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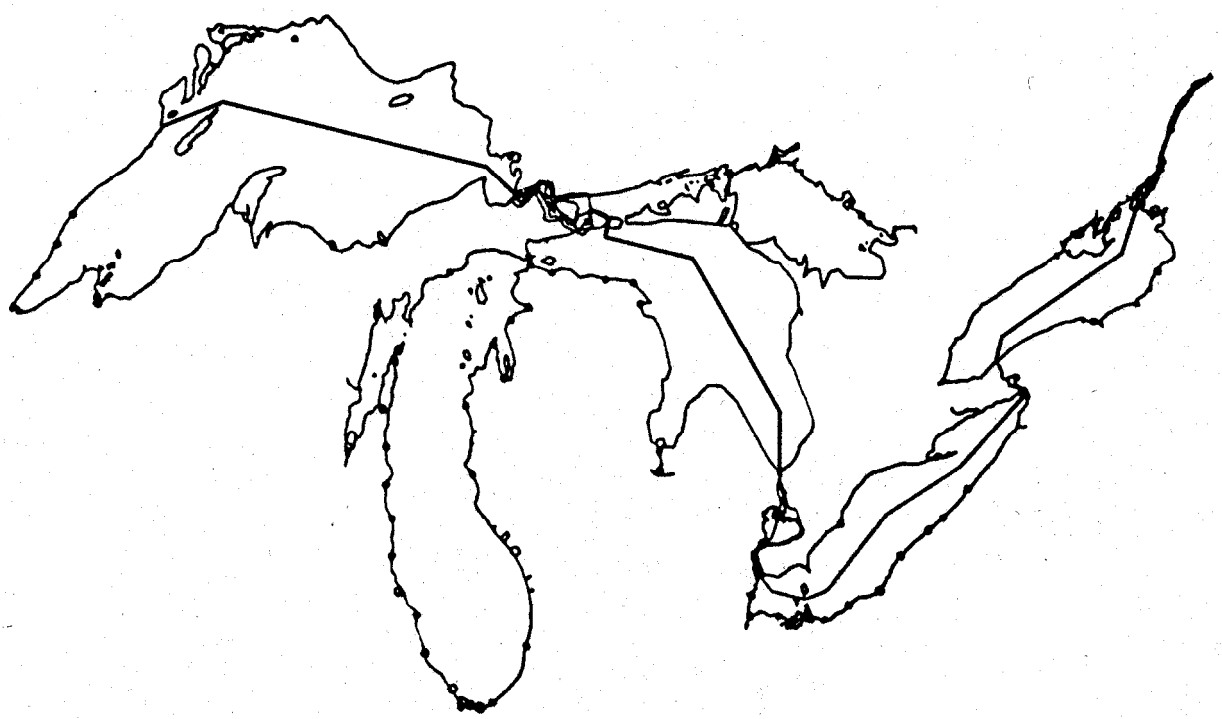
ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume IX-Lake Erie

Great Lakes-St. Lawrence Seaway Navigation Season Extension Program



Fish and Wildlife Service
U.S. Department of the Interior

Corps of Engineers
U.S. Department of the Army

The Biological Services Program was established within the U.S. Fish and Wildllfe Service to supply scientific information and methodologies on key environmental issues that Impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
- To gather, analyze, and present information that will aid decisionmnakers in the identification and resolution of problems associated with major changes in land and water use.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relatfng to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technlcal assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their informatlon needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

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The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning-and management; Natlonal Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staffs, who provide a link to problems at theoperating level;and staffs at certain Fish and Wildlife Service research facilities, who conduct in-house research studies.

FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME IX
Lake Erie

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered -water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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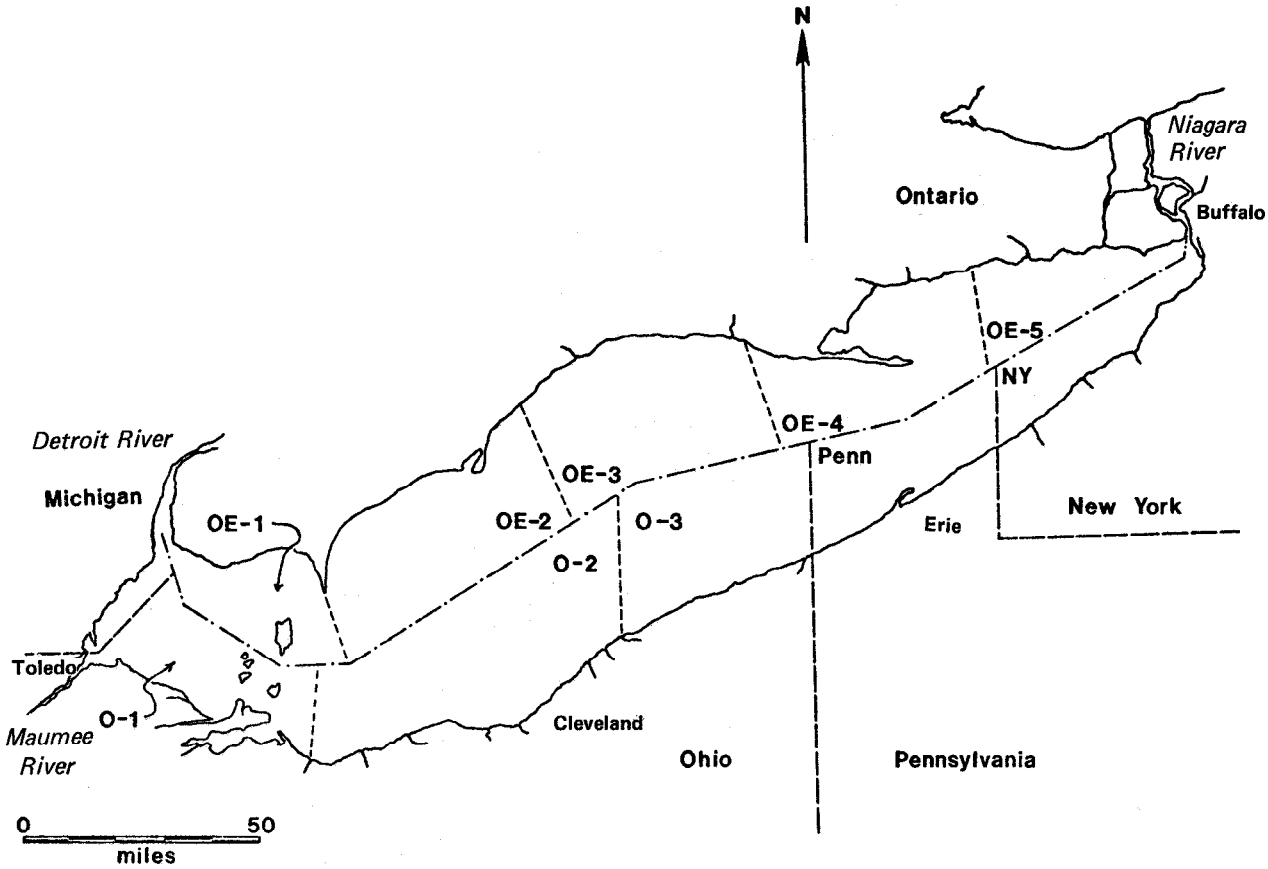
INTRODUCTION



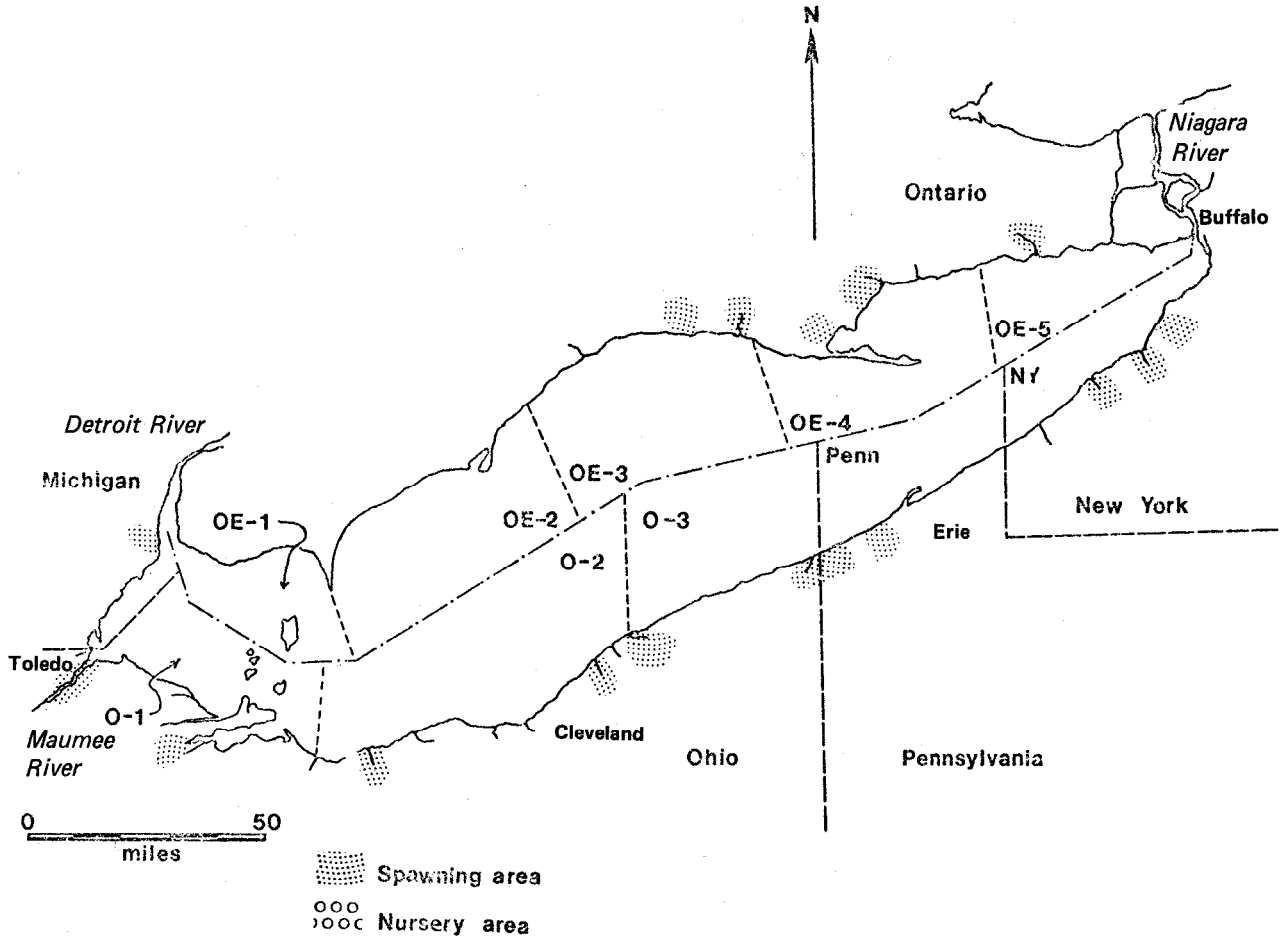
More than 100 species of fish have been recorded as residents in Lake Erie (Baker, pers. comm. 1979; Dymond 1922; Kenyon, pers. comm. 1979; Emery 1976; Muth, pers. comm. 1979; MWRC 1975; Shepherd, pers. comm. 1979; Van Meter and Trautnan 1970). This volume describes the reproductive habitat used by the 91 species for which information was available. Eighty-one species treated in this volume were native to the lake. Most of these 81 native species spawned (or spawn) in tributaries or in shallow, protected waters of the lake. Only the emerald shiner utilizes the deep offshore waters, along with the nearshore waters, for spawning.

