Enclosure C – Binder 1 of 2

Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS)

Letter L-11-165

References

Page 1 of 4

Requested References	**Tab**
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System Description for Meteorological Monitoring System for the Toledo Edison Company Davis-Besse Nuclear Power Station, Unit 1, Oak Harbor, Ohio, SD-032C, Rev. 2, 10/04/2005	AM 2
Ohio EPA, Davis-Besse Station, Auxiliary Boiler Air Quality Permit, Date of Issuance: 05/26/89.	AM 3
Ohio EPA, No Permit Needed for Diesel Generators at Davis-Besse NPS, October 1, 1996.	AM 4
TRC Environmental Corporation, Emission Inventory Report, Centerior Energy Corporation, Davis-Besse Nuclear Power Station, Oak Harbor, Ohio, February 10, 1995. **NOTE: This document is Confidential and is not provided due to Attorney-Client Privilege.**	AM 5
DBNPS, Greenhouse gas emissions at Davis-Besse, dated 03/04/2011 (1 page)	AM 6
DPNPS, Actual vs Potential Emissions of Stationary Combustion Sources for 2005-2010 (18 pages)	AM 7
Memorandum from J.S. Seitz (OAQPS), Second Extension of January 25, 1995 Potential to Emit Transition Policy and Clarification of Interim Policy, July 10, 1998 (4 pages)	AM 8
Ohio EPA, Final Title V Permit to West Lorain Plant, Issue Date: 11/19/04 (1 page)	AM 9
Ohio EPA, 2004-2005 Non-Title V Air Emissions Report for Davis-Besse Station, dated 02/21/2005 (1 page)	AM 10
Ohio EPA, 2006-2007 Non-Title V Air Emissions Report for Davis-Besse Station, dated 04/04/2008 (1 page)	AM 11
Ohio EPA, 2008-2009 Non-Title V Air Emissions Report for Davis-Besse Station, dated 02/26/2010 (1 page)	AM 12
Ohio EPA, Engineering Guide #61, "What is Ohio EPA's policy for limiting the potential to emit (PTE) of air contaminant emissions at a facility for purposes of avoiding federal permitting?," Revised September 5, 1996 (3 pages)	AM 13
Letter from Polly Bolssoneault (DBNPS) to Jay Liebrecht (Ohio EPA), Submittal of the 2010 Annual Report for DBNPS Auxiliary Boiler (3 pages)	AM 14
Davis-Besse 10 Yr. Average Operating Hours and Fuel Burn (2 pages)	AM 15
DBNPS, Diesel PM summaries (2 pages)	AM 16

Requested References	**Tab**
TR6.d_Downhower 1988.pdf	T 19
TR6.d_Ewert and Rodewald 2008, Mng Habitats for Migrating Birds in West Lake Erie Basin.pdf	T 20
TR6.d_FirstEnergy 2008.pdf	T 21
TR6.d_USFWS 2008.pdf	T 22
TR6.e_ERIE 1995.pdf	T 23
TR6.e_Lucas 2008.pdf	T 24
TR6.e_Ottawa 2008.pdf	T 25
TR6.e_Sandusky 2008.pdf	T 26
TR6.f_USFWS 2009_Refuge Profiles.pdf	T 27
TR6.g_FECorp 2009,pdf	T 28
TR6.g_0PSB 2007.pdf	T 29
TR6.g_USEPA 2009.pdf	T 30

Air & Meteorology

AM 1

From: James Kosarik [James.Kosarik@noaa.gov]
Sent: Tuesday, March 03, 2009 7:44 PM
To: SNOOKS John H (AREVA NP INC)
Subject: Re: Ohio Climatology

Attachments: Toledo_Climate.jpg
Mr Snooks:

Thanks for getting in touch. You are right, it is not easy to find a generic climate text summary for Toledo. I found a version that comes with the Annual Climate Summary. This publication is put out by the National Climatic Data Center (NCDC) in Asheville, NC. I could not find a version on-line and scanned a copy. It is attached, unfortunately it is a JPG file.

The NCDC write-up is commerce oriented which may be fine. If you want a summary that is strictly weather oriented, you could say the following...

"Toledo is located on the Maumee River on Maumee Bay at the western end of Lake Erie. It has a continental climate which is modified by its proximity to the Great Lakes. Summers are warm to hot with humid weather being common. Winter is cold although frequent thaws occur. The Great Lakes have a moderating effect on temperature and extremes are seldom recorded. On average, only 15 days a year reach or exceed 90 degrees. On about 8 days a year the temperature drops to zero or lower.

While the Great Lakes contribute little to the annual precipitation, it does enhance cloudiness during the winter months. Heavy snow storms typically occur once or twice a winter but light snows are common. Thunderstorms occur regularly from late Spring through Summer with much of the summer precipitation coming from thunderstorm rains. Strong thunderstorms occur a few times each year.

The terrain is mostly flat and has little influence on the weather. An east wind off Lake Erie will bring significant cooling to the downtown and lake shore areas each spring and fog can also occur. The lake breeze brings a comfortable cooling effect to the lake shore during the summer months. A prolonged strong east wind, although rare, can produce lake shore flooding."

If you use this write-up, please credit "NOAA/National Weather Service". If you use the NCDC write-up (attached) or a combination of the two please credit NOAA/National Climatic Data Center.

Let me know if you have any questions.

Jim Kosarik
Meteorologist, National Weather Service, Cleveland

SNOOKS John H (AREVA NP INC) wrote:

Hello,

I have been trying in vain to obtain a good description of the climatology of northern Ohio, especially around Toledo. I have ample data on temps, precip, and the usual from the NCDC, but nothing on the type of weather patterns, air masses that contribute to the seasonal weather and so forth.

Hopefully, you can point me to a person, Web sight or publication that describes Ohio weather in general. Usually the state climatologist has something, but I couldn't find anything on his Web site.

Many thanks,

J.H. Snooks
Senior Environmental Consultant
AREVA NP Inc.
An AREVA and Siemens Company
400 Donald Lynch Blvd.
Marlborough, MA 01752
Work: 508.573.6577
Fax: 508.573.6614
e-mail: john.snooks@areva.com

2005 TOLEDO, OHIO (TOL)

Toledo is located on the western end of Lake Erie at the mouth of the Maumee River. Except for a bank up from the river about 30 feet, the terrain is generally level with only a slight slope toward the river and Lake Erie. The city has quite a diversified industrial section and excellent harbor facilities, making it a large transportation center for rail, water, and motor freight. Generally rich agricultural land is found in the surrounding area, especially up the Maumee Valley toward the Indiana state line.

Rainfall is usually sufficient for general agriculture. The terrain is level and drainage rather poor, therefore, a little less than the normal precipitation during the growing season is better than excessive amounts. Snowfall is generally light in this area, distributed throughout the winter from November to March with frequent thaws.

The nearness of Lake Erie and the other Great Lakes has a moderating effect on the temperature, and extremes are seldom recorded. On average, only fifteen days a year experience temperatures of 90 degrees or higher, and only eight days when it drops to zero or lower. The growing season averages 160 days, but has ranged from over 220 to less than 125 days.

Humidity is rather high throughout the year in this area, and there is an excessive amount of cloudiness. In the winter months the sun shines during only about 30 percent of the daylight hours. December and January, the cloudiest months, sometimes have as little as 16 percent of the possible hours of sunshine.

Severe windstorms, causing more than minor damage, occur infrequently. There are on the average twenty-three days per year having a sustained wind velocity of 32 mph or more.

Flooding in the Toledo area is produced by several factors. Heavy rains of 1 inch or more will cause a sudden rise in creeks and drainage ditches to the point of overflow. The western shores of Lake Erie are subject to flooding when the lake level is high and prolonged periods of east to northeast winds prevail.

AM 2

SYSTEM DESCRIPTION
FOR
METEOROLOGICAL MONITORING SYSTEM

FOR
THE TOLEDO EDISON COMPANY
DAVIS-BESSE NUCLEAR POWER STATION
UNIT 1
OAK HARBOR, OHIO

Approvals: Carl A. Horvath Date 10-4-05
Preparer

N/A PER DON HOOK, DESIGN ENG SUPV 10/4/05 Date
Design Engineering Reviewer

Mark G. Roelant MARK G. ROELANT FOR TRACY A. ST. CLAIR Date 10/04/2005
Cognizant Supervisor

SD-032C
Rev. 2

LIST OF EFFECTIVE PAGES

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RECORD OF REVISIONS

Rev. No.	Date	Summary of Change	Preparer (Initials and Date)	Checker (Initials and Date)
0		Issued for Use	*	*
1	9/18/98	Revised to incorporate AR-96-ENVMG-01-OBS-05 as per NA request.	*	*
2	10/4/05	Incorporate SDCN 032C-01-001	CAH/10-4-05	[illegible]/10-04-05

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METEOROLOGICAL MONITORING SYSTEM DESCRIPTION

1.0 SYSTEM REQUIREMENTS

1.1 SYSTEM BOUNDARIES AND FUNCTIONS

1.1.1 System Boundaries

1.1.1.1 Meteorological Monitoring System

The Meteorological Monitoring System consists of two sets of wind speed, wind direction, and temperature instruments. Precipitation and dew point are also monitored. The instruments are located on a freestanding meteorological tower and on an auxiliary tower. Recorders and power supply equipment are located at the base of the meteorological tower (Reference 4.4.2). A simplified system schematic diagram is shown in Figure 1.1 and 1.2.

1.1.1.2 Electrical circuit breakers and fuses that control or feed the equipment or circuits in this system are included within the boundary of this system.

1.1.1.3 Control and instrumentation necessary for the operation of the Meteorological Monitoring System are included within the system boundary.

1.1.2 Functions

1.1.2.1 Functions Important to Safe Plant Operation

The Meteorological System collects data for Radiological dose calculations and historical meteorological data review and does not directly impact plant operations.

1.1.2.2 Other Operational Functions

Meteorological Monitoring System

The primary function of the meteorological system is to determine the atmospheric dilution and dispersion parameters of the site. This is accomplished through the monitoring of local meteorological conditions that provide basic input data for determining atmospheric dilution and analysis of radioactive gas releases to the atmosphere. Historical as well as real-time data are necessary to determine the dispersion of radioactive material in the atmosphere during controlled releases as well as accidental releases.

1.2 DESIGN REQUIREMENTS

1.2.1 Process/Performance Requirements

The primary requirement of the Meteorological System is to determine the atmospheric dilution and dispersion characteristics of the plant site. This should be accomplished by measuring and recording wind speed, wind direction, atmospheric temperature, in accordance with RG 1.23 "Proposed Rev. 1, Circa 1980" and NUREG-0737 (References 4.4.4 and 4.4.6).

The instruments should be capable of measuring wind direction, wind speed, ambient air temperature. The tower or mast should be located at approximately the same elevation and in the same area as the plant structures. The tower-mounted instruments should be at an elevation of 10 meters above the ground, and an upper level 55 meters above the lower level instruments (Reference 4.4.4).

The system should meet the following additional requirements as noted:

- Instruments should be situated in the plant area so that plant structures should not affect their measurements (Reference 4.4.4).
- The measured parameters should be displayed in the Control Room via DADS system M-points M001-M100.
- Information should be recorded and retained to determine the actions to be taken due to the dispersion of radiological releases to the atmosphere, post-accident, and the actions necessary as required by NUREG-0654, FEMA-REP-1, Rev. 1.

1.2.2 Structural Requirements

The meteorological tower(s) should be located in the same area as the plant structures and at the same elevation. The location should be such that the data shall not be influenced by interference from the plant structures (Reference 4.4.4).

The tower or mast should be capable of withstanding the most severe wind expected for the site and shall be capable of withstanding or being protected from a direct lightning strike by proper application of grounding (Reference 4.4.4).

The equipment should be suitable for continuous operation in an environment of -20°F to 100°F (Reference 4.5.1).

1.2.3 System Configuration and Interface Requirements

The Meteorological Monitoring System is configured as discussed in Subsection 1.1.1.1. The system shall interface with the Control Room to display and record system data (Reference 4.4.2). The recorded data shall be submitted to the U.S. Nuclear Regulatory Commission (NRC) annually. Refer to Figure 1.1 and 1.2 for the system configuration and interfaces with the Control Room.

1.2.4 Surveillance Testing and Inservice Inspection (ISI) Requirements

The meteorological instruments should be inspected and serviced at a frequency that will ensure at least a 90 percent joint data recovery for temperature, wind speed, and wind direction at a level that represents the effluent release point and that will minimize extended periods of instrument outage. The system instruments should be calibrated at least semiannually and as frequently as necessary to ensure that the accuracy requirements are met. If any instrument fails a calibration test, the data should be rejected until the instrument passes the calibration test. This is in accordance with RG 1.23 and meets the intent of ANSI/ANS 2.5 (Reference 4.4.4). Surveillance requirements are included in the Technical Requirements Manual, Section 4.3.3.4a, and 4.3.3.4b.

1.2.5 Setpoint Basis

There are no setpoints for this system instrumentation, since the instruments continuously read the environmental condition at the plant.

1.2.6 Electrical Requirements

The Meteorological Monitoring System does not perform a safety-related function. System instrumentation shall be available all the time to maintain continuity of the weather time history recording. The system instrumentation should be supplied by a primary and a backup power source to meet the requirements of NUREG-0654.

1.2.7 Quality Assurance Requirements

The Meteorological Monitoring System is an augmented quality system and is within the scope and design of the AQ criteria of the Quality Assurance Program.

1.2.8 Codes and Standards

The following codes and standards shall apply:

- Regulatory Guide 1.23 (Proposed Revision 1), 1980 Onsite Meteorological Programs
- NUREG-0654, Rev. 1, November 1980, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants
- NUREG-0737, Section III.A.2, Improving Licensee Emergency Preparedness, Long Term

1.2.9 Environmental Qualification Requirements

The Meteorological Monitoring System is not a safety-related system and, therefore, the equipment is not required to meet environmental qualification. However, the Meteorological Monitoring System instruments should be protected against severe environmental conditions, such as icing, salt, sand, and air pollution (Reference 4.4.4).

1.2.10 Fire Protection or Security Requirements

1.2.10.1 There are no special security requirements for the Meteorological Monitoring System.

2.0 SYSTEM DESIGN DESCRIPTION

2.1 DESIGN DESCRIPTION

2.1.1 General Description

The Meteorological Monitoring System consists of two sets of three wind direction, three wind speed, two differential temperature, two ambient temperature, one dew point, one multi-channel strip chart recorder, Barometric Pressure and Solar Insolence; and three strip chart recorders, one for each primary monitoring level on the tower (Reference 4.4.2). Subsection 2.1.2 discusses the system in detail.

2.1.2 Loop Description

The collection of meteorological data from the 100 meter freestanding meteorological tower and 10 meter auxiliary tower is representative of the site. These data can be obtained by providing instrumentation at different levels on the 100 meter freestanding meteorological tower and on the 10 meter auxiliary tower. Wind direction and speed are measured at 75 meter and 100 meter on the 100 meter freestanding meteorological tower, and at 10 meter on the satellite tower. The low-level wind data most representative of the finished plant grade are those from the 10 meter auxiliary tower. Measurement of delta T (differential temperature) is made between the 10 and 75 meter elevations and between the 10 meter and 100 meter elevations. In addition, dew point measurement is made at the 10 meter level of the freestanding meteorological tower. Precipitation measurements are made at the ground level near the base of the 10 meter auxiliary tower. These data are transmitted on a continuous basis directly to the Control Room and the Emergency Control Center. The data recording and signal conditioning equipment are housed in an environmentally controlled shelter located near the base of the 100 meter freestanding meteorological tower. Signals from the instruments mounted on the tower are changed from analog to digital at the Meteorological Data Processing System (MDPS), which is located in the environmentally controlled instrument shelters located at the base of the freestanding meteorological tower (Reference 4.4.2). The MDPS collects all real-time data and produces a 15-minute average from the real-time values.

2.2 SENSORY EQUIPMENT

The Meteorological Monitoring System instruments are provided to measure different meteorological parameters, such as precipitation, wind speed, wind direction, ambient temperature differential temperature, and dew point temperature, at various levels on the freestanding meteorological tower and auxillary tower. Each sensor is wired to the environmentally controlled instrumentation shelter located at the base of the meteorological tower. The shelter serves as a signal conditioning and data logging facility. Wind speed and direction sensors are located at

specific levels on the towers as described in Subsection 2.1.2. In addition, temperature sensors monitor ambient temperature and provide basic data for determining temperature differentials between the three-tower instrument levels. This information provides the basis for establishing the ambient temperature at the low level and for the thermal inversion characteristics of the area.

At the lowest tower level, the moisture content of the air is monitored by a dew point sensor. This information can be used to establish the operating parameters for the cooling tower, in addition to providing basic data for environmental impact studies. The precipitation monitor is located at ground level, approximately 100 feet away from the instrument shelter.

A description and function of meteorological instruments are provided in Subsections 2.1.2 and 2.3.

2.3 SIGNAL PROCESSING AND OUTPUT DEVICES

All analog instrumentation signals are converted into digital signals in the meteorological shelter. Most of these signals are also fed to recorders. The data are also made available to the DADS computer as 15-minute and hourly averages. Points M001 through M100 should be used via DADS system.

Wind speed and wind direction data are recorded on Esterline-Angus dual-channel strip chart recorders, one recorder for each primary tower level instruments. Ambient temperature, dew point, delta T, and precipitation are recorded on one Esterline-Angus multipoint strip chart recorder, each parameter being recorded on an individual channel (Reference 4.4.2). Strip charts are de-energized and only energized for meteorological evaluation in support of possible sensor malfunctions. Reference Subsection 2.4 and Figure 1.1 and 1.2 for meteorological instrument details.

2.4 COMPONENT DATA

The Meteorological Monitoring System instrumentation consists of the following:

- Tower-mounted instrumentation - sensors

  Location of the instruments is discussed in Subsection 2.1.2.

  - Wind speed transmitter.
  - Wind direction transmitter.
  - Temperature detector

- Dew point detector
- Rainfall monitor

o Instrument shelters, including:

- Meteorological system instrumentation
- MDPS/21X Datalogger
- Digital communications system
- AC power distribution system
- Digital telemetry interface communications to the DADS computer and Emergency Control Center

The various system components are shown on the simplified system schematic, Figure 1.1 and 1.2.

2.5 SYSTEM ARRANGEMENT

The system consists of the following:

o A 100 meter tower, which supports meteorological sensors at selected heights above ground level

o A 10 meter auxillary tower, which also supports meteorological sensors

o Two equipment shelters located near the 100 meter meteorological tower containing recording and signal conditioning equipment

o A rainfall monitor mounted at ground level near the primary shelter

o The entire station (shelters and towers) enclosed by protective fencing

2.6 ANCILLARY INDICATIONS

This system does not use any ancillary indications.

2.7 ELECTRICAL SYSTEMS AND POWER SUPPLIES

2.7.1 Meteorological Monitoring System

2.7.1.1 External Power Supplies

BY-5 is the 480 V distribution center that powers the primary system. The backup system is fed by a pole mounted transformer, X3006. Auto Transfer Switch D-3002 supplies power to Panelboard BY-5 from two sources (Reference 4.1.2) to fulfill the requirements of Subsection 1.2.6.

2.7.1.2 Internal Power Supplies

The wind speed transmitters, wind direction transmitters, and wind translator are equipped with integral 12 VDC power supplies. Devices that do not come with integral power supplies and require DC power are fed from Teledyne Geotech Series 40 AC power supply, which converts the 120 VAC line voltage to ±12 VDC (adjustable). This power supply is located in each Meteorological Shelter.

3.0 SYSTEM LIMITATIONS, SETPOINTS, AND PRECAUTIONS

3.1 Section Deleted.

3.2 OTHER LIMITS AND PRECAUTIONS

Technical Requirements Manual Table 3.3-8 lists the meteorological instrumentation channels that shall be demonstrated to be operable to avoid a limiting condition (Reference 4.4.5).

Wind speed, wind direction, temperature, and dew point data should be averaged over a period of at least 15 minutes once each hour (Reference 4.4.4).

4.0 REFERENCES

4.1 DESIGN DRAWINGS AND DOCUMENTS

4.1.1 Design Criteria Manual, Section I.D

4.1.2 Drawings E4, Sheet 4, E428, Sheets 1-5, E1801 series,

4.2 EQUIPMENT SPECIFICATIONS

4.3 VENDOR EQUIPMENT MANUALS AND DRAWINGS

4.3.1 Meteorological Monitoring System for Davis-Besse, G-MT-0007

4.4 USAR SECTIONS, TECHNICAL REQUIREMENTS MANUAL, AND REGULATORY DOCUMENTS

4.4.1 USAR Section 2.3, Meteorology

4.4.2 Regulatory Guide 1.23, 1972, Onsite Meteorological Programs

4.4.3 Technical Requirements Manual Sections 4/3.3.3 and 4/3.3.4

4.4.4 NUREG-0737, TMI Action Plan Requirements

4.4.5 NUREG-0654, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, Rev. 1

4.4.6 Standard for Determining Meteorological Information at Nuclear Power Sites, ANSI/ANS 2.5, 1984

4.5 MISCELLANEOUS CONTROLLED DOCUMENTS

4.5.1 Miscellaneous NUS and Davis-Besse drawings for Meteorological System.

FIGURE 1.1

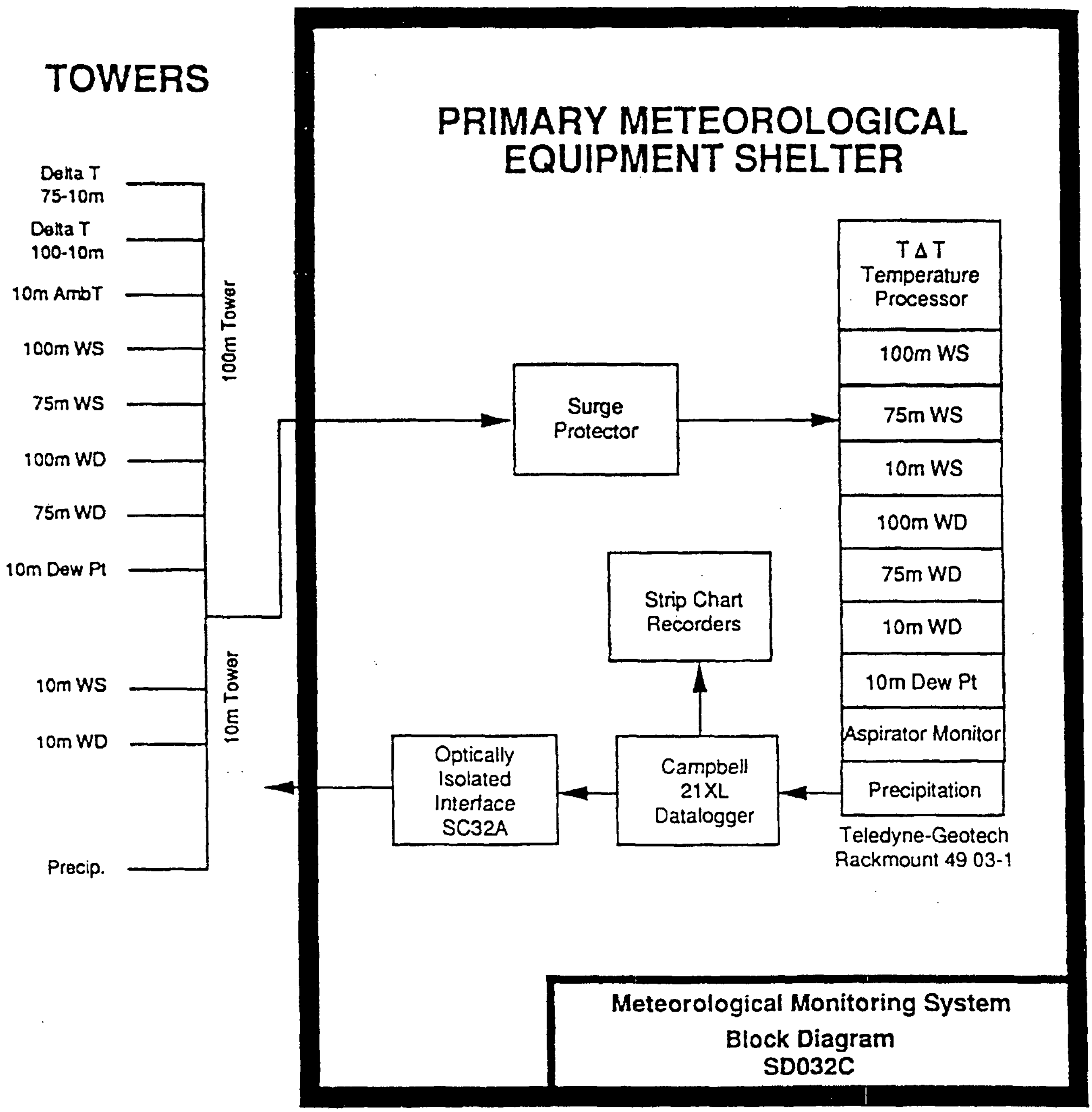
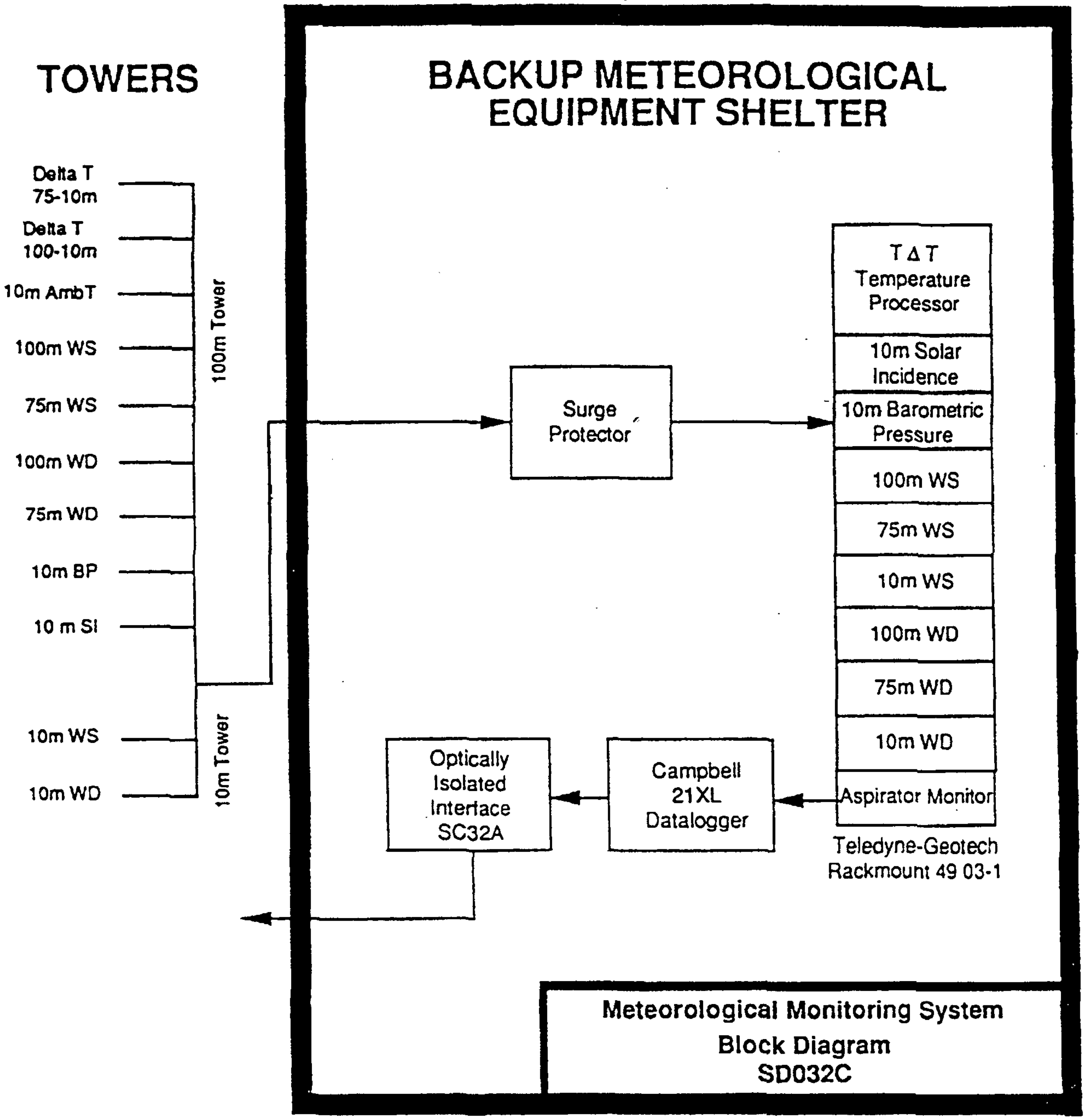

TOWERS
PRIMARY METEOROLOGICAL EQUIPMENT SHELTER
Delta T 75-10m
Delta T 100-10m
10m AmbT
100m WS
75m WS
100m WD
75m WD
10m Dew Pt
10m WS
10m WD
Precip.
100m Tower
10m Tower
Surge Protector
Strip Chart Recorders
Optically Isolated Interface SC32A
Campbell 21XL Datalogger
T Δ T Temperature Processor
100m WS
75m WS
10m WS
100m WD
75m WD
10m WD
10m Dew Pt
Aspirator Monitor
Precipitation
Teledyne-Geotech Rackmount 49 03-1
Meteorological Monitoring System
Block Diagram
SD032C

FIGURE 1.2


TOWERS
BACKUP METEOROLOGICAL EQUIPMENT SHELTER
Delta T 75-10m
Delta T 100-10m
10m AmbT
100m WS
75m WS
100m WD
75m WD
10m BP
10 m SI
10m WS
10m WD
100m Tower
10m Tower
Surge Protector
T Δ T Temperature Processor
10m Solar Incidence
10m Barometric Pressure
100m WS
75m WS
10m WS
100m WD
75m WD
10m WD
Aspirator Monitor
Teledyne-Geotech Rackmount 49 03-1
Optically Isolated Interface SC32A
Campbell 21XL Datalogger
Meteorological Monitoring System
Block Diagram
SD032C

AM 3

OhioEPA
State of Ohio Environmental Protection Agency
P.O. Box 1049, 1800 WaterMark Dr.
Columbus, Ohio 43266-0149

Richard F. Celeste
Governor

0362000091 8001
DAVIS - BESSE STATION
MR JOSEPH E MURRAY
300 MADISON
TOLEDO OH 43652

CERTIFIED MAIL

May 26, 1989

Dear Sir or Madam:

Enclosed are Permit(s) to Operate which allow you to operate the described air contaminant source(s) in the manner indicated in the permit(s). Because these permits contain several conditions and restrictions, I urge you to read them carefully.

You are hereby notified that this action of the Director is final and may be appealed to the Environmental Board of Review pursuant to Section 3745.04 of the Ohio Revised Code. The appeal must be in writing and set forth the action complained of and the grounds upon which the appeal is based. It must be filed with the Environmental Board of Review within thirty (30) days after notice of the Director's action. A copy of the appeal must be served on the Director of the Ohio Environmental Law Division of the Office of the Attorney General within three (3) days of filing with the board. An appeal may be filed with the Environmental Board of Review at the following address:

Environmental Board of Review
236 East Town Street
Room 300
Columbus, Ohio 43215

If you have any questions, please contact the air pollution control agency to which you submitted your application.

Very truly yours,

Thomas G. Rigo

Thomas G. Rigo, Manager
Field Operations Section
Division of Air Pollution Control

TGR/gs

EPA-3167
04/23/87

STATEMENT OF

THE OHIO ENVIRONMENTAL PROTECTION AGENCY

0362000091B001
APPLICATION NUMBER

$270.00
AMOUNT DUE

DAVIS - BESSE STATION
FACILITY NAME

PURSUANT TO SEC.3745.11 OF THE OHIO REVISED CODE, FULL AMOUNT OF THIS PERMIT FEE IS DUE WITHIN FIFTEEN (15) DAYS OF THIS PERMIT.
MAKE CHECKS PAYABLE TO:

THE TREASURER OF THE STATE OF OHIO.

RETURN THIS STATEMENT WITH YOUR REMITTANCE USING THE ENCLOSED ENVELOPE TO:

GENERAL ACCOUNTING
OHIO EPA
P.O. BOX 1049
COLUMBUS, OH 43266-0149

ALL QUESTIONS REGARDING THIS FEE SHOULD INCLUDE THE APPLICATION NUMBER SHOWN ABOVE.

OhioEPA
State of Ohio Environmental Protection Agency

PERMIT TO OPERATE AN AIR CONTAMINANT SOURCE

Date of Issuance 05/26/89 Application No. 0362000091B001

Effective Date 05/26/89 Permit Fee $270

This document constitutes issuance to:

DAVIS - BESSE STATION
RFD NO 1 STATE ROUTE 2
OAK HARBOR OHIO 43449

of a permit to operate for:
226 MMBTU/HR NO. 2 OIL FIRED BOILER
AUXILIARY BOILER

The following terms and conditions are hereby expressly incorporated into this permit to operate:

1. This permit to operate shall be effective until 05/25/92
You will be contacted approximately six months prior to this date regarding the renewal of this permit. If you are not contacted, please write to the appropriate Ohio EPA field office.
2. The above-described source is and shall remain in full compliance with all applicable State and federal laws and regulations and the terms and conditions of this permit.
3. Prior to any modification of this source, as defined in rule 3745-31-01 of the Ohio Administrative Code (OAC), a permit to install must be granted by the Ohio EPA pursuant to OAC Chapter 3745-31.
4. The Director of the Ohio EPA or an authorized representative may, subject to the safety requirements of the permit holder, enter upon the premises of this source at any reasonable time for purposes of making inspections, conducting tests, examining records or reports pertaining to any emission of air contaminants, and determining compliance with any applicable State and federal air pollution laws and regulations and the terms and conditions of this permit.
5. A permit fee in the amount specified above must be remitted within 15 days from the issuance date of this permit.
6. Any transferee of this permit shall assume the responsibilities of the prior permit holder. The appropriate Ohio EPA field office must be notified in writing of any transfer of this permit.
7. This source and any associated air pollution control system(s) shall be maintained regularly in accordance with good engineering practices in order to minimize air contaminant emissions. Any malfunction of this source or any associated air pollution control system(s) shall be reported immediately to the appropriate Ohio EPA field office in accordance with OAC rule 3745-15-06. Except as provided in that rule, any scheduled maintenance or malfunction necessitating the shutdown or bypassing of any air pollution control system(s) shall be accompanied by the shutdown of this source.
8. Any unauthorized or emergency release of an air contaminant from this source which, due to the toxic or hazardous nature of the material, may pose a threat to public health, or otherwise endanger the safety or welfare of the public, shall be reported immediately to the appropriate Ohio EPA field office (during normal business hours) or to the Ohio EPA's Emergency Response Group (1-800-282-9378). (Additional reporting may be required pursuant to the federal Comprehensive Environmental Response, Compensation, and Liability Act.)
9. The appropriate Ohio EPA field office is:
OHIO EPA, NORTHWEST DISTRICT OFFICE
AIR POLLUTION GROUP 1035 DEVLAC GROVE DR.
BOWLING GREEN, OH 43402 (419) 352-8461
10. ☒ If this term and condition is checked, the permit holder is subject to the attached special terms and conditions.

OHIO ENVIRONMENTAL PROTECTION AGENCY

Richard L Shank

Director

EPA-3834
REVISED 1-87

AM 4

RAIC - 96 - 51

OhioEPA
State of Ohio Environmental Protection Agency
orthwest District Office
7 North Dunbridge Road
owling Green, Ohio 43402
(419) 352-8461 FAX (419) 352-8468

EXT- 96-02102

George V. Voinovich
Governor

Re: Ottawa County
Davis-Besse Nuclear Power Station
Premise No. 0362000091

October 1, 1996

Mr. Al Pervical
Davis-Besse Nuclear Power Station
300 Madison Avenue M.S. 3065
Toledo, Ohio 43652

Dear Mr. Pervical:

This letter shall serve as follow-up to the inspection conducted on July 10, 1996, of the above referenced facility by Megan Murphy and the writer. The purpose of this inspection was to determine the compliance status of all air contaminant sources located there.

Based on our discussions, observations during the inspection, and a review of the company files all sources appear to be in compliance with air pollution control regulations of the Ohio Environmental Protection Agency at this time.

Thank you for the courtesy extended to us during our visit. Should you have any questions and/or comments, feel free to contact this office at the above address or call me at (419)373-3133.

Sincerely,

Shawn P. Naber
Division of Air Pollution Control

/cs

pc: Don Waltermeyer, DAPC, NWDO
Megan Murphy, DAPC, NWDO
NWDO File

COMMITMENT CLOSEOUT FORM
ED 7974-3

TO	CCN NO.
T. K. Wasch	
FROM	DATE
A. M. Percival	08/06/96

TERMS

A18174

DESCRIPTION OF CLOSEOUT ACTIVITY

TERMS item A18174, which requests additional information on our emergency diesel sources, may be closed out at this time.

On a July 10, 1996 visit to our facility by Ohio EPA staff, a copy of final legislation was provided to us that exempts all of our emergency diesels (see attached copy of OAC 3745-31-03).

In order to maintain these exemptions we must:

1) Operate our diesel sources less than 500 hours (each source) per rolling 12 month period and burn fuel with less than or equal to 0.5% by weight sulfur.

2) Maintain monthly records that contain the rolling twelve month hours of operation; and

3) Maintain records that show the type of fuel used and the percent by weight sulfur contained in these fuels.

We have been maintaining these records for twenty months already. The permit applications, which were submitted by us to the Ohio EPA on May 11, 1994, were returned to us during this visit.

RESPONSIBLE MANAGER/SUPERVISOR	DATE

ATTACH/LIST SUPPORTING DOCUMENTATION

See attached

LICENSING APPROVAL

☐ CLOSEOUT APPROVED ☐ CLOSEOUT DISAPPROVED - REASON

COGNIZANT LICENSING INDIVIDUAL	DATE

AM 5

AM 5 **TRC Environmental Corporation, Emission Inventory Report, Centerior Energy Corporation, Davis-Besse Nuclear Power Station, Oak Harbor, Ohio, February 10, 1995.**

This document is Confidential and is not provided due to Attorney-Client Privilege.

AM 6

Kristin S Yanko
03/04/2011 11:36 AM

To: Marjorie G. Twymon/FirstEnergy@FirstEnergy
cc:
Subject: GHG emissions at Davis Besse

Gale:

As requested, below are the 2010 GHG emissions from stationary and mobile combustion sources at Davis Besse:

Stationary Sources (includes auxiliary boiler, EDG1, EDG2, SBODG):

- CO_2 = 4,321 metric tons
- CH_4 = 0.64 metric tons
- N_2O = 0.09 metric tons
- CO_2e = 4,364 metric tons

These are based on gallons of number 2 fuel oil used in 2010 (as provided by the facility), and are calculated using Tier 1 methodology as described in US EPA"s GHG Mandatory Reporting Rule.

Mobile Sources (diesel tractors, vehicles, cranes, backhoes, etc):

- CO_2 = 326 metric tons
- CH_4 = 0.02 metric tons
- N_2O = 0.01 metric tons
- CO_2e = 329 metric tons

These are based on approximate fuel usage for mobile units in 2010 (as provided by the facility), and are calculated using equations and default emission factors as described in The Climate Registry 's General Reporting Protocol (2008).

AM 7

Davis-Besse Emergency Diesel and Auxiliary Boiler Hours

Date	SBODG	12 mo. ave.	EDG1-1	12 mo. Ave.	EDG1-2	12 mo. ave.	Misc.	12 mo. ave.	Fire Pump	12 mo. Ave.	ERF (DBAB) Diesel	12 mo. ave.	Aux. Boiler
Year 2010 Time	27		44.7		44.7		37.2		11.26		29.47		1099

B001 - Auxiliary Boiler Emission Calculations (B001) - 226 mmBtu/hr.

	Actual Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content (Btu/gallon)	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions (lbs/hr.)	Proposed Maximum Fuel Consumption (gallons/year)	Potential Emissions (PTE) (tons/year)	Potential Emissions (PTE) (lbs/hr)
PM	401,336	0.00200		138,265	2,000	0.40	0.73	**2,700,000**	2.70	0.62
SO2	401,336	0.14200	0.019	138,265	2,000	0.54	0.99	**2,700,000**	3.64	0.83
NOx	401,336	0.02400		138,265	2,000	4.82	8.76	**2,700,000**	32.40	7.40
VOC	401,336	0.00020		138,265	2,000	0.04	0.07	**2,700,000**	0.27	0.06
CO	401,336	0.00500		138,265	2,000	1.00	1.83	**2,700,000**	6.75	1.54

P001 - Station Blackout Diesel Generator (Z001) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	27.00	8,760	4,731	0.01370			2000	0.03	2.40	**50,000**	0.34	0.08
SO2	27.00	8,760	4,731	0.13800	0.019		2000	0.33	0.46	**50,000**	0.07	0.01
NOx	27.00	8,760	4,731	0.43800			2000	1.04	76.75	**50,000**	10.95	2.50
VOC	27.00	8,760	4,731	0.01120			2000	0.03	1.96	**50,000**	0.28	0.06
CO	27.00	8,760	4,731	0.11600			2000	0.27	20.33	**50,000**	2.90	0.66

P002 - Emergency Diesel Generator 1-1 (Z002) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	44.70	8,760	6,122	0.01370			2000	0.04	1.88	**50,000**	0.34	0.08
SO2	44.70	8,760	6,122	0.13800	0.019		2000	0.42	0.36	**50,000**	0.07	0.01

NOx	44.70	8,760	6,122	0.43800			2000	1.34	59.99	**50,000**	10.95	2.50
VOC	44.70	8,760	6,122	0.01120			2000	0.03	1.53	**50,000**	0.28	0.06
CO	44.70	8,760	6,122	0.11600			2000	0.36	15.89	**50,000**	2.90	0.66

P003 - Emergency Diesel Generator 1-2 (Z003) - 29.7 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	44.70	8760	6,360	0.01370			2000	0.04	1.95	**50,000**	0.34	0.08
SO2	44.70	8760	6,360	0.13800	0.019		2000	0.44	0.37	**50,000**	0.07	0.01
NOx	44.70	8760	6,360	0.43800			2000	1.39	62.32	**50,000**	10.95	2.50
VOC	44.70	8760	6,360	0.01120			2000	0.04	1.59	**50,000**	0.28	0.06
CO	44.70	8760	6,360	0.11600			2000	0.37	16.50	**50,000**	2.90	0.66

P005 - DBAB Diesel Generator (Z004) 7.6 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	29.47	8760	1,300	0.01370			2000	0.01	0.60	**10,000**	0.07	0.02
SO2	29.47	8760	1,300	0.13800	0.019		2000	0.09	0.12	**10,000**	0.01	0.00
NOx	29.47	8760	1,300	0.43800			2000	0.28	19.32	**10,000**	2.19	0.50
VOC	29.47	8760	1,300	0.01120			2000	0.01	0.49	**10,000**	0.06	0.01
CO	29.47	8760	1,300	0.11600			2000	0.08	5.12	**10,000**	0.58	0.13

P006 - Misellaneous Diesel Generator (Z005) - 2.3 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	37.20	8,760	100	0.01370			2000	0.00	0.04	**10,000**	0.07	0.02
SO2	37.20	8,760	100	0.13800	0.019		2000	0.01	0.01	**10,000**	0.01	0.00
NOx	37.20	8,760	100	0.43800			2000	0.02	1.18	**10,000**	2.19	0.50
VOC	37.20	8,760	100	0.01120			2000	0.00	0.03	**10,000**	0.06	0.01

CO	37.20	8,760	100	0.11600			2000	0.01	0.31	**10,000**	0.58	0.13

P004 - Fire Pump Diesel Engine (Z006) - 24.8 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	11.26	8760	3,900	0.01370			2000	0.03	4.75	**10,000**	0.07	0.02
SO2	11.26	8760	3,900	0.13800	0.019		2000	0.27	0.91	**10,000**	0.01	0.00
NOx	11.26	8760	3,900	0.43800			2000	0.85	151.71	**10,000**	2.19	0.50
VOC	11.26	8760	3,900	0.01120			2000	0.02	3.88	**10,000**	0.06	0.01
CO	11.26	8760	3,900	0.11600			2000	0.23	40.18	**10,000**	0.58	0.13

Total Station

									Annual Emissions (tons/year)	Actual Emissions lbs/Hr.	Maximum Annual Emissions (tons/year)	Maximum Emissions lbs/Hr.
PM									**0.56**	**12.34**	**3.93**	**0.90**
SO2									**2.09**	**3.21**	**3.88**	**0.89**
NOx									**9.75**	**380.03**	**71.82**	**16.40**
VOC									**0.17**	**9.57**	**1.28**	**0.29**
CO									**2.31**	**100.15**	**17.19**	**3.92**

Notes:
1. Emission factors are from USEPA's Chief Webfire site. Aux. Boiler SCC ID 1-01-005-01 and diesel SCC ID 2-02-004-01
2. Auxillary Boiler annual fuel usage is as reported in the Annual Report for Operation of the Davis-Bess Auxiliary Boiler; diesel annual fuel usage from plant reports
3. Auxiliary boiler potential emissions based on proposed maximum fuel consumption (voluntary restriction on auxiliary boiler fuel burn to limit potential emissions to below major source thresholds).
4. Diesels operate under Ohio EPA's permit by rule (PRB); included in calculations for facility potential to emit for synthetic minor consideration.
5. Fuel burn for exempt engines (P005 and P006) estimated based on ratio of fuel burn and operating hours from 1995 TRC report and current operating hours.

Davis-Besse Emergency Diesel and Auxiliary Boiler Hours

Date	SBODG	12 mo. ave.	EDG1-1	12 mo. Ave.	EDG1-2	12 mo. ave.	Misc.	12 mo. ave.	Fire Pump	12 mo. Ave.	ERF (DBAB) Diesel	12 mo. ave.	Aux. Boiler
Year 2009 Time	23.5		31.2		33.2		7.3		19.85		23.19		388

B001 - Auxiliary Boiler Emission Calculations (B001) - 226 mmBtu/hr.

	Actual Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content (Btu/gallon)	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions (lbs/hr.)	Proposed Maximum Fuel Consumption (gallons/year)	Potential Emissions (PTE) (tons/year)	Potential Emissions (PTE) (lbs/hr)
PM	236,349	0.00200		138,590	2,000	0.24	1.22	**2,700,000**	2.70	0.62
SO2	236,349	0.14200	0.019	138,590	2,000	0.32	1.64	**2,700,000**	3.64	0.83
NOx	236,349	0.02400		138,590	2,000	2.84	14.62	**2,700,000**	32.40	7.40
VOC	236,349	0.00020		138,590	2,000	0.02	0.12	**2,700,000**	0.27	0.06
CO	236,349	0.00500		138,590	2,000	0.59	3.05	**2,700,000**	6.75	1.54

P001 - Station Blackout Diesel Generator (Z001) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	23.50	8,760	4,731	0.01370			2000	0.03	2.76	**50,000**	0.34	0.08
SO2	23.50	8,760	4,731	0.13800	0.019		2000	0.33	0.53	**50,000**	0.07	0.01
NOx	23.50	8,760	4,731	0.43800			2000	1.04	88.18	**50,000**	10.95	2.50
VOC	23.50	8,760	4,731	0.01120			2000	0.03	2.25	**50,000**	0.28	0.06
CO	23.50	8,760	4,731	0.11600			2000	0.27	23.35	**50,000**	2.90	0.66

P002 - Emergency Diesel Generator 1-1 (Z002) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	31.20	8,760	6,122	0.01370			2000	0.04	2.69	**50,000**	0.34	0.08
SO2	31.20	8,760	6,122	0.13800	0.019		2000	0.42	0.51	**50,000**	0.07	0.01

NOx	31.20	8,760	6,122	0.43800			2000	1.34	85.95	**50,000**	10.95	2.50
VOC	31.20	8,760	6,122	0.01120			2000	0.03	2.20	**50,000**	0.28	0.06
CO	31.20	8,760	6,122	0.11600			2000	0.36	22.76	**50,000**	2.90	0.66

P003 - Emergency Diesel Generator 1-2 (Z003) - 29.7 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	33.20	8760	6,360	0.01370			2000	0.04	2.62	**50,000**	0.34	0.08
SO2	33.20	8760	6,360	0.13800	0.019		2000	0.44	0.50	**50,000**	0.07	0.01
NOx	33.20	8760	6,360	0.43800			2000	1.39	83.90	**50,000**	10.95	2.50
VOC	33.20	8760	6,360	0.01120			2000	0.04	2.15	**50,000**	0.28	0.06
CO	33.20	8760	6,360	0.11600			2000	0.37	22.22	**50,000**	2.90	0.66

P005 - DBAB Diesel Generator (Z004) 7.6 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	23.19	8760	1,300	0.01370			2000	0.01	0.77	**10,000**	0.07	0.02
SO2	23.19	8760	1,300	0.13800	0.019		2000	0.09	0.15	**10,000**	0.01	0.00
NOx	23.19	8760	1,300	0.43800			2000	0.28	24.55	**10,000**	2.19	0.50
VOC	23.19	8760	1,300	0.01120			2000	0.01	0.63	**10,000**	0.06	0.01
CO	23.19	8760	1,300	0.11600			2000	0.08	6.50	**10,000**	0.58	0.13

P006 - Misellaneous Diesel Generator (Z005) - 2.3 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	7.30	8,760	100	0.01370			2000	0.00	0.19	**10,000**	0.07	0.02
SO2	7.30	8,760	100	0.13800	0.019		2000	0.01	0.04	**10,000**	0.01	0.00
NOx	7.30	8,760	100	0.43800			2000	0.02	6.00	**10,000**	2.19	0.50
VOC	7.30	8,760	100	0.01120			2000	0.00	0.15	**10,000**	0.06	0.01

CO	7.30	8,760	100	0.11600			2000	0.01	1.59	**10,000**	0.58	0.13

P004 - Fire Pump Diesel Engine (Z006) - 24.8 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	19.85	8760	3,900	0.01370			2000	0.03	2.69	**10,000**	0.07	0.02
SO2	19.85	8760	3,900	0.13800	0.019		2000	0.27	0.52	**10,000**	0.01	0.00
NOx	19.85	8760	3,900	0.43800			2000	0.85	86.06	**10,000**	2.19	0.50
VOC	19.85	8760	3,900	0.01120			2000	0.02	2.20	**10,000**	0.06	0.01
CO	19.85	8760	3,900	0.11600			2000	0.23	22.79	**10,000**	0.58	0.13

Total Station

									Annual Emissions (tons/year)	Actual Emissions lbs/Hr.	Maximum Annual Emissions (tons/year)	Maximum Emissions lbs/Hr.
PM									**0.39**	**12.94**	**3.93**	**0.90**
SO2									**1.87**	**3.89**	**3.88**	**0.89**
NOx									**7.77**	**389.26**	**71.82**	**16.40**
VOC									**0.15**	**9.70**	**1.28**	**0.29**
CO									**1.90**	**102.27**	**17.19**	**3.92**

Notes:
1. Emission factors are from USEPA's Chief Webfire site. Aux. Boiler SCC ID 1-01-005-01 and diesel SCC ID 2-02-004-01
2. Auxillary Boiler annual fuel usage is as reported in the Annual Report for Operation of the Davis-Bess Auxiliary Boiler; diesel annual fuel usage from plant reports
3. Auxiliary boiler potential emissions based on proposed maximum fuel consumption (voluntary restriction on auxiliary boiler fuel burn to limit potential emissions to below major source thresholds).
4. Diesels operate under Ohio EPA's permit by rule (PRB); included in calculations for facility potential to emit for synthetic minor consideration.
5. Fuel burn for exempt engines (P005 and P006) estimated based on ratio of fuel burn and operating hours from 1995 TRC report and current operating hours.

Davis-Besse Emergency Diesel and Auxiliary Boiler Hours

Date	SBODG	12 mo. ave.	EDG1-1	12 mo. Ave.	EDG1-2	12 mo. ave.	Misc.	12 mo. ave.	Fire Pump	12 mo. Ave.	ERF (DBAB) Diesel	12 mo. ave.	Aux. Boiler
Year 2008 Time	24.8		31.3		44.5		29.3		11.13		23.6		987

B001 - Auxiliary Boiler Emission Calculations (B001) - 226 mmBtu/hr.

	Actual Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content (Btu/gallon)	Conversion (lbs/ton)	Actual Emissions (tons/year)	Actual Emissions (lbs/hr.)	Proposed Maximum Fuel Consumption (gallons/year)	Potential Emissions (PTE) (tons/year)	Potential Emissions (PTE) (lbs/hr)
PM	394,622	0.00200		138,711	2,000	0.39	0.80	**2,700,000**	2.70	0.62
SO2	394,622	0.14200	0.023	138,711	2,000	0.64	1.31	**2,700,000**	4.41	1.01
NOx	394,622	0.02400		138,711	2,000	4.74	9.60	**2,700,000**	32.40	7.40
VOC	394,622	0.00020		138,711	2,000	0.04	0.08	**2,700,000**	0.27	0.06
CO	394,622	0.00500		138,711	2,000	0.99	2.00	**2,700,000**	6.75	1.54

P001 - Station Blackout Diesel Generator (Z001) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	24.80	8,760	4,067	0.01370			2000	0.03	2.25	**50,000**	0.34	0.08
SO2	24.80	8,760	4,067	0.13800	0.009		2000	0.28	0.20	**50,000**	0.03	0.01
NOx	24.80	8,760	4,067	0.43800			2000	0.89	71.82	**50,000**	10.95	2.50
VOC	24.80	8,760	4,067	0.01120			2000	0.02	1.84	**50,000**	0.28	0.06
CO	24.80	8,760	4,067	0.11600			2000	0.24	19.02	**50,000**	2.90	0.66

P002 - Emergency Diesel Generator 1-1 (Z002) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	31.30	8,760	8,702	0.01370			2000	0.06	3.81	**50,000**	0.34	0.08
SO2	31.30	8,760	8,702	0.13800	0.009		2000	0.60	0.35	**50,000**	0.03	0.01

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
NOx	31.30	8,760	8,702	0.43800			2000	1.91	121.77	**50,000**	10.95	2.50
VOC	31.30	8,760	8,702	0.01120			2000	0.05	3.11	**50,000**	0.28	0.06
CO	31.30	8,760	8,702	0.11600			2000	0.50	32.25	**50,000**	2.90	0.66

P003 - Emergency Diesel Generator 1-2 (Z003) - 29.7 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	44.50	8760	8,215	0.01370			2000	0.06	2.53	**50,000**	0.34	0.08
SO2	44.50	8760	8,215	0.13800	0.009		2000	0.57	0.23	**50,000**	0.03	0.01
NOx	44.50	8760	8,215	0.43800			2000	1.80	80.86	**50,000**	10.95	2.50
VOC	44.50	8760	8,215	0.01120			2000	0.05	2.07	**50,000**	0.28	0.06
CO	44.50	8760	8,215	0.11600			2000	0.48	21.42	**50,000**	2.90	0.66

P005 - DBAB Diesel Generator (Z004) 7.6 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	23.60	8760	1,300	0.01370			2000	0.01	0.75	**10,000**	0.07	0.02
SO2	23.60	8760	1,300	0.13800	0.023		2000	0.09	0.17	**10,000**	0.02	0.00
NOx	23.60	8760	1,300	0.43800			2000	0.28	24.13	**10,000**	2.19	0.50
VOC	23.60	8760	1,300	0.01120			2000	0.01	0.62	**10,000**	0.06	0.01
CO	23.60	8760	1,300	0.11600			2000	0.08	6.39	**10,000**	0.58	0.13

P006 - Misellaneous Diesel Generator (Z005) - 2.3 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	29.30	8,760	500	0.01370			2000	0.00	0.23	**10,000**	0.07	0.02
SO2	29.30	8,760	500	0.13800	0.023		2000	0.03	0.05	**10,000**	0.02	0.00
NOx	29.30	8,760	500	0.43800			2000	0.11	7.47	**10,000**	2.19	0.50
VOC	29.30	8,760	500	0.01120			2000	0.00	0.19	**10,000**	0.06	0.01

CO	29.30	8,760	500	0.11600			2000	0.03	1.98	**10,000**	0.58	0.13

P004 - Fire Pump Diesel Engine (Z006) - 24.8 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	11.13	8760	2,000	0.01370			2000	0.01	2.46	**10,000**	0.07	0.02
SO2	11.13	8760	2,000	0.13800	0.023		2000	0.14	0.57	**10,000**	0.02	0.00
NOx	11.13	8760	2,000	0.43800			2000	0.44	78.71	**10,000**	2.19	0.50
VOC	11.13	8760	2,000	0.01120			2000	0.01	2.01	**10,000**	0.06	0.01
CO	11.13	8760	2,000	0.11600			2000	0.12	20.84	**10,000**	0.58	0.13

Total Station

									Annual Emissions (tons/year)	Actual Emissions lbs/Hr.	Maximum Annual Emissions (tons/year)	Maximum Emissions lbs/Hr.
PM									**0.56**	**12.83**	**3.93**	**0.90**
SO2									**2.35**	**2.88**	**4.55**	**1.04**
NOx									**10.16**	**394.35**	**71.82**	**16.40**
VOC									**0.18**	**9.92**	**1.28**	**0.29**
CO									**2.42**	**103.90**	**17.19**	**3.92**

Notes:
1. Emission factors are from USEPA's Chief Webfire site. Aux. Boiler SCC ID 1-01-005-01 and diesel SCC ID 2-02-004-01
2. Auxillary Boiler annual fuel usage is as reported in the Annual Report for Operation of the Davis-Bess Auxiliary Boiler; diesel annual fuel usage from plant reports
3. Auxiliary boiler potential emissions based on proposed maximum fuel consumption (voluntary restriction on auxiliary boiler fuel burn to limit potential emissions to below major source thresholds).
4. Diesels operate under Ohio EPA's permit by rule (PRB); included in calculations for facility potential to emit for synthetic minor consideration.
5. Fuel burn for exempt engines (P005 and P006) estimated based on ratio of fuel burn and operating hours from 1995 TRC report and current operating hours.

Davis-Besse Emergency Diesel and Auxiliary Boiler Hours

Date	SBODG	12 mo. ave.	EDG1-1	12 mo. Ave.	EDG1-2	12 mo. ave.	Misc.	12 mo. ave.	Fire Pump	12 mo. Ave.	ERF (DBAB) Diesel	12 mo. ave.	Aux. Boiler
Year 2007 Time	21.1		31.9		37.2		8.1		15.97		26.39		6

B001 - Auxiliary Boiler Emission Calculations (B001) - 226 mmBtu/hr.

	Actual Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content (Btu/gallon)	Conversion (lbs/ton)	Actual Emissions (tons/year)	Actual Emissions (lbs/hr.)	Proposed Maximum Fuel Consumption (gallons/year)	Potential Emissions (PTE) (tons/year)	Potential Emissions (PTE) (lbs/hr)
PM	1,085	0.00200		138,078	2,000	0.00	0.36	**2,700,000**	2.70	0.62
SO2	1,085	0.14200	0.190	138,078	2,000	0.01	4.88	**2,700,000**	36.42	8.32
NOx	1,085	0.02400		138,078	2,000	0.01	4.34	**2,700,000**	32.40	7.40
VOC	1,085	0.00020		138,078	2,000	0.00	0.04	**2,700,000**	0.27	0.06
CO	1,085	0.00500		138,078	2,000	0.00	0.90	**2,700,000**	6.75	1.54

P001 - Station Blackout Diesel Generator (Z001) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	21.10	8,760	4,240	0.01370			2000	0.03	2.75	**50,000**	0.34	0.08
SO2	21.10	8,760	4,240	0.13800	0.190		2000	0.29	5.27	**50,000**	0.66	0.15
NOx	21.10	8,760	4,240	0.43800			2000	0.93	88.02	**50,000**	10.95	2.50
VOC	21.10	8,760	4,240	0.01120			2000	0.02	2.25	**50,000**	0.28	0.06
CO	21.10	8,760	4,240	0.11600			2000	0.25	23.31	**50,000**	2.90	0.66

P002 - Emergency Diesel Generator 1-1 (Z002) - 29.7 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	31.90	8,760	7,200	0.01370			2000	0.05	3.09	**50,000**	0.34	0.08
SO2	31.90	8,760	7,200	0.13800	0.190		2000	0.50	5.92	**50,000**	0.66	0.15

NOx	31.90	8,760	7,200	0.43800			2000	1.58	98.86	**50,000**	10.95	2.50
VOC	31.90	8,760	7,200	0.01120			2000	0.04	2.53	**50,000**	0.28	0.06
CO	31.90	8,760	7,200	0.11600			2000	0.42	26.18	**50,000**	2.90	0.66

P003 - Emergency Diesel Generator 1-2 (Z003) - 29.7 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	37.20	8760	7,148	0.01370			2000	0.05	2.63	**50,000**	0.34	0.08
SO2	37.20	8760	7,148	0.13800	0.190		2000	0.49	5.04	**50,000**	0.66	0.15
NOx	37.20	8760	7,148	0.43800			2000	1.57	84.16	**50,000**	10.95	2.50
VOC	37.20	8760	7,148	0.01120			2000	0.04	2.15	**50,000**	0.28	0.06
CO	37.20	8760	7,148	0.11600			2000	0.41	22.29	**50,000**	2.90	0.66

P005 - DBAB Diesel Generator (Z004) 7.6 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	26.39	8760	915	0.01370			2000	0.01	0.48	**10,000**	0.07	0.02
SO2	26.39	8760	915	0.13800	0.190		2000	0.06	0.91	**10,000**	0.13	0.03
NOx	26.39	8760	915	0.43800			2000	0.20	15.19	**10,000**	2.19	0.50
VOC	26.39	8760	915	0.01120			2000	0.01	0.39	**10,000**	0.06	0.01
CO	26.39	8760	915	0.11600			2000	0.05	4.02	**10,000**	0.58	0.13

P006 - Misellaneous Diesel Generator (Z005) - 2.3 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	8.10	8,760	77	0.01370			2000	0.00	0.13	**10,000**	0.07	0.02
SO2	8.10	8,760	77	0.13800	0.190		2000	0.01	0.25	**10,000**	0.13	0.03
NOx	8.10	8,760	77	0.43800			2000	0.02	4.16	**10,000**	2.19	0.50
VOC	8.10	8,760	77	0.01120			2000	0.00	0.11	**10,000**	0.06	0.01

CO	8.10	8,760	77	0.11600			2000	0.00	1.10	10,000	0.58	0.13

P004 - Fire Pump Diesel Engine (Z006) - 24.8 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	15.97	8760	35	0.01370			2000	0.00	0.03	**10,000**	0.07	0.02
SO2	15.97	8760	35	0.13800	0.190		2000	0.00	0.06	**10,000**	0.13	0.03
NOx	15.97	8760	35	0.43800			2000	0.01	0.96	**10,000**	2.19	0.50
VOC	15.97	8760	35	0.01120			2000	0.00	0.02	**10,000**	0.06	0.01
CO	15.97	8760	35	0.11600			2000	0.00	0.25	**10,000**	0.58	0.13

Total Station

									Annual Emissions (tons/year)	Actual Emissions lbs/Hr.	Maximum Annual Emissions (tons/year)	Maximum Emissions lbs/Hr.
PM									**0.14**	**9.47**	**3.93**	**0.90**
SO2									**1.37**	**22.32**	**38.78**	**8.85**
NOx									**4.31**	**295.69**	**71.82**	**16.40**
VOC									**0.11**	**7.49**	**1.28**	**0.29**
CO									**1.14**	**78.06**	**17.19**	**3.92**

Notes:
1. Emission factors are from USEPA's Chief Webfire site. Aux. Boiler SCC ID 1-01-005-01 and diesel SCC ID 2-02-004-01
2. Auxillary Boiler annual fuel usage is as reported in the Annual Report for Operation of the Davis-Bess Auxiliary Boiler; diesel annual fuel usage from plant reports
3. Auxiliary boiler potential emissions based on proposed maximum fuel consumption (voluntary restriction on auxiliary boiler fuel burn to limit potential emissions to below major source thresholds).
4. Diesels operate under Ohio EPA's permit by rule (PRB); included in calculations for facility potential to emit for synthetic minor consideration.
5. Fuel burn for exempt engines (P005 and P006) estimated based on ratio of fuel burn and operating hours from 1995 TRC report and current operating hours.

Davis-Besse Emergency Diesel and Auxiliary Boiler Hours

Date	SBODG	12 mo. ave.	EDG1-1	12 mo. Ave.	EDG1-2	12 mo. ave.	Misc.	12 mo. ave.	Fire Pump	12 mo. Ave.	ERF (DBAB) Diesel	12 mo. ave.	Aux. Boiler
Year 2006 Time	24.8		41		46.3		8.1		10.61		31.22		713

B001 - Auxiliary Boiler Emission Calculations (B001) - 226 mmBtu/hr.

	Actual Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content (Btu/gallon)	Conversion (lbs/ton)	Actual Emissions (tons/year)	Actual Emissions (lbs/hr.)	Proposed Maximum Fuel Consumption (gallons/year)	Potential Emissions (PTE) (tons/year)	Potential Emissions (PTE) (lbs/hr)
PM	384,996	0.00200		134,883	2,000	0.38	1.08	**2,700,000**	2.70	0.62
SO2	384,996	0.14200	0.210	134,883	2,000	5.74	16.10	**2,700,000**	40.26	9.19
NOx	384,996	0.02400		134,883	2,000	4.62	12.96	**2,700,000**	32.40	7.40
VOC	384,996	0.00020		134,883	2,000	0.04	0.11	**2,700,000**	0.27	0.06
CO	384,996	0.00500		134,883	2,000	0.96	2.70	**2,700,000**	6.75	1.54

P001 - Station Blackout Diesel Generator (Z001) - 29.7 mmBtu/hr

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	24.80	8,760	4,831	0.01370			2000	0.03	2.67	**50,000**	0.34	0.08
SO2	24.80	8,760	4,831	0.13800	0.21		2000	0.33	5.65	**50,000**	0.72	0.17
NOx	24.80	8,760	4,831	0.43800			2000	1.06	85.32	**50,000**	10.95	2.50
VOC	24.80	8,760	4,831	0.01120			2000	0.03	2.18	**50,000**	0.28	0.06
CO	24.80	8,760	4,831	0.11600			2000	0.28	22.60	**50,000**	2.90	0.66

P002 - Emergency Diesel Generator 1-1 (Z002) - 29.7 mmBtu/hr

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	41.00	8,760	7,654	0.01370			2000	0.05	2.56	**50,000**	0.34	0.08
SO2	41.00	8,760	7,654	0.13800	0.21		2000	0.53	5.41	**50,000**	0.72	0.17

NOx	41.00	8,760	7,654	0.43800			2000	1.68	81.76	**50,000**	10.95	2.50
VOC	41.00	8,760	7,654	0.01120			2000	0.04	2.09	**50,000**	0.28	0.06
CO	41.00	8,760	7,654	0.11600			2000	0.44	21.65	**50,000**	2.90	0.66

P003 - Emergency Diesel Generator 1-2 (Z003) - 29.7 mmBtu/hr.

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	46.30	8760	9,606	0.01370			2000	0.07	2.84	**50,000**	0.34	0.08
SO2	46.30	8760	9,606	0.13800	0.21		2000	0.66	6.01	**50,000**	0.72	0.17
NOx	46.30	8760	9,606	0.43800			2000	2.10	90.88	**50,000**	10.95	2.50
VOC	46.30	8760	9,606	0.01120			2000	0.05	2.32	**50,000**	0.28	0.06
CO	46.30	8760	9,606	0.11600			2000	0.56	24.07	**50,000**	2.90	0.66

P005 - DBAB Diesel Generator (Z004) 7.6 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	31.22	8760	1,082	0.01370			2000	0.01	0.47	**10,000**	0.07	0.02
SO2	31.22	8760	1,082	0.13800	0.21		2000	0.07	1.00	**10,000**	0.14	0.03
NOx	31.22	8760	1,082	0.43800			2000	0.24	15.18	**10,000**	2.19	0.50
VOC	31.22	8760	1,082	0.01120			2000	0.01	0.39	**10,000**	0.06	0.01
CO	31.22	8760	1,082	0.11600			2000	0.06	4.02	**10,000**	0.58	0.13

P006 - Misellaneous Diesel Generator (Z005) - 2.3 mmBtu/hr.

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	8.10	8,760	77	0.01370			2000	0.00	0.13	**10,000**	0.07	0.02
SO2	8.10	8,760	77	0.13800	0.21		2000	0.01	0.28	**10,000**	0.14	0.03
NOx	8.10	8,760	77	0.43800			2000	0.02	4.16	**10,000**	2.19	0.50
VOC	8.10	8,760	77	0.01120			2000	0.00	0.11	**10,000**	0.06	0.01

CO	8.10	8,760	77	0.11600			2000	0.00	1.10	**10,000**	0.58	0.13

P004 - Fire Pump Diesel Engine (Z006) - 24.8 mmBtu/hr

	Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	10.61	8760	23	0.01370			2000	0.00	0.03	**10,000**	0.07	0.02
SO2	10.61	8760	23	0.13800	0.21		2000	0.00	0.06	**10,000**	0.14	0.03
NOx	10.61	8760	23	0.43800			2000	0.01	0.95	**10,000**	2.19	0.50
VOC	10.61	8760	23	0.01120			2000	0.00	0.02	**10,000**	0.06	0.01
CO	10.61	8760	23	0.11600			2000	0.00	0.25	**10,000**	0.58	0.13

Total Station

									Annual Emissions (tons/year)	Actual Emissions lbs/Hr.	Maximum Annual Emissions (tons/year)	Maximum Emissions lbs/Hr.
PM									**0.54**	**9.78**	**3.93**	**0.90**
SO2									**7.35**	**34.51**	**42.87**	**9.79**
NOx									**9.72**	**291.21**	**71.82**	**16.40**
VOC									**0.17**	**7.22**	**1.28**	**0.29**
CO									**2.31**	**76.39**	**17.19**	**3.92**

Notes:
1. Emission factors are from USEPA's Chief Webfire site. Aux. Boiler SCC ID 1-01-005-01 and diesel SCC ID 2-02-004-01
2. Auxillary Boiler annual fuel usage is as reported in the Annual Report for Operation of the Davis-Bess Auxiliary Boiler; diesel annual fuel usage from plant reports
3. Auxiliary boiler potential emissions based on proposed maximum fuel consumption (voluntary restriction on auxiliary boiler fuel burn to limit potential emissions to below major source thresholds).
4. Diesels operate under Ohio EPA's permit by rule (PRB); included in calculations for facility potential to emit for synthetic minor consideration.
5. Fuel burn for exempt engines (P005 and P006) estimated based on ratio of fuel burn and operating hours from 1995 TRC report and current operating hours.

Davis-Besse Emergency Diesel and Auxiliary Boiler Hours

Date	SBODG	12 mo. ave.	EDG1-1	12 mo. Ave.	EDG1-2	12 mo. ave.	Misc.	12 mo. ave.	Fire Pump	12 mo. Ave.	ERF (DBAB) Diesel	12 mo. ave.	Aux. Boiler
Year 2005 Time	21.7		64.1		27.8		7.9		16.1		26.2		606

B001 - Auxiliary Boiler Emission Calculations (B001) - 226 mmBtu/hr.

	Actual Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content (Btu/gallon)	Conversion (lbs/ton)	Actual Emissions (tons/year)	Actual Emissions (lbs/hr.)	Proposed Maximum Fuel Consumption (gallons/year)	Potential Emissions (PTE) (tons/year)	Potential Emissions (PTE) (lbs/hr)
PM	231,405	0.00200		137,710	2,000	0.23	0.76	**2,700,000**	2.70	0.62
SO2	231,405	0.14200	0.330	137,710	2,000	5.42	17.89	**2,700,000**	63.26	14.44
NOx	231,405	0.02400		137,710	2,000	2.78	9.16	**2,700,000**	32.40	7.40
VOC	231,405	0.00020		137,710	2,000	0.02	0.08	**2,700,000**	0.27	0.06
CO	231,405	0.00500		137,710	2,000	0.58	1.91	**2,700,000**	6.75	1.54

P001 - Station Blackout Diesel Generator (Z001) - 29.7 mmBtu/hr

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	21.70	8,760	4,378	0.01370			2000	0.03	2.76	**50,000**	0.34	0.08
SO2	21.70	8,760	4,378	0.13800	0.33		2000	0.30	9.19	**50,000**	1.14	0.26
NOx	21.70	8,760	4,378	0.43800			2000	0.96	88.36	**50,000**	10.95	2.50
VOC	21.70	8,760	4,378	0.01120			2000	0.02	2.26	**50,000**	0.28	0.06
CO	21.70	8,760	4,378	0.11600			2000	0.25	23.40	**50,000**	2.90	0.66

P002 - Emergency Diesel Generator 1-1 (Z002) - 29.7 mmBtu/hr

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	64.10	8,760	11,752	0.01370			2000	0.08	2.51	**50,000**	0.34	0.08
SO2	64.10	8,760	11,752	0.13800	0.33		2000	0.81	8.35	**50,000**	1.14	0.26

NOx	64.10	8,760	11,752	0.43800			2000	2.57	80.30	**50,000**	10.95	2.50
VOC	64.10	8,760	11,752	0.01120			2000	0.07	2.05	**50,000**	0.28	0.06
CO	64.10	8,760	11,752	0.11600			2000	0.68	21.27	**50,000**	2.90	0.66

P003 - Emergency Diesel Generator 1-2 (Z003) - 29.7 mmBtu/hr.

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	27.80	8760	5,691	0.01370			2000	0.04	2.80	**50,000**	0.34	0.08
SO2	27.80	8760	5,691	0.13800	0.33		2000	0.39	9.32	**50,000**	1.14	0.26
NOx	27.80	8760	5,691	0.43800			2000	1.25	89.66	**50,000**	10.95	2.50
VOC	27.80	8760	5,691	0.01120			2000	0.03	2.29	**50,000**	0.28	0.06
CO	27.80	8760	5,691	0.11600			2000	0.33	23.74	**50,000**	2.90	0.66

P005 - DBAB Diesel Generator (Z004) 7.6 mmBtu/hr.

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	26.20	8760	908	0.01370			2000	0.01	0.47	**10,000**	0.07	0.02
SO2	26.20	8760	908	0.13800	0.33		2000	0.06	1.58	**10,000**	0.23	0.05
NOx	26.20	8760	908	0.43800			2000	0.20	15.18	**10,000**	2.19	0.50
VOC	26.20	8760	908	0.01120			2000	0.01	0.39	**10,000**	0.06	0.01
CO	26.20	8760	908	0.11600			2000	0.05	4.02	**10,000**	0.58	0.13

P006 - Misellaneous Diesel Generator (Z005) - 2.3 mmBtu/hr.

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	7.90	8,760	75	0.01370			2000	0.00	0.13	**10,000**	0.07	0.02
SO2	7.90	8,760	75	0.13800	0.33		2000	0.01	0.43	**10,000**	0.23	0.05
NOx	7.90	8,760	75	0.43800			2000	0.02	4.16	**10,000**	2.19	0.50
VOC	7.90	8,760	75	0.01120			2000	0.00	0.11	**10,000**	0.06	0.01

CO	7.90	8,760	75	0.11600			2000	0.00	1.10	**10,000**	0.58	0.13

P004 - Fire Pump Diesel Engine (Z006) - 24.8 mmBtu/hr

	Actual Operating Hours	Annual Hours	Fuel Consumption (gallons/year)	Emission Factor (lb/gal)	% Sulfur	Heat Content	Conversion (lbs/ton)	Annual Emissions (tons/year)	Actual Emissions lbs/hr.	Proposed Maximum Fuel Consumption (gallons/year)	Maximum Annual Emissions tons/year	Maximum Emissions lbs/hr
PM	16.10	8760	35	0.01370			2000	0.00	0.03	**10,000**	0.07	0.02
SO2	16.10	8760	35	0.13800	0.33		2000	0.00	0.10	**10,000**	0.23	0.05
NOx	16.10	8760	35	0.43800			2000	0.01	0.95	**10,000**	2.19	0.50
VOC	16.10	8760	35	0.01120			2000	0.00	0.02	**10,000**	0.06	0.01
CO	16.10	8760	35	0.11600			2000	0.00	0.25	**10,000**	0.58	0.13

Total Station

									Annual Emissions (tons/year)	Actual Emissions lbs/Hr.	Maximum Annual Emissions (tons/year)	Maximum Emissions lbs/Hr.
PM									**0.39**	**9.48**	**3.93**	**0.90**
SO2									**7.00**	**46.86**	**67.36**	**15.38**
NOx									**7.78**	**287.77**	**71.82**	**16.40**
VOC									**0.15**	**7.20**	**1.28**	**0.29**
CO									**1.90**	**75.70**	**17.19**	**3.92**

Notes:
1. Emission factors are from USEPA's Chief Webfire site. Aux. Boiler SCC ID 1-01-005-01 and diesel SCC ID 2-02-004-01
2. Auxillary Boiler annual fuel usage is as reported in the Annual Report for Operation of the Davis-Bess Auxiliary Boiler; diesel annual fuel usage from plant reports
3. Auxiliary boiler potential emissions based on proposed maximum fuel consumption (voluntary restriction on auxiliary boiler fuel burn to limit potential emissions to below major source thresholds).
4. Diesels operate under Ohio EPA's permit by rule (PRB); included in calculations for facility potential to emit for synthetic minor consideration.
5. Fuel burn for exempt engines (P005 and P006) estimated based on ratio of fuel burn and operating hours from 1995 TRC report and current operating hours.

AM 8

July 10, 1998

MEMORANDUM

SUBJECT: Second Extension of January 25, 1995 Potential to Emit Transition Policy and Clarification of Interim Policy

FROM: John S. Seitz, Director /s/
Office of Air Quality Planning and Standards (MD-10)

Eric V. Schaeffer, Director
Office of Regulatory Enforcement (2241A)

TO: See Addressees

This memorandum further extends the Environmental Protection Agency's (EPA) January 25, 1995 transition policy for potential to emit (PTE) limits relative to maximum achievable control technology (MACT) standards issued under section 112 of the Clean Air Act and federal operating permits issued under Title V programs. It also clarifies how the EPA's interim policy on PTE, first discussed in a January 22, 1996 memorandum, works with the transition policy.

Background

Many Clean Air Act requirements apply only to "major" sources, that is, those sources whose actual or potential emissions of air pollution exceed threshold emissions levels specified in the Act. A source's total potential to emit is determined by a two step process. First, the source's potential emissions at maximum physical capacity are established. This figure is then reduced by any recognized, practically enforceable limits on the source's emissions, such as limits on rates of production, hours of operation, and type and amount of fuel burned or materials processed. The three primary programs where PTE is a significant factor are (1) the section 112 MACT program to control emissions of hazardous air pollutants (HAPs); (2) the Title V operating permits program; and (3) the New Source Review (NSR) programs in Part C of Title I (the prevention of significant deterioration (PSD) program) and Part D of Title I (the nonattainment NSR program). These programs each contain a definition of PTE. Due to several court decisions addressing the requirement in EPA's regulatory definition of PTE under these programs that any enforceable limits on potential emissions be federally enforceable, these regulations are currently under review, and the EPA is engaged in a rulemaking process to consider amendments to the current requirements. The EPA has reviewed information provided

through a stakeholder process and is preparing a proposed rule presenting several options related to practical and federal enforceability. Further information on options being considered is contained in January 1996 and November 1997 options papers (available on the Internet at http://www.epa.gov/ttn/oarpg/).

The Current Transition Policy

In a January 25, 1995 policy memorandum entitled "Options for Limiting the Potential to Emit (PTE) of a Stationary Source Under Section 112 and Title V of the Clean Air Act (Act)," issued before the court decisions regarding the definition of PTE and federal enforceability, the EPA announced a transition policy for Section 112 and Title V (available on the Internet at http://www.epa.gov/ttn/oarpg/t5pgm.html). This transition policy alleviated concerns that some sources may face gaps in the ability to acquire federally enforceable PTE limits because of delays in State adoption or EPA approval of programs or in their implementation. In order to ensure that such gaps would not create adverse consequences for States or for sources, the EPA provided that during a 2-year period extending from January 1995 to January 1997, for sources lacking federally enforceable limitations, State and local air regulators had the option of treating the following types of sources as non-major in their Title V programs and under section 112:

(1) sources that maintain adequate records to demonstrate that their actual emissions are less than 50 percent of the applicable major source threshold, and have continued to operate at less than 50 percent of the threshold since January 1994, and

(2) sources with actual emissions between 50-100 percent of the threshold, but which hold State-enforceable limits that are enforceable as a practical matter.

On August 27, 1996, the EPA announced an extension of the transition policy until July 31, 1998. See Memorandum entitled "Extension of January 25, 1995 Potential to Emit Transition Policy" (Aug. 27, 1996) (Internet site http://www.epa.gov/ttn/oarpg/t5pgm.html). This extension was originally based, in part, on the schedule for completing the rulemaking on the definition of PTE.

Second Extension of Transition Policy

The EPA does not expect that the PTE rulemaking which will address the PTE requirements in, among other rules, the MACT standard General Provisions (40 C.F.R. part 63, subpart A) and the Title V operating permits program, will be completed before July 1998. These rule amendments will affect federal enforceability requirements for PTE limits under these programs. Thus, there will continue to be uncertainty with respect to federally enforceable limits, and a basis for the January 25, 1995 transition policy will continue to be valid after July 31, 1998. The EPA is, therefore, extending the transition period for the MACT and Title V programs until December 31, 1999, or until the effective date of the final rule in the PTE rulemaking, whichever is sooner.

Interim Policy During Period Between D.C. Circuit Opinions and Final PTE Rule

A January 22, 1996 policy memorandum entitled "Release of Interim Policy on Federal Enforceability of Limitations on Potential to Emit" sets forth the EPA's interim policy on federal enforceability during the period prior to the effective date of a final PTE rule (available on the Internet at http://www.epa.gov//ttn/oarpg/t5pgm.html). Because there have been several inquiries into the application of the interim policy, the EPA encourages Regions, States and regulated sources to review that policy memorandum, as it still represents the EPA's position. A brief description is provided below.

Section 112: In National Mining Association v. EPA, 59 F.3d 1362 (D.C. Cir. 1995), the D.C. Circuit questioned whether the federal enforceability requirement in the General Provisions to 40 C.F.R. part 63 was "necessary." The court remanded, but did not vacate, the definition of PTE in the General Provisions. Nonetheless, as noted above, since January 25, 1995, in a policy decision prior to the National Mining opinion, the EPA has followed the transition policy regarding what limits are necessary to render a source of hazardous air pollutants a "synthetic minor" source for purposes of section 112. As discussed above, today's memorandum extends the transition policy until December 31, 1999.

Title V: In Clean Air Implementation Project v. EPA, No. 96-1224 (D.C. Cir. June 28, 1996) (CAIP), the court vacated and remanded the requirement for federal enforceability for PTE limits under 40 C.F.R. part 70. The EPA has stated that the term "federally enforceable" in section 70.2 should now be read to mean "federally enforceable or legally and practicably enforceable by a State or local air pollution control agency" pending any additional rulemaking by the EPA.

As stated in the August 1996 memorandum, the EPA interprets the court order vacating the part 70 definition as not affecting any requirement for federal enforceability in existing State rules and programs. Pending the outcome of the current rulemaking effort, the EPA believes that States are not likely to pursue submittals for program revisions. Thus, despite the State program requirements for federal enforceability, there may be States wishing to continue to observe the transition policy -- the transition policy specifically allows States to follow it in determining Title V applicability. Therefore, as stated above, the EPA is extending the transition policy as it relates to Title V permitting until December 31, 1999.

New Source Review: In Chemical Manufacturers Association v. EPA, No. 89-1514 (D.C. Cir. Sept. 15, 1995) the court remanded and vacated the federal enforceability requirement in the federal NSR/PSD rules. The EPA reiterates that neither the January 25, 1995 transition policy, the opinion in National Mining nor the court order in CAIP impacts the NSR or PSD programs. A full discussion of the EPA's policy with respect to PTE issues related to the NSR and PSD programs is presented in the January 22, 1996 policy memorandum.

In brief, that memorandum states that the court's order in Chemical Manufacturers Association did not impact the individual state rules implementing these programs that have been incorporated into EPA-approved State Implementation Plans (SIPs). Thus, the order's practical impacts on NSR/PSD programs are not substantial for new construction -- federal enforceability is still required to create "synthetic minor" new and modified sources in most circumstances

pending completion of the PTE rulemaking. The precise impact of the vacatur on NSR/PSD applicability can be definitively determined only by reviewing the applicable SIP provisions.

Distribution/Further Information

We are asking Regional Offices to send this memorandum to States within their jurisdiction. Questions concerning specific issues and cases should be directed to the appropriate Regional Office. The Regional Office staff may contact John Walke of the Office of General Counsel at 202-260-9856; or Carol Holmes of the Office of Regulatory Enforcement at 202-564-8709. The document is also available on the Internet, at http:\\www.epa.gov\ttn\oarpg, under "OAR Policy and Guidance Information."

Addressees:
Director, Office of Ecosystem Protection, Region I
Director, Division of Environmental Planning and Protection, Region II
Director, Division of Air Quality, Region III
Director, Air, Pesticides, and Toxics Management Division, Region IV
Director, Air and Radiation Division, Region V
Director, Multimedia Planning and Permitting Division, Region VI
Director, Air, RCRA, and TSCA Division, Region VII
Assistant Regional Administrator, Office of Pollution Prevention, State, and Tribal Assistance, Region VIII
Director, Air and Toxics Division, Region IX
Director, Office of Air, Region X
Regional Counsels, Regions I-X
Director, Office of Environmental Stewardship, Region I
Director, Division of Enforcement and Compliance Assurance, Region II
Director, Enforcement Coordination Office, Region III
Director, Compliance Assurance and Enforcement Division, Region VI
Director, Enforcement Coordination Office, Region VII
Assistant Regional Administrator, Office of Enforcement, Compliance and Environmental Justice, Region VIII
Enforcement Coordinator, Office of Regional Enforcement Coordination, Region IX

cc: C. Holmes (2242A)
J. Ketcham-Colwill (6103)
J. Walke (2344)
L. Hutchinson (MD12)

AM 9

OhioEPA

State of Ohio Environmental Protection Agency

FINAL TITLE V PERMIT

Issue Date: **11/19/04** Effective Date: **01/03/05** Expiration Date: **01/03/10**

This document constitutes issuance of a Title V permit for Facility ID: 02-47-08-0487 to:
WEST LORAIN PLANT
7101 WEST ERIE AVENUE
LORAIN, OH 44053-0000

Emissions Unit ID (Company ID)/Emissions Unit Activity Description

B001 (GENERAL ELECTRIC CT-1A)
GENERAL ELECTRIC MODEL 7000 COMBUSTION TURBINE

B002 (GENERAL ELECTRIC CT-1B)
GENERAL ELECTRIC MODEL 7000 COMBUSTION TURBINE

B003 (AUX. BOILER, A)
AUX. BOILER, ERIE DISTILLATE OIL-FIRED STEAM BOILER

B006 (AUX. BOILER, B)
AUX. BOILER, OIL-FIRED STEAM BOILER

P001 (GE CT Unit # 2)
GENERAL ELECTRIC COMBUSTION TURBINE MODEL 7EA

P002 (GE CT Unit # 3)
GENERAL ELECTRIC COMBUSTION TURBINE MODEL 7EA

P003 (GE CT Unit # 4)
GENERAL ELECTRIC COMBUSTION TURBINE MODEL 7EA

P004 (GE CT Unit # 5)
GENERAL ELECTRIC COMBUSTION TURBINE MODEL 7EA

P005 (GE CT Unit # 6)
GENERAL ELECTRIC COMBUSTION TURBINE MODEL 7EA

You will be contacted approximately eighteen (18) months prior to the expiration date regarding the renewal of this permit. If you are not contacted, please contact the appropriate Ohio EPA District Office or local air agency listed below. This permit and the authorization to operate the air contaminant sources (emissions units) at this facility shall expire at midnight on the expiration date shown above. If a renewal permit is not issued prior to the expiration date, the permittee may continue to operate pursuant to OAC rule 3745-77-08(E) and in accordance with the terms of this permit beyond the expiration date, provided that a complete renewal application is submitted no earlier than eighteen (18) months and no later than one-hundred eighty (180) days prior to the expiration date.

Described below is the current Ohio EPA District Office or local air agency that is responsible for processing and administering your Title V permit:

Northeast District Office
2110 East Aurora Road
Twinsburg, OH 44087
(330) 425-9171

OHIO ENVIRONMENTAL PROTECTION AGENCY

Christopher Jones
Director

AM 10

2004-2005 NON-TITLE V AIR EMISSIONS REPORT

Mailed 4-12-06

OhioEPA

State of Ohio Environmental Protection Agency
Division of Air Pollution Control - PIER
P.O. Box 1049, Columbus, OH 43216-1049
http://www.epa.state.oh.us/dapc/nontvfee.html

Need Assistance? Contact us!
Ohio EPA (Northwest District Office)
Samir Araj, (419) 373-3138
or
OCAPP 1-800-329-7518

FACILITY ID # 0362000091

0362000091

DUE: APRIL 17, 2006

02/21/2005

RAYMOND EVANS
DAVIS - BESSE STATION
C/O FIRST ENERGY ENVIRONMENTAL DEPT
76 S MAIN ST
AKRON, OH 44308

FACILITY LOCATION:
DAVIS - BESSE STATION
RFD NO 1 STATE ROUTE 2
OAK HARBOR, OH 43449

FORM SIDE ONE

For each year, please complete ONE of the options numbered 1-7 for this facility.		2004	2005
1. **More than zero, but less than 10 Tons per Year (TPY)** for all pollutants facility-wide.		☐	☐
2. **10 TPY or more, but less than 50 TPY** for all pollutants facility-wide.		☑	☑
3. **50 TPY or more, but less than 100 TPY** for all pollutants facility-wide. Specify the amount (in tons) of each pollutant listed that your facility emitted for each year.	Particulate Matter (PM)		
	Sulfur Dioxide (SO2)		
	Nitrogen Oxide (NOx)		
	Organic Compounds (OC)		
4. **100 TPY or more** for all pollutants facility-wide. Specify the amount (in tons) of each pollutant listed that your facility emitted for each year.	Particulate Matter (PM)		
	Sulfur Dioxide (SO2)		
	Nitrogen Oxide (NOx)		
	Organic Compounds (OC)		
5. **Zero Emissions** (no air contaminant sources operated at any time during this year and we wish to keep our permits or registrations active).		☐	☐
6. All air contaminant sources were **permanently shut down or dismantled** at this location as of December 31st of checked year. SHUTDOWN DATE: ________		☐	☐
7. I/ The company did not own or operate this facility on December 31st of checked year. OWNERSHIP TRANSFER DATE ________ IMPORTANT: COMPLETE OWNERSHIP CHANGE INFORMATION ON REVERSE SIDE		☐	☐

By checking this option and signing this form, you are attesting to the following: For the period(s) checked, I am not required to apply for a permit under the provisions of the OAC rule 3745-77-02 Title V program for the facility for which this annual emissions fee is being paid. I affirm, based on information and belief formed after reasonable inquiry, that all factual statements in this report are true to the best of my knowledge, and that all judgments and estimates provided in this report have been made in good faith. I understand that the data provided in this document will be used by the Ohio EPA to calculate a fee, which my facility will be required to pay under Ohio Revised Code 3745.11(D) and Ohio Administrative Code 3745-78-02(D), based on the tons of pollution emitted by the facility.

Signature and Title of Company Official: Raymond L. Evans, Manager Date: 4-12-06

Name, Title, and Phone# of Company Official (please print): RAYMOND L. EVANS, MGR. MONITORING/REPORTING (330)761-4452

MAKE A COPY FOR YOUR RECORDS. SEE OTHER SIDE TO UPDATE ADDRESS, OWNER OR CONTACT INFORMATION.

OhioEPA

2006 2007 Non-Title V Air Emissions Report

Need Assistance? Contact us!

Ohio EPA DAPC, Northwest District Office (419)352-8461, OCAPP 1-800-329-7518, or Central Office (614)644-2270

State of Ohio Environmental Protection Agency
Division of Air Pollution Control-PIER
P.O. Box 1049, Columbus, OH 43216-1049
http://www.epa.state.oh.us/dapc/nontvfee.html

FACILITY ID : 0362000091

DUE DATE: June 6, 2008

Gail Iwayman

4/4/2008

RAYMOND EVANS
DAVIS - BESSE STATION
C/O FIRST ENERGY ENVIRONMENTAL DEPT
76 S MAIN ST
AKRON, OH 44308

Facility Location:
RFD NO 1 STATE ROUTE 2
OAK HARBOR, OH 43449

How do I determine what my annual emissions are?
To assist you in completeing the current report we provided you with the emissions information given to Ohio EPA for the previous reporting period.

2004: 10 or more but less than 50
2005: 10 or more but less than 50

Emissions Information For the year(s) provided, complete one of the facility-wide emissions level options numbered 1-5 with a check mark. If the emissions were greater than 50 or 100 TPY provide info on each specified pollutant. **See page 2 to indicate an ownership change or that this facility is shutdown.**

Emissions Reporting Year:		2006
1. Zero Emissions (did not operate this year)		
2. More than zero, but less than 10 TPY		✓
3. More than 10, but less than 50 TPY		
4. More than 50 TPY*		
5. More than 100 TPY*		
*If you checked line 4 or 5 provide the emissions per pollutant.	Particulate Matter (PM)	
	Sulfur Dioxide (SO2)	
	Nitrogen Oxide (NOx)	
	Organic Compounds (OC)	
6. Permanently shutdown this year (see p. 2)		

Emissions Reporting Year:		2007
1. Zero Emissions (did not operate this year)		
2. More than zero, but less than 10 TPY		✓
3. More than 10, but less than 50 TPY		
4. More than 50 TPY*		
5. More than 100 TPY*		
*If you checked line 4 or 5 provide the emissions per pollutant.	Particulate Matter (PM)	
	Sulfur Dioxide (SO2)	
	Nitrogen Oxide (NOx)	
	Organic Compounds (OC)	
6. Permanently shutdown this year (see p. 2)		

Emissions Statement Requirement: Total VOC and NOx emissions for the year specified must be reported if the actual emissions of VOC or NOx is 25 TPY or more.

By checking this option and signing this form, you are attesting to the following: For the period(s) checked, I am not required to apply for a permit under the provisions of the OAC rule 3745-77-02 Title V program for the facility for which this annual emissions fee is being paid. I affirm based on information and belief formed after reasonable inquiry, that all factual statements in this report are true to the best of my knowledge, and that all judgements and estimates provided in this report have been made in good faith. I understand that the data provided in this document will be used by the Ohio EPA to calculate a fee, which will be required to pay under Ohio Revised Code 3745.11(D) and Ohio Administrative Code 3745-78-02(D), based on the tons of pollution emitted by the facility.

Signature and Title of Company Official: [signature] Date: 5/28/08

Name, Title, and Phone # of Company Official (please print): Michael J. Jirousek, Manager Environmental

MAKE A COPY FOR YOUR RECORDS

AM 12

Ohio Environmental Protection Agency
Division of Air Pollution Control-PIER
P.O. Box 1049, Columbus, OH 43216-1049
http://www.epa.ohio.gov/dapc/nontvfee.aspx

2008 2009 Non-Title V Air Emissions Report

Need Assistance? Contact us!
Ohio EPA DAPC, Northwest District Office (419)352-8461,
OCAPP 1-800-329-7518, or Central Office (614)644-2270

FACILITY ID : 0362000091

DUE DATE: April 15, 2010

DOC# 1902004154
fax 8024344

2/26/2010

RAYMOND EVANS
Fenoc - Davis - Besse Station
C/O FIRST ENERGY ENVIRONMENTAL DEPT
76 S MAIN ST
AKRON, OH 44308

Facility Location:
RFD NO 1 STATE ROUTE 2
OAK HARBOR, OH 43449

How do I determine what my annual emissions are?
To assist you in completeing the current report we provided you with the emissions information given to Ohio EPA for the previous reporting period.

2006: More than 0 but less than 10 Tons per Year
2007: More than 0 but less than 10 Tons per Year

Emissions Information For the year(s) provided, complete one of the facility-wide emissions level options numbered 1-5 with a check mark. If the emissions were greater than 50 or 100 TPY provide info on each specified pollutant. **See page 2 to indicate an ownership change or that this facility is shutdown.**

Emissions Reporting Year:		2008
1. Zero Emissions (did not operate this year)		
2. More than zero, but less than 10 TPY		
3. More than 10, but less than 50 TPY		√
4. More than 50 TPY*		
5. More than 100 TPY*		
*If you checked line 4 or 5 provide the emissions per pollutant.	Particulate Matter (PM)	
	Organic Compounds (OC)	
	Nitrogen Oxides (NOx)	
	Sulfur Dioxide (SO2)	
6. Permanently shutdown this year (see p. 2)		

Emissions Reporting Year:		2009
1. Zero Emissions (did not operate this year)		
2. More than zero, but less than 10 TPY		
3. More than 10, but less than 50 TPY		√
4. More than 50 TPY*		
5. More than 100 TPY*		
*If you checked line 4 or 5 provide the emissions per pollutant.	Particulate Matter (PM)	
	Organic Compounds (OC)	
	Nitrogen Oxides (NOx)	
	Sulfur Dioxide (SO2)	
6. Permanently shutdown this year (see p. 2)		

By completing and signing this form, you are attesting to the following: For the period(s) checked, I am not required to apply for a permit under the provisions of the OAC rule 3745-77-02 Title V program for the facility for which this annual emissions fee is being paid. I affirm based on information and belief formed after reasonable inquiry, that all factual statements in this report are true to the best of my knowledge, and that all judgements and estimates provided in this report have been made in good faith. I understand that the data provided in this document will be used by the Ohio EPA to calculate a fee, which will be required to pay under Ohio Revised Code 3745.11(D) and Ohio Administrative Code 3745-78-02(D), based on the tons of pollution emitted by the facility.

Signature and Title of Company Official: [signature], Mgr. Date: 3/29/10

Name, Title, and Phone # of Company Official (please print): Michael J. Jirousek, Manager 330-384-5744

RCC-623143
C/E-650310
I/O-3221450

MAKE A COPY FOR YOUR RECORDS

AM 13

Engineering Guide #61

Question:

What is Ohio EPA's policy for limiting the potential to emit (PTE) of air contaminant emissions at a facility for purposes of avoiding federal permitting?

Answer:

In response to the January 25, 1995 and September 6, 1995 guidance memoranda from John S. Seitz, Director, Office of Air Quality Planning and Standards, USEPA, on limiting an entity's PTE to avoid federal permitting requirements, Ohio EPA has prepared the following guidance document. We asked USEPA Region V staff to review this document, and they concurred that this engineering guide is consistent with federal policy.

