CHAPTER 5

ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION

5.1 EFFECTS OF OPERATION OF THE HEAT DISSIPATION SYSTEM

Although the present plans call for the dissipation of waste heat through a natural draft evaporative cooling tower for each unit, the complete design of these towers and their operating characteristics have not yet been specified. Therefore, the estimated effects of operating the towers must be considered preliminary at this time. The effects will involve the intake of makeup water from Sandusky Bay, the discharge of evaporated water and drift (water droplets) into the air, and the discharge of the cooling tower blowdown back into the Bay. The intake of makeup water will remove aquatic organisms entrained in the water while the discharge of water into the air could cause an increase in fogging and icing near the tower. (Meteorological effects of cooling tower operation will be done by other AEPSC contractors.) Also, this water represents the loss of a potential water resource. The blowdown water returned to the Bay will be warmer and have a higher concentration of dissolved solids and other chemicals than the water in the Bay.

5.1.1 PHYSICAL EFFECTS

5.1.1.1 Estimation of Tower Operating Characteristics

Since the design of the natural draft cooling towers has not yet been completely specified, the operating characteristics necessary for estimating the effects of the tower operation were based on simplified concepts and comparison with towers designed for similar heat loadings. The overall tower dimensions will be about 520 feet in diameter, about 500 feet tall, and have a throat diameter (diameter at the narrowest part of the tower) on the order of 275 feet. The towers usually have sufficient mass transfer capacity so that the relative humidity of the air leaving the towers is almost 100 percent. It is further assumed that (1) the towers behave as cylinders with height equal to the total tower height and diameter equal to the throat diameter, (2) the outlet air temperature is equal to the blowdown temperature which is equal to the cold water return temperature, (3) the average absolute temperature of air in the tower is the geometric mean of the inlet and outlet absolute temperature of the air, (4) the total pressure is 1 atmosphere, and (5) the drift is negligible.

The heat load on each tower is assumed to be equal to the heat ted by a 1,600 MWe power plant operating at 39 percent efficiency. This load is about 2.37 million Btu/sec. The following equation describes ransfer of this heat in the tower to the air in terms of sensible heat sing the temperature of the air stream) and latent heat (evaporating r into the air stream and thereby increase its humidity):

$$Q = F \left[C \; (T_H - T_C) + \lambda \; (q_H - q_C) \right] \tag{1}$$

e Q is the heat load, Btu/sec

F is the air flow rate, lb/sec

C is the heat capacity of air approximately 0.24 Btu/(lb F)

, T_C are the temperatures of the air leaving the tower and the ambient air, respectively, F

λ is the latent heat of evaporation for water, approximately 1,040 Btu/lb

, q_C are the humidities of the air leaving the tower and the ambient air, respectively, lb water/ lb dry air.

nidity can be related to temperature and relative humidity by the follow-g expression:

$$q = \frac{0.622}{5.932\text{x}10^{-6} \; \exp \; (\frac{7254}{T+391})/RH - 1} \tag{2}$$

ere RH is the relative humidity $(0 \leq RH \leq 1)$.

e air flow rate is given by

$$F = \frac{\pi \; Md^2}{4R} \sqrt{2gh(T_H - T_C)} \; [(T_H + 460)(T_C + 460)]^{-0.75} \tag{3}$$

here M is the molecular weight of air, approximately 29 lb/lb mole

d is the tower diameter at the throat, ft

R is the gas constant, approximately 0.73 ft^3 atm/(mole R)

g is the acceleration of gravity, approximately 32.2 ft/sec^2

h is the tower height, ft.

Combining the above expressions leads to an iterative process for obtaining T_H when T_C, RH, Q, d and h are known. This value of T_H is assumed to equal the blowdown temperature and the cold water return temperature. The rate of water evaporation in the tower is given by,

$$E = F\ (q_H - q_C) \tag{4}$$

where E is the evaporation rate, lb/sec.

Estimates of the operating characteristics of the towers are given in Table 5.1.1. These estimates can only be considered representative since the actual tower design may be different from the one used in the estimates and the performance of the actual towers may be considerably different. In particular, the estimates during the extreme cold month conditions are only qualitative values which indicate that the circulating water might freeze. However, these estimates do indicate the approximate temperatures, air flow rates, and evaporation rates that might be expected.

The amount of makeup water taken into the cooling system must equal the amount of water discharged to the air plus the amount of blowdown water discharged. Present plans call for the makeup water to be withdrawn from Sandusky Bay and the blowdown discharged back into the Bay. The amount of blowdown depends on the allowable build-up of dissolved solids in the circulating water. It is presently believed that the allowable build-up of dissolved solids will be somewhere between a factor of 2 to 5 so that the amount of makeup water required will be 25 to 100 percent greater than the water evaporated and the amount of blowdown will be 25 to 100 percent of the water evaporated. Table 5.1.2 contains estimates of the makeup water requirements, evaporation rates (water discharged to the air since drift is assumed to be negligible), and blowdown rates for a single cooling tower based on the evaporation rates shown in Table 5.1.1.

The blowdown may have a temperature different than the Bay. Since the calculations used to estimate tower operating characteristics assumed the temperature of the blowdown is equal to the cold water return temperature, the blowdown temperatures would be the same as the cold water return temperature given in Table 5.1.1. The blowdown will be further cooled in a canal or series of holding ponds which will have a surface area of

TABLE 5.1.1. ESTIMATED OPERATING CHARACTERISTICS FOR ONE NATURAL DRAFT COOLING TOWER AT THE SITE(a)

Month	Air Temp F	Relative Humidity	Air Flow Rate 10^5lb/sec	Cold Water Return Temp F(d)	Evap Rate GPM
			AVERAGE MONTHLY CONDITIONS(b)		
JAN	28.8	0.78	1.890	53.9	8501
FEB	29.4	0.76	1.878	54.3	8620
MAR	37.5	0.74	1.760	60.3	9723
APR	47.9	0.68	1.595	67.6	11157
MAY	59.3	0.67	1.423	75.9	12456
JUN	69.9	0.68	1.270	83.9	13431
JUL	74.6	0.65	1.188	87.1	13916
AUG	72.8	0.67	1.224	85.9	13710
SEP	66.5	0.68	1.320	81.3	13122
OCT	55.0	0.70	1.496	73.0	11915
NOV	42.2	0.73	1.690	63.7	10340
DEC	31.5	0.75	1.847	55.8	8919
			EXTREME MONTHLY CONDITIONS(b,c)		
JAN	-16	0.68	2.456	16.8	2998
FEB	-15	0.70	2.446	17.8	3087
MAR	-3	0.64	2.301	28.2	4473
APR	14	0.61	2.076	42.0	6755
MAY	32	0.59	1.814	55.5	9302
JUN	104	0.73	0.825	111.0	15426
JUL	105	0.72	0.805	111.6	15484
AUG	105	0.74	0.820	111.9	15443
SEP	99	0.74	0.898	107.0	15185
OCT	22	0.59	1.961	48.0	7908
NOV	0	0.66	2.265	30.7	4825
DEC	-13	0.71	2.423	19.6	3280

(a) Tower is 500 feet high, 520 feet in diameter at base, 275 feet in diameter at the throat and has a heat load of 2.37 million Btu/sec.

(b) Based on Sandusky, Ohio observations.

(c) Extreme high temperature June through Sep. Extreme low temperature Oct through May.

(d) See Appendix N for conversion of farenheit to centigrade.

TABLE 5.1.2. MAKEUP, BLOWDOWN AND EVAPORATED WATER RATES FOR ONE EVAPORATIVE COOLING TOWER AT THE SITE

lonth	Air Temp F(c)	Relative Humidity	Water Discharged To Air 10^3GPM	Makeup Water 2 Concentrations 10^3GPM	Makeup Water 5 Concentrations 10^3GPM	Blowdown Water 2 Concentrations 10^3GPM	Blowdown Water 5 Concentrations 10^3GPM
				AVERAGE MONTHLY CONDITIONS(a)			
JAN	28.8	0.78	8.5	17.0	10.6	8.5	2.1
FEB	29.4	0.76	8.6	17.2	10.8	8.6	2.2
MAR	37.5	0.74	9.7	19.4	12.1	9.7	2.4
APR	47.9	0.68	11.2	22.4	14.0	11.2	2.8
MAY	59.3	0.67	12.5	25.0	15.6	12.5	3.1
JUN	67.9	0.68	13.4	26.8	16.8	13.4	3.3
JUL	74.6	0.65	13.9	27.8	17.4	13.9	3.5
AUG	72.8	0.67	13.7	27.4	17.1	13.7	3.4
SEP	66.5	0.68	13.1	26.2	16.4	13.1	3.3
OCT	55.0	0.70	11.9	23.8	14.9	11.9	3.0
NOV	42.2	0.73	10.3	20.6	12.9	10.3	2.6
DEC	31.5	0.75	8.9	17.8	11.1	8.9	2.2
				EXTREME MONTHLY CONDITIONS (a,b)			
JAN	-16	0.68	3.0	6.0	3.8	3.0	0.8
FEB	-15	0.70	3.1	6.2	3.9	3.1	0.8
MAR	- 3	0.64	4.5	9.0	5.6	4.5	1.1
APR	14	0.61	6.8	13.6	8.5	6.8	1.7
MAY	32	0.59	9.3	18.6	11.6	9.3	2.3
JUN	104	0.73	15.4	30.8	19.3	15.4	3.9
JUL	105	0.72	15.5	31.0	19.4	15.5	3.9
AUG	105	0.74	15.4	30.8	19.3	15.4	3.9
SEP	99	0.74	15.2	30.4	19.0	15.2	3.8
OCT	22	0.59	7.9	15.8	9.9	7.9	2.0
NOV	0	0.66	4.8	9.6	6.0	4.8	1.2
DEC	-13	0.71	3.3	6.6	4.1	3.3	0.8

) Based on Sandusky, Ohio observations.

) Extreme high temperature Jun. through Sept. Extreme low temperature Oct. through May.

) See Appendix N for conversion of farenheit to centigrade.

about 225 acres. The blowdown will then be discharged at low velocity into the Bay. The temperature of this discharge should be compared with the temperature in the Bay in order to estimate the possible effects on the aquatic ecosystem. At present there have not been enough temperature measurements made in the Bay near the Site to determine monthly average temperatures of the Bay in this area. A full year's (1970) temperature measurements have been made near Gypsum (Scholl, 1971). Recent measurements at stations throughout the western basin indicate little difference between locations so that the Gypsum measurements should be representative of the Site. The calculated blowdown temperatures, discharge temperatures, and monthly average water temperatures are given in Table 5.1.3. The discharge temperatures shown in Table 5.1.3 were calculated by a method suggested by Brady, Graves, and Geyer (1969).

Table 5.1.3 also shows estimates of the difference between the discharge temperature and the temperature of the Bay as represented by measurements near Gypsum. During average monthly conditions, the maximum difference is about 12 F (6.7 C) and occurs in March. For extreme monthly conditions the maximum difference is about 29 F (16 C) in summer. The calculated discharge and blowdown temperatures should only be considered as preliminary approximations of the actual operating characteristics. In particular, those estimates which predict water temperatures below freezing are only qualitative and simply indicate the water might freeze at those conditions.

5.1.1.2 Effects of the Cooling Tower Blowdown on the Temperature of Sandusky Bay

In order to predict the effects of the cooling tower blowdown on the temperature of Sandusky Bay, one must have adequate information on the temperature and flow rate of the blowdown, the temperature and velocity of the water in the Bay, and the air temperature, windspeed, and relative humidity over the Bay. However, only approximate or incomplete information is available at present and, consequently, only preliminary estimates of the temperature effects can be made at this time. It therefore is not appropriate to investigate all possible situations and only a few were selected in order to bracket the expected range of effects.

TABLE 5.1.3. ESTIMATED BLOWDOWN TEMPERATURES, DISCHARGE TEMPERATURES, WATER TEMPERATURES, AND TEMPERATURE DIFFERENCES

Month	Air Temp F(e)	Relative Humidity	Wind Speed MPH	Blowdown Temp F(e)	Discharge Temp,F(a) 2 Conc.	5 Conc.	Water Temp at Gypsum	Temp. Diff., F(2 Conc.	5 Conc.
				AVERAGE MONTHLY CONDITIONS(c)					
JAN	28.8	0.78	10.8	53.9	34.2	31.7	33.2	1.0	-1.5
FEB	29.4	0.76	10.9	54.3	37.7	35.6	34.1	3.6	1.5
MAR	37.5	0.74	11.3	60.3	47.7	46.1	35.7	12.0	10.4
APR	47.9	0.68	10.6	67.6	59.0	57.9	51.8	7.2	6.1
MAY	59.3	0.67	9.0	75.9	71.4	70.7	65.3	6.1	5.4
JUN	69.9	0.68	8.1	83.9	80.8	80.4	71.8	9.0	8.6
JUL	74.6	0.65	7.6	87.1	83.4	82.9	73.5	9.9	9.4
AUG	72.8	0.67	7.6	85.9	80.8	80.0	74.9	5.9	5.1
SEP	66.5	0.68	8.4	81.3	72.8	71.5	69.6	3.2	1.9
OCT	55.0	0.70	9.3	73.0	60.4	58.5	56.1	4.3	2.4
NOV	42.2	0.73	10.9	63.7	46.0	43.5	42.1	3.9	1.4
DEC	31.5	0.75	10.6	55.8	35.4	32.6	33.0	2.4	-0.4
				EXTREME MONTHLY CONDITIONS(c,d)					
JAN	-16	0.68	10.8	16.8	-17.3	-18.1	32	-49.3	-50.1
FEB	-15	0.70	10.9	17.8	-12.9	-13.7	32	-44.9	-45.7
MAR	- 3	0.64	11.3	28.8	3.4	2.2	32	-28.6	-29.8
APR	14	0.61	10.6	42.0	34.8	34.0	39	-4.2	-5.0
MAY	32	0.59	9.0	55.5	54.9	54.8	57	-2.1	-2.2
JUN	104	0.73	8.1	111.0	106.0	105.5	77	29.0	28.5
JUL	105	0.72	7.6	111.6	107.3	106.9	79	28.3	27.9
AUG	105	0.74	7.6	111.9	105.7	105.2	80	25.7	25.2
SEP	99	0.74	8.4	107.0	98.9	98.1	73	25.9	25.1
OCT	22	0.59	9.3	48.0	34.2	32.3	52	-17.8	-19.7
NOV	0	0.66	10.9	30.7	-7.2	-9.1	31	-38.2	-40.1
DEC	-13	0.71	10.6	19.6	-13.6	-14.6	31	-44.6	-45.6

(a) Temperature of discharge for either a factor of 2 or 5 concentration of dissolved solids.

(b) Difference between discharge temperature and Gypsum temperature for factor of 2 or 5 concentration of dissolved solids.

(c) Based on Sandusky, Ohio, observations.

(d) Extreme high temperature June through September. Extreme low temperature October through May.

(e) See Appendix N for farenheit to centigrade conversions.

In view of the preliminary nature of these estimates, a simple mathematical model was used to predict the isotherms in the Bay resulting from the blowdown discharge. This model is adequate to describe thermal dispersion and convection in a shallow bay which can be assumed to be homogeneously mixed in the vertical direction and, in differential form is,

$$V \, \partial T/\partial X = A \, \partial^2 T/\partial y^2 \qquad (5)$$

where T is the temperature in the Bay at any point, F

X is the longshore distance from the point where the blowdown is discharged, ft

y is the offshore distance, ft

V is the longshore current, ft/sec

A is a dispersion coefficient, ft^2/sec.

A solution to Equation (5) for constant blowdown rate and temperature is

$$T = T_G + B(T_D - T_G)[\pi D^2 AVX]^{-1/2} \exp [-Vy_2/(4AX)] \qquad (6)$$

where T_G is the undisturbed temperature in the Bay (measured near Gypsum), F

T_D is the temperature of the blowdown discharge, F

B is the blowdown flowrate, ft^3/sec

D is the average depth of the Bay near the discharge point, ft.

Equation (6) can be rewritten in a form that locates the points on a given isotherm. This form is

$$y^2 = (4AX/V)\ln [B(T_D - T_G)/\sqrt{\pi D^2 AVX(T-T_G)^2}] \, . \qquad (7)$$

Examination of Equation (7) indicates that the maximum longshore distance for a given isotherm is

$$X_{MAX} = B^2(T_D - T_G)^2 \, [\pi D^2 AV \, (T - T_G)^2]^{-1} \qquad (8)$$

where X_{MAX} is the maximum longshore distance of the isotherm, ft.

At X = 0 and X = X_{MAX}, y is zero for a given isotherm indicating that the isotherms are curves which originate and end at the shoreline. The maximum offshore distance of the isotherm occurs at X = X_{MAX}/e and is

$$y_{MAX} = [4AX_{MAX}/eV]^{1/2} \qquad (9)$$

where y_{MAX} is the maximum offshore distance of the isotherm, ft. The surface area enclosed by the isotherm is

$$S_A = [2\pi e/27]^{1/2}\ y_{MAX}\ X_{MAX} = 0.795\ y_{MAX}X_{MAX} \qquad (10)$$

where S_A is the surface area enclosed by the isotherm, ft^2. Figure 5.1.1 is a generalized plot of Equation (7) showing the general shape of the isotherms.

Equations (8), (9), and (10) were used to calculate the maximum dimensions and surface area for the isotherm corresponding to a 3 F (1.7 C) temperature rise in the Bay resulting from the blowdown discharge. This isotherm is significant with respect to Ohio EPA regulations on thermal discharges. The results of these calculations are given in Table 5.1.4. The rates of blowdown discharge for two units are twice the values given in Table 5.1.2 and the temperatures of the discharge are the values given in Table 5.1.3. Other values used in the calculations are the average longshore current (about 0.15 ft/sec), the dispersion coefficient (about 1 ft/sec^2 which is in the range of values measured for lakes and large ponds), and the average depth of the Bay (3.93 ft).

Sandusky Bay would be expected to be considered as a lake with respect to Ohio EPA regulations on thermal discharges. The applicable portions of these regulations are:

> Lake water temperature shall not exceed by more than three degrees fahrenheit (1.7 degrees centigrade) the water temperature which would occur if there were no temperature change of such waters attributable to human activities. At no time shall water temperature exceed the maximum temperatures indicated below.

MAXIMUM ALLOWABLE TEMPERATURE IN DEGREES CENTIGRADE & FAHRENHEIT DURING MONTH

Water		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
All Waters Except Ohio River	C	10.0	10.0	15.6	21.1	26.7	32.2	32.2	32.2	32.2	25.6	21.1	13.9
	F	50	50	60	70	80	90	90	90	90	78	70	57

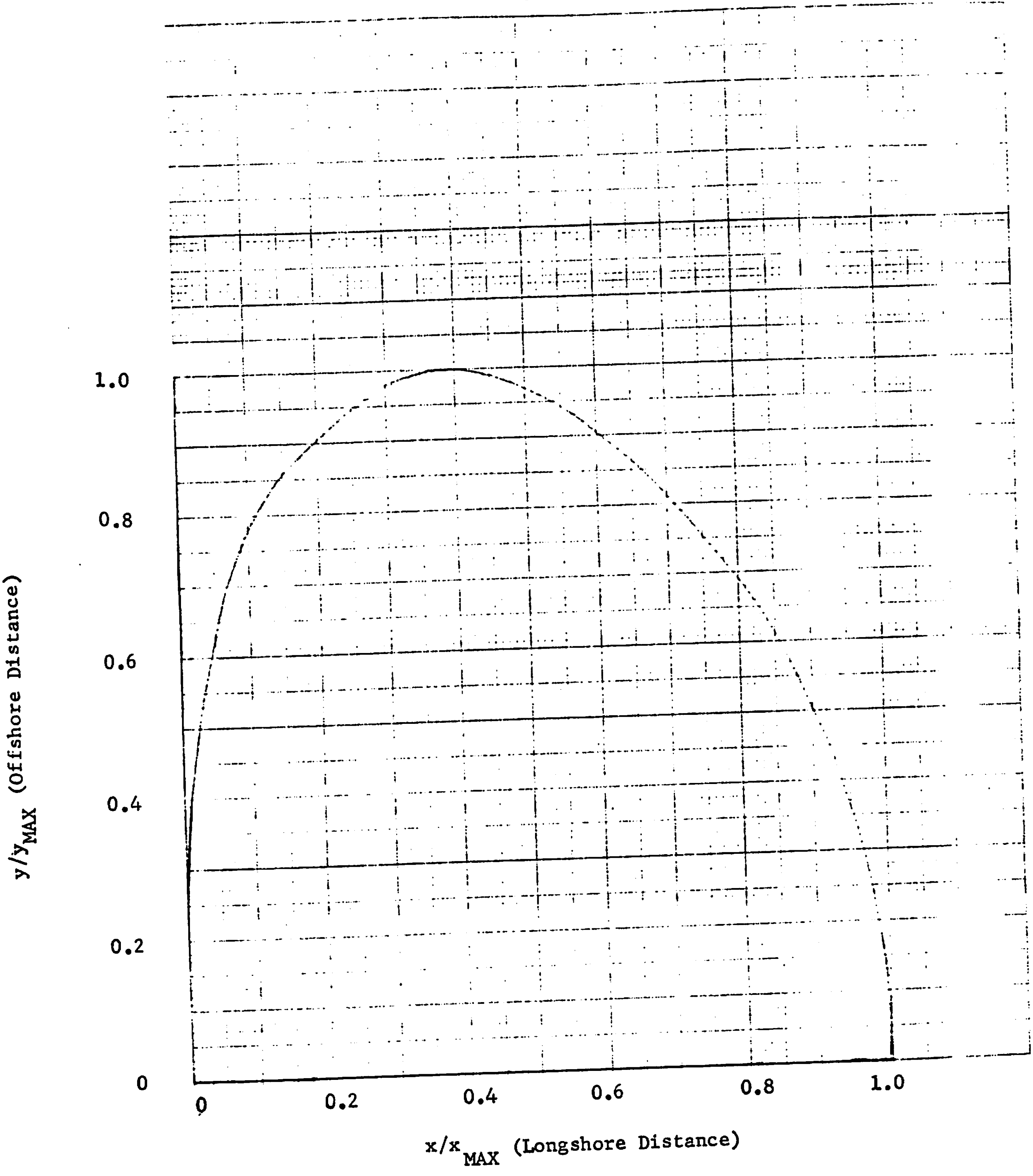


FIGURE 5.1.1. GENERALIZED SHAPE OF A THEORETICAL ISOTHERM

TABLE 5.1.4. MAXIMUM DIMENSIONS AND SURFACE AREA OF THE THEORETICAL ISOTHERM CORRESPONDING TO A 3 F (1.7 C) TEMPERATURE RISE IN THE BAY(a)

	2 Concentrations			5 Concentrations		
	Maximum Distance, ft		Surface Area, acres	Maximum Distance, ft		Surface Area, acres
Month	Longshore	Offshore		Longshore	Offshore	
Jan	0	0	0	0	0	0
Feb	291	53	0.28	0	0	0
Mar	4107(b)	201	15.05(b)	189	43	0.15
Apr	1971(b)	139	5.00	88	29	0.05
May	1762(b)	131	4.23	85	29	0.04
Jun	4409(b)	208	16.74(b)	244	49	0.22
Jul	5740(b)	237	24.87(b)	328(b)	57	0.34
Aug	1980(b)	139	5.04	91	30	0.05
Sep	533(b)	72	0.70	0	0	0
Oct	794(b)	88	1.28	0	0	0
Nov	489(b)	69	0.62	0	0	0
Dec	0	0	0	0	0	0

(a) Calculations are for two towers operating at average monthly weather conditions based on Sandusky, Ohio observations, a longshore current of 0.15 ft/sec, and a dispersion coefficient of 1 ft^2/sec.

(b) Theoretical isotherm exceeds allowable extent in any direction (300 ft) or surface area (12 acres) of mixing zone.

These temperature limitations apply beyond a defined mixing zone. The regulations define the allowable mixing zone for a lake as follows. No mixing zone in an inland lake shall . ..

(a) extend in any direction more than 300 feet from the point of discharge,
(b) include hypolimnetic waters,
(c) include spawning or nursery areas of any indigenous aquatic species,
(d) include a drinking water supply intake.

Within this mixing zone, the following temperature limitations apply:

> Water temperature at any depth shall not exceed natural water temperatures outside the mixing zone by more than 15 degrees fahrenheit (8.3 degrees centigrade) during the months of May, June, July, August, September, and October or by more than 23 degrees fahrenheit (12.8 degrees centigrade) during the months of November, December, January, February, March and April.

Upon comparing these regulations with the estimates in Tables 5.1.3 and 5.1.4, it can be seen that the predicted blowdown discharge falls within most of the limitations during average monthly conditions if the towers are operated with a factor of 5 concentration of dissolved solids. The only exception is the maximum longshore extent of the mixing zone during July which may barely exceed the allowable 300 feet. With a factor of 2 concentration of dissolved solids, the isotherm corresponding to a 3 F (1.7 C) temperature rise may exceed the allowable extent for a mixing zone in the longshore direction during most of the year and may exceed the allowable surface area (12 acres) during March, June, and July. During extreme monthly conditions, the thermal discharge may exceed several of the thermal limitations at both concentration factors but no isotherm calculations were made due to the uncertainty in the predictions of the tower performance.

5.1.1.3 Effects of Cooling Tower Blowdown on Total Dissolved Solids Loading in Sandusky Bay (See Section 5.4)

5.1.2 ECOLOGICAL EFFECTS

5.1.2.1 Fishes

Reutter and Herdendorf (1973) studied the seasonal temperature preference of some Lake Erie fishes in order to predict how such fishes might react to the thermal plume of the Davis-Besse reactor. Table 5.1.5 shows their results. For purposes of predicting the heat preferences of Sandusky Bay fishes, it can be assumed the species living in the Bay are part of the same Lake population. From this preference data, it can be seen that most species found in the Bay and Lake prefer temperatures close to ambient or slightly higher.

It can be seen from the preference data that the fishes of the Bay would avoid the plume from March through October. All species would be attracted to the plume in the winter months of November, December, January, February, and March. The attraction would be greatest when the difference between temperature preference and ambient Bay temperature is greatest. During spring and fall months fishes would probably be attracted to the periphery of the plume.

The gizzard shad (Dorosoma cepedianum) and freshwater drum (Aplodinotus grunniens) are quite sensitive to heat changes and might be affected by the suddenness of temperature change in being attracted into the plume (Reutter and Herdendorf, 1973).

The walleye (Stizostedion vitreum) and white bass (Marone chrysops) both migrate through the Bay in route to the Sandusky River. Walleye and white bass spawn in the Sandusky River in the vicinity of the City of Fremont, (Chapman, 1955). The small area of water in the western basin to be affected is so small, it is doubtful that the migration of the above species will be changed. For these species of fishes spawning in the western basin, particularly in the vicinity of the heated discharge, the survival of eggs and fry,

TABLE 5.1.5. MEAN TEMPERATURE PREFERENCE OF LAKE ERIE FISH SPECIES BY SEASON
(From Reutter and Herdendorf, 1973)

	Winter ≤5.5 C			Spring 5.5 C-20.0 C			Summer ≥20.0 C			Fall 20.0 C-5.5 C		
	No.	Pref		No.	Pref		No.	Pref		No.	Pre	
Species Tested	Tested	C	F	Tested	C	F	Tested	C	F	Tested	C	F
<u>Alosa pseudoharengus</u>				11	21.2	(70.2)						
<u>Ambloplites rupestris</u>[(a)]							9	18.7	(65.7)	5	5	(71.2)
<u>Aplodinotus grunniens</u>							60	26.7	(80)	1	19.6	(67.3)
<u>Carassius auratus</u>	12	23.0	(71.6)				7	25.8	(78.4)	1	24.0	(75.2)
<u>Carpiodes cyprinus</u>										1	22.1	(71.8)
<u>Catostomus commersoni</u>										3	22.4	(72.3)
<u>Cyprinus carpio</u>				4	25.2	(77.4)	9	29.7	(85.5)			
<u>Dorosoma cepedianum</u>										24	22.3	(72.1)
<u>Ictalurus natalis</u>							22	28.3	(82.9)			
<u>I. nebulosus</u>				24	22.6	(72.7)	20	25.2	(77.4)	5	23.6	(74.5)
<u>I. punctatus</u>							134	25.2	(77.4)	30	24.4	(75.9)
<u>Lepisosteus osseus</u>							2	27.5	(81.5)			
<u>Lepomis gibbosus</u>							7	25.0	(77)	9	26.9	(80.4)
<u>L. macrochirus</u>	20	27.4	(81.3)									
<u>Micropterus d. dolomieui</u> (YOY)[(c)]	13	18	(64.4)	4	19-24	(66.2-75.2)	19	31	(87.8)	2	24-27	(75.2-80.6)
<u>M. d. dolomieui</u> (AD)[(c)]	2	12-13	(53.6-55.4)	4	15-16	(59-60.8)	2	30	(86)	4	21-23	(69.8-73.4)
<u>Morone chrysops</u>							17	21.6	(70.9)			
<u>M. chrysops</u> (YOY)[(c)]	18	10-13	(50-55.4)	15	16-18	(60.8-64.4)	23	31	(87.8)	55	28	(82.4)
<u>M. chrysops</u> (AD)[(c)]	6	12-17	(53.6-62.6)	30	12-17	(53.6-62.6)	13	28-30	(82.4-86)	22	16-17	(60.8-62.6)
<u>Notemigonus crysoleucas</u>[(a)]	6	16.6										

TABLE 5.1.5. (Continued)

Species Tested	Winter ≤5.5 C No. Tested	Winter Pref C	Winter Pref F	Spring 5.5 C-20.0 C No. Tested	Spring Pref C	Spring Pref F	Summer ≥20.0 C No. Tested	Summer Pref C	Summer Pref F	Fall 20.0 C-5.5 C No. Tested	Fall Pre C	Fall Pre F
Notropis atheriniodes	35	9.3	(48.7)									
N. atheriniodes (YOY)(c)	89	10-12	(50-53.6)	52	13-15	(55.4-59)	95	22-23	(71.6-73.4)	76	13-14	(55.4-57.2)
N. atheriniodes (AD)(c)	40	5-6	(41-42.8)	40	16	(60.8)	27	22-24	(71.6-75.2)	33	15-17	(59-62.6)
N. hudsonius	15	10.2	(50.4)	27	14.2	(57.6)						
Noturus flavus	5	5.2(b)	(41.4)							13	25.1	(77.2)
Oncorhynchus kisutch				5	11.4	(52.5)						
Perca flavescens	33	13.8	(56.8)				61	21.0	(69.8)	21	19.9	(67.8)
P. flavescens (YOY)(c)	28	10-13	(50-55.4)	21	18	(64.4)	27	25-27	(77-80.6)	28	28	(82.4)
P. flavescens (AD)(c)	27	7-12	(44.6-53.6)	27	13-16	(55.4-60.8)	13	27	(80.6)	38	22-25	(71.6-77)
Pomoxis annularis	4	16.0	(60.8)	35	17.0	(62.6)	9	21.4	(70.5)			
P. nigromaculatus	20	19.3	(66.7)	55	21.0	(69.8)	49	21.4	(70.5)			

(a) Discrepancies that occur in this data are due to small sample sizes and tests run either in late spring or early fall when water temperatures are very close to 20.0 C (68 F).

(b) The reason for this extremely low value is undetermined.

(c) Barans and Tubb (1973).

AD = Adult

YOY = Young-of-the-year.

might be changed. Metabolic rates, growth rates, feeding rates, and/or swimming rates may be affected by increasing temperature.

The Critical Thermal Maximum (C.T.M. - the temperature at which the fish loses locomotor control) values for some Lake Erie species was also determined by Reutter and Herdendorf (1973). Table 5.1.6 shows the results of their tests on the local species.

From these data it is evident that from May through August, the highest temperature in the plume would approach or exceed the C.T.M. of all species of fishes in the Bay. In addition, in the fall and spring seasons, the highest plume temperature would be very close to the C.T.M. of most species. Carp (Cyprinus carpio), channel catfish (Ictalurus punctatus), bullheads (Ictalurus nebulosus), and bluegills (Lepomis sp.), having the highest C.T.M., would be least affected during the spring and fall in the Bay, having a comparatively low C.T.M. and would most likely be affected by the plume during summer.

Sudden changes in temperature are known to be as lethal to fishes as the extremes of their temperature tolerance. Cold shock (swimming from within the plume or having the plume disappear due to plant shut-down) and heat shock (swimming from ambient Bay water into the plume) could result in temporary immobilization of the fishes. Based on the data of Reutter and Herdendorf (1973) cold shock could occur during winter months when there exists the greatest difference between plume and ambient temperatures. They found that no fishes tested died from heat shock when ambient temperature was 16.5 C (61.7 F) or less. While they were testing for the effects for a plume 11 C (20 F) above ambient, results might be somewhat different in Sandusky Bay with higher temperature changes.

A fish entering the larger plume would seek a temperature close to its preference and avoid temperatures close to its C.T.M. thus, minimizing heat shock. Cold shock could be more critical, especially if the plume were to disappear due to plant shut down during winter.

TABLE 5.1.6. HIGHEST OBSERVED C.T.M. OF SPECIES TESTED IN HEAT SHOCK (From Reutter and Herdendorf, 1973)

Species	C.T.M. Summer or Highest Observed C	C.T.M. Summer or Highest Observed F	Ambient Temp. C	Ambient Temp. F	Season of Observation
Alosa pseudoharengus	28.3	(82.9)	16.4	(61.5)	spring
Ambloplites rupestris	31.2	(88.2)	14.6	(58.3)	spring
Amia calva	>29.0 but <35.5	(>84.2 but <96)	24.4	(75.9)	summer
Aplodinotus grunniens	34.0	(93.2)	21.2	(70.2)	summer
Carassius auratus	>34.3	(93.7)	25.6	(78.1)	summer
Carpiodes cyprinus	37.2	(99)	23.3	(73.9)	summer
Catostomus c. commersoni	>29.9	(>85.8)	14.3	(57.7)	fall
Cyprinus carpio					
Carassius auratus	25.3	(77.5)	9.3	(48.7)	fall
Cyprinus carpio	39.0	(102.2)	23.3	(73.9)	summer
Dorosoma cepedianum	31.7	(89.1)	15.9	(60.6)	fall
Ictalurus natalis	35.0	(95)	19.7	(67.5)	fall
I. nebulosus	37.1	(98.8)	23.5	(74.3)	summer
I. punctatus	36.5	(97.7)	22.7	(72.9)	summer
Icthymyzon unicuspis	31.6	(88.9)	4.5	(40.1)	winter
Lepomis gibbosus	34.2	(93.6)	21.0	(69.8)	summer
L. humilis	26.0	(78.8)	5.6	(42.1)	spring
L. macrochirus	36.0	(96.8)	22.5	(72.5)	summer
Micropterus d. dolomieui	>32.2 but <35.2	(>90 but <95.4)	23.1	(73.6)	summer
Morone chrysops	>34.4 but <36.0	(>93.9 but <96.8)	23.3	(73.9)	summer
Notemigonus crysoleucas	30.5	(86.9)	14.4	(57.9)	spring
Notropis atherinoides	27.1	(80.8)	10.5	(50.9)	spring
N. hudsonius	27.9	(82.2)	10.0	(50)	spring
Noturus flavus	29.0	(84.2)	1.6	(34.9)	winter
Osmerus eperlanus	24.9	(76.8)	6.0	(42.8)	spring
Perca flavescens	33.5	(92.3)	23.0	(73.4)	summer
Percopsis omiscomaycus	22.9	(73.2)	1.7	(35.1)	winter
Pimephales notatus	27.8	(82)	6.0	(42.8)	spring
Pomoxis annularis	>30.3 but <35.5	(>86.5 but <95.9)	24.4	(75.9)	summer
P. nigromaculatus	>30.0 but <34.5	(>86 but <94.1)	23.5	(74.3)	summer
Stizostedion v. vitreum	>34.4	(>93.9)	23.3	(73.9)	summer

Young-of-the-year emerald shiners (Notropis atherinoides) and perch (Perca flavescens) show a temperature preference slightly higher than the adults, particularly in winter and spring. Recognizing the Bay as a large nursery, these young fishes could be attracted to the plume more than their adult forms.

Reutter and Herdendorf (1973) found recovery rates as high as 93 percent for fishes placed back in ambient temperatures from shock. If a fish survivies shock, it might be more susceptable to secondary fungal infections (Horning and Pearson, 1973).

Eure and Esch (1973) in studying the effects of thermal effluents from the Savannah River Power Plant on helminth populations in smallmouth bass noted that the number of parasites per host was significantly higher in fishes taken from those areas with elevated water temperature as compared to those from normal areas. Water temperatures in the heated area for late summer and fall often exceeded 40 C (104 F) when the reactor was operating at high levels. Intermediate host populations were most dense at the heated end of Par Pond; therefore, the more food bass consumed in the area, the greater the chance for ingestion of an infected intermediate host.

Bourque and Esch (1973) noted that individual parasite species from emydid turtles reacted dissimilarly to the thermal modification of several aquatic habitats at the Savannah River Plant, Aiken, South Carolina. Nematode levels increased in heated river swamps but decreased in heated ponds when compared with similar natural habitats. Trematodes were adversely affected, but certain species of Acanthocephalans increased in heated habitats.

DeSylva (1969) noted that elevated water temperatures offer improved media for the growth, reproduction, and rate of infestation and infection of parasites and disease. Cited in his literature review is Brett's (1956) data on the near obliteration of sockeye salmon in the Columbia River from a combination of high temperature and bacterial infection. Using hatchery-reared salmon Ordal and Pacha (1967) found that higher water temperatures drastically increased the effect of kidney disease, furunculosis, vibrio disease, and columnaris in young fish. Fujihara and Hungate (1972) found that the incidence of the bacterium Chondrococcus columnaris (causative agent of columnaris) exposure and infection of fishes from the Columbia and Snake Rivers was, in most instances, clearly related to river temperatures above 13 C (55 F). Stround and Douglas (1968) and McGraw (1952), respectively, have reported an increased incidence of columnaris and furunculosis in the heated areas of the Columbia River (Borque and Esch, 1973).

An instance of favorable results from increased water temperatures has been cited by Amend (1970) who found that mortalities of sockeye salmon caused by the infectious hematopoietic necrosis virus (IHN) could be prevented by raising the water temperature to at least 18 C (64.5 F) within the first 24 hours after infection and maintaining the same temperature for 4-6 days. The disease did not recur after this treatment but the fish could become reinfected.

Based on the experimental evidence and other data cited in Section 2.7, the elevation of water temperatures even 2-5 C (4-9 F) during peak and non-peak periods of parasite and intermediate host activity will favor increases in infections of those fishes in the immediate area of cooling tower blowdown or holding pond discharges. Likewise, temperatures in the immediate vicinity of blowdown discharges will periodically exceed the CTM of some of the species residing in the Bay. However, the total area affected is quite small, and these effects are not expected to elicit widespread impact on the Sandusky Bay fisheries.

5.1.2.2 Benthos

Very little information is available on the minimum and maximum temperature tolerances for the Oligochaetes. Brinkhurst (1962) states that Branchiura sowerbyi is found in the Thames at Reading where water temperatures normally reach a maximum of 25 C (77 F). He further states that this is a tropical species with the ability to adapt to local situations. Temperature affects the respiration of Oligochaetes, for instance, tubificids are known to withstand anaerobic conditions for 48 days at 0-2 C (32-36 F) but only 9 days at 18-20 C (65-68 F) (Brinkhurst and Jamieson, 1971).

According to Curry (1962) the Chironomid larvae can generally tolerate seasonal fluctuations from 0 C to 33 C (32-92 F) with a few tolerating temperatures to 35 C (95 F).

Maximum temperatures in the plume would probably be lethal to Oligochaetes and Dipteran larvae. However, in mixing zones and lower temperature areas of the plume, the benthic organisms would probably survive and flourish.

The overall affect upon macro-invertebrate populations in the vicinity of the heated discharge, may amount to a decline in summer standing crops and an increase in standing crops in the winter. Stressing temperatures would eliminate some invertebrates in the periphery of the plume and most in the more heated zone. However, the area would be constantly reseeded by drifting eggs, larval movement, and storms moving the bottom substrate. During the winter months, the warm water of the plume would be attractive to many benthic species.

5.1.2.3 Phytoplankton

In general, the blue-green algae have more species that prefer temperatures from 35 C (95 F) upward, whereas the green algae have a relatively large number of species that grow best in temperatures ranging up to 35 C (95 F). Most of the diatoms species prefer lower temperatures, usually below 30 C (86 F). The natural seasonal succession of algal species is largely due to the fact that some species can out-compete others at specific temperatures.

One might expect the proliferation of blue-green species in and near the plume during the spring, summer, and fall months. Diatom species diversities would probably be reduced all but for the very coldest winter months. Since the blue-green algae are not as good as forage as other phytoplankton, this could result in a shift in species composition of first trophic level zooplankters.

A discussion of the influence of physical factors on primary productivity of phytoplankton in Sandusky Bay was presented in Section 2.7. Primary productivity reaches maxima during periods of high water temperature and increased solar insolation, i.e., during summer. That a thermal stimulation to photosynthesis might result from entrainment of phytoplankters and/or exposure to elevated temperatures in thermal plumes needs to be evaluated in terms of (1) effect of temperature on cellular integrity and (2) effect of temperature upon photosynthesis.

Howells (1969) found no significant damage to phytoplankton passed through the condensers of the Indian Point Power Plant. Patrick (1969) reported that the effect of condenser passage on phytoplankton was slight, if existent, at temperatures not higher than 34.5 C (94.1 F). Although cell integrity may have been maintained, evidence that primary productivity is retarded by exposure to condenser temperatures is available. Morgan and Stross (1970) found that (1) an increase of approximately 8 C (14.4 F) stimulated photosynthesis when water temperatures were 16 C (61 F) or cooler and (2) a similar increase in temperature when ambient temperatures were 20 C (68 F) or warmer inhibited photosynthesis. Fox and Moyer (1973) reported that primary production at the Crystal River Power Plant (Florida) decreased 25.9 percent when the thermal effluent was 5 C (9 F) above a 27 C (80.6 F) ambient.

Preliminary calculations of tower performance and blowdown temperatures indicate that for extreme monthly conditions blowdown temperatures will exceed 34 C (93.2 F) on occassion during June, July, August, and September; under average monthly conditions blowdown temperatures will not exceed 34 C (93.2 F). Discharge temperatures follow a similar pattern. The areas bounded by specific temperatures within the anticipated plume are not yet available.

It is expected that primary production by entrained phytoplankters and phytoplankters in the mixing zone will be enhanced during cool months and inhibited during summer due to exposure of elevated temperature. This prediction is based singly upon temperature effects and disregards the influence of other factors, which may be more influential upon primary productivity exhibited by phytoplankters entrained and by those in the mixing zone.

5.1.2.4 Birds

Blowdown water discharged into the Bay is expected to maintain only a small area (less than one acre) of open water during December and January, when the Bay is normally frozen for several weeks. However, the 200 acres of holding ponds are expected to remain ice-free all winter. Sandusky Bay and Lake Erie normally freeze about mid-December (Ohio Department of Natural Resources, 1971). Meeks (personal communication, 1974) believes that greater numbers of waterfowl such as Canada geese, mallards, black ducks, and common mergansers will overwinter (in addition to waterfowl presently overwintering) due to the open water maintained by blowdown. These birds may increase the depredations on surrounding agricultural fields. The Canada goose, in particular, may feed in winter wheat fields, as it did during the spring migration (See Section 2.7).

Meeks (personal communication, 1974) reports that waterfowl (sometimes in excess of 1,000 birds) utilize the Blue Hole and Miller's Blue Hole when surrounding water bodies are frozen. He feels that birds concentrated at these small areas of open water are potentially susceptible to the Dutch duck plague (also known as DVE or duck virus enteritis), which killed large numbers of wintering waterfowl at the Lake Andes National Wildlife Refuge, South Dakota, in the winter of 1972-73. This disease has not been reported in Ohio, but the Bureau of Sport Fisheries and Wildlife is concerned that the deadly virus might be spread through migrating flocks (National Wildlife Federation, 1973). If an outbreak of this disease should occur at the holding ponds or blowdown discharge area due to a build-up of waterfowl feces, control measures similar to those used at Lake Andes will be used as instructed by Federal or State biologists. This may include eradication with chlorine crystals and confinement of the overwintering population.

Canada geese have radically altered their migration routes in the past decade. This change is due mainly to a rapid adaption to newly created waterfowl refuges and feeding grounds (Bellrose, 1968). In fact, the States of Tennessee and Alabama have officially protested that Ohio is "short-stopping" the Tennessee Valley goose population at the expense of the hunters in those states (Ohio Department of Natural Resources, 1971). The open water resulting from the operation of two nuclear power plants could increase the number of geese that are "short-stopped". Hanson and Eberhardt (1971) concluded that nuclear reactors constructed in the proposed Hanford Reservation on the Columbia River in Washington "...would affect Canada geese by creating micriclimates of heat near reactor outfalls or cooling towers. These might be beneficial by stimulating growth of aquatic biota along shorelines by providing ice-free loafing areas, and by promoting the growth of green grass in areas of warm, moist air during winter months."

Any fishes impinged on the cooling water intake screen may result in a food source for bald eagles. Snow (1973) reports that these birds feed primarily on fishes, and dead or dying fishes are eaten as readily as live fishes. However, any unexpected impacts on fishes which would significantly lower their populations would have serious effects on the bald eagles and other piscivorous birds, such as great blue herons, great egrets, all three mergansers, and the belted kingfisher.

Collisions

A direct impact of the 500-foot cooling towers will be collision of birds against these tall structures. Mortalities will be more frequent during the spring and fall periods when small nocturnal migrants are in the vicinity. (see Section 2.7 for migration periods).

In recent years, ornithologists have reported an increasing number of instances of mass bird mortalities in the eastern and southern United States. The majority of these large kills involve songbirds, which migrate between their breeding and wintering ranges by flying at night. These reports describe bird impacts at such structures as ceilometers (Howell et al, 1954). Ceilometers are instruments used at airports to measure the height of the cloud ceiling. They consist of a 25-million candlepower beam of light produced by a mercury-vapor lamp.

Many nocturnal migrants have also been killed at tall buildings and lighthouses (Baldwin, 1965), or at tall smoke stacks, especially ones that are brightly illuminated (W. J. Richardson, Biologist, LGL, Ltd., unpublished data, 1973).

TV towers are particularly lethal to night-migrating birds due to the many supporting cables and guy wires. Examples of large kills at tall towers have been reported by Cochran and Graber (1958) for a 984-foot TV tower in Illinois, by Stoddard and Norris (1967) for a 1,010-foot TV tower in Florida, and by the U. S. Department of the Interior, Prairie Wildlife Research Center (1974) for a 1,200-foot navigation station tower in North Dakcta. Bird mortalitv at cooling towers on the Site would be expected to be somewhat greater than at Davis-Besse, since two 500-foot cooling towers are proposed.

Chandler Robbins, ornithologist, Bureau of Sport Fisheries and Wildlife (in Vosburgh, 1966), believes that a small number of towers located in certain geographic patterns could cause excessively high mortality among certain age-sex classes of a given species. If this were to occur, it could seriously affect the species breeding potential over a wide area. However, bird impacts recorded at natural draft cooling towers are numerically small in comparison to mortality at other structures. Annual bird kills were 3,000 at a Florida TV tower (Stoddard and Norris, 1967) and an estimated 2,149 at a North Dakota navigation tower (U. S. Department of the Interior, Prairie Wildlife Research Center, 1972a and b, 1973 and 1974). In comparison, kills at the preoperational Davis-Besse cooling tower and reactor buidling were only 157 during three migratory seasons (Vessey et al, 1974).

Major Migration Routes. The Lake Erie region is one of the most heavily travelled areas of bird migration in North America (Richardson, personal communication). For example, waterfowl migration corridors cross at Lake Erie between the Atlantic and Mississippi flyways (Bellrose, 1968). Also, two well-defined migration routes are used by non-waterfowl avian species in the southwestern Lake Erie area. The "island-hopping route" goes from the Catawba, Marblehead, Cedar Point areas across the Lake Erie islands to Pelee Point, Ontario. This route is used in both spring and fall by perching birds (Campbell, 1968:18).

During the spring, a second route swings westward across Maumee Bay near Little Cedar Point in Lucas County and follows the Lake Erie shores to the narrows near Detroit. In autumn, birds cross the lake at about the same place, but then they move southwestward in a broad lane which extends across much of Monroe and Lucas counties. This route is used by migrants such as crows, hawks, woodpeckers, swallows, and blackbirds (Campbell, 1968:18). These birds migrate largely by day. Most nocturnal migrants, on the other hand, move across Lake Erie on a broad front, with very little deviation caused by local land forms or shorelines (Richardson, personal communication).

Peak Migration Periods. In the spring, the heaviest songbird migrations take place during the last week of April and the first 3 weeks of May. Songbirds migrating during this period include warblers, flycatchers, and sparrows. Other bird groups migrating at this time are shorebirds and marshbirds (Campbell, 1968:26).

The fall migration of songbirds normally begins in late August, and continues through September and October. The warblers and flycatchers usually migrate first, followed by the sparrows and blackbirds (Campbell, 1968:27-28). The autumn migration is larger than in spring due to the addition of young birds of the year. Able (1973) determined by radar that the largest autumn flights occur during northerly winds, falling temperatures, and the anticyclonic weather that usually prevails after a cold front has passed through. However, in spring the major movements are usually in warm southerly air flows on the west side of high pressure centers.

Reasons for Collision. Birds are more or less likely to collide with tall structures depending on the height of migration, weather conditions, and attraction to lights, which may cause them to become disoriented.

Bellrose (1971) determined the height of nocturnal migrants by using a light aircraft equipped with auxiliary landing lights. He found that small nocturnal migrants had similar altitudinal distribution under both clear and overcast skies. Forty-eight percent of the migrants occurred at the 500- and 1,000-foot levels under clear skies, and 51 percent occurred at the same levels under overcast skies. He also found little difference between altitudinal distribution of migrants on spring and fall transects. About 50 percent of the nocturnal migrants during both periods were at the 500- and 1,000-foot levels, with very few small migrants at 5,000 feet or above.

Aerial observations agree fairly well with the information obtained by Gauthreaux (1972) from radar and direct visual observations of nocturnal migrants. He found that most nocturnal migration occurred between 800 and 1,600 feet.

Altitudinal information collected on small nocturnal migrants explains why structures above 500 feet high are responsible for most of the bird mortalities. However, tall structures which are under 500 feet may also be the site of bird kills when the weather is bad.

Most studies of large bird kills agree that they occur on nights when an advancing cold front in the autumn brings together adverse weather conditions such as lowered cloud ceilings, nocturnal migrants, and ceilometers and/or tall structures (Johnston and Haines, 1957; and Howell et al, 1954). Normally, heavy kills occur when birds begin a migratory flight under good conditions, but encounter worsening conditions in the vicinity of tall structures. These nights are usually moonless (Richardson, unpublished data).

Apparently birds are attracted to, and/or confused by, lights. Ceilometers are particularly lethal on nights with low cloud ceilings. Birds are attracted to the beam and become confused to the point where they collide with each other and with the ground (Howell et al, 1954). Even red warning lights are sufficient to attract migrants to towers on overcast nights (U.S. Department of the Interior, Prairie Wildlife Research Center, 1974; Cochran and Graver, 1958).

Towers and tall buildings which are lit by floodlights can attract and/or confuse nocturnal migrants. Many of these sites have reduced bird mortality by turning the floodlights off during migration periods (Vessey et al, 1974; Richardson, unpublished report; Vosburgh, 1966; and Baldwin, 1964).

Herbert (1970) believes that birds become spatially disoriented in a manner similar to human pilots. Birds use both visual and sensory cues for maintaining orientation in the air. Since the eyes are the predominant organ of spatial orientation, the visual cues are used by birds even if they disagree with the sensory cues. Weather situations which restrict birds' visibility are low ceilings with precipitation and/or fog. If birds flying under these poor conditions approach a bright light, the bird may accept the light as the true horizon and reorient itself accordingly. Under these conditions, a bird may become disoriented resulting in collision with structures such as stacks, buildings, or even the ground (Richardson, personal communication).

Specimens Collected. The vast majority of birds killed at towers are usually warblers, vireos, or sparrows. Richardson (unpublished data) found that warblers comprised 77 percent and vireos 15 percent of the birds killed at a tower on the Ontario shoreline of Lake Erie. The U. S. Department of the Interior, Prairie Wildlife Research Center (1974) reported that warblers and sparrows suffered the greatest losses at a navigation tower in North Dakota. The impact to waterfowl, however, was slight.

Johnston and Haines (1957) reviewed bird kills at 25 localities in the eastern United States. The ovenbird, (Seiurus aurocapillus), magnolia warbler, (Dendroica magnolia), red-eyed vireo (Vireo olivaceus),and chestnut-sided warbler (Dendroica pensylvanica) were the most frequently recorded species of more than 100,000 examined. A similar bird species composition was recorded at the Davis-Besse Nuclear Power Plant near Port Clinton, Ohio. Warblers, kinglets, and fringillids were the families most frequently represented (Vessey et al, 1974).

Loss of dead birds to scavengers may result in an underestimate of birds killed at towers. Studies of bird specimens placed at known locations indicate that losses to predators may vary considerably, depending on the area. The U. S. Department of the Interior, Prairie Wildlife Research Center (1974) found that of the 81 birds placed on sample areas, 8.6 percent were taken during the first night, 2.5 percent the second night, 3.7 percent the third night, and 8.6 percent after longer periods of time. In another study at the Davis-Besse power plant, 58 percent of the dead birds placed on the ground were eaten by scavengers during the 3-day study and an additional 8 percent were missing. It is not surprising that more specimens were eaten in the area by undisturbed marsh (Vessey et al, 1974).

At the navigation tower in North Dakota, the U. S. Department of the Interior, Prairie Wildlife Research Center (1974) found general agreement in relative abundance and dates of arrival between bird species observed during daytime field studies and birds killed at the tower. However, waterfowl, shorebirds, and blackbirds were abundant in the field and were almost absent from tower kills.

Examination of species killed at towers and ceilometers seem to be a random sample of the nocturnal passerine migrants to be expected at that time and place. Major species killed are those considered to be common summer residents or transients at that locality (Johnston and Haines, 1957; Howell et al, 1954).

Repellents. No repellents are presently available that can completely eliminate all bird mortalities at tall structures. However, elimination of floodlights has reduced mortalities at stacks (Richardson, unpublished data).

Intermittent lights (especially strobe lights) presently hold the most promise for reducing mortality at tall structures. Lighthouses in England where intermittent lights (one flash every ten seconds) were installed in place of a rotating, constant-beam light have completely eliminated bird kills (Baldwin, 1965). Apparently, the dark period between flashes is long enough to allow birds to reorient themselves, thus avoiding collision with the lighthouses. (Richardson, personal communication).

Although strobe lights were used during the day on the Davis-Besse cooling tower, they were not used at night because of possible disturbance to nearby residents. On the basis of recommendations by other researchers, however, Vessey et al (1974) suggest the use of strobe lights at night under rain and low ceiling conditions when migration is likely to occur.

Richardson (personal communication) recommends not only the use of strobe lights and elimination of floodlights directed upward, but several other lighting tests were also suggested. Red filters on floodlights were effective in reducing bird-tower impacts. However, this may have been due to the reduction in light intensity when the filters were in use, and not to the color of the filters. Other suggestions include use of diffuse ground lighting or ultra-violet "black" lights to reduce kills. Vosburgh (1966) also recommends filters on lights for reducing migration collisions.

The U. S. Department of the Interior, Prairie Wildlife Research Center (1971, 1972a and b, 1973, and 1974) tested an alarm system that produces a sound which is claimed to disrupt a bird's ability to receive and interpret acoustical information. Although testing was limited, it appeared that birds within a 100-foot radius responded by leaving the area of intense sound. As soon as the unit was turned off, the birds began to return almost at once. The units, Av-Alarm Model TAV-60, were purchased from Av-Alarm Corporation, Mountain View, California.

Lustick (1973) suggests that laser beams might be effective, since this form of energy does result in aversive responses, especially on birds that are normally nocturnal migrants. Best results were achieved with a focused beam laser, which also represents the greatest hazard to non-target species, including man. Lustick suggests additional experiments including variation of wave length combined with an acoustic repellent system.

Cooling Tower Bird Kills. Bird mortality data from the Davis-Besse cooling tower and reactor provides the best estimate of the impact on migratory birds resulting from the construction and operation of cooling towers at the proposed Site. Total bird kills were 157 at Davis-Besse for three migratory seasons. However, the plant is not operational yet. Air flow and falling water noise in the operational cooling tower may change the average number of birds killed each season (Vessey et al, 1966).

It is improbable that major mortalities of birds will occur due to impaction with cooling towers on the Site. Small numbers of bird-tower impacts will occur, but monitoring of these kills and testing of various equipment, such as lighting systems, should reduce the number to a level which is insignificant in comparison to natural forms of mortality in bird population.

5.2 RADIOLOGICAL IMPACT ON BIOTA OTHER THAN MAN

(To be prepared by AEPSC)

5.3 RADIOLOGICAL IMPACT ON MAN

(To be prepared by AEPSC)

5.4 EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES

5.4.1 PHYSICAL EFFECTS

The loss of water by evaporation from the cooling tower will increase the concentration of dissolved solids in the cooling water system. In order to keep this concentration at reasonable levels, it is necessary to remove some of the circulating water from the system and add makeup water in amounts equal to the amount removed and the amount evaporated. This removed water is called blowdown and the present plans call for this blowdown to be discharged back into the Bay.

It is presently believed that the allowable buildup of dissolved solids will be somewhere between a factor of 2 to 5. The normal concentration of dissolved solids in the Bay is on the order of 300 ppm. With the allowable buildup, the blowdown will be discharged with a dissolved solids content of from 600 to 1,500 ppm. Other chemicals may also be added to the circulating water and these will also appear in the blowdown. Chlorine will be added as a biocide and may appear in the blowdown at a concentration of about 1 ppm. Also, sulfuric acid will be added for pH control and the rate may be about 0.2 liter/min. for each tower. The minimum blowdown rate from Table 5.1.2 is about 800 gal/min. for each tower and this could result in a maximum increase in the sulfate ion concentration of about 100 ppm in the blowdown. The blowdown may contain other chemicals which may have been added to the cooling water or concentrated above their levels in the Bay, but the design of the cooling system has not progressed to the point where these can be estimated.

Present plans call for all nonradioactive wastes, except sewage, to be discharged with the cooling tower blowdown but the kinds and quantities of chemicals in these wastes have not been specified. However, the quantities are likely to be very small in comparison to those derived from the cooling system since the blowdown rate is much greater than the combination of all of these other flow rates.

A simple model, analogous to the one used for temperature, can be used to predict the concentration profile of waste chemicals discharged to the Bay. In terms of chemical discharges, this model is exceptions are that the maximum extent of the concentration isogram may possibly exceed the allowable extent of the mixing zone in the longshore direction. As in the case of the isotherms, calculations were not made for concentration isograms during extreme monthly conditions because of the uncertainty in the predictions of the tower performance. However, it is expected that the maximum longshore extent of the concentration isogram corresponding to a 150 ppm increase in dissolved solids will exceed the allowable extent during the summer months.

5.4.2 ECOLOGICAL EFFECTS

5.4.2.1 Fishes

McKee and Wolf (1963) recommended a total dissolved solids limit of 2,000 mg/l (or ppm) although the limiting concentration range appears to be from 5,000-10,000 mg/l dependent on the species and prior acclimation. In several instances McKee and Wolf indicated tolerance levels of specific fish for specific salts. A value of 4,000 mg/l chloride was listed as being harmful to bass, pike, and perch (all of which are present in Sandusky Bay). A value of 7,000 mg/l sodium chloride was listed as being lethal to most freshwater fishes. Eight-hundred mg/l calcium is listed as being lethal to the stickleback. While stickleback occur in a small tributary (Millers Blue Hole stream) to Sandusky Bay (Hille, 1954), it would not be affected by blowdown discharge.

Young (1923) studied the effects of specific salts on the perch (Perca flavescens), pumpkinseed (Lepomis gibbosus), and white sucker (Catostomus commersoni). For the species tested high concentrations of the specific salts are required to cause mortality. In the case of the pumpkinseed even high values were not lethal. The values used in these tests are higher by a factor of 5-16 times (with the exception of potassium chloride) than the projected total dissolved solids value of 800-1,600 ppm. The fact that none of these salts will be the only salt present, but a combination of salts will compose the total dissolved solids indicates that a total dissolved solids concentration of 800-1,600 ppm should not be lethal.

From the work of Clemens and Jones (1955), LT_{50} values were determined for several species of warm-water fishes to NaCl and Cl. For those species of fishes that occur in Sandusky Bay, chloride values from 33-67 times greater than the project chloride discharge level (160 ppm) would be required to cause death to 50 percent of the population.

Standard 96 hour bioassay was performed on perch taken from Sandusky Bay. The test concentrations were prepared from Bay water or Instant Ocean Synthetic Sea Salt. Three concentrations of total dissolved salts were prepared; a 5x concentration of Sandusky Bay water (accomplished by evaporating a large volume of Bay water), a 25x, and 50x concentration prepared from the synthetic sea salt. A control of x concentration (natural Bay water) was used as a standard. A partial chemical analysis of the Instant Ocean is given in Table 5.4.2.

TABLE 5.4.2. CHEMICAL ANALYSIS-INSTANT OCEAN SYNTHETIC SEA SALT

	25x	50x
Cl	4600 ppm	9,200 ppm
Na	2550 ppm	5,100 ppm
SO_4	625 ppm	1,250 ppm
Mg	300 ppm	600 ppm
K	92.5 ppm	185 ppm
Ca	92.5 ppm	185 ppm
HCO_3	35 ppm	70 ppm

$$C = C_G + B\ (C_D - C_G)\ [\pi D^2 AVX]^{-1/2}\ \exp\ [-Vy^2/(4AX)] \qquad (11)$$

where C is the concentration of the chemical in the Bay at any point, ppm

C_G is the normal concentration of the chemical in the Bay, ppm

C_D is the concentration of the chemical in the blowdown discharge, ppm.

All other variables are the same as those in Equation (6) and (7) in Section 5.1.2. The equations for the isograms of constant concentration are also analogous and, in generalized form, are identical to the isogram in Figure 5.1.1.

The equations for concentration isograms, analogous to Equations (8), (9), and (10) (see Section 5.1.2), were used to calculate the maximum dimensions and surface area of the concentration isogram corresponding to a 150 ppm increase in dissolved solids in the Bay. This concentration increase is significant with respect to Ohio EPA regulations and is the only comparison with the regulations that can be made at this time. The results of these calculations are given in Table 5.4.1. Since the blowdown rate is related to the factor of concentration increase, the term $B(C_D-C_G)$ in Equation (11) is identical for both 2 and 5 factors of concentration. All other parameter values are identical to those used to calculate the dimensions of the isotherms in Table 5.1.4.

The Ohio EPA regulations for dissolved solids which are assumed to be applicable to Sandusky Bay are:

> Dissolved solids may exceed one, but not both of the following;
>
> (1) 1500 mg/l
>
> (2) 150 mg/l attributable to human activities.

There is no specific reference to a mixing zone with respect to dissolved solids in the regulations but the mixing zone for thermal discharges and other pollutants is probably also applicable to dissolved solids.

Upon comparing these regulations with the maximum concentration of dissolved solids in the blowdown (1,500 ppm) and the results in Table 5.4.1, it can be seen that the blowdown discharge falls within most of the limitations set by the regulations during average monthly conditions. The only

TABLE 5.4.1. MAXIMUM DIMENSIONS AND SURFACE AREA OF THE THEORETICAL CONCENTRATION ISOGRAM CORRESPONDING TO A 150 PPM CONCENTRATION INCREASE IN THE BAY[(a)]

Month	Maximum Distance, ft Longshore	Maximum Distance, ft Offshore	Surface Area, acres
Jan	197	44	0.16
Feb	203	45	0.17
Mar	258	50	0.24
Apr	340(b)	58	0.36
May	423(b)	64	0.50
Jun	492(b)	69	0.62
Jul	528(b)	72	0.69
Aug	513(b)	71	0.66
Sep	470(b)	68	0.58
Oct	387(b)	62	0.44
Nov	292	53	0.28
Dec	217	46	0.18

(a) Calculations are for two towers operating at average monthly weather conditions based on Sandusky, Ohio observations, a longshore current of 0.15 ft/sec, and a dispersion coefficient of 1 ft^2/sec.

(b) Theoretical concentration isogram may exceed allowable extent in any direction (300 ft) of a mixing zone.

The fish weighed from 16.5-25.0 g and ranged in standard length from 10.24-13.12 cm. A total of 16 fish, four in each tank, were used. Observations began immediately after all 16 fish were transferred and continued at 15-minute intervals for 8 hours. After this time tanks were observed every 8 hours. Table 5.4.3 lists the experimental conductivity, total dissolved solids (TDS), pH, temperature, and salinity at the beginning of the test period. The conductivity, pH, and temperature were monitored at 8-hour intervals to maintain test conditions. Oxygen was at saturation. All values remained fairly constant during the 96-hour test. The values for these parameters at the end of the test are given in the second portion of Table 5.4.3.

Observations made during the first 8 hours indicated that the fish in tanks 3 and 4 (25x and 50x) were highly stressed. The fish surfaced for air, returned to the bottom, and then returned to the surface. The fish in the control and 5x tanks did not appear stressed nor did they exhibit any unusual behavior. By 25 hours all the fish in the 50x tank were dead. The fish in the 25x tank had acclimated to their habitat and no longer showed signs of stress.

When the fish in the 50x tank began to show signs of extreme stress the fish were transferred to freshwater. Three fish did not recover when transferred to freshwater. One fish recovered for a brief period. The fish contracted a body slime and died. At 96 hours all surviving fish were transferred to freshwater. There was no post-experimental mortality.

This experiment indicates that the TL_{50} (concentration at which 50 percent of the test organisms die) for perch lies between a total dissolved solids concentration of 7,200 ppm and 15,600 ppm. Both of these values are well above the anticipated discharge concentration of 800-1,500 ppm.

TABLE 5.4.3. SOME CHEMICAL AND PHYSICAL PARAMETERS OF TEST CONDITIONS (BIOASSAY) (*Perca* sp.)

Initial Values

Date: 2-10-74

Cond. (uohms)	TDS (ppm)	pH	Temp. °C *	Salinity %	Tank
500	300	8.4	14.0	1	x
2,500	1,500	8.0	14.0	2	5x
12,500	7,500	7.6	14.0	9	25x
26,000	15,600	7.8	14.0	20	50x

Values at Conclusion of Test

Date: 2-14-74

Cond. (uohms)	TDS (ppm)	pH	Temp. °C*	Salinity %	Tank
560	300	8.0	19.0	0	x
2,500	1,500	8.4	20.0	0	5x
12,000	7,200	7.8	18.0	0	25x
26,000	15,600	7.8	18.0	100	50x

* See Appendix N for centigrade-farenheit conversions.

The literature review and pilot bioassay appear to indicate that a total dissolved solids concentration of 800-1,600 ppm will not have a lethal effect on the Sandusky Bay fish population. However, the effects, if any, of increased total dissolved solids on the embryo and larval stages of fishes spawning in Sandusky Bay are not known. This point deserves consideration as the area is a spawing ground and nursery area (Hartmen, 1973) not only for Sandusky Bay fishes, but also for Lake Erie fishes.

