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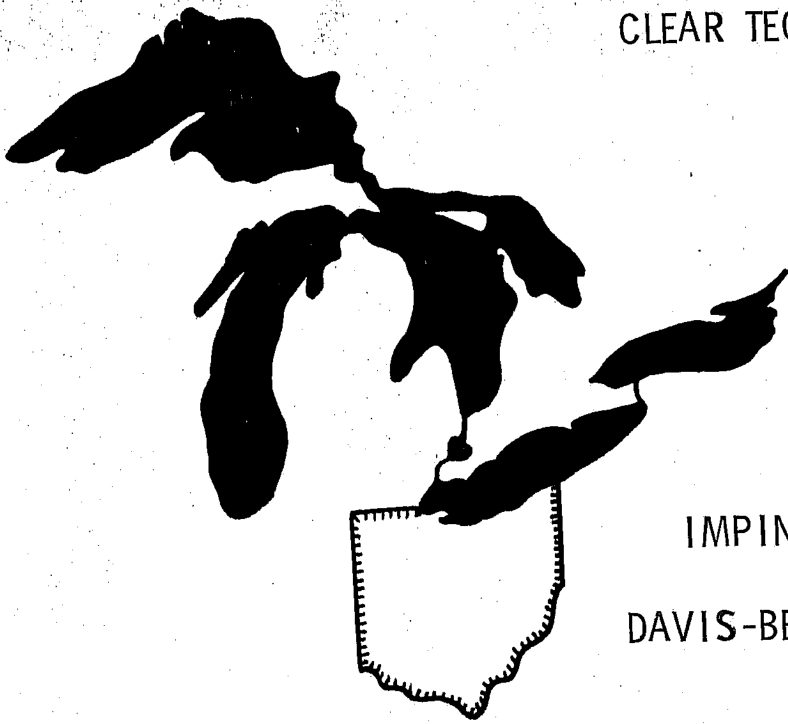

IMPINGEMENT AND ENTRAINMENT AT THE DAVIS-BESSE NUCLEAR POWER STATION UNIT 1

316(b) DEMONSTRATION

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SUMMARY AND IMPACT ASSESSMENT

The Davis-Besse Nuclear Power Station is located on the southwest shore of Lake Erie at Locust Point and is co-owned by the Toledo Edison Company and the Cleveland Electric Illuminating Company and operated by the Toledo Edison Company. Unit 1 is capable of generating 906 MWe and has a closed condenser cooling system. Make-up water for cooling purposes is drawn from Lake Erie from a submerged intake crib 3000 feet offshore through a buried eight-foot diameter conduit to a closed, but uncovered, intake canal. The canal is approximately 2950 feet long and terminates at the trash racks of the intake structure. Water is drawn through the intake crib and conduit by gravity. Design capacity for Unit 1 is 42,000 gpm with a resultant approach velocity through the crib ports of 0.25 ft/sec. Cooling tower blowdown is discharged at a point approximately 1200 feet offshore through a six-foot diameter buried conduit which terminates in a high velocity nozzle to promote rapid mixing. The maximum allowable ΔT is $20^{o}F$. The scope of work performed for the following 316(b) demonstration was in direct compliance with a study plan agreed upon by the U.S. Nuclear Regulatory Commission and the Toledo Edison Company (Environmental Technical Specifications, Appendix B to Facility Operating License No. NPF-3).

Studies of fish impinged on the traveling screens of the power station were conducted during the period 1 January through 31 December 1978. During this period the date, time, and duration of operation of the plant's traveling screens was recorded. Fish were collected during 144 of the 221 screen operations by placing a wire barrier with the same mesh as the traveling screens (¼ inch) in the sluiceway through which all back-washed material must pass. When the screens were turned off, the fish in front of this barrier were removed by hand. All impinged fish were identified and enumerated, a total weight was determined for each species, and all or at least 50 fish of each species were weighed and measured individually.

Since the time and duration of every screen operation was known, it was possible to determine the number of hours represented by each collection. From this and the number of fish impinged during that period, a concentration, fish impinged/hour, was developed. The average of these concentrations was used to estimate impingement during hours when screen-washed fish were not collected.

Entrainment estimates were computed by multiplying ichthyoplankton concentrations as observed in the lake at the intake crib by the volume of water pumped through the plant. Ichthyoplankton concentrations were determined at approximately ten-day intervals during the period of larval occurrence in 1978 (April through August) from four three-minute oblique tows (bottom to surface) with a 0.75 m diameter heavy-duty oceanographic plankton net at night.

It is estimated that a total of 6,607 fish representing 20 species was impinged on the traveling screens at the Davis-Besse Nuclear Power Station during 1978. No species listed as rare and endangered by the Ohio

Department of Natural Resources, or appearing on the "Federal Register of Endangered Species" were impinged or entrained during 1978. Non-sport fish made up approximately 75 percent of the total number impinged and no smallmouth bass, walleye, or white bass were impinged.

It is estimated that approximately 6,311,000 larvae and 44,000 eggs were entrained during 1978. Again, non-sport species represented over 75 percent of this total with gizzard shad leading the way at 69 percent.

Ohio EPA's Division of Industrial Wastewater in their report "Section 316 Guidelines" (30 September 1978) states, "The general overall goal of any 316(b) demonstration should be to: 1) establish reliable loss projections of all life history stages of representative aquatic species; and 2) evaluate the significance of the projected losses (magnitude of adverse impact) to the impacted species populations and communities." This 316(b) demonstration has met these two goals. Impingement and entrainment losses have been presented with confidence limits, and we have determined that three of the six dominant sport and commercial species, smallmouth bass, walleye, and white bass, were not impinged at Davis-Besse during 1978. Furthermore, two of these species, smallmouth bass and white bass, were not entrained, either. Those fish which were impinged amounted to 0.04 percent by number and less than 0.001 percent by weight of the sport fishing harvest from only the Ohio waters of Lake Erie. Seventy-six percent of the entrainment losses were gizzard shad, an underutilized species, the population of which is currently on the increase. Entrainment losses were also evaluated based upon the number of adults required to lay a number of eggs equal to the entrainment losses. It was estimated that 16 female gizzard shad and three female walleye could have produced the required number of eggs.

Ohio EPA's "Section 316 Guidelines" go on to say, "The acceptability of this damage [entrainment and impingement] is dependent upon the following: 1) the number of organisms entrained and impinged; 2) the percentage of each representative species population lost due to entrainment and impingement damage (when applicable to certain high risk intakes); 3) magnitude of damage to endangered species; 4) magnitude of damage to commercial and sport species; 5) magnitude of damage to ecologically valuable species; and 6) whether the observed entrainment and impingement damage contributes to community unbalance." Based upon these criteria, entrainment and impingement losses at the Davis-Besse Nuclear Power Station must be considered acceptable, for 1) the number entrained and impinged was relatively small; 2) no endangered species were harmed; 3) damage to commercial, sport, and "ecologically significant" species was insignificant, relative to commercial and sport harvests; and 4) there were no indications that entrainment and impingement losses were contributing to community unbalance. It should be noted here that Ohio EPA has designated "facilities, located on Lake Erie, with submerged offshore intakes" as "intermediate risk" rather than "high risk". Ohio EPA goes on to say that intakes of this type will generally be considered low risk, "but distance offshore, depth, and the interrelated factor of biological richness will influence risk assessment." It is the opinion of the authors that the design and the distance offshore would place the Davis-Besse intake in the low risk category, but that the biological richness of the Western Basin of Lake Erie causes any intake in this area to move into the intermediate risk group where it will receive careful scrutiny. It is apparent that Davis-Besse has passed this scrutiny.

The "Section 316 Guidelines", having previously described the goals of a 316(b) demonstration, describe the objective of 316(b) demonstrations as follows: "The primary objective of any 316(b) evaluation should be to determine if an existing or proposed cooling water intake structure minimizes adverse environmental impact." From the above discussions and the substantiative findings presented within the body of this report, it is apparent that entrainment and impingement losses at the Davis Besse Nuclear Power Station during 1978 were well within acceptable limits and that the intake structure is minimizing adverse environmental impact.

INTRODUCTION

Section 316(b) of Public Law 92-500 (Federal Water Pollution Control Act of 1972) requires the location, design construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact. If it can be demonstrated that a power generating facility, with its present cooling system design, is not having an adverse effect on the environment, the requirements of the above law have been met. The purpose of this report is to define and evaluate fish impingement and entrainment at the Davis-Besse Nuclear Power Station, Unit 1. This station is presently being operated by the Toledo Edison Company and is co-owned by the Cleveland Electric Illuminating Company; both companies are members of the Central Area Power Coordination Group (CAPCO), a group of four electric utilities in Ohio and Pennsylvania that pool their generating and transmission capabilities for mutual benefit. The scope of work, as described in this report, was performed in direct compliance with a study plan agreed upon by the U.S. Nuclear Regulatory Commission and Toledo Edison Company (Environmental Technical Specifications, Appendix B to Facility Operating License No. NPF-3).

Impingement

Impingement is the noun form of the verb impinge, arising from the Latin verb "impingere" meaning "to fasten". In the terminology of 316(b) discussions, impingement refers to fish which are impinged on the traveling screens at the cooling water intakes of power plants. The U.S. Fish and Wildlife Service (Edsall and Yocom, 1972) has concluded that the constant pressure exerted on the impinged organisms by the cooling water flow can prevent their escape from the intake screens and, as a result, may cause them to perish by suffocation. The number of fish impinged depends on both physical and biological factors. Some physical factors that may contribute to impingement include: (1) intake structure design and location, (2) the volume of water withdrawn, (3) the velocity of water approaching and flowing through the intake screens, (4) time of day, (5) meteorological conditions, (6) ice control procedures, (7) water levels and currents, and (8) water temperature and other water quality characteristics. Some biological factors affecting impingement include: (1) the species in question and their population densities, (2) their seasonal abundance, (3) size, (4) swimming ability (speed and endurance), (5) distribution in the water column, (6) diel activity, and (7) physiological condition of the organisms (presence or absence of stress, coefficient of condition, etc.). Quantitative predictions of fish impingement and correlations of impingement with individual biological or physical parameters are extremely difficult due to the complexity of the interactions between the physical and biological factors.

Recently, King _et al_. (1977) and Tatham _et al_. (1977) have shown that assuming 100 percent mortality of impinged fish is probably too high as actual mortality ranges from 10-93 percent depending on the species, season, and mode of traveling screen operation.

Entrainment

Entrainment is the noun form of the verb entrain, meaning "to draw along with" and originates from the Middle French verb "entrainer," meaning "to drag". In the terminology of 316(b) discussions, entrainment refers to aquatic organisms, smaller than the mesh of the intake screens, which are "entrained" with the cooling water flow and drawn through the plant. The most-frequently entrained organisms are: (1) microscopic algal cells (phytoplankton), microcrustaceans, protozoans and rotifers (zooplankton), and (3) planktonic eggs and larvae of fish (ichthyoplankton). Only the ichthyoplankton segment is addressed in this report.

Nature has countered the extremely high natural mortality rates these early live stages suffer with high fecundities. Many species lay over 500,000 eggs yearly. However, entrainment of these early life stages still warrants scrutiny since future age classes must arise from this group.

Quantifying entrainment requires frequent monitoring due to the high variability in the densities of fish eggs and larvae. However, these forms are present for only a few months each year, and entrainment losses for any planktonic species can be estimated simply by multiplying densities observed in front of the intake screens by the flow through the plant. It should be noted that this technique yields the number which are entrained but does not address entrainment mortality. Recently, Cannon et al. (1977) found that mortality of entrained fish larvae generally ranges from 0-30 percent when the maximum temperature experienced by the larvae during condenser passage is less than 30°C. However, since Davis-Besse has a closed condenser cooling system, 100 percent mortality of entrained organisms has been assumed.

STATION DESCRIPTION

Station Location

The Davis-Besse Nuclear Power Station, Unit 1 is located in Ottawa County, Ohio, on the southwest shore of Lake Erie, about 21 miles east of Toledo. The 954-acre site is located in Carroll Township adjacent to the mouth of the Toussaint River (coordinates: 41°35'57" N and 83°05'28" W). The site has 7,250 feet of Lake Erie frontage (Figure 1). This section of shoreline is flat and marshy with maximum elevation only a few feet above the lake level (U.S. Atomic Energy Commission, 1973).

General Station Description

Unit 1 is a nuclear-powered electric generating facility with a net electrical capacity of 906 MWe. The facility utilizes a pressurized water reactor (PWR) manufactured by Babcock and Wilcox Company. Most of the heat from the turbine steam condenser is dissipated to the atmosphere by means of natural-draft cooling tower, 493 feet high and 415 feet in diameter at its base.

Cooling Water Intake Design

The cooling water intake shown in Figure 2 is made up of three principle elements; the intake crib and conduit, intake canal, and intake structure. The Unit obtains its cooling water from Lake Erie through the intake crib. Water entering the intake crib flows by gravity through the eight-foot diameter intake conduit buried beneath the lake bottom to the intake canal. The water then flows through the intake canal to the intake structure located at the west end of the intake canal forebay. From the intake structure cooling water will be pumped to the various systems within the unit. These three principle components are described in detail in the following sections.

Intake Crib. The intake crib for the Davis-Besse Nuclear Power Station is located in the Western Basin of Lake Erie approximately 3000 feet offshore from the land area commonly known as Locust Point in approximately 11 feet of water at low water datum (568.6 ft. I.G.L.D.). The lake area off of Locust Point has been identified as an area of constant sand movement. The intake crib is a wooden cross shaped structure rising 3'-10" above the lake bottom with intake screens (ports) located in the ends of each of the four arms so that water enters the crib downward through the ports. At the design maximum flow of 42,000 gpm, the intake velocity has been calculated at 0.25 ft/sec (U.S. Nuclear Regulatory Commission, 1975). Table 1 shows calculated intake velocities for various pumping rates. At the 42,000 gpm design flow rate, the velocity through the eight-foot diameter conduit would be approximately 1.8 ft/sec. This design is similar to the one used at the Oregon, Ohio, and Port Clinton, Ohio, municipal water intakes. Figure 3 compares the similarities of these intakes.

Normal practice in intake design has been to locate intake cribs in 20 to 50 feet of water to avoid ice formation and the possibility of blockage from ice jams. Inlet ports should be located four to eight feet off the bottom to minimize the uptake of sand, silt, and other sediment. However, adherance to these practices has not always been possible in the Western Basin of Lake Erie because of its shallowness. This is the case with the design chosen for the Davis-Besse intake crib. The Davis-Besse intake crib is located in relatively shallow water, 11 feet below low water datum, and five feet below the lowest water level experienced at the site, 562.9 IGLD computed from the Toledo gauging station records corrected to the site. Therefore, the intake design must be such that the crib will not be exposed by low water and the intake ports have to be high enough off the bottom that sand and sediment are not drawn into the crib.

Locating the crib in deeper water was investigated but found not to be a viable alternative. Water depths of 20 feet are not reached in the vicinity of the site until approximately four to five miles from shore. The design finally chosen utilized a downward flow of water into the crib so that the intake ports could be located as far off the lake bottom as possible and still be under water during low lake level conditions.

During the design of the intake crib, consideration was given to using velocity caps to change the direction of the intake flow from vertical to horizontal. However, this did not turn out to be feasible, since under low lake level conditions the upper portion of the velocity caps would have been above water. Also, since the velocity caps would protrude above the top of the intake crib, they would be subjected to winter ice conditions. These ice conditions, floating ice, and wind blown ice masses, would most likely damage the velocity caps annually and in doing so could cause structural damage to the intake crib itself.

Intake Canal. The intake canal is an open channel with earthen embankments to convey water from the intake conduit (bringing water from the intake crib) to the intake structure located immediately east of Unit No. 1. The intake canal is approximately 2950 feet long including the forebay and is separated from the lake by a sand beach and beachfront dike constructed of large limestone rip-rap. The canal is approximately 40 to 45 feet wide at the bottom, with 3:1 side slopes and a water depth of 13 to 14 feet at normal lake levels except in the vicinity of the intake structure where it widens to form the forebay. At a flow rate of 42,000 gpm, the calculated velocity in the intake canal is approximately 0.11 ft/sec. The intake canal forebay is approximtely 800 feet long, 200 feet wide, at the bottom, with 3:1 side slopes and a water depth of 16 to 17 feet at normal lake levels.

Intake Structure. The intake structure is shown in Figure 4 and is located at the western end of the intake canal forebay. All of the water which is used by the unit is pumped via the pumps located in the intake structure. The following pumps are located in the intake structure.

Service Water Pumps - 2 operating, 1 standby
Cooling Tower Makeup Pump - 2 used as required
Dilution Pump - 1 used as required
Water Treatment Feedpumps - 1 operating, 1 standby
Screen Backwash Pumps - 2 used as required

These pumps are preceded by the trash racks and traveling screens. The trash racks are fixed screens, have four inch by twenty-six inch openings, and will be manually cleaned. The traveling screens have one-quarter inch square openings and will be automatically cleaned either on a pre-set time interval or differential pressure across the screens.

Water Use

The quantity of water used for cooling at the Davis-Besse Nuclear Power Station, Unit No. 1, has been minimized by using a closed condenser cooling water system and a natural draft cooling tower. The unit's water usage has further been reduced by recycling the heated discharge from the service water system and using it as makeup to the closed condenser cooling water system. This exceeds the requirement of 40 CFR 423.13, "Effluent limitation guidelines representing the degree of effluent reduction attainable by the application of the best available technology economically achievable" as well as 40 CFR 423.15, "New Source Performance Standards" which would permit the heated discharge from the service water system to be discharged, provided it meets chlorine limitations. The unit's water use scheme is shown in Figure 5. Table 2 shows the unit's maximum, minimum, and average water usage for each month at the intake crib.

Discharge System

All station effluents (except storm water drainage and certain building drains which go to the Toussaint River) are mixed in the collection box prior to discharge into Lake Erie. Most of this mixture is cooling tower blowdown water and its associated dilution water. The collection box has a small volume compared with the flow rates into it, and, therefore, the box merely serves to mix the various effluents. From the collection box, the station discharge flows through a six-foot diameter buried pipe to the slot-type jet discharge structure (4.5 feet wide x 1.5 feet high) 1200 feet offshore in Lake Erie (Figure 2). The elevation of the collection box provides the necessary head for discharge through the pipe to the lake under all predicted water level conditions. The slot-type discharge has an exit water velocity of about 6.5 ft/sec at the design maximum discharge flow of 20,000 gpm. The nominal calculated water velocity of 3.6 ft/sec, at the typical discharge rate of 11,000 gpm, promotes rapid entrainment and mixing with lake water. The lake bottom has been rip-rapped with rock for about 200 feet in front of the slot discharge to minimize scouring of the lake bottom and associated turbidity.

Chemical Discharge. All of the makeup water to the recirculating system (cooling tower) is partially neutralized with sulfuric acid, releasing carbon dioxide, and thereby reducing the amount of scale formed in the condenser. The only other chemical added to the circuits is elemental chlorine for defouling. The recirculating cooling water blowdown contains the major faction of all chemicals discharged to Lake Erie. Due to the evaporation of water in the cooling tower, the concentration of dissolved solids in the recirculating water is approximately double that in the lake. Because of the addition of sulfuric acid and the loss of carbon dioxide, the sulfate ratio is slightly higher and the carbonate ratio is slightly lower in discharge water while ratios for various other chemicals are the same as in lake water.

Thermal Discharge. The discharge of cooling tower blowdown from the station's submerged discharge structure generates a thermal plume in Lake Erie. The plume is calculated to have a maximum surface area of 0.7 acres (U.S. Atomic Energy Commission, 1973). The temperature difference between cooling tower blowdown water and ambient lake water ranges as high as 30°F. Lake water is used to dilute the blowdown so that the effluent to the lake never exceeds 20°F above ambient lake water temperature.

ANALYSIS OF FACTORS AFFECTING ENTRAINMENT AND IMPINGEMENT

A literature review of western Lake Erie hydrology and the biology and economic importance of fish species resident along the south shore of western Lake Erie was conducted in an attempt to determine the reasons for the incidence of entrainment and impingement of those fish species and size classes collected, and to determine the significance of these losses to man. Factors included in this analysis were: (1) swimming speeds, (2) fecundity, (3) economic and trophic importance, (4) hydrology, (5) habitat and habitat preference, and (6) rare and endangered species status. The following sections discuss these factors and relate them to the impingement/entrainment potential for important species. These findings are later related to the results of the monitoring program to place fish impingement and entrainment at the power station in perspective with fish population dynamics in the Western Basin of Lake Erie.

Swimming Speeds

Ichthyoplankton, consisting of fish eggs and larvae, is the portion of the fish population which is susceptible to entrainment at the power station. Being planktonic, fish in these life stages are incapable of sustained swimming and, therefore, have virtually zero swimming speeds. Until the post-larval stages, these individuals are largely passive floaters and their primary mobility is due to water currents.

Adult swimming speeds are generally related to body form (morphology) and length. Burst speeds of 10 body lengths (BL) per second and cruising speeds of 3 BL/sec are generally accepted for fish (Bainbridge, 1958; Blaxter, 1969). Cruising speeds can be sustained for up to several hours (Bainbridge, 1960). Fry and Hart (1948) observed that swimming ability decreases rapidly when the temperature is extremely low or high.

Much work has been done over the past 80 years on fish swimming speeds. Comparison between investigators is difficult, however, because the differences in apparatus and in definition of various swimming responses. Apparatus has varied from a rotating annular chamber to photography of a fishes progress against a measured background. Therefore, various types of swimming speeds were measured. Burst speed is a quick, unsustainable response of only a few seconds. It is usually utilized to escape danger. Cruising (sustained) speed is used more in migratory studies when speeds are maintained over a long period of time.

Regnard (1893) concluded that the maximum burst speed of fishes was 10 BL/sec. Bainbridge (1958), who later measured speed in relation to amplitude and size of tail beat arrived at the same conclusion. Blaxter (1969) concluded that the only fishes capable of burst speeds of 10 BL/sec were Salmonids (trout, lake whitefish, and cisco), Scombriods (pelagic fishes of tropical, sub-tropical, and temperate open oceans), and some freshwater and a few marine species. He further states that the cruising speed for most fishes is between 2 and 3 BL/sec.

Most of the work dealing with swimming speeds of fishes was performed with marine or western North American species. There are, however, some measurements of swimming speeds for fish species found in Lake Erie. Measurements for 19 of these species are given in Table 3.

Intake velocities were calculated at the intake crib for January to December 1978. Maximum, minimum, and mean velocities from each month are listed in Table 2. Under average conditions (3.3 cm/sec), fish greater than 1.1 cm in length, and under maximum velocity conditions (8.6 cm/sec), fish greater than 2.9 cm in length, should easily escape impingement. This assumption is based on a sustained swimming speed of 3 BL/sec. However, fish smaller than these size ranges are often planktonic and have not yet attained the capability of positive swimming.

Fecundity

Fecundity is the general term used to describe the number of eggs produced by fish (Lagler, et al., 1962). The number of eggs that are produced by an individual female varies according to a great many different factors including age, size, environmental conditions, and species. Some eggs are buoyant (pelagic) and have specific gravity about the same as fresh water, e.g., freshwater drum. Most stream and nearshore lake fish, on the contrary, have eggs that are heavier than fresh water, causing them to sink (demersal) and have an adhesive coating which keeps them from being swept away by currents.

The reproductive characteristics of 33 common Lake Erie species are listed in Table 4. This list was derived from a large number of sources; figuring most prominently were the following: Trautman (1957), Carlander (1953), and unpublished observations of fishery biologists with the Ohio Division of Wildlife and the U.S. Fish and Wildlife Service. The first column gives sexual maturity, listed either as age class, length, or weight at which maturity is normally reached. The second column is spawning temperature. The third and fourth columns are fecundity. Egg production is listed as eggs per female of a specific age, weight, or length. In some cases, more than one figure is given to indicate changes in reproductive capacity with age. Spawning season is column five. The season listed is for Lake Erie; however, if data were not available specifically for Lake Erie, data from a comparable latitude were used. This is also true for spawning temperature. Longevity is the final column in the reproductive portion of the table. Fish species are listed in phylogenic order, with scientific and common names in accord with those recommended by the American Fisheries Society in its Special Publication

No. 6, A List of Common and Scientific Names of Fishes From the United States and Canada, 1970. The information given under fecundity characteristics for each of the species has been obtained from one or more of the 50 numbered references (indicated in parenthesis following the data) which are listed in Table 5.

The reported fucundity of the most commonly entrained species ranged from a few thousand to nearly a million eggs per female. With the exception of yellow perch (44,000) and emerald shiners (500-1,500), all of the common species (gizzard shad, white bass, freshwater drum, and walleye) have a mean egg production between 300,000-600,000 per female. Therefore, because of similar fecundities, entrainment of a particular species appears to be related more to the number of gravid females in the area than to the relative egg production between species.

Economic and Trophic Importance

Commercial fishing has been an important industry for people living around western Lake Erie for over 100 years. Annual Lake Erie production (commercial catch) has varied between 15,000 to 35,000 tons (average 25,000 tons) which accounts for approximately 50 percent of the total annual production of the Great Lakes (Hartman, 1973). Presently yellow perch and white bass are the most important commercial species (Table 6). The walleye fishery, which has been closed to commercial fishermen in Ohio and Michigan for the past five years, has recovered significantly, but it will remain closed for commercial fishing at least through 1980.

Sport fishing in the Ohio waters of Lake Erie is a popular sport; nearly 300,000 Ohio licensed anglers fish in Lake Erie. In 1978, approximately 15.6 million fish (3,437 metric tons) were harvested by sportsmen in these waters (Table 6). Yellow perch, walleye, white bass, freshwater drum, and channel catfish, respectively, were the most common species taken. They accounted for over 97 percent of the total catch.

The economic and tropic importance of 15 of the most common species of fish found in western Lake Erie is given in Table 7. Figures through December 1978 indicate a commercial fish harvest of 9.3 million pounds which is 9 percent greater than the 8.5 million pounds landed in 1977 and 20 percent over the 7.8 million pounds harvested in 1976 (Ohio Division of Wildlife, 1979). The landed or dock value of the commercial harvest increased 8 percent in 1978 to nearly $2,600,000. A major portion of this increase was due to increased landings of white bass with an estimated dock value of $800,000. License and royalty fees paid by the commercial fisheries for the privilege to harvest fish from Ohio waters of Lake Erie were $73,600. Sport anglers on the Ohio waters of Lake Erie annually expend an estimated $60,000,000 in pursuit of their sport. In 1978, they caught nearly 15.6 million fish for an average cost of $3.85 per fish landed.

Hydrology

Circulation Patterns. Western Lake Erie is dominated by the large inflow of the Detroit River with mean flow of approximately 210,000 cfs. The midchannel flow of this river penetrates deep into the Western Basin, at times reaching the vicinity of Locust Point. The Maumee River, with an average flow of 4,700 cfs, is the second largest stream flowing into the lake and carries 37 percent of the sediment loading to the lake, but accounts for less than three percent of the total water drainage to Lake Erie. Maumee River water enters the lake through Maumee Bay where it divides into a northern flow along the Michigan shore and a southern eastern flow along the Ohio shore toward Locust Point. The Toussaint River, with an average flow of only 76 cfs, is a minor contributor to circulation patterns in the vicinity of Locust Point.

East of the dominating effect of the Detroit River, the prevailing southwest winds produce a clockwise surface flow around the Bass Islands to the northeast of Locust Point. However, this surface flow is often altered by changes in the direction, intensity and duration of the wind. Strong winds from any direction can drive the surface currents over most of the basin toward the windward shore (Herdendorf, 1975). Current maps of western Lake Erie in the vicinity of Locust Point for various wind conditions are presented in Figure 6. Bottom currents have essentially the same pattern as surface flow in that part of the basin influenced by the Detroit River. However, in other parts of the basin bottom currents are commonly the reverse of and compensate for strong, wind-driven, surface currents (Herdendorf, 1970).