Inherent Physical Limitations

An entity can take advantage of an inherent physical limitation that in effect limits the entity's potential air pollution emissions. These inherent physical limitations can now be considered as a true restriction for calculating the PTE for each regulated pollutant as defined in OAC rule 3745-77-01(DD) or in federal new source review law (PSD & Nonattainment New Source Review). For example, a machine may be physically limited in operation well below the 8760 hours that the theoretical potential to emit has been traditionally based. An entity must document this inherent physical limitation (e.g., using a manufacturer's specification for maximum operating conditions for a specific machine) and use this "common sense" approach to establish a more accurate PTE. Again, the inherent physical limitation makes it impossible to exceed these limitations. If necessary, records (e.g., production records or operating hours) may be maintained that demonstrate the inherent physical limitation is not exceeded. USEPA points out that for small entities these inherent physical limitations are straightforward. Seasonal operations or limited shifts [where physical conditions limit the operations (e.g., the operations can only occur during daylight hours)] are other examples of inherent physical limitations. Operational records must be maintained for seasonal or shift limitations to prove compliance with the inherent physical limitation. For larger facilities, it may be difficult to prove that an inherent physical limitation exists. If an entity can take advantage of an inherent physical limitation, we request that the entity's representative notify Ohio EPA that it now qualifies for non-Title V status. Please submit this notification by May 15, 1995 or immediately after the determination is made in accordance with the instructions described below.

Presumed Inherent Physical Limitations (Title V applicability only)

Ohio EPA is taking the position that a very small emitting facility is presumed to have inherent physical limitations if the facility's actual emissions are below twenty percent of any major regulated pollutant threshold. Owners and operators of such small facilities can take advantage of this presumption by maintaining actual emission records showing that emissions are less than twenty percent of the major threshold. Also, owners and operators of facilities that take advantage of this presumed inherent physical limitation due to size, must initially notify Ohio EPA in writing (only once) that the facility is a non-Title V facility. Please submit this notification by May 15, 1995 or immediately after the determination is made in accordance with the instructions described below. Since all owners and operators of air emitting (non-Title V and Title V) facilities are required to maintain actual emission records for fee purposes (OAC Chapter 3745-78), these same records can be used as documentation that the entity has presumed inherent physical limitations. Ohio EPA's common sense position eliminates the need for very small air pollution emitting facilities to obtain federally enforceable State operating permits (FESOP's). If an entity avoiding Title V permitting is taking advantage of this presumption, and in a future year the regulated pollutant emissions exceed the twenty percent threshold, then the entity will have one year to obtain a FESOP or submit a complete Title V permit application.

Two-Year Transition Period (Title V applicability only)

Ohio will take advantage of the discretion that USEPA allows to facilities that are potential major Title V facilities, but have actual emissions that are less than fifty percent of the major threshold. Persons owning or operating qualifying facilities may choose to delay obtaining federally enforceable conditions in a FESOP for up to three and one half years (July 31, 1998) and operate as a non-Title V facility. Eligible participating facilities must maintain adequate records on site to demonstrate that emissions are maintained below these thresholds for the entire facility. Again, a person owning or operating any facility that qualifies, who intends to delay obtaining a FESOP, must notify the Ohio EPA in writing (only once). Please submit this notification by May 15, 1995 or immediately after the determination is made in accordance with the instructions described below.

Other Possible Synthetic Minors

If a person owns or operates a facility that has a potential to emit over the major threshold, but actual emissions for one or more regulated pollutants are at or above fifty percent of the major threshold, the owner or operator needs to obtain a FESOP or file a complete Title V application within the required deadline. Since Ohio's FESOP State Implementation Plan (SIP) request was approved on December 27, 1994, Ohio will not take advantage of the temporary programs that USEPA has created for states that do not have approved FESOP SIP's.

Hazardous Air Pollutants

Under Ohio's current approved FESOP SIP (effective December 27, 1994), the owner or operator can limit potential hazardous air pollutant (HAP) emissions that are federally enforceable in a permit to operate issued under the provisions of OAC rule 3745-35-07.

Emergency Generators

For purposes of this guidance, an emergency generator means a generator whose sole function is to provide back-up power when electric power from the local utility is interrupted. The emission source for such generators is typically a gasoline or diesel-fired engine, but can in some cases include a small gas turbine.

For emergency generators, a reasonable and realistic worst-case estimate of the number of hours that power would be expected to be unavailable from the local utility may be used as the maximum capacity of such generators for the purpose of estimating their potential to emit. Potential to emit for emergency generators should be determined based upon an estimate of the maximum amount of hours the generator could operate, taking into account: (1) the number of hours power would be expected to be unavailable; and (2) the number of hours for maintenance activities. Ohio EPA will accept an assumption of 500 hours per year as the maximum amount of hours an emergency generator could operate, unless there is clear evidence that more hours of operation have been experienced in the past and will be experienced in future years. The owner or operator of an emergency generator may assume less than 500 hours per year of operation for purposes of calculating potential to emit based upon historical operating experience and future operating projections.

This guidance is only meant to address emergency generators as described. Specifically, the guidance does not address: (1) peaking units at electric utilities; (2) generators at industrial facilities that typically operate at low rates, but are not confined to emergency purposes; and (3) any standby generator that is used during time periods when power is available from the utility. This guidance is also not intended to discourage Ohio EPA from establishing operational limitations in PTI s when such limitations are deemed appropriate or necessary. Additionally, this guidance is not intended to be used as the basis to rescind any such restrictions already in place.

Title V Fees

Facilities that are considered minors because of physically inherent limitations or presumed physically inherent limitations are not required to pay a Title V fee or file a Title V fee emission report. Two-year transition facilities will not be required to pay a Title V fee or file a Title V fee emission report during the two-year transition period [i.e., for the 1995 fee (assessed for CY 1994 emissions) and the 1996 fee (assessed for CY 1995 emissions)].

Notifications

If a facility is requested or required to notify the Ohio EPA as discussed in the sections on physically inherent limitations, presumed physical inherent limitations, or two-year transition period facilities, the notification should be sent to

Mike Ahern
Ohio Environmental Protection Agency
Division of Air Pollution Control
Lazarus Government Center
P.O. Box 1049
Columbus, Ohio 43216-1049

The appropriate Ohio EPA District Office or local air agency should be copied.

Calculating Potential to Emit

For your convenience, the guidance is attached that has been provided to Ohio facilities to instruct them on how to calculate potential to emit. This instruction has been revised to reflect the most current guidance and understanding.

Instructions for Calculating Potential To Emit

"Potential to emit" means the maximum capacity of a stationary source to emit any regulated air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of a source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as a part of its design if the limitation is enforceable by the administrator of the USEPA. The term does not alter or affect the use of this term for any other purposes under the Act, or the term "capacity factor" as used in Title IV of the Clean Air Act or the regulations promulgated thereunder.

Note: For potential to emit purposes, to take credit for air pollution control equipment or operational restrictions there must be federally enforceable limitations. What this means is that USEPA must be able to enforce the restrictions that are established with a State Implementation Plan (SIP) limitation (e.g., an emission limitation rule which USEPA has approved as part of Ohio's SIP), or federally enforceable limitations established in a permit to install (issued first as a draft, then issued final), or FESOP that both the public and USEPA had an opportunity for comment prior to final issuance. If there is no SIP emission limit or federally enforceable PTI or PTO restriction, then you must calculate the potential to emit for the emission based on the uncontrolled emission rate at maximum capacity.

"Nitrogen oxides" means all oxides of nitrogen which are determined to be ozone precursors, including, but not limited to nitrogen oxide and nitrogen dioxide, but excluding nitrous oxide, collectively expressed as nitrogen dioxide.

Ohio EPA
Division of Air Pollution Control
April 27, 1995
Revised November 6, 1995
Revised September 5, 1996

AM 14

FENOC
FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station
5501 N. State Route 2
Oak Harbor, Ohio 43449

January 14, 2011

L-11-005

Mr. Jay Liebrecht
Northwest District Office
Ohio Environmental Protection Agency
347 North Dunbridge Road
Bowling Green, Ohio 43402-0466

SUBJECT:
Submittal of the 2010 Annual Report for Davis-Besse Nuclear Power Station Auxiliary Boiler

Enclosed is the Annual Report for operation of the Davis-Besse Nuclear Power Station Auxiliary Boiler for the 2010 calendar year. This report is submitted in accordance with the Special Terms and Conditions of the Permit to Operate an Air Contaminant Source (Permit Application Number 0362000091B001).

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Alfred M. Percival, Senior Nuclear Specialist, at (419) 321-7883.

Sincerely,

Polly M. Boissoneault

Polly M. Boissoneault

Manager – Site Chemistry
Davis-Besse Nuclear Power Station

KAS/AMP

Enclosure
A. Annual Report for Operation of the Davis-Besse Auxiliary Boiler

cc: Z. A. Clayton, Ohio Environmental Protection Agency

ANNUAL REPORT for OPERATION of the DAVIS-BESSE AUXILIARY BOILER

Application No. 0362000091B001	**Year 2010**
Equipment Description: 226 M BTU/Hr.	**No. 2 oil-fired boiler**
Quantity of Oil Consumed in Boiler	**401,336 gallons**
Average Heat Content	**138,265 BTU/gallon**
Weight Percent Ash	**<0.001**
Weight Percent Sulfur	**<0.020**
Weight Percent Nitrogen	**<0.75**

For internal distribution only:

bcc: Director Site Operations
Manager Site Chemistry
Director Site Engineering
FirstEnergy Environmental
FileNet

Davis Besse 10 Yr. Average Operating Hours and Fuel Burn

	hours	fuel burn	hours	fuel burn	hours	fuel burn	hours	fuel burn
Date	**SBODG**		**EDG1-1**		**EDG1-2**		**Misc.**	
Year 2000 Time	24	4,313	37.4	6,745	36.7	6,976	8.4	711
Year 2001 Time	20.1	3,954	32.6	5,889	32	6,244	43.8	881
Year 2002 Time	20.5	3,807	31.4	6,055	41.8	8,373	21.6	922
Year 2003 Time	18.9	4,225	104.3	17,224	110.7	16,707	65.5	1,165
Year 2004 Time	22.4	4,120	31.1	5,890	35.3	6,722	54.5	917
Year 2005 Time	21.7	4,378	64.1	11,752	27.8	5,691	7.9	908
Year 2006 Time	24.8	4,831	41	7,654	46.3	9,606	8.1	1,082
Year 2007 Time	21.1	4,240	31.9	7,200	37.2	7,148	8.1	915
Year 2008 Time	24.8	4,067	31.3	8,702	44.5	8,215	29.3	1,300
Year 2009 Time	23.5	4,731	31.2	6,122	33.2	6,360	7.3	1,300
10 Yr. Avg	22.18	4,266	43.63	8,323	44.55	8,204	25.45	1,010
5 Yr. Avg.	23.18	4,449	39.9	8,286	37.8	7,404	12.1	1,101

Davis Besse 10 Yr. Average Operating Hours and Fuel Burn

hours	fuel burn	hours	fuel burn	hours	
Fire Pump		**ERF (DBAB) Diesel**		**Aux. Boiler**	
47.3	80	20.5	104	450	200,898
97.9	416	25.4	214	9	1,136
78.71	205	26.59	172	3032	537,054
19.9	622	33.6	44	5637	1,489,191
22.68	518	26.44	50	1357	1,729,230
16.1	75	26.2	35	606	231,405
10.61	77	31.22	23	713	384,996
15.97	77	26.39	35	6	1,085
11.13	500	23.6	2,000	987	394,622
19.85	100	23.19	3,900	388	236,349
34	267	26	658	1,319	520,597
14.7	166	26.12	1,199	540	249,691

AM 16

The Emergency Diesel Generators (EDGs) and the Station Blackout Diesel Generator (SBODG) preventive maintenance activities are largely based on a recommended maintenance practices document authored by a diesel generator owners group. The largest engine maintenance activity is the twelve year preventive maintenance (PM) activity, which removes each of the 20 cylinders' power packs (cylinder head, piston, cylinder liner) for replacement of cylinder liner seals. The six year PMs remove each of the twenty heads, and replace the jacket water seals. Four and / or two year PMs perform activities such as checking the torque on engine fasteners, performing detailed in-cylinder inspections, fuel rack adjustments, governor oil replacement, standby lube oil pump and motor replacements, lube and diesel oil filter changes, and intake air filter inspections. Numerous other smaller scope PM activities are performed at intervals down to quarterly.

Per the EPRI/FENOC Equipment Reliability Template for Small Standby Diesels (NORM-ER-3406A) the Engine for the Diesel Fire Pump contains the following Preventative Maintenance Tasks:

Bi-Monthly:
- Oil Sample

Annual Inspection:
- Air Intake System - inspection
- Coolant System – inspection, filter change and proper additive concentration
- Universal Joints - Grease
- Lubricating System - Oil (and filter) change
- Fuel System - filter change
- Heat Exchange zinc plugs inspection
- Belt inspection
- Air Cleaner inspection/change
- Mounting bolt – inspection
- Controller – Clean and inspect

Every 18-months:
- Capacity/Flow test (150%, 100%, and 50% load)
- Vibration Monitoring (150% and 100% load)
- Overspeed trip test

Bi-Annual Inspection:
- Fuel Injector and valve adjustment
- Cooling System flush
- Batteries - replace

Five Year inspection:
- Fuel Injector – replace
- Oiler Cooler – replace
- Water pump – inspection

- Turbocharger – inspection
- Vibration Damper – inspection
- Fuel Pump - refurbish

Fifteen year Inspections:

- Cylinder head and liner – inspection
- Cam Lobe – inspection
- Rocker arm and rollers – inspection
- Pushrod – inspection
- Timing gear - inspection
- Crank case breathers - inspection
- Exhaust System - inspection

Aquatic

A 1

FirstEnergy

Davis-Besse Nuclear Power Station
5501 North State Route 2
Oak Harbor, Ohio 43449-9760

February 5, 2008
L-08-039

Ohio Department of Natural Resources
Division of Water
Water Resources Section
2045 Morse Road, Bld. B-2
Columbus, Ohio 43229-6605

SUBJECT:
Water Withdrawal Report for the Davis-Besse Nuclear Power Station, Unit 1 for 2007

In accordance with Ohio Revised Code 1521.16, "Water Withdrawal Registration," enclosed is the Water Withdrawal Report for the Davis-Besse Nuclear Power Station for the year 2007. This report is required to be submitted by all registered facilities that have a 100,000 gallon per day or greater capacity. Flow values were obtained from continuous data acquisition systems and were based on hourly averages.

If there are any questions or if additional information is required, please contact Mr. Stephen M. Chimo, Advanced Nuclear Specialist, at (419) 321-7149.

Sincerely,

Patrick J. McCloskey
Manager – Site Chemistry
Davis-Besse Nuclear Power Station

JCS/SMC

Enclosure:
A. Water Withdrawal Report for the Davis-Besse Nuclear Power Station for 2007

Water Withdrawal Report

for the

Davis-Besse Nuclear Power Station for 2007

(one form follows)

STATE OF OHIO WATER WITHDRAWAL FACILITY REGISTRATION ANNUAL REPORT FORM

SEND TO: OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
WATER RESOURCES SECTION
2045 MORSE ROAD, BLD. B-2
COLUMBUS, OHIO 43229-6693
(614) 265-6745

AUTHORITY: Ohio Revised Code Section 1521.16 requires that any owner of a facility, or combination of facilities, with the capacity to withdraw more than 100,000 gallons of water daily, register such facilities and file an annual report with the Ohio Department of Natural Resources, Division of Water.

Water Withdrawal Report for the Year Ending December 31, 2007

Contact Information:

Contact Name: Patrick J. McCloskey — Is this a new Contact Name? ☐ YES ☒ NO

Company Name: FirstEnergy Nuclear Generation Corp. - Davis-Besse Power Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: — Is this a new Phone Number? ☐ YES ☒ NO

–Downloaded Internet eForm –

Facility Owner:

Owner Name: FirstEnergy Corp. — Is this a new Owner Name? ☐ YES ☒ NO

Company Name: FirstEnergy Nuclear Generation Corp. - Davis-Besse Power Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: 419-321-7274 — Is this a new Phone Number? ☐ YES ☒ NO

Facility Name and Withdrawal Mode:

County: Ottawa

*Registration Number: 00598 — * Please double check the registration number, Thank you.

Facility Name: FENOC-Davis-Besse Nuclear Power Station

Please note changes in facility status, or naming, in the gray spaces next to the well or intake number(s) below.

Facility's WELL (Ground Water) Identification	Facility's INTAKE (Surface Water) Identification
	01

If you have questions about this form please call (614) 265-6745

WITHDRAWALS

NOTE: This page may be photocopied if additional space is required. Please be sure to sign and date each copy.

GROUND WATER (in Units of Millions of Gallons) Registration Number________

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
TOTAL													GRAND TOTAL
MAXIMUM													
MINIMUM													
DAYS IN OPERATION													TOTAL OPERATION DAYS

Are ground water withdrawal amounts based on metered readings? ☐ yes ☐ **no** (check one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

SURFACE WATER (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
INTAKE	1290	1119	1461	1349	1402	1279	1454	1393	1293	1338	1241	1206	15825
INTAKE													
INTAKE													
INTAKE													
INTAKE													
TOTAL	1290	1119	1461	1349	1402	1279	1454	1393	1293	1338	1241	1206	GRAND TOTAL 15825
MAXIMUM													
MINIMUM													
DAYS IN OPERATION	31	28	31	30	31	30	31	31	30	31	30	29	TOTAL OPERATION DAYS 363

Are surface water withdrawal amounts based on metered readings? ☒ yes ☐ **no** (check one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

RETURN FLOW (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
FLOW	1044	899	1218	1121	1146	1002	1171	1106	1018	1073	1010	993	12801
FLOW													
TOTAL	1044	899	1218	1121	1146	1002	1171	1106	1018	1073	1010	993	GRAND TOTAL 12801

Are return flow amounts based on metered readings? ☒ yes ☐ **no** (check one) If "no," how were the reported return flow amounts determined? (Attach separate sheet, if necessary)

NOTE: Is the information originally supplied on your registration form still correct? ☒ yes ☐ **no** (check one)
If "no," please attach a separate sheet indicating the nature of the change. If needed, a new registration form will be forwarded to you so that you may provide this office with the necessary revisions.

Owner or authorized representative's signature	Date
Patrick J. McCloskey [signature]	02/05/08

DNR 7805e (12/04/07)

A 2

FENOC
FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station
5501 N. State Route 2
Oak Harbor, Ohio 43449

February 11, 2009
L-09-027

Ohio Department of Natural Resources
Division of Water
Water Resources Section
2045 Morse Road, Bld. B-2
Columbus, Ohio 43229-6605

SUBJECT:
Water Withdrawal Report for the Davis-Besse Nuclear Power Station, Unit 1 for 2008

In accordance with Ohio Revised Code 1521.16, "Water Withdrawal Registration," enclosed is the Water Withdrawal Report for the Davis-Besse Nuclear Power Station for the year 2008. This report is required to be submitted by all registered facilities that have a 100,000 gallon per day or greater capacity. Flow values were obtained from continuous data acquisition systems and were based on hourly averages.

Also enclosed is the "Water Withdrawal Baseline Capacity Reporting Form 2008" to update the registered water withdrawal baseline capacity.

If there are any questions or if additional information is required, please contact Mr. Stephen M. Chimo, Advanced Nuclear Specialist, at (419) 321-7149.

Sincerely,

Polly M. Boissoneault

Polly M. Boissoneault
Manager – Site Chemistry
Davis-Besse Nuclear Power Station

TSC/SMC

Enclosure:
A. Water Withdrawal Report for the Davis-Besse Nuclear Power Station for 2008
B. Water Withdrawal Baseline Capacity Reporting Form 2008

Enclosure A
L-09-027
Page 1 of 1

Water Withdrawal Report

for the

Davis-Besse Nuclear Power Station for 2008

(one form follows)

STATE OF OHIO WATER WITHDRAWAL FACILITY REGISTRATION ANNUAL REPORT FORM

SEND TO: OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
WATER RESOURCES SECTION
2045 MORSE ROAD, BLD. B-2
COLUMBUS, OHIO 43229-6693
(614) 265-6745

AUTHORITY: Ohio Revised Code Section 1521.16 requires that any owner of a facility, or combination of facilities, with the capacity to withdraw more than 100,000 gallons of water daily, register such facilities and file an annual report with the Ohio Department of Natural Resources, Division of Water.

Water Withdrawal Report for the Year Ending December 31, 2008

Contact Information:

Contact Name: Ms. Polly M. Boissoneault — Is this a new Contact Name? ☒ YES ☐ NO

Company Name: FENOC-Davis-Besse Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: 1.419.321.8549 — Is this a new Phone Number? ☒ YES ☐ NO

-Downloaded Internet eForm -

Facility Owner:

Owner Name: FirstEnergy Corp. — Is this a new Owner Name? ☐ YES ☒ NO

Company Name: FENOC-Davis-Besse Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: 1.419.321.8549 — Is this a new Phone Number? ☒ YES ☐ NO

Facility Name and Withdrawal Mode:

County: Ottawa

*Registration Number: 00598 — * Please double check the registration number, Thank you.

Facility Name: FENOC-Davis-Besse Nuclear Power Station

Please note changes in facility status, or naming, in the gray spaces next to the well or intake number(s) below.

Facility's WELL (Ground Water) Identification			Facility's INTAKE (Surface Water) Identification		
			01		

If you have questions about this form please call (614) 265-6745.

WITHDRAWALS

NOTE: This page may be photocopied if additional space is required. Please be sure to sign and date each copy.

GROUND WATER (in Units of Millions of Gallons)

Registration Number________

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
TOTAL													GRAND TOTAL
MAXIMUM													
MINIMUM													
DAYS IN OPERATION													TOTAL OPERATION DAYS

Are ground water withdrawal amounts based on metered readings? ☐ yes ☐ no (check one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

SURFACE WATER (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
INTAKE	511	1050	1309	1314	1428	1309	1583	1615	1376	981	957	1221	14654
INTAKE													
INTAKE													
INTAKE													
INTAKE													
TOTAL	511	1050	1309	1314	1428	1309	1583	1615	1376	981	957	1221	GRAND TOTAL 14654
MAXIMUM													
MINIMUM													
DAYS IN OPERATION	31	29	31	30	31	30	31	31	30	31	30	31	TOTAL OPERATION DAYS 366

Are surface water withdrawal amounts based on metered readings? ☒ yes ☐ no (check one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

RETURN FLOW (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	J UNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
FLOW	490	864	944	960	1037	913	1158	1189	970	596	603	949	10673
FLOW													
TOTAL	490	864	944	960	1037	913	1158	1189	970	596	603	949	GRAND TOTAL 10673

Are return flow amounts based on metered readings? ☒ yes ☐ no (check one) If "no," how were the reported return flow amounts determined? (Attach separate sheet, if necessary)

NOTE: Is the information originally supplied on your registration form still correct? ☐ yes ☒ no (check one)
If "no," please attach a separate sheet indicating the nature of the change. If needed, a new registration form will be forwarded to you so that you may provide this office with the necessary revisions.

Owner or authorized representative's signature	Date
Polly M. Boissonneault	2/10/09

DNR 7805e (12/04/07)

Water Withdrawal Baseline Capacity Reporting

Form 2008

for the

Davis-Besse Nuclear Power Station

(one form follows)

Ohio Department of Natural Resources
Division of Water
Water Withdrawal Baseline
Capacity Reporting Form 2008

RETURN TO:
OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER, WATER RESOURCES SECTION
2045 MORSE ROAD, BLD. B-2
COLUMBUS, OHIO 43229-6693

Facility Name: FENCO-DAVIS BESSE NUCLEAR POWER STATION Registration Number: 00598

Well Capacities

☐ All **registered** well capacity values are correct, I have no edits or new wells to report.

Well ID	ODNR Well Log Number	**Registered** Well Capacity *(mg/d)	Your **Current** Well Capacity *(mg/d)

Please provide additional comments if needed. * mg/d = Millions of Gallons per Day.

Intake Capacities

☐ All **registered** intake capacity values are correct, I have no edits or new intakes to report.

Intake ID	Water Body Name	**Registered** Intake Capacity *(mg/d)	Your **Current** Intake Capacity *(mg/d)
01	LAKE ERIE	50	80

Please provide additional comments if needed. * mg/d = Millions of Gallons per Day.

Owner or authorized representative's signature	Date
Polly M. Boissoneault	2/10/09

Great Lakes – St. Lawrence River Basin Water Resources Compact Becomes Law and Will Impact Future Water Withdrawals

December 2008

Dear Lake Erie Basin Water Withdrawer:

As you may already have heard, the Great Lakes-St. Lawrence River Basin Water Resources Compact was recently passed by Congress and signed into law by President Bush. This interstate compact prohibits new and increased diversions of water out of the Great Lakes Basin and requires each of the eight Great Lakes states to regulate new or increased withdrawals within the Basin. Existing withdrawals will not be regulated under the Compact and your current withdrawal will, therefore, not be impacted.

To fully protect existing water withdrawals, the Ohio Department of Natural Resources is developing a list of existing Lake Erie Basin withdrawals and their capacities. This list will serve as the baseline for existing withdrawals and capacities that will be "grandfathered" and not subjected to future regulation as a new or increased withdrawal.

On the table on the reverse side of this page, we have listed the existing wells and/or intakes that are included on your water withdrawal facility registration, along with the withdrawal capacities that you have provided. **To assure that we have your complete withdrawal capacity for inclusion on the list of existing withdrawals, we are requesting that you review these listed wells and/or intakes and their capacities to make sure they are still current and accurate.**

Please revise the table on the reverse side of this page and return it with your annual withdrawal report in the enclosed envelope.

Thank you for your cooperation in this important matter. If you have questions, please call Mike Hallfrisch at 614-265-6745 or e-mail him at: mike.hallfrisch@dnr.state.oh.us

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Instructions for Completing the Baseline Capacity Reporting Form

In determining withdrawal capacities, be sure to include those wells and/or intakes that are operable or could be readily made operable (e.g., by adding pumping capacity), even if they may not currently be in regular use. Also, if the withdrawal quantities of existing wells and/or intakes could readily be increased (e.g., again, by adding pumping capacity), list the well and/or intake capacity rather than the current pumping capacity.

Well or Intake ID: This is the well/intake identification number that your facility assigned to the well/intake and listed on the registration form sent to the Ohio Department of Natural Resources, Division of Water.

- If the well/intake identification has changed, please note those changes on this form.
- Please add any wells or intakes at the facility that are not on this list.

Well or Intake Capacity: This is the capacity of each individual well or intake (in millions of gallons per day) that was listed on the registration form sent to the Ohio Department of Natural Resources, Division of Water.

Changes or Modifications to Well or Intake Capacity: If the well/intake capacity in the "Registered Well Capacity" or "Registered Intake Capacity" column is incorrect, please make changes in this column.

Additional Comments: Please add any additional comments that you feel are appropriate.

Please complete form on back

A 3

FENOC
FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station
5501 N. State Route 2
Oak Harbor, Ohio 43449

January 22, 2010
L-10-030

Ohio Department of Natural Resources
Division of Soil and Water Resources
Water Planning Program
2045 Morse Road, Bld. B-2
Columbus, Ohio 43229-6693

SUBJECT:
Water Withdrawal Report for the Davis-Besse Nuclear Power Station, Unit 1 for 2009

In accordance with Ohio Revised Code 1521.16, "Water Withdrawal Registration," enclosed is the Water Withdrawal Report for the Davis-Besse Nuclear Power Station for the year 2009. This report is required to be submitted by all registered facilities that have a 100,000 gallon per day or greater capacity. Flow values were obtained from continuous data acquisition systems and were based on hourly averages.

If there are any questions or if additional information is required, please contact Mr. Stephen M. Chimo, Advanced Nuclear Specialist, at (419) 321-7149.

Sincerely,

Polly M. Boissoneault

Polly M. Boissoneault
Manager- Site Chemistry
Davis-Besse Nuclear Power Station

KAS/SMC

Enclosure:
Water Withdrawal Report for the Davis-Besse Nuclear Power Station for 2009

Enclosure
L-10-030

Water Withdrawal Report

for the

Davis-Besse Nuclear Power Station

Page 1 of 3

STATE OF OHIO
WATER WITHDRAWAL
FACILITY REGISTRATION
ANNUAL REPORT FORM

SEND TO: OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF SOIL AND WATER RESOURCES
WATER PLANNING PROGRAM
2045 MORSE ROAD, BLD. B-2
COLUMBUS, OHIO 43229-6693
(614) 265-6938

AUTHORITY: Ohio Revised Code Section 1521.16 requires that any owner of a facility, or combination of facilities, with the capacity to withdraw more than 100,000 gallons of water daily, register such facilities and file an annual report with the ODNR, Division of Soil and Water Resources.

Water Withdrawal Report for the Year Ending December 31, 2009

Contact Information:

Contact Name: Ms. Polly M. Boissoneault — Is this a new Contact Name? ☐ YES ☒ NO

Company Name: FENOC-Davis-Besse Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: 1.419.321.8549 — Is this a new Phone Number? ☐ YES ☒ NO

–Downloaded Internet eForm –

Facility Owner:

Owner Name: FirstEnergy Corp. — Is this a new Owner Name? ☐ YES ☒ NO

Company Name: FENOC-Davis-Besse Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: 1.419.321.8549 — Is this a new Phone Number? ☐ YES ☒ NO

Facility Name and Withdrawal Mode:

County: Ottawa

*Registration Number: 00598 — * Please double check the registration number, Thank you.

Facility Name: FENOC-Davis-Besse Nuclear Power Station

Please note changes in facility status, or naming, in the gray spaces next to the well or intake number(s) below.

Facility's WELL (Ground Water) Identification						Facility's INTAKE (Surface Water) Identification			
						01			

If you have questions about this form please call (614) 265-6938.

WITHDRAWALS

NOTE: This page may be photocopied if additional space is required. Please be sure to sign and date each copy.

GROUND WATER (in Units of Millions of Gallons) Registration Number 00598

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
TOTAL													GRAND TOTAL
MAXIMUM													
MINIMUM													
DAYS IN OPERATION													TOTAL OPERATION DAYS

Are ground water withdrawal amounts based on metered readings? ☐ yes ☐ no (circle one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

SURFACE WATER (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
INTAKE	1275	1158	1416	1196	1371	1418	1513	1547	1381	1270	1240	1170	15955
INTAKE													
INTAKE													
INTAKE													
INTAKE													
TOTAL	1275	1158	1416	1196	1371	1418	1513	1547	1381	1270	1240	1170	GRAND TOTAL 15955
MAXIMUM													
MINIMUM													
DAYS IN OPERATION	31	28	31	30	31	30	31	31	30	31	30	31	TOTAL OPERATION DAYS 365

Are surface water withdrawal amounts based on metered readings? ☒ yes ☐ no (circle one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

RETURN FLOW (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
FLOW	1080	962	1181	1089	1093	1145	1221	1255	1108	1018	997	953	13102
FLOW													
TOTAL	1080	962	1181	1089	1093	1145	1221	1255	1108	1018	997	953	GRAND TOTAL 13102

Are return flow amounts based on metered readings? ☒ yes ☐ no (circle one) If "no," how were the reported return flow amounts determined? (Attach separate sheet, if necessary)

NOTE: Is the information originally supplied on your registration form still correct? ☒ yes ☐ no (circle one)
If "no," please attach a separate sheet indicating the nature of the change. If needed, a new registration form will be forwarded to you so that you may provide this office with the necessary revisions.

Owner or authorized representative's signature	Date
Polly M. Boissonault	1/22/10

DNR 7805e (12/04/09)

A 4

FENOC

FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station
5501 N. State Route 2
Oak Harbor, Ohio 43449

February 16, 2011
L-11-033

P-31

Ohio Department of Natural Resources
Division of Soil and Water Resources
Water Planning Program
2045 Morse Road, Bld. B-2
Columbus, Ohio 43229-6693

SUBJECT:
Water Withdrawal Report for the Davis-Besse Nuclear Power Station, Unit 1, for 2010

In accordance with Ohio Revised Code 1521.16, "Water Withdrawal Registration," enclosed is the Water Withdrawal Report for the Davis-Besse Nuclear Power Station for the year 2010. The report is required to be submitted by all registered facilities that have a 100,000 gallon per day or greater capacity. Flow values were obtained from continuous data acquisition systems and were based on hourly averages.

If there are any questions or if additional information is required, please contact Mr. Stephen M. Chimo, Senior Nuclear Specialist, at 419-321-7149.

Sincerely,

Polly M. Boissoneault

Polly M. Boissoneault
Manager – Site Chemistry
Davis-Besse Nuclear Power Station

SMC/KAS

Enclosure:
Water Withdrawal Report for the Davis-Besse Nuclear Power Station for 2010

2010 Water Withdrawal Report

for the

Davis-Besse Nuclear Power Station

(one form follows)

STATE OF OHIO WATER WITHDRAWAL FACILITY REGISTRATION ANNUAL REPORT FORM

SEND TO: OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF SOIL AND WATER RESOURCES
WATER PLANNING PROGRAM
2045 MORSE ROAD, BLD. B-2
COLUMBUS, OHIO 43229-6693
(614) 265-6938

AUTHORITY: Ohio Revised Code Section 1521.16 requires that any owner of a facility, or combination of facilities, with the capacity to withdraw more than 100,000 gallons of water daily, register such facilities and file an annual report with the ODNR, Division of Soil and Water Resources.

Water Withdrawal Report for the Year Ending December 31, 2010

Contact Information:

Contact Name: Polly Boissoneault — Is this a new Contact Name? ☐ YES ☒ NO

Company Name: FENOC-Davis-Besse Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: 419.321.8549 — Is this a new Phone Number? ☐ YES ☒ NO

–Downloaded Internet eForm –

Facility Owner:

Owner Name: FirstEnergy Corp. — Is this a new Owner Name? ☐ YES ☒ NO

Company Name: FENOC-Davis-Besse Station — Is this a new Company Name? ☐ YES ☒ NO

Address: 5501 North State Route 2
Oak Harbor, Ohio 43449 — Is this a new Address? ☐ YES ☒ NO

Phone: 419.321.8549 — Is this a new Phone Number? ☐ YES ☒ NO

Facility Name and Withdrawal Mode:

County: Ottawa

*Registration Number: 00598 — * Please double check the registration number, Thank you.

Facility Name: FENOC-Davis-Besse Nuclear Power Station

Please note changes in facility status, or naming, in the gray spaces next to the well or intake number(s) below.

Facility's WELL (Ground Water) Identification	Facility's INTAKE (Surface Water) Identification
	01

If you have questions about this form please call (614) 265-6938.

WITHDRAWALS

NOTE: This page may be photocopied if additional space is required. Please be sure to sign and date each copy.

GROUND WATER (in Units of Millions of Gallons) Registration Number________

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
TOTAL													GRAND TOTAL
MAXIMUM													
MINIMUM													
DAYS IN OPERATION													TOTAL OPERATION DAYS

Are ground water withdrawal amounts based on metered readings? ☐ yes ☐ no (check one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

SURFACE WATER (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
INTAKE	1171	1046	508	531	563	623	1194	1295	1383	1316	1177	1201	12008
INTAKE													
INTAKE													
INTAKE													
INTAKE													
TOTAL	1171	1046	508	531	563	623	1194	1295	1383	1316	1177	1201	GRAND TOTAL 12008
MAXIMUM													
MINIMUM													
DAYS IN OPERATION	31	28	31	30	31	30	31	31	30	31	30	31	TOTAL OPERATION DAYS 365

Are surface water withdrawal amounts based on metered readings? ☒ yes ☐ no (check one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

RETURN FLOW (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
FLOW	963	870	508	525	563	531	950	997	1108	1045	959	979	9998
FLOW													
TOTAL	963	870	508	525	563	531	950	997	1108	1045	959	979	GRAND TOTAL 9998

Are return flow amounts based on metered readings? ☒ yes ☐ no (check one) If "no," how were the reported return flow amounts determined? (Attach separate sheet, if necessary)

NOTE: Is the information originally supplied on your registration form still correct? ☒ yes ☐ no (check one)
If "no," please attach a separate sheet indicating the nature of the change. If needed, a new registration form will be forwarded to you so that you may provide this office with the necessary revisions.

Owner or authorized representative's signature	Date
P. Boissonnault	2/16/11

DNR 7805e (12/04/2010)

A 5

FirstEnergy.

Davis-Besse Nuclear Power Station
5501 North State Route 2
Oak Harbor, Ohio 43449-9760

RAOG 07-0009 P-31

February 5, 2007
~~February 2, 2007~~

Ohio Department of Natural Resources
Division of Water
Water Resources Section
2045 Morse Road, Bld. B-2
Columbus, Ohio 43229-6605

Subject: Water Withdrawal Report for 2006

Ladies and Gentlemen:

Enclosed is the Water Withdrawal Report for 2006 for the Davis-Besse Nuclear Power Station. This report is submitted pursuant to Ohio Revised Code Section 1521.16, which requires that registered facilities with the capacity to withdraw more than 100,000 gallon per day file an annual report. Flow values were obtained from continuous data acquisition systems and were based on hourly averages.

If you have any question or require additional information, please contact Mr. Stephen M. Chimo, Advanced Nuclear Specialist, at (419) 321-7149.

Very truly yours,

Patrick J. McCloskey
Manager – Site Chemistry
Davis-Besse Nuclear Power Station

JCS/SMC

Enclosure
Attachment

RAOG 07-0009
Enclosure 1

Water Withdrawal Report for 2006

(one form to follow)

STATE OF OHIO WATER WITHDRAWAL FACILITY REGISTRATION ANNUAL REPORT FORM

SEND TO: OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
WATER RESOURCES SECTION
2045 MORSE ROAD, BLD. B-2
COLUMBUS, OHIO 43229-6605
(614) 265-6745

AUTHORITY: Ohio Revised Code Section 1521.16 requires that any owner of a facility, or combination of facilities, with the capacity to withdraw more than 100,000 gallons of water daily, register such facilities and file an annual report with the Ohio Department of Natural Resources, Division of Water.

Water Withdrawal Report for the Year Ending December 31, 2006

According to our records the Contact is listed as: | **Please Make Corrections Below**

Contact Name: Patrick J. McCloskey

Company Name: FirstEnergy Nuclear Generation Corp-Davis-Besse Plant

Address: 5501 North State Route 2

Oak Harbor, Ohio 43449

Phone: 1.419.321.7274

The Owner is listed as: | **Please Make Corrections Below** (Notify us if facility ownership has changed)

Owner Name:

Company Name: FirstEnergy Nuclear Generation Corp.

Address:

5501 North State Route 2

Oak Harbor, Ohio 43449

Phone: 1.419.321.7274

Facility Name and Withdrawal Mode:

County: Ottawa

Registration Number: 00598

Facility Name: FENOC-Davis-Besse Nuclear Power Station

Registration Date:

Please note changes in facility status, or naming, in the gray spaces next to the well or intake number(s) below.

Facility's WELL (Ground Water) Identification						Facility's INTAKE (Surface Water) Identification			
						01			

WITHDRAWALS

NOTE: This page may be photocopied if additional space is required. Please be sure to sign and date each copy.

GROUND WATER (in Units of Millions of Gallons) Registration Number 00598

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
WELL NO.													
TOTAL													GRAND TOTAL
MAXIMUM													
MINIMUM													
DAYS IN OPERATION													TOTAL OPERATION DAYS

Are ground water withdrawal amounts based on metered readings? yes no (circle one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

SURFACE WATER (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
INTAKE	1241	1199	513	692	1397	1452	1566	1561	1373	1410	1317	1369	15090
INTAKE													
INTAKE													
INTAKE													
INTAKE													
TOTAL	1241	1199	513	692	1397	1452	1566	1561	1373	1410	1317	1369	GRAND TOTAL 15090
MAXIMUM													
MINIMUM													
DAYS IN OPERATION	31	28	31	30	31	30	31	31	30	31	30	31	TOTAL OPERATION DAYS 365

Are surface water withdrawal amounts based on metered readings? (yes) no (circle one) If "no," how were the reported withdrawal amounts determined? (Attach separate sheet, if necessary)

RETURN FLOW (in Units of Millions of Gallons)

SOURCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL PER YEAR
FLOW	938	936	474	663	1018	1075	1149	1142	1039	1048	1024	1035	11541
FLOW													
TOTAL	938	936	474	663	1018	1075	1149	1142	1039	1048	1024	1035	GRAND TOTAL 11541

Are return flow amounts based on metered readings? (yes) no (circle one) If "no," how were the reported return flow amounts determined? (Attach separate sheet, if necessary)

NOTE: Is the information originally supplied on your registration form still correct? (yes) no (circle one)
If "no," please attach a separate sheet indicating the nature of the change. If needed, a new registration form will be forwarded to you so that you may provide this office with the necessary revisions.

Owner or authorized representative's signature	Date
Patrick J. McCloskey / [signature]	02/05/07

DNR 7805 (12/2006)

A 6

CLEAR TECHNICAL REPORT NO. 222

DISTRIBUTION, ABUNDANCE AND ENTRAINMENT STUDIES OF LARVAL FISHES IN THE WESTERN AND CENTRAL BASINS OF LAKE ERIE

Prepared by

C. Lawrence Cooper
John J. Mizera
Charles E. Herdendorf

Project Officer

Nelson A. Thomas
Large Lakes Research Station
U.S. Environmental Protection Agency
Grosse Ile, Michigan 48138

Prepared for

Environmental Research Laboratory - Duluth
Office of Research and Development
U.S. Environmental Protection Agency
Duluth, Minnesota 55804

Grant No. R-804612

THE OHIO STATE UNIVERSITY
CENTER FOR LAKE ERIE AREA RESEARCH
COLUMBUS, OHIO

October 1981

DISCLAIMER

This report has been reviewed by the Environmental Research Laboratory - Duluth, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

As part of a multi-agency effort to assess the impact of entrainment of larval fishes at steam-generating electrical power plants, personnel from The Ohio State University collected samples of larval fishes from waters of the Western and Central Basins of Lake Erie. Samples were collected in the Western Basin in 1975, 1976 and 1977. Samples were collected along the southshore of the Central Basin in 1978.

A total of 19 taxa of larval fish was collected with metered plankton nets in Ohio and adjacent Ontario waters of the Western Basin of Lake Erie in 1975 and 1976. Analysis of yellow perch collections indicates that shallow inshore areas serve as important nursery areas for this species. Collection of larvae provides evidence of relict breeding populations of lake whitefish and sculpin in the Western Basin. Sufficient data was gathered from 1975 and 1976 collections to permit calculation of an estimate of the impact of entrainment on adult yellow perch and emerald shiner populations using the equivalent adult approach of Goodyear.

A total of 17 taxa were collected in the Maumee River estuary during sampling periods in 1975, 1976 and 1977. A total of 11 taxa were collected from the Sandusky River estuary in 1976. Gizzard shad/alewife, white bass/white perch and freshwater drum constituted 98 percent of the larvae collected in the Maumee River estuary proper and 91 percent of the larvae collected in the Sandusky River estuary.

Gizzard shad/alewife, emerald shiners, white bass/white perch, and yellow perch, constituted over 97 percent of the larval fish collected in Ohio and Michigan waters of the Western Basin of Lake Erie in 1977. Significantly greater numbers of gizzard shad/alewife and spottail shiner larvae were captured immediately adjacent to the shore than at a depth of five meters offshore while greater numbers of smelt larvae were captured at points further offshore at a depth of five meters than at points immediately adjacent to the shore. Significantly greater numbers of walleye larvae were collected along the Ohio shoreline portion of the study area than in Maumee Bay or along the Michigan shoreline. Significantly greater numbers of freshwater drum larvae were collected in Maumee Bay.

A total of 25 taxa of larval fish was collected in Ohio waters of the Central Basin portion of Lake Erie in 1978. Gizzard shad/alewives, emerald shiners and spottail shiners constituted 82.4 percent of the larval fish collected. Larval gizzard shad, carp/goldfish, spottail shiners, troutperch and yellow perch densities were significantly higher in shallow (1-2 m deep) nearshore areas than offshore in areas five and ten meters deep. Significant differences were found between entrainment estimates derived from field samples and in-plant samples from the Central Basin for gizzard shad, rainbow smelt, carp and freshwater drum. All estimates of entrainment from field collections were higher than those for in-plant collections.

FIGURES

FIGURES (cont'd.)

FIGURES (cont'd.)

TABLES

ACKNOWLEDGEMENTS

This work is the product of the combined efforts of numerous faculty, staff, graduate and undergraduate research assistants at the Center for Lake Erie Area Research. Valuable assistance in the field and in the laboratory was provided in 1975 and 1976 by Mr. W. Bartholomew, Mr. D. Davis, Ms. M. Gessner, Mr. M. Heniken, Mr. W. Overholtz, and Mr. F. Snyder. Similar assistance in 1977 was provided by Mr. W. Bartholomew, Mr. C. Bowen, Mr. D. Breier, Mr. L. Davidson, Mr. J. Haub, Mr. L. MacLean, Mr. L. Saunders and Mr. R. Thoma. In 1978, field and laboratory assistance was provided by Mr. D. Breier, Mr. J. Johnson, Mr. T. Reed and Dr. A. White and his staff at Environmental Research Associates, Cleveland Heights, Ohio. Laboratory studies of collections were performed with the assistance of Mr. D. Breier, Ms. T. Gordon, Mr. J. Hageman and Ms. A. Rush. The analysis and presentation of the data herein was aided throughout the study by Dr. J. Reutter. Figures were prepared by Ms. L. Fletcher, Ms. C. Kimerline and Mr. J.M. Mizera. The manuscript was typed by Ms. S. Hessler. Numerous others who assisted at various points throughout the study but not mentioned above are acknowledged collectively.

The assistance of Mr. J. Reidy, Ohio Environmental Protection Agency and the support of Mr. Nelson Thomas, Project Officer - USEPA Large Lakes Research Station, is gratefully acknowledged.

TABLE OF CONTENTS

SECTION 1

INTRODUCTION

The Great Lakes provide a freshwater supply for 70 to 75 percent of the basin's 29 million residents (Great Lakes Communicator, 1979), increasingly attractive recreational boating and sport fishing areas, and water for industrial processes and electrical generation. Concern over the impacts of these conflicting uses has changed the prospective of this being an inexhaustible resource. The purpose of this report is to summarize a series of studies conducted to assess the abundance, distribution and entrainment of larval fishes in the Ohio and Michigan waters of Lake Erie. The study area serves as one of the best examples in the Great Lakes of divergent interests competing of a single resource. The impact of electrical generating facilities on larval fish numbers is potentially large. Electrical generation is the largest user of Great Lakes water. The 89 electrical generating stations in the coastal areas of the Great Lakes are responsible for over 70 percent of the total water use in the Great Lakes Basin (Murray and Reeves, 1977; Kelso and Milburn, 1979). With the United States relying more heavily on domestic energy supplies, the role of the Great Lakes will become even more important in energy production; it is planned that there will be an additional 17 power plants in the basin by the mid-1980's (Kelso and Milburn, 1979).

Thermal electric generating stations convert water into high pressure steam which powers electric generators. Little difference exists between fossil fuel and nuclear generating systems other than the type of fuel used to create high pressure steam. However, neither system uses all of the energy available for converting heat to electricity. The steam used to generate electricity must be condensed before re-heating for maximum efficiency. This is where the large water requirements and the environmental concerns arise (Kelso and Milburn, 1979).

Steam electric generating plants have three major types of adverse effects upon the aquatic environment when they use large amounts of cooling water: 1. the intake of cooling water by a facility can cause the entrapment and impingement of fishes upon plants' intake structures; 2. entrainment can have a damaging effect upon smaller aquatic organisms such as plankton, fish eggs, fish larvae, and shellfish larvae; and 3. the discharge of heated cooling-waters into the aquatic environment can disrupt the function of complex and highly productive natural systems (Bugbee, 1977). The effect of entrainment on larval fish numbers is the focal point of this study.

Wickliff (1931) suggested and recent studies have supported (Heniken, 1977; Bartholomew, 1978; Cole, 1978a; and Waybrant and Schauver, 1979) that the nearshore zone of Lake Erie is a valuable fish spawning and nursery area. The movement of larval fishes is often controlled more by water movement than by swimming ability (Houde, 1969). Thus the high densities of larval fishes and bouyant fish eggs in nearshore areas are highly susceptible to the hazards posed by high volume cooling water intakes.

Congress approved and the President signed into law, on October 18, 1972, The Federal Water Pollution Control Ammendments of 1972, (Public Law 92-500), the objectives being to restore and maintain the chemical, physical, and biological integrity of the nation's navigable waters. Sections 316 (A) and (B) of this act, respectively, deal with the effects of thermal discharges and cooling water intakes upon the biological system. These sections created a need for detailed knowledge of fish eggs and larvae, also known as ichthyoplankton (Boreman, 1976). Prior to the passsage of this legislation, scientific investigations of the egg, embryonic, and larval stages of fish received cursory attention in comparison with many other aspects of freshwater fishery science. In reference to Lake Erie, very few studies exist and few have examined more than species composition of larval fishes.

Marie Poland Fish (1932), in her classic study, described the early developmental stages of 62 species of fish found in Lake Erie and its tributaries. This study produced an important atlas of developmental stages of these species but gave little insight into the abudance or distribution of these fishes. Discussing this project, Wickliff (1931) noted that greater species diversity and higher numbers of fish larvae were captured around the island region of the Western Basin and in the nearshore zone than offshore.

The Ohio Division of Wildlife sampled Sandusky Bay for young-of-the-year fishes with beach seines. Eighteen species were captured (Chapman, 1955). The Ohio Division of Wildlife also conducted a study attempting to locate major walleye spawning grounds in the Western Basin of Lake Erie. Walleye eggs and larvae were found to be most abundant in areas that have hard, rocky bottoms (Keller, et al., unpublished).

Most recent larval fish investigations in the United States have been conducted as required by Section 316(b) of Public Law 92-500. A number of such studies have been conducted in Lake Erie. Unfortunately, these studies tend to report efforts concentrated in limited areas and have a very limited circulation. Larval fish in the Locust Point area of the Western Basin have been studied by Reutter and Herdendorf, (1975) as part of the pre-operational, and post-operational study (Reutter 1978a; 1978b; 1979a; 1979b; 1980a; 1980b), for the Davis-Besse Nuclear Power Station (CLEAR Tech. Rept. No. 78a and 78b). Reutter (1979a and b) also reported on entrainment at Toledo Edison's Acme and Bayshore plants. Hartley and Herdendorf (1976) reported the work of Donald Davis on larval fishes found during a study of a proposed power plant site in the Sandusky Bay area. This report will summarize portions of a series of studies (Bartholomew, 1979; Heniken, 1977; Herdendorf, 1977; Herdendorf and Cooper, 1975 and 1976; Herdendorf, Cooper, Heniken and Snyder, 1976 and 1977; Reutter, Herdendorf and Sturm, 1978a and 1978b; and Snyder, 1978) conducted in Western Basin waters including the Maumee and Sandusky River estuaries between 1975 and 1977. The extent of fish production in these downstream or estuarine portions of the lake has received little attention until recent times. Studies of larval fishes in the Central Basin include on reported by the United States Nuclear Regulatory Commission (1974) at Berlin Heights and one conducted by Aquatic Ecology Associates (1978) for a proposed United States Steel plant in Conneaut, Ohio.

Without question, the most complete study of larval fishes in Lake Erie is the overall program, of which the present study is a part, designed to assess the impact to cooling water intakes in Michigan and Ohio. This study was funded and coordinated by the Large Lakes Research Station (Grosse Ile, Michigan) of the United States Environmental Protection Agency and included sampling in Ohio, Michigan, and Canadian waters of Lake Erie, along with other on-site studies (Nelson and Cole, 1975; Heniken, 1977; Snyder, 1977; Cole, 1978a and 1978b; Patterson, 1979; Waybrant and Shauver, 1979).

Environmental studies in the vicinity of Detroit Edison's Monroe, Michigan site began in 1970. Larval fish studies were initiated in 1973. A large multi-agency study of larval fish distribution was funded by the Large Lakes Laboratory, USEPA, in 1975. Data collected by personnel from The Ohio State University, Michigan Department of Natural Resources and Michigan State University allowed Dr. Richard Patterson of the University of Michigan to estimate losses of yellow perch due to entrainment in 1975 and 1976 at the 3200 MW generating facility at Monroe. Personnel from The Ohio State University collected samples in the nearshore zone of the Western Basin in 1977 to provide additional data for Dr. Patterson's model calculations. Collections were made in the nearshore zone of the Central Basin in 1978. This study makes independent entrainment estimates for selected power plants in the Western and Central Basins. In addition, the distribution and abundance of selected larval fish species are described for the study period extending from May, 1975 to August, 1978.

SECTION 2

CONCLUSIONS

1. Sampling procedures employed were selective for species inhabiting limnetic areas and may not adequately represent species which inhabit littoral regions.

2. Abundance estimates were made. The resultant standard deviations and standard errors of the mean calculated were large but were smaller, i.e., improved, when mean densities exceeded 100 fish/100 m^3.

3. The capture of whitefish larvae on reefs and along the Michigan and Ohio shorelines indicated that a remnant spawning population of whitefish was inhabiting the Western Basin.

4. The capture of sculpin larvae on reefs in the island area indicated that a remnant spawning population of sculpins was inhabiting the Western Basin.

5. The Maumee River estuary contained higher densities and greater estimated numbers of larvae than the Sandusky River estuary. Production estimates of gizzard shad and freshwater drum in the two estuaries often approached or matched the production estimates of these species in the Western Basin study areas.

6. Both the Maumee and Sandusky River estuaries are important spawning and nursery sites for gizzard shad, white bass, walleye and freshwater drum.

7. Higher densities of gizzard shad, white bass and freshwater drum were captured in Maumee Bay and in Sandusky Bay than along either the Ohio or Michigan shorelines. This would indicate that these areas are valuable nursery areas for these species. The high densities of larvae in these areas may result from spawning in the bay as well as result from larvae carried into the bay areas by river currents.

8. Rainbow smelt and yellow perch larvae were almost entirely restricted to the lake proper.

9. In the Western Basin in 1975 and 1976, larval yellow perch were found predominantly in nearshore areas associated with sandy and/or gravel substrate. Perch larvae were concentrated near the bottom. Walleye larvae were collected in the same areas as perch larvae in the nearshore zone as well as offshore on the reefs.

10. Higher densities of rainbow smelt and emerald shiner were collected at stations in deeper open water station than at stations located adjacent to the shoreline.

11. In the Western Basin in 1977, larval yellow perch densities were highest in the area along the Michigan shoreline north of Woodtick Peninsula and south of the River Raisin. The larvae found here may have been carried into and retained in this area by the eddying effects of the Maumee and Detroit Rivers, as suggested by the fact that spawning habitat in the area is not ideal for yellow perch.

12. In the Western Basin, yellow perch and walleye larvae densities were generally highest along the Ohio shoreline, particularly in the Locust Point area. The sandy, gravel bottom and offshore islands and shoals provide the best spawning habitat for these species remaining in Lake Erie.

13. High densities of pro-larval smelt captured along Cedar Point in the Central Basin indicated that the area probably is being used as a spawning site for rainbow smelt. If so, this would be the first record of smelt spawning that far west along the United States shoreline.

14. The capture of larval freshwater drum was limited to the western half of the Central Basin study area. Freshwater drum prefer water less than 12 meters deep. East of Cleveland, water less than 12 meters deep is limited to a very narrow band along the shoreline, limiting spawning habitat.

15. In 1978, highest densities of larval yellow perch sampled were found in the eastern third of the Central Basin study area. Perch in the area are believed to be using the harbor breakwalls and sands collected in the quiet areas of these structures as spawning habitat.

16. Because fish densities were highest in the Maumee estuary and Bay, and since Toledo Edison's Bayshore Plant is located at the mouth of the Maumee River, entrainment is likely to be higher at the Bayshore plant than at any other power plant studied.

17. Significant differences were found between entrainment estimates derived from field collections and in-plant collections at Central Basin power plants.

18. In-plant estimates of entrainment, when samples are collected with submersible pumps, are believed to give a better estimate of entrainment than field collections made with metered nets. Avoidance of the sampling gear is not as much a problem for pump samplers as it is for nets.

19. Using in-plant collections entrainment estimates were highest at the Avon Lake power station. A total of 231,543,500 larvae or 60.1% of total entrainment in the study area of the Central Basin occurred here. Cyprinids accounted for 53% of the Avon Lake entrainment total.

20. Yellow perch entrainment was calculated to be highest at the Avon Lake and Ashtabula A and B plants. An estimated 1,340,500 yellow perch larvae were estimated to have been entrained at Avon Lake and 1,315,417 at the Ashtabula A and B Plant.

21. Estimates of entrainment at the Ashtabula A and B Plant and the Ashtabula C Plant represent a comparison of entrainment losses due to inshore and offshore intakes. The Ashtabula C Plant, where the water intake is located 1200 meters offshore, has 78% of the water requirement of the Ashtabula A and B Plant with an intake located 425 meters offshore. Estimates of entrainment were found to be much lower for the C Plant in all cases except rainbow smelt, which was 10 times higher. Yellow perch entrainment at the C Plant was found to be 20% of that at the A and B Plant.

22. Central Basin entrainment estimates generally represented between 2 and 4% of total estimated nearshore production. Yellow perch entrainment represented 3% of total yellow perch production. The highest percentage of any species entrained was carp, as 36% of the total nearshore carp production was entrained.

SECTION 3

SITE DESCRIPTION

The southern border of the Great Lakes Basin from Green Bay, Wisconsin to Rochester, New York has been characterized as the "industrial crescent", the premier heavy manufacturing region in the United States. Its people produce 70% of the nation's steel, 66% of the nation's autos, and almost 50% of its metals and machinery (Great Lakes Communicator 1980. Large industrial centers such as Buffalo, New York; Cleveland and Toledo, Ohio; and Detroit, Michigan make Lake Erie the center of Great Lakes manufacturing, therefore this region has a massive requirement for electrical power. Lake Erie serves as the major source of cooling water for these facilities.

Lake Erie is unique among the Great Lakes by reason of several of its natural characteristics. It is the shallowest, having a mean depth of 18.5 meters and a maximum depth of 64.0 meters. It is the southern-most and warmest, with midlake surface water temperatures reaching an average maximum of about 24^{o}C. Lake Erie has the shortest flow-through time, approximately 2½ years. It is the most biologically productive of the Great Lakes and is the only one with its long axis parallel to the prevailing winds (Browne, 1975).

Of considerable ecological importance is the natural morphological division of Lake Erie into three basins: Western, Central, and Eastern (Hartman, 1972). Of concern to this study is the immediate nearshore zone of the Western and Central Basins. Due to the dependence of successful fish reproduction on physical characteristics of the spawning area, an understanding of the Western and Central Basins is useful. The major features of these basins are discussed below.

WESTERN BASIN

The Western Basin is the focal point of many competing interests. Manufacturing industries in Detroit and Toledo use the lake and its tributaries for industrial source water. Great Lakes shipping industries especially utilize the Western Basin in the ports of Toledo and Detroit. These interests compete directly with an extensive recreation industry centered on sport fishing and boating. A resilient commercial fishing industry persists in the face of bans and prohibitions; and a vocal charter fishing industry is growing here in the wake of increasing fish stocks.

The Western Basin lies west of an island chain extending from Point Pelee, Ontario to Marblehead, Ohio (Figure 1) (Upchurch, 1976). The basin bottom is essentially a flat mud plane with sharply rising rock islands and shoals along the southern and central portions of the basin. The Western Basin reaches a maximum depth of 20.4 meters with an average depth of 7.4 meters, making it the shallowest of the three basins. The Western Basin is also the smallest basin, having a surface of 3276 km^2 (13% of the total lake surface area) and a volume of 24.2 km^3 (5.1% of the total lake volume) (Hartman, 1972).

Several environmental conditions in the Western Basin are unique in Lake Erie. Primary productivity and turbidity are higher here than in the other basins of the lake (Fay, 1976; Hartley, et al., 1966). Winds effectively mix the water column, allowing isothermal conditions to exist most of the time (Hartley, et al., 1966 Patuzkey, 1966). Temporarily stratified conditions do occur, but only after extended periods of hot calm weather (Patuzkey, 1966). Winds also subject this basin to extreme short-term lake water level fluctuations, especially during storm periods (Hartley, et al., 1966). And the overall shallow nature of the basin with its rock islands and shoals make it the most important spawning and nursery grounds in the lake (Hartman, 1972).

Two major rivers, the Detroit and Maumee Rivers, and several smaller streams empty into the Western Basin. The Detroit and Maumee Rivers together provide over 93% of the total water flow into Lake Erie. The Detroit River accounts for over 90% of the total having an average discharge of 4,988 m^3/sec, while the Maumee River at 187 m^3/sec and accounting for only 3.4% of the flow into the lake, contributes 34% of the total sediment loading (Lewis and Herdendorf, 1976). Table 1 lists the streams in the study area, their flow rates and sediment loadings. Streams entering the study area have downstream portions influenced by lake conditions and may properly be described as freshwater estuaries (Brant and Herdendorf, 1972).

Although surface flow in the Western Basin is often changed by changes in wind direction and intensity, currents in the Western Basin are dominated by the Detroit River inflow. Figure shows the inflow pattern of Detroit River water and dominant summer surface currents. This shows a definite southern movement of midchannel Detroit River water with eddie effects along the sides of the midchannel flow. These eddies lead to sluggish movement of surface water between Stony Point, Michigan and Toledo, Ohio. Bottom currents, as shown in Figure , are very similar to surface currents being dominated by the Detroit River inflow. An eddy effect along the western side of the Detroit River inflow between Stoney Point, Michigan and the mouth of Maumee Bay tends to partially retain input materials leading to higher concentrations of water-quality related constituents in this area (U. S. Department of the Interior, 1968).

For purposes of comparison and discussion, the Western Basin is divided into three physiographic regions: the Michigan shoreline, Maumee Bay, and the Ohio shoreline. A closer look at the characteristics, particularly geologic, of each area follows.

Michigan Shoreline

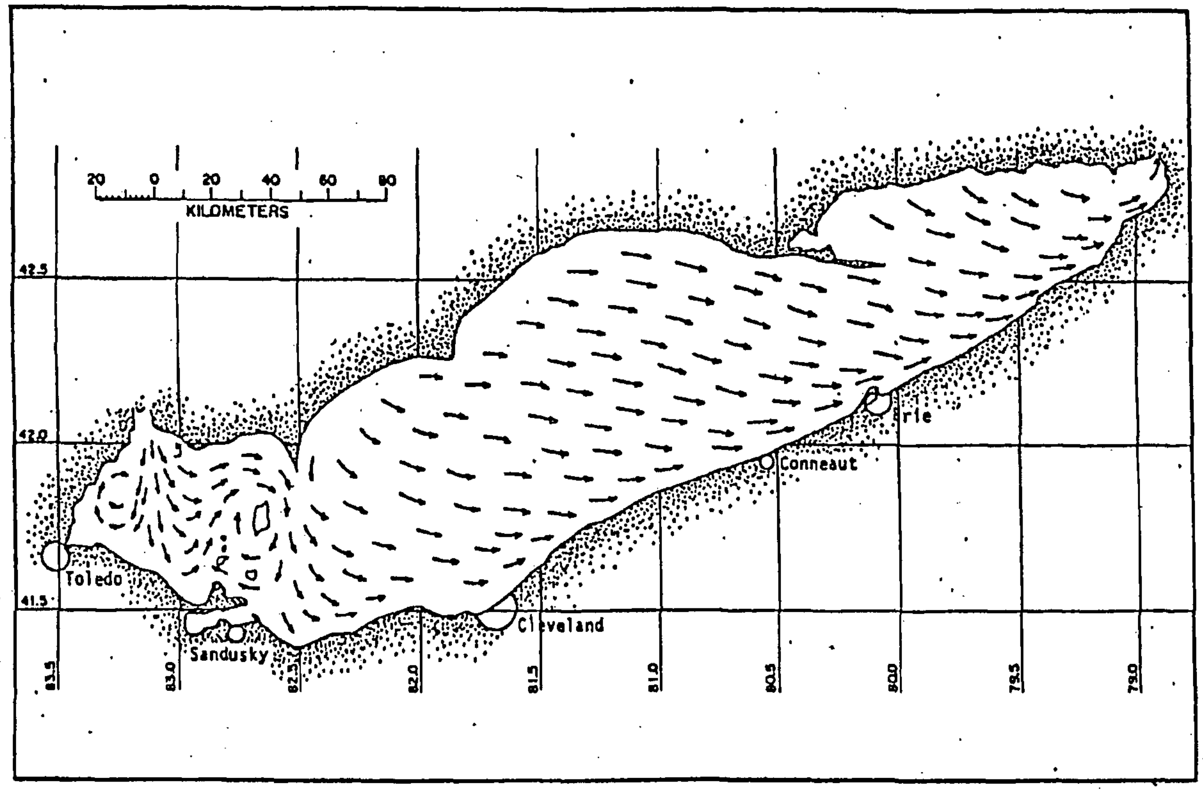
Along the 30-mile stretch of shoreline between the Detroit River and Maumee Bay the dominant littoral drift is southwest. The shoreline is low, marshy and composed of unconsolidated till and lake deposits, except for an outcrop of Sulurian dolomite at Stony Point seven miles north of Monroe. A sandy spit, Woodtick Peninsula and North Cape has formed a baymouth bar at the northern margin of Maumee Bay from material eroded from the low bluffs along the Michigan shoreline (Herdendorf, 1973). Marshy areas and the area around Woodtick Peninsula and North Cape are excellent spawning habitat for many lake fish species.

TABLE 1. STREAMS IN THE STUDY AREA

STREAM	AVERAGE DISCHARGE (m^3/sec)	% OF LAKE ERIE TOTAL	SUSPENDED SOLIDS (mtons/year)	% OF LAKE TOTAL
WESTERN BASIN				
Michigan				
Detroit	4988	90.0	1.42×10^6	25.7
Huron	16	0.3	1.63×10^3	0.1
Raisin	19	0.3	4.26×10^3	0.1
Others	20	0.4	3.69×10^3	0.1
Ohio				
Ottawa	3	0.1	9.07×10^2	0.1
Maumee	187	3.4	1.06×10^6	37.1
Toussaint	3	0.1	6.35×10^2	0.1
Portage	17	0.3	1.09×10^5	2.0
Sandusky River	8.6	0.2		0.1
CENTRAL BASIN				
Huron	11	0.2	1.09×10^4	0.2
Vermilion	9	0.2	8.16×10^3	0.1
Black	14	012	1.39×10^4	0.3
Rocky	9	0.2	2.68×10^4	0.5
Cuyahoga	23	0.4	2.36×10^5	4.3
Chagrin	9	0.2	3.18×10^4	0.6
Grand			1.92×10^5	3.5
Ashtabula	3	0.1	4.99×10^3	0.1
Conneaute	6	0.1	3.63×10^3	0.1
Others	31	0.6	1.81×10^5	3.3

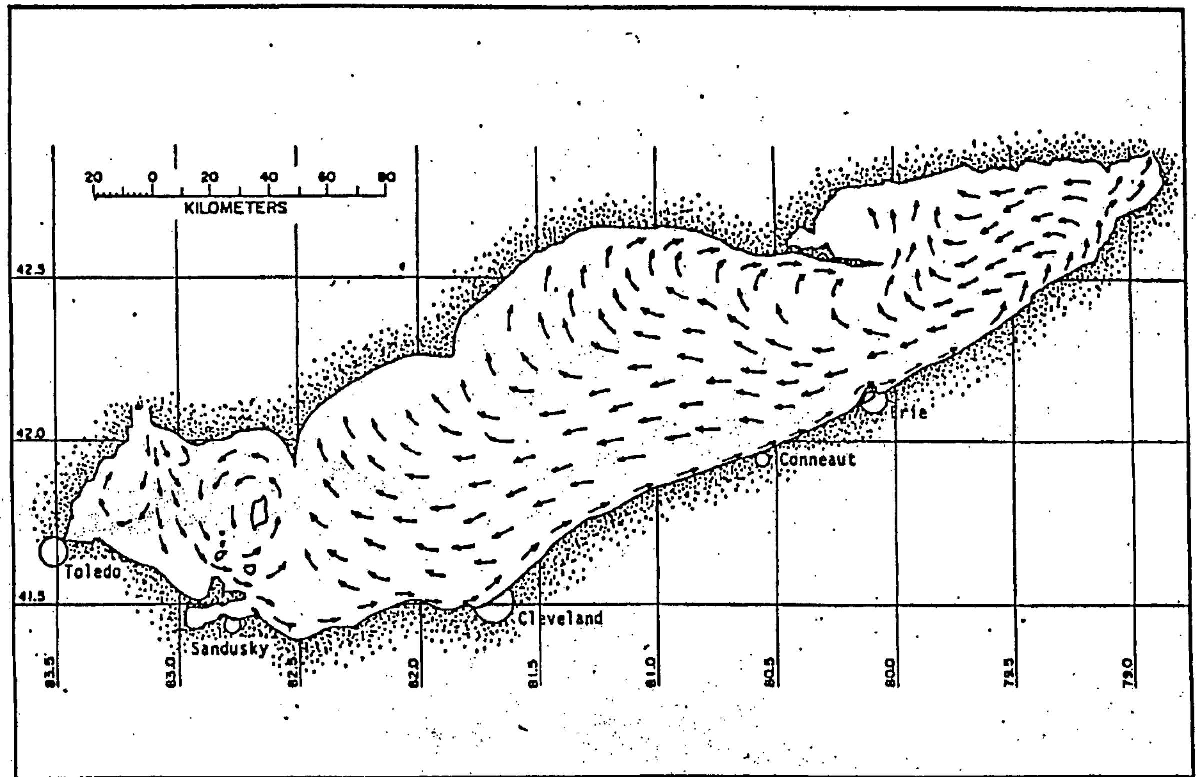
Source: Lewis and Herdendorf (1976)

Figure 1. Dominant Summer Surface Currents.



Source: U.S. Dept. of Interior, 1967.

Figure 2. Dominant Summer Bottom Currents.



Source: U.S. Dept. of Interior, 1967.

The bottom here slopes gently from the shore out to an 8-meter depth, 5-10 miles offshore (U. S. Department of the Interior, 1968). A thin band of sand and gravel lines the shoreline with the bottom offshore made up of a mud sand mixture (Thomas et al., 1976). Several small streams of little more than local importance enter the Western Basin here (Table 1). The largest of these, the River Raisin, is used extensively as a water source for industrial purposes and electrical generation.

Maumee Bay

Maumee Bay lies at the western-most end of Lake Erie between 41°41'N and 41°45'N latitude and 83°20'W and 83°29'W longitude. It is separated from Lake Erie by two spits (Figure 1): (1) Woodtick Penninsula, with North Cape at its southern tip, extends southerly from the Michigan shoreline; and (2) Little Cedar Point projecting northwesterly from the Ohio shore (Herdendorf et al., 1978). At the mouth of the Maumee River, Maumee Bay is very important as a nursery area for different species and many fish reside there throughout their first summer before moving out into the lake (Herdendorf and Cooper, 1975; Fraleigh et al., 1974).

Bathymetrically, Maumee Bay is a broad shallow shelf sloping gently downward toward the northeast. The maximum depth is 3 meters below low water atum and mean depth is 1.5 meters. Bisecting Maumee Bay in a northest-southwest direction is a navigation channel maintained annually to a depth of 10 meters. Adjacent to the channel, about 2000 feet from either side, is a series of linearly arranged dredge spoil islands and shoals, composed of sandy material, creating possible spawning sites for walleye, yellow perch and white bass.

The shoreline of Maumee Bay is characterized by low clay bluffs, is highly developed as a residential/industrial area to the west and grading through a less intense development on the south to marsh on the northeast. Bottom material is lacustrine clay with a thin overburden of recently deposited silt, except near Little Cedar Point where a relatively thick overburden of sand exists (Herdendorf, 1975).

Ohio Shoreline

The 21-mile shoreline between Little Cedar Point and Port Clinton, Ohio is characterized by a northwest drift. Elongated, dominately sandy bodies of low relief, their long axes lying essentially parallel to the trend of lake bottom contours, dominate much of the area east of Little Cedar Point. These features lie lakeward of extensive marshy areas and lowlands, most of which have been diked. The sandy bodies are composed mostly of fine, well-sorted sand. Coarser sand and fine gravel are dominant fractions in surf zone.

The nearshore bottom slopes very gently lakeward. As distance is increased offshore the sand particles gradually become smaller in size. A short distance offshore a band of fine lacustrine clay lies parallel to the shoreline. Northeast of this band of clay, between Wards Canal and Marblehead Penninsula lie extensive areas of sand, gravel and rocky shoals (Pincus, 1960). These areas provide perhaps the best spawning habitat in the study area.

CENTRAL BASIN

Along the Ohio reach of the Central Basin the predominate feature is a complex of residential, commercial and industrial development extending almost continuously from the low lake planes near Sandusky to the high bluffs at Painesville, Ashtabula, and Conneaute. Few if any natural areas remain. Overall the impression is a relative homogenous environment characterized by extensive development. Water use in the Central Basin is largely limited to shipping and heavy industry; recreational uses are confined to tributaries and the immediate nearshore zone. Recreational fishing is largely limited to the tributaries, piers, and breakwalls. Commercial fishermen, however, catch more yellow perch annually in the Central Basin than in the Western Basin (Davies et al., 1979).

The Central Basin is separated from the Western Basin by the rock escarpment previously described and from the Eastern Basin by a relatively shallow sand and gravel bar of glacial moraine origin extending between Erie, Pennsylvania and Long Point, Ontario (Figure 1) (Upchurch, 1976). With a surface area of 16,177 km^2 and a volume of 299.2 km^3 the Central Basin is the largest of the lake's three basins (63% of both surface area and volume of the entire lake). The Central Basin has a maximum depth of 25.6 meters and a mean depth of 18.5 meters (Hartman, 1972).

Several environmental conditions are radically different here than in the Western Basin. Because of the larger size and the fact that streams entering the Central Basin do not carry silt loads comparable to those of the Detroit and Maumee Rivers, turbidity is generally much lower here than in the Western Basin. By June most of the waters in the Basin are thermally stratified, with percent oxygen saturation in much of the hypolimnion approaching zero by August (Burno, 1976). Perhaps of most interest for of commercial and sport fish is the fact that the bottom slopes away from the shoreline at a much greater rate here than in the Western Basin, limiting potential spawning areas to a narrow band along the shoreline.

Rivers flowing into the Central Basin are small when compared to the Detroit and Maumee Rivers (Table 1). Industrial development here is extensive and most of the rivers are utilized for industrial source water. All of these rivers except for the Vermilion, Rocky and Chagrin Rivers, have extensively dredged bottoms and are used as lake front ports.

The effect of wind dominant currents in the Central Basin. With its long axis essentially parallel to the prevailing southwesterly wind, this effect is especially important (United States Department of the Interior, 1968). However the dominant summer surface flow as depicted in Figure 1 shows a definite flow of Western Basin water through Pelee Passage and subsequently southward to move parallel along the southern shore of the lake. Bottom currents, (Figure 2) on the Central Basin are not similar to surface flow. Because surface currents are generally moving water in much greater quantities than can be removed from the Basin, the balancing movement must be subsurface and essentially a return flow over most of the basin (U. S. Department of Interior, 1968), in opposition to the surface flow.

Mud covers more than two-thirds of the bottom of the Central Basin. A very narrow strip of sand and gravel can be found along most of the Ohio shoreline. This strip reaches its greatest width of 5 miles or more between Cleveland and Fairport, Ohio (U. S. Department of Interior, 1968). Sand deposits can also be found on the bottom of the eastern sides of breakwalls at the Huron, Vermilion, Grand, and Ashtabula Rivers, and Beaver and Conneaut Creeks (Herdendorf, 1963). For many species of fish, spawning habitat in the Central Basin is limited to man-made structures and estuarine environments of streams entering the area.

SECTION 4

METHODS

SAMPLING

The open lake portion of the study area in 1975 and 1976 encompassed approximately 1740 sq. km of Ohio and Ontario waters of the Western Basin of Lake Erie (Figure 3). This portion of the lake was subdivided for study purposes into six depth zones, referenced to National Oceanic and Atmospheric Administration, U.S. Department of Commerce, navigation chart 39 of Lake Erie. A two-meter contour interval was used to delineate each depth zone, each zone consisting of a vertical column of water bounded by two depth contours.

Sampling stations were established in a stratified random pattern. A total of 56 stations were sampled during 1975 and 60 stations were sampled during 1976. A total of nine cruises were made between May 12 and September 3 during 1975 and fourteen cruises between April 12 and September 3 during 1976.

Collections in the open lake were made during the daylight hours with conventional plankton nets (0.75 m diameter, 0.760 mm mesh, conical design). Flow rates through the nets were measured with calibrated General Oceanic flowmeters located slightly off-center in the nets. The meters were calibrated by multiple tows of the meter suspended in a bridle over a known distance. During the sampling period, the nets were towed in a circular pattern to avoid propwash. Tows were conducted at speeds of 2-5 knots from a 21-foot Boston Whaler. A single surface and bottom tow was made at each station. A single tow was made at stations where water was less than one meter deep. Stations were located with the aid of landmarks and a variety of stationary navigational aids.

The Maumee River portion of the study area encompassed a 14 sq km zone extending from the river mouth to the riffles above the head of the estuary at Perrysburg, Ohio, a distance of 28.2 km (Figure 3). Sampling stations were located at the river mouth and at points in the lower estuary at 8.4 km upstream, approximately mid-estuary at a distance 14.8 km upstream and at the head of the estuary 25.4 km upstream. Stations at the lower three locations were sampled in 1975 and 1977. In 1976, a station at the head of the estuary as well as one in the riffle above the estuary was sampled. Stations were sampled bimonthly between May 15 and October 3 in 1975, twice weekly between April 7 and June 8 in 1976, and weekly or twice weekly between March 16 and September 1 in 1977.

The Sandusky River portion of the study area encompassed a 2 sq km zone extending from the river mouth at the head of Sandusky Bay to the upper limit of the estuary at the Fremont, Ohio riffle, a distance of 24.9 km (Figure 3). Four stations, including one within the riffle, were sampled twice weekly between April 12 and June 7, 1976. Sampling stations were located at the river mouth and at points 8.9 km, 15.1 km and 24.9 km upstream.

Collections in the estuaries were made during the daylight hours with conventional plankton nets (0.75 m diameter, 0.760 mm mesh, conical design). A limited number of samples were collected during the night-time hours in 1976. Plankton nets with 0.571 mm mesh netting were used in 1977. Flow rates through the nets were measured with calibrated General Oceanic flowmeters located slightly off-center in the nets. The meters were calibrated by multiple tows of the meter suspended in a bridle over a known distance. During the sampling periods, the nets were towed in a circular pattern from an outboard motor powered boat. Samples in the riffles were taken by walking a hand-held net over a known distance. A single surface and bottom sample was collected at each station in 1975 and 1976. Triplicate surface and bottom samples were colelcted at stations in the lower portion of the estuary in 1977.

A total of ten transects in the nearshore portion of the Western Basin (five located along the Michigan shore, two within Maumee Bay and three along the Ohio shore) were sampled during eight cruises between April 13 and July 8, 1977 (Figure 4). Five replicate samples were collected at each of three stations composing each transect. The mean density of the five replicates was calculated and standardized to the number of larvae per 100 cubic meters based upon the volume filtered. Along the Ohio and Michigan shores, stations were located immediately nearshore at the 1 to 1.5 meter depth contour and further offshore at the 3 and 5 meter depth contours. Transects ran perpendicular to the shoreline. Within Maumee Bay, the two transects were located east and west of the navigation channel and ran parallel to the channel. Maumee Bay stations were located in water two to three meters deep. All stations were located with the aid of lighted landmarks, a variety of lighted aids to navigation and a lead line. Oblique full stratum tows were made during the night with conventinal plankton nets (0.75 m diameter, 0.571 mm mesh, conical design). Tows were conducted at speeds of 2-5 knots from a 21-foot Boston Whaler.

A total of ten transects in the nearshore zone of the Central Basin portion of Lake Erie were sampled during eight cruise periods between May 2 and August 9, 1978 (Table 5). In addition, three river mouth locations (Grand River, Black River, and Huron River) were sampled during the eight intervals. Four replicate samples were collected at three stations composing each transect. The mean density of each species of fish was calculated and standardized to report the number of larvae per 100 cubic meters of water. Stations were located immediately nearshore at the one to two meter depth contour (this contour depth was absent and samples were not colelcted at this station for a transect in the vicinity of Cleveland) and offshore at the five and ten meter depth contours. Transects ran perpendicular to the shoreline. All stations were located with the aid of lighted landmarks and depth meters or lead lines. Oblique full stratum tows were made during the night with conventional plankton nets (0.75 m, 0.571 mm mesh, conical design).

Field collections were preserved in buffered 5 percent formaldehyde solution. Larvae from each sample were identified to the lowest taxon possible, counted, measured for total length and transferred to a 70 percent ethanol solution. Several species, which are morphologically similar during their early developmental stages, could not be efficiently

FIGURE 3. STATION LOCATION AND DELINEATION OF STUDY AREA DURING 1975-1976 STUDY PERIOD

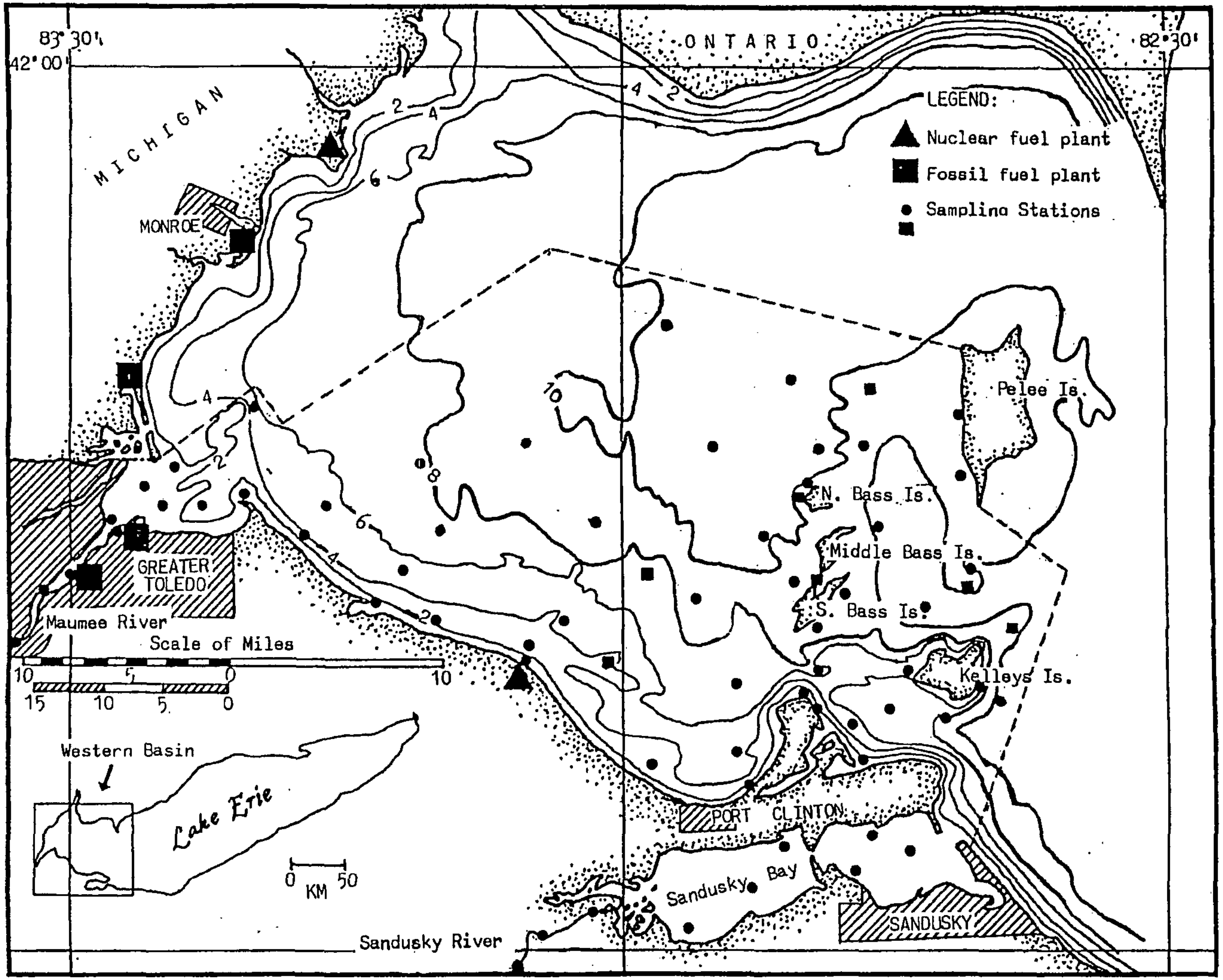


Figure 4. LOCATION OF THE SAMPLING STATIONS IN THE WESTERN BASIN OF LAKE ERIE - 1977.

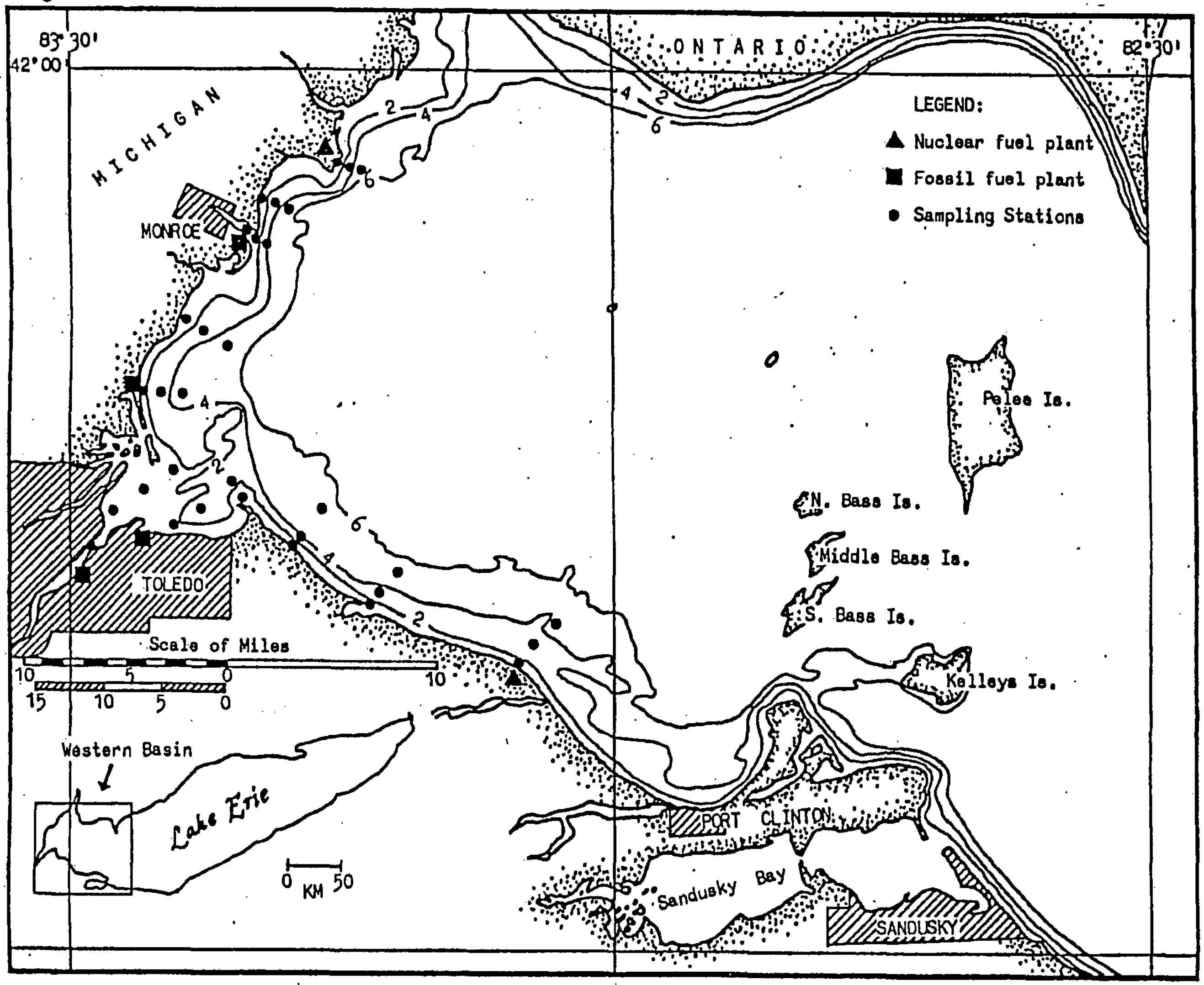
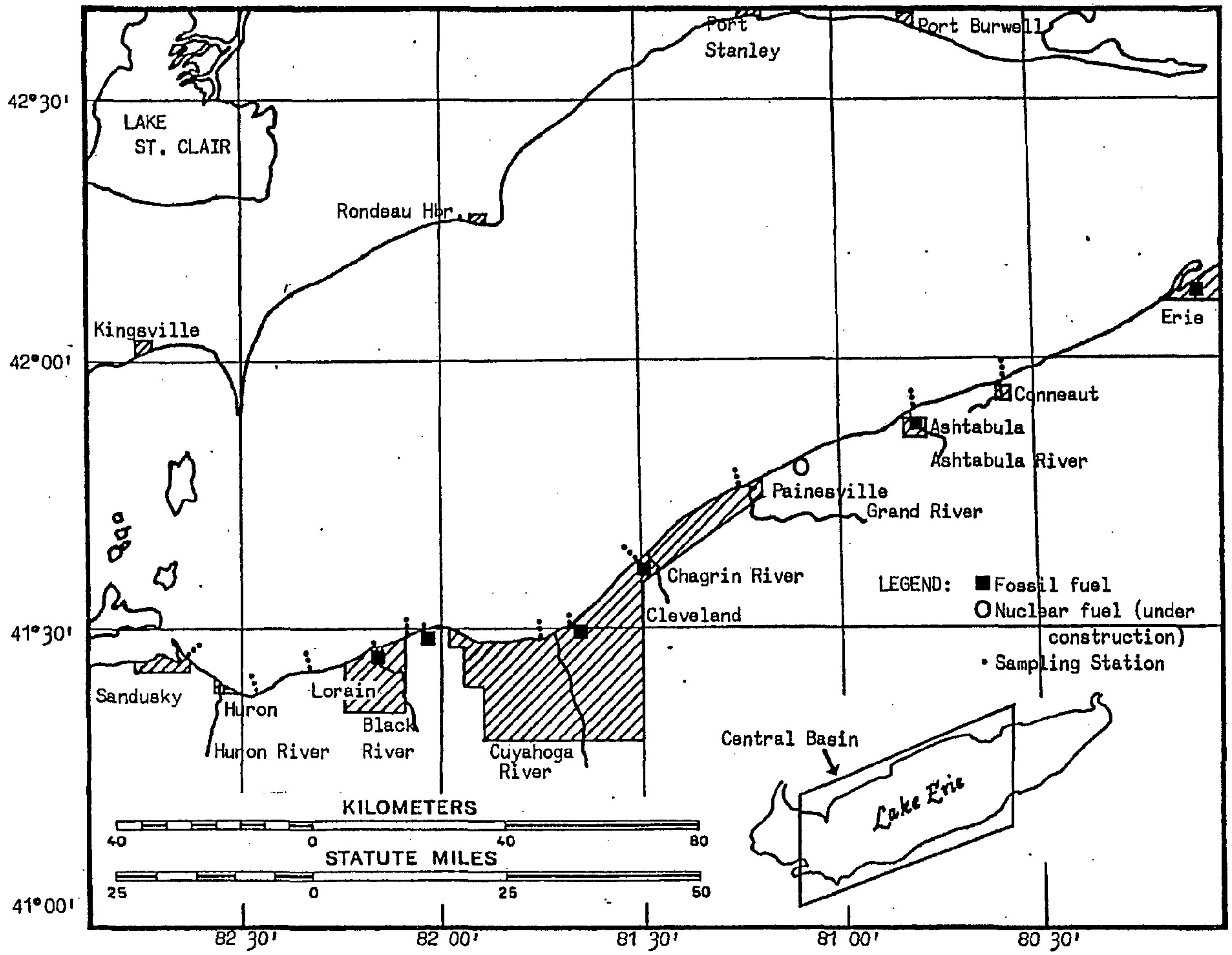


Figure 5. LOCATION OF THE SAMPLING STATIONS IN THE CENTRAL BASIN OF LAKE ERIE - 1978.



separated in large samples. Gizzard shad and alewife were grouped and reported as gizzard shad/alewife. Carp and goldfish larvae and their hybrids were similarly groups and are reported by carp/goldfish. White bass and white perch larvae were groups and reported as white bass/white perch. Black crappie and white crappie are reported as crappie. All sunfish specimens are reported as sunfish. This study included both prolarval and postlarval developmental stages which were determined according to the definitions of Hubs (1943). Developmental stages of selected species were also determined according to the definitions of Snyder and Snyder (1978). Common and scientific names used in the text are listed in Table 2. The data was punched onto computer cards and all calculations and statistical procedures were performed using either an IBM 360 or an Amdahl 470 computer housed at the Instructional and Research Computer Center of The Ohio State University (Barr, 1976; Hollander and Wolf, 1973).

For purposes of analyzing onshore-offshore distribution along nearshore transects sampled during 1977 and 1978 the study area was divided into three depth zones: depth zone 1 contained all was 0-1 meter deep; depth zone 2 contained all water 1-3 meters deep in the Western Basin and 1-5 meters deep in the Central Basin, and depth zone 3 contained water 3-5 meters deep in the Western Basin and 5-10 meters deep in the Central Basin.

Volume weighted estimates of the total number of larvae in each of these depth zones were calculated. To do this it was necessary to make two assumptions: (1) concentrations of larvae changed linearly from one station to another; and (2) the catch at each station was representative of larvae concentrations of a volume of water extending to a point mid-way between stations along the transect.

Characteristics of power plants located along the Western Basin are summarized in Table 3 and the characteristics of power plants located along the Central Basin are summarized in Table 4. Open lake samples were used to estimate the number of larvae entrained at each power plant along the shoreline of our study site. These were calculated by multiplying the density of larvae at our station closest to the power plant water intake by the average flow rate for that power plant per day. No stations were sampled in close proximity to the intakes of the Toledo Edison Bayshore plant as a part of this study or Consumers Power's Whiting plant. For these power plants average larvae concentrations in Maumee Bay were used. It was assumed that concentrations of larvae change linearly with time, and cooling water flow rates remained constant through the study period.

Finally, at six power plants along the shoreline of the Central Basin: Edgewater, (Lorain), Avon Lake, Eastlake, Ashtabula A, B and C, in-plant ichthyoplankton samples were collected weekly with the cooperation of the respective utility companies. These samples were taken to provide an estimate of the impact of power generation on fish populations in the lake. Samples for the Edgewater Plant were collected and identified by Geo-Marine, Inc. Collections at the other five plants were collected and identified by Applied Biology, Inc. Necessary information regarding collection techniques is presented in Table 5.

TABLE 2. COMMON AND SCIENTIFIC NAMES OF FISH SPECIES MENTIONED IN THE TEXT

COMMON NAME	SCIENTIFIC NAME
Lake Sturgeon	Acipenser fulvescens
Alewife	Alose pseudoharengus
Gizzard Shad	Dorosoma cepedianum
Lake Trout	Salvelinus namaycush
Lake Herring or Cisco	Coregonus artedii
Whitefish	Coregonus clupeaformis
Rainbow Smelt	Osmerus mordax
Quillback Carpsucker	Caprodes cyprinus
White Sucker	Catostomus commersoni
Carp	Cyprinus carpio
Goldfish	Carassius auratus
Cyprinids	Cyprinidae
Golden Shiner	Notemigonus crysoleucas
Striped Shiner	Notropis cornutus
Emerald Shiner	Notropis atherinoides
Spottail Shiner	Notropis hudsonius
Bluntnose Minnow	Pimephales notatus
Channel Catfish	Ictalurus punctatus
Burbot	Lota lota
Trout Perch	Percopsis omiscomaycus
White Bass	Morone chrysops
White Perch	Morone americana
Rock Bass	Ambloplites rupestris
White Crappie	Pomoxis annulris
Black Crappie	Pomoxis nigromaculatus
Smallmouth Bass	Micropterus dolomieui
Sauger	Stizostedion canadense
Walleye	Stizostedion vitreum vitreum
Blue Pike	Stizostedion vitreum glaucum
Yellow Perch	Perca flavescens
Log Perch	Percina caprodes
Johnny Darter	Etheostoma nigrum
Greenside Darter	Etheostoma blennoides
Freshwater Drum	Aplodinotus grunniens
Mottled Sculpin	Cottus bairdi

TABLE 3. CHARACTERISTICS OF WESTERN BASIN POWER PLANTS.

Characteristic	Monroe	Whitting	Bay Shore	Davis-Besse
Location	Western Shore Lake Erie, Monroe, Michigan	Western Shore Lake Erie	Southwest Corner of Maumee Bay, Toledo, Ohio	South Shore Western Basin, Locust Point
Maximum Generating Capacity	3,150 Megawatts	345 Megawatts	623 Megawatts	906 Megawatts
Average Flow	7.3×10^6 m^3/day	1.17×10^6 m^3/day	2.83×10^6 m^3/day	8.18×10^4 m^3/day
Intake Location	Raisin River Mile 0.1	North Maumee Bay	Maumee River Mile 0.1	914 meters offshore, Water Depth 4 meters
Special Features	Draws water from the Raisin River Estuary	Draws water from Maumee River Estuary	Intake Channel 914 m drawing water from Maumee River Estuary	Only operational power plant in study area with cooling tower.

TABLE 4. CHARACTERISTICS OF CENTRAL BASIN POWER PLANTS

CHARACTERISTIC	PLANT NAME Avon Point	Edgewater	Lake Shore	Eastlake	Ashtabula A & B	Ashtabula C
Location	Avon, Ohio Avon Point	Southwest Corner of Lorain Harbor at mouth of Black River	Cleveland	Immediately West of the Mouth of Chagrin River	Immediately East of the Ashtabula River	Immediately East of the Ashtabula River
No. Electric Units	9 units	3 units	5 units	5 units	5 units	4 units
Gross Generating Capacity	1344 MW	175 MW	554 MW	1372 MW	499 MW	200 MW
Average Flow	832 Million gal/day m^3	146,000 gal/day; 3.1 mil m^3	406 million gal/day; 1.5 million m^3	754 million gal/day 2.8 million m^3	286 million gal/day 1.1 million m^3	223 million gal/day 0.8 million m^3
Distance Offshore	375 m	350 m	375 m	40 m	425 m	1200 m
Depth of Intake	5 m	5 m	5 m	4.6 m	4.6 m	9 m

TABLE 5. IN-PLANT COLLECTION METHODS

CHARACTERISTIC	PLANT NAME					
	Avon Point	Edgewater	Lake Shore	Eastlake	Ashtabula A & B	Ashtabula C
Data Collected	Applied Biology Inc. 6-hour pump at surface, midchannel and bottom of intake channel behind traveling screens. Day and night samples	Geo-Marine Inc. Samples were obtained by tapping a line off one of two of Unit #3 circulating water lines Water filtered through 505-micron mesh plankton net	Applied Biology Inc. 6-hour pump at surface, midchannel and bottom of intake channel behind traveling screens. Day and night samples	Applied Biology Inc. 6-hour pump at surface, midchannel and bottom of intake channel behind traveling screens. Day and night samples	Applied Biology Inc. 6-hour pump at surface, midchannel and bottom of intake channel behind traveling screens. Day and night samples.	Applied Biology Inc. 6-hour pump at surface, midchannel channel behind traveling screens. Day and night samples.
Special Features	Intake curved NE to reduce effects of storms-drive debris into intake canal	Intake protected by breakwalls	Intake curved NE to reduce effects of storms-drive debris into canal	Intake curved to W to minimize inflow of debris and warm water from Chagrin	Intaked curved north	Subsurface intake well offshore

SECTION 5

RESULTS

OVERVIEW

In 1975 and 1976, the study area encompassed the U.S. waters of the Western Basin, a limited portion of adjacent Ontario waters and the water of the Maumee River estuary and Sandusky River estuary. Personnel from The Ohio State University collected samples in Ohio and Ontario waters while personnel from Michigan State University and the Michigan Department of Natural Resources collected samples in Michigan and Ontario waters. The overall purpose of the effort was to gain a first-order approximation of the distribution and abundance of larval fish species in the U.S. and adjacent Ontario waters of the Western Basin. The study focused, in particular, on yellow perch larvae and the impact of entrainment of yellow perch larvae at the Monroe, Michigan electrical generating plant operated by Detroit Edison Company. An analysis of the impact of entrainment at this facility during the 1975 and 1976 period was reported by Patterson (1979). This study reports analyses of samples collected by Ohio State University personnel.