5.4.2.2 Benthos

Clemens and Jones (1955) determined the toxicity thresholds for benthic invertebrates in NaCl at 96-hour exposures. Table 5.4.4 shows their values of median tolerable toxicity for NaCl and Cl for various benthic invertebrates.

TABLE 5.4.4. TLM_{96} FOR SELECTED BENTHIC INVERTEBRATE SPECIES

	NaCl (ppm)	Cl (ppm)
Cambarus (cray fish)	17,403	10,440
Lebelliudae (dragonflies)	15,943	8,639
Physa (pouch snail)	5,353	--
Diaphnia pulex (water fleas)	2,932	2,513

Under the conditions proposed for Sandusky Bay, none of the TDS toxicity levels for benthos would be reached.

While it is difficult to predict the ultimate effect of a 5x increase in TDS on the aquatic biota, the literature seems to indicate a beneficial effect on benthos populations. Threshold values for toxic effects in benthos and plankton populations are well above the estimated 800-1,500 ppm concentrations resulting from blowdown.

5.4.2.3 Phytoplankton

Increased levels of total dissolved solids in the blowdown may affect the phytoplankton of Sandusky Bay in the immediate vicinity of the discharge.

Northcote and Larkin (1956) found that at total dissolved solids levels above 100 ppm there were high volumes of plankton. Lakes with the highest total dissolved solids values, however, had low plankton volumes. Correspondingly, there were only sparce bottom fauna at total dissolved solids levels below 180 ppm. Moderate bottom fauna was found at all levels and high levels of total dissolved solids (above 120 ppm) produced abundant bottom fauna. This relationship is not, however, precise.

Patrick et al (1968) used Nitzschia lineris (a diatom found in Sandusky Bay) to test the effect of NaCl and KCl. Their results were: NaCl, 2,430; KCL, 1,337 ppm. At these levels there was a 50 percent reduction in diatom cells. Patrick et al's levels of toxicity and Anderson's are above the projected 5x total dissolved solids for Sandusky Bay for the NaCl in all cases but under for KCl, MgCl, and CaCl. However, the total dissolved solids concentration is not equal to any of these specific salt concentrations, but is composed of a mixture of salts. It is likely that no one salt will be concentrated to its specific level of toxicity by evaporative cooling.

Dissolved solids present in the cooling water will be concentrated due to evaporative water loss and will result in a buildup of total dissolved solids in the blowdown water ranging from approximately 600 to 1,500 mg/l. Additionally, chlorine will be added to the cooling water such that residual chlorine concentration in the blowdown water will be approximately 1 mg/l. Sulfate concentration, due to addition of sulfuric acid for pH control, will approach 100 mg/l in the blowdown.

Primary productivity in the discharge ponds is expected to be low due to the above chemical additions (Brook and Baker, 1972; Brungs, 1973). Information is not available at this time to calculate the residual chlorine concentrations in the mixing zone of the Bay. It is anticipated, however, that if a system of ponds and/or discharge canals precedes the outfall of blowdown to the Bay, then chlorine concentrations in the mixing zone should be considerable less than the 1 mg/l concentration in the blowdown released to the discharge ponds and/or canals.

5.4.2.4 Terrestrial Vegetation

As described in Section 6.1 a preliminary investigation was undertaken to determine if maximum loading of salts from the drift emanating from natural draft cooling towers could have any effect on oldfield vegetation of the Site. Changes in percent cover for the three species common to all quadrats in both spring and fall were tested (clover, Queen Anne's Lace, and grasses). These values were analyzed using a one-way analysis of variance to test for significant differences among the treatments and are listed in Table 5.4.5. None of the F-ratios were significant at the .10 level, but the

TABLE 5.4.5. ANALYSIS OF VARIANCE OF CHANGE IN PERCENT COVERAGE

Abbreviation in Text	Treatment Concentration	Number of Applications	Mean Change in % Coverage	Mean Separation	Standard Deviation	F-Ratio	Significance Level
			CLOVER				
C	1 x base solution	1	-13.3		16.1	1.86	0.17
F	5 x base solution	1	- 6.7		2.9		
D	1 x base solution	2	- 6.0		23.1		
E	1 x base solution	3	- 4.0		8.5		
B	1/2 x base solution	1	2.3		12.7		
A	0	0	16.7		2.9		
			QUEEN ANNE'S LACE				
C	1 x base solution	1	- 1.3		4.2	1.01	0.45
A	0	0	0.0		0.0		
F	5 x base solution	1	0.0		0.0		
E	1 x base solution	3	0.7		1.1		
D	1 x base solution	2	5.7		6.0		
B	1/2 x base solution	1	8.7		15.0		
			GRASS				
D	1 x base solution	2	5.3		5.5	1.13	0.39
A	0	0	10.3		25.4		
E	1 x base solution	3	28.6		18.6		
F	5 x base solution	1	31.6		32.5		
C	1 x base solution	1	32.0		23.6		
B	1/2 x base solution	1	36.6		5.8		

Duncan's Mean Separation Test Associated with the ANOVA for the change in percent coverage of clover, did show the control treatment to have a significantly higher mean (at level $\alpha = .0$) than any one of treatments F, C, D, and E. The control mean was a sizable positive number, indicating increase in coverage over the summer, whereas the means for treatments F, C, D, through E were all negative, indicating decreases in coverage. However, the mean for treatment B, which had the low salt concentration of .5, was not significantly different from any of the other treatment means. Also, treatments F, C, D, through E were not significantly different from one another.

The results of this investigation appear to agree with literature discussing the sensitivity of salt of certain species of clover (U.S.D.A. Handbook No. 60, 1954; Struzeski 008526, 1971; 011899, 1970). However, these analyses cannot be used to conclusively substantiate the literature, because the significance levels of the analyses were only marginal and few replicates were taken for each treatment. More replicates would be required to allow a definite statement concerning the sensitivity of clover on the Site to maximum potential drift loading rates.

Present indications are that there would be no statistically significant effect of maximum drift rates on the vegetation in the vicinity of the Site.

5.5 EFFECTS OF SANITARY AND OTHER WASTE DISCHARGES

Sanitary wastes and wastes from other plant components such as the demineralizer for supplying makeup water to the reactor primary and secondary systems will also be discharged. Some estimates of these discharges can be made by comparison with the Davis-Besse Plant (USAEC, 1972).

Regeneration wastes from the demineralizer may contain 6,600 ppm of dissolved solids and 7,500 gallons per week may be discharged from two units. This would amount to an average discharge rate of about 0.2 lb/min. The sewage treatment system may discharge liquid wastes containing 1 ppm chlorine at an average rate of 2 gpm or about $2x10^{-5}$ lb/min. Sewage will be treated by extended aeration plus chlorination, or more extensive treatment as the Ohio EPA may now require for such an installation in this region. The effluent from this sewage treatment plant will be discharged into Sandusky Bay through a separate outlet pipe. The quality of the discharge will be in conformance with all applicable State standards.

Nutrient and materials loading due to sanitary and other waste discharges attributable to the operation of two units on the Site will be infinitesimal in comparison to natural loading rates discussed in Section 2.7.2.

Thus, no significant effects on the aquatic ecology or water quality of Sandusky Bay are expected to result from sanitary or other waste discharges.

5.6 EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEM

(To be completed by AEPSC)

5.7 OTHER EFFECTS

Maintenance of the dike system for water level control will reduce flooding in the northwestern portion of the property. This will lead to a marked improvement in the habitat for wildlife by making more land available for foraging and cover. Control of the water level will prevent further losses of trees, shrubs, and herbaceous vegetation which is presently dying because of constant flooding. More land will also be available for waterfowl management in the marshes. Most animal species in the area will benefit from these practices; examples of beneficiaries are migrating waterfowl, breeding ducks (mallards, wood ducks, bluewing teal), marsh birds, deer, fox, squirrel, muskrat, rabbit, raccoon and snakes.

5.8 RESOURCES COMMITTED

Various types of human and earth resources would be committed or altered due to Site development. Some commitments would be of a virtually permanent nature, but the majority of commitments would be transitory. The exact relationship between transitory and permanent resource commitments would be related to the environmental impact of Site development and the type of decommissioning subsequent to the permanent shutdown of the facility. Decommissioning will include removal of superstructures, fuel, and reactor vessels, followed by filling in all cavities with clean rubble topped with soil to grade level. Differentiations between transitory and permanent resource commitments are made in the following categorization of various types of resource commitments which would occur with Site development followed by decommissioning as described above.

5.8.1 LAND USE COMMITMENTS

In the recent past, the prevalent land use at the Site has been for cultivation of cereal grains. The production capacity of the surface soil at the Site is significantly lower than average in Sandusky County. It is expected that Site development would remove the majority of the land from this type of use. However, the overall significance of its removal to the agricultural productivity of Sandusky County would be insignificant. We estimate that up to 300 acres of the 2,400-acre Site would be overlain by various buildings, cooling towers, ponds, etc., contingent to Site development. This acreage would be effectively removed from a biologically productive status for the lifetime of the facility constructed on the Site. It is expected that the majority of this acreage would undergo normal succession patterns to oldfield communities subsequent to decommissioning operations.

The Sandusky Bay shoreline on the Site has been privately owned in the recent past. Thus, there would be no change in access to Sandusky Bay due to the Site development. Likewise, no changes in land ownership and rights would occur due to Site development since the Applicant presently owns the land. Armament of the shoreline will be included in Site development and will represent a protection of a portion of the Sandusky Bay Shorline which has been historically subjected to extensive and rapid erosion (see Section 2.4).

5.8.2 CONSUMPTIVE WATER USE

It is anticipated that a facility with a power output of 3,000 megawatts on the Site would require a consumptive water use of up to 50,000 gallons per minute for heat dissipation. The majority of this evaporated water would typically be moved by prevailing southwesterly winds, as described in the meteorology section of this report. This means that the majority of evaporated water would move along the longitudinal access of Lake Erie. The maximum consumptive use approximates 0.3 percent of the total annual evaporation from Lake Erie. Some of this evaporated water would return to Lake Erie via precipitation within Lake Erie's watershed. Thus, the total evaporative loss from the entire hydrological system would be insignificant, and would occur only during the operational lifetime of the facilities constructed at the Site. Thus, there are no irretrievable commitments of water resources which would be associated with Site development.

5.8.3 METEOROLOGICAL/AESTHETIC RESOURCES

Several climatological alterations might occur due to the operation of the heat dissipation system. A certain degree of increased fogging within 5 miles of the Site would be expected, especially during the spring and summer months. In addition, slight additional snowfall in the immediate area of the Site would be expected during the winter months. However, it is not expected that the operation of cooling towers in this area would produce other than localized climatological alterations. These local alterations would occur only throughout the operation lifetime of facilities on the Site.

The aesthetic attributes of the Site and adjacent regions would be altered by the construction of cooling towers, buildings, etc., on the Site. Whereas the hyperbolic shape of cooling towers are architecturally pleasing, their immense height (in the general area of 500 feet) would be a very significant feature on the landscape in the area. Different individuals would react in different ways to the physical presence of these structures on the Site. However, the existing aesthetic attributes of the Site and adjacent regions are not very significant. Also, any or all aesthetic resource commitments that would occur due to the construction and operation of facilities on the Site would be readily retrievable subsequent to decommissioning. Thus, no irretrievable aesthetic resource commitments would occur due to Site development.

5.8.4 COMMITMENT OF ECOLOGICAL RESOURCES

5.8.4.1 Terrestrial

Operations on the Site will result in the loss of land and habitat occupied by buildings, roads, parking lots, holding ponds, and other structures. Elimination of woodlots will result in decreased food and cover areas for deer, squirrel, rabbit, mice and predatory animals. However, the land to be utilized by facilities is not very productive for mammals from a wildlife viewpoint. White-tail deer activity is centered on the west side of the Site, outside of the construction area. Fox squirrel usage of the area is also centered on the western portion of the area. Fencerow habitats which are utilized by rabbits, mice, and shrew and serve as feeding areas for fox, skunk, raccoon, and opposum will be reduced. This may cause a net decline in the local populations of all species utilizing the area. Individuals of the more mobile species will be displaced to other areas and survive to the extent that food and cover are available. Woodchucks will likely be displaced to adjoining areas without any major stresses to the populations.

The greatest impact to the mammal populations will be the removal of the fencerows and woodlots which will be permanently lost. Movement patterns of deer will be altered, reducing movement along the bay; and squirrel, rabbit, and small mammal populations will be reduced. However, the net result will be minor for wildlife since the adjacent land has similar wildlife use patterns and species and the area to be utilized is not optimum wildlife habitat.

Land occupied by buildings, roads, and other facilities will also be permanently lost as a habitat for reptiles and amphibians. Fencerows, woodlots, and drainage ditches which are eliminated will have the greatest impact on snake, turtle, and frog populations. The total impact on the populations on the Site and surrounding areas will be minimal as the animals are common in adjacent areas, and the numbers in the affected area are quite low due to agricultural practices.

It is improbable that major mortalities of birds will occur due to impaction with cooling towers on the Site. Small numbers of bird-tower impacts will occur, but monitoring of these kills and testing of various equipment, such as lighting systems, should reduce the number to a level which is insignificant in comparison to other forms of mortality in bird populations.

Presently, it is anticipated that Site development and subsequent decommissioning would not result in significant irretrievable losses of terrestrial ecology.

5.8.4.2 Aquatic

Essentially all organisms (plankton, fish eggs, larval fish, etc.) which are drawn into intake structures will be killed. However, since there will be low intake velocities at the intake crib, very few adult fishes are expected to be drawn in. In addition, some small fishes and plankton entrained in the blowdown plume might be disabled as a result of buffeting, thermal shock, or simply exposure to sublethal chlorine concentrations. Intake and/or discharge locations, however, are not expected to be of significance with respect to spawning areas in the immediate vicinity of the Site. Given the oftentimes extensive productivity of plankton populations, it is presently anticipated that plankton productivity would be sufficient to compensate for mortalities due to makeup water intake. Thus, the base of the food chain is not expected to be altered contingent with Site development.

5.8.5 COMMITMENT OF MINERAL RESOURCES

As in any large industrial project, considerable mineral resources would be committed to the construction of facilities on the Site. Concrete, for all practical purposes, would be irretrievable.

With the exception of the reactor vessel, much of the metal used in the construction of the Site facilities could be recovered as scrap for reuse subsequent to decommissioning.

The uranium-235 consumed during operation of facilities on the Site would be irretrievable, but some uranium-238 in the fuel would be converted to fissionable plutonium-239. Of this plutonium, a small amount would be consumed by fission in the reactor reducing slightly the consumption of uranium-235. The remainder could be recovered during fuel reprocessing and would contribute to the general reserves of fissionable material. Irretrievable commitments of uranium-235 resources due to Site operation would not represent a threat to the present domestic supply of uranium and would not foreclose present military and/or other uses of nuclear materials.

5.9 DECOMMISSIONING AND DISMANTLING

It is projected that the operational lifetimes of the two nuclear units on the Site will be approximately 40 years. Decommissioning will commence after these facilities have operated throughout this period, and will return practically all portions of the Site to their status prior to Site development.

Decommissioning will include removal of superstructures, fuel, and reactor vessels, followed by filling in all cavities with clean rubble topped with soil to grade level. Offshore intake and discharge structures above base level of Sandusky Bay will also be removed. Those structures beneath base level of the Bay will be left intact. Shoreline armament will also be left intact in order to continue the protection of the shoreline. The prospect of reduced shoreline erosion should thus be interpreted as an irretrievable commitment of about 2 miles of shoreline which will allow for future options regarding land use decisions on the Site.

The overall environmental consequences of decommissioning and dismantling the facilities are expected to be minor, although the overall effort involved in decommissioning will be significant. Some heavy construction equipment will have to be moved on-Site, but access can be provided by existing roads and the rail spur. Thus, no appreciable damage of natural habitats will occur. Effects on the aquatic ecology of Sandusky Bay are likewise expected to be negligible. Immediately subsequent to dismantling, those portions of the Site which had been developed will revert to conditions prior to Site development with two exceptions--shoreline armament will remain, and water level control dikes in the marshlands on the Site will remain. Both of these constitute long-term land-use improvements.

CHAPTER 6

EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 APPLICANTS PREOPERATIONAL ENVIRONMENTAL PROGRAM

6.1.1 SURFACE WATERS

6.1.1.1 Physical and Chemical Parameters

Ice Surveys

Aerial photographic surveys were conducted over Sandusky Bay to record detailed icing conditions. Photographic data were obtained on January 24 and February 20, 1974. A ground survey was also made on February 22. Initially, photo surveys were planned on a biweekly basis, and especially during periods of predominant icing conditions in the bay (75-100 percent ice). Weather conditions, however, prevented the scheduled overflights.

The aircraft photography was obtained with a vertically mounted Wild RC-8 cartographic camera with a focal length of 152-32 mm (6 inches) and 240 x 240 mm format (9.5 x 9.5 inches). The reconnaissance altitude of the aircraft was 12,000 and 5,000 feet. Panchromatic film was used in conjunction with a yellow filter to reduce atmospheric haze. Overlap between successive frames was 60 percent to provide stereo viewing. To augment the aerial photography, imagery obtained by NASA's Earth Resources Technology Satellite-I was also analyzed. The satellite imagery was obtained by a four-channel scanner system from an altitude of 1,034 km (600 miles) in the visible and near-infrared spectral range (0.5-1.1 micron). The photography was analyzed at photo scales from 1:1,000,000 to 1:24,000. The satellite photography shown in this report was recorded in the upper portion of the visible spectral band (0.6-0.7) and is roughly equivalent to the black and white aircraft photography (0.5-0.7). While satellite data taken from an altitude of 1,034 km (600 miles) do not display the photographic detail inherent in good aircraft photography, the multispectral data clearly reveal ice, snow, open water, major ice channels, and cracks. Ice-related aircraft and satellite imagery were obtained and analyzed for the following dates:

2-18-73 (ERTS-I)	1-24-74 (Aircraft)
12-22-73 (ERTS-I)	2-14-74 (ERTS-I)
1-8-74 (ERTS-I)	2-20-74 (Aircraft).

ERTS-1 and Skylab multispectral imagery were used to identify the gross circulation patterns in the Sandusky Bay area.

Water Quality

Water temperature of the Bay and tributaries was measured by using the thermistor of a YSI (51A) Oxygen probe. Water temperature of the flowing well at Bayshore was measured by using a standard laboratory thermometer.

Specific conductance was measured using a Beckman Solu Bridge with a field probe for on-site measurements. Data were recorded as umhos/cm at 25 C.

Transparency was measured using a standard limnological Secchi disc (20 cm diameter, Wildco). All readings were taken from the shaded side of a boat and expressed in centimeters.

Turbidity was measured in the laboratory by the use of a Hack Turbidometer. All samples were shaken vigorously for approximately one minute before placed in the turbidometer. All results were recorded in standard Jackson Turbidity Units (J.T.U.).

Dissolved oxygen was measured by using either the azide modification of the Winkler method or with a YSI (51A) Oxygen meter. Results are expressed in mg/l (ppm) dissolved oxygen.

The following parameters were measured using a Hack Chemical Company water analysis kit. The methods are Hack modifications of Standard Methods (APHA).

pH - colorimetric-wide range method

Alkalinity - direct titration method (APHA) and expressed as mg/l total alkalinity

Ortho-phosphate - ascorbic acid method with results expressed as mg/l phosphate (PO_4)

Nitrate-nitrogen - cadmium reduction method with results expressed as mg/l nitrate-nitrogen

Silica - Heteropoly Blue method with results expressed as mg/l SiO_2

Sulfate - turbidimetric method with results expressed as mg/l sulfate (SO_4)

Carbon dioxide - direct titration method (APHA) with results expressed as mg/l carbon dioxide.

Nutrient Budgets

During those periods when the productivity experiments were conducted, water samples were obtained from Sandusky Bay and selected inflow streams (see Figure 6.1.1) stored frozen, returned to BCL, and analyzed for total phosphate, dissolved phosphate, total organic nitrogen, nitrate-nitrogen, and total organic carbon. Duplicate samples were obtained from all stations and analyses were conducted on both samples.

Phosphates were analyzed using the stannous-chloride method outlined in Standard Methods (A.P.H.A, 1971).

Total organic nitrogen was determined by digestion of the sample following removal of free ammonia in Kjeldahl apparatus; final evaluation of organic nitrogen content was completed with a titration of ammonia in the distillate with standard 0.02N sulfuric acid. The ammonia was contained under boric acid and the titration end-point was indicated by a mixed indicator solution consisting of methyl-red and methylene-blue indicators.

The cadmium reduction method was used to determine inorganic nitrogen components in the water samples. This method (adapted from Hach, and discussed in Standard Methods) registers both nitrite and nitrate-nitrogen. Nitrate in the presence of cadmium is reduced almost completely to nitrite which is then analyzed colorimetrically. The final result is expressed as nitrate-nitrogen.

Analysis for total organic carbon was conducted with a Beckman infrared gas analyzer. Prior to analysis, particulate matter in the water sample was disrupted ultrasonically (Sonifer Cell Disruptor, Model W185). A microsample of the water to be analyzed was injected into a catalytic combustion tube enclosed by an electric furnace at 950 C. The water was vaporized and the carbonaceous material oxidized to carbon dioxide (CO_2) and steam in a carrier stream of oxygen. The oxygen flow carried the steam and CO_2 out of the furnace where the steam was condensed and the condensate removed. The CO_2, oxygen, and remaining water vapor entered an infrared analyzer sensitized to provide a measure of CO_2. The amount of CO_2 present was directly proportional to the concentration of carbonaceous material in the injected sample.

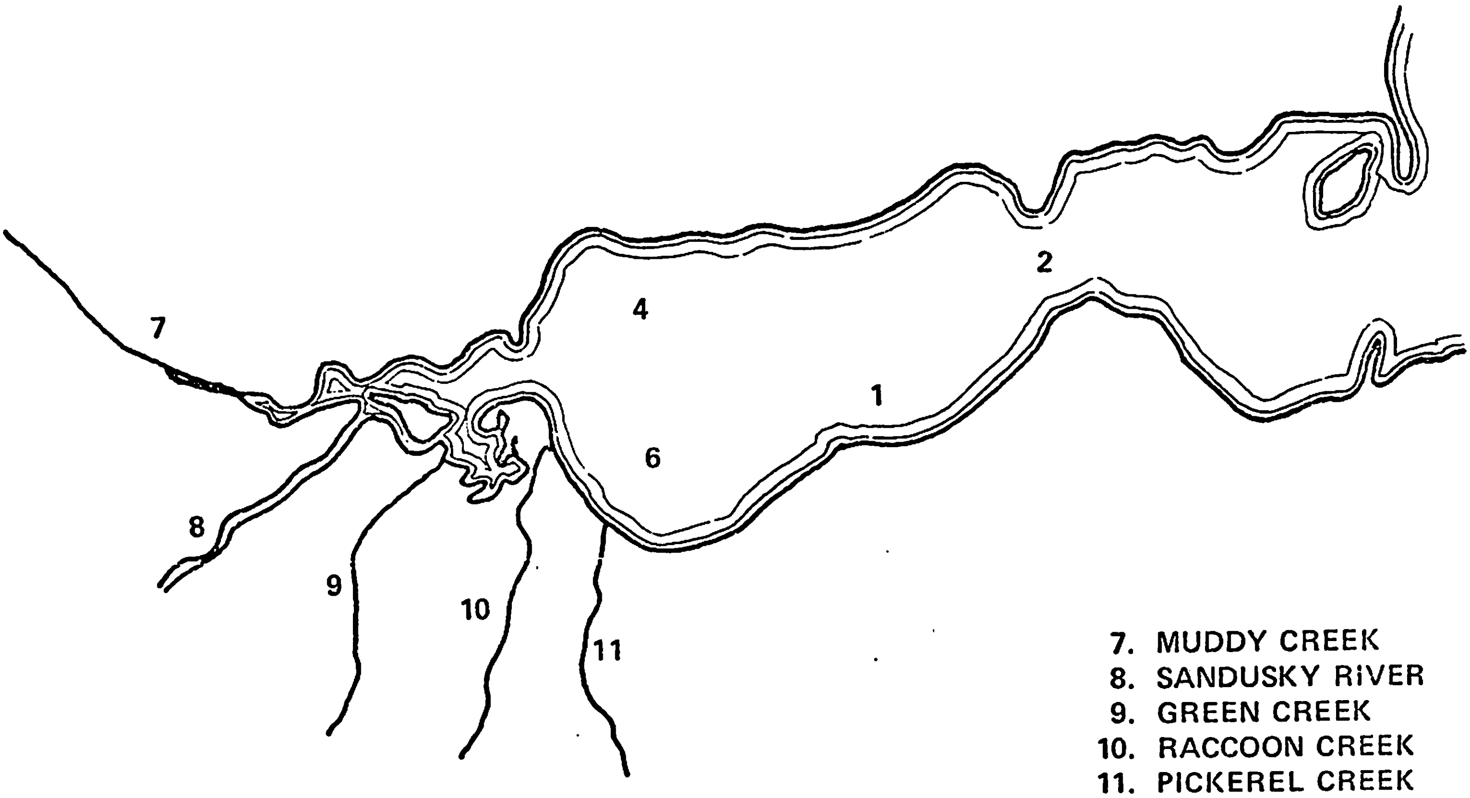


FIGURE 6.1.1. SANDUSKY BAY AND TRIBUTARIES WITH WATER SAMPLING STATIONS MARKED

6.1.1.2 Ecological Parameters

Sampling Program

Thirty-two sample stations were established in the southern half of the western basin of Sandusky Bay during Phase I. These stations were laid out in a one-square kilometer grid from the south shore to the middle of the basin. This saturation sampling was designed to disclose any significant differences that might exist in water-related parameters and associated biota. Figure 2.7.6 shows the position and number of the sample stations in the western basin of the Bay.

In addition, a series of five stations were established along the main channel of the Bay from the mouth of Muddy Creek Bay to the eastern basin between Johnson's Island and the City of Sandusky. Three of these stations were in the western basin, one in the central basin, and one in the eastern basin. Figure 2.7.7.shows the position and number of the mid-bay transect stations.

Two stations on Pickerel Creek were established; one at the junction of Route 6 (39) and the other at the junction of Route 247 (43). Two similar stations were established on Scherz Ditch (40-44).

Because of the great volume of work involved in saturation sampling and because of the lack of any really significant differences between stations in the one-kilometer grid, it was decided for the Phase II study to sample only eight stations. These stations were 5, 6, 8, on a north-south axis with the mouth of Pickerel Creek, 16, 17, and 19, on the same axis in the middle of the Site, and 29 and 31, on the same axis on the east end of the Site. In the present study these stations are referred to as the shore/near-shore stations.

The mid-bay stations as well as the tributary stations were continued in the Phase II study. In addition, three new stations were established for the Phase II study; Station 37, located on the north shore in the same axis with Stations 16, 17, and 19; Station 41 in the Millers Blue Hole stream close to the mouth of the Blue Hole itself; and Station 42 at the flowing well near Bayshore on Route 6.

The schedule used for sampling all stations is found in Table 6.1.1. Benthos was sampled monthly at all stations except the flowing well. Plankton was sampled monthly at two stations in the grid (17 and 21) and along the mid-bay transect. Water quality measurements were made monthly at all stations and biweekly at selected onshore, and near-shore and mid-bay stations. Fish samples were taken monthly, also at selected sites with different collecting gear.

Benthos

A total of 44 stations were sampled in Sandusky Bay and adjacent waters to determine (a) the spatial distribution of the benthic community, (b) species composition and density of standing crop, and (c) seasonal changes. Table 6.1.2 shows the schedule of benthic sampling from November, 1972, to March, 1974.

Most bottom samples from the Bay were taken with a 9 x 9-inch Eckman dredge (November, 1972, samples were taken with a 6 x 6-inch Eckman dredge and a Ponar grab sampler). Stream samples, except the Millers Blue Hole stream, were also taken with a 9 x 9-inch Eckman dredge. The Millers Blue Hole stream was sampled using a Surber stream bottom sampler (Welch, 1948).

Eckman samples were washed through a No. 40 U.S. Standard Sieve having a mesh opening of 0.42 mm. The material retained in the sieve was reverse-washed into a sample container and preserved with 10 percent formalin. Each sample was washed, in the laboratory, through a No. 50 Standard Sieve having a mesh opening of 0.297 mm. The sieve contents were reverse-washed into an enamel pan where the organisms were removed by hand with the aid of a 4 x magnifier. All organisms were placed in small shell vials and preserved in 80 percent ethanol.

Oligochaetes and Chironomid larvae require special preparation before identification can be accomplished. Chironomid larvae were placed in a super-saturated KOH for 48 hours, then washed and mounted on a slide with Hoyer's solution. Identification was made using head characteristics according to Mason, 1968. Oligochaetes were placed in a Lactophenol solution (Amen's solution) for 48 hours then mounted on a microscope slide for identification.

TABLE 6.1.1. SANDUSKY BAY SAMPLING PROGRAM

Parameters	Stations*																	
	5	6	8	16	17	19	21	29	31	33	35	36	38	39	40	41	42	37
Benthos (monthly)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plankton(1) (monthly)					X		X			X	X	X	X					X
Diatometers(2) (bi-weekly)					X		X							X	X	X		
Water quality samples (bi-weekly)					X		X			X	X	X	X	X	X	X	X	X
Water quality measurements (monthly)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fish fyke net (monthly)	X																	
Fish gill net (monthly)	X				X		X											
Fish trawl(3) (monthly)		X			X	X	X	X										X
Fish shore seine (monthly)	X			X				X						X	X			

Notes: 1. Vertical tow and whole-water sample.
2. Vertical tow at Stations 17 and 21.
3. Ten-minute trawl.

* Inland Station Locations:

39 - Pickerel Creek at U.S. Route 6.
40 - Scherz Ditch at U.S. Route 6.
41 - Miller Blue Hole Stream at head.
42 - Flowing well at Bayshore.
43 - Pickerel Creek at County Road 247.
44 - Scherz Ditch at County Road 247.

TABLE 6.1.2. SCHEDULE OF BENTHIC SAMPLES TAKEN FROM NOVEMBER, 1972 TO MARCH, 1974

Station	November, 1972	March, 1973	May, 1973	June, 1973	July, 1973	August, 1973	September, 1973	October, 1973	November, 1973	December, 1973	January, 1974	February, 1974	March, 1974
1	X				X					NO SAMPLE		NO SAMPLE	
2	X												
3	X				X								
4	X				X								
5	X	X	X	X	X	X	X	X	X		X		X
6	X	X	X	X	X	X	X	X	X		X		X
7	X				X								
8	X	X	X	X	X	X	X	X	X		X		X
9	X				X								
10	X				X								
11	X				X								
12	X				X								
13	X				X								
14	X				X								
15	X				X								
16	X	X	X	X	X	X	X	X	X		X		X
17	X	X	X	X	X	X	X	X	X		X		X
18	X				X								
19	X	X	X	X	X	X	X	X	X		X		X
20	X				X								
21	X	X	X	X	X	X	X	X	X		X		X
22	X				X								
23	X				X								
24	X				X								
25	X				X								
26	X				X								
27	X				X								
28	X				X								
29	X	X	X	X	X	X	X	X	X		X		X
30	X				X								
31	X	X	X	X	X	X	X	X	X		X		X
32	X				X								
33	X	X	X	X	X	X	X	X	X		X		X
34	X												
35	X	X	X	X	X	X	X		X				
36	X	X	X	X	X	X	X	X	X				
37				X	X	X	X	X	X		X		X
38	X	X	X	X	X		X	X	X				
39					X	X	X	X	X				
40					X	X	X		X				
41						X	X	X	X				
42													
43						X	X	X	X				
44						X	X	X	X				

Plankton and Periphyton

Plankton and periphytic diatom surveys of Sandusky Bay were conducted to assess both qualitative and quantitative aspects of these communities which play a vital role in the dynamics of higher trophic levels. Separate methods were used in the evaluation of plankton and of periphytic diatoms.

Plankton was collected at the dates and stations indicated in Table 6.1.1 by means of vertical and 100-foot horizontal tows with a plankton Sedgewicknet of Number 20 Silk bolting cloth. The vertical tows were used for quantitative evaluation while the 100-foot horizontal tows gave a good sample for qualitative work. The collected sample was preserved with 5 percent commercial formalin in the field and transported to the laboratory for processing. Samples were diluted to a known volume to facilitate counting of dense samples. A 1.0 ml sample was removed and placed in a Sedgewick-Rafter counting chamber (SR). Using a Whipple disc in an ocular lens of a Leitz Dialux microscope, the organisms in 25 random fields were identified and counted at 100X total magnification. Zooplankton was counted by organism; phytoplankton by cells except for filamentous and colonial forms given in Table 6.1.3 which were counted as shown. Organisms were identified to genus and species where possible at this magnification. The numbers of organisms in the 25 random fields were used to compute the number of organisms per liter.

Plankton samples were also examined for diatoms. A portion of each sample was washed and decanted to remove the formalin preservative, then cleaned by the method of van der Werff (1959) using 30 percent hydrogen peroxide and potassium dichromate. After thorough washing, the cleaned frustules were mounted in Hyrax. Burn mounts of planktonic diatoms were also made by placing material on coverslips, heated to 500 C for 3 hours and mounted in Hyrax. This method enabled the more weakly silicified diatom taxa of _Rhizosolenia_ _eriensis_, _Melosira_ _subsalsa_, and some small centric diatoms to be identifed.

Mounted diatom samples were then examined with a Leitz Dialux microscope equipped with 10X periplan, widefield oculars, a 100X 1.30N.A. oil immersion objective lens, and a 0.90N.A. condenser.

TABLE 6.1.3. ALGAE OF THE FOLLOWING GENERA WERE COUNTED AS INDICATED

Genus	1 =
Actinastrum	Colony
Anabaena	Filament
Aphanizomenon	Filament
Asterionella	Colony
Coelastrum	Colony
Diatoma	Colony
Dinobryon	Colony
Fragilaria	Filament
Melosira	Filament
Micractinium	Colony
Microcystis	Colony
Mougeotia	Filament
Oscillatoria	Filament
Pediastrum	Colony
Scenedesmus	Colony
Tabellaria	Colony

Periphytic diatoms were collected on artificial substrates of glass slides in diatometers on the dates and stations given in Table 6.1.1. The diatometers consisted of three standard microscope glass slides mounted in a plastic frame and suspended from a marker buoy. Slides from the diatometers were collected at approximately 3-week intervals during the study. The diatoms were removed from the slides by scraping with the sharpened wide end of a toothpick to minimize breakage of the frustules. The samples were then cleaned using the aforementioned method of van der Werff and mounted in Hyrax. From examination of diatom samples under 1000X, species and variety identification were made of the taxa encountered. Nanoplankton, other than what was found on the diatometer slides, was investigated as a special part of this study. Landacre (1908) found a total of 209 species of Protozoa in the Bay and its vicinity. In addition he found 25 species of Euglenas, two species of golden-brown algae, eight species of green algae, and seven species of yellow-brown algae.

Primary Productivity

The radioactive carbon technique was employed for determination of carbon fixation rates by pelagic phytoplankton. Although this technique is rather complex, its accuracy outweighs any disadvantages. The general work plan for primary productivity experimentation in Sandusky Bay included placement of water samples enclosed in glass bottles and "spiked" with aliquots of carbon-14 solution at six stations throughout Sandusky Bay. At each station water was obtained at 0.2 m, 0.8 m, and 1.4 m depths using a polyvinyl chloride (PVC) Kemmerer sampler. This water with its constituent phytoplankters was decanted into 125-ml Pyrex glass-stoppered containers which served as incubation bottles. At each station, three incubation bottles were used for each sampling depth; one bottle from each of the three 3-bottle sets was covered with a black polyethylene bag in order to exclude sunlight. The dark bottles were needed to determine uptake of ^{14}C by non-phototrophic organisms, i.e., heterotrophs. The contents of each incubation bottle was innoculated with 2 to 8 µCi of ^{14}C (the amount of ^{14}C needed varies with season) prior to in situ suspension. After addition of the isotope, the bottles were placed into holders designed specifically to hold three bottles in a horizontal position in the water. Researchers often suspend primary productivity incubation bottles in a vertical position by simply fastening the neck of each bottle to a metered line. Such positioning of the bottles, however, can yield lower primary productivity rates compared to values obtained from bottles placed or held in a horizontal position (Elster and Motsch, 1966, cited in Vollenweider, 1969; Ohle, 1958). Moreover, it was decided that experimentation in the turbid waters of Sandusky Bay required <u>in situ</u> suspension of the incubation bottles in a fashion allowing maximum light incidence. For these reasons a holder which supported bottles horizontally in the water column was fabricated. The bottles were inserted into the holders which were held in place by a system of lines, floats, and anchors and allowed to incubate within the water column of Sandusky Bay for 4 hours during midday.

Upon termination of the incubation period, the suspended bottles were removed from the Bay and their phytoplanktonic contents killed by the addition of formalin. This was done to stop active uptake or incorporation of ^{14}C by the phytoplankton. A portion (25 ml) of the contents of each bottle was filtered using Millipore HA filters (25 mm diam, 0.45 μ pore) and a filter manifold. The phytoplankton remained as a residue upon the filters and these, in turn, were air-dried, dissolved in a scintillation cocktail, and radioassayed using a Packard Tri-Carb scintillation counter. Primary productivity rates were computed from the count data obtained.

Concomitant with productivity measurements, several physical and chemical parameters of the Sandusky Bay environment were measured: alkalinity, pH, temperature, transparency of the water, and solar radiation. Water characteristics were determined at each station. Temperature was measured with a Yellow Springs Instrument Company telethermometer. Transparency was measured with a Secchi disc. Water samples were obtained at each station and returned to the field laboratory where pH was measured with a Beckman ChemMate Portable pH meter and total alkalinity determined potentiometrically (A.P.H.A., 1971). Care was taken to maintain these water samples at ambient Sandusky Bay temperature and to complete the analyses as soon as possible.

Solar radiation was measured in langleys/minute using a YSI Model 68 pyranometer equipped with a silicon solar cell and linked to a strip-chart recorder. Solar insolation was measured on those days when the productivity experiments were conducted. Data recorded on charts were converted to numerical data, langleys/incubation period, and langleys/12-hour day by using a K&E polar planimeter. These data were required for calculating photosynthetic rates on a daily basis. Pyranometer data allowed conversion of partial-day productivity rates to estimates of full-day values by the relationship suggested by Schindler (1971):

$$\text{Daily primary production} = \frac{I_o\text{, daily}}{I_o\text{, incubation period}} \times \begin{array}{l}\text{Primary production}\\ \text{during incubation}\end{array} \quad ,$$

where I_o = global radiation at the surface of Sandusky Bay and is assumed to be the same as at the pyranometer station.

Fishes

The fish population characteristics in Sandusky Bay were determined spatially and seasonally. In order to achieve this, a variety of catch gear was employed at 12 different stations in Sandusky Bay and inshore areas. The catch gear included

(1) 3000 x 6-foot commercial seine with 2-inch mesh
(2) 350-foot gill net with 2-inch mesh
(3) 100 x 6-foot bag seine (shore) with 1.2-inch mesh
(4) 125-foot gill net (experimental) with panels of 1, 1-1/2, and 2-inch mesh
(5) 4-foot-diameter fyke net
(6) 2-1/2-foot-diameter hoop net
(7) 50-foot trawl net.

Fishes were collected a total of six times throughout the study period. With the weather permitting, all stationary nets were emptied and pulled the day after they were set. Fishes taken from the nets were measured for total length and weight. For age, growth, and fitness determinations, several scales were removed from just above the lateral line. For the analysis of feeding habits, the fishes stomachs were removed and preserved. All appropriate information and fish parts were marked along with the sex and species name.

Stations 5, 16, and 28 (see Figures 2.7.6 and 2.7.7) along the shore were sampled with a 100-foot bag seine. Station 17, a near-shore station was sampled with gill and trawl nets. Station 21, a mid-bay station was also sampled with gill and trawl nets. The mouth of Pickerel Creek was sampled by using either a hoop net, a fyke net, or a gill net. One sample was made of the eastern basin in conjunction with a commercial fisherman using a 3,000-foot commercial seine. The Millers Blue Hile Stream was sampled with a 15-foot hand seine.

Parasitological investigations of the fishes of Sandusky Bay were begun during the latter part of Phase II in order to gain some information on the state of health of the fishes of Sandusky Bay and its tributaries.

Using electrofishing equipment, fish samples were taken from Sandusky Bay and two of its tributaries, Pickerel Creek and Raccoon Creek on May 22, 1974. The fishes taken from each station are listed in Table 6.1.4.

Fish specimens from Pickerel Creek were eviscerated immediately after capture and the viscera placed in plastic bags, labeled, and frozen using dry ice. The viscera were kept frozen until examined for parasites. Fishes from Raccoon Creek and Sandusky Bay were placed on ice in ice chests, returned to the laboratory, and kept in the refrigerator until examination.

Each organ was dissected in a separate dish in "Ringer's" cold physiological saline. The external surface of each fish was examined for ectoparasites. Trematodes were removed to tap water for de-egging and tapeworms were relaxed in distilled water before fixation in Lavdowsky's AFA. Nematodes were fixed in hot saline, stored in AFA or 70 percent alcohol for 24 hours, and cleared for study in alcohol-glycerine. Semichon's carmine-stained tapeworms and trematodes were permanently mounted in piccolyte for study. The single mite (Hydracarina) specimen recovered from the intestine of a yellow perch was placed directly in 70 percent alcohol and later mounted and cleared in Hoyer's mounting media.

Taxonomic identifications were made using Schmidt (1970), Schell (1970), and Hoffman (1965).

TABLE 6.1.4. SPECIES OF FISH TAKEN ON MAY 22 AND 23, 1974

Fish Species	Pickerel Creek	Raccoon Creek	Sandusky Bay
Pomoxis nigromaculatus (black crappie)	X		
Pomoxis annularis (white crappie)	X	X	
Lepomis macrochirus (bluegill)	X		
Lepomis cyanellus (green sunfish)	X		
Carassius auratus (goldfish)	X	X	X
Cyprinus carpio (carp)	X	X	X
Dorosoma cepedianum (gizzard shad)	X	X	X
Moxostoma macrolepidatum (shorthead redhorse)	X		
Roccus chrysops (white bass)		X	X
Ictalurus nebulosus (brown bullhead)		X	X
Perca flavescens (yellow perch)		X	X

6.1.2 GROUNDWATER HYDROLOGY

Three existing and flowing wells, two on the Site and one just east of its eastern boundary, have been monitored for flow rate and temperature on a daily basis since September 2, 1973, and are still being observed. The location of these monitoring Stations 1, 2, and 3 are shown in Figure 2.4.5 of Section 2.4. Details of the monitoring program, computer programs for data reduction, raw data, and reduced data can be found in the Phase II report by Battelle (1974).

6.1.3 AIR

(To be prepared by AEPSC)

6.1.4 LAND

6.1.4.1 Geology and Soils

Geology segment to be prepared by AEPSC.
Soil survey details are provided in Appendix D.

6.1.4.2 Land Use and Demographic Surveys

The land use within five miles of the Site was determined by visual surveys of the area by automobile. Township sections (1 square mile) could easily be identified from county maps. With this unit of analysis percentage composition of a sector by various types of vegetation could be identified. In addition to this data, approximate numbers for farm animals were also obtained.

The method of projecting population is based upon a simulation program described in Appendix A.

6.1.4.3 Ecological Parameters

Vegetation

The baseline assessment field program for terrestrial and semi-aquatic vegetation has been designed to map and to structurally define the plant communities occupying the Site and adjacent areas. On and off-Site aerial reconnaissance and airphoto interpretation has been conducted to determine that the on-Site communities were similar to adjacent communities and that no unique or unusual assemblages exist within the boundaries. Taxonomic determination follows Gray's Manual of Botany (Fernald, 1950).

Baseline Assessment of Woody Vegetation. Location of all of the woodlots on the Site is identified in Figure 2.7.1. Quantitative sampling of woody vegetation was accomplished in those areas numbered 1 through 10 on Figure 2.7.1. Qualitative information in the form of extensive field notes taken on aspect dominants and/or any unusual or flowering species was taken in those areas numbered 11 through 17. In areas where quantitative information was obtained, a transect was laid out to a maximum length of 100 meters. Several lengths were shorter since many woodlots were not of sufficient size to contain this length. Widths of the transects were usually two meters but were extended to ten meters in one particularly open woodlot (No. 4) (Figure 2.7.1), i.e., sparse canopy with very few trees. The total size of each sample is reported on the appropriate table (Appendix D). Within this area all woody plants were recorded as to species, location within the unit, and diameter (D.B.H.) if greater than 1 inch.

Statistical analyses of terrestrial vegetation patterns were conducted. Relative frequency, density, dominance, and importance of each species in each woodlot were calculated according to techniques modified from Oosting (1948), Phillips (1959), and Daubenmire (1968). Expressions in the analyses are as follows:

$$\text{Relative Density} = \frac{\text{Total Number of Individuals of Species}}{\text{Total Area } (m^2)}$$

$$\text{Relative Frequency} = \frac{\text{Number of Units in Which Species Occurred}}{\text{Total Number of Units Measured}}$$

$$\text{Total Basal Area/Species} = \frac{\sum (\text{diameter})^2 \pi}{4}$$

$$\text{Relative Dominance} = \frac{\text{Total Basal Area for Species}}{\text{Total Area } (m^2)}$$

Percent density, percent frequency, and percent dominance are calculated by summing the "relative" values for all species for each calculation for each quadrat and dividing the "relative" value by the corresponding sum. The importance value of each species is calculated by summing percent density, percent frequency, and percent dominance and dividing by 3. These measures of density, frequency, and dominance give a picture of the structure of the vegetative community in a quantitative and dimensionless manner.

Density reflects the absolute number of individuals per area sampled. As such, it is a dimensional expression and may misrepresent the densities of tightly-clumped species as opposed to abundant by evenly-distributed species.

Frequency, on the other hand, provides information as to the uniformity of distribution. Frequency is defined as the percentage of occurrence of a species in a series of samples of uniform size contained in a single stand. This measurement is obtained by dividing a transect up into a series of smaller units and recording the presence or absence of each species in each subunit.

The measure of dominance expresses the size or bulk of the species within the sample in relation to the space available within the area.

By calculation of these statistics a measure of the abundance of each species, its spacial layout within the unit being measured, and each species' contribution to the ground cover or its spacial occupation is obtained. By blending the three independent measures, a measure of "importance" for each species within that area is achieved. While useful in determining the relative importance of a species, evaluation of the data requires interpretation of all statistics available on that species. Results of these analyses are presented in Appendix D.

Baseline Assessment of Herbaceous Vegetation. Distribution of herbaceous flora on the Site is determined in large part by the substrate conditions (surface and groundwater levels) and successional stage. Evaluation of the on-Site herbaceous flora was keyed to identify the variety of habitats with which an herbaceous species was associated and to determine at which seasons flowering and seed dissemination regularly occurs. Extensive on-Site flooding for long periods during the assessment period had considerable effect upon flowering and seed production so that the data cannot be considered as representative of the species in general.

Herbaceous vegetation was observed at all seasons. Species occurrence by habitat is recorded in Table 2.7.2.

Productivity. Oldfield productivity studies were initiated in July, 1973, and will continue through the fall of 1974. The studies have been designed to analyze seasonal productivity as well as yield data relevant to quantitative analysis of net productivity. Since biomass analysis is done at a species level, this information is useful in the determination of successional patterns of revegetation following land clearing required for construction activities.

Standard methods are being utilized for the productivity studies. $1/4^2$m quadrats are established on a random basis within an oldfield on the Site (#15a on Figure 2.7.1) selected for the study. The quadrats are then clipped and the vegetation is separated by species, dried, and weighed. Percent composition by weight of each species is calculated to determine standing biomass of each species within the oldfield. Studies are continuing throughout the year in order that a seasonality index to productivity can be determined. Appendix D lists the data obtained to date. This information includes the percent biomass contribution of the species present in each quadrat. This information will be useful (1) for baseline assessment and (2) for inclusion in measurement of productivity which is proceeding.

To give a measure of woody species productivity for the Site, data on basal area of each species for each woodlot were converted to square feet per acre. This yields information of the standing crop of woody plant species and input to comparison of relative productivity.

Effects of Environmental Stress on Existing Vegetation. Investigations of the effects of several types of environmental stress on vegetational communities on the Site are in progress. Stresses investigated include vegetational stripping and salt-spray application and were selected on the basis of those which would likely occur coincident with Site development. This aspect of the program includes (1) determination of oldfield productivity in the region, (2) investigations of early successional patterns following land clearing, and (3) investigations of the potential effects of drift accumulating and/or damaging the soils or vegetation of the area.

Succession. Succession studies have been initiated to provide a record of the reappearance of vegetation following disruption of the vegetative cover. This study will result in determination of the order of vegetation reappearance on a seasonal basis for 1 year, and it would also serve in prediction of the type of postconstruction revegetation that would be anticipated to occur naturally. Data (species and percent cover) are being collected from 2 x 2-meter plots from which all vegetation was cut and removed and the soil tilled (#15a on Figure 2.7.1). Although seed sources would not be as abundant on the Site following construction as at present, it is felt that the results of this testing program will be applicable to postconstruction conditions.

Drift Effects. The short-term effects of salt application are being investigated at the present time. The data collected should lead to a statement regarding the potential effect, if any, of salt application on vegetation. 1/4 m^2 test plots were set up in an oldfield on the Site (see #15a on Figure 2.7.1). Salt-spray application rates approximate the net amount of salts in one month's drift from 4-cycle cooling towers required to dissipate the heat from five 1100-megawatt units running at 80 percent capacity. Salt-solution composition approximates the average dissolved solids composition of Sandusky Bay water. Table 6.1.5 and Figure 6.1.2 the design and chemical assumptions on which the experiments were based.

Applications were made as follows: three control plots with no spray, three plots at one-half the base concentration applied once, three plots with one application of the base concentration, three plots with two applications of the base concentration applied 1 month apart, and three plots with three applications of the base concentration applied 1 month apart. This method while yielding short-term effects approximates accumulative effects also. Figure 6.1.1 is a schematic diagram of the plot layout. Appendix D lists the data obtained to date. This includes analyses of the vegetative composition of the test plots and percent cover of the ground by vegetation. Following the final spraying vegetative composition and percent ground cover were reevaluated in order that any significant changes would be identified.

To examine the herbaceous vegetation samples for effects caused by the salt treatments, the charge in percent coverage in each quadrat for each of three vegetation species or groups of species--red and white clover (Trifolium spp.), Queen Anne's lace (Daucus carota), and grass (Gramineae)--was first calculated by subtracting the percent coverage in spring from the percent coverage in late fall. These values were then analyzed using a one-way analysis of variance to test for significant differences among the six distinct treatments.

Mammals

Preoperational monitoring programs for mammals began in the spring of 1973. These consisted of trap lines in various habitats for small mammals and reconnaissance of the entire area on foot and by auto for signs of animal activity and abundance. Small mammal trap lines consisted of two

TABLE 6.1.5. DESIGN AND CHEMICAL ASSUMPTION FOR DRIFT SIMULATION EXPERIMENTS

Assumptions:

Drift concentration = 1200 ppm

Drift rate = 10^{-2}%

Dispersal = [1 x] (uniform in 0.2 miles^2 radius)

Maximum atmospheric discharge of water (July) = 3.3×10^{11} ml/day

$\therefore$ Drift = 3.3×10^{6} 1/day

At 1200 mg/1 = 3960×10^{6} mg/day

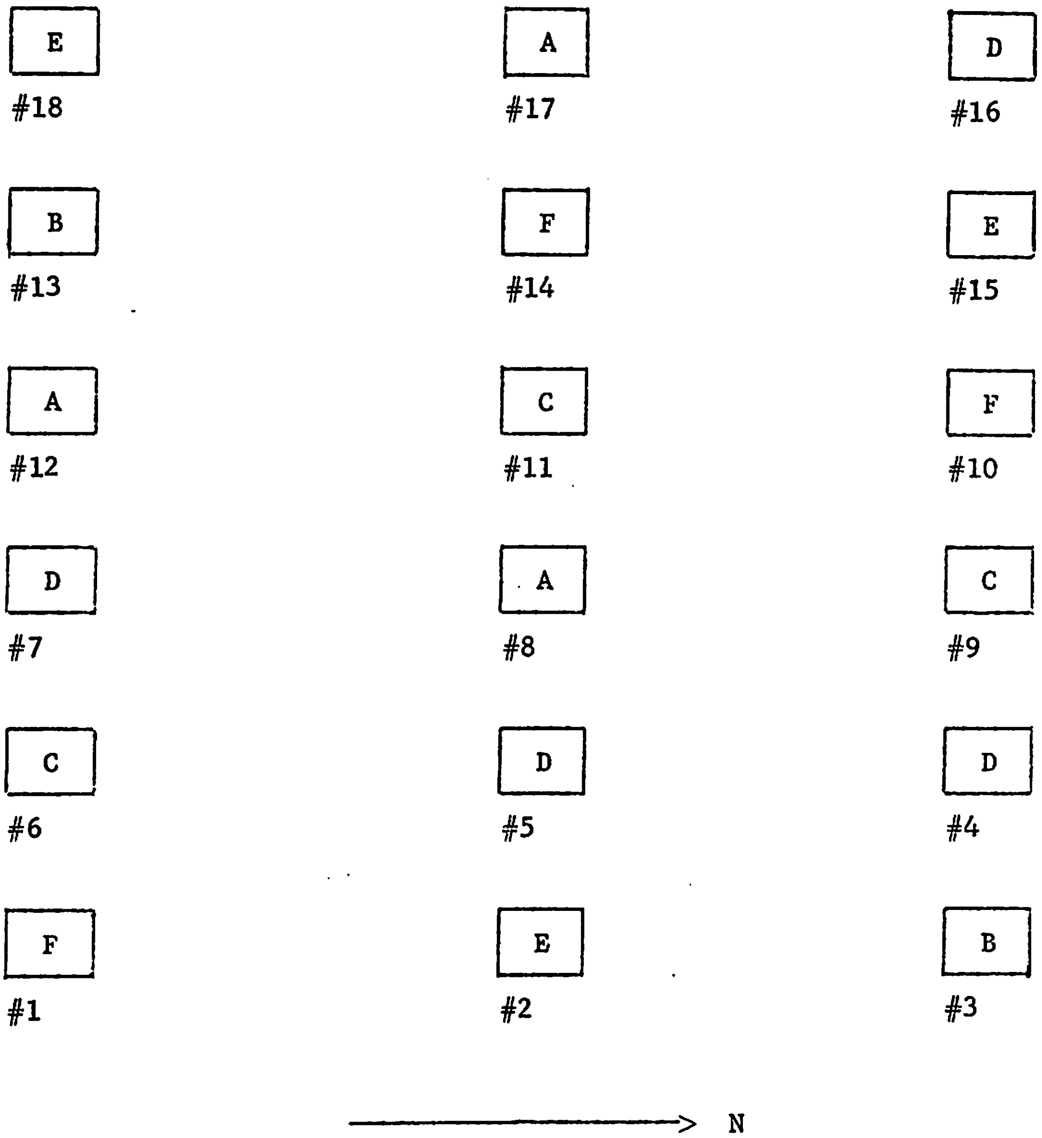
= 2.5×10^{5} $\text{g/mile}^2\text{/day}$

= 100 $\text{mg/m}^2\text{/day}$

$\therefore$ [1 x] = 100 $\text{mg/1/m}^2\text{/day}$

Stock salt solution adjusted to pH 7.4 contains per 100 ml

	mg
Ca^{++}	450
Mg^{++}	20.5
Fe^{+++}	11.4
K^{+}	6.8
Al^{++}	4.5
Na^{+}	2.3
$So_4^{=}$	240
$CO_3^{=}$	240
Cl^{-}	68



Treatment Concentration	Number of Applications
A = 0	0
B = 1/2 x base solution	1
C = 1 x base solution	1
D = 1 x base solution	2
E = 1 x base solution	3
F = 5 x base solution	1

FIGURE 6.1.2. VEGETATION STUDY PLOTS FOR DRIFT EFFECTS ON AN OLD FIELD

(a) Area located as Number 15a on Figure 2.7.1.

Museum Special mouse traps placed at stations 25 feet apart. The number of stations varied from 9 to 20, depending on the size and nature of the area being sampled, and stations were usually checked for 3 nights. Trap line locations are shown in Figure 6.1.3. This is a modification of the North American Small Mammal Census (Calhoun and Casby, 1958) and provides an index of the density and species composition in an area. By comparing the capture per station night (two traps set 1 night = 1-station night), one is able to obtain an index of the number of animals present and of the species composition of the area. The habitats trapped were fencerows, woodlots, and fields which were not being cultivated at the time of trapping. Trapping was conducted on a seasonal basis in spring and early fall. The decision to use trap lines to establish population indices rather than population census was based upon the layout of the Site. The International Biological Program recommends the use of a square grid of at least 2.7 ha (approximately 7 acres) (Smith et al, 1969) to determine the density of small mammals. This area should be homogeneous and surrounded by many acres of the same habitat type. Those areas on the Site in which trapping is feasible do not meet this requirement. Areas unfeasible for trapping include flooded land and agricultural land.

Data on the distribution of larger mammals and their utilization of the Site was obtained by walking over all portions of the area not inundated, driving the roads on the Site, and nightlighting. This was done on several occasions throughout the year. Information obtained was based on sightings, trails, burrows, runways, signs of feeding activity, and interviewing local residents. Muskrat population information was obtained by interviewing local trappers and estimating the number of rats harvested.

Birds

In order to assess the avian use of the Site, various bird surveys were conducted during all four seasons of the year. Migratory waterfowl were surveyed during November, 1973, plus March and April, 1974. Winter birds were surveyed during late January, 1974. Breeding bird surveys were conducted during late June, 1974. Finally, birds colliding with the meterological tower were collected from March to June, 1974. This includes the spring migration period for small, nocturnal migrants.

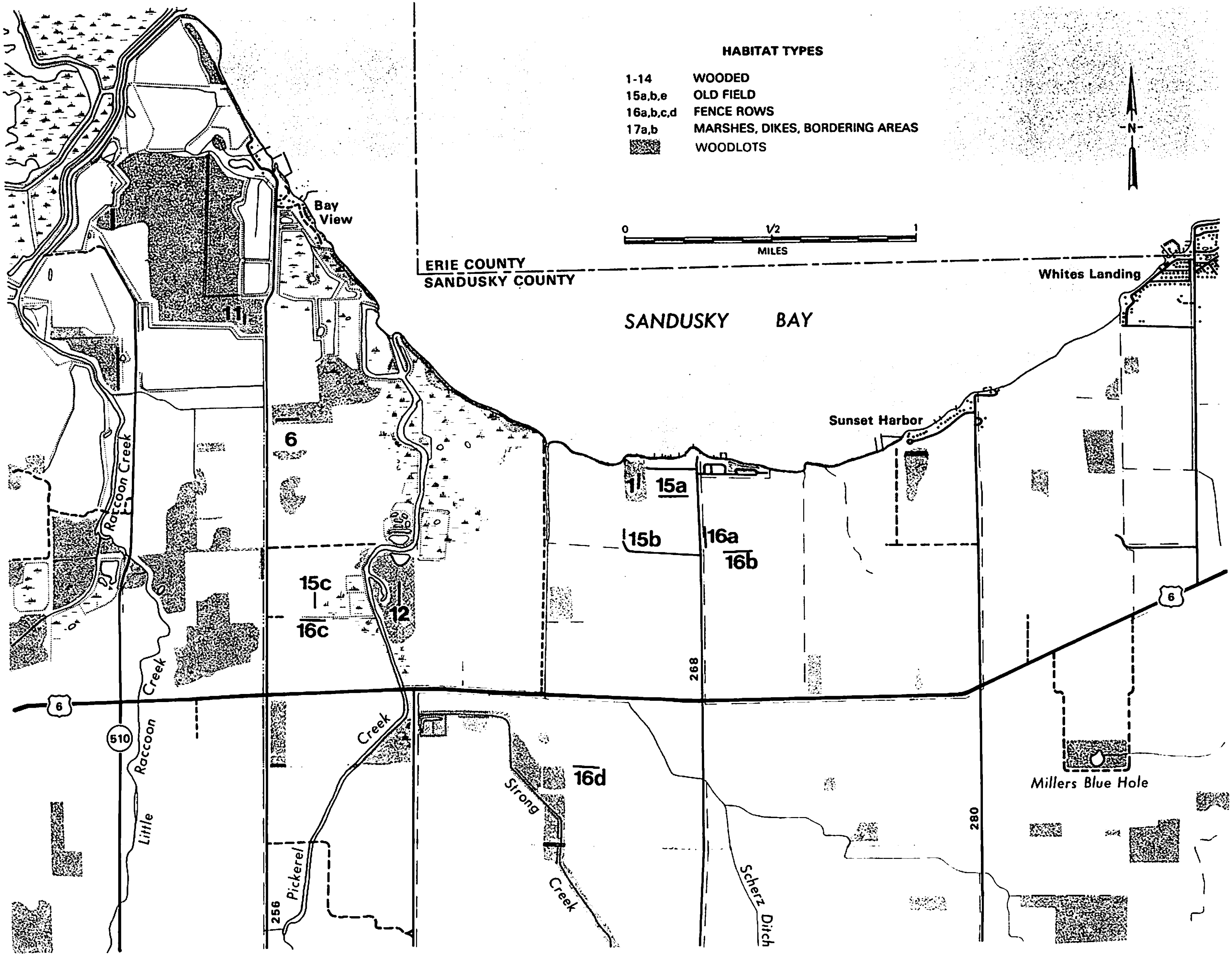


FIGURE 6.1.3 SMALL MAMMAL TRAPLINE LOCATIONS

Migratory Waterfowl Survey Methods. The following waterfowl survey techniques which were used have incorporated suggestions made by three Ohio biologists: (1) Dr. Robert Meeks, Superintendent-biologist, Winous Point Shooting Club; (2) Karl Bednarik, Supervisor, Wetlands Game Research, Ohio Division of Wildlife; and (3) Dr. Milton Trautman, Professor Emeritus, Environmental Biology Department, The Ohio State University.

Ten survey stations (Figure 6.1.4) were chosen based on a study of aerial photos and aerial reconnaissance on October 26, 1973. The five marsh stations included four areas along Pickerel Creek and one area along Raccoon Creek. These five stations were surveyed first, beginning at 1/2 hour before sunrise, since it was expected that the majority of the waterfowl using these marshes would be puddle ducks. The five stations along Sandusky Bay were surveyed during midday, since most ducks using this habitat are diving ducks. Each of the ten stations was surveyed for 1/2 hour. The survey of marsh stations was usually completed by 10:30 to 11:00 a.m., and the stations along Sandusky Bay were usually surveyed by 3:00 to 4:00 p.m. Waterfowl observed on the water were recorded separately from waterfowl flying over the area. Birds were recorded as on the water whether they landed for a few seconds or remained for the full 1/2-hour observation period. Birds at the bay sites were only recorded if they swam or flew within 300 yards of the shoreline observation point. Nonwaterfowl avian species observed while walking or driving to survey stations, or during late afternoon reconnaissance of the Site, were recorded separately from the waterfowl.

Both the spring and fall waterfowl surveys were made during the periods when peak waterfowl populations are normally in the area. However, species differences and environmental conditions can change these normal dates considerably. The fall survey was conducted on November 6 to 9, 20 to 22, and 26 to 29, a total of 11 days. The spring survey was conducted on March 17 to 24 and April 2 to 5, a total of 12 days.

Winter Bird Survey Methods. Birdlife at the Site was surveyed by three methods during 9 days in the period January 16 to February 1, 1974. A density index of permanent residents and winter visitors was obtained by

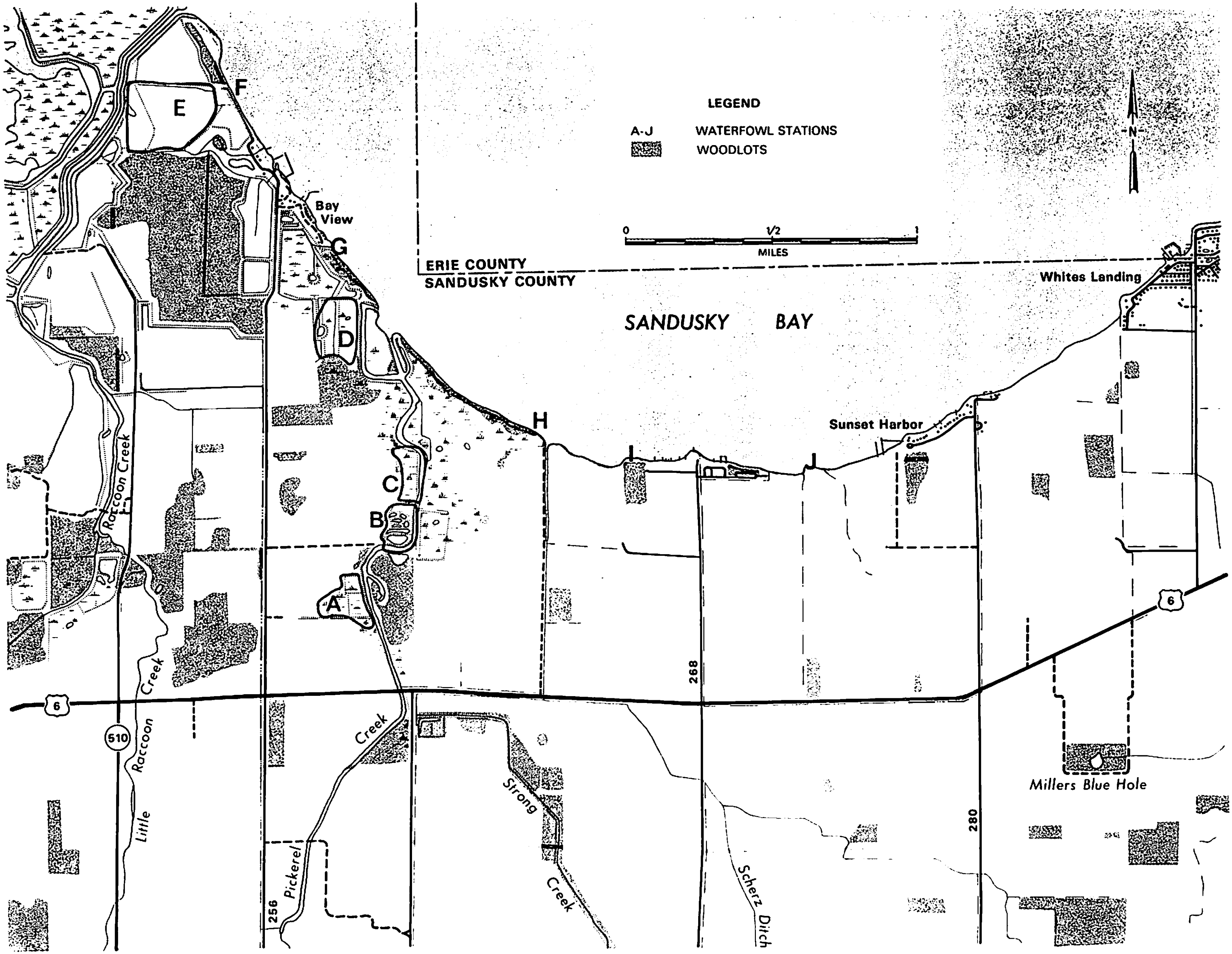


FIGURE 6.1.4 MIGRATORY WATERFOWL SURVEY STATIONS (SPRING & FALL)

an 8-day woodlot and hedgerow survey (Figure 6.1.5). Birds were also recorded during a general reconnaissance of the portion of the Site not included in transect surveys.