The ten exotic species treated in this volume were introduced by man or immigrated to the lake during the period of record, from populations established elsewhere in the Great Lakes drainage. Four of these are salmonids which spawn in tributaries; the other six exotic species spawn in tributaries and also in protected nearshore waters in some areas.

Information on nursery areas used by the 91 species treated in this volume is fragmentary, but as would be expected, it suggests that tributaries and nearshore waters are important as nursery areas, at least for the earliest life stages. Dispersal from spawning areas is rapid for some species which have small, pelagic larvae, whereas the juveniles of some salmonids that spawn in tributaries may remain in or near spawning areas in those tributaries for as many as three years before entering the lake and dispersing.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Each species narrative presents the available information systematically by statistical fishing district (Smith et al. 1961) beginning with the Michigan district and ending with district OE-5. Within each district the presentation proceeds systematically from one end of the district to the other, by shoreline segment and adjacent littoral and offshore water areas. For each referenced location within a district, the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

SEA LAMPREY



The first recorded capture of the sea lamprey in Lake Erie occurred in 1921 (Dymond 1922), 92 years after the completion of the first Welland Canal connecting Lake Erie with Lake Ontario. It is likely that the construction of the second Welland Canal in 1914-1932 further facilitated the movement of sea lampreys from Lake Ontario to Lake Erie (Morman et al. 1980). The first recorded spawning run in a Lake Erie tributary occurred in the Huron River (Michigan) in May 1932 (Creaser 1932b). The population in Lake Brie is small because only a few tributaries have suitable spawning habitat (Applegate and Moffett 1955; Beeton 1966, 1969; Dees 1980; Bartman 1972; Pearce et al. 1980; Smith 1971); ammocoetes have been found in only 14 streams (Pearce et al. 1980). The tributaries listed below are classified as spawning streams based on the presence of ammocoetes, spawning adults, or both.

Michigan

Huron River (42°02', 83°12') (Creaser 1932b). A run was last observed here in 1938 (Smith and Tibbles 1980).

Ohio

O-1

Maumee River (41°41', 83°28'). Spawning was observed in Swan Creek, a tributary to the river, in 1935 (Hubbs and Pope 1937; ODNR 1976; Trautman 1957).

Sandusky River (41°27', 82°59') (Braem and Rugen 1977; Pearce et al. 1980).

O-2

Vermilion River (41°26', 82°22'). Historically, spawning occurred in the river when it was undammed and unpolluted (Trautman 1950).

Chagrin River (41°41', 81°26'). A spawning run presently occurs (White, pers. comm. 1979).

O-3

Grand River (41°46', 81°17') and Conneaut River (41°58', 80°33') (Braem and Rugen 1977; GLFC 1975; Pearce et al. 1980).

Pennsylvania

Raccoon Creek (41°59', 80°29') and Crooked Creek (42°00', 80°26') (Braem and Rugen 1977; GLFC 1975; Pearce et al. 19801.

Walnut Creek (42°04', 80°14') (Kenyon, pers. comm. 1979).

New York

Canadaway Creek (42°28', 79°22'1, Cattaraugus Creek (42°34', 79°08'), and Delaware Creek (42°38', 79°04') (Pearce et al. 1980).

Ontario

Most Ontario tributaries to Lake Erie do not have suitable spawning habitat for sea lampreys (Hogg 1955).

OE-3

Catfish Creek (42°39', 81°01') and Big Otter Creek (42°37', 80°48') (Pearce et al. 1980; SLCC 1979a).

OE-4

Big Creek (42°36', 80°27') (Hogg 1955; Pearce et al. 1980; SLCC 1979a; Thomas 1961b, 1962; Whillans 1977).

Dedrick Creek (42°36', 80°27') (Whillans 1977).

Potters Creek (42°43', 80°19') and Young Creek (42°45', 80°15') (Pearce et al. 1980; SLCC 1979a; Thomas 1961b).

OE-5

Grand River (42°51', 79°35') (Pearce et al. 1980; SLCC 1979a).

LAKE STURGEON

In Lake Erie, lake sturgeon entered tributaries in the spring, primarily in late May and June, and later returned to the lake (Bean 1902, 1903; Langlois 1944; Moore 1894; Rathbun and Wakeham 1897; Trautman 1977). Siltation and the construction of dams have denied lake sturgeon the use of spawning habitat in most rivers (Hartman 1972; Langlois 1954). After tributary conditions became unfavorable, spawning may have occurred on beaches and bars in the lake proper (Greeley 1929; Langlois 1954; White, pers. comm. 1979).

Michigan

Detroit River (42°03', 83°08'). Hennepin's writings of his travels in 1675 reported thait lake sturgeon migrated to the banks of the lake near the mouth of the Detroit River to spawm (MSBFC 1893). Spawning was observed near the river mouth (Harkness and Dymond 1961; Langlois 1954).

Huron River (42°02', 83°12'). Historically, a spawning run entered the river (Langlois 1954).

Stony Point (41°56', 83°16'). During the 1890s-1900s lake sturgeon spawned in an area (41°55', 83°16') 1/2 mi S of Stony Point over clay bottom in about 18 ft of water (Organ et al. 1978).

Ohio

O-1

Maumee River (41°41', 83°28'). Prior to 7900, large spawning runs occurred in the Maumee River upstream to the rapids at Perrysburg and to Waterville; these runs were eliminated by 1885 (Kirsch 1895; Langlois 1954; Smith and Snell 1891; Trautman, pers. comm 1979). Spawning declined in Maumee Bay (41°43', 83°25') because adults could not reach the spawning grounds (Pinsak and Meyer 1976).

Portage River (41°31', 82°56'). Historically, a spawning run entered the river (Langlois 1954, 1965).

Sandusky River (41°27', 82°59'). The lowland swamp forests and flooded prairies were once favorable spawning sites (Trautman 1975). During the mid-1800s, lake sturgeon weighing from 70-100 lbs were commonly observed migrating up the river in the spring (Keeler 1904). Spawning runs declined when mill dams built in the 1800s and the Ballville Dam built in the early 1900s blocked the passage to spawning grounds (Hartley and Herdendorf 1975).

O-2

Cuyahoga River (41°30', 81°43'). The river supported a spawning run until approximately 1850, when pollution destroyed the spawning grounds in the lower reaches of the river (Kirtland 1850, as cited in Trautman 1957; USDI 1967; White, pers. comm. 1979).

o-3

Conneaut (41°58', 80°33'). Spawning occurred on rocky bottom along shore, where lake sturgeon were very abundant in June and July (Smith and Snell 1891).

Pennsylvania

Walnut Creek (42°04', 80°14'). During the 1950s ripe fish were caught just east of the creek; it is not known where these fish spawned (Larsen, pers. comm. 1979).

New York

Dunkirk (42°29', 79°20'). Historically, spa-wning occurred here (Harkness and Dymond 1961).

Silver Creek (42°33', 79°10'). Lake sturgeon probably spawned at the mouth of the creek (Smith and Snell 1891).

Buffalo (42°55', 78°53'). Lake sturgeon spawned on bars near Buffalo Harbor (42°52', 78°53') until these were removed by dredging (Greeley 1929; Harkness and Dymond 1961). The most important fishery was carried out during the spawning season along the Erie County shore between Buffalo and Irving (42°34', 79°07'); the heaviest run occurred from mid- or late May to early June (Moore 1894, Smith and Snell 1891). Spawning probably occurred along this entire shoreline (Rathbun and Wakeham 1897).