Subsequently, an intensive sampling effort was conducted in a portion of the nearshore zone of the Western Basin and the Maumee estuary in 1977 and in the nearshore zone of the south shore of the Central Basin in 1978. Independent analyses of the impact of entrainment at selected power plants were performed for selected species during each year of the study, 1975-1978.

SOURCES OF ERROR AND VARIABILITY IN SAMPLING

Inherent to all ichthyoplankton sampling programs are multiple sources of sample variability. This variability limits the reliability of the data, applicable statistical treatments and discussion of observed results. Therefore sample variability must be an important consideration when discussing ichthyoplankton investigations.

Several methods for collection of ichthyoplankton are available, each having special applications and each contributing to variability in a different way. Three different collection techniques were used in this study. Metered nets were used in the open lake survey and either submersible pumps or plant line taps were used to collect in-plant samples. When comparing results obtained using a variety of sampling gear, the limitations of each sampling method must be an integral part of the analysis.

Sources of sample variability have been identified as arising from three sources: (1) non-random spatial distributions of larvae; (2) mechanical problems inherent to the particular sampling gear used and (3) active avoidance of the sampling device (Weibe and Hollander, 1968). A brief discussion of these sources of variability, how they influence results of this particular study, and our efforts to control each follows.

The non-random distribution of larval fishes can affect the validity of assumptions upon which statistical treatments are based and limit the confidence that can be placed on data interpretation. Thus variation in the distribution (patchiness) are of primary concern and efforts must be made to keep variability to a minimum. The effects of patchy distributions can be minimized by collecting replicate samples and filtering large volumes of water during each sample collection (Weibe, 1978). The use of replicate samples to overcome patchiness is not a panacea. To detect a change in five species from day to night or location to location would require at least seven replicates. To detect a ten percent difference in numbers of individuals would require ten replicates in a densely populated area and 15 or more in sparsely populated area (Roessler, 1965). Cole (1978b) analyzed catch results from three lake stations along the Michigan shoreline of Lake Erie. He concluded that the intensity of sampling on a given date must be increased at least 100 times (depending on species and time) to reduce permissible error from 50 percent to ten percent of the mean with a 95 percent confidence interval.

When collecting samples with a metered net, as in our lake survey, long oblique tows through the water column are best for reducing the effects of patchiness (McGowan, and Fraundorf, 1966). By making long oblique tows the probability of the net passing through a patch of larvae suspended in the water column is increased. Replicate samples collected by towing a net introduce problems of their own by disturbing the study area by repeated passage of the boat motor and net (Brown and Langford, 1975). In a summary of 13 studies, Weibe and Hollander (1968) demonstrated that a 95 percent confidence interval for a single net tow exceeded one half to two times the observed value.

Pump samplers, generally, can not sample and adequate volume of water to overcome the effects of patchiness. When Kenco pump rates provided by Reutter, et al. (1978) are compared with volumes filtered during this survey, one concludes that it would require operating pump samplers three hours to sample the same volume of water as a single three minute net tow.

Sources of variability associated with mechanical problems of metered nets include extrusion of larvae through the mesh, clogging of mesh (Aron, et al., 1965; Taylor, 1953; Winsor and Clark, 1940) and subtle changes in collection technique (Aron and Collard, 1969). Towed nets are selective. Retention of various size larvae and eggs is largely a function of the size and the distortion of the mesh (Vannucci, 1968). A single mesh size can not sample the entire size range of an important species with 100% efficiency (Bowels et al., 1978). For example the size range for rainbow smelt that may be sampled at the same time ranges from 5mm to 20 mm long. Very early life stages are frequently under sampled because of mesh selection due to extrusion of small larvae through the net (Ahlstrom, 1954; Saville, 1959; Lenarz, 1972). Escape of organisms larger than the mesh is aided by the compressibility of the organisms and the flexibility of the net (Vannucci, 1968). Extrusions of larvae through the net can be reduced by decreasing towing speed or reducing mesh size (Quirk, Lawler and Matuskey, 1974). However, if one decreases towing speed active avoidance may increase; finer meshes are more susceptible to clogging.

As a sample tow progresses, organisms and debris become trapped in the meshes of the net, decreasing the amount of water passing through the net. As the tow continues and the degree of clogging increases, the filtering efficiency of the net, i.e. the ability of the net to representatively sample species distribution and composition, continually decreases (Bowles et al., 1978). As the net becomes clogged water passing through the mouth will not be able to pass through the mesh, creating a backwell and pressure wave at the net mouth. This pressure wave at the mouth of the net can sweep larvae not exhibiting an escape response away from the mouth of the net, stimulate active avoidance, and decrease the performance of the flow meter.

Accurate estimates of the amount of water filtered are essential for quantitative ichthyoplankton measurements. Center mounted flow meters tend to register a lower volume of water than is actually filtered (Taylor, 1953). Theoretical calculations of water filtered based on center mounted flow meter are low and generally unreliable (Aron et al., 1965; Taylor, 1953; and Winsor and Clark, 1940).

Changes in net speed and towing depth can produce relatively large changes in the number and size distribution of larvae captured (Aron, 1969). Relatively small changes in boat speed, in spite of careful control of the throttle setting, can introduce a considerable variability in actual net speed and depth, significantly affecting the length frequency distributions of some species in the catch (Aron and Collard, 1969). Nobel (1970) noted this effect to be extreme for yellow perch.

Pump samples have several advantages over metered nets. The effects of clogging and avoidance are greatly reduced. Pumps can provide a more accurate measure of the water volume filtered. However, pumps can not provide adequate sample volumes (unless high volume pumps are used) to overcome variance associated with patchy distribution (Bowles, et al., 1978). Generally, pump sampling in areas such as power plant intake and discharge structures is more quantitative than net sampling because turbulence does not interfere as much as with net performance (Icanberry and Richardson, 1973; Davies and Jensen, 1974). A major disadvantage of using pumps to sample is that a high percentage of larvae become damaged and are then unidentifiable.

No results from successful pipe tap samplers or in-line filters have been reported in the literature (Bowles et al., 1978). Several utilities have discontinued within-plant sampling because of the large number of damaged and extruded organisms. In addition to these problems water velocity through the pipes, even under turbulent conditions, decreases at the boundary near the pipe wall. The particle distribution of larvae within the pipe is affected by the water velocity profile. Thus samples representative of a cross-section of a pipe are difficult to obtain.

Active avoidance of a net is a problem particularly with older, more developed larvae. Hydraulic characteristics of the gear and flow conditions in the vicinity of the gear are the most important factors influencing the accuracy of metered nets (Bowles et al., 1978). Fish are highly sensitive to pressure stimuli (Knight-Jones and Qasin, 1955). Hydrostatic pressure ques from the sampling gear, i.e., turbulence caused

by the towing line and bridles moving through the water or to a pressure wave at the mouth of the net, can stimulate active avoidance in larvae which have developed limited swimming capabilities (Bary et al., 1958; Flemminger and Cluttler, 1965). Brown and Langford (1975) reported that turbulence caused by the movement of the boat motor and the net can decrease the accuracy of replicate samples taken in a single area.

Water turbulance created by pump samplers is much less than that created by moving nets. Therefore active avoidance of pump samplers is much less than that for meter nets, resulting in a more representative length frequency distribution of larvae.

In summary, three sampling methods were used in this study (metered nets, pump samplers, and in-plant line taps). In-plant line taps have never been demonstrated to provide accurate samples. Pump samplers are a good sampling method for areas difficult to sample using nets. If large volumes of water are filtered, pump samples are believed to be more quantitative than those obtained using nets because turbulance does not interfere as much with pump performance (Icanberry and Richardson, 1973). However, a large proportion of larvae obtained using pump samplers are damaged and left unidentifiable. Sampling large volumes of water is relatively easy with metered nets. However active avoidance of older larvae stimulated by water turbulance in front of the net results in an underestimation of density of larger larvae.

WESTERN BASIN, 1975-1976

A total of 19 taxa of larval fish was collected in Ohio and Ontario waters of the Western Basin in 1975 and 1976 (Table 6). The raw data, consisting of the number of larvae at each station for each sampling date can be found in Herdendorf, et al. (1976, 1977), as well as in Heniken, 1977. Yellow perch larvae were identified in samples from four cruises in 1975 and four cruises in 1976. Analysis of yellow perch data indicates concentrations in bottom samples were significantly higher than in surface samples during three of the four sampling periods in 1975 and during two of the four periods in 1976 (Wilcoxin signed rank test, $p < 0.05$). During the period of peak abundance in 1975 and 1976, average yellow perch concentrations were significantly higher in the inshore depth zones than in the shallow offshore reef areas (Wilcoxin rank sum test, $p < 0.05$). With the exception of the first cruise encountering perch larvae in 1975 and the last one in 1976, concentrations of yellow perch inshore samples were higher than concentrations in all offshore samples throughout the period of capture during both years (Wilcoxin rank sum test, $p < 0.20$). For the most part, mean densities were not significantly different in series arbitrarily drawn sectors (A-G) of the study area (Kruskal-Wallis test, $p < 0.05$). An in-depth presentation of perch concentrations within the study area is provided by Patterson (1979).

Emerald shiner and gizzard shad were the most abundant larvae collected. Pro-larval stages of gizzard shad and emerald shiner were rare, post-larvae predominated. The greatest gizzard shad numbers consistently occurred in the highly turbid waters of Maumee estuary and bay and in the Sandusky estuary and bay. Emerald shiner numbers were greatest

in the less turbid, open water portions of the areas sampled. The relative abundance of emerald shiner was different in each of the two years of the study. The large difference served to alter the relative abundance of other species even though estimates of their respective numbers did not change appreciably. No simple explanation of this difference in abundance is apparent at this time. Differential mortality, differential susceptibility to the sampling gear and attendant age factors could affect the relative rankings of the species collected.

Pro-larval smelt were almost entirely lacking in collections. Smelt larvae densities were greatest at open water, offshore sampling stations. Inspection of smelt concentrations and water mass movements lead to the conclusion that smelt in the Western Basin are dispersed by the Detroit River discharge and smelt in the Central Basin are dispersed into the Ohio nearshore zone from spawning areas at Point Pelee and Pelee Island by currents passing through Pelee Passage. Smelt larvae were rarely collected at nearshore sampling points. Walleye larvae were collected at shalalow nearshore stations and on offshore reefs. Nearshore distributions of walleye and yellow perch were quite similar. Logperch and white sucker larvae were collected in greatest numbers at nearshore rather than offshore stations. Of particular interest is the finding of larval whitefish on the reefs and in the nearshore area near Locust Point and larval sculpin on the reefs of the island area. Formerly abundant (Trautman, 1957), this study confirms a relict breeding populations of each is extant in the Western Basin.

It is likely that some species with very small pro-larval stages were not colelcted and the abundance of others with relativey small larval stages were underestimated due to the relatively large mesh nets used to collect samples in 1975 and 1976. It is reasonable to assume that post-larval stages were effectively samples. Larval stages were determined using the definitions of Hubbs (1942). Selected species were also determined using the definitions of Snyder and Snyder (1978). Lengths and stages are provided in Appendix A.

MAUMEE AND SANDUSKY RIVER ESTUARIES, 1975-1977

The results of this three-year sampling effort are summarized in Tables 7 and 8. A total of 17 taxa of larval fish are reported from the Maumee River estuary and 11 taxa from the Sandusky estuary. The raw data consisting of number of larvae at each station for each sampling date can be found in Bartholomew (1979); Herdendorf (1977); Herdendorf and Cooper (1975 and 1976); Herdendorf, Cooper, Heniken and Snyder (1976 and 1977); Reutter, Herdendorf and Sturm (1978a and 1978b and Snyder (1978). Gizzard shad, white bass and freshwater drum composed 98 percent of the fish larvae collected each year in the Maumee River estuary. These species constituted approximately 91 percent of the larvae collected during the study of the Sandusky River estuary. Snyder's (1978) investigation of larvae in the riffle areas above the estuaries proper indicated a greater abundance of carp larvae in the riffle areas. This indicated greater carp larvae densities in littoral areas and may have resulted in an overall underestimate of their abundance in the study areas. The abundance and period of occurrence of larval fish species distributed predominantly in the littoral zone, e.g., sunfish, crappie, catfish, madtoms, were

similarly underestimated. The abbreviated sampling period in 1976 probably resulted in an underestimate of the relative abundance of species, freshwater drum in particular, exhibiting period of peak abundance which extend beyond the limits of the sampling periods in 1976.

During periods of high densities (>100 larvae/100 m^3), Snyder found significantly (ANOVA, $p < 0.05$) more larval gizzard shad and white bass in sheltered low flow portions than in the mid-channel portion of the mid-estuary sampling location. The predominate number of rainbow smelt and yellow perch larvae were collected at the Maumee River mouth location. Very limited numbers of yellow perch and no rainbow smelt were collected further upstream; neither species were colected in the Sandusky River estuary. It is suggested that lake water intruding into the lower portion of the estuary carried lake spawned yellow perch and rainbow smelt larvae to the river mouth location (Bartholomew, 1979; Reutter, et al., 1978a, b; Snyder, 1978).

Larval walleyes were of particular interest. Walleye larvae ranked fourth, fifth and sixth in each respective year of the study in the Maumee River estuary and ranked sixth among all larvae captured in the Sandusky River estuary. The average density of larvae throughout the study ranged from less than 1.0 to 3.5/100 m^3. Snyder analyzed egg and larvae counts from samples taken in the riffle areas. The results indicate a patchy, or nonrandom, distribution of walleye eggs ($\overline{X}^2$ dispersion test) while larvae were randomly (Poisson) distributed. Bartholomew found no significant differences (Wilcoxin signed rank tests, $p < 0.05$) between numbers of larval yellow perch and walleye in surface and bottom samples collected at the mid-estuary and lower estuary locations. Similar analyses at the river mouth location revealed significant ($p < 0.05$) differences in larval walleye but no in yellow perch numbers. Larval walleye were apparently located in near-bottom areas at this location. The effect of lake water intrusion on walleye distribution at the river mouth location was not determined. Overall, larval walleye densities decrease from relatively high densities upsteream to relatively low densities downstream.

Calculations by Snyder (1978) indicated that the Maumee estuary produced larger numbers of individuals of all larval species than did the Sandusky estuary although higher densities of walleye and logperch larvae were recorded in the Sandusky estuary. Approximately 100 times more gizzard shad larvae were estimated in the Maumee than the Sandusky estuary. White bass larvae were collected almost exclusively in the estuaries, at river mouths and in Maumee and Sandusky bays. The tributaries of the Western and Central Basins seem to be the primary white bass spawning areas. The bays may serve as nursery grounds for post-larvae and juveniles. The greatest numbers of freshwater drum were collected in the same, highly turbid areas.

The combined volumes of the Maumee and Sandusky estuaries are less than two percent of the Western Basin study area. Comparison of similar sampling dates indicates the estimated number of larvae in the Maumee estuary was equal to that of the Western Basin study area. On a fish per volume basis, the Maumee estuary contained more gizzard shad, white bass, logperch, walleye and freshwater drum than the Western Basin study area on many sampling dates.

TABLE 6. PERIOD OF CAPTURE AND RELATIVE ABUNDANCE OF LARVAL FISH IN THE OHIO WATERS OF THE WESTERN BASIN OF LAKE ERIE DURING 1975 AND 1976

SPECIES	FIRST CAPTURE		LAST CAPTURE		PEAK ABUNDANCE	RELATIVE ABUNDANCE[a]	
	1975	1976	1975	1976		1975	1976
Gizzard Shad/Alewife	24 May	30 April	3 Sept.	3 Sept.	June - Mid-July	40%(1)	17%(2)
Lake Whitefish	--	12 April	--	30 April	Late April	--	<0.1%
Rainbow Smelt	13 May	10 May	13 July	21 June	Mid - Late May	7%(5)	7%(3)
Mooneye	22 May	--	22 May	--	Late May	<0.1%	--
Carp/Goldfish	23 May	30 May	4 Aug.	28 July	Mid- Late June	2%(7)	0.6%(8)
Emerald Shiner	22 May	22 June	3 Sept.	3 Sept.	Mid-June - Early Aug.	16%(3)	62%(1)
Spottail Shiner	22 May	23 May	2 July	2 July	Early - Mid-June	2%(8)	2.7%(6)
Quillback Carpsucker	1 June	23 May	17 June	23 May	Early - Mid-June	<0.1%	<0.1%
White Sucker	22 May	30 April	22 May	30 May	Mid - Late May	<0.1%	<0.1%
Troutperch	--	23 May	--	23 May	Late May	--	<0.1%
White Bass/White Perch	22 May	23 April	15 July	4 Aug.	Early - Mid-June	2%(6)	0.1%(10)
Sunfish (*Lepomis* spp.)	21 June	22 June	15 July	28 July	Early - Mid-July	<0.1%	<0.1%
Smallmouth Bass	11 June	--	11 June	--	Early June	<0.1%	--
Crappie (*Pomoxis* spp.)	1 June	7 June	4 Aug.	3 Sept.	Late June - Early July	<0.1%	<0.1%
Yellow Perch	12 May	23 April	23 June	7 July	Early May - Early June	12%(4)	5.8%(4)
Logperch Darter	11 June	7 June	3 July	16 July	Mid-June	<0.1%	<0.1%(9)
Walleye	22 May	21 April	22 May	22 May	Late April - Early May	<0.1%	0.8%(7)
Freshwater Drum	22 May	7 June	4 Aug.	5 Aug.	Early - Late June	19%(2)	4%(5)
Sculpin (*Cottus* sp.)	--	30 April	--	22 May	Early May	--	<0.1%

[a]Numbers enclosed parenthetically indicate relative rank

TABLE 7. LIMNETIC FISH LARVAE FROM THE MAUMEE RIVER ESTUARY, 1975-1977.

SPECIES	First Capture			Last Capture			Period of Peak Abundance 3 year Summary	Avg. Density No./100 m^3 1976	Relative Abundance[2]			Avg. Density No./100 m^3 1977
	1975	1976	1977	1975	1976[1]	1977			1975	1976	1977	
Gizzard Shad/ Alewife	15 May	23 Apr	7 May	25 Aug	8 June	25 Aug	Late May-Early June	355	49%(1)	89%(1)	77%(1)	278
Rainbow Smelt	25 June	7 May	7 May	24 July	8 June	28 July	---	<1	0.6%(5)	<0.1%(9)	<0.1%(14)	<1
Carp/Goldfish	15 May	21 Apr	24 Apr	5 Aug	8 June	25 Aug	Late May	14	<0.1%(8)	4%(3)	0.2%(6)	<1
Emerald Shiner	25 June	---	4 June	25 Aug	---	18 Aug	Late July	---	0.3%(7)	---	0.1%(8)	<1
Spottail Shiner	---	28 May	23 May	---	---	11 Aug	---	<1	---	---	<0.1%(10)	<1
Quillback	---	---	7 May	---	---	7 May	---	---	---	---	<0.1%(15)	<1
White Sucker	15 May	21 Apr	25 Apr	15 May	8 June	11 May	Early May	1	<0.1%	0.1%(8)	<0.1%(11)	<1
Channel Catfish	8 July	---	27 May	24 July	---	11 Aug	---	---	<0.1%(10)	---	<0.1%(13)	<1
Madtom (Noturus sp.)	24 July	---	7 July	24 July	---	14 July	---	---	<0.1%	---	<0.1%(17)	<1
Troutperch	---	---	15 May	---	---	15 May	---	---	---	---	<0.1%(16)	<1
White Bass/ White Perch	15 May	27 Apr	14 May	24 July	8 June	4 Aug	Late May-Early June	24	3%(3)	6%(2)	7%(3)	79
Sunfish (Lepomis spp.)	8 July	---	24 May	25 Aug	---	28 July	---	---	<0.1%(9)	---	1%(4)	2
pie omoxis spp.)	---	---	31 May	---	---	11 Aug	---	---	---	<0.1%(10)	<.1%(9)	<1
Yellow Perch	15 May	23 Apr	30 Apr	5 Aug	8 June	25 Aug	Mid-May-Early June	3	0.6%(4)	0.1%(6)	0.3%(5)	1
Walleye	15 May	8 Apr	16 Apr	15 May	20 May	15 May	Mid-Late April	<1	0.4%(6)	0.1%(5)	0.2%(7)	3.5
Logperch	6 June	23 Apr	25 Apr	6 June	27 May	7 July	Mid-Late May	1	<0.1%	0.1%(7)	<.1%(12)	<1
Freshwater Drum	6 June	25 May	11 May	5 Aug	8 June	1 Sept	Early June	4	46%(2)	0.4%(4)	14%(2)	60

[1]Truncated sampling period in 1976 (7 April to 8 June)

[2]Relative rank indicated parenthetically

TABLE 8. LIMNETIC FISH LARVAE FROM THE SANDUSKY RIVER ESTUARY, 1976.

SPECIES	First Capture 1976	Last Capture 1976[1]	Period of Peak Abundance	Relative Abundance[2] 1976	Avg. Density No./100m^3
Gizzard Shad/Alewife	26 April	7 June	---	80%(1)	61
Carp/Goldfish	22 April	7 June	---	3%(4)	36
White Sucker	26 April	31 May	Mid-May	0.3%(7)	1
Sucker (<u>Catastomidae</u> sp.)	19 May	19 May	Mid-May	<0.1%	--
Troutperch	2 June	2 June	---	0.3%(8)	--
White Bass/White Perch	26 April	7 June	---	11%(2)	10
Sunfish (<u>Lepomis</u> spp.)	3 May	3 May	---	<0.1%	--
Crappie (<u>Pomoxis</u> spp.)	26 May	26 May	---	<0.1%	--
Walleye	12 April	3 May	Late April	0.6%(6)	1
Logperch	22 April	7 June	---	4%(3)	4
Freshwater Drum	26 May	7 June	---	0.7%(5)	7

[1]Truncated sampling period (12 April to 7 June)

[2]Relative rank indicated parenthetically

WESTERN BASIN, 1977

An intensive survey of the nearshore zone of the Western Basin in 1977 resulted in the collection of 20 taxa of larval fishes. Sixteen species were identified, representing 10 families and comprising 99.05% of the catch. The other 0.05% of the catch was identified to the genus or family level.

Ten species, gizzard shad, yellow perch, emerald shiner, white bass, carp, freshwater drum, log perch, walleye, rainbow smelt and spottail shiner were collected in numbers great enough to be considered abundant (i.e., average basin-wide density 0.10/100 m^3). Four species, gizzard shad, yellow perch, emerald shiner, and white bass made up over 97% of the catch, with gizzard shad alone accounting for 87% of the total catch. The other 10 taxa were represented by a few or sometimes only a single specimen. Table 9 lists the average density for the entire sampling period and percentage of the total catch represented by each taxon for the entire nearshore zone of the Western Basin.

Seventeen taxa of larval fishes were captured along the Michigan shoreline from Stoney Point to Woodtick Peninsula. Eleven taxa, gizzard shad, emerald shiner, yellow perch, carp, white bass, log perch, rainbow smelt, freshwater drum, walleye, spottail shiner, and sunfish Lepomis spp. were abundant. Five species, gizzard shad, emerald shiner, yellow perch, carp, and white bass made up 98.5% of the catch. Whitefish larvae, although rare, were captured on April 29th along the entire Michigan shoreline. Whitefish densities were greatest at Station M2 where the average density of larvae was found to be 9103 per 100 m^3 (see Figure 6 for station location). Table 10 lists the average density for the entire sampling period and the percentage of the total catch represented by each taxon of larvae collected along the Michigan shoreline.

Samples collected in Maumee Bay contained a total of 18 taxa of larval fishes. Gizzard shad, white bass, yellow perch, emerald shiner, freshwater drum, rainbow smelt, carp, log perch, walleye, and spottail shiner larvae were found to be abundant. Three species, gizzard shad, white bass, and yellow perch made up over 97.5% of the catch with gizzard shad larvae representing 90.58% of the total larvae catch. Sauger larvae were captured on May 12 and on June 3 at two locations, MB2/2 and MB1/2. Table 11 lists the average density for the entire sampling period and the percentage of the total catch represented by each taxon of larvae collected in Maumee Bay.

Fifteen taxa were collected during our sampling effort along the Ohio shoreline of the Western Basin. Again gizzard shad yellow perch, emerald shiner, white bass, walleye, freshwater drum, log perch, carp, smelt, and spottail shiner were abundant. Game fish, yellow perch, white bass and walleye contributed to 13.8% of the total larvae captured. Whitefish larvae were found in a single sample collected on April 29 at Station OH3/1 (see Figure 6 for station location). Table 12 lists the average density for the entire sampling period and the percentage of the total catch represented by each taxon of larvae collected along the Ohio shoreline.

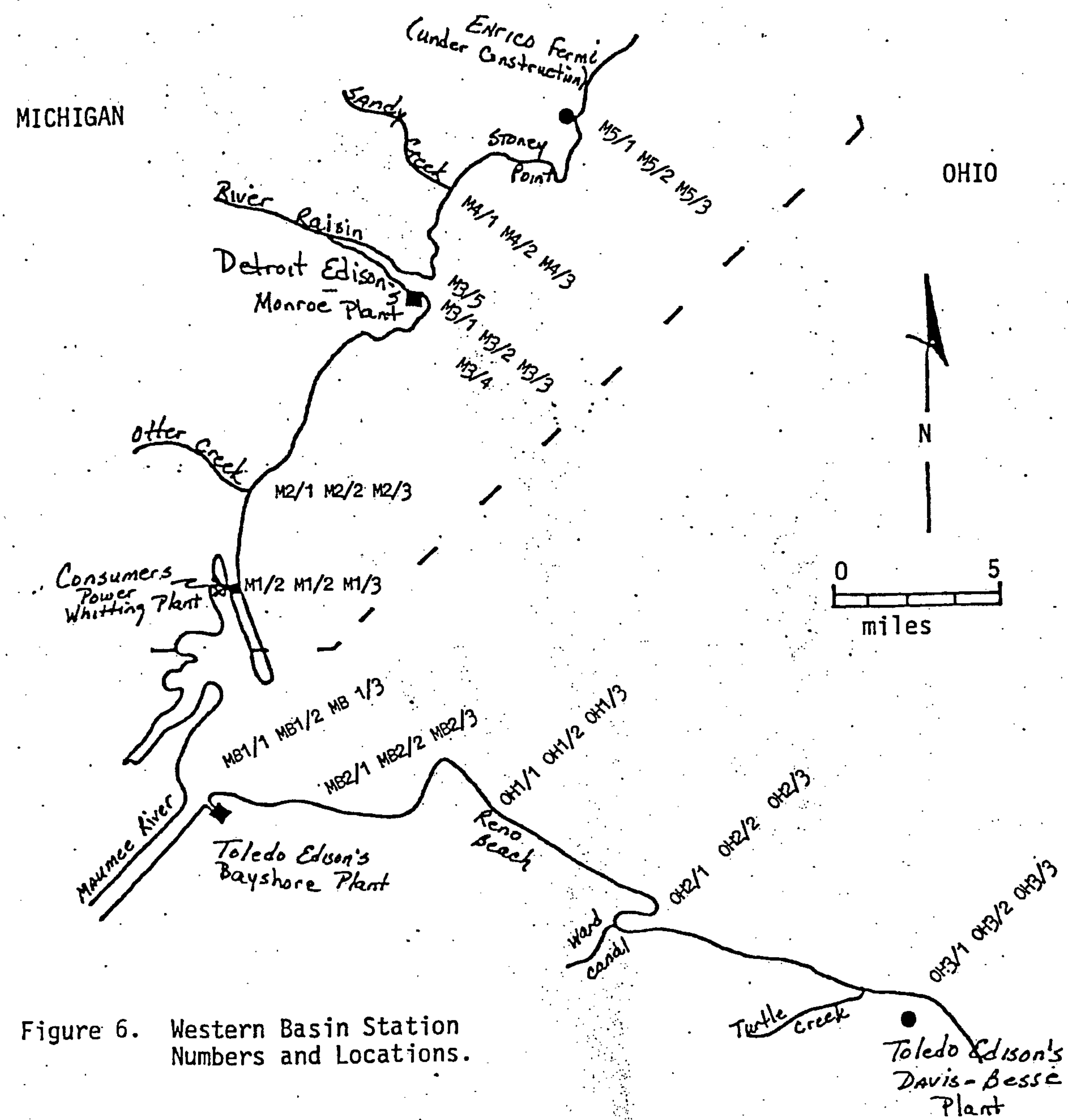


Figure 6. Western Basin Station Numbers and Locations.

TABLE 9. RELATIVE ABUNDANCE OF LARVAL FISHES CAPTURED IN THE WESTERN BASIN OF LAKE ERIE IN 1977

SPECIES	AVERAGE DENSITY[1] (# larvae/100m^3)	PERCENT[2] OF CATCH
Gizzard Shad/Alewife	266.16	82.58
Yellow Perch	21.31	6.61
Emerald Shiner	18.72	5.81
White Bass	7.85	2.44
Carp	2.82	0.88
Freshwater Drum	1.76	0.55
Log Perch	1.43	0.44
Walleye	0.99	0.31
Rainbow Smelt	0.88	0.28
Spottail Shiner	0.18	0.06
Unidentified Sunfish (*Lepomis* spp.)	0.05	0.02
Whitefish	0.04	0.01
Unidentified *Cyprinidae* spp.	0.03	0.01
White Sucker	0.02	<0.01
Quillback Carpsucker	0.02	<0.01
Channel Catfish	0.01	<0.01
Trout Perch	0.01	<0.01
Sauger	0.01	<0.01
Unidentified *Percidae* spp.	<0.01	<0.01
Unidentified Crappie (*Pomoxis* spp.)	<0.01	<0.01
TOTAL	322.30	

[1]Average densities found by dividing the sum of the calculated densities by the number of tows taken during period of larval occurrence.

[2]Species ranked according to descending percent of catch.

TABLE 10. RELATIVE ABUNDANCE OF LARVAL FISHES CAPTURED ALONG THE MICHIGAN SHORELINE FROM STONEY POINT TO WOODTICK PENINSULA IN 1977

SPECIES	AVERAGE DENSITY[1] (# larvae/100 m^3)	PERCENT[2] OF CATCH
Gizzard Shad/Alewife	193.82	75.00
Emerald Shiner	31.98	12.38
Yellow Perch	21.07	8.15
Carp	4.77	1.85
White Bass	3.02	1.17
Log Perch	2.00	0.76
Rainbow Smelt	0.63	0.24
Freshwater Drum	0.50	0.19
Walleye	0.21	0.08
Spottail Shiner	0.12	0.04
Unidentified Sunfish (Lepomis spp.)	0.11	0.04
Whitefish	0.09	0.04
Unidentified Cyprinidae spp.	0.06	0.02
White Sucker	0.01	< 0.01
Trout Perch	0.01	< 0.01
Channel Catfish	0.01	< 0.01
Unidentified Crappie (Pomoxis spp.)	0.01	< 0.01
TOTAL	258.42	

[1]Average density found by dividing the sum of the calculated densities by the number of tows taken during period of larval occurrence.

[2]Species ranked according to descending percent of catch.

TABLE 11. RELATIVE ABUNDANCE OF LARVAL FISHES CAPTURED IN MAUMEE BAY IN 1977

SPECIES	AVERAGE DENSITY (# larvae/100m^3)	PERCENT[2] OF CATCH
Gizzard Shad/Alewife	541.80	90.58
White Bass	23.32	3.99
Yellow Perch	17.84	2.98
Emerald Shiner	5.57	0.93
Freshwater Drum	5.07	0.85
Rainbow Smelt	2.00	0.34
Carp	1.22	0.21
Log Perch	0.74	0.12
Walleye	0.30	0.05
Spottail Shiner	0.16	0.03
Sauger	0.05	<0.01
Unidentified	0.05	<0.01
Quillback Carpsucker	0.02	<0.01
Unidentified _Cyprinidae_ spp.	0.02	0.01
Channel Catfish	0.01	<0.01
Unidentified _Percidae_ spp.	0.01	<0.01
Unidentified Sunfish (_Lepomis_ spp.)	0.01	<0.01
Trout Perch	0.01	0.01
TOTAL	598.18	

[1]Average density found by dividing the sum of the calculated densities by the number of tows made during the period of larval occurrence.

[2]Species ranked according to descending order of percent of catch.

TABLE 12. RELATIVE ABUNDANCE OF LARVAL FISHES CAPTURED ALONG THE OHIO SHORELINE BETWEEN LITTLE CEDAR POINT AND LOCUST POINT IN 1977

SPECIES	AVERAGE DENSITY[1] (#larvae/100m^3)	PERCENT OF CATCH
Gizzard Shad/Alewife	183.26	81.27
Yellow Perch	24.19	10.65
Emerald Shiner	6.97	3.07
White Bass	4.50	1.99
Walleye	2.72	1.18
Freshwater Drum	1.35	0.60
Log Perch	1.04	0.45
Carp	0.85	0.37
Smelt	0.54	0.24
Spottail Shiner	0.25	0.11
Whitefish	0.05	0.02
Unidentified Crappie (Pomoxis spp.)	<0.02	<0.01
Channel Catfish	<0.01	<0.01
Trout Perch	0.01	<0.01
Quillback Carpsucker	0.01	<0.01
TOTAL	231.20	

[1]Average densities found by dividing the sum of the calculated densities by the number of tows made during the period of larval abundance.

[2]Species ranked according to descending percent of catch.

TABLE 13. VOLUME WEIGHTED ESTIMATES OF LARVAL FISHES IN THE WESTERN BASIN (1977)

Species	Volume Weighted Total	Percent of Total Production[1]
Gizzard Shad/Alewife	1.03×10^9	79.24
Yellow Perch	1.35×10^8	10.38
Emerald Shiner	5.16×10^8	3.97
White Bass	2.65×10^8	2.04
Carp	1.64×10^8	1.26
Freshwater Drum	1.42×10^7	1.09
Log Perch	6.82×10^7	0.52
Rainbow Smelt	6.34×10^7	0.49
Walleye	6.08×10^7	0.47
Spottail Shiner	1.27×10^6	0.10
Whitefish	2.32×10^6	0.02
Sauger	2.25×10^6	0.02
<u>Pomoxis</u> sp.	1.63×10^5	0.01
Unidentifiable	1.36×10^5	<0.01
White Sucker	1.28×10^5	<0.01
<u>Lepomis</u> sp.	1.12×10^5	<0.01
Quillback Carpsucker	7.65×10^5	<0.01
Cyprinidae	6.70×10^5	<0.01
Channel Catfish	6.69×10^5	<0.01
Trout Perch	3.83×10^5	<0.01
Percidae	2.66×10^5	<0.01

[1]Species ranked in descending order of production.

Volume weighted estimates of total species abundance were calculated to give an indication of larvae production in the nearshore zone in 1977. The estimates as presented in Table 13 are believed to be much lower than what is actually true. Based on the assumption that sampling once every ten days assures each larval cohort will be vulnerable to the sampling gear once, it is probable that two or possibly three cohorts were not sampled because of a combination of equipment failure and inclement weather. Volume weighted estimates calculated for each depth zone during each sampling period are available in Appendix B.

A detailed description of the spatial and temporal distributions of the ten most abundant larval species captured in the Western Basin follows.

Clupeids (Gizzard shad and Alewife)

With a basin-wide mean density of 266.16 larvae per 100 m^3, clupeid larvae were the most abundant larval fish species captured at all stations in the Western Basin in 1977. Clupeid were first collected on May 22 and were found in large numbers in every sample collected during the remainder of the sampling season. Clupeid larvae were most abundant in samples collected on June 4 with a mean basin-wide density of 803 larvae per 100 m^3. Figure 7 shows the mean density of gizzard shad larvae on each sampling date summed over all stations.

Figure 8 displays the mean number of larvae captured at each station summed over all sampling periods. The Kruskal-Wallace test was used to test for significant differences between the three physiographic areas, i.e. the Michigan shoreine, Maumee Bay, and the Ohio shoreline. No significant differences in larval densities could be detected (α =.05). Friedman's Rank Sum Test was conducted to test for differences between transects, with stations being replicate samples. Statistical differences (α=.01, df=9) were detected between areas of highest, the M2 and MB1 transects, and lowest densities, the M4, M5 and OH3 transects. Friedman's test was also used to test for differences between depth zones, with transects being replicate samples. Statistical differences were detectable (=.01, df=2) between the first and second depth zones. No siginificant differences were detectable between depth zones one and three or depth zones two and three. Highest densities sampled were on June 4 at Station MB1/1, 4983 larvae per 100 m^3, and 2674 larvae per 100 m^3 on June 12 at Station M2/1.

Rainbow Smelt

With a basin-wide mean density of 0.88 larvae per 100 m^3, smelt larvae were the ninth most abundant species collected. Smelt larvae were first collected on May 22 and were collected during every sampling effort thereafter. The samples collected indicate smelt densities were highest in the Western Basin on June 6, with a basin-wide mean density of 2.98 larvae per 100 m^3 (Figure 9).

No statistical differences in densities of larvae were detectable between the three physiographic areas (Kruskal-Wallis, α=.05), nor were statistical differences in densities detectable between transects (Friedman's Rank Sum, α=.05, df=9). Statistical differences were

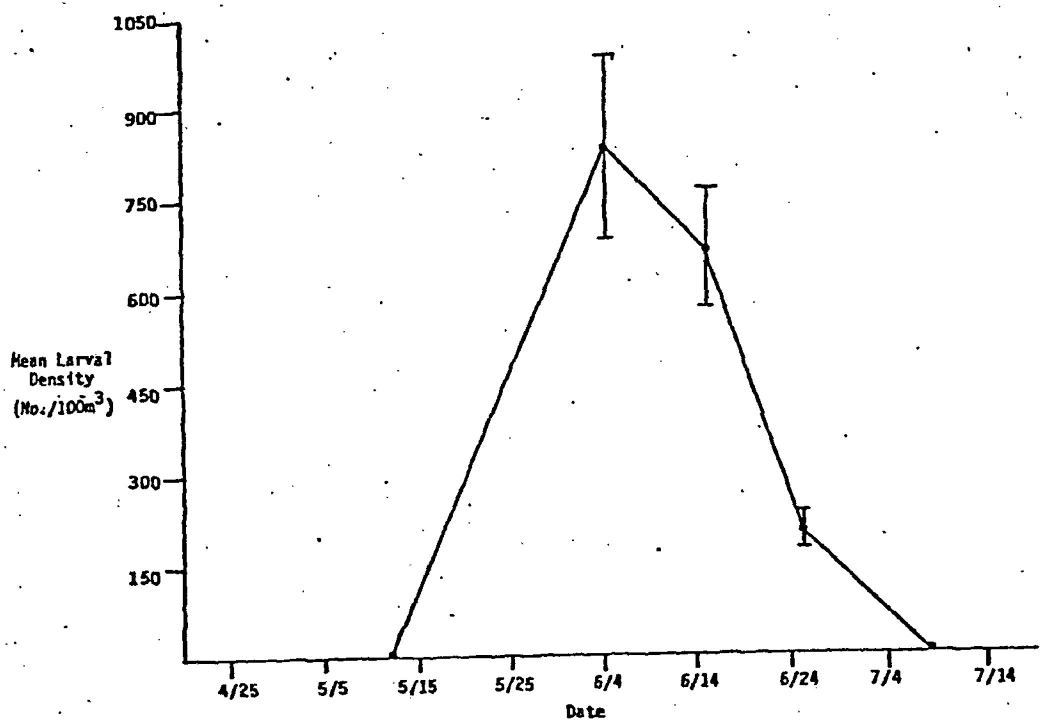


Figure 7. Mean Density of Clupeid Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

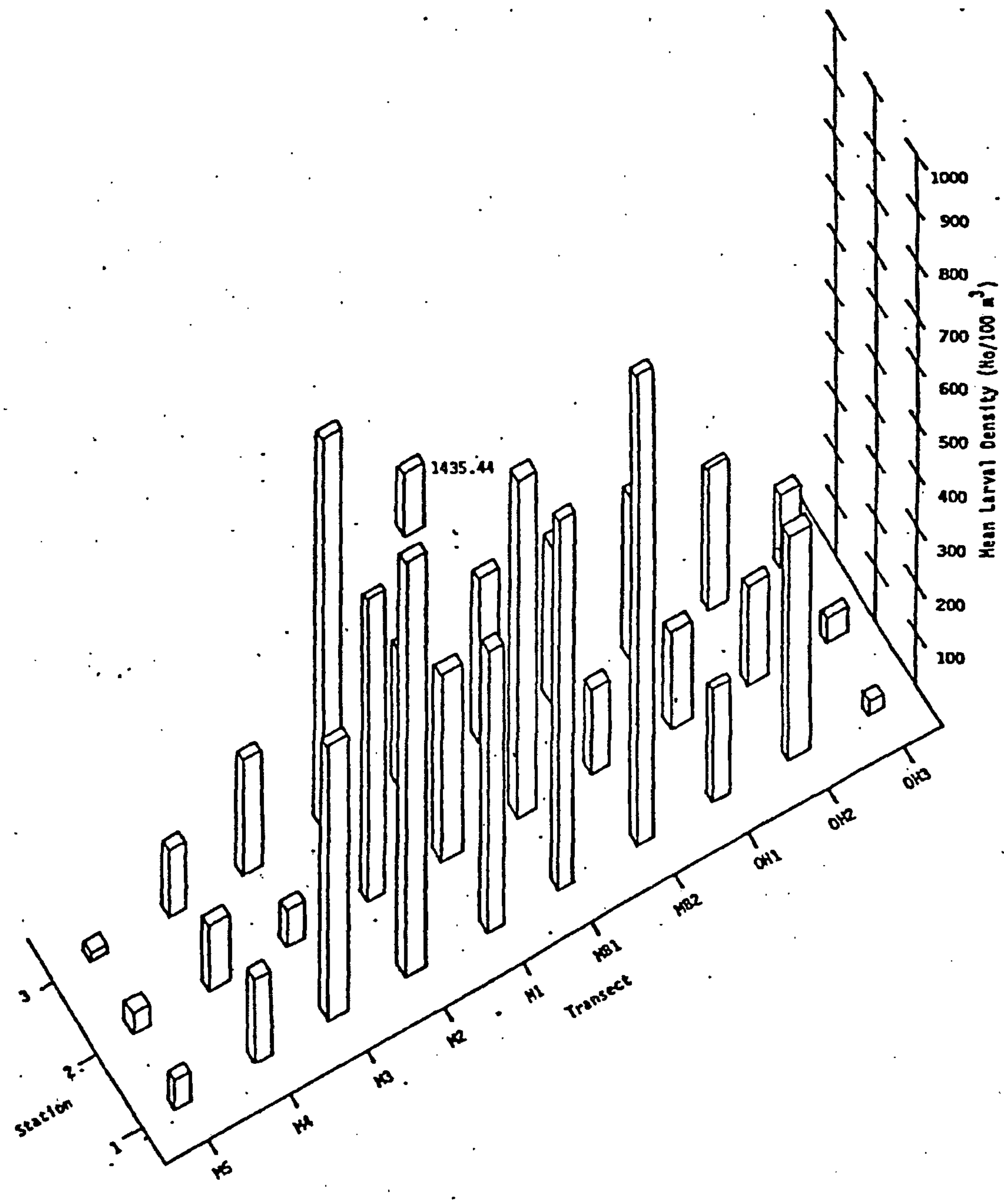


Figure 8. Western Basin - 1977.
Mean Density of Clupeid Larvae at Each Station.

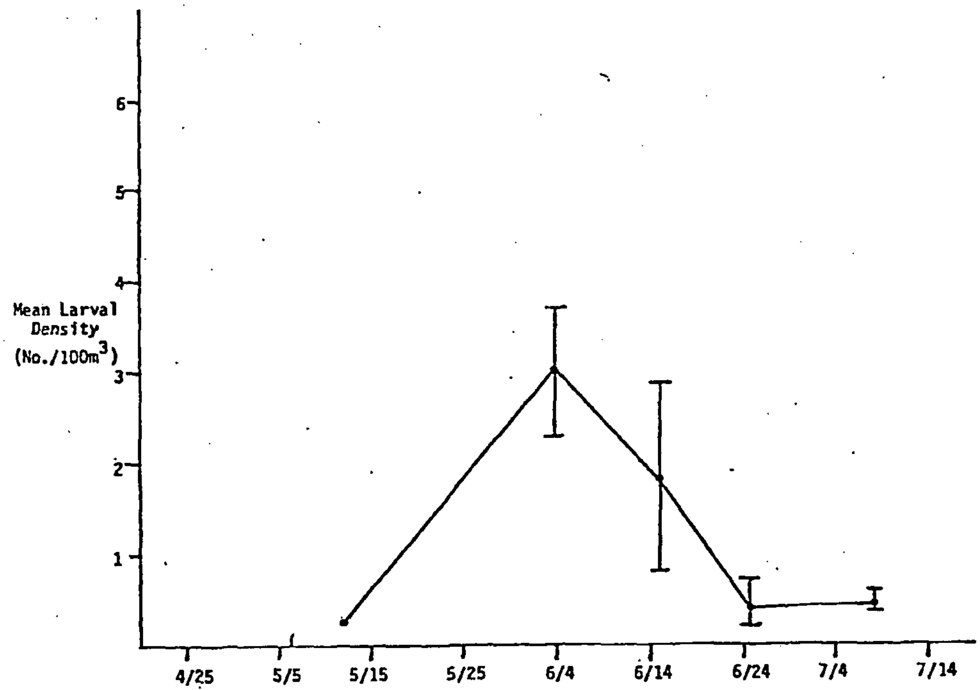


Figure 9. Mean Density of Smelt Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

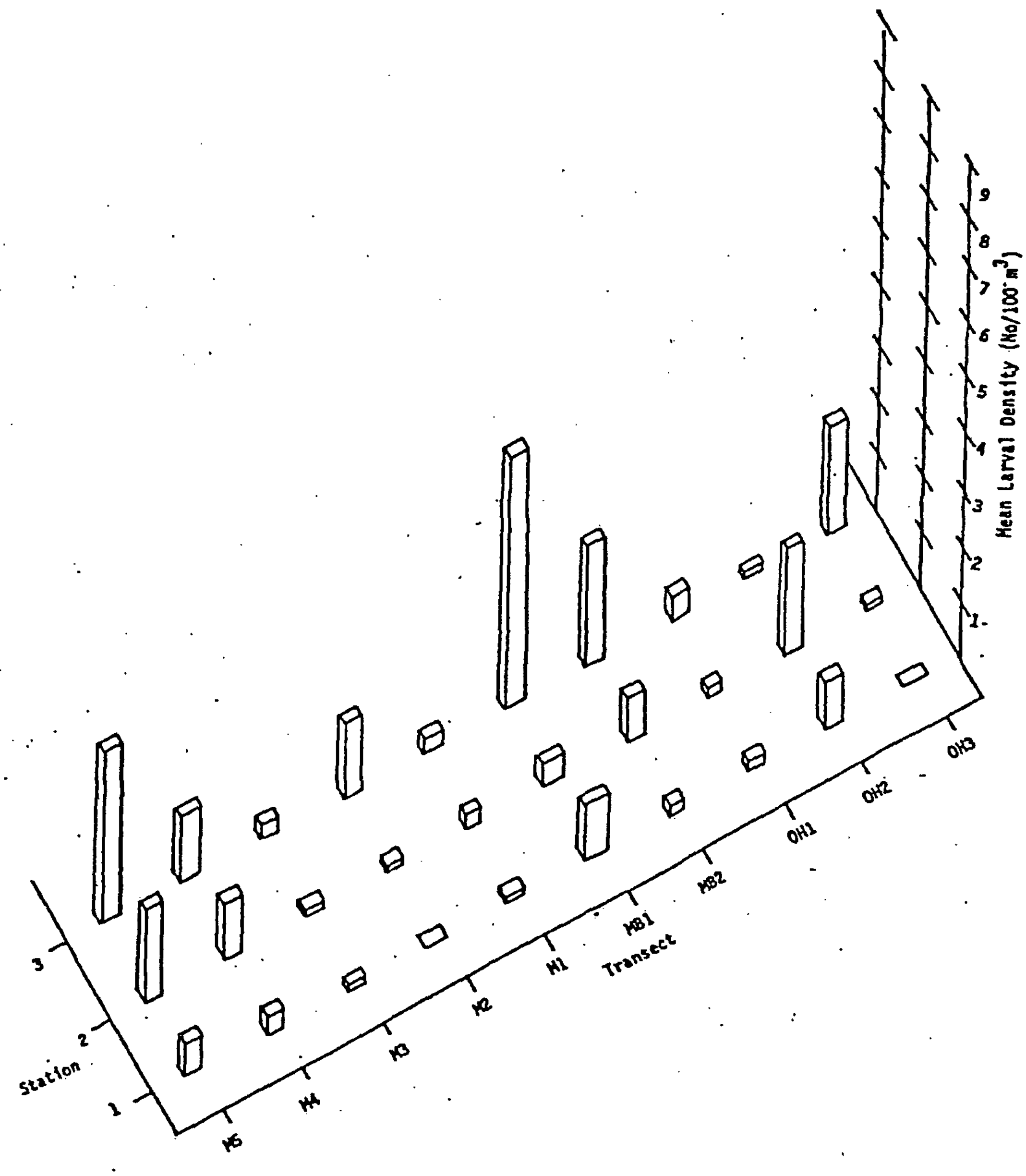


Figure 10. Western Basin - 1977.
Mean Density of Smelt Larvae at Each Station.

detectable between larvae densities in the onshore and offshore depth zones. With higher densities of smelt larvae being found offshore, 65% of the total number of smelt were captured offshore. Generally smelt densities were highest in Maumee Bay and the two northern-most Michigan transects, M4 and M5, where 43% and 27%, respectively, of the total smelt catch was made (Figure 10). Highest density of smelt larvae occurred at Station MB1/3, 54.5 larvae per 100 m^3.

Carp/Goldfish and Hybrids

With a mean basin-wide density of 2.82 larvae per 100 m^3, carp larvae were the fifth most abundant species captured in the Western Basin in 1977. Carp larvae were first captured on May 5 and were collected during each sampling effort thereafter. Carp larvae were most abundant in our samples collected on June 4 with a basin-wide larval density of 9.7 larvae per 100 m^3 (Figure 11).

No statistical differences were detectable between densities in Maumee Bay, the Michigan or the Ohio shorelines (Kruskal-Wallis α=.05), nor were statistical differences detectable between transects (Friedman's Rank Sum α=.05, df=9) or between depth zones (Friedman's Rank Sum α=.05, df=2). Highest densities of carp larvae were captured on June 14 at Stations M1/2, (499 larvae per 100 m^3), and M3/1, (419 larvae per 100 m^3). No carp larvae were captured at Stations MB1 and OH3 (Figure 12).

Emerald Shiner

Emerald shiner, with an average basin-wide density of 18.72 larvae per 100 m^3 were the third most abundant species of larval fish captured. Emerald shiner larvae were first captured on June 4 and were captured during every sampling effort thereafter. Samples collected indicated larval emerald shiner reached a maximum basin-wide density of 101 larvae per 100 m^3 on June 22 (Figure 13).

Statistical tests indicated there were no differences in densities between physiographic areas, transects, or stations. However, looking at the distribution of emerald shiner larvae in Figure 14, the majority of larvae were captured along transects M4 (33% of the total catch) and M5 (31% of the total catch), and in the first depth zone where 50% of the total numer of emerald shiner were captured. Highest densities of emerald shiner, 1432 larvae per 100 m^3, occurred at Station M5/1 on June 22.

Spottail Shiner

With a basin-wide mean density of 0.18 larvae per 100 m^3 spottail shiner were ranked tenth in abundance of larval fishes captured in 1977. Spottail shiner were first captured on June 4 and were captured during each sampling effort for the remainder of the sampling season. Samples indicated larval spottails were in greatest abundance on June 4 with a basin-wide mean density of 0.49 larvae per 100 m^3 (Figure 15).

Although 59% of the spottail catch was made along transects M4 and M5, no statistical differences in density could be detected between physiographic areas or between transects. Friedman's Rank Sum Test (α=.05, df=2)

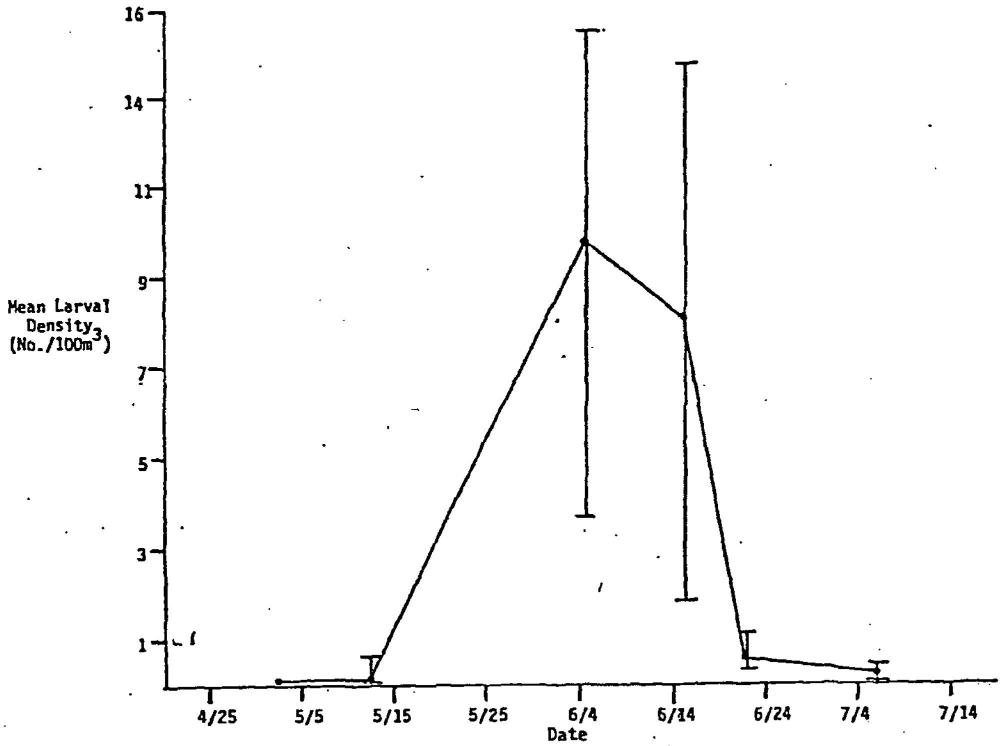


Figure 11. Mean Density of Carp Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

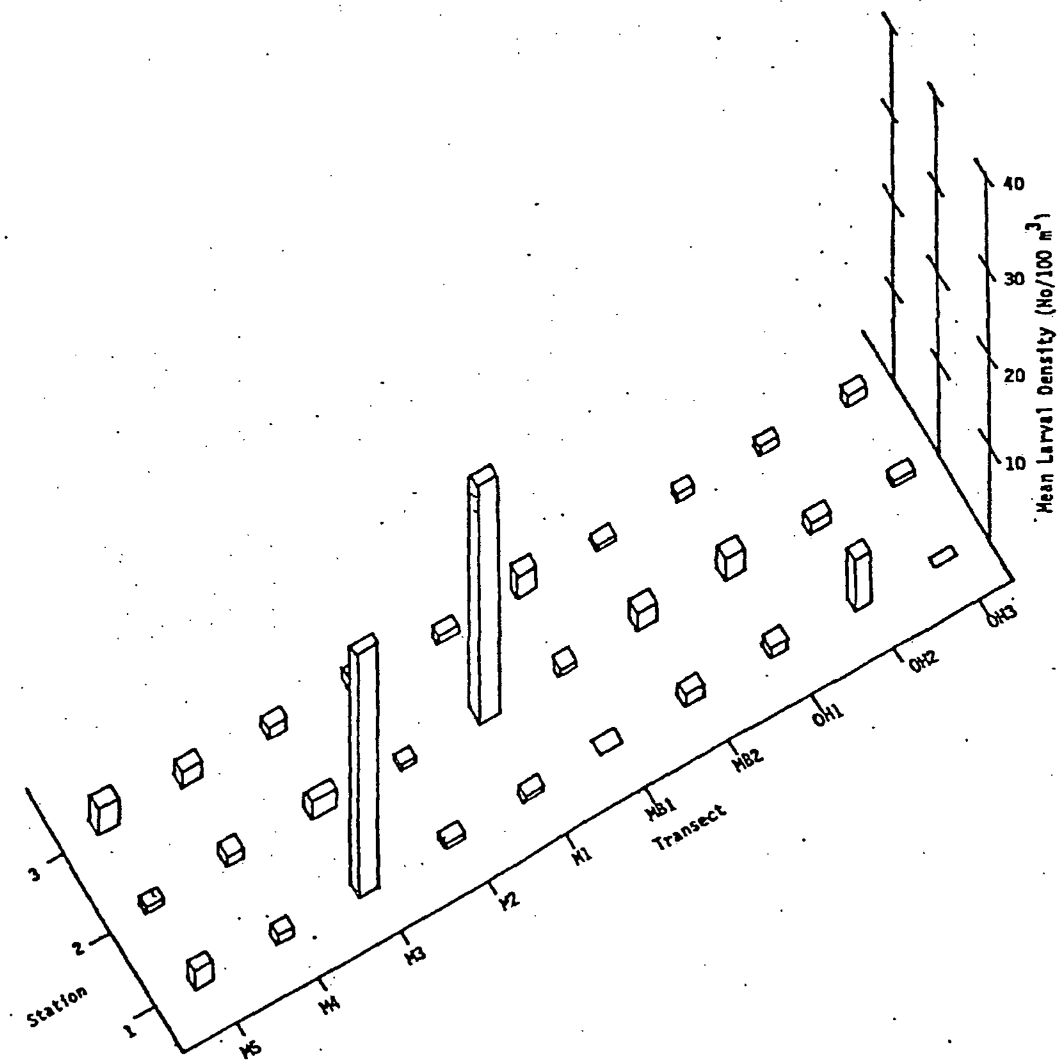


Figure 12. Western Basin - 1977.
Mean Density of Carp Larvae at Each Station.

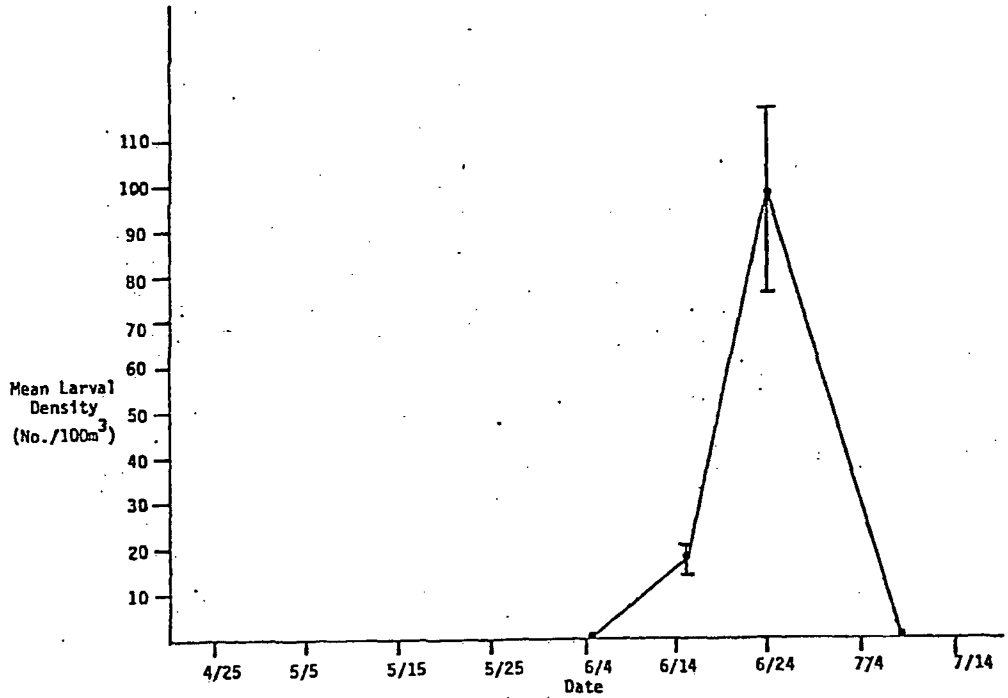


Figure 13. Mean Density of Emerald Shiner Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

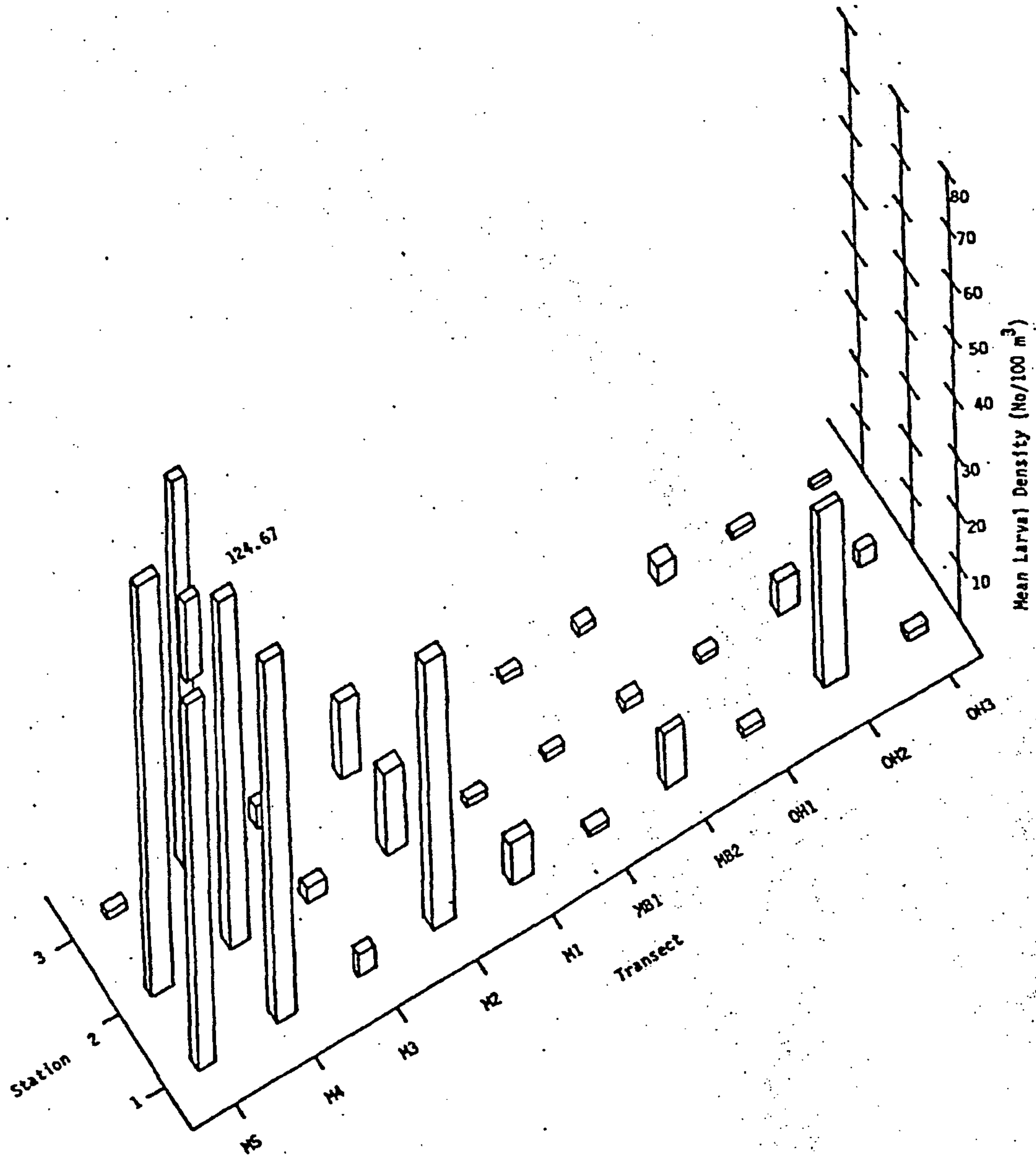


Figure 14. Western Basin - 1977.
Mean Density of Emerald Shiner Larvae at Each Station.

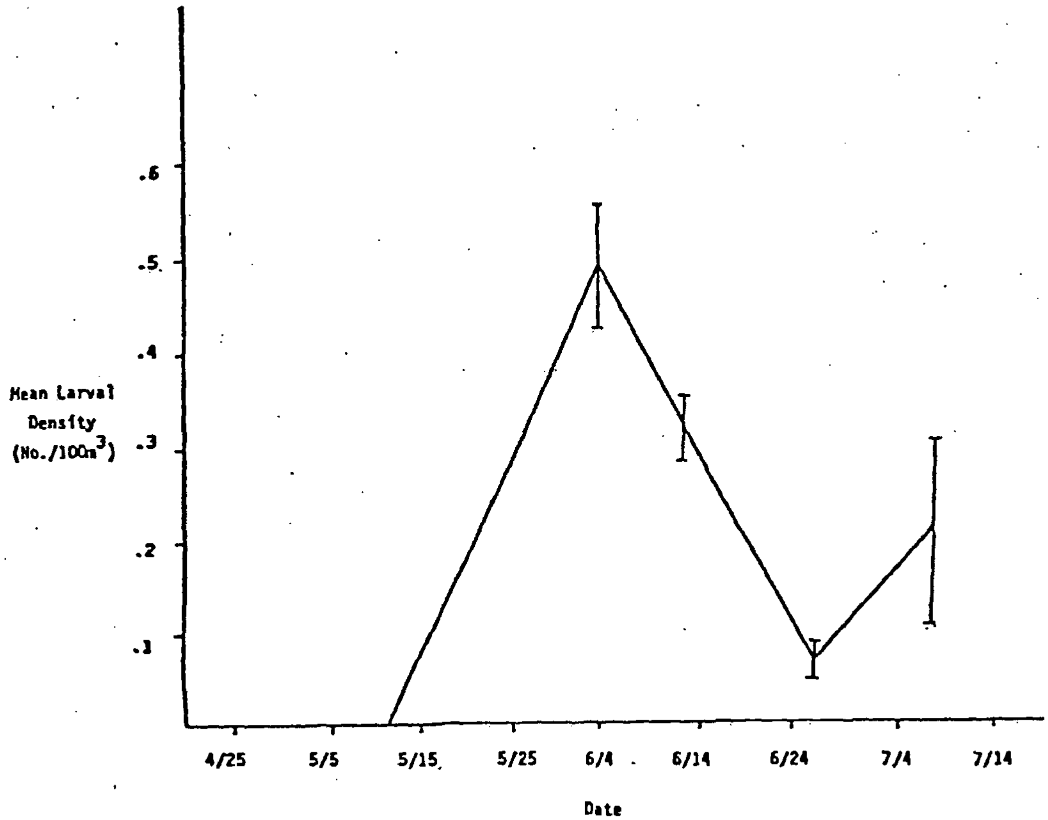


Figure 15. Mean Density of Spottail Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

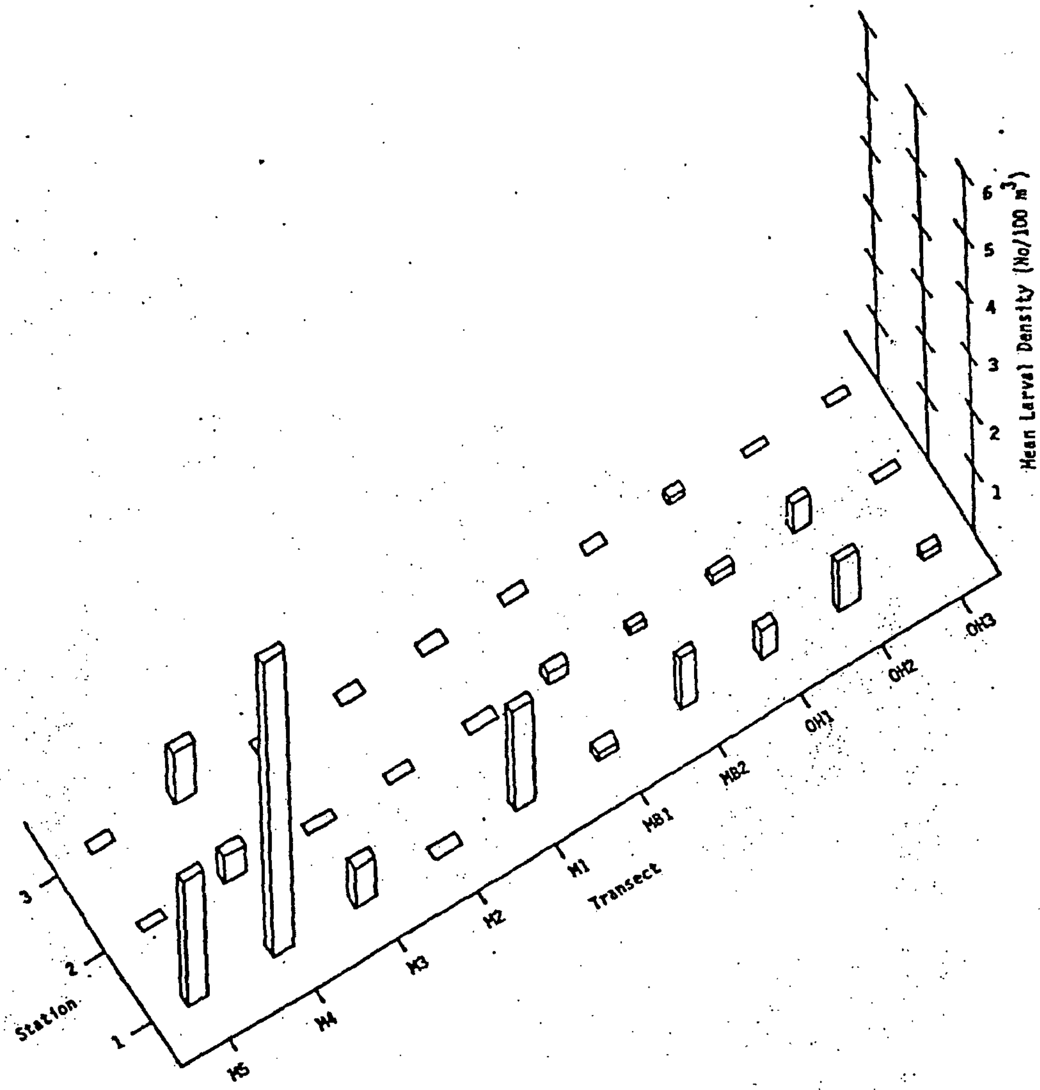


Figure 16. Western Basin - 1977.
Mean Density of Spottail Shiner Larvae at Each Station.

indicated significantly higher densities of spottails were found in the nearshore zone than offshore (81.4% of the total spottail catch was made in depth zone 1). Maximum density of spottail shiner sampled was 5.02 larvae per 100 m^3 at Station M4/1 on June 13 (Figure 16).

White Bass

With a basin-wide mean density of 7.85 larva per m^3, white bass were the fourth most abundant species captured in this study. White bass were first collected on May 22 and were collected during every sampling effort thereafter. Samples collected indicated peak densities of 29.5 white bass larvae per 100 m^3 occurred on June 13 (Figure 17).

Densities of larval white bass were found to be significantly greater in Maumee Bay than along either the Michigan or Ohio shorelines. Sixty-three percent of the total white bass catch was found in Maumee Bay (Kruskal-Wallis $\alpha = .05$). Friedman's Rank Sum Test ($\alpha = .01$) indicated lowest densities of white bass larvae were sampled at OH3 and M5 (Figure 18). No significant differences were detected between depth zones (Friedman's Rank Sum Test $\alpha = .05$). Maximum density of white bass sampled was 283.3 larvae per 100 m^3 on June 4 at Station MB1/1.

Yellow Perch

With a basin-wide mean density of 21.31 larvae per 100 m^3, yellow perch larvae were the most abundant commercial or sportfish larvae captured in this study. Yellow perch larvae were first captured on April 20 and were collected during every sampling effort thereafter. Samples collected indicated peak larval yellow perch densities of 87 per 100 m^3 occurred on May 2 (Figure 19).

No significant differences could be detected between larvae densities in Maumee Bay or along the Ohio and Michigan shoreline (Kruskal Wallis $\alpha = .05$). Friedman's Rank Sum Test could not detect significant differences between onshore and offshore densities of either pro-larvae or total number of perch larvae (i.e., pro- and post-larvae) but did indicate that larvae (combined pro- and post-larvae) densities were highest along the M2 and OH3 transects and lowest along the M5 and M3 transects (Figure 20). Pro-larvae densities were highest along transects M2 and M1 and lowest along transects A2, M3 and M5 (Figure 21). Maximum density of perch larvae (combined pro-and post-larvae) sampled was 665 larvae per 100 m^3, 380 of which were pro-larvae, at Station M2/1 on May 1.

Walleye

With a mean basin-wide density of 0.99 larvae per 100 m^3, walleye were the ninth most abundant larval species captured. Larval walleye were first collected on April 20 and were captured during the next three cruises. No walleye were found in samples collected after June 4. Samples collected indicated larval walleye densities were highest on May 1 with an average basin density of 4.6 larvae per 100 m^3 (Figure 22).

Statistical differences were detected, indicating walleye larvae densities were greater along the Ohio shoreline than in Maumee Bay or along

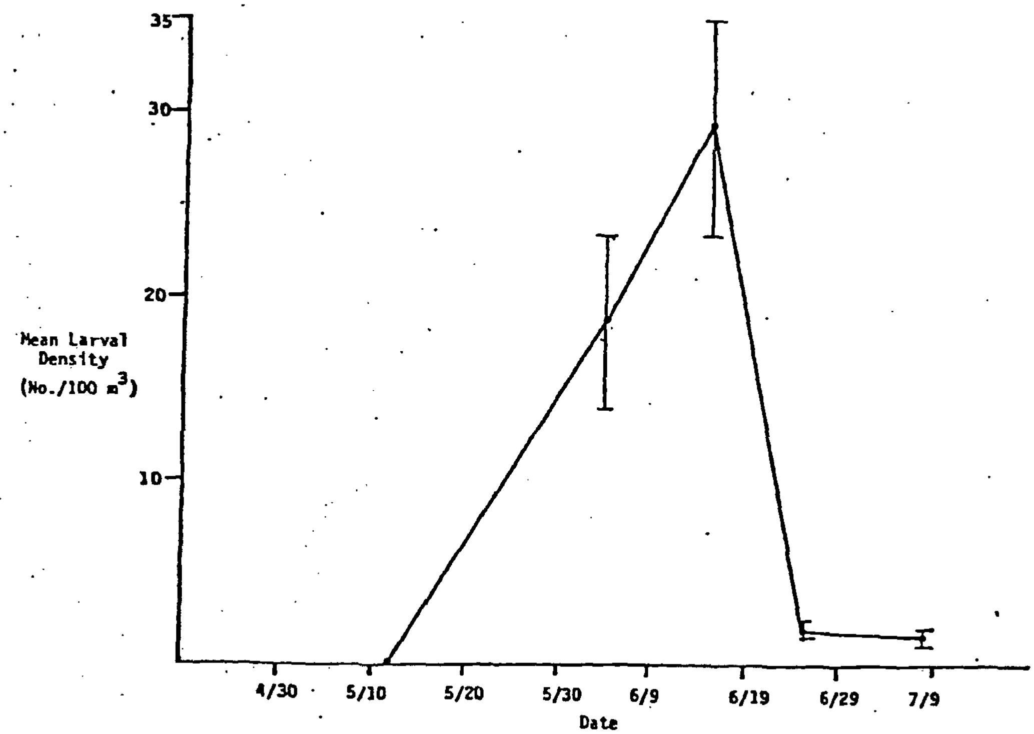


Figure 17. Mean Density of White Bass Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

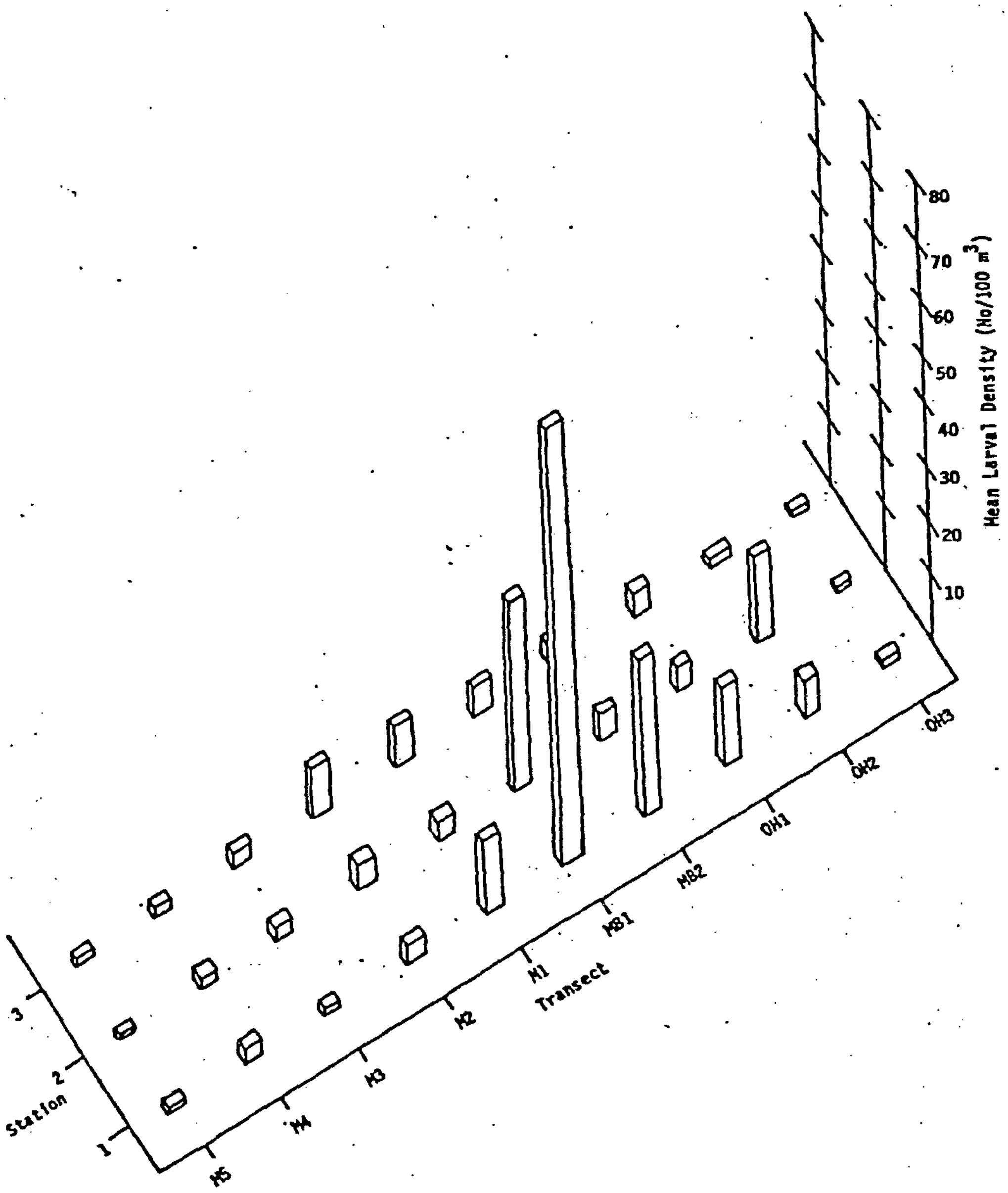


Figure 18. Western Basin - 1977.
Mean Density of White Bass Larvae at Each Station.

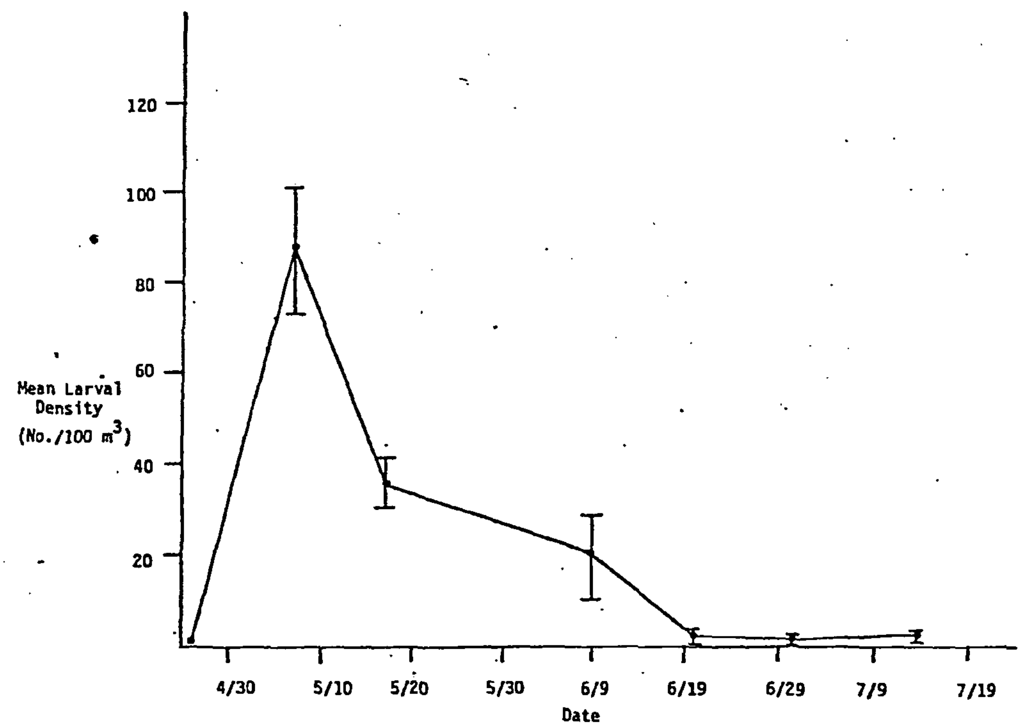


Figure 19. Mean Density of Yellow Perch Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

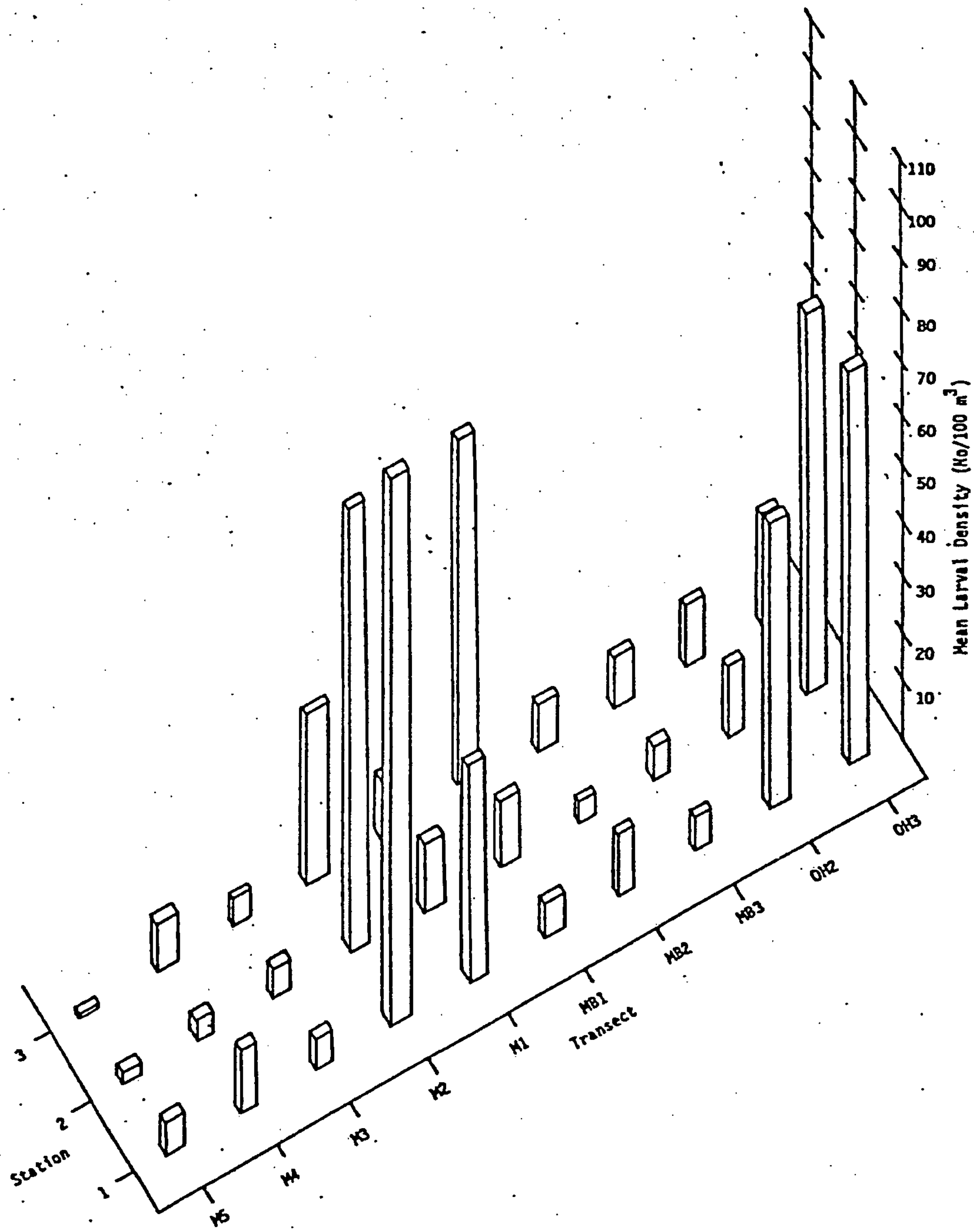


Figure 20. Western Basin - 1977.
Mean Density of Yellow Perch Larvae at Each Station.

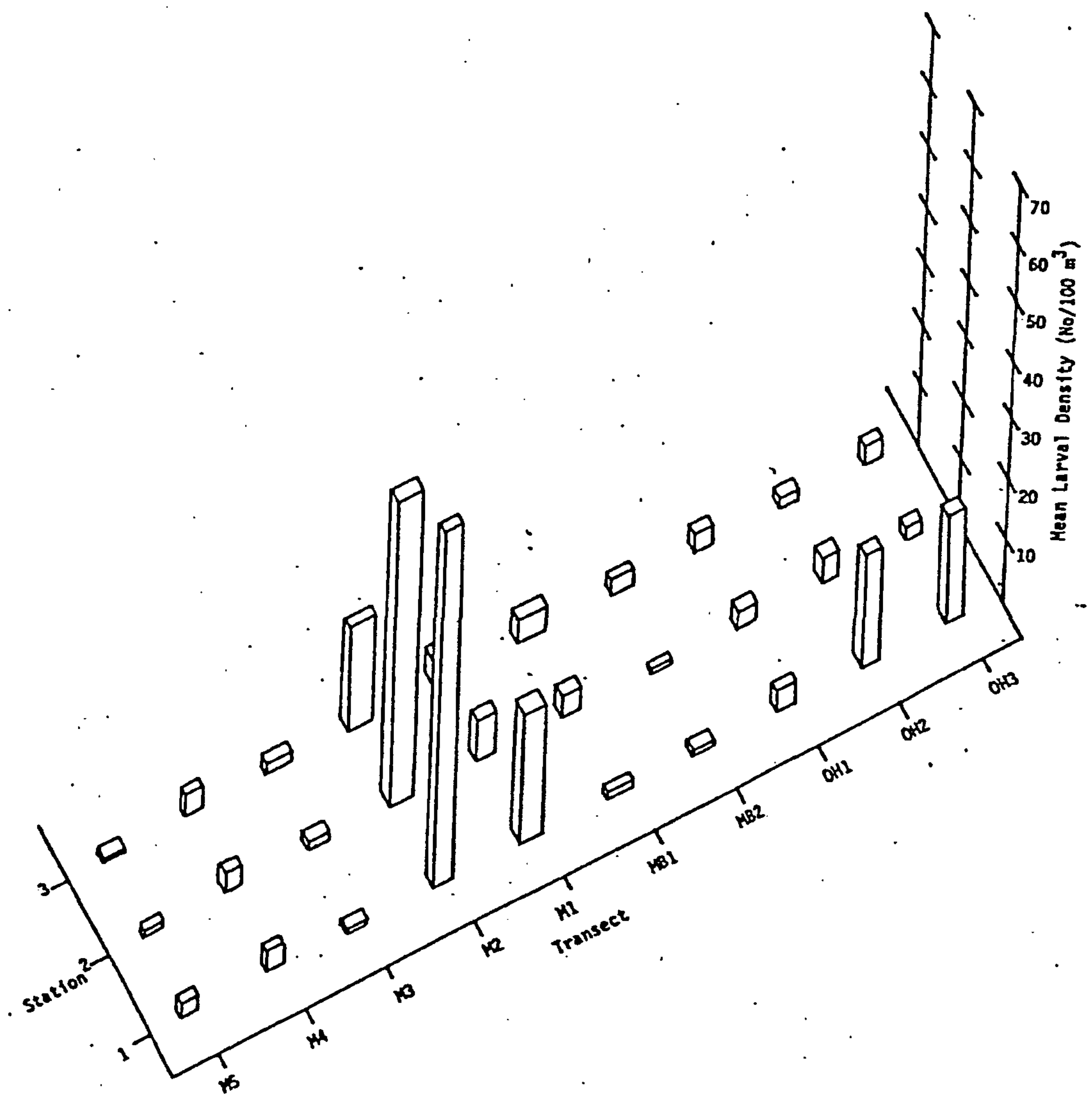


Figure 21. Western Basin - 1977.
Mean Density of Yellow Perch Pro-Larvae at Each Station.

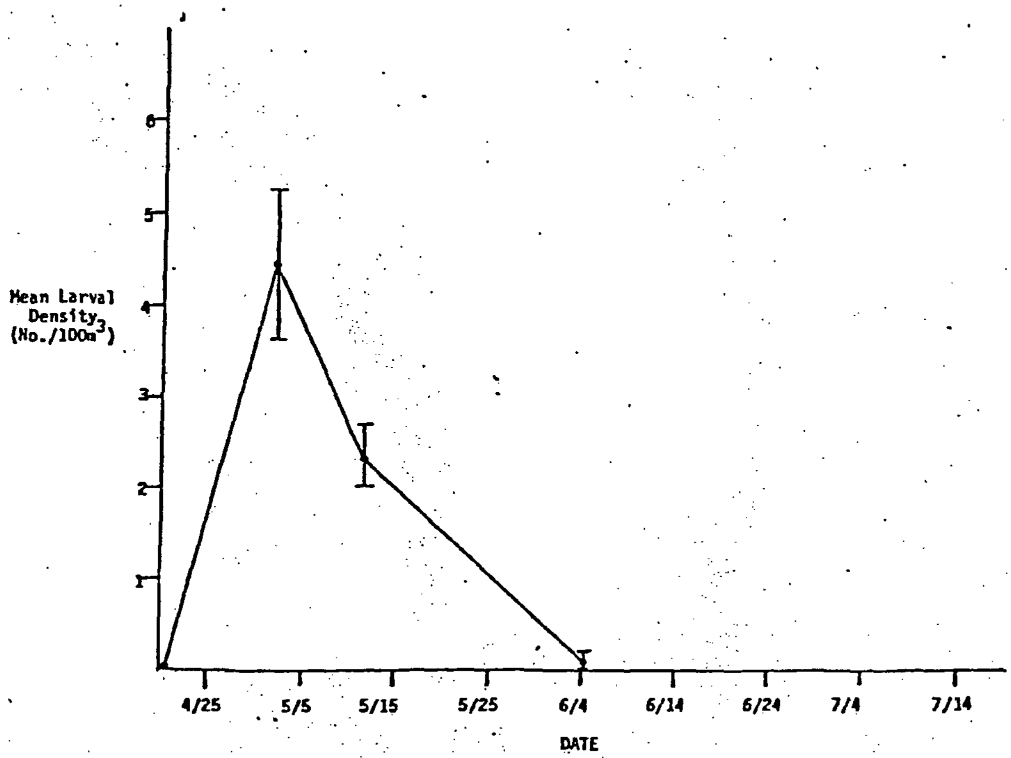


Figure 22. Mean Density of Walleye Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

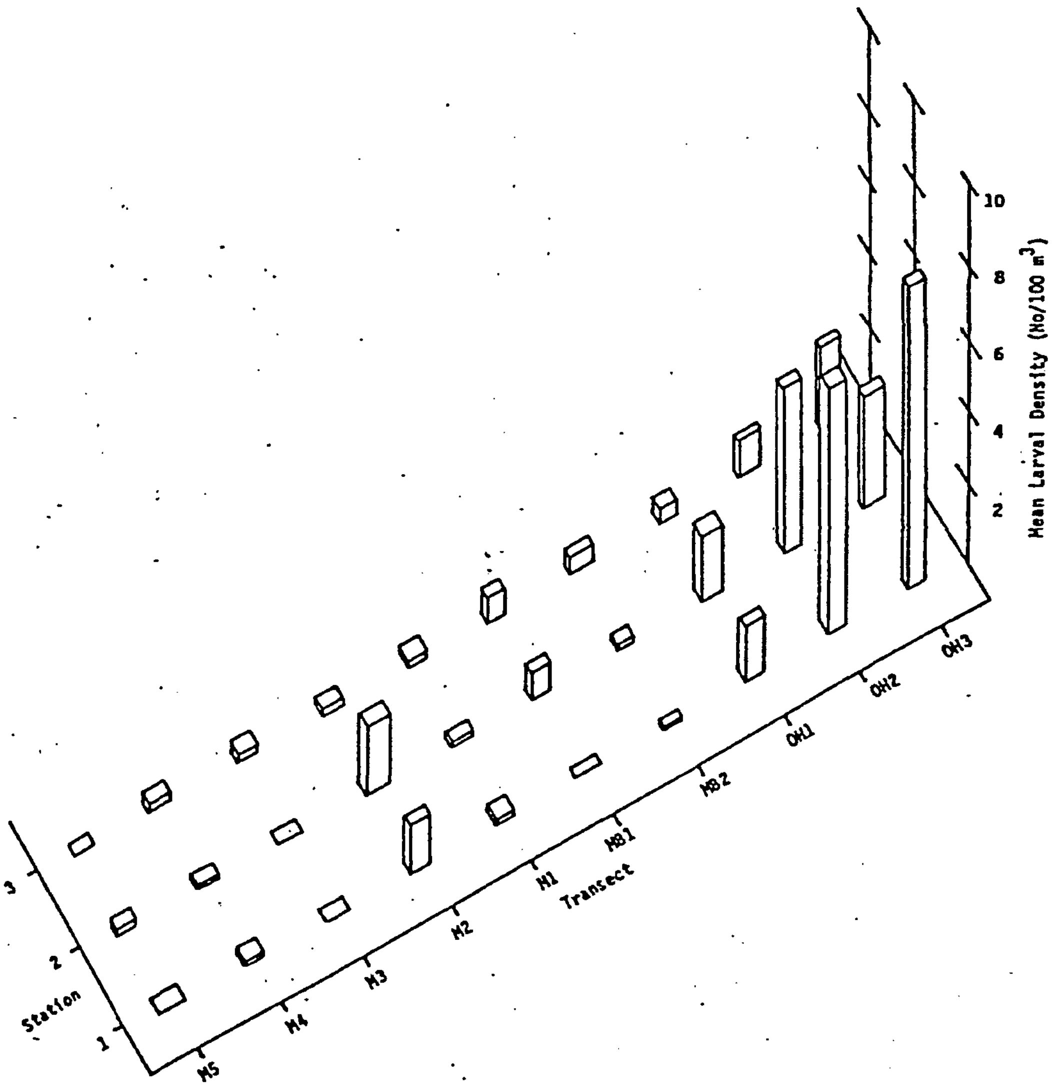


Figure 23. Western Basin - 1977.
Mean Density of Walleye Larvae at Each Station.