Birds using four mesic woodlots (Section 2.7.1.1) were surveyed using the plot method described by Kolb (1965). Woodlots were marked with flagging so that the same route could be traversed on each of 8 days. The birds observed were recorded on a map of the woodlot. Arrows were used to indicate flight paths in an effort to avoid recording the same bird more than once. At the end of the sampling period, the daily sightings of each bird were averaged The resulting statistic can be used an an index of the density per acre. Thus, a comparison of yearly changes in abundance can be made, if the same technique is used in future years.

An 8-day transect survey of 2 miles of fence or hedgerow habitat (Section 2.7.1.1) was conducted. Records of daily observations were made, and an 8-day average was computed in a manner similar to the woodlot survey. However, the index computed gives the average daily observations per mile. In both surveys, density figures were not calculated for averages of less than 0.5 birds per trip, as suggested by Kolb (1965).

Observations on all birds not included in a specific survey were made during the portion of each day remaining after plot and transect surveys were completed. A table of the relative frequency of observation of these birds was compiled for the 9 days of field investigation.

Breeding Bird Surveys

Plot Survey. The largest woodlot at the Site which was not in standing water was chosen as the station for a breeding-bird plot survey as described by Hall (1946) and revised by Van Velzen (1972). The mature, oak-hickory, floodplain woodlot surveyed is located near the intersection of Pickerel Creek and State Road 6. Although the woodlot is about 31.8 total acres, only 21 acres were included in the mapping of territorial males. Woodlot and study plot areas were planimetered from aerial photos (1 inch = 300 feet). The oxbows, powerline right-of-way, and swamp-woods portions were excluded from the survey. Only densities of birds using the relatively uniform vegetation in the center of the woodlot were calculated.

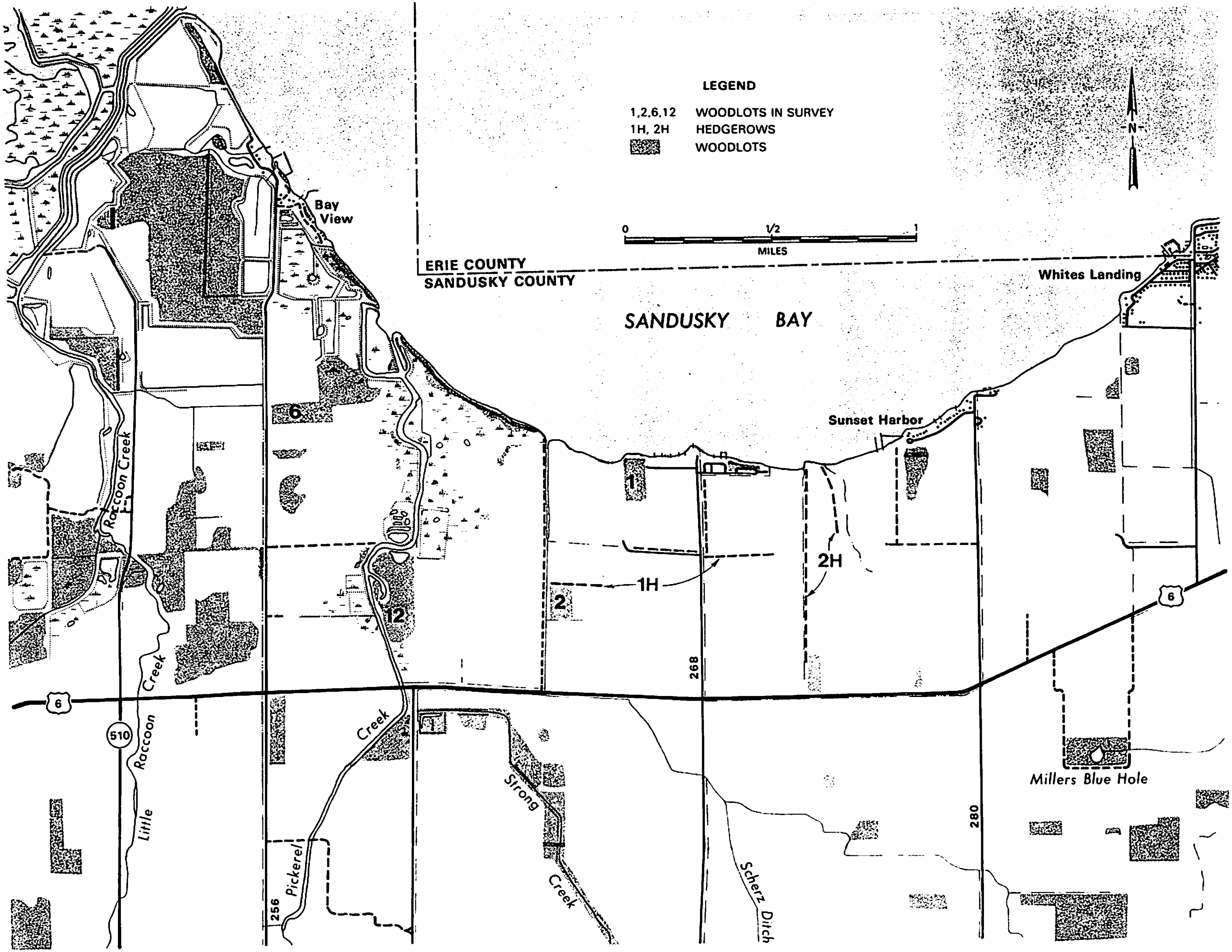


FIGURE 6.1.5 WINTER-BIRD WOODLOT SURVEY PLOTS AND HEDGEROW TRANSECTS (JANUARY)

Three census trails were marked with plastic flagging for use when plotting field records of birds on a visit map of the survey plot. These trails divided the roughly-rectangular plot fairly evenly (Figure 6.1.6) and were followed during nine visits on June 19 to 21 and June 24 to 28, 1974. Eight of the surveys began 1/2 hour before sunrise and one visit began 1 hour before sunset.

Breeding birds which established breeding territories, such as the noncolonial passerine types, can be censused by territorial mapping. Once a pair selects a territory, the male announces his claim to the area by calling, which also serves as a warning to others of the same species to keep away.

Individual territories were determined by slowly walking through the plot and marking the exact location of each male heard singing. Three field records grouped in a cluster were considered necessary to confirm the presence of a breeding bird territory. After each survey, all field records were transferred to individual species maps. After the last visit, territorial clusters were established by circling each group of three or more records which appeared to be associated with a territory held by one male.

The total number of territories per species yields the following information: (1) an annual index of population levels, (2) an estimate of population densities, and (3) species composition of the woodlot surveyed.

Roadside Breeding Bird Survey. A roadside survey similar to the one used by the Bureau of Sport Fisheries and Wildlife (1973) was adapted for the Site to obtain an index of abundance of breeding birds. It provides information on distribution and relative abundance of breeding birds using the Site. The survey differed from the Federal survey in that the route was run for 4 days at 20 stops which were 1/2 mile apart (Figure 6.1.7) instead of on only 1 day for 50 stops at a similar distance apart. This change was necessary because of the size and shape of the Site.

Each of the four surveys began at 1/2 hour before sunrise and continued for about 2 hours and 45 minutes. The route was run from stop 1 through 20 on June 19 and 21, and run in reverse order from stop 20 through 1 on June 20 and 24. Birds were counted at each stop for exactly 3 minutes.

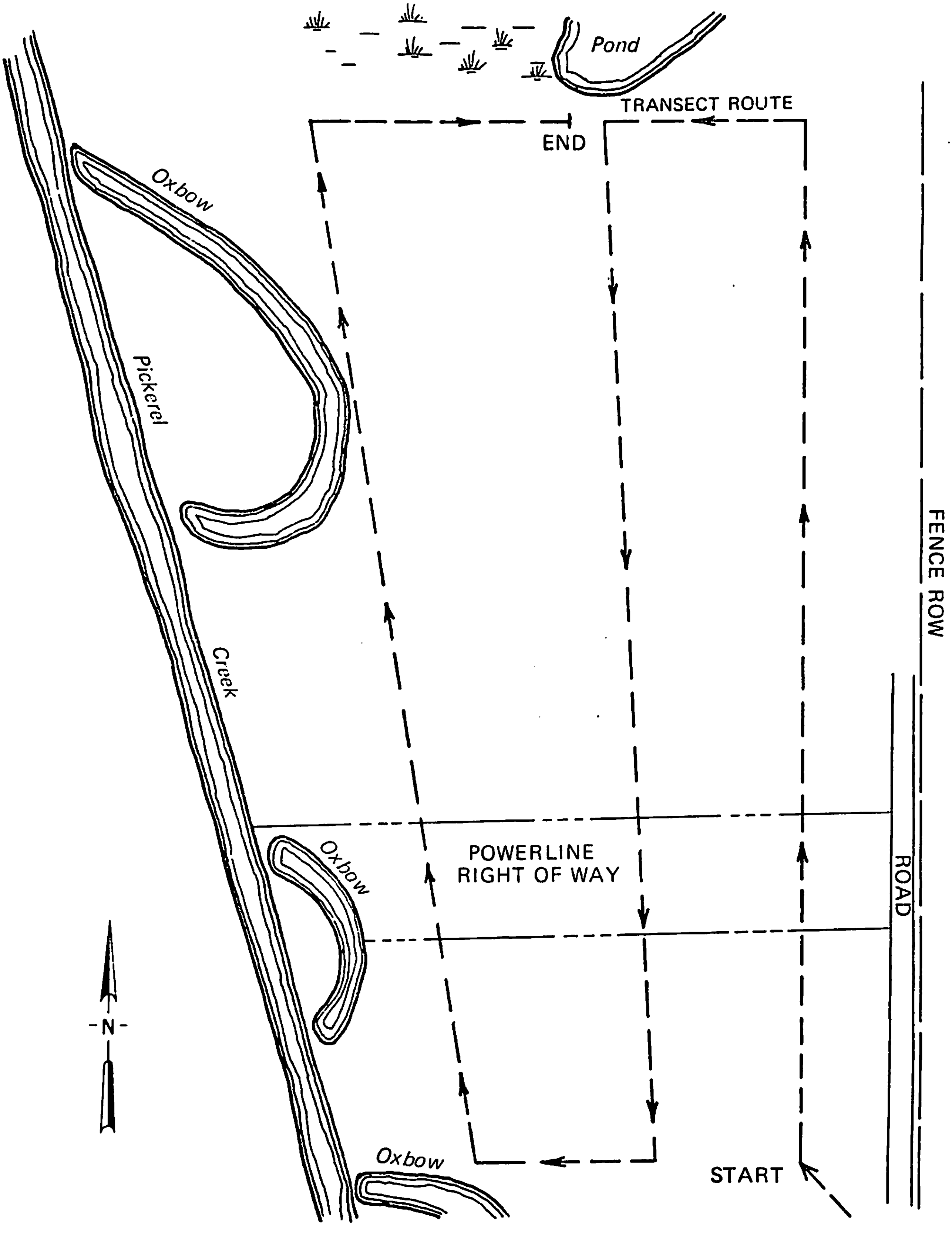


FIGURE 6.1.6. BREEDING-BIRD SURVEY PLOT IN WOODLOT 12
(SEE FIGURE 2.7.1)

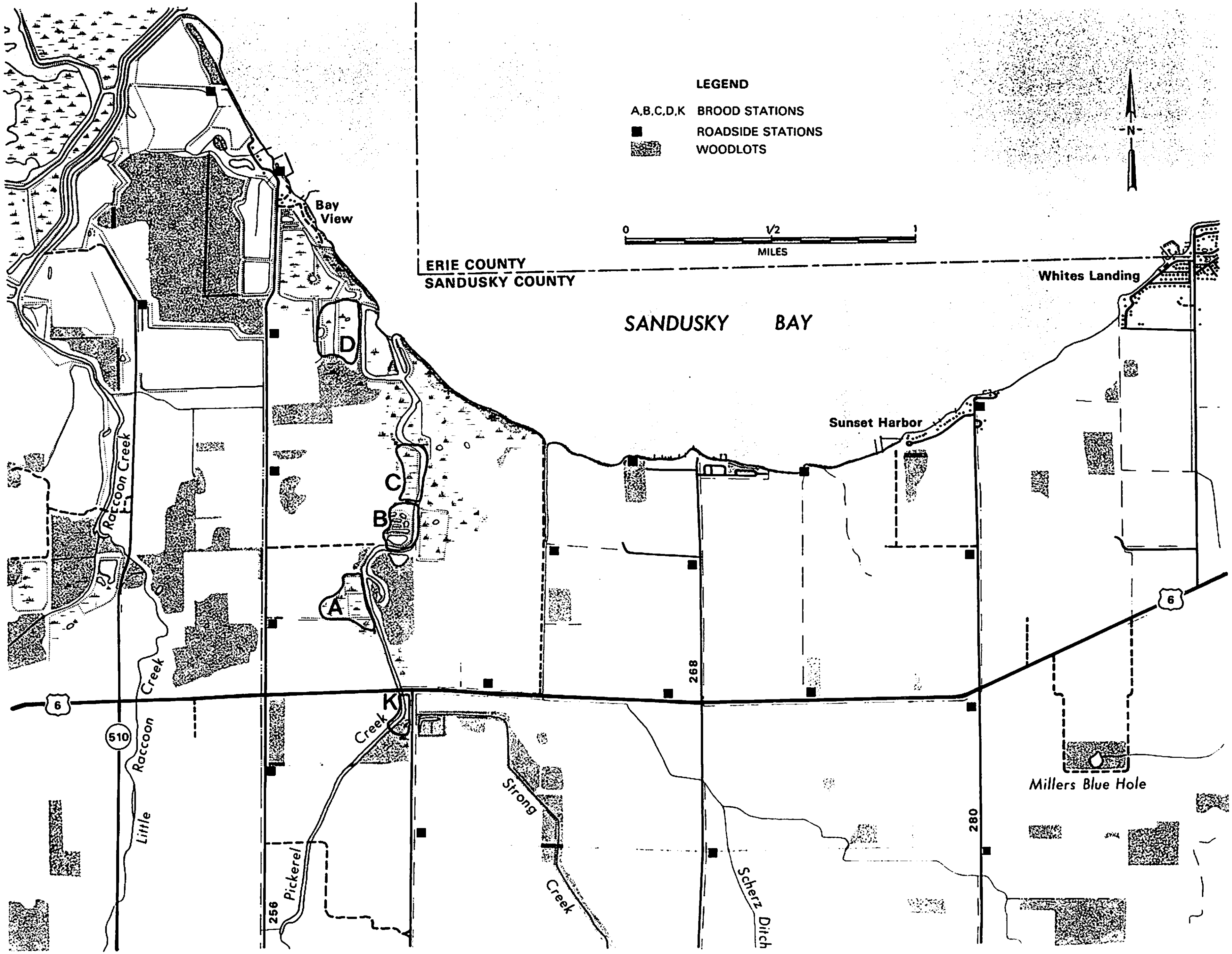


FIGURE 6.1.7 DUCK BROOD SURVEY AND ROADSIDE BREEDING-BIRD SURVEY STATIONS (JUNE)

All birds heard, and birds seen within 0.25 mile, were recorded on standard forms supplied by the Migratory Bird and Habitat Research Laboratory, Bureau of Sport Fisheries and Wildlife. All four surveys were run on mornings without precipitation or fog. Wind speed reached Beaufort 3 (8 - 12 miles per hour) on only the first morning.

Duck Brood Survey. Five marsh stations along Pickerel Creek (Figure 6.1.7) were chosen for a 4-day survey of duck broods. Beginning at 1/2 hour before sunrise, the stations were observed for 20 minutes each in the order A, B, C, D, and K on June 25 and 27, and in the reverse order beginning with Site K on June 26 and 27. All 4 surveys were completed by 0815 EDST. Adult ducks without broods, plus all juveniles alone or in broods were recorded. The ages of ducklings were estimated using the age class system described by Gallop and Marshall (1954). This information can be used as an index to duck brood use of the Pickerel Creek marshes.

General Reconnaissance Surveys. General reconnaissance surveys of most areas of the Site not included in a specific survey were conducted during the afternoons of June 18 to 21 and June 24 to 28. All major woodlots on the Site, including those with bald eagle nests, were surveyed on foot, for a total of 55 manhours. A table giving relative frequency of observation was prepared for a rough comparison of species abundance and to make a more complete list of species using the Site during June. Most of the observation time was spent at woodlots and marshes, with very little time spent in agricultural fields, where bird diversity is very low.

Breeding-Bird Evidence. June is considered the month when most adult birds breeding in the Sandusky Bay area are either nesting or caring for their young. However, some species seen during this month at the Site may not breed there. Therefore, an attempt was made to search for bird nests, especially during the plot survey and general reconnaissance survey. Records of all nests, eggs, nestlings, and fledglings were kept on special forms to confirm the breeding status of as many birds as possible. The three bald eagle nests were observed frequently for signs of activity.

Bird Impaction Studies

Daily rounds on foot were made at the base of a 252-foot meteorological tower on the Site to search for any birds which may have collided with this structure during the night. At least two circuits were made around the tower at different distances. Checks were made about sunrise from March 1 to June 28. All birds collected were given a numbered tag, put in a plastic bag, and stored in a freezer. These birds were later transported to Battelle's Columbus Laboratories and identified to species. Records were kept of the location where each bird was collected, and the weather conditions on the date of collection. This information has been useful in determining which species, of the small, nocturnal migrants, may be most likely to collide with natural draft cooling towers erected on the Site.

Insects

Given the wide diversity of habitats on the Site, six habitats were chosen for sample stations. These are the following stations as seen on Figure 6.1.8: 1, heavy underbrush, woodlot; 6, medium underbrush, woodlot; 12, mature woodlot; 17a, sedge marsh; 15a, oldfield; and 16a, fencerow. Site 12 had little underbrush but only the canopy was at climax as the area was grazed in 1972-1973. Samples were taken using a sweep net with one hundred 180 degree sweeps. The insects were then killed with ethyl acetate and transferred to plastic bags for storage and transporting. The insects were separated into orders, families, and species and the data analyzed according to the Shannon-Wiener Index (Odum, 1971).

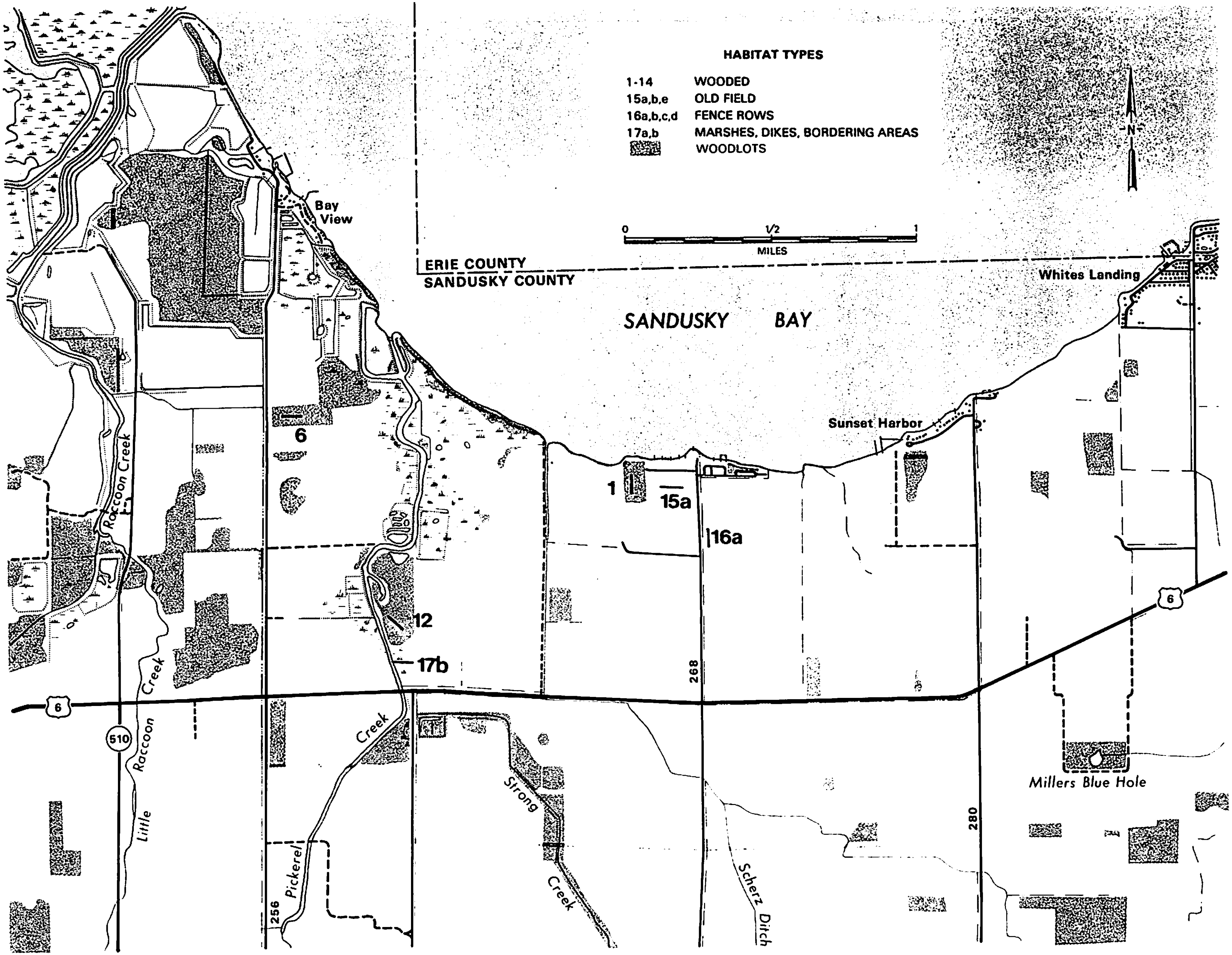


FIGURE 6.1.8 LOCATION OF INSECT SAMPLING STATIONS

CHAPTER 7

ENVIRONMENTAL EFFECTS OF ACCIDENTS

CHAPTER 8

ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION

8.0 METHODOLOGY

When attempting to identify the benefits and costs of the construction and operation of a nuclear power plant, one must view the construction as an exogenous input to a system. Both direct and indirect effects will result which impinge upon many components of an area's social, economic and environmental structure. Impacts in these areas are not always quantifiable and in many cases different units of measure will be used to describe the costs and benefits. In essence, then, the generation of an overall cost-benefit balance is most difficult to achieve.

Figure 8.0.1 depicts a casual model of the impacts resulting from plant construction. The creation of new construction jobs will provide an incentive for workers and their families to move into the area. This will further cause demands upon the existing housing market and facilities and services such as schools and hospitals. Should this influx be of a significant magnitude relative to the indigenous population, some change may result in cultural patterns. Economic effects flow primarily from the payment of wages and taxes. A portion of the wages paid will be used to generate retail sales which further affects the region's economy. Construction at the Site will alter the present land usage and will contribute to a greater utilization of transportation facilities.

Of the previously mentioned impacts, most may be classed either as benefits or costs while for a few variables it is difficult to determine exactly what the final balance would be. In these cases, a discussion is presented of the relevant interactions which exist among other system variables.

The facility being planned will have two 1,500 MWe high temperature gas-cooled reactors (HTGR's). Units of this type have not previously been built on a commercial basis at this rule which makes it impossible to use past experiences to estimate the costs and manpower required for construction. The basic assumption, then, upon which all resultant impacts will be based is that the construction and operation of an HTGR unit will be similar to competitive reactor units in terms of equipment costs, labor force requirements, duration of construction, and operating costs. Construction of an HTGR, however,

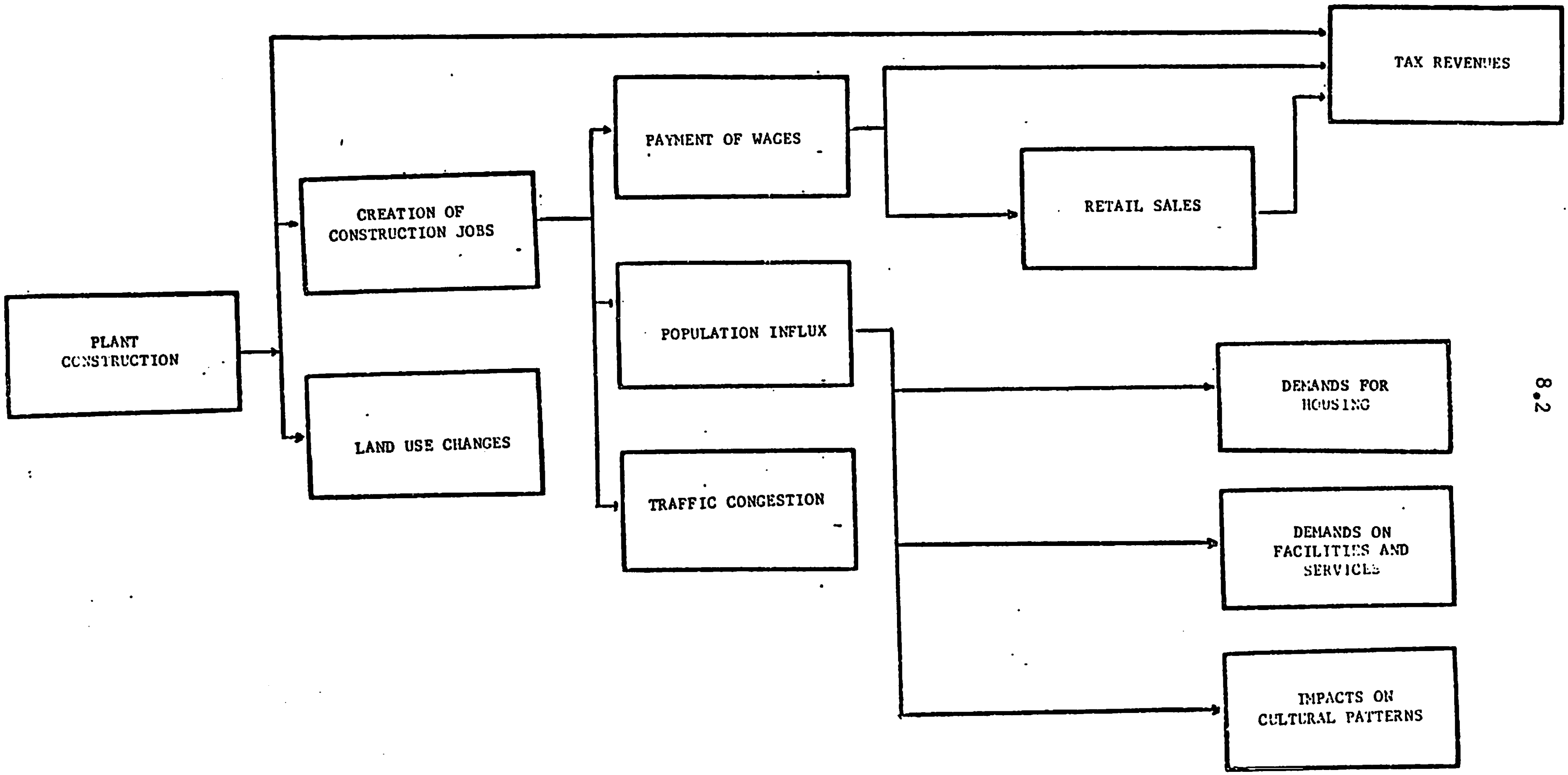


FIGURE 8.0.1. CAUSAL MODEL OF THE IMPACTS OF PLANT CONSTRUCTION

involves a field assembled prestressed concrete reactor vessel which could have a significant effect upon the length of time needed for construction but it is not known whether this would be positive or negative.

8.1 BENEFITS

Benefits evolving from the construction and operation of a nuclear power plant may be either direct or indirect. Direct benefits arise specifically from the generation of electricity while indirect benefits include the social and economic changes which occur.

8.1.1 PRIMARY BENEFITS

8.1.1 Generated Electricity

The annual output of electrical energy for the two 1,500 MWe units will be approximately $2x10^{10}$ kilowatt hours assuming they are operated at 80 percent capacity.

8.1.1.2 Expected Use of Electricity

The exact distribution of electrical energy is not known, however, two power companies offering service to the Sandusky Bay area, Toledo Edison and Cleveland Electric, report the average distribution shown in Table 8.1.1. In recent years, this breakdown has remained fairly constant even though the absolute number of customers has increased.

TABLE 8.1.1. DISTRIBUTION OF ELECTRICAL POWER TO CUSTOMERS

Electrical User	Percent of Total Generation Consumed
Industrial	50.
Commercial	19.
Residential	25.
Other	6.
Total	100.

8.1.1.3 Averted Load Shedding, Brownouts

No data were provided relative to previous experience with load shedding in the area. However, the existence of this plant should reduce the likelihood of such occurrences.

8.1.1.4 Sales of By-Products

At this time it is not expected that there will be any sales of steam or other plant by-products.

8.1.2 SECONDARY SOCIO-ECONOMIC BENEFITS

The need for construction workers directly alters the employment characteristics of the area and has many far-reaching social and economic effects. Among the parameters affected are employment, wages, retail sales, and taxes.

8.1.2.1 Employment

Due to the uncertainties of plant construction mentioned previously, it is assumed that six years will be needed to complete the facility and a work force of the magnitude shown in Table 8.1.2 will be used. These assumptions form the basis for most of the economic and social impacts resulting from plant construction.

TABLE 8.1.2. ANNUAL CONSTRUCTION FORCE NEEDED

Year of Construction	Number of Workers Needed
1	425
2	1,500
3	4,000
4	4,000
5	2,000
6	200

In addition to the duration and magnitude of work efforts, it is necessary to determine from where the construction workers will be drawn. For a similar project in Houston County, Alabama, a questionnaire was issued to construction workers (Daniel Construction Company, 1974). The results indicated that 25 percent of the workers relocated within 25 miles of the Site. Another 7 percent relocated adjacent to the Site in temporary quarters and commuted to their permanent residence on weekends. Eighteen percent commuted on a daily basis from outside of a 50 mile-radius, while the remaining 50 percent already lived within 50 miles of the Site. This distribution is expected to be different for the Sandusky Site due to the proximity of the population centers shown in Table 8.1.3. Toledo and Lorain, the most distant, are easily accessible via the Ohio Turnpike and many daily commuters from these urban centers would be expected. Given these considerations, the following distribution of workers will be assumed to apply:

- 5 percent will live adjacent to the Site
- 65 percent will be natives of within 50 miles
- 20 percent will in-migrate to within 25 miles
- 10 percent will commute from outside 50 miles.

It is expected that the 20 percent who relocate within 25 miles will settle primarily in the three counties of Sandusky, Erie, and Ottawa.

TABLE 8.1.3. MAJOR POPULATION CENTERS WITHIN 35 MILES OF THE SITE

City	Miles from Site	1970 Population
Fremont	9.5.S.W.	18,490
Sandusky	9.5 S.W.	41,175
Norwalk	20.0 S.E.	13,386
Tiffin	24.0 S.W.	21,596
Fostoria	30.0 S.W	16,037
Toledo	32.0 N.W.	383,818
Lorain	34.0 E.	78,185

Source: U.S. Census, 1970.

8.1.2.2 Wages

In 1970, the average contract construction wage for the three county region was $8,500 per year. By applying this rate to the magnitude of the construction force needed during each year, the total annual wages to be paid can be estimated. These are shown in Table 8.1.4.

TABLE 8.1.4. ESTIMATED ANNUAL WAGES PAID TO CONSTRUCTION FORCE

Year of Construction	Total Wages to be Paid to Work Force
1	$ 3,600,000
2	12,800,000
3	34,000,000
4	34,000,000
5	17,000,000
6	1,700,000

8.1.2.3 Retail Sales

In 1970, the ratio of retail sales to total personal income was .52 for the three county area.* This number was then used to calculate the expected annual amount of retail sales accruing from construction wages paid. These are shown in Table 8.1.5.

8.1.2.4 Taxes

Taxes collected in the region will change as a result of several factors. Increased wages will directly affect income taxes. Retail sales, as mentioned previously, will increase and thus cause an increased amount of sales tax to be collected. Additional increased tax revenue will result from the regional change in land use. As new demands and uses cause land

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* Calculated from the <u>1967 Census of Business</u>, and <u>the 1970 Census of Population</u> the U.S. Department of Commerce.

operation are not precisely known. It is expected though, that the cost per unit, including the necessary structures and improvements, reactor vessel, waste system, generator and electrical units, and cooling tower, would be within a range \$6.5 x 10^8 to \$8.0 x 10^8. These figures are comparable to current competitive light water reactors (U.S. Atomic Energy Commission, 1973).

Operating costs include an annual payroll of approximately \$4,000,000 (1985 dollars) to a work force of 200 persons.

8.2.2 TEMPORARY EXTERNAL COSTS

8.2.2.1 Demographic Characteristics

Table 8.2.1 shows the expected population influx assuming an average household size of 2.8 persons for the State of Ohio (1970 Census of Housing).

TABLE 8.2.1. POPULATION INFLUX DURING PLANT CONSTRUCTION

Year of Construction	Total Force	Number Migrating into the Three Counties	Total Population Influx
1	425	85	238
2	1,500	300	840
3	4,000	800	2,240
4	4,000	800	2,240
5	2,000	400	1,120
6	200	40	112

The cities which seem most likely to receive new workers are shown in Table 8.2.2 along with the distance from the Site, magnitude of additional population, and percent increase over its 1970 population.

to become more valuable and as new structures improve the land, the amount of property tax collected will increase. The actual amount of taxes to be paid by the power company during plant construction and operation are not known at this time, but these should add substantially to the tax revenue of Sandusky County.

TABLE 8.1.5. RETAIL SALES ACCRUING FROM CONSTRUCTION WAGES PAID

Year of Construction	Retail Sales
1	$ 1,870,000
2	6,650,000
3	17,680,000
4	17,680,000
5	8,840,000
6	880,000

8.2 COSTS

Costs generated by the construction and operation of a nuclear power plant are categorized as being internal or external. Internal costs are those born by the utility company as it constructs and operates the plant while external costs are those affecting parties other than the utility company. External costs may be either temporary or long-term.

8.2.1 INTERNAL COSTS

Included in the internal costs are those associated with actual plant operation and construction. Construction costs include land acquisition and improvements and the purchasing of the necessary machinery and equipment. HTGR units similar to those planned for this Site have not been constructed commercially as yet, and thus the costs associated with their construction and

TABLE 8.2.2. DISTRIBUTION OF POPULATION INFLUX

City	1970 Population	Population Influx Workers/Total		Percent Of 1970 Population
Sandusky County				
Clyde	5,503	48	134	2.4
Gibsonburg	2,585	48	134	5.2
Fremont	18,490	240	672	3.6
Erie County				
Huron	6,896	48	134	1.9
Sandusky South	8,501	48	134	1.6
Sandusky	41,175	240	672	1.6
Ottawa County				
Oak Harbor	2,807	48	134	4.8
Port Clinton	7,202	80	224	3.1

As shown by this table, for all communities considered, the impact will be slight. Of more significance, however, is the availability of housing within each of these centers.

8.2.2.2 Housing

Shown in Table 8.2.3 are the housing characteristics for the cities being considered. By comparing the number of vacancies shown with the population influx in peak years (Projected Demand Column of Figure 8.2.3) it can be seen that in Fremont and Oak Harbor there will be a deficiency in housing. Changes in housing characteristics over time may alter these figures somewhat, but more important is the possibility that a far greater number of persons would choose to locate in the Sandusky area. Sandusky, being accessible to the Site along Highway 6, has a much larger availability of housing than do the other population centers.

8.2.2.3 Services and Facilities

The addition of new residents results in a corresponding increase in demand on the existing services and facilities. Water, sewer, and educational systems are likely to be affected due to the presence of additional

TABLE 8.2.3. HOUSING CHARACTERISTICS OF SELECTED CITIES

		Type			Occupancy				Condition		Projected Demand	
		Percent Single	Percent Multiple	Percent Mobile	Number of Year Round Housing Units	Percent Occupied	Vacancies Number	Vacancies Percent	Percent Lack Plumbing	Percent Built Before 1940	Demand in Peak Years	Vacancies — Demand
ndusky												
5,583	Clyde	75.9	13.5	10.6	1,710	95.6	76	4.4	1.5	62.6	48	+ 28
2,585	Gibsonburg	83.4	15.1	1.5	888	94.6	48	5.4	1.6	77.0	48	0
8,490	Fremont	76.4	20.1	3.5	6,253	97.0	229	3.0	1.7	70.1	240	- 11
ie												
6,896	Huron	85.3	14.1	0.6	2,335	93.9	143	6.1	0.6	36.9	48	+ 95
8,501	Sandusky South	92.6	4.8	2.6	2,221	97.3	60	2.7	4.2	18.2	48	+ 12
1,175	Sandusky	65.7	32.9	1.4	11,803	92.5	884	7.5	3.4	65.1	240	+644
ttawa												
2,807	Oak Harbor	83.6	16.4	0.0	967	95.8	41	4.2	1.7	64.4	48	- 7
7,202	Port Clinton	75.1	24.5	0.7	2,452	96.3	91	3.7	1.6	55.7	80	+ 11

urce: Housing Characteristics for States, Cities, and Counties; U.S. Department of Commerce; Volume I, Ohio; Tables 18, 23, 53, 58.

loads, but this would only be significant in the immediate area surrounding the Site. The magnitude of the problem will depend upon the number of mobile homes which are utilized to house workers adjacent to the Site.

8.2.2.4 Transportation

The transportation system will be affected by plant construction in three respects: the system will receive more extensive use, roads may be improved to facilitate access to the Site, and a rail spur will be constructed leading into the Site. Improvements and new construction would be classed as benefits while the increased congestion would be a cost felt by the transportation system.

Assuming a maximum work force of 4,000 persons and two persons per car on the average commute to the Site, as many as 4,000 additional trips will be made along Highway 6 per day. The additional loading which this may cause may be mitigated through the use of two or three work shifts per day.

8.2.3 LONG-TERM EXTERNAL COSTS

Long-term external costs are those which do not disappear when the plant construction is complete. Rather these costs emanate from permanant changes to the local environment.

8.2.3.1 Restricted Access

The marshy area in the northwestern portion of the Site will not be used for hunting during plant construction or operation. In addition to this restricted land area, the exclusion area boundary may extend into Sandusky Bay thus reducing the availability of fishing waters.

8.2.3.2 Impact on Public Facilities

The source of this long-term impact is from the presence of the plant operating force. This will be approximately 200 persons, many of whom will be current residents while a small proportion will be highly skilled technicians and upper management personnel. Since the magnitude of this population group is predicted to be negligible, no impacts on housing, facilities, and services or cultural patterns are foreseen.

8.2.3.3 Land Use

Land use changes will primarily be a transition of about 800 acres of agricultural lands into the exclusion area of the Site itself. At present the Site encompasses approximately 2,600 acres.

8.2.3.4 Cultural Patterns

Effects such as changes in values, traditions, behavior patterns, and community cohesion could result from plant construction. In general, these changes will be a function of the amount of social interaction between permanent residents and the relocated construction workers. Due to the relatively small proportion of persons who will in-migrate to any of the population centers, it is assumed that very little changes will occur in the area's cultural patterns. However, some opposition to the plant could arise from persons who live adjacent to the Site and who perceive the project as a threat to their property and privacy.

CHAPTER 9

ALTERNATE ENERGY SOURCES AND SITES
(To be prepared by AEPSC)

CHAPTER 10

PLANT DESIGN ALTERNATIVES

10.0 INTRODUCTION

The alternatives considered at the present stage of the plant design are (1) the use of mechanical draft evaporative cooling towers in place of the natural draft cooling towers, (2) the use of wet/dry hybrid natural draft cooling towers, (3) the use of alternative intake structures, and (4) the use of a submerged jet discharge of the cooling tower blowdown instead of an open ditch.

In addition to these alternative plant designs, the Site is also being considered for the operation of 5-1,600 MWe HTGR's instead of 2. This increased number of reactors would increase the makeup and blowdown water flows proportionately (by a factor of 5/2) since each reactor will require its own cooling tower. The temperature of the blowdown discharge would be higher than with two reactors since the heat load on the holding pond would be higher while its heat dissipating capacity (the surface area) would not increase. The predicted water flows and discharge temperatures are given in Table 10.0.1. These data were used to estimate the maximum dimensions of the isotherms corresponding to a 3 F temperature rise in the Bay resulting from the slow discharge of this blowdown from an open ditch. These dimensions and surface area enclosed by this isotherm are given in Table 10.0.2.

Upon comparing the dimensions and surface areas in Table 10.0.2 with the Ohio EPA regulations, it can be seen that the theoretical isotherm exceeds these regulations all year if the towers are operated with a factor of 2 concentration of dissolved solids. With a factor of 5 concentration, the maximum longshore distance exceeds the allowable 300 feet during March through August and slightly exceeds it during October. No other criterion is exceeded at 5 concentrations. The discharge temperatures at either concentration factor are within regulations for maximum temperature and maximum temperature rise.

TABLE 10.0.1. WATER FLOWS AND TEMPERATURES FOR FIVE EVAPORATIVE COOLING TOWERS AT THE SITE(a)

	Water Flows, 1000 gpm				Temperatures, F			
	2 Concentrations		5 Concentrations		2 Concentrations		5 Concentrations	
Month	Makeup	Blowdown	Makeup	Blowdown	Discharge	Rise(b)	Discharge	Rise(b)
Jan	85.0	42.5	53.1	10.6	47.4	14.2	35.0	1.8
Feb	86.2	43.1	53.9	10.8	48.8	14.7	38.4	4.3
Mar	97.2	48.6	60.8	12.2	56.2	20.5	48.3	12.6
Apr	111.6	55.8	69.7	13.9	65.2	13.4	59.4	7.6
May	124.6	62.3	77.9	15.6	74.8	9.5	71.6	6.3
Jun	134.3	67.2	83.9	16.8	83.0	11.2	81.0	9.2
Jul	139.2	69.6	87.0	17.4	86.1	12.6	83.6	10.1
Aug	137.1	68.6	85.7	17.1	84.7	9.8	81.0	6.1
Sep	131.2	65.6	82.0	16.4	79.4	9.8	73.2	3.6
Oct	119.2	59.6	74.5	14.9	70.7	14.6	61.0	4.9
Nov	103.4	51.7	64.6	12.9	59.2	17.1	46.8	4.7
Dec	89.2	44.6	55.7	11.1	50.1	17.1	36.3	3.3

(a) Calculated for average monthly conditions at Sandusky, Ohio.
(b) Discharge temperature minus average monthly temperature measured at Gypsum.

TABLE 10.0.2. MAXIMUM DIMENSIONS AND SURFACE AREA OF THE THEORETICAL ISOTHERM CORRESPONDING TO A 3 F TEMPERATURE RISE IN THE BAY WITH FIVE UNITS(a)

	2 Concentrations			5 Concentrations		
	Maximum Distance, ft		Surface area, acres	Maximum Distance, ft		Surface area, acres
Month	Longshore	Offshore		Longshore	Offshore	
Jan	27,600	520	262.23	0	0	0
Feb	30,420	546	303.41	163	40	1.19
Mar	75,222	859	1,179.84	1,791	133	4.33
Apr	42,369	645	498.73	846	91	1.41
May	26,545	510	247.34	732	85	1.13
Jun	42,928	649	508.64	1,810	133	4.40
Jul	58,281	756	804.62	2,340	152	6.48
Aug	34,250	580	362.50	825	90	1.35
Sep	31,320	554	316.99	264	51	0.25
Oct	57,380	750	786.05	404	63	0.46
Nov	59,230	762	824.35	279	52	0.27
Dec	44,079	658	529.23	102	32	0.06

(a) Calculations are for five towers operating at average monthly weather conditions based on Sandusky, Ohio observations, a longshore current of 0.15 ft/sec, and a dispersion coefficient of 1 ft^2/sec.

(b) The maximum allowable extent of a mixing zone in any direction is 300 ft and its maximum surface area is 12 acres.

10.1 COOLING SYSTEM ALTERNATIVES

10.1.1 MECHANICAL DRAFT EVAPORATIVE COOLING TOWERS

The use of mechanical draft evaporative cooling towers at the Site could result in significant differences with respect to aesthetic effects, terrestrial effects, and the potential for fogging and icing. The towers would occupy a greater land surface but their height (on the order of 40 to 60 feet) would be much less than for natural draft towers (500 feet). Therefore, their visual impact would be much less. This lower height, however, would increase the potential for ground fog and icing in the vicinity.

The effects with respect to water withdrawal and discharge would not differ significantly from the natural draft towers. Both types of towers would evaporate water at approximately the same rates and return blowdown to the Bay at about the same rates and with about the same levels of chemicals. The temperatures of the blowdown discharged to the Bay would also be about the same for both types of towers.

10.1.2 HYBRID WET/DRY COOLING TOWERS

There are potential advantages in the use of wet/dry hybrid cooling towers for the HTGR's at the Site. In these towers, ambient air enters the bottom of the tower and passes through a "wet" zone where it comes into intimate contact with the circulating condenser cooling water. In a normal wet cooling tower the air then passes out the top of the tower without further heating. However, in a hybrid tower, the air leaving the wet zone passes through a heat exchanger where it is further heated by the hot condenser cooling water as it enters the tower. The heated air then passes out the top of the tower and the partially cooled condenser cooling water goes from the heat exchanger to the wet zone. This water is further cooled by evaporation in the wet zone and then collects at the bottom of the tower before returning to the condensers.

A hybrid cooling tower could be controlled to maintain a given cold water return temperature or to evaporate the minimum amount of water within a prescribed range of cold water return temperatures. The operating characteristics of the tower are difficult to estimate since they would strongly depend on the specific design and the strategy of control. However, the operating characteristics of the hybrid tower are bounded by those of an evaporative tower and those of a "dry" tower. Estimates of the characteristics of evaporative towers were previously given in Section 5.1. Estimates for a dry tower, which does not evaporate water, are given in Table 10.1.1 along with the air flows and cold water return temperature previously given for a wet tower. The characteristics of a hybrid tower will be between these bounds.

Some of the potential advantages of using wet/dry hybrid towers include (1) reduced water consumption (and, therefore, reduced blowdown), (2) reduced fogging potential, and (3) prevention of freezing during extremely cold weather. It is also possible that, if designed properly, the dry section of the tower could carry the full cooling load (with some reduction in turbine efficiency) if the water flow were temporarily interrupted by a seiche, an ice jam, or a clogged intake. The hybrid tower could be controlled to bypass the wet zone during extremely cold, winter weather and thus keep the water from freezing. Also, if ice tended to form at the intake structure, the blowdown could be diverted and the temperature could be adjusted to keep the system ice free. The hybrid tower would reduce the potential for tower-induced fog by (1) slightly reducing the evaporative heat load, (2) increasing the buoyancy of the plume so that the plume will rise higher, and (3) reducing the relative humidity of the air leaving the tower to below 100 percent.

The main problem with the use of such a hybrid tower is that none of the tower manufacturers are presently willing to design this type of tower nor guarantee its performance. Some manufacturers offer hybrid mechanical draft towers which are strictly for fog abatement and are not designed to carry any significant load in the dry section. In fact, the most common design reduces the capacity of the tower in the fog abatement mode.

TABLE 10.1.1. ESTIMATED OPERATING CHARACTERISTICS FOR A NATURAL DRAFT COOLING TOWER AT THE SITE(a)

	WET TOWER		DRY TOWER	
Month	Air Flow Rate 10^5lb/sec	Cold Water Return Temp F(d)	Air Flow Rate 10^5lb/sec	Cold Water Return Temp F(d)
	AVERAGE MONTHLY CONDITIONS(b)			
JAN	1.890	53.9	2.374	70.4
FEB	1.878	54.3	2.373	71.0
MAR	1.760	60.3	2.335	79.8
APR	1.595	67.6	2.286	91.1
MAY	1.423	75.9	2.234	103.5
JUN	1.270	83.9	2.190	115.0
JUL	1.188	87.1	2.170	120.1
AUG	1.224	85.9	2.180	118.1
SEP	1.320	81.3	2.204	111.3
OCT	1.496	73.0	2.297	98.8
NOV	1.690	63.7	2.313	84.9
DEC	1.847	55.8	2.362	73.3
	EXTREME MONTHLY CONDITIONS(b,c)			
JAN	2.456	16.8	2.612	21.8
FEB	2.446	17.8	2.606	22.9
MAR	2.301	28.2	2.539	35.9
APR	2.076	42.0	2.450	54.3
MAY	1.814	55.5	2.357	73.9
JUN	0.825	111.0	2.057	152.0
JUL	0.805	111.6	2.053	153.1
AUG	0.820	111.9	2.053	153.1
SEP	0.898	107.0	2.075	146.6
OCT	1.961	48.0	2.408	63.0
NOV	2.265	30.7	2.526	39.1
DEC	2.423	19.6	2.599	25.0

(a) Tower is 500 feet high, 520 feet in diameter at base, 275 feet in diameter at the throat and has a heat load of 2.37 million Btu/sec.

(b) Based on Sandusky, Ohio observations.

(c) Extreme high temperature June through Sep. Extreme low temperature Oct through May.

(d) See Appendix N for temperature unit conversions.

10.2 INTAKE SYSTEM ALTERNATIVES

10.2.1 FACTORS AFFECTING INTAKE STRUCTURE DESIGNS

The siting of a power plant on Sandusky Bay presents some problems with respect to the makeup water requirements of the heat dissipation system. The natural draft cooling towers proposed for the Site could have maximum makeup water requirements of up to 155,000 gpm for five towers. The usual techniques for removing these amounts of water from the Bay may not work because of the following constraints:

(1) Sandusky Bay is an extremely shallow body of water. Its maximum normal depth within a reasonable distance offshore from the Site is 7 feet and the comparatively small depth of the water column poses significant problems in the design of offshore structures.

(2) The depth of the water column in Sandusky Bay is not constant. Seiche activity in Lake Erie and Sandusky Bay has an extensive influence upon water depth. Seiches are long-wave movements of the water surface which are typically instigated by storm activity and wind patterns.

(3) Sediments within the western basin of Sandusky Bay are unconsolidated, and are quite susceptible to suspension within the water column during periods of even moderate agitation caused by wind activity. The unconsolidated nature and suspension capability of these sediments causes a shifting bottom topography.

(4) Suspended solids concentrations within the water column are comparatively high even in the absence of outside disruptive factors causing sediment disruption.

(5) Ice formation in Sandusky Bay occurs regularly during the winter months. The ice tends to jam and windrow in the western portion of Sandusky Bay. Under these circumstances, ice can extend to the bottom of the bay immediately underneath and adjacent to ice jams and windrows.

10.2.2 NORMAL INTAKE STRUCTURES

The water intake systems of most power stations are not constrained by the depth limitations applicable to Sandusky Bay. These intake structures usually consist of a submerged pipe leading from a polygonal intake chamber surrounded by bar screens and various other materials barriers. An intake design such as this would not be practicable for Sandusky Bay due to the extremely shallow water column. In addition, the unconsolidated nature of the sediments and the typically high turbidity of Sandusky Bay might cause relatively large amounts of this sediment to be drawn into the heat dissipation system along with the intake water.

10.2.3 MAKEUP FROM GROUNDWATER

Groundwater supplies are tapped for a variety of purposes in the vicinity of the Site. It might be possible to withdraw makeup water from on-Site aquifers during periods of low Bay level as an auxiliary to drawing makeup supplies from western Sandusky Bay during periods of normal and high water levels. Withdrawal rates sufficient to achieve makeup requirements would be substantially higher than those presently achieved in the vicinity of the Site. In addition, the extremely high dissolved solids concentrations in the region's groundwater could increase scaling problems and/or environmental impacts associated with the operation of the heat dissipation system. It is planned to examine this possible means of meeting makup water requirements during low Bay level conditions in more detail during subsequent investigations.

10.2.4 LONG RECTANGULAR INTAKE STRUCTURE

The depth constraint imposed by the shallowness of Sandusky Bay might possibly be surmounted by having a long rectangular intake structure instead of a polygonal one. However, withdrawing water through such a structure could result in rapid intake volocities and could conceivably become a problem. Additionally, this alteration of the "typical" design would not surmount the problem of drawing unconsolidated sediments into the heat dissipation system.

10.2.5 INFILTRATION GALLERY

The depth problem associated with Sandusky Bay could also be surmounted by having the intake structures submerged below the bottom of the bay and have it overlain by a gravelly infiltration bed. Using this design, the shallowness of Sandusky Bay would pose no direct problem. However, the high turbidity of the water and the generally unconsolidated nature of the sediments within Sandusky Bay could cause clogging of the infiltration bed by alluvial silt and this would pose a continual problem. The clogging could be dealt with by periodic backwashing, but this could conceivably produce locally severe ecological effects, particularly upon the plankton and benthos in Sandusky Bay.

10.2.6 ON-SITE HOLDING PONDS

Problems due to the shallowness of Sandusky Bay, water level variations in Sandusky Bay, and high suspended solids concentrations in Sandusky Bay waters could be surmounted in large part by withdrawing intake water for makeup requirements from a series of on-Site holding ponds. This would necessitate that the holding ponds be dug to depths deeper than the elevation of the bottom of Sandusky Bay. Water could be derived from Sandusky Bay by spillways or pumps. The volume of water contained within the holding ponds below the top of the spillways would be sufficient to supply total water requirements for full capacity operation for a time period at least equal to the maximum possible seiche period. The maximum consumptive water use of the power plant at full capacity for five units (8,000 MWe) would be about 155,000 gpm. The maximum recorded seiche period for this region is approximately 24 hours. Therefore, the maximum capacity of the holding ponds would be one day's water requirements or about 223 million gallons. This requirement could be met by a single intake holding pond approximately 30 feet deep and 1,000 feet square, or multiple holding ponds totaling the same volume.

Suspended solids concentrations within the water column of relatively deep (30 feet) holding ponds would be lower than those in Sandusky Bay. The water in the ponds would not be subjected to as much stirring action as in the Bay and there would be no currents except near the inlet and outlet of the pond. Suspended particles would tend to settle out at the bottom of the holding ponds and could periodically be dredged out or sucked out and deposited elsewhere.

A holding pond intake design would also eliminate potential icing problems in the wintertime. Any intake structure located in the Bay, particularly in the vicinity of the southern shore of the western basin, would potentially be subject to ice jamming or even collapse due to the tremendous forces associated with migrating ice. However, holding ponds located on shore could be located so as to be isolated from all ice jams, even those severe enough to be driven on shore by the wind. If ice tended to form within the holding ponds or tended to block the spillways leading to the ponds, it would be possible to return the heated blowdown water to these areas to help melt the interfering ice. It should be pointed out that it would take considerable time to completely freeze a column of water 30 feet deep. At the extreme weather conditions for January (-16 F, 68 percent humidity, and 10.8 mph wind speed) it would take over 30 days to completely freeze a 30-foot column of water. Therefore, if the outlet from the holding pond to the condenser and the alternate blowdown return were toward the bottom of the pond, there would be little danger from ice blocking the water circulation.

10.3 DISCHARGE SYSTEM ALTERNATIVES

Instead of discharging the cooling tower blowdown at low velocity through an open ditch, the blowdown could be discharged at a relatively high-velocity through a diffuser or other type of discharge header designed to promote rapid mixing. Approximate dimensions, surface areas, and volumes of the Bay necessary to achieve various dilution ratios can be estimated from the following expressions which are based on expressions developed by Hirst (1971):

$$W \doteq W_o/\sigma \tag{1}$$

$$y = 3.1\ W_o\ (\sigma^2 + 1) \tag{2}$$

$$S_A = 1.55\ W_o^{\ 2}\ (\sigma^4 + 3) \tag{3}$$

$$V = S_A D \tag{4}$$

where

W_o is the width of a slot having the same cross sectional area as the discharge header or diffuser, ft

D is the depth of this slot, ft

σ is the dilution ratio

W is the width of the plume, ft.

y is the distance from the discharge point out into the Bay necessary to achieve the given dilution, ft

S_A is the surface area of the plume, ft^2

V is the volume of the Bay necessary to achieve the given dilution, ft^3 .

If the maximum discharge velocity is limited to about 10 fps at the maximum blowdown rate and the depth of the slot is taken to be the average depth of the Bay (3.93 feet), the width of an equivalent discharge slot would have to be about 4.39 feet or approximately 4 feet. This is based on the estimated blowdown rate (about 77,400 gpm) from five towers operating at a factor of 2 concentration during extreme July conditions.

Setting W_o equal to 4 feet in Equations (1) through (4), the dimensions, surface areas, and volumes of the plume required to dilute the discharge temperature to a 3 F rise were calculated and the results are shown in Table 10.3.1. These results are based on a direct discharge of the blowdown to the Bay without intermediate cooling in ponds or canals.

Upon comparing the results in Table 10.3.1 with Table 10.0.2, it can be seen that a high velocity discharge may be better than a low velocity open ditch with respect to Ohio EPA thermal discharge regulations. However, there may be other problems associated with a high velocity discharge that would offset this advantage. In particular, the discharge may scour the bottom of the Bay creating unacceptable erosion on the bottom and increased silt load in the water.

TABLE 10.3.1. ESTIMATED DIMENSIONS, SURFACE AREA, AND VOLUME OF THE PLUME ENCLOSING THE 3 F TEMPERATURE RISE ISOTHERM RESULTING FROM DISCHARGING THE BLOWDOWN FROM FIVE UNITS THROUGH A HIGH VELOCITY DISCHARGE(a)

	Dimensions, ft		Surface area,	Volume
Month	Width	Length(b)	acres	1000 gal
Jan	190	603(c)	1.29	1656
Feb	181	575(c)	1.17	1501
Mar	269	847(c)	2.58	3300
Apr	111	356(c)	0.44	563
May	50	167	0.09	116
Jun	65	214	0.15	195
Jul	82	267	0.24	310
Aug	54	179	0.10	134
Sep	61	201	0.13	171
Oct	127	406(c)	0.58	737
Nov	207	655(c)	1.53	1962
Dec	231	729(c)	1.90	2436

(a) Calculations are for five towers operating at average monthly weather conditions based on Sandusky, Ohio observations. The discharge temperature is the same as the blowdown temperature.

(b) Length is equivalent to the offshore distance.

(c) Plume exceeds allowable extent in any direction (300 ft).

CHAPTER 11

SUMMARY OF BENEFIT-COST ANALYSIS
(To be prepared by AEPSC)

CHAPTER 12

ENVIRONMENTAL APPROVALS AND CONSULTATIONS

(To be prepared by AEPSC)

CHAPTER 13

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APPENDIX A

Description of Dynamic Simulation Model

This appendix contains a description of the dynamic simulation model used in this study. The simulation model seeks to portray the real world through the use of three components, the demographic submodel, the economic submodel, and the feedback mechanism. Each submodel contains relationships operating in the real world and uses those relationships to portray the real world in a true simulation, thus the model becomes dynamic. Each of the component submodels is discussed below.

Demographic Submodel

The demographic submodel is based upon the cohort-survival method of projecting population. In this method the three components of population change, births, deaths, and migration are summed over time and added to the previous year's population to give a new total population for the county.

Since the population changes vary by age group, the three components of population change birth rates, death rates, and migration rates are age specific. The population is separated into 1 year age cohorts and to these cohorts are applied their respective rates. The net natural change in population plus the net migration are then summed to give the new population. This process is reiterated for every year simulated.

Changes in the model's birth and migration rates over time are caused by the feedback mechanism which will be discussed at a later time. These changes over time that occur within the model are a result of its dynamic nature and not changes related to the original assumptions concerning fertility and migration.

Economic Submodel

Employment projections by industry are the result of the economic submodel. As in the demographic submodel, real world relationships are simulated over time to generate employment projections within various industries in the local economy. Basically this submodel consists of various relationships among export industry, home serving industry, and business serving industry. Employment in each of these industrial sectors responds and changes for different reasons.

Export Employment. Employment in the export sector is a function of demand which is exogenous to the local area. Since the export sector produces goods and services which are exported from the local area, the employment required within a given export industry and the changes in that employment over time depend upon factors beyond the control of the local economy. If exogenous demand for a given export product increases, employment in that industry will increase. Historical export employment growth rates have been determined for export industries in Alabama and are included in the model.

Business Serving Employment. Business serving employment is a function of the total employment within the local economy. Since demand for business serving industries depends by definition upon other businesses, it follows that as total employment increases business serving employment increases and vice versa. Given a change in export industry employment there will be a corresponding change in total employment and thus business serving employment. The availability of labor in the local area also affects the magnitude of the employment change in the business serving sector. For example, as employment in the export sector increases the unemployment rate decreases making less labor available for any given job. Businesses must now compete for the available labor supply and a specific business may not be able to hire all the labor it would like. This factor is represented within the model and it dampens the relationship between business serving employment and total employment.

Household Serving Employment. Household serving employment is a function of total population within the local economy. Household serving employment provides goods and services to the local population and as the population and their demand increase so does employment in the household serving factor. Examples of household serving industries are hospitals, entertainment, eating and drinking places, and retail trade.

As before, the amount of labor desired by any particular household serving industry is adjusted to take account of the current labor availability in the local area. Thus, desired change in employment may not be equal to actual change.

Feedback Sector

The feedback sector of the model relates the economic and demographic submodels of the system. The basic concept of the feedback sector is the relationship between unemployment and other variables within the model. The unemployment rate within an area serves as an indication of that area's economic vitality. Migration rates, labor force participation rates, and birth rates are all affected by the degree of unemployment within a given area.

Migration Rates.

Migration, especially for the working ages, can largely be explained by economic opportunity. People gravitate toward areas having relatively low unemployment rates. This relationship between migration rates and unemployment has been identified and estimated by means of regression analysis and incorporated into the feedback sector of the model. Basically, as the local unemployment rate becomes less than the national unemployment rate there is net in-migration and as the local-unemployment rate becomes greater than the national unemployment rate there is net out-migration. Out-migration reduces the total population and thus affects the household serving sector of the economy. Changes in total employment caused by changes in the household serving sector affect the business serving sector and out-migration may be further increased. A comparable process operates in a reverse manner to affect in-migration.

Birth Rates.

Birth rates also may be related to the level of unemployment within a given area. Studies have shown that national birth rates respond positively to business cycles within our economy. (Silver, 1965) Within our model it is assumed that this relationship also holds true for the local area. Unemployment rates are used to represent the business cycle and as the unemployment rate rises the birth rate falls. Conversely, as the unemployment rate falls the birth rate increases. One can sense this relationship intuitively by considering that when jobs become scarce it is generally the younger age groups that are most severely affected. Since these groups are the most fertile groups in our society and since they plan their families on the basis of their economic situations, the importance of the relationship between the unemployment rate and the birth rate becomes apparent.

Labor Force Participation Rates. The labor force participation rate is an important link between the economic and demographic submodels. It is defined as the percentage of the population ages 14 and over that is working or actively seeking employment. The labor force participation rate is computed for specific age groups within the model since actual rates vary by age group, geographic area, and over time. Past investigations by Battelle have indicated that labor force participation rates are inversely related to the unemployment rates. As the unemployment rate increases and the number of jobs available becomes smaller, some workers become discouraged and withdraw from the labor force. Conversely, as the economic situation improves and the number of jobs increase, the number of persons seeking employment increases. Changes in labor force participation rates affect unemployment rates and other variables within the model and once again the model's dynamics come into play.

APPENDIX B

ADDITIONAL INFORMATION ON WATER USE PATTERNS WITHIN A 20 MILE RADIUS FROM THE SITE

TABLE B-1

PUBLIC AND PRIVATE WATER WITHDRAWALS, RETURNS, AND AMOUNTS USED FOR COOLING, FOR ALL MANUFACTURING PLANTS--1955 (MILLIONS GALLONS DAILY) FOR ALL COUNTIES AT LEAST PARTIALLY INCLUDED WITHIN, AND ALL MUNICIPALITIES WITHIN 20-MILE RADIUS FROM SITE

	Area	1970 Population	Withdrawal			Amount Returned			Amount for Cooling	Percent for Cooling
			Total	Public Supply	Private Supply	Total	Inland Surface	Under-ground		
Portage River Basin	Sandusky County		0.736	0.024	0.712	0.530	0.498	0.032	0.432	58.6
	Gibsonburg	(2,585)	0.497	0.012	0.485	0.369	0.361	0.008	0.290	58.3
	Ottawa County		4.280	0.721	3.559	3.271	2.858	0.413	1.070	25.0
	Elmore	(1,316)	0.154	--	0.154	0.015	0.015	--	0.115	74.6
	Gypsum		1.866	0.075	1.791	1.319	0.906	0.413	0.560	30.0
	Marblehead	(726)	0.001	0.001	--	0.001	0.001	--	--	--
	Oak Harbor	(2,807)	0.034	0.026	0.008	0.024	0.024	--	0.007	20.5
	Point Clinton	(7,202)	0.618	0.618	--	0.498	0.498	--	0.008	1.2
	Seneca County		1.356	0.687	0.669	1.280	1.159	0.121	0.565	41.6
Sandusky River Basin	Sandusky County		0.951	0.339	0.612	0.826	0.826	--	0.262	27.5
	Fremont	(18,490)	0.798	0.339	0.459	0.695	0.695	--	0.262	32.8
	Gibsonburg	(2,585)	0.153	--	0.153	0.131	0.131	--	--	--
	Seneca County		4.748	0.141	4.607	4.581	4.579	0.002	2.801	58.9
	Bettsville	(833)	0.008	0.004	0.004	0.006	0.006	--	0.001	12.5
Huron-Black Rivers Basin	Sandusky County		0.475	0.448	0.027	0.445	0.424	0.021	0.245	51.5
	Bellevue	(8,604)	0.561	0.177	0.384	0.512	0.510	0.002	0.061	10.8
	Clyde	(5,503)	0.474	0.447	0.027	0.444	0.423	0.021	0.245	51.6
	Erie County		7.922	1.890	6.032	6.545	6.524	0.021	4.136	52.2
	Avery		0.027	--	0.027	0.008	0.008	--	0.009	33.3
	Baybridge	(150)	4.794	--	4.794	3.561	3.561	--	2.397	50.0
	Milan	(1,405)	0.101	0.101	--	0.101	0.101	--	0.080	79.2
	Sandusky	(41,175)	2.992	1.783	1.209	2.870	2.849	0.021	1.650	55.1
	Huron County		0.991	0.502	0.489	0.848	0.846	0.002	0.230	23.2
	Monroeville	(1,455)	0.002	0.002	--	0.001	0.001	--	--	--
	Norwalk	(13,386)	0.308	0.205	0.103	0.239	0.239	--	0.153	49.6
	Portage River Basin		6.854	1.470	5.384	5.483	4.911	0.572	2.233	32.5
	Sandusky River Basin		6.914	1.300	5.614	6.530	6.476	0.054	3.958	57.2
	Huron-Black River Basin		210.448	9.644	200.804	207.468	207.408	0.059	171.796	81.6
	State		3,124.959	254.399	2,870.560	3,008.405	2,993.044	15.361	2,554.006	81.7

Source: "Industrial Water Use in Ohio", Report No. 8, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (December, 1960).