Herdendorf and Braidech (1972) measured currents at 68 stations in the vicinity of Locust Point and the offshore reefs during a three-year study. The average recorded velocity for surface currents was 0.28 knots (0.48 ft/sec) and 0.15 knot (0.26 ft/sec) for bottom currents. These velocities are not capable of eroding bottom material, but are able to transport fine sand, silt, clay, and fish eggs or larvae once they have been placed in suspension. Velocities in excess of 0.5 knots (0.84 ft/sec) were recorded on the reefs but not in the nearshore zone of Locust Point. The mean intake velocity for the station is approximately half of the average bottom current velocity measured by Herdendorf and Braidech (1972).

Littoral Drift. Locust Point is at a position of diverging littoral (alongshore) drifts of sand which ordinarily would result in the beach being starved of sand because of movement east and west away from the headlands which form the point. However, the shore is apparently maintained at near equalibrium by replenishment from an extensive sand and gravel deposit which lies north of a narrow strip of compact glacio-lacustrine clay that fronts the point beyond the sandy nearshore zone. Transportation of this material from offshore to the beach can be accomplished by at least three forces: 1) currents induced by wind action or Detroit River flow, 2) wave action, and 3) ice shove. Most of the sand probably migrates shoreward by wave action and currents generated by northeast and northwest storms. Evidence for the shoreward movement of sand can be found in the position of bars before and after major storms. For example, fathometer profiles of the lake bottom at Locust Point before (13 June 1972) and after (28 June 1972) tropical storm Agnes revealed that two offshore bars migrated 20 to 25 feet shoreward as a result of wave attack from the northwest storm (Herdendorf and Hair, 1972).

Thermal Conditions. Water temperatures in western Lake Erie range from 32°F in the winter to about 75°F in late summer. The Western Basin frequently freezes from shore to shore in January and the ice cover breaks up in March and April. A shallow epilimnion develops early during the spring, but because the basin is so shallow, wind action causes efficient vertical mixing and by June the water becomes vertically isothermal. Diurnal microthermoclines are common in the summer, but prolonged periods of hot, calm weather can cause temporary thermal stratification, due to the heating of the surface water without the benefit of mixing. In 1953, such a situation resulted in severe oxygen depletion in the bottom water (Britt, 1955).

Water Quality. Nutrient overenrichment is the most significant water quality problem in western Lake Erie. Locust Point, being within the nearshore zone, is also characterized by low transparency, a high concentration of dissolved solids, and warmer water temperature when compared with offshore areas. The Ohio State University, Center for Lake Erie Area Research initiated water quality studies at Locust Point in July 1972. Over the past seven years most parameters have shown typical seasonal trends with only small variations from year to year. Trends for eight water quality parameters from July 1972 through November 1978 are shown on Figures 7, 8, and 9. Temperature and dissolved oxygen (DO) show normal seasonal trends for each year with only minor variations from one year to the next or over the entire period. DO appears to have undergone more depletion in 1976 and 1977 than in previous years or in 1978. Hydrogen-ion concentration (pH) and alkalinity remained fairly stable over the period. Transparency, turbidity, phosphorus, and conductivity have shown some radical variations which are probably due to storms and dredging activities that have disturbed the bottom sediments. Phosphorus levels were low in 1977 and 1978, compared to earlier years. In general however, no significant deviations from the normal quality of the water in this part of western Lake Erie have been observed during the past seven years.

Habitat Description and Preference

The Western Basin of Lake Erie has long been considered important in the reproduction of many fish species, due to its shallow nature and many reefs and shoals (Hartman, 1970). Trautman (1957) and Scott and Crossman (1973) provide life history information on Lake Erie fish species and indicate that many lake-dwelling populations are migratory, utilizing tributary waters, such as the lower Maumee River and Maumee Bay, as spawning and nursery areas. This attraction of spawners to tributary waters results in the concentration of spawning activity and consequently fish eggs and larvae in relatively small areas.

Tables 7 and 8 contain summaries of the habitat preferences of common fish species in Lake Erie. The habitat requirements of the 55 species listed on Table 8 were derived from Trautman (1957), Scott and Crossman (1973), and direct observations by the authors. The first two columns indicate the preferred habitat for spawning. For the purpose of this table, tributaries are defined as the portions of Lake Erie tributaries that are above the estuarine or "lake effected" lower reaches of these streams. Nearshore includes the shallows (less than ten meters) near the shore, offshore reefs and shoals, and estuarine lower courses of the tributaries. The remainder of the characteristics refer to the preferred habitats for mature individuals during non-spawning seasons. The demarcation of shallow and deep water has been taken at a depth of approximately ten meters. Water clarity refers to the amount of suspended particulate material (largely inorganic) in the water. Turbid water can roughly be defined as that having a Secchi disk transparency of less than one meter. Bottom types have been sub-divided primarily on the size of the sediment particles forming the bottom. Mud is defined as semi-fluid silt-and-clay-sized particles (less than 62 microns). Sand includes sand-and gravel-sized particles which include pebbles and cobbles (62 microns to 256 mm). Rocky bottoms include boulders (256 mm to 4096 mm) and larger slabs of exposed bedrock. Organic bottoms are generally fine-grained in nature but contain high percentages of partially decomposed plant and animal parts. Rooted aquatic plants (macrophytes) are categorized on density of growth rather than type. Table 8 contains a similar listing for both spawning and nursery habitat preferences.

Locust Point and Western Lake Erie. Locust Point is a gently curving headland on the south shore of western Lake Erie, approximately ten miles west of Port Clinton, Ohio (Figure 10). The Davis-Besse Nuclear Power Station is located on a 954-acre tract of land on this point. The terrain of the point is relatively flat and contains about 600 acres of marshland. The station has a 7500-foot frontage on Lake Erie along the point. The point has a relatively stable barrier beach which separates Navarre Marsh from the lake. The shore is not tending to straighten itself or advance over the wetland which is usual for barrier beaches with such a configuration. This may be in part due to the extensive rip-rap dike placed on the berm of the beach during the record-high water levels of 1972 and 1973. This dike has been of benefit to the wetlands by preventing lake encroachment in addition to serving its primary purpose of protection of the station site.

Hydrographic surveys show a very gentle slope of the lake bottom from the shore out for a distance of at least 4000 feet (Figure 10). Two sand bars typically lie in the nearshore zone, one at 120 feet offshore and the other at 280 feet from the beach. The deeper area between the beach and the first sand bar has a thin bottom layer of fluffy silt and shell fragments over the sand. The inshore slope of the first bar contains an abundant population of naiad clams. The sand bottom, generally medium- to fine-grained, extends to 800 feet offshore (5.0 feet water depth, IGLD, 1955). At this point the bottom deepens by 0.5 feet and is composed of hard, glaciolacustrine clay which forms a 500-700-foot wide strip around the point. Lakeward the bottom again becomes sandy and the sand increases in thickness in a lakeward direction. The lake reaches a depth of ten feet at a distance of 2200 feet offshore and 12 feet at 4000 feet offshore. The sand and gravel bottom, underlain by hard clay persists lakeward to the rocky reefs about three miles offshore (Figure 11).

The offshore reefs consist of bedrock and associated rock rubble and gravel. The topography of the reef tops ranges from rugged surfaces caused by bedrock pinnacles and large angular boulders, to smooth slabs of horizontally bedded rock. In places the exposed bedrock has the appearance of low stairs with steps dipping slightly to the east from the crest to the fringe of the submerged reef. All of the bedrock formations that form the reefs and shoals are carbonate rocks which contain abundant solution cavities, in many cases up to one or two cm in diameter. The bedrock itself is commonly masked by rubble composed of both autochthonous and glacial origin and ranging from small pebbles to boulders up to five feet in diameter. On the reefs, isolated patches of sand and gravel fill vertical joint cracks and small depressions in the bedrock; at the fringes of the reefs, sand and gravel beds, or glacial till lap over the rock. During quiet periods the rocks are often covered by a thin layer of fluff, organic-rich silt, which can be several millimeters thick (Herdendorf, 1970).

Lakeward of the reefs the depths increase rapidly to 24 feet. Here the bottom is composed of mud (semi-fluid silt and clay sized particles and less than ten percent sand (Figure 11).

The lack of permanent siltation on the bedrock and gravel reefs make them the only suitable sites for "clean water" benthic organisms such as certain mayflies, caddisflies, isopods, and amphipods. These organisms are important in the food web of many of the commercial and game fish species of western Lake Erie. The absence of these animals on or in the adjacent mud bottoms limits the feeding to the reefs and inshore areas.

The reefs project above the bottom and they are generally areas of higher energy due to the force of waves and currents. These factors allow simulation of the environment found in the riffles of streams. Several species of fish, particularly walleye and white bass, appear to have enjoyed success in Lake Erie because of the availability of this type of habitat.

Because of the lack of shelter in the nearshore zone of Locust Point, except the intake and discharge structures, the area does not appear to support a large resident fish population. Monthly fish collections in this area (gill net, shore seine, and trawl) show great variability in species composition and relative abundance which strongly suggest a transient fish population. Results from 15 years of sampling at Locust Point indicate that approximately 50 different species of fish have been captured (Table 9) but only ten species are of any real numerical or commercial significance. Alewife, carp, gizzard shad, white bass, emerald shiner, spottail shiner, yellow perch, channel catfish, freshwater drum and walleye constitute over 97 percent of the total number of fish that were captured in the area (Reutter and Herdendorf, 1976).

The general flat or gently sloping lake bottom in the nearshore zone (within one mile of the shore) of Locust Point is broken only by the intake and discharge structures and the clay fill along the route of the buried pipelines which will soon be unnoticeable due to the eroding effects of waves and ice. An ice barrier of rip-rap rock has been constructed on the lake side of the intake crib and a scour prevention apron of similar material has been placed on the bottom lakeward of the discharge nozzle. In 1976, ichthyoplankton sampling stations were established in the vicinity of the water intake/discharge structures as well as control stations at similar distances offshore in an attempt to determine if these structures were inducing higher than normal spawn rates for their position offshore. The populations at these structures were within the normal range observed at the control stations, indicating that the populations at the intake and discharge were not unusual for that position in the nearshore zone (Reutter and Herdendorf, 1976).

Intake Canal. In September 1974, the intake canal was poisoned to eliminate resident fish prior to the operation of the station. During periods of 1972 and 1973 the intake canal was open to Lake Erie and fish were free to enter the canal through an opening at the beachfront. In 1974 the canal was closed off at the beach and the only water communication with the lake was via the 3000-foot-long, buried, intake conduit. Immediately prior to the poisoning, 22 trawls yielded 411 fish of 18 species. Trawls taken in the canal in October 1974, one month after poisoning yield only one fish, an adult carp, indicating that the kill was essentially complete. The benthic population was also destroyed in the process (Reutter and Herdendorf, 1975). Later trawls, in 1975, yielded 420 individuals of 13 species indicating some fish were entering the crib and traveling via the pipeline to the intake canal. The most common species found in the canal were white crappie, bullheads, black crappie, carp, yellow perch, and sunfish.

Trawls in the intake canal were not continued after 1975. However, there is evidence that white crappie, goldfish, and other species have developed resident populations in the intake canal and these populations represent a sizeable percentage of the fish impinged on the traveling screens. The relative species composition of several of the species impinged at the station was markedly different than that observed in the open lake near the intake using gill nets, shore seines, and trawls. Goldfish was the most notable example as it was the most abundant species impinged yet, during 1978 it constituted only 0.07 percent of the open lake catch (Table 10).

The intake canal is constructed of earthen walls and has a mud bottom over hard clay. The step-sided walls of the canal preclude the development of extensive aquatic vegetation. The entire surface of the canal is unshaded. Velocities in the canal during 1978, are calculated to have had a maximum, minimum, and mean velocity of 0.16, 0.02, and 0.06 feet/sec, respectively.

Habitat Preference in Western Lake Erie. In conjunction with USEPA investigations of larval fish populations in western Lake Erie and the potential impact of power plants on these populations, the Center for Lake

Erie Area Research (Heniken, 1977) conducted surveys designed to quantify fish larvae densities throughout the Western Basin during the spring spawning seasons of 1975-1977. The following discussion of habitat preferences for the major species in the Western Basin is derived from the results of these surveys.

Gizzard shad concentrations in western Lake Erie appear to be centered mainly in Maumee and Sandusky Bays; concentrations of larvae exceed 1000/100m^3. These bays have the poorest water quality in the basin--Secchi disc readings seldom exceed 0.3 m and specific conductance is approximately twice that of the open lake. To a lesser extent, the Ohio shoreline, which is influenced by plumes of turbid water from the Maumee River, is also a spawning area. Gizzard shad generally appear to utilize turbid water areas for lake spawning and nursery grounds.

Within the Western Basin, white bass larvae are also found exclusively in the bay areas. However, because of the large numbers of larvae found in the tributary rivers, the primary spawning grounds may not be the bays. The larvae found in the bays may originate in the rivers and flow downstream to the bays with river currents. The bays however, do serve as important nursery grounds.

Freshwater drum is another species found almost exclusively in the highly turbid areas. Drum eggs and pro-larvae contain a large oil globule which causes them to float near the surface. Eggs are often seen and collected on the surface. This characteristic permits them to survive in areas where oxygen tensions are low in the bottom water and also places the drum larvae in the surface waters where plankton is concentrated. The increase in drum populations in Lake Erie may be in part due to this characteristic.

Yellow perch larvae are found mostly in the nearshore areas and appear to be concentrated near the bottom. The tendency for perch to be near the bottom may be a reaction to light levels because in the more turbid areas of the lake stratification was not as obvious. Perch prefer to spawn in sandy areas with vegetation (Scott and Crossman, 1973). The inshore areas where the larvae were found are sandy to gravelly with Cladophora being the main vegetation.

Walleye larvae were not collected in large enough numbers in the lake to characterize their spawning areas; however, the walleye larvae were found in areas similarly to those preferred by the yellow perch. Walleye larvae were found inshore in sandy to rocky substrates. The presence of larvae inshore between Locust and Catawba Points could be a result of the southerly flow of the Detroit River across the reefs depositing larvae in this area (Figure 6). The fact that a large number of larvae were found on Niagara Reef (68/100 m^3) indicates that the reefs are probably being utilized for spawning.

Emerald shiner larvae were found in highest numbers in the least-turbid and open water portions of the basin, especially in the deeper water adjacent to rocky reefs. Larvae were generally captured in the larger size ranges (late post-larvae to juvenile stages). These larvae either do not sense the collection net or are unable to avoid the net. If the latter situation is the case, then emerald shiner larvae are probably incapable of moving off the reefs under their own locomotion, but are swept off the reef by the same strong currents which are responsible for sweeping the reefs clean of sediments (Herdendorf, 1970). The other alternative situation is that this species does spawn in deeper waters.

Neither spottail shiners nor carp larvae were ever collected in large numbers. Both species appeared centered in the Bass and Kelleys Islands areas. These species apparently favor the rocky areas around the islands. At times, Cladophora was scraped loose during bottom tows over the reefs and carp eggs were often found in this green, filamentous algae.

Rainbow smelt favor gravelly areas for spawning (Scott and Crossman, 1973). Distribution patterns for larvae in the Western Basin indicate that spawning probably takes place on the clean gravel bottoms in Canadian waters and that the larvae are carried southward by Detroit River flow. Smelt larvae are seldom collected nearshore or in bays where turbidity is high.

Rare and Endangered Species

No fish species listed as endangered on the "Federal Register of Endangered Species" were collected during this study. The Ohio Division of Wildlife issued, effective 1 May 1976, a revised list of 40 endangered fish species in Ohio. These species are listed in "Endangered Wild Animals in Ohio, " publication 316(R576) of the ODW. Of the 40 species listed, non were taken in impingement samples at the Davis-Besse Nuclear Power Station. However, it should be noted that the silver chub (Hybopsis storeriana) and the Great Lakes muskellunge (Esox m. masquinongy) have been collected in gill nets set in the vicinity of the plant intake and discharge during the preoperational monitoring program.

No endangered species were taken in the entrainment samples. Herdendorf and Cooper (1975) reported mooneye larvae in samples collected in May 1975 on a submerged sand bar at the entrance to Maumee Bay. No other endangered species have been reported from ichthyoplankton studies of western Lake Erie within the past three years.

METHODS

Impingement

For the purpose of this 316(b) demonstration, impingement at the Davis-Besse Nuclear Power Station will be estimated from samples collected between 1 January and 31 December 1978. During the above mentioned 12-month interval the traveling screens at the Davis-Besse Nuclear Power Station were operated 221 times. The date, time, and duration of each screen operation were recorded and keypunched, even when the impinged fish were not collected (Table 11). Collections of impinged fish were made by Toledo Edison personnel during 144 of the 221 screen operations by placing a screen having the same mesh size as the traveling screens (¼-inch bar mesh) in the sluiceway through which the backwashed material passed. Fish collected in this manner were placed in plastic bags, labeled with the date and time of screen operation, and frozen. The samples were picked up by personnel of The Ohio State University's Center for Lake Erie Area Research (CLEAR) weekly and carried to the laboratory where all specimens were identified (Trautman, 1957) and enumerated. The total number and the total weight of each species impinged was recorded. All specimens, or a representative number thereof, were also weighed and measured individually. The representative number sellected was 50 individuals as this would assure an estimated standard deviation of the length and weight to within 20 percent of the true standard deviations (Feder et al., 1976). Further accuracy in the estimation of mean weights was deemed unnecessary as the total number of each species impinged had been determined by actual counts. Greater accuracy in the estimation of mean weight is sometimes warranted if the total weight of an impinged species is to be divided by the mean weight per fish to estimate the number of fish in the sample. All of the above mentioned data were keypunched and stored on magnetic tape at The Ohio State University for use with the Statistical Analysis System: SAS (Barr et al., 1976) on an AMDAHL 470 computer.

Since the time and duration of every screen operation was known, it was possible to determine the number of hours represented by each collection, e.g. if the screen had been in operation at noon on 20 January, the collection made at noon on 22 January would represent all the fish which had been impinged during the 48 hours between the two screen operations. From this, a concentration, fish impinged/hour, was developed. The average of these concentrations was used to estimate impingement during hours when screen-washed fish were not collected.

Entrainment

For the purpose of this 316(b) demonstration at the Davis-Besse Nuclear Power Station, entrainment was monitored during the period of larvae occurrence in Lake Erie during 1978.

Fish egg and larvae (ichthyoplankton) entrainment at the Davis-Besse Nuclear Power Station was computed by multiplying the ichthyoplankton concentration observed at the intake by the intake volume. This method assumes that all ichthyoplankters observed at the intake are entrained.

Ichthyoplankton densities were determined at approximately 10-day intervals from four 3-minute, oblique (bottom to surface) tows at 3-4 knots made at night on each date (Table 12) with a 0.75-meter diameter heavy-duty oceanographic plankton net (No. 00, 0.75 mm mesh) equipped with a calibrated General Oceanics flowmeter. 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 populations of species which may cling to the bottom during daylight. Samples were preserved in five percent formalin and returned to the laboratory for sorting and analysis. All specimens were classified as to larval stage, identified, and enumerated using the works of Fish (1932), Norden (1961a and b), and 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, walleye were not found on 30 April or on 7 June or later (Table 12). They were present in samples from 11 May and 21 May. Therefore, the period of occurrence was estimated to have been from 6 May (the midpoint between 30 April and 11 May) to 30 May (the midpoint between 21 May and 7 June) (Table 13). The mean density of walleye during this period was estimated to have been 41.6/100 m^3, computed from the concentration of 79.2/100 m^3 observed on 11 May and the concentration of 4.0/100 m^3 observed on 21 May. It was this concentration, 41.6/100 m^3, which was multiplied by the volume of water drawn through the plant from 6 May to 30 May.

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.

IMPINGEMENT

Results

A total of 6,607 fish representing 20 species was impinged on the traveling screens at the Davis-Besse Nuclear Power Station from 1 January through 31 December 1978 (Table 14). No species designated as rare or endangered on the federal or state lists were observed in impingement samples. Goldfish was the dominant species impinged representing 49.9 percent of the total. Only 6 other species represented more than 1 percent of the total: yellow perch, 23.9 percent; emerald shiner, 15.0 percent; gizzard shad, 5.9 percent; black crappie, 1.2 percent; freshwater drum, 1.2 percent; and rainbow smelt, 1.0 percent. No smallmouth bass, walleye, or white bass were impinged.

Impingement was also computed on a monthly basis (Table 15). Most of the impingement occurred during April (43.5 percent) and December (35.3 percent). Of the 2,875 fish estimated to have been impinged during April, 834 (29.0 percent) were emerald shiners, 799 (27.8 percent) were goldfish, and 1,098 (38.2 percent) were yellow perch. Of the 2,330 fish estimated to have been impinged during December, 1,870 (80.3 percent) were goldfish and 360 (15.5 percent) were gizzard shad.

Although the station did not reach 75 percent of its capacity for power production until December 1977, and although it is not discussed within this report, it should be noted the impingement monitoring started at the Davis-Besse Nuclear Power Station on 17 August 1977. Based on the results of 45 collections, Reutter (1978a) estimated that impingement from 17 August to 31 December 1977 was 1,936 fish of 15 species.

Discussion

With the exception of the blackside darter and the bluntnose minnow, all species impinged at the Davis-Besse Nuclear Power Station have been captured within the past ten years at Locust Point (See Table 9). However, both the blackside darter and bluntnose minnow have been reported from the island area of Lake Erie and most of the tributaries, including the Toussaint River and Turtle Creek near Locust Point (Trautman, 1957).

With the exception of goldfish and black and white crappies the impinged fish occurred in relative numbers which were not unusual for populations in Lake Erie at Locust Point. These three species occurred in relative proportions well above that of the open lake. This indicates probable use of the intake canal as a permanent residence for these species. Furthermore, due to the small sizes of these fish (they were young-of-the-year) and results from previous trawling efforts (Reutter and Herdendorf, 1975), it appears that these species are also spawning within the intake canal and, consequently, these losses should not be considered as a negative impact on the lake populations of these species.

Impingement losses at the Davis-Besse Nuclear Power Station during 1978 were extremely low when compared to other power plants (Reutter et al., 1978). Tables 6, 16, and 17 present sport and commercial fish landings from the Ohio waters of Lake Erie and commercial landings from all of Lake Erie. Although the fish impinged at Davis-Besse were primarily young-of-the-year (mean length, 74 mm) and, consequently, much more abundant than the adults taken by commercial and sport fishermen, the total number impinged (including gizzard shad which are not taken by sport fishermen) was only 0.04 percent of the number harvested by Ohio sport fishermen. This figure becomes even less significant when one realizes that the Ohio sport catch was only 83.4 percent of the Ohio 1978 commercial catch and only 15.9 percent of the 1978 commercial catch from all of Lake Erie.

The above comparisons make it obvious that impingement losses at the Davis-Besse Nuclear Power Station have an insignificant effect on Lake Erie fish stocks. Furthermore, it should be noted that although by number impingement losses were 0.04 percent of the Ohio sport fishing harvest, by weight impingement was less than 0.001 percent of the Ohio sport harvest. Furthermore, based on the estimates of Patterson (1976) (See Page 23) the impingement of 1,582 young-of-the-year yellow perch, a species which is very important to sport and commercial fishermen, will result in the loss of only 28-75 adults which is from 0.0002 to 0.0007 percent of the number captured by Ohio sport fishermen in 1978.

ENTRAINMENT

Results

Ichthyoplankton densities observed at the intake during 1978 indicated that ichthyoplankters were entrained at the Davis-Besse Nuclear Power Station from 6 May to 17 August (Table 13). May 6 was selected as the first day since it is midway between 30 April (the first sampling date and a date when no larvae were collected) and 11 May (the first collection date on which larvae were observed within the samples). August 17 was selected as the last day because larvae were present in night samples on 11 August (Table 12) but were absent from day samples on 23 August and later (Reutter, 1979).

The mean larvae density from all night samples at Station 8 (47.5/100 m^3) was 49 percent greater than the mean density observed by Reutter (1979) from all day samples collected at the intake (31.9/100 m^3). Gizzard shad constituted 69 percent of the night ichthyoplankton population followed by walleye at 22 percent and emerald shiners at 5 percent (Table 12).

Based on the above results, it is estimated that 6,311,371 larvae and 44,278 eggs were entrained at the Davis-Besse Nuclear Power Station during 1978 (Table 13). Of this total, gizzard shad constituted 76 percent, walleye 15 percent, and emerald shiners 5 percent. No species listed as rare or endangered on the federal or state lists were observed during this study. A further breakdown of entrainment results is contained in Appendix A.

Discussion

Ichthyoplankton entrainment at the Davis-Besse Nuclear Power Station during 1978 was typical for an intake on the south shore of the Western Basin of Lake Erie--it was strongly dominated by gizzard shad. Gizzard shad populations are on the increase and, consequently, it would not be surprising if they represented even a greater portion of the entrainment next year. Walleye is another species which is increasing greatly in the Western Basin. This species constituted 0.02 percent of the 1976 population, 11 percent of the 1977 population and, now, 22 percent in 1978 (Reutter and Herdendorf, 1977; Reutter, 1978b). The brood stock of walleye in the Western Basin is still increasing so ichthyoplankton densities next year may be even greater. Perch entrainment was very low in 1978 as would be expected since this population is currently declining (Ohio Division of Wildlife, 1979).

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 estimated 4,796,964 entrained larvae could have been produced by 16 females; based on an average of 331,000 eggs/female walleye (Hartley and Herdendorf, 1977), the 916,738 entrained larvae could have been produced by three females; and based on 44,000 eggs/female yellow perch (Hartley and Herdendorf, 1977) the 35,259 entrained larvae could have been produced by one female. 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 eggs 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 1,600 gizzard shad, 300 walleyes, and 100 perch. These values are less than 0.1 percent of the number of perch and walleye captured by Ohio sport fishermen in 1978 (Ohio Division of Wildlife, 1979). Furthermore, if one looks at the worst case, the value for the upper 95 percent confidence limit and assumes 99 percent mortality from eggs to larvae, the losses of perch and walleye larvae are still represented the spawn of less than 0.25 percent of the number harvested by Ohio sport fishermen.

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 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 young-of-the-year = 4 to 17 percent;
young-of-the-year 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 916,738 entrained walleye larvae could have produced 917 to 9,167 age class III adults and the 35,259 entrained yellow perch larvae could have produced 35 to 353 age class III adults. It should be noted, that this projected loss of age class III walleyes was between 0.055 and 0.55 percent of the Ohio sport harvest in 1978 and, therefore, insignificant by comparison.

The authors feel the above impact assessments should be viewed with caution 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. Furthermore, the success of the hatch is dependent upon the size of the brood stock and weather conditions during spawning and incubation. However, in the case of Davis-Besse, the off-shore intake where larvae densities are lower and the low volume intake (1978 mean = 21,389 gpm) due to the cooling tower and closed cooling system necessitate a very low-level impact on Western Basin fish populations. This will be true no matter how large or small ichthyoplankton populations become.