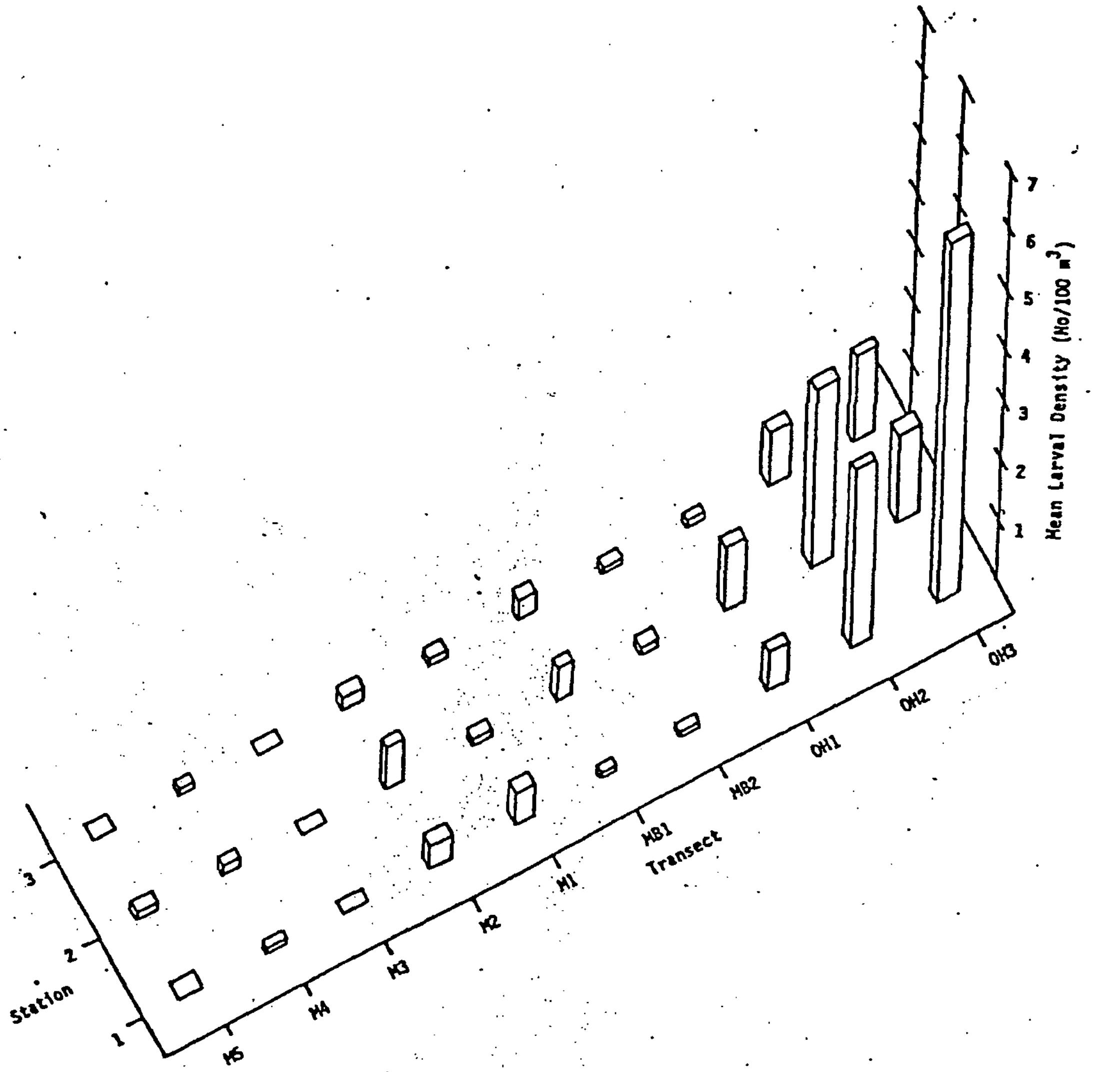


Figure 24. Western Basin - 1977.
Mean Density of Walleye Pro-Larvae at Each Station.

the Michigan shoreline for both larvae (pro- and post-larvae) and pro-larvae (Kruskal Wallis α=.05). No statistical differences between onshore and offshore densities were detectable. Friedman's Rank Sum test (α =.05, df=9) indicated that highest larvae and pro-larvae densities were found along transects OH3 and OH2 and lowest densities were along transects M3 and M5. Maximum densities of both pro-larvae (31 per 100 m^3) and larval walleye (38 per 100 m^3) were found at Station OH3/1. Figure 23 represents spatial distributions of larval walleye and Figure 24 represents spatial distributions of pro-larval walleye in the Western Basin in 1977.

Log Perch

With a basin-wide mean density of 1.43 larvae per 100 m^3, log perch were the seventh most abundant larval species captured in the Western Basin in 1977. Log perch larvae were first collected on April 30 and were collected during every sampling effort thereafter. Samples collected indicated average larval densities in the basin reached a maximum of 4.76 larvae per 100 m^3 on June 3 (Figure 25).

No statistical differences in density of logperch larvae were detectable between the three physiographic areas, onshore/offshore or between transects. Larval log perch densities were highest along transect M4 (40.8% of the total catch) and M5 (12% of the total catch) with a maximum density of 25.1 larvae per 100 m^3 sampled on June 15. Figure 26 represents spatial distributions of larval log perch in the Western Basin in 1977.

Freshwater Drum

With a basin-wide mean density of 1.76 larvae per 100 m^3, freshwater drum were the fifth most abundant species collected in the Western Basin in 1977. Drum larvae were first collected on June 3, with an average basin density of 3.2 larvae per 100 m^3; by June 10 the average basin density had dropped to 1.08 larvae per 100 m^3. Larval drum densities rose again reaching a maximum density of 5.6 larvae per 100 m^3 on July 7 (Figure 27).

Statistical differences in density of larvae were detected for the three physiographic areas (Kruskal Wallis α=.05) with highest densities found in Maumee Bay and lowest densities found along the Michigan shoreline. Friedman's Rank Sum test (α =.01) detected significant differences between highest densities of larval fishes found along transects MB2 and OH2 and lowest densities along transects M3 and M1. No statistical differences were detectable between onshore and offshore densities (Figure 28). Maximum density of drum sampled was 78.5 larvae per 100 m^3 at Station MB1/1 on July 7.

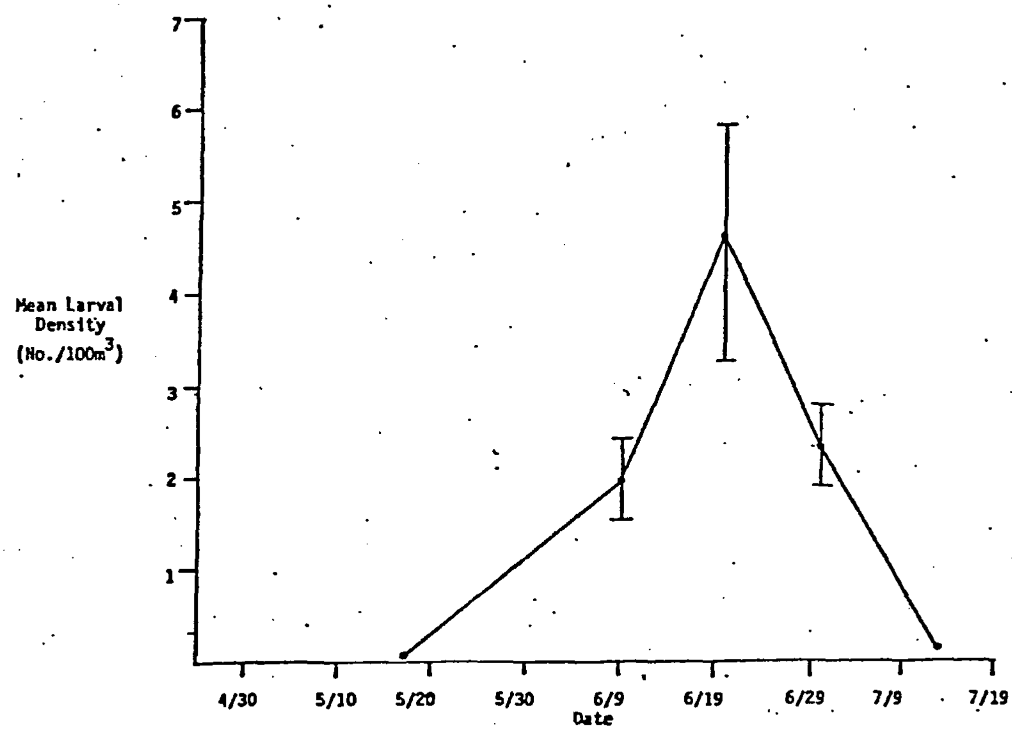


Figure 25. Mean Density of Log Perch Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

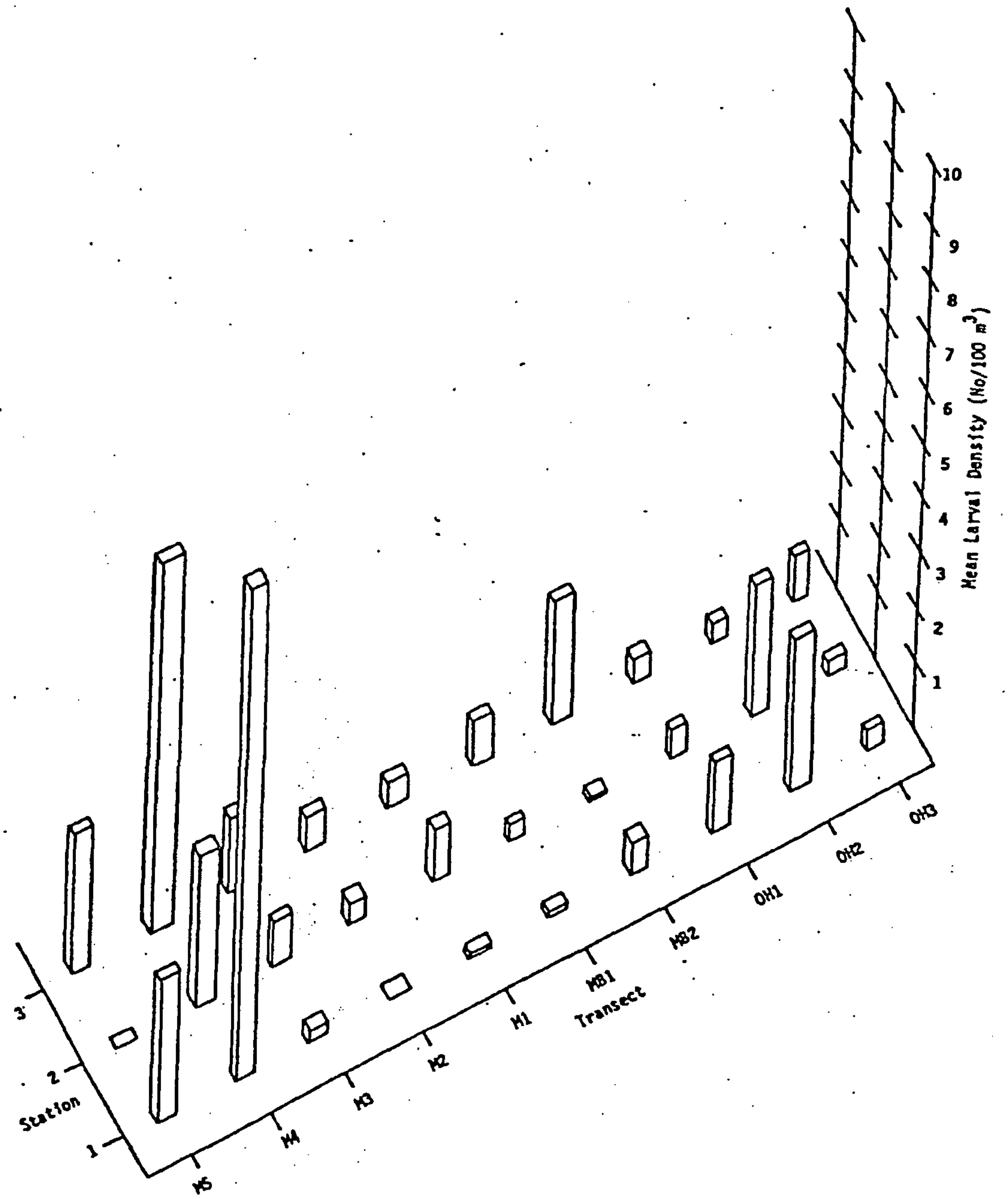


Figure 26. Western Basin - 1977.
Mean Density of Log Perch Larvae at Each Station.

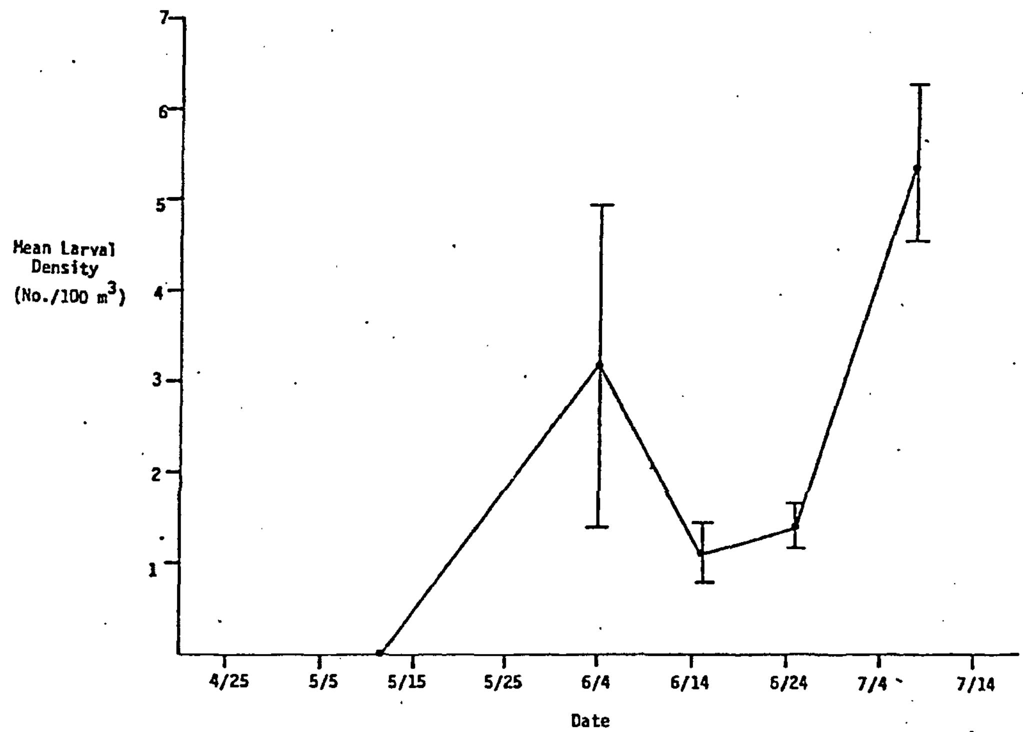


Figure 27. Mean Density of Freshwater Drum Larvae in the Western Basin During 1977. Distance between bars represents one standard error of the mean.

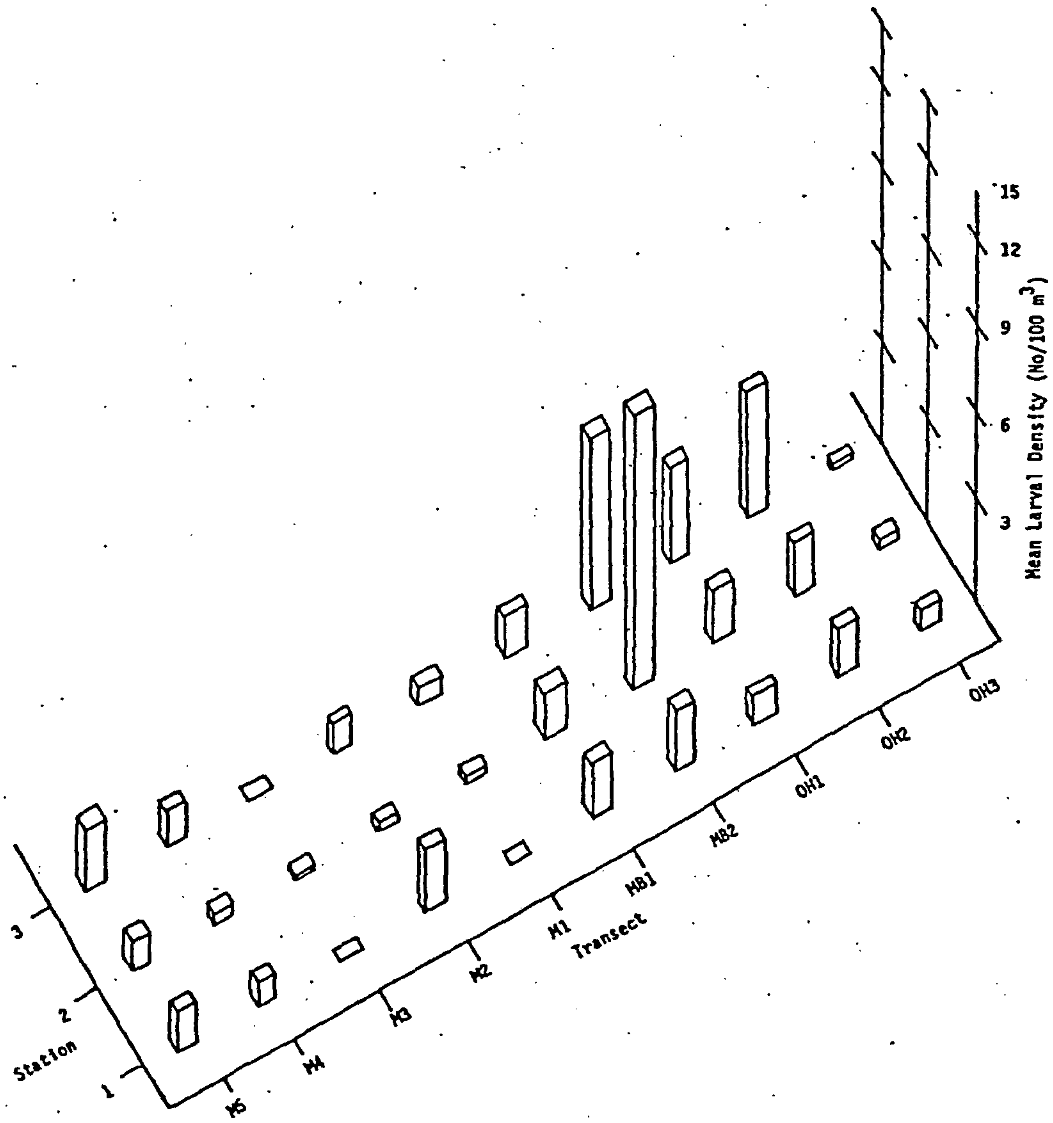


Figure 28. Western Basin - 1977.
Mean Density of Freshwater Drum Larvae at Each Station.

Central Basin

An intensive survey of the nearshore zone of the Central Basin in 1978 resulted in the collection of 28 taxa of larval fishes. Twenty-two species were identified representing 14 families and comprising 98.89% of the total catch; 1.03% were identified to genus or family level with only 0.08% remaining unidentified.

Nine species, emerald shiner, gizzard shad, spottail shiner, freshwater drum, rainbow smelt, carp, yellow perch, trout perch, and log perch were collected in numbers great enough (i.e., average basin-wide density .10/100 m^3) and occurred in samples often enough to be considered abundant. Johnny darter and mottled sculpin had average basin densities .10 per 100 m^3, .84 and .50 larvae per 100 m^3 respectively, but since the capture of these larvae was limited to a few stations the author does not consider them to have been abundant in the Central Basin in 1978. Table 14 lists the average densities for the entire sampling period and percentages of the total catch represented by each taxon for the entire Central Basin.

Volume weighted estimates of total larval abundance are presented in Table 15. Volume weighted estimates differ from relative abundance of catch. Emerald shiners represent a large percentage of the total larval abundance, 54%, than relative abundance, 34%. Clupeid larvae and spottail shiner, although still ranked second and third each represent a smaller percentage of the total abundance than relative catch. Drum larvae, the fourth most abundant larvae captured, representing 4.21% of the total catch, is ranked eighth in relative abundance, comprising only 1.35% of total larval abundance.

A detailed description of the spatial and temporal distributions of the nine abundant larval species captured in the Central Basin follows. Station locations as referred to in the following can be found in Figure 29.

<u>Clupeids (Gizzard Shad/Alewife)</u>

With a mean basin density of 28.42 larvae per 100 m^3, clupeid larvae were the second most abundant larval species captured. Larval clupeids were first collected on May 25 and were captured during every sampling effort thereafter. Samples collected indicated larval gizzard shad were most abundant on June 19 (Figure 30).

The highest densities of larval clupeids were collected west of Cleveland with over 60% of the catch occurring along transects 3 and 4 (Figure 31). Friedman's Rank Sum Test (α =.05, df=9) detected significant differences between transects 3 and 4 and transect 7, where the lowest densities were found, and (α=.05, df=2) identified the mid-depth zone as having the lowest densities of larval gizzard shad and depth zone 1 as having the highest densities. Maximum density of gizzard shad sampled was 437 larvae per 100 m^3 at Station 3/1 on July 17.

Rainow Smelt

With an average density of 3.40 larvae per 100 m^3 smelt were the fifth most abundant larvae captured in the Central Basin in 1978. Smelt larvae were first captured on May 20 and were captured during every sampling effort thereafter. Samples collected indicated smelt densities reached their maximum on July 5 with an average basin density of 14.6 larvae per 100 m^3 (Figure 32).

Although 72% of smelt larvae were captured offshore, Friedman's Rank Sum Test (α=.05, df=2) was unable to detect statistical differences between onshore and offshore densities of smelt larvae. The majority of smelt larvae were captured west of Cleveland with transects 1-4 contributing to 68.25% of the smelt catch (Figure 33). No statistical differnces were detectable for differences in densities of larvae between transects. Maximum density of smelt sampled was 100.1 larvae per 100 m^3 at Station 3/2 on July 5.

Carp/Goldfish and their Hybrids

With a mean basin density of 2.58 larvae per 100 m^3 carp larvae were the sixth most abundant larval fish captured. Carp larvae were first captured on May 24 and were found in samples collected during each sampling effort thereafter. Samples collected indicated carp densities were highest on July 6 with a mean basin density of 11.3 larvae per 100 m^3 (Figure 34).

Friedman's Rank Sum Test (α =.01, df=2) detected statistical differences between onshore and offshore densities. 89% of the total number of carp larvae captured occurred in depth zone 1 (Figure 35). Although 62% of the carp larvae were captured along transect 9, no statistical differences in densities could be detected between transects. Maximum density of carp larvae sampled was 269 larvae per 100 m^3 at Station 9/1 on July 8.

Emerald Shiner

Emerald shiner larvae were the most abundant larval fish species collected in the Central Basin in 1978. Emerald shiner larvae were first captured on June 16 and were captured during every sampling effort thereafter. Emerald shiner larvae were most abundant in samples collected on July 21, with a calculated basin-wide average of 195 larvae per 100 m^3 (Figure 36).

Emerald shiner larvae were most abundant along the shoreline east of Cleveland with 76.5% of the total emerald catch made between transects 1 and 4. Lowest emerald shiner densities were found in the Cleveland area, transects 5 and 6 (Figure 37). Friedman's Rank Sum Test (α=.05, df=9) detected significant differences between areas of highest densities along transect 3 and areas of lowest larval density along transects 5 and 6. No significant differences were detected between onshore and offshore densities. Maximum density of emerald shiner sampled was 2329 per 100 m^3 at Station 3/3 on July 21.

TABLE 14. RELATIVE ABUNDANCE OF LARVAL FISHES CAPTURED ALONG THE OHIO SHORELINE OF THE CENTRAL BASIN IN 1978

SPECIES	AVERAGE DENSITY	PERCENTAGE OF TOTAL CATCH
Emerald Shiner	32.30	34.28
Gizzard Shad/Alewife	28.42	30.53
Spottail Shiner	16.37	17.58
Freshwater Drum	3.92	4.21
Rainbow Smelt	3.40	3.66
Carp	2.85	3.06
Yellow Perch	1.25	1.34
Trout Perch	1.00	1.01
Johnny Darter	0.80	0.84
Log Perch	0.74	0.79
Mottled Sculpin	0.47	0.50
Cyprinidae	0.46	0.48
Notropis sp.	0.25	0.26
Percidae	0.20	0.21
Unidentified Larvae	0.07	0.08
Lepomis sp.	0.07	0.06
Striped Shiner	0.06	0.06
White Sucker	0.05	0.04
Walleye	0.04	0.04
White Bass	0.03	0.03
Rock Bass	0.02	0.03
Burbot	0.02	0.03
Golden Shiner	0.02	0.02
Pomoxis sp.	0.01	0.02
Sauger	0.01	0.02
Quillback Carpsucker	0.01	< 0.01
Black Crappie	0.01	< 0.01
Smallmouth Bass	0.01	< 0.01

[1]Average density found by dividing the sum of the calculated densities by the number of samples collected during the period of larval occurrence.

Species ranked in descending order of average density.

TABLE 15. VOLUME WEIGHTED ESTIMATES OF TOTAL PRODUCTION OF LARVAL FISHES IN THE NEARSHORE ZONE OF THE CENTRAL BASIN IN 1978

SPECIES	VOLUME WEIGHTED TOTAL	% OF TOTAL ABUNDANCE[1]
Emerald Shiner	4.28×10^{9}	54.14
Gizzard Shad/Alewife	1.51×10^{9}	19.07
Spottail Shiner	8.32×10^{8}	10.53
Rainbow Smelt	4.28×10^{8}	5.42
Carp	1.26×10^{8}	1.59
Johnny Darter	1.12×10^{8}	1.40
Yellow Perch	1.09×10^{8}	1.38
Freshwater Drum	1.07×10^{8}	1.36
Cyprinidae spp.	1.04×10^{7}	1.23
Trout Perch	9.75×10^{7}	1.00
Mottled Sculpin	5.89×10^{7}	0.68
Log Perch	5.23×10^{7}	0.66
Percidae spp.	3.40×10^{7}	0.44
Black Crappie	2.16×10^{7}	0.27
Pomoxis spp.	1.43×10^{6}	0.18
Striped Shiner	7.65×10^{6}	0.10
Walleye	5.69×10^{6}	0.07
Burbot	2.58×10^{6}	0.03
White Bass	1.92×10^{6}	0.02
Lepomis spp.	1.89×10^{6}	0.02
White Sucker	1.65×10^{6}	0.02
Sauger	1.14×10^{6}	0.01
Quillback Carpsucker	5.55×10^{5}	<0.01
Golden Shiner	2.67×10^{5}	<0.01
Greenside Darter	2.59×10^{5}	<0.01
Total	7.90×10^{10}	

[1]Species ranked in descending order of abundance.

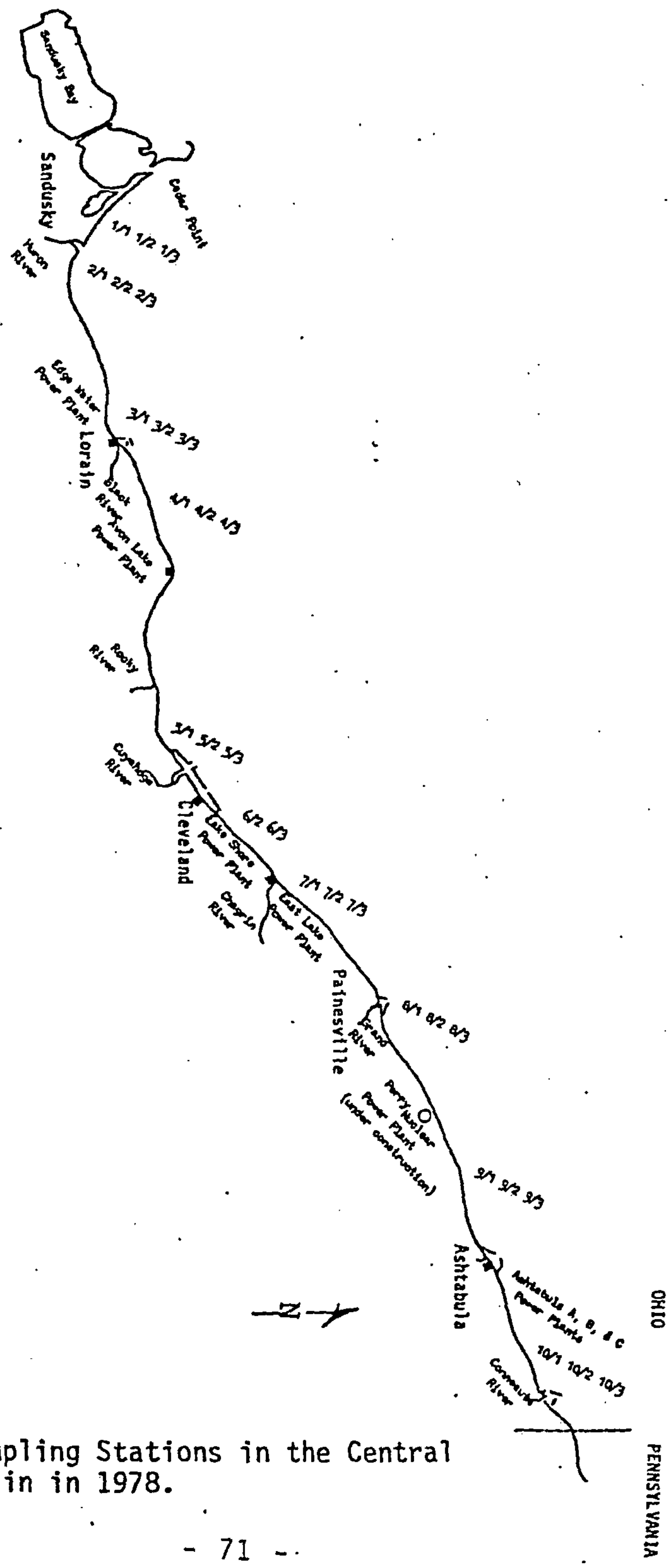


Figure 29. Sampling Stations in the Central Basin in 1978.

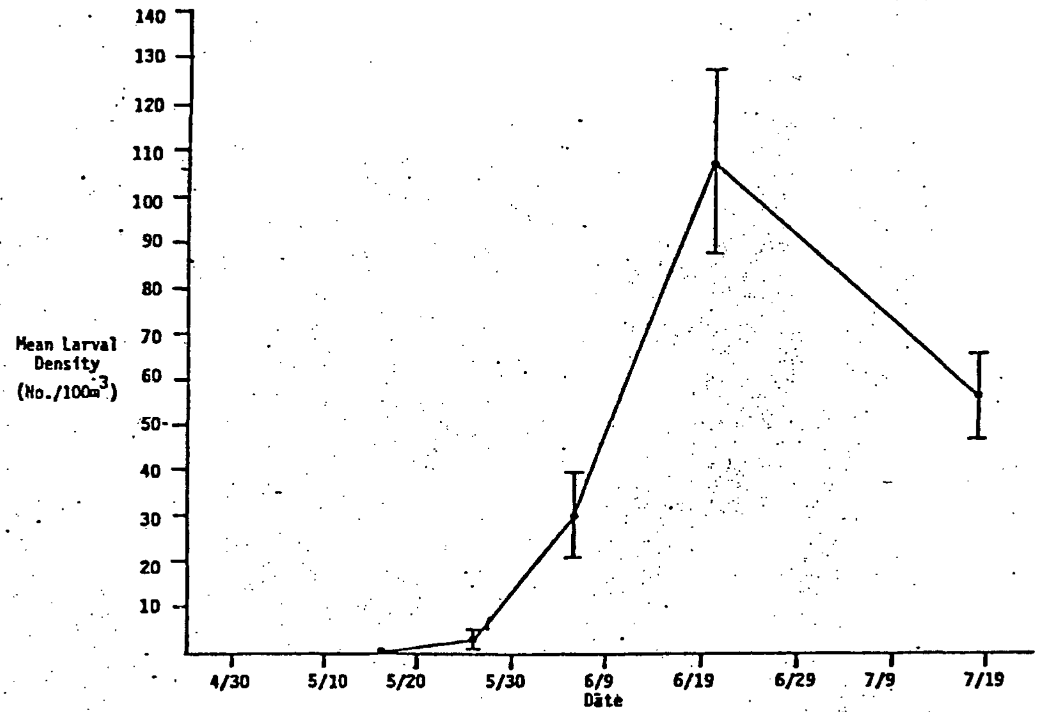


Figure 30. Mean Density of Clupeid Larvae in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

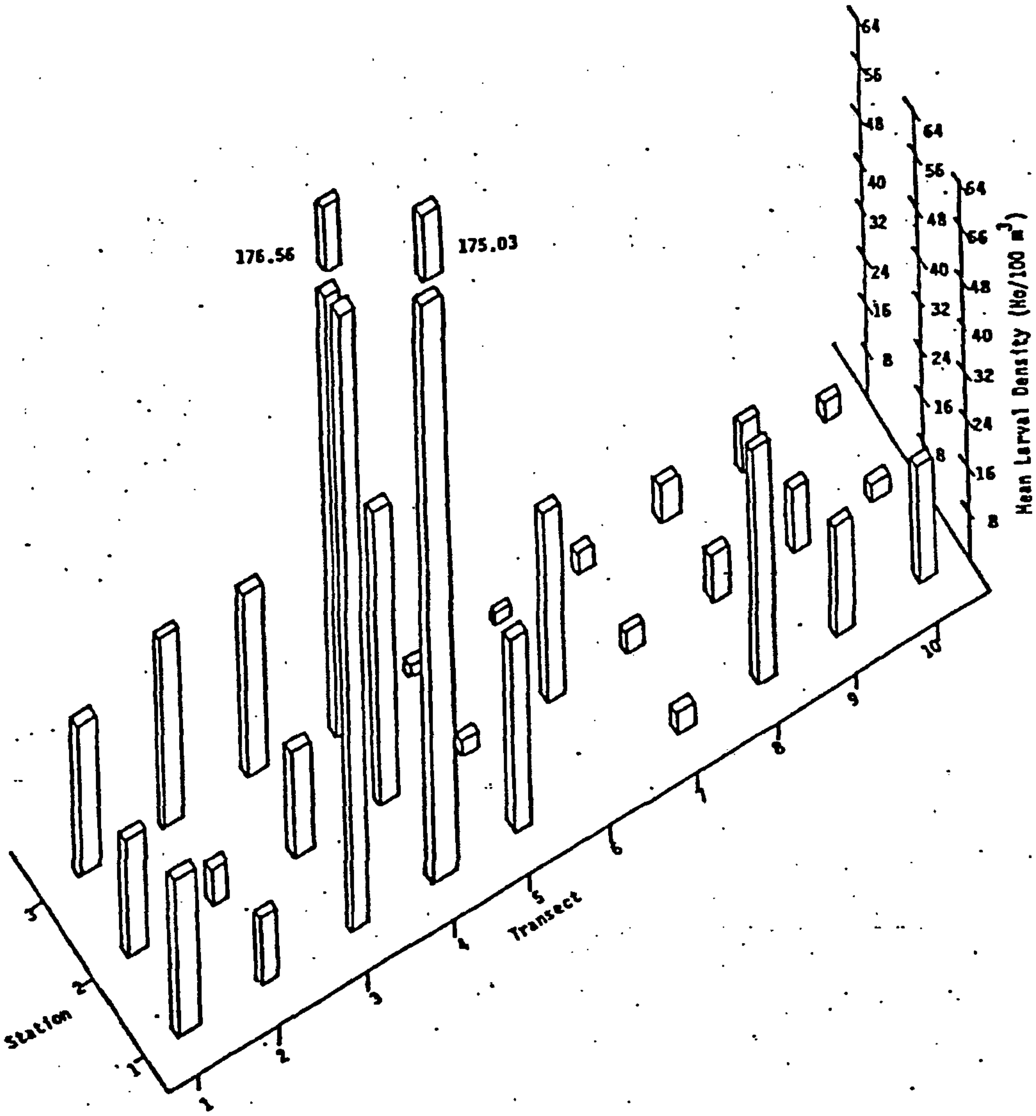


Figure 31. Central Basin - 1978.
Mean Density of Clupeid Larvae at Each Station.

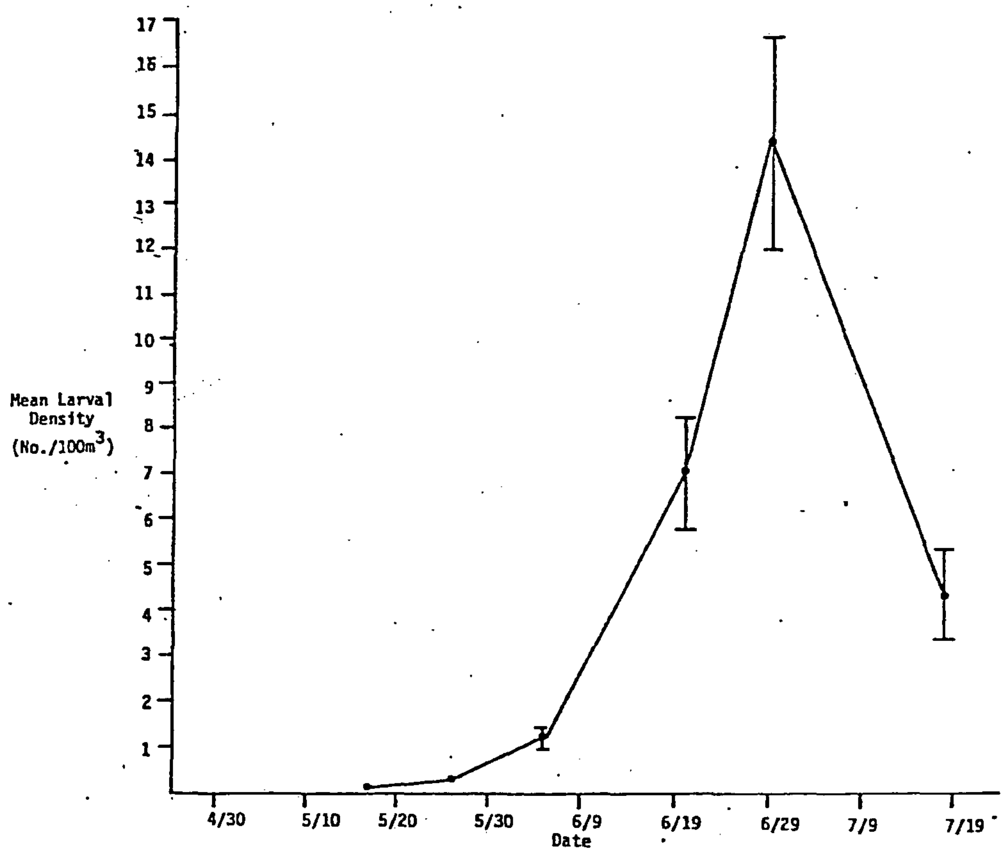


Figure 32. Mean Density of Smelt Larvae in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

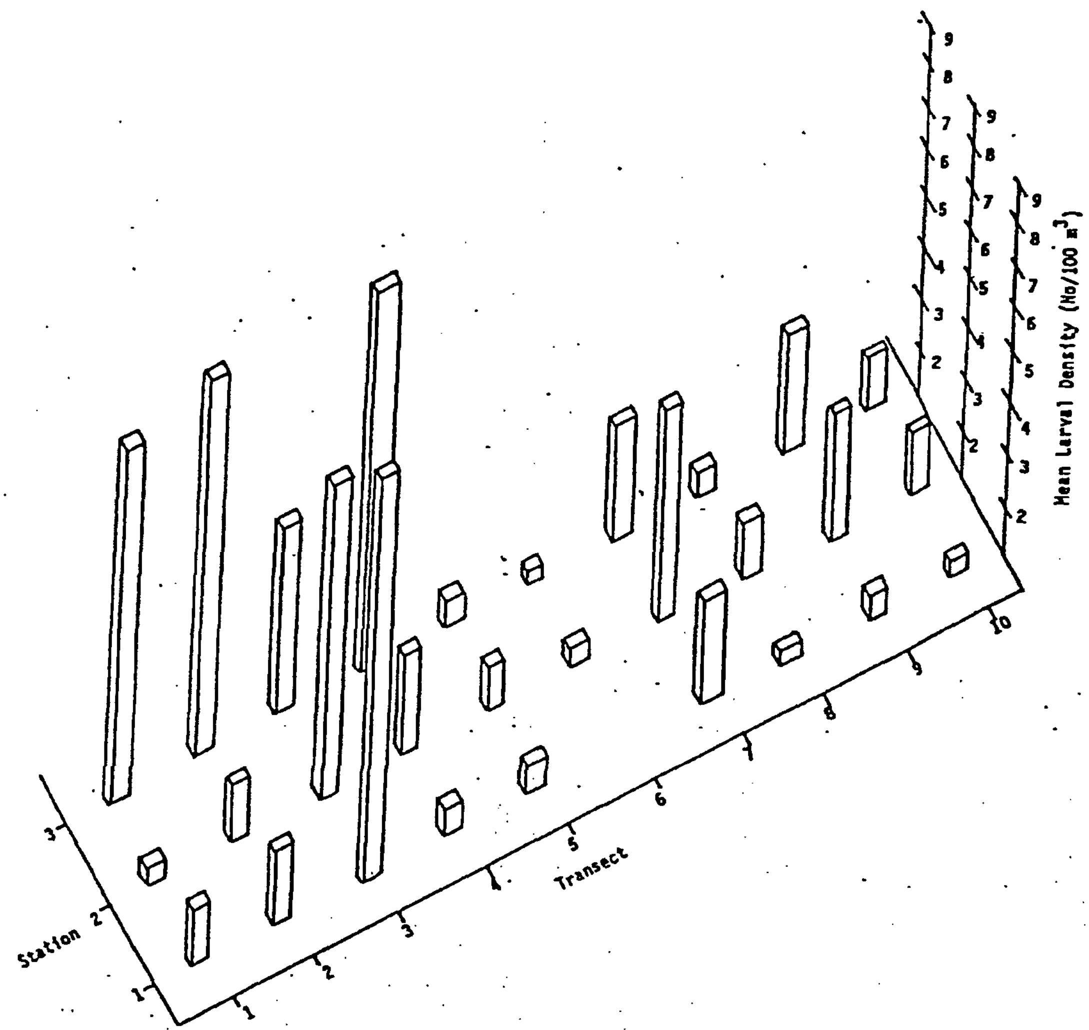


Figure 33. Central Basin - 1978.
Mean Density of Rainbow Smelt Larvae at Each Station.

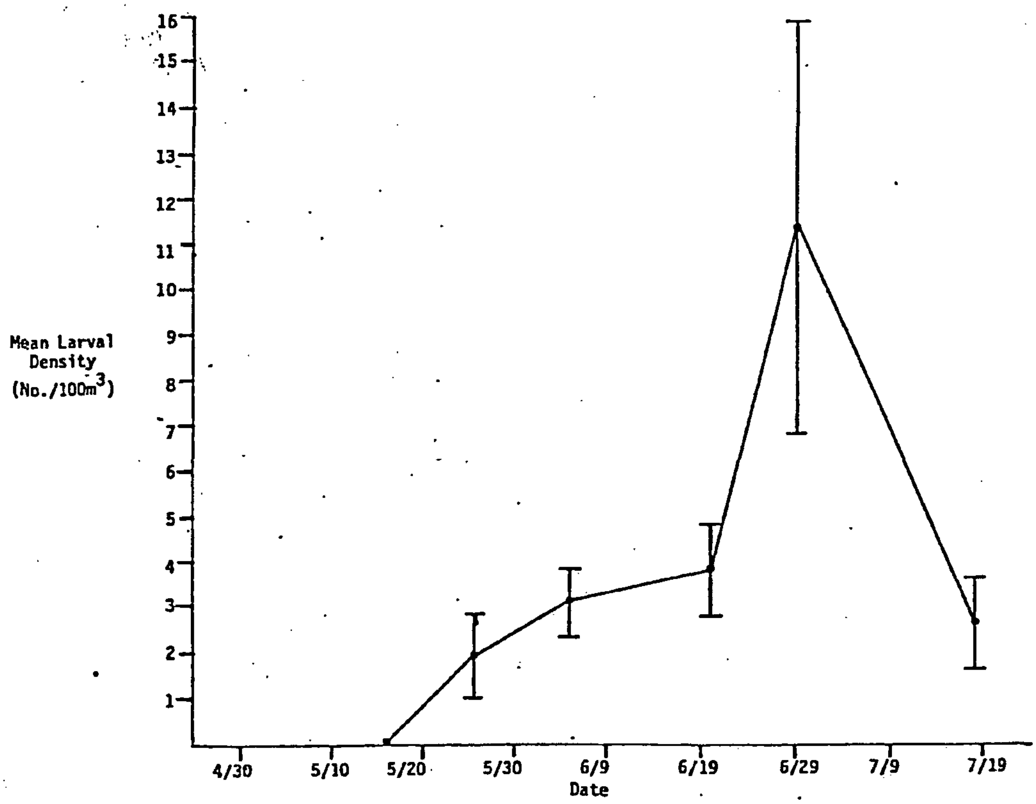


Figure 34. Mean Density of Carp Larvaé in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

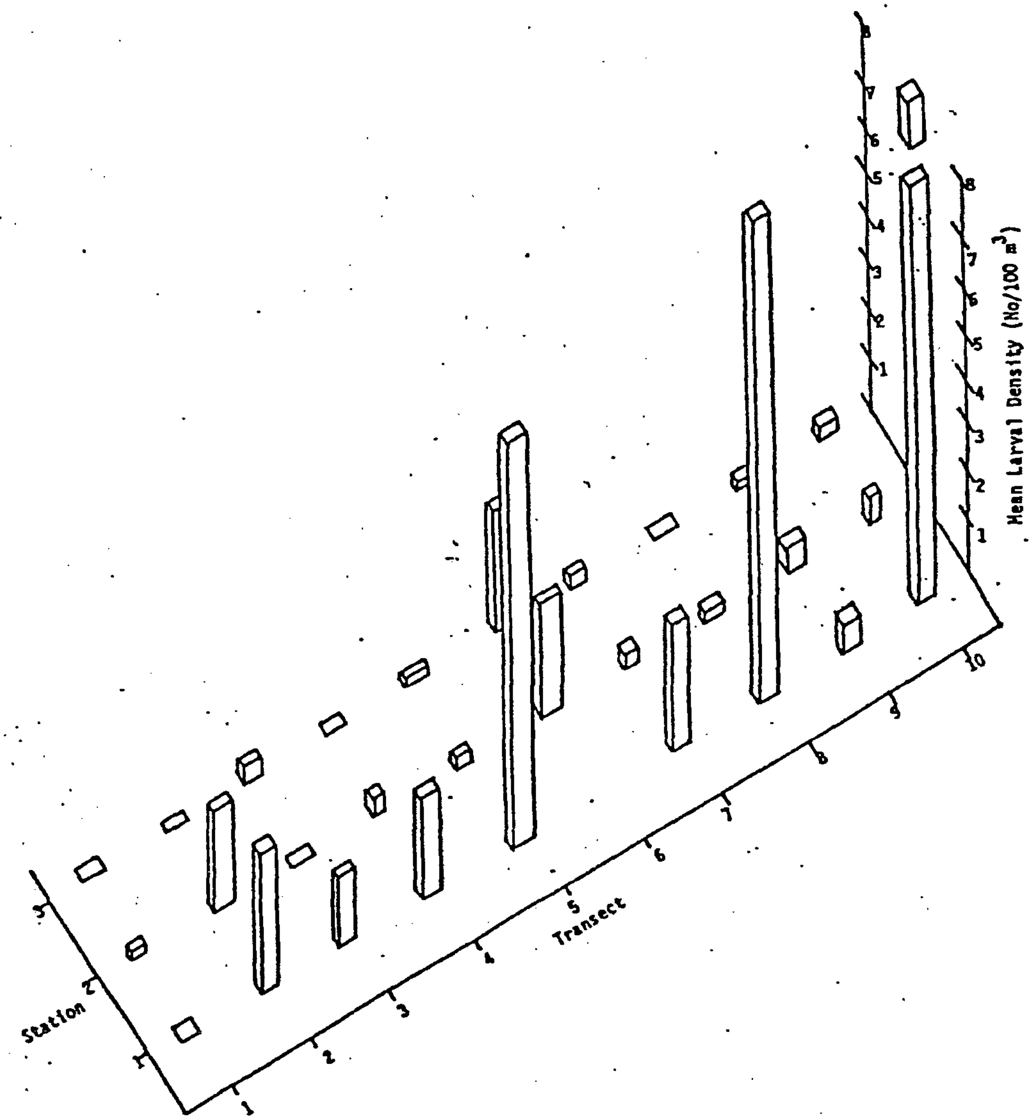


Figure 35. Central Basin - 1978.
Mean Density of Carp Larvae at Each Station.

Spottail Shiner

With a basin-wide average density of 16.37 larvae per 100 m^3, spottail shiner larvae were the third most abundant species captured in the Central Basin in 1978. Spottails were first captured on July 16 and were captured during every sampling effort thereafter. Samples indicated maximum density of spottails occurred on June 27 with a basin-wide average density of 54 larvae per 100 m^3 (Figure 38).

Friedman's Rank Sum Test (α=.01, df=2) indicated significantly more larvae wre captured at the nearshore stations than the midway or offshore stations. Ninety-four percent of the total spottail catch was made in depth zone 1. Significant differences were also detected between areas of highest, along transects 8, 9, and 10, and lowest larval densities along transects 2 and 6 (α=.05, df=9), (Figure 39). Maximum larval density sampled was 1168 larvae per 100 m^3 at Station 9/1 on July 21.

Trout Perch

With an average basin-wide density of 1.0 larvae per 100 m^3, trout perch were the eighth most abundant larval species captured in the Central Basin in 1978. Larval trout perch were first captured on May 23 and were captured during every sampling effort thereafter. Samples collected indicate larval densities of trout perch were highest on June 11 with a basin-wide mean larval density of 11.75 larvae per 100 m^3 (Figure 40).

Very few larval trout perch were captured west of Cleveland with 83.3% of the total trout perch catch coming from transects 8, 9, and 10 (Figure 41). Friedman's Rank Sum Test (α=.01, df=9) indicated densities along transects 8, 9, 10 to be significantly greater than those along 1, 4, and 5. Seventy-four percent of the total trout perch were captured in the first depth zone. Friedman's test (α=.05, df=2) indicated onshore densities were greater than offshore densities. Maximum density of trout perch sampled was 45.6 larvae per 100 m^3 at Station 8/1 on May 23.

Yellow Perch

With an average basin-wide density of 1.25 larvae per 100 m^3 yellow perch were the seventh most abundant species captured in the Central Basin in 1978. Yellow perch larvae were first captured on May 11 and were captured during every sampling effort thereafter. Samples collected indicated yellow perch larvae densities were highest at 6.2 larvae per 100 m^3 on June 19 (Figure 42).

Eighty-seven percent of the total number of yellow perch larvae captured were pro-larvae. Friedman's Rank Sum Test (α=.01, df=2) indicated significantly higher numbers of yellow perch larvae were captured in depth zone 1 than in depth zones 2 or 3 (77% of the total larvae catch was made in depth zone 1). Although transects 8, 9, and 10 accounted for 19, 20 and 29% of the total pro-larvae captured and 16, 20 and 23% of the total number of yellow perch larvae captured, no significant differences in larvae densities could be detected between transects (Friedman's Rank Sum, α =.05, df=9). Figures 43 and 44 graphically demonstrate the spatial distributions of pro-larvae and larval yellow

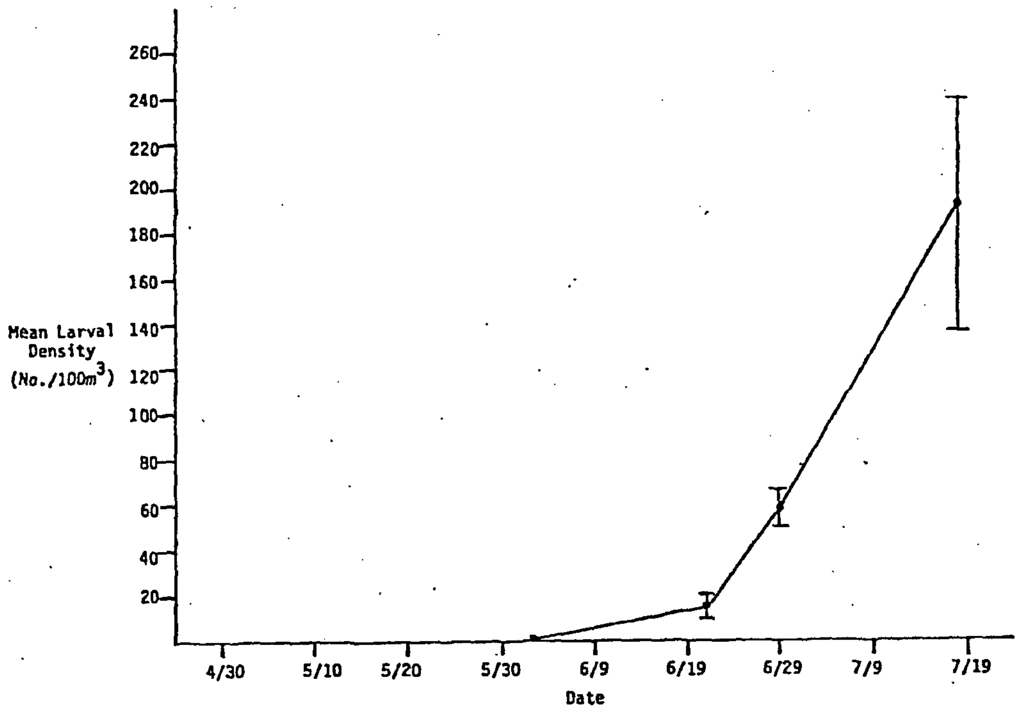


Figure 36. Mean Density of Emerald Shiner Larvae in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

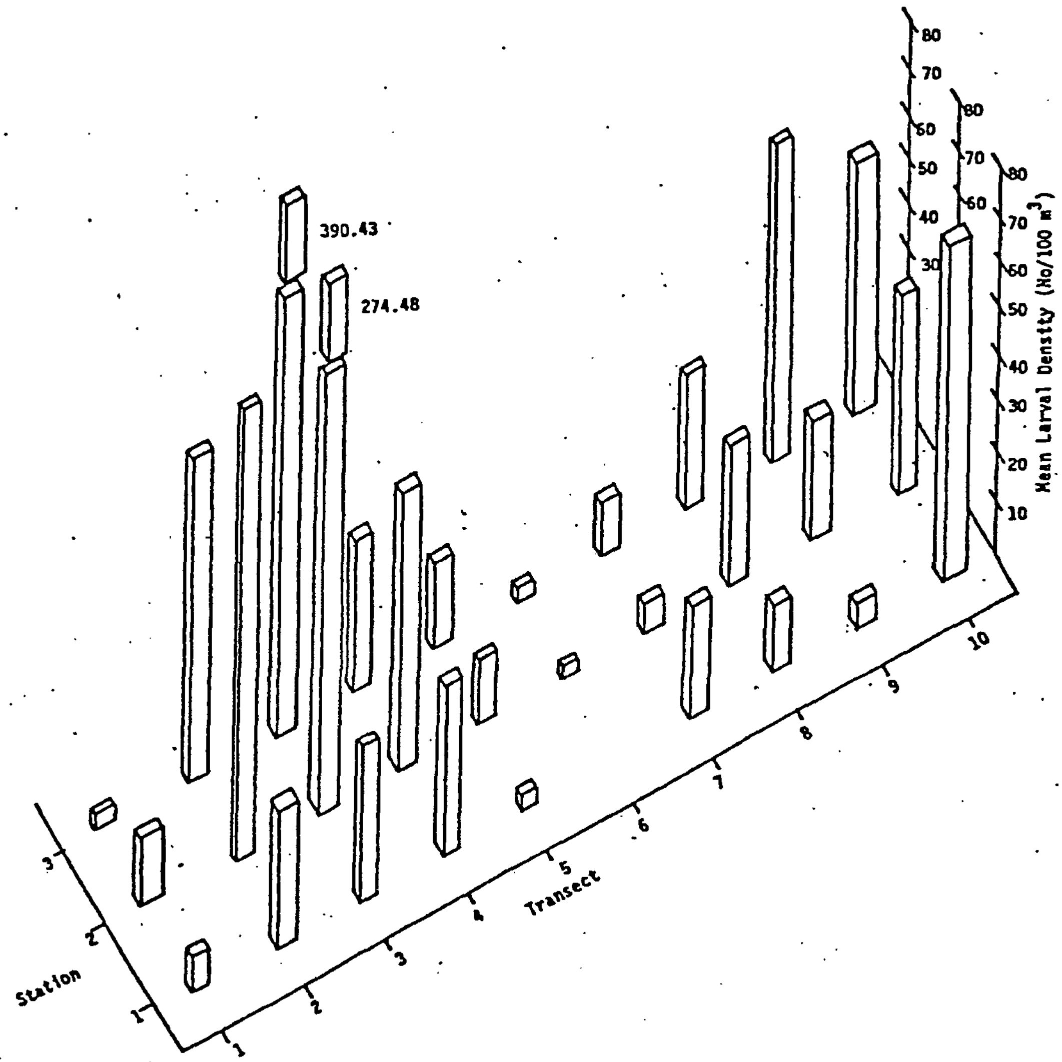


Figure 37. Central Basin - 1978.
Mean Density of Emerald Shiner Larvae at Each Station.

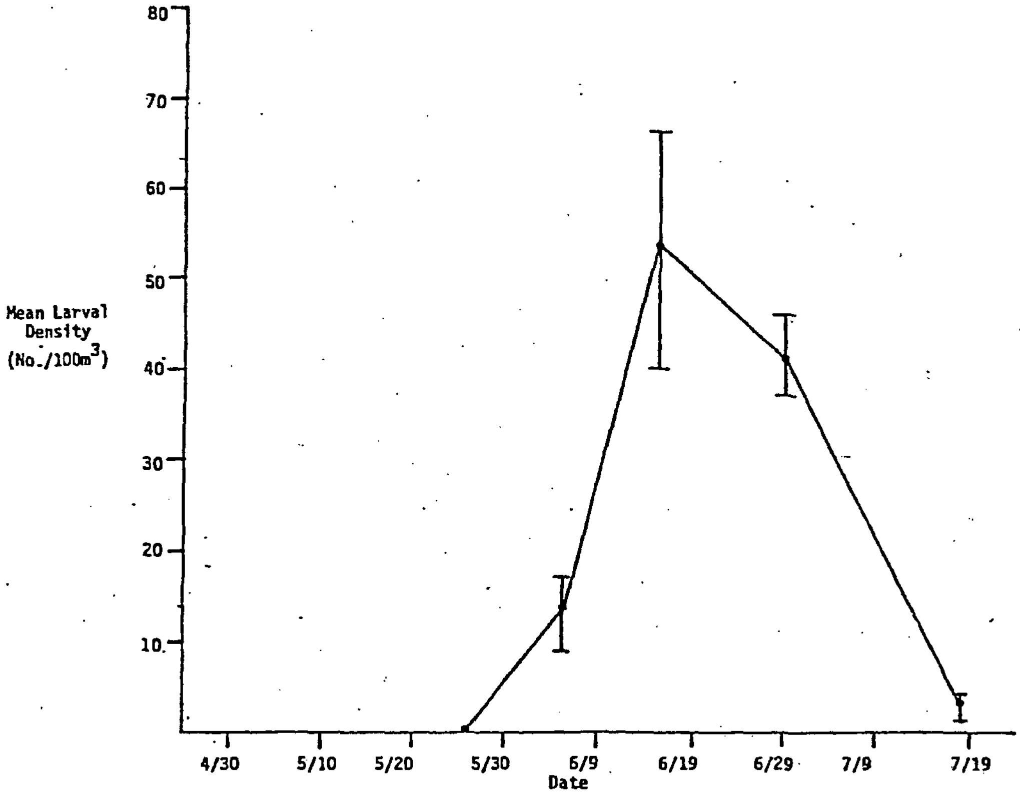


Figure 38. Mean Density of Spottail Shiner Larvae in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

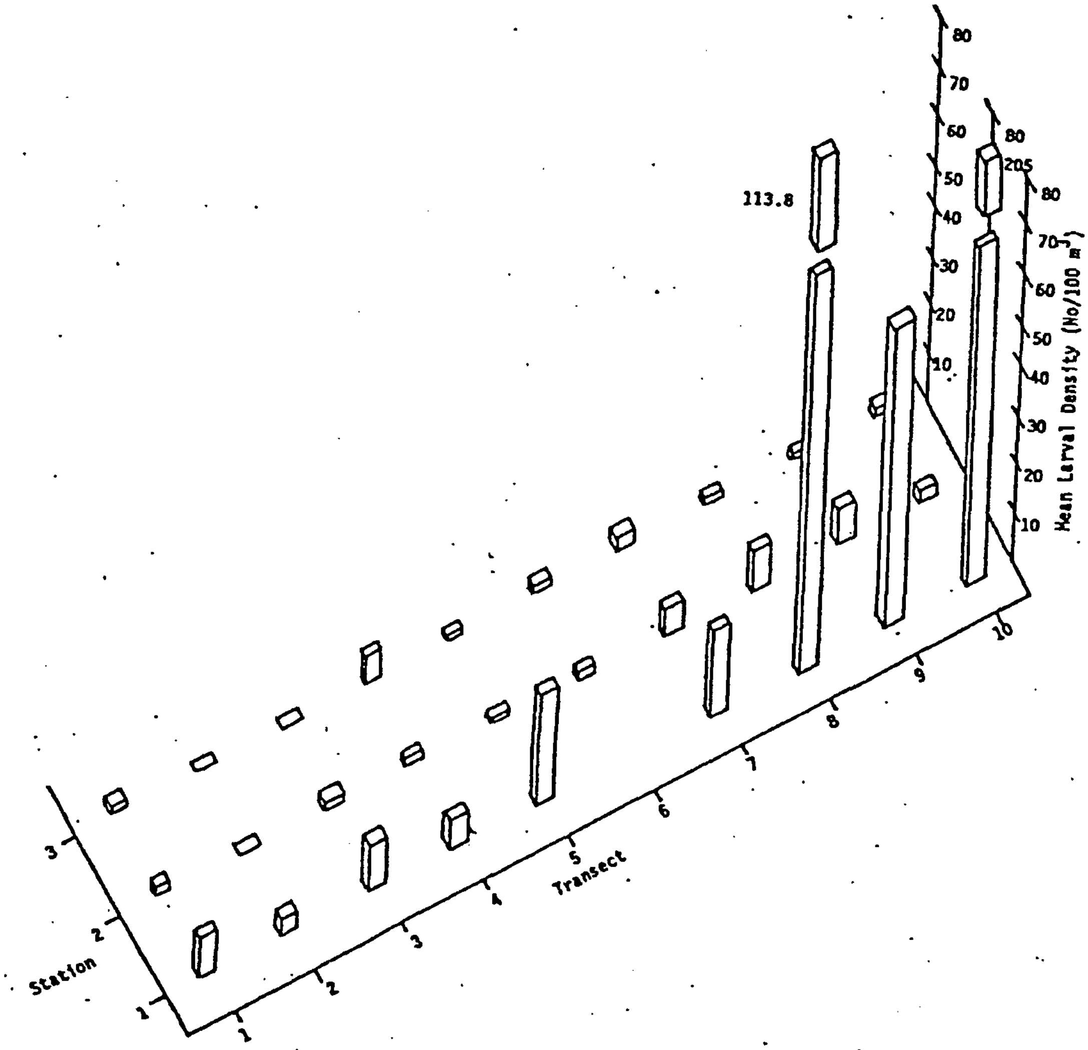


Figure 39. Central Basin - 1978.
Mean Density of Spottail Shiner Larvae at Each Station.

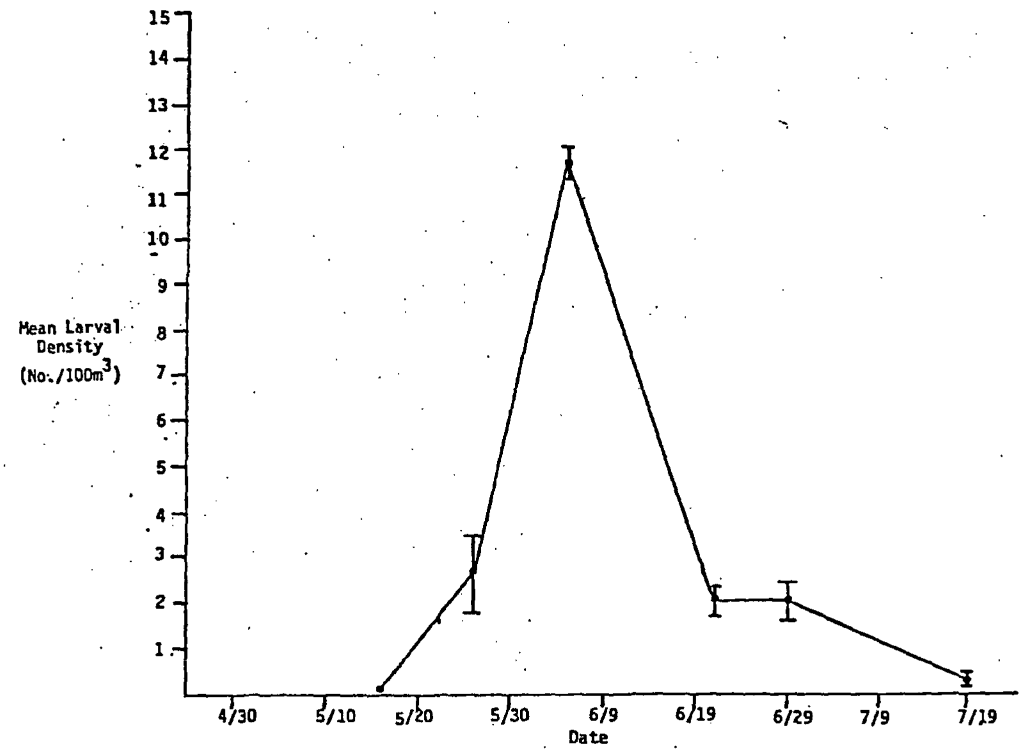


Figure 40. Mean Density of Trout Perch Larvae in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

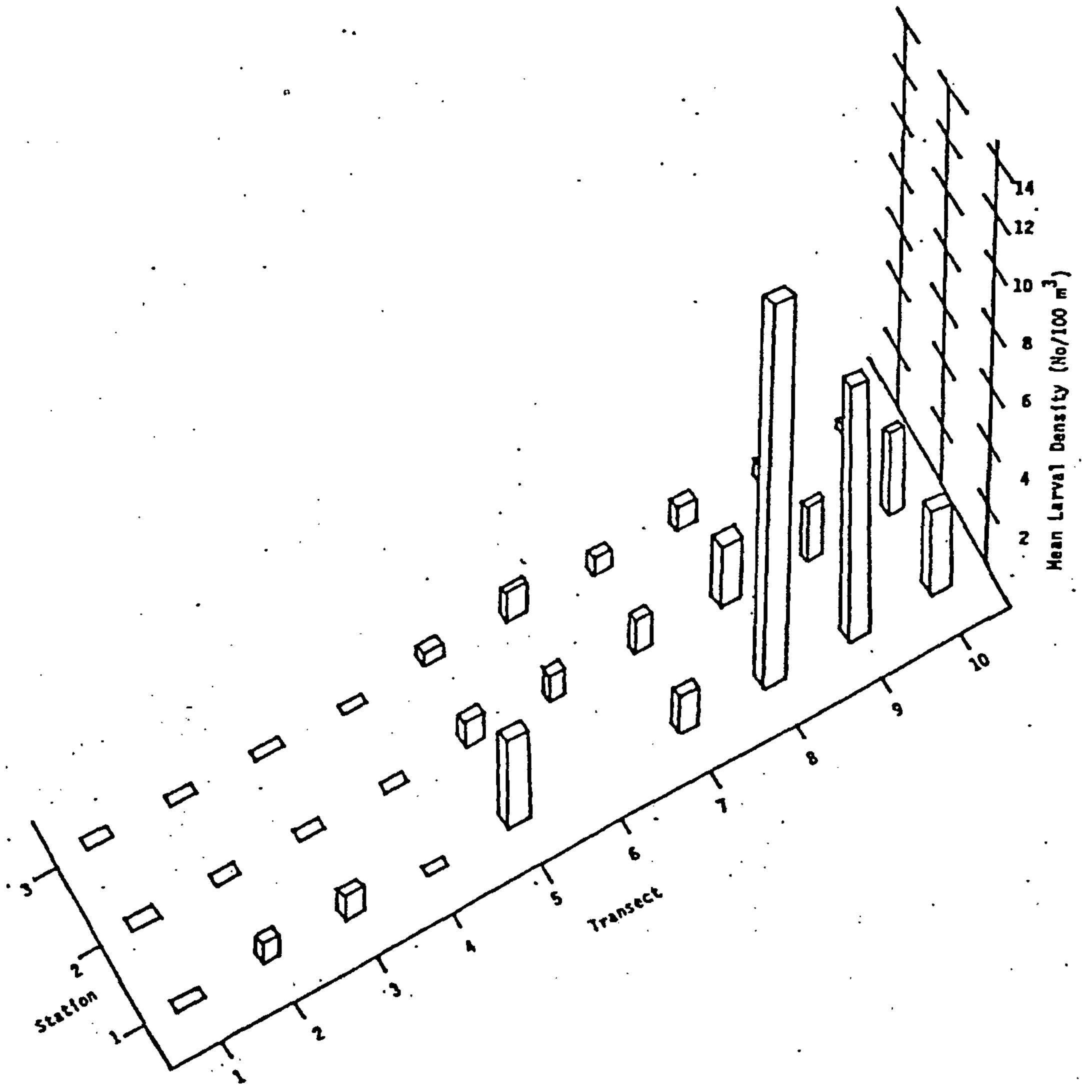


Figure 41. Central Basin - 1978.
Mean Density of Trout Perch Larvae at Each Station.

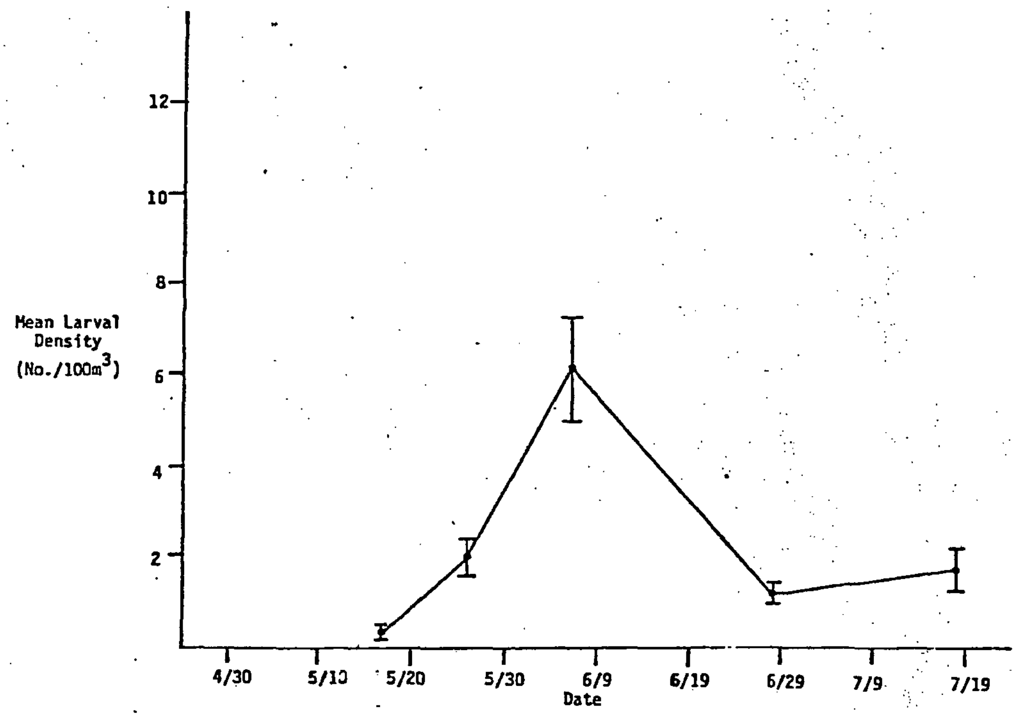


Figure 42. Mean Density of Yellow Perch Larvae in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

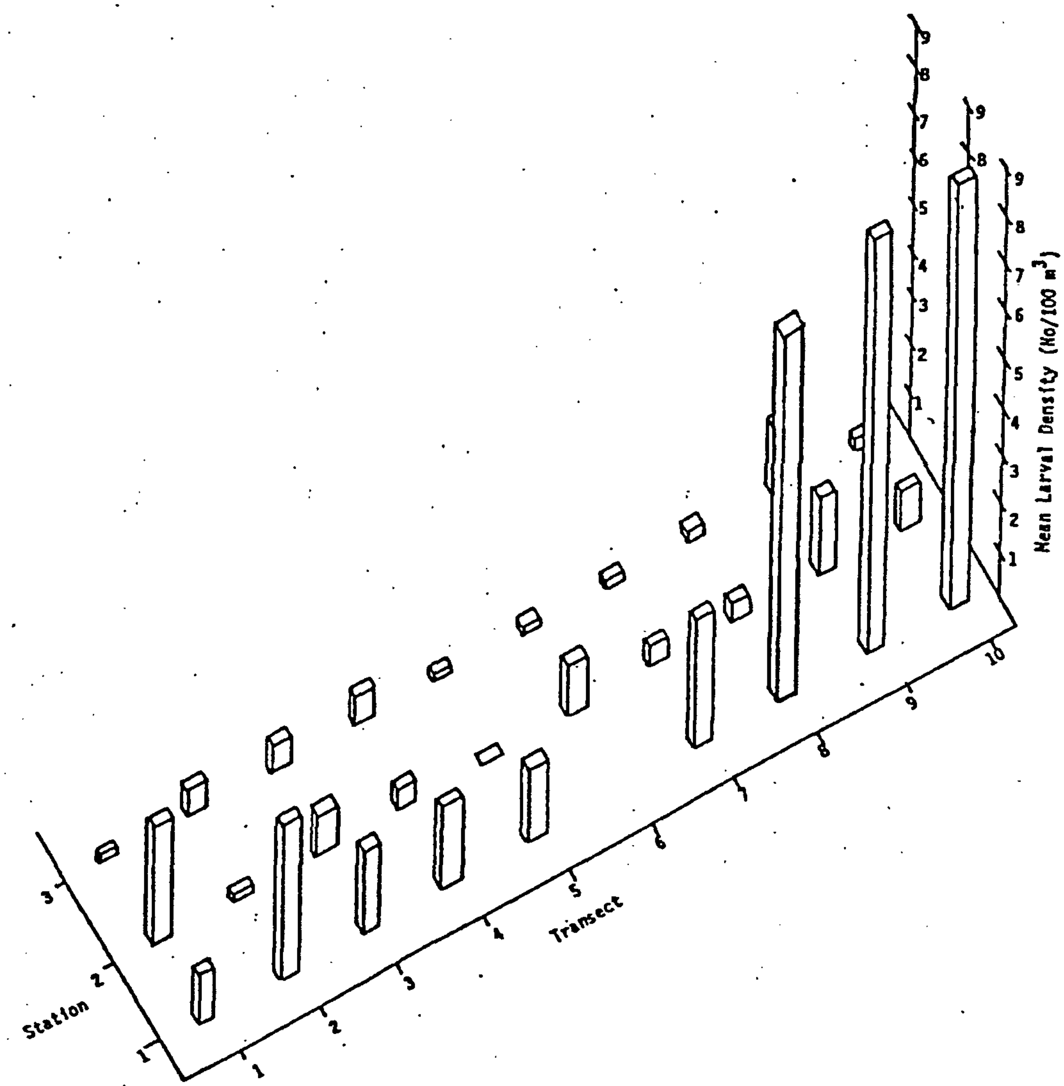


Figure 43. Central Basin - 1978.
Mean Density of Yellow Perch Larvae at Each Station.

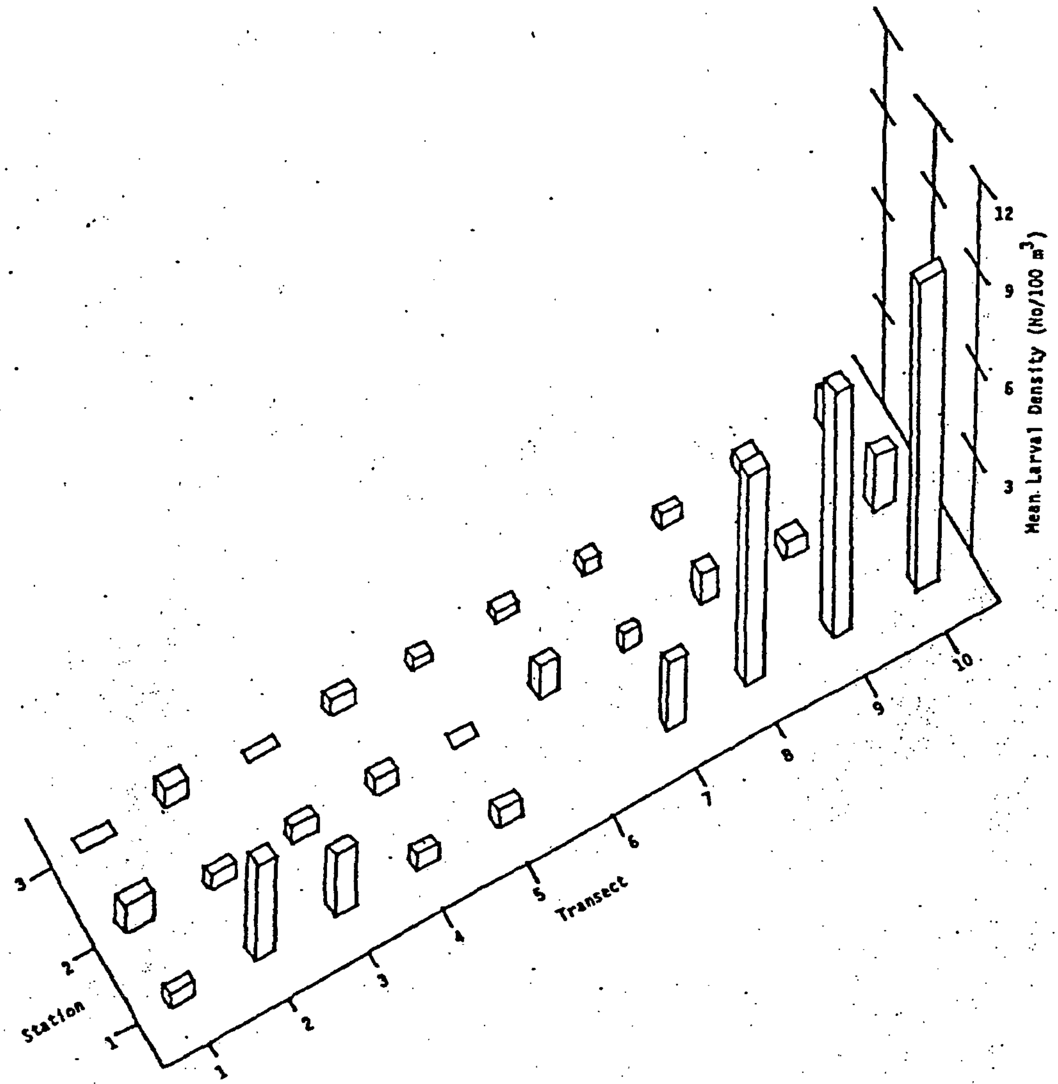


Figure 44. Central Basin - 1978.
Mean Density of Yellow Perch Pro-Larvae at Each Station.

perch. Maximum density of larval yellow perch sampled was 48.5 larvae per 100 m^3 on June 19 at Station 9/1.

Log Perch

With a basin-wide average density of .74 larvae per 100 m^3, log perch were the tenth most abundant species captured. Log perch larvae were first captured on May 19 and were captured during every sampling effort thereafter. Samples collected indicated log perch densities were highest on May 25 with a mean basin density of 2.01 larvae per 100 m^3 (Figure 45).

The distribution of log perch larvae throughout the study area was rather uniform (Figure 46). No statistical differences in densities were detectable between depth zones (Friedman's Rank Sum α=.05, df=2) or between transects (Friedman's α =.05, df=9). Maximum density of log perch sampled was 14.82 larvae per 100 m^3 at Station 5/1 on June 26.

Freshwater Drum

With a basin-wide average density of 3.92 larvae per 100 m^3 freshwater drum were the fourth most abundant larval species captured in the Central Basin in 1978. Larval drum were first captured on May 25 and were captured during every sampling effort thereafter. Samples collected indicated drum larvae were most abundant on July 18 with a mean basin density of 23.8 larvae per 100 m^3 (Figure 47).

The distribution of drum larvae was almost limited to the area west of Cleveland, with 86.7% of the total drum catch coming from transects 1-4 (Figure 48). Friedman's Rank Sum Test (α =.05, df=8) demonstrated significant differences between the transects west of and those east of Cleveland. No significant differences could be detected between onshore and offshore densities. Maximum density of larval drum sampled was 40.1 larvae per 100 m^3 at Station 4/3 on July 18.

POWER PLANT ENTRAINMENT

Western Basin and Estuaries, 1975-1976

The two principal power plants located within the 1975-1976 study area were Toledo Edison's Davis-Besse Nuclear Power Plant and the Bayshore Power Plant. Sufficient data was developed from the 1975-1976 larval fish collections to permit the use of Goodyear's (1978) equivalent adult approach to estimate the impact of entrainment on yellow perch (Appendix C) and emerald shiner (Appendix C). These calculations estimate the loss of approximately 192,704 three-year old yellow perch due to entrainment (assuming 100 percent mortality: 127,184 assuming 66 percent mortality) at the Bayshore Plant in 1975. Entrainment at this facility in 1976 would result in the loss of 36,306 (23,962, 66% mortality) three-year-old fish. Calculation of entrainment losses at the Davis-Besse facility in 1976 were lower, 949 fish. The small number at Davis-Besse is due to the reduced demand for cooling water at a facility with a large cooling tower. It must be borne in mind that these are undoubtedly underestimates due to daylight/large mesh net sampling methods and the use of an average density

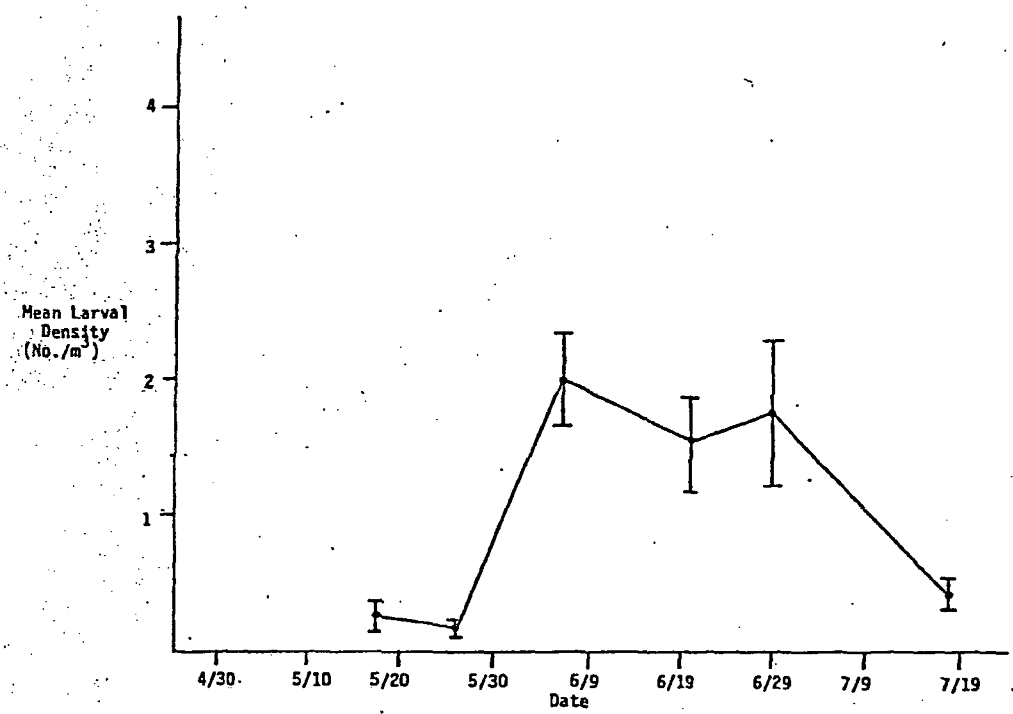


Figure 45. Mean Density of Log Perch in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

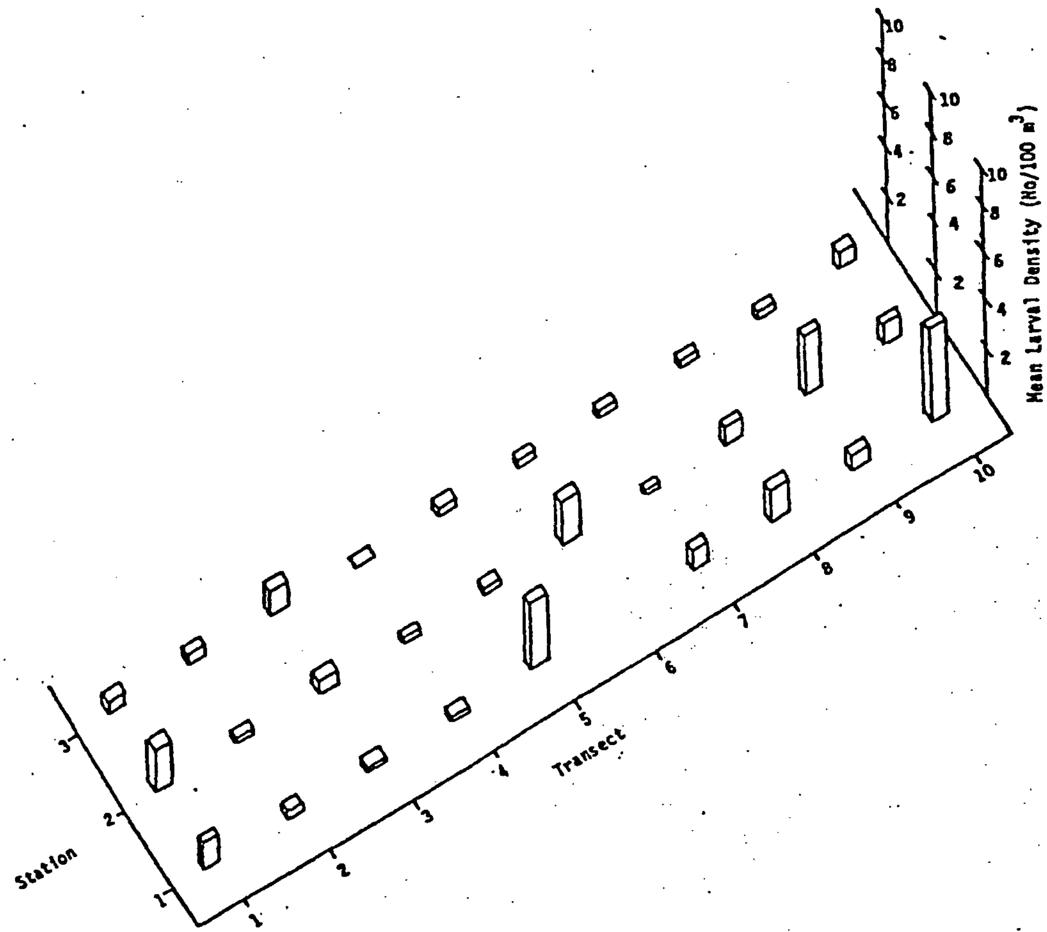


Figure 46. Central Basin - 1978.
Mean Density of Log Perch Larvae at Each Station.

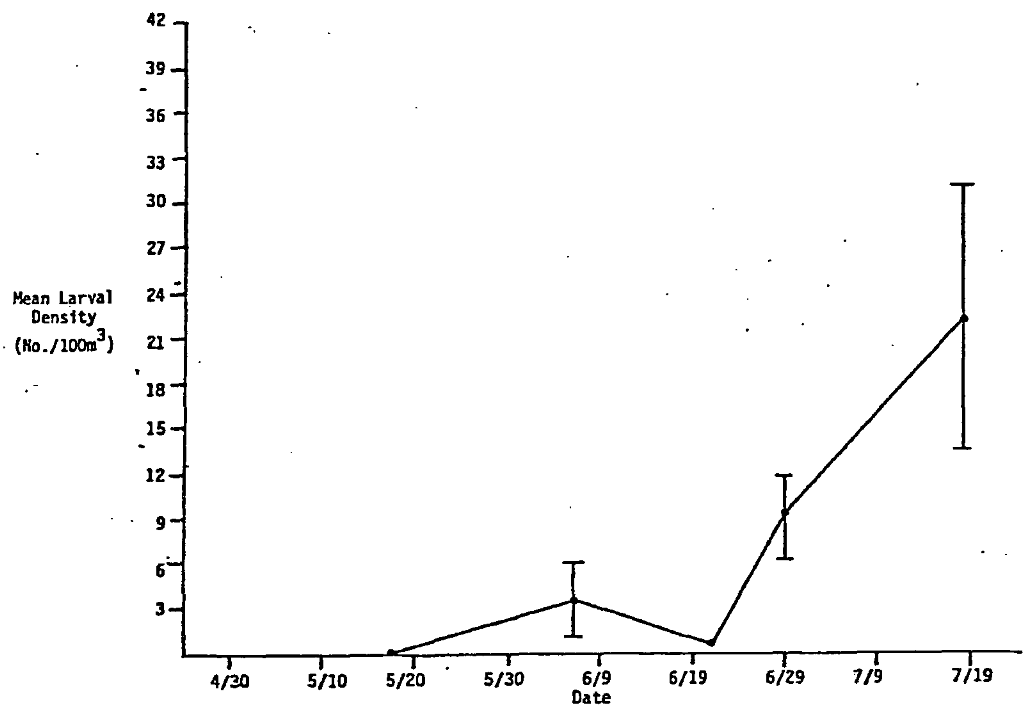


Figure 47. Mean Density of Freshwater Drum Larvae in the Central Basin During 1978. Distance between bars represents one standard error of the mean.

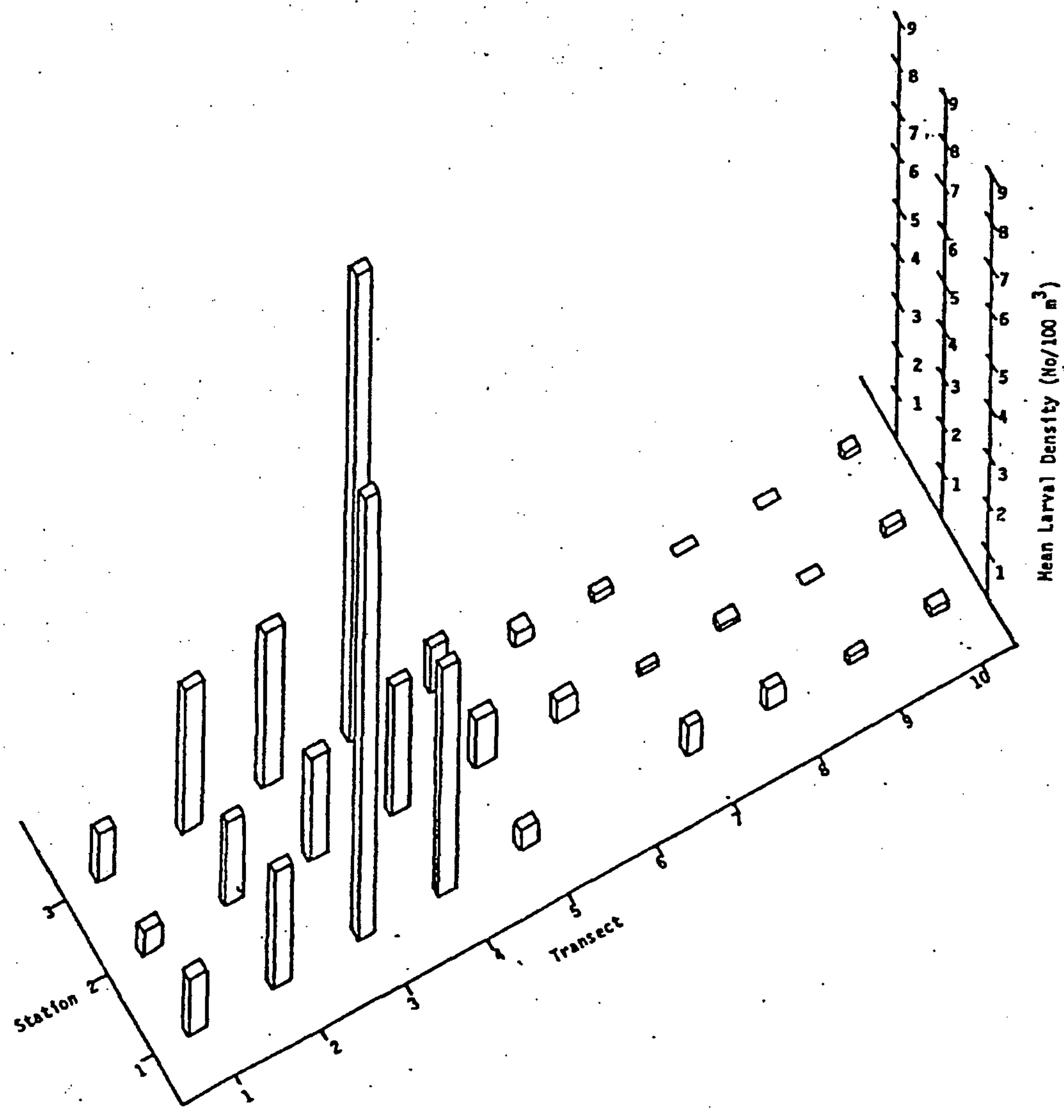


Figure 48. Central Basin - 1978.
Mean Density of Freshwater Drum Larvae at Each Station.

value which includes data from a considerable number of offshore deep water sampling stations where yellow perch larvae were sparsely distributed or missing entirely. Calculations of the losses of one-year-old emerald shiner were considerably larger than the estimated losses of three-year-old perch.

Western Basin, 1977

In 1977, estimates of the losses of larvae at the Bayshore Power Plant and the Acme Power Plant operated by Toledo Edison Company on the Maumee River estuary were calculated by Reutter, Herdendorf and Sturm (1978a, 1978b). They estimated that approximately 2.8 x 10^8 larval fishes were entrained at the Bayshore Plant with clupeids and white bass representing 78.4 percent and 11.6 percent of the total, respectively. Of the 19 taxa of larval fishes collected in the Bayshore entrainment samples, only carp, freshwater drum, clupeids and white bass represented more than one percent of the total. Approximately 7.9 x 10 larval fishes were entrained at the Acme Plant with gizzard shad and freshwater drum representing 56.5 percent and 33.4 percent of the total, respectively. Of the 15 taxa collected in the Acme samples, only carp, freshwater drum, clupeids and white bass represented more than one percent of the total.

Entrainment estimates using field samples were made for four power plants along the Western Basin shoreline: the Monroe, Whiting, Bayshore and The Davis-Besse power plants (see Figure 6 for power plant locations). Clupeids were the most abundant larvae entrained, accounting for 90.54% of the total estimate of larvae entrained. Carp larvae were the second most abundant, accounting for 4.48% of the total entrained, and yellow perch were third with 2.15% of the total. Entrainment estimates were highest at the Monroe Plant where 2,965,727,308 larvae, or 60.86% of the total calculated entrainment occurred. The lowest number entrained was at Davis-Besse, 0.33% of total entrainment. The Bayshore plant entrained the largest number of yellow perch, 48% of the total number of yellow perch larvae entrained. Table 16 lists the estimated number of each species entrained at each power plant in the Western Basin. Using Bartholomew's (1979) samples collected in the vicinity of the Bayshore Power Plant intake canal and his calculated density values, we estimate between 2.2 x 10^6 (100% mortality and 1.4 x 10^6 (66% mortality) 3-year-old yellow perch were lost due to larval entrainment at this site (Appendix C) in 1977.

Central Basin, 1978

In 1978 samples were collected in the immediate area of power plant intake structures (field samples) as well as from inside the plants' screen houses (in-plant samples) at six power plants along the Ohio portion of the Central Basin; they were the Avon Lake, Edgewater, Lake Shore, Eastlake, Ashtabula A & B and Ashtabula C Plants. Paired T-tests were performed to detect differences in species composition between in-plant and field samples. No statistical differences at the α=.05 level were detectable for any of the power plants. Paired T-tests were also used to test for differences in density of larvae between field and in-plant samples. Significant differences were detectable (α =.01) for samples collected at the Avon Lake, East Lake, and Lake Shore plants. No additional differences were detected at α =.05.

Entrainment estimates for each power plant were calculated using both in-plant (Table 17) and field collections (Table 18). Estimates using in-plant samples indicated Cyprinidae were the most abundant larvae entrained, accounting for 50.31% of the total (summed over all power plants), with carp (12.0% and rainbow smelt (1.7%) ranking second and third. In-plant samples estimated 3,617,717 yellow perch larvae (0.97% of the total) were entrained. Samples indicated an estimated 231,543,500 larvae entrained (137,186,000 Cyprinidae) at the Avon Lake Station, accounting for 60.1% of the total entrainment estimate in the Central Basin.

Estimates using field samples also indicated Cyprinidae were the most abundant larvae entrained, accounting for 37.21% of total entrainment in the basin. Gizzard shad (25.04%) and rainbow smelt (13.02%) ranked second and third. Samples indicated entrainment was highest at the Ashtabula A & B Plant, which entrained 76,106,800 larvae (31% of total basin entrainment). The Ashtabula A & B Plant entrained an estimated 1,703,350 yellow perch larvae, which was 37% of the total estimate of yellow perch larvae entrainment.