TABLE B-2

PUBLIC WATER WITHDRAWAL AND SOURCE, FOR MUNICIPALITIES WITHIN 20 MILES OF SITE--1957

	Location	Population Served	Withdrawals by Source, mgd			All Sources, mgd	Number of Wells	System Capacity, mgd
			Lake Erie	Inland Surface	Underground			
Sandusky County	Gibsonburg	2,527	--	--	0.160	0.160	2	2.090
	Green Springs	1,107	--	--	0.079	0.079	2	0.480
	Fremont	19,244	--	2.000	--	2.000	--	4.500
	Clyde	4,996	--	0.700	--	0.700	9	2.000
	Bellevue	7,760	--	1.406	--	1.406	--	--
Ottawa County	Elmore	1,234	--	--	0.070	0.070	2	0.300
	Port Clinton(1)	6,413	1.132	--	--	1.132	--	3.000
	Put-In-Bay	512	0.015	--	--	0.015	--	0.245
	Lakeside(2)	3,500	0.175	--	--	0.175	--	0.400
	Marblehead(2)	NA	0.045	--	--	0.045	--	NA
Erie County	Baybridge(2)	150	0.008	--	--	0.008	--	0.025
	Kelly's Island	278	0.025	--	--	0.025	--	0.200
	Sandusky	36,000	7.470	--	--	7.470	--	18.000
	Milan	1,042	--	--	0.160	0.160	2	0.320
Seneca County	Bettsville	705	--	--	0.040	0.040	2	0.144
Huron County	Monroeville	1,438	--	0.090	--	0.090	--	0.250
	Norwalk	11,406	--	1.500	--	1.500	1	2.200

Source: "Municipal Water Supply in Ohio", Report No. 9, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (July, 1962).

(1) Port Clinton also services Oak Harbor and part of Portage County.

(2) Served by privately owned water supply systems:
Lakeside by Lakeside Camp Meeting Association
Marblehead by Chemstone Corporation
Baybridge by Medusa Cement Company (supply abandoned in 1958).

TABLE B-3

MUNICIPAL AND PRIVATE INDUSTRIAL WATER WITHDRAWALS AND SOURCE, FOR MUNICIPALITIES WITHIN 20 MILES OF SITE (NOT INCLUDING HURON COUNTY)(1)--1955 (IN MILLIONS GALLONS DAILY)

	Location	Municipal Water			Private Industrial			Total Municipal and Private Industrial
		Lake Erie	Surface	Ground	Lake Erie(2)	Surface	Ground	
Sandusky County	Gibsonburg	--	--	0.145	--	0.297	0.341	0.783
	Green Springs	--	--	0.082	--	--	--	0.082
	Fremont	--	2.100	--	--	--	0.459	2.559
	Clyde	--	0.660	--	--	--	0.027	0.687
	Bellevue	--	1.445(4)	--	--	--	0.384	1.829
Ottawa County	Elmore	--	--	0.071	--	0.138	0.016	0.225
	Port Clinton	1.246	--	--	--	--	--	1.246
	Put-In-Bay	0.015	--	--	--	--	0.026	0.041
	Gypsum Area(3)	Included in Port Clinton amount			1.453	--	0.413	1.866
	Lakeside(3)	0.140	--	--	--	--	--	0.140
	Marblehead	0.044	--	--	--	--	--	0.044
Erie County	Baybridge(3)	--	--	0.025	4.794	--	--	4.819
	Kelly's Island	0.013	--	--	--	--	--	0.013
	Castalia			Included in Sandusky amount				
	Sandusky	6.663	--	--	1.088	0.005	0.116	7.872
Seneca County	Bettsville	--	--	0.039	--	--	0.004	0.043
Private wells in towns in Sandusky River Basin		--	--	--	--	--	0.227	0.227

Source: "Water Inventory of the Portage River and Sandusky River Basins", Report No. 20, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (1966).

(1) Data not available for Huron County.

(2) From Sandusky Bay.

(3) Unincorporated.

(4) From Frink Run, tributary of west branch of Huron River.

TABLE B-4

AVERAGE DAILY RURAL WATER USE, FOR WATERSHEDS AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE--1955 (IN MILLIONS GALLONS DAILY)

River Basin	Suburban Homes(1)	Farm Homes	Live-stock	Farm Irrigation	Nursery	Green-house	Golf Course	Total	Percent of State	Rural Water Use Per 50 Million (gallons/day)
Portage	0.8	1.6	0.8	0.5	0.003	0.1	0.4	4.2	2	4,400
Sandusky	0.7	1.3	2.0	0.3	0.003	N	0.2	4.5	2	3,300
Huron-Black	1.8	3.7	1.6	4.3	0.007	0.4	4.2	16.0	7	8,200

(1) According to classification of 1950 Census.

N = Negligible.

Source: "Irrigation and Rural Water Use in Ohio", Report No. 7, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (October, 1959).

TABLE B-5

WATER WITHDRAWAL FOR FARM FIELD IRRIGATION, FOR WATERSHEDS AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE--1955 (IN MILLIONS GALLONS DAILY)

River Basin	Total Use		Public Source--Lake Erie	Private Source			Total Private	Percent of Total State Withdrawal
	Net Daily	Average		Lake Erie	Inland Surface	Ground		
Portage	3.047	0.523	--	0.019	0.378	0.127	0.523	7
Sandusky	1.347	0.283	--	--	0.071	0.211	0.283	1
Huron-Black	15.995	4.316	0.134	0.236	3.184	0.761	4.182	15

Source: "Irrigation and Rural Water Use in Ohio", Report No. 7, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (October, 1959).

TABLE B-6

WATER WITHDRAWAL FOR FARM FIELD IRRIGATION, FOR COUNTIES AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE--1955 (IN MILLIONS GALLONS DAILY)

	Total Use		Source (Private)			
County	Net Daily	Average	Lake Erie	Inland Surface	Under-ground	Total Private
Sandusky	0.307	0.076	--	0.053	0.022	1.076
Ottawa	2.799	0.545	0.255	0.164	0.127	0.545
Erie	3.245	0.541	--	0.541	--	0.541
Seneca	0.476	0.091	--	0.025	0.066	0.091
Huron	4.586	1.002	--	1.002	--	1.002
State (1)	125.238	28.054	0.585	17.680	8.443	27.718

(1) State withdrawal includes 1.345 from Ohio River.

Source: "Irrigation and Water Use in Ohio", Report No. 7, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (October, 1959).

TABLE B-7

AGRICULTURAL WATER WITHDRAWAL FOR COUNTIES AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE--1965 (MILLIONS GALLONS DAILY)

County	Water Use	Amount
Sandusky	Farm and suburban homes	1.312
	Livestock	0.599
	Farm irrigation	0.184
	Golf course irrigation	0.066
	Greenhouse and nursery	0.050
Ottawa	Farm and suburban homes	1.024
	Livestock	0.151
	Farm irrigation	0.076
	Golf course irrigation	0.022
	Greenhouse and nursery	0.013
Erie	Farm and suburban homes	1.096
	Livestock	--
	Farm irrigation	0.096
	Golf course irrigation	0.130
	Greenhouse and nursery	0.082
Seneca	Farm and suburban homes	1.761
	Livestock	0.776
	Golf course irrigation	0.022
Huron	Farm and suburban homes	0.666
	Livestock	0.517
	Farm irrigation	0.135
	Golf course irrigation	0.044
	Greenhouse and nursery	0.021

Source: Northwest Ohio Water Development Plan, Department of Natural Resources, State of Ohio, Columbus, Ohio (1967).

TABLE B-8

SOURCES OF PUBLIC AND PRIVATE WATER WITHDRAWALS FOR ALL MANUFACTURING PLANTS-1955 (MILLIONS GALLONS DAILY) FOR COUNTIES AT LEAST PARTIALLY INCLUDED WITHIN, AND ALL MUNICIPALITIES WITHIN 20-MILE RADIUS FROM SITE

	Area (County and Municipality)	1970 Population	Public Supply			Private Supply		
			Lake Erie	Inland Surface	Under-ground	Lake Erie(1)	Inland Surface	Under-ground
Portage River Basin	Sandusky County		--	--	0.024	--	0.463	0.249
	Gibsonburg	(2,585)	--	--	0.012	--	0.297	0.188
	Ottawa County		0.720	--	0.001	--	1.721	1.838
	Elmore	(1,316)	--	--	--	--	0.138	0.016
	Gypsum		0.075	--	--	--	1.378	0.413
	Marblehead	(726)	0.001	--	--	--	--	--
	Oak Harbor	(2,807)	0.026	--	--	--	--	0.008
	Port Clinton	(7,202)	0.618	--	--	--	--	--
	Seneca County		--	0.682	--	--	0.078	0.591
Sandusky River Basin	Sandusky County		--	0.339	--	--	--	0.612
	Fremont	(18,490)	--	0.339	--	--	--	0.459
	Gibsonburg	(2,585)	--	--	--	--	--	0.153
	Seneca County		--	0.137	0.004	--	--	4.607
	Bettsville	(833)	--	--	0.004	--	--	0.004
Huron-Black Rivers Basin	Sandusky County		--	0.448	--	--	--	0.027
	Bellevue	(8,604)	--	0.177	--	--	--	0.384
	Clyde	(5,503)	--	0.447	--	--	--	0.027
	Erie County		1.789	--	0.101	1.088	4.826	0.118
	Avery		--	--	--	--	0.027	--
	Baybridge	(150)	--	--	--	--	4.794	--
	Milan	(1,405)	--	--	0.101	--	--	--
	Sandusky	(41,175)	1.783	--	--	1.088	0.005	0.116
	Huron County		--	0.383	0.119	--	0.002	0.487
	Monroeville	(1,455)	--	0.002	--	--	--	--
	Norwalk	(13,386)	--	0.205	--	--	0.103	--
Portage River Basin			0.720	0.704	0.046	--	2.618	2.766
Sandusky River Basin			--	1.165	0.135	--	--	5.614
Huron-Black Rivers Basin			8.264	1.076	0.304	1.088	199.010	0.706
State			126.255	64.634	43.650	293.716	1,743.683	257.629

Source: "Industrial Water Use in Ohio", Report No. 8, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (December, 1960).

(1) From Sandusky Bay.

TABLE B-9

PUBLIC WATER WITHDRAWALS, SOURCE, PER CAPITA USE AND SEWAGE RETURN, FOR MUNICIPALITIES WITHIN 20 MILES OF SITE (NOT INCLUDING HURON COUNTY)(1)-- 1955 (IN MILLIONS GALLONS DAILY)

	Location	Population Served	Water Withdrawal	Per Capita Daily Use, gallons	Sewage Return, mgd
Sandusky County	Gibsonburg	2,600	0.145	56	0.116
	Green Springs	1,200	0.082	68	0.080
	Fremont	18,353	2.100	114	2.390
	Clyde	4,500	0.660	147	0.611
	Bellevue	8,235	1.445(5)	175	0.065
Ottawa County	Elmore	1,400	0.071	51	0.057
	Port Clinton	10,000	1.246	125	0.600
	Put-In-Bay	393	0.015	38	0.012
	Lakeside(3)	400	0.140	350	0.112
	Marblehead(4)	858	0.044	51	0.035
Erie County	Baybridge(2)	150	0.025	167	0.020
	Kelly's Island	253	0.013	51	0.010
	Castalia		Included in Sandusky amount		
	Sandusky	35,000	6.663	190	4.650
Seneca County	Bettsville	500	0.039	78	0.031

Source: "Water Inventory of the Portage River and Sandusky River Basins", Report No. 20, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (1966).

(1) Data not available.

(2) Unincorporated area served by Medusa Cement Compnay, until supply abandoned in 1958.

(3) Unincorporated area served by Lakeside Camp Meeting Association.

(4) Served by Chemstone Corporation, own supply 1959.

(5) From Frink Run, tributary of west branch of Huron River.

TABLE B-10

USE OF WATER BY LIVESTOCK, FOR WATERSHEDS AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE--1955

Basin	Water Consumption By Livestock, mgd	Basin Area, sq mile	Use Per Square Mile, gpd	Percent Total Water Used By Livestock in State
Portage	0.8	1,044	800	1.7
Sandusky	2.0	1,421	1,380	4.2
Huron-Black	1.6	1,993	820	3.5

TABLE B-11

KINDS OF CROPS IRRIGATED, FOR WATERSHEDS AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE

River Basin	Total Acres	Tree Fruit	Small Fruit	Field Corn	Sweet Corn	Potatoes	Vegetables	Pasture	Other	Nursery	Greenhouse
Portage	330	41	3	130			45	60		44	7
Sandusky	244		17	10	10		46	113		40	8
Huron-Black	3,264	281	5	150		42	1,995	318	300	96	140

Source: "Irrigation and Water Use in Ohio", Report No. 7, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (October, 1959).

TABLE B-12

PUBLIC WATER WITHDRAWAL AND SOURCE, FOR COUNTIES AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE--1957

County	Source(s) of Supply (Principal Sources First)	Amount of Withdrawal (MGD)
Sandusky	Inland surface, underground	4.5
Ottawa	Lake Erie, underground	1.5
Erie	Lake Erie, inland surface, underground	9.2
Seneca	Inland surface, underground	1.7
Huron	Inland surface, underground	2.9

Source: "Municipal Water Supply in Ohio", Report No. 9, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (July, 1962).

TABLE B-13

PUBLIC WATER WITHDRAWAL AND SOURCE, FOR WATERSHEDS AT LEAST PARTIALLY INCLUDED WITHIN 20-MILE RADIUS FROM SITE--1957

	Source and Amount of Withdrawal (MGD)			
Watershed	Lake Erie	Inland Surface	Underground	No. of Wells
Portage River Basin	1.2	1.7	0.9	37
Sandusky River Basin		5.5	1.5	24
Huron-Black River Basin	28.2	6.9	2.2	43

TABLE B-14

DAILY AND ANNUAL WATER WITHDRAWALS FROM PUBLIC AND PRIVATE SOURCES FOR RAILROADS, SAND AND GRAVEL PLANTS, AND ELECTRIC POWER GENERATING PLANTS--1955 (MILLIONS GALLONS DAILY) FOR COUNTIES AT LEAST PARTIALLY INCLUDED WITHIN, AND ALL MUNICIPALITIES WITHIN 20-MILE RADIUS FROM SITE

	Public Supply				Total Public Supply		Private Supply				Total Private Supply		Grand Total Public and Private	
	Surface Water		Underground Water				Surface Water		Underground Water					
Usage and Area	Per Day	Annual	Per Day	Annual	Per Day	Annual	Per Day	Annual	Per Day	Annual	Per Day	Annual	Per Day	Annual
Railroads														
Erie County (Sandusky)	0.164	59.686			0.164	59.686							0.164	59.686
Huron County (Bellevue)	0.883	321.769			0.882	321.769	0.548	200.000			0.548	200.000	1.430	521.769
Sand and gravel plants														
Huron County							0.001	0.419			0.001	0.419	0.001	0.419
Sandusky County	0.001	0 300			0.001	0.300	0.001	0.600			0.001	0.600	0.002	0.900
Electric power generating plants														
Huron County							6.035	2,202.797			6.035	2,202.797	6.035	2,202.797
Sandusky County							0.383	139.795			0.383	139.795	0.383	139.795

Source: "Industrial Water Use in Ohio", Report No. 8, Ohio Water Plan Inventory, Department of Natural Resources, State of Ohio (December, 1960).

APPENDIX C

DESCRIPTION OF ARCHAEOLOGICAL SITES IN THE IMMEDIATE VICINITY OF THE SITE

APPENDIX C

SITE 1

Location: SE-1/4 SE-1/4 Section 24, Riley Township, Sandusky County, Ohio

Description: Low ridge on west side of small swale representing former tributary (now channelized) of Pickerel Creek.

Survey Conditions: Excellent. Plowed, weathered field.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	1
	Devonian cherts	6
	Unidentified	2

Flint Artifacts:

Fragment of cache blade or blank	Upper Mercer flint
Parallel-sided flake with retouch and wear along lateral margin	Unidentified flint

Cultural and Temporal Affinities of Site: All recovered material undiagnostic.

SITE 2:

Location: SW-1/4 SE-1/4 Section 13, Riley Township, Sandusky County, Ohio.

Description: West bank of Pickerel Creek, at head of large meander.

Survey Conditons: Good. Old corn field with some weed cover.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	2
	Devonian cherts	3
	Upper Mercer flint	1
	Unidentified	4

Flint Artifacts:

Four crude, parallel-sided flakes showing fine chipping along lateral sides	Devonian cherts

Other Artifacts:

Banded slate chipped ovate disc used as a scraper or possibly an unfinished celt. Length, 80.0 mm; Width, 50.6 mm; Thickness, 21.0 mm.

Cultural and Temporal Affinities of Site: All recovered material undiagnostic.

SITE 3

Location: East central NE-1/4 Section 24, Riley Township, Sandusky County, Ohio

Description: East bank of Pickerel Creek upstream from confluence with Fuller Creek.

Survey Conditions: Very good. Weathered soybean field.

Material Recovered:

Unutilized Chippage:	Devonian cherts	8
	Upper Mercer flint	1
	Unidentified	1

Cultural and Temporal Affinities of Site: All recovered material undiagnostic.

SITE 4

Location: SE-1/4 NW-1/4 Section 13, Riley Township, Sandusky County, Ohio

Description: Low knoll along edge of former channel of tributary of Pickerel Creek.

Survey Conditions: Excellent. Weathered corn field.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	4
	Devonian cherts	16
	Upper Mercer flint	10
	Unidentified	11

Flint Artifacts:

Broken elongate cache blade. Length (estimated), 80 mm; Width, 41.8 mm; Thickness, 11.4 mm	Devonian chert
Corner-notched Archaic point, resharpened. Length, 44.4 mm; Width, 38.6 mm; Haft Width, 23.1 mm; Thickness, 9.0 mm; Basal Width, 28.1 mm. Small Kirk or Charlestown Corner-notched point. (Figure 1 G)	Devonian chert
Le Croy Bifurcated Base point, no basal grinding. Length, 22.6 mm; Width, undeterminable; Thickness, 16.9 mm.	Devonian chert

Undiagnostic point fragments, 1 of Devonian chert and 1 of unidentified chert

Blank fragments of Devonian chert

End scraper on large broken blade of unidentified flint

Small Hopewell-like bladelet of unidentified flint (Figure 1 I).

Cultural and Temporal Affinities of Site: Early Archaic camp site, Kirk or Charlestown point dating around 7000-8000 B.C. The Le Croy Bifurcated Base point has been dated at 6300 B.C. The small well-made bladelet may indicate a Middle Woodland campsite of around 100-500 A.D.

SITE 5

Location: NW-1/4 SE-1/4 Section 12, Riley Township, Sandusky County, Ohio

Description: Knoll on west bank of abandoned meander of Pickerel Creek. Knoll is probably due to post-glacial deformation and subsequent travertine/tufa deposition by spring water.

Survey Conditions: Good to excellent. Part of the site is in weathered soybean crop with slight to moderate weed cover. A small part of the site is uncultivated and in grass and weeds.

Material Recovered:

Unutilized Chippage:

Plum Brook flint	24
Devonian cherts	26
Pebble cherts	5
Rhyolite	2
Unidentified	28

Flint Artifacts:

Broken point fragment of unidentified chert

Crude, parallel-sided flake with lateral wear

Ceramics:

Grit-tempered, thick sherd, interior and exterior cordmarked, probably Leimbach Thick (Shane 1967). Thickness, 16.8 mm.	
Grit-tempered, split sherdlets, probably Leimbach Thick	4
Grit-tempered, exterior cordmarked sherds, probably Late Woodland. Thickness: 6.9, 5.8, 6.3, 6.5 mm.	4
Grit-tempered, exterior smooth sherds, probably Late Woodland. Thickness: 7.1, 7.0, 7.3, 5.8, 9.3, 6.8, 3.8, 5.8, 7.4, 7.9, 4,0, 5.6 mm.	12
Grit-tempered, simple-stamped sherd, 8.2 mm thick	1

Parker Festooned rimsherd (Figure 1 0), grit-tempered, flat, smooth lip, 6.8 mm thick.	1
Grit-tempered, tool-impressed fragments, 5.0 and 7.7 mm thick.	2
Grit-tempered split sherdlets	9

Faunal Remains:

Deer calcaneum, radius, tooth
Elk phalange
Opossum mandible
11 unidentified mammal bone fragments
2 unidentified bird bone fragments
1 human skull fragment
23 drumfish (Aplodinotus) otoliths
Fresh-water and terrestial gastropods, including Mesodon thyroides (Say) and Stagnicola reflexa (Say)

Historic Materials:

3 fragments of salt glazed stoneware
8 fragments of blue print ironstone

Cultural and Temporal Affinities of Site: This site is the only previously reported site within the study area. It has been described as the Stull earthworks; though there is no evidence of actual earthworks, an earthen circle may once have existed at the site. Thinness of the midden and site location suggests that this site was used as a hunting and fishing camp. The location on the lee side of the small knoll, within a mile of the lake shore might suggest that the site was occupied year round, with deliberate effort being made to live in as sheltered a position as possible. It is considered more likely, however, that the site was used only as a spring and fall fishing and hunting camp. The Leimbach Thick potsherds, despite the absence of diagnostic stemmed flint points, indicates the presence of an Adena-like Early Woodland component circa 500 to 100 B.C. The major component, however, is represented by the bulk of the ceramics, including the Parker Festooned rimsherd, which dates around 1200 to 1500 A.D. The

The absence of shell-tempered pottery suggests that the Late Woodland-Late Prehistoric occupation occurred comparatively early during this 300 year period.

Unfortunately, none of the identifiable bone refuse can be related to the aboriginal occupation of the site. A few unidentifiable bone fragments are burned, suggesting contemporaneity with the prehistoric components, but many of the remains could postdate the prehistoric occupation of the site. The drumfish and the molluscan remains have weathered from the marl which underlies the site and are not related to the human habitation of the site.

SITE 6

Location: SE-1/4 NW-1/4 Section 19, Townsend Township, Sandusky County, Ohio.

Description: Former bank of Fuller Creek, edge of abandoned meander on east bank of the creek, 1/2 mile above confluence with Pickerel Creek.

Survey Conditions: Poor to excellent. Part of the area was weathered corn field, but portions had only recently been plowed for spring planting. Part of the site was in pasture.

Material Recovered:

Unutilized Chippage:

Plum Brook flint	9
Devonian chert	68
Upper Mercer flint	6
Unidentified	14

Flint Artifacts:

Broken triangular point. Length, indeterminate; Width, indeterminate; Thickness, 3.8 mm	Devonian chert
Broken Archaic bifurcate base point. (Figure 1 E)	Devonian chert
"Thumbnail" endscraper of Upper Mercer flint	
Combination side and end scraper on crude large blade.	Plum Brook flint
End scraper on large lamellar flake of Devonian chert.	
Side scraper on large lamellar flake of Devonian chert.	
End scraper on small lamellar flakes of Plum Brook flint. (2).	
Blank fragment of Plum Brook flint.	

Cultural and Temporal Affinities of Site: The two diagnostic flint artifacts recovered at this site indicate short term occupation during the Archaic period and again during the Late Prehistoric period. The site may also have been used during the intervening period as a camp site or chipping station. The high percentage of drab Devonian cherts among the recovered chippage is interesting and is probably representative of a single component.

SITE 7

Location: SW-1/4 NW-1/4 Section 20, Townsend Township, Sandusky County, Ohio.

Description: West bank of abandoned meander of Strong Creek, south of Norfolk and Western RR and 1/5 mile east of Vickery.

Survey Conditions: Poor to very good. A large part of the site is planted in winter wheat and could not be examined. The rest of the site is recently cleared ground, providing good survey conditions.

Material Recovered:

Unutilized Chippage:		
	Plum Brook flint	28
	Devonian cherts	9
	Upper Mercer flint	2
	Pebble cherts	1
	Unidentified	11

Flint Artifacts:

Serrated large triangular point (Figure 1 M). Length, 43.5 mm; Width, 28.8 mm; Thickness, 6.5 mm Plum Brook flint

Unidentified corner or side notched point fragment.

Faunal Remains:

2 unidentified mammal bone fragments.

Floral Remains:

Charred hickory nut fragments.

Cultural and Temporal Affinities of Site: Uncertain. Triangular flint point may indicate Late Woodland or Late Prehistoric component but could also be earlier.

SITE 8

Location: SW-1/4 SW-1/4 Section 17, Townsend Township, Sandusky County, Ohio.

Description: East bank of Strong Creek, 0.4 mile Northeast of Vickery.

Survey Conditions: Excellent. Plowed, weathered field.

Material Recovered:

Unutilized Chippage:

Plum Brook flint	13
Devonian chert	10
Upper Mercer flint	2
Unidentified	4

Flint Artifacts:

Broken Plano lanceolate or stemmed point base. Chippage and wear along edge of hinge fracture suggests secondary utilization as a scraper. Basal width, 19.8 mm; Thickness, 6.0 mm. (Figure 1 A).	Upper Mercer flint
Broken "thumbnail" scraper.	Upper Mercer flint
Broken drill tip.	Upper Mercer flint
Undiagnostic point fragments (2) of Plum Brook flint and Devonian chert.	
Fragmentary blank of unidentified flint	
Random lamellar flakes with distal chipping (2) of Plum Brook flint.	

Faunal Remains:

Blarina brevicauda skull

Cultural and Temporal Affinities of Site: The Plano point base is the oldest artifact found during the course of this survey. It can be assigned to late Paleo-Indian or Plano times and dates around 8000 B.C. This site, considering the small sample size, has yielded a noticeably large proportion of artifacts made from Upper Mercer flint. It is possible, though by no means certain, that the thumbnail scraper and even the drill tip also represent the Plano component.

SITE 9

Location: SW-1/4 NE-1/4 Section 18, Townsend Township, Sandusky County, Ohio.

Description: East bank of Strong Creek, between Strong Creek and abandoned tributary.

Survey Conditons: Poor. Newly plowed field

Material Recovered:

Unutilized Chippage:	Plum Brook flint	1
	Upper Mercer flint	3
	Pebble chert	3
	Flint Ridge flint	1
	Unidentified	9

Flint Artifacts:

"Transitional" point of unidentified flint. Basal and lateral grinding on stem. Length, 42.3 mm; Width, 22.9 mm; Stem Width, 17.5 mm; Thickness, 6.7 mm. (Figure 1 B).

Unidentifiable point fragment of Upper Mercer flint.

2 broken parallel-sided flakes with distal retouch, both of Upper Mercer flint.

Crude, broken parallel-sided flake with distal retouch, of Plum Brook flint.

Crude, broken parallel-sided flake with both distal and lateral retouch, of unidentified flint.

Lamellar flake end scraper with graver spur. Unidentified white Devonian flint.

Crude ovate scraper of Plum Brook flint.

Cultural and Temporal Affinities of Site: Smith (1957) and Converse (1970) consider the "Transitional" point type a late Paleo-Indian or Early Archaic type. Smith apparently included Benton-like points in his Transitional type, and Benton-Savannah River type points are generally dated in the Late Archaic, circa 3500-1200 B.C. Converse, however, restricts the Transitional point to Late Paleo-Indian or early Archaic times. The occurrence at Site 9 with a scraper-graver tool lends some support to this age assignment.

SITE 10

Location: NW-1/4 NE-1/4 Section 18, Townsend Township, Sandusky County, Ohio.

Description: Northwest-southeast trending ridge 0.2 mile east of Strong Creek.

Survey Conditions: Excellent. Weathered open field.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	6
	Unidentified (small)	24

Flint Artifacts:

Crude parallel-sided flake with lateral chipping, of Plum Brook flint.

2 crude parallel-sided flakes with lateral chipping, of unidentified flint.

End scraper on crude blade of Devonian chert.

Ceramics:

Grit-tempered cordmarked sherds. Thickness: 7.1, 6.1, 7.8, 5.1, 5.9, 5.4, 4.7, 7.6, 4.6, 6.9, 8.4, 7.3 mm.

Grit-tempered split sherdlets (10).

Grit-tempered cordmarked rim sherd, slightly thickened rim with cordmarked flat lip, 7.6 mm thick.

Faunal Remains:

Deer	5
Rabbit	2
Pig	1
Unidentified mammal bone fragments	53
Unidentified small bird bone fragments	6
Drumfish	2
Unidentified fish bones	13
Fish scale indicating spring mortality	1

Molluscan Remains:

*Anguispira alternata (Say)
Discus patulus (Deshayes)
Allogona profunda (Say)
Stenotrema hirsutum (Say)
Zonitoides arboreus (Say)
Stagnicola palustris (Muller)
Pleurocera acutum Rafinesque
Helisoma pseudotrivolvis (Baker)

Cultural and Temporal Affinities of Site: Although none of the fish bones recovered in the bone refuse can certainly be related to the Indian occupation, it is probable that this site represents a spring and fall fishing and hunting camp occupied during Late Woodland times.

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* All of the species in this list are previously unreported from Sandusky County.

SITE 11

Location: NE-1/4 SE-1/4 Section 1, Riley Township, Sandusky County, Ohio.

Description: West bank of Pickerel Creek, 1/2 mile from mouth of stream.

Survey Conditions: Excellent. Weathered open field.

Material Recovered:

Ceramics:

Grit-tempered potsherd

Cultural and Temporal Affinities of Site: The single Late Woodland potsherd recovered at this site is of some significance as it may indicate the location of the Muskash earthworks reported by Williams (1882). Especial care was taken in surveying this section in an attempt to locate the Muskash earthworks, but this is the only site that yielded any ceramics. There is no indication of an earthworks at this site, but Williams himself had observed that the earthworks was no longer visible. The complete lack of chippage or other material indicative of aboriginal occupation at this point is disconcerting. Mills (1914) locates an earthwork in the NW-1/4 NE-1/4 of Section 1, but limited testing at that location failed to discover any artifact or refuse material.

SITE 12

Location: SE-1/4 SW-1/4 Section 1, Riley Township, Sandusky County, Ohio.

Description: Slight knoll along west side of channelized stream.

Survey Conditions: Fair. Recently plowed 19th Century house site.

Material Recovered:

Flint Artifacts:

"Transitional" point damaged by impact fracture. Basal grinding present. Length, indeterminable; Width, 26.9 mm; Basal Width, 15.8 mm; Thickness, 6.6 mm. Plum Brook flint.

Historic Materials:

White "kaolin" pipe stem fragments, rhomboidal cross-section.

Stem diameter	Bore diameter
8.5 x 10.6 mm	2.3 mm
6.8 x 9.7 mm	2.3 mm
9.6 x	

White "kaolin" pipe bowl fragment.

"Piso's Cure" bottle fragment. 1860-post 1900.

Ironstone crockery fragment, The Wick Co. cartouche.
19th Century (Barber 1904).

Brown print ironstone fragment.

Blue edge crockery fragment.

Cultural and Temporal Affinities of Site: The single Indian artifact recovered from this site dates from early Archaic or late Paleo-Indian times. The pipe, crockery, and bottle fragments relate to a 19th century dwelling.

SITE 13

Location: NW-1/4 NE-1/4 Section 12, Riley Township, Sandusky County, Ohio.

Description: Small rise on west side of Pickerel Creek.

Survey Conditons: Excellent. Weathered plowed field.

Material Recovered:

Unutilized Chippage:	Devonian cherts	4
	Upper Mercer flint	2

Flint Artifacts:

Broken, thin-bladed corner-notched point.	Upper Mercer flint
Crude parallel sided flake with retouch on distal edge.	Plum Brook flint

Other Artifacts:

Quartzite celt. Length, 116.9 mm; Width, 54.9 mm; Thickness, 21.0 mm. (Figure 1 Q).

Faunal Remains:

2 fragments of unidentified burned mammal bone.

Historic Materials:

"Gaudy Dutch" fragment of crockery.

White "kaolin" pipe stem fragments:

Stem diameter	Bore diameter
10.0 x 11.9 mm	2.4-2.6 mm
6.5 mm	2.3 mm

Cultural and Temporal Affinities of Site: Undetermined. Celt could be either Archaic or Woodland in provenance.

SITE 14

Location: SE-1/4 NE-1/4 Section 16, Townsend Township, Sandusky County, Ohio.

Description: Marl-tufa knoll surrounding small spring at source of tributary of Scherz Ditch.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	4
	Devonian cherts	2
	Unidentified	9

Historic Materials:

Ironstone crockery fragment.

2 hole shell button.

Faunal Material:

Deer tooth, tibia, phalanges (2), antler fragments (2).
Rabbit humerus
Sheep/goat calcaneum
Wolf mandible fragment
Muskrat mandible
Raccoon mandible
Horse tibia
Frog femur
Painted turtle 3 fragments of carapace
Unidentified bird bone fragments (9)

Molluscan Remains:

**Triodopsis multilineata* (Say)
Strobilops affinis Pilsbry
Anguispira alternata (Say)
Allogona profunda (Say)
Stenotrema hirsutum (Say)
S. monodon (Rackett)
Triodopsis fraudulenta (Pilsbry)

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* None of the molluscs in this list have been previously reported from Sandusky County.

Carychium exile Lea
Helicodiscus parallelus (Say)
Discus patulus (Deshayes)
Gastrocopta contracta (Say)
G. tappaniana (Adams)
Vertigo ovata (Say)
Stagnicola reflexa (Say)
Helisoma trivolvis (Say)
Amblema plicata (Say)

Cultural and Temporal Affinities of Site: No artifact material was recovered from this site, though sparse scattered flint debitage indicates that the spring site was utilized by primitive man. The site has been included because of the comparatively large and diverse fauna represented in the bone material recovered. The animals represented in the faunal collection undoubtedly were attracted to the site because of the spring. The abundance of wildlife may in turn have attracted the aborigines. It is noteworthy that the wolf did not become extinct in the Black Swamp area until the latter part of the 19th Century. Although Brayton (1882) indicates that it had disappeared by 1848, Offutt (1967) reports an occurrence as late as 1880.

SITE 15

Location: Central SW-1/4 Section 9, Townsend Township, Sandusky County, Ohio.

Description: Western slope of low rise surrounding Millers Spring.

Survey Conditions: Poor to moderately good. Part of the site has been recently plowed; part is old cornfield with some weed cover.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	1

Flint Artifacts:

Fragmentary triangular point of unidentified flint.

Historic Material:

"Kaolin" pipe stem fragment with bore diameter of 2.0 mm.

"Kaolin" pipe bowl fragments (2), one with leaf covered mold seam.

2 hole shell button, 14.8 mm diameter.

Cultural and Temporal Affinities: Late Prehistoric hunting is indicated by the small well made triangular point. This historic materials are probably associated with a nearby house foundation. 19th Century.

The dearth of material in the immediate vicinity of Millers Spring is somewhat surprising, for the spring undoubtedly attracted much wildlife. Sites 18, 19, and 20, however, are relatively close to Millers Spring, and the occupants of these sites may well have utilized the Millers Spring area.

SITE 16

Location: NE-1/4 NE-1/4 Section 17, Townsend Township, Sandusky County, Ohio.

Description: North bank of tributary of Scherz Ditch, immediately above confluence of small (dry) tributary.

Survey Conditions: Good. Weathered plowed field.

Material Recovered:

Unutilized Chippage:	Plum Brook	3
	Unidentified	3

Flint Artifacts:

Triangular cache blade of Devonian chert. Length, 76.4 mm; Width, 52.9 mm; Thickness, 8.9 mm.

Cultural and Temporal Affinities of Site: No diagnostic artifacts were recovered from the site. The cache blade probably belongs to the Early or Middle Woodland time period.

SITE 17

Location: North central Section 17, Townsend Township, Sandusky County, Ohio.

Description: Southern bank of abandoned (channelized) tributary of Scherz Ditch.

Survey Conditions: Excellent. Weathered plowed field.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	4
	Devonian cherts	1
	Upper Mercer flint	1
	Unidentified	3

Flint Artifacts:

Archaic corner notched knife, with slight basal grinding. Length, 54.7 mm; Width, 27.5 mm; Haft Width, 16.3 mm; Basal Width, 18.1 mm; Thickness, 8.0 mm. (Figure 1 H) Unidentified flint.

Historic Material:

Military button with embossed eagle, South's (1964) Type 27. Civil War vintage.

Cultural and Temporal Affinities: The single flint artifact recovered is ascribable to the late Archaic period. The military button indicates post Civil War activity at the site.

SITE 19

Location: NW-1/4 NW-1/4 Section 9, Townsend Township, Sandusky County, Ohio.

Description: Probably an extension of Site 18.

Survey Conditions: Excellent. Weathered soybean field.

Material Recovered:

Unutilized Chippage:	Plum Brook flint	17
	Devonian cherts	3
	Unidentified flint	25

Flint Artifacts:

Broken triangular point, Levanna type, of Devonian chert.

Crude parallel sided flakes with chipping on distal end, 1 of Plum Brook flint, 1 of unidentified flint.

Crude parallel sided flake with distal and lateral retouch. Devonian chert.

Ceramics:

1 grit tempered cordmarked body sherd. Thickness, 4.8 mm.

Faunal Remains:

Deer tooth

Unidentified mammal bones (2)

Unidentified bird bone fragments (9)

Cultural and Temporal Affinities of Site: Late Woodland campsite.

SITE 20

Location: East Central NE-1/4 Section 20, Townsend Township, Sandusky County, Ohio.

Description: Banks of former channel of stream flowing from Millers Spring.

Survey Conditions: Excellent. Weathered soybean field

Material Recovered:

Unutilized Chippage:

Plum Brook flint	85
Devonian cherts	34
Pebble cherts	9
Upper Mercer flint	2
Unidentified flint	129

Flint Artifacts:

Crude triangular blade (Figure 1 P). Length undeterminable; Width, 31.2 mm; Thickness, 6.7 mm. Devonian chert.

Triangular point (Figure 1 N). Length, 43.1 mm; Width, 19.7 mm; Thickness, 8.8 mm. Devonian chert.

Broken Levanna point of Plum Brook flint. Length and width undeterminable; Thickness, 11.0 mm.

Unidentified point fragments of Plum Brook flint (3), Upper Mercer flint (1), and Devonian chert (1).

Middle Woodland type bladelet (Figure 1 I) of Plum Brook flint.

Crude parallel sided utilized flake of Plum Brook flint.

Utilized flakes of Upper Mercer (1), Devonian (1), and Plum Brook (1) flints.

Blocky, tabular spall with chipping along one edge. Plum Brook flint.

Faunal Remains:

Deer antler fragment

Unidentified mammal bone fragment.

Molluscan Remains:

Stagnicola caperata (Say)

Cultural and Temporal Affinities of Sites: Triangular Levanna-like point suggest Late Woodland occupation. Hopewellian flake knife more strongly indicates a Middle Woodland component. It is also probable that one or more Archaic components exist at the site but have gone unrecognized because of the lack of diagnostic artifact material.

APPENDIX D

SOILS CHARACTERISTICS

TABLE D-1. LEGEND FOR SOILS KEY

Map Symbol		Soil Series	Map Symbol		Slope	Map Symbol		Erosion
108	=	Sloan	A	-	0-2% level	+	-	Deposition
2A86	=	Mermill	B	-	2-6% gently sloping	0	-	No apparent erosion
9125 9126 9128	=	Fulton	C	-	6-12% sloping	1	-	Plow layer is mostly topsoil
9136	=	Lucas	D	-	12-18% moderately sloping	2	-	Plow layer is mixture of top-soil and subsoil
9188	=	Toledo	E	-	18-25% steep	3	-	Plow layer is subsoil
942 9425	=	No name, but similar to Warners	F	-	25-35% very steep	4	-	Frequent deep gullies
9495	=	Warners	G	-	35% + very steep			
9524	=	Rimer						

TABLE D-2. CHARACTERISTICS OF THE SOIL SERIES ON THE SITE

SOIL SERIES AND MAP SYMBOL	SUITABILITY FOR WINTER GRADING	SUSCEPTIBILITY TO FROST ACTION	CHEMICAL CHARACTERISTICS	
			Organic Matter(Percent)*	Subsoil pH*
Sloan - 108	Poor - very poorly drained, subject to flooding	High	4.0 - 6.0	6.0 - 6.5
Mermill 2A86	Poor - very poorly drained	High	4.0 - 5.0	6.0 - 6.5
Fulton - 9125 Fulton - 9126 Fulton - 9128	Poor, somewhat poorly drained, clayey	High	2.5 - 3.0	5.0 - 5.5
Lucas - 9136	Moderate	High	2.5 - 3.0	5.0 - 5.5
Toledo - 9188	Poor- very poorly drained, clayey	High	4.0 - 5.0	6.5 - 7.0
(No Name) - 942 (No Name) - 9425 Warners - 9495	Poor - very poorly drained	High	>20	5.5 - 7.0
Rimer - 9524	Poor; somewhat poorly drained	Low		

* After, 1974-75 Agronomy Guide, Cooperative Extension Service The Ohio State University, Bulletin 472.

TABLE D-2. (Continued)

	SUITABILITY AS SOURCE OF			SOIL FEATURES AFFECTING	
SOIL SERIES AND MAP SYMBOL	TOPSOIL	ROADFILL		HIGHWAY LOCATION	PIPELINE CONSTRUCTION AND MAINTENANCE
		Subsoil	Substratum		
Sloan - 108	Good	Poor	Fair to Poor	Upon very natural drainage, subject to flooding	Subject fo flooding, seasonally high water table
Mermill 2A86	Good	Fair to Poor	Poor	Very poor natural drainage	Seasonally high water table
Fulton - 9125 Fulton - 9126 Fulton - 9128	Fair to poor	Poor	Poor	Poor natural drainage, slow runoff	Seasonally high water table
Lucas - 9136	Fair	Poor	Fair to Good	Moderately well drained	Seasonally high water table
Toledo - 9188	Poor	Poor	Poor	Very poor natural drainage, slow runoff	Seasonally high water table
(No Name) - 942 (No Name) - 9425 Warners - 9495	Poor to fair	Unsuitable Muck	Unsuitable Marl	Mostly soft marl, very poor natural drainage	High water table
Rimer - 9524	Fair	Fair to Good	Poor	Somewhat poor natural drainage	Seasonally high water table; upper part subject to caving

TABLE D-2. (Continued)

	DEGREE AND KIND OF LIMITATION FOR SPECIFIC LAND USE		
SOIL SERIES AND MAP SYMBOL	BUILDING SITES	LAWNS, LANDSCAPES AND PLANTINGS	STREETS AND PARKING LOTS
Sloan - 108	Severe flooding; high water table	Severe; high water table; flooding	Severe; flooding; high water table
Mermill 2A86	Severe; high water table	Severe; high water table	Severe; high water table; susceptibility to frost heaving
Fulton - 9125 Fulton - 9126 Fulton - 9128	Moderately; seasonally high water table	Moderate; seasonally high water table	Moderate; seasonally high water table; susceptibility to frost heaving
Lucas - 9136	Moderate; seasonally high water table	Moderate; seasonally high water table	Moderate; seasonally high water table; susceptibility to frost heaving
Toledo - 9188	Severe; high water table	Severe; high water table	Severe; high water table
(No Name) - 942 (No Name) - 9425 Warners - 9495	Severe; high water table; soft, unstable material	Severe; high water table; muck or marl, chunks of travertine in some areas	Severe; high water table, susceptibility to frost heaving, some unstable material
Rimer - 9524	Moderate; seasonally high table	Moderate; seasonally high water table	Moderate; seasonally high water table

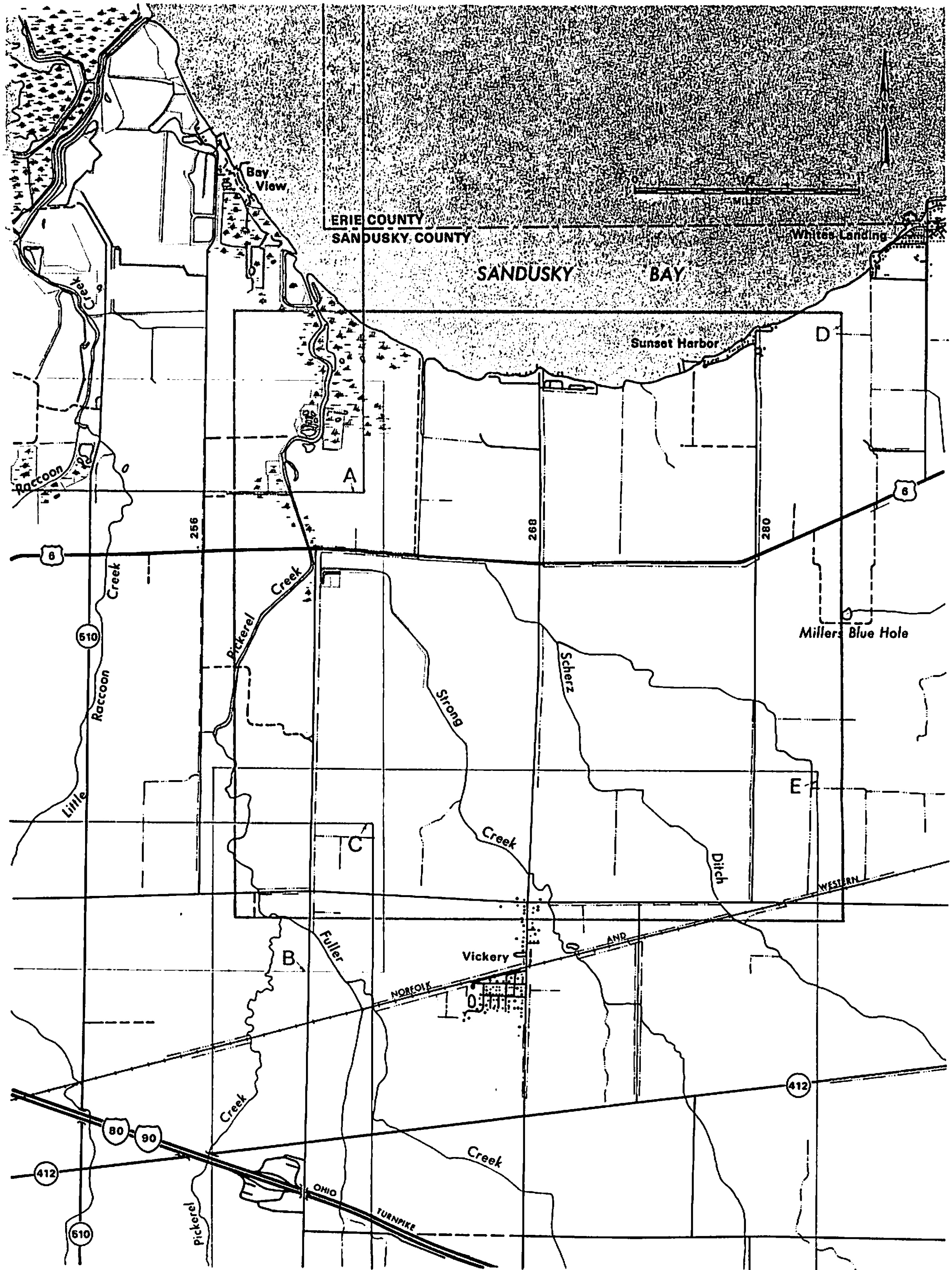

FIGURE D.1 GUIDE SHEET TO FOLLOWING SOIL SURVEY PHOTOCHARTS

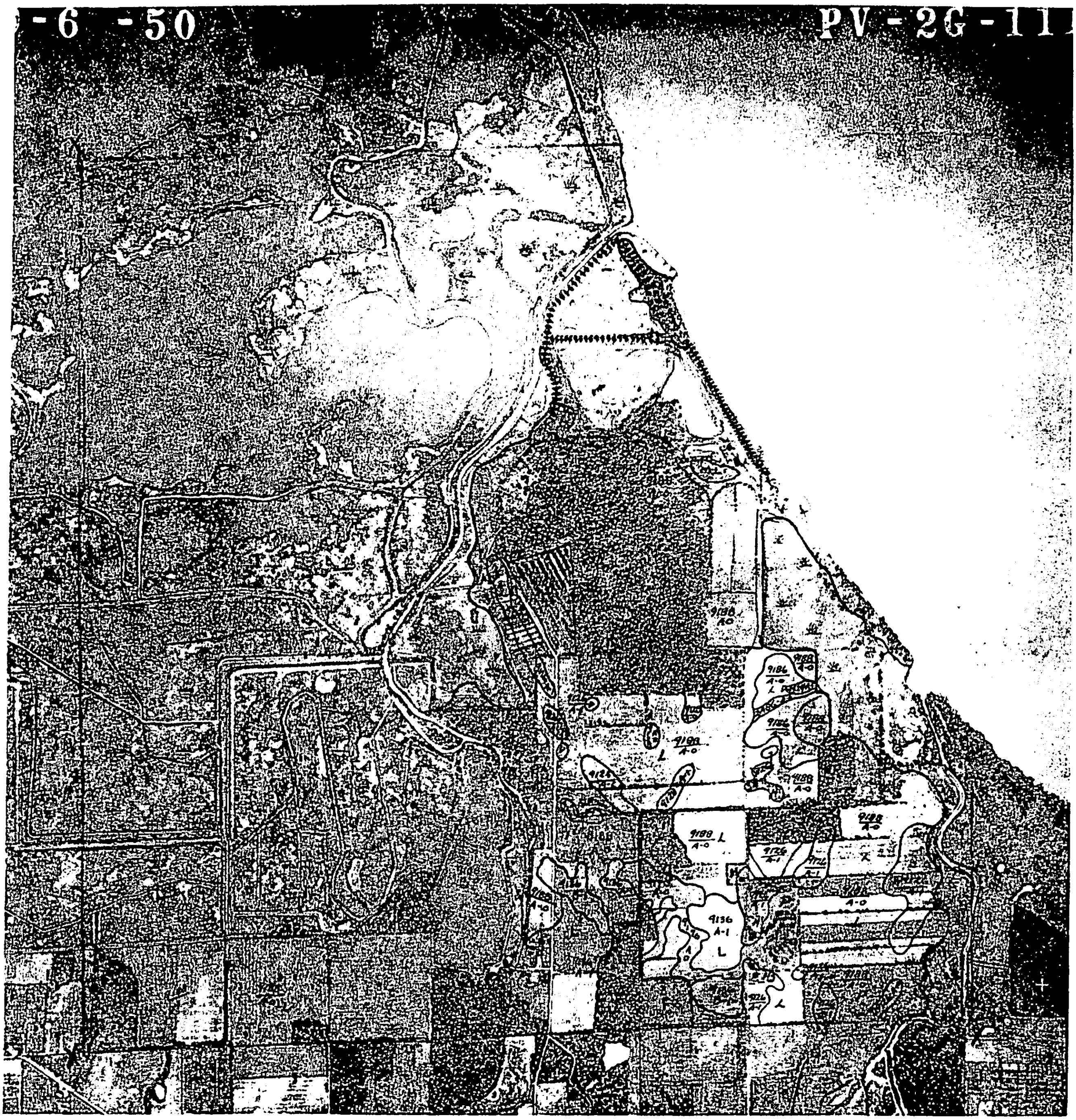

FIGURE D. 2. SOIL PHOTOCHART A

FIGURE D. 3. SOIL PHOTOCHART B

FIGURE D. 4. SOIL PHOTOCHART C

FIGURE D. 5. SOIL PHOTOCHART D

APPENDIX E

VEGETATION CHARACTERISTICS

FIGURE D. 6. SOIL PHOTOCHART E

SITE EVALUATION (Soil Survey)

FOR

OHIO POWER COMPANY

Prepared for Ohio Power Company

Prepared by John Battles, District Conservationist

In Cooperation with the Sandusky County Soil and
Water Conservation District
1401 Walter Avenue
Fremont, Ohio 43420

Phone: 322-0415

Requested by Battelle for Ohio Power Company

Assisted by John Battles, District Conservationist,
U. S. Department of Agriculture
Soil Conservation Service

Location: Riley and Townsend Townships

Date: February 6, 1974

Situation: The Ohio Power Company has acquired 2400 acres in Riley and Townsend townships of Sandusky County. An ecological study is being made of the area by Battelle for use as site for power plants. Soils information is needed for these studies.

Suggested Solutions: The soils information and maps are being provided to assist in the ecological study. The information is attached. More information on these soils is available from the Erie County Soil Survey Report. A copy of the report can be obtained from the Soil Conservation Service, Post Office Building, Norwalk, Ohio 44857.

from which Lucas soils developed is stratified clays, silts, and sands. The depth of water laid materials over glacial clay till is generally about eight to nine feet. The upper two to four feet are silty clay in which an A horizon of silt loam has developed. At greater depth, texture of the substratum is silty clay loam or clay loam, then silt loam or loam, and sandy loam. The lower substratum ranges from calcareous sandy loam to clean sand and fine gravel. Lime concretions are common in the lower part of the profile.

Toledo Silty Clay - 9188

The Toledo series consists of dark colored, very poorly drained soils that formed in clayey lake bed deposits. The original vegetation consisted of lowland hardwoods and swamp forest. The soils are on the lake plain. They occupy broad level areas. Fulton soils occupy adjacent knolls. A typical profile in a cultivated area has a nine inch plow layer of very dark gray, firm silty clay. The subsoil consists of 41 inches of mottled, very firm clay that, in the uppermost six inches, has a matrix color of grayish brown and, below this, a matrix color of gray. The underlying material consists of yellowish brown, mottled very firm limy silty clay. Runoff is slow to ponded, permeability is slow, and the available moisture capacity is high. The water table is high for extended periods, and in some areas there is excess surface water. The organic matter content is high, and tilth is generally good.

(No Name) Silt Loam - 942
(No Name) Loam - 9425

These soils are somewhat similar to Warners. They have a thin layer of topsoil, lighter in color than the Warners, over a marl layer one to two feet in thickness. These soils are somewhat poorly drained.

Warners Loam - 9495

The Warners series consists of dark colored, very poorly drained soils that formed in much and mineral soil material underlain by marl. The depth to marl is greatest in the center of the basin and becomes thinner toward the edges. Areas of these soils are surrounded by Warners soils, clayey subsoil variant, and Toledo soils, calcareous variant. A typical profile has a seven inch layer of black, very friable muck at the surface. Below this is four inches of very dark gray, very friable muck. The underlying material is light gray, very friable marl. Below the marl is lake laid clay at a depth of 40 inches to more than 5 feet. Runoff is very slow, permeability is moderate, and the available moisture capacity is high. The water table is very high. Productivity is moderate, if drainage is adequate.

Rimer Fine Sandy Loam - 9525

The Rimer series consists of nearly level, somewhat poorly drained soils that are sandy and that formed in outwash of loamy fine sand to fine sandy loam texture and are underlain at a depth of 18 to 40 inches by glacial till or lake sediments. A typical profile in a cultivated area has a six inch plow layer of very dark grayish brown, very friable fine sandy loam. Below the plow layer is an eight inch layer of brown, mottled, loose loamy fine sand. The subsoil consists of eight inches of dark yellowish brown, mottled, very friable fine sandy loam over four inches of brown, mottled, firm silty clay loam. The underlying material consists of brown, mottled, very firm, limy silty clay loam over yellowish brown, mottled, firm, limy, stratified silt loam and silty clay loam. Runoff is slow, and the available moisture capacity is medium. Permeability is moderately rapid to rapid in the upper part of the profile and moderately slow in the lower part. The water table is seasonally high.

TABLE E-1. STATISTICAL ANALYSIS OF WOODY VEGETATION

TRANSECT 1[(a)]

Species	Total Count	Individuals >1"<3"	Individuals >3"	Relative Density	Relative Frequency	Relative Dominance	Relative Importance
Green & white ash	15		3	2.16	10.87	73.13	28.87
Black locust	261			45.39	13.04	.00	19.48
Dogwood	155			26.96	15.22	.00	14.06
Silver maple	7		1	1.22	4.35	16.88	7.48
Hawthorn	25			4.35	13.04	.00	5.80
N. red oak	4		1	.70	4.35	9.99	5.01
Red elm	36			6.26	8.70	.00	4.99
Bur oak	11			1.91	8.70	.00	3.54
Eastern wahoo	30			5.22	4.35	.00	3.19
Blue ash	9			1.57	4.35	.00	1.97
Grapevine	2			.35	4.35	.00	1.57
Serviceberry	8			1.39	2.17	.00	1.19
Mulberry	5			.87	2.17	.00	1.01
Black ash	5			.87	2.17	.00	1.01
Chestnut oak	2			.35	2.17	.00	.84

(a) Diversity index = 2.426
Total area = 160 sq m
Transect numbers correspond to Habitat numbers on Figure 2.7.1.

TABLE E-1. (Continued)

TRANSECT 2[(a)]

Species	Total Count	Individuals >1"-3"	Individuals > 3"	Relative Density	Relative Frequency	Relative Dominance	Relative Importance
Dogwood	136	9		48.75	16.07	2.14	22.32
Pin oak	12		10	4.30	7.14	54.33	21.93
Silver maple	34	2	3	12.19	14.29	19.35	15.27
Red elm	24	5	1	8.60	12.50	4.59	8.56
Box elder	10	3	4	3.58	12.50	1.46	5.85
Shagbark hickory	3		1	1.08	3.57	12.65	5.76
Hawthorn	29			10.39	5.36	.00	5.25
Green & white ash	5		2	1.79	5.36	4.08	3.74
Black cherry	7	3		2.51	5.36	.41	2.76
Sumac	6			2.15	5.36	.00	2.50
Grapevine	3			1.08	5.36	.00	2.14
N. red oak	5	1	1	1.79	3.57	.76	2.04
Hazelnut	3	1		1.08	1.79	.23	1.03
Black ash	2			.72	1.79	.00	.83

(a) Diversity index = 2.609
Total area = 200 sq m

TABLE E-1. (Continued)

TRANSECT 3[(a)]

Species	Total Count	Individuals >1"<3"	>3"	Relative Density	Relative Frequency	Relative Dominance	Relative Importance
Silver maple	94	15	9	24.74	17.31	54.98	32.34
Green & white ash	184	11	3	48.42	17.31	15.82	27.18
Box elder	6	3	2	1.58	1.92	18.12	7.21
Sumac	23	3		6.05	9.62	.82	5.49
Hawthorn	21			5.53	9.62	.00	5.05
Swamp white oak	11	6		2.89	9.62	.95	4.49
Black ash	18	2		4.74	7.69	.23	4.22
Pin oak	2		3	.53	1.92	7.87	3.44
Red elm	7			1.84	5.77	.00	2.54
Grapevine	3			.79	5.77	.00	2.19
Shagbark hickory	2			.53	3.85	.97	1.78
Dogwood	5			1.32	3.85	.00	1.72
Unidentified	2			.53	1.92	.00	.82
Basswood	1	1		.26	1.92	.24	.82
N. red oak	1			.26	1.92	.00	.73

(a) Diversity index = 2.340
Total area = 166 sq m

TABLE E-1. (Continued)

TRANSECT 4[a]

Species	Total Count	Individuals		Relative Density	Relative Frequency	Relative Dominance	Relative Importance
		>1"<3"	>3"				
Pin oak	5		5	33.33	28.57	37.69	33.20
Bur oak	3		3	20.00	21.43	16.56	19.33
Swamp white oak	2		2	13.33	14.29	19.93	15.85
Shagbark hickory	2		2	13.33	14.29	5.69	11.10
Green & white ash	1		1	6.67	7.14	7.64	7.15
Walnut	1		1	6.67	7.14	6.33	6.71
N. red oak	1		1	6.67	7.14	6.16	6.66

(a) Diversity index = 2.549
Total area = 1000 sq m

Species	Total Count	Individuals		Relative Density	Relative Frequency	Relative Dominance	Relative Importance
		>1"<3"	>3"				
Red elm	85	26	13	25.99	26.32	43.71	32.01
Dogwood	166	15		50.76	23.68	10.33	28.26
Hawthorn	39	12	11	11.93	23.68	28.06	21.22
Box elder	32	5	1	9.79	13.16	4.58	9.18
Walnut	1		1	.31	2.63	7.10	3.35
Green & white ash	2	1	1	.61	5.26	2.22	2.70
Honey locust	1		1	.31	2.63	4.00	2.31
Grapevine	1			.31	2.63	.00	.98

(a) Diversity index = 1.817
Total area = 196 sq m

Green & white ash	93	24	2	28.01	14.75	8.28	17.02
Shagbark hickory	36	14	11	10.84	14.75	17.93	14.51
Dogwood	86	1		25.90	13.11	.05	13.02
Hawthorn	33	6		9.94	14.75	1.36	8.68
Red elm	28	10		8.43	8.20	1.97	6.20
Black cherry	15	1		4.52	11.48	.05	5.35
Eastern Wahoo	25			7.53	4.92	.00	4.15
Hackberry	4	1		1.20	3.28	.32	1.60
Bur oak	2			.60	3.28	.64	1.51
Grapevine	1			.30	1.64	.00	.65

(a) Diversity index = 2.769
Total area = 200 sq. m

	Count	[illegible]	[illegible]	Density	Frequency	Dominance	Importance
Pin oak	2		2	2.22	8.70	77.09	29.33
Dogwood	40	2		44.44	21.74	.12	22.10
Green & white ash	15	3	4	16.67	17.39	10.73	14.93
Mulberry	6	2	3	6.67	8.70	4.34	6.57
Black locust	7			7.78	8.70	.00	5.49
Hawthorn	1		1	1.11	4.35	3.99	3.15
Swamp white oak	1		1	1.11	4.35	3.05	2.84
Red elm	2	2		2.22	4.35	.49	2.35
Bitternut hickory	1			1.11	4.35	.00	1.82
Shagbark hickory	1			1.11	4.35	.00	1.82

(a) Diversity index = 2.506
Total area = 100 sq. m

Red elm	41	1		21.24	14.08	.15	11.82
Green & white ash	40	1		20.73	14.08	.09	11.63
Hackberry	30	1	1	15.54	11.27	2.96	9.92
Bitternut hickory	7		1	3.63	7.04	3.10	4.59
Dogwood	13			6.74	7.04	.00	4.59
Black locust	9			4.66	7.04	.00	3.90
Mulberry	4			2.07	5.63	.00	2.57
Serviceberry	4			2.07	4.23	.00	2.10
Shagbark hickory	5			2.59	1.41	.00	1.33
Hawthorn	2	1		1.04	2.82	.09	1.31
Elderberry	2			1.04	2.82	.00	1.28
Chestnut oak	2			1.04	2.82	.00	1.28
Swamp white oak	1		1	.52	1.41	1.31	1.08
Sugar maple	2	1		1.04	1.41	.09	.84
Walnut	1			.52	1.41	.00	.64
N. red oak	1			.52	1.41	.00	.64

(a) Diversity index = 3.247
Total area = 200 sq. m

een & white ash	21	8	3	15.91	13.79	60.22	29.98
gwood	39	1		29.55	17.24	.92	15.90
d elm	13	5		9.85	6.90	17.39	11.38
agbark hickory	11	3		8.33	13.79	6.56	9.56
rviceberry	19			14.39	13.79	.00	9.40
r oak	3	1	1	2.27	6.90	14.91	8.03
ack cherry	14			10.61	10.34	.00	6.98
derberry	4			3.03	6.90	.00	3.31
ack locust	3			2.27	6.90	.00	3.06
wthorn	5			3.79	3.45	.00	2.41

) Diversity index = 2.895
Total area = 100 sq. m

Green & white ash	182	5	7	54.49	21.43	17.80	31.24
Shagbark hickory	17	1	6	5.09	16.67	32.42	18.06
Bur oak	3		2	.90	4.75	42.48	16.05
Black cherry	68			20.36	14.29	.00	11.55
Red elm	39			11.68	16.67	.00	9.45
Dogwood	20			5.99	14.29	.00	6.76
N. Red oak	2		1	.60	4.76	7.30	4.22
Chestnut oak	2			.60	4.76	.00	1.79
Hawthorn	1			.30	2.38	.00	.89

(a) Diversity index = 1.943
Total area = 180 sq. m

TABLE E-2 STANDING TIMBER (ft^2/acre)

Species: Latin Name	Species: Common Name	Habitats: 1	2	3	4	5	6	7	8	9	10
CANOPY:											
Acer negundo	Boxelder		4.30	39.82		5.89					
Acer saccharinum	Silver maple	23.32	57.05	120.80							
Acer saccharum	Sugar maple								.11		
Carya cordiformis	Bitternut hickory								3.97		
Carya ovata	Shagbark hickory		37.30	2.13	6.24		38.13			1.57	44.09
Celtis occidentalis	Hackberry						.69		3.79		
Fraxinus americana and *F. pennsylvanica*	Green & white ash	101.91	12.03	34.75	8.39	2.85	17.61	38.00	.11	14.45	24.21
Fraxinus nigra	Black ash			.51							
Fraxinus quadrangulata	Blue ash										
Gleditsia triacanthos	Honey locust					5.13					
Juglans nigra	Black walnut				6.95	9.12					
Morus spp.	Mulberry							15.38			
Prunus serotina	Black cherry		1.22				.11				
Quercus bicolor	Swamp white oak			2.09	21.87			10.81	1.68		
Quercus macrocarpa	Bur oak				18.18		1.35			3.58	57.78
Quercus palustris	Pin oak		160.22	17.29	41.37			273.10			
Quercus prinus	Chestnut oak										
Quercus rubra	N. red oak	13.8	2.24		6.76		147.61				9.93
Robinia pseudoacacia	Black locust										
Tilia americana	Basswood			.53					51.42		
Ulmus rubra	Red elm		13.53			56.12	4.18	1.75	.19	4.17	
UNDERSTORY:											
Amelanchier arborea	Shadbush							.65			
Cornus spp.	Dogwood		6.31			13.26	.11	.44		.22	
Crataegus spp.	Hawthorn					36.03	2.88	14.13	.11		
Corylus americanus	Hazelnut		.70								
Euonymous atropurpureus	Eastern wahoo										
Rhus spp.	Sumac			1.79							
Sambucus canadensis	Elderberry										
Vitis spp.	Grapevine										
	Total ft^2/acre in each habitat	139.03	294.9	219.7	109.76	128.4	212.7	354.3	61.48	24.0	136.0