Ontario

OE-1

Pelee Island (41°47', 82°40'). Many lake sturgeon were caught around the island in early May and June, and spawning was believed to occur here (Rathbun and Wakeham 1897).

Point Pelee (41°55', 82°30'). Historically, spawning was observed over hard clay, gravel or shale, and boulders near the point (Langlois 1954; Rathbun and Wakeham 1897). In 1952, spawning was reported on shoals at the point in June, but this report was not confirmed (Langlois 1954).

OE-2

Rondeau Harbour (42°15', 81°53'). In about 1890, the bays here were considered to be spawning areas (Kerr and Kerr 1860-1898).

OE-4

Clear Creek (42°34', 80°35'). In 1891, a good run entered the creek in May and June (Kerr and Kerr 1860-1898).

Long Point Ray (42°40', 80°10'). Inner Bay (42°37', 80°22') was an important spawning area, especially in Sturgeon (42°36', 80°23') Little Rice (42°35', 80°21') and at Turkey Point (42°39', 80°21') bays, but these areas have not been used since at least the 1920s (Kerr and Kerr 1860-1898; Whillans 1977, 1979a). Sturgeon spawned on the Lakeward side of the tip of Long Point (42°33', 80°05'); ripe fish were taken and spawning was observed there as recen-tly as the early 1960s (Whillans, pers. comm. 1979).

SPOTTED GAR

Ohio

Spotted gars spawned in the marshy areas along the Ohio shore until 1930, when most of the marshes were destroyed (Trautman, pers. comm. 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). .A resident population of spotted gars spawns over vegetation in the lagoon area of Presque Isle Bay. Spawning was observed during mid- to late May (Kenyon, pers. comm. 1979).

LONGNOSE GAR

The longnose gar spawns in shallow water during May and June (Fish 1932; Langlois 1954).

Michigan

Monroe (41°55', 83°24'). Adults move into the discharge canal of the Monroe Power Plant (41°53', 83°21') during the spawning season; larvae were also collected in the canal (Cole 1976).

Long Point (possibly Woodtick Peninsula, 41°44', 83°25'). In 1948, young-of-the-year (YOY) were collected along the Michigan shore at Long Point in mid-July (Langlois 1954).

Ohio

During the 1800s, large schools of longnose gars entered rivers in Ohio during April to spawn (McCormick 1892; White, pers. comm. 1979).

o-1

Maumee River (41°41', 83°28'). Spawning runs of longnose gars enter the Maumee River (Trautman, pers. comm. 1979).

South Bass Island (41°39', 82°50'). Spawning occurs in shallow, vegetated areas between South Bass Island and Starve Island (41°38', 82°49') and also in Squaw Harbor (41°39', 82°49') and Terwilliger Pond (41°39', 82°50') during mid-May to mid-June (Langlois 1954; Trautman, pers. comm. 1979). Substrate varies from mud to rocky shoreline. Water temperature ranges from 66-70°F; most spawning activity occurs at 66°F (Langlois 1954). The beds of vegetation between South Bass and Starve Islands and in Squaw Harbor are also nursery areas. Fry were observed lying on the tops of leaves among dense beds of aquatic vegetation (Trautman, pers. comm. 1979). Young-of-the-year were also observed in association with schools of young smallmouth bass in Fishery Bay (41°39', 82°49') (Langlois 1954).

Sandusky Bay (41°29', 82°46'). In 1953, spawning was observed in Winous Point Marsh (41°28', 82°59') at the head of Sandusky Bay during May (Langlois 1954). Some spawning occurs in the bay (FWS 1979d).

o-2

Chagrin Harbor (41°41', 81°26'). In 1972-74, YOY were collected in the lower Chagrin River and adjacent shoreline areas (White et al. 1975); larvae were also collected in Chagrin Harbor (White, pers. comm. 1979).

o-3

Ashtabula (41°55', 80°47') and Conneaut (41°58', 80°33'). Larvae were collected in the harbors here (White, pers. comm. 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). A resident population of longnose gars spawns in the shallow lagoon areas over vegetation (Kenyon, pers. comm. 1979; Larsen 1952); spawning usually occurs from late May to mid-June (Larsen 1952). Young-of-the-year were collected in vegetated backwater areas during August (Kenyon, pers. comm. 1979).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Longnose gars are believed to spawn in this area in mid-April (Reid 1978). Fishermen see them in the spring in many shallow areas of Inner Bay (42°37', 80°22'), including Sturgeon Bay (42°36', 80°23'), Coletta Bay (42°35', 80°26'), marshes at the mouth of Big Creek (42°36', 80°27'), and Turkey Point (42°39', 80°21'), (Whillans, pers. comm. 1979); YOY are found during July and August in these same marsh areas (Hamley and MacLean 1979; Reid 1978; Whillans, pers. comm. 1979). Reproducing populations are also probably established in the larger lagoons at the tip of Long Point (42°33', 80°05') (Mahon 1979).

BOWFIN

The bowfin spawns in protected bays over vegetated mud bottom (Langlois 1954). Larvae are found in weedy areas nearshore, in harbors, and in rivers (White, pers. comm. 1979).

Michigan

Bolles Harbor (41°51', 83°24'). Since 1921, spawning has occurred in an area (41°51', 83°22') 1-1/2 mi E of Belles Harbor, along the 6 ft depth contour, over a mud substrate (Organ et al. 1978).

Ohio

O-1

South Bass Island (41°39', 82°50'). In 1953, several males in breeding colors were caught in Fishery Bay (41°39', 82°49') in June (Langlois 1954).

Winous Point Marsh (41°28', 82°59'). A school of young was collected in the marsh (Langlois 1954).

o-2

Old Woman Creek (41°23', 82°31'). The mouth of the creek is excellent spawning habitat (FWS 1979d).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). A resident population spawns in the lagoon area of the bay. Bowfins spawn there at depths of less than 6 ft, among weedy, submergent vegetation; ripe males and gravid females were collected among the vegetation and young-of-the-year (YOY) were collected in the area in September (Kenyon, pers. comm. 1979).

Ontario

OE-2

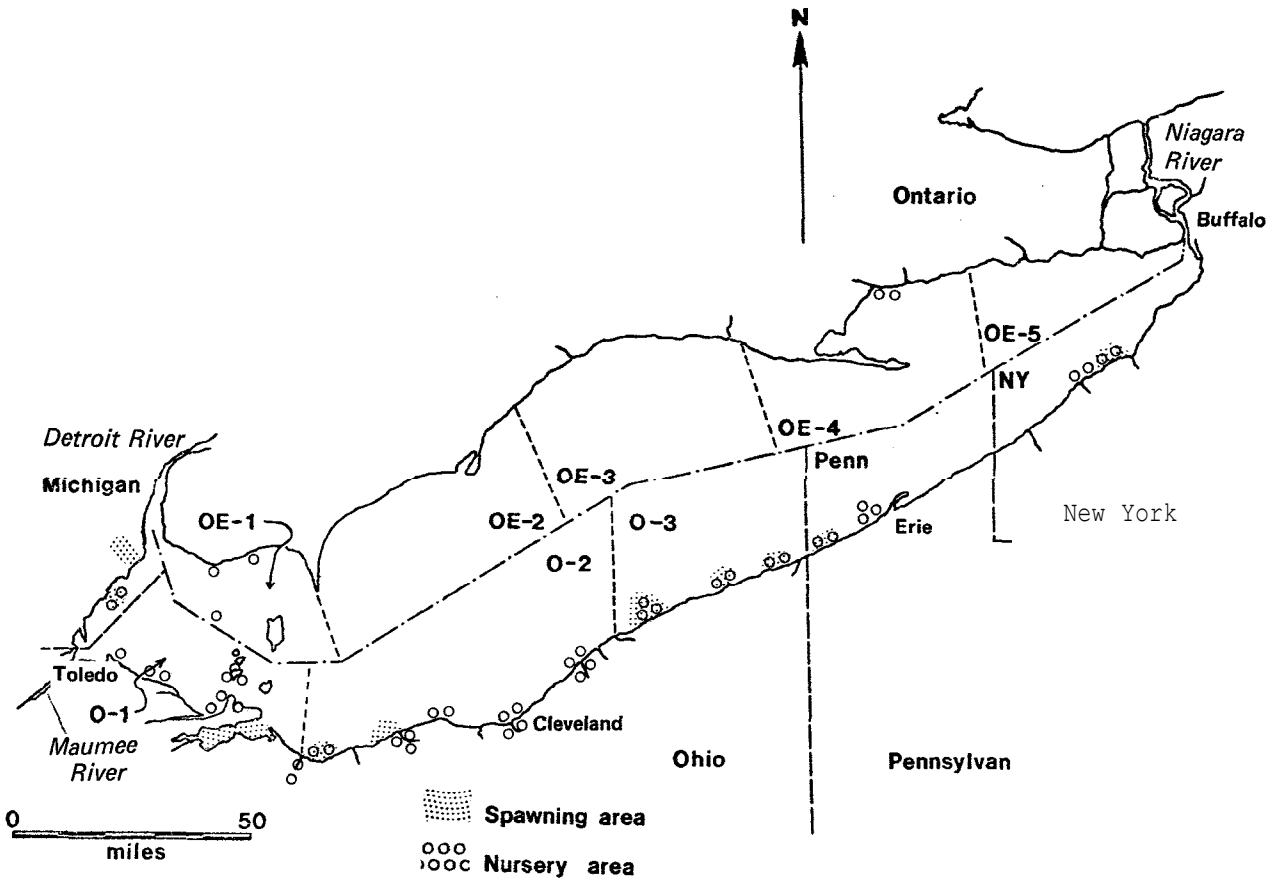
Rondeau Harbour (42°15', 81°53'). Bowfin nests were observed in marshes in the Rondeau Harbour area. Eggs were found adhering to decaying vegetation on the bottom of the nests and to surrounding upright reed stems in water less than 1 ft deep at temperatures of about 77°F (Doan 1938). "The Ponds" along the southeast shore is a major spawning area, where adults were seen guarding nests in June (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). During the late 1880s and mid-1890s, bowfins spawned at Turkey Point (42°39', 80°21') in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898). Bowfins are numerous in the area, although there was a brief decline in the population in the early

1960s (Whillans 1977). They are thought to spawn in early May (Reid 1978), and fishermen see them during the spring in many shallow areas of Inner Ray, including Sturgeon Bay (42°36', 80°23'), Coletta Bay (42°35', 80°26'), the marshes at the mouth of Big Creek (42°36', 80°27'), and Turkey Point (Whillans, pers. comm. 1979); YOY are found in July and August in these same marsh areas (Hamley and MacLean 1979; Whillans, pers. comm. 1979). Bowfins also spawn in the muddy, soft-bottomed lagoon areas at the tip of Long Point (42°33', 80°05'); in 1977, a male was observed guarding young here (Mahon, pers. comm. 1979). Self-sustaining populations are probably established in the larger lagoons of Long Point (Mahon 1979).