TABLE 16. ENTRAINMENT ESTIMATES FOR WESTERN BASIN POWER PLANTS (CALCULATED FROM FIELD COLLECTIONS)

Species	Monroe	Whiting	Bayshore	Davis-Besse	Total
Clupeids	2.70×10^{9} $\pm 6.53 \times 10^{8}$	4.90×10^{8} $\pm 8.10 \times 10^{6}$	1.20×10^{9} $\pm 2.00 \times 10^{8}$	1.30×10^{7} $\pm 3.21 \times 10^{6}$	4.40×10^{9} $\pm 5.86 \times 10^{8}$
Whitefish	2.30×10^{5} $\pm 3.83 \times 10^{4}$				2.30×10^{5} $\pm 5.74 \times 10^{4}$
Rainbow Smelt	3.79×10^{5} $\pm 1.10 \times 10^{5}$	2.98×10^{6} $\pm 4.27 \times 10^{5}$	7.24×10^{6} $\pm 1.04 \times 10^{6}$	1.99×10^{5} $\pm 3.32 \times 10^{4}$	1.08×10^{7} $\pm 1.64 \times 10^{6}$
Quillback Carpsucker		4.53×10^{4} $\pm 7.56 \times 10^{3}$	1.10×10^{5} $\pm 1.84 \times 10^{4}$		1.56×10^{5} $\pm 2.61 \times 10^{4}$
Carp	2.13×10^{8} $\pm 1.05 \times 10^{7}$	1.50×10^{6} $\pm 1.64 \times 10^{5}$	3.65×10^{6} $\pm 3.99 \times 10^{5}$	2.54×10^{4} $\pm 4.23 \times 10^{3}$	2.18×10^{7} $\pm 5.28 \times 10^{6}$
Cyprinidae	2.98×10^{5} $\pm 4.86 \times 10^{4}$	2.66×10^{4} $\pm 8.79 \times 10^{3}$	6.46×10^{4} $\pm 2.38 \times 10^{4}$		3.89×10^{5} $\pm 5.80 \times 10^{7}$
Emerald Shiner	1.53×10^{7} $\pm 2.54 \times 10^{6}$	4.41×10^{6} $\pm 7.45 \times 10^{5}$	1.07×10^{7} $\pm 1.81 \times 10^{6}$	1.14×10^{5} $\pm 1.89 \times 10^{4}$	3.05×10^{7} $\pm 3.35 \times 10^{4}$

TABLE 16 (continued). ENTRAINMENT ESTIMATES FOR WESTERN BASIN POWER PLANS (CALCULATED FROM FIELD COLLECTIONS)

Species	Monroe	Whiting	Bayshore	Davis-Besse	Total
Spottail Shiner	9.36×10^{5} $\pm 1.58 \times 10^{5}$	1.10×10^{5} $\pm 3.84 \times 10^{4}$	2.67×10^{5} $\pm 9.32 \times 10^{4}$		1.31×10^{6} $\pm 1.05 \times 10^{5}$
Channel Catfish		4.90×10^{3} $\pm 8.12 \times 10^{2}$	1.19×10^{4} $\pm 1.98 \times 10^{3}$		1.68×10^{4} $\pm 2.82 \times 10^{3}$
White Bass	3.31×10^{6} $\pm 4.68 \times 10^{5}$	2.05×10^{7} $\pm 2.51 \times 10^{5}$	4.99×10^{7} $\pm 6.09 \times 10^{6}$	2.63×10^{4} $\pm 4.24 \times 10^{3}$	7.37×10^{7} $\pm 1.14 \times 10^{7}$
Lepomis sp.	3.10×10^{5} $\pm 5.17 \times 10^{4}$	3.50×10^{3} $\pm 1.75 \times 10^{3}$	8.50×10^{3} $\pm 4.25 \times 10^{3}$		3.22×10^{5} $\pm 7.65 \times 10^{4}$
Percidae		4.44×10^{3} $\pm 7.42 \times 10^{2}$	1.08×10^{4} $\pm 1.70 \times 10^{3}$		1.52×10^{4} $\pm 2.55 \times 10^{3}$
Sauger		4.34×10^{5} $\pm 4.89 \times 10^{4}$	1.05×10^{6} $\pm 1.19 \times 10^{5}$		1.49×10^{6} $\pm 2.49 \times 10^{5}$

TABLE 16 (continued). ENTRAINMENT ESTIMATES FOR WESTERN BASIN POWER PLANTS (CALCULATED FROM FIELD COLLECTIONS)

Species	Monroe	Whiting	Bayshore	Davis-Besse	Total
Walleye		5.35×10^5 $\pm 4.79 \times 10^4$	1.30×10^6 $\pm 1.16 \times 10^5$	1.22×10^5 $\pm 1.23 \times 10^4$	1.96×10^6 $\pm 2.93 \times 10^5$
Yellow Perch	3.10×10^7 $\pm 4.35 \times 10^6$	2.09×10^7 $\pm 2.06 \times 10^6$	5.07×10^7 $\pm 5.01 \times 10^6$	2.24×10^6 $\pm 6.48 \times 10^5$	1.05×10^8 $\pm 1.01 \times 10^7$
Log Perch	1.25×10^6 $\pm 6.26 \times 10^5$	1.14×10^6 $\pm 2.52 \times 10^5$	2.78×10^6 $\pm 6.11 \times 10^5$	1.15×10^5 $\pm 2.95 \times 10^4$	5.30×10^6 $\pm 5.50 \times 10^5$
Freshwater Drum		3.01×10^6 $\pm 5.76 \times 10^5$	7.32×10^6 $\pm 1.40 \times 10^6$	1.04×10^4 $\pm 1.76 \times 10^3$	1.03×10^7 $\pm 1.73 \times 10^6$
Unidentifiable		1.73×10^5 $\pm 2.75 \times 10^4$	4.21×10^5 $\pm 6.68 \times 10^4$		5.95×10^5 $\pm 9.96 \times 10^4$
Total	2.97×10^9 $\pm 1.50 \times 10^8$	5.49×10^8 $\pm 3.09 \times 10^7$	1.33×10^9 $\pm 6.62 \times 10^7$	1.58×10^7 $\pm 7.47 \times 10^5$	4.87×10^9 $\pm 2.43 \times 10^8$

TABLE 17. ENTRAINMENT ESTIMATES FOR CENTRAL BASIN POWER PLANTS (CALCULATED FROM IN-PLANT COLLECTIONS)[1]

Species	Edgewater	Avon Lake	Eastlake	Lake Shore	Ashtabula A & B	Ashtabula C	Total
Clupeid	5.87×10^{6} $\pm 4.83 \times 10^{5}$	2.52×10^{7} $\pm 1.66 \times 10^{6}$	1.78×10^{6} $\pm 2.37 \times 10^{5}$	1.42×10^{6} $\pm 3.45 \times 10^{5}$	2.32×10^{6} $\pm 2.81 \times 10^{5}$	2.05×10^{5} $\pm 5.79 \times 10^{4}$	3.68×10^{7} $\pm 3.90 \times 10^{6}$
Rainbow Smelt		2.58×10^{7} $\pm 2.58 \times 10^{6}$	5.00×10^{6} $\pm 4.15 \times 10^{5}$	5.93×10^{5} $\pm 2.52 \times 10^{4}$	7.83×10^{4} $\pm 7.83 \times 10^{3}$	8.20×10^{5} $\pm 5.05 \times 10^{4}$	3.23×10^{7} $\pm 4.16 \times 10^{6}$
White Sucker	7.66×10^{4} $\pm 1.74 \times 10^{4}$	8.37×10^{5} $\pm 1.39 \times 10^{5}$	9.28×10^{5} $\pm 9.80 \times 10^{4}$	1.14×10^{5} $\pm 1.90 \times 10^{5}$	7.44×10^{4} $\pm 1.24 \times 10^{4}$		2.04×10^{6} $\pm 1.73 \times 10^{5}$
Carp	2.78×10^{5} $\pm 3.33 \times 10^{4}$	9.13×10^{6} $\pm 1.72 \times 10^{5}$	1.59×10^{7} $\pm 1.49 \times 10^{6}$	5.29×10^{6} $\pm 3.46 \times 10^{5}$	1.46×10^{7} $\pm 6.23 \times 10^{5}$		4.52×10^{7} $\pm 2.81 \times 10^{6}$
Shiner	4.08×10^{7} $\pm 7.84 \times 10^{5}$	1.30×10^{8} $\pm 1.20 \times 10^{7}$	2.43×10^{7} $\pm 2.11 \times 10^{6}$	1.02×10^{5} $\pm 1.69 \times 10^{4}$	1.30×10^{7} $\pm 6.20 \times 10^{5}$	1.20×10^{6} $\pm 5.48 \times 10^{5}$	2.09×10^{8} $\pm 1.83 \times 10^{7}$
Minnow	2.57×10^{6} $\pm 3.96 \times 10^{5}$	7.66×10^{6} $\pm 3.49 \times 10^{5}$	9.75×10^{6} $\pm 8.07 \times 10^{5}$	7.79×10^{5} $\pm 5.64 \times 10^{4}$	1.14×10^{7} $\pm 9.97 \times 10^{5}$	5.04×10^{4} $\pm 8.04 \times 10^{3}$	3.22×10^{7} $\pm 1.98 \times 10^{6}$
Bluntnose Minnow		7.17×10^{5} $\pm 3.31 \times 10^{5}$					7.17×10^{5} $\pm 1.19 \times 10^{5}$
Burbot		2.42×10^{5} $\pm 2.42 \times 10^{4}$					2.42×10^{5} $\pm 4.03 \times 10^{4}$
Trout Perch	4.18×10^{5} $\pm 6.97 \times 10^{5}$	3.22×10^{6} $\pm 6.75 \times 10^{4}$	3.85×10^{5} $\pm 3.27 \times 10^{3}$	1.92×10^{5} $\pm 1.75 \times 10^{3}$	7.12×10^{5} $\pm 1.19 \times 10^{5}$	1.04×10^{5} $\pm 1.40 \times 10^{3}$	5.03×10^{6} $\pm 4.42 \times 10^{5}$
White Bass					2.00×10^{5} $\pm 3.32 \times 10^{4}$		2.00×10^{5} $\pm 3.32 \times 10^{4}$
Lepomis sp.	1.96×10^{5} $\pm 2.45 \times 10^{3}$	2.78×10^{4} $\pm 2.78 \times 10^{3}$				6.80×10^{4} $\pm 6.80 \times 10^{3}$	2.92×10^{5} $\pm 3.14 \times 10^{4}$
Micropterus sp.				1.70×10^{5} $\pm 2.83 \times 10^{4}$			1.70×10^{5} $\pm 2.83 \times 10^{4}$
Percidae			3.85×10^{5} $\pm 3.27 \times 10^{5}$		4.54×10^{5} $\pm 2.57 \times 10^{5}$		$.8.40 \times 10^{5}$ $\pm 8.90 \times 10^{4}$
Sauger	2.09×10^{4} $\pm 3.48 \times 10^{3}$						2.09×10^{4} $\pm 3.48 \times 10^{3}$
Walleye					3.71×10^{5} $\pm 6.18 \times 10^{4}$	6.35×10^{4} $\pm 6.35 \times 10^{3}$	4.34×10^{5} $\pm 6.06 \times 10^{4}$
Yellow Perch		1.35×10^{6} $\pm 1.31 \times 10^{5}$	7.02×10^{5} $\pm 7.61 \times 10^{4}$		1.32×10^{6} $\pm 1.42 \times 10^{5}$	2.59×10^{5} $\pm 3.47 \times 10^{4}$	3.62×10^{6} $\pm 2.48 \times 10^{5}$
Log Perch	3.83×10^{5} $\pm 3.12 \times 10^{4}$	3.33×10^{6} $\pm 2.09 \times 10^{5}$	2.55×10^{6} $\pm 1.06 \times 10^{6}$	6.76×10^{5} $\pm 1.01 \times 10^{5}$	1.08×10^{6} $\pm 6.71 \times 10^{4}$	1.26×10^{3} $\pm 4.67 \times 10^{2}$	8.15×10^{6} $\pm 5.27 \times 10^{5}$
Freshwater Drum	1.97×10^{5} $\pm 3.69 \times 10^{4}$	4.10×10^{5} $\pm 8.75 \times 10^{3}$		1.14×10^{5} $\pm 1.73 \times 10^{4}$			7.20×10^{5} $\pm 6.66 \times 10^{4}$
Moltted Sculpin		2.17×10^{5} $\pm 3.62 \times 10^{4}$			8.21×10^{4} $\pm 1.37 \times 10^{4}$		2.99×10^{5} $\pm 3.60 \times 10^{4}$
Unidentifiable		2.44×10^{7} $\pm 1.79 \times 10^{6}$	1.76×10^{7} $\pm 1.39 \times 10^{6}$	1.42×10^{6} $\pm 1.35 \times 10^{5}$	4.97×10^{6} $\pm 1.47 \times 10^{5}$	9.17×10^{5} $\pm 9.35 \times 10^{4}$	4.93×10^{7} $\pm 4.19 \times 10^{6}$
Total	5.06×10^{7} $\pm 3.81 \times 10^{6}$	2.33×10^{8} $\pm 6.50 \times 10^{6}$	7.93×10^{7} $\pm 1.60 \times 10^{6}$	1.09×10^{7} $\pm 2.70 \times 10^{5}$	5.07×10^{7} $\pm 1.36 \times 10^{6}$	3.81×10^{6} $\pm 1.22 \times 10^{5}$	4.28×10^{8} $\pm 3.13 \times 10^{7}$

[1]Lower number in each cell is equal to one standard error of the mean.

TABLE 18. ENTRAINMENT ESTIMATES FOR CENTRAL BASIN POWER PLANTS (CALCULATED FROM FIELD COLLECTIONS)[1]

Species	Edgewater	Avon Lake	Eastlake	Lake Shore	Ashtabula A & B	Ashtabula C	Total
Clupeid	7.91×10^{6} $\pm 2.03 \times 10^{6}$	2.38×10^{7} $\pm 3.44 \times 10^{6}$	9.21×10^{6} $\pm 2.60 \times 10^{5}$	4.77×10^{6} $\pm 8.60 \times 10^{5}$	1.01×10^{7} $\pm 2.90 \times 10^{6}$	5.60×10^{6} $\pm 1.75 \times 10^{6}$	6.14×10^{7} $\pm 2.59 \times 10^{6}$
Rainbow Smelt	2.91×10^{5} $\pm 1.54 \times 10^{3}$	1.27×10^{6} $\pm 1.53 \times 10^{5}$	2.19×10^{7} $\pm 3.44 \times 10^{6}$	9.33×10^{5} $\pm 1.03 \times 10^{5}$	4.46×10^{6} $\pm 3.40 \times 10^{5}$	3.06×10^{6} $\pm 3.88 \times 10^{5}$	3.19×10^{7} $\pm 3.08 \times 10^{6}$
Carp	4.78×10^{5} $\pm 1.18 \times 10^{5}$		4.17×10^{5} $\pm 1.39 \times 10^{4}$	2.70×10^{6} $\pm 2.42 \times 10^{5}$	1.36×10^{6} $\pm 2.26 \times 10^{5}$	1.34×10^{5} $\pm 2.24 \times 10^{4}$	5.09×10^{6} $\pm 3.81 \times 10^{5}$
Cyprinidae	4.14×10^{4} $\pm 6.90 \times 10^{3}$						4.14×10^{4} $\pm 6.30 \times 10^{3}$
Emerald Shiner	9.73×10^{5} $\pm 2.10 \times 10^{5}$	7.44×10^{5} $\pm 1.65 \times 10^{5}$	1.33×10^{7} $\pm 2.91 \times 10^{6}$	2.39×10^{6} $\pm 7.02 \times 10^{5}$	3.18×10^{7} $\pm 8.69 \times 10^{6}$	3.09×10^{7} $\pm 6.76 \times 10^{6}$	8.01×10^{7} $\pm 5.48 \times 10^{6}$
Spottail Shiner	2.48×10^{5} $\pm 5.52 \times 10^{4}$	1.12×10^{5} $\pm 2.91 \times 10^{4}$	5.82×10^{6} $\pm 5.84 \times 10^{5}$	5.45×10^{5} $\pm 7.45 \times 10^{4}$	4.11×10^{6} $\pm 8.68 \times 10^{5}$	$3,32 \times 10^{5}$ $\pm 1.50 \times 10^{5}$	1.12×10^{7} $\pm 9.20 \times 10^{5}$
Burbot					7.70×10^{4} $\pm 1.28 \times 10^{4}$	7.20×10^{4} $\pm 1.20 \times 10^{4}$	1.49×10^{5} $\pm 1.43 \times 10^{4}$
Trout Perch			2.20×10^{6} $\pm 3.56 \times 10^{5}$	9.44×10^{5} $\pm 1.19 \times 10^{5}$	2.37×10^{6} $\pm 2.05 \times 10^{5}$	3.39×10^{5} $\pm 1.55 \times 10^{5}$	5.85×10^{6} $\pm 4.00 \times 10^{5}$
White Bass	9.43×10^{5} $\pm 1.57 \times 10^{5}$						9.43×10^{5} $\pm 1.40 \times 10^{5}$
Lepomis sp.						2.88×10^{4} $\pm 4.80 \times 10^{3}$	2.88×10^{4} $\pm 4.38 \times 10^{3}$
Percidae		1.40×10^{5} $\pm 2.35 \times 10^{4}$	6.72×10^{4} $\pm 1.12 \times 10^{4}$		3.18×10^{5} $\pm 5.29 \times 10^{5}$	4.24×10^{5} $\pm 7.07 \times 10^{4}$	3.81×10^{5} $\pm 4.68 \times 10^{5}$
Walleye			7.65×10^{4} $\pm 1.28 \times 10^{4}$	4.05×10^{4} $\pm 4.75 \times 10^{3}$			1.17×10^{5} $\pm 1.20 \times 10^{4}$
Yellow Perch	4.83×10^{4} $\pm 8.05 \times 10^{3}$	9.84×10^{4} $\pm 3.61 \times 10^{3}$	8.57×10^{5} $\pm 1.59 \times 10^{5}$	1.10×10^{6} $\pm 1.89 \times 10^{5}$	1.70×10^{6} $\pm 1.57 \times 10^{5}$	7.94×10^{5} $\pm 1.98 \times 10^{5}$	4.60×10^{6} $\pm 2.33 \times 10^{5}$
Log Perch	2.65×10^{5} $\pm 1.07 \times 10^{5}$	2.53×10^{5} $\pm 4.11 \times 10^{4}$		2.06×10^{6} $\pm 3.82 \times 10^{5}$	2.34×10^{6} $\pm 1.57 \times 10^{5}$	1.50×10^{5} $\pm 1.97 \times 10^{4}$	5.07×10^{6} $\pm 3.94 \times 10^{5}$
Johnny Darter					6.08×10^{6} $\pm 1.12 \times 10^{6}$	7.92×10^{6} $\pm 1.35 \times 10^{6}$	1.40×10^{7} $\pm 1.36 \times 10^{6}$
Freshwater Drum	4.30×10^{5} $\pm 1.97 \times 10^{5}$	1.03×10^{7} $\pm 5.13 \times 10^{6}$	1.26×10^{5} $\pm 2.10 \times 10^{4}$	7.03×10^{5} $\pm 5.25 \times 10^{4}$	8.81×10^{5} $\pm 2.37 \times 10^{5}$	2.08×10^{5} $\pm 2.52 \times 10^{4}$	1.26×10^{7} $\pm 1.50 \times 10^{6}$
Molted Sculpin					7.69×10^{6} $\pm 3.84 \times 10^{6}$	1.26×10^{6} $\pm 6.05 \times 10^{5}$	8.95×10^{6} $\pm 1.15 \times 10^{6}$
Unidentifiable	1.51×10^{5} $\pm 2.51 \times 10^{4}$						1.51×10^{5} $\pm 2.30 \times 10^{4}$
Total	1.18×10^{7} $\pm 4.21 \times 10^{5}$	3.67×10^{7} $\pm 1.36 \times 10^{6}$	5.40×10^{7} $\pm 1.38 \times 10^{6}$	1.62×10^{7} $\pm 3.00 \times 10^{5}$	7.61×10^{7} $\pm 1.71 \times 10^{6}$	5.12×10^{7} $\pm 1.68 \times 10^{6}$	2.52×10^{8} $\pm 8.59 \times 10^{6}$

[1]Lower number in each cell is equal to one standard error of the mean.

SECTION 6

DISCUSSION

SPECIES DISTRIBUTION

Before one can attempt to predict the effects of power plant entrainment on fish populations, or before intake structures for proposed power plant locations can be located, such that losses due to entrainment are minimized, the spatial and temporal distributions of fish larvae in the area must be accurately described. Graphical depictions, as well as verbal summaries have been presented to provide insight into the spatial and temporal distributions of fish larvae commonly found in the Western Basin of Lake Erie in 1975-1977 and in the Central Basin in 1978. A discussion of the major distributional findings follows.

Western Basin

In 1977, 20 taxa of larval fishes were collected along the near-shore zone of the Western Basin. Larval clupeids, principally gizzard shad, were the most abundant species collected, comprising 87% of the total larval catch. Species of sport and/or commercial interest collected were rainbow smelt, whitefish, carp, white bass, yellow perch, sauger, walleye and freshwater drum.

Larval whitefish and sauger, although rarely captured, are of significance. Both whitefish and sauger were abundant and commercially fished throughout the 1950's. Populations of these two species were reduced to the point that only rarely were whitefish or sauger captured. Efforts have been made through stocking programs to re-establish the native sauger population. The capture of larval sauger in this study indicated these efforts may have been successful. The capture of whitefish larvae indicated a small population of whitefish still uses spawning sites in the Western Basin.

Although rainbow smelt were commonly captured in the Western Basin, very few pro-larval smelt were found. This indicates smelt larvae were carried into the study area by currents, possibly by the Detroit River.

Littoral areas, i.e., quiet areas of bays and harbors, or slowly moving rivers and streams, are preferred as spawning habitat by carp. Large numbers of carp larvae were captured with highest densities of carp in samples taken at the intake of the Detroit Edison power plant near the mouth of the River Raisin. The majority of carp found in Lake Erie were probably spawned in tributaries and harbors.

Both white bass and freshwater drum larvae were found to be significantly more abundant in the estuaries and adjacent bays than along either the Michigan or Ohio shorelines or the open water portions of

the basin. The majority of white bass found in Maumee Bay were probably spawned over the sandy dredge spoil islands on both sides of the Toledo navigation channel or near the Ottawa River mouth in North Maumee Bay. The majority of drum larvae captured in Maumee Bay (87% of species total) were developed beyond the pro-larvae stage. Drum larvae are extremely bouyant and easily carried by currents. Snyder (1978) reported drum densities in the Maumee River estuary in excess of 500 per 100 m^3. Therefore, many of the drum larvae captured in the bay may have been carried there from the lower Maumee River estuary.

Densities of yellow perch larvae were higher off Otter Creek, Michigan (transect M2) than anywhere else in the study area. The reason for this high concentration of larvae is not obvious examining the habitat in the area. However, the dominant summer surface currents shown in Figure 1 depict that the intersection of currents from the Maumee and Detroit Rivers results in an eddy in this area. This eddy effect has been demonstrated to concentrate pollutants here (U.S. Dept. of Interior, 1967). Therefore the high concentrations of perch larvae found along transect M2 may have resulted from larvae being transported from Maumee Bay and from along the Michigan shoreline. Overall, yellow perch and walleye larvae densities were higher along the Ohio shoreline than anywhere in the study area. The spawning habitat found here, consisting of a sand and gravel bottom, and off-shore rock shoals is perhaps the best to be found in the U.S. waters of Lake Erie for walleye and yellow perch.

Central Basin

In 1978, 21 taxa of larval fishes were captured along the shoreline of the Ohio portion of the Central Basin. The bulk of the catch was made up of cyprinid fishes, with emerald and spottail shiners contributing 32% and 16% of the total catch respectively. Cleupids, mainly gizzard shad, ranked second, making up 30% of the total. Volume weighted estimates of production indicated 54% of all larvae in the nearshore zone were emerald shiner. Species of commercial and/or sport interest captured were rainbow smelt, carp, white bass, yellow perch, sauger and walleye. The capture of walleye and sauger was limited to only a few specimens at a limited number of locations.

No rainbow smelt spawning activity has been reported in the study area. Historically it has been believed that any smelt larvae found in the area were probably spawned in the Pelee Island-Long Point area and drifted into the study area with surface currents flowing southward from Pelee Passage to the Ohio shoreline (Figure 1) (MacCallum and Regier, 1969). The fact that 72% of the larvae were captured well offshore and that over 98% of the catch was made up of smelt developed beyond the pro-larval stage indicates that most of the larvae captured were probably carried into the study area by these currents. On July 17 pro-larvae smelt were captured at Station 1/1 near Sandusky at a calculated density of 14.25 larvae per 100 m^3, suggesting that smelt spawn in the sandy shallows along Cedar Point.

Sheltered habitat found in the large harbors of the Central Basin are ideal for carp. Large catches of carp larvae were made in these harbors. Although one of the major commercial species in Lake Erie, carp are usually held in low regard and few, if any, management decisions are developed around protecting carp.

The vast majority of freshwater drum larvae were collected in the western-third of the Central Basin study area, with 87% of the catch coming from Transects 1-4. Although drum are reported as pelagic spawners, adult drum usually inhabit water less than 12 meters deep. The area west of Cleveland, where most of the drum larvae were captured, contains a larger band of relatively shallow water than the area east of Cleveland. East of Cleveland, water less than 12 meters deep is limited to a very narrow band along the shoreline.

Yellow perch are the species of main concern in the Central Basin of the lake. Perch larvae were found to be concentrated mostly along the shore, particularly in the eastern-third of the study area. Yellow perch deposit their eggs in ribbon-like tubes in debris, aquatic vegetation, or on clean gravel or sand. The area where the majority of yellow perch larvae were captured has very limited quantities of clean gravel and sand, and even less aquatic vegetation. Yellow perch, therefore, appear to be using the harbor breakwalls and the sand accumulated on the lee-side of these structures as spawning habitat.

POWER PLANT ENTRAINTMENT

Western Basin

Numbers of larval fishes entrained were estimated for four power plants along the shoreline of the Western Basin (Table 16). Estimates were obtained by multiplying average larval concentrations at the station(s) most immediately adjacent to the cooling water intake structures by the pumping rates reported by each plant. Calculations indicate 4.4×10^9 clupeid larvae were entrained at the four plants. This represented 90.3% of total larval entrainment. Carp were the second most frequently entrained larvae, representing 4.4% of the total. Yellow perch (2.2% of total) and walleye (0.04% of total) ranked third and eleventh, respectively, in numbers entrained.

Estimates of larval abundance in three depth zones of the nearshore zone of the Western Basin were also calculated (see Appendix C). The combined estimated fish entrainment at the four power plants is presented in Table 19. Table 19 shows a comparison of nearshore production vs. entrainment in an effort to quantify the effect of the power plants on larval fish populations in the nearshore zone. This comparison suggests that for several species, entrainment estimates approach, nearshore abundance estimates, indicating sources of larval fish beyond the limits of the study area.

TABLE 19. TOTAL ENTRAINMENT ESTIMATES OF FOUR WESTERN BASIN POWER PLANTS DURING THE 1977 SAMPLING PERIOD

Species	NEARSHORE PRODUCTION	ENTRAINMENT ESTIMATE	PERCENT ENTRAINED
Clupeid	1.30×10^{10}	4.40×10^{9}	33.85
Whitefish	2.32×10^{6}	2.30×10^{5}	9.90
Rainbow Smelt	6.34×10^{7}	1.08×10^{7}	17.00
Quillback Carpsucker	7.65×10^{5}	1.56×10^{5}	20.00
Carp	1.64×10^{8}	2.18×10^{7}	13.3
Emerald Shiner	5.16×10^{8}	3.05×10^{7}	5.90
Spottail Shiner	1.27×10^{7}	1.31×10^{6}	10.30
Channel Catfish	6.69×10^{5}	1.68×10^{4}	2.50
White Bass	2.65×10^{8}	7.37×10^{7}	27.80
Lepomis sp.	4.12×10^{6}	3.22×10^{5}	7.82
Percidae	2.66×10^{5}	1.52×10^{4}	5.70
Sauger	2.25×10^{6}	1.49×10^{6}	66.20
Walleye	6.08×10^{7}	1.96×10^{6}	3.20
Yellow Perch	1.35×10^{9}	1.05×10^{8}	7.80
Log Perch	6.82×10^{7}	5.30×10^{6}	7.80
Freshwater Drum	1.42×10^{8}	1.03×10^{7}	7.30

Both entrainment estimates and estimated larval production in the nearshore zone are believed to be accurate within the limits associated with the sampling program. However, no attempt was made to estimate the input of larvae from the tributaries during the 1977 study period. Snyder (1978) estimated abundance of gizzard shad, freshwater drum, and white bass in a 14 km^2 area extending from the mouth of the Maumee River to the head of the Maumee estuary to rival if not exceed the estimate of abundance of these species in a 1740 km^2 portion of the Western Basin proper studied by Heniken (1977) in 1975 and 1976.

Reutter et al. (1978a, 1978b) examined larvae abundance in a portion of the lower Maumee River estuary during the 1977 sampling season. Comparison of nearshore production estimates reported herein with Reutter's abundance estimates in the Maumee estuary leads to a conclusion similar to that of Snyder (1978), in that the estuary is a major larvae production area. This conclusion is evident in numbers presented in Table 20. The white bass production estimate at the mouth of the Maumee River was two times greater than that of the nearshore study area. Freshwater drum production in the Maumee estuary clearly exceeded that from the lake. It is suggested that the large number of drum larvae in the Maumee River is partially responsible for the high densities of drum larvae occurring in Maumee Bay. While not exceeding the nearshore production, clupeid, largely gizzard shad larvae were very abundant in the Maumee River. In contrast, estimates of yellow perch and emerald shiner larvae occur predominantly in nearshore areas of the lake. The latter species are comparatively infrequent in the Maumee River estuary area studied by Reutter.

Although comparisons of nearshore production estimates have been made, very clear incongruities are evident. These comparisons can be used only with great care, realizing the inherent bias resulting from unmeasured estuarine inputs.

A total of 4.87×10^9 larvae were estimated to have been entrained by the four power stations along the shoreline of the Western Basin in 1977. An estimated 2.97×10^9 (61% of the total) larvae were entrained at Detroit Edison's Monroe Plant. Toledo Edison's Bayshore plant ranked second in total entrainment, accounting for 27.3% of the total. Consumers Power Whiting Plant and the Toledo Edison-operated Davis-Besse Nuclear Power Plant accounted for 11.3 and 0.3%, respectively, of the total entrainment.

Entrainment estimates indicated clupeid larvae were by far the most numerous larvae entrained at all the power plants. Clupeid larvae represented between 91% of the total entrainment at Monroe to 82% at Davis-Besse (Table 21). Carp/Goldfish larvae represented 7.2% of the total entrainment at Monroe. The latter is a far greater percentage than calculated for the three other facilities. The River Raisin and the immediately adjacent wetland areas undoubtedly contribute the greater proportion of carp larvae entrained at the Monroe facility.

TABLE 20. COMPARISON OF NEARSHORE AND ESTUARINE PRODUCTION ESTIMATES DURING THE 1977 STUDY PERIOD

Species	Production Estimates		
Nearshore/ Estuarine Species	Nearshore Estimate	Maumee River Mouth Estimate	Maumee River Estuary Estimate
White Bass	2.65×10^{8}	5.6×10^{8}	1.15×10^{8}
Freshwater Drum	1.42×10^{8}	1.4×10^{8}	1.43×10^{9}
Gizzard Shad	1.30×10^{10}	6.5×10^{9}	1.30×10^{9}
Nearshore Species			
Yellow Perch	1.35×10^{9}	1.30×10^{7}	4.60×10^{6}
Emerald Shiner	5.16×10^{8}	1.20×10^{6}	1.90×10^{5}

TABLE 21. ESTIMATES OF THE RELATIVE ABUNDANCE OF FISH SPECIES ENTRAINED AT EACH OF FOUR WESTERN LAKE ERIE POWER PLANTS DURING THE 1977 STUDY PERIOD

Species	Monroe (%)	Whiting (%)	Bayshore (%)	Davis-Besse (%)	All Power Plants (%)
Clupeid	90.90	89.31	90.23	82.01	90.31
Whitefish	0.08				0.05
Rainbow Smelt	0.13	0.54	0.54	1.30	0.22
Quillback Carpsucker		0.01	0.01		0.01
Carp/Goldfish	7.20	0.27	0.27	0.16	4.40
Cyprinidae	0.01	0.05	0.03		0.08
Emerald Shiner	0.05	1.20	0.80	0.72	0.63
Spottail Shiner	0.03	0.02	0.02		0.03
Channel Catfish		0.01	0.01		
White Bass	0.01	3.73	3.75	0.17	1.50
Lepomis sp.	0.01	0.01	0.01		0.01
Percidae		0.01	0.01		0.01
Sauger		0.08	0.08		0.03
Walleye		0.10	0.10	0.77	0.04
Yellow Perch	1.04	3.80	3.81	1.41	2.20
Log Perch	0.04	0.21	0.21	0.73	
Freshwater Drum		0.55	0.55	0.07	
Unidentifiable		0.15	0.03		
Total	100.00	100.00	100.00	100.00	100.00

The number of carp entrained here was larger than the nearshore abundance estimate. Protected littoral habitat along the River Raisin estuary and the Maumee River estuary provide spawning habitat for fish species preferring shallow, quiet waters.

Although entrainment at the Monroe facility accounted for 61% of the total entrainment, a relatively small percentage of commercial and sport fishes were entrained here. Of the larval yellow perch entrained, 48.3% were entrained at Toledo Edison's Bayshore Plant, while the larger Monroe Plant entrained only 30%. Entrainment of larval sauger and freshwater drum occurred only at the Bayshore and Whiting Plants. Entrainment of larval walleye was largely limited to the Bayshore and Whiting Plants with 6.2% of walleye entrainment occurring at the Davis-Besse Plant. Table 22 provides percentage of the total entrainment estimate for each species at each power plant.

Central Basin

Entrainment estimates were calculated for six power plants located along the Ohio shoreline of the Central Basin. Separate estimates were developed using in-plant collections as well as field collections of larvae. Basin-wide entrainment estimates derived from in-plant and field collections did not differ statistically when summed over all species (Wilcoxon's Signed-Rank Test; $\alpha = .05$). However, when species-by-species or plant-by-plant comparisons were made, statistical differences between field and in-plant estimates were often found. Statistical differences were found between entrainment estimates, summed over all power plants, for clupeids, white suckers, carp, and freshwater drum (Wilcoxon's Signed Rank Test; $\alpha = .05$) (Table 23). Entrainment estimates derived from field samples for carp, and drum were significantly higher than estimates derived from in-plant samples. Clupeid and white sucker estimates were statistically higher when derived from in-plant samples. Estimates of entrainment derived from field and in-plant collections, summed over all species, were significantly different for the Avon Lake Plant and the Ashtabula C Plant (Wilcoxon's Signed Rank Test; $\alpha = .05$). Estimates of entrainment were higher for in-plant samples at the Avon Lake Plant and from field samples at the Ashtabula C Plant.

Entrainment estimates developed from field collections indicated a total of 2.52×10^8 larvae were entrained by Central Basin power plants in 1978 (Table 18). Emerald shiner larvae were the most frequently entrained species (31.79% of the total). Clupeid and rainbow smelt larvae ranked second and third representing 24.36 and 12.66% of the total entrainment, respectively. A total of 4.60×10^6 yellow perch larvae (1.83% of the total) and 1.17×10^5 walleye larvae (.05% of the total) were calculated to have been entrained.

Entrainment estimates derived from field collections were compared with estimated larval abundance in the Central Basin nearshore zone. Table 24 contains the percentage of the estimated

TABLE 22. ESTIMATE OF THE PERCENTAGE OF TOTAL ENTRAINMENT BY SPECIES AT EACH OF FOUR LAKE ERIE WESTERN BASIN POWER PLANTS DURING THE 1977 STUDY PERIOD

Species	Monroe (%)	Whitting (%)	Bayshore (%)	Davis-Besse (%)	Total
Clupeid	61.0	11.0	27.0	1.00	4.40×10^{9}
Whitefish	100.0				2.30×10^{5}
Rainbow Smelt	3.5	27.6	67.0	1.80	1.08×10^{7}
Quillback Carpsucker		27.0	73.0		1.56×10^{5}
Carp	97.7	0.7	1.6	0.01	2.18×10^{7}
Emerald Shiner	50.0	14.0	35.0	1.00	3.05×10^{7}
Spottail Shiner	71.0	8.4	20.4	0.20	1.31×10^{6}
White Bass	4.5	27.8	67.7	0.01	7.37×10^{7}
Lepomis sp.	96.3	1.1	2.6		3.22×10^{5}
Percidae		29.2	70.8		1.52×10^{6}
Sauger		29.1	70.9		1.49×10^{6}
Walleye		27.3	66.3	6.20	1.96×10^{6}
Yellow Perch	29.5	19.9	48.3	2.10	1.05×10^{8}
Log Perch	23.6	21.5	52.50	2.2	5.30×10^{6}
Freshwater Drum		29.0	71.0		1.03×10^{7}

TABLE 23. COMPARISON OF RELATIVE ABUNDANCE OF ESTIMATED ENTRAINED SPECIES. IN-PLANT VS. FIELD SURVEYS

SPECIES	IN-PLANT ESTIMATES NUMBER ENTRAINED	IN-PLANT ESTIMATES % OF TOTAL	FIELD ESTIMATES NUMBER ENTRAINED	FIELD ESTIMATES % OF TOTAL	DIFFERENCE[1]
Clupeid	3.68×10^7	11.30	6.14×10^7	24.36	-2.46×10^7
Rainbow Smelt	3.23×10^7	9.92	3.19×10^7	12.66	4.00×10^5
White Sucker	2.03×10^6	0.62	0	0	2.03×10^6
Carp/Goldfish	4.52×10^7	13.88	5.09×10^6	2.01	4.01×10^7
Shiner & Minnow	1.88×10^8	57.74	9.13×10^7	36.23	9.67×10^7
Emerald & Spottail Shiner					
Bluntnose Minnow	7.17×10^5	0.22	0	0	7.17×10^5
Burbot	2.42×10^5	0.07	1.49×10^5	0.06	9.30×10^4
Trout Perch	4.66×10^6	1.43	5.85×10^6	2.32	-1.19×10^6
White Bass	2.00×10^5	0.06	9.43×10^4	0.04	1.06×10^5
Lepomis sp.	2.92×10^5	0.09	2.88×10^4	0.01	2.63×10^5
Micropterus sp.	1.70×10^5	0.05	0	0	1.70×10^5
Percidae	1.40×10^5	0.26	3.81×10^6	1.51	-2.97×10^6
Sauger	2.09×10^4	0.01	0	0	2.09×10^4
Walleye	4.34×10^5	0.14	1.16×10^5	0.05	3.18×10^5
Yellow Perch	3.62×10^6	1.11	4.60×10^6	1.83	-9.80×10^5
Log Perch	4.85×10^6	1.49	5.07×10^6	2.01	-2.20×10^5
Johnny Darter	0	0	1.40×10^7	5.56	-1.40×10^7
Freshwater Drum	7.20×10^5	0.22	1.27×10^7	5.04	-1.20×10^7
Mottled Sculpin	2.99×10^5	0.09	8.95×10^6	3.55	-8.61×10^6
Unidentifiable (Damaged) Larvae	4.19×10^6	1.29	1.51×10^5	0.06	4.04×10^6
Total	3.26×10^8		2.52×10^8		7.40×10^7

[1]Negative values indicate larger estimates from field samples. Positive values indicate larger estimates from in-plant samples.

TABLE 24. ESTIMATE OF THE PERCENTAGE OF TOTAL ENTRAINMENT BY SPECIES AT EACH OF SIX CENTRAL BASIN POWER PLANTS (Estimated from Field Collections)

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)	Total
Clupeid	12.88	38.76	15.00	7.77	16.44	9.12	6.14×10^7
Rainbow Smelt	0.91	3.98	68.65	2.92	13.98	9.59	3.19×10^7
Carp/Goldfish	9.39		8.19	53.04	26.72	2.60	5.09×10^6
Cyprinidae	100.00						4.14×10^4
Emerald Shiner	1.21	0.93	16.60	2.99	39.70	38.58	8.01×10^7
Spottail Shiner	2.20	1.09	51.20	4.87	36.70	2.96	1.12×10^7
Burbot					51.67	48.32	1.49×10^5
Trout Perch			37.61	16.14	40.51	5.79	5.85×10^5
White Bass	100.00						9.43×10^5
Lepomis sp.						100.00	2.88×10^4

TABLE 24 (continued). ESTIMATE OF THE PERCENTAGE OF TOTAL ENTRAINMENT BY SPECIES AT EACH OF SIX CENTRAL BASIN POWER PLANTS (Estimated from Field Collections)

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)	Total
Percidae		3.67	1.76		83.46	11.13	3.81×10^6
Walleye			65.38	34.62			1.17×10^5
Yellow Perch	1.05	2.14	18.63	23.91	36.96	17.26	4.60×10^6
Log Perch	5.23	4.99		40.63	46.15	2.96	5.07×10^6
Johnny Darter					43.43	56.57	1.40×10^7
Freshwater Drum	3.41	81.75	1.00	5.58	6.99	1.65	1.26×10^7
Mottled Sculpin					86.00	14.00	8.95×10^6
Unidentifiable	100.00						1.51×10^5
All Species	4.68	14.56	21.43	6.43	30.20	20.32	2.52×10^8

nearshore abundance entrained by power plants in the Central Basin in 1978. Examination of these values indicates a relatively small percentage of larvae of all species except white bass, johnny darter, freshwater drum and mottled sculpin were entrained. The relatively high entrainment estimates for white bass and freshwater drum can be explained using the estuary context developed in the preceding Western Basin discussion, i.e. preferred spawning habitat of these species was not sampled during this study.

Entrainment losses estimated from field collections were greatest at Ashtabula A & B Plant. An estimated 7.61 x 10^7 larvae representing 30.8% of the total were entrained here. Emerald shiner larvae were the most abundant larvae entrained at this plant (3.09 x 10^7 larvae, 41.79% of the total). Clupeid larvae were second (13.2% of the total). Yellow perch larvae represented 2.23% of the total entrainment at the Ashtabula A & B Plant. Field estimates indicated 21.43% of the total entrainment occurred at the Eastlake Plant and 20.32% at the Ashtabula C Plant. Estimated entrainment was lowest at the Lorain Edgewater Plant where 1.18 x 10^7 larvae were entrained. The latter represented 4.68% of the entrainment estimated at power plants located along the south shore of the Central Basin. The percentage of total entrainment at each power plant represented by each species is presented in Table 25.

In the Central Basin a species of major interest is yellow perch. Entrainment estimates based on field samples indicated yellow perch entrainment was highest as the Ashtabula A & B Plant where an estimated 7.61 x 10^7 larval yellow perch were entrained (30.80% of total yellow perch entrainment). The Ashtabula C Plant ranked second in yellow perch entrainment with 20.32% of the total. Calculated yelow perch entrainment was lowest at the Edgewater Plant where 1.18 x 10^7 (4.68% of the total) were entrained. A complete list of the percentage of the total entrainment estimate for each species entrained at each power plant is available in Table 26.

Entrainment estimates calcualted using in-plant data (Table 17) indicate a total of 4.28 x 10^8 larvae were entrained by Central Basin power plants in 1978. Of these, 1.88 x 10^8 were cyprinids which comprised 54.7% of the total estimate. Carp larvae were the second most frequently entrained species (13.88% of the total). A total of 3.62 x 10^6 larval yellow perch, representing 1.11% of the total, ranked as the seventh most frequently entrained species (Table 27).

Comparison of entrainment estimates developed from in-plant samples with nearshore production estimates (Table 27) leads to the conclusion that a relatively small percentage of each fish species was entrained. Exceptions to this conclusion are the estimates for carp, white bass and log perch. It has been noted that our sampling program did not sample carp and white bass spawning habitat in estuarine areas. The inconsistency of the log perch estimate has no obvious explanation

TABLE 25. COMPARISON OF NEARSHORE PRODUCTION ESTIMATES AND TOTAL ENTRAINMENT ESTIMATES OF SIX CENTRAL BASIN POWER PLANTS DURING THE 1978 SAMPLING PERIOD (CALCULATED FROM FIELD SAMPLES)

Species	Nearshore Production	Entrainment Estimate	Percent Entrained
Clupeid	1.51×10^{10}	6.14×10^{7}	0.41
Rainbow Smelt	4.28×10^{8}	3.19×10^{7}	7.50
Carp/Goldfish	1.26×10^{8}	5.09×10^{6}	11.32
Emerald Shiner	4.28×10^{9}	8.01×10^{7}	1.87
Spottail Shiner	8.38×10^{8}	1.12×10^{7}	1.34
Burbot	2.58×10^{6}	1.49×10^{5}	5.78
Trout Perch	1.04×10^{8}	5.05×10^{6}	5.62
White Bass	1.92×10^{6}	9.43×10^{5}	49.08
Percidae	3.50×10^{7}	3.81×10^{6}	1.11
Walleye	5.69×10^{6}	1.17×10^{5}	2.10
Yellow Perch	1.09×10^{8}	4.60×10^{6}	4.23
Log Perch	5.23×10^{7}	5.07×10^{6}	9.69
Johnny Darter	1.12×10^{8}	1.40×10^{7}	12.50
Freshwater Drum	1.07×10^{8}	1.26×10^{7}	11.00
Mottled Sculpin	5.39×10^{7}	8.95×10^{6}	16.62

TABLE 26. TOTAL ENTRAINMENT AT CENTRAL BASIN POWER PLANTS (ESTIMATED FROM FIELD COLLECTIONS)

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)
Clupeid	67.03	64.85	17.06	29.44	13.20	10.94
Rainbow Smelt	2.47	3.46	40.56	5.76	5.86	5.98
Carp/Goldfish	4.05		0.72	16.67	1.79	0.26
Cyprinidae	0.35					
Emerald Shiner	8.20	2.02	24.63	14.75	41.79	60.42
Spottail Shiner	2.10	0.31	10.77	3.36	5.40	0.65
Burbot					0.10	0.14
Trout Perch			4.07	5.83	3.10	0.66
White Bass	7.99					
Lepomis sp.						0.01

TABLE 26 (continued). TOTAL ENTRAINMENT AT CENTRAL BASIN POWER PLANTS (ESTIMATED FROM FIELD COLLECTIONS)

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)
Percidae		0.38	0.12		4.18	0.83
Walleye			0.14	0.25		
Yellow Perch	0.41	0.27	1.59	6.79	2.23	1.55
Log Perch	2.25	0.69		12.72	3.07	0.29
Johnny Darter					7.99	15.47
Freshwater Drum	3.64	28.07	0.23	4.33	1.16	0.41
Mottled Sculpin					10.00	2.46
Unidentifiable	1.28					
Total	100.00	100.00	100.00	100.00	100.00	100.00

TABLE 27. ESTIMATES OF THE RELATIVE ABUNDANCE OF FISH SPECIES ENTRAINED AT EACH OF SIX CENTRAL BASIN POWER PLANTS

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)	Total
Clupeid	15.95	68.43	4.84	3.86	6.30	0.56	3.68×10^7
Rainbow Smelt		79.88	15.48	1.80	0.24	2.54	3.23×10^7
White Sucker	3.74	41.03	45.49	5.59	3.65		2.04×10^6
Carp/Goldfish	0.61	20.20	35.18	11.70	32.30		4.52×10^7
Shiners	19.53	62.20	11.63	0.05	6.22	0.57	4.52×10^7
Minnows	7.98	23.79	30.28	2.42	35.40	0.16	2.09×10^8
Bluntnose Minnow		100.00					3.22×10^7
Burbot		100.00					2.42×10^5
Trout Perch	8.31	64.02	7.65	3.81	14.15	2.06	5.03×10^6

TABLE 27 (continued). ESTIMATES OF THE RELATIVE ABUNDANCE OF FISH SPECIES ENTRAINED AT EACH OF SIX CENTRAL BASIN POWER PLANTS

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)	Total
White Bass					100.0		2.00×10^5
Lepomis sp.	67.12	9.52				23.29	2.92×10^5
Micropterus sp.				100.00			1.70×10^5
Percidae			45.83		54.05		8.40×10^5
Sauger	100.0						2.09×10^4
Walleye					85.48	14.52	4.34×10^5
Yellow Perch		37.29	19.39		36.46	7.15	3.62×10^6
Freshwater Drum	27.36	56.94		15.83			7.20×10^5
Mottled Sculpin		72.58			27.42		2.99×10^5
Unidentifiable		49.49	35.70	2.88	10.08	1.86	4.93×10^7
All Species	11.82	54.44	18.53	2.55	11.85	0.89	4.28×10^8

except that problems in the study design as discussed in the section "Sources of Sample Variability" may be operating in this instance.

In-plant estimates of losses due to entrainment are greatest at the Avon Lake Plant where an estimated 2.33 x 10^8 (54.44% of the total) were entrained. Shiners were the most frequently entrained species (55.95% of Avon Lake total), followed by rainbow smelt (11.16%) and gizzard shad (10.87%). A total of 1.35 x 10^6 larval yellow perch (0.58%) were entrained at the Avon Lake Plant. The second highest entrainment estimates were calculated from in-plant collections at the Eastlake Plant where 7.93 x 10^7 larvae (18.53% of the total) were entrained. Entrainment at the Ashtabula A & B Plant and the Ohio Edison Edgewater Plant was essentially the same (5.06 x 10^7 and 5.07 x 10^7 larvae, respectively) with each contributing to 11.8% of the total Central Basin entrainment estimate. At the Ashtabula C Plant, an estimate of only 3.81 x 10^6 fish (0.89% of the total) were entrained. Table 28 gives the percentage of the total entrainment estimate for each species entrained at each plant.

Esimates indicated no larval yellow perch were entrained at either the Edgewater or Lake Shore Plants. Highest yellow perch entrainment was estimated at the Avon Lake Plant where 1.35 x 10^6 or 37.3% of the total yellow perch entrainment occurred. Entrainment at the Ashtabula A & B Plant was estimated at 1.32 x 10^6 yellow perch or 36.5% of the total perch entrainment. The Eastlake and Ashtabula C Plants accounted for the remaining 26.5% (19.7 and 7.1% respectively). The percentage of the total entrainment estimate for each species entrained at each power plant is presented in Table 29.

In general, the entrainment estimates derived from in-plant collections probably better represent the actual entrainment numbers than those calculated from field surveys. Not being weather-dependent, the in-plant collections were made on a more regular basis than field collections. Avoidance is less of a problem with pump-collected samples. One must use caution when comparing entrainment estimates derived from in-plant collections to abundance estimates derived from the field survey. The collection techniques are obviously different.

It should also be noted that the technique used in this study yields the number entrained, but does not thoroughly address the impact on adult populations. No mention has been made of mortality of entrained larvae, of natural mortality rates, or of density dependent mechanisms influencing natural mortality rates as influenced by entrainment. The state of the art in these areas is poorly developed at best.

In general, power plant entrainment of larval fishes probably has a rather small impact on Lake Erie fish populations, particularly in the Central Basin. In the Western Basin, losses due to entrainment of

species of commercial and/or sport interest are greatest at Toledo Edison's Bayshore Plant, due to its location at the mouth of the Maumee River estuary. Future power plants can be located to minimize losses due to entrainment. Power plants located in estuaries result in greater losses due to entrainment than those along the shoreline. The selection of an appropriate site along the shoreline must be made with care. The results of this study indicate selected areas along the Ohio shoreline contain valuable spawning and nursery areas for species of commercial and sport interest, i.e., the area between Little Cedar Point and Locust Point. Similarly the results of this study indicate the Detroit Edison Plant at Monroe is well located in a relatively depauperate area of the Western Basin. An alternative explanation, of course, is that the area is relatively devoid of larvl fishes due to the operation of the plant.

TABLE 27. COMPARISON OF NEARSHORE PRODUCTION ESTIMATES AND TOTAL ENTRAINMENT ESTIMATES OF SIX CENTRAL BASIN POWER PLANTS DURING THE 1978 SAMPLING PERIOD (CALCULATED FROM IN-PLANT COLLECTIONS)

Species	Nearshore Production	Entrainment Estimate	Percent Entrained
Clupeid	1.51×10^{10}	3.68×10^{7}	0.24
Rainbow Smelt	4.28×10^{8}	3.23×10^{7}	7.51
White Sucker	1.65×10^{6}	2.04×10^{6}	124.00
Carp/Goldfish	1.26×10^{8}	4.52×10^{7}	35.92
Shiner & Minnow	5.22×10^{9}	2.41×10^{8}	4.61
Burbot	2.58×10^{6}	2.42×10^{5}	9.42
Trout Perch	1.04×10^{8}	5.03×10^{6}	4.84
White Bass	1.92×10^{6}	2.00×10^{5}	10.01
Percidae	3.50×10^{7}	8.40×10^{5}	2.42
Sauger	1.14×10^{6}	2.09×10^{4}	1.83
Walleye	5.69×10^{6}	4.34×10^{5}	7.61
Yellow Perch	1.09×10^{8}	3.62×10^{6}	3.32
Log Perch	5.23×10^{7}	8.15×10^{6}	15.01
Freshwater Drum	1.07×10^{8}	7.20×10^{5}	0.77
Mottled Sculpin	5.39×10^{7}	2.99×10^{5}	0.55

TABLE 28. PERCENTAGE OF TOTAL ESTIMATED ENTRAINMENT BY SPECIES AT EACH OF SIX CENTRAL BASIN POWER PLANTS

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)
Clupeid	55.42	10.87	2.24	13.07	4.58	5.49
Rainbow Smelt		11.16	6.29	5.46	0.15	21.92
White Sucker	0.01	0.36	1.17	1.05	0.15	
Carp/Goldfish	2.63	3.94	20.01	48.65	28.80	
Shiners	3.86	55.94	30.51	0.93	25.64	31.97
Minnows	24.26	3.31	12.26	7.16	22.48	1.30
Bluntnose Minnow	6.77					
Burbot		0.10				
Trout Perch	0.39	1.30	0.48	1.77	1.40	2.77
White Bass		0.09				

TABLE 28 (continued). PERCENTAGE OF TOTAL ESTIMATED ENTRAINMENT BY SPECIES AT EACH OF SIX CENTRAL BASIN POWER PLANTS

Species	Edgewater (%)	Avon Lake (%)	Eastlake (%)	Lake Shore (%)	Ashtabula A & B (%)	Ashtabula C (%)
Lepomis sp.	0.26		0.25		0.13	
Micropterus			0.48	1.56		
Percidae					1.01	
Sauger	0.20					
Walleye					0.78	1.70
Yellow Perch		0.58	0.88		2.60	6.93
Log Perch	3.62	1.14	3.21	6.21	2.89	3.37
Freshwater Drum	1.87	0.18		1.05		
Mottled Sculpin		0.09			0.16	
Unidentifiable		10.53	22.20	13.06	9.44	24.51
Total	100.00	100.00	100.00	100.00	100.00	100.00

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APPENDIX A

TABLE A-1. DEVELOPMENTAL STAGES AND RANGE OF LENGTHS OF LARVAL FISHES CAPTURED IN THE NEARSHORE ZONE AND THE MAUMEE AND SANDUSKY ESTUARIES OF THE WESTERN BASIN OF LAKE ERIE, 1975-1977

SPECIES	DEVELOPMENTAL STAGE[1]	MAUMEE AND SANDUSKY RIVER ESTUARIES-1975/1976 (mm)	NEARSHORE ZONE OF WESTERN BASIN 1977 (mm)
Gizzard Shad/Alewife	Pro-Larvae	3.0 - 6.5	
	Post-Larvae	4.0 - 18.0	5.0 - 25.0
Lake Whitefish	Post-Larvae		12.0 - 19.5
Rainbow Smelt	Post-Larvae		6.5 - 23.0
Carp/Goldfish	Pro-Larvae	4.5 - 7.0	4.5 - 6.0
	Post-Larvae	6.5 - 14.0	6.0 - 17.0
Emerald Shiner	Pro-Larvae	4.7 - 6.0	
	Post-Larvae	5.0 - 15.0	6.0 - 14.0
Spottail Shiner	Pro-Larvae		5.0 - 6.0
	Post-Larvae		6.0 - 17.0
Quillback	Pro-Larvae		8.5 - 12.0
	Post-Larvae		12.0 - 13.0
White Sucker	Pro-Larvae	6.8 - 8.0	
	Post-Larvae	8.0 - 17.0	12.5 - 21.0
Channel Catfish	Post-Larvae		13.0 - 17.0
Trout Perch	Pro-Larvae	6.0 - 7.0	5.0 - 7.0
	Post-Larvae	7.0 - 10.0	
White Bass/White Perch	Pro-Larvae	2.5 - 3.5	4.0 - 7.0
	Post-Larvae	3.5 - 14.0	7.0 - 20.0
Sunfish	Pro-Larvae	4.0 - 5.5	6.0
	Post-Larvae	5.5 - 9.0	7.0 - 10.0
Crappie	Pro-Larvae	2.5 - 5.0	
	Post-Larvae	4.0 - 16.0	7.0 - 8.0
Yellow Perch	Pro-Larvae	4.1 - 7.0	4.0 - 6.0
	Post-Larvae	7.0 - 13.0	6.0 - 21.0
Sauger	Pro-Larvae		6.5 - 8.5
	Post-Larvae		9.0
Walleye	Pro-Larvae	6.0 - 10.0	6.0 - 9.0
	Post-Larvae	9.5 - 15.0	9.0 - 22.0
Logperch	Pro-Larvae	4.5 - 6.2	6.0
	Post-Larvae	5.5 - 14.0	6.5 - 21.0
Freshwater Drum	Pro-Larvae	2.0 - 4.4	4.0 - 6.5
	Post-Larvae	4.4 - 15.0	7.0 - 15.0

[1]Developmental stages as defined by Hubbs (1944)

APPENDIX A

TABLE A-2. DEVELOPMENTAL STAGES[1] AND RANGE OF LENGTHS OF SELECTED LARVAL FISH CAPTURED IN THE WESTERN BASIN DURING 1975 AND 1976

SPECIES	DEVELOPMENTAL STAGE	RANGE (mm)
Gizzard Shad/Alewife	Protolarvae	3.0 - 10.0
	Mesolarvae	9.0 - 15.0
	Metalarvae	15.0 - 20.0
	Juveniles	22+
Emerald Shiner	Protolarvae	4.0 - 8.0
	Mesolarvae	8.0 - 10.0
	Metalarvae	11.0 - 14.0
	Juveniles	13.0+
White Bass/White Perch	Protolarvae	3.0 - 8.0
	Mesolarvae	8.0 - 11.0
	Metalarvae	10.0 - 23.0
Yellow Perch	Protolarvae	4.0 - 10.0
	Mesolarvae	10.0 - 13.0
	Metalarvae	13.0 - 17.0
Freshwater Drum	Protolarvae	3.0 - 5.5
	Mesolarvae	6.0 - 7.0

[1]Developmental stages as defined by Snyder (1977).

TABLE A-3. DEVELOPMENTAL STAGES [1] AND RANGE OF LENGTHS OF SELECTED LARVAL FISHES CAPTURED IN THE NEARSHORE ZONE OF WESTERN LAKE ERIE DURING 1977

SPECIES	DEVELOPMENTAL STAGE	RANGE (mm)
Gizzard Shad/Alewife	Protolarvae	4.0 - 10.0
	Mesolarvae	10.0 - 16.0
	Metalarvae	14.0 - 22.0
White Bass/White Perch	Protolarvae	4.0 - 8.0
	Mesolarvae	8.0 - 12.0
	Metalarvae	10.0 - 20.0
Walleye	Protolarvae	6.0 - 11.0
Logperch	Protolarvae	5.0 - 8.0
	Mesolarvae	11.0 - 15.0
	Metalarvae	15.0 - 21.0
Freshwater Drum	Protolarvae	5.0 - 6.0
	Mesolarvae	7.0 - 13.0
	Metalarvae	9.0 - 22.0

[1] Developmental stages as defined by Snyder (1977).

APPENDIX B

TABLE B-1. VOLUME WEIGHTED ESTIMATES OF LARVAL ABUNDANCE IN THREE NEARSHORE DEPTH ZONES OF THE WESTERN BASIN (1977)

SPECIES	0-1 Meter Depth Zone	1-3 Meter Depth Zone	3-5 Meter Depth Zone	Western Basin Nearshore Total
Gizzard Shad	3.12×10^{9}	2.64×10^{9}	4.52×10^{9}	1.03×10^{10}
	3.91×10^{8}	2.83×10^{9}	3.96×10^{8}	4.62×10^{8}
Whitefish	4.99×10^{4}	4.80×10^{5}	7.47×10^{5}	2.32×10^{6}
	1.73×10^{4}	1.78×10^{5}	2.11×10^{5}	4.71×10^{5}
Rainbow Smelt	1.89×10^{7}	1.63×10^{7}	2.81×10^{7}	6.34×10^{7}
	2.21×10^{6}	2.26×10^{6}	3.51×10^{6}	2.92×10^{6}
Quillback Carpsucker	2.13×10^{5}	3.08×10^{5}	2.44×10^{5}	7.65×10^{5}
	1.06×10^{5}	1.16×10^{5}	7.13×10^{4}	2.28×10^{4}
White Sucker	4.99×10^{4}	4.80×10^{5}	7.47×10^{5}	1.28×10^{6}
	1.73×10^{4}	1.78×10^{5}	2.11×10^{5}	1.66×10^{5}
Carp	8.76×10^{6}	3.59×10^{7}	1.20×10^{8}	1.64×10^{8}
	7.22×10^{5}	3.02×10^{6}	1.67×10^{7}	2.73×10^{7}

TABLE B-1 (continued).

SPECIES	0-1 Meter Depth Zone	1-3 Meter Depth Zone	3-5 Meter Depth Zone	Western Basin Nearshore Total
Cyprinidae	2.42×10^5 8.89×10^4	3.51×10^5 4.21×10^4	7.70×10^4	6.70×10^5 6.50×10^4
Emerald Shiner	5.58×10^7 6.75×10^6	1.81×10^8 3.62×10^7	2.78×10^8 5.24×10^7	5.16×10^8 5.22×10^7
Spottail Shiner	2.01×10^6 2.87×10^5	5.10×10^6 9.27×10^5	5.59×10^6 1.11×10^6	1.27×10^7 9.16×10^5
Channel Catfish	3.13×10^5 1.04×10^5	9.38×10^4 8.01×10^3	2.62×10^5 2.24×10^4	6.69×10^5 5.41×10^4
Trout Perch	1.22×10^4 2.10×10^3	1.45×10^5 2.20×10^4	2.27×10^5 7.55×10^4	3.83×10^5 5.10×10^4
White Bass	1.31×10^8 1.55×10^7	5.21×10^7 4.86×10^6	8.26×10^7 1.04×10^7	2.65×10^8 1.87×10^7
Pomoxis sp.		3.41×10^5	1.29×10^6	1.63×10^6 3.16×10^5

TABLE B-1 (continued).

SPECIES	0-1 Meter Depth Zone	1-3 Meter Depth Zone	3-5 Meter Depth Zone	Western Basin Nearshore Total
Lepomis sp.	2.21×10^{5}	2.52×10^{5}	6.43×10^{5}	4.12×10^{6}
	9.95×10^{4}	1.12×10^{5}	1.53×10^{5}	1.11×10^{5}
Percidae	2.66×10^{5}			2.66×10^{5}
				7.24×10^{4}
Sauger	7.56×10^{5}	1.49×10^{6}		2.25×10^{6}
				2.59×10^{5}
Walleye	4.63×10^{6}	2.27×10^{7}	3.35×10^{7}	6.08×10^{7}
	4.12×10^{5}	2.12×10^{6}	4.14×10^{6}	6.87×10^{6}
Yellow Perch	1.41×10^{8}	4.46×10^{8}	7.58×10^{8}	1.35×10^{9}
	1.23×10^{7}	3.85×10^{7}	6.99×10^{7}	1.46×10^{8}
Log Perch	6.65×10^{6}	2.95×10^{7}	3.20×10^{7}	6.82×10^{7}
	7.44×10^{5}	3.77×10^{6}	2.51×10^{6}	6.59×10^{6}

TABLE B-1 (continued).

SPECIES	0-1 Meter Depth Zone	1-3 Meter Depth Zone	3-5 Meter Depth Zone	Western Basin Nearshore Total
Freshwater Drum	2.52×10^7 4.11×10^6	9.41×10^7 1.64×10^7	2.24×10^7 1.93×10^8	1.42×10^8 1.91×10^7
Unidentifiable	1.03×10^6 4.48×10^4	3.33×10^5		1.36×10^6 2.48×10^5
Total	3.52×10^9 2.04×10^8	3.53×10^9 1.23×10^8	5.88×10^9 2.06×10^8	1.30×10^{10} 4.77×10^8

APPENDIX B

TABLE B-2. VOLUME WEIGHTED ESTIMATES (FOR ENTIRE SAMPLING PERIOD) OF LARVAL FISHES IN THE NEARSHORE ZONE OF THE CENTRAL BASIN IN 1978

SPECIES	0-1 METER DEPTH ZONE	3-5 METERS DEPTH ZONE	5-10 METERS DEPTH ZONE	CENTRAL BASIN NEARSHORE TOTAL
Gizzard Shad	1.09×10^{6}	5.06×10^{8}	1.00×10^{10}	1.51×10^{10}
	9.05×10^{4}	3.85×10^{7}	7.36×10^{8}	2.88×10^{9}
Rainbow Smelt	8.30×10^{4}	7.48×10^{7}	3.53×10^{8}	4.28×10^{8}
	1.02×10^{4}	6.38×10^{6}	2.56×10^{7}	1.07×10^{8}
Quillback	1.32×10^{3}	5.54×10^{5}		5.55×10^{5}
Carpsucker	7.20×10^{2}	3.97×10^{4}		1.84×10^{5}
White Sucker	2.74×10^{3}	1.34×10^{6}	3.12×10^{5}	1.65×10^{6}
	1.93×10^{3}	1.09×10^{5}	7.11×10^{4}	4.03×10^{5}
Carp	2.47×10^{5}	1.00×10^{8}	2.53×10^{7}	1.26×10^{8}
	2.17×10^{4}	8.51×10^{6}	2.18×10^{6}	3.00×10^{7}
Cyprinidae sp.	1.80×10^{5}	8.00×10^{7}	1.73×10^{7}	9.75×10^{7}
	2.10×10^{4}	9.01×10^{6}	1.49×10^{6}	2.43×10^{7}
Golden Shiner	1.49×10^{2}	2.24×10^{5}	4.27×10^{4}	2.67×10^{5}
	7.40×10	3.85×10^{4}	4.20×10^{3}	6.18×10^{4}

TABLE B-2. (continued)

SPECIES	0-1 METER DEPTH ZONE	3-5 METERS DEPTH ZONE	5-10 METERS DEPTH ZONE	CENTRAL BASIN NEARSHORE TOTAL
Striped Shiner	7.14×10^{3} 7.14×10^{2}	4.00×10^{6} 1.22×10^{6}	3.64×10^{6} 1.04×10^{6}	7.65×10^{6} 1.28×10^{6}
Emerald Shiner	4.83×10^{5} 6.51×10^{4}	7.43×10^{8} 1.09×10^{8}	3.53×10^{9} 6.80×10^{8}	4.28×10^{9} 1.08×10^{9}
Spottail Shiner	1.77×10^{6} 1.93×10^{5}	7.26×10^{8} 8.18×10^{7}	1.04×10^{8} 4.43×10^{7}	8.38×10^{8} 2.26×10^{7}
Burbot	3.26×10^{3} 3.40×10^{2}	1.80×10^{6} 9.58×10^{5}	7.86×10^{5} 7.86×10^{4}	2.58×10^{6} 5.19×10^{5}
Trout Perch	1.07×10^{5} 6.51×10^{3}	6.00×10^{7} 3.64×10^{6}	4.42×10^{7} 2.20×10^{6}	1.04×10^{8} 1.79×10^{7}
White Bass	1.74×10^{3} 1.93×10^{2}	2.31×10^{5} 6.36×10^{4}	1.69×10^{6} 6.79×10^{5}	1.92×10^{6} 5.28×10^{5}
Pomoxis sp.	6.41×10^{2} 1.42×10^{2}	3.24×10^{5} 4.81×10^{4}	1.11×10^{6} 2.25×10^{5}	1.43×10^{6} 3.28×10^{5}

TABLE B-2. (continued)

SPECIES	0-1 METER DEPTH ZONE	3-5 METERS DEPTH ZONE	5-10 METERS DEPTH ZONE	CENTRAL BASIN NEARSHORE TOTAL
Black Crappie	1.86×10^{2}	9.35×10^{4}	2.15×10^{7}	2.16×10^{7}
	1.86×10^{2}	9.35×10^{4}	3.15×10^{6}	7.14×10^{6}
Lepomis sp.	1.46×10^{3}	1.22×10^{6}	6.72×10^{5}	1.89×10^{6}
	2.98×10^{2}	1.52×10^{5}	1.12×10^{5}	3.52×10^{5}
Percidae sp.	7.13×10^{3}	1.35×10^{7}	2.15×10^{7}	3.50×10^{7}
	1.56×10^{2}	1.64×10^{6}	3.15×10^{6}	6.27×10^{6}
Sauger	2.16×10^{3}	1.14×10^{6}		1.14×10^{6}
	2.16×10^{3}	1.28×10^{5}		3.80×10^{5}
Walleye	2.39×10^{3}	2.55×10^{6}	3.14×10^{6}	5.69×10^{6}
	3.14×10^{2}	3.47×10^{5}	6.69×10^{5}	9.63×10^{5}
Yellow Perch	1.24×10^{5}	6.50×10^{6}	4.40×10^{7}	1.09×10^{8}
	1.15×10^{4}	5.84×10^{5}	3.50×10^{6}	1.91×10^{7}

APPENDIX C

TABLE C-1. Determination of the Average Lifetime Fecundity (F_a) of a Three Year-Old Recruit to the Yellow Perch Population of the Ohio Waters of the Western Basin of Lake Erie.

AGE	S_j[1]	P_j[2]	E_j[3]	$P_j S_j E_j$[4]
2	1.00	0.14	---	---
3	0.94	0.85	15,000	13564
4	0.62	0.95	17,500	10308
5	0.06	1.00	20,000	1200
6	0.001	1.00	20,000	20

$$F_a = \sum_{j=3}^{6} P_j S_j E_j = 25092$$

[1]From Davies, D. H., M. R. Rawson and G. A. Emond. 1979. Performance Report. Lake Erie Fishery Research, Fed. Aid Proj. F-35-R-17, Study II. 56 p.

[2]Preliminary data from M. R. Rawson. Pers. comm.

[3]Van Meter, H. 1966. Yellow Perch Fecundity. Unpublished memo.

[4]The survival fraction (S_j) of females and the fraction of mature females within each age class (P_j) and the fecundity of mature females within each age class (E_j) are estimated from published and unpublished sources.

APPENDIX C

TABLE C-2. Seasonal Length Frequency Distribution of Larval Yellow Perch Needed to Estimate the Instantaneous Rate of Mortality on Length (d).

LENGTH CLASS (l)	LENGTH (mm)	NUMBER COLLECTED (1975)	NUMBER COLLECTED (1976)
1	6.0- 6.9	833	836
2	7.0- 7.9	389	160
3	8.0- 8.9	220	68
4	9.0- 9.9	212	41
5	10.0-10.9	234	60
6	11.0-11.9	36	37
7	12.0-12.9	11	22
8	13.0-13.9	8	12
9	14.0-14.9	7	3

$$d = -\ln \frac{\sum_{l=2}^{9} N_l}{\sum_{l=1}^{9} N_l}$$

$d_{1975} = 0.5568$

$d_{1976} = 1.1231$

APPENDIX C

TABLE C-3. Estimates of $S_{e,l}$ and S_l, for Each Length Class of Larval Yellow Perch.[1]

LENGTH CLASS	LENGTH (mm)	SURVIVAL PROBABILITY FROM EGG TO LENGTH CLASS l $(S_{e,l})^3$		SURVIVAL PROBABILITY FROM LENGTH CLASS l TO AGE 3	
		1975	1976	1975	1976
1	6.0- 6.9	0.0749	0.0752	0.0016	0.0016
2	7.0- 7.9	0.0350	0.0144	0.0034	0.0083
3	8.0- 8.9	0.0199	0.0061	0.0060	0.0196
4	9.0- 9.9	0.0191	0.0037	0.0063	0.0323
5	10.0-10.9	0.0211	0.0054	0.0057	0.0221
6	11.0-11.9	0.0032	0.0033	0.0374	0.0362
7	12.0-12.9	0.0010	0.0020	0.1196	0.0598
8	13.0-13.9	0.0007	0.0011	0.1708	0.1087
9	14.0-14.9	0.0006	0.0003	0.1993	0.3984

$$S_{e,l} = H\frac{Ne}{No} \qquad S_l = \frac{3}{S_{e,l}\,F_a}$$

H = fraction of eggs that hatch
Ne = number of larvae of length class l
No = estimated initial number of larvae

[1]Parameter estimates are 0.135,[2] d_{1975} = 0.5568, d_{1976} = 1.1231, F_a = 25092 and h = 4mm

[2]Estimated by averaging fractions of eggs that hatch on various substrates reported by Johnson (1961) for walleye (Stizostedion v. vitreum) in Lake Winnibogoshigh, Minnesota.

[3]Note that length at hatching (h) is 4 mm which is 2 mm less than the first length class for which data are available. In performing the calculations of $S_{e,l}$, the value of d was assumed to be correct for these smaller length classes.

APPENDIX C

TABLE C-4. Estimate of the Loss of Three Year-Old Yellow Perch Recruits as a Result of Entrainment Mortality at the Davis-Besse Nuclear Power Plant in 1976.[1]

LENGTH CLASS (l)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED 1.00	NUMBER OF LARVAE OF LENGTH CLASS l N_l	SURVIVAL PROBABILITY FROM LENGTH CLASS l TO AGE 3 S_l	ADULTS (AGE 3)	
							PER DAY	PERIOD OF CAPTURE
1	6.0- 6.9	0.065	8x10^4	1.00	5200	0.0016	8.32	216.3
2	7.0- 7.9	0.012	8x10^4	1.00	960	0.0083	7.97	207.2
3	8.0- 8.9	0.003	8x10^4	1.00	240	0.0196	4.70	150.5
4	9.0- 9.9	0.001	8x10^4	1.00	80	0.0323	2.58	82.7
5	10.0-10.9	0.002	8x10^4	1.00	160	0.0221	3.54	148.5
6	11.0-11.9	0.001	8x10^4	1.00	80	0.0362	2.90	57.9
7	12.0-12.9	0.0007	8x10^4	1.00	56	0.0598	3.35	67.0
8	13.0-13.9	0.0006	8x10^4	1.00	48	0.1087	5.22	15.7
9	14.0-14.9	0.00003	8x10^4	1.00	2.4	0.3984	0.96	2.9
TOTAL				1.00			39.54	948.7

[1]Davis-Besse did not operate during 1975

APPENDIX C

TABLE C-5. Estimate of the Loss of Three Year Old Yellow Perch Recruits as a Result of Entrainment Mortality at the Bayshore Power Plant in 1975.

LENGTH CLASS (l)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED	NUMBER OF LARVAE OF LENGTH CLASS l N_l	SURVIVAL PROBABILITY FROM LENGTH CLASS l TO AGE 3 S_l	ADULTS (AGE 3)	
							NO./DAY	PERIOD OF CAPTURE
1	6.0- 6.9	0.081	2.8x10^6	1.00/0.66	2.268x10^5	0.0016	362.88/239.50	13063.7/8622.0
2	7.0- 7.9	0.038	2.8x10^6	1.00/0.66	1.064x10^5	0.0034	361.75/238.76	13023.4/8595.4
3	8.0- 8.9	0.024	2.8x10^6	1.00/0.66	6.72x10^4	0.0060	403.20/266.11	14515.2/9580.0
4	9.0- 9.9	0.023	2.8x10^6	1.00/0.66	6.44x10^4	0.0063	405.72/267.78	14605.9/9639.9
5	10.0-10.9	0.021	2.8x10^6	1.00/0.66	5.88x10^4	0.0057	335.16/221.21	12065.8/7963.4
6	11.0-11.9	0.004	2.8x10^6	1.00/0.66	1.12x10^4	0.0374	418.88/276.46	15079.7/9952.6
7	12.0-12.9	0.0036	2.8x10^6	1.00/0.66	1.008x10^4	0.1196	1205.57/795.67	32550.3/21483.2
8	13.0-13.9	0.003	2.8x10^6	1.00/0.66	8.4x10^3	0.1708	1434.72/946.92	38737.4/25566.7
9	14.0-14.9	0.002	2.8x10^6	1.00/0.66	5.6x10^3	0.1993	1116.08/736.61	39062.8/25781.4
TOTAL				1.00/0.66			6043.96/3989.01	192704.2/127184.8

APPENDIX C

TABLE C-6. Estimate of the Loss of Three Year-old Yellow Perch Recruits as a Result of Entrainment Mortality at the Bayshore Power Plant in 1976.

LENGTH CLASS (l)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED	NUMBER OF LARVAE OF LENGTH CLASS l N_l	SURVIVAL PROBABILITY FROM LENGTH CLASS l TO AGE 3 S_l	ADULTS (AGE 3) NO./DAY	
							NO./DAY	PERIOD OF CAPTURE
1	6.0- 6.9	0.065	2.8×10^6	$\frac{1.00}{0.66}$	1.82×10^5	0.0016	$\frac{291.20}{192.19}$	$\frac{7571.2}{4997.0}$
2	7.0- 7.9	0.012	2.8×10^6	$\frac{1.00}{0.66}$	3.36×10^4	0.0083	$\frac{278.88}{184.06}$	$\frac{7250.9}{4785.6}$
3	8.0- 8.9	0.003	2.8×10^6	$\frac{1.00}{0.66}$	8.40×10^3	0.0196	$\frac{164.64}{108.66}$	$\frac{5268.5}{3477.2}$
4	9.0- 9.9	0.001	2.8×10^6	$\frac{1.00}{0.66}$	2.80×10^3	0.0323	$\frac{90.44}{59.69}$	$\frac{2894.1}{1910.1}$
5	10.0-10.9	0.002	2.8×10^6	$\frac{1.00}{0.66}$	5.60×10^3	0.0221	$\frac{123.76}{81.68}$	$\frac{5197.9}{3430.6}$
6	11.0-11.9	0.001	2.8×10^6	$\frac{1.00}{0.66}$	2.80×10^3	0.0362	$\frac{101.36}{66.90}$	$\frac{2027.2}{1337.9}$
7	12.0-12.9	0.0007	2.8×10^6	$\frac{1.00}{0.66}$	1.96×10^3	0.0598	$\frac{117.20}{77.40}$	$\frac{2344.2}{1547.1}$
8	13.0-13.9	0.0006	2.8×10^6	$\frac{1.00}{0.66}$	1.68×10^3	0.1087	$\frac{182.62}{120.53}$	$\frac{3652.3}{2410.5}$
9	14.0-14.9	0.00003	2.8×10^6	$\frac{1.00}{0.66}$	8.40×10^2	0.3984	$\frac{33.50}{22.09}$	$\frac{100.4}{066.3}$
TOTAL				$\frac{1.00}{0.66}$			$\frac{1383.6}{913.18}$	$\frac{36306.7}{23962.4}$

APPENDIX C

TABLE C-7. ESTIMATE OF THE LOSS OF THREE-YEAR-OLD YELLOW PERCH RECRUITS AS A RESULT OF ENTRAINMENT MORTALITY AT THE BAYSHORE POWER PLANT IN 1977.

LENGTH CLASS (ℓ)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED	NUMBER OF LARVAE OF LENGTH CLASS ℓ N_ℓ	SURVIVAL PROBABILITY FROM LENGTH GLASS ℓ. TO AGE 3 S_ℓ	ADULTS (AGE 3) NO./DAY	
							NO./DAY	PERIOD OF CAPTURE (33 DAYS)
1	6.0-6.9	.3117	2.8×10^6	$\frac{1.00}{0.66}$	8.7276×10^5	0.0016	$\frac{1.4\times10^3}{9.2\times10^2}$	$\frac{4.6\times10^4}{3.0\times10^4}$
2	7.0-7.9	.3158	2.8×10^6	$\frac{1.00}{0.66}$	8.8424×10^5	0.0083	$\frac{7.3\times10^3}{4.8\times10^3}$	$\frac{2.4\times10^5}{1.6\times10^5}$
3	8.0-8.9	.1646	2.8×10^6	$\frac{1.00}{0.66}$	4.6088×10^5	0.0196	$\frac{9.0\times10^3}{6.0\times10^3}$	$\frac{3.0\times10^5}{2.0\times10^5}$
4	9.0-9.9	.0647	2.8×10^6	$\frac{1.00}{0.66}$	1.8116×10^5	0.0323	$\frac{5.9\times10^3}{3.9\times10^3}$	$\frac{1.9\times10^5}{1.3\times10^5}$
5	10.0-10.9	.0399	2.8×10^6	$\frac{1.00}{0.66}$	1.1172×10^5	0.0221	$\frac{2.5\times10^3}{1.6\times10^3}$	$\frac{8.1\times10^4}{5.4\times10^4}$
6	11.0-11.9	.0564	2.8×10^6	$\frac{1.00}{0.66}$	1.5792×10^5	0.0362	$\frac{5.7\times10^3}{3.8\times10^3}$	$\frac{1.9\times10^5}{1.2\times10^5}$
7	12.0-12.9	.0582	2.8×10^6	$\frac{1.00}{0.66}$	1.6296×10^5	0.0598	$\frac{9.7\times10^3}{6.4\times10^3}$	$\frac{3.2\times10^5}{2.1\times10^5}$
8	13.0-13.9	.0789	2.8×10^6	$\frac{1.00}{0.66}$	2.2092×10^5	0.1087	$\frac{2.4\times10^4}{1.5\times10^4}$	$\frac{7.9\times10^5}{5.2\times10^5}$
							$\frac{6.5\times10^4}{4.3\times10^4}$	$\frac{2.2\times10^6}{1.4\times10^6}$

APPENDIX D

TABLE D-1. Determination of the Average Lifetime Fecundity (F_a) of a One Year-old Recruit to the Western Basin Emerald Shiner Population.[1]

AGE	S_i	P_i	E_i	$P_i S_i E_i$
0	1.00	0.00	---	0
1	0.655	0.296	1800	349
2	0.345	0.561	4000	774
3	0.170	0.092	8000	125
4	0.019	0.051	8000	8

$$F_a = \sum_{i=0}^{4} P_i S_i E_i = 1256$$

[1]The survival fraction (S_i) of females, the fraction (P_i) of females within each age class and the fecundity of mature females (E_i) are known (Flittner, 1964).

APPENDIX D

TABLE D-2. Seasonal Length Frequency Distribution of Emerald Shiner Larvae Needed to Estimate the Instantaneous Rate of Mortality on Length (d).

LENGTH CLASS (l)	LENGTH (mm)	NUMBER COLLECTED	
		1975	1976
1	7.0- 7.9	340	---
2	8.0- 8.9	167	---
3	9.0- 9.9	176	1054
4	10.0-10.9	114	475
5	11.0-11.9	45	367
6	12.0-12.9	22	245
7	13.0-13.9	12	97
8	14.0-14.9	6	5
9	15.0-15.9	2	1

$$d_{1975} = -ln \frac{\sum_{l=2}^{9} N_l}{\sum_{l=1}^{9} N_l} = -ln\ 0.61538 = 0.4855$$

$$d_{1976} = -ln\ 0.53030 = 0.6343$$

APPENDIX D

TABLE D-3. Estimates of $S_{e,l}$ and S_l for Each Length Class of Larval Emerald Shiner.[1]

LENGTH CLASS	LENGTH (mm)	SURVIVAL PROBABILITY FROM EGG TO LENGTH CLASS l ($S_{e,l}$)[2]		SURVIVAL PROBABILITY FROM LENGTH CLASS l TO AGE 1	
		1975	1976	1975	1976
1	7.0- 7.9	0.0531	---	0.0199	---
2	8.0- 8.9	0.0261	---	0.0305	---
3	9.0- 9.9	0.0275	0.1647	0.0289	0.0048
4	10.0-10.9	0.0178	0.0742	0.0447	0.0107
5	11.0-11.9	0.0070	0.0573	0.1137	0.0139
6	12.0-12.9	0.0034	0.0383	0.2342	0.0208
7	13.0-13.9	0.0019	0.0152	0.4191	0.0524
8	14.0-14.9	0.0009	0.0008	0.8849	0.9950
9	15.0-15.9	0.0003	0.0002	2.6539	3.9891

$$S_{e,l} = H\frac{Ne}{No} \qquad S_l = \frac{1}{S_{e,l}\ F_a}$$

H = fraction of eggs that hatch
Ne = number of larvae of length class
No = estimated initial number of larvae

[1]Parameter estimates are 0.25, d_{1975} = 0.486, d_{1976} = 0.634, F_a = 1256 and h = 5 mm

[2]Note that length at hatching (h) is 5 mm which is 2-4 mm less than the first length class for which adequate data are available. In performing the calculations of $S_{e,l}$, the value of d was assumed to be correct for these smaller length classes.

APPENDIX D

TABLE D-4. Estimate of the Loss of One Year-old Emerald Shiner Recruits as a Result of Entrainment Mortality at the Toledo Edison Bayshore Power Plant in 1975.

LENGTH CLASS (*I*)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED	NUMBER OF LARVAE OF LENGTH CLASS *I* N_I	SURVIVAL PROBABILITY FROM LENGTH CLASS *I* TO AGE 1	ADULTS (AGE 1)	
							PER DAY	PERIOD OF CAPTURE
1	7.0- 7.9	0.0333	$2.8x10^6$	1.00 / 0.66	93,240	0.0199	1,855.48 / 1,224.61	179,981.2 / 118,787.6
2	8.0- 8.9	0.0111	$2.8x10^6$	1.00 / 0.66	31,080	0.0305	947.94 / 625.64	91,950.2 / 60,687.1
3	9.0- 9.9	0.0097	$2.8x10^6$	1.00 / 0.66	27,160	0.0289	784.92 / 518.05	65,148.7 / 42,998.1
4	10.0-10.9	0.0068	$2.8x10^6$	1.00 / 0.66	19,040	0.0447	851.09 / 561.72	70,640.3 / 46,622.6
5	11.0-11.9	0.0028	$2.8x10^6$	1.00 / 0.66	7,840	0.1137	891.41 / 588.33	57,941.5 / 38,241.4
6	12.0-12.9	0.0022	$2.8x10^6$	1.00 / 0.66	6,160	0.2342	1,442.67 / 952.16	93,773.7 / 61,890.6
7	13.0-13.9	0.0011	$2.8x10^6$	1.00 / 0.66	3,080	0.4191	1,290.83 / 851.95	83,903.8 / 55,376.5
8	14.0-14.9	0.0005	$2.8x10^6$	1.00 / 0.66	1,400	0.8849	1,238.86 / 817.65	80,525.9 / 53,147.1
9	15.0-15.9	0.0002	$2.8x10^6$	1.00 / 0.66	560	2.6539	1,486.18 / 980.88	14,861.8 / 9,808.8
TOTAL				1.00 / 0.66			10,789.38 / 7,120.99	738,727.1 / 487,560.3

APPENDIX D

TABLE D-5. Estimate of the Loss of One Year-old Emerald Shiner Recruits as a Result of Entrainment Mortality at the Toledo Edison Bayshore Power Plant in 1976.

LENGTH CLASS (*I*)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED	NUMBER OF LARVAE OF LENGTH CLASS *I* N_I	SURVIVAL PROBABILITY FROM LENGTH CLASS *I* TO AGE 1 S_I	ADULTS (AGE 1)	
							PER DAY	PERIOD OF CAPTURE
1	9.0- 9.9	0.320	$2.8x10^6$	1.00 / 0.66	896,000	0.0048	4,300.80 / 2,838.53	206,438.4 / 136,249.3
2	10.0-10.9	0.166	$2.8x10^6$	1.00 / 0.66	464,800	0.0107	4,973.36 / 3,282.41	238,721.3 / 157,556.0
3	11.0-11.9	0.131	$2.8x10^6$	1.00 / 0.66	366,800	0.0139	5,098.52 / 3,366.02	244,729.0 / 161,521.1
4	12.0-12.9	0.072	$2.8x10^6$	1.00 / 0.66	201,600	0.0208	4,193.28 / 2,767.56	201,277.4 / 132,843.1
5	13.0-13.9	0.029	$2.8x10^6$	1.00 / 0.66	81,200	0.0524	4,254.88 / 2,808.22	327,625.8 / 216,233.0
6	14.0-14.9	0.012	$2.8x10^6$	1.00 / 0.66	33,600	0.9950	33,432.0 / 22,065.12	568,344.0 / 375,107.0
7	15.0-15.9	0.0002	$2.8x10^6$	1.00 / 0.66	560	3.9891	2,233.90 / 1,474.37	17,871.2 / 11,795.0
TOTAL				1.00 / 0.66			58,486.74 / 38,601.25	1,805,007.1 / 1,191,304.7

APPENDIX D

TABLE D-6. Estimate of the Loss of One Year-old Emerald Shiner Recruits as a Result of Assumed Entrainment Mortality at the Davis-Besse Nuclear Power Plant in 1975.[1]

LENGTH CLASS (*l*)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED	NUMBER OF LARVAE OF LENGTH CLASS *l* N_l	SURVIVAL PROBABILITY FROM LENGTH CLASS *l* TO AGE 1	ADULTS (AGE 1) PER DAY	PERIOD OF CAPTURE
1	7.0- 7.9	0.0333	8x10^4	1.00	2,664	0.0199	53.01	5,142.3
2	8.0- 8.9	0.0111	8x10^4	1.00	888	0.0305	27.08	2,627.1
3	9.0- 9.9	0.0097	8x10^4	1.00	776	0.0289	22.43	1,861.4
4	10.0-10.9	0.0068	8x10^4	1.00	544	0.0447	24.32	2,018.3
5	11.0-11.9	0.0028	8x10^4	1.00	224	0.1137	25.47	1,655.5
6	12.0-12.9	0.0022	8x10^4	1.00	176	0.2342	41.22	2,679.2
7	13.0-13.9	0.0011	8x10^4	1.00	88	0.4191	36.88	2,397.3
8	14.0-14.9	0.0005	8x10^4	1.00	40	0.8849	35.40	2,300.7
9	15.0-15.9	0.0002	8x10^4	1.00	16	2.6539	42.46	424.6
TOTAL				1.00			308.27	21,106.4

[1]Davis-Besse Nuclear Power Plant did not operate during 1975

APPENDIX D

TABLE D-7. Estimate of the Loss of One Year-old Emerald Shiner Recruits as a Result of Entrainment Mortality at the Davis-Besse Nuclear Power Plant in 1976.

LENGTH CLASS (*l*)	LENGTH (mm)	MEAN DENSITY No./m^3	PLANT FLOW m^3/day	FRACTION KILLED	NUMBER OF LARVAE OF LENGTH CLASS *l* N_l	SURVIVAL PROBABILITY FROM LENGTH CLASS *l* TO AGE 1 S_l	ADULTS (AGE 1) PER DAY	PERIOD OF CAPTURE
1	9.0- 9.9	0.320	8x10^4	1.00	25,600	0.0048	122.88	5,898.2
2	10.0-10.9	0.166	8x10^4	1.00	13,280	0.0107	142.10	6,820.8
3	11.0-11.9	0.131	8x10^4	1.00	10,480	0.0139	145.67	6,992.3
4	12.0-12.9	0.072	8x10^4	1.00	5,760	0.0208	119.81	5,750.9
5	13.0-13.9	0.029	8x10^4	1.00	2,320	0.0524	121.57	9,360.7
6	14.0-14.9	0.012	8x10^4	1.00	960	0.9950	955.20	16,238.4
7	15.0-15.9	0.0002	8x10^4	1.00	16	3.9891	63.82	510.6
TOTAL				1.00			1,671.05	51,571.9

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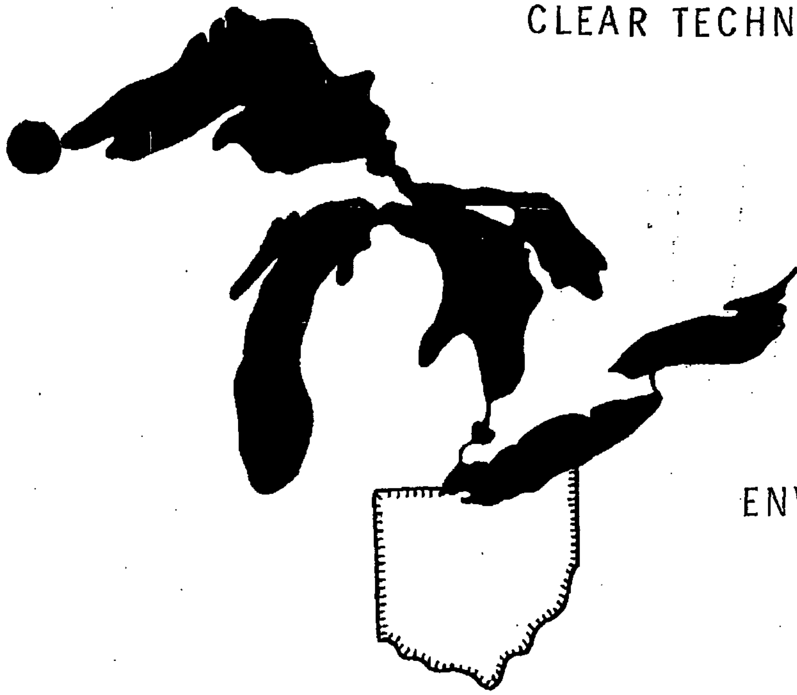

ENVIRONMENTAL EVALUATION OF A NUCLEAR POWER PLANT ON LAKE ERIE

PROJECT NO. F-41-R FINAL REPORT STUDY I

Prepared by

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COLUMBUS, OHIO

September 1980

Ohio Department of Natural Resources
Division of Wildlife

RESPONSE OF FISH AND INVERTEBRATES TO THE HEATED DISCHARGE FROM THE DAVIS-BESSE NUCLEAR POWER STATION, LAKE ERIE, OHIO

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ABSTRACT

The Davis-Besse Nuclear Power Station is located in Ottawa County, Ohio, at Locust Point on the southwest shore of Lake Erie, about 21 miles east of Toledo. Unit 1 has a net electrical capacity of 906 MWe and a closed cycle cooling system which dissipates heat to the atmosphere by means of a natural-draft cooling tower, 493 feet high and 415 feet in diameter at its base. 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

*Final Report of research conducted for the Ohio Department of Natural Resources, Division of Wildlife, under Federal Aid in Fish Restoration Project F-41-R-1 through R-11, Study 1 (1 June 1969 through 30 June 1980).

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 $20^{0}F$.

Studies of the aquatic environment in Lake Erie in the vicinity of the intake and discharge of this station were initiated in 1969. From 1973 to 1979, with few exceptions, the following parameters were sampled, during ice-free times, at approximately monthly intervals: water quality, phytoplankton, zooplankton, benthic macroinvertebrates (60-day intervals in 1977, 1978, and 1979), fish, and ichthyoplankton (approximately 10-day intervals during the spring spawning season). As is to be expected when a new unit first goes "on line", Unit 1 was operated sporadically from August 1977 through December 1979. It is the purpose of this report to summarize the information collected since 1969 and to define the changes in the aquatic environment (impact) caused by the thermal discharge from the Davis-Besse Nuclear Power Station.

Phytoplankton. Quantitative estimates of phytoplankton densities at Locust Point were obtained at approximately monthly intervals from 1974 through 1979. Operational phytoplankton densities were larger during the spring and fall than pre-operational densities. This was a natural phenomenon occurring throughout the nearshore waters of western Lake Erie and not caused by the thermal discharge.

Zooplankton. Quantitative estimates of zooplankton densities in Lake Erie at Locust Point were obtained at approximately monthly intervals from 1973 through 1979. With the exception of cladoceran densities, which were very similar during the pre-operational and operational studies,

zooplankton operational densities, though generally similar to pre-operational densities, were somewhat lower than the corresponding pre-operational monthly density. However, these differences appeared to be due to natural phenomena occurring along the south shore of the Western Basin and not related to the thermal discharge.

Benthic Macroinvertebrates. Benthic macroinvertebrate densities in Lake Erie at Locust Point were observed at approximately 30-day intervals from 1973-1976 and 60-day intervals from 1977-1979. Operational densities were within the ranges established during the pre-operational study for every month except September. Differences were attributable to natural variation.

Fish. Monthly gill net catches from Lake Erie near Locust Point from 1973-1979 were used to evaluate the impact of unit operation. Fish populations for each of the eight major species at Locust Point, alewife, channel catfish, freshwater drum, gizzard shad, spottail shiner, walleye, white bass, and yellow perch, and the density of all species combined showed little or no variation between pre-operational and operational results.

Ichthyoplankton. Ichthyoplankton densities from Lake Erie in the vicinity of the intake and discharge were monitored at approximately 10-day intervals from 1974 through 1979. Tremendous variability was observed from year to year. However, due to the similarity in densities observed at the intake and discharge and control stations, there is indication that the thermal discharge has not significantly altered these populations.

Water Quality. Eighteen water quality parameters were monitored at approximately monthly intervals beginning in April 1974. In general the quality of Lake Erie water in the vicinity of the Station's discharge

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BACKGROUND

The Toledo Edison Company and The Cleveland Electric Illuminating Company have constructed Unit I of the Davis-Besse Nuclear Power Station on the south shore of Lake Erie at Locust Point (Figure 1). This plant utilizes a closed condenser cooling water system to dissipate heat from the steam condenser to the atmosphere by means of a natural draft cooling tower. Water from Lake Erie is used to replenish the supply and dilute the cooling tower blowdown water which is returned to the lake at a maximum of 11.1^{o}C above ambient lake temperature (U.S. Nuclear Regulatory Commission, 1975). The area of the 0.56^{o}C isotherm should be less than 1.6 hectares and the area of the 1.67^{o}C isotherm should be approximately 0.3 hectares. The effluent is discharged from the lake bottom, through a high velocity nozzle, over a rockfill approximately 305 meters offshore. According to Eugene C. Novak, Chief Mechanical Engineer for Toledo Edison (personal communication, January 1974), under adverse high lake level conditions the discharge structure can hydraulically handle a maximum flow of 190,000 l/min. It is designed with 2 slots 137 cm long which could each discharge 76,000 l/min at 200 cm/sec. Initially, one slot will be closed resulting in a velocity of 113 cm/sec at the average flow rate of 41,800 l/min for the first unit.

Two additional units are planned on the Davis-Besse site in addition to a new nuclear plant under construction in Perry, Ohio. In addition to these plants there are 14 fossil-fueled plants currently operating on the shores or tributaries of Lake Erie. Most of these older plants do not possess cooling towers and often utilize water from the lake at rates exceeding 500,000 gpm.

This study was initiated in June 1969 to characterize the aquatic environment in the Locust Point vicinity prior to the operation of the Davis-Besse Nuclear Power Station. Unit 1 began operating in August of 1977. Results obtained since that date have been compared to previous results in an effort to determine changes brought about by the thermal discharge and unit operation.

Data obtained prior to 1972 are not included in this report as they are not comparable to data collected since 1972 and only a portion of the data collected in 1972 was used. Originally, Davis-Besse was designed without a cooling tower. Consequently, sampling stations visited from 1969 to 1971 covered a much larger area of the lake, since the thermal plume would have been much larger without a cooling tower. Furthermore, sampling methods prior to 1973 were not always directly comparable with later techniques.

This report serves two purposes. It presents the results from the 1979 field season which have never been presented before, and it summarizes eight years of sampling effort (1972-1979) and assesses the impact of unit operation on the aquatic environment. In this capacity it combines the results of Job 1-a, "Fish, Plankton, and Benthos Populations and Primary Productivity Prior to Operation of the Davis-Besse Nuclear Power Station," and Job 1-b, "Fish, Plankton and Benthos Populations During Plant Operation."

STUDY OBJECTIVE

To specify the changes in plankton, benthos, and fish populations caused by thermal discharges from the Davis-Besse Nuclear Power Station into Lake Erie; and to correlate laboratory predictions of the reactions of

Lake Erie fish to thermal discharges (F-41-R Study 2), with the final report including recommendations for developing and managing the fishery in discharge plumes.

PROCEDURES

Sampling Station Location

In 1973, 1974 and 1975 field data were collected from 25 stations, 18 along four transects in the open lake, two stations in the intake canal, 2 stations in the marshes, and three stations along the shoreline (Figure 1). Sampling stations in 1972 were similar. Of the four transects, one followed the intake conduit, one the discharge conduit, while control transects were set up on the east and west sides of the entire intake and discharge complex. Control west ran due north from the shore-end of the intake conduit with sampling stations located at 500 ft (150 m) (Station 1), 1000 ft (300 m) (Station 2), 2000 ft (610 m) (Station 3), and 3000 ft (910 m) (Station 4) from the shoreline. Sampling stations on the intake were located at 500 ft (150 m) (Station 5), 1000 ft (300 m) (Station 6), 2000 ft (610 m) (Station 7), 3000 ft (910 m) (Station 8, proposed intake), and 4000 ft (1,220 m) (Station 9) from shore. Along the discharge transect sampling stations were at distances of 500 ft (150 m) (Station 10), 1000 ft (300 m) (Station 11), 1500 ft (460 m) (Station 12, proposed discharge), 2000 ft (610 m) (Station 13), and 3000 ft (910 m) (Station 14) from shore. Additional stations were placed 500 ft (150 m) due north of Station 12 (Station 15) and 500 ft (150 m) south of Station 12 (Station 16). Control east ran perpendicular to the shoreline, parallel to the intake, and approximately 2500 ft (760 m) east of the intake. Stations were located

Station 19 was located in the center of the intake canal, 1000 ft (300 m) from the lake shore. Sampling at Station 20 was discontinued when it was drained of all water in 1974. Stations 21 and 22 were located in the northwest and southeast marshes, respectively. Stations 23-25 were on the shoreline at the intersection of the intake conduit and 1500 ft (460 m) to either side.