TABLE E-3. DRY WEIGHTS OF VEGETATION SAMPLES COLLECTED FROM SANDUSKY BAY

Dry Weight of Vegetation Samples September 18, 1973

Species			Plot Number												
Latin Name	Common Name	Units	1	2	3	4	5	6	7	8	9	10	11	12	Ave lb/ac
<u>Allium</u> sp.	Onion	$g/1/4\ M^2$	-	-	-	1.2	-	-	-	-	-	-	-	-	3.6
		lb/acre				42.9									
<u>Ambrosia</u> sp.	Ragweed	$g/1/4\ M^2$	-	0.8	1.2	4.6	5.8	5.2	9.6	-	12.1	1.5	13.2	13.1	199.7
		lb/acre		28.6	42.9	164.3	207.2	185.7	342.9		432.2	53.6	471.5	467.9	
<u>Asclepias</u> sp.	Milkweed	$g/1/4\ M^2$	-	-	0.2	-	-	-	-	-	-	-	-	-	.6
		lb/acre			7.1										
<u>Desmodium</u> sp.	Beggar's lice	$g/1/4\ M^2$	-	-	-	3.0	-	-	-	-	-	-	-	-	8.9
		lb/acre				107.2									
Cvperaceae	Sedge	$g/1/4\ M^2$	-	0.9	-	-	1.0	4.4	5.3	7.1	-	-	5.0	2.9	79.2
		lb/acre		32.1			35.7	157.2	189.3	253.6			178.6	103.6	
Labiatae	Mint	$g/1/4\ M^2$	0.7	-	0.2	0.6	0.7	0.3	-	3.2	-	4.0	1.0	-	31.8
		lb/acre	25.0		7.1	21.4	25.0	10.7		114.3		142.9	35.7		
<u>Plantago</u> sp.	Plantain	$g/1/4\ M^2$	-	0.7	0.4	0.3	-	0.6	-	-	-	-	0.5	-	7.4
		lb/acre		25.0	14.3	10.7		21.4					17.9		
Gramineae	Grass	$g/1/4\ M^2$	1.2	1.6	4.7	32.9	50.7	25.2	8.9	16.7	64.8	34.1	33.9	34.8	921.3
		lb/acre	42.9	57.2	167.9	1175.2	1810.9	900.1	317.9	596.5	2314.6	1218.0	1210.9	1243.0	
<u>Polygonum</u> sp.	Knotweed	$g/1/4\ M^2$	-	-	-	0.2	-	-	0.2	9.7	0.2	1.8	-	0.5	37.5
		lb/acre				7.1			7.1	346.5	7.1	64.3		17.9	
<u>Trifolium</u> spp.	Clover	$g/1/4\ M^2$	8.2	10.7	15.2	25.7	14.1	13.5	11.3	13.5	5.4	23.4	2.7	-	427.7
		lb/acre	292.9	382.2	542.9	917.9	503.6	482.2	403.6	482.2	192.9	835.8	96.4		
Unknown		$g/1/4\ M^2$	-	0.2	-	-	-	-	-	0.2	-	0.4	-	-	2.4
		lb/acre		7.1						7.1		14.3			
Dead		$g/1/4\ M^2$	2.0	2.6	5.2	38.7	25.2	36.3	39.9	18.3	38.4	32.1	24.6	25.6	745.9
		lb/acre	71.4	92.9	185.7	13.8	900.1	1296.6	1425.2	653.7	1371.6	1146.6	878.7	914.1	
													Total Average lb/acre of vegetation		2466.1

Dry Weight of Vegetation Samples May 30, 1974

Species			Plot Number												
Latin Name	Common Name	Units	1	2	3	4	5	6	7	8	9	10	11	12	Ave lb/ac
<u>Allium</u> sp.	Onion	$g/1/4\ M^2$				1.9			4.7				3.6		121.5
		lb/acre				67.9			167.9				128.6		
<u>Ambrosia</u> sp.	Ragweed	$g/1/4\ M^2$				-			0.7				0.7		16.7
		lb/acre				-			25.0				25.0		
<u>Daucus carota</u>	Queen Anne's Lace	$g/1/4\ M^2$				-			-				1.4		16.7
		lb/acre				-			-				50.0		
<u>Glechoma lederacea</u>	Spreading chervil	$g/1/4\ M^2$				-			-				0.1		1.2
		lb/acre				-			-				3.6		
Gramineae	Grasses	$g/1/4\ M^2$				0.1			-				1.1		14.3
		lb/acre				3.6			-				39.3		
<u>Rumex crispus</u>	Curled dock	$g/1/4\ M^2$				-			0.9				-		10.7
		lb/acre				-			32.2				-		
<u>Trifolium</u> spp.	Clover	$g/1/4\ M^2$				142.9			154.7				132.5		5121.0
		lb/acre				5104.3			5525.8				4732.8		
Unknown		$g/1/4\ M^2$				-			-				2.6		31.0
		lb/acre				-			-				92.9		
Dead		$g/1/4\ M^2$				-			2.6				4.8		88.1
		lb/acre				-			92.9				171.5		
													Total Average lb/acre of vegetation		5421.2

Quadrat No.	Species[a]		Number of Individuals	Percent Covered	Number of Individuals	Covered
	Latin Name	Common Name				
1 (F)[6]	*Ambrosia* sp.	Ragweed	40	25	0	0
	Gramineae	Grass	--	15	227	80
	Polygonum sp.	Smartweed	0	0	1	--
	Rumex crispus	Curled dock	11	15	0	0
	Sonchus oleraceus	Sow thistle	4	2	0	0
	Trifolium spp.	Clover	--	25	107	20
	Unknowns	--	6	3	0	0
	Totals		61	85	335	100
2 (F)	*Allium canadense*	Meadow garlic	3	1	0	0
	Ambrosia sp.	Ragweed	15	20	0	0
	Daucus carota	Queen Anne's Lace	0	0	8	2
	Gramineae	Grass	--	30	219	80
	Polygonum sp.	Smartweed	1	1	2	--
	Rumex obtusifolia	Broad leaf dock	3	1	0	0
	Sonchus oleraceus	Sow thistle	2	1	0	0
	Trifolium spp.	Clover	--	20	88	15
	Totals		24	74	317	97

TABLE E-4. (Continued)

	Species		Summer 1973		Fall 1973	
Quadrat No.	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
3 (b)	*Ambrosia* sp.	Ragweed	--	33	0	0
	Cruciferae	Mustard	1	2	0	0
	Daucus carota	Queen Anne's Lace	15	14	55	40
	Gramineae	Grass	0	0	90	30
	Lepidium virginicum	Peppergrass	--	2	0	0
	Medicago sativa	Alfalfa	10	10	14	5
	Trifolium spp.	Clovers	--	19	40	10
	Totals		26	80	199	85
4 (d)	*Allium canadense*	Meadow garlic	2	1	0	0
	Ambrosia sp.	Ragweed	--	14	0	0
	Daucus carota	Queen Anne's Lace	6	3	42	15
	Gramineae	Grass	--	29	139	40
	Plantago sp.	Plantain	3	7	6	2
	Rumex crispus	Curled dock	10	14	0	0
	Rumex obtusifolius	Broad leaf dock	1	1	0	0
	Sonchus oleraceus	Sow thistle	1	1	0	0
	Trifolium spp.	Clover	--	24	43	10
	Totals		23	94	230	67

TABLE E-4. (Continued)

Quadrat No.	Species		Summer 1973		Fall 1973	
	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
5 (B)	Ambrosia sp.	Ragweed	--	10	0	0
	Gramineae	Grass	--	10	79	50
	Plantago sp.	Plantain	2	19	10	1
	Rumex crispus	Curled dock	20	19	0	0
	Rumex obtusifolius	Broad leaf dock	1	1	0	0
	Trifolium spp.	Clover	--	14	64	30
	Totals		23	73	153	81
6 (C)	Ambrosia sp.	Ragweed	--	23	0	0
	Compositae	Thistle	1	1	0	0
	Daucus carota	Queen Anne's Lace	4	7	8	1
	Gramineae	Grass	--	4	129	30
	Plantago sp.	Plantain	0	0	8	1
	Polygonum sp.	Smartweed	1	1	0	0
	Rumex crispus	Curled dock	4	7	0	0
	Trifolium spp.	Clover	--	5	59	10
	Totals		10	48	204	42

TABLE E-4. (Continued)

	Species		Summer 1973		Fall 1973	
Quadrat No.	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
7 (D)	*Ambrosia* sp.	Ragweed	--	10	0	0
	Aster sp.	Aster	0	0	4	5
	Compositae	Thistle	1	2	0	0
	Gramineae	Grass	--	15	131	15
	Plantage sp.	Plantain	4	7	0	0
	Polygonum sp.	Smartweed	0	0	3	2
	Rumex crispus	Curled dock	12	10	0	0
	Trifolium spp.	Clover	--	15	75	35
		Totals	17	59	213	57
8 (A)	*Ambrosia* sp.	Ragweed	--	20	0	0
	Cyperaceae	Sedge	0	0	21	10
	Gramineae	Grass	--	27	92	15
	Plantago sp.	Plantain	1	1	2	1
	Polygonum sp.	Smartweed	0	0	3	3
	Rumex crispus	Curled dock	20	20	0	0
	Trifolium spp.	Clover	--	25	76	40
	Unknown		4	4	0	0
		Totals	25	97	194	69

TABLE E-4. (Continued)

Quadrat No.	Species		Summer 1973		Fall 1973	
	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
9 (C)	*Ambrosia* sp.	Ragweed	--	20	0	0
	Bidens frondosa	Beggar's - Ticks	0	0	43	30
	Cyperaceae	Sedge	--	15	0	0
	Gramineae	Grass	--	3	41	15
	Plantago sp.	Plantain	0	0	1	1
	Polygonum sp.	Smartweed	20	10	4	1
	Rumex crispus	Curled dock	2	2	0	0
	Trifolium spp.	Clover	--	35	22	10
	Unknown	--	--	15	0	0
		Totals	22	100	112	57
10 (F)	*Allium canadense*	Meadow garlic	3	1	0	0
	Ambrosia sp.	Ragweed	--	20	0	0
	Compositae	Thistle	1	1	0	0
	Gramineae	Grass	--	15	69	15
	Lepidium virginicum	Field peppergrass	17	17	0	0
	Plantago sp.	Plantain	0	0	3	2
	Rumex crispus	Curled dock	7	5	0	0
	Trifolium spp.	Clover	--	40	50	30
	Unknown	--	2	1	0	0
		Totals	30	100	122	47

TABLE E-4. (Continued)

Quadrat No.	Species		Summer 1973		Fall 1973	
	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
11 (C)	*Allium canadense*	Meadow garlic	2	1	0	0
	Ambrosia sp.	Ragweed	6	5	0	0
	Cyperaceae	Sedge	--	20	32	8
	Daucus carota	Queen Anne's Lace	5	2	4	4
	Gramineae	Grass	--	2	69	60
	Lepidium virginicum	Field peppergrass	2	20	0	0
	Plantago sp.	Plantain	--	3	1	2
	Polygonum sp.	Smartweed	3	1	4	2
	Rumex crispus	Curled dock	8	10	0	0
	Rumex obtusifolius	Broad leaf dock	3	2	0	0
	Trifolium spp.	Clover	--	30	37	10
		Totals	29	96	147	86
12 (A)	*Ambrosia* sp.	Ragweed	--	20	0	0
	Gramineae	Grass	--	25	178	30
	Plantago sp.	Plantain	--	1	4	2
	Polygonum sp.	Smartweed	--	5	4	2
	Rumex crispus	Curled dock	--	12	0	0
	Rumex obtusifolius	Broad leaf dock	--	1	0	0
	Trifolium spp.	Clover	--	10	59	30
	Unknown	--	--	1	0	0
		Totals	--	75	245	64

TABLE E-4. (Continued)

Quadrat No.	Species		Summer 1973		Fall 1973	
	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
13 (B)	Ambrosia sp.	Ragweed	--	31	0	0
	Gramineae	Grass	--	10	80	50
	Polygonum sp.	Smartweed	--	5	1	--
	Rumex crispus	Curled dock	6	5	0	0
	Sonchus oleraceus	Sow thistle	2	2	0	0
	Trifolium spp.	Clover	--	30	52	30
	Unknown	--	2	2	0	0
	Totals		10	85	133	80
14 (F)	Allium canadense	Meadow garlic	1	1	0	0
	Ambrosia sp.	Ragweed	--	17	0	0
	Gramineae	Grass	--	10	93	40
	Lepidium virginicum	Field peppergrass	--	15	0	0
	Plantago sp.	Plantain	--	10	2	1
	Polygonum sp.	Smartweed	--	3	2	1
	Rumex crispus	Curled dock	10	7	0	0
	Trifolium spp.	Clover	--	25	29	20
	Unknown	--	--	10	0	0
	Totals		11	98	126	62

TABLE E-4. (Continudd)

Quadrat No.	Species		Summer 1973		Fall 1973	
	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
15 (E)	*Allium canadense*	Meadow garlic	1	1	0	0
	Ambrosia sp.	Ragweed	--	32	0	0
	Gramineae	Grass	--	14	104	30
	Medicago sativa	Alfalfa	5	5	14	20
	Plantago sp.	Plantain	--	1	0	0
	Polygonum sp.	Smartweed	--	1	0	0
	Rumex crispus	Curled dock	15	7	0	0
	Trifolium spp.	Clover	--	32	29	20
	Unknown	--	--	5	0	0
		Totals	21	98	147	70
16 (D)	*Ambrosia* sp.	Ragweed	--	20	0	0
	Bidens frondosa	Beggar's - Ticks	0	0	25	70
	Cyperaceae	Sedge	--	15	0	0
	Daucus carota	Queen Anne's Lace	0	0	7	5
	Gramineae	Grass	--	13	35	5
	Medicago sativa	Alfalfa	0	0	2	1
	Polygonum sp.	Smartweed	--	3	6	2
	Rumex crispus	Curled dock	14	15	0	0
	Trifolium spp.	Clover	--	34	26	10
		Totals	14	100	101	93

TABLE E-4. (Completed)

Quadrat No.	Species		Summer 1973		Fall 1973	
	Latin Name	Common Name	Number of Individuals	Percent Covered	Number of Individuals	Percent Covered
17 (A)	*Ambrosia* sp.	Ragweed	--	7	0	0
	Gramineae	Grass	--	2	64	40
	Plantago sp.	Plantain	0	0	2	1
	Polygonum sp.	Smartweed	--	40	30	20
	Rumex crispus	Curled dock	12	7	0	0
	Trifolium spp.	Clover	--	15	52	30
	Unknown	--	1	4	0	0
		Totals	13	75	148	91
18 (E)	*Allium canadense*	Meadow garlic	1	1	0	0
	Ambrosia sp.	Ragweed	--	10	0	0
	Cyperaceae	Sedge	--	10	10	5
	Gramineae	Grass	--	--	90	20
	Polygonum sp.	Smartweed	--	15	15	5
	Rumex crispus	Curled dock	8	4	0	0
	Sonchus oleraceus	Sow thistle	4	27	4	10
	Trifolium spp.	Clover	--	25	39	30
		Totals	13	92	158	70

(a) Only living material was counted in the study.

(b) Application of Salt Solution to Quadrats:

Abbreviation in Text	Treatment Concentration	Number of Applications
(A)	0	0
(B)	½ x base solution	1
(C)	1 x base solution	1
(D)	1 x base solution	2
(E)	1 x base solution	3
(F)	5 x base solution	1

APPENDIX F

WILDLIFE

TABLE F-1 . MAMMALS THAT MAY OCCUR ON THE SITE AND THE HABITATS UTILIZED

		Stream Ditch	Marsh	Cultivated Field	Old Field	Roadside	Fence Row	Woodlot
Opossum*	Didelphis marsupialis			+	+		+	+
Masked Shrew	Sorex cinereus				+		+	+
Short-tailed Shrew*	Blarina brevicauda		+	+	+		+	+
Least Shrew	Cryptotis parva		+		+			+
Star-nosed Mole	Condylura cristata				+			+
Eastern Mole	Scalopus aquaticus			+	+		+	+
Keen's Bat	Myotis keenii							+
Little Brown Bat	Myotis lucifugus							+
Indiana Bat	Myotis sodalis							+
Small-footed Bat	Myotis subulatus							+
Silver-haired Bat	Lasionycteris noctivagans							+
Eastern Bat	Pipistrellus subflavus							+
Big Brown Bat	Eptesicus fuscus							+
Evening Bat	Nycticeius humeralis							+
Hoary Bat	Lasiurus cinereus							+
Red Bat	Lasiurus borealis							+
Eastern Cottontail*	Sylvilagus floridanus			+	+	+	+	+
Fox Squirrel*	Sciurus niger							+
Gray Squirrel	Sciurus carolinensis							+
Red Squirrel	Tamiasciurus hudsonicus							+
Woodchuck*	Marmota monax					+	+	+
13-Lined Ground Squirrel	Spermophilus tridecemlineatus				+			
Eastern Chipmunk	Tamias striatus							+

TABLE F-1. (Continued)

		Stream Ditch	Marsh	Cultivated Field	Old Field	Roadside	Fence Row	Woodlot
Southern Flying Squirrel	*Glaucomys volans*							+
Deer Mouse	*Peromyscus maniculatus*			+	+	+	+	+
White-Footed Mouse*	*Peromyscus leucopus*				+		+	+
Meadow Vole*	*Microtus pennsylvanicus*				+		+	+
Pine Vole	*Microtus pinetorum*							+
Muskrat*	*Ondatra zibethica*	+	+					+
Norway Rat	*Rattus norvegicus*			+			+	
House Mouse*	*Mus musculus*			+	+			
Meadow Jumping Mouse*	*Zapus hudsonius*				+			
Red Fox*	*Vulpes fulva*			+	+		+	+
Gray Fox*	*Urocyon cinereoargenteus*							+
Raccoon*	*Procyon lotor*	+	+					+
Least Weasel	*Mustela rixosa*				+		+	+
Long-tailed Weasel	*Mustela frenata*	+			+		+	+
Mink*	*Mustela vison*	+	+					+
Striped Skunk*	*Mephitis mephitis*				+		+	+
White-tailed Deer*	*Odocoileus virginianus*			+				+

* Species that have been observed on the site.

TABLE F-2. (Continued)

Date	Trapline	Habitat	Nights	Stations	Captures		Capture/ Station Nights
					Species	Number	
21-24 May 1974	15a	Field	3	20	*Microtus pennsylvanicus*	9	0.150
					TOTAL	9	0.150
	16a	Fencerow	3	20	*Peromyscus leucopus*	2	0.033
					Microtus pennsylvanicus	3	0.050
					Zapus hudsonius	1	0.017
					TOTAL	6	0.100

TABLE F-3. AMPHIBIANS AND REPTILES THAT MAY OCCUR ON THE SITE AND THE HABITATS UTILIZED

		Streams Ditches	Marshes	Cultivated Field	Old Field	Fence Row	Woodlot
Mud Puppy	Necturus maculosus	+					
Blue-spotted Salamander	Ambystoma laterale	+	+				
Jefferson Salamander	Ambystoma jeffersonianum	+	+				
Spotted Salamander	Ambystoma maculatum	+	+				+
Small-mouthed Salamander	Ambystoma texanum	+					
Marbled Salamander	Ambystoma opacum	+	+				+
Eastern Tiger Salamander	Ambystoma tigrinum tigrinum	+					
Red Spotted Newt	Diemictylus viridescens viridescens	+	+				+
Red-backed Salamander	Plethodon cinereus cinereus						+
Northern Red Salamander	Pseudotriton ruber ruber	+					
Northern Two-Lined Salamander	Eurycea bislineata bislineata	+	+				
American Toad	Bufo americanus	+				+	+
Fowler's Toad*	Bufo woodhousei fowleri	+	+			+	+
Northern Spring Peeper	Hyla crucifer crucifer						+
Eastern Gray Treefrog	Hyla versicolor versicolor						+
Blanchard's Cricket Frog	Acris crepitans blanchardi	+	+				
Western Chorus Frog	Pseudacris triseriata triseriata	+	+				+
Pickerel Frog	Rana palustris	+	+				
Northern Leopard Frog*	Rana pipiens pipiens	+	+				
Green Frog	Rana clamitans melanota	+	+				
Wood frog	Rana sylvatica sylvatica	+					+
Bullfrog*	Rana catesbeiana	+	+				
Common Snapping Turtle	Chelydra serpentina serpentina	+					
Stinkpot	Sternotherus odoratus	+					
Spotted Turtle	Clemmys guttata	+	+				
Blanding's Turtle	Emydoidea blandingi	+	+				
Eastern Box Turtle*	Terrapene carolina carolina					+	+

TABLE F-3 . (Continued)

		Streams Ditches	Marshes	Cultivated Field	Old Field	Fence Row	Woodlot
Midland Painted Turtle*	*Chrysemys picta marginata*	+	+				
Map Turtle	*Graptemys geographica*	+					
Eastern Spiny Softshell	*Trionyx spinifer spinifer*	+					
Five-lined Skink	*Eumeceys fasciatus*						+
Northern Water Snake*	*Natrix sipedon sipedon*	+	+				
Queen Snake	*Natrix septemvittata*	+					
Kirtland's Water Snake	*Natrix kirtlandi*		+				+
Northern Brown Snake	*Storeria dekayi wrightorum*		+				+
Midland Brown Snake	*Storeria dekayi dekayi*		+				+
Eastern Garter Snake*	*Thamnophis sirtalis sirtalis*	+	+	+	+	+	+
Eastern Ribbon Snake*	*Thamnophis sauritus sauritus*	+	+				
Butler's Garter Snake	*Thamnophis butleri*			+	+		
Eastern Hognose Snake	*Heterodon platyrhinos platyrhinos*				+	+	
Northern Ringneck Snake	*Diadophis punctatus edwardsi*						+
Blue Racer	*Coluber constrictor foxi*			+	+		+
Eastern Yellow-bellied Racer	*Coluber constrictor flaviventris*			+	+	+	+
Black Rat Snake*	*Elaphe obsoleta obsoleta*				+	+	+
Eastern Fox Snake*	*Elaphe vulpina gloydi*		+				+
Eastern Milk Snake	*Lampropeltis doliata triangulatum*			+	+	+	+
Eastern Smooth Green Snake	*Opheodrys vernalis vernalis*				+		+

* Species that have been observed on the site.

APPENDIX G

BIRDS

TABLE G-1. COMPARISON OF BIRD ABUNDANCE FOUND DURING SURVEYS AT THE SITE TO ABUNDANCE REPORTED FOR THE OTTAWA NATIONAL WILDLIFE REFUGE COMPLEX AND THE STATE OF OHIO

		Battelle's Surveys at White's Landing[2]				Wildl. Ref. Complex BSFW (1970)[3]				Status in Ohio - Trautman and Trautman (1968)[4]				Rare or Endangered Species in Ohio[5]
Common Name	Scientific Name	Sp Mar. Ap. May	Su June July	Fa Nov.	Wi Dec. Jan.	Sp	Su	Fa	Wi	Spring Migration and	Summering Nesting	Fall Migration	Winter	Smith et al. (1973)
Common Loon	Gavia immer	-	-	-	-	o	-	o	r	Ac.-U 4/10-5/10	VR	R-C 10/1-12/1	VR	Extirpated
Horned Grebe	Podiceps auritis	-	-	VR(M)	-	u	-	u	o	R-C 3/10-4/15	Ac.	R-VC 10/5-12/5	Ac.-VR	-
Eared Grebe	Podiceps nigricollis	-	-	-	-	r	-	r	-	Accidental or Very Rare Occurrence				-
Pied-billed Grebe	Podilymbus podiceps	U(M)	-	-	-	c	c*	c	r	R-C 3/15-5/15	R-N May-July	U-C 9/1-12/10	Ac.-R	Pop. Declining
White Pelican	Pelecanus erythrorhynchos	-	-	-	-	r	r	r	-	Ac.-VR Apr.-May	-	Ac.-VR Aug.-Nov.	-	-
Double-crested Cormorant	Phalacrocorax auritis	VR(M)	-	-	-	o	o	o	r	Ac.-VR 4/1-5/15	Ac.-VR	R-U 9/15-11/10	Ac.	Extirpated
Great Blue Heron	Ardea herodias	VC(M)	A(G),C(R)	C(M)	P-D	c	c*	c	u	U-VC 3/15-4/20	U-VC Apr.-Aug.	U-VC 8/15-12/1	Ac.-R	-
Green Heron	Butorides virescens	P-M	C(G),VR(R)	-	-	c	c*	c	-	RC 4/18-5/18	R-C Apr.-July	R-C 8/1-10/5	Ac.	-
Little Blue Heron	Florida caerulea	-	-	-	-	r	o	o	-	Ac.-VR Apr.-May	Ac.-U	Ac.-VR July-Sept.	-	-
Cattle Egret	Bubulcus ibis	P-M	-	-	-	u	u	-	-	Accidental or Very Rare Occurrence				-
Great Egret	Casmerodius albus	R(M)	VR(G)	VR(M)	-	c	c*	c	x	R-U 4/1-5/15	R-C Apr.-July	R-U 6/20-10/20	Ac.	Rare
Snowy Egret	Egretta thula	-	-	-	-	x	r	r	-	Ac.-VR May	Ac.-VR June	Ac.-VR July-Oct.	-	-
Black-crowned Night Heron	Nycticorax nycticorax	-	R(G)	-	-	c	c*	c	o	R-C 4/1-5/10	VR-C Apr.-Aug.	U-C 8/10-10/10	Ac.-VR	-
Yellow-crowned Night Heron	Nyctanassa violacea	-	-	-	-	r	r	-	-	Ac.-U Apr.-May	Ac.-U Apr.-July	Ac.-VR Aug.-Sept.	-	Peripheral
Least Bittern	Ixobrychus exilis	-	R(G)	-	-	u	u*	u	x	Ac.-U 5/1-6/1	Ac.-U May-July	Ac.-R 8/1-9/20	-	Rare
American Bittern	Botaurus lentiginosus	-	VR(G,R)	-	-	u	u*	u	r	Ac.-U 4/1-5/10	Ac.-R Apr.-July	Ac.-U 9/10-10/15	VR	Pop. Declining
Glossy Ibis	Plegadis falcinellus	-	-	-	-	o	o	-	-	Accidental or Very Rare Occurrence				-
Mute Swan	Cygnus olor	-	-	-	-	r	r	r	r		Exotic			-
Whistling Swan	Olor columbianus	U(M)	-	-	-	a	x	c	o	Ac.-C 3/10-5/1	Ac.	Ac.-C 10/20-11/10	VR	-
Canada Goose	Branta canadensis	VC(M)	-	VC(M)	VC(G)	a	c*	a	a	U-C 3/1-4/10	VR-U Apr.-July	C-Ab. 9/24-10/20	R-C	-
Brant	Branta bernicla	-	-	-	-	x	-	r	-	Ac.-VR Mar.-May	-	Ac.-VR Oct.-Dec.	Ac.	-
Barnacle Goose	Branta leucopsis	-	-	-	-	-	x	x	x		Exotic			-
Bar-headed Goose	Anser indicus	-	-	-	-	x	-	-	x					-
White-fronted Goose	Anser albifrons	U(M)	-	-	-	-	-	x	x	Accidental or Very Rare Occurrence				-
Snow Goose	Chen caerulescens	-	-	-	-	o	-	c	u	R-U Mar.-Apr.	Ac.	U-C 10/19-11/20	Ac.-VR	-
Fulvous Tree Duck	Dendrocygna bicolor	-	-	-	-	-	-	x	-	Accidental or Very Rare Occurrence				-
Mallard	Anas platyrhynchos	A(M)	C(G,R)*	A(M)	VC(G)	a	a*	a	a	C-VC 3/10-4/15	R-U Apr.-July	C-VC 8/20-12/1	U-C	-
Black Duck	Anas rubripes	A(M)	-	VC(M)	A(G)	a	c*	a	a	C-VC 3/1-4/10	R-U Apr.-July	C-VC 9/1-12/10	U-C	-
Gadwall	Anas strepera	VC(M)	-	U(M)	-	c	u*	c	r	U-C 3/7-5/11	Ac.-VR	U-C 9/1-12/1	R	-
Pintail	Anas acuta	VC(M)	-	-	-	a	u*	a	c	U-C 3/1-4/18	Ac.-VR	U-C 8/20-12/1	R-U	Peripheral
Green-winged Teal	Anas crecca	VC(M)	-	U(M)	-	c	u*	c	o	U-C 3/6-5/15	VR May-July	U-C 8/20-12/1	R	Peripheral
Blue-winged Teal	Anas discors	A(M)	U(G)	-	-	c	c*	a	x	U-C 3/20-5/15	VR-U May-July	U-C 7/25-11/6	VR	-
European Wigeon	Anas penelope	-	-	-	-	r	-	r	x	VR-R Mar.-May	-	-	Ac.	-
American Wigeon	Anas americana	A(M)	-	VC(M)	-	a	u*	a	o	C-VC 3/1-5/1	Ac.-VR May-Aug.	U-C 8/10-12/1	R	Peripheral
Northern Shoveler	Anas clypeata	A(M)	-	U(M)	-	c	u*	c	r	U-C 3/10-5/15	VR May-July	U-C 9/1-11/18	VR	Peripheral
Wood Duck	Aix sponsa	VC(M)	U(G),R(R)	VR(M)	-	c	c*	a	r	R-C 3/15-4/20	U-VC Apr.-Aug.	C-VC 8/15-11/10	VR	-
Redhead	Aythya americana	C(M)	-	VR(M)	R(G)	c	u*	c	o	U-VC 3/10-5/10	Ac.-VR May-July	R-VC 10/25-12/1	VR-R	Peripheral
Ring-necked Duck	Aythya collaris	C(M)	-	-	-	c	x	c	r	VU-VC 3/1-5/10	Ac.-VR	VU-C 10/15-12/1	R-U	-
Canvasback	Aythya valisineria	U(M)	-	-	R(G)	a	x	a	c	VU-VC 2/20-4/15	Ac.	VU-C 10/25-12/15	R-U	-
Greater Scaup	Aythya marila	-	-	VR(M)	-	u	-	u	r	VR-R Feb.-Apr.	-	VR-R Oct.-Dec.	VR	-
Lesser Scaup	Aythya affinis	C(M)	-	VR(M)	-	a	u*	c	u	C-VC 3/1-5/25	Ac.-VR May-July	C-VC 10/12-12/10	R	Peripheral
Common Goldeneye	Bucephala clangula	VR(M)	-	-	U(G)	c	-	c	c	U-C 2/10-3/30	VR	U-C 10/25-12/21	U-C	-
Bufflehead	Bucephala albeola	U(M)	-	VR(M)	-	c	-	c	u	U 3/1-5/20	-	U 10/25-12/21	R-U	-
Oldsquaw	Clangula hyemalis	-	-	-	-	r	-	r	r	R Mar.-May	-	R Nov.-Dec.	VR-R	-
King Eider	Somateria spectabilis	-	-	-	-			x		Accidental or Very Rare Occurrence				-
White-winged Scoter	Melanitta deglandi	-	-	-	-	o	-	o	o	Ac.-R Mar.-May	-	VR-U Oct.-Dec.	VR	-
Surf Scoter	Melanitta perspicillata	-	-	-	-	o	-	o	o	Ac.-VR Mar.-May	-	VR-R Oct.-Nov.	Ac.-VR	-
Black Scoter	Melanitta nigra	-	-	-	-	-	-	o	r	Ac.-VR Mar.-May	-	VR Oct.-Nov.	Ac.	-
Ruddy Duck	Oxyura jamaicensis	U(M)	-	U(M)	U(G)	a	u*	c	u	U-VC 3/12-5/1	Ac.-VR	U-VC 9/15-12/1	Ac.-VR	Peripheral
Hooded Merganser	Lophodytes cucullatus	VC(M)	-	R(M)	-	c	u*	c	u	U-C 2/25-4/30	Ac.-VR Apr.-July	U-C 10/20-12/20	VR	Rare
Common Merganser	Mergus merganser	VC(M)	-	A(M)	C(G)	a	r	a	a	R-U 2/10-4/2	VR	R-U 10/20-12/20	R-C	Extirpated
Red-breasted Merganser	Mergus serrator	VC(M)	-	A(M)	-	u	-	u	r	R-VC 3/15-5/20	Ac.-VR	U-VC 10/23-12/15	R	-
Turkey Vulture	Cathartes aura	VR(M)	R(G)	-	-	c	u*	u	-	U-VC 3/1-5/1	U-C Apr.-July	U-C 9/20-11/15	Ac.-VR	-
Goshawk	Accipiter gentilis	-	-	-	-	r	-	r	r	Ac.-VR Feb.-Apr.	-	Ac.-VR Nov.-Dec.	Ac.-VR	-
Sharp-shinned Hawk	Accipiter striatus	-	-	-	-	c	-	u	r	R-U 3/15-5/20	Ac.-R Mar.-July	R-U 9/1-10/15	Ac.-VR	Rare
Cooper's Hawk	Accipiter cooperii	VR(M)	-	VR(M)	-	u	u*	u	u	U-C 3/1-5/15	U Mar.-July	U-C 10/1-12/1	U-C	Rare
Red-tailed Hawk	Buteo jamaicensis	R(M)	U(G)*	R(M)	U(G),R(W)	c	c*	c	c	U-VC 3/1 5/10	U Mar.-June	U-VC 10/1-12/15	U-C	-
Red-shouldered Hawk	Buteo lineatus	-	-	-	-	u	u*	u	o	R-U 3/1-5/10	R-U Mar.-July	R-U 10/1-11/25	VR	Pop. Declining
Broad-winged Hawk	Buteo platypterus	-	-	-	-	c	-	c	-	R-C 4/1-5/20	Ac.-R Apr.-July	VR-U 9/1-10/20	Ac.	-
Rough-legged Hawk	Buteo lagopus	-	-	-	-	u	-	u	c	R-C 3/21-4/30	-	R-C 10/20-12/10	R-C	-
Golden Eagle	Aquila chrysaetos	-	-	-	-	r	-	r	r	Ac.-VR Mar.-Apr.	-	Ac.-VR Nov.-Dec.	Ac.-VR	-
Bald Eagle	Haliaeetus leucocephalus	VR(M)	VR(G)	R(M)	R(G)	u	u*	u	u	Ac.-R Feb.-Mar.	Ac.-R Feb.-July	Ac.-R Oct.-Nov.	Ac.-R	Endangered
Marsh Hawk	Circus cyaneus	R(M)	-	R(M)	R(W,H),U(G)	u	u*	u	u	R-C 3/21-4/20	R-U Mar.-July	R-C 9/21-11/15	U-C	-

TABLE G-1. (Continued)

Common Name	Scientific Name	Battelle's Surveys at White's Landing[1]				Wildl. Ref. Complex BSFW (1970)[2]				Status in Ohio - Trautman and Trautman (1968)[3]				Rare or Endangered Species in Ohio[4]
		Sp Mar. Ap. May	Su June July	Fa Nov.	Wi Dec. Jan.	Sp	Su	Fa	Wi	Spring Migration and	Summering Nesting	Fall Migration	Winter	Smith et al. (1973)
Common Grackle	*Quiscalus quiscula*	C(M)	VC(G),A(R), R(W)			a	a*	a	u	U-Ab 2/15-4/20	U-Ab Apr.-July	U-Ab9/1-11/21	Ac.-C	-
Brown-headed Cowbird	*Molothrus ater*	P-M	U(R)*,C(W)			c	c*	c	u	U-VC 2/28-4/30	U-VC Apr.-Aug.	U-VC 9/1-11/15	Ac.-C	-
Scarlet Tanager	*Piranga olivacea*	P-M	P-J			c	u*	c	-	Ac.-C 4/25-5/25	Ac.-U May-July	Ac.-U 8/15-9/25	-	-
Summer Tanager	*Piranga rubra*					r	x	x	-	Ac.-C 4/28-5/15	Ac.-C May-July	Ac.-U 9/1-9/22	-	-
Cardinal	*Cardinalis cardinalis*	U(M)	R(R),C(G,W)	U(M)	R(M),U(G,W)	c	c*	c	c	R-VC Mar.-Apr.	R-VC Apr.-Aug.	R-VC Sept.-Oct.	R-VC	-
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	P-M				c	r*	c	-	U-C 4/25-5/30	Ac.-U May-July	U-C 8/29-10/10	-	-
Blue Grosbeak	*Guiraca caerulea*	P-M								Accidental or Very Rare Occurrence				-
Indigo Bunting	*Passerina cyanea*	P-M	VC(G,R,W)			c	c*	c	-	U-VC 4/27-6/2	U-VC May-Sept.	U-C 8/26-10/4	-	-
Dickcissel	*Spiza americana*		R(G)			u	u*	u	-	Ac.-C 4/29-5/25	Ac.-U May-Aug.	Ac.-U 8/15-9/20	Ac.	-
Evening Grosbeak	*Hesperiphona vespertina*					o	-	o	o	Ac.-U Apr.-May	-	Ac.-U Oct.-Nov.	Ac.-U	-
Purple Finch	*Carpodacus purpureus*					u	x	u	u	Ac.-C Apr.-May	Ac.-R May-July	Ac.-C Sept.-Nov.	Ac.-U	Peripheral
Hoary Redpoll	*Acanthis hornemanni*					x	-	x	-	Accidental or Very Rare Occurrence				-
Common Redpoll	*Acanthis flammea*					o	-	o	o	Ac.-U Mar.-Apr.	-	Ac.-U Nov.-Dec.	Ac.-U	-
Pine Siskin	*Spinus pinus*					u	-	u	o	Ac.-C Apr.-May	Ac.?	Ac.-C Oct.-Nov.	Ac.-C	Peripheral
American Goldfinch	*Spinus tristus*	P-M	VC(G),C(R), R(W)	R(M)	R(G)	c	c*	c	c	U-Ab 4/12-5/22	R-C June-Sept.	U-Ab 9/15-11/1	Ac.-U	-
Rufous-sided Towhee	*Pipilo erythrophthalmus*	P-M	R(G),VR(R)*, C(W)			c	c*	c	u	U-VC 3/8-5/15	U-VC Apr.-July	U-VC 9/15-10/3	Ac.-C	-
Savannah Sparrow	*Passerculus sandwichensis*	P-M				c	c*	c	x	U-VC 3/23-5/10	Ac.-C May-July	U-VC 9/1-10/25	Ac.	-
Grasshopper Sparrow	*Ammodramus savannarum*					o	u*	o	-	R-C 4/15-5/22	Ac.-U May-Aug.	R-C 8/15 10/10	Ac.	Pop. Declining
Le Conte's Sparrow	*Ammospiza lecontei*					x	-	r	-	Accidental or Very Rare Occurrence				-
Henslow's Sparrow	*Ammodramus henslowii*					x	x	-	-	Ac.-C 4/15-5/22	Ac.-U May-Sept.	Ac.-U 6/14-10/1	-	Pop. Declining
Sharp-tailed Sparrow	*Ammospiza caudacuta*					r	-	r	-	Ac.-R May-June	-	Ac.-R Sept.-Oct.	-	-
Vesper Sparrow	*Pooecetes gramineus*	P-M	VR(G,R)			u	u*	u	x	U-Ab 3/6-5/4	U-Ab Apr.-Aug.	U-Ab 9/10-11/10	Ac.-VR	-
Dark-eyed Junco	*Junco hyemalis*	R(M)		VR(M)	U(C,W)	c	-	c	u	U-Ab 3/5-5/5	Ac. May-July	U-Ab 9/20-11/15	VR-C	Peripheral
Tree Sparrow	*Spizella arborea*	C(M)		C(M)	VC(G),U(H,W)	c	-	c	c	U-Ab 2/22-5/5	-	U-Ab 10/12-12/12	U-VC	-
Chipping Sparrow	*Spizella passerina*	P-M	VR(G,R)			u	u*	u	-	U-VC 3/20-5/15	U-VC Apr.-July	U-VC 9/10-10/30	Ac.	-
Field Sparrow	*Spizella pusilla*	P-M	U(R),C(G,W)		R(G)	u	u*	u	r	U-VC 3/15-5/5	U-VC Apr.-Aug.	U-VC 9/10-10/30	Ac.-U	-
Harris' Sparrow	*Zonotrichia querula*					x	-	x	-	Ac.-VR Mar.-May	-	Ac.-VR Oct.	Ac.	-
White-crowned Sparrow	*Zonotrichia leucophrys*	P-M				c	x	c	u	R-C 4/20-5/25	Ac.	R-C 9/28-11/1	Ac.-R	-
White-throated Sparrow	*Zonotrichia albicollis*	P-M			R(W)	c	x	c	u	U-Ab 3/28-5/27	Ac.-VR May-July	U-Ab 9/15-11/5	Ac.-R	Peripheral
Fox Sparrow	*Passerella iliaca*				P-D	c	-	c	r	R-C 3/5-4/23	-	R-C 9/28-11/10	Ac.-VR	-
Swamp Sparrow	*Melospiza georgiana*	P-M			P-D	u	r*	c	o	R-C 4/1-5/16	Ac.-U May-July	R-C 9/15-11/5	Ac.-R	Pop. Declining
Song Sparrow	*Melospiza melodia*	VC(M)	A(R),C(G,W)	U(M)	U(H),C(G), R(W)	c	c*	c	u	C-Ab Feb.-Apr.	C Mar.-Aug.	C-Ab Sept.-Nov.	R-Ab	-
Lapland Longspur	*Calcarius lapponicus*					u	-	u	u	Ac.-VC 2/10-5/10	-	Ac.-VC 10/25-12/1	Ac.-C	-
Snow Bunting	*Plectrophenax nivalis*					c	-	c	c	Ac.-C 2/1-3/20	-	Ac.-C 10/25-12/1	Ac.-C	-

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1 After American Ornithologists' Union Check-List (1957) as amended in the April 1973 issue of The Auk.

2 Abundance for Battelle Surveys: A = Abundant, VC = Very Common, C = Common, U = Unusual, R = Rare, VR = Very Rare, * = Nesting, G = General Reconnaissance Survey Jan 15-Feb 1, 1974/June 18-28, 1974, H = Hedgerow Survey Jan 16-Feb 1, 1974, M = Marsh Survey Nov 6-24, 1973/Mar 17-Apr 5, 1974, R = Roadside Survey June 19-24, 1974, W = Woodlot Survey Jan 16-Feb 1, 1974/June 18-28, 1974, P-D = Present in December 18-20, 1973, P-J = Present in July 16-18, 1973, P-M = Present in May 14-31, 1973 or May 20-24, 1974.

3 Abundance for Ottawa National Wildlife Refuge Complex: a = Abundant - a common species which is very numerous, c = Common - certain to be seen in suitable habitat, u = Uncommon - present, but not certain to be seen, o = Occasional - seen only a few times during a season, r = Rare - seen at intervals of 2 to 5 years, x = Accidental - has been seen only once or twice, * = Nesting.

4 Abundance for Ohio: Ab = Abundant, VC = Very Common, C = Common, FC = Fairly Common, U = Uncommon, VU = Very Uncommon, R = Rare, VR = Very Rare, AC = Accidental. Dates given are average dates of arrival and departure in Ohio. Underlined refers to nesting in Ohio.

5 For Smith et al: extirpated - no recent breeding records; endangered - prospects of survival and reproduction are in immediate jeopardy; rare - exists in small numbers and may become endangered; status undetermined - possibly endangered and insufficient information to determine status; peripheral - at the edge of its natural range in Ohio; pop. declining - population declining.

TABLE G-2. IMPORTANT PLANT FOODS RANKED ACCORDING TO THEIR VALUE TO FOUR GROUPS OF BIRDS WHICH ARE FOUND AT THE SITE[1]

Plant Group	Bird Group			
	Waterbirds	Marsh-Shorebirds	Upland Gamebirds	Songbirds
Woody Plants	Oak (Quercus) Dogwood (Cornus) Elm (Ulmus) Beech (Fagus) Grape (Vitis) Ash (Fraxinus) Greenbriar (Smilax)	Oak (Quercus)	Grape (Vitis) Blackberry (Rubus) Oak (Quercus) Dogwood (Cornus) Wild Cherry (Prunus) Greenbrier (Smilax) Sumac (Rhus) Hazelnut (Corylus) Maple (Acer) Poison Ivy (Rhus) Beech (Fagus) Willow (Salix) Hawthorn (Crataegus) Ash (Fraxinus) Elderberry (Sambucus) Elm (Ulmus) Serviceberry (Amelanchier) Hickory (Carya)	Blackberry (Rubus) Wild Cherry (Prunus) Dogwood (Cornus) Oak (Quercus) Grape (Vitis) Maple (Acer) Mulberry (Morus) Poison Ivy (Rhus) Sumac (Rhus) Virginia Creeper (Parthenocissus) Elderberry (Sambucus) Beech (Fagus grandifolia) Elm (Ulmus) Tuliptree (Liriodendron) Serviceberry (Amelanchier) Greenbrier (Smilax) Ash (Fraxinus) Hickory (Carya) Hawthorn (Crataegus) Hazelnut (Corylus)
Upland Weeds and Herbs	Sedge (Carex)	Sedge (Carex) Ragweed (Ambrosia) Clover (Trifolium) Panicgrass (Panicum)	Ragweed (Ambrosia) Clover (Trifolium) Dandelion (Taraxacum) Crabgrass (Digitaria) Sedge (Carex) Pokeweed (Phytolacca) Sheepsorrel (Rumex) Panicgrass (Panicum) Pigweed (Amaranthus) Plantain (Plantago)	Ragweed (Ambrosia) Crabgrass (Digitaria) Panicgrass (Panicum) Pigweed (Amaranthus) Sedge (Carex) Sheepsorrel (Rumex) Pokeweed (Phytolacca) Dandelion (Taraxacum) Clover (Trifolium) Plantain (Plantago)
Marsh and Aquatic Plants	Pondweed (Potamogeton) Wildrice (Zizania) Bulrush (Scirpus) Wildcelery (Vallisneria) Naiad (Najas) Smartweed (Polygonum) Duckweed (Lemnaceae) Algae Burreed (Sparganium) Cutgrass (Leersia) Spikerush (Eleocharis) Wildmillet (Echinochloa) Arrow-arum (Peltandra virginica) Arrowhead (Sagittaria)	Bulrush (Scirpus) Wildrice (Zizania) Pondweed (Potamogeton) Smartweed (Polygonum) Spikerush (Eleocharis) Arrowhead (Sagittaria) Wildmillet (Echinochloa) Cutgrass (Leersia) Burreed (Sparganium) Duckweed (Lemnaceae) Algae Arrow-arum (Peltandra) Wildcelery (Vallisneria)	Smartweed (Polygonum) Wildrice (Zizania) Cutgrass (Leersia) Wildmillet (Echinochloa)	Smartweed (Polygonum) Wildrice (Zizania) Wildmillet (Echinochloa) Bulrush (Scirpus)
Cultivated Plants	Corn (Zea) Wheat (Triticum) Oats (Avena)	Wheat (Triticum)	Corn (Zea) Wheat (Triticum) Oats (Avena) Apple (Malus)	Corn (Zea) Oats (Avena) Wheat (Triticum) Timothy (Phleum) Apple (Malus)

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[1] Revised from Martin et al. (1951). Only plants existing in the Sandusky Bay area are ranked, beginning with the plant most important to all birds in a given group. Bird category includes the following groups: (1) Waterbirds - loons, grebes, pelicans, cormorants, swan, geese, ducks (including mergansers), coot, gulls, and terns; (2) Marsh-Shorebirds - herons, egrets, bitterns, ibises, cranes, rails, gallinules, plovers, turnstones, sandpiper family, avocet, phalaropes; (3) Upland Gamebirds [illegible] pheasants; (4) Songbirds [illegible]

TABLE G-3. FOOD PREFERENCES[(a,b)] OF MIGRATORY WATERFOWL WHICH MAY UTILIZE SANDUSKY BAY OR ITS ADJACENT MARSHES[(c)]

Common Name	Animal Food[(d)]	Plant Food[(e)]			
Mute Swan	(SA) larvae of aquatic beetles and dragonflies	Grasses	Wildcelery	Pondweed	Smartweed
Whistling Swan	(SA) larvae of aquatic beetles and dragonflies	Grasses	Wildcelery	Pondweed	Smartweed
Canada Goose	(SA to none)	Spikerush	Naiad	Bulrush	
Brant	(SA) gastropods, bivalves, annelid worms, crustaceans	Alga			
Snow Goose	(none)	Rootstocks of: Bulrush	Cattail	Panicgrass	Wildrice
Mallard	(SA) aquatic beetles, dragonfly and damselfly nymphs, fly larvae, aquatic bugs	Wildrice	Pondweed	Smartweed	Wildmillet
Black Duck	(Some) mollusks, crustaceans, insects, few fish	Pondweed	Wildrice	Bulrush	Smartweed
Gadwall	(SA) 3/4 mollusks, 1/4 insects	Bulrush	Sedge	Pondweed	(98%FW)^2
Pintail	(SA) mollusks,crustaceans, insects, small fish, frogs	Bulrush	Smartweed	Pondreed	Wildrice
Green-Winged Teal	(SA) insects, mollusks, small crustaceans	Bulrush	Wildrice	Wildmillet	Sedge
Blue-Winged Teal	(1/4) mollusks, insect larvae, a few crustaceans	Duckweed	Naiad	Pondweed	Bulrush
European Wigeon	Probably similar to American Wigeon	Grain	Watercelery[(b)]		
American Wigeon	(SA) mollusks, aquatic insects	(Pondweed	Naiad	Bulrush)[(a)]	(Grain)[(b)]
Northern Shoveler	(1/4) mollusks, aquatic insects, crustaceans	Bulrush	Pondweed	Alga	Spikerush
Wood Duck	(SA) beetles, truebugs, ants, other Hymenoptera, spiders, crustaceans, mollusks	Wildrice	Pondweed	Burreed	Smartweed
Redhead	(10%)[(b)] grasshoppers, midge and caddisfly larvae, mollusks, snails	Pondweed	Wildrice	Wildcelery	Bulrush
Ring-necked Duck	(1/4) insects, mollusks, fish, spiders, worms	Pondweed	Smartweed	Wildrice	Naiad
Canvasback	(20%)[(b)] bivalves, gastropods, dragonflies, damselflies, water bugs, some small fish	Wildcelery	Pondweed	Wildrice	Bulrush

TABLE G-3. (Continued)

Common Name	Animal Food[4] (d)	Plant Food (e)			
Greater Scaup	(1/2) mollusks, insect larvae, amphipods, mud crabs, barnacles	Pondweed	Wildcelery	Naiad	Burreed
Lesser Scaup	(2/3) mollusks, dragonfly and damselfly nymphs, insects	Wildcelery	Pondweed	Wildrice	Naiad
Common Goldeneye	(3/4) crustaceans, insects, mollusks, fish	Pondweed	Wildcelery	Smartweed	Sedge
Bufflehead	(80%)(b) insects, crustaceans, mollusks, fish	Naiad	Pondweed	Wildcelery	Wildrice
Oldsquaw	(90%)(b) crustaceans, mollusks, insects, fish	(SA)			
White-Winged Scoter	94% total diet mollusks,(b) crustaceans, insects, fishes	(SA) Pondweed			
Surf Scoter	(90%)(b) mollusks, crustaceans, insects, fish, echinoderms	(SA) Pondweed Alga			
Black Scoter	(90%)(b) mollusks, crustaceans, insects, fish, echinoderms	(SA) Marine plants			
Ruddy Duck	(1/3 usually) insects, mollusks, crustaceans	Pondweed	Wildcelery	Bulrush	Naiad
Hooded Merganser	(Primarily fish) crawfish, shrimp, frogs, insects, mollusks	(Neg)			
Common Merganser	(Primarily fish) crawfish, shrimp, frogs, insects, mollusks	(Neg)			
Red-Breasted Merganser	(Primarily fish) crawfish, shrimp, frogs, insects, mollusks	(Neg)			

(a) Food preferences after Martin et al. (1959) unless indicated otherwise.

(b) Food preferences after Sprunt et al. (1961).

(c) Migratory waterfowl species (not including accidentals after BSFW (1970).

(d) Entries in parentheses indicate percentage of animal food eaten out of total amount of food eaten. Animal foods listed in order of quantity eaten. (SA) = Small Amounts.

(e) Plant foods listed in order of quantity eaten. (98%FW) indicates 98% of food eaten in fall and winter is plant food (SA) = Small Amounts. (Neg) = negligible am

TABLE G-1. COMPARISON OF BIRD ABUNDANCE FOUND DURING SURVEYS AT THE SITE TO ABUNDANCE REPORTED FOR THE OTTAWA NATIONAL WILDLIFE REFUGE COMPLEX AND THE STATE OF OHIO

Common Name	Scientific Name	Battelle's Surveys[2] the site: Sp Mar. Ap. May	Su June July	Fa Nov.	Wi Dec. Jan.	Wildl. Ref. Complex BSFW (1970)[1]: Sp	Su	Fa	Wi	Status in Ohio - Trautman and Trautman (1968)[4]: Spring Migration and	Summering Nesting	Fall Migration	Winter	Rare or Endangered Species in Ohio[5] Smith et al. (1973)
Common Loon	Gavia immer	-	-	-	-	o	-	o	r	Ac.-U 4/10-5/10	VR	R-C 10/1-12/1	VR	Extirpated
Horned Grebe	Podiceps auritus	-	-	VR(M)	-	u	-	u	o	R-C 3/10-4/15	Ac.	R-VC 10/5-12/5	Ac.-VR	-
Eared Grebe	Podiceps nigricollis	-	-	-	-	r	-	r	-	Accidental or Very Rare Occurrence				-
Pied-billed Grebe	Podilymbus podiceps	U(M)	-	-	-	c	c*	c	r	R-C 3/15-5/15	R-U May-July	U-C 9/1-12/10	Ac.-R	Pop. Declining
White Pelican	Pelecanus erythrorhynchos	-	-	-	-	r	r	r	-	Ac.-VR Apr.-May	-	Ac.-VR Aug.-Nov.	-	-
Double-crested Cormorant	Phalacrocorax auritus	VR(M)	-	-	-	o	o	o	r	Ac.-VR 4/1-5/15	Ac.-VR	R-C 9/15-11/10	Ac.	Extirpated
Great Blue Heron	Ardea herodias	VC(M)	A(G),C(R)	C(M)	P-D	c	c*	c	u	U-VC 3/15-4/20	U-VC Apr.-Aug.	U-VC 8/15-12/1	Ac.-R	-
Green Heron	Butorides virescens	P-M	C(G),VR(R)	-	-	c	c*	c	-	RC 4/18-5/18	R-C Apr.-July	R-C 8/1-10/5	Ac.	-
Little Blue Heron	Florida caerulea	-	-	-	-	r	o	o	-	Ac.-VR Apr.-May	Ac.-U	Ac.-VR July-Sept.	-	-
Cattle Egret	Bubulcus ibis	P-M	-	-	-	u	u	-	-	Accidental or Very Rare Occurrence				-
Great Egret	Casmerodius albus	R(M)	VR(G)	VR(M)	-	c	c*	c	x	R-U 4/1-5/15	R-C Apr.-July	R-U 6/20-10/20	Ac.	Rare
Snowy Egret	Egretta thula	-	-	-	-	x	r	r	-	Ac.-VR May	Ac.-VR June	Ac.-VR July-Oct.	-	-
Black-crowned Night Heron	Nycticorax nycticorax	-	R(G)	-	-	c	c*	c	o	R-C 4/1-5/10	VR-C Apr.-Aug.	U-C 6/10-10/10	Ac.-VR	-
Yellow-crowned Night Heron	Nyctanassa violacea	-	-	-	-	r	r	-	-	Ac.-U Apr.-May	Ac.-U Apr.-July	Ac.-VR Aug.-Sept.	-	Peripheral
Least Bittern	Ixobrychus exilis	-	R(G)	-	-	u	u*	u	x	Ac.-U 5/1-6/1	Ac.-U May-July	Ac.-R 6/1-9/20	-	Rare
American Bittern	Botaurus lentiginosus	-	VR(G,R)	-	-	u	u*	u	r	Ac.-U 4/1-5/10	Ac.-R Apr.-July	Ac.-U 9/10-10/15	VR	Pop. Declining
Glossy Ibis	Plegadis falcinellus	-	-	-	-	o	o	-	-	Accidental or Very Rare Occurrence				-
Mute Swan	Cygnus olor	-	-	-	-	r	r	r	r		Exotic			-
Whistling Swan	Olor columbianus	U(M)	-	-	-	a	x	c	o	Ac.-C 3/10-5/1	Ac.	Ac.-C 10/20-11/10	VR	-
Canada Goose	Branta canadensis	VC(M)	-	VC(M)	VC(G)	a	c*	a	a	U-C 3/1-4/10	VR-U Apr.-July	C-Ab. 9/24-10/20	R-C	-
Brant	Branta bernicla	-	-	-	-	x	-	r	-	Ac.-VR Mar.-May	-	Ac.-VR Oct.-Dec.	Ac.	-
Barnacle Goose	Branta leucopsis	-	-	-	-	-	x	x	x		Exotic			-
Bar-headed Goose	Anser indicus	-	-	-	-	x	-	-	x					-
White-fronted Goose	Anser albifrons	U(M)	-	-	-	-	-	x	x	Accidental or Very Rare Occurrence				-
Snow Goose	Chen caerulescens	-	-	-	-	o	-	c	u	R-U Mar.-Apr.	Ac.	U-C 10/19-11/20	Ac.-VR	-
Fulvous Tree Duck	Dendrocygna bicolor	-	-	-	-	-	-	x	-	Accidental or Very Rare Occurrence				-
Mallard	Anas platyrhynchos	A(M)	C(G,R)*	A(M)	VC(G)	a	a*	a	a	C-VC 3/10-4/15	R-U Apr.-July	C-VC 8/20-12/1	U-C	-
Black Duck	Anas rubripes	A(M)	-	VC(M)	A(G)	a	c*	a	a	C-VC 3/1-4/10	R-U Apr.-July	C-VC 9/1-12/10	U-C	-
Gadwall	Anas strepera	VC(M)	-	U(M)	-	c	u*	c	r	U-C 3/7-5/11	Ac.-VR	U-C 9/1-12/1	R	-
Pintail	Anas acuta	VC(M)	-	-	-	a	u*	a	c	U-C 3/1-4/18	Ac.-VR	U-C 8/20-12/1	R-U	Peripheral
Green-winged Teal	Anas crecca	VC(M)	-	U(M)	-	c	u*	c	o	U-C 3/6-5/15	VR May-July	U-C 8/20-12/1	R	Peripheral
Blue-winged Teal	Anas discors	A(M)	U(G)	-	-	c	c*	a	x	U-C 3/20-5/15	VR-U May-July	U-C 7/25-11/6	VR	-
European Wigeon	Anas penelope	-	-	-	-	r	-	r	x	VR-R Mar.-May	-	-	Ac.	-
American Wigeon	Anas americana	A(M)	-	VC(M)	-	a	u*	a	o	C-VC 3/1-5/1	Ac.-VR May-Aug.	U-C 8/10-12/1	R	Peripheral
Northern Shoveler	Anas clypeata	A(M)	-	U(M)	-	c	u*	c	r	U-C 3/10-5/15	VR May-July	U-C 9/1-11/18	VR	Peripheral
Wood Duck	Aix sponsa	VC(M)	U(G),R(R)	VR(M)	-	c	c*	a	r	R-C 3/15-4/20	U-VC Apr.-Aug.	C-VC 8/15-11/10	VR	-
Redhead	Aythya americana	C(M)	-	VR(M)	R(G)	c	u*	c	c	U-VC 3/10-5/10	Ac.-VR May-July	R-VC 10/25-12/1	VR-R	Peripheral
Ring-necked Duck	Aythya collaris	C(M)	-	-	-	c	x	c	r	VU-VC 3/1-5/10	Ac.-VR	VU-C 10/15-12/1	R-U	-
Canvasback	Aythya valisineria	U(M)	-	-	R(G)	a	x	a	c	VU-VC 2/20-4/15	Ac.	VU-C 10/25-12/15	R-U	-
Greater Scaup	Aythya marila	-	-	VR(M)	-	u	-	u	r	VR-R Feb.-Apr.	-	VR-R Oct.-Dec.	VR	-
Lesser Scaup	Aythya affinis	C(M)	-	VR(M)	-	a	u*	c	u	C-VC 3/1-5/25	Ac.-VR May-July	C-VC 10/12-12/10	R	Peripheral
Common Goldeneye	Bucephala clangula	VR(M)	-	-	U(G)	c	-	c	c	U-C 2/10-3/30	VR	U-C 10/25-12/21	U-C	-
Bufflehead	Bucephala albeola	U(M)	-	VR(M)	-	c	-	c	u	U 3/1-5/20	-	U 10/25-12/21	R-U	-
Oldsquaw	Clangula hyemalis	-	-	-	-	r	-	r	r	R Mar.-May	-	R Nov.-Dec.	VR-R	-
King Eider	Somateria spectabilis	-	-	-	-			x		Accidental or Very Rare Occurrence				-
White-winged Scoter	Melanitta deglandi	-	-	-	-	o	-	o	o	Ac.-R Mar.-May	-	VR-U Oct.-Dec.	VR	-
Surf Scoter	Melanitta perspicillata	-	-	-	-	o	-	o	o	Ac.-VR Mar.-May	-	VR-R Oct.-Nov.	Ac.-VR	-
Black Scoter	Melanitta nigra	-	-	-	-	-	-	o	r	Ac.-VR Mar.-May	-	VR Oct.-Nov.	Ac.	-
Ruddy Duck	Oxyura jamaicensis	U(M)	-	U(M)	U(G)	a	u*	c	u	U-VC 3/12-5/1	Ac.-VR	U-VC 9/15-12/1	Ac.-VR	Peripheral
Hooded Merganser	Lophodytes cucullatus	VC(M)	-	R(M)	-	c	u*	c	u	U-C 2/25-4/30	Ac.-VR Apr.-July	U-C 10/20-12/20	VR	Rare
Common Merganser	Mergus merganser	VC(M)	-	A(M)	C(G)	a	r	a	a	R-U 2/10-4/2	VR	R-U 10/20-12/20	R-C	Extirpated
Red-breasted Merganser	Mergus serrator	VC(M)	-	A(M)	-	u	-	u	r	R-VC 3/15-5/20	Ac.-VR	U-VC 10/25-12/15	R	-
Turkey Vulture	Cathartes aura	VR(M)	R(G)	-	-	c	u*	u	-	U-VC 3/1-5/1	U-C Apr.-July	U-C 9/20-11/15	Ac.-VR	-
Goshawk	Accipiter gentilis	-	-	-	-	r	-	r	r	Ac.-VR Feb.-Apr.	-	Ac.-VR Nov.-Dec.	Ac.-VR	-
Sharp-shinned Hawk	Accipiter striatus	-	-	-	-	c	-	u	r	R-U 3/15-5/20	Ac.-R Mar.-July	R-U 9/1-10/15	Ac.-VR	Rare
Cooper's Hawk	Accipiter cooperii	VR(M)	-	VR(M)	-	u	u*	u	u	U-C 3/1-5/15	U Mar.-July	U-C 10/1-12/1	U-C	Rare
Red-tailed Hawk	Buteo jamaicensis	R(M)	U(G)*	R(M)	U(G),R(W)	c	c*	c	c	U-VC 3/1-5/10	U Mar.-June	U-VC 10/1-12/15	U-C	-
Red-shouldered Hawk	Buteo lineatus	-	-	-	-	u	u*	u	o	R-U 3/1-5/10	R-U Mar.-July	R-U 10/1-11/25	VR	Pop. Declining
Broad-winged Hawk	Buteo platypterus	-	-	-	-	c	-	c	-	R-C 4/1-5/20	Ac.-R Apr.-July	VR-U 9/1-10/20	Ac.	-
Rough-legged Hawk	Buteo lagopus	-	-	-	-	u	-	u	c	R-C 3/21-4/30	-	R-C 10/20-12/10	R-C	-
Golden Eagle	Aquila chrysaetos	-	-	-	-	r	-	r	r	Ac.-VR Mar.-Apr.	-	Ac.-VR Nov.-Dec.	Ac.-VR	-
Bald Eagle	Haliaeetus leucocephalus	VR(M)	VR(G)	R(M)	R(G)	u	u*	u	u	Ac.-R Feb.-Mar.	Ac.-R Feb.-July	Ac.-R Oct.-Nov.	Ac.-R	Endangered
Marsh Hawk	Circus cyaneus	R(M)	-	R(M)	R(W,H),U(G)	u	u*	u	u	R-C 3/21-4/20	R-U Mar.-July	R-C 9/21-11/15	U-C	-

TABLE G-1. (Continued)