ALEWIFE



The alewife presumably entered Lake Erie from Lake Ontario via the Welland Canal. Alewives were first observed in Lake Erie in 1931 and became abundant in about 1950 (Miller 1957).

In the central basin, alewives spawn close to shore, primarily in harbor areas (Wolfert, pers. comm. 1979).

The western basin is the major spawning and nursery area in Lake Erie (Doremus 1975). Alewives spawn almost everywhere throughout the basin (Wolfert, pers. comm. 1979). Most of the hatching in the basin occurs during June 15-30 at 72°F (Comm. Fish, Rev. 1961a). Numerous young-of-the-year (YOY) were collected in the basin; they first appeared in mid-July (Baker 1966; Van Vooren and Davies 1974; Van Vooren et al. 1977). The wide size range of YOY collected in the fall indicated an extended spawning season (Parker 1964).

Michigan

Huron River (42°02', 83°12′). Alewives enter the river and run upstream to the Flat Rock Dam to spawn (Janssen, pers. comm. 1979).

Raisin River (41°53', 83°20'). Alewives spawn at the mouth of the Raisin River in 1-3 ft of water and also just off the discharge of the Monroe Power Plant (41°53', 83°21') over mud and aquatic vegetation (Organ et al. 1978). Large catches of YOY during the early 1970s indicate that the area around the mouth of the Raisin River and north to Sterling State Park (41°55', 83°20') is a nursery area (Ball and Scholl 1973; Hair and Scholl 1971; MDNR 1970-1976; Parkhurst 1971; Rudolph and Scholl 1970).

Ohio

Alewives move from deeper water into nearshore shallows or into tributaries to spawn in June and July (Trautman 1957).

O-1

Potters Pond (41°41', 83°18'). In 1962, YOY were fairly abundant in August off Potters Pond (Ayers et al. 1970).

Crane Creek (41°38', 83°12'). Young-of-the-year are fairly abundant off Crane Creek (Gehres and Scholl 1969; Hair and Scholl 1971; USNRC 1973, 1975a).

Locust Point (41°36', 83°05'). Young-of-the-year were very abundant inshore in July and August off the point (Barnes and Reutter 1979; CLEAR 1976; Reutter and Herdendorf 1974, 1977; USNRC 1975b).

Catawba Island (41°35', 82°51'). In 1966, a high concentration of YOY was found in an area (approximately 41°34', 82°53') west of Catawba Island in early August (Baker 1967a).

East Harbor (41°32', 82°47'). In 1966, 1967, and 1969, high densities of YOY were found inside and just outside of East Harbor in late July and early August (Baker 1967a,c; Ball and Scholl 1973; Gehres and Scholl 1969; Rudolph and Scholl 1970).

Middle Sister Island (41°51', 83°00'). In 1966, one of the highest concentra-tions of YOY was found just south of Middle Sister Island in early August (Baker 1967a).

South Bass Island (41°39', 82°50'). In 1953, YOY were collected around the island in mid-July (Langlois 1954).

Sandusky Bay (41°29', 82°46'). The bay is a minor spawning area (FWS 1979d).

O-2

Huron River (41°24', 82°33'). In 1976, fry were moderately abundant in the lower Huron River (Cleveland Environ. Res. Group, undated).

Erie Nuclear Plant site (41°23', 82°30'). In 1974, spawning in this area began in early May, when the water temperature was below 54°F. Eggs and prolarvae were collected in shallow water less than 10 ft deep in June

and July, and it was assumed that spawning occurred near shore. Densities of larvae peaked on July 10. Larvae were common in surface collections in water about 16-33 ft deep, suggesting that they moved away from shore after hatching (Ohio Edison Company 1977).

Beaver Creek (41°26', 82°15'). In 1979, prolarvae and postlarvae were collected to the 36 ft depth contour off the creek; YOY were collected in late August (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). In 1975, alewife larvae were abundant in Lorain Harbor in July (Wapora 1977a); in 1977 they were very scarce in the harbor (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1977-78, 6% of the larvae entrained during the summer at the plant were alewives (Applied Biology 1979c).

Cleveland (41°30', 81°43'). In 1972-74, fry or YOY were abundant in Cleveland Harbor (41°31', 81°42') and in the lower Rocky River (41°30', 81°50') and adjacent shore areas; these may be spawning areas (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, alewife fry or YOY were abundant in the lower river and adjacent shore areas; this may be a spawning area (White et al. 1975).

o-3

Perry Power Plant (41°48', 81°09'). Prolarvae and postlarvae have been found in the vicinity of the plant. Many juveniles about 1-2 in. long were seined along shore in late July and late August (NUS 1975).

Ashtabula (41°55', 80°47') and Conneaut (41°58', 80°33'). Alewives spawn outside the harbor breakwalls on the beach and on gravel bars (White, pers. comm. 1979). Alewives were 7% of the larvae collected in the lake near Ashtabula in the spring (Applied Biology 1979d,e). In 1977, alewife fry were collected in Conneaut Harbor in August (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22'). Adults in spawning condition were found in the lake off the creek in July; larvae were also collected here (GPU Serv. Corp. 1979).

Walnut Creek (42°04', 80°14'). In 1973, YOY less than 0.5 in. long, were collected in an area (42'06', 80°14') off the creek mouth in about 30 ft of water, over a sand bottom in July (Kenyon, pers. comm. 1979).

New York

Van Buren Bay (42°27', 79°25'). No alewive eggs or prolarvae were collected, but postlarvae were more abundant those those of most other species from early June to late August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk (42°29', 79°20'). Prolarvae were found here in June and entrained by the Dunkirk Steam Station (42°30', 79°21') in June and July. Alewife postlarvae were entrained in June to August and were more abundant than those of most other species at that time (Tex. Instrum. 1977d,e).

Eagle Bay (42°32', 79°14'). Alewife eggs were found off Eagle Bay in late May and mid-June (Tex. Instrum. 1977a). Prolarvae were collected from mid-June to mid-July and postlarvae were found from mid-June to August. Young-of-the-year appear in July and are abundant in August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

OE-1

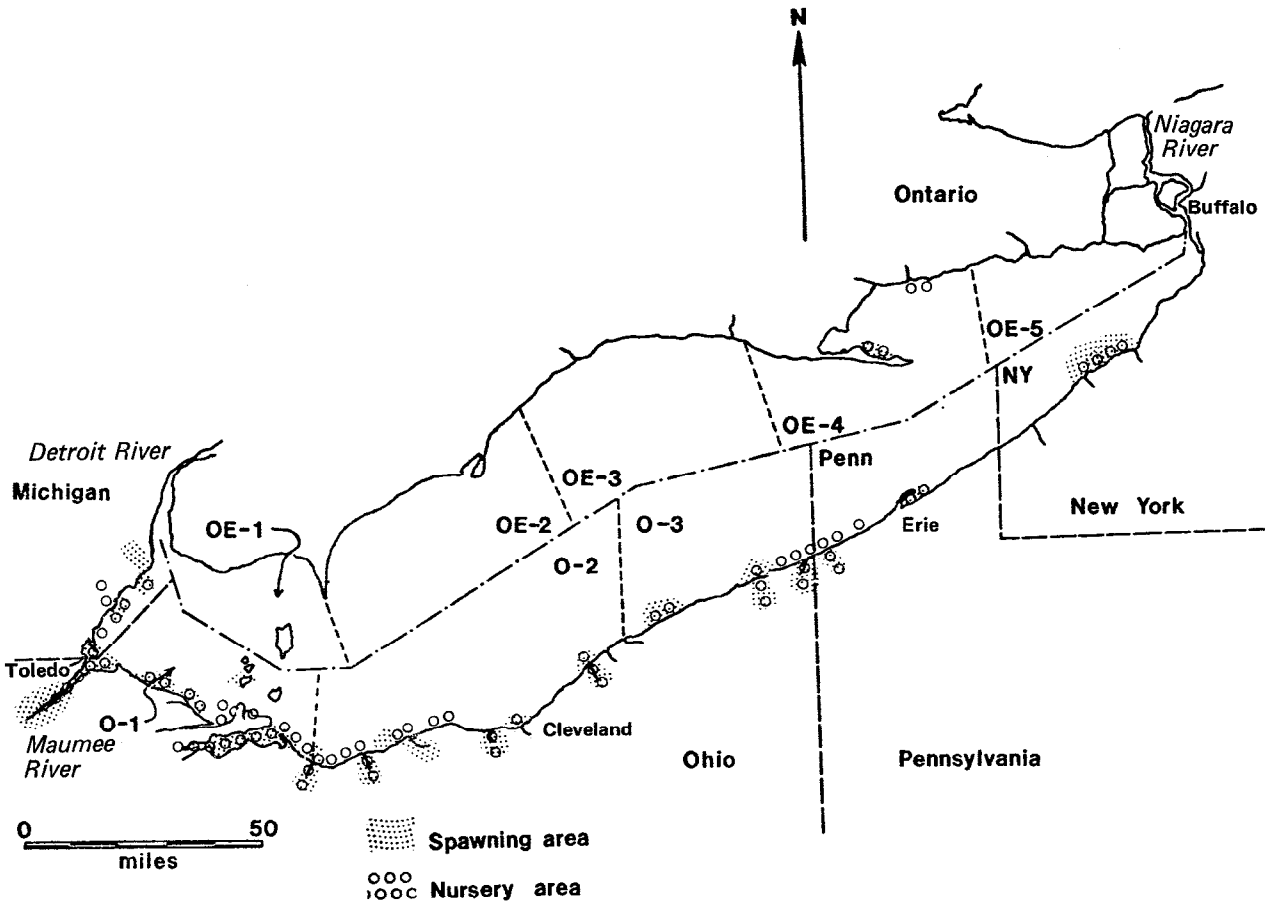
Colchester (41°59', 82°56'). In 1953, YOY were collected along a beach west of Colchester in mid-July (Langlois 1954).