In 1976 this sampling format was altered slightly to provide control stations on either side of the intake and plume area and to sample the plume area more thoroughly (Figure 2). Stations 2, 4, 5, 10, 19, and 20 were eliminated and Station 26 to 29 were added. In 1977 it was indicated that Stations 7, 11, 12, 16, and 27 could be eliminated without jeopardizing results. Station 26 is on the control west transect and located 3800 ft (1170 m) from its intersection with the shoreline. Station 26 serves as a control station 3000 ft (910 m) northwest of Station 8 (intake) and the same distance offshore as Station 8 (3000 ft). Station 28 is on the discharge transect 4500 ft (1,380 m) from its intersection with the shoreline. Station 28 also serves as a control station for Station 8 as it is 3000 ft (910 m) southeast of Station 8 and equidistant offshore. Station 29 provides a control 3000 ft (910 m) southeast of Station 13 (plume area). Station 3 is the control to the northwest of Station 13. Stations 3, 13, and 29 are approximately equidistant from shore. Sampling stations in 1978 and 1979 were the same as those in 1977.

Plankton

Plankton monitoring at the Davis-Besse Nuclear Power Station has been completed approximately monthly during ice-free periods since 1973 (Table 1). The stations at which samples were collected each year are listed in Table 2 and shown on Figures 1 and 2. In 1973 only quantitative

zooplankton samples were collected, while both quantitative zooplankton and phytoplankton samples were collected in all other years. The preservation techniques have been modified occasionally as new techniques to make specimen identification easier appeared in the literature. However, no modifications which would have quantitatively affected the results were made, and formalin was always the final preservative. Two vertical tows, bottom to surface, were collected at each station for phytoplankton and zooplankton with a Wisconsin plankton net (12 cm mouth; 0.064 mm mesh in 1973 and 1974 and 0.080 mm mesh from 1975-1979). Each sample was concentrated to 50 ml and preserved. The volume of water sampled was computed by multiplying the depth of the tow by the area of the net mouth. Three 1-ml aliquots were withdrawn from each 50-ml sample and placed in counting cells.

Whole organism counts of the phytoplankton were made from 25 random Whipple Disk fields in each of the three 1-ml aliquots from each of the 2 samples. When filamentous forms numbered 100 or more in 10 Whipple fields, they were not counted in the remaining 15 fields. Identification was carried as far as practicable, usually to the genus or species level.

All zooplankters within each of the three 1-ml aliquots from each of the 2 samples were counted by scanning the entire counting cell with a microscope. Identification was carried as far as practicable, usually to the genus or species level.

Benthos

Benthic macroinvertebrate densities in the vicinity of the Davis-Besse Nuclear Power Station were monitored at approximately monthly intervals during ice-free periods (normally April through November) from 1973 through 1976, and at invervals of approximately 60 days during the

ice-free periods of 1977, 1978, and 1979 (Table 3). The stations at which samples were collected each year are listed in Table 4 and shown on Figures 1 and 2. Population densities were sampled with a Ponar dredge (Area=0.052 m^2). Three replicate grabs were collected at each station on each date from 1974 through 1979, whereas one sample was collected at each station on each date during 1973. Samples were sieved on the boat through a U.S. #40 soil sieve, preserved in 10% formalin, and returned to the laboratory for identification and enumeration. Individuals were identified as far as practicable (usually to genus; to species when possible). Results were reported as the number of organisms per m^2.

Fish

Fish populations in Lake Erie at Locust Point in the vicinity of the Davis-Besse Nuclear Power Station were monitored at approximately monthly intervals during ice-free periods (normally April - November) from 1973 through 1979. Fish were collected by three sampling techniques, experimental gill nets, shore seines, and trawls.

Experimental gill nets (125 feet long, consisting of five 25-ft contiguous panels of ½, 3/4, 1, 1½, and 2-inch bar mesh) were set parallel to the intake pipeline at Station 8 (intake) and parallel to the discharge pipeline at Station 13 (discharge or plume area) from 1973 through 1979 (Table 5). During 1976, 1977, 1978, and 1979, nets were also placed at Stations 3, 26, 28 and 29 to serve as controls (Figure 2). Starting in 1976, the direction of fish entry into the nets was also monitored. Each net was fished at the lake bottom for approximately 24 hours. Results were reported as catch per unit effort (CPE), where one unit of effort was equal to one 24-hour set with one net.

Shore seining was conducted at Stations 23, 24, and 25 with a 100-ft bag seine (¼-inch bar mesh) (Table 6). The seine was stretched perpendicular to the shoreline until the shore brail was at the water's edge. The far brail was then dragged through a 90^{o} arc back to shore. Two hauls were made at each station in opposite directions.

Four 5-minute bottom tows with a 16-ft trawl (1/8-inch mesh bag) were conducted on a transect between Stations 8 (intake) and 13 (plume area) at a speed of 3 - 4 knots. Starting in 1977, tows were also made on transects between Stations 3 and 26 and Stations 28 and 29 for comparative purposes (Table 7). Stomach analyses were conducted on fish from these collections.

All fish captured by each technique were identified, enumerated, weighed, and measured (Trautman, 1957; Bailey, et al., 1970). All results were keypunched and stored on magnetic tape at The Ohio State University Computer Center.

Ichthyoplankton

Ichthyoplankton was sampled at Locust Point in the vicinity of the Davis-Besse Nuclear Power Station from 1974 through 1979 with a 0.75-meter diameter oceanographic plankton net (No.00, 0.75 mm mesh). Each sample consisted of a 5-minute circular tow at 3 to 4 knots. Samples were collected at the surface and bottom of each station.

Sampling was conducted at the following stations during the following years: 1974, Stations 8 and 12; 1975, Stations 8, 12, and Toussaint Reef (Figure 3); 1976-1979, Stations 3, 8, 13, 26, 28, 29, and Toussaint Reef. Toussaint Reef was used for comparisons since the Ohio Division of Wildlife considers it a spawning location. Each sample was preserved in 5 percent formalin and returned to the laboratory for sorting and analysis. Samples were generally collected at approximately 10-day intervals from April through August. Sampling was terminated at the end of August to add a

margin of safety to the USEPA (Grosse Ile Office) sampling program for the Western Basin of Lake Erie which terminated each year in July (Table 8).

From 1974 to 1976, a single sample was collected at each depth of each station, and results were reported as the number of individuals per 5-minute tow. In 1977, 1978 and 1979, duplicate samples were collected at the surface and bottom of each station, and the net was equipped with a calibrated General Oceanics flowmeter to allow presentation of the results as the number of individuals per 100 m^3 of water. All specimens were identified and enumerated using the works of Fish (1932), Norden (1961a and b), and Nelson and Cole (1975).

Water Quality

Field Measurements. Water quality measurements were made approximately every 30 days at Stations 1, 8 and 13 from 1974 to 1979 during ice-free periods (Figure 2). Measurements of temperature, dissolved oxygen, conductivity, transparency and solar radiation were made in the field at the surface and approximately 50 cm above the bottom. Temperature and dissolved oxygen were measured with a YSI model 54A meter, conductivity with a Beckman RB3-3341 solubridge temperature-compensated meter, transparency with a 30-cm diameter Secchi disk and solar radiation with a Protomatic underwater photometer (Table 9).

Laboratory Determinations. Water samples were collected at the surface and approximately 50 cm above the bottom using a three-liter Kemmerer sampler and were placed in one-gallon collapsible polyethlene containers. These containers, supplied by the Toledo Edison Company Chemistry Laboratory, were filled completely, labelled with station number, date and depth and delivered to the laboratory. Laboratory determinations of 15 water quality parameters (Table 9) were performed at

the Toledo Edison Company Chemistry Laboratory, normally within 24-48 hours after sampling.

Primary Productivity

The procedures developed and used for the primary productivity studies can be summarized as follows. They are similar to those used by many other investigators who have utilized the ^{14}C technique for measuring primary productivity, but vary in some details that represent modifications required by site characteristics.

For example, the ^{14}C-tagged sodium bicarbonate, $NaH^{14}CO_3$, used to innoculate the incubation bottles was prepared with a concentration of 1 microcurie/ml. Prior studies have reported using higher concentrations, up to 10 microcuries/ml. However the productivity at the Locust Point study site is usually so high that the use of lesser ^{14}C concentrations is possible. It is axiomatic in radiotracer work that no more radioactivity be used than is necessary.

Typically, when a sampling station was reached, two clear and two black bottles for each depth to be sampled were innoculated. The innoculation consisted of one milliliter of the $NaH^{14}CO_3$ solution. Innoculation was performed at the site rather than enroute or prior to leaving the Put-in-Bay Research Building. This was to prevent prolonged evaporation prior to the addition of lake water. Prolonged evaporation could result in loss of radioactivity and produce erroneous measurements of productivity.

At the first station to be reached, a 1/20 dilution of the $NaH^{14}CO_3$ was prepared by adding one milliter from the stock solution to 20 milliliters of distilled water. This dilution provides an indication of the amount of radioactivity added to each bottle, and is used in the computational procedure for determining productivity.

Water samples were taken from each depth to be investigated and were used to fill the previously-innoculated, 300-milliliter incubation bottles. Depths of 0.5 and one meter were sampled at each station. An additional depth of either two or three meters was also sampled, depending upon the depth of the water column at each station.

After the incubation bottles were filled, stoppered, and lowered to the appropriate depths, a vertical illumination profile was obtained by taking readings at half-meter intervals with a Protomatic photometer. Concurrently, Secchi depth measurements were made with a 20-cm disc. Other parameters measured at that time included temperature, pH, and alkalinity.

Nominal incubation times of two hours were used. Experiments conducted at the F.T. Stone Laboratory indicated that incubation times ranging from one to five hours were appropriate, but a two-hour incubation time was convenient when measuring four stations per cruise.

After this in-situ incubation, the bottles were recovered and placed in a light-proof box until filtration could be initiated. Filtration was begun as soon as possible after the bottles were recovered, usually within 15 minutes after recovery. One hundred-milliliter aliquots were taken from each bottle and vacuum filtered through a 0.45-micron filter. Prior studies have used varying volumes. The 100-milliliter volume was chosen to provide a more representative sample than might be provided by a smaller volume. Volumes larger than 100 milliliters frequently caused problems of filter clogging. The vacuum was maintained at less than 15 inches of mercury. After filtration, the filters were rinsed with a dilute, 0.003N, hydrochloric acid solution followed by distilled water.

The United States Environmental Protection Agency (Prater, 1976) has recommended that the hydrochloric acid rinse not be utilized. The report

expresses concern that the acid rinse may damage cell walls and membranes, cause loss of cell contents, and thus produce erroneous data. The same report also recommends that the filtration vacuum not exceed six to eight inches of mercury, again to prevent cell damage.

Unfortunately, these recommendations were not published until after this project had started. Since one of the main objectives of the study was to compare productivity at the study site before and after the plant went into operation, the initial procedures were continued to maintain uniformity of baseline data. Recent experiments at the F.T. Stone Laboratory indicate that the dilute hydrochloric acid rinse has no significant effect on measured values of productivity.

After filtration was completed, the filters were placed in locking Petri dishes for transportation to the CLEAR Radiological Laboratory at the South Bass Island Lighthouse. The filters were dried and then placed in ten milliliters of RPI 3a70B scintillation cocktail in a 20-milliliter scintillation vial. The vials were counted with an Intertechnique Model SL-30 liquid scintillation spectrometer.

Productivity values, in $mgC/m^3/hr$, were computed using the equation:

$$P = \frac{3(r)C(1.06)10^3}{20(R)t}$$

where "3" is a correction factor for the 100-ml aliquot from the 300-ml incubation bottle.

"r" is the count rate from the filter.

"C" is available carbon in mg/l and is calculated by Saunders' method (1962), involving temperature, pH, and alkalinity.

"1.06" is a correction factor for the "isotope effect", the slower diffusion of the ^{14}C isotope compared to the more abundant isotope, ^{12}C.

"10^3" is a factor for converting liters to cubic meters.

"20" is a correction factor for the 1:20 dilution described earlier.

"R" is the count rate from a one-milliliter aliquot of the 1/20 dilution made at the time of innoculation

"t" is the incubation time in hours.

FINDINGS

Plankton

1979 Phytoplankton Data

Phytoplankters collected from May through November 1979 were divided into 50 taxa, generally to the genus level (Table 10). Twenty one taxa were grouped in Bacillariophyceae, 18 in Chlorophyceae, 2 in Dinophyceae, and 9 in Myxophyceae.

Monthly mean phytoplankton populations ranged from 4,595/l in June to 734,777/l on May 1 (Table 10). The mean density from all samples collected in 1979 was 224,008/l. Phytoplankton densities at individual sampling stations ranged from 1,945/l at Station 8 in June to 889,947/l at Station 13 on May 1 (Table 11). Population pulses were observed in the spring and the summer (Figure 4). The spring pulse was caused by diatoms while the summer pulse was caused by blue-green algae (Figure 5).

Monthly mean bacillariophycean densities ranged from 1,628/l in June to 733,663/l on May 1 (Table 10). The annual mean bacillariophycean density from all samples collected during 1979 was 109,293/l or 49 percent of the entire phytoplankton density. The dominant diatom taxa were

Asterionella formosa in May, October and November; Melosira spp. in June; and Fragilaria spp. in July, August and September. A. formosa had the largest annual mean population, 91,912/l. Diatoms were the dominant phytoplankton group on May 1 and May 23 and in June, October and November when they constituted 99.8, 90.8, 35.4, 47.4, and 92.3 percent, respectively, of the total phytoplankton density.

Monthly mean chlorophycean densities ranged from 261/l on May 1 to 70,992/l in September with an annual mean population from all samples collected during 1979 of 12,932/l or 6 percent of the total phytoplankton population (Table 10). The dominant green algae taxa were Mugeotia sp. on both dates in May and in November, Pediastrum duplex in June, Botryococcus sudeticus in July and August, and Binuclearia tatrana in September and October. Binuclearia tatrana had the largest annual mean population, 8,631/l. Chlorophyceae peaked in September but was never the dominant phytoplankton group.

Monthly mean myxophycean densities ranged from 842/l on May 1 to 418,298/l in September with an annual mean density from all samples collected in 1979 of 97,417/l, or 43 percent of the total phytoplankton mean (Table 10). The dominant myxophycean taxa were Oscillatoria spp. on both dates in May and in June, October and November, and Aphanizomenon flos-aquae from July through September. Myxophyceae was the dominant phytoplankton group in July, August and September representing 81.4, 91.0, and 83.4 percent, respectively, of the total phytoplankton density.

Dinophyceans were represented by 2 taxa, Ceratium hirundinella and Peridinium sp. Ceratium was more abundant than Peridinium and reached its greatest density in July at 34,372/l (Table 10).

All raw data were keypunched and are stored in Columbus, Ohio at the offices of the Center for Lake Erie Area Research on the campus of The Ohio State University.

1979 Zooplankton Data

Zooplankters collected May through November 1979 were grouped in 47 taxa generally to the species level (Table 12). Eighteen taxa were grouped under Rotifera, 17 under Copepoda, 9 under Cladocera, 1 under Protozoa, 1 under Ostracoda and 1 under Tardigrada. Monthly mean densities ranged from 22/l in November to 1,252/l in July. The mean density from all samples collected in 1979 was 475/l. Zooplankton densities at individual sampling stations ranged from 10/l at Station 13 in November to 1,597/l at Station 18 in July (Table 13).

Monthly mean rotifer densities ranged from 11/l in November to 346/l in September (Table 12). The annual mean rotifer density for all samples collected in 1979 was 131/l or 27.6 percent of the entire zooplankton density. The dominant rotifer taxa during 1979 were Synchaeta spp. on May 1 and in October and November; Keratella quadrata on May 23; Polyarthra vulgaris in June, August and September; and Keratella cochlearis in July. Polyarthra vulgaris had the largest annual mean density, 41/l. Rotifera was the dominant zooplankton group on May 1 and in collections from September and November representing 81.3, 60.3 and 49.1 percent, respectively, of the total zooplankton density. In contrast to this, rotifers represented only 8.1 percent of the July zooplankton density.

Monthly mean copepod densities ranged from 10/l in November to 262/l in June (Table 12). The mean copepod density from all samples collected in 1979 was 115/l or 24 percent of the entire zooplankton population.

Cyclopoid nauplii was the dominant copepod taxon during every collection. Copepoda was the dominant zooplankton group in the May 23 collection and the June collection representing 36.4 and 54.3 percent, respectively, of the total zooplankton density.

Monthly mean cladoceran densities ranged from 1/l in November to 162/l in May (Table 12). The mean cladoceran density from all samples collected in 1979 was 59/l or 12 percent of the total zooplankton population. Cladoceran populations were dominated by Chydorus sphaericus on May 1; Daphnia retrocurva on May 23 and collection dates in June and July; and Eubosmina coregoni in August, September, October and November. Daphnia retrocurva had the largest annual mean density, 28/l or 6 percent of the entire zooplankton density. Cladocera was never the dominant zooplankton group.

Monthly mean protozoan densities ranged from 0/l in May and November to 901/l in July (Table 12). The annual mean density of 170/l was 36 percent of the total zooplankton population. Difflugia sp. was the only protozoan taxon. Protozoa was the dominant zooplankton group in July, August and October representing 72.0, 34.1, and 49.7 percent, respectively, of the entire zooplankton density.

Two other groups, Ostracoda and Tardigrada, appeared in collections during 1979. An ostracod was found on May 23, while a tardigrad was found on May 1.

All raw data were keypunched and are stored in Columbus, Ohio at the office of the Center for Lake Erie Area Research on the campus of The Ohio State University.

1974 - 1979 Phytoplankton Data Summary

Yearly results of the phytoplankton monitoring program have been presented in the annual performance reports for this project beginning with 1974 (F-41-R-6). This section of the report summarizes the findings presented in these earlier reports through graphic presentations of monthly densities of the major phytoplankton components, Bacillariophyceae, Chlorophyceae, and Myxophyceae, encountered yearly from 1974-1979 (Figures 5 - 10). Figure 4 presents the monthly estimates of the total phytoplankton density from 1974 through 1979.

Table 14 and Figures 11 - 14 summarize the above data in a different manner by combining all monthly density estimates from all years and all stations and comparing pre-operational means, minima, maxima, and standard deviations with operational results. Table 15 and Figures 15 - 17 use this same technique to compare the total phytoplankton densities observed at Station 8 (intake structure), Station 13 (plume area), and Station 3 (control station). A discussion of these comparisons follows.

Diatoms. Both pre-operational and operational densities were high during the spring and fall, and low during the summer (Figure 11). Spring densities were highest. This is typical for western Lake Erie and as one would expect since diatoms are cold-water forms. Operational densities observed during the spring and fall were larger than the corresponding pre-operational values. However, operational standard deviations overlapped the pre-operational standard deviations.

Green Algae. Chlorophycean densities, in general, were much lower than diatom densities or blue-green algae densities during the pre-operational and the operational studies. Furthermore, these green algae population densities are much less predictable seasonally than diatoms.

Reutter (1976) has demonstrated that green algae densities parallel transparency closely and are opposite to turbidity and, therefore, are often controlled by factors such as the wind, which affects transparency by suspending bottom sediments through wave action. However, most of the monthly samples collected during the operational period fell within the range established during the pre-operational period, and for those which were outside the range (July, September, and November), the standard deviation of the operational period overlapped the standard deviation of the pre-operational period (Figure 12).

Blue-Green Algae. Myxophycean populations during both the pre-operational and operational periods showed tendencies toward sudden, large, mid-summer pulses (Figure 13). Operational densities were generally larger than pre-operational densities. However, with the exception of October and November, the operational standard deviations always overlapped the pre-operational standard deviations.

Total Phytoplankton. The total phytoplankton density, i.e., the sum total of the 3 major component groups previously discussed and several other minor classes, was higher during most of the operational study than during the pre-operational study (Figure 14). However, with the exception of April and October, the standard deviations of the means observed during the operational study overlapped the standard deviations from the pre-operational study.

1972 - 1979 Zooplankton Data Summary

The results of the zooplankton monitoring program have been presented in the annual performance reports for this project beginning with F-41-R-4. This section of this report summarizes the findings presented in these

earlier reports through graphic presentations of the monthly densities of the total zooplankton population and its major components, rotifers, copepods, and cladocerans encountered yearly from 1972 - 1979 (Figures 18 - 21).

Table 16 and Figures 22 - 25 summarize the data in a different manner by combining all monthly density estimates from all years and all stations and comparing pre-operational means, minima, maxima, and standard deviations with operational results. Table 17 and Figures 26 - 28 use this same technique to compare total zooplankton densities observed at Station 8 (intake structure), Station 13 (plume area), and Station 3 (control station). A discussion of these comparisons follows.

Total Zooplankton. The total zooplankton population density, i.e., a sum total of the major zooplankton groups (rotifers, copepods, and cladocerans) and any minor classes or orders, has usually exhibited two pulses, one in the late spring or early summer and a smaller pulse in the fall. This is true of both pre-operational and operational results, although operational densities were generally lower than pre-operational densities (Figure 22).

Rotifers. Rotifer densities at Locust Point during the operational period were lower for every month than the mean value from the pre-operational period for the same month (Figure 23). However, the operational monthly mean was below the pre-operational monthly range only during June and November, and the operational monthly mean was always less than two standard deviations from the pre-operational mean.

Copepods. Copepod densities at Locust Point during the pre-operational study generally exhibited spring pulses (Figure 24). This was also the case during the operational study, except the pulse was somewhat

data were keypunched and are maintained on file at the offices of the Center for Lake Erie Area Research in Columbus, Ohio.

1972 - 1979 Data Summary

The results of the benthos monitoring program have been presented in the annual performance reports for this project beginning with F-41-R-4. This section of the report summarizes the findings presented in these earlier reports through a graphic presentation of the monthly benthic macroinvertebrate densities encountered yearly from 1972 - 1979 (Figure 29).

Table 19 and Figures 30 - 34 summarize the data in a different manner by combining all monthly density estimates for the major benthic groups from all years and all stations during the pre-operational study, and comparing these pre-operational monthly means, minima, maxima, and standard deviations to operational results. Table 20 and Figures 35 - 37 use this same technique to compare total benthic macroinvertebrate densities observed at Station 8 (intake structure), Station 13 (discharge area), and Station 3 (control station). A discussion of these comparisons follows.

Total Benthic Macroinvertebrates. The population densities of all benthic macroinvertebrates, i.e., the sum total of the major benthic groups (Coelenterata, Annelida, Arthropoda, and Mollusca), were generally the highest in the late summer and fall during the pre-operational study. During the operational study the highest densities occurred slightly earlier in the summer and fall (Figure 30). Operational densities were very close to the pre-operational mean during every month except September, when they were slightly lower than the pre-operational minimum.

the bluntnose minnow (*Pimephales notatus*) and the white perch (*Morone americana*) (Table 21). The three fishing methods combined yielded a total of 186,505 fish, of which 4.1 percent occurred in gill nets, 94.1 percent in shore seines, and 1.8 percent in trawls (Table 22). The combined results of all three sampling methods indicated that the numerically dominant species in the Locust Point vicinity during 1979 were gizzard shad (49.9 percent), alewife (26.8 percent), emerald shiner (10.1 percent), spottail shiner (9.9 percent), yellow perch (2.4 percent), freshwater drum (0.4 percent), white bass (0.2 percent), channel catfish (0.1 percent), and carp (0.1 percent) (Table 23). No other species comprised more than 0.1 percent of the total catch by number.

Gill Nets. Gill nets set from April through November 1979 yielded 7,663 fish weighing 702.7 kg and representing 19 species (Tables 22). Monthly catches of all stations combined ranged from a maximum of 1,814 (CPE = 302.3) in August to a minimum of 329 (CPE = 54.8) in April. The maximum catch occurred at Station 3 in September (481 fish), and the minimum catch occurred at Station 13 in October (7 fish) (Table 24). In general, catches were much higher during summer than during spring or fall (Tables 22 and 24). Species captured consisted primarily of yearling-size or larger yellow perch, freshwater drum, gizzard shad, spottail shiner, and white bass, as well as young-of-the-year (YOY) alewife and gizzard shad. There were no marked differences in direction of movement by fishes with respect to either species, month or station. There was no trend in abundance of fishes at offshore (8, 26, and 28) vs. inshore stations (3, 13, and 29). Although the differences were not great and not consistent,

greater numbers of fish were generally collected at control stations (3, 26, 28, and 29) than at the intake (8) and discharge (13) stations. Additional gill net catch data are presented in Tables 25 - 32.

Trawls. Trawling in the Locust Point vicinity during 1979 yielded 3,329 fish weighing 70.0 kg and representing 20 species (Table 22). Monthly catches along all three transects ranged from a maximum of 1,904 (CPE = 634.7) in November to a minimum of 82 (CPE = 27.3) in May. The maximum catch occurred on Transect 28-29 in November (972 fish), and the minimum catch occurred on Transect 3-26 in June (22 fish). After an initial high catch of 208 fish in April, catches decreased in May and June, then increased gradually through summer and fall until the highest catch in November (Tables 22 and 33). Species captured were primarily YOY and yearling-size or larger alewife, gizzard shad, spottail shiner, emerald shiner, brown bullhead, channel catfish, trout-perch, white bass, yellow perch, and freshwater drum. Alewives were caught in greatest numbers as YOY in late summer and fall. The unusually high catch in November consisted largely of YOY gizzard shad. There were no marked differences or trends in the abundance of fishes at control transects (3-26 and 28-29) vs. the intake-discharge transect (8-13) (Table 33). Additional trawl data are presented in detail in Tables 34 - 41.

Shore Seines. Shore seining in the Locust Point vicinity during 1979 yielded 175,513 fish weighing 210.1 kg and representing 13 species (Table 22). Monthly catches at all three stations ranged from a maximum of 153,570 (CPE = 51,190.0) in July to a minimum of 67 (CPE = 14.7) in May. The maximum catch occurred at Station 25 in July (92,591 fish), and the minimum catch occurred at Station 25 in October (13 fish) (Tables 22 and 42). The large July catch consisted primarily of YOY alewife and gizzard

shad. In general, catches were much greater during early spring and mid-summer than during other sampling periods. Species captured were primarily YOY alewives, gizzard shad, and white bass, and both adult and YOY emerald shiners and spottail shiners. There were no marked differences or trends in abundance of fishes at control station (23 and 25) vs. the intake-discharge (24) station (Table 42). Shore seine data are presented in detail in Tables 43 - 50).

Food Habits. Food items of the major fish species in the Locust Point vicinity during 1979 were relatively limited in variety. Zooplankton, primarily cyclopoid Copepoda and several common species of Cladocera were the major dietary items of yellow perch, freshwater drum, spottail shiners, emerald shiners, and young white bass. Minor dietary items of these species included several taxa of insects, primarily chironomid larvae, rotifers, mites, amphipods, oligochaetes, small fish, and unidentified plant and animal material. White bass adults were almost entirely piscivorous. There was no marked difference in amount or kinds of food items found in fish from the control transect (3-26) vs. the intake-discharge transect (8-13). Food habits data are presented in detail in Tables 51-58.

1973 - 1979 Data Summary

The results of the fisheries population studies have been presented in the annual performance reports beginning with F-41-R-4. With the exception of the 1979 data which are being presented as part of this report, the previously mentioned reports contained the results from all fisheries work conducted as part of this project. These reports have shown gill netting to be the superior sampling technique for measuring the impact of the thermal discharge (and unit operation) for several reasons:

1. gill nets can be set right at the point of impact, are relatively unbiased sampling devices, and collect adequate sample sizes (quantities of fish);

2. shore seines sample mainly YOY fish and, consequently, are subject to sudden pulses following spawning;

3. shore seines sample at locations over 1000 feet from the point of discharge;

4. trawls collect few fish.

Consequently, although the results of shore seining and trawling have been used to greatly increase our ability to interpret yearly results, gill nets have proven to be the most effective assessment tool, and, therefore, this data summary will pertain mainly to this gear type.

Fifty-one fish species have been collected at Locust Point since 1963 (Table 21). However, the fish community at Locust Point has consistently been dominated by seven species: alewife, emerald shiner, freshwater drum, gizzard shad, spottail shiner, white bass, and yellow perch. These seven species generally constituted well over 90 percent of the annual catch by the sampling program. The monthly mean, minimum, maximum, and standard deviation of the number of each of these species, except emerald shiner, collected in the gill net set at the discharge have been presented in Table 59 and Figures 38 - 45. Emerald shiners are seldom collected in gill nets of these mesh sizes, so they were not included in the tabulations. However, due to their economic importance, channel catfish

and walleye were added to the list. Table 60 and Figures 46 - 51 summarize the gill net results by presenting pre-operational means, minima, maxima, and standard deviations and comparing them to operational results at Stations 8 (intake), 13 (discharge or plume area), 3 and 26 (controls).

Alewife. Alewife densities in the vicinity of the unit discharge during both the operational and pre-operational periods were generally highest during the late summer and early fall (Figure 38). The maximum pre-operational catch was 322, while 136 was the maximum catch during the operational period (Table 59). Although operational catches were generally lower than pre-operational catches, they were always within the pre-operational range.

Channel Catfish. Channel catfish catches during both the pre-operational and operational studies were greatest during the summer (Figure 39). They were seldom a significant component of the catch, as 18 was the maximum pre-operational catch and 6 was the maximum operational catch (Table 59). The pre-operational and operational catches were quite similar, and all operational means were within the pre-operational range.

Freshwater Drum. During both the pre-operational and operational studies, freshwater drum were most abundant during the summer (Figure 40). The maximum catch during the pre-operational study was 50, while 75 was the maximum operational catch (Table 59). With the exception of June, which was higher, all operational catches were within the range established during the pre-operational study.

Gizzard Shad. Gizzard shad densities during both the pre-operational and operational studies were always greatest during the late summer and fall (Figure 41). The maximum pre-operational catch was 184, while 291 was the maximum operational catch (Table 59). The monthly pre-operational and

operational mean catches were generally quite similar, and all but one of the operational means were within the pre-operational range (Figure 41).

Spottail Shiner. Spottail shiners were always most abundant during the month of May (Figure 42). In fact, with the exception of April and June, the minimum catch in May was greater than the maximum catch of any of the other months during the pre-operational period. The operational catch was within the range established during the pre-operational period during all months but September.

Walleye. Walleye catches during both the pre-operational and operational studies were greatest during the summer (Figure 43). This species was never a significant portion of the catch, as 15 was the maximum prior to plant operation and 8 was the maximum afterwards (Table 59). With the exception of August, when the operational catch was above the range of pre-operational catches, all catches after the unit began operation were within the range of catches prior to unit operation.

White Bass. White bass were generally most abundant during the summer (Figure 44 and Table 59). The magnitude of the pre-operational and operational catches were very similar, but the pre-operational peak occurred in August whereas the operational peak occurred in June. With the exception of June and July, when the operational catch was above the pre-operational mean, all operational values were within the range established during the pre-operational study.

Yellow Perch. Yellow perch generally occurred in similar numbers from month to month during the pre-operational period with a slight increase in the early fall, followed by a decrease to low densities in November (Figure 45). Operational densities were of similar magnitude

during all months but August when they were higher than the pre-operational mean but very close to the pre-operational maximum for September.

Food Habits. Zooplankters constituted the major portion of the stomach contents of the fish species collected in the Locust Point vicinity from 1972 - 1979. Chironomids were the next most frequently observed item followed by small fish occasionally observed in the stomachs of some of the piscivorous species, primarily white bass and yellow perch.

Ichthyoplankton

1979 Data

Specimens collected during the 1979 field season were placed into 15 taxa (Table 61). Ten taxa were to the species level, while the remaining 5 consisted of unidentified, unidentified shiner, unidentified sunfish, fish eggs, and freshwater drum eggs. Collections from Toussaint Reef (a spawning area) produced 9 taxa, all of which were found at Locust Point except for an unidentified percid which was found on 9 May (Table 62). Emerald shiner, walleye, and drum egg concentrations were higher at Toussaint Reef than at Locust Point, while the opposite was true for the concentrations of all other taxa. Overall, ichthyoplankton concentrations at Locust Point (66.79/100 m^3) were greater than those at Toussaint Reef (51.67/100 m^3) (Tables 61 and 62). Gizzard shad, yellow perch, emerald shiner, fish egg, and rainbow smelt were the dominant taxa representing 81.8, 11.2, 2.5, 1.6, and 1.3 percent, respectively, of the total ichthyoplankton density. No other taxon made up as much as 1.0 percent of the total. Gizzard shad were collected between 31 May and 15 August and peaked on 31 May at 200.4/100 m^3. Yellow perch were collected between 1 May and 5

June, and they appeared again on 3 August. Perch densities peaked on 31 May at 66.1/100 m^3. Emerald shiners were collected between 21 June and 15 August and peaked on 5 June at 10.4/100 m^3. Rainbow smelt were collected between 31 May and 3 August and peaked on 31 May at 5.6/100 m^3.

Stations 3 and 13 (plume area), the inshore stations, exhibited the greatest mean larval densities, 82.98 and 82.52/100 m^3, respectively, while Station 8 (intake) yielded the lowest larval densities. Stations 3, 8 and 29 had greater densities at the surface while Station 13 had greater densities at the bottom. Toussaint Reef had much higher larval densities at the surface than at the bottom.

All raw data were keypunched and stored at the offices of The Ohio State University's Center for Lake Erie Area Research in Columbus, Ohio. A voucher collection of all samples is also maintained at these offices.

1974 - 1979 Data Summary

The results of the ichthyoplankton analyses have been thoroughly described in the annual performance reports for this project beginning with F-41-R-6. Since the reporting of results changed (catch per unit effort vs. no./100 m^3) during the course of the study, direct comparisons of results from 1977, 1978, and 1979 with those of the early pre-operational years, 1974 - 1976, are not possible. However, comparisons of the relative portions of the total density constituted by each species are possible and will be discussed within the "Analysis" section.

Water Quality

1979 Data

The results of the monthly 1979 water quality determinations at Stations 1, 8 and 13 are presented in Tables 63-70. The monitoring stations were selected to characterize Lake Erie water quality at several distinct areas within the vicinity of the Davis-Besse Nuclear Power Station (Figure 52). Station 1, at 500 feet offshore and 1,500 feet west of the discharge structure, is positioned to monitor nearshore water masses and serves as a control for the other two stations. Station 8 is 3,000 feet offshore and is positioned in the vicinity of the water intake crib. Station 13 is located 500 feet east of the discharge structure in the region of the discharge plume. All of the stations lie within Excepted Area "B" for Lake Erie water quality standards, established by the Ohio Environmental Protection Agency (1978, p. 80).

Mean annual (April through November) values and ranges for the monthly water quality determinations for the 19 parameters are presented in Table 71. The results of the 1979 monitoring program indicate that none of the parameters examined exceeded Ohio EPA standards.

1974 - 1979 Data Summary

Water quality measurements during the period April 1974 to November 1979 were used for the purposes of this summary. The results of these water quality monitoring studies are contained in the annual performance reports for this study beginning with F-41-R-6. The data used included

Station No. 13 (500 feet east of the discharge structure) and Station No. 8 (adjacent to the water intake crib). Station No. 13 serves as the station most likely to be impacted, while Station No. 8 serves as a control station (Figure 52). Each station was visited once a month during the ice-free period of the year (normally April-November). Surface and bottom water samples were taken at each station. However, because the intake and discharge structures are located at or near the bottom, bottom samples were used for comparing pre-operational and operational conditions. Tables 72 to 89 summarize pre-operational and operational data for the 18 water quality parameters at the intake and discharge stations. These data are displayed graphically for the discharge station on Figures 58 to 75. The following discussion summarizes the comparison for each of the parameters.

Dissolved Oxygen. During both the pre-operational and operational period DO showed a typical trend of high values in the spring and fall with low concentrations in the summer. Operational concentrations were considerably lower than the pre-operational range in April and November, but not during the critical summer months (Figure 58).

Hydrogen-ions (pH). Throughout the pre-operational and operational period pH values remained relatively stable, never exceeding 9.0 or falling below 7.5. The operational values showed more variability than the nearly straight-line mean concentration for the pre-operational period (Figure 59). However, both periods had a mean pH of 8.3.

Transparency. Both the pre-operational and operational measurements showed the lowest water clarity in the spring, the best transparency in the summer, and intermediate clarity in the fall. In general, operational values were within the range of pre-operational values throughout the year (Figure 60).

Turbidity. Being somewhat the reciprocal of transparency, the lowest readings occurred in the summer, the highest in spring and intermediate values in the fall for the pre-operational period. Operational values showed a general decreasing trend throughout the year, with only a slight rise in the fall. However, values for May, June, and September well exceeded the pre-operational ranges for those months (Figure 61).

Suspended Solids. This parameter, like turbidity showed a "U" shaped trend during the pre-operational period with summer concentrations being the lowest. Like transparency and turbidity, high particulate material in the water during the spring and fall months of the operational period yielded readings in excess of the pre-operational ranges for these months (Figure 62).

Conductivity. This parameter is a measure of the ionized material in the water and it also shows high concentrations in the spring for both the pre-operational and operational periods. Only conductivity values in April for the operational period exceed the range for this month during the pre-operational period (Figure 63).

Dissolved Solids. The concentrations of dissolved substances in the water during pre-operational and operational periods were relatively similar, with the operational data falling within or nearly within the pre-operational range for each month. Operational concentrations were somewhat lower than pre-operational conditions for April and October, while September was slightly higher (Figure 64).

Calcium. This element, one of the most common found in Lake Erie water, showed relatively consistent values during both the pre-operational and operational period. High concentrations typified the spring with considerably lower values in the summer and fall. Only in November did

operational concentrations exceed the range of pre-operational data (Figure 65).

Chloride. Operational chloride concentrations were within the range of pre-operational concentrations during six of the eight months for which comparative data are available. The greatest discrepancy occurred in April and November. Pre-operational data show a progressive decrease in concentration throughout the year, while operational data indicate a more "U" shaped trend (Figure 66).

Sulfate. Both pre-operational and operational sulfate data show relatively consistent concentrations throughout the year with somewhat higher values in the spring. Operational data were more erratic, with four months above the pre-operational range and one month below the range (Figure 67).

Sodium. A trend similar to that of sulfate was noted for sodium. Operational data again showed greater variability with two months above and one month below the range for pre-operational data. April and November yielded the highest concentrations for the operational period, both beyond the pre-operational range (Figure 68).

Magnesium. This parameter showed the least agreement between pre-operational and operational data of any of those tested. Operational concentrations exceeded the range of pre-operational data for all months except May. In April, the operational mean value was nearly double the pre-operational mean concentration (Figure 69).

Total Alkalinity. This parameter showed considerable variability in both the pre-operational and operational data, with the highest values occurring in the spring and fall during the pre-operational period and in the spring and summer during operation. April, July, August, and November

were periods when operational values exceeded pre-operational ranges, while May and June were months of relatively low operational alkalinity (Figure 70).

Nitrate. Serving as a biological nutrient, this parameter fluctuates widely in response to plankton productivity. Concentrations during both the pre-operational and operational periods were highest in the spring but decreased in the summer as this material was utilized by algae. Fall concentrations increased as algal productivity declined. Concentrations during both periods were relatively consistent, with operational values being somewhat higher, particularly in June, August, and November (Figure 71).

Phosphorus. This parameter is also an important biological nutrient and, like nitrate, shows seasonal variations such as high spring and low summer concentrations. Pre-operational and operational data were relatively consistent throughout the year, except for May which showed a considerably higher mean concentration during the pre-operational period (Figure 72).

Silica. As a necessary material for diatom cells, silica also undergoes seasonal changes in concentration. As the growing season progresses this material greatly declines in the water. Both pre-operational and operational data show the same seasonal trend. Operational concentrations exceeded the pre-operational ranges for May and November (Figure 73).

Biochemical Oxygen Demand. BOD levels were relatively consistent throughout the year for both the pre-operational and operational periods. Values were highest in the spring and lowest in the fall. All of the operational concentrations fall within the range of pre-operational data, except for June (Figure 74).

Temperature. Both pre-operational and operational data show typical seasonal temperature trends for Lake Erie; and both data sets are relatively consistent. Most of the operational values fall within the range of pre-operational data (Figure 75).

Primary Productivity

Three primary productivity cruises were conducted during the 1979 field year. The productivity results are summarized in Table 90. In general, these results are consistent with measurements from prior years.

Table 91 summarizes the comparisons of productivity at Stations 8, 13, and 14 with productivity at the "control" Station 3. These comparisons are a measure of whether the productivity at the indicated station is greater or less than the productivity at Station 3. If the value is greater than one, the productivity at the indicated station was greater than at Station 3. If it is less than one, the productivity at Station 3 was greater than at the indicated station. For example, on October 12, the productivity at Station 13 was 25 percent greater than at Station 3. On June 25, the productivity at Station 8 was 11 percent less than at Station 3.

As in prior years, the comparisons vary from station to station for any given cruise and the comparison for each station varies from cruise to cruise. However, when all three cruises are averaged, each station demonstrates essentially the same productivity, within one standard deviation of the productivity at Station 3.

Similar comparisons between Stations 13 and 14 are summarized in Table 92. A value greater than one indicates that the productivity at Station 13 was greater than at Station 14. For example, on June 25, the

productivity at a depth of 0.5 meters was three percent greater at Station 13 than at Station 14. On the same date, however the productivity at a depth of one meter was 24 percent less at Station 13 than at Station 14. When both depths and all three cruise dates are averaged, the productivity at Station 13 appears to be six percent greater than the productivity at Station 14. But with a standard deviation of 18 percent, the difference between the two stations is not significant.

Measurements of illumination as a function of depth are shown in Table 93, and Secchi depth measurements are summarized in Table 94. While the surface illumination values are generally lower in 1979 than in 1978, the slopes of the extinction curves are similar for all stations measured in both August and October. Slopes of the extinction curves for June are somewhat variable from station to station and deviate from the slopes of the extinction curves obtained in June, 1978. Field notes indicate a heavy sediment load for the June cruise in 1979. However, it appeared to be a general phenomenon occurring along the entire shoreline and not specifically associated with the plant discharge. Secchi depth readings were comparable with 1978 values.

In general, the decrease of productivity with depth parallels the decrease of illumination with depth. This relationship is illustrated in Figure 76, and was noted also in the F-41-R-8 performance report for the 1976 field year. Although the relationship is generally valid, there are frequent deviations at depths of 0.5 meters. In 28 percent of the measurements made from 1975 through 1979, the productivity measured at 0.5 meters, for any given station, was less than the productivity measured at one meter. This situation is illustrated in Figure 77.

No explanation for this deviation is readily apparent. Although 28 percent is not a dominant trend, the condition occurred with sufficient frequency that the productivity values at 0.5 meters and one meter were averaged for the purpose of comparing stations for any particular cruise.

ANALYSIS

Prior to the appraisal of the effects of the thermal discharge and unit operation on the aquatic communities at Locust Point, some assistance in interpreting these results is warranted. First, one should bear in mind that when sampling the same population eight months each year for seven years, and plotting data with monthly minima and maxima, as in this report, eight minima and eight maxima will be generated. That is, there will be seven values for each of the eight months, or one value for each month from each of the seven years. Each of the eight months will have a minimum value and a maximum value, and, since there are eight months, there will be a total of eight minimum values and eight maximum values (one of each for each month). If there is nothing unusual about the environmental conditions which existed during any of the seven years, then each year would have an equal chance (probability) of producing several monthly minimum or maximum values. Assuming each year does have an equal probability of producing these minima and maxima, and since there are eight monthly minimum values and eight monthly maximum values, each year of the seven years would produce 1.14 of the monthly minimum values and 1.14 of the monthly maximum values. This is pointed out to demonstrate that it is natural for any year to produce a population extreme (monthly minimum or maximum value). Consequently, it should not be automatically viewed as a unit produced effect if any operational variable is above or below the pre-operational range.

Another point useful in the interpretation of these results involves the distance of the operational monthly mean from the pre-operational mean. A general "rule-of-thumb" is that when dealing with a normal distribution, the area within one standard deviation on either side of the mean will contain approximately 66 percent of the values, two standard deviations would contain approximately 95 percent of the values, and three standard deviations would contain approximately 99 percent of the values.

As a final aid in interpreting these results, population densities are presented from control stations (unaffected) to allow comparison with the discharge where the impact should be greatest. This allows a distinction to be made between unusual values caused by unit operation and unusual results which are typical of the entire lake due to an unusual set of climatic or biological conditions -- natural variation.

Within each of the sections in the "Analysis" section of this report, the sampling dates will be compared to unit operation. When the unit was not operating, although the circulating pumps were generally still operating, the discharge water was not heated, and, consequently, it was impossible to accurately assess the effects of the thermal plume on the aquatic environment at these times.

Plankton

Analysis of 1979 Results

Phytoplankton. The Center for Lake Erie Area Research has monitored phytoplankton populations at Locust Point since 1974 (Figure 4). Radical differences were noted between populations in 1974 and 1975, but 77 percent of the variation was explainable by variation in physical and chemical parameters of water quality (Reutter, 1976). Bacillariophycean and

chlorophycean populations observed in 1974 and 1975 were quite comparable (Figures 6 and 7). The myxophycean component of the populations accounted for the differences between the 2 years. No myxophycean bloom occurred in 1974, whereas a huge Aphanizomenon sp. bloom occurred in August 1975. This bloom was highly correlated with increased transparency (80 percent greater than in 1974) and decreased turbidity (20 percent of that observed in 1974) (Reutter, 1976). A correlation of this type was first hypothesized by Chandler and Weeks (1945).

Bacillariophycean and chlorophycean populations in 1976 were similar in size and composition to those observed in 1974 and 1975 (Figures 6, 7, and 8). The diatom population, especially, was strikingly similar from year to year, with 1976 most resembling 1974. Populations were always greatest in spring and fall, pulses which began and ended abruptly were commonplace. Chlorophycean populations tended to increase in the fall. A very small pulse was observed in June 1975 which was not observed in 1974 or 1976.

The 1976 myxophycean population was between the extremes set forth in 1974 and 1975. A bloom of Aphanizomenon sp. occurred in July and August. This corresponded well in time of occurrence with the 1975 August bloom, but, it was slightly longer in peak duration, it was only one-third the magnitude of the 1975 bloom and it started and ended much more abruptly. Again, these pulses appear to be explainable by variation in transparency and turbidity. Transparency in 1976 was similar to 1975 and much greater than 1974, while turbidity, though more variable than in 1974 or 1975, reached a low in July similar to that observed in 1975 and below that of 1974 (Figures 79 and 80).

The 1977 phytoplankton population exhibited diatom blooms in fall and spring as in preceding years, however, the spring bloom was approximately twice as large as those observed from 1974-1976 (Figure 9). The myxophycean population showed pulses in summer as in 1975 and 1976, but blue-greens also increased in the fall which was only hinted at in previous years. Chlorophycean populations were generally low and were very similar to those observed in 1974 and 1976.

The major differences between 1977 and previous years were in the size of the spring and fall diatom pulses and the summer myxophycean pulse. However, lack of a large summer blue-green bloom was not unusual (1974) and the unusually long and cold winters of 1976-1977 and 1977-1978 undoubtedly had a large influence on diatom densities as they are cold water forms. Furthermore, the increase in the myxophycean densities in the fall of 1977 was due to *Oscillatoria* sp. which is also a cold water form.

The 1978 phytoplankton population exhibited spring and fall blooms and was very nearly a mirror image of the 1977 population (Figure 4). All three major components of the phytoplankton, diatoms, greens, and blue-greens, exhibited relatively large blooms during 1978 (Figure 10).

Although no unusual taxa were observed during 1979, phytoplankton densities were the largest observed to date and exhibited pulses in the early spring and mid- to late-summer. Diatoms (*Asterionella formosa*) caused the spring pulse, and their densities were more than 10 times greater than the fall pulse and more than twice as large as any previous diatom (or any group) bloom (Figure 5). The summer bloom was caused by blue-greens, *Aphanizomenon flos-aquae*, in July, August and September with green algae (*Binuclearia tatrana*) making significant contributions in September. The myxophycean densities were also the largest recorded to

date. When divided into its three major components, Bacillariophyceae, Chlorophyceae, and Myxophyceae, the 1979 population, though much larger, was very similar to the 1976 phytoplankton population (Figures 5 and 8).

The large diatom and green algae densities observed in 1979 should be considered natural phenomena as the pulses were caused by species which have been shown to bloom every year. Furthermore, it is highly unlikely that monthly sampling would detect the maximum value reached during these short duration pulses caused by phytoplankton species with patchy distributions. Personal observations by the authors indicate that to date during the common summer blue-green blooms, samples have not been collected from the areas of greatest density due to the chance distribution of these populations around the sampling stations. Consequently, it is probable that at some time in the future even greater densities will be recorded.

In summary, phytoplankton populations observed at Locust Point during 1979 are similar to those of previous years and appear typical for those occurring in the nearshore waters of the Western Basin of Lake Erie. No adverse impact due to the thermal plume or unit operation was detected.

Zooplankton. Zooplankton populations at Locust Point have been monitored since 1972. Densities observed in 1979 were very similar to the densities observed during 1978, except that the large July pulse observed in 1979 was more representative of densities observed in 1974, 1975, and 1977 (Figure 18). Monthly zooplankton densities were within the ranges established during previous years with the exception of June, July and November. The June total of 483/l, although it was the lowest recorded to date, was very close to the 1978 density, 518/l. The July total of 1,252/l was the largest recorded to date. However, it should be noted that this July pulse would have fallen within the range of previous years were it not

for a sudden pulse of the dinoflagellate Difflugia spp., 901/l. The November density, 22/l, although it was the lowest recorded to date, was similar to densities in 1977, 55/l.

Of the three major components of the zooplankton population, rotifer densities are by far the most erratic and unpredictable (Figure 19). On Figure 19, 1976 results illustrate this vividly. However, with the exception of November when all zooplankton densities were the lowest recorded to date, rotifer densities observed during 1979 were within the range established during the previous years of study at Locust Point.

Copepod populations are much more regular and predictable than rotifer populations (Figure 20). They generally exhibit one peak per year and this usually occurs in the May/June period. This also occurred in 1979. With respect to population size, 1979 copepod densities were relatively low compared to 1973, 1974, 1975 and 1977. However, 1979 densities were larger than 1978 and very similar to 1976.

As with the copepod densities, cladoceran densities are quite regular and predictable from year to year. They often exhibit two peaks, one in the spring and one in the fall (Figure 21). This was the case in 1979. Cladoceran densities during 1979 were lower than those observed during 1974, 1975, 1976, and 1978. However, they were similar to 1977 densities and greater than 1973 densities. The months of May and August produced new highs, while June and November produced new lows.

There are several plausible explanations for the variation which has occurred. Samples in 1972 were collected with a 3-l Kemmerer water bottle at the surface, with a Wisconsin plankton net. A brief comparison study in 1973 showed that the vertical tow captured approximately 50 percent more taxa than a 3-l grab (Reutter and Herdendorf, 1974). The actual stations

sampled have varied from year to year. In 1973 the intake and discharge pipelines were being dredged, and in 1972, tropical storm Agnes affected the weather. Due to the weather, samples were neither collected on the same day of the month each year nor spaced exactly one month apart. Hubschman (1960) pointed out the tremendous differences which occurred between daily samples, and these samples were taken monthly. Wieber and Holland (1968) showed that even with replication, wide variation can occur due to patchiness in population densities. The high spring populations from 1975 were undoubtedly largely due to early warming and lower turbidity as the total zooplankton population was significantly correlated with both temperature and turbidity (r = 0.587 and -0.328, respectively) (Reutter, 1976). Finally, operation of station circulating pumps was common in 1976, 1977, 1978, and 1979.

In summary, due to the large variability observed in previous years, zooplankton populations observed in 1979 should be considered typical for the south shore of the Western Basin of Lake Erie. No adverse impact due to the thermal discharge and/or unit operation was detected.

Thermal Impact Assessment

The limitations of this assessment should first be noted. Between September 1977 and the end of 1979, the operational period, plankton samples were collected on 18 occasions. On five of these dates, the station was operating at 90 percent capacity, 8 percent capacity, 100 percent capacity, 99 percent capacity, and 48 percent capacity, respectively. On the remaining 13 sampling dates the station was not operating.

Phytoplankton. Operational phytoplankton densities were somewhat larger than pre-operational densities (Figure 14). This appears to be a general trend, as the operational values of the three major phytoplankton groups were never below the pre-operational range and often above it. Due to the unusually harsh winters of 1978 and 1979, it is likely that these differences were caused by natural weather conditions.

Figures 15 - 17 present phytoplankton densities at the station intake (Station 8), discharge (Station 13), and a control station (Station 3). It would probably be safe to use the station intake as a control station, however, as an extra measure of caution Station 3, 3000 feet northwest of the discharge, was selected as a control. Using this comparative technique, any difference between pre-operational and operational data observed at the discharge which was also observed at the intake or Station 3 would obviously have been due simply to natural variation in population densities. The only large differences between operational and pre-operational data at the discharge were unusually high spring and fall population densities, and, since these were also observed at the intake and Station 3, they were obviously a natural phenomenon and not caused by unit operation.

In conclusion, to date, operation of and the thermal discharge from the Davis-Besse Nuclear Power Station, Unit 1, has not had a significant effect on Lake Erie phytoplankton densities.

Zooplankton. Zooplankton operational densities, though generally similar to pre-operational densities, were often somewhat lower than the corresponding pre-operational monthly density (Figures 22 - 25). However, as with the phytoplankton, these differences should not be interpreted as due to unit operation, for it appears that zooplankton densities even in

unaffected areas (control stations) were lower during the operational period (Figures 26 - 28). Consequently, these differences were obviously attributable to natural variation and not unit operation or the thermal discharge.

The obvious conclusion is that to date, operation of and the thermal discharge from the Davis-Besse Nuclear Power Station, Unit 1, has not had a significant effect on Lake Erie zooplankton densities.

Benthos

Analysis of 1979 Results

Benthic macroinvertebrate populations collected at Locust Point during 1979 were typical for populations along the south shore of western Lake Erie and similar to those observed during preceding years (Figure 29). In fact, the 1978 annual mean was 1,107.5/m^2 which is only 23.3/m^2 greater than the density observed in 1979 (1,084.2/m^2). Species composition, mainly immature oligochaetes, chironomids, and cladocerans, was also similar to that observed from 1972-1978.

During the past eight years, a trend was noted of increasing population density, as distance from shore increased. However, this trend has often been interrupted at individual stations due to the shifting substrate encountered in the Locust Point vicinity. This was also the case in 1979, as the greatest densities were observed at Stations 9 and 26 (the farthest off shore), but Station 1 (nearshore) exhibited a density greater than Station 3, which was farther from shore.

In summary, benthic macroinvertebrate populations found at Locust Point during 1979 must be considered typical for those of the nearshore waters of the Western Basin of Lake Erie. Furthermore, no significant

environmental changes due to the thermal discharge or unit operation were observed.

Thermal Impact Assessment

Initially it should be pointed out, as discussed in the beginning of the "ANALYSIS" section (see page 56), that operational densities which are outside the pre-operational range may be due to natural variation and not related to unit operation. To allow comparisons of ambient densities with densities at the unit discharge, population densities have been presented from Station 3, a control station located 3000 ft northwest of the unit discharge structure, the same distance from shore as the discharge and at approximately the same water depth. These comparisons allow one to more accurately assess the causes of observed differences - natural variation or the thermal discharge and unit operation.

During what is defined as the operational period, samples were collected on ten occasions. On these ten occasions, the unit was operating at 98 percent on one occasion, 100 percent on another, 99 percent on another, and not operating on the remaining seven dates. While this is very critical to water quality and plankton results, it is somewhat less important when observing benthic communities. Benthic communities are much less mobile than plankton or fish, and, therefore, are generally considered to be good pollution indicators, even of intermittent pollutants or environmental changes. The rationale is that even if the unit were not operating on the sampling date, a large portion of the community sampled would have been present when the unit was operating and when the thermal plume was present. This is not true of plankters, and fish are capable of leaving when unfavorable conditions exist and then returning quickly when the conditions are improved.

Benthic macroinvertebrate densities observed during the operational study were within the limits established during the pre-operational study on all but one occasion. A review of Figures 35 - 37 shows that variability in population densities was widespread and not related to unit operation. Operational densities observed at the discharge (Figure 36) more closely resembled pre-operational densities than did those observed at the intake (Figure 35) or Station 3 (Figure 37), which were designed to be the control stations. Results at Station 3, which is well away from the intake and discharge and where no construction has ever occurred, are graphic examples of the discussion at the beginning of this appraisal section, showing that natural variability can produce values far from the pre-operational densities. Furthermore, this type of variability is to be expected in the Locust Point vicinity, a shallow wave-swept zone with shifting substrate.

In conclusion, to date, the thermal discharge and operation of the Davis-Besse Nuclear Power Station, Unit 1, have not had a significant effect on Lake Erie benthic macroinvertebrate densities.

Fish

Analysis of 1979 Results

Adults. The Lake Erie fish community at Locust Point since 1963 has been dominated by alewife, gizzard shad, spottail shiner, emerald shiner, white bass, yellow perch, and freshwater drum. Percentages and absolute numbers of these species have varied from year to year, but the same species have predominated. During 1979, fish sampling at Locust Point yielded similar results. A large percentage of the numbers of dominant species collected consisted of YOY taken in shore seines, but yearling-

size and larger individuals of these species were also numerically more abundant than other species collected during 1979. The open, wave-swept nature of the nearshore zone at Locust Point and the lack of aquatic vegetation and other sheltering structures precludes the establishment of large resident populations of species which require more sheltered or quiescent conditions (i.e., northern pike, carp, goldfish, bluntnose minnow, spotfin shiner, quillback, white sucker, shorthead redhorse, brown bullhead, yellow bullhead, white crappie, black crappie, and logperch, all of which were collected but not abundant during 1979), although small populations or transient individuals of such species do occur in the area. Of the approximately 83 species present or formerly present in the coastal waters of Lake Erie, the majority are abundant only in bays, marshes, and estuaries or around islands, bars, points, and reefs. The less abundant species captured at Locust Point during 1978 were generally of this type. Pelagic and benthipelagic schooling species consisting of intermediate predators and benthic foragers (i.e., white bass, freshwater drum, yellow perch) and forage fish (i.e., alewife, gizzard shad, spottail shiner, and emerald shiner) make up the bulk of the community. Larger predators (i.e., walleye and channel catfish) are consistently common but less abundant than these dominant species. This type of community, consisting of highly mobile groups of fishes, is typical of such nearshore habitats. Residents of the deeper offshore waters (i.e., trout-perch and rainbow smelt) commonly move inshore and are collected at Locust Point during their spring spawning seasons. The silver chub is an Ohio endangered species consistently collected in small numbers at Locust Point. This was originally a common nearshore schooling species which evidently succumbed to increasing turbidity in the lake (Trautman, 1975). The white perch was

Rather, transient groups of fishes move through the area in response to food abundance, wave action, physicochemical changes and change of season. Densities of yearling and older fishes, as reflected in trawl and gill net catches, are greatest during the summer, due probably to greater food abundance and ambient water temperature, as well as the general concentration movement of most species to inshore spawning areas during spring and summer. Young-of-the-year fish, hatched in spring or summer generally become susceptible to shore seine capture during June and large numbers may be captured in shore seines until August. Thereafter, increased size and dispersal of these fish and decreased numbers due to mortality result in decreased shore seine catch. Many YOY become susceptible to capture by gill net and trawl during the fall.

Food Habits. The major fish food resources in the Locust Point vicinity during 1979 were zooplankton, chironomid larvae, and small forage fish. Analysis of feeding habits of yellow perch, white bass, freshwater drum, spottail shiner, and emerald shiner indicated no marked differences in feeding habits between Transect 8-13 (test) and Transect 3-26 (control). White bass were primarily piscivorous, and the remaining four species relied on zooplankton and chironomid larvae. These results are similar to those obtained during previous years of monitoring (1972 - 1979).

In conclusion, fish populations at Locust Point during 1979 were similar to those observed in previous years of monitoring at the Davis-Besse Nuclear Power Station (1972 - 1978). No trends of attraction to or repulsion from the intake or discharge areas were noted.

Thermal Impact Assessment

In the assessments of the phytoplankton, zooplankton, and benthos sections, it was shown that extreme values, i.e., either maxima or minima, in addition to being potentially due to the thermal discharge and unit operation, will occur by chance alone, due to natural variation. Furthermore, the magnitude of the standard deviation gives one a good indication of the magnitude of natural variation to be expected.

The above statements are hardly necessary when evaluating the impact of the thermal discharge and unit operation on the fishery populations in the vicinity of the Davis-Besse Nuclear Power Station, for there was little or no variation out of the pre-operational range during the operational period for the eight major species (Figures 38 - 45). However, on the 17 sampling dates during the operational period, the unit was operating at above 90 percent capacity on four dates, 15.0 percent capacity on another, and not operating on the remaining twelve dates. This limited operational history has made it impossible to develop correlations of these field data with the laboratory temperature preference and tolerance data from Study II of the project.

Another way to measure impact and an approach which allows us to include all species (not just the major eight) is to compare catches at the discharge (Station 13) and those at the intake (Station 8) with control stations (Figures 46 - 51 and Table 60). This method shows that the only operational catches at the intake and discharge which were outside the pre-operational range occurred during November (Figures 46 and 47). Both of these catches were above pre-operational data which is an indication that it was either a lake-wide occurrance, or a case of fish being attracted to

the rip-rap material which was placed around these structures to prevent bottom scouring and ice damage. However, since an identical November increase occurred at the control stations (Figures 48 - 51), natural variation, not unit operation, should be considered the cause.

In conclusion, it appears that to date, the thermal discharge from and operation of the Davis-Besse Nuclear Power Station, Unit 1, has not had a significant effect on Lake Erie fish populations at Locust Point.

Ichthyoplankton

Thermal Impact Assessment

Ichthyoplankton populations have shown tremendous variations since 1974. Emerald shiners constituted 81 percent of the 1974 larvae, 1 percent of the 1975 larvae, 60 percent of the 1976 larvae, 3 percent of the 1977 larvae, 14 percent of the 1978 larvae and 3 percent of the 1979 larvae. Yellow perch constituted 5 percent of the 1974 larvae, 70 percent of the 1975 larvae, 4 percent of the 1976 larvae, 26 percent of the 1977 larvae, 2 percent of the 1978 larvae, and 11 percent of the 1979 larvae. Gizzard shad appear to have increased significantly reaching 34 percent of the 1976 larvae, 56 percent of the 1977 larvae, 69 percent of the 1978 larvae, and 82 percent of the 1979 larvae. It is felt that the above described variability is largely due to the fact that we are sampling schooling specimens. Consequently, when the net is drawn through a school the density appears quite high. This is also quite dependent on the seasonal frequency of sampling. For example, if the weather allows more frequent spring sampling but prohibits summer sampling, then spring species such as perch and walleye appear relatively more abundant.

The 1979 ichthyoplankton density (66.79/100 m^3) was 18 percent greater than the 1978 density (56.6/100 m^3). Although walleye densities

decreased from 6.1/100 m^3 to 0.15/100 m^3, the loss was more than offset by yellow perch densities which increased from 1.2/100 m^3 in 1978 to 7.46/100 m^3 in 1979 and gizzard shad densities which increased from 38.9/100 m^3 in 1978 to 54.64/100 m^3 in 1979. It appears that walleye and yellow perch densities will fluctuate yearly, however, a definite increasing trend is emerging for gizzard shad densities.

In 1976, control stations (3, 26, 28 and 29) were established on either side of the intake (Station 8)/discharge (Station 13) complex to determine if unusually large fish larvae populations were occurring due to possible spawning in the rip-rap material around these structures. This does not appear to be occurring to any significant degree as Station 13 (plume area) exhibited densities similar to Station 3 (control) and Station 8 (intake) exhibited the lowest densities. These lower densities observed at Station 8 are probably due to the fact that this station is the farthest from shore and in the deepest water.

In summary, there is no indication of significant spawning occurring at Locust Point. However, the nearshore waters here, as with the rest of the nearshore waters along the south shore of the Western Basin, appear to serve as a nursery ground for larvae. Furthermore, due to the similarity between test and control stations, there is no indication that the activities of the plant (including the thermal discharge) have significantly altered these populations.

Water Quality

Analysis of 1979 Results

Seasonal Variations. The quality of the water in the vicinity of the Davis-Besse Nuclear Power Station during the ice-free period of 1979 was

typical for the south shore of western Lake Erie and showed normal seasonal trends. Average temperature rose 14^{o}C from early May to late July and then dropped over 18^{o}C by late November (Figure 53). Average dissolved oxygen concentrations fell from 9.5 ppm in early May to a low of 8.1 ppm in late July and August then rose again to 12.4 ppm in late November. Hydrogen-ion concentrations remained fairly stable throughout the year, varying only 1.7 units. A slight rise was noted in the September pH (8.9) which corresponds to higher algal productivity and CO_2 utilization during early fall. Low temperatures and low primary productivity in late November account for a nearly-neutral pH (7.2) at that time (Figure 52).

Mild turbulence in spring and fall is reflected by the higher turbidity and suspended solids measurements for these periods (Figure 54). The decreased sediment load during summer months accounts for the higher transparency readings in July, August and September (Figure 54). A three-fold improvement in the water clarity was noted between early May and September, and a corresponding three-fold decrease was observed from September and late November. Biochemical oxygen demand (BOD) levels were relatively low and stable throughout the year, even during periods of high turbidity, indicating that the suspended material was largely of an inorganic nature. Slightly elevated BOD values in June may be in response to algal productivity.

Major dissolved ions, including calcium, magnesium, sodium, chloride and sulfate generally yielded the highest concentrations in the spring, the lowest concentrations in the summer and intermediate values in the fall (Figure 55). Similar patterns were exhibited by other parameters, including conductivity and total dissolved solids which are measures of dissolved ions (Figure 56). Alkalinity, which is largely a measure of

bicarbonate ions, was relatively stable throughout the year, varying only 20 mg/l and showing a pattern similar to the other ions (Figure 56).

The biological nutrients, such as phosphorus, nitrate, and silica, also generally yielded the highest concentrations in the spring or early summer, their lowest concentrations in the late summer and intermediate values in the fall (Figure 57). This cycle is attributed to utilization of these nutrients by photosynthesizing plankton. In November, when primary production was at a lower rate, nitrate concentration rose to three times the October level.

In July, 1979 the dissolved oxygen (DO) concentration dropped to 6.6 ppm (Station 1), the lowest value recorded during the 1979 monitoring program. This represents a continuing improvement over the lowest concentration observed in 1977 (3.0 ppm) and is consistent with concentrations measured in earlier years:

Year	DO Range (ppm)
1974	5.7-14.1
1975	7.2-13.6
1976	5.0-12.5
1977	3.0-12.2
1978	5.7-12.5
1979	6.6-12.7

The International Joint Commission recommends a minimum DO level of 6.0 ppm for Lake Erie water (Canada-United States Water Quality Agreement of 1978). However, Ohio EPA (1978) has established a minimum DO standard of 4.0 ppm for the nearshore waters of Lake Erie within the vicinity of Locust Point.

Station Variations. Stations 1, 8 and 13 are located approximately 500, 3,000 and 1,200 feet offshore respectively. In general no consistently significant differences in water quality were observed between the stations. In May and November when the concentrations of most parameters were the highest, a slight gradient was noted for most parameters from the closest inshore station (1) to the farthest offshore station (2). During the summer months these differences were not apparent. In August several of the dissolved and suspended materials parameters showed slightly higher concentrations at Station 13 (Table 67). This may have been related to the proximity of the power station discharge; however, no elevation in water temperature was noted at Station 13 in relation to the other stations. Suspended solids, transparency and turbidity measurements indicate a general increase in water clarity from inshore to offshore (except in November), but differences were normally small.

Differences between the surface and bottom water quality were also slight because of the shallowness (1.0 -4.3 meters) of this portion of Lake Erie and its well-mixed nature. Some depressions in the level of DO and small increases of suspended and dissolved materials were noted near the bottom. This may be due to the high oxygen demand of the sediments and the disturbance of these sediments by currents and wave action. As would be expected, the amount of solar radiation measured at the lake's bottom was significantly lower than the surface irradiance. The difference between surface and bottom readings at the three stations was found to be directly proportional to the water depth.

Thermal Impact Assessment

In general the quality of Lake Erie water in the vicinity of the Station's discharge structure has remained relatively constant over the past seven years (Figures 78, 79, and 80). In comparing the 18 water quality parameters during the ice-free months for the pre-operational versus the operational period (Figures 58 to 75), it can be seen that there is a 67% agreement (operational data within pre-operational range) between the two data sets. This is a relatively good agreement (Figure 81).

Table 95 summarizes this comparison and provides an indication of the degree of difference between the two periods. In general the concentrations of dissolved and suspended substances were higher during the operational period, particularly: magnesium, silica, nitrate, turbidity, and suspended solids. Dissolved oxygen was lower after operation. The magnitude of these differences was not great and seemed to be caused by the general condition of the nearshore waters of Western Lake Erie rather than Station operation. For example, Table 83 shows that magnesium was not only high at the discharge (Station 13) but also high at the water intake (Station 8) which serves as a control station.

Table 96 indicates the percent change in water quality at the Lake intake (Station 8) and discharge (Station 13) from the pre-operational period through the operational period. Dissolved oxygen and phosphorus showed the largest decreases in concentration (7 and 35 percent, respectively), while sulfate, magnesium, BOD, silica, chloride, turbidity, and suspended solids all had increases greater than 5%. In all cases where an increase in excess of 5% occurred at the discharge station, a similar increase was also observed at the control station. These observations further substantiate the conclusion that most of the changes are due to

general lake conditions, and not localized changes resulting from Station operation and the thermal discharge. The decrease in phosphorus concentration is consistent with other nearshore measurements in western Lake Erie which indicate a decline in this substance as a result of pollution abatement programs.

Based on the results of this study, short-term degradation of Lake Erie water quality can not be demonstrated as a result of Station operation. The stability of water quality in the vicinity of Locust Point is well-documented; long-term deleterious impacts resulting from station and the thermal discharge are unlikely.

Primary Productivity

When the decision was made to monitor primary productivity, a tacit assumption was that one or more aspects of plant operation could affect the rate of phytoplankton growth. Impacts that could affect phytoplankton, and that are frequently mentioned in the literature, include changes in temperature, turbidity, and chemical additives. An increase in temperature caused by the heated water discharge might be expected to result in increased productivity. Increased turbidity, a possible result of bottom scouring by the plant discharge, could result in decreased productivity. Chemicals included in the plant discharge could cause changes in pH or alkalinity, both of which are determining factors in the rate of increase of phytoplankton biomass. As either pH or alkalinity increases, so does productivity.

No significant changes in any of these parameters was noted during the five years of the study. Nor were there discernible, long-term changes in the measured values of productivity during the study period.

Nevertheless, there was considerable variability from cruise to cruise and from station to station during any one cruise. Since the temperature was constant from station to station, and both pH and alkalinity were constant throughout the study period, this variability is most probably the result of natural factors such as non-homogeneous distribution throughout the study site, changes in phytoplankton species composition throughout the year (Tables 5 - 10), or availability of nutrients (Tables 78 - 80).

If any factors associated with plant operation were to impact primary productivity, the changes would be expected to be measurable at Station 13, the closest station to the plant discharge. However, the observations during the 1979 field year confirmed earlier observations that any impact of the plant discharge is either too localized to be measured at Station 13, which is 500 feet from the discharge, or so extensive that it extends beyond Station 14. Since productivity at Station 8 is comparable to Stations 13, 14, and 3, the control station, it is unlikely that any impact is very extensive. Rather, any impact is most probably highly localized. Such a localized impact is hardly liable to cause extensive environmental alteration.

<u>Summary</u>

Although little operational data was actually collected due to unit outages, that information which was collected indicated that the thermal impact at the Davis-Besse Nuclear Power Station is so localized as to be all but undetectable by the sampling program. To some degree this is a function of sampling station location, however, the stations were located in a systematic fashion capable of detecting any significant impact. Consequently, it appears that no significant aquatic environmental impact is occurring from the thermal discharge at the Davis-Besse Nuclear Power

Station. Based on the experience of the authors at other power stations on Lake Erie, the reason for this is the presence of the closed condenser cooling system which minimizes the size of the thermal plume and the volume of intake water. This project and other research by the authors has indicated that the design features at Davis-Besse, i.e., cooling tower, off-shore intake, closed intake canal, bottom intake and a high velocity discharge nozzle, may be the optimal design features to minimize aquatic environmental impacts due to cooling water intakes and thermal discharges.

RECOMMENDATIONS

The Davis-Besse Nuclear Power Station began commercial power production 29 August 1977. Since that time the station has been operating at 50 percent or more of its capacity on less than 25 percent of the sampling dates. Although every effort has been made to obtain the best possible interpretation from the data which were collected, the authors do not believe that enough operational information has been obtained to adequately assess the impact of the thermal discharge on the aquatic environment. Consequently, it is recommended that the study be reinitiated to allow the collection of more information when the station is operating on a more regular basis.

Based on the results obtained to date, it is recommended that if sampling is ever initiated again, sampling stations be moved closer to the discharge and be collected more frequently in an effort to actually measure the effects of the thermal discharge. The present station location would document a significant impact. However, the actual effects of the thermal discharge could be missed if these effects (the impact) were very localized as is now expected.

It is not recommended that the fish management policies of the Ohio Division of Wildlife be significantly changed to handle fish populations in thermal discharges. However, as large numbers of fish should be attracted to these thermal discharges, it is recommended that public education programs be initiated to make sport fishermen aware of unique fishing opportunities which may exist during fall, winter and spring in thermal plumes.

Based on the results from this study and other research conducted by the authors at power stations on Lake Erie, it is possible to make several recommendations for power plant design features which would minimize aquatic environmental impacts.

1. The location and design of the cooling water intake is critical. Offshore intakes and closed intake canals appear to be very effective at minimizing adverse aquatic environmental impacts. These design features allow fish which are orienting to the shoreline as they swim to swim past power stations. Open intake canals at the shoreline serve as fish collection devices and often lead to the entrainment and impingement of large numbers of fish on the power stations traveling screens. In Lake Erie, fish concentrations in nearshore waters are higher than offshore, and, consequently, less fish are affected if the intake is located offshore.
2. Devices such as cooling towers, cooling lagoons, etc. serve two useful purposes: they reduce the quantity of water required by the power station; and they reduce the size of the thermal plume. A reduction in the volume of water required for cooling purposes

generally reduces losses due to entrainment and impingement. A reduction in the size of the thermal plume reduces the likelihood of recirculation of cooling water after it has been discharged and reduces the number of fish which would be attracted to the thermal discharge during cold weather. This reduction in the number of fish attracted to the plume can lead to significant reductions in the number of fish impinged as cooling water intakes and discharges are often relatively close together.

3. Care should be taken to locate thermal discharges downstream from the intakes to avoid recirculation of cooling water. On the south shore of Lake Erie cooling water discharges should be to the east of the intakes.

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The authors wish to acknowledge the cooperation of the Ohio Department of Natural Resources, (ODNR), the Toledo Edison Company and the U.S. Fish and Wildlife Service (USFWS). Toledo Edison supplied plant operating characteristics which greatly increased our ability to interpret the results. The entire staff of Lake Erie Fishery Unit of ODNR has provided valuable technical input throughout the study with regard to sampling techniques, frequencies and sampling station locations. However, we wish to especially acknowledge the contributions and cooperation of D. Barry Apgear, Allen W. Cannon, Delmar E. Handley and Russell L. Scholl, who were extremely helpful with both technical and administrative problems. For similar contributions, we would like to acknowledge the efforts of Donald V. Friberg (USFWS).

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<u>Project Staff</u>

Charles E. Herdendorf	- Project Leader; Analysis of Water Quality and Physical Parameters
Jeffrey M. Reutter	- Assistant Leader and Project Manager; Analysis of Biological Parameters
Mark D. Barnes	- Coordination of field sampling; Adult Fish and Stomach Analysis
Donald L. Breier	- Field sampling; Laboratory Analysis of Ichthyoplankton
Walter E. Carey	- Primary Productivity Supervisor
C. Lawrence Cooper	- Supervisor Ichthyoplankton Identification
Deborah L. Downey	- Secretarial Services
James W. Fletcher	- Plankton Identification
Laurie J. Fletcher	- Drafting and Secretarial Services
Jo Ann Franks	- Administrative Assistance
Richard Froelich	- Identification of Benthic Macroinvertebrates
Patricia B. Herdendorf	- Primary Productivity
Suzanne L. Hessler	- Secretarial Services

PROJECT STAFF (cont'd.)

Cheryl L. Kimerline	-	Clerical Assistance
William S. Snyder	-	Keypunching, Field Sampling, Clerical Assistance
Kristina I. White	-	Project Accountant

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TABLES

TABLE 1

PLANKTON AND WATER QUALITY SAMPLING DATES

Month \ Year	1973[1]	1974	1975	1976	1977	1978	1979
March				18			
April		18	22	14	26		
May	25	22	29	17	24	11	1 and 23
June	27	19	16	16	22	29	21
July	25	17	14	20	13	25	28
August	23	22	11	18	30	17	29
September	26	10	8	14	12	15	27
October		9	6	19	26	17	30
November	6	7	3	2	22	1	28
December	4		16				

[1] No phytoplankton collections.

TABLE 2

PHYTOPLANKTON AND ZOOPLANKTON SAMPLING STRUCTURE, 1973-1979[1]

Station	1973[2]	1974	1975	1976	1977	1978	1979
1	X	X	X	X	X	X	X
2							
3	X	X	X	X	X	X	X
4							
5	X						
6		X	X	X	X	X	X
7	X						
8	X	X	X	X	X	X	X
9	X	X	X				
10	X	X	X				
11							
12	X	X	X	X			
13	X	X	X	X	X	X	X
14		X	X	X	X	X	X
15							
16							
17	X						
18	X	X	X	X	X	X	X
19	X	X	X				
20	X						
21							
22							
23							
24							
25							
26				X			
27				X			
28				X			
29				X			
First Month Last Month	May December	April November	April December	March November	April November	May November	May November

[1] All samples were collected by a vertical tow with a Wisconsin plankton net; 12cm mouth 0.064 mm mesh in 1973 and 1974 and 0.080 mm mesh from 1975-1979.

[2] No phytoplankton sampling; Zooplankton only.

TABLE 3

BENTHIC MACROINVERTEBRATE SAMPLING DATES

Month \ Year	1973	1974	1975	1976	1977	1978	1979
March				18			
April		17-18	23	9	27		
May	25	22-23	21	4		11	30
June		19-20	19	7	22		
July	2, 26-1	17	17	5		26	29
August	23	14	19	5	16		
September	19-26	6	11	3		26	30
October		10	9	5	3		
November	2-7	7	6	1		1	4
December	4		16				

TABLE 4

BENTHIC MACROINVERTEBRATE SAMPLING STRUCTURE, 1973-1979[1]

Station	1973	1974	1975	1976	1977	1978	1979
1	X	X	X	X	X	X	X
2	X	X	X				
3	X	X	X	X	X	X	X
4	X	X	X				
5	X	X	X				
6	X	X	X	X			
7	X	X	X	X			
8	X	X	X	X	X	X	X
9	X	X	X	X	X	X	X
10	X	X	X				
11	X	X	X	X			
12	X	X	X	X			
13	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X
16	X	X	X	X			
17	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X
19	X	X	X				
20	X	X[2]					
21							
22							
23							
24							
25							
26				X	X	X	X
27				X			
28				X			
29				X			
First Month	May	April	April	March	April	May	May
Last Month	December	November	December	November	October	November	November
Frequency	Monthly	Monthly	Monthly	Monthly	Every-other-month	Every-other-month	Every-other-month

[1] Three replicate grab samples with a ponar dredge ($A=0.052\ m^2$) were collected at the stations indicated each year except 1973 when only one grab was collected at each station.

[2] Samples were collected only in April as water at this station was removed after this date to allow construction on the intake pumps.

TABLE 5

GILL NET SAMPLING DATES

Year / Month	1973	1974	1975	1976	1977	1978	1979
April		25-26	17-18	12-13	18-19		30-1 (May)
May		21-22	22-23	10-11	16-17	18-19	30-31
June		13-14	16-17	14-15	13-14	29-30	20-21
July	2-3	10-11	14-15	14-15	12-13	24-25	28-29
August	2-3, 30-31	19-20	11-12	11-12	9-10	17-18	28-29
September	28-29	12-13	8-9	30-1	13-14	24-25	29-30
October		16-17	6-7		20-21	17-18	27-28
November	12-13	25-26	3-4, 17-18	4-5		1-2	3-4
December			16-17				

TABLE 6

SHORE SEINE SAMPLINE DATES

MONTH	YEAR						
	1973	1974	1975	1976	1977	1978	1979
April		12	17	6	18		
May		21	22	5	16	10	1, 30
June	14	13	17	10	13	29	20
July		9	15	7	12	24	28
August	1	27	12	10	9	17	28
September		12	10	20	13	15	29
October	3	16	14	15	20	18	27
November	12	14	5	15		2	3

TABLE 7

TRAWL SAMPLING DATES

MONTH	YEAR						
	1973	1974	1975	1976	1977	1978	1979
April		25		19	3		30
May		21	5, 27	13	18	12	24
June	29	21	17	17	23	30	22
July	17	19	15	16	19	25	31
August	24	16	21	20	23	18	31
September	27	13	15	13	27	15	25
October		10	14	12	24	19	30
November	5	8	7	2	8	1	6

TABLE 8

ICHTHYOPLANKTON SAMPLING DATES

Month \ Year	1973	1974	1975	1976	1977	1978	1979
March							
April			22	6, 14, 30	20, 29	30	
May		21	12, 25	10, 17, 27	21	22	1, 9, 31
June		14	2, 15, 22	11, 17, 28	2, 13, 25	8, 20	5, 21
July		10	2, 13	8, 23, 29	5, 13, 20, 27	5, 19	5, 12, 20
August		19	4, 30	9, 20, 31	12, 22	1, 11, 23	3, 15
September		12			2		
October		16					
November		25					

TABLE 9

PROCEDURES FOR WATER QUALITY DETERMINATION

Parameter	Units	References for Analytical Methods
1. Dissolved Oxygen	^{o}C	APHA (1975): Sec. 422B
2. Hydrogen-ions (pH)	pH units	ASTM (1973): D1293-65
3. Transparency	meters	Welch (1948): Secchi disk
4. Turbidity	F.T.U.	APHA (1975): Sec. 214A
5. Suspended Solids	mg/l	APHA (1975): Sec. 208D
6. Conductivity	umhos/cm(25^{o}C)	ASTM (1973): D1125-64
7. Dissolved Solids	mg/l	USEPA (1974)
8. Calcium (Ca)	mg/l	APHA (1975): Sec. 306C
9. Chloride (Cl)	mg/l	APHA (1975): Sec. 408B
10. Sulfate (SO_4)	mg/l	ASTM (1973): D516-68C
11. Sodium (Na)	mg/l	ASTM (1973): D1428-64
12. Magnesium (Mg)	mg/l	APHA (1975): Sec. 313C
13. Alkalinity (Total as $CaCO_3$)	mg/l	APHA (1975): Sec. 403
14. Nitrate (NO_3)	mg/l	ASTM (1973): D992-71
15. Phosphorus (Total as P)	mg/l	APHA (1975): Sec. 425F
16. Silica (SiO_2)	mg/l	ASTM (1973): D859-68B
17. Biochemical Oxygen Demand	mg/l	APHA (1975): Sec. 507
18. Temperature	^{o}C	APHA (1975): Sec. 212

TABLE 10

MONTHLY MEAN DENSITIES* OF INDIVIDUAL PHYTOPLANKTON

TAXA AT LOCUST POINT - 1979

TAXA / DATE	May 1	May 23	June 21	July 28	Aug. 29	Sept. 27	Oct. 30	Nov. 28	MEAN
BACILLARIOPHYCEAE (Diatoms)									
Asterionella formosa	680123	14439	221	111	0	0	30211	10187	91912
Cosinodiscus spp.	0	0	0	0	0	0	17	0	2
Cyclotella spp.	6	0	0	0	0	0	0	0	1
Cymatopleura spp.	7	0	0	0	0	0	0	0	1
Diatoma spp.	8	16	0	0	0	0	0	0	3
Fragilaria spp.	2706	7415	106	7276	5571	6365	9161	3071	5209
Gyrosigma spp.	0	0	0	7	0	0	0	0	1
Melosira spp.	39353	5308	700	3422	68	5548	11930	489	8352
Navicula spp.	86	0	0	34	0	0	0	0	15
Nitzschia spp.	12	0	0	0	0	0	0	0	1
Penularia spp.	0	0	0	0	0	0	8	0	1
Pleurosoma sp.	0	7	0	0	0	0	0	0	1
Rhizosolinia spp.	5	0	0	0	0	0	0	0	1
Sceletonema subsalsa	0	0	481	0	0	0	0	0	60
Stephanodiscus binderanus	10142	5847	11	0	23	0	5175	2833	2948
S. spp.	7	0	0	0	0	0	8	0	2
Surirella spp.	0	0	17	32	44	0	8	0	13
Synedra spp.	87	17	53	0	0	0	70	1034	158
Tabellaria spp.	1014	2492	39	0	0	0	113	798	557
Unidentified Centric	0	33	0	0	6	17	0	0	7
Unidentified Centric Filament	109	281	0	0	0	0	0	0	49
Subtotal	733663	35855	1628	10882	5712	11930	56703	17967	109293

TABLE 10(Cont'd)

MONTHLY MEAN DENSITIES* OF INDIVIDUAL PHYTOPLANKTON

TAXA AT LOCUST POINT - 1979

TAXA \ DATE	May 1	May 23	June 21	July 28	Aug. 29	Sept. 27	Oct. 30	Nov. 28	MEAN
CHLOROPHYCEAE									
(Green Algae)									
Actinastrum spp.	0	0	13	0	0	0	93	0	13
Ankistrodesmus falcatus	0	0	50	0	14	0	0	0	8
Binuclearia tatrana	0	0	338	255	195	57144	11069	44	8631
Botryococcus sudeticus	0	0	0	1360	1977	59	0	0	424
Closteriopsis longissima	11	184	7	13	0	0	9	21	31
Closterium spp.	0	0	6	17	0	0	0	0	3
Coelastrum spp.	0	0	0	79	47	0	0	0	16
Cosmarium spp.	0	0	0	35	0	0	0	0	4
Dictyosphaerium sp.	8	17	0	0	0	0	0	0	3
Micractinium sp.	6	0	0	0	0	0	0	0	1
Mugeotia sp.	146	1958	111	84	85	12747	8068	385	2948
Oocystis spp.	0	0	0	47	0	11	5	0	8
Pediastrum duplex	18	151	899	716	955	355	241	0	417
P. simplex	28	85	67	1018	422	636	224	84	323
Scenedesmus spp.	26	7	42	64	0	17	10	0	21
Schroederia sp.	0	0	8	0	0	0	0	0	1
Staurastrum paradoxum	10	14	34	404	75	23	78	0	80
Tetraspora spp.	7	0	0	0	0	0	0	0	1
Subtotal	261	2416	1574	4092	3791	70992	19798	534	12932

TABLE 10 (Cont'd)

MONTHLY MEAN DENSITIES* OF INDIVIDUAL PHYTOPLANKTON

TAXA AT LOCUST POINT - 1979

TAXA \ DATE	May 1	May 23	June 21	July 28	Aug. 29	Sept. 27	Oct. 30	Nov. 28	MEAN
MYXOPHYCEAE									
(Blue-green Algae)									
Anabaena spiroides	0	0	13	129	259	17	22	10	56
A. sp.	45	8	129	26	15	277	0	0	63
Aphanizomenon flos-aquae	18	0	110	215464	96118	405876	2198	0	89973
Aphanothece spp.	0	0	0	0	5	0	0	0	1
Chroococcus spp.	0	524	0	147	0	0	0	0	84
Gomphosphaeria spp.	0	0	0	0	8	0	0	0	1
Merismopedia spp.	0	0	7	21	0	0	0	0	4
Microcystis spp.	0	0	0	1071	189	0	0	0	158
Oscillatoria spp.	779	689	984	100	103	12128	40903	945	7079
Subtotal	842	1221	1243	216958	96697	418298	43123	955	97417
DINOPHYCEAE									
(Protozoa)									
Ceratium hirundinella	0	5	149	34372	40	147	0	0	4339
Peridinium sp.	11	0	0	197	5	0	0	0	27
Subtotal	11	5	149	34570	45	147	0	0	4366
TOTAL	734777	39497	4595	266502	106244	501368	119624	19456	224008

* Expressed as number of whole organisms/liter and computed from duplicate vertical tows (bottom to surface) with a Wisconsin plankton net (12cm diameter, 0.080mm mesh) from 7 sampling stations on dates indicated.

TABLE 11

MONTHLY MEAN PHYTOPLANKTON DENSITIES* FROM

SAMPLING STATIONS AT LOCUST POINT, LAKE ERIE - 1979

STATION \ DATE	May 1	May 23	June 21	July 28	Aug. 29	Sept. 27	Oct. 30	Nov. 28	GRAND MEAN
1	630647	52546	7624	317485	81514	406729	120938	38020	206938
3	737866	45212	8252	327506	94904	517548	145597	21221	237263
6	633462	48808	3851	440997	79302	444691	134103	13662	224859
8	872472	28665	1945	94904	181824	481395	100882	17527	222452
13	889947	36594	3961	260850	96672	692887	133682	12320	265864
14	672223	28405	2762	206194	185327	363659	112627	12497	197962
18	706825	36252	3773	217577	24168	602667	89539	20943	212718
GRAND MEAN	734777	39497	4595	266502	106244	501368	119624	19456	224008

* Data presented as the number of whole organisms/liter and computed from duplicate vertical tows (bottom to surface) with a Wisconsin plankton net (12cm diameter, 0.080mm mesh) at each of the indicated stations.

TABLE 12

MONTHLY MEAN DENSITIES* OF INDIVIDUAL ZOOPLANKTON

TAXA AT LOCUST POINT - 1979

TAXA \ DATE	May 1	May 23	June 21	July 28	Aug. 29	Sept. 27	Oct. 30	Nov. 28	MEAN
ROTIFERA									
Asplanchna priodonta	0.1	2.2	0.2	0.1	5.4	0.0	0.0	0.0	1.0
Brachionus angularis	6.5	0.8	10.5	15.2	4.0	5.1	0.3	0.0	5.3
B. calyciflorus	27.8	0.7	0.3	0.0	0.0	0.0	0.0	0.0	3.6
B. caudatus	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	0.0	<0.1
B. diversicornus	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	<0.1
B. havanaensis	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	<0.1
Cephalodella spp.	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	<0.1
Filinia terminalis	2.0	0.4	0.8	0.1	0.0	0.0	0.0	0.0	0.4
Kellicottia longispina	0.0	14.4	4.6	0.0	<0.1	0.0	<0.1	0.4	2.4
Keratella cochlearis	16.5	30.2	9.9	38.6	1.4	102.8	13.8	1.5	26.8
K. quadrata	16.0	112.5	9.7	<0.1	<0.1	0.0	0.3	0.0	17.3
Lecane spp.	0.6	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Notholca spp.	16.8	4.2	0.0	0.0	0.0	0.0	0.1	0.1	2.6
Polyarthra vulgaris	37.2	3.3	15.0	13.6	20.4	208.7	25.9	0.8	40.6
Synchaeta spp.	76.1	1.0	14.5	8.3	0.4	7.4	68.1	7.9	23.0
Trichocerca multicrinis	0.0	0.6	4.5	25.5	9.1	22.1	0.0	0.0	7.7
T. similis	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	<0.1
Unidentified Rotifer	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
Subtotal	199.5	170.3	70.2	101.8	40.8	346.2	108.5	10.6	131.0

TABLE 12 (Cont'd)

MONTHLY MEAN DENSITIES* OF INDIVIDUAL ZOOPLANKTON

TAXA AT LOCUST POINT - 1979

TAXA \ DATE	May 1	May 23	June 21	July 28	Aug. 29	Sept. 27	Oct. 30	Nov. 28	MEAN
COPEPODA									
Calanoid Copepods									
Diaptomus ashlandii	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
D. minutis	<0.1	0.8	0.1	1.4	1.2	0.0	0.0	0.1	0.4
D. oregonensis	0.0	0.0	0.0	0.5	1.0	0.0	0.0	0.0	0.2
D. sicilis	0.0	1.5	0.0	0.1	<0.1	0.0	0.0	0.0	0.2
D. siciloides	0.1	0.2	6.9	6.8	5.4	2.0	0.0	0.7	2.8
Eurytemora affinis	0.0	0.1	<0.1	0.0	0.0	0.0	0.0	0.0	<0.1
Copepodids, calanoid	3.4	25.5	3.8	3.0	8.5	8.9	0.7	0.0	6.7
Nauplii, calanoid	2.0	11.8	4.5	4.8	1.2	21.0	0.4	0.0	5.7
Cyclopoid Copepods									
Cyclops bicuspidatus thomasi	0.2	8.4	1.1	0.0	0.1	0.0	0.2	0.1	1.3
C. vernalis	0.0	2.8	51.2	0.9	4.2	2.5	0.4	0.0	7.8
Mesocyclops edax	0.0	0.0	0.0	1.4	0.2	0.0	0.0	0.0	0.2
Tropocyclops prans nex	0.0	0.1	0.0	0.1	1.3	0.0	0.0	0.0	0.2
Copepodids, cyclopoid	3.7	20.9	19.1	3.6	16.3	13.8	7.3	1.6	10.8
Nauplii, cyclopoid	33.1	119.2	175.5	153.6	47.9	54.0	30.4	7.2	77.6
Harpacticoid Copepods									
Canthocamptus robertcokeri	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Copepodids, harpacticoid	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
Nauplii, harpacticoid	0.5	2.6	0.0	0.0	0.0	0.0	0.2	0.0	0.4
Subtotal	43.7	195.0	262.3	176.3	87.4	102.0	39.7	9.6	114.5

TABLE 12(Cont'd)

MONTHLY MEAN DENSITIES* OF INDIVIDUAL ZOOPLANKTON

TAXA AT LOCUST POINT - 1979

TAXA \ DATE	May 1	May 23	June 21	July 28	Aug. 29	Sept. 27	Oct. 30	Nov. 28	MEAN
CLADOCERA									
Alona spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	<0.1
Bosmina longirostris	0.2	2.2	0.6	0.0	0.0	0.0	1.4	0.4	0.6
Ceriodaphnia lacustris	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	<0.1
Chydorus sphaericus	0.7	13.5	5.1	4.4	34.6	18.6	8.0	<0.1	10.6
Daphnia galeata mendotae	0.0	0.1	0.0	26.3	0.0	0.0	0.0	0.0	3.3
D. retrocurva	0.6	121.5	48.7	33.1	15.8	6.5	<0.1	0.0	28.3
Diaphanosoma leuchtenbergianum	<0.1	0.1	0.0	0.1	0.8	0.4	0.0	0.0	0.2
Eubosmina coregoni	0.5	24.6	9.3	8.3	41.0	23.5	19.6	0.8	15.9
Leptodora kindtii	0.0	0.3	<0.1	0.7	0.0	0.0	0.0	0.0	0.1
Subtotal	2.0	162.3	63.8	72.9	92.2	49.0	29.3	1.2	59.1
PROTOZOA									
Difflugia spp.	0.0	8.6	86.9	901.3	114.0	76.8	175.4	0.0	170.4
OSTRACODA	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
TARDIGRADA	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1
TOTAL	245.3	536.1	483.1	1252.2	334.4	574.1	352.9	21.5	475.0

* Data presented as number of organisms/liter and computer from duplicate vertical tows (bottom to surface) with a Wisconsin plankton net (12cm diameter, 0.080mm mesh) from 7 stations in Lake Erie at Locust Point in the vicinity of the Davis-Besse Nuclear Power Station.

TABLE 13

MONTHLY MEAN ZOOPLANKTON DENSITIES* FROM

SAMPLING STATIONS AT LOCUST POINT, LAKE ERIE - 1979

STATION \ DATE	May 1	May 23	June 21	July 28	August 29	Sept. 27	Oct. 30	Nov. 28	GRAND MEAN
1	238.2	645.3	537.9	1,374.9	340.4	936.5	265.9	20.3	544.9
3	206.9	568.1	488.7	802.0	257.0	362.2	385.2	22.9	386.6
6	200.8	405.3	421.0	1,117.3	158.2	575.1	452.8	16.0	418.3
8	217.9	657.0	336.7	1,285.4	290.9	312.8	334.9	22.1	432.2
13	287.4	354.3	563.2	1,433.0	402.6	753.6	440.3	10.3	530.6
14	255.2	617.6	478.9	1,156.3	312.7	198.7	302.6	18.3	417.5
18	310.9	505.5	555.6	1,596.5	578.8	879.8	288.8	40.3	594.5
GRAND MEAN	245.3	536.1	483.1	1,252.2	334.4	574.1	352.9	21.5	475.0

* Data presented as number of organisms/liter and computed from duplicate vertical tows (bottom to surface) with a Wisconsin plankton net (12cm diameter, 0.080mm mesh) at each station.

TABLE 14

PRE-OPERATIONAL AND OPERATIONAL PHYTOPLANKTON DATA FROM LAKE ERIE IN THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION

	BACILLARIOPHYCEAE							
	Pre-Operational Data[1] (no/l)				Operational Data[2] (no/l)			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	22404	---	---	---	---	---
April	7531	216609	105938	85684	---	---	733663[3]	---
May	2080	167574	69785	78218	35855	408898	222377	263781
June	90	6573	2131	2991	1628	11078	6353	6682
July	285	2556	1206	1073	1830	10882	6356	6401
August	772	20481	7513	8870	3372	5712	4542	1655
September	907	17383	7577	8674	4996	18138	11688	6574
October	5958	34799	24927	16432	12505	89804	53004	38782
November	7993	13002	10584	2509	16471	105250	46563	50830
December	---	---	79879	---	---	---	---	---
Mean	3202	59872	33194	37727	10951	92823	135568	252388

CHLOROPHYCEAE

Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	32	---	---	---	---	---
April	102	2888	916	1323	---	---	261[3]	---
May	432	2110	1167	716	700	2416	1558	1213
June	904	8347	4604	3951	1574	5556	3565	2816
July	1024	3384	1955	1012	4092	26052	15072	15528
August	793	5910	2362	2194	3791	4192	3992	284
September	2921	9511	5780	3381	2843	10034	27956	37443
October	7366	21872	13686	7431	16665	27160	21208	5388
November	1691	21198	11544	9755	27141	117566	48414	61348
December	---	---	1522	---	---	---	---	---
Mean	1904	9528	4357	4706	8115	27568	15253	16785

[1]Results from samples collected from 1974 through August 1977.

[2]Results from samples collected from September 1977 through 1979.

[3]April sample actually collected May 1.