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T A B L E S

TABLE 1

CALCULATED INTAKE CRIB VELOCITIES FOR UNIT 1

FOR VARIOUS PUMPING RATES

Pumping Rate		Intake Velocity (ft/sec)
(gpm)	(mgd)	
0	0	0.00
5,000	7.2	0.03
10,000	14.4	0.06
15,000	21.6	0.09
20,000	28.8	0.12
25,000	36.0	0.15
30,000	43.2	0.18
35,000	50.4	0.21
40,000	57.6	0.24
45,000	64.8	0.27
50,000	72.0	0.30
55,000	79.2	0.33
60,000	86.4	0.36
65,000	93.6	0.39
70,000	100.8	0.42
75,000	108.0	0.45
80,000	115.2	0.48
85,000	122.4	0.51
90,000	129.6	0.54
95,000	136.8	0.57
100,000	144.0	0.60

TABLE 2

MONTHLY PUMPING RATES AND
CALCULATED VELOCITIES AT THE DAVIS-BESSE
NUCLEAR POWER STATION WATER INTAKE CRIB
FOR 1978

Month	Maximum		Minimum		Mean		Total
	Pumping Rate (mgd)	Velocity (ft/sec)	Pumping Rate (mgd)	Velocity (ft/sec)	Pumping Rate (mgd)	Velocity (ft/sec)	Millions of gallons
January	34.6	0.14	23.4	0.10	29.6	0.12	918.8
February	40.0	0.17	21.5	0.09	32.0	0.13	895.4
March	52.4	0.22	22.1	0.09	34.2	0.14	1059.9
April	56.2	0.23	23.0	0.10	38.1	0.16	1142.7
May	44.3	0.18	21.5	0.09	25.4	0.11	785.9
June	23.0	0.10	14.7	0.06	21.3	0.09	639.6
July	43.2	0.18	21.5	0.09	33.4	0.14	1035.7
August	53.8	0.22	10.4	0.05	38.9	0.16	1205.0
September	107.5	0.45	49.8	0.21	73.5	0.31	2203.5
October	64.6	0.27	36.1	0.15	55.6	0.23	1724.8
November	69.3	0.29	41.7	0.17	55.3	0.23	1657.5
December	83.5	0.35	25.7	0.11	43.3	0.18	1341.6
Annual	107.5	0.45	10.4	0.05	40.0	0.17	13268.8

TABLE 3

SWIMMING SPEEDS OF FISH FOUND IN LAKE ERIE

SPECIES	SIZE (cm)	SWIMMING SPEED: Sustained Speed cm/sec	SWIMMING SPEED: Sustained Speed BL/sec	SWIMMING SPEED: Burst Speed cm/sec	SWIMMING SPEED: Burst Speed BL/sec	DATA SOURCE
Alewife	7.1	18.6	2.6	-	-	Kothas (1970)
Alewife	7.9	56.1	7.1	-	-	Kothas (1970)
Alewife	-	-	-	-	13.8	Bell (1973)
Bluegill	3.5	15.7	4.0	-	-	King (1969)
Bluegill	4.5	14.3	3.2	-	-	King (1969)
Carp	-	-	-	-	12.6	Bainbridge (1958)
Carp	-	-	-	36.6	-	Kreitmann (1933)
Channel catfish	-	-	-	-	4.2	Hocutt (1973)
Channel catfish	3.0	27.5	9.2	-	-	King (1969)
Channel catfish	10.0	38.3	3.8	-	-	King (1969)
Coho salmon	fry	30.0	-	-	-	Brett et. al. (1958)
Coho salmon	36.0	216.0	6.0	-	-	Weaver (1963)
Coho salmon	61.0	549.0	9.0	-	-	Weaver (1963)
Goldfish	-	-	6.4	-	-	Fry and Hart (1948)
Goldfish	21.3	-	-	200	9.4	Bainbridge (1958)
Goldfish	-	-	-	-	10.0	Blaxter and Dickson (1959)
Lamprey	-	-	-	189.0	-	Sakowicz and Zarnecki (1954)
Largemouth bass	-	-	-	-	8.1	Hocutt (1973)
Largemouth bass	27.0	65	2.4	-	-	Morgan and Moore (1972)
Northern pike	-	-	-	42.7	-	Sakowicz and Zarnecki (1954)
Northern pike	-	-	-	-	10.0	Gray (1953)
Quillback	2.4	21.7	9.0	-	-	King (1969)
Pumpkinseed	7.5	17.0	2.3	-	-	King (1969)

TABLE 3 CON'T.

SWIMMING SPEEDS OF FISH FOUND IN LAKE ERIE

SPECIES	SIZE (cm)	SWIMMING SPEED Sustained Speed cm/sec	SWIMMING SPEED Sustained Speed BL/sec	Burst Speed cm/sec	Burst Speed BL/sec	DATA SOURCE
Smallmouth bass	fry	-	6.8	-	-	Larimore and Duever (1968)
Spotfin shiner	-	-	-	-	8.6	Hocutt (1973)
Spottail shiner	5.4	10.7	2.0	-	-	Schuler (1968)
Sucker	-	-	-	-	9.8	Wales (1950)
Walleye	1.5	4.7	3.1	-	-	Houde (1969)
White crappie	6.0	11.7	2.0	-	-	King (1969)
White crappie	8.1	21.7	2.7	-	-	King (1969)
White sucker	-	-	-	-	8.0	Bell (1973)
Yellow perch	1.3	4.2	3.2	-	-	Houde (1969)

TABLE 4

REPRODUCTIVE AND HABITAT CHARACTERISTICS OF COMMON LAKE ERIE FISH

TAXON	REPRODUCTIVE CHARACTERISTICS						HABITAT CHARACTERISTICS (42,45)												
			Fecundity				Spawning Location		Water Depth		Water Clarity		Bottom Type				Rooted Aquatic Plants		
Family and Species	Maturity Age Class	Spawning Temperature (°C)	Female Age or Size	Egg Production/Female	Spawning Season	Longevity Years	Tributaries	Nearshore	Shallow	Deep	Clear	Turbid	Mud	Sand	Rocky	Organic	Absent	Moderate	Abundan[t]
ACIPENSERIDAE																			
Acipenser fulvescens Lake sturgeon	XX(38)	12–19°C(22)	13,608–17,690g 48,535–52,617g	181,720–188,800(50) 652,904–682,640(50)	May–June(45)	80+(38)	X		X		X			X	X		X		
CLUPEIDAE																			
Alosa pseudoharengus Alewife	M–II F–III(26)	22°C(13)	178 mm	10,000–12,000(26)	June–July(45)	9+(26)	X	X	X	X	X		X	X	X	X			
Dorosoma cepedianum Gizzard shad	II(24)	19.5°C(6)	282–297 mm 434–452 mm	23,405–96,560(24) 267,216–350,288(24)	June–July(6)	9+(24)	X	X	X	X	X	X	X	X	X	X			
SALMONIDAE																			
Coregonous artedii Cisco	II–III(24)	1.1–5.0°C(16)	II III	16,000–42,500 (24) 14,000–38,600(24)	Nov.–Dec.(16)	13(24)		X	X	X	X		X		X		X		
Salvelinus namayoush Lake trout	XIII–XVII(24)			6,000 (24)	Sept.–Nov.(19)	41(24)		X	X	X	X		X		X		X		
OSMERIDAE																			
Osmerus mordax Rainbow smelt	II–III(24)	10°C(13)	241 mm 185–195 mm	57,910 (33) 25,102 (30)	May (13)	6(24)	X	X		X	X		X		X		X		
ESOCIDAE																			
Esox lucius Northern pike	M–II–III F–II(12)	8°C(1)	431–480 mm 597 mm	22,000 (49) 48,950 (31)	Feb.–March(45)	24(24)	X	X	X	X	X			X	X	X			X
Esox musquinongy Muskellunge	M–III F–III–IV(24)	4.5–10°C(45)	900–1170 mm	22,092–164,112 (25)	April(45)	30(24)	X	X	X	X	X		X			X			X
CYPRINIDAE																			
Carassius auratus Goldfish	100–185 mm(32)			1400(28)		4(24)	X	X	X		X	X	X	X	X	X			X
Cyprinus carpio Carp	M–II–IV F–III–V(5)	25.2°C(40)	1225–1905g	72,000–347,000(44)	April June(24)	16(24)	X	X	X		X	X	X	X	X	X		X	
Notemigonus crysoleucas Golden shiner	I–II(8)	16–27°C(8) 23°C(47)			May–August(14)	8(15)	X		X		X			X		X			X
Notropis atherinoides Emerald shiner	M–II–III F–III–IV(48)		III–IV(48)	500–1,500(est.)	June–August(24)	5(48)		X	X		X		X	X	X	X	X		
Notropis hudsonius Spottail shiner	59–84 mm(48)	20°C(13)	87–127 mm	1769–4380(48)	June (13)	5(48)		X	X	X	X			X	X				
Notropis spilopterus Spotfin shiner	I–II(43)		61–82 mm	316–1,155(43)	June–late August (43)	5(43)	X		X			X	X					X	
Pimephales promelas Fathead minnow	<I(10)	15.6°C(10)		800,1,000(10)	May–August(10)	1(10)	X		X			X	X				X	X	
Pimephales notatus Bluntnose minnow	<I(10)	>21°C(10)		200–500 (10)	April–Sept.(10)	3(10)	X		X		X	X	X	X	X	X			
CATOSTOMIDAE																			
Carpiodes cyprinus Quillback	1800–2700g(42)			4,000–15,000(45)	April–May(45)	3(24)	X	X	X	X	X			X	X				
Catostomus commersoni White sucker	M–III–VII(17) F–III–IX	10°C(47)	406–510 mm	56,000–139,000(49)	March–April(24)	12(24)	X		X	X	X	X	X	X	X	X	X	X	

TABLE 4 (Con't.)

REPRODUCTIVE AND HABITAT CHARACTERISTICS OF COMMON LAKE ERIE FISH

TAXON	REPRODUCTIVE CHARACTERISTICS						HABITAT CHARACTERISTICS (42,45)												
			Fecundity				Spawning Location		Water Depth		Water Clarity		Bottom Type				Rooted Aquatic Plants		
Family and Species	Maturity Age Class	Spawning Temperature(°C)	Female Age or Size	Egg Production/Female	Spawning Season	Longevity Years	Tributaries	Nearshore	Shallow	Deep	Clear	Turbid	Mud	Sand	Rocky	Organic	Absent	Moderate	Abundant
ICTALURIDAE																			
Ictalurus melas Black bullhead	III(3)	15.6–23.9°C(45)	183–224 mm	168–6,820(11)	May–June(45)	9(35)	X	X	X			X	X					X	
Ictalurus natalis Yellow bullhead	II–III(42)	15.6–23.9°C(45)	170–680g	1,652–6,660(46)	May–June(45)	5(41)	X	X	X		X			X	X	X			X
Ictalurus nebulosus Brown bullhead	F–III(42)	15.6–23.9°C(45)	203–330 mm	2,400–13,800(18,34,49)	May–June(45)	6(37)	X	X		X	X			X	X	X		X	
Ictalurus punctatus Channel catfish	IV–VI(29)	27°C(47)	406–508 mm	4,200–106,000(34)	April–August(45)	8(36)	X		X	X	X			X	X		X		
PERCICHTHYIDAE																			
Morone chrysops White bass	III(36)	19°C(47)		242,000–933,000(42)	April–May(45)	7(36)	X		X		X			X	X				
CENTRARCHIDAE																			
Lepomis gibbosus Pumpkinseed	II(23)	18–21°C(8)	61–92 mm	600–2,923(46)	April–May(45)	8–10(42)		X	X		X			X		X			X
Lepomis macrochirus Bluegill	II–III(32)	19–27°C(8)		2,360–47,400(8)	May–August(4)	8–10(42)		X	X		X			X	X	X		X	
Pomoxis annularis White crappie	II–III(21)	18°C(47)		5,000–30,000(45)	May–June(45)	8(21)		X	X		X	X	X	X	X	X		X	
Pomoxis nigromaculatus Black crappie	II–III(27)	14–18°C(2)		11,000–188,000(8)	March–May(2)	8–10(42)		X	X		X			X		X			X
Micropterus dolomieui Smallmouth bass	III–VI(32)	13–18°C(8)		2,000–10,000(2)	May–July(42)	15(42)		X	X		X				X			X	
Micropterus salmoides Largemouth bass	II(4)	18–22°C(4)		2,000–25,000(10)	May–July(4)	15(42)	X	X	X		X			X	X	X			X
PERCIDAE																			
Perca flavescens Yellow perch	M–II F–III(48)	16°C(40)	246 mm	44,000(48)	Mid–April–May(45)	8(48)		X	X	X	X			X		X			X
Stizostedion canadense Sauger	M–23.7mm F–26.2mm(9)	8.2°C(45)	305–311 mm	43,000–48,500(9)	April–May(45)	10(9)	X	X	X			X	X				X	X	
Stizostedion v. vitreum Walleye	M–II–III F–III–V(48)	4.5–11.1°C(45)		48,000–614,000(48)	March–May(45)	13(39)	X	X	X		X			X	X		X		
SCIAENIDAE																			
Aplodinotus grunniens Freshwater drum	M–III–VII F–V–VI(7)	21.0°C(47)		100,000–500,000(45)	Spring(45)	9(7)		X	X	X	X				X				

Data Source: Hartley and Herdendorf (1977)

TABLE 5

FISH FECUNDITY AND HABITAT LITERATURE

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TABLE 6

ESTIMATED 1978 SPORT AND COMMERCIAL FISH HARVEST FROM THE OHIO WATERS OF LAKE ERIE[a]

SPECIES	SPORT HARVEST		COMMERCIAL HARVEST		TOTAL HARVEST	
	No. of Individuals	Weight (Kilograms)	No. of Individuals	Weight (Kilograms)	No. of Individuals	Weight (Kilograms)
Yellow Perch	11,483,000	1,116,386	9,178,000[b]	890,294	20,661,000	2,006,680
Walleye	1,652,000	1,515,906	0[f]	0	1,652,000	1,515,906
White Bass	1,533,000	334,825	3,380,000[b]	736,842	4,913,000	1,071,667
Freshwater Drum	668,000	363,200	981,000[b]	533,904	1,649,000	897,104
Channel Catfish	218,000	86,033	235,000[b]	92,843	453,000	178,876
Smallmouth Bass	32,000	20,203	0[f]	0	32,000	20,203
Others	c	c	—	1,867,983[d]	—	1,867,983[e]
TOTAL	15,586,000[e]	3,436,553[e]	—	4,121,866	—	7,648,419

[a] Ohio Division of Wildlife (1979).
[b] Estimated based on mean weight of sport fish.
[c] Data not available.
[d] Thirty-eight percent carp.
[e] Excludes weight of "Others" caught by sport fishermen.
[f] Closed to commercial fishing.

TABLE 7

ECONOMIC AND TROPHIC IMPORTANCE OF COMMON FISH IN WESTERN LAKE ERIE

Fish	Spawning Habitat	Spawning Time	Adult Feeding Niche	Importance to Man
Walleye *Stizostedion vitreum* (Mitchill)	rocky shoals in lakes and rivers	Spring (6-11°C) pre-spawn migration 1.1°C	fish predator	perhaps the most important commercial and sport fish in Lake Erie.
White bass *Morone chrysops* (Rafinesque)	rocky shoals in lakes and rivers	Spring (12-20°C)	fish predator	important commercial and sport fish
Yellow perch *Perca flavescens* (Mitchill)	weedy shallows or sand and gravel	Spring (8-13°C)	fish and bottom	important commercial fish and a food fish for Walleye
Freshwater drum *Aplodinotus grunniens* Rafinesque	over mud or sand bottom in shallow water	Summer (20+)	bottom and some fish	commercial fish and a food fish for Walleye
Carp *Cyprinus carpio* Linnaeus	weedy or grassy shallows	Spring (17-26°C)	benthic omnivore	environmentally a destructive pest species but also a commercial fish
Goldfish *Carassius auratus* (Linnaeus)	warm, weedy shallows	Late Spring	benthic omnivore	little to no value
Channel catfish *Ictalurus punctatus* (Rafinesque)	in dark nests in holes, log jams in shallow area of turbid waters	Summer (24-30°C)	bottom	commercial fish
White sucker *Catostomus commersoni* (Lacepede)	quiet, gravel shallows of lakes and rivers	Spring (10°C)	benthic omnivore	minor commercial; fish when abundant a major food item for predatory fish
Quillback *Carpiodes cyprinus* (Lesueur)	shallow quiet, mud or sand areas of lakes and rivers	Late Spring	benthic omnivore	of little value either directly to man or in the food chain to important species

TABLE 7 --continued

ECONOMIC AND TROPHIC IMPORTANCE OF COMMON FISH IN WESTERN LAKE ERIE

Fish	Spawning Habitat	Spawning Time	Adult Feeding Niche	Importance to Man
Gizzard shad *Dorosoma cepedianum* (Lesueur)	probably over sand or gravel bottom	Late spring to summer	phytoplankton feeders	Small gizzard shad are an important forage fish for game and commercial species.
Alewife *Alosa pseudoharengus* (Wilson)	shallow beaches, ponds and quiet rivers	Spring	zooplankton feeders	Generally considered a nuisance due to annual die-offs but can be an important forage fish for game and commercial species.
Northern pike *Esox lucius* Linnaeus	in weedy flood plains of rivers and in marshes and weedy bays	Early Spring	fish predator	important but rare commercial and sport fish
Emerald shiner *Notropis atherinoides* Rafinesque	midwater	Late spring to summer	plankton	major food item for several sport fish; used as bait minnow by man
Spottail shiner *Notropis hudsonius* (Clinton)	over sandy shoals	Spring and early summer	omnivore	an important forage fish; used as bait minnow by man
Logperch *Percina caprodes* (Rafinesque)	sandy inshore shallows	Late spring	benthic carnivore	unknown importance as forage fish for game and commercial species

Data Source: Fraleigh, et al. (1975); Scott and Crossman (1973).

TABLE 8

SPAWNING AND NURSERY HABITAT PREFERENCE OF COMMON LAKE ERIE FISH SPECIES

Common and Scientific Name	SPAWNING AREAS - HABITAT TYPE: Tributary	Shallow protected Sand or Mud Bottom: Vegetation	Shallow protected Sand or Mud Bottom: Without Vegetation	Shallow exposed: Sand or Gravel Bottom	Shallow exposed: Rock or Rubble Bottom	Gravel or Rubble with Current	Mid-Water	NURSERY AREAS - HABITAT TYPE: Tributary	Shallow protected Sand or mud bottom: Vegetation	Shallow protected Sand or mud bottom: Without Vegetation	Shallow exposed: Sand or Gravel Bottom	Shallow exposed: Rock or Rubble Bottom	Medium Depth Mud Bottom	Gravel or Rubble with Current	Mid-Water	Deep: Mud Bottom	Deep: Sand or Gravel Bottom
Silver lamprey (Ichthyomyzon unicuspis)	X							X									
Sea lamprey (Petromyzon marinus)	X							X									
Lake sturgeon (Acipenser fulvescens)	X											X	X				
Spotted gar (Lepisosteus oculatus)			X						X								
Longnose gar (Lepisosteus osseus)			X						X								
Bowfin (Amia calva)		X	X						X								
Alewife (Alosa pseudoharengus)				X							X						
Gizzard shad (Dorosoma cepedianum)				X					X	X	X		X				
Coho salmon (Oncorhynchus kisutch)	X							X									
Lake whitefish (Coregonus clupeaformis)					X	X						X		X			
Rainbow smelt (Osmerus mordax)					X	X									X		X
Mooneye (Hiodon tergisus)	X							X									
Central mudminnow (Umbra limi)		X							X								
Grass pickerel (Esox americanus vermiculatus)		X							X								
Northern pike (Esox lucius)		X							X								
Muskellunge (Esox masquinongy)		X							X								
Carp (Cyrinus carpio)		X	X						X	X			X				
Goldfish (Carassius auratus)		X	X						X	X			X				
Silver chub (Hybopsis storeriana)							X								X		
Golden shiner (Notemigonus crysoleucas)		X							X								
Emerald shiner (Notropis atherinoides)							X								X		
Spottail shiner (Notropis hudsonius)				X							X						
Spotfin shiner (Notropis spilopterus)		X	X						X	X	X	X					
Bluntnose minnow (Pimephales notatus)		X	X						X	X							
Fathead minnow (Pimephales promelas)		X	X						X	X							
Quillback (Carpiodes cyprinus)		X							X								
White sucker (Catostomus commersoni)	X							X									
Bigmouth buffalo (Ictiobus cyprinellus)		X											X				
Silver redhorse (Moxostoma anisurum)	X							X									
Golden redhorse (Moxostoma erythrurum)	X							X									
Black bullhead (Ictalurus melas)		X	X						X	X							
Yellow bullhead (Ictalurus natalis)		X	X						X	X							
Brown bullhead (Ictalurus nebulosus)		X	X						X	X							
Channel catfish (Ictalurus punctatus)					X				X	X	X	X	X				
Stonecat (Noturus flavus)					X							X		X			
Tadpole madtom (Noturus gyrinus)		X							X								

TABLE 8 - CON'T.

SPAWNING AND NURSERY HABITAT PREFERENCE
OF COMMON LAKE ERIE FISH SPECIES

Common and Scientific Name	SPAWNING AREAS - HABITAT TYPE							NURSERY AREAS - HABITAT TYPE									
		Shallow protected Sand or Mud Bottom		Shallow exposed		Gravel or Rubble with Current	Mid-Water		Shallow protected Sand or Mud Bottom		Shallow exposed		Medium Depth Mud Bottom	Gravel or Rubble with Current	Mid-Water	Deep	
	Tributary	Vegetation	Without Vegetation	Sand or Gravel Bottom	Rock or Rubble Bottom			Tributary	Vegetation	Without Vegetation	Sand or Gravel Bottom	Rock or Rubble Bottom				Mud Bottom	Sand or Gravel Bottom
Banded killifish (Fundulus diaphanus)		X							X								
Burbot (Lota lota)					X	X						X					
Troutperch (Percopsis omiscomaycus)				X							X	X				X	X
White bass (Morone chrysops)					X	X					X	X	X				
Rock bass (Ambloplites rupestris)					X							X					
Pumpkinseed (Lepomis gibbosus)		X	X						X	X							
Bluegill (Lepomis macrochirus)		X	X						X	X							
Smallmouth bass (Micropterus dolomieui)					X					X							
Largemouth bass (Micropterus salmoides)		X	X						X	X							
White crappie (Pomoxis annularis)			X	X						X			X				
Black crappie (Pomoxis nigromaculatus)		X							X								
Yellow perch (Perca flavescens)				X	X	X					X	X					
Sauger (Stizostedion canadense)					X	X					X						
Walleye (Stizostedion v. vitreum)					X	X					X						
Johnny darter (Etheostoma nigrum)					X						X						
Logperch (Percina caprodes)				X					X		X						
Freshwater drum (Aplodinotus grunniens)				X	X	X	X				X		X			X	X
Mottled sculpin (Cottus bairdi)			X								X						
Brook silverside (Labidesthes sicculus)		X	X						X	X							

Data sources: Hartley and VanVooren (1977) Herdendorf, et al. (1977a and b).

TABLE 9

SPECIES FOUND IN THE LOCUST POINT AREA 1963 - 1978[2]

1972	1973	1974	1975	1976	1977	1978	Scientific Name[1]	Common Name
							Amiidae	
*		*	*				<u>Amia calva</u>	bowfin
							Atherinidae	
		*	*	*	*	*	<u>Labidesthes sicculus</u>	brook silversides
							Catostomidae	
*				*	*	*	<u>Carpiodes cyprinus</u>	quillback
*	*	*	*	*	*	*	<u>Catostomus commersoni</u>	white sucker
		*					<u>Minytrema melanops</u>	spotted sucker
*							<u>Moxostoma erythrurum</u>	golden redhorse
					*		<u>Moxostoma macrolepidotum</u>	shorthead redhorse
*							<u>Ictiobus cyprinellus</u>	bigmouth buffalo fish
				*			<u>Hypentelium nigricans</u>	northern hogsucker
							Centrarchidae	
		*					<u>Ambloplites rupestris</u>	rock bass
	*	*	*				<u>Lepomis cyanellus</u>	green sunfish
		*	*				<u>L. gibbosus</u>	pumpkinseed sunfish
	*	*					<u>L. humilis</u>	orangespotted sunfish
		*	*				<u>L. macrochirus</u>	bluegill
	*						<u>L. microlophus</u>	redear sunfish
*	*	*				*	<u>Micropterus dolomieui</u>	smallmouth bass
	*	*					<u>M. salmoides</u>	largemouth bass
	*	*	*	*	*	*	<u>Pomoxis annularis</u>	white crappie
*	*	*	*	*	*		<u>P. nigromaculatus</u>	black crappie
							Clupeidae	
*	*	*	*	*	*	*	<u>Alosa pseudoharengus</u>	alewife
*	*	*	*	*	*	*	<u>Dorosoma cepedianum</u>	gizzard shad
							Cyprinidae	
*	*	*	*	*	*	*	<u>Carassius auratus</u>	goldfish
*	*						<u>C. auratus</u> x <u>Cyprinus carpio</u>	carp x goldfish hybrid
*	*	*	*	*	*	*	<u>Cyprinus carpio</u>	carp
	*	*	*	*	*	*	<u>Hybopsis storeriana</u>	silver chub
						*	<u>Notemigonus crysoleucas</u>	golden shiner
*	*	*	*	*	*	*	<u>Notropis atherinoides</u>	emerald shiner
*	*	*	*	*	*	*	<u>N. hudsonius</u>	spottail shiner
	*		*	*	*		<u>N. spilopterus</u>	spotfin shiner
	*		*				<u>N. volucellus</u>	mimic shiner
			*				<u>Pimephales promelas</u>	fathead minnow
							Esocidae	
							<u>Esox lucius</u>	northern pike

TABLE 9 (CON'T)

SPECIES FOUND IN THE LOCUST POINT AREA 1963 - 1978[2]

1972	1973	1974	1975	1976	1977	1978	Scientific Name[1]	Common Name
							Ictaluridae	
		*	*		*	*	*Ictalurus melas*	black bullhead
*	*	*				*	*I. natalis*	yellow bullhead
*	*	*	*	*	*	*	*I. nebulosus*	brown bullhead
*	*	*	*	*	*	*	*I. punctatus*	channel catfish
							Noturus flavus	stonecat
							Lepisosteidae	
		*		*	*		*Lepisosteus osseus*	longnose gar
							Osmeridae	
*	*	*	*	*	*	*	*Osmerus mordax*	rainbow smelt
							Percidae	
			*		*		*Etheostoma nigrum*	johnny darter
*	*	*	*	*	*	*	*Perca flavescens*	yellow perch
	*	*	*	*	*	*	*Percina caprodes*	logperch
			*	*	*	*	*Stizostedion canadense*	sauger
*	*	*	*	*	*	*	*S. v. vitreum*	walleye
							Percichthyidae	
*	*	*	*	*	*	*	*Morone chrysops*	white bass
							Percopsidae	
	*	*	*	*	*	*	*Percopsis omiscomaycus*	trout-perch
							Petromyzontidae	
		*					*Petromyzon marinus*	sea lamprey
							Salmonidae	
*		*					*Oncorhynchus kisutch*	coho salmon
							Sciaenidae	
*	*	*	*	*	*	*	*Aplodinotus grunniens*	freshwater drum
23	28	34	30	25	27	25		

[1] Bailey et al. (1970)

[2] Barnes and Reutter (1979)

TABLE 10

MONTHLY CATCH IN NUMBERS OF INDIVIDUALS OF FISH SPECIES AT LOCUST POINT IN 1978, USING EQUAL EFFORT[1] WITH EACH TYPE OF GEAR (GILL NETS, SHORE SEINES, TRAWLS)[2]

SPECIES \ MONTH	May	June	July	Aug.	Sept.	Oct.	Nov.	TOTAL
Alewife		2		201	599	150	165	1117
Black Bullhead			17		4	1	1	23
Brook Silverside				5				5
Brown Bullhead	1	2		2				5
Carp	3	19	16	22	7		1	68
Channel Catfish	3	48	14	5	2			72
Emerald Shiner	11	102	1	406	191	22	540	1273
Freshwater Drum	24	287	91	10	16	4		432
Gizzard Shad	4	5664	4457	1092	1178	165	180	12,740
Goldenshiner					14			14
Goldfish			7	10	1	1		19
Logperch	3					1	1	5
Quillback		14	1	1				16
Rainbow Smelt	2	1	3	59	4		2	71
Sauger	2	3					1	6
Silver Chub	1							1
Smallmouth Bass			1					1
Spottail Shiner	556	35	54	49	276	234	111	1315
Trout-Perch	5					1		6
Walleye	12	19	9	15	6		1	62
White Bass	9	273	196	163	87	10	4	742
White Crappie			1		1	1		3
White Sucker					3	1	1	5
Yellow Bullhead						1	1	2
Yellow Perch	131	65	140	246	285	70	81	1018
Number of Species	15	14	15	15	16	14	14	25
TOTAL	767	6534	5008	2286	2674	662	1090	19,021

1 Four units effort/month (gill net), three units effort/month (shore seine), two units effort/month (trawl).

2 Barnes and Reutter (1979).

TABLE 11

TRAVELING SCREEN OPERATION AT THE DAVIS-BESSE NUCLEAR POWER STATION
FROM 1 JANUARY TO 31 DECEMBER 1978

DATE	TIME OF SCREEN OPERATION		FISH COLLECTION YES/NO	HOURS SINCE LAST SCREEN OPERATION
	ON	OFF		
2 January 1978	22.09	22.41	Y	46.41
4 "	21.30	22.00	Y	47.59
5 "	16.15	17.05	N	19.05
6 "	16.39	17.17	Y	24.12
8 "	16:01	16.37	Y	47.20
12 "	16.45	17.15	N	96.73
14 "	17.50	18.30	N	49.15
20 "	20.15	20.45	Y	146.15
22 "	17.30	18.00	Y	45.55
24 "	17.00	18.24	Y	48.24
28 "	18.00	19.30	Y	97.06
30 "	20.30	21.00	Y	49.70
1 February 1978	20.45	21.15	N	48.15
3 "	20.55	21.25	Y	48.10
5 "	16.45	17.16	Y	43.91
7 "	17.30	18.00	Y	48.84
9 "	21.00	21.30	Y	51.30
11 "	17.40	18.15	Y	44.85
13 "	20.00	20.40	Y	50.25
17 "	17.00	17.30	Y	92.90
19 "	17.12	17.45	Y	48.15
21 "	20.30	21.20	N	51.75
22 "	18.40	17.20	N	20.00
23 "	19.55	20.50	N	27.30
25 "	20.57	21.40	N	48.90
27 "	18.10	19.40	Y	46.00
1 March 1978	23.00	23.40	N	52.00
2 "	16.30	17.10	N	17.70
3 "	18.00	18.35	Y	25.25
5 "	20.30	21.00	Y	50.65
6 "	21.30	22.00	N	25.00
7 "	20.15	20.50	Y	22.50
10 "	19.40	20.10	Y	71.60
11 "	19.10	19.45	Y	23.35
12 "	17.20	17.50	N	22.05
13 "	17.30	18.00	N	24.50
15 "	17.50	18.22	Y	48.22
17 "	18.50	19.20	Y	48.98
19 "	20.40	21.12	Y	49.92
21 "	19.58	20.28	N	47.16
23 "	20.50	21.26	Y	48.98
25 "	22.40	23.10	Y	49.84
26 "	18.00	18.30	N	19.20
27	20.00	21.05	N	26.75
29 "	21.19	21.56	Y	48.51

TABLE 11 (Con't.)