Common Name[1]	Scientific Name[1]	Battelle's Surveys the site[2]				Wildl. Ref. Complex BSFW (1970)[3]				Status in Ohio - Trautman and Trautman (1968)[4]				Rare or Endangered Species in Ohio[5]
		Sp Mar. Ap. May	Su June July	Fa Nov.	Wi Dec. Jan.	Sp	Su	Fa	Wi	Spring Migration and	Summering Nesting	Fall Migration	Winter	Smith et al. (1973)
Osprey	Pandion haliaetus	-	-	-	-	u	r	u	-	R 4/1-5/20	Ac.	R 9/1-10/30	-	Extirpated
Gyrfalcon	Falco rusticolus	-	-	-	-	x	-	x	x	Accidental or Very Rare Occurrence				-
Peregrine Falcon	Falco peregrinus	-	-	-	-	r	-	r	r	R-U 3/10-5/20	Ac.	R 9/1-11/10	VR	-
Merlin	Falco columbarius	-	-	-	-	r	-	r	r	R-C 3/15-5/18	-	R-C 9/15-10/20	-	Extigpated
American Kestrel	Falco sparverius	R(M)	VR(G)	VR(M)	U(G)	c	c*	c	c	U-C	U-C Feb.-July	U-C	U-C	-
Bobwhite	Colinus virginianus	P-M	U(G,R),R(W)	-	U(G)	u	u*	u	u	R-C	R-C May-Aug.	R-C	R-C	-
Ring-necked Pheasant	Phasianus colchicus	U(M)	R(G),C(R)	U(M)	R(G,H,W)	c	c*	c	c	R-C	R-C Apr.-Aug.	R-C	R-C	Pop. Declining
Sandhill Crane	Grus canadensis	-	-	-	-	r	-	x	-	Ac.-VR Apr.	Ac.	Ac.-VR Oct.	-	Extirpated
King Rail	Rallus elegans	P-M	VR(G)	-	-	o	u*	o	r	R 4/15-5/15	Ac.-R May-July	VR 8/20-10/1	Ac.	Rare
Virginia Rail	Rallus limicola	-	-	-	-	o	o*	o	r	Ac.-U 4/10-5/10	Ac.-U May-July	Ac.-U 8/25-10/15	Ac.	Pop. Declining
Sora	Porzana carolina	-	P-J	-	-	c	u*	c	r	R-U 4/10-5/20	Ac.-U May-July	R-U 9/1-10/20	-	-
Yellow Rail	Coturnicops noveboracensis	-	-	-	-	x	-	x	-	Ac.-R 4/15-5/5	Ac.	Ac.-R Sept.-Oct.	-	-
Black Rail	Laterallus jamaicensis	P-M	-	-	-	x	-	x	-	Accidental or Very Rare Occurrence				Rare
Common Gallinule	Gallinula chloropus	-	VR(G)	-	-	c	c*	c	x	R-U 4/14-5/10	VR-U June-Aug.	R-U 8/15-10/5	-	Pop. Declining
American Coot	Fulica americana	VC(M)	-	VC(M)	-	a	c*	a	u	U-VC 3/10-5/20	R-U May-Aug.	U-VC 9/20-11/25	-	-
Semipalmated Plover	Charadrius semipalmatus	P-M	-	-	-	c	x	c	-	R-C 5/7-6/5	Ac.	U-C 8/5-10/10	-	-
Piping Plover	Charadrius melodus	-	-	-	-	r	r*	r	-	Ac.-VR Apr.-May	Ac. May-July	Ac. Aug.-Sept.	-	Status Undetermined
Wilson's Plover	Charadrius wilsonia	-	-	-	-	-	x	-	-	Accidental or Very Rare Occurrence				-
Killdeer	Charadrius vociferus	VC(M)	C(G,R)	C(M)	-	c	c*	c	r	U-Ab 2/20-4/20	R-VC Apr.-July	C-Ab 7/20-11/5	Ac.-R	-
American Golden Plover	Pluvialis dominica	-	-	-	-	c	u	u	-	R-Ab 4/1-5/10	VR	R-U 8/10-10/25	-	-
Black-bellied Plover	Pluvialis squatarola	-	-	-	-	c	u	u	-	VR-U 5/6-6/3	Ac.	VR-U 8/15-10/10	-	-
Ruddy Turnstone	Arenaria interpres	-	-	-	-	c	u	c	-	Ac.-C 5/5-6/5	Ac.	Ac.-R 8/1-10/15	-	-
American Woodcock	Philohela minor	P-M	VR(G)	-	-	u	u*	u	-	VR-U 3/10-5/10	VR-R Mar.-July	VR-U 9/10-10/25	Ac.	-
Common Snipe	Capella gallinago	VR(M)	-	VR(M)	-	c	c*	c	r	U-VC 3/4-5/15	Ac. Apr.-July	U-C 8/5-10/25	Ac.-VR	-
Whimbrel	Numenius phaeopus	-	-	-	-	r	r	r	-	Ac.-R May-June	-	Ac.-VR July-Oct.	-	-
Upland Sandpiper	Bartramia longicauda	-	-	-	-	u	u*	u	-	R-U 4/1-5/10	R-U Apr.-June	R-C 7/15-9/18	-	Rare
Spotted Sandpiper	Actitis macularia	P-M	R(G)	-	-	c	c*	c	-	U-C 4/20-5/20	U-C May-July	U-C 7/15-10/1	-	-
Solitary Sandpiper	Tringa solitaria	P-M	-	-	-	c	c	c	-	U-C 4/15-5/20	VR	U-C 7/15-10/1	-	-
Willet	Catoptrophorus semipalmatus	-	-	-	-	r	x	r	-	Ac.-VR May-June	-	Ac.-VR July-Sept.	-	-
Greater Yellowlegs	Tringa melanoleucus	P-M	-	R(M)	-	c	c	c	-	U-C 3/25-5/15	VR	U-C 7/20-10/20	-	-
Lesser Yellowlegs	Tringa flavipes	-	P-J	-	-	c	c	c	-	U-C 4/1-5/25	VR	U-C 7/7-10/15	-	-
Red Knot	Calidris canutus	-	-	-	-	u	o	o	-	Ac.-U 5/15-6/3	Ac.	Ac.-VR Aug.-Sept.	-	-
Pectoral Sandpiper	Calidris melanotos	-	-	-	-	c	c	c	-	C-VC 3/25-5/10	Ac.	C-VC 7/20-10/20	-	-
White-rumped Sandpiper	Calidris fuscicollis	-	-	-	-	r	r	r	-	Ac.-VR 5/10-6/2	Ac.	Ac.-U 8/1-10/20	-	-
Baird's Sandpiper	Calidris bairdii	-	-	-	-	r	r	r	x	Ac.-VR Apr.-May	-	Ac.-U 8/15-10/1	-	-
Least Sandpiper	Calidris minutilla	-	-	-	-	c	c	c	-	U-C 5/5-6/2	Ac.-VR	R-C 7/20-10/15	-	-
Dunlin	Calidris alpina	P-M	-	C(M)	-	a	c	a	r	R-C 5/7-6/3	Ac.-VR	R-C 9/15-11/20	Ac.	-
Short-billed Dowitcher	Limnodromus griseus	-	-	-	-	c	c	c	-	Ac.-U 4/25-6/2	Ac.	Ac.-C 7/4-9/7	-	-
Long-billed Dowitcher	Limnodromus scolopaceus	-	-	-	-	u	u	u	-	Ac. Mar.	-	Ac.-C 7/14-11/1	-	-
Stilt Sandpiper	Micropalama himantopus	-	-	-	-	x	u	u	-	Ac.	Ac.	Ac.-C 7/17-10/5	-	-
Semipalmated Sandpiper	Calidris pusillus	-	-	-	-	a	c	c	-	R-C 5/1-6/5	Ac.	R-C 7/10-10/15	-	-
Western Sandpiper	Calidris mauri	-	-	-	-	r	r	r	-	-	-	Ac.-R 7/15-9/20	-	-
Buff-breasted Sandpiper	Tryngites subruficollis	-	-	-	-	r	r	r	-	Ac.	-	Ac.-R 8/15-10/1	-	-
Marbled Godwit	Limosa fedoa	-	-	-	-	r	r	r	-	Ac. Apr.-May	-	Ac. Aug.-Oct.	-	-
Hudsonian Godwit	Limosa haemastica	-	-	-	-	x	r	r	-	Ac. May	-	Ac.-R Aug.-Oct.	-	-
Sanderling	Calidris alba	-	-	-	-	o	c	c	x	Ac.-U 5/10-6/4	Ac.	Ac. 7/20-10/10	-	-
American Avocet	Recurvirostra americana	-	-	-	-	r	-	r	-	Ac. May	Ac.	Ac. Aug.-Oct.	-	-
Red Phalarope	Phalaropus fulicarius	-	-	-	-	-	-	r	x	Ac.	-	Ac.-VR Sept.-Nov.	-	-
Wilson's Phalarope	Steganopus tricolor	-	-	-	-	o	o	o	-	Ac.-VR 4/28-6/2	Ac.	Ac.-R Aug.-Oct.	Ac.	-
Northern Phalarope	Lobipes lobatus	-	-	-	-	o	o	o	x	Ac.-VR May-June	Ac.	Ac.-R Aug.-Oct.	Ac.	-
Parasitic Jaeger	Stercorarius parasiticus	-	-	-	-	-	x	r	-	-	-	Ac.-VR Aug.-Dec.	-	-
Skua	Catharacta skua	-	-	-	-	-	-	x	-					
Glaucous Gull	Larus hyperboreus	-	-	-	-	r	x	r	r	Ac. 3/21-4/3	Ac.	-	Ac.-VR 12/21-3/20	-
Iceland Gull	Larus glaucoides	-	-	-	-	-	-	r	r					
Great Black-backed Gull	Larus marinus	-	-	-	-	c	u	c	c	Ac.-U Jan.-Mar.	Ac.-R	Ac.-U Dec.	U-C Dec.	-
Herring Gull	Larus argentatus	VC(M)	VR(G)	VC(M)	U(G)	a	c*	a	a	R-Ab 3/1-5/1	Ac.-C Apr.-July	R-Ab 9/15-12/15	R-C	-
Ring-billed Gull	Larus delawarensis	VC(M)	VR(G)	A(M)	-	a	c*	a	a	R-VC 3/5-5/15	Ac.-C May-Aug.	R-Ab 8/25-12/10	Ac.-C	-
Franklin's Gull	Larus pipixcan	-	-	-	-	x	r	r	x	Ac.	Ac.	Ac.-R 9/10-12/1	-	-
Bonaparte's Gull	Larus philadelphia	VR(M)	-	VC(M)	-	c	o	a	a	Ac.-C 3/15-5/20	Ac.-R	Ac.-Ab 9/1-12/15	Ac.-C	-
Forster's Tern	Sterna forsteri	-	-	-	-	r	o	u	-	Ac.-R Apr.-June	Ac.-VR	Ac.-U 8/10-11/5	-	-
Common Tern	Sterna hirundo	-	-	-	-	c	c*	c	x	VR-C 4/15-6/5	Ac.-C May-Aug.	VR-C 8/25-11/15	-	Rare
Least Tern	Sterna albifrons	-	-	-	-	-	x	x	-	Ac. May-June	-	Ac. Aug.-Sept.	-	-
Caspian Tern	Hydroprogne caspia	-	-	-	-	u	c	c	-	Ac.-C 4/15-6/1	Ac.-U	Ac.-C 8/1-10/15	-	-
Black Tern	Chlidonias niger	-	-	-	-	c	c*	c	-	R-C 5/1-6/15	Ac.-U May-Aug.	R-C 8/1-9/15	-	Pop. Declining

TABLE G-1. (Continued)

		Battelle's Surveys the site				Wildl. Ref. Complex BSFW (1970)[3]				Status in Ohio - Trautman and Trautman (1968)[4]				Rare or Endangered Species in Ohio[5]
Common Name[1]	Scientific Name[1]	Sp Mar. Ap. May	Su June July	Fa Nov.	Wi Dec. Jan.	Sp	Su	Fa	Wi	Spring Migration and	Summering Nesting	Fall Migration	Winter	Smith et al. (1973)
Rock Dove	Columba livia	VR(M)	P-J	-	R(G)					C Apr.-May	C Mar.-Sept.	C Sept.-Oct.	C	-
Mourning Dove	Zenaida macroura	C(M)	VC(G),C(R,W)*	U(M)	VR(G),R(H,W)	c	c*	c	c	C-Ab 3/10-5/1	C Mar.-Sept.	C-Ab 9/15-11/20	R-C	-
Yellow-billed Cuckoo	Coccyzus americanus	P-M	VR(G),U(W)	-	-	u	u*	u	-	U-C 5/8-6/18	U-C June-Sept.	U-C 8/15-10/1	-	-
Black-billed Cuckoo	Coccyzus erythropthalmus	P-M	VR(R)	-	-	o	o*	o	-	R-C 5/8-6/18	Ac.-C June-Sept.	R-C 8/15-10/1	-	-
Groove-billed Ani	Crotophaga ani	-	-	-	-	-	-	x	-	Accidental or Very Rare Occurrence				-
Barn Owl	Tyto alba	-	-	-	-	u	u*	u	u	R-U	R-U May-Oct.	R-U	R-U	Rare
Screech Owl	Otus asio	-	R(W)	-	-	c	c*	c	c	R-C	R-C Mar.-Sept.	R-C	R-C	Pop. Declining
Great Horned Owl	Bubo virginianus	-	R(G),VR(R)	-	VR(G)	c	c*	c	c	R-C	R-C Feb.-June	R-C	R-C	-
Snowy Owl	Nyctea scandiaca	-	-	-	-	o	-	o	o	Ac. Mar.-Apr.	-	Ac.-R Nov.-Dec.	Ac.-R	-
Barred Owl	Strix varia	-	-	-	-	r	r*	r	r	R-U	R-U Mar.-July	R-U	R-U	-
Long-eared Owl	Asio otus	-	-	-	-	o	o*	o	o	Ac.-U Mar.-Apr.	Ac.-R Mar.-June	Ac.-U Oct.-Dec.	Ac.-U	Peripheral
Short-eared Owl	Asio flammeus	VR(M)	-	-	VR(G)	o	-	o	o	Ac.-U	Ac.-VR Apr.-July	Ac.-C	Ac.-U	Peripheral
Saw-whet Owl	Aegolius acadicus	-	-	-	-	o	x*	o	r	Ac.-U Mar.-Apr.	Ac.	Ac.-U Nov.-Dec.	Ac.-R	-
Whip-poor-will	Caprimulgus carolinensis	-	-	-	-	u	-	r	-	Ac.-C 4/20-5/20	Ac.-C May-July	VR-C 8/20-10/15	-	Pop. Declining
Common Nighthawk	Chordeiles minor	P-M	-	-	-	c	a*	c	-	U-C 4/28-6/10	R-C May-July	U-Ab 8/10-10/1	-	-
Chimney Swift	Chaetura pelagica	P-M	U(R),R(G,W)	-	-	c	u*	a	-	C 4/10-5/25	U-C May-July	C 7/25-10/8	-	-
Ruby-throated Hummingbird	Archilochus colubris	P-M	R(G)	-	-	u	u*	u	-	U-C 5/3-5/25	R-U May-Aug.	U-C 8/10-9/25	-	-
Belted Kingfisher	Megaceryle alcyon	VR(M)	U(G),VR(R)	R(M)	VR(G)	c	c*	c	o	R-C 3/15-5/10	Ac.-U May-July	R-C 7/15-10/15	Ac.-R	-
Common Flicker	Colaptes auratus	V(M)	U(G,W)	R(M)	VR(G),R(W)	c	c*	c	u	U-VC 3/5-5/2	R-C Apr.-July	C-VC 9/1-11/1	VR-C	-
Red-bellied Woodpecker	Centurus carolinus	P-M	VR(G)	-	-	u	u*	u	u	Ac.-C	Ac.-C Apr.-July	Ac.-C	Ac.-C	-
Red-headed Woodpecker	Melanerpes erythrocephalus	R(M)	R(G),U(W)	U(M)	U(G),VC(W)	c	c*	c	u	VR-C 4/20-5/20	VR-C Apr.-Aug.	VR-C 9/1-10/10	VR-C	-
Yellow-bellied Sapsucker	Sphyrapicus varius	-	-	-	-	c	-	c	r	U-C 3/25-5/12	Ac.-VR May-July	U-C 9/15-10/24	Ac.-VR	Peripheral
Hairy Woodpecker	Dendrocopos villosus	-	R(G)	VR(M)	R(G)	u	u*	u	u	R-U	R-U Feb.-July	R-U	R-U	-
Downy Woodpecker	Dendrocopos pubescens	VR(M)	U(G)	R(M)	R(H),U(G,W)	c	c*	c	c	U-C	U-C Feb.-July	U-C	U-C	-
Eastern Kingbird	Tyrannus tyrannus	P-M	U(G)	-	-	c	c*	c	-	U-C 4/25-5/20	U-C May-July	U-C 8/15-9/15	-	-
Western Kingbird	Tyrannus verticalis	-	-	-	-	-	x	x	-	Accidental or Very Rare Occurrence				Peripheral
Great Crested Flycatcher	Myiarchus crinitus	P-M	U(G),C(W)	-	-	c	c*	c	-	U-C 4/30-5/20	U-C May-July	U-C 8/20-9/25	-	-
Eastern Phoebe	Sayornis phoebe	-	-	-	-	u	u*	u	-	U-C 3/15-5/5	R-U Mar.-July	U-C 9/1-10/15	Ac.-VR	-
Yellow-bellied Flycatcher	Empidonax flaviventris	-	P(J)	-	-	u	-	u	-	R-U 5/10-5/25	-	R-U 8/20-9/20	-	-
Acadian Flycatcher	Empidonax virescens	P-M	R(G),C(W)*	-	-	r	r*	r	-	U-C 5/6-5/30	R-U May-Aug.	U-C 8/25-9/25	-	-
Willow Flycatcher	Empidonax traillii	P-M	U(G),R(R)	-	-	c	c*	c	-	R-C 5/8-6/1	R-C May-Aug.	R-C 8/10-9/11	-	-
Least Flycatcher	Empidonax minimus	-		-	-	c	c*	c	-	R-C 4/30-5/27	Ac.-VR	R-U 8/25-9/28	-	-
Eastern Wood Pewee	Contopus virens	P-M	U(G),VR(R)*, VC(W)	-	-	c	c*	c	-	R-C 5/7-6/2	R-C May-Aug.	R-C 8/20-9/28	-	-
Olive-sided Flycatcher	Nuttallornis borealis	-	-	-	-	u	u	u	-	VR-R 5/14-6/9	Ac. June	VR-R 8/1-9/24	-	-
Horned Lark	Eremophila alpestris	U(M)	-	-	C(G)	c	u*	c	c	U-C 2/10-3/25	R-C Feb.-July	U-VC 10/1-12/10	R-VC	-
Tree Swallow	Iridoprocne bicolor	U(M)	U(G),VR(R)	-	-	c	a*	a	x	U-VC 4/1-5/20	Ac.-C Mar.-July	U-Ab 7/25-10/15	-	-
Bank Swallow	Riparia riparia	-	-	-	-	c	a*	c	-	U-VC 4/10-5/25	Ac.-VC May-July	VR-Ab 7/15-9/10	-	-
Rough-winged Swallow	Stelgidopteryx ruficollis	-	P-J	-	-	c	c*	c	-	U-C 4/12-5/20	R-C May-July	U-C 7/1-9/1	-	Pop. Declining
Barn Swallow	Hirundo rustica	P-M	U(G),C(R)	-	-	c	c*	c	-	C-Ab 4/2-5/20	R-Ab Apr.-Aug.	C-Ab 7/15-10/15	-	-
Cliff Swallow	Petrochelidon fulva	-	-	-	-	u	r*	u	-	Ac.-C 5/2-5/28	Ac.-VR May-July	Ac.-C 8/5-9/12	-	-
Purple Martin	Progne subis	R(M)	U(G),U(R)	-	-	c	c*	c	-	C-VC 3/15-5/20	R-VC Apr.-Aug.	C-Ab 8/10-9/20	-	Pop. Declining
Blue Jay	Cyanocitta cristata	U(M)	C(G),VR(R), U(W)	VU(M) -	U(H),C(G,W) -	a	c*	c	c	U-Ab 3/1-5/25	R-C Mar.-July	U-VC 8/15-11/1	-	-
Black-billed Magpie	Pica pica	-			-	x	-	-	x	Accidental or Very Rare Occurrence				-
Common Crow	Corvus brachyrhynchos	C(M)	VR(G),U(R), R(W)	VR(M)	C(G)	c	u*	c	u	U-Ab 1/20-5/1	U-C Mar.-July	U-Ab 9/15-11/1	VR-Ab	Pop. Declining
Black-capped Chickadee	Parus atricapillus	-		-	P(D)	u	-	u	u	Ac.-C 3/10-5/25	Ac.-C Mar.-July	Ac.-C 10/10-12/1	Ac.-C	-
Tufted Titmouse	Parus bicolor	U(M)	U(C),VR(R), C(W)	VR(M)	R(C,H),U(W)	u	u*	u	u	C	R-C Mar.-July	C	C	-
White-breasted Nuthatch	Sitta carolinensis	VR(M)	-	VR(M)	R(G,W)	o	o*	o	o	U-C	U-C Mar.-July	U-C	U-C	-
Red-breasted Nuthatch	Sitta canadensis	P-M	-	-		u	-	u	u	Ac.-C 4/15-5/30	Ac.-R May-July	Ac.-C 8/28-11/1	Ac.-C	Peripheral
Brown Creeper	Certhia familiaris	-		-	R(W)	u	-	u	u	R-C 4/1-5/4	Ac.-R May-July	R-C 10/1-11/1	R-C	Peripheral
House Wren	Troglodytes aedon	P-M	C(G),R(R), U(W)	-	-	c	c*	c	x	U-C 4/5-5/25	Ac.-C Apr.-July	U-C 9/1-10/10	-	-
Winter Wren	Troglodytes troglodytes	-	-	-	-	u	-	u	u	R-C 3/15-5/10	Ac.-VR May-July	R-C 9/24-11/10	Ac.-U	Peripheral
Bewick's Wren	Thryomanes bewickii	-	-	-	-	x	x	x	x	Ac.-U 3/25-4/25	Ac.-U Apr.-July	Ac.-R Aug.-Sept.	Ac.-VR	-
Carolina Wren	Thryothorus ludovicianus	P-M	-	-	-	r	r*	r	r	VR-C	VR-C Mar.-July	VR-C	VR-C	-
Long-billed Marsh Wren	Telmatodytes palustris	P-M	R(G)	-	-	c	c*	c	r	R-C 4/10-6/1	Ac.-C May-Sept.	R-C 9/10-10/15	Ac.-R	Pop. Declining
Short-billed Marsh Wren	Cistothorus platensis	-	-	-	-	r	r*	r	x	Ac.-R 5/5-6/5	Ac.-U May-Sept.	Ac.-U 9/12-10/15	Ac.	Rare
Mockingbird	Mimus polyglottos	-	-	-	-	r	r*	r	r	Ac.-C	Ac.-C Apr.-Aug.	Ac.-C	Ac.-C	-
Gray Catbird	Dumetella carolinensis	P-M	C(G,R,W)*	-	-	c	c*	c	r	U-VC 4/20-5/30	U-C May-July	U-C 8/20-10/15	Ac.-R	-
Brown Thrasher	Toxostoma rufum	P-M	U(G),VR(R), R(W)	- -	- -	c	c*	c	r	U-C 3/25-5/30	U-C Apr.-July	U-C 9/1-10/12	Ac.	-
American Robin	Turdus migratorius	VC(M)	VC(R),C(W)	-	VR(G)	c	a*	c	u	C-Ab 1/20-6/24	C-Ab Mar.-Aug.	C-Ab 9/1-11/5	Ac-Ab	-
Wood Thrush	Hylocichla mustelina	P-M	R(G,R),U(W)	-	-	u	u*	o	-	U-C 4/6-5/20	U-C Apr.-Aug.	U-C 8/25-10/5	-	-
Hermit Thrush	Catharus guttata	P-M	-	-	-	c	-	c	r	U-C 3/25-5/20	Ac.-VR May-July	U-C 9/28-11/10	Ac.-R	Peripheral
Swainson's Thrush	Catharus ustulata	P-M	-	-	-	c	-	c	-	C-Ab 4/24-5/25	-	U-VC 8/31-10/15	-	Peripheral

TABLE G-1. (Continued)

		Battelle's Surveys the site[2]				Wildl. Ref. Complex BSFW (1970)[3]				Status in Ohio - Trautman and Trautman (1968)[4]				Rare or Endangered Species in Ohio[5]
Common Name[1]	Scientific Name[1]	Sp Mar. Ap. May	Su June July	Fa Nov.	Wi Dec. Jan.	Sp	Su	Fa	Wi	Spring Migration and	Summering Nesting	Fall Migration	Winter	Smith et al. (1973)
Gray-cheeked Thrush	Catharus minima	P-M	-	-	-	u	-	u	-	R-C 5/1-6/1	-	R-C 9/10-10/15	Ac.	-
Veery	Catharus fuscescens	P-M	-	-	-	u	u*	o	-	R-C 4/25-5/30	Ac.-R May-July	R-C 8/31-9/30	-	Peripheral
Eastern Bluebird	Sialia sialis	-	-	-	-	u	u*	u	r	R-C 2/20-5/10	R-C Mar.-Aug.	R-C 9/5-11/15	R-C	-
Blue-gray Gnatcatcher	Polioptila caerulea	P-M	R(G),U(W)*	-	-	c	u*	c	-	R-VC 4/10-5/20	R-C Apr.-July	R-C 8/25-9/10	-	-
Golden-crowned Kinglet	Regulus satrapa	-	-	VR(M)	-	c	-	c	u	R-C 3/15-5/3	-	R-C 9/25-10/10	R-U	-
Ruby-crowned Kinglet	Regulus calendula	P-M	-	-	-	c	-	c	r	R-C 4/1-5/20	-	R-C 9/10-11/1	Ac.-VR	-
Water Pipit	Anthus spinoletta	P-M	-	-	-	u	-	u	r	Ac.-C 3/20-5/20	Ac.	Ac-U 9/10-11/5	Ac.-VR	-
Bohemian Waxwing	Bombycilla garrulus	-	-	-	-	-	-	-	x					-
Cedar Waxwing	Bombycilla cedrorum	P-M	R(G)	-	-	c	u*	c	u	R-Ab 4/20-6/5	Ac.-U May-Sept.	R-Ab 8/20-10/30	VR-C	-
Northern Shrike	Lanius excubitor	-	-	-	-	r	-	r	r	Ac.-R 4/6	-	Ac.-R 10/24	Ac.-R	-
Loggerhead Shrike	Lanius ludovicianus	-	-	-	-	o	o*	o	r	Ac.-R 3/16-8/30	Ac.-VR Mar.-June	Ac.-VR 8/10-9/15	Ac.-VR	Rare
Starling	Sturnus vulgaris	VC(M)	A(G,R)	VR(M)	A(G),U(W)	a	a*	a	a	C-Ab Feb.-Apr.	C-Ab Apr.-July	C-Ab Aug.-Nov.	U-Ab	-
White-eyed Vireo	Vireo griseus	P-M	-	-	-	o	-	o	-	Ac.-C 4/20-5/15	Ac.-C May-July	Ac.-U 8/20-10/1	-	-
Yellow-throated Vireo	Vireo flavifrons	P-M	VR(G),U(W)*	-	-	u	u*	u	-	Ac.-C 4/20-5/10	Ac.-C Apr.-Aug.	Ac.-C 8/20-9/20	-	-
Solitary Vireo	Vireo solitarius	-	-	-	-	u	-	u	-	U-C 4/20-5/20	Ac.-VR June-July	U-C 8/20-10/1	-	Peripheral
Red-eyed Vireo	Vireo olivaceus	P-M	R(R),C(G,W)*	-	-	c	c*	c	-	C-Ab 4/30-6/1	C-VC May-Aug.	C-Ab 9/1-10/5	-	-
Philadephia Vireo	Vireo philadelphicus	P-M	-	-	-	u	-	u	-	VR-U 5/1-6/2	-	VR-U 9/6-10/5	-	-
Warbling Vireo	Vireo gilvus	-	VR(G)	-	-	c	c*	c	-	R-C 4/20-5/12	R-C May-Aug.	R-C 9/1-10/1	-	Pop. Declining
Black-and-White Warbler	Mniotilta varia	P-M	-	-	-	c	-	c	-	R-C 4/20-5/20	Ac.-U May-July	R-C 8/1-9/30	-	-
Prothonotary Warbler	Protonotaria citrea	-	-	-	-	u	u*	u	-	Ac.-U Apr.-May	Ac.-U May-July	Ac.-U Aug.-Sept.	-	Rare
Worm-eating Warbler	Helmitheros vermivorus	-	-	-	-	r	-	x	-	Ac.-C May	Ac.-U May-July	Ac.-U Aug.-Sept.	-	-
Golden-winged Warbler	Vermivora chrysoptera	-	-	-	-	u	-	u	-	Ac.-R May	Ac.-VR May-July	Ac.-VR Aug.-Sept.	-	Peripheral
Blue-winged Warbler	Vermivora pinus	-	-	-	-	u	r*	u	-	Ac.-U 4/2-5/30	Ac.-U May-July	Ac.-U July-Sept.	-	-
Tennessee Warbler	Vermivora peregrina	-	-	-	-	c	-	c	-	U-VC 4/28-5/30	-	U-C 8/24-10/12	-	-
Orange-crowned Warbler	Vermivora celata	-	-	-	-	o	-	o	x	Ac.-R 4/25-5/20	-	Ac.-R 9/1-10/20	-	-
Nashville Warbler	Vermivora ruficapilla	P-M	-	-	-	c	-	c	-	U-C 4/26-5/30	Ac. June-July	U-C 8/23-10/15	-	Peripheral
Northern Parula	Parula americana	-	-	-	-	o	-	o	-	Ac.-U 4/20-5/24	Ac.-R May-July	Ac.-U 8/20-10/1	-	Rare
Yellow Warbler	Dendroica petechia	P-M	C(G),U(RW)	-	-	c	c*	c	-	U-VC 4/20-5/20	U-VC Apr.-July	U-C 8/1-9/17	-	-
Magnolia Warbler	Dendroica magnolia	P-M	-	-	-	c	x	c	-	U-VC 5/1-6/1	Ac.-VR June-July	U-C 8/20-10/17	-	Peripheral
Cape May Warbler	Dendroica tigrina	-	-	-	-	c	-	c	-	U-Ab 5/1-5/31	-	U-C 8/28-10/1	-	-
Black-throated Blue Warbler	Dendroica caerulescens	-	-	-	-	c	-	c	-	R-U 5/1-5/25	Ac.-VC May-July	R-U 9/1-10/6	-	Peripheral
Yellow-rumped Warbler	Dendroica coronata	P-M	-	-	-	a	-	a	o	C-Ab 4/15-5/25	-	C-Ab 9/15-11/10	Ac.-C	-
Black-throated Green Warbler	Dendroica virens	-	-	-	-	c	-	c	-	U-VC 4/22-5/30	Ac.-VC May-July	U-VC 8/30-9/15	-	Peripheral
Cerulean Warbler	Dendroica cerulea	-	R(W)	-	-	u	x*	o	-	U-C 4/30-5/25	Ac.-C May-July	U-C 8/22-9/10	-	-
Blackburnian Warbler	Dendroica fusca	P-M	-	-	-	c	-	c	-	U-C 4/26-5/30	Ac.-VR June-July	U-C 8/28-10/18	-	Peripheral
Yellow-throated Warbler	Dendroica dominica	-	-	-	-	x	-	-	-	Ac.-U 4/10-5/22	Ac.-U Apr.-July	Ac.-R Aug.-Sept.	-	-
Chestnut-sided Warbler	Dendroica pensylvanica	P-M	-	-	-	c	o*	c	-	R-C 5/1-5/28	Ac.-VR May-July	R-C 8/27-10/5	-	Peripheral
Bay-breasted Warbler	Dendroica castanea	P-M	-	-	-	c	-	c	-	U-VC 5/5-5/25	-	U-VC 8/30-10/5	-	-
Blackpoll Warbler	Dendroica striata	-	-	-	-	c	-	c	-	U-C 5/5-6/2	-	U-VC 9/1-10/25	-	-
Pine Warbler	Dendroica pinus	-	-	-	-	o	-	o	x	Ac.-U 4/19-5/25	Ac.-VR May-July	Ac.-U 9/10-10/10	-	Rare
Prairie Warbler	Dendroica discolor	-	-	-	-	o	-	o	-	Ac.-C 4/25-5/23	Ac.-C May-July	Ac.-U Aug.-Sept.	-	-
Palm Warbler	Dendroica palmarum	-	-	-	-	c	-	c	-	R-VC 4/20-5/25	AC	R-Ab 9/5-10/25	Ac.	-
Ovenbird	Seiurus aurocapillus	-	-	-	-	c	c	c	-	U-C 4/24-5/26	VR-C May-July	U-C 9/9-10/20	Ac.	-
Northern Waterthrush	Seiurus noveboracensis	-	-	-	-	c	-	c	-	R-C 4/20-5/20	Ac.-R May-July	R-U 8/10-10/4	-	Peripheral
Louisiana Waterthrush	Seiurus motacilla	-	-	-	-	r	x	x	-	Ac.-C 3/24-5/5	Ac.-C Apr.-July	Ac.-U July-Aug.	-	-
Kentucky Warbler	Oporornis formosus	-	-	-	-	r	r*	r	-	Ac.-C 4/25-5/8	Ac.-C May-July	Ac.-R 8/20-9/20	-	-
Connecticut Warbler	Oporornis agilis	-	-	-	-	r	-	r	-	Ac.-U 5/8-6/5	-	Ac.-U 8/30-10/2	-	-
Mourning Warbler	Oporornis philadelphia	-		-	-	u	-	u	-	VR-U 5/5-6/3	Ac.-R June-July	VR-U 8/25-10/2	-	Peripheral
Common Yellowthroat	Geothlypis trichas	P-M	C(G),VR(R), U(W)	-	-	c	c*	c	r	U-Ab 4/25-6/1	U-C May-Aug.	U-Ab 8/10-10/10	Ac.	-
Yellow-breasted Chat	Icteria virens	P-M		-	-	u	u*	u	-	Ac.-C 4/25-5/20	Ac.-C May-Aug.	Ac.-U Aug.-Sept.	Ac.	-
Hooded Warbler	Wilsonia citrina	-	-	-	-	r	r*	r	-	Ac.-U 4/25-5/25	Ac.-U May-July	Ac.-U Aug.-Sept.	-	-
Wilson's Warbler	Wilsonia pusilla	P-M	-	-	-	c	-	c	-	R-C 4/30-6/1	-	R-C 8/25-9/28	-	-
Canada Warbler	Wilsonia canadensis	P-M	-	-	-	c	-	c	-	R-U 5/7-6/2	Ac. June-July	R-U 8/18-9/25	-	Peripheral
American Redstart	Setophaga ruticilla	P-M	VR(G)	-	-	c	r*	c	-	R-C 5/1-5/25	Ac.-C May-July	R-C 8/4-10/5	-	-
House Sparrow	Passer domesticus	U(M)	C(G),A(R)	R(M)	VC(G)	a	a*	a	a	C-Ab Mar.-Apr.	C-Ab Mar.-Aug.	C-Ab Sept.-Oct.	C-Ab	-
Bobolink	Dolichonyx oryzivorus	P-M	-	-	-	u	u*	u	-	VR-Ab 4/22-5/25	Ac.-U May-Aug.	VR-Ab 8/1-10/10	-	Pop. Declining
Eastern Meadowlark	Sturnella magna	U(M)	U(G)	-	P-D	c	c*	c	u	U-Ab 2/15-3/15	U-Ab Apr.-Aug.	U-Ab 8/1-11/1	Ac.-U	-
Western Meadowlark	Sturnella neglecta	-	-	-	-	u	u*	u	-	Ac.-U Mar. May	Ac.-U Mar.-July	Ac.-R Aug.-?	-	Peripheral
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	-	-	-	-	r	x	x	-	Accidental or Very Rare Occurrence				-
Red-winged Blackbird	Agelaius tricolor	A(M)	A(G,R),R(W)	A(M)	VR(G),R(H)	a	a*	a	a	C-Ab 2/5-/415	C-Ab Apr.-July	C-Ab 9/1-11/15	Ac.-C	-
Orchard Oriole	Icterus spurius	P-M	VR(R)	-	-	r	r*	r	-	Ac.-C 4/29-5/20	Ac.-C May-July	Ac.-C 8/1-9/5	-	Rare
Northern Oriole	Icterus galbula	P-M	U(G),R(R,W)*	-	-	c	u*	u	x	R-C 4/28-5/25	R-C Apr.-July	R-C 8/10-9/5	AC	Pop. Declining
Rusty Blackbird	Euphagus carolinus	U(M)	-	C(M)	VR(G)	c	-	c	u	R-C 2/22-5/12	-	R-C 9/29-11/21	Ac.-C	-
Brewer's Blackbird	Euphagus cyanocephalus	-	-	-	-	o	-	o	r	Accidental or Very Rare Occurrence				-

TABLE G-1. (Continued)

Common Name	Scientific Name	Battelle's Surveys a the site				Wildl. Ref. Complex BSFW (1970)[3]				Status in Ohio - Trautman and Trautman (1968)[3]				Rare or Endangered Species in Ohio[5]
		Sp Mar. Ap. May	Su June July	Fa Nov.	Wi Dec. Jan.	Sp	Su	Fa	Wi	Spring Migration and	Summering Nesting	Fall Migration	Winter	Smith et al. (1973)
Common Grackle	Quiscalus quiscula	C(M)	VC(G),A(R), R(W)			a	a*	a	u	U-Ab 2/15-4/20	U-Ab Apr.-July	U-Ab9/1-11/21	Ac.-C	-
Brown-headed Cowbird	Molothrus ater	P-M	U(R)*,C(W)			c	c*	c	u	U-VC 2/28-4/30	U-VC Apr.-Aug.	U-VC 9/1-11/15	Ac.-C	-
Scarlet Tanager	Piranga olivacea	P-M	P-J			c	u*	c	-	Ac.-C 4/25-5/25	Ac.-U May-July	Ac.-U 8/15-9/25	-	-
Summer Tanager	Piranga rubra					r	x	x	-	Ac.-C 4/28-5/15	Ac.-C May-July	Ac.-U 9/1-9/22	-	-
Cardinal	Cardinalis cardinalis	U(M)	R(R),C(G,W)	U(M)	R(H),U(G,W)	c	c*	c	c	R-VC Mar.-Apr.	R-VC Apr.-Aug.	R-VC Sept.-Oct.	R-VC	-
Rose-breasted Grosbeak	Pheucticus ludovicianus	P-M				c	c*	c	-	U-C 4/25-5/30	Ac.-U May-July	U-C 8/29-10/10	-	-
Blue Grosbeak	Guiraca caerulea	P-M								Accidental or Very Rare Occurrence				-
Indigo Bunting	Passerina cyanea	P-M	VC(G,R,W)			c	c*	c	-	U-VC 4/27-6/2	U-VC May-Sept.	U-C 8/26-10/4	-	-
Dickcissel	Spiza americana		R(G)			u	u*	u	-	Ac.-C 4/24-5/25	Ac.-U May-Aug.	Ac.-U 8/15-9/20	Ac.	-
Evening Grosbeak	Hesperiphona vespertina					o	-	o	o	Ac.-U Apr.-May	-	Ac.-U Oct.-Nov.	Ac.-U	-
Purple Finch	Carpodacus purpureus					u	x	u	u	Ac.-C Apr.-May	Ac.-R May-July	Ac.-C Sept.-Nov.	Ac.-U	Peripheral
Hoary Redpoll	Acanthis hornemanni					x	-	x	-	Accidental or Very Rare Occurrence				-
Common Redpoll	Acanthis flammea					o	-	o	o	Ac.-U Mar.-Apr.	-	Ac.-U Nov.-Dec.	Ac.-U	-
Pine Siskin	Spinus pinus					u	-	u	o	Ac.-C Apr.-May	Ac.?	Ac.-C Oct.-Nov.	Ac.-C	Peripheral
American Goldfinch	Spinus tristis	P-M	VC(G),C(R), R(W)	R(M)	R(G)	c	c*	c	c	U-Ab 4/12-5/22	R-U June-Sept.	U-Ab 9/15-11/1	Ac.-U	-
Rufous-sided Towhee	Pipilo erythrophthalmus	P-M	R(G),VR(R)*, C(W)			c	c*	c	u	U-VC 3/8-5/15	U-VC Apr.-July	U-VC 9/15-10/3	Ac.-C	-
Savannah Sparrow	Passerculus sandwichensis	P-M				c	c*	c	x	U-VC 3/20-5/10	Ac.-C May-July	U-VC 9/1-10/25	Ac.	-
Grasshopper Sparrow	Ammodramus savannarum					o	o*	o	-	R-C 4/15-5/22	Ac.-C May-Aug.	R-C 8/15 10/10	Ac.	Pop. Declining
Le Conte's Sparrow	Ammospiza lecontei					x	-	r	-	Accidental or Very Rare Occurrence				-
Henslow's Sparrow	Ammodramus henslowii					x	x	-	-	Ac.-C 4/15-5/22	Ac.-U May-Sept.	Ac.-U 8/14-10/1	-	Pop. Declining
Sharp-tailed Sparrow	Ammospiza caudacuta					r	-	r	-	Ac.-R May-June	-	Ac.-R Sept.-Oct.	-	-
Vesper Sparrow	Pooecetes gramineus	P-M	VR(G,R)	VR(M)		u	u*	u	x	U-Ab 3/8-5/4	U-Ab Apr.-Aug.	U-Ab 9/20-11/10	Ac.-VR	-
Dark-eyed Junco	Junco hyemalis	R(M)		C(M)	U(G,W)	c	-	c	u	U-Ab 3/5-5/5	Ac. May-July	U-Ab 9/20-11/15	VR-C*	Peripheral
Tree Sparrow	Spizella arborea	C(M)			VC(G),U(H,W)	c	-	c	c	U-Ab 2/22-5/5	-	U-Ab 10/12-12/12	U-VC	-
Chipping Sparrow	Spizella passerina	P-M	VR(G,R)			u	u*	u	-	U-VC 3/20-5/15	U-VC Apr.-July	U-VC 9/10-10/30	Ac.	-
Field Sparrow	Spizella pusilla	P-M	U(R),C(G,W)		R(G)	u	u*	u	r	U-VC 3/15-5/5	U-VC Apr.-Aug.	U-VC 9/20-10/30	Ac.-U	-
Harris' Sparrow	Zonotrichia querula					x	-	x	-	Ac.-VR Mar.-May	-	Ac.-VR Oct.	Ac.	-
White-crowned Sparrow	Zonotrichia leucophrys	P-M				c	x	c	u	R-C [illegible]-5/25	Ac.	R-C 9/26-11/1	Ac.-R	-
White-throated Sparrow	Zonotrichia albicollis	P-M			R(W)	c	x	c	u	U-Ab 3/20-5/27	Ac.-VR May-July	U-Ab 9/15-11/5	Ac.-R	Peripheral
Fox Sparrow	Passerella iliaca				P-D	c	-	c	r	R-C 3/5-4/23	-	R-C 9/28-11/18	Ac.-VR	-
Swamp Sparrow	Melospiza georgiana	P-M			P-D	u	r*	c	o	R-C 4/1-5/10	Ac.-U May-July	R-C 9/15-11/5	Ac.-R	Pop. Declining
Song Sparrow	Melospiza melodia	VC(M)	A(R),C(G,W)	U(M)	U(H),C(G), R(W)	c	c*	c	u	C-Ab Feb.-Apr.	C Mar.-Aug.	C-Ab Sept.-Nov.	R-Ab	-
Lapland Longspur	Calcarius lapponicus					u	-	u	u	Ac.-VC 2/10-5/10	-	Ac.-VC 10/25-12/1	Ac.-C	-
Snow Bunting	Plectrophenax nivalis					c	-	c	c	Ac.-C 2/1-3/20	-	Ac.-C 10/25-12/1	Ac.-C	-

[1] After American Ornithologists' Union Check-List (1957) as amended in the April 1973 issue of The Auk.

[2] Abundance for Battelle Surveys: A = Abundant, VC = Very Common, C = Common, U = Unusual, R = Rare, VR = Very Rare, * = Nesting, G = General Reconnaissance Survey Jan 15-Feb 1, 1974/June 18-28, 1974, H = Hedgerow Survey Jan 16-Feb 1, 1974, M = Marsh Survey Nov 6-29, 1973/Mar 17-Apr 5, 1974, R = Roadside Survey June 19-24, 1974, W = Woodlot Survey Jan 16-Feb 1, 1974/June 18-28, 1974, P-D = Present in December 18-20, 1973, P-J = Present in July 16-18, 1973, P-M = Present in May 14-31, 1973 or May 20-24, 1974.

[3] Abundance for Ottawa National Wildlife Refuge Complex: a = Abundant - a common species which is very numerous, c = Common - certain to be seen in suitable habitat, u = Uncommon - present, but not certain to be seen, o = Occasional - seen only a few times during a season, r = Rare - seen at intervals of 2 to 5 years, x = Accidental - has been seen only once or twice, * = Nesting.

[4] Abundance for Ohio: Ab = Abundant, VC = Very Common, C = Common, FC = Fairly Common, U = Uncommon, VU = Very Uncommon, R = Rare, VR = Very Rare, Ac = Accidental. Dates given are average dates of arrival and departure in Ohio. Underlined refers to nesting in Ohio.

[5] For Smith et al: extirpated - no recent breeding records; endangered - prospects of survival and reproduction are in immediate jeopardy; rare - exists in small numbers and may become endangered; peripheral - at the edge of its natural range in Ohio; status undetermined - possibly endangered and insufficient information to determine status; pop. declining - population declining.

TABLE G-2. IMPORTANT PLANT FOODS RANKED ACCORDING TO THEIR VALUE TO FOUR GROUPS OF BIRDS WHICH ARE FOUND AT THE SITE[1]

Plant Group	Bird Group			
	Waterbirds	Marsh-Shorebirds	Upland Gamebirds	Songbirds
Woody Plants	Oak (Quercus) Dogwood (Cornus) Elm (Ulmus) Beech (Fagus) Grape (Vitis) Ash (Fraxinus) Greenbriar (Smilax)	Oak (Quercus)	Grape (Vitis) Blackberry (Rubus) Oak (Quercus) Dogwood (Cornus) Wild Cherry (Prunus) Greenbrier (Smilax) Sumac (Rhus) Hazelnut (Corylus) Maple (Acer) Poison Ivy (Rhus) Beech (Fagus) Willow (Salix) Hawthorn (Crataegus) Ash (Fraxinus) Elderberry (Sambucus) Elm (Ulmus) Serviceberry (Amelanchier) Hickory (Carya)	Blackberry (Rubus) Wild Cherry (Prunus) Dogwood (Cornus) Oak (Quercus) Grape (Vitis) Maple (Acer) Mulberry (Morus) Poison Ivy (Rhus) Sumac (Rhus) Virginia Creeper (Parthenocissus) Elderberry (Sambucus) Beech (Fagus grandifolia) Elm (Ulmus) Tuliptree (Liriodendron) Serviceberry (Amelanchier) Greenbrier (Smilax) Ash (Fraxinus) Hickory (Carya) Hawthorn (Crataegus) Hazelnut (Corylus)
Upland Weeds and Herbs	Sedge (Carex)	Sedge (Carex) Ragweed (Ambrosia) Clover (Trifolium) Panicgrass (Panicum)	Ragweed (Ambrosia) Clover (Trifolium) Dandelion (Taraxacum) Crabgrass (Digitaria) Sedge (Carex) Pokeweed (Phytolacca) Sheepsorrel (Rumex) Panicgrass (Panicum) Pigweed (Amaranthus) Plantain (Plantago)	Ragweed (Ambrosia) Crabgrass (Digitaria) Panicgrass (Panicum) Pigweed (Amaranthus) Sedge (Carex) Sheepsorrel (Rumex) Pokeweed (Phytolacca) Dandelion (Taraxacum) Clover (Trifolium) Plantain (Plantago)
Marsh and Aquatic Plants	Pondweed (Potamogeton) Wildrice (Zizania) Bulrush (Scirpus) Wildcelery (Vallisneria) Naiad (Najas) Smartweed (Polygonum) Duckweed (Lemnaceae) Algae Burreed (Sparganium) Cutgrass (Leersia) Spikerush (Eleocharis) Wildmillet (Echinochloa) Arrow-arum (Peltandra virginica) Arrowhead (Sagittaria)	Bulrush (Scirpus) Wildrice (Zizania) Pondweed (Potamogeton) Smartweed (Polygonum) Spikerush (Eleocharis) Arrowhead (Sagittaria) Wildmillet (Echinochloa) Cutgrass (Leersia) Burreed (Sparganium) Duckweed (Lemnaceae) Algae Arrow-arum (Peltandra) Wildcelery (Vallisneria)	Smartweed (Polygonum) Wildrice (Zizania) Cutgrass (Leersia) Wildmillet (Echinochloa)	Smartweed (Polygonum) Wildrice (Zizania) Wildmillet (Echinochloa) Bulrush (Scirpus)
Cultivated Plants	Corn (Zea) Wheat (Triticum) Oats (Avena)	Wheat (Triticum)	Corn (Zea) Wheat (Triticum) Oats (Avena) Apple (Malus)	Corn (Zea) Oats (Avena) Wheat (Triticum) Timothy (Phleum) Apple (Malus)

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[1] Revised from Martin et al. (1951). Only plants existing in the Sandusky Bay area are ranked, beginning with the plant most important to all birds in a given group. Bird category includes the following groups: (1) Waterbirds - loons, grebes, pelicans, cormorants, swan, geese, ducks (including mergansers), coot, gulls, and terns; (2) Marsh-Shorebirds - herons, egrets, bitterns, ibises, cranes, rails, gallinules, plovers, turnstones, sandpiper family, avocet, phalaropes; (3) Upland Gamebirds - quail, pheasant; (4) Songbirds - [illegible]

TABLE G-3. FOOD PREFERENCES[a,b] OF MIGRATORY WATERFOWL WHICH MAY UTILIZE SANDUSKY BAY OR ITS ADJACENT MARSHES

Common Name	Animal Food	Plant Food			
Mute Swan	(SA) larvae of aquatic beetles and dragonflies	Grasses	Wildcelery	Pondweed	Smartweed
Whistling Swan	(SA) larvae of aquatic beetles and dragonflies	Grasses	Wildcelery	Pondweed	Smartweed
Canada Goose	(SA to none)	Spikerush	Naiad	Bulrush	
Brant	(SA) gastropods, bivalves, annelid worms, crustaceans	Alga			
		Rootstocks of:			
Snow Goose	(none)	Bulrush	Cattail	Panicgrass	Wildrice
Mallard	(SA) aquatic beetles, dragonfly and damselfly nymphs, fly larvae, aquatic bugs	Wildrice	Pondweed	Smartweed	Wildmillet
Black Duck	(Some) mollusks, crustaceans, insects, few fish	Pondweed	Wildrice	Bulrush	Smartweed
Gadwall	(SA) 3/4 mollusks, 1/4 insects	Bulrush	Sedge	Pondweed	(98%FW)[2]
Pintail	(SA) mollusks,crustaceans, insects, small fish, frogs	Bulrush	Smartweed	Pondweed	Wildrice
Green-Winged Teal	(SA) insects, mollusks, small crustaceans	Bulrush	Wildrice	Wildmillet	Sedge
Blue-Winged Teal	(1/4) mollusks, insect larvae, a few crustaceans	Duckweed	Naiad	Pondweed	Bulrush
European Wigeon	Probably similar to American Wigeon	Grain	Watercelery[2]		
American Wigeon	(SA) mollusks, aquatic insects	(Pondweed	Naiad	Bulrush)[1]	(Grain)[2]
Northern Shoveler	(1/4) mollusks, aquatic insects, crustaceans	Bulrush	Pondweed	Alga	Spikerush
Wood Duck	(SA) beetles, trubugs, ants, other Hymenoptera, spiders, crustaceans, mollusks	Wildrice	Pondweed	Burreed	Smartweed
Redhead	(10%)[2] grasshoppers, midge and caddisfly larvae, mollusks, snails	Pondweed	Wildrice	Wildcelery	Bulrush
Ring-necked Duck	(1/4) insects, mollusks, fish, spiders, worms	Pondweed	Smartweed	Wildrice	Naiad
Canvasback	(20%)[2] bivalves, gastropods, dragonflies, damselflies, water bugs, some small fish	Wildcelery	Pondweed	Wildrice	Bulrush

TABLE G-3. (Continued)

Common Name	Animal Food	Plant Food			
Greater Scaup	(1/2) mollusks, insect larvae, amphipods, mud crabs, barnacles	Pondweed	Wildcelery	Naiad	Burreed
Lesser Scaup	(2/3) mollusks, dragonfly and damselfly nymphs, insects	Wildcelery	Pondweed	Wildrice	Naiad
Common Goldeneye	(3/4) crustaceans, insects, mollusks, fish	Pondweed	Wildcelery	Smartweed	Sedge
Bufflehead	(80%)[2] insects, crustaceans, mollusks, fish	Naiad	Pondweed	Wildcelery	Wildrice
Oldsquaw	(90%)[2] crustaceans, mollusks, insects, fish	(SA)			
White-Winged Scoter	94% total diet mollusks,[2] crustaceans, insects, fishes	(SA) Pondweed			
Surf Scoter	(90%)[2] mollusks, crustaceans, insects, fish, echinoderms	(SA) Pondweed Alga			
Black Scoter	(90%)[2] mollusks, crustaceans, insects, fish, echinoderms	(SA) Marine plants			
Ruddy Duck	(1/3 usually) insects, mollusks, crustaceans	Pondweed	Wildcelery	Bulrush	Naiad
Hooded Merganser	(Primarily fish) crawfish, shrimp, frogs, insects, mollusks	(Neg)			
Common Merganser	(Primarily fish) crawfish, shrimp, frogs, insects, mollusks	(Neg)			
Red-Breasted Merganser	(Primarily fish) crawfish, shrimp, frogs, insects, mollusks	(Neg)			

a Food preferences after Martin et al. (1959) unless indicated otherwise.

b Food preferences after Sprunt et al. (1961).

c Migratory waterfowl species (not including accidentals after BSFW (1970).

d Entries in parentheses indicate percentage of animal food eaten out of total amount of food eaten. Animal foods listed in order of quantity eaten. (SA) = Small Amounts.

e Plant foods listed in order of quantity eaten. (98%FW) indicates 98% of food eaten in fall and winter is plant food. (SA) = Small Amounts (Neg) = negligible amount

APPENDIX H

LIST OF AQUATIC ORGANISMS REPORTED FROM SANDUSKY BAY

(Literature and Present Study)

TABLE H-1.

PAGE 1

HEADING	GENUS AND SPECIES		HABITAT	ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
GREEN	ALGAE	CHLOROPHYTA	PLK	COL	0	0	0	0	0	0	0	0	0	+
VOLVOX	TERTIUS		EUL	FIL	0	0	0	0	0	0	0	0	0	+
ULOTHRIX	TENERRIMA		EHK	FIL	0	0	0	0	0	0	0	0	0	+
STIGEOCLONIUM	ATTENUATUM		EUL	FIL	0	0	0	0	0	0	0	0	0	+
CLADOPHORA	GLOMERATA		PLK	COL	0	0	+	0	0	0	0	0	0	+
PEDIASTRUM	BORYANUM		PLK	COL	0	0	0	0	0	0	0	0	0	+
PEDIASTRUM	DUPLEX	CLATHRATUM	PLK	COL	0	0	0	0	0	0	0	0	0	+
PEDIASTRUM	DUPLEX	GRACILLIMUM	PLK	COL	0	0	0	0	0	0	0	0	0	+
PEDIASTRUM	SIMPLEX		PLK	COL	0	0	0	0	0	0	0	0	0	+
PEDIASTRUM	SIMPLEX	DUODENARIUM	PLK	SOL	0	0	0	0	0	0	0	0	0	+
LAGERHEIMIA			PLK	COL	0	0	0	0	0	0	0	0	0	+
DICHTYOSPHAERIUM			PLK	COL	0	0	+	0	0	0	0	0	0	+
SCENEDESMUS	DIMORPHUS		PLK	COL	0	0	0	0	0	0	0	0	0	+
ACTINASTRUM	HANTZSCHII	FLUVIATILE	PLK	SOL	0	0	0	0	0	0	0	0	0	+
ANKISTRODESMUS	CONVOLUTUS		EUL	FIL	0	0	0	0	0	0	0	0	+	+
SPIROGYRA			LHK	FIL	0	0	+	0	0	0	0	0	0	+
CHARA			PLK	COL	0	0	+	0	0	0	0	0	0	0
SCENEDESMUS	OBTUSUS		PLK	COL	0	0	0	0	0	0	0	0	0	+
CRUCIGENIA	TETRAPEDIA		PLK	COL	0	0	+	0	0	0	0	0	0	0
SCENEDESMUS	QUADRICARDA		PLK	SOL	0	0	+	0	0	0	0	0	0	0
TETRAEDRON	TRIGONUM	MINUS	PLK	SOL	0	0	+	0	0	0	0	0	0	0
TETRAEDRON	TRIGONUM	BIFURCETUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
TETRAEDRON	TETRAGONUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
TETRAEDRON	MINIMUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
TETRAEDRON	ENORME													

TABLE H-1. (Continued)

PAGE 2

HEADING	GENUS AND SPECIES			HABITAT		DECADE AND APPEARANCE									
					ORGANIZATION	1800	1890	1900	1910	1920	1930	1940	1950	1960	1970
	COELASTRUM	MICROPORUM		PLK	COL	0	0	+	0	0	0	0	0	0	0
	COELASTRUM	CAMBRICUM		PLK	COL	0	0	+	0	0	0	0	0	0	0
	SORASTRUM	SPINULOSUM		PLK	COL	0	0	+	0	0	0	0	0	0	0
	PEDIASTRUM	DUPLEX		PLK	COL	0	0	+	0	0	0	0	0	0	+
	PEDIASTRUM	TETRAS		PLK	COL	0	0	+	0	0	0	0	0	0	0
	HYDRODICTYON	RETICULATUM		EUL	COL	0	0	+	0	0	0	0	0	0	0
	GLOEOCYSTIS	GIGAS		PLK	COL	0	0	+	0	0	0	0	0	0	0
	HAEMATOCOCCUS	LACUSTRIS		PLK	SOL	0	0	+	0	0	0	0	0	0	0
	SPONDYLOMORUM	QUATERNORIUM		PLK	COL	0	0	+	0	0	0	0	0	0	0
	PANDORINA	MORUM		PLK	COL	0	0	+	0	0	0	0	0	0	0
	EUDORINA	ELEGANS		PLK	COL	0	0	+	0	0	0	0	0	0	0
	VOLVOX	GLOBATOR		PLK	COL	0	0	+	0	0	0	0	0	0	0
	CLADOPHORA	DECLINATA	FLUITANS	EUL	FIL	0	0	+	0	0	0	0	0	0	0
	MICROSPORA	VULGARIS		EUL	FIL	0	0	+	0	0	0	0	0	0	0
	MICROSPORA	FUGACISSIMA		EUL	FIL	0	0	+	0	0	0	0	0	0	0
	BULBOCHAETE	RHADINOSPORA		EUL	FIL	0	0	+	0	0	0	0	0	0	0
	PEDIASTRUM			PLK	COL	0	0	0	0	0	0	0	+	0	0
	ACTINASTRUM			PLK	COL	0	0	0	0	0	0	0	+	0	0
	COELASTRUM			PLK	COL	0	0	0	0	0	0	0	+	0	0
	TETRASTRUM			PLK	COL	0	0	0	0	0	0	0	+	0	0
	SCENEDESMUS			PLK	COL	0	0	0	0	0	0	0	+	0	0
	ULOTRIX			PLK	FIL	0	0	0	0	0	0	0	+	0	0
	MOUGEOTIA			EUL	FIL	0	0	0	0	0	0	0	0	0	+
	DIMORPHOCOCCUS	CORDATUS		PLK	COL	0	0	+	0	0	0	0	0	0	0
DESMIDS			CHLOROPHYTA												

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES	HABITAT	ORGANIZATION	DECADE AND APPEARANCE 1800	1890	1900	1910	1920	1930	1940	1950	1960	1970
CLOSTERIUM	STIRGOSUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
CLOSTERIUM	LUNULA	PLK	SOL	0	0	+	0	0	0	0	0	0	0
CLOSTERIUM	CUCUMIS	PLK	SOL	0	0	+	0	0	0	0	0	0	0
CLOSTERIUM	ACUMINATUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
CLOSTERIUM	LEIBLEINII	PLK	SOL	0	0	+	0	0	0	0	0	0	0
DOCIDIUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	LAEVE	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	CONTRACTUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	GRANATUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	OBICULATUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	ARITATUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	BOTRYTIS	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	PORTIANUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	INTERMEDIUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	SUBURBICULAR	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	COELATUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	SUBCRENATUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	BLYTTII	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	BIRETUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	ORNATUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	BROOMEI	PLK	SOL	0	0	+	0	0	0	0	0	0	0
COSMARIUM	PARDALIS	PLK	SOL	0	0	+	0	0	0	0	0	0	0
EUCSTRUM	ANS	PLK	SOL	0	0	+	0	0	0	0	0	0	0
STAURASTRUM	MUTICIUM	PLK	SOL	0	0	+	0	0	0	0	0	0	0

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES		HABITAT	ORGANIZATION	DECADE AND APPEARANCE									
					1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
STAURASTRUM	ISPINUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
STAURASTRUM	POLYMORPHUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
STAURASTRUM	PEUTACLADIUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
STAURASTRUM	ASPINOSUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
STAURASTRUM	GRALLATORIUM		PLK	SOL	0	0	+	0	0	0	0	0	0	0
HYALOTHECA	DESSILIENS		PLK	FIL	0	0	+	0	0	0	0	0	0	0
DESMIDIUM	APTOGNIUM		PLK	FIL	0	0	+	0	0	0	0	0	0	0
STAURASTRUM			PLK	SOL	0	0	0	0	0	0	0	+	0	+
COSMARIUM			PLK	SOL	0	0	0	0	0	0	0	0	0	+
CLOSTERIUM			PLK	SOL	0	0	0	0	0	0	0	+	0	+
YELLOW-GREEN	ALGAE	XANTHOPHYCEAE												
VAUCHERIA			EUL	FIL	0	0	0	0	0	0	0	0	+	+
YELLOW-BROWN	ALGAE	CHRYSOPHYCEAE												
DINOBRYON			PLK	COL	0	0	0	0	0	0	0	+	0	0
DIATOMS		BACILLARIOPHYCEA												
ASTERIONELLA			PLK	COL	0	0	0	0	0	0	0	+	0	+
COCCONEIS			EPI	SOL	0	0	0	0	0	0	0	0	0	+
CYMBELLA			EUL	SOL	0	0	0	0	0	0	0	0	0	+
GOMPHONEMA			EUL	SOL	0	0	0	0	0	0	0	0	0	+
NITZSCHIA			EUL	SOL	0	0	0	0	0	0	0	0	0	+
SIRURELLA			EUL	SOL	0	0	0	0	0	0	0	0	0	+
CYMATOPLEURA			EUL	SOL	0	0	0	0	0	0	0	0	0	+
MELOSIRA			PLK	FIL	0	0	0	0	0	0	0	0	0	+
COSCINODISCUS			PLK	SOL	0	0	0	0	0	0	0	0	0	+

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES			HABITAT	ORGANIZATION	DECADE AND APPEARANCE									
						1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
STEPHANODISCUS				PLK	SOL	0	0	0	0	0	0	0	0	0	+
NAVICULA				PLK	SOL	0	0	0	0	0	0	0	+	0	+
SYNEDRA				PLK	SOL	0	0	0	0	0	0	0	+	0	+
FRAGILARIA				PLK	FIL	0	0	0	0	0	0	0	+	0	+
GYROSIGMA				PLK	SOL	0	0	0	0	0	0	0	+	0	0
PINNULARIA				PLK	SOL	0	0	0	0	0	0	0	+	0	0
TABELLARIA				PLK	COL	0	0	0	0	0	0	0	+	0	0
MELASIRA	VARIANS			PLK	FIL	0	0	0	0	0	0	0	+	0	0
MELASIRA	GRANULATA			PLK	FIL	0	0	0	0	0	0	0	+	0	0
CYCLOTELLA	MICHIGANIANA			PLK	SOL	0	0	0	0	0	0	0	+	0	0
STAURONEIS				PLK	SOL	0	0	0	0	0	0	0	0	0	+
EUGLENAS		EUGLENOPHYTA													
EUGLENA				PLK	SOL	0	0	0	0	0	0	0	+	0	0
PHACUS				PLK	SOL	0	0	0	0	0	0	0	+	0	0
LEPINOCINCLIS				PLK	SOL	0	0	0	0	0	0	0	+	0	0
EUGLENA	ACUS			PLK	SOL	0	0	0	0	0	0	0	0	0	+
EUGLENA	ACUS	RIGIDA		PLK	SOL	0	0	0	0	0	0	0	0	0	+
EUGLENA	GRACILIS			PLK	SOL	0	0	0	0	0	0	0	0	0	+
EUGLENA	OSYURIS			PLK	SOL	0	0	0	0	0	0	0	0	0	+
EUGLENA	VIRIDIS			PLK	SOL	0	0	0	0	0	0	0	0	0	+
PHACUS	ANACOELUS	UNDULATA		PLK	SOL	0	0	0	0	0	0	0	0	0	+
GOLDEN-BROWN	ALGAE	PYRROPHYTA													
PERIDINIUM				PLK	SOL	0	0	0	0	0	0	0	+	0	0
BLUE-GREEN	ALGAE	CYANOPHYTA													

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES		HABITAT		DECADE AND APPEARANCE									
				ORGANIZATION	1880	1990	1900	1910	1920	1930	1940	1950	1960	1970
	MERISMOPEDIA	GLAUCA	PLK	COL	0	0	+	0	0	0	0	0	0	0
	OSCILLATORIA		EUL	FIL	0	0	0	0	0	0	0	+	+	0
	APHANIGOMENON		PLK	FIL	0	0	0	0	0	0	0	+	0	0
	MICROCYSTIS	INCERTA	PLK	COL	0	0	0	0	0	0	0	0	0	+
	OSCILLATORIA	SUBBREVIS	EUL	FIL	0	0	0	0	0	0	0	0	0	+
	ARTHROSPIRA	JENNERI	PLK	FIL	0	0	+	0	0	0	0	0	0	0
	APHANIZOMENON	FLOS-AQUAE	PLK	FIL	0	0	+	0	0	0	0	0	0	+
	ANABAENA		PLK	FIL	0	0	0	0	0	0	0	0	0	+
	MERISMOPEDIA	CONVOLUTA	PLK	COL	0	0	+	0	0	0	0	0	0	0
	MICROCYSTIS		PLK	COL	0	0	0	0	0	0	0	+	0	0
	COELOSPHAERIUM	KUFTENGEANUM	PLK	COL	0	0	+	0	0	0	0	0	0	0
RED	ALGAE	RHODOPHYTA												
	BATRACHOSPERMUM		RHE	FIL	0	0	0	0	0	0	0	0	0	+
AQUATIC	VASCULAR	PLANTS												
	POTAMOGETON	FOLIOSUS	EUL	SOL	0	+	0	0	0	0	0	0	+	0
	POTAMOGETON	PERFOLIATUS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
	VALLISNERIA	SPIRALIS	EUL	SOL	0	+	+	0	0	0	0	0	0	0
	NYMPAEA	ADVENA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
	NELUMBO	LUTEA	EUL	SOL	0	+	+	0	0	0	0	0	0	0
	TYPHA	LATIFOLIA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
	PHRAGMITES		EUL	SOL	0	0	+	0	0	0	0	0	0	0
	HIBISCUS	MOSCHEUTOS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
	CALAMOGROSTIS		EUL	SOL	0	0	+	0	0	0	0	0	0	0
	ALISMA	PLANTAGO	EUL	SOL	0	+	0	0	0	0	0	0	0	0

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES	HABITAT ORGANIZATION		DECADE AND APPEARANCE 1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
		EUL	SOL	0	+	0	0	0	0	0	0	0	0
BRASENIA	PELTATA	EUL	SOL	0	+	+	0	0	0	0	0	0	0
CERATOPHYLLUM	DEMERSUM	EUL	SOL	0	+	0	0	0	0	0	0	0	0
EQUISETUM	LIMNOSUM	EUL	SOL	0	+	+	0	0	0	0	0	0	0
EQUISETUM	PRATENSE	EUL	SOL	0	+	0	0	0	0	0	0	0	0
HYDROPHYLLUM		EUL	SOL	0	+	0	0	0	0	0	0	0	0
LEMNA		EUL	SOL	0	+	0	0	0	0	0	0	0	0
LAPHOTOCARPUS	CALYCINES	EUL	SOL	0	+	0	0	0	0	0	0	0	0
LUDWIGIA	ALTERNIFLORA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
LUDWIGIA	PALUSTRIS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
PONTEDERIA	CORDATA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
NUPHAR	ADVENA	EUL	SOL	0	+	0	0	0	0	0	0	+	0
NYMPHAEA	TUBEROSA	EUL	SOL	0	+	+	0	0	0	0	0	0	0
EQUISETUM	ARVENSE	EUL	SOL	0	+	0	0	0	0	0	0	0	0
POTAMOGETON	INTERRUPTUS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
SAGITTARIA		EUL	SOL	0	+	0	0	0	0	0	0	0	0
RANUNCULUS	CIRCINATUS	EUL	SOL	0	+	+	0	0	0	0	0	0	0
TYPHA	ANGUSTIFOLIA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
WOLFFIA		LMK	SOL	0	+	0	0	0	0	0	0	0	0
ZANNICHELLIA	PALUSTRIS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
MYRIOPHYLLUM	SPICATUM	EUL	SOL	0	0	+	0	0	0	0	0	0	0
ELODEA	CANDIDENSIS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
ZIZANIA	AQUATICA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
NYMPHAEA	ADVENA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
UTRICULARIA	VULGARIS												

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES		HABITAT ORGANIZATION		DECADE AND APPEARANCE 1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
PONTIDERIA	CORDATA		EUL	SOL	0	0	+	0	0	0	0	0	0	0
ALISMA	PLANTAGO	AQUATICA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
BIDENS	BECKII		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CAREX	AQUATILIS		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CAREX	COMOSA		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CAREX	LANUGINOSA		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CAREX	MUHLENBERGII		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CERATOPHYLLOM	DEMERSUM		EUL	SOL	0	0	+	0	0	0	0	0	0	0
NAIAS	FLEXILIS		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CAREX	STIPATA		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CAREX	TRIBULOIDES		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CASTALIS	TUBEROSA		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CYPERUS	FILICULMIS		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CYPERUS	RIVULARIS		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CYPERUS	SCHWEINITZII		EUL	SOL	0	0	+	0	0	0	0	0	0	0
CYPERUS	STRIGOSUS		EUL	SOL	0	0	+	0	0	0	0	0	0	0
ELEOCHARIS	ACUMINATA		EUL	SOL	0	0	+	0	0	0	0	0	0	0
ELEOCHARIS	INTERMIDEA		EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	FOLIOSUS	NIAGAIENSIS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
ELODEA	CANADENSIS		EUL	SOL	0	+	0	0	0	0	0	0	0	0
EQUISETUM	ROBUSTUM		EUL	SOL	0	0	+	0	0	0	0	0	0	0
EQUISETUM	VARIEGATUM		EUL	SOL	0	0	+	0	0	0	0	0	0	0
JUNCUS	BALTICUS		EUL	SOL	0	0	+	0	0	0	0	0	0	0
JUNCUS	NODOSUS	MEGACEPHALUS	EUL	SOL	0	0	+	0	0	0	0	0	0	0