Cedar Beach (42°01', 82°47'). In 1975, many YOY were collected here in mid-July (Paine 1976).

OE-4

Long Point Bay (42°40', 80°10′). In 1974, young-of-the-year (YOY) alewives were entrained at the Nanticoke Generating Station (42°48', 80°03') from June to August (Hamley and MacLean 1979; Teleki 1976). In 1976, YOY also dominated the shore seine catch in the Stelco dock area (42°47′, 80°05′) from July to September (Chamberlain 1976). Adult alewives are especially abundant in the Nanticoke plume during the spring (Hamley and MacLean 1979).

GIZZARD SHAD



The gizzard shad may be native to Lake Erie, however the species was first reported in the lake in 1848, 18 years after the first canal connecting the lake with the Ohio River was completed (Miller 1957). Gizzard shad are now common throughout most of the inshore waters of Lake Erie; they are often attracted to warm water outlets (Wolfert, pers. comm. 1979). Gizzard shad spawn in harbors and rivers in the central basin of Lake Erie, mainly near breakwalls and dock pilings over Cladophora beds (White, pers. comm. 1979). The western basin is the major spawning and nursery area for gizzard shad in Lake Erie (Doremus 1975). Spawning occurs almost everywhere throughout the basin, but the more turbid areas centered mainly in Maumee Bay and Sandusky Bay appear to be the primary spawning and nursery areas. Large numbers of adults ascend rivers along the Ohio shoreline to spawn in May to July; peak spawning occurs in mid-June at a minimum water temperature of 67°F (Bodola 1966; CLEAR 1978a,b; Heniken 1977; Wapora 1977c; Wolfert, pers. comm. 1979). In 1960, the major hatching period in the western basin was June 15-30 at a water temperature of 72°F (Comm. Fish Rev. 1961a), but fry were captured as early as late May (Baker 1966b; Manz 1963). Young-of-the-year (YOY) are

abundant; they first appear in trawls in late June and early July and peak catches are made in late August (Van Vooren and Davies 1974; Van Vooren et al. 1977).

Michigan

Huron River (42°02', 83°12'). During the 1960s, gizzard shad ran upstream to the dam at Flat Rock to spawn (Janssen, pers. comm. 1979).

Swan Creek (41°58', 83°15')--Point aux Peaux (41°57', 83°15'). Since 1950, gizzard shad have spawned along this shoreline over mud bottom at depths to 16 ft (Organ et al. 1978). Yolk-sac larvae are abundant inshore during early June. Late postlarvae were collected in early July; abundance decreased by mid-July and early August (Detroit Edison 1978).

Raisin River (41°53', 83°20'). The large numbers of larvae and YOY collected here indicate that the area around the mouth of the river is a nursery area; in 1977, they were found in an area (41°54', 83°21') in early June near the mouth of the river (Patterson 1979a). In 1969-76, YOY were abundant from Sterling State Park (41°55', 83°20') south to the river (Gehres and Scholl 1969; Hair and Scholl 1971; MDNR 1970-76; Rudolph and Scholl 1970). Many young were collected in the discharge canal of the Monroe Power Plant (41°53', 83°21') (Parkhurst 1971). The lower end of the canal including its mouth could provide excellent spawning habitat for gizzard shad (Nelson 1975; Nelson and Cole 1975). Occasionally, large numbers of YOY also appear in the intake canal in July (Eisele and Malaric 1977). Since 1950, gizzard shad have spawned at the mouth of the river and along the adjacent shoreline south to the plant discharge canal in 8 ft or less of water (Organ et al. 1978).

Toledo Beach (41°50', 83°24'). In 1977, gizzard shad larvae were found in early to mid-June in an area (41°49', 83°22') about 2-1/4 mi off Toledo Beach (Patterson 1979a).

Woodtick Peninsula (41°44', 83°25'). Since 1950, gizzard shad have spawned over mud bottom in 10 ft of water or less along the northern shore of the peninsula from 41°47' to 41°46' (Organ et al. 1978). In 1974, YOY were found there (MDNR 1970-76). In 1978, gizzard shad were the dominant larvae entrained at the Whiting Power Plant (41°47', 83°27'); peak entrainment of gizzard shad larvae and peak abundance in the bay occurred in June (Wapora 1979b).

Ohio

0-1

Maumee Bay (41°43', 83°25'). The bay is one of the major areas of concentration in the western basin (Heniken 1977). Gizzard shad migrate upstream through the bay to spawn in tributaries of the Maumee River

(41°41', 83°28') (Trautman and Gartman 1974). Since 1952, spawning occurred in the western part of the bay from 41°42', 83°27' north to Indian Island (41°45', 83°27') (Organ et al. 1978). Spawning also occurred during May 15-August 15 over the sand and gravel channel "side castings" (Pinsak and Meyer 1976). Ripe adults were found in the bay in May (USACE 1976c). The Maumee estuary is a nursery area, and the young remain in the river through the later developmental stages; they tend to concentrate at the surface by the end of May after reaching a length of 0.3-0.4 in. (CLEAR 1977; Reutter, Herdendorf and Sturm 1978a,b; Snyder 1978; Wapora 1977c). Larvae appear to be concentrated in the lower river, mainly at the mouth in late June (Wapora 1977b). In 1975-77, larvae and YOY were very abundant throughout the bay and in the lower Maumee River in May to July (Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Herdendorf et al. 1976; Patterson 1979a). Very large concentrations were present at the mouth of the bay; many larvae were found at Turtle Island (41°45', 83°23') (Herdendorf et al. 1976). In 1977, large concentrations of postlarvae were found at Cedar Qoint (41°42', 83°20') (Patterson 1979a). Young-of-the-year are reported to overwinter in the bay (FWS 1979d).

Metzger Marsh (41°39', 83°14'). In 1976, high densities of larvae were present in mid- to late June along the shoreline of the marsh, which is used extensively for spawning (Heniken 1977). In 1977, high concentrations of early postlarvae were found in early to mid-June inshore near Ward Canal (41°39', 83°14') (Patterson 1979a).

Crane Creek (41°38', 83°12'). Young-of-the-year were very abundant off Crane Creek in 1971 (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; USNRC 1973, 1975a).

Locust Point (41°36', 83°05'). Eggs and larvae of gizzard shad dominate collections in the Locust Point area, where spawning occurs from early June to early July; abundance was especially high near the intake and discharge of the Davis-Besse Power Station (41°36', 83°04') (CLEAR 1975b, 1976; Heniken 1977; Reutter 1979b,c; Reutter and Herdendorf 1977; USNRC 1973, 1975a,b). Large numbers of YOY are present along shore from mid-June through the summer (Barnes and Reutter 1979; CLEAR 1975a, 1975b, 1976; Reutter and Herdendorf 1977). Extremely high numbers of larvae, 1.1-1.4 in. long and YOY were present at the Davis-Besse Station in mid-June and early July (Reutter and Herdendorf 1974).

Catawba Island (41°35', 82°51'). High densities of YOY were collected in an area (approximately 41°34', 82°53') just west of Catawba Island (Baker 1967a; Ball and Scholl 1973; Hair and Scholl 1971).

Fast Harbor (41°32', 82°47'). During 1966 to 1973, YOY were found in large concentrations inside and outside the harbor (Baker 1967a; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970).

South Bass Island (41°39', 82°50'). In the early 1950s, spawning gizzard shad were collected in greatest numbers on a bar extending from Oak Point (41°39', 82°49') to Gibraltar Island (41°39', 82°49') in 2-4 ft

of water over sand, gravel, and boulders with aquatic vegetation. Spawning occurred from early June to mid-July, and peaked in mid-June (Bodola 1955, 1966).