TABLE 14 (cont'd)

PRE-OPERATIONAL AND OPERATIONAL PHYTOPLANKTON DATA FROM LAKE ERIE IN THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION

	MYXOPHYCEAE							
	Pre-Operational Data[1]				Operational Data[2]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	82	---	---	---	---	---
April	81	954	358	402	---	---	842[3]	---
May	0	688	221	315	1221	1886	1554	470
June	13	12854	3471	6269	1243	45570	23407	31344
July	313	84901	37539	35129	28878	216958	122918	132993
August	35	315263	101877	146415	69043	96697	82870	19554
September	1881	17977	7902	8780	19954	75577	171276	215727
October	5109	14203	8394	5045	19629	60168	40973	20355
November	1504	2578	2179	588	28219	31652	20275	16820
December	---	---	1563	---	---	---	---	---
Mean	1117	56177	16359	32084	24027	75501	58027	62124

TOTAL PHYTOPLANKTON

Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	22517	---	---	---	---	---
April	7860	224076	108178	88757	---	---	734777	---
May	4883	168899	71305	77644	39497	411501	225499	263047
June	1604	17817	10357	12247	4595	62414	33505	40884
July	3460	87260	41833	34760	59120	266502	162811	146641
August	1603	327915	112143	147757	76687	106244	91466	20900
September	5751	31352	21378	13705	48372	83480	211073	252015
October	19232	70129	47052	25778	99846	126796	115422	13958
November	17148	33499	24324	8357	161456	165699	115537	83236
December	---	---	82963	---	---	---	---	---
Mean	7693	121368	54205	37254	69939	174662	211261	220686

[1]Results from samples collected from 1974 through August 1977.

[2]Results from samples collected from September 1977 through 1979.

[3]April sample actually collected May 1.

TABLE 15

PRE-OPERATIONAL AND OPERATIONAL PHYTOPLANKTON DATA[1] FROM THE VICINITY OF THE INTAKE AND DISCHARGE STRUCTURES AND A CONTROL STATION

	STATION 3							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	---	---	---	---	---	---
April	5929	188717	91274	76544	---	---	737866[4]	---
May	3553	201735	74227	91342	45212	267882	156547	157451
June	1607	18380	6303	8079	8252	30840	19546	15972
July	2737	113803	48155	47231	57331	327506	192419	191043
August	1329	358252	125142	162782	48336	94904	71620	32929
September	3891	27850	16441	12020	40281	64617	207482	268801
October	12016	66619	46585	30064	152681	226943	175074	45060
November	12786	33484	20171	11552	149954	244023	138399	111850
December	---	---	---	---	---	---	---	---
Mean	5481	102539	53537	41018	71721	179531	212369	221533
	STATION 8							
March	---	---	22747	---	---	---	---	---
April	8250	142686	72523	57337	---	---	872472[4]	---
May	1634	124782	58863	62864	28665	384544	206605	251644
June	1348	22427	7242	10174	1945	6778	4362	3417
July	2313	80734	39508	32224	31659	94904	63282	44721
August	1562	389417	133684	182880	116805	181824	149315	45975
September	5528	28524	19847	12473	36743	82952	200363	244475
October	14883	52375	35282	18963	71015	116363	96087	23051
November	15181	43947	26842	14813	93383	199435	103448	91371
December	---	---	79075	---	---	---	---	---
Mean	6337	111737	49561	37676	54316	152400	211992	275361
	STATION 13							
March	---	---	21247	---	---	---	---	---
April	6657	193221	113796	78639	---	---	889947[4]	---
May	4224	191170	78251	87463	36594	429182	232888	277602
June	1597	23356	9191	10200	3961	85402	44682	57587
July	2139	53265	35461	23674	47743	260850	154297	150689
August	1679	405706	132161	186211	96672	119697	108185	16281
September	6444	40540	23973	17068	46421	89766	276358	361375
October	17977	98873	52447	41752	77695	136376	115918	33129
November	13995	26408	20205	6207	75855	111081	66422	50057
December	---	---	83306	---	---	---	---	---
Mean	6839	129067	57004	42833	54992	176051	236087	275701

[1]Data presented as number of whole organisms per liter.

[2]Data collected from 1974 through August 1977.

[3]Data collected from September 1977 through 1979.

[4]April sample actually collected May 1, 1979.

TABLE 16

PRE-OPERATIONAL AND OPERATIONAL ZOOPLANKTON DATA FROM THE LOCUST POINT AREA

	ROTIFERS							
	Pre-Operational Data[1] (no/l)				Operational Data[2] (no/l)			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	27	---	---	---	---	---
April	39	362	169	138	---	---	200[3]	---
May	94	479	304	166	170	264	217	66
June	87	234	149	71	33	70	52	26
July	35	573	259	234	39	102	71	45
August	23	592	292	213	36	41	39	4
September	119	369	241	128	82	213	214	132
October	73	681	280	347	70	120	100	26
November	143	513	282	164	15	49	25	21
December	219	236	228	12	---	---	---	---
Mean	92	449	223	86	64	123	115	82
	COPEPODS							
March	---	---	5	---	---	---	---	---
April	24	46	35	9	---	---	44[3]	---
May	233	851	400	255	31	195	113	116
June	182	591	340	165	91	262	177	121
July	62	423	186	148	126	176	151	35
August	33	163	77	51	87	141	114	38
September	66	177	103	51	47	109	86	34
October	67	105	82	20	59	67	55	14
November	24	119	68	42	25	48	28	19
December	32	52	42	14	---	---	---	---
Mean	80	281	134	134	67	143	96	53

[1]Results from samples collected from 1973 through August 1977.

[2]Results from samples collected from September 1977 through 1979.

[3]April sample actually collected May 1.

TABLE 16 (cont'd)

PRE-OPERATIONAL AND OPERATIONAL ZOOPLANKTON DATA FROM THE LOCUST POINT AREA

	CLADOCERAN							
	Pre-Operational Data[2] (no/l)				Operational Data[2] (no/l)			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	0.2	---	---	---	---	---
April	0	11	3	5	---	---	2[3]	---
May	8	130	45	49	1	162	82	114
June	103	335	198	90	64	360	212	209
July	39	188	134	61	73	122	98	35
August	2	39	25	15	72	92	82	14
September	29	205	104	74	30	192	90	89
October	26	211	101	97	27	56	37	16
November	17	58	34	18	16	26	14	13
December	12	24	18	8	---	---	---	---
Mean	26	133	66	65	40	144	77	66
	TOTAL ZOOPLANKTON							
March	---	---	32	---	---	---	---	---
April	77	439	217	157	---	---	245[3]	---
May	555	1086	819	191	295	536	416	170
June	707	1365	902	266	483	518	501	25
July	306	1168	911	345	252	370	811	624
August	144	825	454	249	250	334	292	59
September	391	627	500	110	251	557	461	182
October	259	831	489	302	159	246	253	97
November	256	650	391	178	55	135	71	58
December	275	303	289	20	---	---	---	---
Mean	330	810	500	296	249	385	381	222

[1]Results from samples collected from 1973 through August 1977.

[2]Results from samples collected from September 1977 through 1979.

[3]April sample actually collected May 1.

TABLE 17

PRE-OPERATIONAL AND OPERATIONAL ZOOPLANKTON DATA IN THE VICINITY OF THE INTAKE AND DISCHARGE STRUCTURES AND A CONTROL STATION

	STATION 3 (Control)							
	Pre-Operational Data[1] (no/l)				Operational Data[2] (no/l)			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	---	---	---	---	---	---
April	54	323	177	118	---	---	207[3]	---
May	415	1007	682	261	327	568	448	170
June	640	1210	862	218	489	535	512	33
July	265	1211	642	360	550	802	676	178
August	223	731	371	244	257	271	264	10
September	386	742	507	163	230	541	378	156
October	214	855	492	329	112	265	254	137
November	248	520	367	138	42	151	72	69
December	---	---	280	---	---	---	---	---
Mean	306	825	487	215	287	448	351	192
	STATION 8 (Intake)							
March	---	---	30	---	---	---	---	---
April	56	318	151	115	---	---	218	---
May	265	846	656	268	124	657	391	377
June	504	1673	897	526	337	386	362	35
July	216	918	487	328	319	1285	802	683
August	100	435	303	148	228	291	260	45
September	243	564	394	133	263	412	329	76
October	256	513	354	139	154	252	247	91
November	225	489	323	144	34	137	64	63
December	---	---	234	---	---	---	---	---
Mean	233	720	383	250	208	489	334	215
	STATION 13 (Discharge)							
March	---	---	33	---	---	---	---	---
April	63	482	223	184	---	---	287	---
May	454	1421	894	350	243	354	299	78
June	621	1230	872	222	498	563	531	46
July	387	1243	808	413	337	1433	885	775
August	136	793	446	262	197	403	300	146
September	363	533	459	83	249	513	505	253
October	282	984	565	370	176	179	265	152
November	237	569	375	140	80	127	72	59
December	170	346	258	124	---	---	---	---
Mean	301	845	493	292	254	510	393	245

[1]Data collected from 1973 through August 1977.

[2]Data collected from September 1977 through 1979.

[3]April sample actually collected May 1.

TABLE 18

MONTHLY MEAN DENSITIES* OF INDIVIDUAL BENTHIC

MACROINVERTEBRATE TAXA AT LOCUST POINT - 1979

TAXA \ DATE	May 30	July 29	Sept. 30	Nov. 4	GRAND MEAN
COELENTERATA					
<u>Hydra</u> sp. (budding polyp)	8.2	0.0	10.2	14.6	8.3
<u>Hydra</u> sp. (single polyp)	13.0	0.0	29.9	59.2	25.5
Subtotal	21.2	0.0	40.1	73.8	33.8
ANNELIDA					
Oligochaeta					
Immatures (hair setae)	0.0	1.9	0.0	0.0	0.5
Immatures (no hair setae)	294.7	1822.1	418.3	478.1	753.3
<u>Branchuira sowerbyi</u>	0.0	17.2	5.1	0.6	5.8
<u>Limnodrilus cervix</u>	2.0	3.8	0.0	0.6	1.6
<u>L. maumeensis</u>	0.0	0.6	0.0	0.0	0.2
<u>Ophidonais serpentina</u>	6.1	91.7	19.1	14.6	32.9
<u>Potamothrix moldaviensis</u>	2.7	9.6	0.6	1.9	3.7
Subtotal	305.5	1946.9	443.1	496.0	798.0
ARTHROPODA					
Cladocera					
<u>Leptodora kindtii</u>	235.3	181.5	38.8	3.8	114.9
Amphipoda					
<u>Gammarus fasciatus</u>	6.1	13.4	17.2	35.0	17.9

TABLE 18 (Con't.)

MONTHLY MEAN DENSITIES* OF INDIVIDUAL BENTHIC

MACROINVERTEBRATE TAXA AT LOCUST POINT - 1979

TAXA \ DATE	May 30	July 29	Sept. 30	Nov. 4	GRAND MEAN
ARTHROPODA					
Diptera					
Chaoborus sp.	0.0	0.0	13.4	0.0	3.4
Chironomidae					
Chironomus sp.	64.1	91.0	10.2	43.9	52.3
Cryptochironomus sp.	2.0	19.7	13.4	15.9	12.8
Polypedilum sp.	0.7	0.0	0.0	0.0	0.2
Procladius sp.	0.7	89.1	8.3	3.8	25.5
P. pupae	0.0	0.0	1.3	0.0	0.3
Tanytarsus sp.	17.7	3.8	14.0	61.1	24.2
T. pupae	0.0	0.0	0.6	0.0	0.2
Ephemeroptera					
Caenis sp.	3.4	0.0	0.0	1.9	1.3
Trichoptera					
Trichocerca sp.	0.0	0.0	0.6	1.9	0.6
Subtotal	330.0	398.6	117.8	167.0	253.6
TOTAL	652.9	2345.5	601.0	737.3	1084.2

* Data presented as number of organisms/m^2 and computed from 3 grabs with a Ponar dredge ($A=0.052m^2$) at each of 10 sampling stations on the dates indicated.

TABLE 19

PRE-OPERATIONAL AND OPERATIONAL BENTHIC MACROINVERTEBRATE DENSITIES[1] FROM LAKE ERIE IN THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION

	COELENTERATA							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	0	---	---	---	---	---
April	0	3	1	2	---	---	---	---
May	9	51	21	20	1	21	11	14
June	0	210	89	89	---	---	---	---
July	0	5	2	2	0	4	2	3
August	0	7	2	3	---	---	---	---
September	1	36	10	17	1	40	21	20
October	2	72	30	37	---	---	57	---
November	7	98	32	44	17	74	46	40
December	0	27	14	19	---	---	---	---
Mean	2	57	20	27	5	35	27	23
	ANNELIDA							
March	---	---	113	---	---	---	---	---
April	506	1448	923	473	---	---	---	---
May	368	1153	637	358	302	306	304	3
June	547	822	705	101	---	---	---	---
July	481	1417	918	397	564	1947	1256	978
August	212	2212	1254	736	---	---	---	---
September	1012	2715	1561	783	443	813	628	262
October	767	2226	1305	801	---	---	1371	---
November	654	1705	1157	509	496	1788	1142	914
December	140	1543	842	992	---	---	---	---
Mean	521	1693	942	409	451.2	1214	940	455
	ARTHROPODA							
March	---	---	11	---	---	---	---	---
April	29	149	89	68	---	---	---	---
May	71	107	120	60	257	330	294	52
June	105	700	449	218	---	---	---	---
July	243	1146	491	437	169	2346	1258	1539
August	109	1583	642	562	---	---	---	---
September	96	1035	602	407	275	601	438	231
October	270	729	440	252	---	---	180	---
November	124	3016	896	1415	239	737	488	352
December	30	217	124	132	---	---	---	---
Mean	120	976	386	290	235	1004	532	424

[1]Data presented as number of organisms per square meter.
[2]Data collected from 1973 through August 1977.
[3]Data collected from September 1977 through 1979.

TABLE 19 (cont'd)

PRE-OPERATIONAL AND OPERATIONAL BENTHIC MACROINVERTEBRATE DENSITIES[1] FROM LAKE ERIE IN THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION

	MOLLUSCA							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	4	---	---	---	---	---
April	0	2	1	1	---	---	---	---
May	0	4	2	2	0	1	1	1
June	0	5	2	2	---	---	---	---
July	1	3	2	1	0	0	0	0
August	0	4	1	2	---	---	---	---
September	0	4	2	2	0	1	1	1
October	0	2	1	1	---	---	1	---
November	0	3	1	1	0	0	0	0
December	0	1	1	1	---	---	---	---
Mean	0	3	2	1	0	1	1	1
	TOTAL BENTHIC MACROINVERTEBRATE POPULATION							
March	---	---	127	---	---	---	---	---
April	540	1592	1018	535	---	---	---	---
May	537	1216	777	315	560	653	607	66
June	653	1557	1241	363	---	---	---	---
July	772	2559	1399	805	737	2346	1542	1138
August	321	2782	1893	1008	---	---	---	---
September	1254	3753	2179	1116	601	1090	846	346
October	1065	3027	1767	1094	---	---	1609	---
November	894	4492	2090	1675	737	2044	1391	924
December	170	1788	979	1144	---	---	---	---
Mean	690	2530	1347	649	659	1533	1199	447

[1]Data presented as number of organisms per square meter.

[2]Data collected from 1973 through August 1977.

[3]Data collected from September 1977 through 1979.

TABLE 20

PRE-OPERATIONAL AND OPERATIONAL BENTHIC MACROINVERTEBRATE DATA[1] FROM THE VICINITY OF THE INTAKE AND DISCHARGE STRUCTURES AND A CONTROL STATION

	STATION 3 (CONTROL)							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	---	---	---	---	---	---	---	---
April	172	1910	1044	816	---	---	---	
May	376	1662	824	604	923	955	939	23
June	1356	4181	2591	1451	---	---	---	---
July	1448	3565	2529	1008	19	204	112	131
August	0	2776	1248	1151	---	---	---	---
September	1191	2540	1828	648	280	382	331	72
October	1719	2903	2209	618	---	---	83	---
November	1573	3247	2320	739	96	4081	2089	2818
December	---	---	2660	---	---	---	---	---
Mean	979	2848	1917	711	330	1406	711	844
	STATION 8 (INTAKE)							
March	---	---	57	---	---	---	---	---
April	64	3361	1598	1642	---	---	---	---
May	255	1483	906	506	89	592	341	356
June	573	1598	1387	455	---	---	---	---
July	458	1834	1127	700	554	3031	1793	1752
August	18	4164	1328	1639	---	---	---	---
September	1229	3095	2178	1003	618	1496	1057	621
October	414	2604	1488	1096	---	---	611	---
November	172	1995	1125	819	649	1706	1178	747
December	51	325	188	194	---	---	---	---
Mean	359	2273	1138	636	478	1706	996	559
	STATION 13 (DISCHARGE)							
March	---	---	191	---	---	---	---	---
April	83	1293	417	585	---	---	---	---
May	280	901	498	280	669	1178	924	360
June	337	1776	884	543	---	---	---	---
July	181	5068	2594	2374	649	1490	1070	595
August	89	3120	1319	1257	---	---	---	---
September	1827	3795	2701	851	140	1012	576	617
October	337	5100	2171	2563	---	---	592	---
November	337	1490	874	700	121	1834	978	1211
December	255	2497	1376	1585	---	---	---	---
Mean	414	2782	1303	907	395	1379	828	229

[1]Data presented as number of organisms per square meter.

[2]Data collected from 1973 through August 1977.

[3]Data collected from September 1977 through 1979.

TABLE 21

SPECIES FOUND IN THE LOCUST POINT AREA 1963 - 1979

1972	1973	1974	1975	1976	1977	1978	1979	SCIENTIFIC NAME[a]	COMMON NAME
								Amiidae	
*		*	*					<u>Amia calva</u>	bowfin
								Atherinidae	
		*	*	*	*	*		<u>Labidesthes sicculus</u>	brook silverside
								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
				*				<u>Hypentelium nigricans</u>	northern hogsucker
								Centrarchidae	
		*						<u>Ambloplites rupestris</u>	rockbass
	*	*	*					<u>Lepomis cyanellus</u>	green sunfish
		*	*					<u>L. gibbosus</u>	pumpkinseed
	*	*						<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>	goldenshiner
*	*	*	*	*	*	*	*	<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 notatus</u>	bluntnose minnow
			*					<u>P. promelas</u>	fathead minnow

TABLE 21 (CON'T)

SPECIES FOUND IN THE LOCUST POINT AREA 1963 - 1979

1972	1973	1974	1975	1976	1977	1978	1979	SCIENTIFIC NAME[a]	COMMON NAME
								Esocidae	
							*	*Esox lucius*	northern pike
				*				*Esox masquinongy*	muskellunge
								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 americana*	white perch
*	*	*	*	*	*	*	*	*M. 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	26	27	26	27		

[a] Bailey et al. (1970)

TABLE 22

NUMBERS OF FISH COLLECTED AT LOCUST POINT, APRIL - NOVEMBER 1979, AT LOCUST POINT USING EQUAL MONTHLY EFFORT WITH EACH TYPE OF FISHING GEAR[a]

METHOD OF CAPTURE	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		TOTAL	
	No. Fish	No. Species	No. Fish	No. Species	No. Fish	No. Species	No. Fish	No. Species	No. Fish	No. Species	No. Fish	No. Species	No. Fish	No. Species	No. Fish	No. Species	No. Fish	No. Species
Gill Net[b]	329	9	800	14	861	9	1,380	12	1,814	13	1,669	9	364	5	446	5	7,663	19
Shore Seine[c]	16,816	7	67	4	1,968	4	153,570	6	666	5	211	5	84	3	2,131	6	175,513	13
Trawl[d]	208	12	82	11	84	11	146	9	256	11	340	9	309	5	1,904	7	3,329	20
TOTAL	17,353	14	949	17	2,913	13	155,096	15	2,736	18	2,220	12	757	6	4,481	10	186,505	27

[a]Values represent sum of catch per unit effort results from all stations at which a type of gear was used each month

[b]Six units effort per month

[c]Three units effort per month

[d]Three units effort per month

TABLE 23

MONTHLY CATCH IN NUMBERS OF INDIVIDUALS OF FISH BY SPECIES AT LOCUST POINT DURING 1979 USING EQUAL EFFORT WITH EACH TYPE OF GEAR[a]

SPECIES \ MONTH	APRIL	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	TOTAL	PERCENT TOTAL
Alewife		1	7	49,181	22	485	201	141	50,038	26.8
Black Crappie				2					2	<0.1
Bluntnose Minnow								1	1	<0.1
Brown Bullhead	3	5	5	14	35	1			63	
Carp	16	5	7	57	46	1		1	133	0.1
Carp X Goldfish					8				8	<0.1
Channel Catfish	9	24	59	57	34				183	0.1
Emerald Shiner	16,419	52	47	15	68	83	52	2,039	18,775	10.1
Freshwater Drum	124	250	287	13	66	8			748	0.4
Gizzard Shad	383	115	2,026	87,119	635	405	333	2,118	93,134	49.9
Goldfish	1	1		9	2			2	15	<0.1
Logperch		1			1				2	<0.1
Northern Pike	1	14							15	<0.1
Quillback			1	6					7	<0.1
Rainbow Smelt		1						1	2	<0.1
Shorthead Redhorse				1	1				2	<0.1
Silver Chub			1						1	<0.1
Spotfin Shiner								1	1	<0.1
Spottail Shiner	206	132	42	17,376	95	300	136	146	18,433	9.9
Trout-perch	37	14			1				52	<0.1
Walleye	5	7	10	11	13	4			50	<0.1
White Bass	16	16	63	209	52	22	3		381	0.2
White Crappie						1			1	<0.1
White Perch					36	4			40	<0.1
White Sucker		1			2				3	<0.1
Yellow Bullhead	3								3	<0.1
Yellow Perch	130	310	358	1,026	1,619	906	32	31	4,412	2.4
No. Species	14	17	13	15	18	12	6	10	27	--
TOTAL	17,353	949	2,913	155,096	2,736	2,220	757	4,481	186,505	100

[a]Gill nets (six units effort per month), trawl (three units effort per month), shore seine (three units effort per month)

TABLE 24

SUMMARY OF GILL NET CATCH RESULTS AT LOCUST POINT DURING 1979[a]

STATION & DIRECTION \ DATE		APRIL[b] 30-1	MAY 30-31	JUNE 20-21	JULY 28-29	AUG. 28-29	SEP. 29-30	OCT. 27-28	NOV. 3-4	TOTAL
3	NW	49	72	44	127	144	178	10	48	672
	SE	23	26	58	95	123	303	21	149	798
	UK	0	0	0	0	0	0	0	0	0
	Subtotal	72	98	102	222	267	481	31	197	1470
26	NW	33	44	41	109	223	149	17	23	639
	SE	14	83	60	149	122	167	54	25	674
	UK	0	0	0	0	0	13	0	0	13
	Subtotal	47	127	101	258	345	329	71	48	1326
8	NW	15	97	113	139	110	113	18	5	610
	SE	18	31	83	123	95	101	7	7	465
	UK	0	6	0	0	3	7	0	0	16
	Subtotal	33	134	196	262	208	221	25	12	1091
13	NW	49	18	58	70	194	87	4	50	530
	SE	29	11	64	68	193	44	3	43	455
	UK	10	0	0	0	0	0	0	0	10
	Subtotal	88	29	122	138	387	131	7	93	995
28	NW	19	109	98	51	112	94	21	9	513
	SE	12	89	76	177	140	136	62	21	713
	UK	0	7	3	0	0	0	0	0	10
	Subtotal	31	205	177	228	252	230	83	30	1236
29	NW	32	147	65	215	162	162	117	29	929
	SE	26	53	98	57	193	102	30	37	596
	UK	0	7	0	0	0	13	0	0	20
	Subtotal	58	207	163	272	355	277	147	66	1545
Inshore[e]	NW	130	237	167	412	500	427	131	127	2131
	SE	78	90	220	220	509	449	54	229	1849
	UK	10	7	0	0	0	13	0	0	30
	Subtotal	218	334	387	632	1009	889	185	356	4010
Offshore[e]	NW	67	250	252	299	445	356	56	37	1762
	SE	44	203	219	449	357	404	123	53	1852
	UK	0	13	3	0	3	20	0	0	39
	Subtotal	111	466	474	748	805	780	179	90	3653
Control[f] West	NW	82	116	85	236	367	327	27	71	1311
	SE	37	109	118	244	245	470	75	174	1472
	UK	0	0	0	0	0	13	0	0	13
	Subtotal	119	225	203	480	612	810	102	245	2796
Control[g] East	NW	51	256	163	606	274	256	138	38	1782
	SE	38	142	174	234	333	238	92	58	1309
	UK	0	14	3	0	0	13	0	0	30
	Subtotal	89	412	340	840	607	507	230	96	3121
Intake-Discharge[h]	NW	64	115	171	209	304	200	22	55	1140
	SE	47	42	147	191	288	145	10	50	920
	UK	10	6	0	0	3	7	0	0	26
	Subtotal	121	163	318	400	595	352	32	105	2086
TOTAL	NW	197	487	419	711	945	783	187	164	3893
	SE	122	293	439	669	866	853	177	282	3701
	UK	10	20	3	0	3	33	0	0	69
GRAND TOTAL		329	800	861	1380	1814	1669	364	446	7663

[a]Total numbers of fish collected at each station on each date using a 24-hr set with an experimental gill net (125 x 6 ft with five 25 x 6-ft panels of ½-in, 3/4-in, 1-in, 1½-in, and 2-in bar mesh)

[b]30 April - 1 May 1979

[c]NW = northwest; NE = northeast; UK = unknown (fish fell from net before direction was determined); determined by direction fish was travelling parallel to shore when entangled in net

[d]Total of Stations 3, 13, and 29

[e]Total of Stations 26, 8, and 28

[f]Total of Stations 3 and 26

[g]Total of Stations 28 and 29

[h]Total of Stations 8 and 13

TABLE 25

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
30 APRIL - 1 MAY 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
3	Gizzard Shad	2	377.5	351.0-404.0	423.0	1	346.0	---	429.0					3	367.0	425.0	1275.0
	Spottail Shiner	21	112.4	85.0-133.0	9.8	11	114.3	87.0-145.0	10.4					32	113.0	10.0	319.0
	Channel Catfish	1	214.0	---	73.0									1	214.0	73.0	73.0
	Trout-perch					2	87.0	81.0- 93.0	7.5					2	87.0	7.5	15.0
	White Bass	2	190.5	188.0-193.0	80.0									2	190.5	80.0	160.0
	Yellow Perch	20	180.8	149.0-201.0	68.1	7	167.7	143.0-208.0	58.3					27	177.4	65.6	1770.0
	Freshwater Drum	3	290.7	270.0-313.0	299.0	2	315.5	311.0-320.0	329.0					5	300.6	311.0	1555.0
	Subtotal	49				23								72			5167.0
26	Northern Pike	1	235.0	---	121.0									1	235.0	121.0	121.0
	Gizzard Shad	1	402.0	---	637.0									1	402.0	637.0	637.0
	Spottail Shiner	5	109.4	99.0-121.0	8.6	3	117.7	109.0-125.0	11.7					8	112.5	9.8	78.0
	White Bass	1	201.0	---	93.0									1	201.0	93.0	93.0
	Yellow Perch	12	167.7	108.0-203.0	61.2	8	158.1	145.0-188.0	49.8					20	163.8	56.6	1132.0
	Freshwater Drum	13	222.1	95.0-290.0	153.6	3	183.7	133.0-243.0	85.7					16	214.9	140.9	2254.0
	Subtotal	33				14								47			4315.0

[a]One 24-hr bottom set with a 125-ft. experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 25 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT

30 APRIL - 1 MAY 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean	No.	Length (mm)		Mean	No.	Length (mm)		Mean	No.	Mean	Weight (g)	
			Mean	Range	Weight(g)		Mean	Range	Weight(g)		Mean	Range	Weight(g)		Length	Mean	Total
8	Spottail Shiner	4	111.0	103.0-121.0	9.5	4	110.3	97.0-130.0	8.8					8	110.6	9.1	73.0
	Channel Catfish	2	142.5	88.0-197.0	31.0									2	142.5	31.0	62.0
	Trout-perch	2	89.0	88.0- 90.0	8.0									2	89.0	8.0	16.0
	Yellow Perch	6	160.2	146.0-199.0	50.7	3	149.7	148.0-151.0	40.7					9	156.7	47.3	426.0
	Walleye	1	253.0	---	151.0									1	253.0	151.0	151.0
	Freshwater Drum					11	252.1	108.0-339.0	174.3					11	252.1	174.3	1917.0
	Subtotal	15				18								33			2645.0
13	Gizzard Shad	1	331.0	---	363.0									1	331.0	363.0	363.0
	Spottail Shiner	31	111.7	82.0-138.0	9.7	17	112.3	97.0-138.0	10.2	10	112.1	104.0-130.0	10.0	58	111.9	9.9	576.0
	Channel Catfish	1	262.0	---	123.0									1	262.0	123.0	123.0
	Yellow Perch	12	177.3	149.0-210.0	70.5	12	161.2	133.0-195.0	50.9					24	169.3	60.7	1457.0
	Freshwater Drum	4	245.5	214.0-293.0	144.8									4	245.5	144.8	579.0
	Subtotal	49				29				10				88			3098.0

[a]One 24-hr bottom set with a 125-ft. experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 25 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
30 APRIL - 1 MAY 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
28	Spottail Shiner	9	118.4	114.0-123.0	11.3	1	116.0	---	11.0					10	118.2	11.3	113.0
	Trout-perch	2	105.5	99.0-112.0	12.5									2	105.5	12.5	25.0
	Yellow Perch	6	168.5	134.0-199.0	63.8	8	169.0	141.0-207.0	63.5					14	168.8	63.6	891.0
	Freshwater Drum	2	261.5	173.0-350.0	293.5	3	213.0	170.0-271.0	124.7					5	232.4	192.2	961.0
	Subtotal	19				12								31			1990.0
29	Gizzard Shad					1	443.0	---	963.0					1	443.0	963.0	963.0
	Spottail Shiner	8	116.8	108.0-133.0	11.3	5	108.4	99.0-118.0	9.2					13	113.5	10.5	136.0
	Channel Catfish	1	234.0	---	107.0	1	249.0	---	155.0					2	241.5	131.0	262.0
	Trout-perch					1	110.0	---	11.0					1	110.0	11.0	11.0
	Yellow Perch	16	176.2	140.0-210.0	74.7	8	166.0	144.0-187.0	61.6					24	172.8	70.3	1688.0
	Walleye	2	205.5	200.0-211.0	73.5	1	245.0	---	146.0					3	218.7	97.7	293.0
	Freshwater Drum	5	191.8	134.0-302.0	122.8	9	188.1	137.0-330.0	104.3					14	189.4	110.9	1553.0
	Subtotal	32				26								58			4906.0
	TOTAL	197				122				10				329			22121.0

[a]One 24-hr bottom set with a 125-ft. experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 26

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT

30-31 MAY 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
3	Northern Pike	1	213.0	---	79.0									1	213.0	79.0	79.0
	Gizzard Shad	4	335.5	170.0-415.0	486.0	4	362.3	330.0-379.0	496.5					8	348.9	491.3	3930.0
	Spottail Shiner	32	115.8	98.0-157.0	10.5	5	115.0	109.0-122.0	10.2					37	115.6	10.4	386.0
	White Bass	1	240.0	---	156.0									1	240.0	156.0	156.0
	Yellow Perch	19	182.3	140.0-213.0	56.8	17	179.8	150.0-203.0	56.9					36	181.1	56.9	2047.0
	Freshwater Drum	15	196.0	118.0-255.0	77.5									15	196.0	77.5	1163.0
	Subtotal	72				26								98			7761.0
26	Northern Pike	1	393.0	---	538.0	2	199.5	192.0-207.0	61.5					3	264.0	220.3	661.0
	Gizzard Shad	7	362.6	206.0-419.0	580.4	6	364.0	171.0-416.0	666.7					13	363.2	620.2	8063.0
	Spottail Shiner					11	113.7	110.0-130.0	12.5					11	113.7	12.5	137.0
	Carp	2	302.5	280.0-325.0	438.0									2	302.5	438.0	876.0
	Channel Catfish	6	304.8	187.0-376.0	317.3	2	251.5	190.0-313.0	38.0					8	291.5	247.5	1980.0
	Trout-perch	2	116.0	115.0-117.0	10.5									2	116.0	10.5	21.0
	Yellow Perch	6	176.8	143.0-205.0	65.0	37	167.2	133.0-203.0	52.4					43	168.5	54.1	2328.0
	Freshwater Drum	20	257.5	134.0-365.0	229.1	25	210.7	112.0-327.0	117.2					45	231.5	167.0	7513.0
	Subtotal	44				83								127			21579.0

[a]One 24-hr bottom set with a 125-ft. experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 26 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT

30-31 MAY 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
8	Northern Pike					1	414.0	---	575.0					1	414.0	575.0	575.0
	Gizzard Shad	15	361.9	181.0-480.0	629.5	3	348.3	194.0-435.0	675.3	3	346.7	332.0-362.0	508.3	21	357.8	618.7	12993.0
	Spottail Shiner	6	133.8	110.0-160.0	26.0	1	110.0	---	15.0					7	130.4	24.4	171.0
	Channel Catfish	1	186.0	---	61.0									1	186.0	61.0	61.0
	White Bass	1	276.0	---	267.0	2	167.5	83.0-252.0	120.0					3	203.7	169.0	507.0
	Yellow Perch	48	166.7	125.0-223.0	59.1	12	169.3	147.0-201.0	60.8					60	167.2	59.5	3568.0
	Walleye	1	249.0	---	145.0									1	249.0	145.0	145.0
	Freshwater Drum	25	211.0	130.0-334.0	114.7	12	202.8	94.0-293.0	140.1	3	188.0	131.0-241.0	88.7	40	206.8	120.3	4814.0
	Subtotal	97				31				6				134			22834.0
13	Gizzard Shad	2	384.0	383.0-385.0	566.0	3	375.7	337.0-397.0	556.3					5	379.0	560.2	2801.0
	Spottail Shiner	5	117.0	112.0-132.0	11.8	7	111.9	106.0-117.0	14.4					12	114.0	13.3	160.0
	White Bass	2	245.0	242.0-248.0	196.0									2	245.0	196.0	392.0
	Yellow Perch	8	157.4	144.0-195.0	37.3	1	152.0	---	44.0					9	156.8	38.0	342.0
	Freshwater Drum	1	311.0	---	365.0									1	311.0	365.0	365.0
	Subtotal	18				11								29			4060.0

[a]One 24-hr bottom set with a 125-ft. experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 26 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
30-31 MAY 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
28	Northern Pike	4	293.8	236.0-355.0	260.0	4	326.8	234.0-360.0	391.0					8	310.3	325.5	2604.0
	Gizzard Shad	15	370.6	328.0-443.0	593.2	15	360.3	316.0-444.0	589.4	1	201.0	---	96.0	31	360.1	575.3	17835.0
	Spottail Shiner	5	117.8	112.0-135.0	17.6	6	127.3	111.0-187.0	26.2					11	123.0	22.3	245.0
	Carp					1	319.0	---	466.0					1	319.0	466.0	466.0
	Channel Catfish	2	222.5	192.0-253.0	128.0	5	216.8	175.0-295.0	166.0					7	218.4	155.1	1086.0
	Trout-perch	1	115.0	---	18.0									1	115.0	18.0	18.0
	Yellow Perch	51	167.3	112.0-225.0	59.8	43	161.1	130.0-207.0	54.4	2	170.0	156.0-184.0	56.0	96	164.6	57.3	5502.0
	Freshwater Drum	31	217.6	126.0-369.0	143.7	15	211.9	114.0-312.0	156.1	4	169.3	154.0-180.0	55.8	50	212.0	140.4	7019.0
	Subtotal	109				89				7				205			34775.0

[a]One 24-hr bottom set with a 125-ft. experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 26 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT

30-31 MAY 1980

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
29	Northern Pike					1	201.0	---	68.0					1	201.0	68.0	68.0
	Alewife	1	164.0	---	35.0									1	164.0	35.0	35.0
	Gizzard Shad	10	325.4	182.0-439.0	498.7	4	358.3	314.0-424.0	636.5	2	293.5	187.0-400.0	99.0	16	329.6	483.2	7731.0
	Spottail Shiner	22	114.6	106.0-121.0	15.1	8	114.1	110.0-117.0	14.3					30	114.5	14.9	446.0
	Carp	1	381.0	---	787.0									1	381.0	787.0	787.0
	Goldfish	1	301.0	---	455.0									1	301.0	455.0	455.0
	White Sucker	1	231.0	---	150.0									1	231.0	150.0	150.0
	Brown Bullhead	1	194.0	---	110.0									1	194.0	110.0	110.0
	Channel Catfish	6	178.7	146.0-197.0	81.5									6	178.7	81.5	489.0
	White Bass	6	268.0	147.0-349.0	291.3									6	268.0	291.3	1748.0
	Yellow Perch	41	168.1	112.0-210.0	58.6	17	170.6	146.0-207.0	63.2	1	141.0	---	39.0	59	168.4	59.6	3515.0
	Walleye	4	248.0	199.0-370.0	168.8									4	248.0	168.8	675.0
	Freshwater Drum	53	189.5	127.0-329.0	83.6	23	201.3	124.0-353.0	90.8	4	227.3	177.0-281.0	154.3	80	194.8	89.2	7136.0
	Subtotal	147				53				7				207			23345.0
	TOTAL	487				293				20				800			114354.0

[a]One 24-hr bottom set with a 125-ft. experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 27

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT

20-21 JUNE 1979

Station	SPECIES	NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
3	Gizzard Shad	17	365.2	323.0-410.0	482.9	20	376.8	238.0-439.0	551.8					37	371.4	520.2	19246.0
	Alewife	3	182.3	174.0-187.0	32.0	2	165.0	164.0-166.0	27.5					5	175.4	30.2	151.0
	Spottail Shiner	4	113.3	108.0-120.0	9.5	1	117.0	---	10.0					5	114.0	9.6	48.0
	Carp					1	337.0	---	566.0					1	337.0	566.0	566.0
	Channel Catfish	1	153.0	---	26.0									1	153.0	26.0	26.0
	White Bass	14	258.7	234.0-295.0	214.6	2	256.5	248.0-265.0	156.0					16	258.4	207.3	3317.0
	Yellow Perch	2	186.5	186.0-187.0	59.0	18	158.3	128.0-180.0	41.1					20	161.1	42.9	858.0
	Freshwater Drum	3	262.0	176.0-329.0	210.3	14	231.5	140.0-324.0	178.6					17	236.9	184.2	3132.0
	Subtotal	44				58								102			27344.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 27 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT

20-21 JUNE 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
26	Gizzard Shad	7	354.3	257.0-402.0	534.3	17	322.5	174.0-423.0	453.9					24	331.8	477.3	11456.0
	Alewife					2	171.0	159.0-183.0	47.5					2	171.0	47.5	95.0
	Spottail Shiner	2	138.5	122.0-155.0	31.0	5	120.4	113.0-132.0	16.6					7	125.6	20.7	145.0
	Carp	1	326.0	---	510.0									1	326.0	510.0	510.0
	Channel Catfish	2	262.0	247.0-277.0	147.0									2	262.0	147.0	294.0
	Yellow Perch	12	169.0	145.0-202.0	50.6	9	165.8	147.0-191.0	57.6					21	167.6	53.6	1125.0
	Walleye					1	245.0	---	118.0					1	245.0	118.0	118.0
	Freshwater Drum	17	284.7	143.0-346.0	278.1	26	250.4	125.0-330.0	191.1					43	264.0	225.5	9695.0
	Subtotal	41				60								101			23438.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1¼ in, and 2 inch bar mesh

TABLE 27 (cont'd)
GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
20-21 JUNE 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	No.	Mean Length	Weight (g) Mean	Weight (g) Total
8	Gizzard Shad	4	341.0	234.0-415.0	556.8	8	394.6	372.0-420.0	586.6					12	376.8	576.7	6920.0
	Spottail Shiner	2	133.0	132.0-134.0	16.5									2	133.0	16.5	33.0
	Carp	1	364.0	---	843.0									1	364.0	843.0	843.0
	Channel Catfish	7	285.0	182.0-407.0	272.0	5	286.8	167.0-415.0	298.0					12	285.8	282.8	3394.0
	White Bass	1	251.0	---	209.0									1	251.0	209.0	209.0
	Yellow Perch	52	153.0	116.0-198.0	42.0	41	150.8	115.0-182.0	40.6					93	152.0	41.4	3847.0
	Walleye	2	233.5	215.0-252.0	110.0	1	239.0	---	108.0					3	235.3	109.3	328.0
	Freshwater Drum	44	248.3	94.0-356.0	196.8	28	249.8	123.0-357.0	223.0					72	248.9	207.0	14901.0
	Subtotal	113				83								196			30475.0
13	Gizzard Shad	10	387.7	358.0-409.0	520.8	12	387.6	345.0-418.0	640.4					22	387.6	586.0	12893.0
	Spottail Shiner	4	123.0	104.0-155.0	17.5									4	123.0	17.5	70.0
	Carp	1	322.0	---	454.0	1	354.0	---	622.0					2	338.0	538.6	1076.0
	Channel Catfish	2	225.5	157.0-294.0	50.0	1	308.0	---	310.0					3	253.0	136.7	410.0
	White Bass	19	261.7	239.0-287.0	216.5	24	255.6	224.0-271.0	198.7					43	258.3	206.6	8882.0
	Yellow Perch	17	156.2	141.0-185.0	43.8	11	154.5	136.0-178.0	38.9					28	155.5	41.9	1172.0
	Freshwater Drum	5	201.8	130.0-363.0	138.8	15	244.8	133.0-337.0	202.3					20	234.0	186.4	3729.0
	Subtotal	58				64								122			28232.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 27 (cont'd)
GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
20-21 JUNE 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	SOUTHEAST No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	UNKNOWN No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	TOTALS No.	Mean Length	Weight (g) Mean	Weight (g) Total
28	Gizzard Shad	4	393.8	366.0-419.0	718.5	3	396.7	358.0-471.0	661.0					7	395.0	693.9	4857.0
	Spottail Shiner	9	130.9	113.0-168.0	22.3									9	130.9	22.3	201.0
	Channel Catfish	4	207.5	174.0-288.0	108.8									4	207.5	108.8	435.0
	White Bass	1	116.0	---	20.0									1	116.0	20.0	20.0
	Yellow Perch	44	153.2	129.0-184.0	43.5	43	150.3	132.0-198.0	39.7	2	151.0	146.0-156.0	39.5	89	151.8	41.6	3699.0
	Walleye	2	219.0	194.0-244.0	96.5									2	219.0	96.5	193.0
	Freshwater Drum	34	279.6	194.0-353.0	253.5	30	247.1	101.0-351.0	176.8	1	122.0	---	25.0	65	262.1	214.6	13947.0
	Subtotal	98				76				3				177			23352.0
29	Gizzard Shad	3	392.7	382.0-412.0	649.0	7	404.7	346.0-447.0	784.4					70	401.1	743.8	7438.0
	Spottail Shiner	3	127.0	108.0-164.0	19.7	3	134.3	115.0-158.0	14.7					6	130.7	17.2	103.0
	Channel Catfish	3	268.3	186.0-415.0	275.0	5	210.6	148.0-371.0	129.8					8	232.3	184.3	1474.0
	White Bass					1	96.0	---	11.0					1	96.0	11.0	11.0
	Yellow Perch	23	162.7	95.0-207.0	51.4	48	156.0	126.0-198.0	37.8					71	158.2	42.2	2998.0
	Walleye	1	221.0	---	124.0	1	228.0	---	296.0					2	224.5	210.0	420.0
	Freshwater Drum	32	275.2	109.0-402.0	254.8	33	253.5	108.0-396.0	198.1					65	264.2	226.0	14690.0
	Subtotal	65				98								163			27134.0
	TOTAL	419				439				3				861			159975.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 28

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 JULY 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
3	Alewife	1	181.0	---	41.0	1	158.0	---	53.0					2	169.5	47.0	94.0
	Gizzard Shad	19	251.5	212.0-376.0	212.0	20	255.8	223.0-386.0	217.8					39	253.7	215.0	8385.0
	Spottail Shiner	26	91.8	81.0-108.0	7.0	11	107.5	77.0-132.0	12.4					37	96.5	8.6	318.0
	Carp	2	333.5	311.0-356.0	517.5	5	332.2	236.0-394.0	564.4					7	332.6	551.0	3857.0
	Quillback	1	208.0	---	131.0									1	208.0	131.0	131.0
	Channel Catfish	7	243.0	176.0-418.0	200.9	5	262.4	192.0-337.0	184.2					12	251.1	193.9	2327.0
	White Bass	13	165.8	102.0-292.0	89.2	3	152.0	130.0-182.0	61.3					16	163.3	84.0	1344.0
	Yellow Perch	57	164.9	139.0-203.0		48	167.7	136.0-196.0	65.1					105	166.2	65.6	6887.0
	Walleye	1	252.0	---	184.0	2	245.5	241.0-250.0	127.0					3	247.7	146.0	438.0
	Subtotal	127				95								222			23781.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 28 (cont'd)
GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 JULY 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
26	Gizzard Shad	10	290.2	221.0-457.0	337.4	14	296.4	242.0-417.0	312.9					24	293.8	323.1	7754.0
	Spottail Shiner	3	113.3	110.0-117.0	18.0	7	112.7	97.0-126.0	15.7					10	112.9	16.4	164.0
	Carp	5	337.6	288.0-407.0	469.6	5	365.0	335.0-393.0	649.8					10	351.3	559.7	5597.0
	Goldfish					1	385.0	---	848.0					1	385.0	848.0	848.0
	Quillback					1	329.0	---	528.0					1	329.0	528.0	528.0
	Channel Catfish	14	252.9	186.0-366.0	169.1	12	216.3	172.0-317.0	140.5					26	236.0	155.9	4053.0
	White Bass	4	245.5	177.0-274.0	195.3	5	219.0	172.0-276.0	152.4					9	230.8	171.4	1543.0
	Yellow Perch	70	166.5	115.0-201.0	61.7	98	170.4	135.0-219.0	63.6					168	168.1	62.8	10547.0
	Walleye	1	497.0	---	986.0	2	251.5	237.0-266.0	112.0					3	333.3	403.3	1210.0
	Freshwater Drum	2	229.0	181.0-277.0	160.0	4	194.3	157.0-266.0	92.5					6	205.8	115.0	690.0
	Subtotal	109				149								258			32934.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 28 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 JULY 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
8	Gizzard Shad	14	323.1	224.0-410.0	380.2	15	284.7	230.0-376.0	287.3					29	303.2	332.1	9632.0
	Spottail Shiner					2	114.5	110.0-119.0	17.0					2	114.5	17.0	34.0
	Carp	5	338.2	282.0-369.0	565.0	3	329.7	310.0-357.0	514.0					8	335.0	545.9	4367.0
	Goldfish					3	333.0	272.0-391.0	667.0					3	333.0	667.0	2001.0
	Quillback	1	264.0	---	279.0	1	325.0	---	621.0					2	294.5	450.0	900.0
	Shorthead Redhorse	1	206.0	---	98.0									1	206.0	98.0	98.0
	Channel Catfish	3	225.0	166.0-281.0	121.3	4	230.0	180.0-370.0	140.3					7	227.9	132.1	925.0
	White Bass	5	218.2	170.0-275.0	135.0	3	240.0	185.0-282.0						8	226.4	164.3	1314.0
	Yellow Perch	108	179.8	143.0-204.0	66.1	88	170.0	136.0-203.0	65.1					196	173.2	65.6	12863.0
	Walleye	1	266.0	---	150.0	3	301.7	250.0-366.0	222.7					4	292.8	204.5	818.0
	Freshwater Drum	1	258.0	---	156.0	1	245.0	---	165.0					2	251.5	160.5	321.0
	Subtotal	139				123								262			33273.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 28 (cont'd)
GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 JULY 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	SOUTHEAST No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	UNKNOWN No.	Length (mm) Mean	Length (mm) Range	Mean Weight(g)	TOTALS No.	Mean Length	Weight (g) Mean	Weight (g) Total
13	Gizzard Shad	10	284.2	231.0-415.0	264.7	3	250.3	247.0-257.0	163.7					13	276.4	241.4	3138.0
	Carp	6	335.7	272.0-383.0	535.7	11	340.2	245.0-443.0	593.0					17	338.6	572.8	9737.0
	Goldfish	2	271.5	230.0-313.0	313.0									2	271.5	313.0	626.0
	Quillback	1	280.0	---	337.0									1	280.0	337.0	337.0
	Channel Catfish	3	265.7	204.0-306.0	172.0	1	196.0	---	55.0					4	248.3	142.8	571.0
	White Bass	18	180.1	115.0-271.0	85.6	7	233.7	117.0-326.0	208.6					25	195.1	120.0	3001.0
	Yellow Perch	30	177.3	136.0-218.0	69.8	46	166.7	125.0-203.0	63.7					76	170.9	66.1	5024.0
	Subtotal	70				68								138			22434.0
28	Gizzard Shad	7	325.3	240.0-425.0	368.3	17	276.1	233.0-396.0	223.2					24	290.5	265.5	6373.0
	Spottail Shiner	1	113.0	---	15.0	2	105.5	98.0-113.0	8.0					3	108.0	10.3	31.0
	Carp	1	319.0	---	462.0	3	291.7	235.0-321.0	357.3					4	298.5	383.5	1534.0
	Channel Catfish	2	266.0	187.0-345.0	226.0	1	171.0	---	44.0					3	234.3	165.3	496.0
	White Bass	2	265.0	262.0-268.0	244.5	2	171.0	150.0-192.0	46.0					4	218.0	145.3	581.0
	Yellow Perch	37	169.4	112.0-210.0	72.3	152	165.6	133.0-200.0	63.8					189	167.2	65.4	12369.0
	Walleye	1	261.0	---	114.0									1	261.0	114.0	114.0
	Subtotal	51				177								228			21498.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 28 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 JULY 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
29	Gizzard Shad	18	286.1	198.0-436.0	299.3	20	323.5	223.0-549.0	363.0					38	305.8	332.8	12648.0
	Spottail Shiner	1	117.0	---	16.0	2	114.5	113.0-116.0	15.5					3	115.3	15.7	47.0
	Carp	4	378.0	310.0-477.0	490.3	2	386.5	376.0-397.0	718.0					6	380.8	566.2	3397.0
	Goldfish					1	251.0	---	210.0					1	251.0	210.0	210.0
	Quillback					1	332.0	---	520.0					1	332.0	520.0	520.0
	Channel Catfish	2	237.5	179.0-296.0	130.5	1	193.0	---	53.0					3	222.7	104.7	314.0
	White Bass	10	161.7	123.0-245.0	68.2	1	163.0	---	64.0					11	161.8	67.8	746.0
	Yellow Perch	179	172.7	131.0-204.0	62.5	27	170.4	133.0-203.0	64.7					206	171.9	62.8	12927.0
	Freshwater Drum	1	247.0	---	146.0	2	280.0	268.0-292.0	197.5					3	269.0	180.3	541.0
	Subtotal	215				57								272			31350.0
	TOTAL	711				669								1380			165270.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 29

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 AUGUST 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean	No.	Length (mm)		Mean	No.	Length (mm)		Mean	No.	Mean	Weight (g)	
			Mean	Range	Weight(g)		Mean	Range	Weight(g)		Mean	Range	Weight(g)		Length	Mean	Total
3	Alewife	6	98.3	81.0-129.0	7.5	4	90.8	79.0- 98.0	4.8					10	95.3	6.4	64.0
	Gizzard Shad	10	217.6	121.0-400.0	193.2	7	184.7	140.0-300.0	92.7					17	204.1	151.8	2581.0
	Spottail Shiner					8	113.8	105.0-130.0	11.0					8	113.8	11.0	88.0
	Carp	4	317.3	247.0-379.0	436.8									4	317.3	436.8	1747.0
	White Perch					3	193.0	141.0-265.0	107.7					3	193.0	107.7	323.0
	Yellow Perch	120	175.8	123.0-205.0	72.3	97	177.7	155.0-197.0	80.6					217	176.7	76.0	16488.0
	Walleye					1	363.0	---	446.0					1	363.0	446.0	446.0
	Freshwater Drum	4	146.0	67.0-248.0	66.0	3	249.0	240.0-262.0	179.7					7	190.1	114.7	803.0
	Subtotal	144				123								267			22540.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ¼ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 29 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 AUGUST 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
26	Alewife	5	96.0	80.0-132.0	8.0									5	96.0	8.0	40.0
	Gizzard Shad	8	210.1	134.0-415.0	174.3	2	252.5	126.0-379.0	260.0					10	218.6	191.4	1914.0
	Spottail Shiner	37	113.0	95.0-120.0	15.5	9	111.7	96.0-123.0	10.7					46	112.7	14.6	671.0
	Carp	4	327.0	312.0-340.0	463.3	5	302.8	248.0-337.0	389.6					9	313.6	422.3	3801.0
	White Perch	1	154.0	---	57.0									1	154.0	57.0	57.0
	Yellow Perch	167	176.1	146.0-197.0	54.8	100	181.4	154.0-215.0	73.1					267	178.9	61.7	16463.0
	Walleye					2	247.0	187.0-307.0	183.5					2	247.0	183.5	367.0
	Freshwater Drum	1	83.0	---	11.0	4	218.0	120.0-308.0	162.5					5	191.0	132.2	661.0
	Subtotal	223				122								345			23974.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 29 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 AUGUST 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
8	Gizzard Shad	6	222.8	120.0-292.0	167.2	6	252.2	130.0-297.0	220.7	1	226.0	---	151.0	13	236.6	190.6	2478.0
	Spottail Shiner	4	92.8	73.0-120.0	5.8	3	114.7	112.0-117.0	15.3					7	102.1	9.9	69.0
	Carp	1	251.0	---	63.0									1	251.0	63.0	63.0
	Carp X Goldfish	2	251.0	247.0-255.0	209.0	3	307.7	302.0-317.0	422.0	1	323.0	---	515.0	6	291.3	366.5	2199.0
	White Sucker	1	343	---	433.0	1	439.0	---	837.0					2	391.0	635.0	1270.0
	Shorthead Redhorse	1	401.0	---	707.0									1	401.0	707.0	707.0
	White Perch	2	165.0	154.0-176.0	67.5	1	187.0	---	91.0					3	172.3	75.3	226.0
	Yellow Perch	90	176.7	142.0-201.0	55.5	80	179.0	134.0-211.0	75.9	1	155.0	---	44.0	171	177.6	65.0	11109.0
	Walleye					1	273.0	---	157.0					1	273.0	157.0	157.0
	Freshwater Drum	3	212.0	176.0-260.0	105.7									3	212.0	105.7	317.0
	Subtotal	110				95				3				208			18595.0
13	Alewife					6	112.5	87.0-134.0	14.8					6	112.5	14.8	89.0
	Gizzard Shad	3	180.3		108.3	4	273.3	245.0-301.0	218.3					7	233.4	171.1	1198.0
	Spottail Shiner	1	101.0	---	6.0	20	112.8	95.0-120.0	15.4					21	112.2	15.0	314.0
	Carp	5	315.4	254.0-341.0	455.6	4	350.5	322.0-365.0	572.8					9	331.0	507.7	4569.0
	Carp X Goldfish	2	214.0	210.0-218.0	153.0									2	214.0	153.0	306.0
	White Perch	16	150.3	115.0-187.0	40.0	13	146.8	123.0-173.0	49.2					29	148.7	44.1	1280.0
	Yellow Perch	167	175.3	143.0-198.0	65.5	146	176.7	157.0-199.0	61.7					313	176.0	63.8	19954.0
	Subtotal	194				193								387			27710.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 29 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
28-29 AUGUST 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
28	Gizzard Shad	7	270.4	125.0-365	262.7	6	212.5	131.0-297.0	140.0					13	243.7	206.1	2679.0
	Carp	5	366.4	295.0-440.0	743.6	1	246.0	---	276.0					6	346.3	665.7	3994.0
	Goldfish	1	237.0	---	233.0	1	331.0	---	560.0					2	284.0	396.5	793.0
	White Bass					1	260.0	---	221.0					1	260.0	221.0	221.0
	Yellow Perch	97	178.0	141.0-222.0	74.8	128	180.3	150.0-204.0	73.3					225	179.2	73.9	16638.1
	Walleye	1	280.0	---	168.0	1	137.0	---	19.0					2	208.5	93.5	187.0
	Freshwater Drum	1	234.0	---	149.0	2	225.5	192.0-259.0	125.0					3	228.3	133.0	399.0
	Subtotal	112				140								252			24911.1

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 29 (cont'd)

GILL NET CATCH PR UNIT EFFORT[a] AT LOCUST POINT
28-29 AUGUST 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
29	Alewife	1	111.0	---	9.0									1	111.0	9.0	9.0
	Gizzard Shad	7	161.0	109.0-244.0	57.7	13	184.8	120.0-409.0	141.2					20	176.4	111.9	2239.0
	Spottail Shiner	2	113.5	108.0-119.0	7.5									2	113.5	7.5	15.0
	Carp	5	335.4	290.0-430.0	577.2	2	269.5	240.0-299.0	310.5					7	316.6	501.0	3507.0
	White Bass					1	253.0	---	223.0					1	253.0	223.0	223.0
	Yellow Perch	145	183.2	150.0-221.0	74.2	175	183.4	164.0-212.0	77.6					320	183.3	76.1	24338.0
	Walleye	2	337.5	262.0-413.0	341.5									2	337.5	341.5	683.0
	Freshwater Drum					2	220.5	197.0-244.0	126.0					2	220.5	126.0	252.0
	Subtotal	162				193								355			31266.0
	TOTAL	945				866				3				1814			148996.1

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 30

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
29-30 SEPTEMBER 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NW Length (mm) Mean	NW Length (mm) Range	NW Mean Weight(g)	SOUTHEAST No.	SE Length (mm) Mean	SE Length (mm) Range	SE Mean Weight(g)	UNKNOWN No.	UNK Length (mm) Mean	UNK Length (mm) Range	UNK Mean Weight(g)	TOTALS No.	Mean Length	Weight (g) Mean	Weight (g) Total
3	Alewife	152	93.9	83.0-103.0	5.4	231	92.9	82.0-113.0	7.1					383	93.4	6.4	2453.0
	Gizzard Shad					11	135.0	103.0-206.0	28.0					11	135.0	28.0	308.0
	Spottail Shiner					15	118.7	97.0-158.0	13.8					15	118.7	13.8	207.0
	Yellow Perch	26	177.0	149.0-190.0	66.0	46	185.8	163.0-211.0	78.8					72	182.6	74.2	5341.0
	Subtotal	178				303								481			8309.0
26	Alewife	20	95.3	88.0-116.0	5.2	9	93.9	81.0-111.0	3.9	7	96.3	82.0-106.0	5.1	36	95.1	4.9	175.0
	Gizzard Shad	16	120.6	96.0-140.0	17.2	6	131.7	115.0-151.0	16.7	1	120.0	---	11.0	23	123.4	16.8	386.0
	Spottail Shiner	14	114.8	110.0-123.0	9.9	12	115.3	108.0-123.0	9.6	1	126.0	---	14.0	27	115.4	9.9	267.0
	Yellow Perch	98	174.1	145.0-220.0	66.2	139	178.6	154.0-220.0	67.7	4	173.5	165.0-182.0	65.0	241	176.2	67.0	16150.0
	Freshwater Drum	1	295.0	---	366.0	1	322.0	---	350.0					2	308.5	358.0	716.0
	Subtotal	149				167				13				329			17694.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 30 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
29-30 SEPTEMBER 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
8	Alewife	3	102.0	95.0-115.0	8.0									3	102.0	8.0	24.0
	Gizzard Shad	6	129.5	110.0-160.0	19.3	8	114.1	108.0-120.0	12.9	4	121.5	97.0-137.0	16.8	18	120.9	15.9	286.0
	Spottail Shiner	10	114.7	100.0-127.0	9.2					1	111.0	---	8.0	11	114.4	9.1	100.0
	White Perch					1	100.0	---	7.0					1	100.0	7.0	7.0
	Yellow Perch	93	181.8	85.0-279.0	79.2	91	174.4	138.0-211.0	71.2	2	167.5	166.0-169.0	52.5	186	177.9	75.0	13944.0
	Walleye	1	560.0	---	1743.0									1	560.0	--	1743.0
	Freshwater Drum					1	318.0	---	385.0					1	318.0	385.0	385.0
	Subtotal	113				101				7				221			16489.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 30 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
29-30 SEPTEMBER 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
13	Alewife					8	90.9	77.0- 99.0	40.0					8	90.9	5.0	40.0
	Gizzard Shad					1	157.0	---	32.0					1	157.0	32.0	32.0
	Spottail Shiner	63	116.9	99.0-133.0	15.5	12	107.7	97.0-127.0	9.5					75	115.4	14.5	1089.0
	Carp					1	235.0	---	169.0					1	235.0	169.0	169.0
	White Perch	2	137.5	93.0-182.0	49.5									2	137.5	49.5	99.0
	Yellow Perch	21	172.4	79.0-216.0	71.1	22	175.2	147.0-203.0	67.2					43	173.8	69.1	2972.0
	Walleye	1	196.0	---	63.0									1	196.0	63.0	63.0
	Subtotal	87				44								131			4464.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 30 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
29-30 SEPTEMBER 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
28	Alewife	8	102.1	88.0-170.0	5.4	2	101.5	94.0-109.0	5.5					10	102.0	5.4	54.0
	Gizzard Shad	15	161.9	116.0-338.0	76.4	21	138.8	104.0-311.0	38.7					36	148.4	54.4	1959.0
	Spottail Shiner	9	113.9	77.0-143.0	10.8	15	114.8	86.0-168.0	12.5					24	114.5	11.9	285.0
	White Bass					2	193.5	137.0-250.0	124.0					2	193.5	124.0	248.0
	Yellow Perch	61	175.0	143.0-208.0	67.5	94	178.2	80.0-230.0	77.4					155	176.0	73.5	11395.0
	Walleye					1	387.0	---	491.0					1	387.0	491.0	491.0
	Freshwater Drum	1	325.0	---	379.0	1	265.0	---	194.0					2	295.0	286.5	573.0
	Subtotal	94				136								230			15005.0
29	Alewife	6	99.8	87.0-112.0	4.8	16	95.6	87.0-111.0	5.4	7	94.7	87.0-102.0	5.7	29	96.2	5.3	155.0
	Gizzard Shad	11	149.7	116.0-320.0	61.5	12	124.8	114.0-134.0	11.8	1	94.0	---	5.0	24	135.0	34.3	822.0
	Spottail Shiner	16	116.4	103.0-163.0	10.8	12	108.3	97.0-121.0	10.1	3	112.3	110.0-116.0	9.3	31	112.9	10.4	321.0
	Yellow Perch	129	181.3	158.0-221.0	70.9	62	182.3	152.0-225.0	73.2	2	174.5	170.0-179.0	62.5	193	181.7	71.5	13808.7
	Subtotal	162				102				13				277			15106.7
	TOTAL	783				853				33				1669			77067.7

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 31

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
27-28 OCTOBER 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
3	Alewife	6	106.2	100.0-117.0	10.0	9	100.4	80.0-121.0	12.1					15	102.7	11.3	169.0
	Gizzard Shad	1	87.0	---	8.0	6	83.0	72.0- 97.0	8.7					7	83.6	8.6	60.0
	Spottail Shiner	2	107.5	105.0-110.0	11.5	6	114.2	106.0-135.0	17.2					8	112.5	15.8	126.0
	White Bass	1	129.0	---	29.0									1	129.0	29.0	29.0
	Subtotal	10				21								31			384.0
26	Alewife	3	97.3	91.0-107.0	8.7	15	99.2	84.0-116.0	10.3					18	98.9	10.0	180.0
	Gizzard Shad	2	72.0	---	6.5	14	81.4	70.0-122.0	8.2					16	80.3	8.0	128.0
	Spottail Shiner	10	109.1	103.0-116.0	15.2	24	107.0	100.0-116.0	13.6					34	107.6	14.1	478.0
	Yellow Perch	2	190.0	188.0-192.0	83.0	1	173.0	---	68.0					3	184.3	78.0	234.0
	Subtotal	17				54								71			1020.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 31 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
27-28 OCTOBER 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
8	Alewife	3	102.8	97.0-112.0	12.0	2	112.0	109.0-115.0	10.0					7	105.4	11.4	80.0
	Gizzard Shad	5	82.4	79.0- 86.0	8.0	1	121.0	---	21.0					6	88.8	10.2	61.0
	Spottail Shiner	6	111.2	105.0-125.0	16.5	4	114.0	110.0-119.0	13.8					10	112.6	15.4	154.0
	Yellow Perch	2	168.0	136.0-200.0	70.5									2	168.0	70.5	141.0
	Subtotal	18				7								25			436.0
13	Spottail Shiner	2	107.0	104.0-110.0	14.5	2	105.0	105.0-105.0	13.0					4	106.0	13.8	55.0
	Yellow Perch	2	165.5	165.0-166.0	57.0	1	140.0	---	38.0					3	157.0	50.7	152.0
	Subtotal	4				3								7			207.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1¼ in, and 2 inch bar mesh

TABLE 31 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
27-28 OCTOBER 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
28	Alewife	5	103.0	101.0-105.0	9.8	31	101.8	82.0-122.0	10.2					36	102.0	10.1	365.0
	Gizzard Shad	6	107.7	80.0-141.0	18.5	12	97.3	73.0-140.0	13.0					18	100.7	14.8	267.0
	Spottail Shiner	6	109.2	107.0-112.0	14.7	12	113.7	104.0-121.0	15.3					18	112.2	15.1	272.0
	Yellow Perch	4	185.8	177.0-190.0	80.5	7	194.3	166.0-227.0	99.7					11	191.2	92.7	1020.0
	Subtotal	21				62								83			1924.0
29	Alewife	85	105.6	87.0-118.0	10.8	19	101.4	93.0-116.0	10.7					104	104.4	10.7	1117.0
	Gizzard Shad	2	284.0	123.0-445.0	572.5									2	284.0	572.5	1145.0
	Spottail Shiner	26	110.2	103.0-123.0	14.0	10	107.4	104.0-111.0	14.2					36	109.4	14.0	505.0
	White Bass	1	174.0	---	28.0									1	174.0	28.0	28.0
	Yellow Perch	3	176.3	163.0-190.0	69.0	1	197.0	---	96.0					4	181.5	75.8	303.0
	Subtotal	117				30								147			3098.0
	TOTAL	187				177								364			7069.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 32

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
3-4 NOVEMBER 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
3	Alewife	9	100.4	88.0-112.0	11.9	16	98.8	77.0-111.0	9.3					25	99.4	10.2	256.0
	Gizzard Shad	24	87.6	73.0-132.0	10.5	112	84.1	73.0-118.0	8.0					136	85.2	8.5	1152.0
	Spottail Shiner	14	106.6	96.0-122.0	14.9	18	109.4	103.0-121.0	12.9					32	108.2	13.8	440.0
	Yellow Perch	1	173.0	---	74.0	3	174.3	172.0-177.0	67.0					4	174.0	68.8	275.0
	Subtotal	48				149								197			2123.0
26	Alewife	6	108.5	100.0-114.0	12.3	6	96.3	89.0-104.0	9.3					12	102.4	10.8	130.0
	Gizzard Shad	6	85.7	76.0-101.0	8.2									6	85.7	3.2	49.0
	Spottail Shiner	5	109.4	101.0-118.0	14.6	18	109.4	96.0-122.0	14.1					23	109.4	14.2	326.0
	Yellow Perch	6	176.7	151.0-191.0	74.3	1	203.0	---	114.0					7	180.4	80.0	550.0
	Subtotal	23				25								48			1055.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in; 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 32 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
3-4 NOVEMBER 1979

Station	SPECIES	DIRECTION OF TRAVEL												TOTALS			
		NORTHWEST				SOUTHEAST				UNKNOWN							
		No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Length (mm)		Mean Weight(g)	No.	Mean Length	Weight (g)	
			Mean	Range			Mean	Range			Mean	Range				Mean	Total
8	Alewife					1	109.0	---	13.0					1	109.0	13.0	13.0
	Spottail Shiner	4	104.0	98.0-113.0	14.0	4	112.8	106.0-121.0	13.8					8	108.4	13.9	111.0
	Yellow Perch	1	198.0	---	101.0	2	182.0	178.0-186.0	83.0					3	187.3	89.0	267.0
	Subtotal	5				7								12			391.0
13	Alewife	25	98.6	82.0-112.0	9.5	27	99.6	73.0-111.0	8.9					55	99.1	9.2	478.0
	Gizzard Shad	3	91.0	77.0-112.0	10.0	8	91.9	76.0-127.0	10.4					11	91.6	10.3	113.0
	Spottail Shiner	17	107.2	96.0-118.0	13.0	7	109.1	104.0-116.0	12.0					24	107.8	12.7	305.0
	Yellow Perch	5	169.0	145.0-196.0	67.6	1	164.0	---	54.0					6	168.2	65.3	392.0
	Subtotal	50				43								93			1288.0

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-ft contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 32 (cont'd)

GILL NET CATCH PER UNIT EFFORT[a] AT LOCUST POINT
3-4 NOVEMBER 1979

Station	SPECIES	DIRECTION OF TRAVEL: NORTHWEST No.	NORTHWEST Length (mm) Mean	NORTHWEST Length (mm) Range	NORTHWEST Mean Weight(g)	SOUTHEAST No.	SOUTHEAST Length (mm) Mean	SOUTHEAST Length (mm) Range	SOUTHEAST Mean Weight(g)	UNKNOWN No.	UNKNOWN Length (mm) Mean	UNKNOWN Length (mm) Range	UNKNOWN Mean Weight(g)	TOTALS No.	TOTALS Mean Length	TOTALS Weight (g) Mean	TOTALS Weight (g) Total
28	Alewife	1	113.0	---	13.0	5	99.2	91.0-106.0	9.[illegible]					6	101.5	10.3	62.0
	Gizzard Shad					1	309.0	---	415.[illegible]					1	309.0	415.0	415.0
	Spottail Shiner	7	106.3	97.0-111.0	14.3	10	109.6	104.0-115.0	13.[illegible]					17	108.2	14.0	238.0
	Yellow Perch	1	189.0	---	93.0	5	203.2	196.0-209.0	105.[illegible]					6	200.8	103.2	619.0
	Subtotal	9				21								30			1334.0
29	Alewife	12	110.8	94.0-183.0	13.3	13	108.6	94.0-194.0	16.[illegible]					25	109.7	15.0	374.0
	Gizzard Shad	9	111.1	81.0-318.0	51.2	15	91.5	73.0-154.0	11.[illegible]					24	98.8	26.4	634.0
	Spottail Shiner	6	111.8	103.0-126.0	16.0	7	109.4	103.0-120.0	15.[illegible]					13	110.5	15.5	201.0
	Goldfish					1	226.0	---	235.[illegible]					1	226.0	235.0	235.0
	Yellow Perch	2	181.5	176.0-187.0	74.0	1	183.0	---	82.[illegible]					3	182.0	76.7	230.0
	Subtotal	29				37								66			1674.0
	TOTAL	164				282								446			7875.0
	ANNUAL GRAND TOTAL	3893				3701				69				7663			702727.8

[a]One 24-hr bottom set with a 125-ft experimental gill net consisting of five 25-ft x 6-[illegible] contiguous panels of ½ in, 3/4 in, 1 in, 1½ in, and 2 inch bar mesh

TABLE 33

SUMMARY OF TRAWLING RESULTS AT LOCUST POINT DURING 1979[a]

DATE \ STATION	3-26	8-13	28-29	TOTAL
30 April	82	58	68	208
24 May	27	25	30	82
22 June	22	37	25	84
31 July	70	34	42	146
31 August	84	79	93	256
25 September	98	134	108	340
30 October	104	120	85	309
6 November	271	661	972	1904
TOTAL	758	1148	1423	3329

[a]Totals of four 5-min. tows with a 16-ft. (1/8-in. bag mesh) bottom trawl at each transect on each date

TABLE 34

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

30 April 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm) MEAN	RANGE	WEIGHT (g) MEAN	TOTAL
3-26	Spottail Shiner	31	108.5	57.0-188.0	21.5	667.5
	Emerald Shiner	11	68.2	41.0-161.0	10.2	112.0
	Brown Bullhead	1	215.0	-- --	118.0	118.0
	Channel Catfish	1	143.0	-- --	21.0	21.0
	Trout-perch	17	91.2	60.0-188.0	16.8	286.0
	White Bass	1	128.0	-- --	32.0	32.0
	Yellow Perch	3	173.7	152.0-191.0	39.3	118.0
	Freshwater Drum	17	134.8	107.0-195.0	31.2	530.0
	Subtotal	82				1884.5
8-13	Spottail Shiner	12	92.8	77.0-127.0	8.3	99.0
	Emerald Shiner	4	57.8	51.0- 66.0	4.5	18.0
	Carp	1	425.0	-- --	1247.0	1247.0
	Goldfish	1	212.0	-- --	195.0	195.0
	Brown Bullhead	1	187.0	-- --	94.0	94.0
	Channel Catfish	1	178.0	-- --	65.0	65.0
	Trout-perch	11	91.5	73.0-123.0	9.2	101.0
	White Bass	3	135.7	134.0-139.0	35.7	107.0
	Yellow Perch	5	159.2	113.0-215.0	48.2	241.0
	Freshwater Drum	19	133.5	100.0-270.0	54.6	1037.0
	Subtotal	58				3204.0
28-29	Spottail Shiner	18	89.2	57.0-136.0	6.1	109.0
	Emerald Shiner	3	59.0	55.0- 64.0	5.0	15.0
	Yellow Bullhead	3	195.7	175.0-208.0	106.7	320.0
	Channel Catfish	1	145.0	-- --	49.0	49.0
	Trout-perch	2	99.5	83.0-116.0	19.5	39.0
	White Bass	4	142.0	115.0-194.0	48.0	192.0
	Yellow Perch	4	165.0	141.0-197.0	61.0	244.0
	Walleye	1	361.0	-- --	445.0	445.0
	Freshwater Drum	32	144.0	102.0-246.0	41.4	1325.0
	Subtotal	68				2738.0
	TOTAL	208				7826.5

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 35

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

24 May 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
3-26	Spottail Shiner	8	98.6	80.0-130.0	8.0	64.0
	Emerald Shiner	3	58.0	56.0- 62.0	1.0	3.0
	Brown Bullhead	1	193.0	-- --	96.0	96.0
	Channel Catfish	1	140.0	-- --	24.0	24.0
	Trout-perch	2	102.0	89.0-115.0	8.0	16.0
	White Bass	2	156.0	126.0-186.0	53.0	106.0
	Yellow Perch	3	170.7	146.0-197.0	52.7	158.0
	Freshwater Drum	7	185.1	122.0-244.0	71.0	497.0
	Subtotal	27				964.0
8-13	Spottail Shiner	8	77.3	66.0- 81.0	2.3	18.0
	Emerald Shiner	1	53.0	-- --	1.0	1.0
	Carp	1	313.0	-- --	445.0	445.0
	Brown Bullhead	2	188.0	172.0-204.0	84.0	168.0
	Trout-perch	1	94.0	-- --	3.0	3.0
	White Bass	2	121.5	110.0-133.0	19.0	38.0
	Yellow Perch	1	146.0	-- --	22.0	22.0
	Walleye	2	246.0	139.0-353.0	223.0	446.0
	Freshwater Drum	7	108.0	99.0-113.0	10.1	71.0
	Subtotal	25				1212.0
28-29	Rainbow Smelt	1	128.0	-- --	10.0	10.0
	Spottail Shiner	7	82.7	68.0-105.0	3.0	21.0
	Emerald Shiner	4	64.5	59.0- 72.0	1.3	5.0
	Brown Bullhead	1	230.0	-- --	135.0	135.0
	Channel Catfish	1	145.0	-- --	22.0	22.0
	Trout-perch	8	90.4	79.0- 98.0	6.0	48.0
	Yellow Perch	3	178.3	160.0-195.0	44.3	133.0
	Freshwater Drum	5	165.8	115.0-210.0	63.8	319.0
	Subtotal	30				693.0
	TOTAL	82				2869.0

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 36

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

22 June 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
3-26	Spottail Shiner	1	85.0	-- --	15.0	15.0
	Brown Bullhead	1	208.0	-- --	140.0	140.0
	Channel Catfish	5	189.6	166.0-250.0	75.8	379.0
	White Bass	1	224.0	-- --	150.0	150.0
	Yellow Perch	11	154.3	93.0-201.0	56.5	621.0
	Walleye	2	235.0	225.0-245.0	115.0	230.0
	Freshwater Drum	1	186.0	-- --	58.0	58.0
	Subtotal	22				1593.0
8-13	Carp	2	464.0	340.0-588.0	1651.0	3302.0
	Brown Bullhead	4	208.0	190.0-230.0	85.0	340.0
	Channel Catfish	19	164.8	130.0-190.0	40.6	771.0
	Yellow Perch	11	143.7	105.0-191.0	32.5	357.0
	Freshwater Drum	1	180.0	-- --	45.0	45.0
	Subtotal	37				4815.0
28-29	Spottail Shiner	1	80.0	-- --	15.0	15.0
	Emerald Shiner	1	60.0	-- --	5.0	5.0
	Silver Chub	1	130.0	-- --	50.0	50.0
	Quillback	1	275.0	-- --	320.0	320.0
	Channel Catfish	5	157.6	145.0-170.0	57.0	285.0
	Yellow Perch	14	141.3	88.0-184.0	41.8	585.0
	Freshwater Drum	2	135.0	100.0-170.0	35.0	70.0
	Subtotal	25				1330.0
	TOTAL	84				7738.0

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 37

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

31 July 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
3-26	Gizzard Shad	6	96.3	77.0-115.0	33.0	198.0
	Spottail Shiner	23	104.3	80.0-130.0	13.8	318.0
	Carp	1	442.0	-- --	1150.0	1150.0
	Goldfish	1	418.0	-- --	956.0	956.0
	Brown Bullhead	10	158.4	137.0-195.0	56.4	564.0
	Channel Catfish	1	356.0	-- --	380.0	380.0
	Yellow Perch	27	168.1	120.0-205.0	59.3	1602.0
	Freshwater Drum	1	133.0	-- --	30.0	30.0
	Subtotal	70				5198.0
8-13	Spottail Shiner	2	114.0	111.0-117.0	10.5	21.0
	Carp	3	371.3	246.0-453.0	1022.0	3066.0
	Goldfish	1	380.0	-- --	920.0	920.0
	Brown Bullhead	2	192.5	155.0-230.0	114.5	229.0
	Channel Catfish	1	295.0	-- --	260.0	260.0
	Yellow Perch	24	167.8	120.0-202.0	60.6	1454.0
	Black Crappie	1	118.0	-- --	19.0	19.0
	Subtotal	34				5969.0
28-29	Gizzard Shad	2	103.5	100.0-107.0	10.5	21.0
	Spottail Shiner	1	111.0	-- --	18.0	18.0
	Carp	1	490.0	-- --	923.0	923.0
	Brown Bullhead	2	172.5	132.0-213.0	86.0	172.0
	Black Crappie	1	112.0	-- --	22.0	22.0
	Yellow Perch	35	164.6	120.0-200.0	60.3	2112.0
	Subtotal	42				3268.0
	TOTAL	146				14435.0

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 38

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

31 August 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
3-26	Spottail Shiner	8	87.3	43.0-120.0	17.3	138.0
	Carp	6	374.3	277.0-620.0	1057.3	6344.0
	Brown Bullhead	3	208.7	163.0-265.0	136.7	410.0
	Channel Catfish	5	197.0	175.0-222.0	71.8	359.0
	Trout-perch	1	60.0	-- --	3.0	3.0
	White Bass	3	63.0	60.0- 67.0	3.7	11.0
	Yellow Perch	40	163.3	66.0-210.0	62.8	2511.0
	Walleye	2	212.0	152.0-272.0	86.0	172.0
	Freshwater Drum	16	69.8	40.0- 88.0	3.2	51.0
	Subtotal	84				9999.0
8-13	Carp	3	260.0	220.0-300.0	240.0	720.0
	Brown Bullhead	11	189.8	155.0-232.0	92.8	1021.0
	Channel Catfish	18	192.4	140.0-275.0	59.8	1077.0
	White Bass	4	135.3	90.0-195.0	38.5	154.0
	Yellow Perch	27	181.6	131.0-295.0	58.4	1576.0
	Logperch	1	75.0	-- --	4.0	4.0
	Freshwater Drum	15	76.9	16.0-220.0	12.0	180.0
	Subtotal	79				4732.0
28-29	Gizzard Shad	1	85.0	-- --	7.0	7.0
	Spottail Shiner	2	73.5	70.0- 77.0	3.0	6.0
	Carp	1	322.0	-- --	490.0	490.0
	Brown Bullhead	21	182.0	133.0-266.0	92.7	1947.0
	Channel Catfish	11	184.2	132.0-210.0	58.9	648.0
	White Bass	1	97.0	-- --	11.0	11.0
	Yellow Perch	39	180.4	155.0-205.0	62.7	2445.0
	Walleye	3	177.7	62.0-303.0	103.0	309.0
	Freshwater Drum	14	112.5	53.0-253.0	31.2	437.0
	Subtotal	93				6300.0
	TOTAL	256				21031.0

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 39

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

25 September 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm)		WEIGHT (g)	
			MEAN	RANGE	MEAN	TOTAL
3-26	Gizzard Shad	72	85.1	60.0-117.0	5.2	376.0
	Alewife	4	102.8	97.0-107.0	8.5	34.0
	Spottail Shiner	15	101.3	71.0-121.0	10.2	153.0
	White Bass	5	84.0	42.0-124.0	12.2	61.0
	Yellow Perch	1	166.0	-- --	54.0	54.0
	Freshwater Drum	1	200.0	-- --	86.0	86.0
	Subtotal	98				764.0
8-13	Gizzard Shad	90	83.2	62.0-106.0	5.5	497.2
	Alewife	8	107.9	102.0-119.0	10.0	80.0
	Spottail Shiner	19	101.3	59.0-132.0	9.9	188.0
	Brown Bullhead	1	211.0	-- --	109.0	109.0
	White Bass	7	53.3	44.0- 67.0	2.0	14.0
	Yellow Perch	7	173.1	151.0-187.0	56.6	396.0
	White Crappie	1	54.0	-- --	2.0	2.0
	Walleye	1	55.0	-- --	24.0	24.0
	Subtotal	134				1310.2
28-29	Gizzard Shad	57	92.6	68.0-117.0	8.3	472.0
	Alewife	4	108.0	102.0-112.0	9.0	36.0
	Spottail Shiner	33	112.4	75.0-130.0	14.1	465.0
	White Bass	4	74.3	46.0-113.0	6.8	27.0
	Yellow Perch	8	169.9	137.0-190.0	58.3	466.0
	Freshwater Drum	2	97.0	92.0-102.0	8.0	16.0
	Subtotal	108				1482.0
	TOTAL	340				3556.2

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 40

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

30 October 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
3-26	Gizzard Shad	84	83.7	68.0-115.0	5.4	453.0
	Alewife	5	101.2	88.0-115.0	8.0	40.0
	Spottail Shiner	11	82.3	56.0-118.0	6.0	66.0
	Yellow Perch	4	125.3	120.0-134.0	22.5	90.0
	Subtotal	104				649.0
8-13	Gizzard Shad	99	83.8	67.0-116.0	5.5	540.0
	Alewife	11	95.5	87.0-106.0	7.0	77.0
	Spottail Shiner	6	85.2	57.0-122.0	7.5	45.0
	White Bass	1	215.0	-- --	149.0	149.0
	Yellow Perch	3	154.0	126.0-196.0	53.0	159.0
	Subtotal	120				970.0
28-29	Gizzard Shad	71	83.4	68.0-112.0	5.6	398.0
	Alewife	5	89.2	79.0-100.0	7.4	37.0
	Spottail Shiner	7	79.7	65.0-99.0	5.3	37.0
	Yellow Perch	2	173.0	168.0-178.0	44.5	89.0
	Subtotal	85				561.0
	TOTAL	309				2180.0

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 41

TRAWL CATCH PER UNIT EFFORT[a] AT LOCUST POINT

6 November 1979

TRANSECT	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
3-26	Rainbow Smelt	1	63.0	-- --	1.0	1.0
	Gizzard Shad	251	77.2	63.0-119.0	4.6	1148.0
	Alewife	7	90.1	80.0-101.0	7.3	51.0
	Spottail Shiner	10	95.0	66.0-129.0	10.6	106.0
	Emerald Shiner	1	63.0	-- --	2.0	2.0
	Carp	1	430.0	-- --	879.0	879.0
	Subtotal	271				2187.0
8-13	Gizzard Shad	970	83.3	66.0-119.0	5.1	4901.0
	Alewife	2	91.5	91.0-92.0	4.5	9.0
	Subtotal	972				4910.0
28-29	Gizzard Shad	642	81.4	65.0-132.0	4.8	3067.0
	Alewife	11	90.5	78.0-110.0	4.4	48.0
	Spottail Shiner	5	90.4	70.0-126.0	6.6	33.0
	Emerald Shiner	1	76.0	-- --	3.0	3.0
	Yellow Perch	2	186.5	186.0-187.0	85.0	170.0
	Subtotal	661				3321.0
	TOTAL	1904				10418.0
ANNUAL GRAND TOTAL		3329				70053.7

[a]Four 5-minute tows with a 16-ft trawl (1/8-in bag mesh) at each transect.

TABLE 42

SUMMARY OF SHORE SEINE RESULTS AT LOCUST POINT DURING 1979[a]

DATE \ STATION	23	24	25	TOTAL
1 May	6,224	5,608	4,984	16,816
30 May	27	24	16	67
20 June	287	640	1,041	1,968
28 July	45,661	15,318	92,591	153,570
28 August	249	285	132	666
29 September	32	42	137	211
27 October	44	27	13	84
3 November	145	206	1,780	2,131
TOTAL	52,669	22,150	100,694	175,513

[a]Total of two hauls through a 90° arc with a 100-ft bag seine ($\frac{1}{4}$-in bar mesh) at each station on each date

TABLE 43

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

1 May 1979

STATION	SPECIES	NUMBER	LENGTH (mm)		WEIGHT (g)	
			MEAN	RANGE	MEAN	TOTAL
23	Gizzard Shad	128	231.7	115.0-513.0	156.7	20062.0
	Spottail Shiner	4	101.5	79.0-130.0	10.0	40.0
	Emerald Shiner	6082	63.4	45.0-110.0	1.1	6873.0
	Carp	9	521.6	337.0-780.0	2380.0	21420.0
	Brown Bullhead	1	241.0	-- --	175.0	175.0
	Subtotal	6224				48570.0
24	Gizzard Shad	137	217.0	123.0-502.0	125.0	17126.0
	Spottail Shiner	5	114.6	100.0-127.0	13.2	66.0
	Emerald Shiner	5461	66.9	43.0-111.0	1.1	6181.5
	Carp	5	481.4	312.0-631.0	1914.6	9573.0
	Subtotal	5608				32946.5
25	Gizzard Shad	112	218.0	121.0-560.0	135.6	15182.0
	Spottail shiner	7	115.4	101.0-130.0	13.0	91.0
	Emerald Shiner	4858	69.3	37.0-111.0	1.1	5494.5
	Carp	1	479.0	-- --	1499.0	1499.0
	White Bass	5	121.6	100.0-141.0	33.4	167.0
	Freshwater Drum	1	259.0	-- --	115.0	115.0
	Subtotal	4984				22548.5
	TOTAL	16816				104065.0

[a]Two hauls through a 90° arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 44

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

30 May 1979

STATION	SPECIES	NUMBER	LENGTH (mm)		WEIGHT (g)	
			MEAN	RANGE	MEAN	TOTAL
23	Gizzard Shad	7	153.9	132.0-180.0	29.4	206.0
	Emerald Shiner	20	71.2	41.0-140.0	2.3	47.0
	Subtotal	27				253.0
24	Gizzard Shad	9	163.3	131.0-195.0	35.4	319.0
	Spottail Shiner	1	131.0	-- --	20.0	20.0
	Emerald Shiner	13	66.2	51.0-103.0	1.5	19.0
	Logperch	1	102.0	-- --	11.0	11.0
	Subtotal	24				369.0
25	Gizzard Shad	5	172.8	157.0-186.0	42.2	211.0
	Emerald Shiner	11	66.2	39.0- 95.0	1.5	16.0
	Subtotal	16				227.0
	TOTAL	67				849.0

[a]Two hauls through a 90^{0} arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 45

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

20 June 1979

STATION	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
23	Gizzard Shad	272	48.7	19.0-301.0	5.8	1575.0
	Spottail Shiner	5	101.2	52.0-139.0	14.4	72.0
	Emerald Shiner	9	77.1	63.0- 88.0	1.9	17.0
	Freshwater Drum	1	130.0	-- --	20.0	20.0
	Subtotal	287				1684.0
24	Gizzard Shad	617	27.7	19.0- 38.0	0.5	310.0
	Emerald Shiner	23	74.0	46.0- 93.0	1.7	39.0
	Subtotal	640				349.0
25	Gizzard Shad	1025	34.7	20.0-237.0	4.0	702.0
	Spottail Shiner	2	126.0	121.0-131.0	20.0	40.0
	Emerald Shiner	14	73.9	59.0- 87.0	1.5	21.0
	Subtotal	1041				763.0
	TOTAL	1968				2796.0

[a]Two hauls through a 90° arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 46

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

28 July 1979

STATION	SPECIES	NUMBER	LENGTH (mm)		WEIGHT (g)	
			MEAN	RANGE	MEAN	TOTAL
23	Gizzard Shad	28265	51.3	21.0-274.0	0.8	23110.5
	Alewife	17342	25.6	15.0- 40.0	0.4	6942.0
	Spottail Shiner	1	59.0	-- --	2.0	2.0
	Emerald Shiner	1	72.0	-- --	2.0	2.0
	White Bass	52	50.3	35.0- 75.0	1.3	68.5
	Subtotal	45661				30125.0
24	Gizzard Shad	7783	41.4	30.0- 56.0	0.7	5441.5
	Alewife	7479	25.6	17.0- 37.0	0.4	2996.0
	Spottail Shiner	1	45.0	-- --	0.5	0.5
	Emerald Shiner	9	70.4	63.0- 85.0	1.2	11.0
	White Bass	46	46.3	37.0- 70.0	1.2	57.0
	Subtotal	15318				8506.0
25	Gizzard Shad	50896	44.6	20.0-386.0	0.7	36074.5
	Alewife	41650	28.6	17.0- 38.0	0.4	16665.0
	Spottail Shiner	1	82.0	-- --	3.0	3.0
	Emerald Shiner	5	81.0	58.0-110.0	3.8	19.0
	White Bass	38	47.7	37.0- 57.0	1.4	51.5
	Freshwater Drum	1	137.0	-- --	28.0	28.0
	Subtotal	92591				52841.0
	TOTAL	153570				91472.0

[a]Two hauls through a 90^{o} arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 47

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

28 August 1979

STATION	SPECIES	NUMBER	LENGTH (mm) MEAN	LENGTH (mm) RANGE	WEIGHT (g) MEAN	WEIGHT (g) TOTAL
23	Gizzard Shad	212	81.6	40.0-264.0	8.0	1702.5
	Spottail Shiner	1	68.0	-- --	3.0	3.0
	Emerald Shiner	27	61.9	26.0- 95.0	2.4	64.0
	White Bass	9	79.8	57.0-108.0	6.1	55.0
	Subtotal	249				1824.5
24	Gizzard Shad	229	88.2	40.0-145.0	5.9	1342.0
	Emerald Shiner	27	47.8	18.0- 80.0	0.7	18.2
	White Bass	28	99.2	68.0-120.0	12.0	335.0
	Freshwater Drum	1	324.0	-- --	418.0	418.0
	Subtotal	285				2113.2
25	Gizzard Shad	113	76.8	36.0-100.0	5.6	632.5
	Emerald Shiner	14	66.1	42.0- 80.0	2.2	30.5
	White Bass	5	59.8	37.0- 80.0	3.8	19.0
	Subtotal	132				682.0
	TOTAL	666				4619.7

[a]Two hauls through a 90° arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 48

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

29 September 1979

STATION	SPECIES	NUMBER	LENGTH (mm)		WEIGHT (g)	
			MEAN	RANGE	MEAN	TOTAL
23	Spottail Shiner	13	65.2	32.0- 82.0	4.3	55.5
	Emerald Shiner	19	69.4	46.0- 84.0	6.0	114.0
	Subtotal	32				169.5
24	Gizzard Shad	7	54.0	36.0- 86.0	1.7	12.0
	Spottail Shiner	22	56.2	30.0- 86.0	2.0	43.0
	Emerald Shiner	10	67.4	39.0- 86.0	3.2	32.0
	White Bass	3	70.0	56.0- 94.0	2.7	8.0
	Subtotal	42				95.0
25	Gizzard Shad	66	92.7	34.0-172.0	11.8	781.0
	Spottail Shiner	15	71.6	38.0-105.0	3.4	51.0
	Emerald Shiner	54	64.9	41.0- 87.0	2.1	112.0
	White Bass	1	44.0	-- --	1.0	1.0
	White Perch	1	89.0	-- --	9.0	9.0
	Subtotal	137				954.0
	TOTAL	211				1218.5

[a]Two hauls through a 90° arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 49

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

27 October 1979

STATION	SPECIES	NUMBER	LENGTH (mm)		WEIGHT (g)	
			MEAN	RANGE	MEAN	TOTAL
23	Gizzard Shad	19	82.2	53.0-120.0	6.7	127.0
	Emerald Shiner	25	67.2	42.0- 95.0	3.1	78.0
	Subtotal	44				205.0
24	Gizzard Shad	6	84.5	53.0-103.0	8.3	50.0
	Spottail Shiner	2	83.5	79.0- 88.0	6.5	13.0
	Emerald Shiner	19	74.2	52.0- 98.0	3.7	70.0
	Subtotal	27				133.0
25	Gizzard Shad	5	88.4	52.0-120.0	9.0	45.0
	Emerald Shiner	8	69.8	52.0- 88.0	2.9	23.0
	Subtotal	13				68.0
	TOTAL	84				406.0

[a]Two hauls through a 90° arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 50

SHORE SEINE CATCH PER UNIT EFFORT[a] AT LOCUST POINT

3 November 1979

STATION	SPECIES	NUMBER	LENGTH (mm)		WEIGHT (g)	
			MEAN	RANGE	MEAN	TOTAL
23	Gizzard Shad	4	65.3	52.0- 85.0	4.0	16.0
	Spottail Shiner	10	83.8	55.0-135.0	8.1	81.0
	Emerald Shiner	129	60.4	41.0- 86.0	1.9	247.0
	Bluntnose Minnow	1	57.0	-- --	3.0	3.0
	Goldfish	1	154.0	-- --	58.0	58.0
	Subtotal	145				405.0
24	Gizzard Shad	7	60.9	43.0- 82.0	2.9	20.0
	Spottail Shiner	4	83.5	61.0-111.0	7.0	28.0
	Emerald Shiner	194	62.9	42.0-100.0	1.9	369.0
	Spotfin Shiner	1	66.0	-- --	4.0	4.0
	Subtotal	206				421.0
25	Gizzard Shad	66	76.0	41.0-148.0	6.0	395.0
	Emerald Shiner	1714	60.4	43.0-102.0	2.0	3492.0
	Subtotal	1780				3887.0
	TOTAL	2131				4713.0
ANNUAL GRAND TOTAL		175513				210139.2

[a]Two hauls through a 90^{0} arc with a 100-ft bag seine (¼-in bar mesh) at each station.