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES	HABITAT		DECADE AND APPEARANCE									
			ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
JUNCUS	RICHARDSONIA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
JUNCUS	TORREYI	EUL	SOL	0	0	+	0	0	0	0	0	0	0
LEMNA	TRISULCA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
LEMNA	MINOR	EUL	SOL	0	0	+	0	0	0	0	0	0	0
LUDWIGIA	ALTERNIFOLIA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
CASTALIA	TUBEROSA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
SCIRPUS	LACUSTRIS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
CAREX	SARTIVELLII	FUL	SOL	0	0	+	0	0	0	0	0	0	0
NYMPHAEA	VARIEGATA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
PHRAGMITES	PHRAGMITES	EUL	SOL	0	0	+	0	0	0	0	0	0	0
PONIEDEPA	CORDATA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	LONCHITES	EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	PECTINATUS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	PUSILLUS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	ZOSTERIFORMI	EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	AMPIFOLIUS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	FOLIOSIS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
POTAMOGETON	LUSCENS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
SPRIODELA	POLYRHIZA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
SPOROGANIUM	EURYCAIPUM	EUL	SOL	0	0	+	0	0	0	0	0	0	0
SAGITTARIA	LATIFOLIA	EUL	SOL	0	0	+	0	0	0	0	0	0	0
SCIPPUS	FLUVIATILIS	EUL	SOL	0	0	+	0	0	0	0	0	0	0
RANUNCULUS	SCELERATUS	FUL	SOL	0	0	+	0	0	0	0	0	0	0
TYPHA	ANGUSTIFOLIA LATIFOLIA	EUL	SOL	0	+	0	0	0	0	0	0	0	0

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES			HABITAT	ORGANIZATION	DECADE AND APPEARANCE 1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
	POTAMOGENTON	NATANS		FUL	SOL	0	0	+	0	0	0	0	0	0	0
	POTAMOGETON	FRIESII	PUHA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
PROTOZOANS			PROTOZOA												
	VORTICELLA			PLK	SOL	0	0	0	0	0	0	0	0	0	+
ROTIFERS			ROTIFERA												
	MELICERTA	CONIFERA		EPI	SOL	0	+	0	0	0	0	0	0	0	0
	MELICERTA	FLOCCULOSA		EPI	SOL	0	+	0	0	0	0	0	0	0	0
	LIMNIAS	CERATOPHYLLI		PLK	SOL	0	+	0	0	0	0	0	0	0	0
	LIMNIAS	SHEAWASSEENS		PLK	SOL	0	+	0	0	0	0	0	0	0	0
	LIMNIAS	ANNALATUS		EPI	SOL	0	+	0	0	0	0	0	0	0	0
	PROALES	GIBBA		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	PROALES	SORDIDA		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	FURCULARIA	LONGISETA		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	MASTIGOFERA	CARINATA		PLK	SOL	0	+	0	0	0	0	0	0	0	0
	MASTIGOFERA	BICORNIS		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	MASTIGOFERA	LATA		PLK	SOL	0	+	0	0	0	0	0	0	0	0
	RATTULUS	SULCATUS		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	COELOPUS	PORCELLUS		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	COELOPUS	TENUIOR		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	SCARIDIUM	ICAUDATUM		PLK	SOL	0	+	0	0	0	0	0	0	0	0
	STEPHANOPS	LAMELLARIS		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	STEPHANOPS	CHILDENA		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	SALPINA	BREVISPINA		EUL	SOL	0	+	0	0	0	0	0	0	0	0
	SALPINA	VENTRALIS		EUL	SOL	0	+	0	0	0	0	0	0	0	0

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES	HABITAT	ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
EUCHLANIS	DILATATA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
EUCHLANIS	TRIQUETRA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
CATHYPNA	LUNA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
LECANE	OHIOENSIS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
MONOSTYLA	LUNARIS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
MONOSTYLA	BULLA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
MONOSTYLA	QUADRIDENTAT	EUL	SOL	0	+	0	0	0	0	0	0	0	0
COLURUS	DEFLEXUS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
METOPEDIA	LEPADELLA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
METOPEDIA	SOLIDUS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
METOPEDIA	OXYSTERNUM	EUL	SOL	0	+	0	0	0	0	0	0	0	0
PTERODINA	PATINA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
PTERODINA	REFLEXA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
BRACHIONUS	MILITARIS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
NOTEUS	QUADRICORUS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
ANURAEA	COCHLEARIS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
ANURAEA	STIPITATA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
ASPLANCHNA		PLK	SOL	0	0	0	0	0	0	0	0	0	+
KERATELLA	COCHLEARIS	PLK	SOL	0	0	0	0	0	0	0	0	0	+
KELLICOTTIA	LONGISPINA	PLK	SOL	0	0	0	0	0	0	0	0	0	+
NOTHOLCA	STRIATA	PLK	SOL	0	0	0	0	0	0	0	0	0	+
BRACHIONUS	CALYCIFLORUS	PLK	SOL	0	0	0	0	0	0	0	0	0	+
BRACHIONUS	ANGULARIS	PLK	SOL	0	+	0	0	0	0	0	0	0	+
FILINIA	LONGISETA	PLK	SOL	0	+	0	0	0	0	0	0	0	+

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES	HABITAT	ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
APSILIS	BIPERA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
STEPHANOCEROS	EICHHORNII	EPI	SOL	0	+	0	0	0	0	0	0	0	0
HELICERTA	RINGEUS	EPI	SOL	0	+	0	0	0	0	0	0	0	0
HELICERTA	TUBICULARIA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
OECISTES	UMBELLA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
CONCHILUS	UNICORNIS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
CONCHILUS	DOSSUARIS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
MICROCODIDES	DUBIUS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
ASPLANCHNA	PRIODONTA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
SACCULUS	ORBICULARIS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
SYNCHAETA	PECTINATA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
SYNCHAETA	STYLATA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
PLEASONIA	TRUNCATA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
PLEASONIA	MOLLIS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
NOTOPS	MINOR	PLK	SOL	0	+	0	0	0	0	0	0	0	0
NOTOMMATA	VORAX	PLK	SOL	0	+	0	0	0	0	0	0	0	0
COPENS	EHRENBERGII	EUL	SOL	0	+	0	0	0	0	0	0	0	0
PROALES	ALGICOLA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
EOSOPHORA	AURITA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
DIOLENA	FORCIPATA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
HERTIVIGIA	PARASITA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
MASTIGOCEACA	RATTUS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
MASTIGOCEACA	BICRISTATA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
MASTIGOCEACA	ELONGATA	PLK	SOL	0	+	0	0	0	0	0	0	0	0

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES	HABITAT	ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
				DECADE AND APPEARANCE									
MASTIGOCEACA	MULTICRINUS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
DINACLARIS	POCILLUM	EUL	SOL	0	+	0	0	0	0	0	0	0	0
POLYCHAETUS	SUBQUADRATUS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
POLYCHAETUS	SERICA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
STEPHANOPS	MUTICUS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
CATHYPNA	LEONTINA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
LECANE	SPINIGERA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
NOTOGONIA	EHRENBERGII	EUL	SOL	0	+	0	0	0	0	0	0	0	0
POLYARTHRA	TRIGULA	PLK	SOL	0	0	0	0	0	0	0	0	0	+
BRACHIONUS	PALA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
BRACHIONUS	TUBERCULATUS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
ANUREA	TECTA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
NOTHALCA	LONGISPINA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
PEDALION	MIRUM	PLK	SOL	0	+	0	0	0	0	0	0	0	0
PHILODINA	ACULCATA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
ROTARIA	VULGARIS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
ROTARIA	TARDUS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
ROTARIA	MACROCEROS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
ROTARIA	MACRURUS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
CALLIDINA	ELEGANS	FUL	SOL	0	+	0	0	0	0	0	0	0	0
ASPLANCHNA	MYRMELIA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
SYNCHAETA	TREMULA	EUL	SOL	0	+	0	0	0	0	0	0	0	0
POLYARTHRA	PLATYPTERA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
FLOSCULARIA	EDENTATA	EUL	SOL	0	+	0	0	0	0	0	0	0	0

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES	HABITAT	ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
				DECADE AND APPEARANCE									
PLOESOMA	LENTICULARE	PLK	SOL	0	+	0	0	0	0	0	0	0	0
PROALES	DECIPIENS	EUL	SOL	0	+	0	0	0	0	0	0	0	0
NOTOMMATA	AURITA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
NOTOMMATA	LACINULATA	PLK	SOL	0	+	0	0	0	0	0	0	0	0
FLOSCULARIA	ORNATA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
FLOSCULARIA	MUTABILIS	PLK	SOL	0	+	0	0	0	0	0	0	0	0
FLOSCULARIA	CORNUTA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
FLOSCULARIA	MILLSII	EPI	SOL	0	+	0	0	0	0	0	0	0	0
FLOSCULARIA	CAMPANULATA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
FLOSCULARIA	AMBIGUA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
OECISTES	CRYSTALLINUS	EPI	SOL	0	+	0	0	0	0	0	0	0	0
OECISTES	LONGICORNIS	EPI	SOL	0	+	0	0	0	0	0	0	0	0
OECISTES	MUTICOLA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
CEPHALOSIPHON	LIMNIAS	EPI	SOL	0	+	0	0	0	0	0	0	0	0
COPEUS	CEREBRUS	EPI	SOL	0	+	0	0	0	0	0	0	0	0
LACINULARIA	SOCIALIS	EPI	COL	0	+	0	0	0	0	0	0	0	0
MEGALATROCHA	ALLEOFLAVICA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
CONCHILUS	VOLVOX	EUL	SOL	0	+	0	0	0	0	0	0	0	0
PHILODINA	RASEOLA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
PHILODINA	CITRINA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
PHILODINA	MEGALATROCHA	EPI	SOL	0	+	0	0	0	0	0	0	0	0
SEGMENTED	WATER WORMS OLIGOCHAETA												
TUBIFICIDAE	IMMATURE	BEN	SOL	0	0	0	0	0	0	0	0	0	+
PELOSCOLEX		BEN	SOL	0	0	0	0	0	0	0	0	0	+

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES		HABITAT	ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
	BRANCHIURA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	LIMNODRILUS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	AMPHICHAETA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	BOTHRIONEURUM		BEN	SOL	0	0	0	0	0	0	0	0	0	+
SNAILS		GASTROPODA												
	PLEUROCERA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	VIVIPARUS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	PLANOBULA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	PHYSA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	VALVATA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	PLANORBULA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	GONIOBASIS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	AMNICOLA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	FERRISSIA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	BULIMNAEA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	HELISOMA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
MUSSELS		PELECYPODA												
	PISIDIUM		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	SPHAERIUM		BEN	SOL	0	0	0	0	0	0	0	0	0	+
WATER FLEAS		CLADOCERA												
	DAPHNIA PULEX		PLK	SOL	0	0	0	0	0	0	0	0	0	+
	ALONA		PLK	SOL	0	0	0	0	0	0	0	0	0	+
	BOSMINA		PLK	SOL	0	0	0	0	0	0	0	0	0	+
COPEPODS		COPEPODA												

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES		HABITAT		DECADE AND APPEARANCE									
				ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
	LIMNOCALANUS		PLK	SOL	0	0	0	0	0	0	0	0	0	+
	NAUPLIUS	IMMATURE FOR	PLK	SOL	0	0	0	0	0	0	0	0	0	+
AMPHIPODS		AMPHIPODA												
	GAMMARUS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
FLIES		DIPTERA												
	CHAOBORUS		PLK	SOL	0	0	0	0	0	0	0	0	0	+
	PALPOMYIA	CERATOPOGONI	BEN	SOL	0	0	0	0	0	0	0	0	0	+
CHIRONOMIDS		DIPTERA												
	CHIRONOMUS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	COELOTANYPUS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	CLINOTANYPUS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	PROCLADIUS		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	ANOTOPYNA		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	POLYPEDILUM		BEN	SOL	0	0	0	0	0	0	0	0	0	+
	UNIDENTIFIABLE		BEN	SOL	0	0	0	0	0	0	0	0	0	+
WATER BEARS		TARDIGRADA												
	PSEUDECHINISCUS		FUL	SOL	0	0	0	0	0	0	0	0	0	+
LAMPPEYS		PETROMYZONTIDAE												
	ICTHYOMYZON	UNICUSPIS	PAR	SOL	0	0	0	0	0	+	0	+	0	0
	PETROMYZON	MARINUS	PAR	SOL	0	0	0	0	+	0	0	+	0	0
	ICHTHYOMYZON	UNICUSPIS	PAR	SOL	+	+	+	0	+	0	0	0	0	0
BROOKSILVERSIDES		ATHERINIDAE												
	LABIDESTHES	SICCULUS	NEK	SOL	0	+	+	+	+	+	+	0	0	+
CATFISH		ICTALURIDAE												

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES		HABITAT ORGANIZATION		DECADE AND APPEARANCE									
					1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
ICTALURUS	PUNCTATUS		NEK	SOL	0	0	0	0	0	+	+	0	+	+
ICTALURUS	NEBULOSUS		NEK	SOL	0	0	+	+	0	+	0	+	+	+
ICTALURUS	NATALIS		NEK	SOL	+	+	+	0	+	+	0	0	+	+
ICTALURUS	MELAS		NEK	SOL	0	0	0	0	+	+	+	+	0	+
NOTURUS	GYRINUS		NEK	SOL	0	0	0	0	0	+	0	0	0	+
SALMON		SALMONIDAE												
COREGONUS	ARTEDII	ALBUS	NEK	SOL	0	0	0	0	0	0	0	0	0	+
COREGONUS	ARTEDII	ALBUS	NEK	SOL	0	0	0	0	0	0	0	+	+	0
SALMO	GAIRDNERI		NEK	SOL	0	0	0	0	0	+	0	0	0	0
COREGONUS	CLUPEAFORMIS		NEK	SOL	0	0	0	0	0	0	0	+	+	0
WHITEFISH		COREGONIDAE												
COREGONUS	CLUPEAFORMIS		NEK	SOL	0	0	0	0	0	0	0	0	0	0
PADDLEFISH		POLYODONTIDAE												
POLYODON	SPATHULA		NEK	SOL	0	0	+	0	0	0	0	0	0	0
STURGEON		ACIPENSERIDAE												
ACIPENSER	FULVESCENS		NEK	SOL	0	0	0	0	0	0	0	+	+	0
BOWFINS		AMIIDAE												
AMIA	CALVA		NEK	SOL	0	0	0	0	+	+	+	+	+	+
GARS		LEPISOSTEIDAE												
LEPISOSTEUS	OSSEUS		NEK	SOL	0	0	0	0	0	+	+	0	0	0
LEPISOSTEUS	PRODUCTUS		NEK	SOL	0	+	+	0	0	+	+	+	0	0
TOP MINNOWS		CYPRINODONTIDAE												
FUNDULUS	DIAPHANUS		NEK	SOL	0	0	0	0	+	+	+	+	0	+
PIKES		ESOCIDAE												

TABLE H-1. (Continued)

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HEADING	GENUS AND SPECIES			HABITAT		DECADE AND APPEARANCE									
				ORGANIZATION		1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
	ESOX	MASQUINONGY	MASQUINONGY	NEK	SOL	0	0	0	0	0	0	0	0	0	+
	OSMERUS	MORDAX		NEK	SOL	0	0	0	0	0	0	0	0	+	0
	ESOX	LUCIUS		NEK	SOL	+	+	+	0	0	0	0	+	0	+
	ESOX	MASQUINONGY		NEK	SOL	0	0	0	0	0	0	+	+	0	0
	ESOX	MASGIUNONGY		NEK	SOL	0	+	0	0	0	0	0	0	0	0
	ESOX	NIGER		NEK	SOL	0	0	0	0	0	0	0	0	0	+
CARPS			CYPRINIDAE												
	NOTROPIS	VOLUCELLUS		NEK	SOL	0	0	0	0	+	0	+	0	0	0
	NOTROPIS	ATHERINOIDES		NEK	SOL	0	0	0	0	+	0	+	0	0	+
	NOTEMIGONUS	CRYSOLEUCAS		NEK	SOL	0	0	0	0	0	+	+	0	0	+
	CARASSIUS	AURATUS		NEK	SOL	0	0	0	0	0	+	+	+	+	+
	CYPRINUS	CARPIO		NEK	SOL	+	+	+	+	+	+	+	+	+	+
	NOTROPIS	RUBELLUS		NEK	SOL	0	+	+	+	+	+	0	0	0	0
	HYBOPSIS	AMBLOPS	AMBLOPS	NEK	SOL	0	+	+	+	+	+	0	0	0	0
	HYBOPSIS	BIGUTTATA		NEK	SOL	0	0	0	0	+	+	0	0	0	0
	NOTROPIS	SPILOPTERUS		NEK	SOL	0	+	+	+	+	+	+	0	0	+
	CARASSUIS	AURATUS		NEK	SOL	+	+	+	+	+	+	+	+	0	0
	NOTROPIS	HUDSONIUS		NEK	SOL	0	0	0	0	+	+	+	+	0	+
	NOTROPIS	HETERODON		NEK	SOL	0	+	0	+	+	0	0	0	0	0
	PHENACOBIUS	MIRABILIS		NEK	SOL	0	0	0	0	0	0	0	+	0	0
	PIMEPHALES	NOTATUS		NEK	SOL	0	0	0	0	0	+	+	0	0	+
	NOTROPIS	STRAMINEUS		NEK	SOL	0	0	0	0	0	0	0	0	0	+
	NOTROPIS	UMBRATILUS		NEK	SOL	0	0	0	0	0	0	0	0	0	+
	OPSOPOEODUS	EMILAE		NEK	SOL	0	0	0	0	+	+	0	0	0	0

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES		HABITAT		DECADE AND APPEARANCE									
				ORGANIZATION	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
NOTROPIS	ATHERINOIDES	ATHERINOIDES	NEK	SOL	0	0	0	0	0	0	0	0	0	+
HYBOPSIS	MICROPOGON		NEK	SOL	0	+	0	0	+	+	0	0	0	0
HYBOPSIS	STORERIANA		NEK	SOL	0	0	0	0	0	+	0	0	0	0
CAMPTOSTOMA	ANOMALUM		NEK	SOL	0	0	0	0	+	0	0	0	0	0
PIMEPHALES	PROMELAS		NEK	SOL	0	0	0	0	0	0	0	0	0	+
NOTROPIS	ANOGENUS		NEK	SOL	0	0	+	0	0	0	0	0	0	0
SUCKERS		CATOSTOMIDAE												
CARPIODES	CYPRINUS	CYPRINUS	NEK	SOL	+	+	+	0	+	+	0	+	0	0
MOXOSTOMA	VALENCIENNES		NEK	SOL	0	+	+	+	+	0	0	0	0	0
ERIMYZON	SUCETTA	KENNERLYI	NEK	SOL	0	0	+	0	+	+	+	+	0	0
ICTIOBUS	BUBALUS		NEK	SOL	0	0	0	0	0	+	+	+	0	0
ICTIOBUS	CYPRINELLUS		NEK	SOL	0	0	0	0	+	+	+	0	+	+
MOXOSTOMA	AUREOLUM	AUREOLUM	NEK	SOL	0	+	+	0	+	0	0	0	0	0
CATOSTOMUS	COMMERSONI		NEK	SOL	0	0	0	0	0	0	0	0	+	0
MOXOSTOMA	MACROLEPIDOT		NEK	SOL	0	0	0	0	0	+	0	0	+	+
ERIMYZON	SUCETTA		NEK	SOL	0	0	0	0	+	0	0	0	0	0
CARPIODES	CYPRINUS		NEK	SOL	0	0	0	0	0	+	0	0	+	+
CATOSTOMUS	COMMERSONII		NEK	SOL	0	0	0	0	0	+	0	0	+	+
MOXOSTOMA	ERYTHRURUM		NEK	SOL	0	0	0	0	0	+	+	0	0	0
MOXOSTOMA	BREVICEPS		NEK	SOL	0	0	0	0	0	0	0	0	0	+
HYPENTELIUM	NIGRICANS		NEK	SOL	0	0	0	0	0	+	0	0	0	0
CARPIODES	HINFI		NEK	SOL	0	0	0	0	0	0	0	0	0	+
CATOSTOMUS	COMMERSONI	COMMERSONI	NEK	SOL	0	0	0	0	0	0	0	0	0	+
MOXOSTOMA	ANISURUM		NEK	SOL	0	0	0	0	0	0	+	0	0	0
MOONEYES		HIODONTIDAE												

TABLE H-1. (Continued)

PAGE 20

HEADING	GENUS AND SPECIES			HABITAT ORGANIZATION		DECADE AND APPEARANCE 1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
HIODON	TERGISUS			NEK	SOL	0	0	0	0	+	0	+	+	+	+
SKIPJACKS		CLUPEIDAE													
DOROSOMA	CEPEDIANUM			NEK	SOL	0	0	0	0	0	+	0	0	+	+
BURBOTS		GADIDAE													
LOTA	LOTA		LACUSTRIS	NEK	SOL	0	0	0	0	0	0	0	+	+	0
DRUM		SCIAENIDAE													
APLODINOTUS	GRUNNIENS			NEK	SOL	+	+	+	+	+	+	+	+	+	+
PERCH		PERCIDAE													
PERCA	FLAVESCENS			NEK	SOL	0	+	+	0	0	+	+	+	+	+
PERCINA	COPELANDI			NEK	SOL	0	0	0	0	+	0	+	0	0	0
STIZOSTEDION	VITREUM			NEK	SOL	0	0	0	0	0	+	0	+	+	+
STIZOSTEDION	CANADENSE			NEK	SOL	0	0	0	0	+	+	0	+	+	0
ETHEOSTOMA	NIGRUM			NEK	SOL	0	0	+	0	+	+	+	0	0	0
PERCINA	SHUMARDI			NEK	SOL	0	0	0	0	+	+	+	+	0	0
STIZOSTEDION	VITREUM		GLAUCUM	NEK	SOL	0	0	0	0	0	0	0	+	0	0
PERCINA	CAPRODES			NEK	SOL	0	0	+	0	+	+	+	0	0	0
PERCINA	SEMIFASCIATA			NEK	SOL	0	0	0	0	0	0	0	0	0	+
ETHEOSTOMA	BLENNIOIDES			NEK	SOL	0	0	0	0	0	0	0	0	0	+
PERCINA	MACULATA			NEK	SOL	0	0	0	0	0	+	0	0	0	0
ETHEOSTOMA	EULEPIS			NEK	SOL	0	0	0	0	0	0	0	0	0	+
SUNFISHES		CENTRARCHIDAE													
LEPOMIS	MACROCHIRUS			NEK	SOL	+	+	+	+	+	+	+	+	+	+
MICROPTERUS	DOLOMIEUI			NEK	SOL	+	+	0	0	+	+	+	0	0	+
POMOXIS	NIGROMACULAT			NEK	SOL	0	0	0	0	+	+	+	+	0	+

TABLE H-1. (Continued)

HEADING	GENUS AND SPECIES		HABITAT ORGANIZATION		DECADE AND APPEARANCE 1880	1890	1900	1910	1920	1930	1940	1950	1960	1970
	POMOXIS	ANNULARIS	NEK	SOL	+	+	+	+	+	0	+	0	+	+
	LEPOMIS	GIBBOSUS	NEK	SOL	0	+	+	+	+	+	+	+	+	+
	LEPOMIS	CYANELLUS	NEK	SOL	0	+	0	0	0	0	0	0	0	+
	AMBLOPLITES	RUPESTRIS	NEK	SOL	0	0	0	0	0	+	0	0	+	+
	LEPOMIS	HUMILIS	NEK	SOL	0	0	0	0	0	0	+	+	0	+
	MICROPTERUS	SALMOIDES	NEK	SOL	0	0	+	0	0	+	+	0	0	+
	LEPOMIS	MEGALOTIS	NEK	SOL	0	+	+	+	+	0	0	0	0	0
	LEPOMIS	MACHROCHIRUS	NEK	SOL	0	0	0	0	0	0	0	0	0	+
BASSES		SERRANIDAE												
	MORONE	CHRYSOPS	NEK	SOL	0	0	0	0	+	0	0	+	+	+
B														

TABLE H-2

ALGAL TAXA FROM SANDUSKY BAY PLANKTON SAMPLES

CHLOROPHYTA

- Actinastrum hantzschii
  - hantzschii var. fluviatiles
- Ankistrodesmus falcatus
  - falcatus var. acicularis
  - falcatus var. spirilliformis
- Binuclearia eriensis
- Characium graciliger
  - sp.
- Chlorella sp.
- Closteriopsis sp.
- Closterium aciculare var. subpronum
- Coelastrum microporum
  - sphaericum
- Cosmarium sp.
- Crucigenia quadrata
- Dictyosphaerium pulchellum
- Eudorina elegans
- Gleocystis gigas
- Golenkinia
- Hormidium sp.
- Hyalotheca dissiliens
- Lagerheimia quadriseta
- Micractinium pusillum
- Microspora sp.
- Mougeotia sp.
- Oocystis crassa
  - elliptica
- Pandorina morum
- Pediastrum clathratum var. asperum
  - boryanum
  - duplex
  - simplex
  - simplex var. ovatum
  - tetras var. tetraodon
- Scenedesmus abundans var. brevicauda
  - acuminatus
  - acuminatus f. globosus
  - bijuga
  - dimorphus
  - ecornis var. virgatus
  - falcatus
  - quadricauda
- Schroederia judayi
- Selenastrum sp.
- Spirogyra sp.
- Staurastrum chaetoceros
  - paradoxum
- Tetraedron regulare v. bifurcatum
  - trigonum
- Tetrastrum heteracanthum
  - sp.
- Treubaria setigerum
  - varia

PYRRHOPHYTA

- Ceratium hirundinella
- Gymnodinium aeruginosum
  - sp.
- Peridinium sp. (cinctum?)

CYANOPHYTA

- Anabaena spp.
- Aphanizomenon flos-aquae
- Chroococcus limneticus
  - sp.
- Lyngbya sp.
- Microcystis aeruginosa
  - flos-aquae
- Oscillatoria spp.
- Schizothrix spp.

CHRYSOPHYTA

- Dinobryon divergens
  - sertularia
- Mallomonas alpina

EUGLENOPHYTA

- Euglena acus
  - ehrenbergii
  - oxyuris
  - spp.
  - viridis
- Phacus pleuronectes
  - torta
- Strombomonas fluviatilis
- Trachelomonas gibberosa
  - hispida
  - schaunislandii
  - spp.

SCHIZOMYCOPHYTA

- Planctomyces Bekefii, Gim.

TABLE H-3

LIST OF DIATOM TAXA FOUND IN SAMPLES DURING THE SANDUSKY BAY SURVEY

Achananthes affinis
coarctata
exigua
hungarica
lanceolata
lanceolata var. dubia
microcephala
minutissima
pinnata
sp.

Amphipleura pellucida

Amphora ovalis
ovalis var. pediculus
veneta
submontana

Asterionella formosa

Caloneis amphisbaena
bacillaris
bacillaris var. thermalis
bacillum
limosa
ventricosa var. truncatula

Cocconeis pediculus
placentula
placentula var. lineata

Coscinodiscus fluviatilis
rothii var. subsalsa

Cyclotella bodanica
kutzingiana
meneghiniana
pseudostelligera
striata

Cymatopleura solea

Cymbella affinis
cistula
parva
prostrata
ventricosa

Diatoma tenue
tenue var. elongatum
vulgare

Diploneis oblongella

Epithemia turgida
zebra
zebra var. saxonica

Eunotia curvata

Fragilaria capucina var. mesolepta
construens var. binodis
construens var. pumila
construens var. venter
lapponica
pinnata
vaucheriae

Frustulia vulgaris

Gomphonema acuminatum var. coronata
angustatum
constrictum
gracile
intricatum
montanum
montanum var. subclavatum
olivaceum
parvulum

Gyrosigma attenuatum
scalproidas
spencerii

Hantzschia amphioxys

Mastogloia grevillei
smithii var. lacustris

Melosira ambigua
distans
granulata
granulata var. angustissima
islandica
italica
subsalsa
varians

Meridion circulare

Navicula biconica
capitata
cincta
circumtexta
conferaceae var. peregrina
contenta var. biceps
cryptocephala

Navicula cryptocephala var. veneta
cuspidata
dicephala ?
exigua var. capitata
heufleri var. leptocephala
lanceolata
lyra
menisculus var. upsaliensis
minuscula
mutica
mutica var. cohnii
oblonga
pupula
pupula var. elliptica
pupula var. rectangularis
radiosa
secreta var. apiculata
simplex
sp. 1
sp. 2
sp. 3
tenera
tripunctata

Neidium iridis

Nitzschia acicularis
amphibia
bremensis
dissipata
fonticola
gracilis
hungarica
linearis
microcephala
palacea
palea
sigma
sigmoidea
sp. 1
sp. 2
tryblionella var. debilis
tryblionella var. levidensis
tryblionella var. victoriae

TABLE H-3 (Continued)

LIST OF DIATOM TAXA FOUND IN SAMPLES DURING THE SANDUSKY BAY SURVEY

- Pinnularia brebissonii
  - clevei
  - major
  - sp. 1
  - sp. 2
  - sp. 3
  - substomatophora
  - viridis
  - viridis var. minor

- Rhizosolenia eriensis

- Rhoicosphenia curvata

- Rhopalodia gibba
  - gibberula

- Stauroneis anceps
  - phoenicenteron f. gracilis
  - sp. 1

- Stephanodiscus astrea (rotula)
  - astrea var. minutula
  - binderana
  - hantzschii
  - tenuis

- Surirella ovalis
  - ovata
  - ovata var. pinnata

- Synedra fasciculata var. truncatula
  - filiformis var. exilis
  - delicatissima
  - parasitica var. subconstricta
  - pulchella
  - sp. 1
  - tenera
  - ulna

- Tabellaria fenestrata
  - flocculosa

APPENDIX I

BENTHIC SURVEY DATA

TABLE I-1

BENTHOS - SANDUSKY BAY, MARCH, 1973
SHORE-NEAR-SHORE STATIONS (GRID)--5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	43	2.5	2.4	559	16.7	15.9	129	17.6	17.6	0	0.0	0.0
Limnodrilus	129	7.5	7.1	43	1.3	1.2	0	0.0	0.0	0	0.0	0.0
Peloscolex	86	5.0	4.7	344	10.3	9.8	0	0.0	0.0	43	33.3	25.0
Immatures	1471	85.1	81.0	2408	71.8	68.3	602	82.4	82.4	86	66.6	50.0
		100			100			100			100	
Total	1729			3354			731			129		
% of Total Sample			95.3			95.1			100			75.0
Diptera												
Chironomus	43	50.0	2.4	172	100.0	4.9	0	0.0	0.0	0	0.0	0.0
Procladius	43	50.0	2.4	0	0.0	0.0	0	0.0	0.0	43	100	25.0
Coelotanypus	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
		100			100			0.0			100	
Total	86			172			0			43		
% of Total Sample			4.7			4.9			0.0			25.0
TOTAL SAMPLE	1815			3526			731			172		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	1075	19.1	18.0	3010	66.5	65.9	215	23.8	19.2	43	25.0	20.0
Limnodrilus	0	0.0	0.0	215	4.8	4.7	387	42.9	34.6	0	0.0	0.0
Peloscolex	0	0.0	0.0	438	9.7	9.6	0	0.0	0.0	86	50.0	40.0
Immatures	4558	80.9	76.3	861	19.0	18.9	301	33.3	26.9	43	25.0	20.0
		100			100			100			100	
Total	5633			4524			903			172		
% of Total Sample			94.2			99.0			80.8			80.0
Diptera												
Chironomus	258	75.0	4.3	43	100	0.9	86	40.0	7.7	43	100	20.0
Procladius	86	25.0	1.4	0	0.0	0.0	86	40.0	7.7	0	0.0	0.0
Coelotanypus	0	0.0	0.0	0	0.0	0.0	43	20.0	3.8	0	0.0	0.0
		100			100			100			100	
Total	344			43			215			43		
% of Total Sample			5.8			1.0			19.2			20.0
TOTAL SAMPLE	5977			4567			1118			215		

Taxa	Total Grid Stations	% of Total Grid	% of Occurrence in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	5,074	28.0	87.5	634	29.6
Limnodrilus	774	4.3	50.0	96	4.5
Peloscolex	997	5.5	62.5	124	5.8
Immatures	10,330	57.0	100.0	1291	60.1
					100.0
Total	17,175				
% of Total Sample					
Diptera					
Chironomus	645	3.6	75.0	80	68.2
Procladius	258	1.4	62.5	32	27.3
Coelotanypus	43	0.2	25.0	5	4.5
					100.0
Total	946				
TOTAL SAMPLE	18,121				

TABLE I-2

BENTHOS - SANDUSKY BAY, MAY, 1973
SHORE-NEAR-SHORE STATIONS (GRID)—5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	0	0.0	0.0	134	9.7	9.5	0	0.0	0.0	19	5.2	3.8
Limnodrilus	19	8.3	5.5	96	7.0	6.8	57	60.0	42.9	76	21.0	15.4
Peloscolex	0	0.0	0.0	96	7.0	6.8	38	40.0	28.6	38	10.5	7.7
Immatures	210	91.7	61.0	1051	76.3	74.3	0	0.0	0.0	229	63.3	46.3
		100			100			100			100	
Total	229			1377			95			362		
% of Total Sample			66.6			97.3			71.4			73.1
Diptera												
Chironomus	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Procladius	96	83.5	28.0	19	50.0	1.3	38	100.0	28.6	76	57.1	15.4
Coelotanypus	19	16.5	5.5	19	50.0	1.3	0	0.0	0.0	57	42.8	11.5
		100			100			100			100	
Total	115			38			38			133		
% of Total Sample			33.4			2.7			28.6			26.9
TOTAL SAMPLE	344			1415			133			495		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	191	34.5	23.2	229	32.4	21.8	172	6.9	5.5	115	1.8	1.7
Limnodrilus	115	20.8	14.0	439	62.2	41.8	0	0.0	0.0	1505	23.4	22.4
Peloscolex	76	13.7	9.2	38	5.4	3.6	0	0.0	0.0	955	14.9	14.2
Immatures	172	31.0	20.9	0	0.0	0.0	2311	93.1	74.2	3858	60.0	57.4
		100			100			100			100	
Total	544			706			2483			6437		
% of Total Sample			67.4			67.2			79.8			95.7
Diptera												
Chironomus	0	0.0	0.0	76	22.1	7.2	38	6.0	1.2	38	13.2	0.6
Procladius	115	46.2	14.0	134	39.0	12.8	210	33.3	6.7	134	46.7	2.0
Coelotanypus	134	53.8	16.3	134	39.0	12.8	382	60.6	12.2	115	40.1	1.7
		100			100			100			100	
Total	249			344			630			287		
% of Total Sample			30.3			32.8			20.2			4.3
TOTAL SAMPLE	822			1050			3113			6724		

Taxa	Total Grid Stations	% of Total Grid	% of Occurrence in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	860	6.1	75	107.5	7.0
Limnodrilus	2,311	16.4	87.5	288.9	18.9
Peloscolex	1,241	8.8	87.5	155.1	10.1
Immatures	7,831	55.6	75	978.9	64.0
					100.0
Total	12,243			1530.4	
% of Total Sample					
Diptera					
Chironomus	152	1.1	37.5	19	8.3
Procladius	822	5,8	100.0	102.8	44.8
Coelotanypus	860	6.1	87.5	107.5	43.9
					100.0
Total	1,834			229.3	
TOTAL SAMPLE	14,077				

TABLE I-3

BENTHOS - SANDUSKY BAY, JUNE, 1973
SHORE-NEAR-SHORE STATIONS (GRID)—5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	38	19.9	6.2
Limnodrilus	57	27.1	19.9	77	22.3	15.5	0	0.0	0.0	38	19.9	6.2
Peloscolex	0	0.0	0.0	115	33.3	23.1	115	100.0	66.9	0	0.0	0.0
Immatures	153	72.9	53.4	153	44.3	30.8	0	0.0	0.0	115	60.2	18.8
		100			100			100			100	
Total	210			345			115			191		
% of Total Sample			73.4			69.4			66.9			31.2
Diptera												
Chironomus	19	25.0	6.6	38	25.0	7.6	19	33.3	11.0	172	40.9	28.1
Procladius	38	50.0	13.3	57	37.5	11.5	0	0.0	0.0	115	27.3	18.8
Coelotanypus	19	25.0	6.6	57	37.5	11.5	38	66.7	22.1	134	31.8	21.9
		100			100			100			100	
Total	76			152			57			421		
% of Total Sample			26.6			30.5			33.1			68.8
TOTAL SAMPLE	286			497			172			612		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	191	43.5	33.4	19	3.8	2.8	19	5.0	4.3	230	8.7	7.6
Limnodrilus	38	8.7	6.6	249	50.0	36.1	0	0.0	0.0	306	11.6	10.1
Peloscolex	19	4.3	3.3	0	0.0	0.0	19	5.0	4.3	191	7.2	6.3
Immatures	191	43.5	33.4	230	46.2	33.3	344	90.0	78.4	1914	72.5	63.3
		100			100			100			100	
Total	439			498			382			2641		
% of Total Sample			76.7			72.2			87.0			87.3
Diptera												
Chironomus	19	14.3	3.3	19	9.9	2.8	19	33.3	4.3	77	20.1	2.5
Procladius	57	42.9	10.0	77	40.1	11.2	19	33.3	4.3	134	35.0	4.4
Coelotanypus	57	42.9	10.0	96	50.0	13.9	19	33.3	4.3	172	44.9	5.7
		100			100			100			100	
Total	133			192			57			383		
% of Total Sample			23.3			27.8			13.0			12.7
TOTAL SAMPLE	572			690			439			3024		

Taxa	Total Grid Stations	% of Total Grid	% of Occurrence in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	497	7.9	62.5	62.1	10.3
Limnodrilus	765	12.2	75.0	95.6	15.9
Peloscolex	459	7.3	62.5	61.9	9.5
Immatures	3,100	49.3	87.5	387.5	64.3
					100.0
Total	4,821				
% of Total Sample					
Diptera					
Chironomus	382	6.0	100	47.6	26.0
Procladius	497	7.9	87.5	62.1	33.8
Coelotanypus	592	9.4	100	74	40.2
					100.0
Total	1,471				
TOTAL SAMPLE	6,292				

TABLE I-4

BENTHOS - SANDUSKY BAY, JULY, 1973
SHORE-NEAR-SHORE STATIONS (GRID)--5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
<u>Oligochaeta</u>												
Branchiura	19	100.0	16.7	268	40.1	38.0	57	75.0	33.1	0	0.0	0.0
Limnodrilus	0	0.0	0.0	325	48.6	46.0	0	0.0	0.0	77	100.0	80.2
Peloscolex	0	0.0	0.0	19	2.8	2.7	0	0.0	0.0	0	0.0	0.0
Immatures	0	0.0	0.0	57	8.5	8.1	19	25.0	11.0	0	0.0	0.0
		100			100			100			100	
Total	19			669			76			77		
% of Total Sample			16.7			94.6			44.2			80.2
<u>Diptera</u>												
Chironomus	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Procladius	57	60.0	50.0	0	0.0	0.0	77	80.2	44.8	19	100.0	19.8
Coelotanypus	38	40.0	33.3	38	100.0	5.4	19	19.8	11.0	0	0.0	0.0
		100			100			100			100	
Total	95			38			95			19		
% of Total Sample			83.3			5.4			55.8			19.8
TOTAL SAMPLE	114			707			172			96		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
<u>Oligochaeta</u>												
Branchiura	38	16.6	4.1	211	46.0	39.4	0	0.0	0.0	153	72.9	32.0
Limnodrilus	115	50.2	12.3	153	33.3	28.6	0	0.0	0.0	19	9.0	4.0
Peloscolex	57	24.9	6.1	38	8.3	7.1	0	0.0	0.0	19	9.0	4.0
Immatures	19	8.3	2.0	57	12.4	10.7	57	100.0	22.9	19	9.0	4.0
		100			100			100			100	
Total	229			459			57			210		
% of Total Sample			24.4			85.8			22.9			44.0
<u>Diptera</u>												
Chironomus	191	27.0	20.4	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Procladius	211	29.8	22.5	19	25.0	3.6	77	40.1	30.9	0	0.0	0.0
Coelotanypus	306	43.2	32.7	57	75.0	10.7	115	59.9	46.2	268	100.0	56.1
		100			100			100			100	
Total	708			76			192			268		
% of Total Sample			75.6			14.2			77.1			56.0
TOTAL SAMPLE	937			535			249			478		

Taxa	Total Grid Stations	% of Total Grid	% of Occurrence in Stations	Mean of Grid	% of Taxa of Total Grid
<u>Oligochaeta</u>					
Branchiura	746	22.6	75.0	124.3	41.5
Limnodrilus	689	21.0	62.5	137.8	38.7
Peloscolex	133	4.0	50.0	137.0	7.4
Immatures	228	7.0	75.0	38.0	12.7
					100.0
Total	1,796				
% of Total Sample					
<u>Diptera</u>					
Chironomus	191	5.8	.12.5	191	12.8
Procladius	460	14.0	75.0	73.7	30.8
Coelotanypus	841	25.6	87.5	120.0	56.4
					100.0
Total	1,432				
TOTAL SAMPLE	3,288			824.8	

TABLE I-5

BENTHOS - SANDUSKY BAY, AUGUST, 1973
SHORE-NEAR-SHORE STATIONS (GRID)--5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	0	0.0	0.0	57	13.6	11.5	19	14.2	11.0	0	0.0	0.0
Limnodrilus	153	89.0	80.1	268	63.8	54.0	115	85.8	66.0	115	85.8	75.6
Peloscolex	19	11.0	9.9	38	9.0	7.7	0	0.0	0.0	0	0.0	0.0
Immatures	0	0.0	0.0	57	13.6	11.5	0	0.0	0.0	19	14.2	12.4
		100			100			100			100	
Total	172			420			134			134		
% of Total Sample			90.0			84.7			78.0			87.6
Diptera												
Chironomus	0	0.0	0.0	38	50.0	7.7	19	50.0	11.0	0	0.0	0.0
Procladius	19	100.0	9.9	19	25.0	3.8	19	50.0	11.0	19	100.0	12.4
Coelotanypus	0	0.0	0.0	19	25.0	3.8	0	0.0	0.0	0	0.0	0.0
		100			100			100			100	
Total	19			76			38			19		
% of Total Sample			10.0			15.3			22.0			12.4
TOTAL SAMPLE	191			496			172			153		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	0	0.0	0.0	115	35.4	33.4	0	0.0	0.0	0	0.0	0.0
Limnodrilus	96	62.7	22.8	153	47.0	44.5	0	0.0	0.0	96	41.7	21.8
Peloscolex	0	0.0	0.0	19	5.8	5.5	19	6.2	2.4	0	0.0	0.0
Immatures	57	37.3	13.5	38	11.7	11.0	287	93.8	37.4	134	58.3	30.5
		100			100			100			100	
Total	153			325			306			230		
% of Total Sample			36.3			94.5			40.0			52.2
Diptera												
Chironomus	0	0.0	0.0	0	0.0	0.0	249	54.1	32.5	172	81.9	39.1
Procladius	38	14.2	9.0	0	0.0	0.0	96	20.9	12.5	19	9.0	4.3
Coelotanypus	230	85.8	54.6	19	100.0	5.5	115	25.0	15.0	19	9.0	4.3
		100			100			100			100	
Total	268			19			460			210		
% of Total Sample			63.7			5.5			60.0			47.3
TOTAL SAMPLE	421			344			766			440		

Taxa	Total Grid Stations	% of Total Grid	% of **Occurrence** in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	191	6.4	37.5	23.8	10.2
Limnodrilus	996	33.4	87.5	124.5	53.1
Peloscolex	95	3.2	50.0	11.9	5.1
Immatures	592	19.8	75.0	71.5	31.6
					100.0
Total	1,874				
% of Total Sample					
Diptera					
Chironomus	478	16.0	50.0	59.6	43.1
Procladius	229	7.7	87.5	28.6	20.6
Coelotanypus	402	13.5	62.5	50.2	36.2
					100.0
Total	1,109				
TOTAL SAMPLE	2,983				

TABLE I-6

BENTHOS - SANDUSKY BAY, SEPTEMBER, 1973
SHORE-NEAR-SHORE STATIONS (GRID)--5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
<u>Oligochaeta</u>												
Branchiura	287	62.5	53.5	115	26.1	21.5	383	69.0	60.7	230	46.2	43.0
Limnodrilus	115	25.0	21.5	268	60.9	50.0	115	20.7	18.2	134	27.0	25.0
Peloscolex	38	8.3	7.1	19	4.3	3.6	38	6.8	6.0	115	23.0	21.5
Immatures	19	4.1	3.6	38	8.6	7.1	19	3.4	3.0	19	3.8	3.5
		100			100			100			100	
Total	459			440			555			498		
% of Total Sample			85.8			82.2			88.0			92.9
<u>Diptera</u>												
Chironomus	38	50.0	7.1	38	40.0	7.1	57	75.0	9.0	19	50.0	3.5
Procladius	19	25.0	3.6	38	40.0	7.1	0	0.0	0.0	0	0.0	0.0
Coelotanypus	19	25.0	3.5	19	20.0	3.6	19	25.0	3.0	19	50.0	3.5
		100			100			100			100	
Total	76			95			76			38		
% of Total Sample			14.2			17.8			12.0			7.1
TOTAL SAMPLE	535			535			631			536		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
<u>Oligochaeta</u>												
Branchiura	57	13.6	8.1	555	58.0	44.0	19	4.0	1.6	0	0.0	0.0
Limnodrilus	134	31.9	19.0	134	14.0	10.7	38	7.9	3.1	115	22.2	9.2
Peloscolex	172	41.0	24.3	211	22.0	16.7	172	36.0	14.1	230	44.5	18.5
Immatures	57	13.6	8.1	57	6.0	4.5	249	52.1	20.3	172	33.3	13.8
		100			100			100			100	
Total	420			957			478			517		
% of Total Sample			59.4			75.7			39.0			41.6
<u>Diptera</u>												
Chironomus	191	[illegible]	27.0	[illegible]	[illegible]	[illegible]	651	87.4	53.2	593	81.6	47.7
Procladius	0	0.0	0.0	[illegible]	[illegible]	[illegible]	38	5.0	3.1	77	10.6	6.2
Coelotanypus	96	33.4	13.6	115	[illegible]	9.0	57	7.6	4.7	57	7.8	4.6
		100			100			100			100	
Total	287			297			746			727		
% of Total Sample			40.6			24.3			61.0			58.4
TOTAL SAMPLE	707			1254			1224			1244		

Taxa	Total Grid Stations	% of Total Grid	% of **Occurrence** in Stations	Mean of Grid	% of Taxa of Total Grid
<u>Oligochaeta</u>					
Branchiura	1,646	24.7	87.5	205.8	38.1
Limnodrilus	1,053	15.8	100	131.5	24.4
Peloscolex	995	14.9	100	124.3	23.0
Immatures	630	9.4	100	78.7	14.6
					100.0
Total	4,324				
% of Total Sample					
<u>Diptera</u>					
Chironomus	1,683	25.2	100	210.3	71.6
Procladius	268	4.0	62.5	33.5	11.4
Coelotanypus	401	6.0	100	50.1	17.0
					100.0
Total	2,352				
TOTAL SAMPLE	6,676				

TABLE I-7

BENTHOS - SANDUSKY BAY, OCTOBER, 1973
SHORE-NEAR-SHORE STATIONS (GRID)--5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	191	43.4	27.7	153	36.3	24.2	325	47.2	36.1	287	39.4	28.3
Limnodrilus	115	26.1	16.7	134	31.8	21.2	115	16.7	12.8	115	15.8	11.3
Peloscolex	77	17.5	11.2	77	18.3	12.2	96	13.9	10.7	115	15.8	11.3
Immatures	57	13.0	8.3	57	13.6	9.0	153	22.2	17.0	211	29.0	20.8
		100			100			100			100	
Total	440			421			689			728		
% of Total Sample			63.9			66.6			76.6			71.7
Diptera												
Chironomus	155	46.2	16.7	77	36.5	12.2	96	45.5	10.7	153	53.3	15.1
Procladius	57	22.9	8.3	38	18.0	6.0	19	9.0	2.1	77	26.8	7.6
Coelotanypus	77	30.9	11.2	96	45.5	15.2	95	45.5	10.7	57	19.9	5.6
		100			100			100			100	
Total	249			211			211			287		
% of Total Sample			36.1			33.4			23.4			28.3
TOTAL SAMPLE	689			632			900			1015		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	115	16.7	10.4	364	41.3	28.8	134	21.9	9.3	96	16.2	7.2
Limnodrilus	153	22.2	13.8	115	13.1	9.0	115	18.8	8.0	134	22.6	10.0
Peloscolex	191	27.7	17.2	249	28.3	19.7	153	25.0	10.7	172	29.0	12.8
Immatures	230	33.4	20.7	153	17.4	12.1	211	34.4	14.7	191	32.2	14.3
		100			100			100			100	
Total	689			881			613			593		
% of Total Sample			62.1			69.7			42.7			44.3
Diptera												
Chironomus	172	40.9	15.5	134	35.0	10.6	402	48.8	28.0	364	48.9	27.2
Procladius	115	27.3	10.4	96	25.1	7.6	230	27.9	16.0	191	25.6	14.3
Coelotanypus	134	31.8	12.1	153	39.9	12.1	191	23.2	13.3	191	25.6	14.3
		100			100			100			100	
Total	421			383			823			746		
% of Total Sample			37.9			30.3			57.3			55.7
TOTAL SAMPLE	1110			1264			1436			1339		

Taxa	Total Grid Stations	% of Total Grid	% of Occurrence in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	1,665	19.9	100	208	32.9
Limnodrilus	996	11.0	100	124.5	19.7
Peloscolex	1,130	13.5	100	141.2	22.4
Immatures	1,263	15.1	100	157.8	25.0
					100.0
Total	5,054				
% of Total Sample					
Diptera					
Chironomus	1,513	18.0	100	189	45.4
Procladius	823	9.8	100	102	24.7
Coelotanypus	995	11.9	100	124	29.9
					100.0
Total	3,331				
TOTAL SAMPLE	8,385				

TABLE I-8

BENTHOS - SANDUSKY BAY, NOVEMBER, 1973
SHORE-NEAR-SHORE STATIONS (GRID)--5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	172	35.9	23.6	153	38.1	22.8	287	41.7	30.6	249	35.1	24.1
Limnodrilus	115	24.0	15.8	115	28.6	17.2	134	19.4	14.3	134	18.9	12.9
Peloscolex	96	20.0	13.2	77	19.2	11.5	134	19.4	14.3	115	16.2	11.1
Immatures	96	20.0	13.2	57	14.2	8.5	134	19.4	14.3	211	29.8	20.4
		100			100			100			100	
Total	479			402			689			709		
% of Total Sample			65.8			60.0			73.6			68.5
Diptera												
Chironomus	155	46.7	15.8	96	35.8	14.3	115	46.2	12.3	115	35.3	11.1
Procladius	77	30.9	10.8	57	21.3	8.5	38	15.3	4.1	115	35.3	11.1
Coelotanypus	57	22.9	7.8	115	42.9	17.2	96	38.6	10.2	96	29.4	9.3
Total	249			268			249			326		
% of Total Sample			34.2			40.0			26.5			31.5
TOTAL SAMPLE	728			670			938			1035		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	134	17.9	10.9	383	42.6	30.3	153	24.2	10.4	115	17.2	8.3
Limnodrilus	172	23.0	14.0	77	8.5	6.0	115	18.2	7.8	134	20.0	9.7
Peloscolex	211	28.2	17.2	268	29.8	21.2	153	24.2	10.4	191	28.5	13.9
Immatures	230	30.8	18.8	172	19.1	13.6	211	33.4	14.3	230	34.3	16.7
		100			100			100			100	
Total	747			900			632			670		
% of Total Sample			61.0			71.2			42.8			48.6
Diptera												
Chironomus	191	40.0	15.6	115	31.6	9.0	383	45.4	26.0	306	43.2	22.2
Procladius	134	28.0	10.9	115	31.6	9.0	249	29.6	16.9	211	29.8	15.3
Coelotanypus	153	32.0	12.5	134	36.8	10.6	211	25.0	14.3	191	27.0	13.9
		100			100			100			100	
Total	478			364			843			708		
% of Total Sample			39.0			28.8			57.2			51.4
TOTAL SAMPLE	1225			1264			1475			1378		

Taxa	Total Grid Stations	% of Total Grid	% of **Occurrence** in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	1,646	18.9	100	205	31.5
Limnodrilus	996	11.4	100	124	19.1
Peloscolex	1,245	14.3	100	155	23.8
Immatures	1,341	15.4	100	167	25.7
Total	5,228				
% of Total Sample					
Diptera					
Chironomus	1,436	16.5	100	179	41.2
Procladius	996	11.4	100	124	28.6
Coelotanypus	1,053	12.0	100	131	30.2
Total	3,485				
TOTAL SAMPLE	8,713				

TABLE I-9

BENTHOS - SANDUSKY BAY, JANUARY, 1974
SHORE-NEAR-SHORE STATIONS (GRID)--5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	191	39.9	23.2	211	39.3	25.6	325	42.5	28.8	230	30.8	18.5
Limnodrilus	115	24.0	14.0	134	25.0	16.2	172	22.5	15.2	172	23.1	13.8
Peloscolex	77	16.1	9.3	96	17.9	11.6	115	15.0	10.2	153	20.5	12.3
Immatures	96	20.0 100	11.7	96	17.9 100	11.6	153	20.0 100	13.6	191	25.5 100	15.4
Total	479			537			765			746		
% of Total Sample			58.1			65.1			67.8			60.0
Diptera												
Chironomus	115	33.3	14.0	96	33.3	11.6	134	36.8	11.9	191	38.4	15.4
Procladius	115	33.3	14.0	77	26.7	9.3	96	26.4	8.5	134	27.0	10.8
Coelotanypus	115	33.3 100	14.0	115	39.9 100	14.0	134	36.8 100	11.9	172	34.6 100	13.8
Total	345			288			364			497		
% of Total Sample			41.9			34.9			32.2			40.0
TOTAL SAMPLE	824			825			1129			1243		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	172	20.9	12.0	421	38.5	28.2	306	32.0	16.7	268	28.6	15.7
Limnodrilus	211	25.6	14.7	134	12.3	9.0	172	18.0	9.4	153	16.3	9.0
Peloscolex	191	23.2	13.3	211	19.3	14.1	191	20.0	10.4	249	26.5	14.6
Immatures	249	30.3 100	17.6	325	29.8 100	21.8	287	30.0 100	15.6	268	28.6 100	15.7
Total	823			1091			956			938		
% of Total Sample			57.4			73.0			52.0			55.0
Diptera												
Chironomus	268	43.8	18.7	153	38.1	10.2	402	45.6	21.9	364	47.5	21.4
Procladius	191	31.2	13.3	134	33.4	9.0	230	26.1	12.5	211	27.5	12.4
Coelotanypus	153	25.0 100	10.7	115	28.6 100	7.7	249	28.3 100	13.6	191	24.8 100	11.2
Total	612			402			881			766		
% of Total Sample			42.6			27.0			48.0			45.0
TOTAL SAMPLE	1435			1493			1837			1704		

Taxa	Total Grid Stations	% of Total Grid	% of Occurrence in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	2,124	20.2	100	265	33.5
Limnodrilus	1,263	12.4	100	157	19.9
Peloscolex	1,283	12.2	100	160	20.3
Immatures	1,665	15.9	100	208	26.3 100.0
Total	6,335				
% of Total Sample					
Diptera					
Chironomus	1,723	16.4	100	215	41.5
Procladius	1,188	11.3	100	148	28.5
Coelotanypus	1,244	11.6	100	155	30.0 100.0
Total	4,155				
TOTAL SAMPLE	10,490				

TABLE I-10

BENTHOS - SANDUSKY BAY, MARCH, 1974
SHORE-NEAR-SHORE STATIONS (GRID)—5, 6, 8, 16, 17, 19, 29, 31

Taxa	Station 5			Station 6			Station 8			Station 16		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	211	37.9	20.4	211	34.4	22.5	306	38.1	24.2	288	32.6	19.7
Limnodrilus	115	20.7	11.1	153	25.0	16.3	172	21.4	13.6	172	20.9	12.7
Peloscolex	115	20.7	11.1	115	18.8	12.2	134	16.7	10.6	172	20.9	12.7
Immatures	115	20.7	11.1	134	21.9	14.3	191	23.8	15.1	211	25.6	15.5
		100			100			100			100	
Total	556			613			803			823		
% of Total Sample			53.7			65.3			63.6			60.6
Diptera												
Chironomus	230	48.0	22.2	115	35.3	12.2	172	37.5	13.6	230	42.9	17.0
Procladius	153	32.0	14.8	96	29.4	10.2	134	29.2	10.6	153	28.5	11.3
Coelotanypus	96	20.0	9.3	115	35.3	12.2	153	33.3	12.1	153	28.5	11.3
		100			100			100			100	
Total	479			326			459			536		
% of Total Sample			46.3			34.7			36.4			39.4
TOTAL SAMPLE	1035			939			1262			1359		

Taxa	Station 17			Station 19			Station 29			Station 31		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	191	21.2	12.3	421	37.9	27.2	306	29.6	15.7	287	28.3	16.9
Limnodrilus	230	25.6	14.8	172	15.5	11.1	211	20.4	10.8	172	17.0	10.1
Peloscolex	191	21.2	12.3	211	19.0	13.6	211	20.4	10.8	249	24.6	14.6
Immatures	287	31.9	18.5	306	27.6	19.7	306	29.6	15.7	306	30.2	18.0
		100			100			100			100	
Total	899			1110			1034			1014		
% of Total Sample			58.3			71.6			53.0			59.6
Diptera												
Chironomus	287	44.1	18.5	[illegible]	43.4	12.3	421	45.8	21.6	344	50.0	20.2
Procladius	191	29.4	12.3	153	34.8	9.9	268	29.2	13.7	172	25.0	10.1
Coelotanypus	172	26.5	11.1	[illegible]	21.8	6.2	230	25.0	11.8	172	25.0	10.1
		100			100			100			100	
Total	650			440			[illegible]			688		
% of Total Sample			42.0			28.4			47.0			40.4
TOTAL SAMPLE	1549			1550			1953			1702		

Taxa	Total Grid Stations	% of Total Grid	% of Occurrence in Stations	Mean of Grid	% of Taxa of Total Grid
Oligochaeta					
Branchiura	2,201	19.4	100	275	32.1
Limnodrilus	1,397	12.3	100	174	20.4
Peloscolex	1,398	12.3	100	174	20.4
Immatures	1,856	16.4	100	232	27.1
					100.0
Total	6,852				
% of Total Sample					
Diptera					
Chironomus	1,990	17.5	100	248	44.3
Procladius	1,320	11.6	100	165	29.4
Coelotanypus	1,187	10.5	100	148	25.4
					100.0
Total	4,497				
TOTAL SAMPLE	11,349				

TABLE I-11

BENTHOS - SANDUSKY BAY, MARCH, 1973
OPEN-BAY STATIONS (TRANSECT)--33, 21, 35, 36, 33

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	688	21.6	11.7	481	92.7	52.1	43	6.6	6.6
Limnodrilus	518	16.2	8.8	0	0.0	0.0	0	0.0	0.0
Peloscolex	1333	41.9	22.6	0	0.0	0.0	86	13.3	13.3
Immatures	645	20.3 100	10.9	38	7.3 100	4.1	516	80.0 100	80.0
Total	3182			519			645		
% of Total Sample			54.0			56.2			100
Diptera									
Chironomus	1591	58.7	27.0	192	47.5	20.8	0	0.0	0.0
Procladius	774	28.5	13.1	212	52.5	23.0	0	0.0	0.0
Coelotanypus	344	12.7 100	5.8	0	0.0 100	0.0	0	0.0 100	0.0
Total	2709			404			0		
% of Total Sample			46.0			43.8			0
TOTAL SAMPLE	5891			923			645		

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	0	0.0	0.0	0	0.0	0.0
Limnodrilus	0	0.0	0.0	0	0.0	0.0
Peloscolex	0	0.0	0.0	86	100	66.7
Immatures	16598	100 100	93.3	0	0.0 100	0.0
Total	16598			86		
% of Total Sample			93.9			66.7
Diptera						
Chironomus	1075	100	6.1	43	100	33.3
Procladius	0	0.0	0.0	0	0.0	0.0
Coelotanypus	0	0.0 100	0.0	0	0.0 100	0.0
Total	1075			43		
% of Total Sample			6.1			33.3
TOTAL SAMPLE	17673			129		

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	1,212	4.8	30	242	5.8
Limnodrilus	518	2.0	20	103	2.5
Peloscolex	1,505	3.0	60	301	7.2
Immatures	17,797	70.5	80	3559	84.5 100.0
Total	21,030				
Diptera					
Chironomus	2,901	11.5	80	580	58.5
Procladius	986	3.9	40	197	23.3
Coelotanypus	344	1.4	20	68.8	8.1 100.0
Total	4,231				
TOTAL SAMPLE	25,261				

TABLE I-12

BENTHOS - SANDUSKY BAY, MAY, 1973
OPEN-BAY STATIONS (TRANSECT)—33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	115	2.8	2.7	267	24.1	21.5	688	11.7	10.6
Limnodrilus	172	4.2	4.0	497	44.9	40.0	172	2.9	2.7
Peloscolex	306	7.6	7.2	229	21.0	18.4	229	3.9	3.5
Immatures	3457	85.0	80.8	115	10.4	9.3	4775	81.4	73.7
		100			100			100	
Total	4050			1108			5864		
% of Total Sample			95.0			89.2			90.6
Diptera									
Chironomus	0	0.0	0.0	19	14.2	1.5	57	9.6	0.8
Procladius	229	100	5.4	19	14.2	1.5	535	90.4	8.3
Coelotanypus	0	0.0	0.0	96	72.0	7.7	0	0.0	0.0
		100			100			100	
Total	229			134			592		
% of Total Sample			5.0			10.8			9.1
TOTAL SAMPLE	4,279			1,242			6,475		

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	210	3.8	3.4	301	23.3	17.9
Limnodrilus	172	3.1	2.8	431	33.4	25.7
Peloscolex	401	7.2	6.5	86	6.7	5.1
Immatures						
	4775	85.9	77.[illegible]	474	36.7	28.2
		100			100	
Total	5558			1292		
% of Total Sample			90.4			77.0
Diptera						
Chironomus	115	20.1	1.[illegible]	129	38.0	7.7
Procladius	229	40.0	3.7	129	38.0	7.7
Coelotanypus	229	40.0	3.7	86	24.0	5.1
		100			100	
Total	573			344		
% of Total Sample			9.3			20.5
TOTAL SAMPLE	[illegible],150			1,679		

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	1,581	8.0	100	316	8.8
Limnodrilus	1,444	7.3	100	288	8.1
Peloscolex	1,251	6.3	100	250	7.0
Immatures	13,596	68.6	100	2719	76.1
					100.0
Total	17,872			3574	
Diptera					
Chironomus	320	1.6	80	64	17.1
Procladius	1,141	5.8	100	228	61.0
Coelotanypus	411	2.0	60	82	22.0
					100.0
Total	1,872			374.4	
TOTAL SAMPLE	19,825			3965	

TABLE I-13

BENTHOS - SANDUSKY BAY, JUNE, 1973
OPEN-BAY STATIONS (TRANSECT)--33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	172	5.3	5.0	0	0.0	0.0	230	6.5	5.4
Limnodrilus	211	6.6	6.1	287	51.7	48.4	249	7.0	5.9
Peloscolex	536	16.7	15.5	230	41.4	38.8	230	6.5	5.4
Immatures	2296	71.4	66.3	38	6.8	6.4	2851	80.0	67.0
		100			100			100	
Total	3215			555			3560		
% of Total Sample			92.8			93.6			83.8
Diptera									
Chironomus	77	30.9	2.2	19	50.0	3.2	96	13.9	2.3
Procladius	153	61.4	4.4	0	0.0	0.0	478	69.4	11.2
Coelotanypus	19	7.6	0.5	19	50.0	3.2	115	16.7	2.7
		100			100			100	
Total	249			38			689		
% of Total Sample			7.2			6.4			16.2
TOTAL SAMPLE	3464			593			4249		

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	172	5.2	4.2	134	6.0	5.4
Limnodrilus	230	7.0	5.6	344	15.5	13.9
Peloscolex	440	13.2	10.8	57	2.6	2.3
Immatures	2488	75.0	61.0	1684	75.9	68.3
		100			100	
Total	3330			2219		
% of Total Sample			81.7			89.9
Diptera						
Chironomus	287	38.4	7.0	134	54.0	5.4
Procladius	249	33.3	6.1	57	23.0	2.3
Coelotanypus	211	28.2	5.2	57	23.0	2.3
		100			100	
Total	747			248		
% of Total Sample			18.3			10.1
TOTAL SAMPLE	4077			2467		

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	708	4.8	80	177	5.4
Limnodrilus	1,321	8.9	100	264	10.3
Peloscolex	1,493	10.1	100	298	11.6
Immatures	9,357	63.0	100	1871	72.7
					100.0
Total	12,879			2510	
Diptera					
Chironomus	613	4.1	100	122	31.1
Procladius	937	6.3	80	243	47.5
Coelotanypus	421	2.9	100	84	21.4
					100.0
Total	1,971			449	
TOTAL SAMPLE	14,850				

TABLE I-14

BENTHOS - SANDUSKY BAY, JULY, 1973
OPEN-BAY STATIONS (TRANSECT)--33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	19	7.1	6.6	134	50.0	26.9	96	20.0	15.7
Limnodrilus	96	35.8	33.4	134	50.0	26.9	115	24.0	18.8
Peloscolex	19	7.1	6.6	0	0.0	0.0	0	0.0	0.0
Immatures	134	50.0	46.7	0	0.0	0.0	268	55.9	43.7
		100			100			100	
Total	268			268			479		
% of Total Sample			93.4			53.8			78.1
Diptera									
Chironomus	0	0.0	0.0	0	0.0	0.0	19	14.2	3.1
Procladius	0	0.0	0.0	134	58.3	26.9	38	28.4	6.2
Coelotanypus	19	100.0	6.6	96	41.7	19.3	77	57.5	12.6
		100			100			100	
Total	19			230			134		
% of Total Sample			6.6			46.2			21.9
TOTAL SAMPLE	287			498			613		

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	38	66.7	7.6	0	0.0	0.0
Limnodrilus	0	0.0	0.0	134	100	31.8
Peloscolex	0	0.0	0.0	0	0.0	0.0
Immatures	19	33.3	3.8	0	0.0	0.0
		100			100	
Total	57			134		
% of Total Sample			11.4			31.8
Diptera						
Chironomus	77	17.5	15.5	77	26.8	18.3
Procladius	287	65.1	57.6	172	59.9	40.9
Coelotanypus	77	17.5	15.5	38	13.2	9.0
		100			100	
Total	441			287		
% of Total Sample			88.6			68.2
TOTAL SAMPLE	496			421		

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	287	12.4	80	57	23.8
Limnodrilus	479	20.7	80	95	39.7
Peloscolex	19	0.8	20	3	1.6
Immatures	421	18.2	60	84	34.9
					100.0
Total	1206				
Diptera					
Chironomus	173	7.5	60	34	15.6
Procladius	631	27.2	80	126	56.8
Coelotanypus	307	13.2	100	61	27.6
		100.0			100.0
Total	1111				
TOTAL SAMPLE	2317				