Sandusky Bay (41°29', 82°46'). Sandusky Bay is one of the major areas of concentration in the western basin (Heniken 1977), and successful spawning occurs in the bay (FWS 1979d). In 1953, large numbers of ripe fish were taken in the western end of the bay in early June (Langlois 1954) l Two peaks of adult abundance were observed in the bay; one in April and May, and a second in August. These peaks probably reflect the movement inshore by adults, to spawn in small streams and ditches of the bay, and the subsequent movement back into the bay after spawning is completed (Hartley and Herdendorf 1975). In 1954, spawning was observed in late May along a stony shore at a water temperature of 63°F (Bodola 1966). Sandusky Bay is a nursery area; larvae remain in the Sandusky River (41°27', 82°59') through later development stages (CLEAR 1977). Concentrations of larvae are especially high, often exceeding 1000/m^3; at the river mouth (Heniken 1977). Fry and YOY are widely distributed throughout the bay, but are especially abundant in the western portion and around Johnson Island (41°30', 82°44') (Chapman 1955; Gehres and Scholl 1969; Hartley and Herdendorf 1975; Keller 1964a; Rudolph and Scholl 1970). In 1964, the area from Sandusky Bay eastward to Vermilion (41°26', 82°22') had one of the highest concentrations of fry in May (Baker 1965).

O-2

Huron River (41°24', 82°33'). Two spawning runs of gizzard shad, possibly from separate populations, enter the river; one run occurs from mid-June to early July and a second one from late July to early August. Large adults return to Lake Erie immediately after spawning; smaller adults remain in the river for a longer period (White, pers. comm. 1979). Large numbers of YOY were collected in the river in late summer (USDI 1967). Immense schools of young were found in the lower river, and densities were high as far as 5 mi upstream. Young-of-the-year were most abundant in late June (Cleveland Environ. Res. Group, undated). In the fall, YOY were found in the lake off the river. Large schools of YOY were present at night around the breakwalls and along the beaches (White, pers. comm. 1979; White et al. 1975). The abundance of fry and YOY in this area during July-October indicates that it is a nursery area (Wolfert et al. 1978).

Erie Power Plant site (41°23', 82°30'). In 1974, many young larvae were collected in June and July; they were most abundant on July 10 in water less than 10 ft deep. The shallow shoreline areas and tributary mouths may be nursery areas. Spawning probably occurs in this area during June and July at water temperatures of about 60-75°F (Ohio Edison 1977).

Vermilion River (41°26', 82°22'). Large numbers of newly hatched fry were collected in the river in July, just upstream from the mouth, and also in the harbor, indicating that large numbers of gizzard shad spawn in the area (Cleveland Environ. Res. Group 1975; U.S. Army Eng. Dist., Buffalo 1976a; USDI 1967). In 1964, the area between Vermilion and Sandusky Bay (41°29', 82°46') had one of the highest concentrations of fry in May (Baker 1965).

Beaver Creek (41°26', 82°75'). In 1979, eqgs and postlarvae were collected to the 36 ft depth contour. Young-of-the-year were collected in trawls off the creek mouth in August and in seines at Oak Point Beach near the creek mouth in July (Commonw. Assoc. 1979).

Black River (41°28', 82°11'). Two separate spawning runs enter the river, possibly from separate populations; one run enters from mid-June to early July and the other enters from late July to early August ('White, pers. comm. 1979). Larvae are abundant after late June in Lorain Harbor (Gee-Marine 1978).

Avon Lake Generating Station (41°30', 82°03'). Gizzard shad larvae were entrained during June and July; they were 15% of the total larvae entrainment during the summer (Applied Biology 1979c).

Rocky River (41°30', 81°50'). Two separate spawning runs enter the river, possibly from separate populations, from mid-June to early July and from late July to early August (White, pers. comm. 1979); YOY were collected in the river (White et al. 1975).

Cleveland Harbor (41°31', 81°42'). In 1960-62 and 1972, fry or YOY were abundant in Cleveland Harbor (White et al. 1975; Woner 1963). In 1975, most of the adults had migrated from the area before spawning and only a few fry were found. Successful spawning appeared to be concentrated west of Cleveland (41°30', 81°43'). Adults migrated from the Cleveland area by early May; presumably they moved toward the western end of the lake where they spawned and spent the summer. Young-of-the-year were much more abundant in the western part of the central basin than near Cleveland, Ashtabula (41°55', 80°47'), or Conneaut (41°58', 80°33'), where spawning was minimal. Adults and YOY migrated to the Cleveland area during late fall, where they overwintered (Caroots 1976). In 1977-78, gizzard shad larvae were the second most abundant larvae (27% of the total) entrained at the Lakeshore Generating Station (41°32', 81°38'). Gizzard shad larvae were most abundant in the vicinity of the station in July (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). Gizzard shad migrate upstream to spawn. Several runs occurred from mid-May to late August. Peak production of larvae occurs in late June in the quiet, shallow backwaters about 4 ft deep. Spawning also occurs on beaches near the river mouth, over partially vegetated substrate (probably in Cladophora) where larvae are collected (Environ. Resour. Assoc. 1978). At least two separate runs, possibly from different populations, enter the river; one run occurs from mid-June to early July, and another from late July to early August (White, pers. comm. 19791. In 1977-78, gizzard shad larvae were entrained at the Eastlake Plant (41°40', 81°27'); gizzard shad larvae were most abundant from mid-April to mid-June when they were 2% of the larvae entrained (Applied Biology 1979b).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, prolarvae and early postlarvae were present near the plant. Juveniles 1.1-2.6 in. long that

had probably migrated from other areas were numerous near shore in late July and August (NUS 1975).

Ashtabula Harbor (41°55', 80°47'). Significant production of larvae occurs in the harbor and the river (Hubbard 1977, as cited in Sweeney 1978; Odin 1979). Gizzard shad larvae were 6% of the total larval catch in the lake at Ashtabula in late June to late August (Applied Biology 1979d,e).

Conneaut (41°58′, 80°33′). Adults migrate into the river to spawn. In 1977, YOY were collected in the river from May to July, they migrated out of the river in late summer and reentered the river in the fall. In 1961, 1962, and 1977, YOY were collected in Conneaut Harbor; larvae were collected offshore in the lake between Conneaut Harbor and Raccoon Creek (41°59′, 80°29') (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Raccoon Creek (41°59', 80°29'). Adults migrated into the creek to spawn; YOY migrated out of the creek in late summer and reentered the creek in the fall (Aquat. Ecol. Assoc. 1978).

Elk Creek (42°01′, 80°22′). In 1974, larvae were abundant in June and July in the lake off the creek (GPU Serv. Corp. 1979).

Presque Isle Bay (42°08', 80°07'). Spawning adults were seen in the bay in 1-2 ft of water over sand and mud bottom with submergent vegetation, filamentous algae, and detritus. Spawning adults were also observed in the shallows of Presque Isle (42°10', 80°06') among submergent and emergent vegetation over mucky bottom, where the water was clear and there was little current. Young-of-the-year were collected where spawning adults were observed (Kenyon, pers. comm. 1979).

New York

van Buren Bay (42°27', 79°25'). Prolarvae, postlarvae, and YOY were found here in June, from mid-May to early August, and September respectively (Envirosphere 1977a; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Canadaway Creek (42°28', 79°22'). Young-of-the-year were collected along shore near the creek over rock bottom in 1-4 ft of water in July and August (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 70°20'), This was identified as a major nursery area; YOY were collected in the harbor throughout the spring and summer, over rock at a depth of 2-4 ft (Griswold and Galati, pers. comm. 1979). In 1976, gizzard shad postlarvae were one of the most abundant postlarvae present, near the lake bottom in July and August. The presence

of gravid, ripe, and spent fish in the harbor suggests spawning occurs there (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). In 1976, prolarvae were entrained at the Dunkirk Steam Station (42°30', 79°21') in June; postlarvae were entrained there in June-August (Tex. Instrum. 1977e).

Eaqle Bay (42°32', 79°14'). Prolarvae and postlarvae were collected in the bay in May-July, suggesting that the bay is a spawning area (Envirosphere 1977a; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a). Young-of-the-year were collected in July to September suggesting that it is a nursery area (Griswold and Galati, pers. comm. 1979; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Pipe gizzard shad were caught along the east side of Pottohawk Point (42°37', 80°17'), to a depth of about 14 ft; YOY were also captured there along shore (Whillans, pers. comm. 1979). In 1974, larvae and YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in June to August. In 1976, larvae and YOY were caught in shore seines in July to September near the station. Peak entrainment of YOY occurred in late July and early August; YOY alewives were more abundant than those of other species collected in shore seines at that time (Chamberlain 1976; Hamley and MacLean 1979; Teleki 1976).

CLUPEID spp.

Michigan

In the latter part of the spawning season, most hatching seems to occur in or near the tributaries along the western shore. The larvae do not avoid surface waters and in a short time are dispersed widely from spawning areas and are abundant all along the western shore (Cole 1978a,b).

Swan Creek (41°58', 83°15'). In 1975-76, the highest density of clupeid larvae in Michigan waters of the lake was recorded in an area (41°59', 83°14') just north of the creek mouth in late June (Waybrant and Shauver 1979).

Monroe (41°55', 83°24'). In 1973-75, clupeid larvae were more abundant than those of other species near the Monroe Power Plant (41°53', 83°21') in June and July (MacMillan 1976). In 1975, clupeid eggs and larvae were entrained at the plant in May and June (Detroit Edison 1976b). In 1974 and 1975, clupeid larvae were collected near the mouth of the Raisin River (41°53', 83°20') and in the plant discharge canal (41°53',

83°21') (Cole 1976). Larvae were usually more abundant nearshore and probably either hatched near the plant or drifted into the area from Maumee Bay (41°43', 83°25') (Cole 1978b; MacMillan 1976). Larvae were consistently found in the plant's discharge canal before they appeared in the intake canal; hatching may have occurred in the canal (Cole 1978b; MacMillan 1976).

woodtick Peninsula (41°44', 83°25'). In 1975 and 1976, high densities of clupeid larvae were found at depths of 6-12 ft off the peninsula in June and were more abundant here than elsewhere in the Michigan waters of the lake (Waybrant and Shauver 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). The bay may be a major spawning area early in the season (Cole 1978a,b).