TRAVELING SCREEN OPERATION AT THE DAVIS-BESSE NUCLEAR POWER STATION
FROM 1 JANUARY TO 31 DECEMBER 1978

DATE	TIME OF SCREEN OPERATION		FISH COLLECTION YES/NO	HOURS SINCE LAST SCREEN OPERATION
	ON	OFF		
2 April 1978	19.06	19.40	Y	93.84
3 "	20.15	20.50	N	25.10
4 "	20.00	20.30	N	23.80
7 "	19.40	20.40	N	72.10
8 "	20.30	21.00	Y	24.60
9 "	20.10	20.40	N	23.40
10 "	21.00	22.00	Y	25.60
12 "	20.50	21.20	Y	47.20
13 "	20.30	21.00	N	23.80
14 "	20.30	21.00	Y	24.00
15 "	17.00	17.45	N	20.45
16 "	16.58	17.36	Y	23.91
17 "	16.30	17.45	N	24.09
18 "	17.25	17.55	Y	24.10
19 "	16.20	17.00	N	23.45
20 "	16.37	17.13	Y	24.13
22 "	18.00	18.35	Y	49.22
24 "	17.32	18.05	Y	47.70
26 "	17.15	17.45	Y	47.40
28 "	18.00	18.30	Y	48.85
30 "	23.20	23.50	Y	53.20
1 May 1978	18.30	19.00	N	19.50
2 "	18.45	19.15	Y	24.15
5 "	10.30	11.00	N	63.85
6 "	21.15	21.45	Y	34.45
8 "	20.25	20.55	Y	47.10
10 "	16.55	17.25	Y	44.70
12 "	22.00	22.30	Y	53.05
14 "	16.30	17.00	Y	42.70
16 "	16.35	17.05	Y	48.05
18 "	16.10	16.40	Y	47.35
20 "	17.00	17.30	N	48.90
22 "	19.00	20.30	Y	51.00
24 "	16.32	17.04	Y	44.74
26 "	14.40	15.10	Y	46.06
28 "	18.03	18.33	Y	51.23
30 "	15.45	16.15	Y	45.82
1 June 1978	16.25	17.00	Y	48.85
3 "	14.50	15.20	Y	46.20
5 "	18.55	19.35	Y	52.15
6 "	18.30	19.15	N	23.80
7 "	21.05	21.35	Y	26.20
9 "	21.36	22.06	Y	48.71
10 "	16.15	16.36	N	18.30
11 "	17.55	18.30	Y	25.94

TABLE 11(Con't.)

TRAVELING SCREEN OPERATION AT THE DAVIS-BESSE NUCLEAR POWER STATION FROM 1 JANUARY TO 31 DECEMBER 1978

DATE	TIME OF SCREEN OPERATION		FISH COLLECTION YES/NO	HOURS SINCE LAST SCREEN OPERATION
	ON	OFF		
12 June 1978	17.00	17.30	N	23.00
13 "	16.35	17.05	Y	23.75
15 "	12.52	13.24	Y	44.19
16 "	18.40	19.10	N	29.86
17 "	13.39	14.10	Y	19.00
19 "	18.45	19.25	N	53.15
20 "	16.25	16.55	N	21.30
21 "	16.07	16.37	Y	23.82
23 "	14.25	14.55	Y	46.18
25 "	16.10	16.50	Y	49.95
27 "	20.30	21.15	N	52.65
28 "	17.25	17.50	N	20.35
29 "	15.50	16.20	Y	22.70
30 "	16.00	16.30	N	24.10
2 July 1978	18.00	18.30	Y	50.00
4 "	17.15	17.45	Y	47.15
6 "	16.20	16.55	Y	47.10
8 "	14.20	14.50	Y	45.95
9 "	18.20	18.50	N	28.00
10 "	18.40	19.20	Y	24.70
11 "	20.45	21.16	Y	25.96
13 "	21.15	21.45	N	48.29
14 "	18.45	19.15	Y	21.70
15 "	16.25	16.55	N	21.40
16 "	16.30	17.00	Y	24.45
17 "	19.20	19.50	Y	26.50
20 "	20.15	20.50	Y	73.00
22 "	19.25	19.55	Y	47.05
24 "	17.00	17.30	Y	45.75
25 "	20.45	21.20	Y	27.90
26 "	20.15	20.45	Y	23.25
27 "	16.55	17.25	N	20.80
28 "	18.25	19.00	Y	25.75
30 "	17.16	17.46	Y	46.46
1 August 1978	17.00	17.30	Y	47.84
2 "	16.20	16.50	N	23.20
3 "	16.35	17.05	Y	24.55
4 "	19.00	19.30	N	26.25
5 "	19.02	19.37	Y	24.07
7 "	16.45	17.15	Y	45.78
9 "	19.30	20.00	Y	50.85
11 "	16.20	16.50	Y	44.50
13 "	16.43	17.18	N	48.68
14 "	22.00	22.30	N	29.12
17 "	20.20	21.30	N	71.00

TABLE 11 (Con't.)

TRAVELING SCREEN OPERATION AT THE DAVIS-BESSE NUCLEAR POWER STATION
FROM 1 JANUARY TO 31 DECEMBER 1978

DATE	TIME OF SCREEN OPERATION		FISH COLLECTION YES/NO	HOURS SINCE LAST SCREEN OPERATION
	ON	OFF		
19 August 1978	18.55	19.29	Y	45.99
21 "	19.20	20.15	Y	48.86
23 "	20.15	20.45	Y	48.30
25 "	18.35	19.10	Y	46.65
26 "	18.05	18.50	N	23.40
27 "	17.37	18.14	Y	23.64
29 "	16.45	17.15	Y	47.01
31 "	17.30	18.00	Y	48.85
1 September 1978	16.38	17.08	N	23.08
3 "	16.13	16.43	Y	47.35
4 "	16.35	17.25	Y	24.82
6 "	16.52	17.23	Y	47.98
8 "	18.07	18.37	Y	49.14
10 "	17.20	18.00	Y	47.63
12 "	20.13	20.45	Y	50.45
14 "	19.15	19.50	Y	47.05
16 "	17.30	18.20	N	46.70
18 "	21.30	22.05	Y	51.85
19 "	22.15	22.50	N	24.45
20 "	20.00	20.30	Y	21.80
22 "	23.00	23.30	Y	51.00
24 "	17.20	18.05	N	42.75
25 "	20.35	21.05	N	27.00
28 "	19.00	19.35	Y	70.30
30 "	16.55	17.25	Y	45.90
2 October 1978	19.25	19.55	Y	50.30
3 "	18.20	18.40	N	22.85
4 "	17.45	18.15	Y	23.75
5 "	16.30	17.01	N	22.86
6 "	20.25	21.00	N	27.99
9 "	16.25	16.55	N	67.55
10 "	17.05	17.36	Y	24.81
11 "	15.05	15.35	N	21.99
12 "	18.43	19.17	Y	27.82
13 "	16.40	17.10	N	21.93
14 "	21.34	22.04	Y	28.94
16 "	17.00	17.30	Y	43.26
20 "	17.20	17.50	Y	96.20
22 "	21.45	22.20	Y	52.70
25 "	18.20	18.50	N	68.30
26 "	16.30	17.00	Y	22.50
28 "	20.05	20.40	Y	51.40
30 "	21.10	21.45	Y	49.05

TABLE 11 (Con't.)

TRAVELING SCREEN OPERATION AT THE DAVIS-BESSE NUCLEAR POWER STATION
FROM 1 JANUARY TO 31 DECEMBER 1978

DATE	TIME OF SCREEN OPERATION		FISH COLLECTION YES/NO	HOURS SINCE LAST SCREEN OPERATION
	ON	OFF		
1 November 1978	18.45	19.17	Y	45.72
3 "	20.45	21.18	Y	50.01
5 "	20.08	20.40	Y	47.22
6 "	16.25	16.55	N	20.15
7 "	16.48	17.12	Y	24.57
8 "	16.40	17.10	N	23.98
9 "	16.50	17.20	Y	24.10
11 "	18.25	18.55	Y	49.35
12 "	17.05	17.35	N	22.80
13 "	18.15	18.35	Y	25.00
14 "	16.26	17.00	N	22.65
15 "	18.30	19.00	Y	26.00
17 "	20.05	20.57	N	49.57
20 "	19.45	20.30	N	71.73
21 "	20.50	21.20	N	24.90
23 "	16.15	16.45	Y	43.25
24 "	19.00	20.08	N	27.63
25 "	20.00	20.30	Y	24.22
27 "	20.30	21.00	Y	48.70
29 "	20.15	20.45	Y	47.45
1 December 1978	19.15	19.45	Y	47.00
3 "	16.28	17.08	Y	45.63
5 "	16.00	17.34	N	48.26
6 "	17.55	18.25	Y	24.91
9 "	17.55	18.25	N	72.00
10 "	19.46	20.23	N	25.98
11 "	16.30	17.00	N	20.77
12 "	17.45	18.15	N	25.15
13 "	18.04	18.34	Y	24.19
15 "	17.20	17.50	Y	47.16
17 "	18.45	19.15	Y	49.65
18 "	17.34	18.10	N	22.95
19 "	22.20	22.50	Y	28.40
20 "	18.20	18.50	N	20.00
21 "	16.25	16.59	Y	22.09
23 "	19.45	20.15	Y	51.56
24 "	19.35	20.05	N	23.90
25 "	21.50	22.20	Y	26.15
27 "	17.30	18.00	N	43.80
28 "	19.37	20.07	N	26.07
29 "	20.20	20.50	Y	24.43
30 "	17.30	19.30	N	22.80
31 "	18.35	19.08	Y	23.78

TABLE 12

ICHTHYOPLANKTON DENSITIES IN THE VICINITY OF THE INTAKE OF THE DAVIS - BESSE NUCLEAR POWER STATION - 1978*

SPECIES	STAGE \ DATE	April 30	May 11	May 21	June 7	July 4	July 19	Aug. 1	Aug. 11	MEAN
Carp	Pro-larvae					0.3				0.04
	Post-larvae									
	Subtotal					0.3				0.04
Emerald Shiner	Pro-larvae					14.7				1.84
	Post-larvae					1.6		1.6	0.8	0.50
	Subtotal					16.3		1.6	0.8	2.34
Freshwater Drum	Pro-larvae			0.7		4.9				0.70
	Post-larvae					0.4				0.05
	Sub-total			0.7		5.3				0.75
Gizzard Shad	Pro-larvae				16.4				0.4	2.10
	Post-larvae				5.2	181.9	30.0	3.6	24.3	30.63
	Subtotal				21.6	181.9	30.0	3.6	24.7	32.73
Rainbow Smelt	Pro-larvae			0.7						0.09
	Post-larvae						4.2		0.6	0.60
	Subtotal			0.7			4.2		0.6	0.69
Spottail Shiner	Pro-larvae				0.3					0.04
	Post-larvae						0.4		0.2	0.08
	Subtotal				0.3		0.4		0.2	0.11
Walleye	Pro-larvae		79.2	4.0						10.40
	Post-larvae									
	Subtotal		79.2	4.0						10.40
Yellow Perch	Pro-larvae		1.4	1.8						0.40
	Post-larvae									
	Subtotal		1.4	1.8						0.40
TOTAL LARVAE	Pro-larvae		80.6	7.2	16.7	19.9			0.4	15.60
	Post-larvae				5.2	183.9	34.6	5.2	25.9	31.85
	Subtotal		80.6	7.2	21.9	203.8	34.6	5.2	26.3	47.45
EGGS					2.4					0.30

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

TABLE 13

ICHTHYOPLANKTON ENTRAINMENT AT THE
DAVIS-BESSE NUCLEAR POWER STATION - 1978

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[d]	
				Lower Limit	Upper Limit		Lower Limit	Upper Limit
Carp	21 June - 12 July	20,443	0.32	-0.69	1.32	6,542	0	26,985
Emerald Shiner	21 June - 17 August	73,704	4.68	-7.70	17.05	344,935	0	1,256,653
Freshwater Drum	16 May - 12 July	49,951	2.00	-5.15	9.15	99,902	0	457,052
Gizzard Shad	30 May - 17 August	91,598	52.36	-38.38	143.00	4,796,071	0	13,098,514
Rainbow Smelt	16 May - 17 August	103,211	0.92	-0.80	2.64	94,954	0	272,477
Spottail Shiner	30 May - 17 August	91,598	0.18	-0.04	0.40	16,488	0	36,639
Walleye	6 May - 30 May	22,037	41.60	-436.15	519.35	916,739	0	11,444,915
Yellow Perch	6 May - 30 May	22,037	1.60	-0.94	4.14	35,259	0	91,233
TOTAL LARVAE						6,310,890		
EGGS	30 May - 21 June	18,449	2.40	-5.24	10.04	44,278	0	185,228

[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.

TABLE 14

FISH SPECIES IMPINGED AT THE DAVIS-BESSE NUCLEAR POWER STATION: 1 January through 31 December 1978

SPECIES	NUMBER IMPINGED			WEIGHT (grams)			LENGTH (mm)		
		95% Confidence Interval			95% Confidence Interval			95% Confidence Interval	
	Estimate	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
Alewife	4	1	9	4	0	8	75	39	110
Black Crappie	82	53	128	17	16	17	117	116	119
Blackside Darter	1	0.5	4	1	*	*	27	*	*
Bluegill Sunfish	5	3	9	10	9	10	68	67	68
Bluntnose Minnow	1	1	3	1	*	*	25	*	*
Carp	6	3	15	2	1	3	56	51	60
Channel Catfish	3	1	7	0.4	*	*	59	*	*
Emerald Shiner	991	636	1,545	1	1	1	60	60	61
Freshwater Drum	80	55	114	4	3	4	81	78	83
Gizzard Shad	391	201	758	7	6	8	88	87	90
Goldfish	3,299	2,435	4,468	5	5	6	72	71	73
Green Sunfish	5	3	11	12	9	16	58	48	68
Logperch Darter	12	8	21	2	1	2	63	60	67
Pumpkinseed Sunfish	9	3	24	11	9	13	82	77	87
Rainbow Smelt	69	45	107	1	1	1	60	59	61
Spottail Shiner	15	9	25	2	2	2	65	63	66
Stonecat Madtom	1	1	3	1	*	*	30	*	*
Trout-perch	29	20	41	4	4	5	80	77	82
White Crappie	22	15	31	8	8	8	88	85	91
Yellow Perch	1,582	1,082	2,312	5	5	5	83	83	84
TOTAL	6,607	5,447	8,015	5	5	5	74	74	75

* Confidence intervals could not be computed when no more than one representative of a given species occurred.

TABLE 15

A SUMMARY OF MONTHLY FISH IMPINGEMENT
AT THE DAVIS-BESSE NUCLEAR POWER STATIONS: 1 January through 31 December 1978

MONTHS	NUMBER IMPINGED			WEIGHT (grams)			LENGTH (mm)		
		95% Confidence Interval			95% Confidence Interval			95% Confidence Interval	
	Estimate	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound	Mean	Lower Bound	Upper Bound
January	45	31	66	13	12	14	104	102	106
February	17	9	31	5	5	6	76	72	79
March	13	7	25	4	4	4	72	70	73
April	2,875	2,157	3,833	5	5	6	79	78	79
May	648	479	874	5	4	5	79	78	79
June	45	29	69	12	7	17	92	86	98
July	7	5	11	9	9	9	79	77	81
August	4	2	8	12	9	14	100	90	110
September	19	12	32	11	9	12	83	80	87
October	28	18	43	10	9	11	59	55	64
November	576	314	1,058	3	3	3	62	61	63
December	2,330	1,594	3,406	3	3	3	68	67	69
TOTAL	6,607	5,447	8,015	5	5	5	74	74	75

TABLE 16

COMMERCIAL FISH LANDINGS FROM THE OHIO WATER OF LAKE ERIE: 1974-1978*

SPECIES	1974	1975	1976	1977	1978
Buffalo	14,528	14,982	13,620	15,890	16,344
Bullhead	12,258	14,074	19,522	29,056	32,688
Carp	1,284,366	1,265,298	1,196,290	1,249,408	701,430
Channel Catfish	136,200	117,586	101,242	115,316	92,843
Freshwater Drum	307,812	340,500	432,208	361,838	533,904
Goldfish	29,510	23,608	60,836	250,154	343,678
Quillback/Shad**	28,148	60,382	331,874	274,670	752,732
Rainbow Smelt	2,270	4,086	15,890	454	4,994
Sucker	39,952	24,516	28,602	14,982	14,982
White Bass	1,314,330	760,450	680,546	501,216	736,842
Yellow Perch	797,678	675,552	652,852	1,051,918	890,294
TOTAL	3,962,512	3,301,488	3,533,482	3,864,902	4,121,866

* Ohio Division of Wildlife (1979). Data presented in kilograms.

** This is primarily the quillback carpsucker (Carpiodes cyprinus), but occasionally some fishermen include gizzard shad (Dorosoma cepedianum).

TABLE 17

COMMERCIAL FISH LANDINGS FROM LAKE ERIE: 1975 - 1978[a]

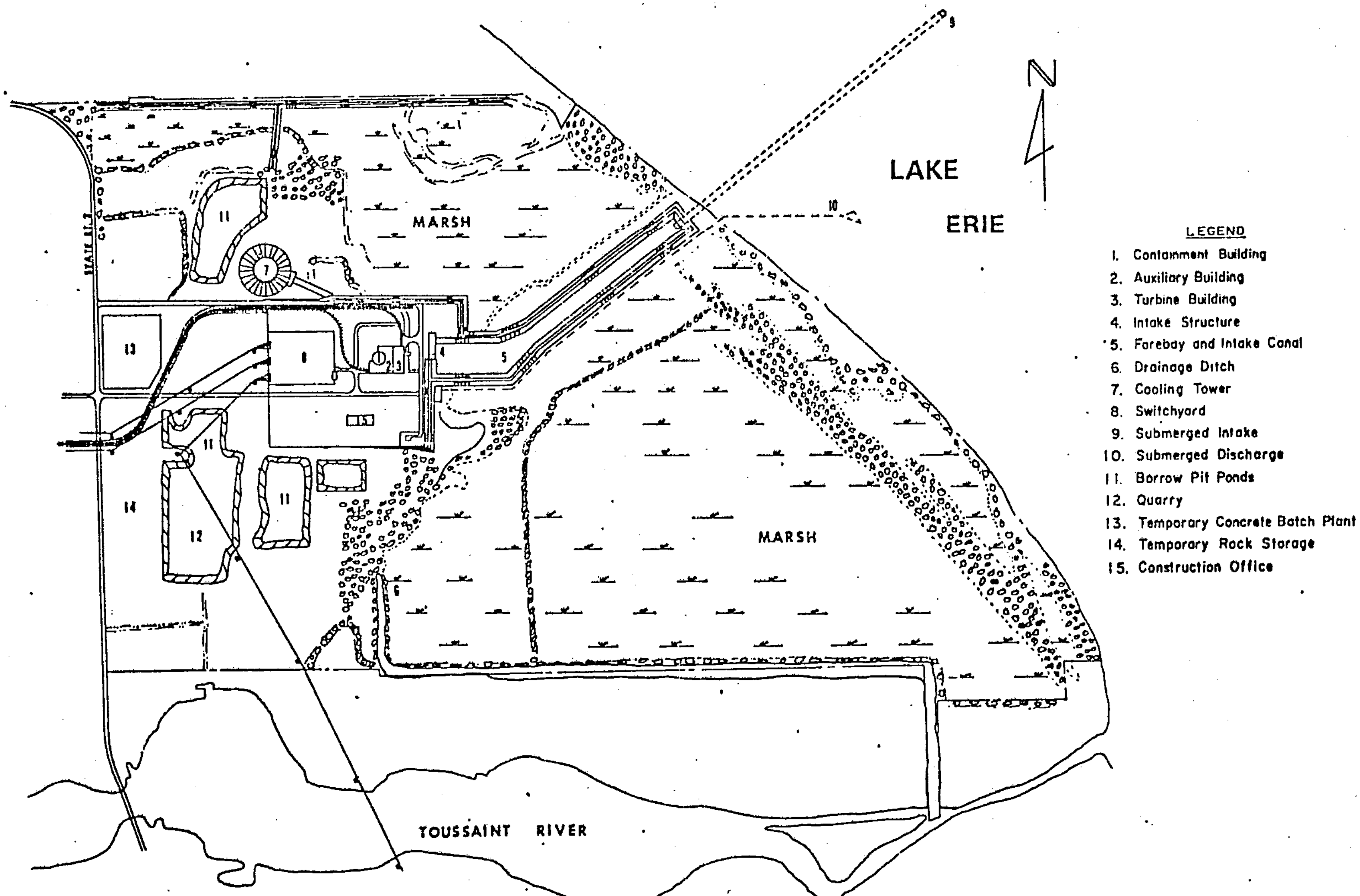
SPECIES	WEIGHT (Kilograms)				
	1975	1976	1977	1978	MEAN
Bowfin	c	c	15,000	12,000	13,500
Buffalo	30,000	43,000	34,000	25,000	33,000
Bullhead	69,000	64,000	77,000	54,000	66,000
Carp	1,491,000	1,444,000	1,439,000	871,000	1,311,250
Channel Catfish	197,000	155,000	160,000	148,000	165,000
Freshwater Drum	538,000	619,000	538,000	692,000	596,750
Gizzard Shad	1,000	301,000	229,000	707,000	309,500
Goldfish	26,000	61,000	250,000	344,000	170,250
Lake Whitefish	c	c	3,000	2,000	2,500
Quillback	60,000	58,000	47,000	47,000	53,000
Rainbow Smelt	7,688,000	7,845,000	9,700,000	11,002,000	9,058,750
Rock Bass	c	c	19,000	10,000	14,500
Sucker	52,000	48,000	31,000	33,000	41,000
Sunfish	c	c	33,000	23,000	28,000
Walleye[b]	114,000	138,000	261,000	295,000	202,000
White Bass	1,932,000	1,162,000	948,000	1,590,000	1,408,000
Yellow Perch	4,597,000	2,903,000	4,801,000	4,918,000	4,304,750
Others	927,00	833,000	928,000	796,000	871,000
TOTAL	17,722,000	15,674,000	19,513,000	21,569,000	18,649,000

a Personal communication, Dr. David Wolfert, USFWS, Sandusky, Ohio.

b Not taken commercially in Ohio and Michigan waters.

c Included with "Others" during this year.