TABLE I-15

BENTHOS - SANDUSKY BAY, AUGUST, 1973
OPEN-BAY STATIONS (TRANSECT)—33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	0	0.0	0.0	57	37.3	24.9	57	24.9	11.9
Limnodrilus	38	33.0	19.9	77	50.3	33.6	57	24.9	11.9
Peloscolex	0	0.0	0.0	19	12.4	8.3	38	16.6	7.9
Immatures	77	67.0	40.3	0	0.0	0.0	77	33.6	16.1
		100			100			100	
Total	115			153			229		
% of Total Sample			60.2			66.8			47.9
Diptera									
Chironomus	0	0.0	0.0	19	25.0	8.3	19	7.6	4.0
Procladius	57	75.0	29.8	0	0.0	0.0	134	53.8	28.0
Coelotanypus	19	25.0	9.9	57	75.0	24.9	96	38.6	20.1
		100			100			100	
Total	76			76			249		
% of Total Sample			39.8			33.2			52.1
TOTAL SAMPLE	191			229			478		

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	0	0.0	0.0			
Limnodrilus	0	0.0	0.0			
Peloscolex	0	0.0	0.0			
Immatures	77	100.0	10.[illegible]			
		100				
Total	77					
% of Total Sample			10.9			
Diptera						
Chironomus	287	45.4	40.5			
Procladius	211	[illegible]	[illegible]			
Coelotanypus	134	21.2	18.[illegible]			
		100				
Total	632					
% of Total Sample			89.1			
TOTAL SAMPLE	709					

Taxa	Total Transect	% of Total Transect	% of Stations **Occurrence**	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	114	7.1	50	28	19.9
Limnodrilus	172	10.7	75	43	30.0
Peloscolex	57	3.5	50	14	9.9
Immatures	231	14.4	75	57	40.2
					100.0
Total	574				
Diptera					
Chironomus	325	20.2	75	61	31.5
Procladius	402	25.0	75	100	38.9
Coelotanypus	306	19.0	100	76	29.6
		100.0			100.0
Total	1033				
TOTAL SAMPLE	1507				

TABLE I-16

BENTHOS - SANDUSKY BAY, SEPTEMBER, 1973
OPEN-BAY STATIONS (TRANSECT)--33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	19	4.5	1.9	134	35.0	17.1	77	11.8	8.7
Limnodrilus	38	9.0	3.8	96	25.0	12.2	230	35.3	26.1
Peloscolex	191	45.5	19.2	153	39.9	19.5	19	2.9	2.2
Immatures	172	41.0	17.3	0	0.0	0.0	325	49.9	36.9
		100			100			100	
Total	420			383			651		
% of Total Sample			42.3			48.8			73.9
Diptera									
Chironomus	268	46.7	27.0	57	14.1	7.3	38	16.5	4.3
Procladius	249	43.4	25.1	134	33.3	17.1	96	41.7	10.9
Coelotanypus	57	9.9	5.7	211	52.5	26.9	96	41.7	10.9
		100			100			100	
Total	574			402			230		
% of Total Sample			57.7			51.2			26.1
TOTAL SAMPLE	994			785			881		

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	57	16.6	6.3	344	46.2	27.3
Limnodrilus	115	33.4	12.8	57	7.7	4.5
Peloscolex	19	5.5	2.1	38	5.1	3.0
Immatures	153	44.5	17.0	304	41.1	24.2
		100			100	
Total	344			743		
% of Total Sample			38.3			59.0
Diptera						
Chironomus	249	44.9	27.7	287	55.5	22.7
Procladius	172	31.0	19.1	115	22.2	9.1
Coelotanypus	134	24.1	14.9	115	22.2	9.1
		100			100	
Total	555			517		
% of Total Sample			61.7			41.0
TOTAL SAMPLE	899			1260		

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	631	13.1	100	126	24.8
Limnodrilus	536	11.1	100	107	21.1
Peloscolex	420	8.7	100	84	16.5
Immatures	956	19.8	80	191	37.6
					100.0
Total	2543				
Diptera					
Chironomus	899	18.6	100	179	39.5
Procladius	766	15.9	100	153	33.6
Coelotanypus	613	12.7	100	122	27.0
		100.0			100.0
Total	2278				
TOTAL SAMPLE	4821				

TABLE I-17

BENTHOS - SANDUSKY BAY, OCTOBER, 1973
OPEN-BAY STATIONS (TRANSECT)--33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	115	18.8	9.0	191	26.3	16.7			
Limnodrilus	77	12.6	6.0	153	21.0	13.3			
Peloscolex	230	37.5	17.9	153	21.0	13.3			
Immatures	191	31.2	14.9	230	31.6	20.0			
		100			100				
Total	613			727					
% of Total Sample			47.8			63.4			
Diptera									
Chironomus	268	40.0	20.9	57	13.6	5.0			
Procladius	211	31.5	16.4	191	45.5	16.7			
Coelotanypus	191	28.5	14.9	172	41.0	15.0			
		100			100				
Total	670			420					
% of Total Sample			52.2			36.6			
TOTAL SAMPLE	1283			1147					

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	134	19.4	10.3	287	31.9	18.5
Limnodrilus	153	22.2	11.8	172	19.1	11.0
Peloscolex	172	25.0	13.2	153	17.0	9.9
Immatures	230	33.4	17.7	287	31.9	18.5
		100			100	
Total	[illegible]			[illegible]		
% of Total Sample			53.0			58.0
Diptera						
Chironomus	249	40.7	19.1	249	38.2	16.0
Procladius	191	31.2	14.7	191	29.3	12.3
Coelotanypus	172	28.1	13.2	211	32.4	13.6
		100			100	
Total	612			651		
% of Total Sample			47.0			42.0
TOTAL SAMPLE	1301			1550		

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	727	13.8	100	181	24.8
Limnodrilus	555	10.5	100	138	19.0
Peloscolex	708	13.4	100	177	24.2
Immatures	938	17.8	100	234	32.0
					100.0
Total	2928				
Diptera					
Chironomus	823	15.6	100	205	35.0
Procladius	784	14.8	100	196	33.3
Coelotanypus	746	14.1	100	186	31.7
		100.0			100.0
Total	2353				
TOTAL SAMPLE	5281				

TABLE I-18

BENTHOS - SANDUSKY BAY, NOVEMBER, 1973
OPEN-BAY STATIONS (TRANSECT)--33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	77	13.4	5.8	153	21.0	13.1	172	21.9	12.8
Limnodrilus	96	16.7	7.3	153	21.0	13.1	134	17.1	10.0
Peloscolex	211	36.7	16.0	153	21.0	13.1	191	24.4	14.3
Immatures	191	32.2	14.4	268	36.9	23.0	297	36.6	21.4
		100			100			100	
Total	575			727			784		
% of Total Sample			43.5			62.3			58.6
Diptera									
Chironomus	297	38.4	21.7	96	21.8	8.2	211	38.0	15.8
Procladius	230	30.8	17.4	172	39.1	14.7	172	31.0	12.8
Coelotanypus	230	30.8	17.4	172	39.1	14.7	172	31.0	12.8
		100			100			100	
Total	747			440			555		
% of Total Sample			56.5			37.7			41.4
TOTAL SAMPLE	1322			1167			1339		

Taxa	Station 36			Station 38		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta						
Branchiura	153	20.5	11.8	287	28.9	18.8
Limnodrilus	153	20.5	11.8	191	19.2	12.5
Peloscolex	191	25.6	14.7	191	19.2	12.5
Immatures	249	33.4	19.1	325	32.7	21.2
		100			100	
Total	746			994		
% of Total Sample			57.3			65.0
Diptera						
Chironomus	230	41.4	17.7	172	32.1	11.2
Procladius	191	34.4	14.7	134	25.0	8.8
Coelotanypus	134	24.1	10.3	230	42.9	15.0
		100			100	
Total	555			536		
% of Total Sample			42.7			35.0
TOTAL SAMPLE	1301			1530		

Taxa	Total Transect	% of Total Transect	% of stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	842	12.6	100	168	22.0
Limnodrilus	727	10.9	100	145	19.0
Peloscolex	937	14.1	100	187	24.5
Immatures	1320	19.8	100	264	34.5
					100.0
Total	3826				
Diptera					
Chironomus	996	15.0	100	199	35.2
Procladius	899	13.5	100	179	31.8
Coelotanypus	938	14.1	100	187	33.1
		100.0			100.0
Total	2833				
TOTAL SAMPLE	6659				

TABLE I-19

BENTHOS - SANDUSKY BAY, JANUARY, 1974
OPEN-BAY STATIONS (TRANSECT)—33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	191	23.8	11.6	287	29.4	17.4			
Limnodrilus	153	19.0	9.3	211	21.6	12.8			
Peloscolex	230	28.6	14.0	191	19.6	11.6			
Immatures	230	28.6	14.0	287	29.4	17.4			
		100			100				
Total	804			976					
% of Total Sample			48.8			59.3			
Diptera									
Chironomus	364	43.2	22.1	230	34.3	14.0			
Procladius	268	31.8	16.3	191	28.5	11.6			
Coelotanypus	211	25.0	12.8	249	37.2	15.1			
		100			100				
Total	843			670					
% of Total Sample			51.2			40.7			
TOTAL SAMPLE	1647			1646					

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	478	14.5	100	239	26.9
Limnodrilus	364	11.1	100	182	20.4
Peloscolex	421	12.8	100	210	23.7
Immatures	517	15.7	100	258	29.0
					100.0
Total	1780				
Diptera					
Chironomus	594	18.0	100	297	39.3
Procladius	459	13.9	100	229	30.3
Coelotanypus	460	14.0	100	230	30.4
		100.0			100.0
Total	1513				
TOTAL SAMPLE	3293				

TABLE I-20

BENTHOS - SANDUSKY BAY, MARCH, 1974
OPEN-BAY STATIONS (TRANSECT)—33, 21, 35, 36, 38

Taxa	Station 33			Station 21			Station 35		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	211	25.0	13.1	287	28.3	17.2			
Limnodrilus	191	22.7	11.9	230	22.7	13.8			
Peloscolex	211	25.0	13.1	211	20.8	12.7			
Immatures	230	27.3	14.3	287	28.3	17.2			
		100			100				
Total	843			1015					
% of Total Sample			52.4			60.9			
Diptera									
Chironomus	325	42.4	20.2	211	32.4	12.7			
Procladius	230	30.0	14.3	211	32.4	12.7			
Coelotanypus	211	27.5	13.1	230	35.3	13.8			
		100			100				
Total	766			652					
% of Total Sample			47.6			39.1			
TOTAL SAMPLE	1609			1667					

Taxa	Total Transect	% of Total Transect	% of Stations Occurrence	Mean of Transect	% of Taxa of Total Transect
Oligochaeta					
Branchiura	498	15.2	100	249	26.8
Limnodrilus	421	12.9	100	210	22.7
Peloscolex	422	12.9	100	211	22.7
Immatures	517	15.8	100	258	27.8
					100.0
Total	1858				
Diptera					
Chironomus	536	16.4	100	268	37.8
Procladius	441	13.5	100	220	31.1
Coelotanypus	441	13.5	100	220	31.1
		100.0			100.0
Total	1418				
TOTAL SAMPLE	3276				

TABLE I-21

BENTHOS - SANDUSKY BAY, STATION 37

Taxa	July			Aug			Sept			Oct		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	38	24.8	19.9	38	19.9	10.5	287	44.1	31.9	306	38.0	27.5
Limnodrilus	96	62.7	50.3	38	19.9	10.5	115	17.7	12.8	134	16.7	12.1
Peloscolex	19	12.4	9.9	0	0.0	0.0	19	2.9	2.1	134	16.7	12.1
Immatures	0	0.0	0.0	115	60.2	31.7	230	35.3	25.6	230	28.6	20.7
		100			100			100			100	
Total	153			191			651			804		
% of Total Sample			80.1			52.6			72.3			72.4
Diptera												
Chironomus	0	0.0	0.0	19	11.0	5.2	77	30.9	8.6	115	37.5	10.4
Procladius	19	50.0	9.9	57	33.2	15.7	38	15.3	4.2	77	25.9	6.9
Coelotanypus	19	50.0	9.9	96	55.9	26.4	134	53.8	14.9	115	37.5	10.4
		100			100			100			100	
Total	38			172			249			307		
% of Total Sample			19.9			47.9			27.7			27.6
TOTAL SAMPLE	191			363			900			1111		

Taxa	[illegible]			[illegible]			March		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta									
Branchiura	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	31.4	[illegible]
Limnodrilus	172	[illegible]	[illegible]	211	21.2	14.0	211	[illegible]	[illegible]
Peloscolex	[illegible]	17.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Immatures	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]			100			100	
Total	[illegible]			[illegible]			[illegible]		
% of Total Sample			[illegible]			[illegible]			[illegible]
Diptera									
Chironomus	[illegible]	41.1	[illegible]	[illegible]	[illegible]	11.4	[illegible]	42.0	[illegible]
Procladius	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.1	[illegible]	32.0	[illegible]
Coelotanypus	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		100			100			100	
Total	[illegible]			[illegible]			[illegible]		
% of Total Sample			[illegible]			[illegible]			[illegible]
TOTAL SAMPLE	1110			[illegible]			[illegible]		

TABLE I-22

BENTHOS - SANDUSKY BAY, STATION 39

Taxa	July			Aug			Sept		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
<u>Oligochaeta</u>									
Branchiura	0	0.0	0.0	0	0.0	0.0	153	42.1	19.5
Limnodrilus	38	14.2	12.4	19	12.4	11.4	134	37.0	17.0
Peloscolex	0	0.0	0.0	19	12.4	11.4	19	5.2	2.4
Immatures	230	85.8 100	75.6	115	75.6 100	66.9	57	15.7 100	7.2
Total	268			153			363		
% of Total Sample			87.6			89.0			46.2
<u>Diptera</u>									
Chironomus	19	50.0	6.2	0	0.0	0.0	211	50.0	26.9
Procladius	0	0.0	0.0	19	100	11.0	96	22.7	12.2
Coelotanypus	19	50.0 100	6.2	0	0.0 100	0.0	115	27.3 100	14.6
Total	38			19			422		
% of Total Sample			12.3			11.0			53.8
TOTAL SAMPLE	306			172			785		

Taxa	Oct			Nov		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
<u>Oligochaeta</u>						
Branchiura	191	31.2	[illegible]	[illegible]	[illegible]	[illegible]
Limnodrilus	191	31.2	[illegible]	211	32.4	17.0
Peloscolex	[illegible]	15.7	8.4	134	20.6	10.8
Immatures	[illegible]	[illegible] 100	[illegible]	[illegible]	17.7 100	[illegible]
Total	[illegible]			[illegible]		
% of Total Sample			[illegible]			[illegible]
<u>Diptera</u>						
Chironomus	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Procladius	172	32.1	[illegible]	211	32.4	17.0
Coelotanypus	172	32.1 100	[illegible]	[illegible]	[illegible] 100	[illegible]
Total	[illegible]			[illegible]		
% of Total Sample			[illegible]			44.7
TOTAL SAMPLE	1147			1344		

TABLE I-23

BENTHOS - SANDUSKY BAY, STATION 40

Taxa	July			Aug			Sept			Nov		
	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total	No./ sq.m.	% of Taxa	% of Total
Oligochaeta												
Branchiura	0	0.0	0.0	0	0.0	0.0	134	31.8	21.9	211	33.3	17.8
Limnodrilus	57	60.0	50.0	0	0.0	0.0	191	45.4	31.2	211	33.3	17.8
Peloscolex	0	0.0	0.0	38	66.7	66.7	19	4.5	3.1	115	18.2	9.7
Immatures	38	40.0	33.3	19	33.3	33.3	77	18.3	12.6	96	15.2	8.1
		100			100			100			100	
Total	95			57			421			633		
% of Total Sample			83.3			100.0			68.7			53.3
Diptera												
Chironomus	0	0.0	0.0	0	0.0	0.0	96	50.0	15.7	191	34.5	16.1
Procladius	19	100	16.7	0	0.0	0.0	77	40.1	12.6	191	34.5	16.1
Coelotanypus	0	0.0	0.0	0	0.0	0.0	19	9.9	3.1	172	31.0	14.5
		100			100			100			100	
Total	19			0			192			554		
% of Total Sample			16.7			0.0			31.3			46.7
TOTAL SAMPLE	114			57			613			1187		

APPENDIX J

BENTHIC DIVERSITY INDICES

TABLE J-1

DIVERSITY INDICES RELATING TO BENTHIC INVERTEBRATES IN SANDUSKY BAY

MAY 1973

Station No.	Number of Species	Number of Organisms	D	$\bar{D}$	D max	D min	R	D exact
5	4	345	146.2	0.4233	203.4	-516.6	0.8112	-380.6
8	6	1417	568.7	0.4013	1095	-2743	0.8570	-2195
9	3	133	62.32	0.4686	61.25	-161.0	0.7472	-104.8
13	6	498	325.1	0.6528	381.1	-736.2	0.7246	-428.5
17	7	823	650.6	0.7906	687.3	-1342	0.6905	-713.7
19	6	1053	700.9	0.6657	812.2	-1302	0.7491	-1221
21	7	1245	840.5	0.6751	1043	-2256	0.7524	-1439
29	5	3120	1185	0.3797	2174	-7362	0.8777	-6196
31	7	6737	3445	0.5113	5683	-17170	0.8505	-13750
33	5	4237	1385	0.3230	2989	-10710	0.9003	-9344
35	7	6483	2654	0.4091	5472	-16430	0.8801	-13800
36	8	6164	2483	0.4028	5554	-15110	0.8814	-12660
38	8	1673	1318	0.7847	1506	-3163	0.7240	-1874

JUNE 1973

Station No.	Number of Species	Number of Organisms	D	$\bar{D}$	D max	D min	R	D exact
5	5	288	159.6	0.5579	195.1	-376.4	0.7433	-229.6
8	6	497	363.4	0.7312	380.3	-734.3	0.6898	-388.5
8	3	172	63.2	0.3675	79.75	-227.4	0.8148	-170.5
16	6	612	441.9	0.7221	469.6	-960.0	0.7037	-536.4
17	7	572	337.1	0.6442	475.7	-841.2	0.7143	-464.9
19	6	690	434.8	0.6302	530.2	-1119	0.7474	-702.2
21	5	593	287.2	0.4843	409.1	-969.9	0.8022	-697.1
29	6	439	166.0	0.3781	335.3	-624.6	0.8440	-474.9
31	7	3024	1689.0	0.5586	2546.0	-6650.0	0.8192	-4988
33	8	3483	1754.0	0.5036	3134.0	-7671.0	0.8405	-594.8
35	7	4249	2175.0	0.5120	3580.0	-9974	0.8416	-7827
36	7	4077	2387.0	0.5855	3435.0	-9497	0.8176	-7138
38	7	2467	1192.0	0.4834	2075.0	-5206	0.8398	-4040

JULY 1973

Station No.	Number of Species	Number of Organisms	D	$\bar{D}$	D max	D min	R	D exact
1	2	402	54.63	0.1359	119.6	-751.8	0.9418	-700.0
3	2	210	53.32	0.2539	61.98	-333.7	0.8742	-234.0
4	3	95	39.21	0.4127	43.27	-101.1	0.7673	-87.51
5	3	114	50.07	0.4392	52.25	-130.3	0.7580	-85.16
6	5	707	363.0	0.5135	488.6	-1211.0	0.7952	[illegible]
7	6	573	325.3	0.5678	439.3	-832.3	0.7671	-374.5
8	4	172	90.57	0.5266	100.2	-205.2	0.7332	-123.7
9	5	517	322	0.6229	356.1	-814.5	0.7373	-507.0
10	6	306	216.4	0.7071	232.2	-386.8	0.6783	-153.4
11	7	1169	938.0	0.8024	979.3	-2086.0	0.7018	-1172.0
12	5	364	187.9	0.5163	249.5	-517.5	0.7724	-342.9
13	4	287	141.6	0.4933	169.1	-406.7	0.7715	-275.2
14	4	211	115.6	0.5478	123.6	-270.6	0.7310	-164.5
15	2	96	20.74	0.2161	27.81	-120.2	0.6739	-102.4
16	2	96	20.74	0.2161	27.81	-120.2	0.8739	-102.4
17	8	956	716.9	0.7499	853.7	-1565.0	0.7144	-874.2
18	6	306	209.7	0.6854	232.2	-393.8	0.6539	-193.0
19	6	535	350.5	0.6551	409.8	-807.7	0.7255	-474.8
20	3	95	39.21	0.4127	43.27	-101.1	0.7673	-87.51
21	4	498	297.8	0.5980	295.8	-825.6	0.7443	-539.1
22	1	19	0.0	0.0	0.0	-34.17	0.5	-17.39
23	5	133	89.52	0.6731	88.87	-130.2	0.6422	-51.92
24	7	517	410.2	0.7935	429.3	-737.3	0.6552	-347.9
25	4	459	228.0	0.4968	272.4	-744.6	0.7365	-527.5
26	6	267	169.8	0.7073	202.0	-321.5	0.6590	-148.2
27	6	422	305.8	0.7245	322.2	-593.1	0.6546	-304.4
28	7	305	234.3	0.7683	250.9	-364.0	0.6492	-146.3
29	3	249	114.3	0.4592	116.3	-359.3	0.7739	-251.9
30	4	766	381.0	0.4974	456.9	-1414.0	0.8027	-1045.0
31	5	478	222.9	0.4663	328.9	-735.7	0.8038	-527.5
32	5	287	157.2	0.5477	195.8	-378.1	0.7484	-233.7
33	4	862	473.3	0.5491	514.6	-1635.0	0.7838	-1174.0
35	6	613	401.1	0.6543	470.4	-952.1	0.7325	-579.0
36	5	498	263.0	0.5280	342.8	-776.4	0.7777	-527.7
37	5	191	112.5	0.5888	129.1	-217.4	0.7093	-116.9
38	4	421	230.0	0.5463	249.5	-667.1	0.7310	-448.0
39	5	325	140.2	0.4315	222.3	-445.9	0.8094	-318.5
40	3	114	50.07	0.4392	52.25	-130.3	0.7580	-83.15

TABLE J-1. (Continued)

DIVERSITY INDICES RELATING TO BENTHIC INVERTEBRATES IN SANDUSKY BAY

AUGUST 1973

Station No.	Number of Species	Number of Organisms	D	$\overline{D}$	D max	D min	R	D exact
5	3	191	52.83	0.2766	83.77	-281.2	0.8670	-214.7
6	7	495	317.4	0.6339	411.6	-698.3	0.7322	-401.1
8	4	172	74.64	0.4340	100.2	-205.2	0.7849	-139.5
16	4	172	74.64	0.4340	100.2	-205.2	0.7849	-139.5
17	5	459	268.1	0.5842	315.7	-699.2	0.7498	-445.3
19	5	344	192.7	0.5602	235.5	-480.8	0.7494	-301.1
21	7	305	239.3	0.7846	250.9	-354.0	0.6412	-143.4
29	5	766	455.7	0.5949	529.8	-1333.0	0.7643	-898.3
31	6	555	377.7	0.6805	425.4	-846.8	0.7171	-486.9
33	4	191	106.0	0.5550	111.6	-236.6	0.7225	-140.0
35	8	535	454.5	0.8495	474.4	-739.3	0.6452	-308.7
36	6	824	571.3	0.6933	634.2	-1400.0	0.7286	-847.8
37	6	383	257.5	0.7034	270.4	-486.2	0.6940	-245.2
39	4	172	74.64	0.4340	100.2	-205.2	0.7849	-139.5
40	2	57	15.76	0.2764	16.18	-58.67	0.8256	-45.62
41	2	555	111.0	0.200	155.8	-1115.0	0.9165	-1009.0
43	2	57	15.76	0.2764	16.18	-58.67	0.8256	-45.62
44	3	57	27.20	0.4771	25.36	-48.05	0.6982	-25.89

OCTOBER 1973

Station No.	Number of Species	Number of Organisms	D	$\overline{D}$	D max	D min	R	D exact
5	7	689	555.2	0.8058	574.3	-1070.0	0.6756	-533.4
6	7	632	509.8	0.8067	526.3	-957.2	0.6709	-469.0
8	7	900	676.0	0.7511	752.3	-1503.0	0.7103	-849.4
16	7	1015	802.2	0.7903	849.3	-1748.0	0.7002	-953.4
17	7	1110	923.7	0.8321	929.5	-1955.0	0.6981	-1033.0
19	7	1264	1011.0	0.7998	1059.0	-2298.0	0.7062	-1312.0
21	7	1147	941.7	0.8210	960.7	-2037.0	0.6939	-1119.0
29	7	1436	1161.0	0.8086	1205.0	-2691.0	0.7033	-1555.0
31	7	1339	1098.0	0.8123	1123.0	-2469.0	0.7040	-1405.0
33	7	1283	1050:0	0.8183	1076.0	-2341.0	0.6999	-1315.0
36	7	1301	1088.0	0.8362	1091.0	-2392.0	0.6938	-1319.0
37	7	1111	890.7	0.8017	930.3	-1957.0	0.6998	-1031.0
38	7	1550	1293.0	0.8340	1301.0	-2957.0	0.7023	-1639.0
39	7	1147	957.9	0.8352	960.7	-2037.0	0.6885	-1103.0
41	2	1895	287.5	0.1517	538.7	-4818.0	0.9475	-4535.0
43	3	325	122.5	0.3770	152.5	-519.7	0.8293	-404.2
44	3	230	88.61	0.3853	107.3	-333.2	0.8140	-251.3
Mean	6	1081	791	0.7216	833	-2004	0.7254	-1234

SEPTEMBER 1973

Station No.	Number of Species	Number of Organisms	D	$\overline{D}$	D max	D min	R	D exact
5	7	535	324.3	0.6062	444.5	-771.1	0.7499	-467.0
6	7	535	324.3	0.6062	444.5	-771.1	0.7499	-467.0
8	6	631	331.8	0.5258	484.4	-998.3	0.7882	-684.3
16	6	536	324.7	0.6058	410.6	-809.7	0.7481	-502.3
17	6	707	518.9	0.7339	543.4	-1154.0	0.7054	-653.7
19	7	1264	904.4	0.7155	1059.0	-2298.0	0.7378	-1418.0
21	6	785	587.3	0.7482	604.0	-1317.0	0.7042	-748.9
29	7	1224	722.2	0.5900	1026.0	-2208.0	0.7839	-1510.0
31	6	1244	735.5	0.5395	960.6	-2338.0	0.7650	-1562.0
33	7	994	727.4	0.7318	831.6	-1703.0	0.7221	-998.5
35	7	881	624.8	0.7092	736.3	-1463.0	0.7261	-860.5
36	7	899	693.6	0.7715	751.4	-1501.0	0.7021	-829.7
37	7	900	658.6	0.7318	752.3	-1503.0	0.7180	-866.7
38	7	1262	940.8	0.7455	1058.0	-2294.0	0.7265	-1377.0
39	7	785	611.1	0.7785	655.3	-1264.0	0.6932	-674.8
40	7	613	458.6	0.7481	510.2	-920.2	0.6942	-482.8
41	3	1263	478.9	0.3792	599.4	-2765.0	0.8603	-2295.0
43	2	229	44.69	0.1952	67.66	-372.5	0.9054	-331.3
44	2	172	47.45	0.2758	50.56	-258.5	0.8576	-214.5
Mean	6	814	533	0.6230	631	-1408	0.7547	-892

NOVEMBER 1973

Station No.	Number of Species	Number of Organisms	D	$\overline{D}$	D max	D min	R	D exact
5	7	728	599.2	0.8231	607.2	-1148.0	0.6712	-570.8
6	7	670	549.5	0.8202	558.3	-1032.0	0.6692	-534.3
8	7	938	740.1	0.7890	734.3	-1583.0	0.6971	-886.1
16	7	1035	847.1	0.8185	856.2	-1791.0	0.6901	-948.0
17	7	1225	1025.0	0.8366	1027.0	-2211.0	-.6909	-1210.0
19	7	1264	991.7	0.7846	1059.0	-2298.0	0.7119	-1331.0
21	7	1167	966.4	0.8281	977.6	-2081.0	0.6919	-1139.0
29	7	1475	1202.0	0.8146	1239.0	-2782.0	0.7073	-1605.0
31	7	1378	1138.0	0.8260	1156.0	-2558.0	0.7001	-1444.0
33	7	1322	1073.0	0.8115	1108.0	-2430.0	0.7037	-1332.0
35	7	1339	1117.0	0.8340	1123.0	-2469.0	0.6959	-1377.0
36	7	1301	1087.0	0.8355	1091.0	-2392.0	0.6941	-1320.0
37	7	1110	904.0	0.8145	929.5	-1955.0	0.6949	-1075.0
38	7	1530	1267.0	0.8279	1234.0	-2910.0	0.7040	-1666.0
39	7	1244	1040.0	0.8361	1043.0	-2253.0	0.6918	-1233.0
40	7	1187	985.4	0.8301	994.5	-2126.0	0.6919	-1155.0
41	2	1492	349.9	0.2345	447.5	-3639.0	0.9155	-3294.0
43	2	211	63.15	0.2993	62.26	-335.8	0.8504	-275.2
44	3	344	129.5	0.3765	161.5	-558.6	0.8301	-433.2
Mean	6	1103	820	0.7390	869	-2029	0.7211	-1204

TABLE J-1. (Continued)

DIVERSITY INDICES RELATING TO BENTHIC INVERTEBRATES
IN SANDUSKY BAY

JANUARY 1974

Station No.	Number of Species	Number of Organisms	D	$\overline{D}$	D max	D min	R	D exact
5	7	824	683.6	0.8296	688.2	-1344.0	0.6748	-683.1
6	7	825	677.5	0.8212	689.0	-1348.0	0.6793	-691.2
8	7	1129	914.0	0.8096	945.5	-1997.0	0.6975	-1107.0
16	7	1243	1044.0	0.8396	1042.0	-2251.0	0.6905	-1232.0
17	7	1435	1202.0	0.8377	1204.0	-2539.0	0.6976	-1512.0
19	7	1493	1186.0	0.7943	1253.0	-2623.0	0.7152	-1663.0
21	7	1646	1382.0	0.8395	1392.0	-3193.0	0.7029	-1827.0
29	7	1837	1523.0	0.8292	1543.0	-3640.0	0.7112	-2143.0
31	7	1704	1416.0	0.8309	1431.0	-3321.0	0.7075	-1931.0
33	7	1647	1368.0	0.8307	1353.0	-3185.0	0.7061	-1843.0
37	7	1511	1241.0	0.8212	1258.0	-2855.0	0.7059	-1650.0
Mean	7	1390	1149	0.8258	1166	-2604	0.6989	-1480

MARCH 1974

Station No.	Number of Species	Number of Organisms	D	$\overline{D}$	D max	D min	R	D exact
5	7	1035	851.3	0.8226	866.2	-1791.0	0.6886	-963.7
6	7	939	780.4	0.8311	785.2	-1585.0	0.6805	-828.1
8	7	1262	1044.0	0.8272	1058.0	-2294.0	0.6958	-1274.0
16	7	1359	1136.0	0.8360	1140.0	-2514.0	0.6958	-1403.0
17	7	1549	1296.0	0.8356	1300.0	-2954.0	0.7014	-1684.0
19	7	1550	1244.0	0.8028	1301.0	-2957.0	0.7136	-1737.0
21	7	1667	1402.0	0.8413	1400.0	-3233.0	0.7028	-1856.0
29	7	1953	1626.0	0.8325	1541.0	-3923.0	0.7125	-2323.0
31	7	1702	1410.0	0.8286	1429.0	-3316.0	0.7082	-1931.0
33	7	1609	1350.0	0.8328	1351.0	-3095.0	0.7022	-1771.0
37	7	1454	1204.0	0.8283	1220.0	-2733.0	0.7016	-1554.0
Maan	7	1462	1213	0.8295	1226	-2763	0.7003	-1575

TABLE K-1. (Continued)

Date	Station	Total Phosphate mg/1	Dissolved Orthophosphate mg/1	NO_3-N mg/1	Org.-N mg/1	Org.-C mg/1	Solar Isolation Langleys/12 hr.day	Water Temperature °C	Secchi disc Transparancy cm	Primary Productivity mgC m^{-2} day^{-1}	pH	Total Alkalinity mg/1 ($CaCO_3$)
10-24-73	1	2.720	1.320	0.03	0.224	19	281	12.7	38	53.2	8.7	115.5
	2	1.990	0.430	0.02	0.196	14		13.0	35	55.8	8.6	107.5
	3							12.4	42	60.0	8.6	112.5
	4	1.630	0.520	0.02	0.280	18		13.0	44	38.2	8.7	122.5
	5							12.8	33	29.2	8.7	137.5
	6	1.270	0.320	0.02	0.252	21		13.2	36	44.5	8.7	120.5
	7	0.940	0.280	0.02	0.336	22						
	8	1.910	0.370	0.44	0.308	18						
	9	1.350	0.280	0.02	0.112	12						
	10	8.350	0.320	0.40	0.280	18						
	11	0.660	0.170	0.03	0.196	18						
11-7-73	1	0.246	0.083	0.025	0.140	18	333	6.0	25	17.6	8.5	119.0
	2	0.153	0.039	0.037	0.182	13		6.0	42	27.2	8.6	111.0
	3							6.0	30	19.8	8.6	114.0
	4	0.172	0.085	0.023	0.196	13		6.0	-	30.1	8.7	117.5
	5							5.5	29	20.8	8.7	146.0
	6	0.220	0.058	0.036	0.182	15		6.0	22	36.5	8.5	118.5
	7	0.265	0.124	0.294	0.364	22						
	8	1.220	0.258	0.313	0.182	14						
	9	0.148	0.120	0.115	0.154	11						
	10	5.200	3.420	1.600	0.316	15						
	11	0.130	0.101	1.250	0.266	12						
3-20-74	1	0.938	0.112	4.110	1.372	15	404	3.3	24	7.8	8.2	109.0
	2	0.450	0.121	4.440	1.176	11		3.5	18	9.7	8.1	110.0
	3							3.5	22	21.4	8.1	113.0
	4	0.600	0.145	4.290	1.269	12		3.5	11	1.7	8.1	92.5
	5							4.0	6	0.0	8.0	99.0
	6	0.590	0.134	4.620	1.246	13		4.0	9	2.4	8.1	100.5
	7	0.257	0.082	6.600	0.658	9						
	8	1.000	0.324	4.560	1.092	17						
	9	0.366	0.090	4.860	0.714	11						
	10	1.810	0.858	7.860	1.232	14						
	11	0.286	0.110	5.490	0.546	8						
4-3-74	1	0.404	0.124	4.250	1.050	11	195	6.3	18	3.9	7.6	102.0
	2	0.320	0.104	3.380	0.952	12		6.9	24	14.1	8.0	104.5
	3							6.4	20	13.4	7.9	104.5
	4	0.480	0.154	4.025	1.027	13		6.0	16	2.4	7.9	104.5
	5							8.0	15	11.0	8.1	131.0
	6	0.410	0.115	3.930	0.966	11		6.8	20	4.8	8.0	109.5
	7	0.180	0.046	5.630	0.728	9						
	8	0.636	0.217	3.160	0.938	12						
	9	0.280	0.085	3.660	0.714	10						
	10	1.415	0.853	5.125	1.386	21						
	11	0.260	0.086	4.690	0.658	9						
4-17-74	1	0.402	0.089	3.675	0.910	12	464	9.0	18	7.5	8.1	108.5
	2	0.222	0.046	1.800	0.644	10		9.0	18	9.4	8.0	100.5
	3							9.6	16	7.4	7.9	108.0
	4	0.440	0.124	4.025	1.106	12		9.8	12	4.1	7.9	114.0
	5							9.9	10	4.7	7.8	105.5
	6	0.554	0.127	3.800	1.176	13		10.1	13	2.4	7.8	105.0
	7	0.318	0.048	4.530	0.840	11		10.0				
	8	0.586	0.224	3.675	0.896	12		11.1				
	9	0.231	0.054	3.435	0.630	12		9.4				
	10	1.268	0.826	4.600	1.484	18		8.3				
	11	0.178	0.097	4.900	0.644	8		10.0				

TABLE K-1. (Continued)

Date	Station	Total Phosphate mg/l	Dissolved Orthophosphate mg/l	NO_3-N mg/l	Org.-N mg/l	Org.-C mg/l	Solar Isolation Langleys/12 hr.day	Water Temperature °C	Secchi disc Transparancy cm	Primary Productivity mgC m^{-2} day^{-1}	pH	Total Alkalinity mg/l ($CaCO_3$)
5-1-74	1	0.200	0.026	3.110	0.924	12	535	15.5	17	54.6	8.3	114.0
	2	0.217	0.024	2.910	0.728	11		15.5	30	97.0	8.5	113.5
	3							15.4	20	78.4	8.4	110.5
	4	0.235	0.044	3.140	0.910	11		15.3	20	85.2	8.3	112.0
	5							15.8	17	109.2	8.4	123.5
	6	0.250	0.066	3.320	0.840	-		15.6	21	59.6	8.3	111.0
	7	0.257	0.033	2.350	0.868	11		18.9				
	8	0.441	0.044	2.120	1.050	15		17.8				
	9	0.160	0.033	1.300	0.476	10		17.8				
	10	2.430	1.755	7.065	1.596	21		18.3				
	11	0.245	0.036	2.470	0.574	12		18.3				
5-15-74	1	0.330	0.013	1.30	1.624	23	297	14.8	12	67.7	8.7	102.0
	2	0.263	0.012	0.95	1.274	11		15.0	14	74.9	8.7	101.5
	3							15.1	16	30.4	8.7	102.0
	4	0.192	0.018	1.83	1.260	17		15.1	14	68.0	8.7	104.0
	5							15.5	14	47.2	8.7	104.0
	6	0.161	0.018	1.55	1.400	13		15.5	19	65.2	8.6	108.0
	7	0.055	0.057	4.70	0.980	11		14.4				
	8	0.208	0.162	0.73	1.022	14		15.0				
	9	0.146	0.096	4.58	0.756	13		13.8				
	10	0.562	0.468	6.68	1.162	15		14.4				
	11	0.103	0.078	9.38	0.924	13		14.4				
5-29-74	1	0.196	0.016	0.82	1.204	15	243	17.2	32	112.4	8.7	112.0
	2	0.188	0.012	0.74	1.078	12		17.5	32	137.4	8.8	107.0
	3							17.0	29	108.2	8.8	107.0
	4	0.260	0.043	0.65	1.302	14		17.2	26	94.8	8.8	109.5
	5							17.5	24	118.4	8.8	114.0
	6	0.202	0.013	0.75	1.232	13		17.5	30	127.7	8.6	101.0
	7	0.183	0.016	2.25	1.218	13		17.8				
	8	0.288	0.220	5.53	1.078	13		18.3				
	9	0.104	0.086	0.83	0.616	9		12.2				
	10	0.988	0.588	2.19	0.994	13		13.3				
	11	0.052	0.057	1.82	0.896	11		14.4				
6-12-71	1	0.174	0.079	0.25	1.003	10	578	19.0	22	56.0	8.3	100.5
	2	0.179	0.064	0.28	0.872	9		19.8	23	74.3	8.3	103.5
	3							20.4	20	93.3	8.5	106.0
	4	0.199	0.071	0.04	1.308	14		20.2	24	151.9	8.5	131.5
	5							20.1	25	145.7	8.4	107.5
	6	0.204	0.059	0.08	1.366	10		20.1	25	105.1	8.3	100.5
	7	0.139	0.072	6.43	1.439	16		17.8				
	8	0.612	0.244	6.26	1.468	12		17.8				
	9	0.059	0.071	0.95	1.381	10		22.0				
	10	1.420	0.906	2.63	1.178	15		17.8				
	11	0.081	0.076	3.37	0.843	13		20.0				
6-25-74	1	0.176	0.058	0.02	1.134	17	524	19.5	47	203.6	9.0	113.0
	2	0.134	0.033	0.02	0.966	12		19.5	34	160.2	9.1	107.5
	3							19.5	37	249.7	9.1	113.0
	4	0.206	0.038	0.02	1.386	20		19.5	42	265.1	9.0	112.5
	5							19.9	23	176.7	8.5	146.0
	6	0.178	0.036	0.01	1.260	19		20.0	23	215.0	8.9	120.0
	7	0.163	0.077	11.13	0.742	11		18.9				
	8	0.440	0.181	3.50	1.624	18		-				
	9	0.218	0.146	8.25	0.784	12		16.1				
	10	0.843	0.564	11.63	1.414	16		16.7				
	11	0.169	0.094	8.88	0.952	12		18.3				

(1) Values for total phosphorus, Orthophosphate, nitrate, organic nitrogen, and organic carbon are averages from duplicate determinations.

APPENDIX L

MONTHLY DISTRIBUTION OF FISHES TAKEN IN SANDUSKY BAY
November, 1972 to January, 1974

MONTHLY DISTRIBUTION OF FISH TAKEN FROM SANDUSKY BAY

November, 1972 - January, 1974

Species	Month 11-72				Month 5-15-73				Month 5-31-73	
					Station and Gear					
	Shore Seine	Bag Seine	Gill Net	Fyke Net		5-d	21-c		5-b	
gizzard shad	151	2	15	33		21			2	
northern pike										
carp	2125	1				4	1			
goldfish	339									
carp X goldfish										
emerald shiner		5								
spotfin shiner										
quillback										
channel catfish									1	
brown bullhead catfish	11			7						
white bass	294	2	3	22					15	
white crappie	11	9	10	10		1			2	
black crappie										
walleye	7						1		3	
yellow perch	11	9	24	35					5	
freshwater drum	98								14	
muskellunge			1	1						
chain pickerel			2							
common white sucker	3									
brook silversides		1								

Month 6-21-73

Species	Station and Gear								
	4-a	17-a	21-c	5-d	16-c	28-a	39-a	Rock Beach a	Ditch - a
gizzard shad	4	3	15					1	
northern pike									
carp		5	33						
goldfish			3						
carp X goldfish									
emerald shiner					400	17		30	4
spotfin shiner								1	
quillback									
channel catfish		1	3						
brown bullhead catfish			1						
white bass									
white crappie				5	2		1	11	
black crappie									
walleye		1							
yellow perch		21	14			1			
freshwater drum		3	7	1					
muskellunge									
chain pickerel									
common white sucker									
brook silversides									

a. 100' shore seine
b. 3000' commercial seine
c. gill net
d. fyke net

MONTHLY DISTRIBUTION OF FISH TAKEN FROM SANDUSKY BAY

November, 1972 - January, 1974

	Month 7-19-73					Month 8-9-73				
Species	Station and Gear									
	16-a	39-a	29-a	40-a		16-a	40-a	39-a	26-a	
gizzard shad	1254	92	3			114	28	14	79	
northern pike										
carp										
goldfish										
carp X goldfish										
emerald shiner	12	1	80	33		39	9	2	6	
scotfin shiner				1		2			2	
quillback										
channel catfish						3				
brown bullhead catfish										
white bass										
white crappie			2						3	
black crappie				2		1				
walleye										
yellow perch						4		2		
freshwater drum										
muskellunge										
chain pickerel										
common white sucker										
brook silversides										

	Month 8-9-73			Month 9-2-73				Month 1-74		
Species				Station and Gear						
	21-c	17-c		5-d	17-c	21-c		6 Trawl	8 Trawl	
gizzard shad	39	14			1	9		93	114	
northern pike		1								
carp		12		2		2				
goldfish	1	1								
carp X goldfish	1	2						12	20	
emerald shiner										
scotfin shiner										
quillback						1				
channel catfish	4	1			1	1				
brown bullhead catfish				2						
white bass	4	7			4	2				
white crappie	1	1		2	3					
black crappie										
walleye	2	2				5				
yellow perch	42	47			15	20		8	2	
freshwater drum		6								
muskellunge										
chain pickerel										
common white sucker										
brook silversides										

a. 100' shore seine
b. 3000' commercial seine
c. gill net
d. fyke net

APPENDIX M

PARASITE FAUNA OF FISHES IN SANDUSKY BAY AND WESTERN LAKE ERIE

BLE M-1. PARASITE SPECIES IN SANDUSKY BAY FISHES[a]

	Scientific Name	Parasite Species[b]
	Alosa pseudoharengus	28,38,48,131
	Fundulus diaphanus	28,38,43,86,95,122,124a,128
	Ictiobus cyprinellus	No data
	Ictalurus melas	1,6,9,18,20,26,28,29,32,37,38,69,71,78,112,122,137,138,149
	Pomoxis nigromaculatus	20,28,29,38,55,78,81,89,95,129,149
r	Notropis heterodon	28,29,38,142
r	Notropis heterolepis	44,128,129
r	Percina maculata	29,38,44,129
	Lepomis macrochirus	14,18,19,20,28,29,43,44,55,61,68,78,81,103,104,112,114,122,124,126,129,137,144,147,148
	Stizostedion vitreum glaucum	15a,17,66,78,85,91,103,115,122a,144
ow[c]	Pimephales notatus	28,29,31,38,43,44,55,77,94,95,114
	Amia calva	21,28,32,35,41,74,78,82,118,122,141
m	Noturus miurus	No data
d	Labidesthes sicculus	3,8,28,38,43,56,68,78,128,129
	Ictalurus nebulosus	1,6,10,18,20,28,29,38,51,53,54a,61,69,71,78,81,94,95,101,105,111,114,122,128,138,149
	Lota lota	28,64,112,129
	Cyprinus carpio	28,29,43,76,94,95,114,126,128,129
[illegible]	Umbra limi	151
sh	Ictalurus punctatus	1,6,9,14,22,28,29,36,37,51,54,63,68,69,70,94,95,100,105,110,114,122,127,128,129,138,140,149
r	Percina copelandi	5,29,38,44,61,66,78,111,114,129
n	Oncorhynchus tschawytscha	No data
	Oncorhynchus kisutch	No data
	Notropis cornutus	7,18,28,29,31,38,44,77,94,95,129,146
r	Notropis atherinoides	28,29,31,33,38,43,44,55,66,78,86,95,129,146
ow	Pimephales promelas	44,86
rum	Aplodinotus grunniens	11,20,26,28,30,38,39,40,44,50,55,61,66,68,78,81,95,102,103,110,112,114,122,128,129,131,137,140,144,149,150
	Dorosoma cepedianum	28,46,55,95,128,143
rse	Moxostoma erythrurum	No data
r	Notemigonus crysoleucas	28,38,44,95,128
	Carassius auratus	28,29,106,127,128
rel	Esox americanus vermiculatus	12,17,18,28,36,44,83,149
sh	Lepomis cyanellus	14,21,26,28,29,44,55,56,68,78,86,103,111,114,122,129,132,145
arter	Etheostoma blennioides	5,8,28,29,38,44,55,61,78,117,129
	Etheostoma exile	8,66,122,128
er	Etheostoma nigrum	5,18,28,29,33,38,43,44,55,61,67,78,114,122,128,129
[illegible]	Erimyzon sucetta	44
son	Acipenser fulvescens	8,25,134
fish	Coregonus clupeaformis	64,79,88,119,121,136
bass	Micropterus salmoides	16,21,27,28,29,32,38,43,44,55,58,68,78,80,81,89,93,95,96,97,99,103,104,113,117,122,124,128,129,132,137,139,148

m (1972); Bangham and Hunter (1939)

ble M-2.

nt fish species

TABLE M-1. (Continued)

Common Name	Scientific Name	Parasite Species
Logperch	*Percina caprodes*	5,18,29,32,33,38,44,61,67,78,81, 85,86,95,103,111,112,114,122, 128,129,140,144,147,149
Longear sunfish	*Lepomis megalotis*	18,28,29,38,43,44,55,148
Longnose gar	*Lepisosteus osseus*	28,34,68,78,84,122,135
Mimic shiner	*Notropis volucellus*	28,29,31,38,44,55,61,126,146,147
Mooneye	*Hiodon tergisus*	23,28,33,49,55,61,66,86,129,146
Muskellunge	*Esox masquinongy*	No data
Northern hogsucker	*Hypentelium nigricans*	18,44,72,95,126
Northern pike	*Esox lucius*	83
Orangespotted sunfish	*Lepomis humilis*	29,38,52,55,148
Pumpkinseed	*Lepomis gibbosus*	12,14,18,20,21,28,29,43,55,78, 94,95,103,108,112,114,122,124, 126,128,129,148
Quillback	*Carpiodes cyprinus*	28,44,47,62,75,95,109,126
Rainbow smelt	*Osmerus mordax*	26,28,57,61,95,120,143
Rock bass	*Ambloplites rupestris*	14,18,20,21,27,28,29,43,55, 61,65,68,78,81,89,95,98,103, 104,107,111,114, 122,124,126,128,129, 130,133,137,144,147,148
Sand shiner	*Notropis stramineus*	18,31,44,55,95
Sauger	*Stizostedion canadense*	12,15a,17,44,66,78,85,89,91, 95,103,114,115,124a,129
Sea lamprey	*Petromyzon marinus*	No data
Shorthead redhorse	*Moxostoma macrolepidotum*	95,146
Silver chub	*Hybopsis storeriana*	7,18,28,29,31,38,44,61,77,95, 122,128,146
Silver lamprey	*Ichthyomyzon unicuspis*	No data
Silver redhorse	*Moxostoma anisurum*	No data
Smallmouth bass	*Micropterus dolomieui*	12,15,17,18,21,27,28,29,32,38, 41,45,55,58,65,68,78,80,81,92, 94,95,96,99,104,108,112,114, 116,122,124,128,129,148
Spotfin shiner	*Notropis spilopterus*	28,29,31,38,44,55,86,94,95,111, 114,129,142,147
Spotted gar	*Lepisosteus oculatus*	No data
Spotted sucker	*Minytrema melanops*	44,73,95,126,145
Spottail shiner[c]	*Notropis hudsonius*	28,29,31,38,44,55,61,77,78,86, 95,108,114,126,128,129,146
Stonecat	*Noturus flavus*	9,28,29,37,38,69,78,122,129,149
Stoneroller	*Campostoma anomalum*	18,28,38,43,44,55,111
Tadpole madtom	*Noturus gyrinus*	1,9,105
Troutperch	*Percopsis omiscomaycus*	24,28,29,38,43,55,60,61,65,81, 92,95,103,114,122,128,129,149
Walleye	*Stizostedium v. vitreum*	12,13,15a,17,28,29,44,59,66, 78,85,89,90,91,103,112,114,115, 122,128,137,149
White bass[c]	*Roccus chrysops*	2,3,14,20,28,29,33,44,61,66,68, 78,81,89,95,101,103,114,128,129, 137,147,148,149
White crappie[c]	*Pomoxis annularis*	14,20, 27,28,29,44,55,68,78,81,95 122,124,128,129,147,149
White sucker	*Catostomus commersoni*	28,44,62,77,89,95,103,108,123, 125,126,128
Yellow bullhead	*Ictalurus natalis*	1,6,14,28,29,38,53,68,69,78,94, 95,111,138
Yellow perch[c]	*Perca flavescens*	4,12,14,18,20,27,28,29,33,41, 44,61,66,78,81,89,91,95,101, 103,110,114,122,126,128,129,137, 140,144,150

TABLE M-2. CHECKLIST OF PARASITES[a]

Trematoda

1. *Acetodextra amiuri*
2. *Allacanthochasmus artus*
3. *Allacanthochasmus varius*
4. *Allacanthochasmus* sp.
5. *Allocreadium boleosomi*
6. *Allocreadium ictaluri*
7. *Allocreadium lobatum*
8. *Allocreadium* sp.
9. *Alloglossidium corti*
10. *Alloglossidium geminus*
11. *Anallocreadium pearsei*
12. *Azygia angusticauda*
13. *Bucephalopsis pusilla*
14. *Bucephalus elegans*
15. *Bucephalus papillosus*
15a. *Bucephalus pusillus*
16. *Caecincola parvulus*
17. *Centrovarium lobotes*
18. *Clinostomum marginatum*
19. *Crassiphiala ambloplitis*
20. *Crepidostomum cooperi*
21. *Crepidostomum cornutum*
22. *Crepidostomum ictaluri*
23. *Crepidostomum illinoiense*
24. *Crepidostomum isostomum*
25. *Crepidostomum lintoni*
26. *Crepidostomum* sp.
27. *Cryptogonimus chyli*
28. *Diplostomulum* sp.
29. Gyrodactyloidea
30. *Homalometron armatum*
31. *Lebouria cooperi*
32. *Leuceruthrus micropteri*
33. *Leuceruthrus* sp.
34. *Macroderoides spinifera*
35. *Macroderoides typica*
36. *Macroderoides* sp.
37. *Megalogonia ictaluri*
38. Metacercariae
39. *Microcotyle eriensis*
40. *Microcotyle spinicirrus*
41. *Microphallus opacus*
42. *Neascus bulboglossa*
43. *Neascus vancleavi*
44. *Neascus* sp.
45. *Neochasmus umbellus*
46. *Octobothrium* sp.
47. *Octomacrum lanceatum*
48. *Octomacrum* sp.
49. *Paurorhynchus hiodontis*
50. *Phyllodistomum fausti*
51. *Phyllodistomum lacustri*
52. *Phyllodistomum lohrenzi*
53. *Phyllodistomum staffordi*
54. *Phyllodistomum* sp.
55. *Posthodiplostomum minimum*[b]
56. *Proterometra macrostoma*
57. *Proterometra* sp.
58. *Rhipidocotyle papillosum*
59. *Sanguinicola occidentalis*[b]
60. *Tetracotyle diminuta*
61. *Tetracotyle* sp.[b]
62. *Triganodistomum attenuatum*
63. *Vietosoma parvum*

Cestoda

64. *Abothrium crassum*
65. *Bothriocephalus claviceps*
66. *Bothriocephalus cuspidatus*
67. *Bothriocephalus formosus*
68. *Bothriocephalus* sp.
69. *Corallobothrium fimbriatum*
70. *Corallobothrium giganteum*
71. *Corallobothrium* n. sp.
72. *Glaridacris catostomi*
73. *Glaridacris* sp.
74. *Haplobothrium globuliforme*
75. *Hypocaryophyllaeus paratarius*
76. *Khawia iowensis*
77. *Ligula intestinalis*[b]
78. *Proteocephalus ambloplitis*[b]
79. *Proteocephalus exiguus*
80. *Proteocephalus fluviatilis*
81. *Proteocephalus pearsei*
82. *Proteocephalus perplexus*
83. *Proteocephalus pinguis*
84. *Proteocephalus singularis*
85. *Proteocephalus stizostethi*
86. *Proteocephalus* sp.
87. *Proteocephalus wickliffi*
88. *Schistocephalus* sp.
89. *Triaenophorus nodulosus*[b]
90. *Triaenophorus stizostedionis*
91. *Triaenophorus* n. sp.
92. *Triaenophorus* sp.

Protozoa

93. *Cyclochaeta domerguei*
94. *Ichthyophthirius multifiliis*[b]
95. Myxosporidia
96. *Myxobolus* sp.
97. Vorticellidae

Copepoda

98. *Achtheres ambloplitis*
99. *Achtheres micropteri*
100. *Achtheres pimelodi*
101. *Achtheres* sp.
102. *Argulus* sp.[b]
103. *Ergasilus caeruleus*

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[a] Bangham (1972); Bangham and Hunter (1939)

[b] Pathogenic parasite species

TABLE M-2. (Continued)

104. *Ergasilus centrarchidarum*
105. *Ergasilus versicolor*
106. *Lernaea cyprinacea*[b]
107. *Lernaea cruciata*
108. *Lernaea* sp.

Hirudinea

109. *Actinobdella triannulata*
110. *Illinobdella moorei*
111. *Illinobdella* sp.
112. *Piscicola punctata*
113. *Placobdella montifera*

Mollusca

114. Glochidia

Virus

115. *Lymphocystis* sp.

Fungus

116. *Saprolegnia parasitica*
117. *Saprolegnia* sp.

Acanthocephala

118. *Acanthocephalus dirus*
119. *Echinorhynchus coregoni*
120. *Echinorhynchus salmonis*
121. *Echinorhynchus* sp.
122. *Leptorhynchoides thecatus*
122a. *Leptorhynchoides* sp.
123. *Neoechinorhynchus crassus*
124. *Neoechinorhynchus cylindratus*
124a. *Neoechinorhynchus* sp.
125. *Octospinifer macilentus*
126. *Pomphorhynchus bulbocolli*[b]
127. *Pomphorhynchus* sp.

Nematoda

128. *Agamonema* sp.
129. *Camallanus oxycephalus*
130. *Capillaria catenata*
131. *Capillaria* sp.
132. *Contracaecum brachyurum*
133. *Contracaecum* sp.[b]
134. *Cucullanus clitellarius*
135. *Cystidicola lepisostei*
136. *Cystidicola stigmatura*
137. *Dichelyne cotylophora*
138. *Dichelyne robusta*
139. *Dioctophyme* sp.
140. *Eustrongylides* sp.[b]
141. *Haplonema immutatum*
142. *Hepaticola bakeri*
143. Nematode (gill cyst)
144. *Philometra cylindracea*[b]
145. *Philonema* sp.
146. *Rhabdochona cascadilla*
147. *Rhabdochona* sp.
148. *Spinitectus carolini*
149. *Spinitectus gracilis*
150. *Spinitectus* sp.
151. *Spiroxys* sp.

TABLE M-3. NEW PARASITE RECORDS FOR FISH IN WESTERN LAKE ERIE[a]

Common Name	Scientific Name	Parasite Species[b]
Black crappie	*Pomoxis nigromaculatus*	25,31,48,49
Bluegill	*Lepomis macrochirus*	17,35,38,39,48,49,66
Blue pike	*Stizostedion vitreum glaucum*	20
Brown bullhead	*Ictalurus nebulosus*	4,29,33,80
Carp	*Cyprinus carpio*	40,41,56,64,79
Channel catfish	*Ictalurus punctatus*	4,29,33
Common shiner	*Notropis cornutus*	42,64
Creek chub	*Semotilus atromaculatus*	8,23
Emerald shiner	*Notropis atherinoides*	42,64
Freshwater drum[c]	*Aplodinotus grunniens*	47,61,68,72
Gizzard shad	*Dorosoma cepedianum*	10,51
Golden redhorse	*Moxostoma erythrurum*	15,42,57,64,68,73
Goldfish	*Carassius auratus*	40,44
Largemouth bass	*Micropterus salmoides*	30,59
Logperch	*Percina caprodes*	32
Mooneye	*Hiodon tergisus*	52
Muskellunge	*Esox masquinongy*	64
Northern pike	*Esox lucius*	12,60,69,74
Pumpkinseed	*Lepomis gibbosus*	18,19,28,34,66
Quillback	*Carpiodes cyprinus*	7,12,14,15,16,53,55,68,68,70,75
Rainbow smelt	*Osmerus mordax*	2,64,74
Rock bass	*Ambloplites rupestris*	22,26,35,36,46,50,78
Sand shiner	*Notropis stramineus*	1
Sauger	*Stizostedion canadense*	20
Shorthead redhorse	*Moxostoma macrolepidotum*	15,42,46,55,57,58,64,68,73
Silver redhorse	*Moxostoma anisurum*	6,15,43,46,57
Smallmouth bass	*Micropterus dolomieui*	24,35,59
Spottail shiner	*Notropis spilopterus*	11,42,46,68,77
Stonecat	*Noturus flavus*	33
Tadpole madtom	*Noturus gyrinus*	29,33
Troutperch	*Percopsis omiscomaycus*	35
Walleye	*Stizostedion v. vitreum*	20,77a
White bass	*Roccus chrysops*	12,13,27
White crappie	*Pomoxis annularis*	25,31,37,48
White sucker	*Catostomus commersoni*	14,15,45,54,57,65,76
Yellow perch[c]	*Perca flavescens*	3,5,9,12,21,35,62,63,67[d],77

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[a] Dechtiar (1972)

[b] See Table M-4.

[c] The pathogen *Ichthyophthirius multifiliis* was also recorded for this host.

[d] New host record.

TABLE M-4. CHECKLIST OF PARASITES[a]

Protozoa

1. *Ceratomyxa* sp.
2. *Glugea hertwigi*[b]
3. *Henneguya doori*[b]
4. *Henneguya exilis*
5. *Icythyosporidium* sp.
6. *Myxobolus conspicuus*
7. *Myxosoma rotundum*
8. *Myxosoma pendula*
9. *Myxosoma scleroperca*[b]
10. *Plistophora cepedianae*
11. *Thelohanellus* sp.[b]
12. *Trichodina* sp.
13. *Trichophrya* sp.

Monogenea

14. *Acolpenteron catostomi*
15. *Anonchohaptor anomalum*
16. *Anonchohaptor* sp.
17. *Actinocleidus bakeri*
18. *Actinocleidus oculatus*
19. *Actinocleidus recurvatus*
20. *Cleidodiscus aculeatus*
21. *Cleidodiscus adspectus*
22. *Cleidodiscus alatus*
23. *Cleidodiscus brachus*
24. *Cleidodiscus banghami*
25. *Cleidodiscus capax*
26. *Cleidodiscus chautauguensis*
27. *Cleidodiscus chrysops*
28. *Cleidodiscus ferox*
29. *Cleidodiscus floridanus*
30. *Cleidodiscus helicus*
31. *Cleidodiscus longus*
32. *Cleidodiscus malleus*
33. *Cleidodiscus pricei*
34. *Cleidodiscus similis*
35. *Cleidodiscus* sp.
36. *Cleidodiscus stentor*
37. *Cleidodiscus uniformis*
38. *Cleidodiscus unguis*
39. *Cleidodiscus venardi*
40. *Dactylogyrus anchoratus*
41. *Dactylogyrus extensus*
42. *Dactylogyrus* sp.
43. *Dactylogyrus urus*
44. *Dactylogyrus vastator*[b]

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[a] Dechitiar (1972)

[b] Pathogenic parasite species

TABLE M-4. (Continued)

45. *Gyrodactylus spathulatus*
46. *Gyrodactylus* sp.
47. *Lintaxine cokeri*
48. *Lyrodiscus longibasus*
49. *Lyrodiscus* sp.
50. *Lyrodiscus rupestris*
51. *Mazocraeoides olentangiensis*
52. *Mazocraeoides* sp.
53. *Neodiscecotyle carpioditis*[b]
54. *Octomacrum lanceatum*
55. *Pellucidhaptor* sp.
56. *Pseudocolpenteron pavlovskii*
57. *Pseudomurraytrema copulatum*
58. *Pseudomurraytrema moxostomi*
59. *Syncleithrium fusiformis*
60. *Tetraonchus monenteron*

Aspidocotylea

61. *Cotylogaster occidentalis*

Digenea

62. *Apophallus itascensis*[b]
63. *Crassiphiala bulboglossa*
64. *Diplostomulum flexicaudum*
65. *Phyllodistomum lysteri*
66. *Posthodiplostomum minimum centrarchi*[b]
67. *Sanguinicola occidentalis*[b]
68. *Sanguinicola* sp.
69. *Uvulifer amblopitis*

Cestoda

70. *Spartoides wardi*

Nematoda

71. *Philometra nodulosa*
72. *Philometra* sp.
73. *Rhabdochona milleri*

Acanthocephala

74. *Metechinorhynchus salmonis*
75. *Neoechinorhynchus carpiodi*
76. *Neoechinorhynchus cristatum*
77. *Neoechinorhynchus rutili*
77a. *Neoechinorhynchus tenellum*
78. *Pomphorhynchus rocci*

Crustacea

79. *Argulus appendiculosus*
80. *Ergasilus elegans*

APPENDIX N

TEMPERATURE UNIT CONVERSION CHART

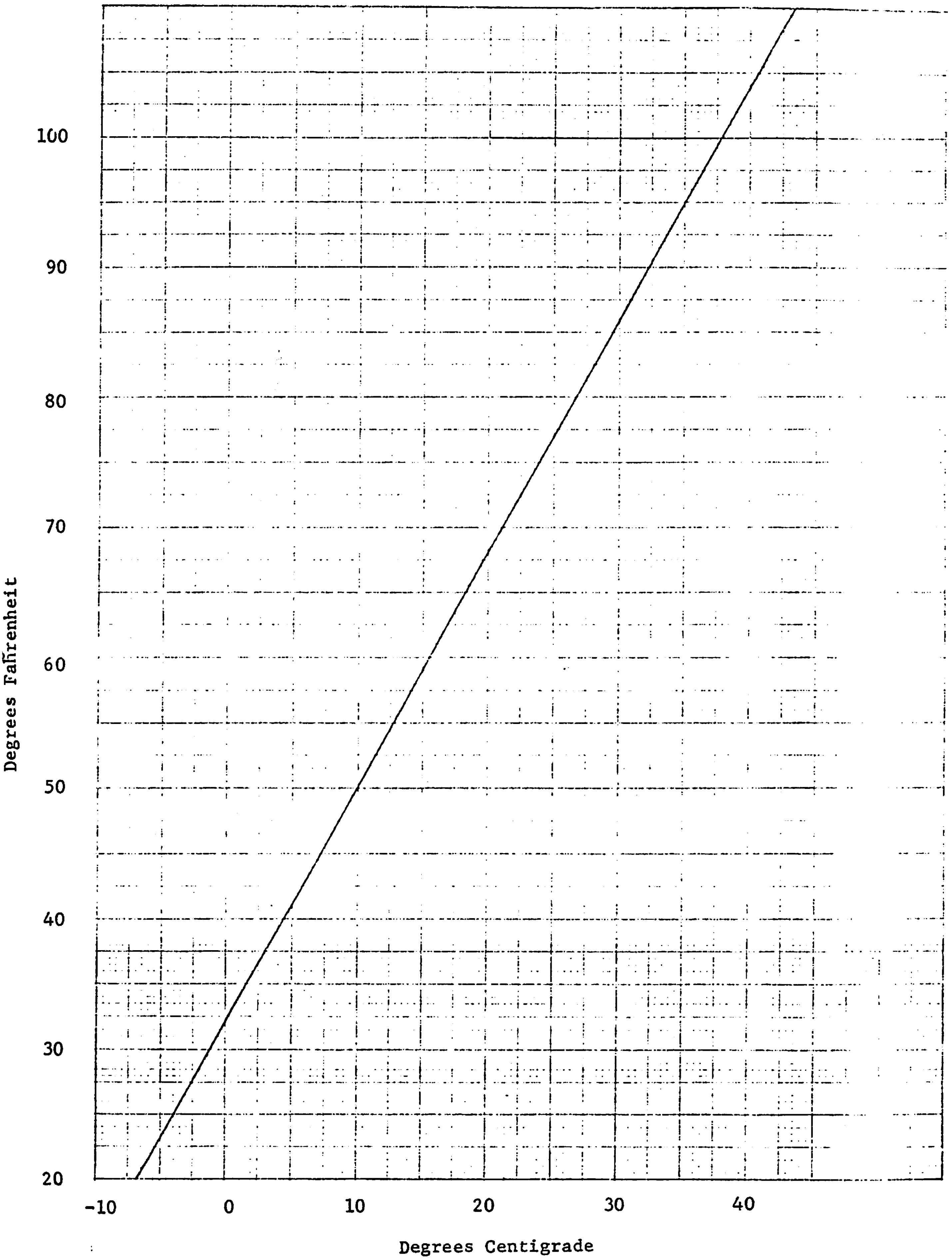

FIGURE N-1. TEMPERATURE UNIT CONVERSION CHART