O-2

Beaver Creek (41°26', 82°15'). Sampling conducted near the mouth of the creek revealed the presence of clupeid eggs in June to early July, prolarvae in late May to early July, postlarvae in late May to September, and juveniles in August and September (Commonw. Assoc. 1979).

MOONEYE

Mooneyes spawn in Lake Erie primarily in April to early June (Fish 1932; Johnson 1951).

Ohio

o-1

Maumee Bay (41°43', 83°25'). In 1929, a few larvae were found off the mouth of the river (Fish 1932). In 1975, larvae were collected in mid-Maumee Bay near the navigation channel in May (Herdendorf and Cooper 1977).

Sandusky Bay (41°29', 82°46'). In 1961, small numbers of young-of-the-year were captured in western Sandusky Bay in May-October (Keller 1964a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Until the late 1940s or early 1950s, spawning runs entered Big Creek (42°36', 80°27') (Whillans, pers. comm. 1979).

OE-5

Grand River (42°51', 79°35'). Spawning runs still enter the river (Whillans, pers. comm. 1979).

LONGJAW CISCO

No longjaw cisco have been taken in Lake Erie since 1957 (Hartman 1972).

Ontario

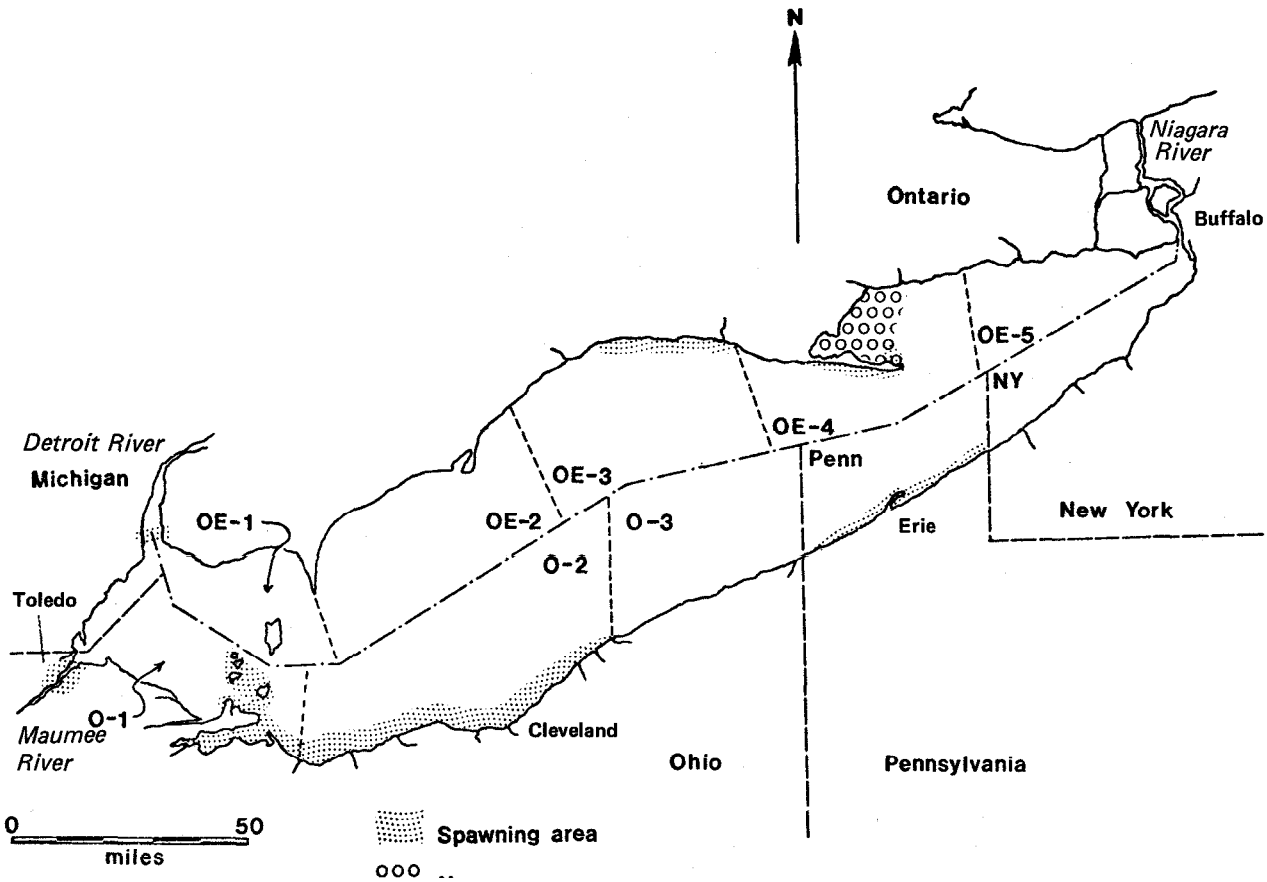
OE-4

Long Point Bay (42°40', 80°10'). Individuals taken at Port Dover (42°47′, 80°12′) in November 1920 were almost ready to spawn (Clemens 1922). All fish taken November 11, 1957, near Long Point (42°33', 80°10') were ripe; one male collected November 13 appeared partly spent (Scott and Smith 1962).

OE-5

Grand River (42°51′, 79°35′). Individuals taken upstream at Dunnville in November 1920 were almost ready to spawn (Clemens 1922).

LAKE HERRING



Lake herring migrated from the deeper waters of the eastern portion of the lake, such as the deep hole off Long Point (42°33', 80°10′), to spawn in shallow water in the western basin (Hile, pers. comm. 1979; Langlois 1948, 1954; Moore 1894; Rathbun and Wakeham 1897; Scott 1951; Trautman, pers. comm. 1979; Wickliff 1936). It was also hypothesized, however, that herring did not migrate from one end of the lake to the other but that the stock was composed of several races (Koelz 1926). Historically, the run began on the Canadian shore near Rondeau (42°15′, 81°53′) and was more pronounced along the shores west of Point Pelee (41°55', 82°30′) and Vermilion (41 °26′, 82°22′). The run along the southern shore of the central basin was believed to be ill-defined, because it was so obstructed by gillnets that the fish had to move along the Canadian shore until deflected southward by Point Pelee (Rathbun and Wakeham 1897). A part of the run continued south to Kelleys Island (41°36′, 82°42'), Huron (41°24', 82°33'), and Vermilion; another portion passed around Point Pelee and spread out over the area west of the islands (Moore 1894). A large number also moved up into the Detroit River

(42°03', 83°08') (MSBFC 1895). The migration began as early as late September. Spawning occurred in open water over all bottom types, mainly between mid-November and early December; the fish returned to the east in December (Bean 1915; Fish 1929; Greeley 1929; Kerr and Kerr 1860-1898; Koelz 1929; Langlois 1954; Rathbun and Wakeham 1897; Wickliff and Miller 1929; Scott 1950). The eggs hatched in April (Langlois 1948); young were pelagic in open water (Greeley 1929).

The decline in the lake herring fishery began in 1902 and was due to overfishing during the spawning season. The major decline began around 1925 (Scott 1951); however, spawn was still being collected in the western basin in the 1940s (Ont. Game Fish 1944, 1945). Commercially important catches were last made in 1946 (Hartman 1972).

Michigan

Detroit River (42°03', 83°08'). Adults migrated upstream to spawn on the rapids before 1900 (Trautman, pers. comm. 1979).

Ohio

O-1

Maumee River (41°41', 83°28'). Adults historically migrated upstream to spawn on the rapids (Trautman, pers. comm. 1979). Lake herring were absent from Maumee Bay (41°43', 83°25') by 1885 (Smith and Snell 1891).

Island Region (41°40', 82°45'). The clean, hard gravel and bedrock substrate around the Bass Islands (41°41' , 82°49') and Kelleys Island (41°36', 82°42') was the primary spawning area for the lake herring in Lake Erie. The heaviest run occurred in November and reached a peak on the west side of the islands approximately 2 weeks later than on the east side. This area was degraded by siltation as early as 1881, and by the early 1890s its use by herring had decreased (Langlois 1954; Moore 1894; Smith and Snell 1891; Trautman 1957, pers. comm. 1979). In 1889, many eggs were found in January in the stomachs of mud puppies captured in Put-In-Bay (41°39', 82°49') (Stranahan 1898).

Sandusky Bay (41°29', 82°46'). Lake herring were fished here for about 60 days during the fall (Klippart 1877). Large catches occurred over sand bottom from Cedar Point (41°29', 82°41') to a location 6 mi E, and from Sugar Bluff (possibly Sugar Rock at 41°34', 82°51') to the bay entrance (Kumlien and True 1887).

O-2

Historically, lake herring spawned along the Ohio shore of the central basin as far east as Fairport (41°46', 81°17') (Rathbun and Wakeham 1897). Heavy runs occurred in mid-November in the Cedar Point (41°29', 82°41')--Avon Point (41°31', 82°01') region (Moore 1894).

Huron (41°24', 82°33'). This area had the most favorable fishery on the lake. Lake herring were caught as they passed into the western basin and were also taken on a large spawning ground that extended 5 mi E and W of Huron (Kumlien and True 1887). More than 1 million pounds were taken in 1885 and almost none were caught in 1894; the decline was attributed to overfishing (MSBFC 1895).

Cleveland (41°30', 81°43'). In 1893, great numbers of herring were found spawning over mud bottom off Cleveland and even farther east (Moore 1894).