TABLE 51

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
30 APRIL 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm)		FOOD ITEMS																																	
				Mean	Range	Rotifera	Oligochaeta	Cladocera	Chydorus sp.	Daphnia spp.	Eubosmina sp.	Leptodora kindtii	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	Gammarus sp.	Insecta (larvae)	Chironomidae	Chironomus sp.	Cryptochironomus sp.	Procladius sp.	Tanytarsus sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	Alosa pseudoharengus	Aplodinotus grunniens	Dorosoma cepedianum	Notropis atherinoides	Notropis hudsonius	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	11	0	68.2	41.0-161.0																																		
	Freshwater Drum	17	0	134.8	107.0-195.0																																		
	Spottail Shiner	31	0	108.5	57.0-188.0																																		
	White Bass	1	0	128.0	---																																		
	Yellow Perch	3	0	173.7	152.0-191.0																																		
	Subtotal	63	0																																				
8-13	Emerald Shiner	4	0	57.8	51.0- 66.0																																		
	Freshwater Drum	19	0	133.5	100.0-270.0																																		
	Spottail Shiner	12	25.0	92.8	77.0-127.0										4																								
	White Bass	3	0	135.7	134.0-139.0																																		
	Yellow Perch	5	0	159.2	113.0-215.0																																		
	Subtotal	43	0.1																																				
	TOTAL	106	<0.1																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 52

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
24 MAY 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm)		FOOD ITEMS																																	
				Mean	Range	Rotifera	Oligochaeta	Cladocera	Chydorus sp.	Daphnia spp.	Eubosmina sp.	Leptodora kindtii	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	Gammarus sp.	Insecta (larvae)	Chironomidae	Chironomus sp.	Cryptochironomus sp.	Procladius sp.	Tanytarsus sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	Alosa pseudoharengus	Aplodinotus grunniens	Dorosoma cepedianum	Notropis atherinoides	Notropis hudsonius	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	3	100.0	58.0	56.0- 62.0				4	64	8				0.3																							x	
	Freshwater Drum	7	57.1	185.1	122.0-244.0		2					1									1																	x	
	Spottail Shiner	8	100.0	98.6	80.0-130.0				20	256	24				1																							x	
	White Bass	2	100.0	156.0	126.0-186.0																															1		x	
	Yellow Perch	3	100.0	170.7	146.0-197.0				27	252	42	2																								0.3		x	
	Subtotal	23	86.9																																				
B-13	Emerald Shiner	1	100	53.0	---					56	2			1																								x	
	Freshwater Drum	7	42.8	108.0	99.0-113.0		1								1						2																	x	
	Spottail Shiner	8	100	77.3	66.0- 81.0				16	264	-5																											x	
	White Bass	2	50.0	121.5	110.0-133.0																															1			
	Yellow Perch	1	100	146.0	---		2		25	390	74	1									2																	x	
	Subtotal	19	73.7																																				
	TOTAL	42	81.0																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 53

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
22 JUNE 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm)		FOOD ITEMS																																	
				Mean	Range	Rotifera	Oligochaeta	Cladocera	Chydorus sp.	Daphnia spp.	Eubosmina sp.	Leptodora kindtii	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	Gammarus sp.	Insecta (larvae)	Chironomidae	Chironomus sp.	Cryptochironomus sp.	Procladius sp.	Tanytarsus sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	Alosa pseudoharengus	Aplodinotus grunniens	Dorosoma cepedianum	Notropis atherinoides	Notropis hudsonius	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	0																																					
	Freshwater Drum	1	100.0	186.0	---		3			6		2						2								8					1							x	
	Spottail Shiner	1	100.0	85.0	---	1			1	57	2	1			2						1																	x	
	White Bass	1	100.0	224.0	---																															3			
	Yellow Perch	11	100.0	154.3	93.0-201.0					87	1	2									2															0.1		x	
	Subtotal	14	100.0																																				
8-13	Emerald Shiner	0																																					
	Freshwater Drum	1	100	180.0	---		1					2									8																	x	
	Spottail Shiner	0																																					
	White Bass	0																																					
	Yellow Perch	11	81.8	143.7	105.0-191.0	1	0.4		10	181	3	1																										x	
	Subtotal	12	83.3																																				
	TOTAL	26	92.3																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 54

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
31 JULY 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm) Mean	LENGTH (mm) Range	Rotifera	Oligochaeta	Cladocera	Chydorus sp.	Daphnia spp.	Eubosmina sp.	Leptodora kindtii	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	Gammarus sp.	Insecta (larvae)	Chironomidae	Chironomus sp.	Cryptochironomus sp.	Procladius sp.	Tanytarsus sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	Alosa pseudoharengus	Aplodinotus grunniens	Dorosoma cepedianum	Notropis atherinoides	Notropis hudsonius	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	0																																					
	Freshwater Drum	1	100.0	133.0						2		1						1			18		2															X	
	Spottail Shiner	23	73.9	104.3	80.0-130.0					180	26	0.2		0.2	2								1															X	
	White Bass	0																																					
	Yellow Perch	27	100.0	168.1	120.0-205.0	0.1	1			220	1	0.4		1	2						0.4																	X	
	Subtotal	51	88.2																																				
8-13	Emerald Shiner	0																																					
	Freshwater Drum	0																																					
	Spottail Shiner	2	100.0	114.0	111.0-117.0	2	0.5			316	12	1			4	0.5																						X	
	White Bass	0																																					
	Yellow Perch	24	100.0	167.8	120.0-202.0		0.2			174	6	0.3									0.2			0.1														X	
	Subtotal	26	100.0																																				
	TOTAL	77	92.2																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 55

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
31 AUGUST 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm) Mean	LENGTH (mm) Range	FOOD ITEMS: Rotifera	Oligochaeta	Cladocera	*Chydorus* sp.	*Daphnia* spp.	*Eubosmina* sp.	*Leptodora kindtii*	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	*Gammarus* sp.	Insecta (larvae)	Chironomidae	*Chironomus* sp.	*Cryptochironomus* sp.	*Procladius* sp.	*Tanytarsus* sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	*Alosa pseudoharengus*	*Aplodinotus grunniens*	*Dorosoma cepedianum*	*Notropis atherinoides*	*Notropis hudsonius*	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	0																																					
	Freshwater Drum	16	50.0	69.8	44.0- 88.0					2.0	0.5	24			4																							x	
	Spottail Shiner	8	100.0	87.3	43.0-120.0					1	0.5	2			9	0.2														0.1								x	x
	White Bass	3	66.7	63.0	60.0- 67.0	0.1				6	3	16			9																							x	
	Yellow Perch	25	72.0	159.6	66.0-210.0					2	0.5	2									0.4							0.1										x	x
	Subtotal	52	69.2																																				
8-13	Emerald Shiner	0																																					
	Freshwater Drum	15	73.3	76.9	16.0-120.0		0.1		0.6	3		21			2	0.1								0.1														x	
	Spottail Shiner	0																																					
	White Bass	4	50.0	135.3	90.0-195.0				0.5	4		36																							0.5	0.2		x	
	Yellow Perch	27	92.6	181.6	131.0-295.0					7		3			4																				0.1			x	x
	Subtotal	46	82.6																																				
	TOTAL	98	75.5																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 56

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
25 SEPTEMBER 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm)		FOOD ITEMS																																			
				Mean	Range	Rotifera	Oligochaeta	Cladocera	Chydorus sp.	Daphnia spp.	Eubosmina sp.	Leptodora kindtii	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	Gammarus sp.	Insecta (larvae)	Chironomidae	Chironomus sp.	Cryptochironomus sp.	Procladius sp.	Tanytarsus sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	Alosa pseudoharengus	Aplodinotus grunniens	Dorosoma cepedianum	Notropis atherinoides	Notropis hudsonius	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	0																																					
	Freshwater Drum	1	100.0	200.0																	7			8							1				1			X	
	Spottail Shiner	15	100.0	101.3	71.0-121.0				0.5		2				3						0.4			0.5					0.7									X	X
	White Bass	5	80.0	84.0	42.0-124.0																1			0.2									0.4					X	
	Yellow Perch	1	0	166.0																																			
	Subtotal	22	90.9																																				
8-13	Emerald Shiner	0																																					
	Freshwater Drum	0																																					
	Spottail Shiner	19	100	101.3	59.0-132.0				1		1	0.2		0.2	2						0.2																	X	X
	White Bass	7	71.4	53.3	44.0- 67.0																2	0.1											0.1		0.1		0.1	X	
	Yellow Perch	7	42.9	173.1	151.0-187.0				0.3			0.3			1						1																	X	X
	Subtotal	33	81.8																																				
	TOTAL	55	85.4																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 57

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
30 OCTOBER 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm)		FOOD ITEMS																																	
				Mean	Range	Rotifera	Oligochaeta	Cladocera	Chydorus sp.	Daphnia spp.	Eubosmina sp.	Leptodora kindtii	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	Gammarus sp.	Insecta (larvae)	Chironomidae	Chironomus sp.	Cryptochironomus sp.	Procladius sp.	Tanytarsus sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	Alosa pseudoharengus	Aplodinotus grunniens	Dorosoma cepedianum	Notropis atherinoides	Notropis hudsonius	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	0																																					
	Freshwater Drum	0																																					
	Spottail Shiner	11	100	82.3	56.0-118.0		0.1			0.1	2										1	1		0.2														X	X
	White Bass	0																																					
	Yellow Perch	4	50	125.3	120.0-134.0										2						1													0.5				X	
	Subtotal	15	86.6																																				
8-13	Emerald Shiner	0																																					
	Freshwater Drum	0																																					
	Spottail Shiner	6	100	85.2	57.0-122.0					0.5	2										1	1		1				0.2										X	X
	White Bass	1	100	215.0	---																													1			1		
	Yellow Perch	3	66.7	154.0	126.0-196.0					0.5												0.5												0.5					
	Subtotal	10	90.0																																				
	TOTAL	25	88.0																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 58

SUMMARY OF FOOD HABITS DATA OF FISH COLLECTED AT LOCUST POINT WITH A 16-FT TRAWL[a]
6 NOVEMBER 1979

TRANSECT	SPECIES	NUMBER IN SAMPLE	PERCENT CONTAINING FOOD	LENGTH (mm)		FOOD ITEMS																																	
				Mean	Range	Rotifera	Oligochaeta	Cladocera	Chydorus sp.	Daphnia spp.	Eubosmina sp.	Leptodora kindtii	Copepoda	Calanoid	Cyclopoid	Ostracoda	Amphipoda	Gammarus sp.	Insecta (larvae)	Chironomidae	Chironomus sp.	Cryptochironomus sp.	Procladius sp.	Tanytarsus sp.	Insecta (pupae)	Chironomidae	Insecta (adults)	Coleoptera	Diptera (Chironomidae)	Hymenoptera	Gastropoda	Fish	Alosa pseudoharengus	Aplodinotus grunniens	Dorosoma cepedianum	Notropis atherinoides	Notropis hudsonius	Animal Debris[b]	Plant Debris[b]
3-26	Emerald Shiner	1	0	63.0	---																																		
	Freshwater Drum	0																																					
	Spottail Shiner	10	100	95.0	66.0-129.0		0.2														1			1														x	x
	White Bass	0																																					
	Yellow Perch	0																																					
	Subtotal	11	90.9																																				
8-13	Emerald Shiner	0																																					
	Freshwater Drum	0																																					
	Spottail Shiner	0																																					
	White Bass	0																																					
	Yellow Perch	0																																					
	Subtotal	0																																					
	TOTAL	11	90.9																																				
	ANNUAL GRAND TOTAL	440	---																																				

[a]Presented as mean number of food items per fish

[b]Item present but not numerically quantifiable

TABLE 59

PRE-OPERATIONAL AND OPERATIONAL GILL NET CATCHES[1] OF SELECTED SPECIES FROM LAKE ERIE IN THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION DISCHARGE (STATION 13)

	ALEWIFE							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
April	0	10	3	5	---	---	0	---
May	0	44	30	20	0	0	0	0
June	0	43	19	19	0	1	1	1
July	0	159	49	68	0	0	0	0
August	0	72	14	32	0	6	3	4
September	0	200	87	102	1	136	48	76
October	4	322	117	178	36	88	41	44
November	0	47	16	22	41	52	47	8
December	---	---	0	---	---	---	---	---
Mean	1	112	37	40	11	40	18	23
	CHANNEL CATFISH							
April	0	1	0	1	---	---	1	---
May	0	1	1	1	0	0	0	0
June	0	7	2	3	3	6	5	2
July	1	18	6	7	3	4	4	1
August	0	5	2	2	0	0	0	0
September	0	2	1	1	0	0	0	0
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	---	---	0	---	---	---	---	---
Mean	0	4	1	2	1	1	1	2
	FRESHWATER DRUM							
April	0	17	4	9	---	---	4	---
May	0	4	1	2	1	1	1	0
June	3	9	5	3	20	75	48	39
July	1	50	18	20	0	14	7	10
August	0	12	5	5	0	6	3	4
September	0	11	4	5	0	3	1	2
October	0	7	4	4	0	0	0	0
November	0	0	0	0	0	0	0	0
December	---	---	0	---	---	---	---	---
Mean	1	14	5	5	3	14	8	16

[1]Results presented as the number of fish per unit effort, where one unit of effort equals a 24-hour bottom set with an experimental gill net 125 ft long consisting of five 25-ft contiguous panels of ½, 3/4, 1, 1½, and 2-inch bow mesh.

[2]Results from samples collected from 1973 through August 1977.

[3]Results from samples collected from September 1977 through 1979.

TABLE 59 (cont'd)

PRE-OPERATIONAL AND OPERATIONAL GILL NET CATCHES[1] OF SELECTED SPECIES FROM LAKE ERIE IN THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION DISCHARGE (STATION 13)

	GIZZARD SHAD							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
April	0	3	1	1	---	---	1	---
May	0	9	4	4	1	5	3	3
June	4	9	8	3	9	22	16	9
July	7	50	30	15	3	13	8	7
August	40	184	103	63	7	109	58	72
September	3	168	76	68	1	114	55	57
October	24	155	106	71	0	291	103	162
November	1	51	26	26	9	11	10	1
December	---	---	7	---	---	---	---	---
Mean	10	79	40	43	4	81	32	37
	SPOTTAIL SHINER							
April	58	142	97	43	---	---	58	---
May	66	1331	482	574	12	224	118	150
June	0	85	29	39	0	4	2	3
July	0	29	8	12	0	14	7	10
August	2	58	15	24	4	21	13	12
September	0	25	10	11	18	75	44	29
October	31	35	33	2	4	27	15	12
November	0	64	21	29	24	26	25	1
December	---	---	5	---	---	---	---	---
Mean	20	221	78	154	9	56	35	38
	WALLEYE							
April	0	3	1	1	---	---	0	---
May	0	2	1	1	0	1	1	1
June	0	4	2	2	0	1	1	1
July	0	15	3	7	0	4	2	3
August	0	2	1	1	0	8	4	6
September	0	1	1	1	0	1	1	1
October	0	1	0	1	0	0	0	0
November	0	0	0	0	0	0	0	0
December	---	---	0	---	---	---	---	---
Mean	0	4	1	1	0	2	1	1

[1]Results presented as the number of fish per unit effort, where one unit of effort equals a 24-hour bottom set with an experimental gill net 125 ft long consisting of five 25-ft contiguous panels of ½, 3/4, 1, 1½, and 2-inch bow mesh.

[2]Results from samples collected from 1973 through August 1977.

[3]Results from samples collected from September 1977 through 1979.

TABLE 59 (cont'd)

PRE-OPERATIONAL AND OPERATIONAL GILL NET CATCHES[1] OF SELECTED SPECIES FROM LAKE ERIE IN THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION DISCHARGE (STATION 13)

	WHITE BASS							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
April	0	3	1	1	---	---	0	---
May	0	3	1	1	0	2	1	1
June	0	6	3	3	8	43	26	25
July	0	6	3	3	4	25	15	15
August	1	29	9	12	0	7	4	5
September	1	11	5	5	0	2	1	1
October	1	4	2	2	0	6	2	3
November	0	1	0	1	0	1	1	1
December	---	---	0	---	---	---	---	---
Mean	0	8	3	3	2	12	6	9
	YELLOW PERCH							
April	10	119	55	47	---	---	24	---
May	9	109	48	44	9	40	25	22
June	3	95	47	39	2	28	15	18
July	5	125	37	50	35	76	56	29
August	33	100	65	28	43	313	178	191
September	32	160	73	60	43	71	53	15
October	18	158	67	79	7	18	12	6
November	0	28	8	14	6	7	7	1
December	---	---	0	---	---	---	---	---
Mean	14	112	44	26	21	79	46	56

[1]Results presented as the number of fish per unit effort, where one unit of effort equals a 24-hour bottom set with an experimental gill net 125 ft long consisting of five 25-ft contiguous panels of ½, 3/4, 1, 1½, and 2-inch bow mesh.

[2]Results from samples collected from 1973 through August 1977.

[3]Results from samples collected from September 1977 through 1979.

TABLE 60

PRE-OPERATIONAL AND OPERATIONAL GILL NET DATA[1] FROM THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION INTAKE, DISCHARGE, AND FOUR CONTROL STATIONS

	STATION 3							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
April	89	197	143	76	---	---	72	---
May	49	176	113	90	98	319	209	165
June	113	263	188	106	102	239	171	97
July	110	219	165	77	71	222	147	107
August	220	396	308	124	241	267	254	18
September	---	---	312	---	178	481	331	151
October	---	---	---	---	31	178	108	74
November	---	---	43	---	162	197	180	25
December	---	---	---	---	---	---	---	---
Mean	116	250	182	99	126	272	184	82

STATION 8

April	8	52	26	19	---	---	33	---
May	32	2077	676	959	20	134	77	81
June	62	260	154	98	69	196	133	90
July	85	179	122	45	86	262	174	124
August	89	166	135	38	122	208	165	61
September	61	343	203	124	174	221	191	26
October	55	652	257	342	25	93	57	34
November	4	112	49	52	12	35	24	16
December	---	---	19	---	---	---	---	---
Mean	50	480	182	202	73	164	107	67

[1]Results presented as number of fish per unit effort, where one unit of effort equals a 24-hour bottom set with an experimental gill net 125 ft long consisting of five 25-ft contiguous panels of ½, 3/4, 1, 1½, and 2-inch bar mesh.

[2]Results from samples collected from 1973 through August 1977.

[3]Results from samples collected from September 1977 through 1979.

TABLE 60 (continued)

PRE-OPERATIONAL AND OPERATIONAL GILL NET DATA[1] FROM THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION INTAKE, DISCHARGE, AND FOUR CONTROL STATIONS

	STATION 13							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
April	88	269	166	75	---	---	88	---
May	120	1381	573	558	29	270	150	170
June	49	232	125	77	112	122	117	7
July	94	254	163	82	85	138	112	37
August	136	327	237	84	186	387	287	142
September	73	382	270	141	122	366	206	138
October	104	691	337	312	7	433	178	225
November	6	208	76	94	85	93	89	6
December	---	---	14	---	---	---	---	---
Mean	84	468	218	166	89	258	153	68

STATION 26

April	60	191	126	93	---	---	47	---
May	44	48	46	3	34	127	81	66
June	114	238	176	88	101	175	138	52
July	41	171	106	92	118	258	188	99
August	143	293	218	106	345	348	347	2
September	---	---	269	---	41	637	336	298
October	---	---	---	---	54	71	61	9
November	---	---	298	---	28	48	38	14
December	---	---	---	---	---	---	---	---
Mean			177	91	103	238	155	126

[1]Results presented as number of fish per unit effort, where one unit effort equals a 24-hour bottom set with an experimental gill net 125 ft long consisting of five 25-ft contiguous panels of ½, 3/4, 1, 1½, and 2-inch bar mesh.

[2]Results from samples collected from 1973 through August 1977.

[3]Results from samples collected from September 1977 through 1979.

TABLE 60 (continued)

PRE-OPERATIONAL AND OPERATIONAL GILL NET DATA[1] FROM THE VICINITY OF THE DAVIS-BESSE NUCLEAR POWER STATION INTAKE, DISCHARGE, AND FOUR CONTROL STATIONS

	STATION 28							
	Pre-Operational Data[2]				Operational Data[3]			
Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
April	23	46	35	16	---	---	31	---
May	31	36	34	4	24	205	115	128
June	110	214	162	74	97	177	137	57
July	124	138	131	10	198	228	213	21
August	173	220	197	33	252	273	263	15
September	---	---	316	---	146	280	219	68
October	---	---	---	---	83	143	120	33
November	---	---	120	---	30	106	68	54
December	---	---	---	---	---	---	---	---
Mean	92	131	142	98	119	202	146	80

STATION 29

April	38	190	114	107	---	---	58	---
May	77	535	306	324	101	207	154	75
June	146	313	230	118	117	163	140	33
July	148	360	254	150	116	272	194	110
August	227	315	271	62	151	355	253	144
September	---	---	510	---	107	277	205	88
October	---	---	---	---	147	250	215	59
November	---	---	137	---	66	199	133	94
December	---	---	---	---	---	---	---	---
Mean	127	343	260	130	115	246	169	61

[1]Results presented as number of fish per unit effort, where one unit of effort equals a 24-hour bottom set with an experimental gill net 125 ft long consisting of five 25-ft contiguous panels of ½, 3/4, 1, 1½, and 2-inch bar mesh.

[2]Results from samples collected from 1973 through August 1977.

[3]Results from samples collected from September 1977 through 1979.

TABLE 61

ICHTHYOPLANKTON DENSITIES AT LOCUST POINT - 1979*

SPECIES	STATION	May 1					May 9					May 31				
		3	8	13	29	Mean	3	8	13	29	Mean	3	8	13	29	Mean
Carp	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Common Shiner	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Emerald Shiner	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Freshwater Drum	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Gizzard Shad	Stage 1											254.5	74.5	118.4	93.6	135.22
	Stage 2											115.1	11.4	46.7	87.6	65.21
	Stage 3															
	Surface											657.5	166.2	260.0	322.2	351.45
	Bottom											81.6	5.7	70.2	40.2	49.44
	Subtotal**											369.6	85.9	165.1	181.2	200.44
Logperch	Stage 1											0.3		0.5	0.3	0.25
	Stage 2											0.6				0.15
	Stage 3															
	Surface											1.7			0.6	0.57
	Bottom													0.9		0.23
	Subtotal**											0.9		0.5	0.3	0.40
Rainbow Smelt	Stage 1												1.2	2.6		0.94
	Stage 2											4.9	7.5	3.8	2.3	4.62
	Stage 3															
	Surface											8.0	12.3	9.2	3.4	8.26
	Bottom											1.8	4.9	3.7	1.1	2.86
	Subtotal**											4.9	8.6	6.4	2.3	5.56
Unidentified	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Unidentified Shiner	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Unidentified Sunfish	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Walleye	Stage 1															
	Stage 2											0.2		0.7	0.2	0.28
	Stage 3											1.7	0.3	2.1	0.8	1.21
	Surface											1.1			1.5	0.65
	Bottom											2.6	0.6	5.5	0.6	2.34
	Subtotal**											1.9	0.3	2.8	1.0	1.49

TABLE 61 (Con't)

ICHTHYOPLANKTON DENSITIES AT LOCUST POINT - 1979*

SPECIES	STATION	May 1					May 9					May 31				
		3	8	13	29	Mean	3	8	13	29	Mean	3	8	13	29	Mean
White Bass	Stage 1											0.8	0.3	4.4		1.37
	Stage 2											2.3	0.5	2.6	1.3	1.69
	Stage 3															
	Surface											5.0	1.2	11.2	1.5	4.70
	Bottom											1.3	0.5	2.8	1.1	1.42
	Subtotal**											3.2	0.8	7.0	1.3	3.06
Yellow Perch	Stage 1	0.2				0.05	0.5	0.4			0.24	9.5	6.0	18.4	20.8	13.65
	Stage 2											29.5	22.5	62.3	64.7	44.75
	Stage 3											4.1	8.3	14.9	3.6	7.73
	Surface	0.4				0.09		0.9			0.22	52.1	36.2	65.3	106.7	65.08
	Bottom						1.1				0.27	34.2	37.2	125.8	71.5	67.19
	Subtotal**	0.2				0.05	0.5	0.4			0.24	43.2	36.7	95.5	89.1	66.13
Fish Egg	Surface		1.0		0.4	0.36	0.5				0.13					
	Bottom				0.5	0.12										
	Subtotal**		0.5		0.5	0.24	0.3				0.07					
Freshwater Drum Egg	Surface															
	Bottom															
	Subtotal**															
Total Ichthyoplankton	Stage 1	0.2				0.05	0.5	0.4			0.24	265.1	81.9	144.1	114.7	151.44
	Stage 2											152.7	41.9	116.2	156.1	116.72
	Stage 3											5.8	8.6	17.0	4.4	8.93
	Eggs		0.5		0.5	0.24	0.3				0.07					
	Surface	0.4	1.0		0.4	0.46	0.5	0.9			0.36	725.4	215.9	345.7	435.9	430.70
	Bottom				0.5	0.12	1.1				0.27	121.6	48.9	208.8	114.6	123.48
	Subtotal**	0.2	0.5		0.5	0.29	0.8	0.4			0.31	423.5	132.4	277.2	275.2	277.09

*Data presented as no./100m^3. Stage 1 = proto-larvae, no rays in fin/finfold. Stage 2 = meso-larvae, first ray seen in median fins. Stage 3 = meta-larvae, pelvic fin bud is visible. Sampling at stations 26 and 28 was inadvertently omitted in 1979.

**This is the subtotal of the larval stages. It is the mean of the surface and bottom densities.

TABLE 61(Con't)

ICHTHYOPLANKTON DENSITIES AT LOCUST POINT - 1979*

SPECIES	STATION	June 5					June 21					July 5				
		3	8	13	29	Mean	3	8	13	29	Mean	3	8	13	29	Mean
Carp	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Common Shiner	Stage 1						0.1		0.1		0.03			0.1		0.04
	Stage 2															
	Stage 3															
	Surface						0.1		0.1		0.06			0.3		0.07
	Bottom															
	Subtotal**						0.1		0.1		0.03			0.1		0.04
Emerald Shiner	Stage 1						5.4	1.8	7.6	5.4	5.04	0.2	11.4	2.2	1.4	3.79
	Stage 2						1.3	2.2	1.8	0.6	1.49		3.5	1.1	1.5	1.53
	Stage 3											1.7	2.5	3.4	1.7	2.32
	Surface						12.7	6.4	17.0	10.3	11.61	2.9	23.9	11.1	8.0	11.48
	Bottom						0.6	1.5	1.8	1.8	1.43	0.9	10.9	2.3	1.2	3.81
	Subtotal**						6.7	4.0	9.4	6.0	6.52	1.9	17.4	6.7	4.6	7.64
Freshwater Drum	Stage 1						0.3	0.3	0.8	0.6	0.49			0.1		0.04
	Stage 2													0.6		0.15
	Stage 3															
	Surface								0.6		0.25					
	Bottom						0.6	0.6	1.0	0.7	0.72			1.4		0.36
	Subtotal**						0.3	0.3	0.8	0.6	0.49			0.7		0.18
Gizzard Shad	Stage 1	103.9	90.5	290.4	195.1	169.99	78.5	22.2	61.8	14.4	44.20	66.8	20.9	45.8	45.4	44.71
	Stage 2	11.6	6.6	12.4	16.5	11.77	10.6	3.5	9.1	7.0	7.54	4.8	1.7	7.0	7.5	5.25
	Stage 3						0.1	0.1	0.9	0.9	0.48	0.5	0.5	0.6	3.2	1.19
	Surface	30.9	158.1	84.4	126.0	99.85	16.3	7.1	30.8	3.7	14.47	24.2	34.4	45.9	96.7	50.28
	Bottom	200.1	36.1	521.3	297.2	263.67	161.8	44.5	112.8	40.8	89.98	120.0	11.8	60.7	15.6	52.03
	Subtotal**	115.5	97.1	302.8	211.6	181.76	89.1	25.8	71.8	22.3	52.23	72.1	23.1	53.3	56.1	51.16
Logperch	Stage 1	0.4	0.8	0.9	0.4	0.61										
	Stage 2		0.4			0.10			0.1		0.02					
	Stage 3															
	Surface				0.8	0.20										
	Bottom	0.7	2.4	1.8		1.22			0.2		0.04					
	Subtotal**	0.4	1.2	0.9	0.4	0.71			0.1		0.02					
Rainbow Smelt	Stage 1		8.0	0.3	0.4	2.20				0.1	0.02					
	Stage 2		0.7			0.17	0.1				0.03					
	Stage 3														0.2	0.04
	Surface		5.5	0.7		1.53	0.1				0.03					
	Bottom		12.0		0.9	3.22	0.1			0.1	0.07				0.3	0.08
	Subtotal**		8.7	0.3	0.4	2.37	0.1			0.1	0.05				0.2	0.04
Unidentified	Stage 1															
	Stage 2												0.2			0.05
	Stage 3															
	Surface												0.4			0.09
	Bottom															
	Subtotal**												0.2			0.05
Unidentified Shiner	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Unidentified Sunfish	Stage 1						0.1				0.02					
	Stage 2															
	Stage 3															
	Surface															
	Bottom						0.2				0.04					
	Subtotal**						0.1				0.02					
Walleye	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															

TABLE 61 (Con't)

ICHTHYOPLANKTON DENSITIES AT LOCUST POINT - 1979*

SPECIES	STATION	June 5					June 21					July 5				
		3	8	13	29	Mean	3	8	13	29	Mean	3	8	13	29	Mean
White Bass	Stage 1			0.4		0.11	0.1		0.1		0.03					
	Stage 2						0.2			0.1	0.08	0.2		0.3	0.2	0.17
	Stage 3														0.2	0.04
	Surface						0.1				0.03					
	Bottom			0.8		0.21	0.5		0.2	0.1	0.19	0.5		0.6	0.7	0.43
	Subtotal**			0.4		0.11	0.3		0.1	0.1	0.11	0.2		0.3	0.3	0.21
Yellow Perch	Stage 1	3.3	3.6	8.9	5.6	5.35										
	Stage 2	1.0	1.6	0.5	3.6	1.68										
	Stage 3	0.3	0.8	1.6	1.6	1.08										
	Surface	3.3	3.3	6.2	6.5	4.80										
	Bottom	5.9	8.6	15.9	15.2	11.40										
	Subtotal**	4.6	5.9	11.0	10.8	8.10										
Fish Egg	Surface			1.6		0.40										
	Bottom	79.3	2.1			20.35										
	Subtotal**	39.6	1.1	0.8		10.37										
Freshwater Drum Egg	Surface								0.5	0.4	0.24					
	Bottom						0.3				0.07					
	Subtotal**						0.1		0.3	0.2	0.15					
Total Ichthyoplankton	Stage 1	107.5	102.9	301.0	201.6	178.25	84.3	24.2	70.3	20.5	49.83	66.9	32.3	48.2	46.8	48.57
	Stage 2	12.6	9.3	12.9	20.1	13.72	12.2	5.8	11.0	7.7	9.15	5.1	5.4	9.0	9.2	7.15
	Stage 3	0.3	0.8	1.6	1.6	1.08	0.1	0.1	0.9	0.9	0.48	2.2	3.0	4.0	5.2	3.60
	Eggs	39.6	1.1	0.8		10.37	0.1		0.3	0.2	0.15					
	Surface	34.2	166.8	92.8	133.3	106.79	29.4	13.5	49.0	14.8	26.69	27.0	58.7	57.3	104.6	61.92
	Bottom	286.0	61.2	539.8	313.3	300.06	164.0	46.5	116.0	43.6	92.54	121.4	22.7	65.0	17.7	56.71
	Subtotal**	160.1	114.0	316.3	223.3	203.42	96.7	30.0	82.5	29.2	59.62	74.2	40.7	61.2	61.2	59.32

*Data presented as no./100m^3. Stage 1 = proto-larvae, no rays in fin/finfold. Stage 2 = meso-larvae, first ray seen in median fins. Stage 3 = meta-larvae, pelvic fin bud is visible. Sampling at stations 26 and 28 was inadvertently omitted in 1979.

**This is the subtotal of the larval stages. It is the mean of the surface and bottom densities.

TABLE 61(Con't)

ICHTHYOPLANKTON DENSITIES AT LOCUST POINT - 1979*

SPECIES	STATION	July 12					July 20					August 3				
		3	8	13	29	Mean	3	8	13	29	Mean	3	8	13	29	Mean
Carp	Stage 1	1.5		0.5		0.48										
	Stage 2															
	Stage 3															
	Surface	1.2		0.3		0.37										
	Bottom	1.7		0.7		0.59										
	Subtotal**	1.5		0.5		0.48										
Common Shiner	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Emerald Shiner	Stage 1	0.3		0.3	0.3	0.23	0.1				0.03					
	Stage 2	0.2	0.4	0.1	1.8	0.64	0.1	0.1		0.2	0.13					
	Stage 3		0.3		2.3	0.65	0.9	0.7	0.1		0.43					
	Surface	0.9	1.1	0.6	4.8	1.83	1.9	1.0	0.2	0.5	0.91					
	Bottom		0.3	0.3	4.2	1.21	0.4	0.7			0.26					
	Subtotal**	0.5	0.7	0.4	4.5	1.52	1.1	0.8	0.1	0.2	0.58					
Freshwater Drum	Stage 1	1.1	0.2	2.0	0.1	0.83										
	Stage 2	0.9		0.1		0.27										
	Stage 3	1.0				0.24										
	Surface	0.6		1.7		0.58										
	Bottom	5.3	0.3	2.5	0.2	2.09										
	Subtotal**	3.0	0.2	2.1	0.1	1.34										
Gizzard Shad	Stage 1	17.4	33.2	5.4	11.1	16.79	29.4	6.6	62.0	19.9	29.50					
	Stage 2	7.3	6.0	1.9	17.5	8.19	2.7	0.2	9.7	3.7	4.06					
	Stage 3	5.6	0.2	1.5	0.6	1.99	0.6			0.1	0.17				0.2	0.06
	Surface	49.2	59.2	11.3	46.5	41.52	9.4		51.1	9.2	17.42				0.5	0.11
	Bottom	11.4	19.7	6.5	12.0	12.39	55.9	13.7	92.3	38.3	50.04					
	Subtotal**	30.3	39.4	8.9	29.2	26.96	32.6	6.8	71.7	23.7	33.73				0.2	0.06
Logperch	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Rainbow Smelt	Stage 1														0.9	0.22
	Stage 2												0.5	0.5		0.24
	Stage 3															
	Surface												0.5			0.12
	Bottom												0.6	0.9	1.8	0.81
	Subtotal**												0.5	0.5	0.9	0.47
Unidentified	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Unidentified Shiner	Stage 1															
	Stage 2															
	Stage 3	0.2				0.04										
	Surface															
	Bottom	0.3				0.08										
	Subtotal**	0.2				0.04										
Unidentified Sunfish	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															
Walleye	Stage 1															
	Stage 2															
	Stage 3															
	Surface															
	Bottom															
	Subtotal**															

TABLE 61(Con't)

ICHTHYOPLANKTON DENSITIES AT LOCUST POINT - 1979*

SPECIES	STATION	July 12					July 20					August 3				
		3	8	13	29	Mean	3	8	13	29	Mean	3	8	13	29	Mean
White Bass	Stage 1															
	Stage 2															
	Stage 3	1.2			0.1	0.32										
	Surface	1.5				0.37										
	Bottom	0.9			0.2	0.28										
	Subtotal**	1.2			0.1	0.32										
Yellow Perch	Stage 1															
	Stage 2												0.3			0.06
	Stage 3															
	Surface															
	Bottom												0.5			0.13
	Subtotal**												0.3			0.06
Fish Egg	Surface															
	Bottom															
	Subtotal**															
Freshwater Drum Egg	Surface			5.8		1.45										
	Bottom	7.8	0.9	1.3	0.9	2.73										
	Subtotal**	3.9	0.4	3.5	0.5	2.09										
Total Ichthyoplankton	Stage 1	20.2	33.4	8.1	11.6	18.32	29.5	6.6	62.0	19.9	29.52				0.9	0.22
	Stage 2	8.4	6.4	2.2	19.3	9.09	2.8	0.3	9.7	3.9	4.19		0.8	0.5		0.31
	Stage 3	7.9	0.5	1.5	3.1	3.24	1.5	0.7	0.1	0.1	0.60				0.2	0.06
	Eggs	3.9	0.4	3.5	0.5	2.09										
	Surface	53.4	60.3	19.6	51.2	46.12	11.3	1.0	51.3	9.6	18.33		0.5		0.5	0.23
	Bottom	27.4	21.2	11.2	17.6	19.37	56.2	14.3	92.3	38.3	50.29		1.1	0.9	1.8	0.94
	Subtotal**	40.4	40.8	15.4	34.4	32.74	33.8	7.7	71.8	24.0	34.31		0.8	0.5	1.1	0.59

*Data presented as no./100m^3. Stage 1 = proto-larvae, no rays in fin/finfold. Stage 2 = meso-larvae, first ray seen in median fins. Stage 3 = meta-larvae, pelvic fin bud is visible. Sampling at stations 26 and 28 was inadvertently omitted in 1979.

**This is the subtotal of the larval stages. It is the mean of the surface and bottom densities.

TABLE 61(Con't)

ICHTHYOPLANKTON DENSITIES AT LOCUST POINT - 1979*

SPECIES	STATION	August 15					Mean									
		3	8	13	29	Mean	3	8	13	29	Mean	3	8	13	29	Mean
White Bass	Stage 1						0.09	0.03	0.49		0.15					
	Stage 2						0.28	0.05	0.29	0.15	0.19					
	Stage 3						0.12			0.03	0.04					
	Surface						0.66	0.12	1.12	0.15	0.51					
	Bottom						0.32	0.05	0.43	0.22	0.25					
	Subtotal**						0.49	0.08	0.77	0.18	0.38					
Yellow Perch	Stage 1						1.35	1.00	2.73	2.64	1.93					
	Stage 2						3.06	2.43	6.28	6.84	4.65					
	Stage 3						0.44	0.91	1.65	0.52	0.88					
	Surface						5.58	4.03	7.14	11.32	7.02					
	Bottom						4.12	4.63	14.16	8.68	7.90					
	Subtotal**						4.85	4.33	10.65	10.00	7.46					
Fish Egg	Surface						0.05	0.10	0.16	0.04	0.09					
	Bottom						7.93	0.21		0.05	2.05					
	Subtotal**						3.99	0.16	0.08	0.05	1.07					
Freshwater Drum Egg	Surface								0.63	0.04	0.17					
	Bottom						0.81	0.09	0.13	0.09	0.28					
	Subtotal**						0.40	0.04	0.38	0.07	0.22					
Total Ichthyoplankton	Stage 1						57.43	28.18	63.38	41.59	47.64					
	Stage 2			0.1		0.03	19.38	6.98	16.15	21.63	16.04					
	Stage 3		0.1	0.3	0.5	0.22	1.77	1.38	2.53	1.60	1.82					
	Eggs						4.39	0.20	0.46	0.11	1.29					
	Surface		0.3	0.8	0.7	0.44	88.18	51.88	61.65	75.11	69.20					
	Bottom				0.2	0.06	77.78	21.60	103.40	54.76	64.38					
	Subtotal**		0.1	0.4	0.5	0.25	82.98	36.74	82.52	64.93	66.79					

*Data presented as no./100m^3. Stage 1 = proto-larvae, no rays in fin/finfold. Stage 2 = meso-larvae, first ray seen in median fins. Stage 3 = meta-larvae, pelvic fin bud is visible. Sampling at stations 26 and 28 was inadvertently omitted in 1979.

**This is the subtotal of the larval stages. It is the mean of the surface and bottom densities.

TABLE 62

RESULTS OF ICHTHYOPLANKTON COLLECTIONS
AT TOUSSAINT REEF - 1979*

SPECIES	DATE	May 1	May 9	May 31	July 5	July 12	July 20	Aug. 3	Aug. 15	MEAN
Emerald Shiner	Stage 1				261.5	3.6				33.13
	Stage 2				16.5	9.0	0.6	0.3		3.30
	Stage 3				6.3	0.8	0.5	0.3	0.1	1.00
	Surface				550.4	25.8	1.9	1.0	0.3	72.42
	Bottom				18.2	1.0	0.3			2.44
	Subtotal**				284.3	13.4	1.1	0.6	0.1	37.43
Freshwater Drum	Stage 1				0.2		0.1			0.04
	Stage 2									
	Stage 3									
	Surface						0.3			0.03
	Bottom				0.3					0.04
	Subtotal**				0.2		0.1			0.04
Gizzard Shad	Stage 1			28.3	0.3	3.5	4.4			4.56
	Stage 2			3.1	1.3	0.5	0.7			0.71
	Stage 3				0.5		0.3			0.10
	Surface			38.3	3.3	0.5	3.9			5.75
	Bottom			24.5	1.0	7.4	7.1			5.00
	Subtotal**			31.4	2.1	4.0	5.4			5.37
Rainbow Smelt	Stage 1			0.5						0.06
	Stage 2			0.2						0.03
	Stage 3									
	Surface			1.0						0.05
	Bottom			0.4						0.13
	Subtotal**			0.7						0.09
Unidentified Percid	Stage 1		0.2							0.03
	Stage 2									
	Stage 3									
	Surface									
	Bottom		0.5							0.06
	Subtotal**		0.2							0.03
Walleye	Stage 1		1.8							0.22
	Stage 2									
	Stage 3									
	Surface		0.8							0.11
	Bottom		2.7							0.33
	Subtotal**		1.8							0.22
Yellow Perch	Stage 1		0.8	21.6						2.79
	Stage 2			27.9						3.48
	Stage 3			3.7						0.46
	Surface			55.3						6.91
	Bottom		1.5	51.0						6.57
	Subtotal**		0.8	53.2						6.74
Eggs	Surface	1.6								0.28
	Bottom	2.3								0.20
	Subtotal**	1.9								0.24
Drum Eggs	Surface					21.2				2.65
	Bottom					3.0				0.38
	Subtotal**					12.1				1.51
TOTAL	Stage 1		2.8	50.4	262.0	7.0	4.5			40.83
	Stage 2			31.2	17.8	9.6	1.3	0.3		7.52
	Stage 3			3.7	6.8	0.8	0.8	0.3	0.1	1.56
	Eggs	1.9				12.1				1.75
	Surface	2.3	0.8	94.0	553.6	47.5	6.0	1.0	0.3	88.20
	Bottom	1.6	4.7	76.5	19.5	11.5	7.4			15.14
	Subtotal**	1.9	2.8	85.3	286.6	29.5	6.6	0.6	0.1	51.67

*Data presented as no./100m^3. Stage 1 = proto-larvae, no rays in fin/finfold. Stage 2 = meso-larvae, first ray seen in median fins. Stage 3 = meta-larvae, pelvic fin bud is visible.

**This is the subtotal of the larval stages. It is the mean of the surface and bottom densities.

TABLE 63

LAKE ERIE WATER QUALITY ANALYSES FOR APRIL 1979

Dates:
Field 5-1-79
Laboratory 5-2-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (°C)	10.5	10.0	11.0	10.0	11.5	10.5	10.0-11.5	10.6	0.6
Dissolved Oxygen (ppm)	9.0	9.5	10.0	9.5	9.5	9.5	9.0-10.0	9.5	0.3
Conductivity (umhos/cm)	450	450	400	410	420	435	400-450	428	21
Transparency (m)	0.35		0.40		0.35		0.35-0.40	0.37	0.03
Depth (m)		2.0		4.0		3.0	2.0-4.0	3.0	1.0
Solar radiation (ft-candles)	3500	0.02	1200	0.01	5000	0.01	0.01-5000	1617	2145
Laboratory Determinations:									
Calcium (mg/l)	50.8	50.8	48.4	46.4	48.0	50.0	46.4-50.8	49.1	1.8
Magnesium (mg/l)	14.9	15.1	12.0	13.4	14.4	13.4	12.0-15.1	13.9	1.2
Sodium (mg/l)	13.5	14.4	12.7	13.2	13.0	14.4	12.7-14.4	13.5	0.7
Chloride (mg/l)	30.5	30.3	25.5	26.0	27.0	27.3	25.5-30.5	27.8	2.1
Nitrate (mg/l)	5.5	5.9	4.4	5.4	6.2	6.4	4.4-6.4	5.6	0.7
Sulfate (mg/l)	46.0	46.0	44.0	44.0	46.0	46.0	44.0-46.0	45.3	1.0
Phosphorus (mg/l)	0.01	0.20	0.01	0.02	0.02	0.02	0.01-0.20	0.05	0.08
Silica (mg/l)	1.59	1.42	0.71	0.83	1.18	1.29	0.83-1.59	1.17	0.34
Total Alkalinity (mg/l)	107	109	103	104	109	107	103-109	107	2.5
B.O.D. (mg/l)	4	6	3	4	4	4	3-6	4	1.0
Suspended Solids (mg/l)	70	140	31	50	74	59	31-140	71	37
Dissolved Solids (mg/l)	168	164	145	140	146	150	140-168	152	11
Turbidity (F.T.U.)	78	84	37	67	72	75	37-84	69	17
pH	8.2	8.1	8.1	8.1	8.1	8.1	8.1-8.2	8.1	0.04
Conductivity (umhos/cm)	450	465	410	420	440	440	410-465	438	20

TABLE 64

LAKE ERIE WATER QUALITY ANALYSES FOR MAY 1979

Dates:
Field 5-24-79
Laboratory 5-25-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (°C)	18.0	17.9	18.1	17.8	18.2	18.0	17.8-18.2	18.0	0.1
Dissolved Oxygen (ppm)	9.4	9.2	9.3	9.2	9.0	9.0	9.0-9.4	9.2	0.2
Conductivity (umhos/cm)	280	285	290	290	280	285	280-290	285	4
Transparency (m)	0.45		0.40		0.40		0.40-0.45	0.42	0.03
Depth (m)		2.1		3.8		3.0	2.1-3.8	2.9	0.9
Solar radiation (ft-candles)	2400	71	1100	0.17	5000	0.01	0.01-5000	1429	1987
Laboratory Determinations:									
Calcium (mg/l)	36.4	36.8	36.0	36.0	36.0	36.0	36.0-36.8	36.2	0.3
Magnesium (mg/l)	8.4	8.2	8.2	8.2	8.9	8.6	8.2-8.9	8.4	0.3
Sodium (mg/l)	8.4	8.4	8.9	8.6	8.9	8.9	8.4-8.9	8.7	0.2
Chloride (mg/l)	18.8	17.8	20.0	20.0	19.8	17.8	17.8-20.0	19.0	1.1
Nitrate (mg/l)	1.4	1.4	1.6	1.7	1.7	1.7	1.4-1.7	1.6	0.2
Sulfate (mg/l)	22.5	22.5	22.5	22.5	22.5	22.5	[illegible]	22.5	0.0
Phosphorus (mg/l)	0.05	0.06	0.07	0.07	0.07	0.08	0.05-0.08	0.07	0.01
Silica (mg/l)	0.09	0.11	0.11	0.07	0.13	0.07	0.07-0.13	0.10	0.02
Total Alkalinity (mg/l)	94	93	94	89	90	92	89-94	92	2
B.O.D. (mg/l)	3	4	3	4	3	3	3-4	3	0.5
Suspended Solids (mg/l)	85	84	83	86	88	89	83-89	86	2
Dissolved Solids (mg/l)	232	226	238	236	232	224	224-238	231	5
Turbidity (F.T.U.)	62	65	41	55	68	75	41-75	61	12
pH	7.9	7.9	7.8	7.7	7.7	7.5	7.5-7.9	7.8	0.2
Conductivity (umhos/cm)	300	295	295	295	295	285	285-300	294	5

TABLE 65

LAKE ERIE WATER QUALITY ANALYSES FOR JUNE 1979

Dates:
Field 6-21-79
Laboratory 6-22-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (°C)	21.0	21.0	21.5	21.0	22.5	21.5	21.0-22.5	21.4	0.6
Dissolved Oxygen (ppm)	9.1	9.1	9.1	8.8	9.3	8.5	8.5-9.3	9.0	0.3
Conductivity (umhos/cm)	300	310	300	300	305	300	300-310	302	4
Transparency (m)	0.40		0.45		0.40		0.40-0.45	0.42	0.03
Depth (m)		2.0		4.0		2.8	2.0-4.0	2.9	1.0
Solar radiation (ft-candles)	1500	90	3200	0.02	2000	0.1	0.02-3200	1132	1328
Laboratory Determinations:									
Calcium (mg/l)	37.6	37.6	36.8	37.2	37.2	37.6	36.8-37.6	37.3	0.3
Magnesium (mg/l)	9.1	9.4	9.4	9.6	10.1	9.8	9.1-10.1	9.6	0.4
Sodium (mg/l)	9.2	9.2	9.2	9.2	7.6	7.6	7.6-9.2	8.7	0.8
Chloride (mg/l)	15.0	15.2	15.2	15.2	15.2	15.5	15.0-15.5	15.2	0.2
Nitrate (mg/l)	6.1	6.1	5.3	7.3	0.9	7.7	0.9-7.7	5.6	2.4
Sulfate (mg/l)	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	0.0
Phosphorus (mg/l)	0.14	0.09	0.03	0.02	0.06	0.03	0.02-0.14	0.06	0.05
Silica (mg/l)	0.22	0.25	0.29	0.28	0.18	0.22	0.18-0.29	0.24	0.04
Total Alkalinity (mg/l)	100	99	98	100	100	100	98-100	99	0.8
B.O.D. (mg/l)	6	6	3	4	6	5	3-6	5	1
Suspended Solids (mg/l)	65	65	44	43	58	56	43-65	55	10
Dissolved Solids (mg/l)	166	168	160	164	168	174	160-174	167	5
Turbidity (F.T.U.)	62	65	41	40	47	49	40-65	51	11
pH	8.5	8.7	8.5	8.3	8.6	8.5	8.3-8.7	8.5	0.1
Conductivity (umhos/cm)	310	300	300	305	310	310	300-310	306	5

TABLE 66

LAKE ERIE WATER QUALITY ANALYSES FOR JULY 1979

Dates:
Field 7-31-79
Laboratory 8-2-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (°C)	25.0	24.5	25.0	24.0	25.0	25.0	24.0-25.0	24.8	0.4
Dissolved Oxygen (ppm)	7.9	6.6	8.6	7.6	8.8	8.8	6.6-8.8	8.1	0.9
Conductivity (umhos/cm)	275	280	265	275	280	275	265-280	275	5
Transparency (m)	0.80		0.85		0.85		0.80-0.85	0.83	0.03
Depth (m)		1.5		4.3		3.2	1.5-4.3	3.0	1.4
Solar radiation (ft-candles)	1900	150	1300	10	4200	20	10-4200	1263	1636
Laboratory Determinations:									
Calcium (mg/l)	32.0	37.2	37.2	36.0	33.2	33.6	32.0-37.2	34.9	2.2
Magnesium (mg/l)	13.9	10.1	10.3	9.6	12.0	12.2	9.6-13.9	11.4	1.6
Sodium (mg/l)	8.0	7.6	7.6	8.0	8.0	8.0	7.6-8.0	7.9	0.2
Chloride (mg/l)	15.0	12.5	13.0	12.5	12.5	12.5	12.5-15.0	13.0	1.0
Nitrate (mg/l)	10.7	6.8	8.5	7.7	8.9	9.3	6.8-10.7	8.7	1.3
Sulfate (mg/l)	30.0	28.0	28.0	28.0	28.0	28.0	28.0-30.0	28.3	0.8
Phosphorus (mg/l)	0.12	0.11	0.11	0.12	0.11	0.12	0.11-0.12	0.12	0.01
Silica (mg/l)	1.03	0.57	0.65	0.45	0.48	0.65	0.45-1.03	0.64	0.21
Total Alkalinity (mg/l)	93	96	97	955	94	95	93-97	95	1.4
B.O.D. (mg/l)	1	3	2	2	2	3	1-3	2.5	1
Suspended Solids (mg/l)	46	12	14	10	24	16	10-46	20	13
Dissolved Solids (mg/l)	228	240	196	174	182	182	174-240	200	27
Turbidity (F.T.U.)	70	54	57	52	35	34	34-70	50	14
pH	8.0	8.2	8.1	8.4	8.5	8.5	8.0-8.5	8.3	0.2
Conductivity (umhos/cm)	230	240	240	230	230	235	230-240	234	5

TABLE 67

LAKE ERIE WATER QUALITY ANALYSES FOR AUGUST 1979

Dates:
Field 8-29-79
Laboratory 8-30-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (°C)	21.0	21.0	22.0	21.5	22.0	21.5	21.0-22.0	21.5	0.5
Dissolved Oxygen (ppm)	7.8	7.9	8.5	8.3	8.1	8.1	7.8-8.5	8.1	0.3
Conductivity (umhos/cm)	245	250	250	250	260	260	245-260	253	6
Transparency (m)	0.50		0.50		0.45		0.45-0.50	0.48	0.03
Depth (m)		1.0		4.0		2.3	1.0-4.0	2.4	1.5
Solar radiation (ft-candles)	2700	1200	2100	16	3000	29	16-3000	513	1077
Laboratory Determinations:									
Calcium (mg/l)	33.2	32.8	32.8	32.0	33.2	33.2	32.0-33.2	32.9	0.5
Magnesium (mg/l)	7.4	7.4	7.2	7.7	8.4	8.4	7.2-8.4	7.8	0.5
Sodium (mg/l)	7.5	7.5	7.5	7.5	7.3	8.3	7.3-8.3	7.6	0.4
Chloride (mg/l)	11.0	11.0	10.8	10.8	12.3	12.3	10.8-12.3	11.4	0.7
Nitrate (mg/l)	2.0	2.7	2.7	2.7	3.1	3.1	2.0-3.1	2.7	0.4
Sulfate (mg/l)	28.5	28.5	28.0	28.0	28.0	28.5	28.0-28.5	28.3	0.3
Phosphorus (mg/l)	0.03	0.04	0.02	0.02	0.02	0.02	0.02-0.04	0.03	0.01
Silica (mg/l)	0.11	0.16	0.04	0.04	0.13	0.02	0.02-0.16	0.08	0.06
Total Alkalinity (mg/l)	97	96	91	96	93	93	91-97	94	2
B.O.D. (mg/l)	2	2	2	2	2	3	2-3	2.3	0.5
Suspended Solids (mg/l)	15	18	20	18	25	22	15-25	20	3
Dissolved Solids (mg/l)	174	184	184	184	198	194	174-198	186	9
Turbidity (F.T.U.)	13	13	14	13	18	16	13-18	14.5	2
pH	8.7	8.7	8.8	8.7	8.6	8.7	8.6-8.8	8.7	0.1
Conductivity (umhos/cm)	260	260	260	225	270	270	225-270	258	17

TABLE 68

LAKE ERIE WATER QUALITY ANALYSES FOR SEPTEMBER 1979

Dates:
Field 9-27-79
Laboratory 9-28-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (°C)	18.0	18.0	18.5	18.0	18.5	18.5	18.0-18.5	18.3	0.3
Dissolved Oxygen (ppm)	9.1	9.0	9.0	9.0	9.3	9.0	9.0-9.3	9.1	0.1
Conductivity (umhos/cm)	283	282	284	284	285	284	282-285	284	1
Transparency (m)	1.00		1.15		1.15		1.00-1.15	1.10	0.09
Depth (m)		1.0		3.3	[illegible]	2.2	1.0-3.3	2.2	1.2
Solar radiation (ft-candles)	4400	2500	3200	10	2900	40	10-4400	2175	1782
Laboratory Determinations:									
Calcium (mg/l)	32.4	32.8	33.6	33.2	33.2	33.2	32.4-33.6	33.1	0.4
Magnesium (mg/l)	9.1	8.9	9.4	10.1	9.8	9.8	8.9-10.1	9.5	0.5
Sodium (mg/l)	8.0	8.0	8.0	8.0	8.0	8.0	-	8.0	0.0
Chloride (mg/l)	13.8	13.5	14.0	13.5	14.5	14.0	13.5-14.5	13.9	0.4
Nitrate (mg/l)	2.40	3.06	2.00	2.40	3.40	1.70	1.70-3.40	2.5	0.6
Sulfate (mg/l)	28.0	28.0	28.0	28.0	28.0	28.0	-	28.0	0.0
Phosphorus (mg/l)	0.04	0.01	0.02	0.01	0.01	0.02	0.01-0.04	0.02	0.01
Silica (mg/l)	0.04	0.04	0.09	0.09	0.07	0.07	0.04-0.09	0.73	1.60
Total Alkalinity (mg/l)	90	91	89	90	90	91	89-91	90	1
B.O.D. (mg/l)	4	4	3	3	3	3	3-4	3.3	0.5
Suspended Solids (mg/l)	14	15	11	11	8	12	8-15	12	2
Dissolved Solids (mg/l)	194	176	188	178	188	176	176-194	183	8
Turbidity (F.T.U.)	10	12	10	10	10	11	10-12	10.5	0.8
pH	8.8	8.9	8.9	8.8	8.9	8.9	8.8-8.9	8.9	0.05
Conductivity (umhos/cm)	270	280	250	250	270	260	250-280	263	12

TABLE 69

LAKE ERIE WATER QUALITY ANALYSES FOR OCTOBER 1979

Dates:
Field 10-30-79
Laboratory 11-1-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (°C)	8.0	8.0	8.0	8.0	8.0	8.5	8.0-8.5	8.1	0.2
Dissolved Oxygen (ppm)	11.3	11.4	10.2	9.5	10.3	10.4	9.5-11.4	10.5	0.7
Conductivity (umhos/cm)	320	315	350	350	330	335	315-350	333	15
Transparency (m)	0.45		0.45		0.50		0.45-0.50	0.47	0.03
Depth (m)		1.0		3.5		2.8	1.0-3.5	2.4	1.3
Solar radiation (ft-candles)	2200	130	1600	0.01	1700	0.02	0.01-2200	938	1002
Laboratory Determinations:									
Calcium (mg/l)	36.8	36.4	36.4	36.8	36.0	36.0	36.0-36.8	36.4	0.4
Magnesium (mg/l)	9.8	10.3	11.0	10.3	10.6	10.1	9.8-11.0	10.4	0.4
Sodium (mg/l)	13.5	13.5	13.5	13.5	13.5	13.5	-	13.5	0.0
Chloride (mg/l)	21.0	21.0	22.0	22.0	21.0	21.0	21.0-22.0	21.0	0.5
Nitrate (mg/l)	0.9	0.6	0.9	1.0	0.8	1.4	0.6-1.4	2.3	3.3
Sulfate (mg/l)	35.5	36.0	35.5	35.5	35.3	35.3	35.3-36.0	35.5	0.3
Phosphorus (mg/l)	0.11	0.13	0.08	0.11	0.06	0.08	0.06-0.13	0.10	0.03
Silica (mg/l)	0.18	0.04	0.04	0.04	0.04	0.07	0.04-0.18	0.07	0.06
Total Alkalinity (mg/l)	101	100	104	102	100	100	100-104	101	2
B.O.D. (mg/l)	2	2	3	2	3	3	2-3	2.5	0.5
Suspended Solids (mg/l)	42	28	15	25	41	79	15-79	38	22
Dissolved Solids (mg/l)	190	186	192	190	180	178	178-192	186	6
Turbidity (F.T.U.)	53	52	38	32	43	42	32-52	43	8
pH	8.6	8.6	8.7	8.8	8.5	8.6	8.5-8.7	8.6	0.1
Conductivity (umhos/cm)	325	322	330	332	320	322	320-332	325	5

TABLE 70

LAKE ERIE WATER QUALITY ANALYSES FOR NOVEMBER 1979

Dates:
Field 11-28-79
Laboratory 11-30-79

Parameters	Station No. 1		Station No. 8		Station No. 13		Range	Mean	Standard Deviation
	Surface	Bottom	Surface	Bottom	Surface	Bottom			
Field Measurements:									
Temperature (^{o}C)	6.0	6.0	6.5	6.5	6.5	6.5	6.0-6.5	6.3	0.3
Dissolved Oxygen (ppm)	12.7	12.6	12.2	12.2	12.3	12.1	12.1-12.7	12.4	0.2
Conductivity (umhos/cm)	260	255	245	245	245	250	245-260	250	6
Transparency (m)	0.30		0.35		0.35		0.30-0.35	0.33	0.03
Depth (m)		1.0		3.5		2.5	1.0-3.5	2.3	1.3
Solar radiation (ft-candles)	100	12	800	0.0	100	0.85	0.0-800	169	313
Laboratory Determinations:									
Calcium (mg/l)	42.0	42.0	37.6	37.6	37.6	36.8	36.8-42.0	38.9	2.4
Magnesium (mg/l)	10.8	11.3	11.0	9.4	9.6	10.8	9.4-11.3	10.5	0.8
Sodium (mg/l)	8.9	8.4	8.0	8.0	9.2	8.0	8.0-9.2	8.4	0.5
Chloride (mg/l)	22.8	22.3	18.5	17.5	18.0	18.3	17.5-22.8	19.6	2.3
Nitrate (mg/l)	8.5	6.5	4.5	6.8	7.7	7.3	4.5-8.5	6.9	1.4
Sulfate (mg/l)	30.8	30.0	28.0	26.0	26.0	26.0	26.0-30.8	27.8	2.2
Phosphorus (mg/l)	0.05	0.06	0.09	0.09	0.12	0.11	0.05-0.12	0.09	0.03
Silica (mg/l)	0.82	0.85	0.34	0.35	0.37	0.31	0.31-0.85	0.51	0.26
Total Alkalinity (mg/l)	101	103	95	96	99	99	95-103	99	3
B.O.D. (mg/l)	2	4	3	2	5	4	2-5	3	1
Suspended Solids (mg/l)	38	23	112	87	145	156	23-156	94	55
Dissolved Solids (mg/l)	146	200	180	176	182	180	146-200	177	18
Turbidity (F.T.U.)	34	35	62	58	64	64	34-64	53	14
pH	7.3	7.4	7.3	7.5	7.0	6.9	6.9-7.5	7.2	0.2
Conductivity (umhos/cm)	390	390	340	340	335	335	335-390	355	27

TABLE 71

MEAN VALUES AND RANGES FOR WATER QUALITY PARAMETERS TESTED IN 1979

	Parameter	April - November 1979		Units
		Mean	Range	
1.	Temperature	16.1	6.0-25.0	°C
2.	Dissolved Oxygen	9.5	6.6-12.7	ppm
3.	Conductivity (field)	301	245-450	umhos/cm
4.	Transparency	0.55	0.30-1.15	m
5.	Solar Radiation	1279	0.0-5000	ft-candles
6.	Calcium	37.4	32.0-50.8	mg/l
7.	Magnesium	10.1	7.2-15.1	mg/l
8.	Sodium	9.5	7.3-14.4	mg/l
9.	Chloride	17.7	10.8-30.5	mg/l
10.	Nitrate	4.4	0.6-10.7	mg/l
11.	Sulfate	30.6	22.5-46.0	mg/l
12.	Phosphorus	0.2	0.01-0.20	mg/l
13.	Silica	1.17	0.02-1.59	mg/l
14.	Total Alkalinity	97	89-109	mg/l
15.	BOD	3	1-6	mg/l
16.	Suspended Solids	49	8-156	mg/l
17.	Dissolved Solids	185	140-240	mg/l
18.	Turbidity	44	10-84	F.T.U.
19.	Hydrogen-ions	8.3	6.9-8.9	pH
20.	Conductivity (lab)	309	225-465	umhos/cm

TABLE 72

DISSOLVED OXYGEN DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

INTAKE (STA. NO. 8)

Month	Pre-Operational Data (ppm)				Operational Data (ppm)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	11.8	11.8	11.8	0.0	-	-	-	-
April	11.0	13.2	11.9	0.9	9.5	9.5	9.5	0.0
May	7.2	10.4	9.1	1.4	9.2	12.4	10.8	2.3
June	7.0	10.2	8.1	1.5	7.2	8.8	8.0	1.1
July	4.8	8.9	6.6	1.7	6.1	7.6	6.9	1.1
August	6.0	9.1	7.4	1.3	8.3	8.4	8.4	0.1
September	8.6	9.3	8.9	0.4	8.2	9.2	9.1	0.1
October	10.0	11.2	10.5	0.6	9.5	11.4	10.7	1.0
November	11.0	12.1	11.5	0.6	10.2	12.2	11.5	1.1
December	11.4	14.1	12.8	1.9	-	-	-	-
Mean			9.9	2.1			9.4	1.6

DISCHARGE (STA. NO. 13)

Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	11.8	11.8	11.8	0.0		-	-	-
April	11.8	12.8	12.3	0.5	9.5	9.5	9.5	0
May	8.6	10.0	9.4	0.6	9.0	12.0	10.5	2.1
June	6.8	10.1	8.5	1.4	5.7	8.5	7.1	2.0
July	4.5	8.4	6.6	1.6	8.3	8.8	8.6	0.4
August	6.6	9.3	7.7	1.2	8.1	8.2	8.2	0.1
September	8.2	9.3	8.6	0.6	8.7	9.2	8.6	0.4
October	10.4	11.3	11.3	0.8	10.4	11.5	11.0	0.6
November	11.3	12.2	11.7	0.5	4.8	12.1	9.6	4.2
December	14.1	10.2	12.2	2.76		-	-	-
Mean			10.0	2.1			9.1	1.3

TABLE 73

HYDROGEN-IONS (pH) DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (pH units)				Operational Data (pH units)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	8.1	8.1	8.1	0.0	-	-	-	-
April	7.7	8.3	8.1	0.3	8.1	8.1	8.1	0.0
May	7.8	8.4	8.2	0.3	7.7	8.0	7.9	0.2
June	8.0	8.6	8.3	0.3	8.3	8.6	8.5	0.2
July	8.1	9.0	8.5	0.4	8.4	8.4	8.4	0.0
August	8.5	8.9	8.8	0.2	8.7	8.7	8.7	0.0
September	7.8	8.6	8.2	0.4	8.6	8.8	8.7	0.1
October	8.2	8.9	8.6	0.4	8.0	8.8	8.4	0.4
November	7.6	8.4	8.0	0.4	7.5	8.0	7.8	0.3
December	8.1	8.3	8.2	0.1	-	-	-	-
Mean			8.3	0.3			8.3	0.3

Month	DISCHARGE (STA. NO. 13)							
	Pre-Operational Data (pH units)				Operational Data (pH units)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	7.8	7.8	7.8	0.0	-	-	-	-
April	7.7	8.5	8.1	0.4	8.1	8.1	8.1	0.0
May	7.8	8.6	8.3	0.3	7.5	8.3	7.9	0.6
June	7.8	8.6	8.3	0.4	8.5	8.6	8.6	0.1
July	8.0	8.7	8.4	0.4	8.1	8.5	8.3	0.3
August	8.0	8.7	8.4	0.3	8.7	8.7	8.7	0.0
September	8.3	8.5	8.4	0.1	8.5	8.9	8.7	0.2
October	8.4	8.8	8.6	0.2	8.0	8.6	8.2	0.3
November	7.7	8.4	8.0	0.7	6.9	8.1	7.6	0.6
December	7.9	8.4	8.2	0.4	-	-	-	-
Mean			8.3	0.2			8.3	0.4

TABLE 74

TRANSPARENCY DATA FOR WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (m)				Operational Data (m)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	0.15	0.15	0.15	0.00	-	-	-	-
April	0.10	0.50	0.34	0.20	0.40	0.40	0.40	0.00
May	0.35	1.00	0.70	0.30	0.20	0.40	0.30	0.10
June	0.50	0.60	0.60	0.05	0.35	0.45	0.40	0.10
July	0.40	1.10	0.70	0.30	0.75	0.85	0.80	0.10
August	0.45	1.30	0.90	0.40	0.50	0.95	0.70	0.30
September	0.60	0.80	0.70	0.10	0.40	1.15	0.72	0.40
October	0.50	0.80	0.60	0.17	0.45	0.60	0.53	0.10
November	0.30	0.50	0.43	0.12	0.35	0.80	0.62	0.20
December	0.40	0.40	0.40	0.00	-	-	-	-
Mean			0.55	0.22			0.56	0.18

Month	DISCHARGE (STA. NO. 13)							
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	0.10	0.10	0.10	0.00	-	-	-	-
April	0.10	0.40	0.25	0.13	0.35	0.35	0.35	0.00
May	0.30	0.70	0.60	0.20	0.20	0.40	0.30	0.10
June	0.30	0.50	0.50	0.10	0.30	0.40	0.35	0.10
July	0.30	0.95	0.61	0.33	0.55	0.85	0.70	0.20
August	0.50	1.00	0.77	0.25	0.45	0.70	0.58	0.20
September	0.50	0.65	0.58	0.08	0.40	1.15	0.68	0.40
October	0.40	0.65	0.53	0.13	0.50	0.50	0.50	0.00
November	0.30	0.60	0.45	0.15	0.35	0.80	0.55	0.20
December	0.40	0.45	0.43	0.04	-	-	-	-
Mean			0.48	0.19			0.49	0.14

TABLE 75

TURBIDITY DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (F.T.U.)				Operational Data (F.T.U.)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	145.0	145.0	145.0	0.0	-	-	-	-
April	12.0	105.0	46.3	42.8	67.0	67.0	67.0	0.0
May	5.5	21.0	14.9	6.7	46.0	55.0	50.5	6.4
June	10.0	53.0	26.3	18.6	40.0	57.0	48.5	12.0
July	3.0	53.0	16.9	24.2	14.0	52.0	33.0	26.9
August	2.0	23.0	10.5	9.0	13.0	18.0	15.5	3.5
September	5.0	10.0	9.3	4.0	10.0	27.0	18.3	8.5
October	7.0	18.0	11.7	5.7	13.0	32.0	20.7	10.0
November	13.0	36.0	21.7	12.5	8.0	58.0	26.0	27.8
December	16.0	47.0	31.5	21.9	-	-	-	-
Mean			33.4	40.8			34.9	18.5

Month	DISCHARGE (STA. NO. 13)							
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	148.0	148.0	148.0	0.0	-	-	-	-
April	18.0	110.0	54.5	42.7	75.0	75.0	75.0	0.0
May	8.5	28.0	17.9	8.0	52.0	75.0	63.5	16.3
June	7.0	25.0	17.5	8.2	49.0	54.0	51.5	3.5
July	4.5	45.0	19.4	18.6	15.0	34.0	24.5	13.4
August	2.0	24.0	12.3	9.5	16.0	17.0	16.5	0.7
September	4.0	16.0	10.0	6.0	11.0	47.0	28.7	18.0
October	9.0	22.0	13.7	7.2	7.0	42.0	23.3	17.6
November	13.0	33.0	19.7	11.6	8.0	64.0	28.0	31.2
December	21.0	54.0	37.5	23.3	-	-	-	-
Mean			35.1	41.9			38.9	21.5

TABLE ~~76~~

SUSPENDED SOLIDS DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	148.0	148.0	148.0	0.0	-	-	-	-
April	13.0	80.0	46.8	36.7	50.0	50.0	50.0	0.0
May	10.0	26.0	16.3	7.1	50.0	86.0	68.0	25.5
June	9.0	60.0	30.3	25.1	43.0	63.0	53.0	14.1
July	1.0	33.0	21.3	14.0	10.0	14.0	12.0	2.8
August	8.0	19.0	12.5	5.5	11.0	18.0	14.5	5.0
September	6.0	15.0	10.0	4.6	11.0	37.0	26.0	13.5
October	9.0	14.0	12.0	2.7	18.0	27.0	23.3	4.7
November	11.0	28.0	20.7	8.7	32.0	87.0	68.7	31.8
December	17.0	21.0	19.0	2.8	-	-	-	-
Mean			33.7	41.6			39.4	23.3
	DISCHARGE (STA. NO. 13)							
March	170.0	170.0	170.0	0.0	-	-	-	-
April	15.0	101.0	58.5	41.9	59.0	59.0	59.0	0.0
May	17.0	34.0	22.8	7.6	49.0	89.0	69.0	28.3
June	7.0	67.0	35.0	29.5	44.0	56.0	50.0	8.5
July	3.0	52.0	28.5	21.0	16.0	18.0	17.0	1.4
August	8.0	24.0	16.3	7.9	12.0	22.0	17.0	7.1
September	10.0	27.0	17.0	8.9	12.0	104.0	47.3	49.6
October	10.0	26.0	18.0	8.0	13.0	79.0	40.7	34.3
November	19.0	34.0	25.3	7.8	27.0	156.0	74.3	71.0
December	23.0	23.0	23.0	0.0	-	-	-	-
Mean			40.4	47.5			46.8	21.5

TABLE 77

CONDUCTIVITY DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (μmhos/cm)				Operational Data (μmhos/cm)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	410.0	410.0	410.0	0.0	-	-	-	-
April	287.0	340.0	314.5	27.9	410.0	410.0	410.0	0.0
May	280.0	365.0	310.8	39.0	290.0	320.0	305.0	21.2
June	285.0	310.0	292.8	11.7	295.0	300.0	297.5	3.5
July	260.0	305.0	280.0	22.9	275.0	300.0	287.5	17.7
August	233.0	285.0	253.8	22.1	250.0	295.0	272.5	31.8
September	217.0	267.0	246.3	26.1	222.0	284.0	262.0	34.7
October	233.0	298.0	272.0	34.4	265.0	350.0	316.7	45.4
November	230.0	300.0	262.7	35.2	245.0	320.0	278.3	38.2
December	283.0	297.0	290.0	9.9	-	-	-	-
Mean			293.3	46.8			303.7	46.5

Month	DISCHARGE (STA. NO. 13)							
March	392.0	392.0	392.0	0.0	-	-	-	-
April	272.0	360.0	312.8	43.9	435.0	435.0	435.0	0.0
May	270.0	365.0	312.5	42.3	285.0	320.0	302.5	24.8
June	286.0	340.0	309.8	24.9	300.0	303.0	301.5	2.1
July	220.0	300.0	268.5	34.2	275.0	300.0	287.5	17.7
August	245.0	280.0	262.8	17.3	260.0	295.0	277.5	24.8
September	215.0	264.0	244.7	26.1	230.0	315.0	276.3	43.0
October	238.0	324.0	280.7	43.0	265.0	335.0	310.7	39.6
November	230.0	306.0	268.0	38.0	250.0	330.0	283.3	41.6
December	285.0	300.0	292.5	10.6	-	-	-	-
Mean			296.2	39.4			309.3	52.3

TABLE 78

DISSOLVED SOLIDS DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	318.0	318.0	318.0	0.0	-	-	-	-
April	158.0	284.0	206.0	55.3	140.0	140.0	140.0	0.0
May	124.0	230.0	178.0	47.2	186.0	236.0	211.0	35.4
June	89.0	178.0	131.3	45.3	164.0	180.0	172.0	11.3
July	136.0	180.0	164.5	20.8	174.0	174.0	174.0	0.0
August	152.0	226.0	171.5	36.4	174.0	184.0	179.0	7.1
September	128.0	214.0	166.0	43.9	146.0	180.0	168.0	19.1
October	158.0	186.0	170.7	14.2	146.0	190.0	164.0	23.1
November	140.0	174.0	156.0	17.1	158.0	184.0	172.7	13.3
December	140.0	160.0	150.0	14.1	-	-	-	-
Mean			181.2	51.8			172.6	19.5

DISCHARGE (STA. NO. 13)

Month	Pre-Operational Min	Pre-Operational Max	Pre-Operational Mean	Pre-Operational Std Dev	Operational Min	Operational Max	Operational Mean	Operational Std Dev
March	310.0	310.0	310.0	0.0	-	-	-	-
April	182.0	396.0	244.0	102.4	150.0	150.0	150.0	0.0
May	116.0	232.0	176.0	51.3	192.0	224.0	208.0	22.6
June	90.0	194.0	137.0	51.1	174.0	194.0	196.0	20.7
July	136.0	190.0	164.0	27.0	160.0	182.0	171.0	15.6
August	150.0	228.0	170.0	38.7	178.0	194.0	186.0	11.3
September	140.0	170.0	153.3	15.3	158.0	196.0	176.7	19.0
October	176.0	194.0	182.0	10.4	152.0	178.0	163.3	13.3
November	142.0	184.0	158.0	22.7	162.0	192.0	178.0	15.1
December	148.0	164.0	156.0	11.3	-	-	-	-
Mean			185.0	52.4			178.5	18.3

TABLE 79

CALCIUM DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	50.8	50.8	50.8	0.0	-	-	-	-
April	32.8	46.4	40.6	6.1	46.4	46.4	46.4	0.0
May	34.0	40.0	37.0	2.6	36.0	38.4	37.2	1.7
June	34.0	38.0	34.9	1.8	36.8	37.2	37.0	0.3
July	32.0	34.4	33.6	1.1	36.0	36.0	36.0	0.0
August	29.2	39.2	32.8	4.3	32.0	35.6	33.8	2.5
September	32.0	36.0	33.9	2.0	30.4	34.8	32.8	2.2
October	31.6	37.2	33.9	3.0	32.4	36.8	34.0	2.4
November	31.2	37.6	34.9	3.3	32.8	37.6	35.7	2.6
December	31.2	34.0	32.6	2.0	-	-	-	-
Mean			36.5	5.6			36.6	4.3

DISCHARGE (STA. NO. 13)

Month	Pre-Op Min	Pre-Op Max	Pre-Op Mean	Pre-Op Std Dev	Op Min	Op Max	Op Mean	Op Std Dev
March	50.4	50.4	50.4	0.0	-	-	-	-
April	33.6	50.4	41.7	7.0	50.0	50.0	50.0	0.0
May	34.0	41.6	37.4	3.5	36.0	36.0	36.0	0.0
June	34.0	38.4	35.9	1.9	36.8	37.6	37.2	0.6
July	32.0	36.4	34.1	1.9	33.6	38.8	36.2	3.7
August	29.6	40.4	33.6	4.7	33.2	35.6	34.4	1.7
September	32.0	36.0	33.3	2.3	31.2	33.2	32.1	1.0
October	32.0	41.2	34.2	3.9	32.8	36.0	34.1	1.7
November	31.2	34.8	33.2	1.8	32.8	38.8	36.1	3.1
December	31.2	35.2	33.2	2.8	-	-	-	-
Mean			36.7	5.5			37.0	5.5

TABLE 80

CHLORIDE DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	22.0	22.0	22.0	0.0	-	-	-	-
April	18.0	26.8	20.6	4.2	26.0	26.0	26.0	0.0
May	18.0	20.0	18.7	1.0	20.0	21.0	20.5	0.7
June	15.5	20.3	17.9	2.3	15.2	20.5	17.9	3.7
July	16.0	19.5	18.0	1.8	12.5	23.0	17.8	7.4
August	13.5	18.3	16.1	2.0	10.8	19.5	15.2	6.2
September	16.0	17.2	16.7	0.6	13.5	17.5	15.8	2.1
October	15.8	18.8	17.4	1.5	14.3	22.0	19.4	4.4
November	13.0	16.5	14.7	1.8	15.0	20.0	17.5	2.5
December	15.0	15.8	15.4	0.6	-	-	-	-
Mean			17.8	2.3			18.8	3.4

Month	DISCHARGE (STA. NO. 13)							
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	22.0	22.0	22.0	0.0	-	-	-	-
April	18.0	26.5	20.8	3.9	27.3	27.3	27.3	0.0
May	17.6	20.0	18.9	1.3	17.8	21.0	19.4	2.3
June	16.3	22.5	18.8	2.9	15.5	20.5	18.0	3.5
July	16.8	20.0	18.2	1.7	12.5	22.0	17.3	6.7
August	13.5	18.3	16.1	2.0	12.3	19.0	15.7	4.7
September	14.5	17.2	15.9	1.4	14.0	19.5	16.7	2.8
October	16.8	21.0	18.4	2.3	15.8	21.0	19.3	3.0
November	13.0	16.0	14.7	1.5	17.3	21.5	19.0	2.2
December	15.0	16.3	15.7	0.9	-	-	-	-
Mean			18.0	2.4			19.1	3.6

TABLE 81

SULFATE DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

INTAKE (STA. NO. 8)

Month	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	10.5	10.5	10.5	0.0	-	-	-	-
April	24.0	37.0	30.8	6.0	44.0	44.0	44.0	0.0
May	25.0	30.0	28.3	2.2	22.5	26.0	24.3	2.5
June	21.0	30.5	26.4	4.3	29.0	33.5	31.3	3.2
July	20.5	26.5	24.0	2.6	23.5	28.0	25.8	3.2
August	18.5	23.0	20.6	1.9	28.0	28.0	28.0	0.0
September	20.0	22.5	21.0	1.3	20.5	28.0	23.5	4.0
October	22.0	28.0	25.7	3.2	18.0	35.5	25.2	9.2
November	19.0	24.0	21.2	2.6	21.5	29.0	25.5	3.8
December	21.0	28.5	24.8	5.3	-	-	-	-
Mean			23.3	5.6			28.5	6.7

DISCHARGE (STA. NO. 13)

Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	10.0	10.0	10.0	0.0	-	-	-	-
April	27.3	41.5	32.5	6.7	46.0	46.0	46.0	0.0
May	28.0	31.0	29.5	1.3	22.5	26.0	24.3	2.5
June	21.0	30.5	26.5	4.1	29.0	32.5	30.8	2.5
July	19.0	26.0	23.5	3.1	23.0	28.0	25.5	3.5
August	19.5	23.5	21.5	1.7	27.5	28.5	28.0	0.7
September	17.0	22.0	19.7	2.5	20.0	28.0	23.3	4.2
October	22.5	30.5	26.7	4.0	15.8	35.3	23.7	10.3
November	19.0	25.5	21.7	3.4	23.0	29.0	26.0	3.0
December	21.5	27.0	24.3	3.9	-	-	-	-
Mean			23.6	6.2			28.5	7.5

TABLE 82

SODIUM DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	10.5	10.5	10.5	0.0	-	-		
April	9.2	12.7	10.8	1.5	13.2	13.2	13.2	0.0
May	10.1	12.6	11.2	1.1	8.5	8.6	8.6	0.1
June	8.4	10.7	9.9	1.0	9.2	9.2	9.2	0.0
July	7.0	11.9	9.6	2.0	8.0	10.7	9.4	1.9
August	6.4	10.3	8.6	1.6	7.5	10.1	8.8	1.8
September	9.2	10.2	9.7	0.5	8.0	10.5	9.0	1.3
October	9.0	15.3	12.2	3.2	7.6	13.5	9.7	3.3
November	7.1	10.4	8.3	1.8	8.0	14.8	11.3	3.4
December	8.5	9.3	8.9	0.6	-	-	-	-
Mean			10.0	1.2			9.8	1.2
	DISCHARGE (STA. NO. 13)							
March	10.0	10.0	10.0	0.0	-	-	-	-
April	8.9	12.4	10.7	1.7	14.4	14.4	14.4	0.0
May	10.1	13.5	11.7	1.7	8.0	8.9	8.5	0.6
June	8.0	11.0	9.9	1.3	7.6	9.2	8.4	1.1
July	7.0	12.1	9.6	2.2	8.0	10.1	9.1	1.5
August	7.1	10.3	8.7	1.3	8.3	10.1	9.2	1.3
September	8.4	10.2	9.4	0.9	8.0	10.5	9.0	1.3
October	9.0	15.3	12.4	3.2	8.4	13.5	10.3	2.8
November	7.1	10.4	8.4	1.8	8.0	14.8	11.3	3.4
December	10.0	10.7	10.4	0.5	-	-	-	-
Mean			10.1	1.2			10.0	2.0

TABLE 83

MAGNESIUM DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	11.3	11.3	11.3	0.0	-	-	-	-
April	5.8	8.4	7.2	1.1	13.4	13.4	13.4	0.0
May	7.1	10.6	9.1	1.2	8.2	8.6	8.4	0.3
June	7.9	10.3	8.9	1.2	9.6	9.6	9.6	0.0
July	8.2	9.4	9.0	0.5	9.6	11.0	10.3	1.0
August	5.5	7.7	6.8	0.9	7.7	9.8	8.8	1.5
September	6.5	7.7	7.1	0.6	7.0	10.1	8.4	1.6
October	7.20	8.90	7.83	.93	7.2	10.3	8.5	1.6
November	5.0	7.7	6.7	1.5	8.2	9.8	9.1	0.8
December	5.3	8.4	6.9	2.2	-	-	-	-
Mean			8.1	1.5			9.6	1.7
	DISCHARGE (STA. NO. 13)							
March	11.5	11.5	11.5	0.0	-	-	-	-
April	5.8	9.1	7.1	1.5	13.4	13.4	13.4	0.0
May	7.7	10.3	9.0	1.1	8.6	8.6	8.6	0.0
June	7.7	9.6	8.5	0.8	9.8	10.1	10.0	0.2
July	8.9	9.4	9.2	0.2	11.5	12.2	11.9	0.5
August	5.3	7.2	6.7	1.0	8.4	9.6	9.0	0.8
September	6.7	7.7	7.4	0.6	7.7	9.8	8.9	1.1
October	7.9	8.2	8.0	0.2	8.2	10.1	8.9	1.0
November	7.2	8.6	7.8	0.7	8.2	10.8	9.5	1.3
December	7.4	7.9	7.7	0.4	-	-	-	-
Mean			8.3	1.4			10.0	1.7

TABLE 84

TOTAL ALKALINITY DATA FOR BOTTOM WATER
IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	110.0	110.0	110.0	0.0	-	-	-	-
April	88.0	101.0	94.5	5.3	104.0	104.0	104.0	0.0
May	92.0	101.0	95.0	4.1	89.0	89.0	89.0	0.0
June	91.0	97.0	94.3	3.2	89.0	100.0	94.5	7.8
July	86.0	92.0	88.8	2.5	95.0	100.0	97.5	3.5
August	84.0	92.0	87.5	3.7	96.0	96.0	96.0	0.0
September	89.0	104.0	95.7	7.6	86.0	95.0	90.3	4.5
October	90.0	97.0	93.7	3.5	92.0	102.0	96.7	5.0
November	87.0	94.0	90.3	3.5	90.0	100.0	95.3	5.0
December	87.0	93.0	90.0	4.2	-	-	-	-
Mean			94.0	6.3			96.0	4.8

Month	DISCHARGE (STA. NO. 13)							
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	110.0	110.0	110.0	0.0	-	-	-	-
April	87.0	98.0	94.8	5.3	107.0	107.0	107.0	0.0
May	91.0	104.0	96.5	5.8	91.0	92.0	91.5	0.7
June	95.0	96.0	95.5	0.6	90.0	100.0	95.0	7.1
July	89.0	96.0	92.0	2.9	95.0	100.0	97.5	3.5
August	85.0	94.0	88.3	4.0	93.0	98.0	95.5	3.5
September	88.0	96.0	92.7	4.2	88.0	96.0	91.7	4.0
October	92.0	111.0	98.3	11.0	92.0	100.0	95.7	4.0
November	90.0	95.0	91.7	2.9	92.0	99.0	95.8	3.5
December	90.0	95.0	92.5	3.5	-	-	-	-
Mean			95.2	5.9			96.2	4.8

TABLE 85

NITRATE DATA FOR BOTTOM WATER
IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std. Dev
March	17.00	17.00	17.00	0.00	-	-	-	-
April	1.99	14.90	7.46	6.19	5.40	5.40	5.40	0.00
May	0.15	13.50	6.30	5.50	1.70	14.20	8.00	8.80
June	0.00	8.00	4.20	4.00	7.30	8.70	8.00	1.00
July	0.00	7.70	3.80	3.30	5.10	7.70	6.40	1.80
August	0.00	1.20	0.40	0.60	1.40	2.70	2.10	1.00
September	0.00	2.70	1.00	1.50	0.60	2.40	1.60	1.00
October	0.50	8.00	3.40	4.10	0.30	1.20	0.80	0.50
November	1.50	2.60	1.97	0.57	5.10	7.90	6.60	1.40
December	2.40	3.60	3.00	0.85	-	-	-	-
Mean			4.90	4.79			4.86	2.93
	DISCHARGE (STA. NO. 13)							
March	17.00	17.00	17.00	0.00	-	-	-	-
April	1.20	17.00	7.81	7.41	6.40	6.40	6.40	0.00
May	0.15	13.50	6.80	5.50	1.70	12.00	6.90	7.30
June	0.00	7.70	4.30	3.80	7.70	11.50	9.60	2.70
July	0.00	8.40	3.70	3.70	4.50	9.30	6.90	3.40
August	0.00	1.20	0.50	0.50	2.30	3.10	2.70	0.60
September	0.00	2.70	1.20	1.40	0.30	1.70	1.20	0.80
October	0.50	7.70	3.13	3.97	0.30	2.00	1.20	0.90
November	0.90	5.10	3.00	2.10	6.50	7.30	7.00	0.50
December	2.00	3.70	2.90	1.20	-	-	-	-
Mean			5.03	4.76			5.24	3.12

TABLE 86

PHOSPHORUS DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	0.28	0.28	0.28	0.00	-	-	-	-
April	0.06	0.12	0.09	0.03	0.02	0.02	0.02	0.00
May	0.02	0.27	0.09	0.12	0.01	0.07	0.04	0.04
June	0.01	0.04	0.03	0.02	0.02	0.04	0.03	0.01
July	0.02	0.07	0.04	0.02	0.02	0.12	0.07	0.07
August	0.01	0.06	0.04	0.02	0.02	0.02	0.02	0.00
September	0.00	0.05	0.02	0.03	0.01	0.04	0.03	0.02
October	0.00	0.05	0.02	0.02	0.01	0.11	0.06	0.05
November	0.02	0.03	0.02	0.01	0.01	0.09	0.05	0.04
December	0.01	0.07	0.04	0.04	-	-	-	-
Mean			0.07	0.08			0.04	0.02
DISCHARGE (STA. NO. 13)								
March	0.26	0.26	0.26	0.00	-	-	-	
April	0.02	0.10	0.06	0.04	0.02	0.02	0.02	0.00
May	0.02	0.44	0.13	0.21	0.01	0.08	0.05	0.05
June	0.01	0.05	0.04	0.02	0.03	0.04	0.04	0.01
July	0.03	0.09	0.06	0.03	0.02	0.12	0.07	0.07
August	0.01	0.06	0.03	0.02	0.01	0.02	0.02	0.01
September	0.00	0.07	0.03	0.04	0.02	0.07	0.0	0.03
October	0.00	0.06	0.03	0.03	0.03	0.08	0.0	0.04
November	0.02	0.03	0.03	0.01	0.01	0.11	0.0	0.05
December	0.02	0.06	0.04	0.03	-	-	-	-
Mean			0.07	0.07			0.05	0.02

TABLE 87

SILICA DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	-	-	-	-	-	-	-	-
April	0.10	3.09	0.96	1.43	0.83	0.83	0.83	0.00
May	0.00	0.23	0.10	0.10	0.07	1.36	0.72	0.91
June	0.17	0.74	0.47	0.28	0.28	0.55	0.42	0.19
July	0.40	1.20	0.77	0.36	0.44	0.45	0.45	0.01
August	0.11	0.38	0.27	0.17	0.04	0.23	0.14	0.13
September	0.06	0.71	0.32	0.34	0.09	0.28	0.16	0.11
October	0.06	0.19	0.12	0.07	0.04	0.13	0.07	0.05
November	0.03	0.12	0.09	0.05	0.07	0.59	0.34	0.26
December	0.19	0.24	0.22	0.04	-	-	-	-
Mean			0.37	0.31			0.39	0.27

DISCHARGE (STA. NO. 13)

Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	-	-	-	-	-	-	-	-
April	0.06	3.50	0.98	1.68	1.29	1.29	1.29	0.00
May	0.0	0.29	0.13	0.12	0.07	1.41	0.74	0.95
June	0.16	0.78	0.46	0.26	0.22	0.62	0.42	0.28
July	0.33	0.91	0.57	0.25	0.47	0.65	0.56	0.13
August	0.10	0.44	0.27	0.18	0.02	0.19	0.11	0.12
September	0.06	0.59	0.28	0.28	0.07	0.36	0.22	0.15
October	0.09	0.19	0.13	0.06	0.07	0.10	0.09	0.02
November	0.03	0.16	0.10	0.07	0.11	0.64	0.35	0.27
December	0.16	0.26	0.21	0.07	-	-	-	-
Mean			0.35	0.28			0.47	0.40

TABLE 88

BIOCHEMICAL OXYGEN DEMAND DATA FOR BOTTOM WATER
IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (mg/l)				Operational Data (mg/l)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	3.00	3.00	3.00	0.00	-	-	-	-
April	0.92	4.00	2.70	1.30	4.0	4.0	4.0	0.0
May	0.50	3.0	1.40	1.10	4.0	2.0	3.0	1.4
June	1.00	3.10	2.00	1.20	4.0	3.0	3.5	0.7
July	2.00	4.00	3.00	1.00	2.0	3.0	2.5	0.7
August	3.00	3.00	3.00	0.00	2.0	2.0	2.0	0.0
September	2.00	3.00	2.33	0.58	1.0	3.0	2.3	1.2
October	2.00	3.00	2.33	0.58	2.0	4.0	2.7	1.2
November	1.00	2.00	1.70	0.60	2.0	2.0	2.0	0.0
December	1.00	2.00	1.50	0.71	-	-	-	-
Mean			2.30	0.63			2.8	0.7

Month	DISCHARGE (STA. NO. 13)							
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	3.00	3.00	3.00	0.00	-	-	-	-
April	2.00	4.50	3.40	1.10	4.0	4.0	4.0	0.0
May	0.60	4.00	2.40	1.50	2.0	3.0	2.5	0.7
June	1.00	3.00	2.10	0.90	3.0	5.0	4.0	1.4
July	1.00	3.00	2.30	1.20	3.0	3.0	3.0	0.0
August	2.00	4.00	3.00	0.80	2.0	3.0	2.5	0.7
September	2.00	3.00	2.67	0.58	2.0	4.0	3.0	1.0
October	2.00	4.00	3.00	1.00	3.0	4.0	3.7	0.6
November	2.00	3.00	2.30	0.60	1.0	4.0	2.3	1.5
December	1.00	2.00	1.50	0.71	-	-	-	
Mean			2.57	0.56			3.13	0.7

TABLE 89

TEMPERATURE DATA FOR BOTTOM WATER

IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

Month	INTAKE (STA. NO. 8)							
	Pre-Operational Data (°C)				Operational Data (°C)			
	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	-	-	-	-	-	-	-	-
April	6.0	10.0	7.7	1.7	10.0	10.0	10.0	0.0
May	14.0	20.0	15.8	2.8	10.4	17.8	14.1	5.2
June	18.0	21.5	20.0	1.5	21.0	24.2	22.6	2.3
July	22.0	24.0	22.6	1.0	24.0	24.0	24.0	0.0
August	22.0	24.2	23.1	1.2	21.5	23.0	22.3	1.1
September	18.0	20.5	19.3	1.3	18.0	21.7	19.8	1.9
October	9.0	13.0	11.2	2.0	8.0	11.2	9.5	1.6
November	5.0	10.0	8.2	2.8	4.0	10.2	6.9	3.1
December	-	-	-	-	-	-	-	
Mean			16.0	6.3			16.2	6.8

DISCHARGE (STA. NO. 13)

Month	Min	Max	Mean	Std Dev	Min	Max	Mean	Std Dev
March	-	-	-	-	-	-	-	-
April	7.5	10.0	8.6	1.1	10.5	10.5	10.5	0.0
May	14.0	20.0	15.8	2.8	10.4	18.0	14.2	5.4
June	19.0	21.0	20.2	1.1	21.5	24.7	23.1	2.3
July	22.0	24.1	22.9	0.9	23.5	25.0	24.3	1.1
August	21.5	24.5	23.0	1.5	21.5	23.0	22.3	1.1
September	18.0	20.5	19.2	1.3	18.5	22.1	19.9	1.9
October	8.5	13.0	11.0	2.3	8.5	11.5	9.9	1.5
November	5.0	10.5	7.9	2.8	4.0	10.1	6.9	3.1
December	-	-	-	-	-	-	-	=
Mean			16.1	6.2			16.4	6.8

TABLE 90

LOCUST POINT PRIMARY PRODUCTIVITY ($mgC/m^3/hr$)

FOR 1979 FIELD SEASON

DATE	DEPTH (meters)	STATION 3	STATION 8	STATION 13	STATION 14
25 June	0.5	101.0	125.0	172.0	167.0
	1.0	37.0	89.0	47.0	62.0
	2.0	3.1	---	1.6	---
	3.0	---	0.5	---	1.5
24 August	0.5	138.0	185.0	165.0	153.0
	1.0	137.0	106.0	92.0	84.0
	2.0	25.0	13.0	9.2	11.0
12 October	0.5	82.0	80.0	87.0	84.0
	1.0	20.0	37.0	40.0	30.0
	2.0	4.5	9.8	7.6	7.0

TABLE 91

1979 RATIOS OF PRIMARY PRODUCTIVITY AT STATIONS 8, 13, AND 14 TO PRODUCTIVITY AT STATION 3 (MEAN OF 0.5-METER AND 1-METER DEPTHS)

DATE	STATION		
	8	13	14
25 June	0.89	0.92	0.96
24 August	1.06	0.93	0.86
12 October	1.16	1.25	1.12
Mean of All Cruises	1.04 ± 0.14	1.03 ± 0.19	0.98 ± 0.13

TABLE 92

1979 RATIOS OF PRIMARY PRODUCTIVITY AT STATION 13

TO PRODUCTIVITY AT STATION 14

DATE	DEPTH (METERS)	RATIO OF STATION 13 PRODUCTIVITY TO STATION 14 PRODUCTIVITY
25 June	0.5	1.03
	1.0	0.76
24 August	0.5	1.08
	1.0	1.10
12 October	0.5	1.04
	1.0	1.33

Mean of all dates and both
0.5-meter and 1-meter depths: 1.06 ± 0.18

TABLE 93

SUMMARY OF 1979 ILLUMINATION VS. DEPTH PROFILES AT LOCUST POINT (ILLUMINATION IS GIVEN IN FOOT-CANDLES)

DATE	DEPTH (meters)	STATION			
		3	8	13	14
25 June	surface	3000.00	500.00	1000.00	4000.00
	0.5	450.00	150.00	350.00	500.00
	1.0	60.00	50.00	55.00	90.00
	1.5	15.00	13.00	5.00	30.00
	2.0	2.00	4.00	1.00	5.50
	2.5	0.20	0.50		0.90
	3.0		0.25		0.35
24 August	surface	1500.00	2700.00	4100.00	4400.00
	0.5	610.00	1200.00	1400.00	1500.00
	1.0	280.00	340.00	360.00	410.00
	1.5	75.00	170.00	93.00	200.00
	2.0	34.00	64.00	33.00	65.00
	2.5	11.00	25.00	12.00	33.00
12 October	surface	800.00	450.00	800.00	750.00
	0.5	250.00	220.00	350.00	310.00
	1.0	73.00	100.00	110.00	140.00
	1.5	19.00	30.00	33.00	50.00
	2.0	6.50	11.00	15.00	20.00
	2.5		4.70	6.00	7.60
	3.0		1.80	2.70	3.60

TABLE 94

SUMMARY OF 1979 SECCHI DEPTHS (IN METERS) AT LOCUST POINT

DATE	STATION			
	3	8	13	14
25 June	0.30	0.25	0.25	0.20
24 August	0.65	0.60	0.50	0.50
12 October	0.50	0.80	0.80	0.80

TABLE 95

OPERATIONAL WATER QUALITY PARAMETERS FALLING OUTSIDE OF THE RANGE OF PRE-OPERATIONAL VALUES AT STATION 13

PARAMETER	Nearest Number of Standard Deviation Units Outside the Pre-operational Range										
	MONTH										
	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Sum of Difference
Dissolved Oxygen		-5	+1	0	0	0	0	0	-3		- 7
Hydrogen-ions(pH)		0	0	0	0	0	+2	-1	0		+ 1
Transparency		0	0	0	0	0	0	0	0		0
Turbidity		0	+4	+3	0	0	+2	0	0		+ 9
Suspended Solids		0	+5	0	0	0	+2	+2	+5		+14
Conductivity		+2	0	0	0	0	0	0	0		+ 2
Dissolved Solids		0	0	0	0	0	0	-1	0		- 1
Calcium		0	0	0	0	0	0	0	+1		+ 1
Chloride		0	0	0	0	0	0	0	+2		+ 2
Sulfate		+1	-3	0	0	+3	+1	0	0		+ 2
Sodium		+1	-1	0	0	0	0	0	+1		+ 1
Magnesium		+3	0	+1	+13	+2	+2	+4	+1		+26
Total Alkalinity		+2	0	0	+1	0	0	0	0		+ 3
Nitrate		0	0	+1	0	+3	0	0	+1		+ 5
Phosphorus		0	0	0	0	0	0	0	+3		+ 3
Silica		0	+4	0	0	0	0	0	+3		+ 7
Biochemical Oxygen Demand		0	0	+1	0	0	0	0	0		+ 1
Temperature		0	0	+2	0	0	0	0	0		+ 2

TABLE 96

MEAN WATER QUALITY VALUES FOR PRE-OPERATIONAL AND OPERATIONAL PERIODS IN THE VICINITY OF LAKE INTAKE AND DISCHARGE STRUCTURES

PARAMETER	UNITS	PRE-OPERATIONAL		OPERATIONAL		PERCENT CHANGE	
		Sta. 8	Sta. 13	Sta. 8	Sta. 13	Sta. 8	Sta. 13
Dissolved Oxygen	ppm	9.9	10.0	9.4	9.1	-5.1	-9.0
Hydrogen-ions	pH	8.3	8.3	8.3	8.3	0.0	0.0
Transparency	m	0.55	0.48	0.56	0.49	+1.8	+2.1
Turbidity	F.T.U.	33.4	35.1	34.9	38.9	+4.5	+10.8
Suspended Solids	mg/l	33.7	40.4	39.4	46.8	+17.0	+15.8
Conductivity	µmhos/cm	293.3	296.2	303.7	309.3	+3.5	+4.4
Dissolved Solids	mg/l	181.2	185.0	172.6	178.5	-4.7	-3.5
Calcium	mg/l	36.5	36.7	36.6	37.0	+0.3	+0.8
Chloride	mg/l	17.8	18.0	18.8	19.1	+5.6	+6.1
Sulfate	mg/l	23.3	23.6	28.5	28.5	+22.3	+20.8
Sodium	mg/l	10.0	10.1	9.8	10.0	-2.0	-1.0
Magnesium	mg/l	8.1	8.3	9.6	10.0	+18.5	+20.5
Total Alkalinity	mg/l	94.0	95.2	96.0	96.2	+2.1	+1.1
Nitrate	mg/l	4.90	5.03	4.86	5.24	-0.8	+4.2
Phosphorus	mg/l	0.07	0.07	0.04	0.05	-42.9	-28.6
Silica	mg/l	0.37	0.35	0.39	0.47	+5.4	+34.3
Biochemical Oxygen Demand (BOD)	mg/l	2.30	2.57	2.80	3.13	+21.7	+21.8
Temperature	C°	16.0	16.1	16.2	16.4	+1.3	+1.9

FIGURES