F I G U R E S



DAVIS-BESSE NUCLEAR POWER STATION UNIT NO. 1

SITE PLAN

FIGURE 1. STATION LOCATION MAP

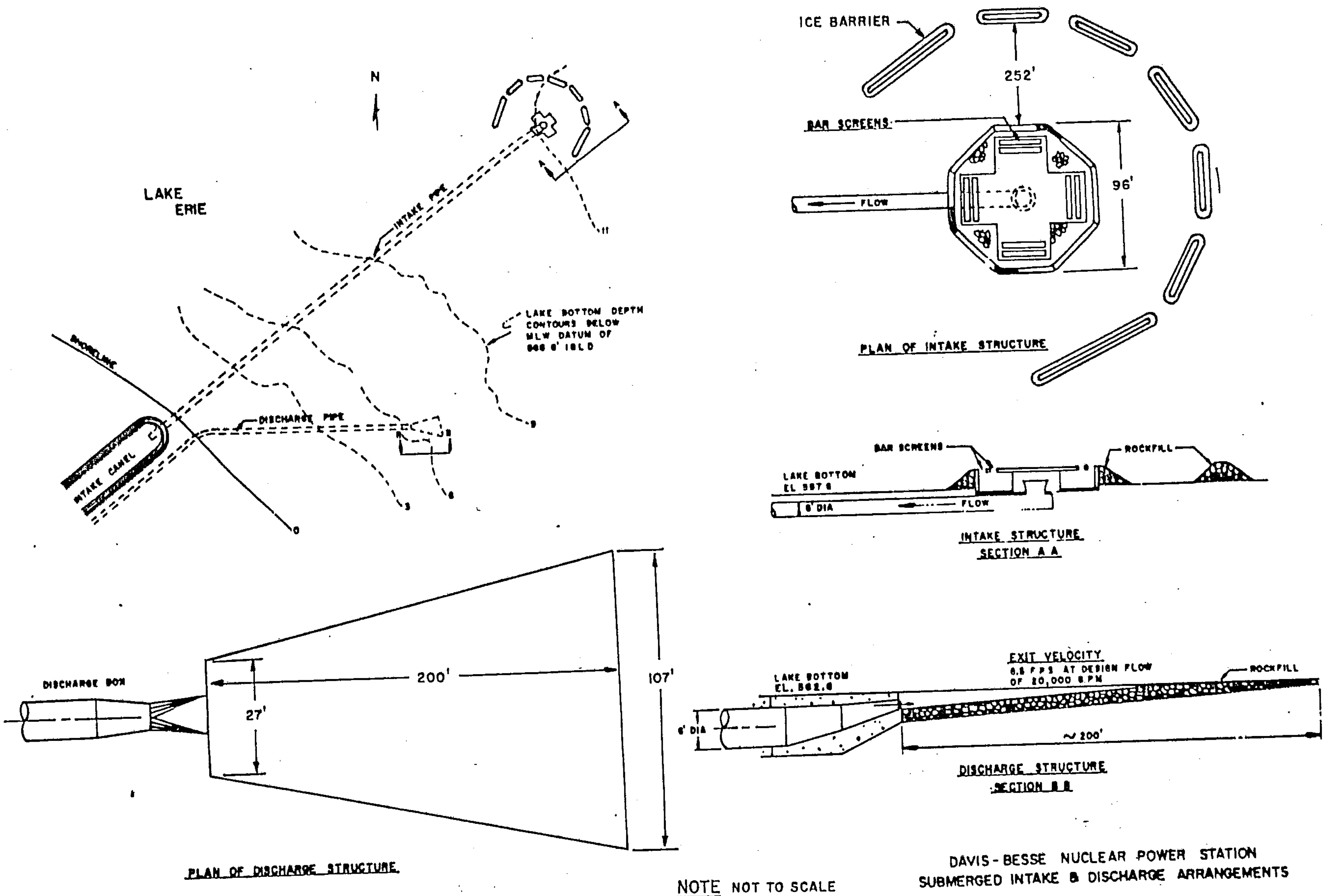
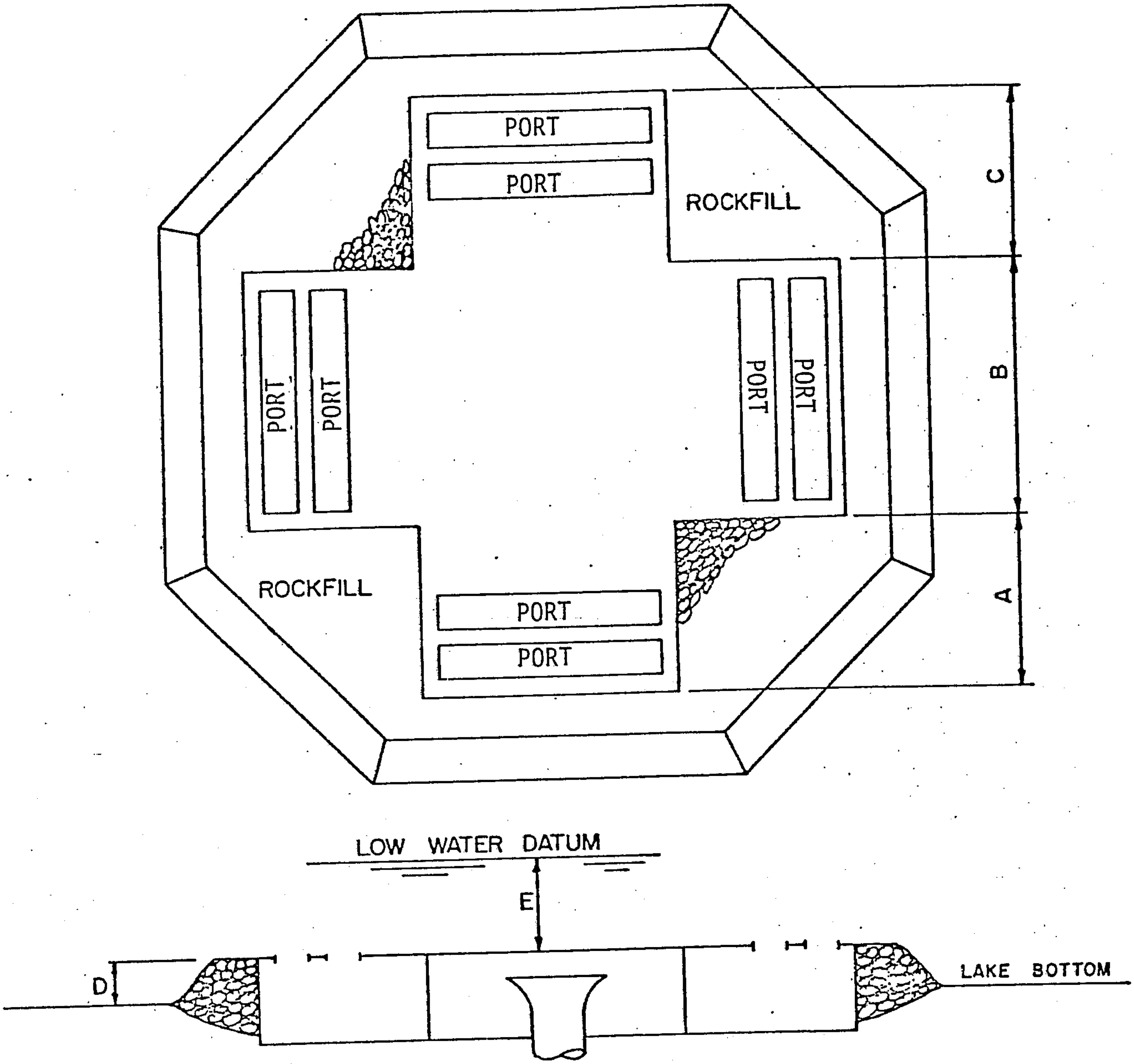


FIGURE 2. WATER INTAKE AND DISCHARGE STRUCTURES



INTAKE CRIB	A	B	C	D	E	DESIGN INTAKE VELOCITY
DAVIS-BESSE	18'-0"*	23'-0"	18'-0"*	3'-10"	6'-9"	0.25 FT/SEC
OREGON	13'-0"	16'-0"	13'-0"	5'-10"	8'-2"	0.25 FT/SEC
PORT CLINTON	11'-2"	9'-8"	11'-2"	3'-11"	6'-2"	0.25 FT/SEC

*18'-2" on the other side of the crib

FIGURE 3. DETAILS OF WATER INTAKE CRIB

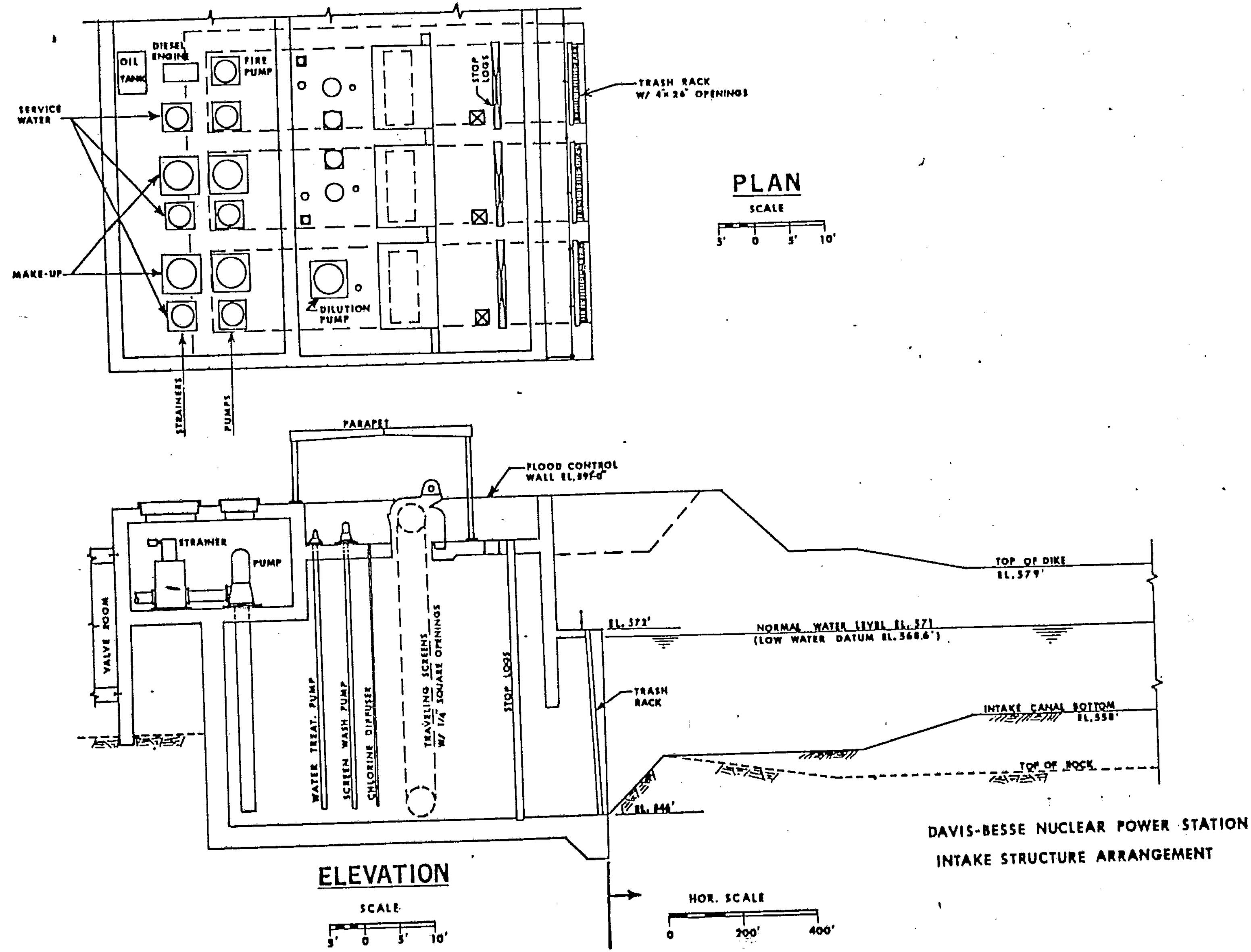


FIGURE 4. WATER INTAKE PUMPS AND SCREENS ARRANGEMENT

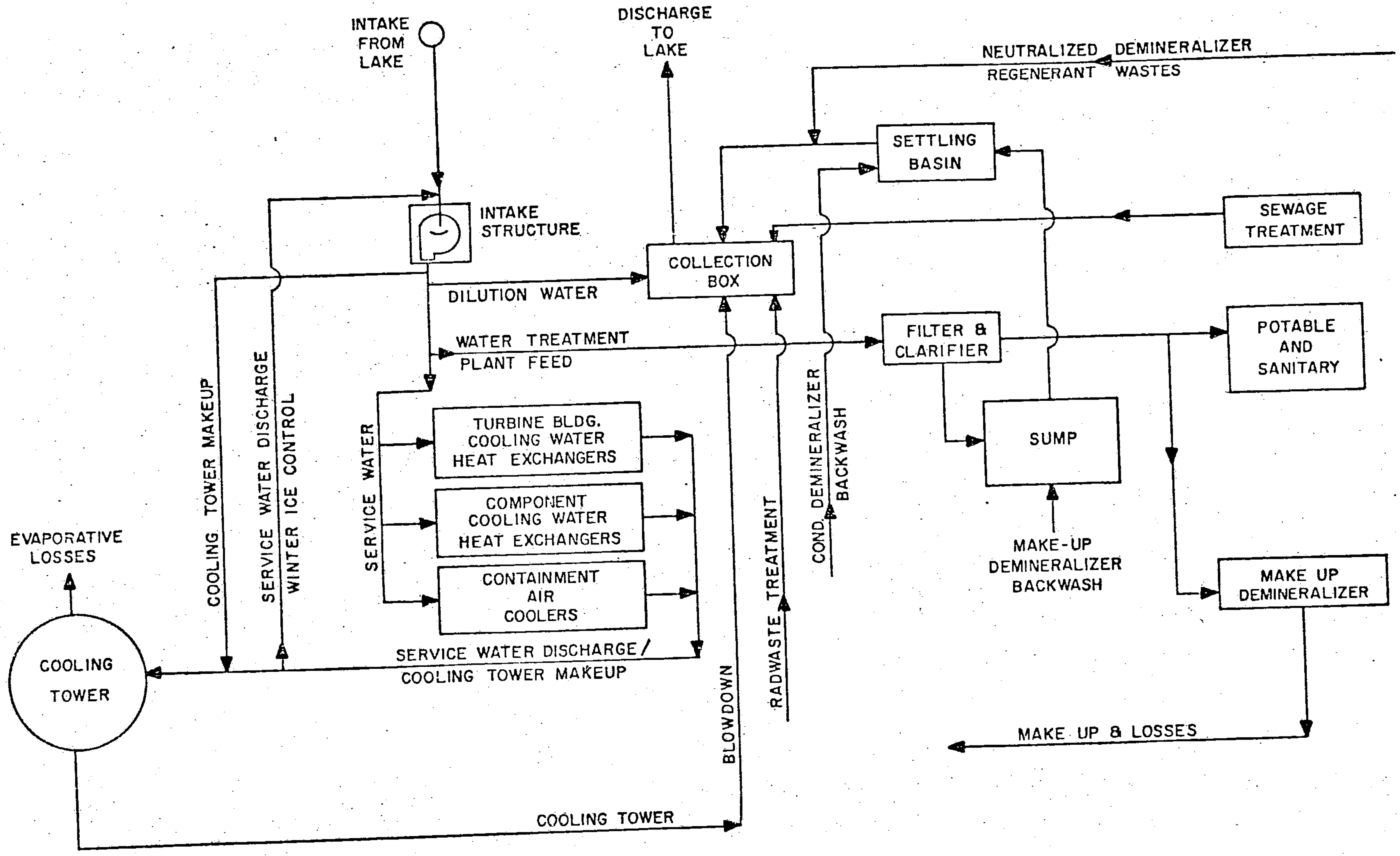
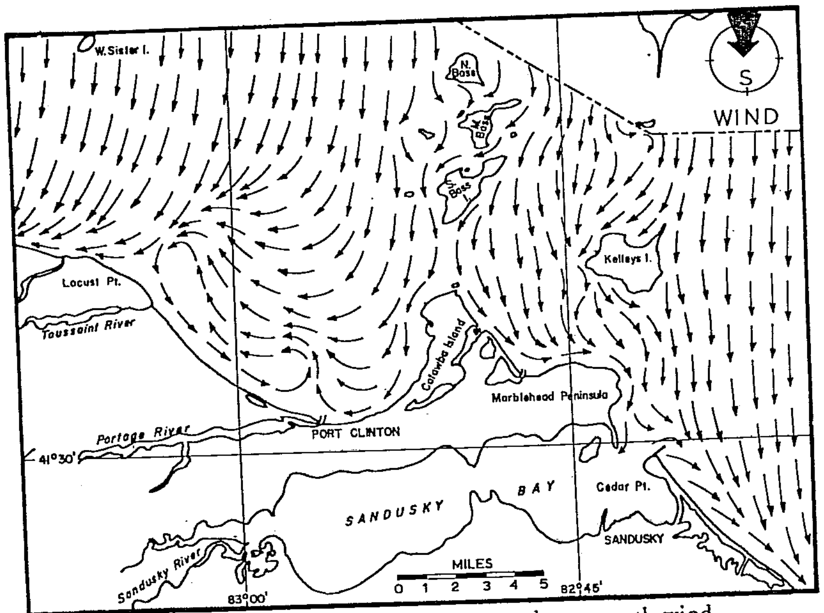
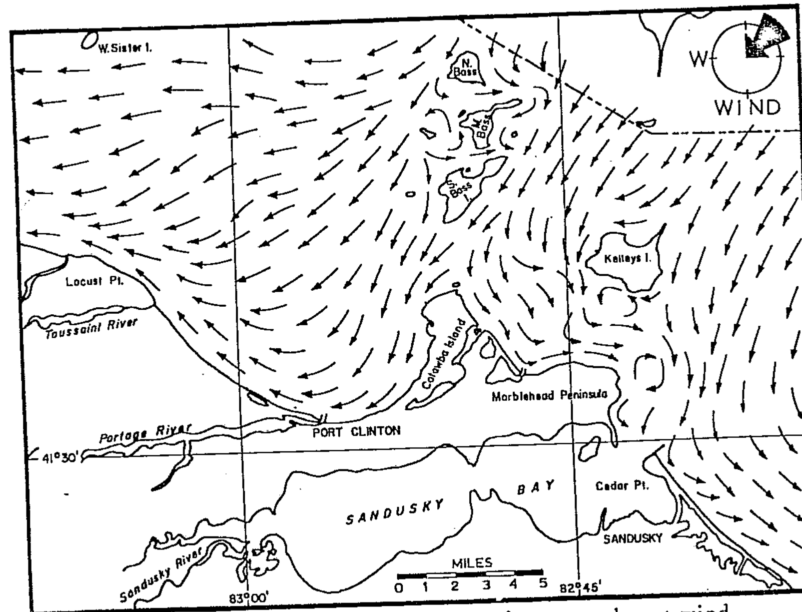


FIGURE 5. WATER USE PLAN

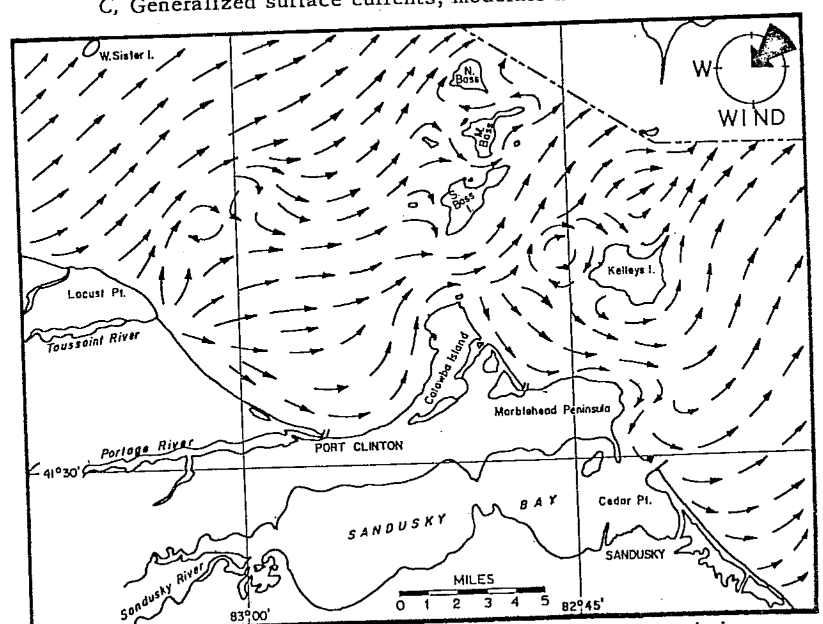


A, Generalized surface currents, moderate north wind



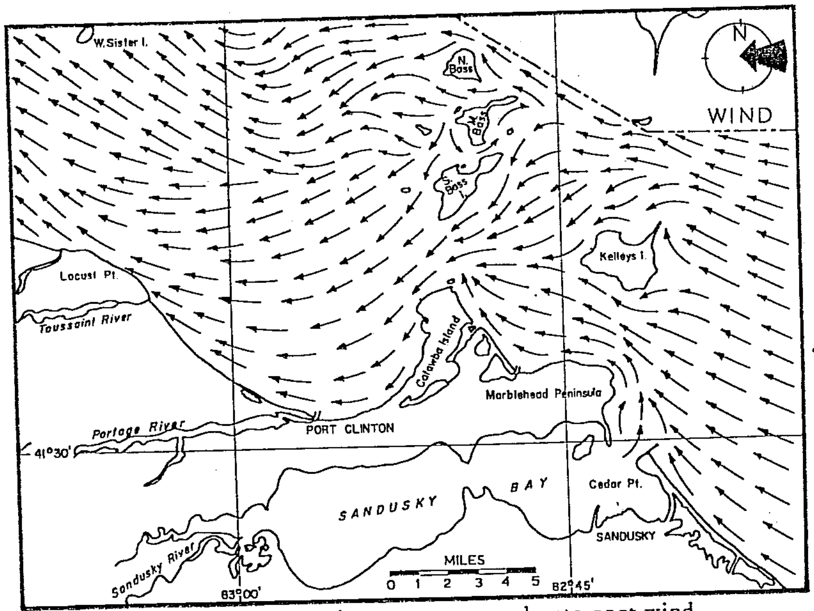
C, Generalized surface currents, moderate northeast wind

B, Generalized bottom currents, moderate north wind

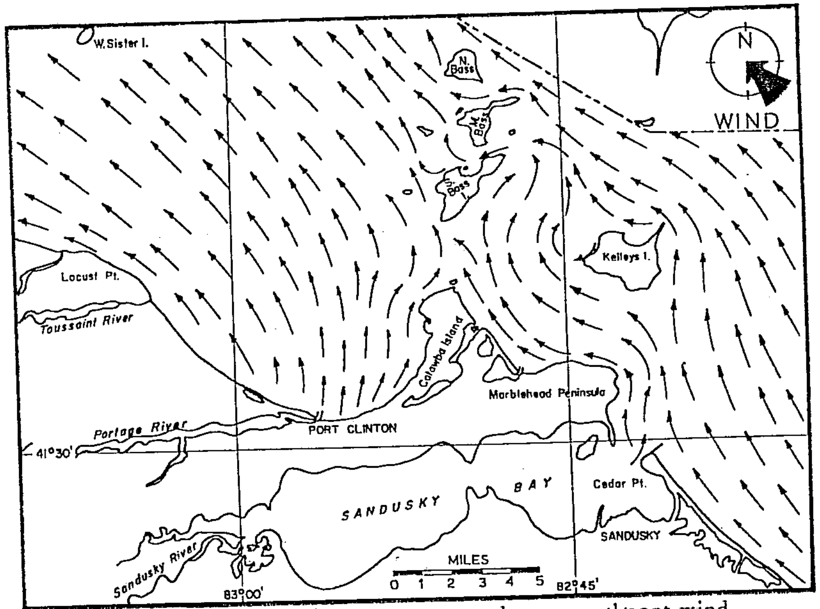


D, Generalized bottom currents, moderate northeast wind

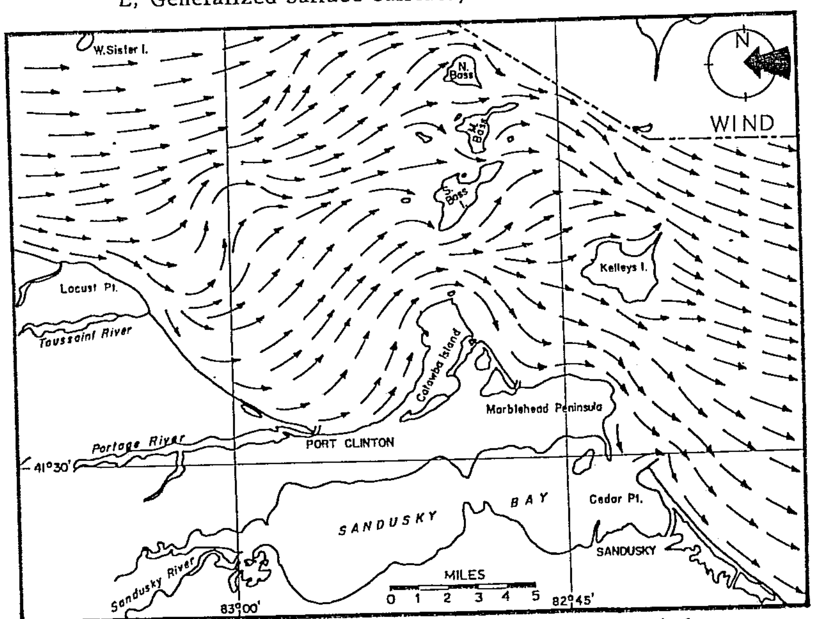
FIGURE 6. CURRENT MAPS OF THE LOCUST POINT AREA OF WESTERN LAKE ERIE



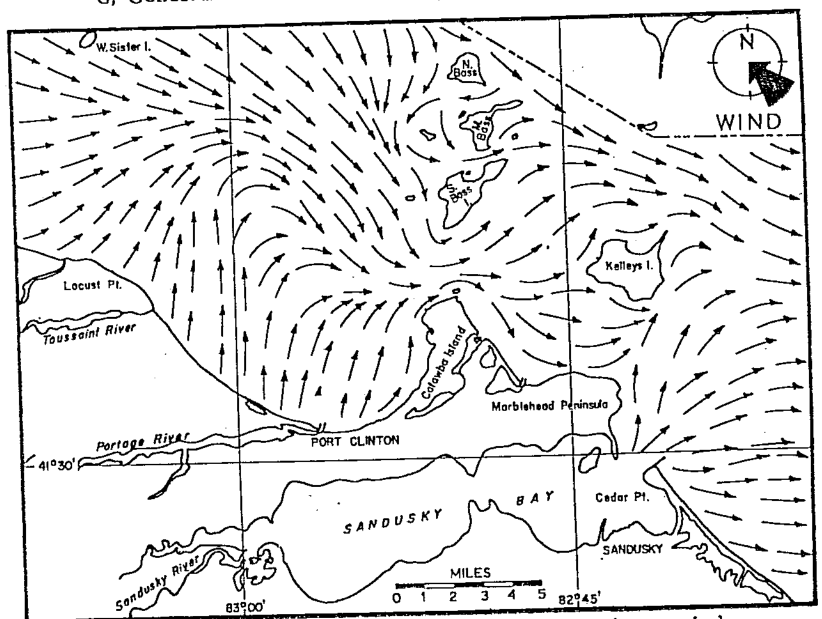
E, Generalized surface currents, moderate east wind



G, Generalized surface currents, moderate southeast wind

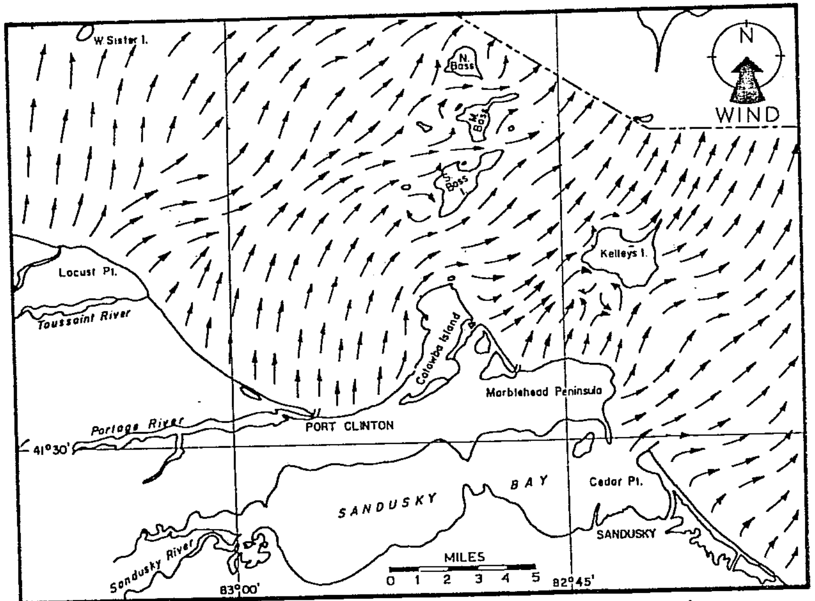


F, Generalized bottom currents, moderate east wind

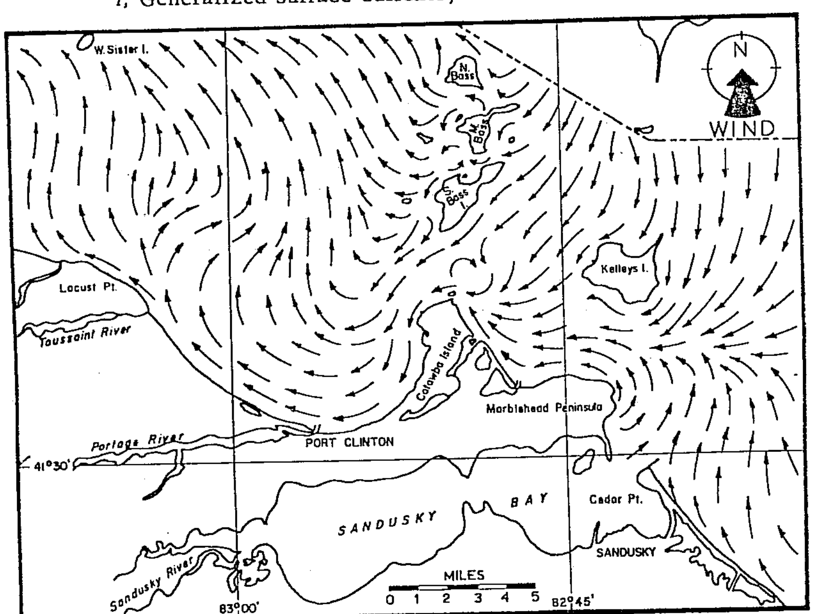


H, Generalized bottom currents, moderate southeast wind

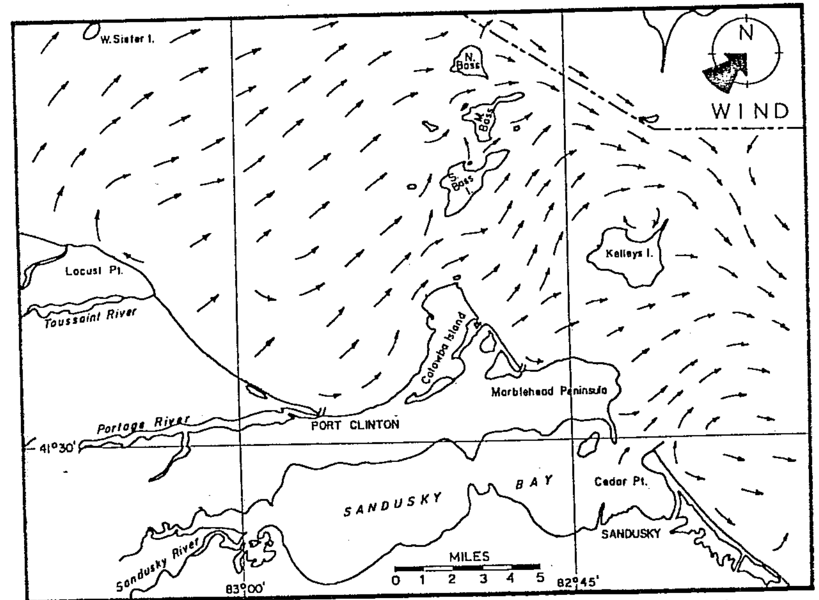
FIGURE 6. CURRENT MAPS OF THE LOCUST POINT AREA OF WESTERN LAKE ERIE (Cont.)



