability in density over time. By comparison, the 1978 loss estimates at Davis-Besse are 1-2 orders of magnitude lower for fish larvae and 3-4 orders lower for fish eggs. Similarly, larval entrainment at Davis-Besse during 1978 was low compared with annual estimates (1975-1977) for the Acme, Bayshore, Monroe, and Whiting plants and roughly equivalent with the Fermi Atomic Power Plant Unit 1 which constituted less than one percent of the 5-plant estimated entrainment losses (Table 12)[35]. Differing years, sampling techniques, site locations, and station designs undoubtedly contribute to the differences. Since Davis-Besse and Locust Point are located in an area of relatively low fish productivity,[18] the site vicinity probably is influenced by the input of plankters from other areas (carried by water currents) such as the offshore reefs, the Detroit River, and surrounding near shore areas where productivity is higher,[18] and perhaps from Maumee Bay where water flow is from the Bay toward the east around Cedar Point[20,21] (Figure 1). As such, the wide confidence intervals around the Davis-Besse entrainment estimates might be reflecting a true variability of the plankton populations there which are influenced as much (or more) by input (or lack of it sometimes) from surrounding areas, as by production in that area. The lower 95 percent confidence interval values of zero also are reflective of the capture of no organisms on some samplings days during the periods of occurrence used for entrainment loss estimates

Sustained annual entrainment losses comparable to those within the confidence intervals of the 1978 loss estimates at Davis-Besse should not add measurably to the total entrainment impact to fishes resulting from the several power plants operating on Lake Erie. The site location in a relatively unproductive area of the western basin should further minimize impacts.

Table 9. Ichthyoplankton Entrainment at the Davis Besse Nuclear Power Station - 1978

Species	Period During Which Entrainment Occurred	Volume of Water ($100 m^3$) Withdrawn During Period[a]	Larvae/$100 m^3$[b]			Number of Larvae Entrained[c]		
				95% Confidence Interval			95% Confidence Interval	
			Mean	Lower Limit	Upper Limit	Mean	Lower Limit	Upper Limit
Carp	June 21 - July 12	20443	0.32	-0.69	1.32	6542	0	26985
Emerald shiner	June 21 - August 17	73704	4.68	-7.70	17.05	344935	0	1256653
Freshwater drum	May 16 - July 12	49951	2.00	-5.15	9.15	99902	0	457052
Gizzard shad	May 30 - August 17	91598	52.36	-38.38	143.00	4796071	0	13098514
Rainbow smelt	May 16 - August 17	103211	0.92	-0.80	2.64	94954	0	272477
Spottail shiner	May 30 - August 17	91598	0.18	-0.04	0.40	16488	0	36639
Walleye	May 6 - May 30	22037	41.60	-436.15	519.35	916739	0	11444915
Yellow perch	May 6 - May 30	22037	1.60	-0.94	4.14	35259	0	91233
TOTAL LARVAE						6310890		26684468
EGGS	May 30 - June 21	18449	2.40	-5.24	10.04	44278	0	185228

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

[b]Average concentration during their period of occurrence.

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

Source: J. M. Reutter and C. E. Herdenorf, The Ohio State University; Reference No. 6.

Table 10. Total Ichthyoplankton Entrainment at the Bay Shore Power Station: September 1, 1976 to September 1, 1977

Species	Total	% of Total	LOWTOT[a/]	UPTOT[b/]
Bluegill sunfish	28201	0.01	4678	169998
Carp	8251539	2.90	4159814	16368014
Channel catfish	564532	0.20	164699	1935025
Emerald shiner	142572	0.05	34151	595207
Freshwater drum	13479134	4.73	7372574	24643639
Gizzard shad	223290406	78.43	134749933	370008388
Logperch darter	28778	0.01	4774	173487
Rainbow smelt	897099	0.32	387843	2075032
Spottail shiner	238132	0.08	44203	1282868
Troutperch	12747	<0.01	981	165631
Unidentified	88078	0.03	28585	271388
Unidentified crappie	28778	0.01	4774	173487
Unidentified shiner	166784	0.06	17593	1581135
Unidentified sucker	357889	0.13	132394	967447
Unidentified sunfish	493434	0.17	82108	2965329
Walleye	441614	0.16	206873	942721
White bass	33107856	11.63	13496529	81215709
White sucker	673614	0.24	249356	1819709
Yellow perch	2426431	0.85	875124	6727696
TOTAL LARVAE	284717618	100.00		
Drum eggs	425804075	99.92	238919134	758872292
Other eggs	346034	0.08		
TOTAL EGGS	426150109	100.00	239225361	759133204

[a/] Lower bound of 95% confidence interval for number entrained.

[b/] Upper bound of 95% confidence interval for number entrained.

Source: J. M. Reutter, et al., The Ohio State University; Reference No. 20.

Table 11. Total Ichthyoplankton Entrainment at the Acme Power Station: September 1, 1976 to September 1, 1977

Species	Total	% of Total	LOWTOT[a/]	UPTOT[b/]
Carp	1144648	1.44	472245	2774446
Channel catfish	92377	0.12	28932	294954
Freshwater drum	26513645	33.35	13381549	52533031
Gizzard shad	44930220	56.52	19516220	103438300
Logperch darter	130032	0.16	22907	738130
Spottail shiner	41401	0.05	6931	247314
Unidentified	114022	0.14	34034	381997
Unidentified madtom	15517	0.02	3627	66392
Unidentified shiner	7853	0.01	1325	43414
Unidentified sucker	141043	0.18	21637	919410
Unidentified sunfish	341613	0.43	75247	1550884
Walleye	195311	0.25	82488	462446
White bass	5777732	7.27	2369161	14364576
White sucker	33025	0.04	12231	89170
Yellow perch	14394	0.02	3394	61049
TOTAL LARVAE	79492563	100.00		
Drum eggs	39968543	22.45	18996413	84094001
Other eggs	138079766	77.55		
TOTAL EGGS	178048309	100.00	53425199	593375433

[a/] Lower bound of 95% confidence interval for number entrained.

[b/] Upper bound of 95% confidence interval for number entrained.

Source: J. M. Reutter, et al., The Ohio State University; Reference No. 21.

Table 12. Estimated Entrainment of Fish Larvae (All Species) at Major U.S. Power Plants in Western Lake Erie during 1975-1977.

Power Plant	Year 1975	1976	1977	Total	Percent of The Total
Acme	2.52×10^8	1.90×10^8	7.90×10^7	5.21×10^8	15.22
Bayshore	1.10×10^9	2.09×10^8	2.85×10^8	1.50×10^9	43.94
Fermi I	2.00×10^6	6.00×10^6	5.00×10^6	1.30×10^7	0.38
Monroe	7.10×10^7	7.70×10^7	7.16×10^8	8.64×10^8	25.24
Whiting*	2.52×10^8	1.90×10^8	7.90×10^7	5.21×10^8	15.22
Total	1.587×10^9	6.720×10^8	1.164×10^9	3.423×10^9	100

*Insufficient data were available for the Whiting plant, so estimates duplicate those of Acme due to the comparability of the two plants in size and environmental location.

Source: R. L. Patterson, University of Michigan; Reference No. 35.

IV. Conclusions

The observed impingement losses during the Phase I study were low in numbers and primarily were non-fishery species. Those fishery species which were impinged also occurred in low numbers and were small fractions of the recreational and commercial harvests.

The intake canal appears to provide habitat for several fish species, some of which apparently contribute to impingement losses. Most notable during 1978 was goldfish, which occurred in low abundance in lake netting studies, but comprised almost 50 percent of the estimated impingement losses. Since the canal apparently permits survival (and subsequent impingement) of some species at levels which exceed those from the lake, the impingement of those species cannot be considered as losses of or impacts to the lake populations.

No fishes listed as endangered by either the U.S. Department of Interior or the State of Ohio were impinged during 1977 and 1978.[6] However, two species listed as endangered by Ohio have been taken during farfield sampling at Davis-Besse: silver club (Hybopsis storeriana) and the Great Lakes muskellunge (Esox masquinongy masquinongy). Silver club has been taken by gillnet in very low numbers (1-3 per year) during every year since 1973,[16] while the Great Lakes muskellunge was collected (one individual specimen) during 1976 only.[33]

Based upon the above analyses, the impact of impingement at Davis-Besse on Lake Erie fish populations is judged to be insignificant and acceptable. The Phase I studies and foregoing analyses have confirmed the FES predictions. The fish species predicted by the FES to be impinged generally have been realized, except for spottail shiner, white bass and alewife which constituted insignificant portions of the impingement estimates for 1977 and 1978. In view of the adequacy of the Phase I sampling program and the insignificance of impact resulting from fish impingement, Phase I may be terminated and Phase II (canal study) and Phase III (bubble screen evaluation) need not be initiated. Although a program specifically designed to determine the contribution of canal-resident fishes to impingment has not been conducted, studies undertaken to date do suggest that the phenomenon is occurring. In the absence of adverse impact due to impingement, an evaluation of a bubble screen at the intake crib (as a mitigative measure) is unnecessary.