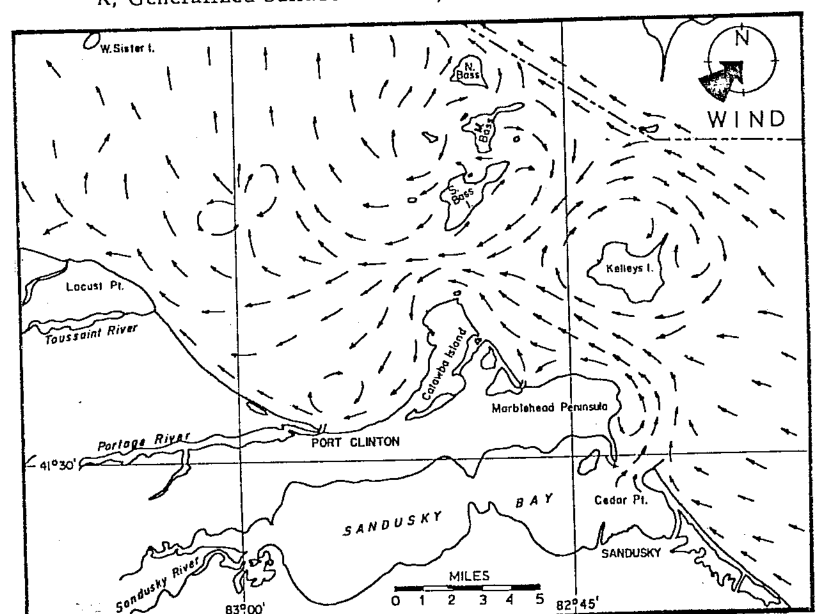
I, Generalized surface currents, moderate south wind



J, Generalized bottom currents, moderate south wind

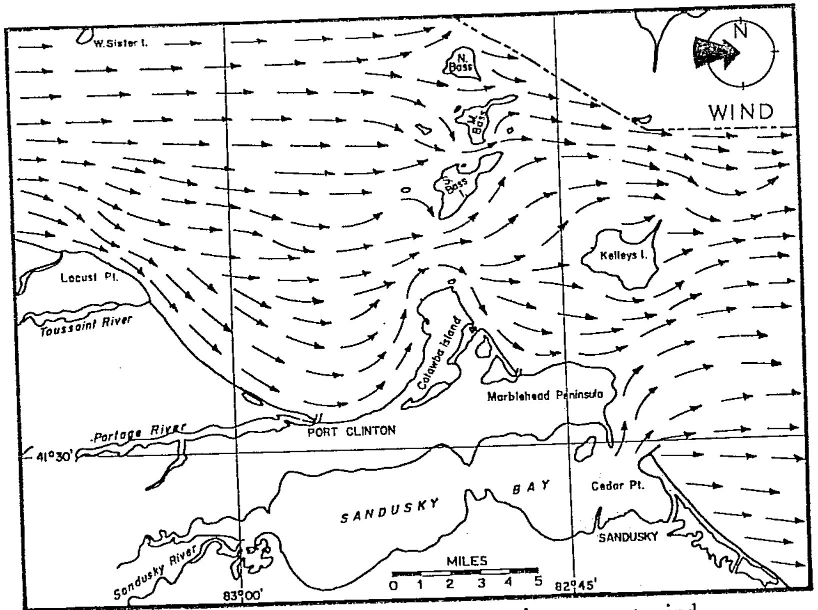


K, Generalized surface currents, moderate southwest wind

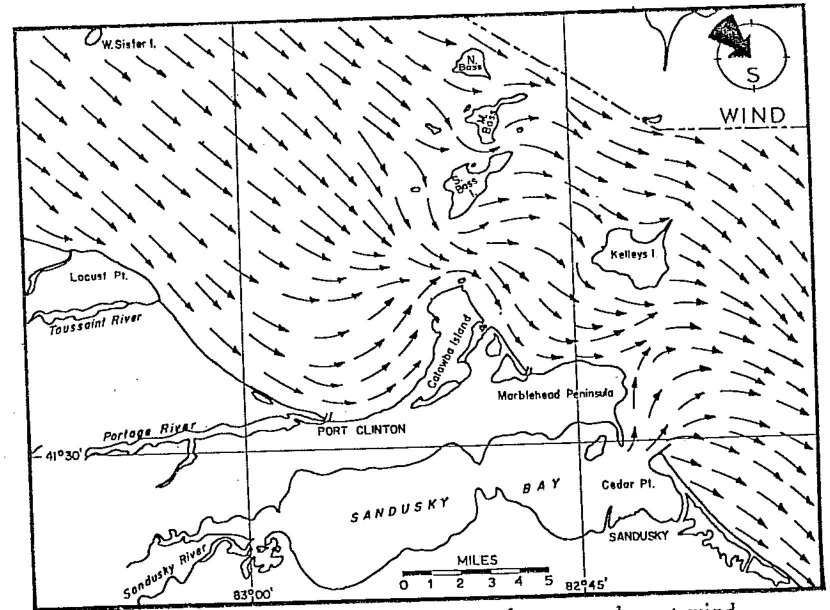


L, Generalized bottom currents, moderate southwest wind

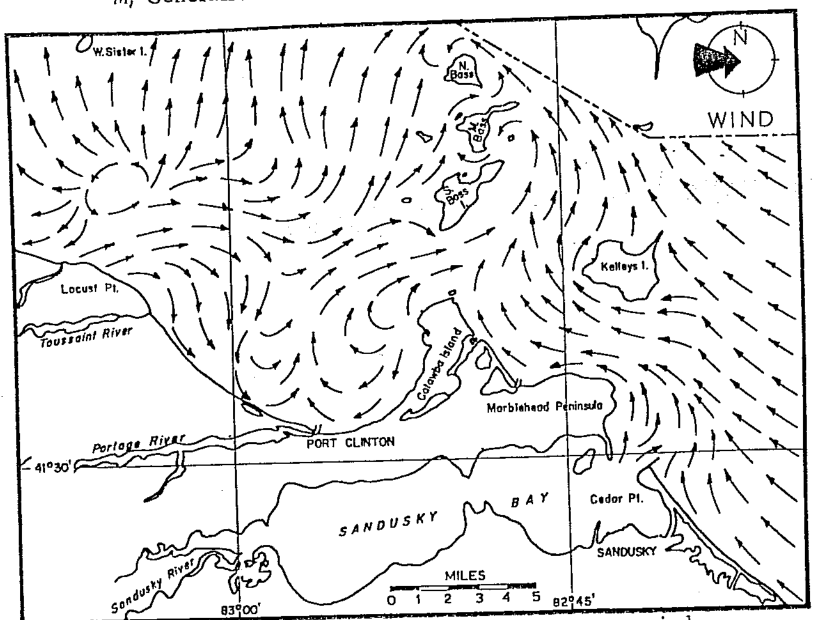
FIGURE 6. CURRENT MAPS OF THE LOCUST POINT AREA OF WESTERN LAKE ERIE (Cont.)



M, Generalized surface currents, moderate west wind



O, Generalized surface currents, moderate northwest wind



N, Generalized bottom currents, moderate west wind

P, Generalized bottom currents, moderate northwest wind

FIGURE 6. CURRENT MAPS OF THE LOCUST POINT AREA OF WESTERN LAKE ERIE (Cont.)

FIGURE 7. TRENDS IN MEAN MONTHLY TEMPERATURE, DISSOLVED OXYGEN, AND HYDROGEN ION MEASUREMENTS FOR LAKE ERIE AT LOCUST POINT FOR THE PERIOD 1972-1978.

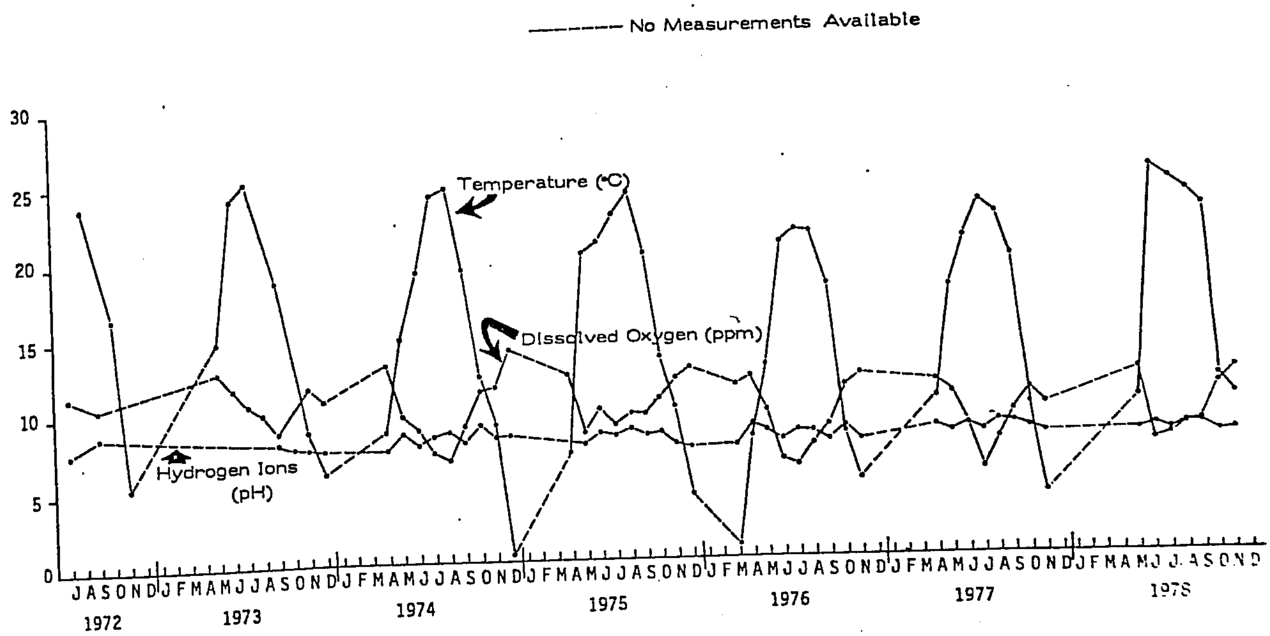


FIGURE 8. TRENDS IN MEAN MONTHLY CONDUCTIVITY, ALKALINITY AND TURBIDITY MEASUREMENTS FOR LAKE ERIE AT LOCUST POINT FOR THE PERIOD 1972-1978.

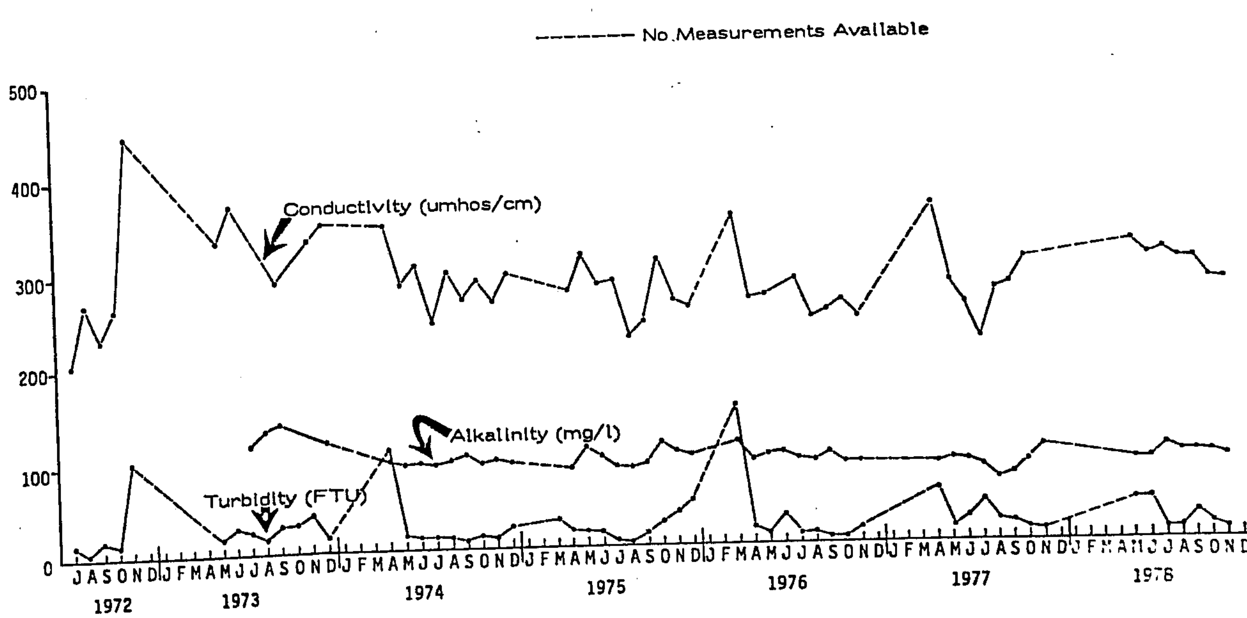
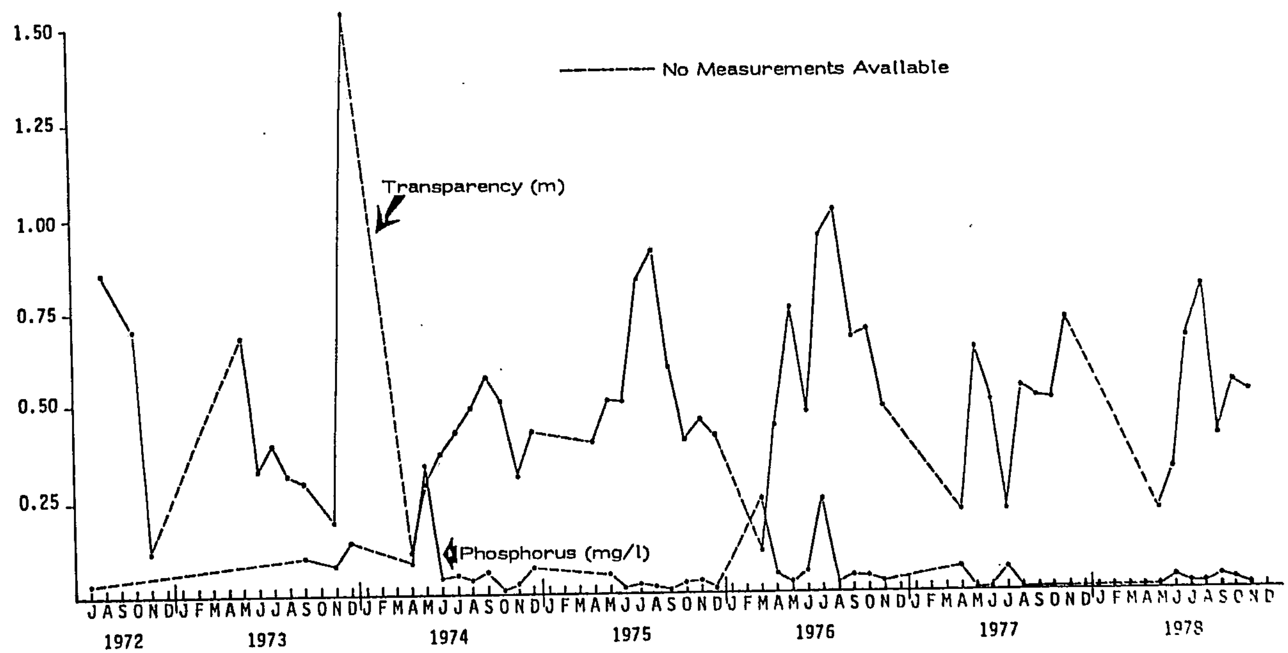


FIGURE 9. TRENDS IN MEAN MONTHLY TRANSPARENCY AND PHOSPHORUS MEASUREMENTS FOR LAKE ERIE AT LOCUST POINT FOR THE PERIOD 1972-1978.



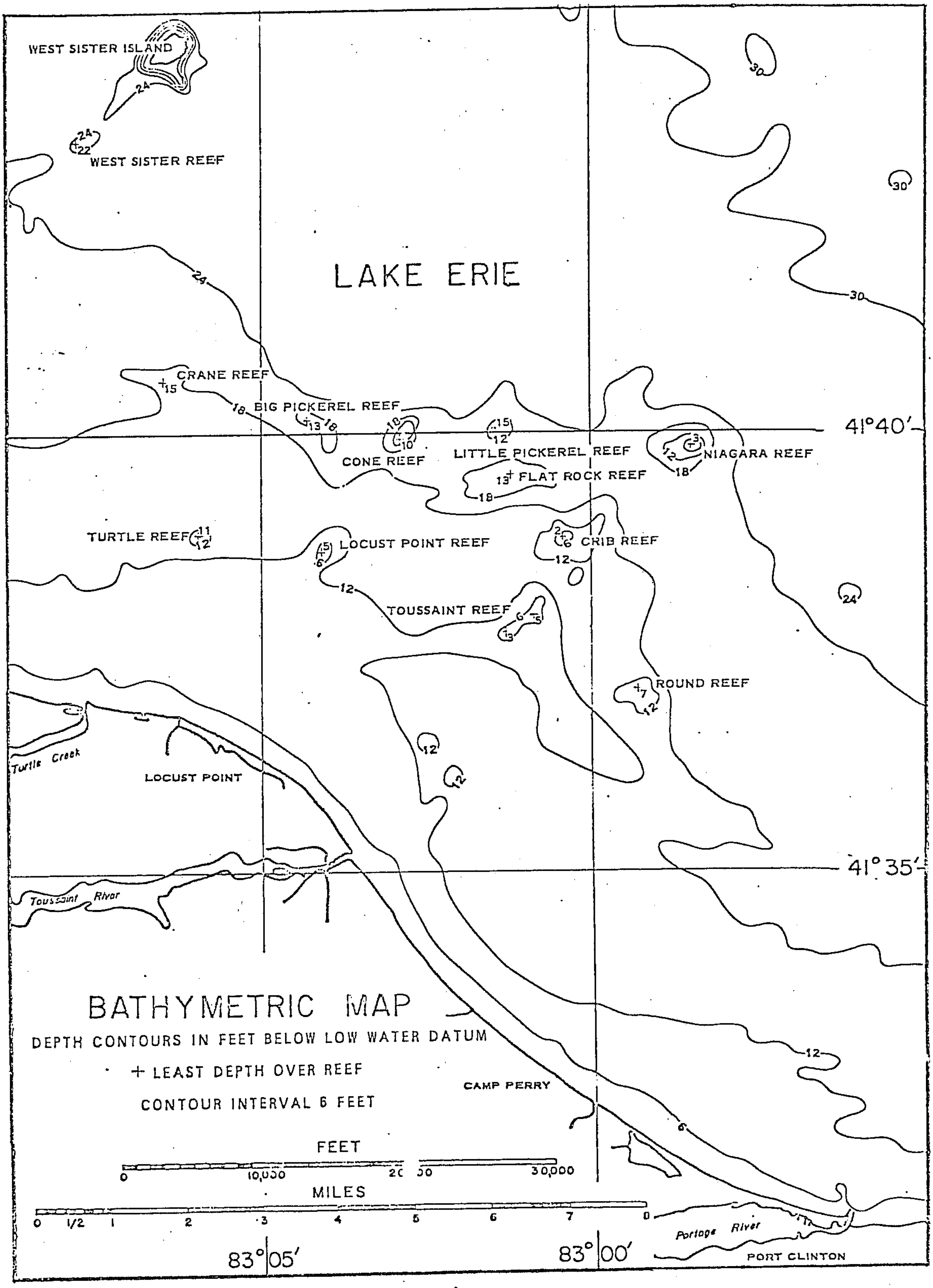


FIGURE 10. BATHYMETRIC MAP OF WESTERN LAKE ERIE IN THE VICINITY OF LOCUST POINT

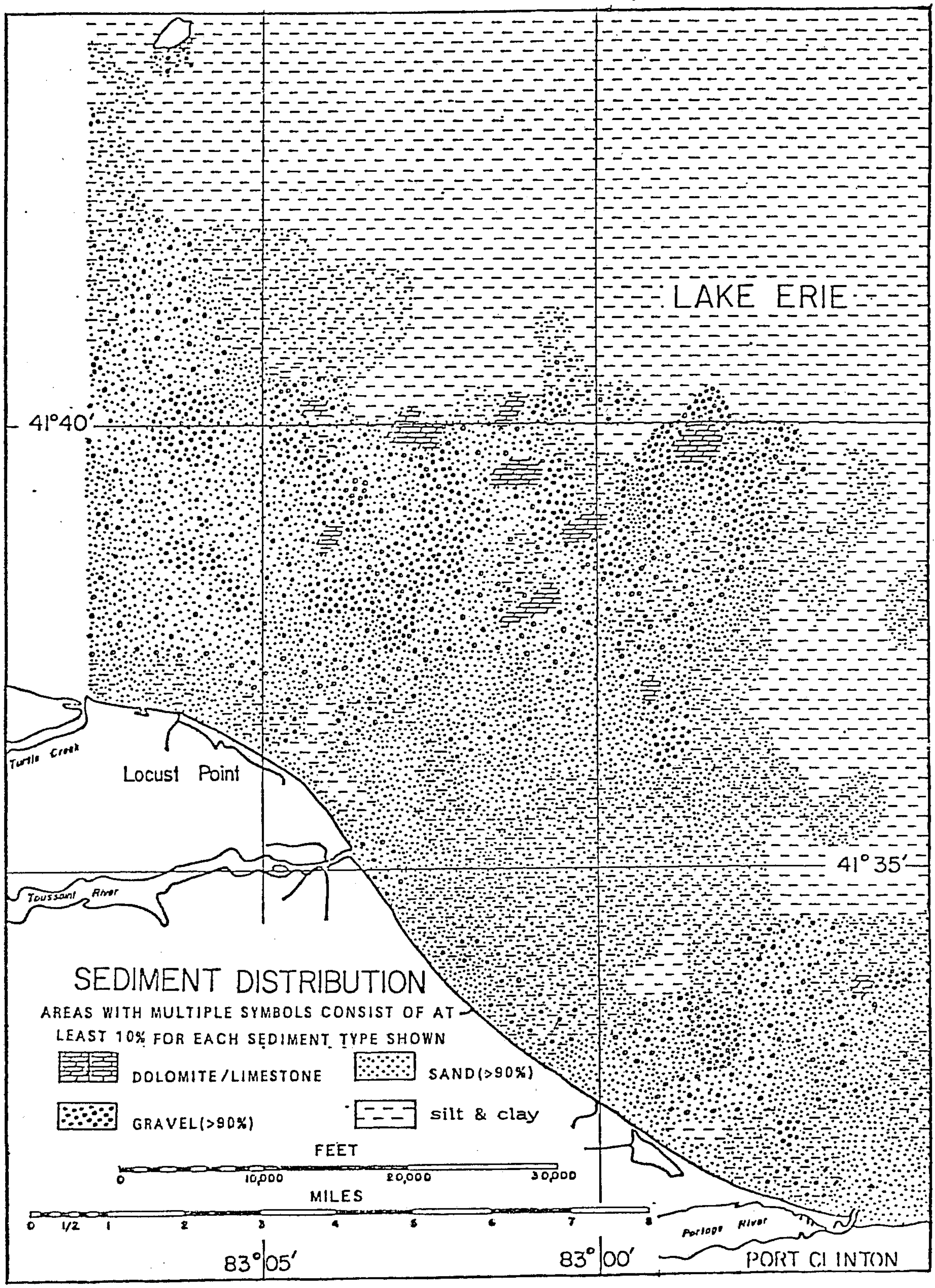


FIGURE 11. SEDIMENT DISTRIBUTION MAP OF WESTERN LAKE ERIE IN THE VICINITY OF LOCUST POINT

APPENDIX A

DAILY ICHTHYOPLANKTON ENTRAINMENT AT THE DAVIS-BESSE NUCLEAR POWER STATION DURING 1978

LEGEND

YEAR = 1978
DAY = Julian date, 1=January 1; 365=December 31
GD = Discharge volume in millions of gallons/day
MGD = Intake volume in gallons/day (discharge volume X 1.3)
MCPDAY = Intake volume in cubic meters/day
WCONC = Intake volume in 100's of cubic meters/day
SPECIES = 4 or 5 letter computer abbreviation:CARP=carp, ESHIN=emerald shiner, DRUM=freshwater drum, GSHAD=gizzard shad, SMELT= rainbow smelt, SPOT= spottail shiner, WALLI=walleye, PERCH= yellow perch, and EGGS=eggs
SSTA = Mean concentration of pro-larvae of the designated species per 100 m^3 of water over the period of entrainment for that species
SSTB = Mean concentration of post-larvae of the designated species per 100 m^3 of water over the period of entrainment for that species
SY = Mean concentration of all larvae (pro-larvae plus post-larvae) of the designated species per 100 m^3 over the period of entrainment for that species
ENTA = Estimated number of pro-larvae of the designated species entrained on the designated day (WCONC multiplied by SSTA)
ENTB = Estimated number of post-larvae of the designated species entrained on the designated day (WCONC multiplied by SSTB)
ENTY = Estimated number of larvae (pro-and post-larvae) of the designated species entrained on the designated day (WCONC multiplied by SY)

LARVAL ENTRAINMENT FOR SEPARATE SPECIES, CALCULATED OVER SPECIFIC PERIOD

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	WCONC	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
1	78	172	11.28	1	14664000	55503	555.03	CARP	0.31505	0.00000	0.31505	174.86	0.00	174.86
2	78	173	16.74	1	21762000	82369	823.69	CARP	0.31505	0.00000	0.31505	259.51	0.00	259.51
3	78	174	16.75	1	21775000	82419	824.19	CARP	0.31505	0.00000	0.31505	259.66	0.00	259.66
4	78	175	1.62	1	2106000	7971	79.71	CARP	0.31505	0.00000	0.31505	25.11	0.00	25.11
5	78	175	16.38	1	21294000	80598	805.98	CARP	0.31505	0.00000	0.31505	253.93	0.00	253.93
6	78	176	16.70	1	21710000	82173	821.73	CARP	0.31505	0.00000	0.31505	258.89	0.00	258.89
7	78	177	16.70	1	21710000	82173	821.73	CARP	0.31505	0.00000	0.31505	258.89	0.00	258.89
8	78	178	16.70	1	21710000	82173	821.73	CARP	0.31505	0.00000	0.31505	258.89	0.00	258.89
9	78	179	16.70	1	21710000	82173	821.73	CARP	0.31505	0.00000	0.31505	258.89	0.00	258.89
10	78	180	16.69	1	21697000	82123	821.23	CARP	0.31505	0.00000	0.31505	258.73	0.00	258.73
11	78	181	16.38	1	21294000	80598	805.98	CARP	0.31505	0.00000	0.31505	253.93	0.00	253.93
12	78	182	25.72	1	33436000	126556	1265.56	CARP	0.31505	0.00000	0.31505	398.72	0.00	398.72
13	78	183	25.72	1	33436000	126556	1265.56	CARP	0.31505	0.00000	0.31505	398.72	0.00	398.72
14	78	184	25.72	1	33436000	126556	1265.56	CARP	0.31505	0.00000	0.31505	398.72	0.00	398.72
15	78	185	16.72	1	21736000	82271	822.71	CARP	0.31505	0.00000	0.31505	259.20	0.00	259.20
16	78	186	16.74	1	21762000	82369	823.69	CARP	0.31505	0.00000	0.31505	259.51	0.00	259.51
17	78	187	16.74	1	21762000	82369	823.69	CARP	0.31505	0.00000	0.31505	259.51	0.00	259.51
18	78	188	16.49	1	21437000	81139	811.39	CARP	0.31505	0.00000	0.31505	255.63	0.00	255.63
19	78	189	16.71	1	21723000	82222	822.22	CARP	0.31505	0.00000	0.31505	259.04	0.00	259.04
20	78	190	16.72	1	21736000	82271	822.71	CARP	0.31505	0.00000	0.31505	259.20	0.00	259.20
21	78	191	25.72	1	33436000	126556	1265.56	CARP	0.31505	0.00000	0.31505	398.72	0.00	398.72
22	78	192	25.72	1	33436000	126556	1265.56	CARP	0.31505	0.00000	0.31505	398.72	0.00	398.72
23	78	193	25.72	1	33436000	126556	1265.56	CARP	0.31505	0.00000	0.31505	398.72	0.00	398.72
24	78	172	11.28	1	14664000	55503	555.03	ESHIN	3.67507	1.00307	4.67814	2039.79	556.74	2596.52
25	78	173	16.74	1	21762000	82369	823.69	ESHIN	3.67507	1.00307	4.67814	3027.13	826.22	3853.35
26	78	174	16.75	1	21775000	82419	824.19	ESHIN	3.67507	1.00307	4.67814	3028.94	826.72	3855.66
27	78	175	1.62	1	2106000	7971	79.71	ESHIN	3.67507	1.00307	4.67814	292.95	79.96	372.91
28	78	175	16.38	1	21294000	80598	805.98	ESHIN	3.67507	1.00307	4.67814	2962.03	808.46	3770.49
29	78	176	16.70	1	21710000	82173	821.73	ESHIN	3.67507	1.00307	4.67814	3019.90	824.25	3844.15
30	78	177	16.70	1	21710000	82173	821.73	ESHIN	3.67507	1.00307	4.67814	3019.90	824.25	3844.15
31	78	178	16.70	1	21710000	82173	821.73	ESHIN	3.67507	1.00307	4.67814	3019.90	824.25	3844.15
32	78	179	16.70	1	21710000	82173	821.73	ESHIN	3.67507	1.00307	4.67814	3019.90	824.25	3844.15
33	78	180	16.69	1	21697000	82123	821.23	ESHIN	3.67507	1.00307	4.67814	3018.09	823.76	3841.94
34	78	181	16.38	1	21294000	80598	805.98	ESHIN	3.67507	1.00307	4.67814	2962.03	808.46	3770.49
35	78	182	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
36	78	183	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
37	78	184	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
38	78	185	16.72	1	21736000	82271	822.71	ESHIN	3.67507	1.00307	4.67814	3023.51	825.24	3848.75
39	78	186	16.74	1	21762000	82369	823.69	ESHIN	3.67507	1.00307	4.67814	3027.13	826.22	3853.35
40	78	187	16.74	1	21762000	82369	823.69	ESHIN	3.67507	1.00307	4.67814	3027.13	826.22	3853.35
41	78	188	16.49	1	21437000	81139	811.39	ESHIN	3.67507	1.00307	4.67814	2981.92	813.88	3795.81
42	78	189	16.71	1	21723000	82222	822.22	ESHIN	3.67507	1.00307	4.67814	3021.70	824.74	3846.45
43	78	190	16.72	1	21736000	82271	822.71	ESHIN	3.67507	1.00307	4.67814	3023.51	825.24	3848.75
44	78	191	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
45	78	192	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
46	78	193	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
47	78	194	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
48	78	195	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
49	78	196	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
50	78	197	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
51	78	198	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
52	78	199	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
53	78	200	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	WCONC	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
54	78	201	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
55	78	202	25.72	1	33436000	126556	1265.56	ESHIN	3.67507	1.00307	4.67814	4651.00	1269.44	5920.44
56	78	203	31.11	1	40443000	153077	1530.77	ESHIN	3.67507	1.00307	4.67814	5625.69	1535.47	7161.16
57	78	204	32.45	1	42185000	159671	1596.71	ESHIN	3.67507	1.00307	4.67814	5868.00	1601.61	7469.61
58	78	205	33.16	1	43108000	163164	1631.64	ESHIN	3.67507	1.00307	4.67814	5996.39	1636.65	7633.05
59	78	206	32.66	1	42458000	160704	1607.04	ESHIN	3.67507	1.00307	4.67814	5905.98	1611.97	7517.95
60	78	207	32.75	1	42575000	161147	1611.47	ESHIN	3.67507	1.00307	4.67814	5922.25	1616.42	7538.67
61	78	208	32.43	1	42159000	159572	1595.72	ESHIN	3.67507	1.00307	4.67814	5864.39	1600.62	7465.01
62	78	209	31.56	1	41028000	155291	1552.91	ESHIN	3.67507	1.00307	4.67814	5707.06	1557.68	7264.74
63	78	210	30.23	1	39299000	148747	1487.47	ESHIN	3.67507	1.00307	4.67814	5466.56	1492.04	6958.59
64	78	211	28.05	1	36465000	138020	1380.20	ESHIN	3.67507	1.00307	4.67814	5072.34	1384.44	6456.78
65	78	212	26.96	1	35048000	132657	1326.57	ESHIN	3.67507	1.00307	4.67814	4875.23	1330.64	6205.88
66	78	213	38.32	1	49816000	188554	1885.54	ESHIN	3.67507	1.00307	4.67814	6929.49	1891.33	8820.82
67	78	214	40.65	1	52845000	200019	2000.19	ESHIN	3.67507	1.00307	4.67814	7350.83	2006.33	9357.16
68	78	215	32.47	1	42211000	159769	1597.69	ESHIN	3.67507	1.00307	4.67814	5871.62	1602.60	7474.22
69	78	216	27.87	1	36231000	137135	1371.35	ESHIN	3.67507	1.00307	4.67814	5039.79	1375.56	6415.35
70	78	217	39.90	1	51870000	196329	1963.29	ESHIN	3.67507	1.00307	4.67814	7215.20	1969.31	9184.52
71	78	218	40.84	1	53092000	200954	2009.54	ESHIN	3.67507	1.00307	4.67814	7385.18	2015.71	9400.89
72	78	219	41.40	1	53820000	203709	2037.09	ESHIN	3.67507	1.00307	4.67814	7486.45	2043.35	9529.80
73	78	220	39.93	1	51909000	196476	1964.76	ESHIN	3.67507	1.00307	4.67814	7220.63	1970.79	9191.42
74	78	221	31.81	1	41353000	156522	1565.22	ESHIN	3.67507	1.00307	4.67814	5752.27	1570.02	7322.29
75	78	222	23.86	1	31018000	117403	1174.03	ESHIN	3.67507	1.00307	4.67814	4314.65	1177.64	5492.29
76	78	223	27.58	1	35854000	135708	1357.08	ESHIN	3.67507	1.00307	4.67814	4987.35	1361.25	6348.60
77	78	136	16.77	1	21801000	82517	825.17	DRUM	1.88691	0.12260	2.00951	1557.02	101.17	1658.19
78	78	137	16.61	1	21593000	81730	817.30	DRUM	1.88691	0.12260	2.00951	1542.17	100.20	1642.37
79	78	138	16.64	1	21632000	81877	818.77	DRUM	1.88691	0.12260	2.00951	1544.95	100.38	1645.34
80	78	139	16.63	1	21619000	81828	818.28	DRUM	1.88691	0.12260	2.00951	1544.02	100.32	1644.35
81	78	140	16.60	1	21580000	81681	816.81	DRUM	1.88691	0.12260	2.00951	1541.24	100.14	1641.38
82	78	141	16.54	1	21502000	81385	813.85	DRUM	1.88691	0.12260	2.00951	1535.67	99.78	1635.45
83	78	142	16.61	1	21593000	81730	817.30	DRUM	1.88691	0.12260	2.00951	1542.17	100.20	1642.37
84	78	143	16.64	1	21632000	81877	818.77	DRUM	1.88691	0.12260	2.00951	1544.95	100.38	1645.34
85	78	144	16.61	1	21593000	81730	817.30	DRUM	1.88691	0.12260	2.00951	1542.17	100.20	1642.37
86	78	145	19.52	1	25376000	96048	960.48	DRUM	1.88691	0.12260	2.00951	1812.35	117.76	1930.11
87	78	146	16.72	1	21736000	82271	822.71	DRUM	1.88691	0.12260	2.00951	1552.38	100.87	1653.25
88	78	147	16.71	1	21723000	82222	822.22	DRUM	1.88691	0.12260	2.00951	1551.45	100.81	1652.26
89	78	148	16.72	1	21736000	82271	822.71	DRUM	1.88691	0.12260	2.00951	1552.38	100.87	1653.25
90	78	149	16.71	1	21723000	82222	822.22	DRUM	1.88691	0.12260	2.00951	1551.45	100.81	1652.26
91	78	150	16.63	1	21619000	81828	818.28	DRUM	1.88691	0.12260	2.00951	1544.02	100.32	1644.35
92	78	151	16.76	1	21788000	82468	824.68	DRUM	1.88691	0.12260	2.00951	1556.09	101.11	1657.20
93	78	152	16.79	1	21827000	82615	826.15	DRUM	1.88691	0.12260	2.00951	1558.88	101.29	1660.17
94	78	153	16.75	1	21775000	82419	824.19	DRUM	1.88691	0.12260	2.00951	1555.17	101.05	1656.21
95	78	154	16.71	1	21723000	82222	822.22	DRUM	1.88691	0.12260	2.00951	1551.45	100.81	1652.26
96	78	155	16.71	1	21723000	82222	822.22	DRUM	1.88691	0.12260	2.00951	1551.45	100.81	1652.26
97	78	156	16.71	1	21723000	82222	822.22	DRUM	1.88691	0.12260	2.00951	1551.45	100.81	1652.26
98	78	157	16.71	1	21723000	82222	822.22	DRUM	1.88691	0.12260	2.00951	1551.45	100.81	1652.26
99	78	158	17.67	1	22971000	86945	869.45	DRUM	1.88691	0.12260	2.00951	1640.58	106.60	1747.18
100	78	159	16.75	1	21775000	82419	824.19	DRUM	1.88691	0.12260	2.00951	1555.17	101.05	1656.21
101	78	160	16.76	1	21788000	82468	824.68	DRUM	1.88691	0.12260	2.00951	1556.09	101.11	1657.20
102	78	161	16.79	1	21827000	82615	826.15	DRUM	1.88691	0.12260	2.00951	1558.88	101.29	1660.17
103	78	162	16.41	1	21333000	80746	807.46	DRUM	1.88691	0.12260	2.00951	1523.60	99.00	1622.60
104	78	163	16.38	1	21294000	80598	805.98	DRUM	1.88691	0.12260	2.00951	1520.81	98.82	1619.63
105	78	164	16.83	1	21879000	82812	828.12	DRUM	1.88691	0.12260	2.00951	1562.59	101.53	1664.12
106	78	165	16.81	1	21853000	82714	827.14	DRUM	1.88691	0.12260	2.00951	1560.74	101.41	1662.15

LARVAL ENTRAINMENT FOR SEPARATE SPECIES, CALCULATED OVER SPECIFIC PERIOD 16:50 FRIDAY, AUGUST 31, 1979 11

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	WCONC	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
107	78	166	16.80	1	21840000	82665	826.65	DRUM	1.88691	0.1226	2.0095	1559.81	101.3	1661.2
108	78	167	16.79	1	21827000	82615	826.15	DRUM	1.88691	0.1226	2.0095	1558.88	101.3	1660.2
109	78	168	16.76	1	21788000	82468	824.68	DRUM	1.88691	0.1226	2.0095	1556.09	101.1	1657.2
110	78	169	16.76	1	21788000	82468	824.68	DRUM	1.88691	0.1226	2.0095	1556.09	101.1	1657.2
111	78	170	16.76	1	21788000	82468	824.68	DRUM	1.88691	0.1226	2.0095	1556.09	101.1	1657.2
112	78	171	11.62	1	15106000	57176	571.76	DRUM	1.88691	0.1226	2.0095	1078.87	70.1	1149.0
113	78	172	11.28	1	14664000	55503	555.03	DRUM	1.88691	0.1226	2.0095	1047.30	68.0	1115.3
114	78	173	16.74	1	21762000	82369	823.69	DRUM	1.88691	0.1226	2.0095	1554.24	101.0	1655.2
115	78	174	16.75	1	21775000	82419	824.19	DRUM	1.88691	0.1226	2.0095	1555.17	101.0	1656.2
116	78	175	1.62	1	2106000	7971	79.71	DRUM	1.88691	0.1226	2.0095	150.41	9.8	160.2
117	78	175	16.38	1	21294000	80598	805.98	DRUM	1.88691	0.1226	2.0095	1520.81	98.8	1619.6
118	78	176	16.70	1	21710000	82173	821.73	DRUM	1.88691	0.1226	2.0095	1550.52	100.7	1651.3
119	78	177	16.70	1	21710000	82173	821.73	DRUM	1.88691	0.1226	2.0095	1550.52	100.7	1651.3
120	78	178	16.70	1	21710000	82173	821.73	DRUM	1.88691	0.1226	2.0095	1550.52	100.7	1651.3
121	78	179	16.70	1	21710000	82173	821.73	DRUM	1.88691	0.1226	2.0095	1550.52	100.7	1651.3
122	78	180	16.69	1	21697000	82123	821.23	DRUM	1.88691	0.1226	2.0095	1549.60	100.7	1650.3
123	78	181	16.38	1	21294000	80598	805.98	DRUM	1.88691	0.1226	2.0095	1520.81	98.8	1619.6
124	78	182	25.72	1	33436000	126556	1265.56	DRUM	1.88691	0.1226	2.0095	2387.99	155.2	2543.2
125	78	183	25.72	1	33436000	126556	1265.56	DRUM	1.88691	0.1226	2.0095	2387.99	155.2	2543.2
126	78	184	25.72	1	33436000	126556	1265.56	DRUM	1.88691	0.1226	2.0095	2387.99	155.2	2543.2
127	78	185	16.72	1	21736000	82271	822.71	DRUM	1.88691	0.1226	2.0095	1552.38	100.9	1653.2
128	78	186	16.74	1	21762000	82369	823.69	DRUM	1.88691	0.1226	2.0095	1554.24	101.0	1655.2
129	78	187	16.74	1	21762000	82369	823.69	DRUM	1.88691	0.1226	2.0095	1554.24	101.0	1655.2
130	78	188	16.49	1	21437000	81139	811.39	DRUM	1.88691	0.1226	2.0095	1531.03	99.5	1630.5
131	78	189	16.71	1	21723000	82222	822.22	DRUM	1.88691	0.1226	2.0095	1551.45	100.9	1652.3
132	78	190	16.72	1	21736000	82271	822.71	DRUM	1.88691	0.1226	2.0095	1552.38	100.9	1653.2
133	78	191	25.72	1	33436000	126556	1265.56	DRUM	1.88691	0.1226	2.0095	2387.99	155.2	2543.2
134	78	192	25.72	1	33436000	126556	1265.56	DRUM	1.88691	0.1226	2.0095	2387.99	155.2	2543.2
135	78	193	25.72	1	33436000	126556	1265.56	DRUM	1.88691	0.1226	2.0095	2387.99	155.2	2543.2
136	78	150	16.63	1	21619000	81828	818.28	GSHAD	3.35578	48.9861	52.3419	2745.97	40084.4	42830.4
137	78	151	16.76	1	21788000	82468	824.68	GSHAD	3.35578	48.9861	52.3419	2767.44	40397.8	43165.2
138	78	152	16.79	1	21827000	82615	826.15	GSHAD	3.35578	48.9861	52.3419	2772.39	40470.1	43242.5
139	78	153	16.75	1	21775000	82419	824.19	GSHAD	3.35578	48.9861	52.3419	2765.79	40373.7	43139.4
140	78	154	16.71	1	21723000	82222	822.22	GSHAD	3.35578	48.9861	52.3419	2759.18	40277.2	43036.4
141	78	155	16.71	1	21723000	82222	822.22	GSHAD	3.35578	48.9861	52.3419	2759.18	40277.2	43036.4
142	78	156	16.71	1	21723000	82222	822.22	GSHAD	3.35578	48.9861	52.3419	2759.18	40277.2	43036.4
143	78	157	16.71	1	21723000	82222	822.22	GSHAD	3.35578	48.9861	52.3419	2759.18	40277.2	43036.4
144	78	158	17.67	1	22971000	86945	869.45	GSHAD	3.35578	48.9861	52.3419	2917.70	42591.2	45508.9
145	78	159	16.75	1	21775000	82419	824.19	GSHAD	3.35578	48.9861	52.3419	2765.79	40373.7	43139.4
146	78	160	16.76	1	21788000	82468	824.68	GSHAD	3.35578	48.9861	52.3419	2767.44	40397.8	43165.2
147	78	161	16.79	1	21827000	82615	826.15	GSHAD	3.35578	48.9861	52.3419	2772.39	40470.1	43242.5
148	78	162	16.41	1	21333000	80746	807.46	GSHAD	3.35578	48.9861	52.3419	2709.64	39554.1	42263.8
149	78	163	16.38	1	21294000	80598	805.98	GSHAD	3.35578	48.9861	52.3419	2704.69	39481.8	42186.5
150	78	164	16.83	1	21879000	82812	828.12	GSHAD	3.35578	48.9861	52.3419	2779.00	40566.5	43345.5
151	78	165	16.81	1	21853000	82714	827.14	GSHAD	3.35578	48.9861	52.3419	2775.69	40518.3	43294.0
152	78	166	16.80	1	21840000	82665	826.65	GSHAD	3.35578	48.9861	52.3419	2774.04	40494.2	43268.2
153	78	167	16.79	1	21827000	82615	826.15	GSHAD	3.35578	48.9861	52.3419	2772.39	40470.1	43242.5
154	78	168	16.76	1	21788000	82468	824.68	GSHAD	3.35578	48.9861	52.3419	2767.44	40397.8	43165.2
155	78	169	16.76	1	21788000	82468	824.68	GSHAD	3.35578	48.9861	52.3419	2767.44	40397.8	43165.2
156	78	170	16.76	1	21788000	82468	824.68	GSHAD	3.35578	48.9861	52.3419	2767.44	40397.8	43165.2
157	78	171	11.62	1	15106000	57176	571.76	GSHAD	3.35578	48.9861	52.3419	1918.71	28008.5	29927.2
158	78	172	11.28	1	14664000	55503	555.03	GSHAD	3.35578	48.9861	52.3419	1862.57	27188.9	29051.5
159	78	173	16.74	1	21762000	82369	823.69	GSHAD	3.35578	48.9861	52.3419	2764.13	40349.5	43113.7

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	WCONC	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
160	78	174	16.75	1	21775000	82419	824.19	GSHAD	3.35578	48.9861	52.3419	2765.79	40373.7	43139
161	78	175	1.62	1	2106000	7971	79.71	GSHAD	3.35578	48.9861	52.3419	267.50	3904.8	4172
162	78	175	16.38	1	21294000	80598	805.98	GSHAD	3.35578	48.9861	52.3419	2704.69	39481.8	42187
163	78	176	16.70	1	21710000	82173	821.73	GSHAD	3.35578	48.9861	52.3419	2757.53	40253.1	43011
164	78	177	16.70	1	21710000	82173	821.73	GSHAD	3.35578	48.9861	52.3419	2757.53	40253.1	43011
165	78	178	16.70	1	21710000	82173	821.73	GSHAD	3.35578	48.9861	52.3419	2757.53	40253.1	43011
166	78	179	16.70	1	21710000	82173	821.73	GSHAD	3.35578	48.9861	52.3419	2757.53	40253.1	43011
167	78	180	16.69	1	21697000	82123	821.23	GSHAD	3.35578	48.9861	52.3419	2755.88	40229.0	42985
168	78	181	16.38	1	21294000	80598	805.98	GSHAD	3.35578	48.9861	52.3419	2704.69	39481.8	42187
169	78	182	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
170	78	183	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
171	78	184	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
172	78	185	16.72	1	21736000	82271	822.71	GSHAD	3.35578	48.9861	52.3419	2760.83	40301.3	43062
173	78	186	16.74	1	21762000	82369	823.69	GSHAD	3.35578	48.9861	52.3419	2764.13	40349.5	43114
174	78	187	16.74	1	21762000	82369	823.69	GSHAD	3.35578	48.9861	52.3419	2764.13	40349.5	43114
175	78	188	16.49	1	21437000	81139	811.39	GSHAD	3.35578	48.9861	52.3419	2722.85	39747.0	42470
176	78	189	16.71	1	21723000	82222	822.22	GSHAD	3.35578	48.9861	52.3419	2759.18	40277.2	43036
177	78	190	16.72	1	21736000	82271	822.71	GSHAD	3.35578	48.9861	52.3419	2760.83	40301.3	43062
178	78	191	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
179	78	192	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
180	78	193	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
181	78	194	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
182	78	195	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
183	78	196	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
184	78	197	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
185	78	198	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
186	78	199	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
187	78	200	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
188	78	201	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
189	78	202	25.72	1	33436000	126556	1265.56	GSHAD	3.35578	48.9861	52.3419	4246.93	61994.6	66242
190	78	203	31.11	1	40443000	153077	1530.77	GSHAD	3.35578	48.9861	52.3419	5136.93	74986.5	80123
191	78	204	32.45	1	42185000	159671	1596.71	GSHAD	3.35578	48.9861	52.3419	5358.19	78216.4	83575
192	78	205	33.16	1	43108000	163164	1631.64	GSHAD	3.35578	48.9861	52.3419	5475.43	79927.8	85403
193	78	206	32.66	1	42458000	160704	1607.04	GSHAD	3.35578	48.9861	52.3419	5392.87	78722.6	84115
194	78	207	32.75	1	42575000	161147	1611.47	GSHAD	3.35578	48.9861	52.3419	5407.73	78939.5	84347
195	78	208	32.43	1	42159000	159572	1595.72	GSHAD	3.35578	48.9861	52.3419	5354.89	78168.2	83523
196	78	209	31.56	1	41028000	155291	1552.91	GSHAD	3.35578	48.9861	52.3419	5211.24	76071.2	81282
197	78	210	30.23	1	39299000	148747	1487.47	GSHAD	3.35578	48.9861	52.3419	4991.62	72865.4	77857
198	78	211	28.05	1	36465000	138020	1380.20	GSHAD	3.35578	48.9861	52.3419	4631.66	67610.8	72242
199	78	212	26.96	1	35048000	132657	1326.57	GSHAD	3.35578	48.9861	52.3419	4451.68	64983.5	69435
200	78	213	38.32	1	49816000	188554	1885.54	GSHAD	3.35578	48.9861	52.3419	6327.46	92365.3	98693
201	78	214	40.65	1	52845000	200019	2000.19	GSHAD	3.35578	48.9861	52.3419	6712.19	97981.4	104694
202	78	215	32.47	1	42211000	159769	1597.69	GSHAD	3.35578	48.9861	52.3419	5361.50	78264.6	83626
203	78	216	27.87	1	36231000	137135	1371.35	GSHAD	3.35578	48.9861	52.3419	4601.94	67176.9	71779
204	78	217	39.90	1	51870000	196329	1963.29	GSHAD	3.35578	48.9861	52.3419	6588.35	96173.7	102762
205	78	218	40.84	1	53092000	200954	2009.54	GSHAD	3.35578	48.9861	52.3419	6743.56	98439.4	105183
206	78	219	41.40	1	53820000	203709	2037.09	GSHAD	3.35578	48.9861	52.3419	6836.03	99789.2	106625
207	78	220	39.93	1	51909000	196476	1964.76	GSHAD	3.35578	48.9861	52.3419	6593.30	96246.0	102839
208	78	221	31.81	1	41353000	156522	1565.22	GSHAD	3.35578	48.9861	52.3419	5252.52	76673.8	81926
209	78	222	23.86	1	31018000	117403	1174.03	GSHAD	3.35578	48.9861	52.3419	3939.80	57511.4	61451
210	78	223	27.58	1	35854000	135708	1357.08	GSHAD	3.35578	48.9861	52.3419	4554.05	66477.9	71032
211	78	136	16.77	1	21801000	82517	825.17	SMELT	0.12032	0.8025	0.9228	99.29	662.2	761
212	78	137	16.61	1	21593000	81730	817.30	SMELT	0.12032	0.8025	0.9228	98.34	655.8	754