The impact of ichthyoplankton entrainment to Lake Erie fish populations is judged to be acceptable. Few fish eggs were entrained and densities of fish larvae near the intake generally were lower than nearby control areas. The site location on Locust Point appears to be in a relatively unproductive area of the Ohio shoreline of Lake Erie. The FES recognition that the immediate site vicinity is not an important spawning or nursery area is still valid. The FES further recognized that plankters of emerald shiner and gizzard shad were dominant forms, with walleye, smallmouth bass, and yellow perch in lesser abundance. Operational sampling generally confirmed this, except for smallmouth bass which was not captured in 1978 during either lake or entrainment sampling. Overall, walleye was less abundant than gizzard shad and emerald shiner in lake samples, but during its peak was the most abundant ichthyoplankter, and was the second most abundant species entrained (following gizzard shad). In view of the acceptability of the impact resulting from entrainment, the ichthyplankton entrainment program may be terminated.

The OEPA 316 Guidelines[30] classify cooling water intake structures with respect to "risks." Criteria for determining whether an intake is high or low risk include: design, capacity, location; and the the probability of involvement (i.e., being entrained or impinged) of resident aquatic organisms with the intake. Criteria applicable to Davis-Besse are as follows:

(1) Facilities located on Lake Erie with shoreline intakes and a maximum cooling water demand of less than or equal to 500 cfs will be considered low risk.

(2) Facilities located on Lake Erie with submerged offshore intakes may be considered intermediate between low and high risk.

(3) Submerged offshore intakes will usually be considered low risk, but distance offshore, depth and the interrelated factor of biological richness will influence the risk assessment; as a general rule, the greater the distance offshore the lower the risk factor; capacity of offshore intakes is also important and will influence the risk factor.

The intake risk classification for Davis-Besse appears to be low for the following reasons:

(1) Low cooling water demand (94 cfs);

(2) Low levels of fish impingement and ichthyoplankton entrainment;

(3) The relative low productivity of the area of the western basin in which the site occurs, thus a relative low probability of involvement of important biota with the intake.

The analysis confirms the FES conclusions that the intake design represents a practical balance between technological and ecological considerations, with minimal environmental impact.

This analysis addresses items of NEPA concern with respect to impingement and entrainment impact to Lake Erie fishes, as identified in the NRC Final Environmental Statements. These subjects have been discussed with the Ohio Environmental Protection Agency (OEPA) and this analysis has included a consideration of OEPA requirements and the 316(b) study results provided to the State. On January 16, 1980, OEPA formally determined that the cooling water intake at Davis-Besse represents best available technology for the minimization of impingement and entrainment of fish as required under Section 316(b) of the Clean Water Act. This determination is included as Appendix I of this assessment.

Conclusion and Basis for Negative Declaration

On the basis of the foregoing analysis, we conclude that there will be no environmental impact attributable to the proposed action. The changes assessed herein are to the environmental monitoring programs and do not involve any change in plant design or operation or involve an increase in effluent types or quantities. The impact of the overall plant has already been predicted and described in the Commission's FES for Davis-Besse Unit 1. On this basis and in accordance with CFR Title 10, Part 51.5, the Commission concludes that no environmental impact statement for the proposed action need be prepared and a negative declaration to this effect is appropriate.

References

1. Letter dated November 16, 1978 from James S. Grant, Vice President Energy Supply, The Toledo Edison Company, Toledo, Ohio; to James G. Keppler Director, Region III Office of Inspection and Enforcement, USNRC, Glen Ellyn, Illinois. 2 pages.

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Appendix I

316(b) Determination by the State of
Ohio Environmental Protection Agency for
Davis-Besse Nuclear Power Station, Unit 1

OhioEPA

January 16, 1980

Re: NPDES Permit # B211*AD

Mr. Lowell E. Roe
Vice President
Facilities Development
Toledo Edison Company
Edison Plaza
300 Madison Avenue
Toledo, Ohio 43652

Dear Mr. Roe:

Members of my staff have reviewed the document entitled " Impingement and Entrainment at the Davis-Besse Nuclear Power Station Unit 1, 316 (b) Demonstration ". The staff has determined that the cooling water intake at Davis-Besse represents best available technology for the minimization of impingement and entrainment of fish as required under Section 316 (b) of the Federal Clean Water Act. The use of closed-cycle cooling in conjunction with an off-shore intake should prevent the occurrence of significant impact to the important sport and commercial fishery in the Western Basin of Lake Erie. Following established procedure, the NPDES permit will be modified to indicate the 316 (b) decision.

If you have any questions or comments please contact Joe Reidy (614) 466-2390.

Very truly yours,

Robert E. Phelps

Robert E. Phelps, P.E.
Chief, Division of Industrial Wastewater

REP:ph

cc: J. Reidy
G. Milburn, USEPA-Region V
C. Hickey, USNRC ✓