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	HCONG	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
213	78	138	16.64	1	21632000	81877	818.77	SMELT	0.120323	0.802453	0.922776	98.517	657.03	755.55
214	78	139	16.63	1	21619000	81828	818.28	SMELT	0.120323	0.802453	0.922776	98.458	656.63	755.09
215	78	140	16.60	1	21580000	81681	816.81	SMELT	0.120323	0.802453	0.922776	98.281	655.45	753.73
216	78	141	16.54	1	21502000	81385	813.85	SMELT	0.120323	0.802453	0.922776	97.925	653.08	751.00
217	78	142	16.61	1	21593000	81730	817.30	SMELT	0.120323	0.802453	0.922776	98.340	655.84	754.19
218	78	143	16.64	1	21632000	81877	818.77	SMELT	0.120323	0.802453	0.922776	98.517	657.03	755.55
219	78	144	16.61	1	21593000	81730	817.30	SMELT	0.120323	0.802453	0.922776	98.340	655.84	754.18
220	78	145	19.52	1	25376000	96048	960.48	SMELT	0.120323	0.802453	0.922776	115.568	770.74	886.31
221	78	146	16.72	1	21736000	82271	822.71	SMELT	0.120323	0.802453	0.922776	98.991	660.19	759.18
222	78	147	16.71	1	21723000	82222	822.22	SMELT	0.120323	0.802453	0.922776	98.932	659.79	758.72
223	78	148	16.72	1	21736000	82271	822.71	SMELT	0.120323	0.802453	0.922776	98.991	660.19	759.18
224	78	149	16.71	1	21723000	82222	822.22	SMELT	0.120323	0.802453	0.922776	98.932	659.79	758.72
225	78	150	16.63	1	21619000	81828	818.28	SMELT	0.120323	0.802453	0.922776	98.458	656.63	755.09
226	78	151	16.76	1	21788000	82468	824.68	SMELT	0.120323	0.802453	0.922776	99.228	661.77	760.99
227	78	152	16.79	1	21827000	82615	826.15	SMELT	0.120323	0.802453	0.922776	99.405	662.95	762.36
228	78	153	16.75	1	21775000	82419	824.19	SMELT	0.120323	0.802453	0.922776	99.169	661.37	760.54
229	78	154	16.71	1	21723000	82222	822.22	SMELT	0.120323	0.802453	0.922776	98.932	659.79	758.72
230	78	155	16.71	1	21723000	82222	822.22	SMELT	0.120323	0.802453	0.922776	98.932	659.79	758.72
231	78	156	16.71	1	21723000	82222	822.22	SMELT	0.120323	0.802453	0.922776	98.932	659.79	758.72
232	78	157	16.71	1	21723000	82222	822.22	SMELT	0.120323	0.802453	0.922776	98.932	659.79	758.72
233	78	158	17.67	1	22971000	86945	869.45	SMELT	0.120323	0.802453	0.922776	104.615	697.70	802.31
234	78	159	16.75	1	21775000	82419	824.19	SMELT	0.120323	0.802453	0.922776	99.169	661.37	760.54
235	78	160	16.76	1	21788000	82468	824.68	SMELT	0.120323	0.802453	0.922776	99.228	661.77	760.99
236	78	161	16.79	1	21827000	82615	826.15	SMELT	0.120323	0.802453	0.922776	99.405	662.95	762.36
237	78	162	16.41	1	21333000	80746	807.46	SMELT	0.120323	0.802453	0.922776	97.156	647.95	745.10
238	78	163	16.38	1	21294000	80598	805.98	SMELT	0.120323	0.802453	0.922776	96.978	646.76	743.74
239	78	164	16.83	1	21879000	82812	828.12	SMELT	0.120323	0.802453	0.922776	99.642	664.53	764.17
240	78	165	16.81	1	21853000	82714	827.14	SMELT	0.120323	0.802453	0.922776	99.524	663.74	763.26
241	78	166	16.80	1	21840000	82665	826.65	SMELT	0.120323	0.802453	0.922776	99.465	663.35	762.81
242	78	167	16.79	1	21827000	82615	826.15	SMELT	0.120323	0.802453	0.922776	99.405	662.95	762.36
243	78	168	16.76	1	21788000	82468	824.68	SMELT	0.120323	0.802453	0.922776	99.228	661.77	760.99
244	78	169	16.76	1	21788000	82468	824.68	SMELT	0.120323	0.802453	0.922776	99.228	661.77	760.99
245	78	170	16.76	1	21788000	82468	824.68	SMELT	0.120323	0.802453	0.922776	99.228	661.77	760.99
246	78	171	11.62	1	15106000	57176	571.76	SMELT	0.120323	0.802453	0.922776	68.796	458.81	527.61
247	78	172	11.28	1	14664000	55503	555.03	SMELT	0.120323	0.802453	0.922776	66.783	445.39	512.17
248	78	173	16.74	1	21762000	82369	823.69	SMELT	0.120323	0.802453	0.922776	99.109	660.98	760.09
249	78	174	16.75	1	21775000	82419	824.19	SMELT	0.120323	0.802453	0.922776	99.169	661.37	760.54
250	78	175	1.62	1	2106000	7971	79.71	SMELT	0.120323	0.802453	0.922776	9.591	63.97	73.56
251	78	175	16.38	1	21294000	80598	805.98	SMELT	0.120323	0.802453	0.922776	96.978	646.76	743.74
252	78	176	16.70	1	21710000	82173	821.73	SMELT	0.120323	0.802453	0.922776	98.873	659.40	758.27
253	78	177	16.70	1	21710000	82173	821.73	SMELT	0.120323	0.802453	0.922776	98.873	659.40	758.27
254	78	178	16.70	1	21710000	82173	821.73	SMELT	0.120323	0.802453	0.922776	98.873	659.40	758.27
255	78	179	16.70	1	21710000	82173	821.73	SMELT	0.120323	0.802453	0.922776	98.873	659.40	758.27
256	78	180	16.69	1	21697000	82123	821.23	SMELT	0.120323	0.802453	0.922776	98.813	659.00	757.82
257	78	181	16.38	1	21294000	80598	805.98	SMELT	0.120323	0.802453	0.922776	96.978	646.76	743.74
258	78	182	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
259	78	183	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
260	78	184	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
261	78	185	16.72	1	21736000	82271	822.71	SMELT	0.120323	0.802453	0.922776	98.991	660.19	759.18
262	78	186	16.74	1	21762000	82369	823.69	SMELT	0.120323	0.802453	0.922776	99.109	660.98	760.09
263	78	187	16.74	1	21762000	82369	823.69	SMELT	0.120323	0.802453	0.922776	99.109	660.98	760.09
264	78	188	16.49	1	21437000	81139	811.39	SMELT	0.120323	0.802453	0.922776	97.629	651.10	748.73
265	78	189	16.71	1	21723000	82222	822.22	SMELT	0.120323	0.802453	0.922776	98.932	659.79	758.72

LARVAL ENTRAINMENT FOR SEPARATE SPECIES, CALCULATED OVER SPECIFIC PERIOD   16:50 FRIDAY, AUGUST 31, 1979   14

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	WCONG	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
266	78	190	16.72	1	21736000	82271	822.71	SMELT	0.120323	0.802453	0.922776	98.991	660.19	759.18
267	78	191	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
268	78	192	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
269	78	193	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
270	78	194	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
271	78	195	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
272	78	196	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
273	78	197	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
274	78	198	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
275	78	199	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
276	78	200	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
277	78	201	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
278	78	202	25.72	1	33436000	126556	1265.56	SMELT	0.120323	0.802453	0.922776	152.276	1015.55	1167.83
279	78	203	31.11	1	40443000	153077	1530.77	SMELT	0.120323	0.802453	0.922776	184.187	1228.37	1412.56
280	78	204	32.45	1	42185000	159671	1596.71	SMELT	0.120323	0.802453	0.922776	192.121	1281.28	1473.40
281	78	205	33.18	1	43108000	163164	1631.64	SMELT	0.120323	0.802453	0.922776	196.324	1309.32	1505.64
282	78	206	32.66	1	42458000	160704	1607.04	SMELT	0.120323	0.802453	0.922776	193.364	1289.57	1482.94
283	78	207	32.75	1	42575000	161147	1611.47	SMELT	0.120323	0.802453	0.922776	193.897	1293.13	1487.03
284	78	208	32.43	1	42159000	159572	1595.72	SMELT	0.120323	0.802453	0.922776	192.002	1280.49	1472.50
285	78	209	31.56	1	41028000	155291	1552.91	SMELT	0.120323	0.802453	0.922776	186.851	1246.14	1432.99
286	78	210	30.23	1	39299000	148747	1487.47	SMELT	0.120323	0.802453	0.922776	178.977	1193.63	1372.60
287	78	211	28.05	1	36465000	138020	1380.20	SMELT	0.120323	0.802453	0.922776	166.070	1107.55	1273.62
288	78	212	26.96	1	35048000	132657	1326.57	SMELT	0.120323	0.802453	0.922776	159.617	1064.51	1224.13
289	78	213	38.32	1	49816000	188554	1885.54	SMELT	0.120323	0.802453	0.922776	226.874	1513.06	1739.93
290	78	214	40.65	1	52845000	200019	2000.19	SMELT	0.120323	0.802453	0.922776	240.669	1605.06	1845.73
291	78	215	32.47	1	42211000	159769	1597.69	SMELT	0.120323	0.802453	0.922776	192.239	1282.07	1474.31
292	78	216	27.87	1	36231000	137135	1371.35	SMELT	0.120323	0.802453	0.922776	165.005	1100.44	1265.45
293	78	217	39.90	1	51870000	196329	1963.29	SMELT	0.120323	0.802453	0.922776	236.228	1575.45	1811.67
294	78	218	40.84	1	53092000	200954	2009.54	SMELT	0.120323	0.802453	0.922776	241.794	1612.56	1854.35
295	78	219	41.40	1	53820000	203709	2037.09	SMELT	0.120323	0.802453	0.922776	245.109	1634.67	1879.78
296	78	220	39.93	1	51909000	196476	1964.76	SMELT	0.120323	0.802453	0.922776	236.406	1576.63	1813.04
297	78	221	31.81	1	41353000	156522	1565.22	SMELT	0.120323	0.802453	0.922776	188.332	1256.01	1444.34
298	78	222	23.86	1	31018000	117403	1174.03	SMELT	0.120323	0.802453	0.922776	141.263	942.11	1083.37
299	78	223	27.58	1	35854000	135708	1357.08	SMELT	0.120323	0.802453	0.922776	163.288	1088.99	1252.28
300	78	150	16.63	1	21619000	81828	818.28	SPOT	0.061779	0.125301	0.187080	50.552	102.53	153.08
301	78	151	16.76	1	21788000	82468	824.68	SPOT	0.061779	0.125301	0.187080	50.948	103.33	154.28
302	78	152	16.79	1	21827000	82615	826.15	SPOT	0.061779	0.125301	0.187080	51.039	103.52	154.56
303	78	153	16.75	1	21775000	82419	824.19	SPOT	0.061779	0.125301	0.187080	50.917	103.27	154.19
304	78	154	16.71	1	21723000	82222	822.22	SPOT	0.061779	0.125301	0.187080	50.796	103.02	153.82
305	78	155	16.71	1	21723000	82222	822.22	SPOT	0.061779	0.125301	0.187080	50.796	103.02	153.82
306	78	156	16.71	1	21723000	82222	822.22	SPOT	0.061779	0.125301	0.187080	50.796	103.02	153.82
307	78	157	16.71	1	21723000	82222	822.22	SPOT	0.061779	0.125301	0.187080	50.796	103.02	153.82
308	78	158	17.67	1	22971000	86945	869.45	SPOT	0.061779	0.125301	0.187080	53.714	108.94	162.66
309	78	159	16.75	1	21775000	82419	824.19	SPOT	0.061779	0.125301	0.187080	50.917	103.27	154.19
310	78	160	16.76	1	21788000	82468	824.68	SPOT	0.061779	0.125301	0.187080	50.948	103.33	154.28
311	78	161	16.79	1	21827000	82615	826.15	SPOT	0.061779	0.125301	0.187080	51.039	103.52	154.56
312	78	162	16.41	1	21333000	80746	807.46	SPOT	0.061779	0.125301	0.187080	49.884	101.17	151.06
313	78	163	16.38	1	21294000	80598	805.98	SPOT	0.061779	0.125301	0.187080	49.792	100.99	150.78
314	78	164	16.83	1	21879000	82812	828.12	SPOT	0.061779	0.125301	0.187080	51.160	103.76	154.92
315	78	165	16.81	1	21853000	82714	827.14	SPOT	0.061779	0.125301	0.187080	51.100	103.64	154.74
316	78	166	16.80	1	21840000	82665	826.65	SPOT	0.061779	0.125301	0.187080	51.069	103.58	154.65
317	78	167	16.79	1	21827000	82615	826.15	SPOT	0.061779	0.125301	0.187080	51.039	103.52	154.56
318	78	168	16.76	1	21788000	82468	824.68	SPOT	0.061779	0.125301	0.187080	50.948	103.33	154.28

LARVAL ENTRAINMENT FOR SEPARATE SPECIES, CALCULATED OVER SPECIFIC PERIOD

OBS	YEAR	DAY	GD	DUMMY	MGD	MGPDAY	WCONC	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
319	78	169	16.76	1	21788000	82468	824.68	SPOT	0.0617787	0.125301	0.18708	50.948	103.333	154.280
320	78	170	16.76	1	21788000	82468	824.68	SPOT	0.0617787	0.125301	0.18708	50.948	103.333	154.280
321	78	171	11.62	1	15106000	57176	571.76	SPOT	0.0617787	0.125301	0.18708	35.323	71.642	106.965
322	78	172	11.28	1	14664000	55503	555.03	SPOT	0.0617787	0.125301	0.18708	34.289	69.546	103.836
323	78	173	16.74	1	21762000	82369	823.69	SPOT	0.0617787	0.125301	0.18708	50.887	103.210	154.096
324	78	174	16.75	1	21775000	82419	824.19	SPOT	0.0617787	0.125301	0.18708	50.917	103.271	154.188
325	78	175	1.62	1	2106000	7971	79.71	SPOT	0.0617787	0.125301	0.18708	4.925	9.988	14.913
326	78	175	16.38	1	21294000	80598	805.98	SPOT	0.0617787	0.125301	0.18708	49.792	100.990	150.782
327	78	176	16.70	1	21710000	82173	821.73	SPOT	0.0617787	0.125301	0.18708	50.765	102.963	153.728
328	78	177	16.70	1	21710000	82173	821.73	SPOT	0.0617787	0.125301	0.18708	50.765	102.963	153.728
329	78	178	16.70	1	21710000	82173	821.73	SPOT	0.0617787	0.125301	0.18708	50.765	102.963	153.728
330	78	179	16.70	1	21710000	82173	821.73	SPOT	0.0617787	0.125301	0.18708	50.765	102.963	153.728
331	78	180	16.69	1	21697000	82123	821.23	SPOT	0.0617787	0.125301	0.18708	50.735	102.901	153.636
332	78	181	16.38	1	21294000	80598	805.98	SPOT	0.0617787	0.125301	0.18708	49.792	100.990	150.782
333	78	182	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
334	78	183	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
335	78	184	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
336	78	185	16.72	1	21736000	82271	822.71	SPOT	0.0617787	0.125301	0.18708	50.826	103.086	153.912
337	78	186	16.74	1	21762000	82369	823.69	SPOT	0.0617787	0.125301	0.18708	50.887	103.210	154.096
338	78	187	16.74	1	21762000	82369	823.69	SPOT	0.0617787	0.125301	0.18708	50.887	103.210	154.096
339	78	188	16.49	1	21437000	81139	811.39	SPOT	0.0617787	0.125301	0.18708	50.127	101.668	151.795
340	78	189	16.71	1	21723000	82222	822.22	SPOT	0.0617787	0.125301	0.18708	50.796	103.025	153.820
341	78	190	16.72	1	21736000	82271	822.71	SPOT	0.0617787	0.125301	0.18708	50.826	103.086	153.912
342	78	191	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
343	78	192	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
344	78	193	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
345	78	194	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
346	78	195	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
347	78	196	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
348	78	197	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
349	78	198	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
350	78	199	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
351	78	200	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
352	78	201	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
353	78	202	25.72	1	33436000	126556	1265.56	SPOT	0.0617787	0.125301	0.18708	78.184	158.575	236.760
354	78	203	31.11	1	40443000	153077	1530.77	SPOT	0.0617787	0.125301	0.18708	94.569	191.807	286.376
355	78	204	32.45	1	42185000	159671	1596.71	SPOT	0.0617787	0.125301	0.18708	98.642	200.069	298.711
356	78	205	33.16	1	43108000	163164	1631.64	SPOT	0.0617787	0.125301	0.18708	100.801	204.446	305.247
357	78	206	32.66	1	42458000	160704	1607.04	SPOT	0.0617787	0.125301	0.18708	99.281	201.363	300.644
358	78	207	32.75	1	42575000	161147	1611.47	SPOT	0.0617787	0.125301	0.18708	99.554	201.918	301.473
359	78	208	32.43	1	42159000	159572	1595.72	SPOT	0.0617787	0.125301	0.18708	98.582	199.945	298.527
360	78	209	31.56	1	41028000	155291	1552.91	SPOT	0.0617787	0.125301	0.18708	95.937	194.581	290.519
361	78	210	30.23	1	39299000	148747	1487.47	SPOT	0.0617787	0.125301	0.18708	91.894	186.381	278.276
362	78	211	28.05	1	36465000	138020	1380.20	SPOT	0.0617787	0.125301	0.18708	85.267	172.941	258.208
363	78	212	26.96	1	35048000	132657	1326.57	SPOT	0.0617787	0.125301	0.18708	81.954	166.220	248.174
364	78	213	38.32	1	49816000	188554	1885.54	SPOT	0.0617787	0.125301	0.18708	116.486	236.260	352.746
365	78	214	40.65	1	52845000	200019	2000.19	SPOT	0.0617787	0.125301	0.18708	123.569	250.625	374.194
366	78	215	32.47	1	42211000	159769	1597.69	SPOT	0.0617787	0.125301	0.18708	98.703	200.192	298.895
367	78	216	27.87	1	36231000	137135	1371.35	SPOT	0.0617787	0.125301	0.18708	84.720	171.831	256.551
368	78	217	39.90	1	51870000	196329	1963.29	SPOT	0.0617787	0.125301	0.18708	121.289	246.001	367.291
369	78	218	40.84	1	53092000	200954	2009.54	SPOT	0.0617787	0.125301	0.18708	124.147	251.797	375.943
370	78	219	41.40	1	53820000	203709	2037.09	SPOT	0.0617787	0.125301	0.18708	125.849	255.249	381.098
371	78	220	39.93	1	51909000	196476	1964.76	SPOT	0.0617787	0.125301	0.18708	121.380	246.186	367.567

LARVAL ENTRAINMENT FOR SEPARATE SPECIES, CALCULATED OVER SPECIFIC PERIOD   16:50 FRIDAY, AUGUST 31, 1979   16

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	WCONC	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
372	78	221	31.81	1	41353000	156522	1565.22	SPOT	0.0618	0.125301	0.1871	96.7	196.123	292.9
373	78	222	23.86	1	31018000	117403	1174.03	SPOT	0.0618	0.125301	0.1871	72.5	147.108	219.6
374	78	223	27.58	1	35854000	135708	1357.08	SPOT	0.0618	0.125301	0.1871	83.8	170.043	253.9
375	78	126	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
376	78	127	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
377	78	128	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
378	78	129	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
379	78	130	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
380	78	131	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
381	78	132	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
382	78	133	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
383	78	134	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
384	78	135	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
385	78	136	16.77	1	21801000	82517	825.17	WALLI	41.6069	0.000000	41.6069	34332.8	0.000	34332.8
386	78	137	16.61	1	21593000	81730	817.30	WALLI	41.6069	0.000000	41.6069	34005.2	0.000	34005.2
387	78	138	16.64	1	21632000	81877	818.77	WALLI	41.6069	0.000000	41.6069	34066.7	0.000	34066.7
388	78	139	16.63	1	21619000	81828	818.28	WALLI	41.6069	0.000000	41.6069	34046.2	0.000	34045.2
389	78	140	16.60	1	21580000	81681	816.81	WALLI	41.6069	0.000000	41.6069	33984.8	0.000	33984.8
390	78	141	16.54	1	21502000	81385	813.85	WALLI	41.6069	0.000000	41.6069	33861.9	0.000	33861.9
391	78	142	16.61	1	21593000	81730	817.30	WALLI	41.6069	0.000000	41.6069	34005.2	0.000	34005.2
392	78	143	16.64	1	21632000	81877	818.77	WALLI	41.6069	0.000000	41.6069	34066.7	0.000	34066.7
393	78	144	16.61	1	21593000	81730	817.30	WALLI	41.6069	0.000000	41.6069	34005.2	0.000	34005.2
394	78	145	19.52	1	25376000	96048	960.48	WALLI	41.6069	0.000000	41.6069	39962.8	0.000	39962.8
395	78	146	16.72	1	21736000	82271	822.71	WALLI	41.6069	0.000000	41.6069	34230.4	0.000	34230.4
396	78	147	16.71	1	21723000	82222	822.22	WALLI	41.6069	0.000000	41.6069	34210.0	0.000	34210.0
397	78	148	16.72	1	21736000	82271	822.71	WALLI	41.6069	0.000000	41.6069	34230.4	0.000	34230.4
398	78	149	16.71	1	21723000	82222	822.22	WALLI	41.6069	0.000000	41.6069	34210.0	0.000	34210.0
399	78	150	16.63	1	21619000	81828	818.28	WALLI	41.6069	0.000000	41.6069	34046.2	0.000	34046.2
400	78	126	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
401	78	127	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
402	78	128	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
403	78	129	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
404	78	130	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
405	78	131	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
406	78	132	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
407	78	133	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
408	78	134	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
409	78	135	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
410	78	136	16.77	1	21801000	82517	825.17	PERCH	1.6161	0.000000	1.6161	1333.6	0.000	1333.6
411	78	137	16.61	1	21593000	81730	817.30	PERCH	1.6161	0.000000	1.6161	1320.9	0.000	1320.9
412	78	138	16.64	1	21632000	81877	818.77	PERCH	1.6161	0.000000	1.6161	1323.3	0.000	1323.3
413	78	139	16.63	1	21619000	81828	818.28	PERCH	1.6161	0.000000	1.6161	1322.5	0.000	1322.5
414	78	140	16.60	1	21580000	81681	816.81	PERCH	1.6161	0.000000	1.6161	1320.1	0.000	1320.1
415	78	141	16.54	1	21502000	81385	813.85	PERCH	1.6161	0.000000	1.6161	1315.3	0.000	1315.3
416	78	142	16.61	1	21593000	81730	817.30	PERCH	1.6161	0.000000	1.6161	1320.9	0.000	1320.9
417	78	143	16.64	1	21632000	81877	818.77	PERCH	1.6161	0.000000	1.6161	1323.3	0.000	1323.3
418	78	144	16.61	1	21593000	81730	817.30	PERCH	1.6161	0.000000	1.6161	1320.9	0.000	1320.9
419	78	145	19.52	1	25376000	96048	960.48	PERCH	1.6161	0.000000	1.6161	1552.3	0.000	1552.3
420	78	146	16.72	1	21736000	82271	822.71	PERCH	1.6161	0.000000	1.6161	1329.6	0.000	1329.6
421	78	147	16.71	1	21723000	82222	822.22	PERCH	1.6161	0.000000	1.6161	1328.8	0.000	1328.8
422	78	148	16.72	1	21736000	82271	822.71	PERCH	1.6161	0.000000	1.6161	1329.6	0.000	1329.6
423	78	149	16.71	1	21723000	82222	822.22	PERCH	1.6161	0.000000	1.6161	1328.8	0.000	1328.8
424	78	150	16.63	1	21619000	81828	818.28	PERCH	1.6161	0.000000	1.6161	1322.5	0.000	1322.5

LARVAL ENTRAINMENT FOR SEPARATE SPECIES, CALCULATED OVER SPECIFIC PERIOD 16:50 FRIDAY, AUGUST 31, 1979 17

OBS	YEAR	DAY	GD	DUMMY	MGD	MCPDAY	WCONG	SPECIES	SSTA	SSTB	SY	ENTA	ENTB	ENTY
425	78	150	16.63	1	21619000	81828.2	818.282	EGGS	2.42624	0	2.42624	1985.35	0	1985.35
426	78	151	16.76	1	21788000	82467.8	824.678	EGGS	2.42624	0	2.42624	2000.87	0	2000.87
427	78	152	16.79	1	21827000	82615.4	826.154	EGGS	2.42624	0	2.42624	2004.45	0	2004.45
428	78	153	16.75	1	21775000	82418.6	824.186	EGGS	2.42624	0	2.42624	1999.68	0	1999.68
429	78	154	16.71	1	21723000	82221.8	822.218	EGGS	2.42624	0	2.42624	1994.90	0	1994.90
430	78	155	16.71	1	21723000	82221.8	822.218	EGGS	2.42624	0	2.42624	1994.90	0	1994.90
431	78	156	16.71	1	21723000	82221.8	822.218	EGGS	2.42624	0	2.42624	1994.90	0	1994.90
432	78	157	16.71	1	21723000	82221.8	822.218	EGGS	2.42624	0	2.42624	1994.90	0	1994.90
433	78	158	17.67	1	22971000	86945.5	869.455	EGGS	2.42624	0	2.42624	2109.51	0	2109.51
434	78	159	16.75	1	21775000	82418.6	824.186	EGGS	2.42624	0	2.42624	1999.68	0	1999.68
435	78	160	16.76	1	21788000	82467.8	824.678	EGGS	2.42624	0	2.42624	2000.87	0	2000.87
436	78	161	16.79	1	21827000	82615.4	826.154	EGGS	2.42624	0	2.42624	2004.45	0	2004.45
437	78	162	16.41	1	21333000	80745.6	807.456	EGGS	2.42624	0	2.42624	1959.08	0	1959.08
438	78	163	16.38	1	21294000	80598.0	805.980	EGGS	2.42624	0	2.42624	1955.50	0	1955.50
439	78	164	16.83	1	21879000	82812.3	828.123	EGGS	2.42624	0	2.42624	2009.23	0	2009.23
440	78	165	16.81	1	21853000	82713.9	827.139	EGGS	2.42624	0	2.42624	2006.84	0	2006.84
441	78	166	16.80	1	21840000	82664.6	826.646	EGGS	2.42624	0	2.42624	2005.64	0	2005.64
442	78	167	16.79	1	21827000	82615.4	826.154	EGGS	2.42624	0	2.42624	2004.45	0	2004.45
443	78	168	16.76	1	21788000	82467.8	824.678	EGGS	2.42624	0	2.42624	2000.87	0	2000.87
444	78	169	16.76	1	21788000	82467.8	824.678	EGGS	2.42624	0	2.42624	2000.87	0	2000.87
445	78	170	16.76	1	21788000	82467.8	824.678	EGGS	2.42624	0	2.42624	2000.87	0	2000.87
446	78	171	11.62	1	15106000	57176.4	571.764	EGGS	2.42624	0	2.42624	1387.24	0	1387.24
447	78	172	11.28	1	14664000	55503.4	555.034	EGGS	2.42624	0	2.42624	1346.65	0	1346.65