Pennsylvania

Historically, spawning fish were caught in limited numbers along the Pennsylvania shore (Moore 1894).

Erie (42°07', 80°05'). In the early 1900s, spawn was taken from ripe fish at Erie (Redband 1912, 1913; Winchester 1915). In the 1950s, ripe fish were collected off Erie (at 42°12', 80°15' and 42°17', 80°00') for hatchery use; these fish were taken during October and November over a sand, gravel, and rubble substrate in water about 60 ft deep (Larsen, pers. comm. 1979).

New York

Dunkirk (42°29', 79°20'). Spawn was collected from ripe fish during December (Redband 1913; Winchester 1912).

Ontario

OE-2

Kent County (42°04', 82°27'--42°27', 81°40'). In 1912, catches were plentiful by mid-October (Scott 1951); catches were still large in 1913 (Ont. Game Fish 1915).

OE-3

Port Stanley (42°39', 81°13')--Port Burwell (42°37', 80°48'). During the spawning season adults congregated inshore between Port Stanley and Port Burwell (Scott 1950, 1951). Fishing was still good in 1912, and spawn was still being taken in 1915 at Port Stanley (Ont. Game Fish 1913a; Rodd 1917; Scott 1951). Historically, the spawning run at Port Stanley began on about October 20 (Kerr and Kerr 1860-1898), and spawning occurred in November (Jordan and Evermann 1911).

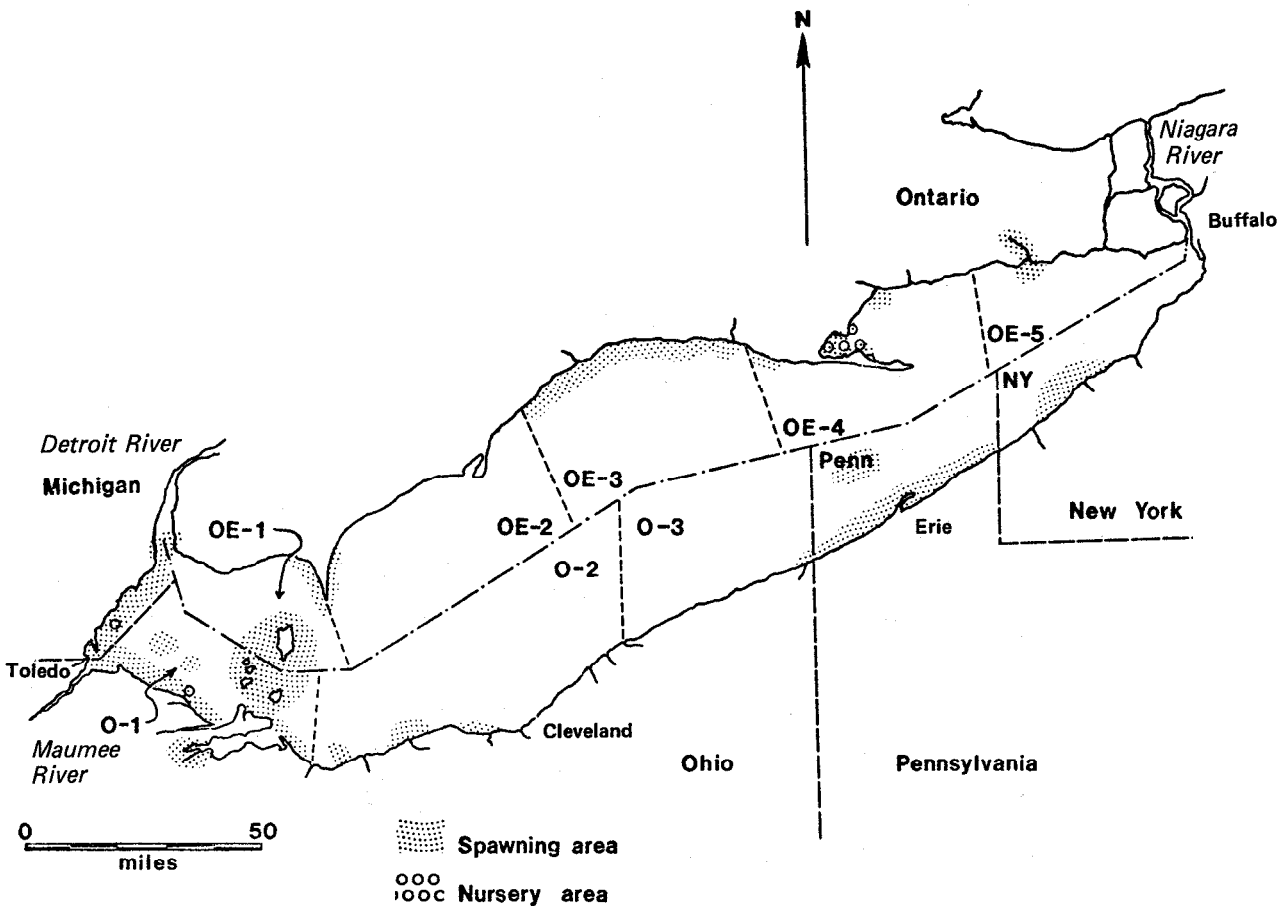
OE-4

Long Point Bay (42°40', 80°10'). Lake herring spawned on the east and west sides of Bluff Bar (42°35', 80°09'), along the south shore of Long Point (42°33', 80°10') and possibly north of Turkey Point (42°39', 80°21'). There are no spawning records for the bay itself, but the bay served as a nursery area at least until 1894 (Whillans 1977, pers. comm. 1979). In 1911, large catches were still being made at Port Dover (42°47', 80°12') in December (Scott 1951).

OE-5

Port Maitland (42°51', 79°35'). Historically, enormous catches were made here in December (Kerr and Kerr 1860-1898; Ont. Game Fish 1912; Scott 1951).

LAKE WHITEFISH



Historically, on about the first of October, lake whitefish began to migrate from the eastern basin of Lake Erie along both the north and south shores to the rocky shoals at the western end of the lake to spawn (Cole 1905; Downing 1904, 1910; Ferguson 1957; Kerr and Kerr 1860-1898; Kumlien and True 1887; Leach 1923; Milner 1874b; Moore 1894; Rathbun and Wakeham 1897; Smith and Snell 1891; Trautman 1957; Wright 1955). Lake whitefish are believed to have moved clockwise around the lake on their spawning migration, often passing to the west through the islands area and back along the Canadian shore (Wolfert, pers. comm. 1979). Lake whitefish passed through the western basin and into the Detroit River and, until the early 1900s, into Lake St. Clair and the St. Clair River to spawn; they returned via Pigeon Bay (42°00', 82°40') which borders Point Pelee on the west (Kerr and Kerr 1860-1898; Keyes 1894; Milner 1874c; MSBFC 1887, 1895; Reighard 1910; Trautman 1957). In Lake Erie, lake whitefish spawned for 18-60 days in late October to December when temperatures were generally 43-53°F (Fish 1929; Kerr 1874; Klippart 1877; Koelz 1929; Langlois 1945b, 1954; Milner 1874a; Price 1940; Rathbun and Wakeham 1897; Stockwell 1875a; Van Oosten and Hile 1949; Wickliff 1928b, 1933a, 1936, 1957; Wickliff and Miller 1929). Spawning usually does not begin until the temperature drops to at least 46°F (Lawler 1965).

Spawning has been reported to occur from November 10 to December 10 in the east end of the lake and from November 15 to December 15 in the west end (MacKay 1957f, 1969). Spawning occurred throughout the western basin wherever shallow, hard bottom (rock, honeycomb, gravel, firm sand) was present (Clark and Bower 1883; Kerr and Kerr 1860-1898; Langlois 1954; Leach 1923; Milner 1874b; Moore 1894). Spawning was completed shortly before the lake began to freeze, and the adults then returned to deeper water. Whitefish eggs developed for about 4 months and hatched in March or April as the water temperature approached 43°F (Downing 1904; Fish 1929; Langlois 1954; Leach 1923; Price 1940).

The western basin of Lake Erie is dotted with shoals and reefs which are natural spawning grounds of the whitefish; adults moved into these areas about mid-November (Clark and Bower 1883; Downing 1904; Geare 1884; MSBFC 1887; Wickliff and Miller 1929). Some of the best spawning grounds were along the shoreline from Monroe (41°55', 83°20') south and east to Port Clinton (41 °31', 82°56') (Clark and Bower 1883; Wright and Tidd 1933). Spawn was collected throughout this area in early November (Howell 1882). Spawn was also collected out of Kingsville, Ontario (42°02', 82°44') (Ontario Game Fish 1943; Rodd 1914, 1917). Spawning grounds were generally distributed along both sides of the international boundary from the Michigan shore southeast toward Kelleys Island (Rathbun and Wakeham 1897). Catches have been insignificant since 1920, and fishermen reported that pollution from the Detroit River drove the fish from the spawning grounds (Koelz 1926). Pollution was probably not the only reason for the decline, however, because the population had already decreased by the 1890s (Wright 1955). Some spawning also occurred at the east end of the lake (Ont. Game Fish 1945).

Michigan

Pointe Mouillee (42°01', 83°12'). Spawning occurred in an area (42°00', 83°09') about 3 mi E of Pointe Mouillee over clay bottom at depths of about 10-15 ft (Organ et al. 1978).

Point aux Peaux (41°57', 83°15'). Lake whitefish spawn along the shoreline from Point aux Peaux south to Stony Point (41°56', 83°16') in 2-12 ft of water. Since 1911, spawning has also occurred 2-3 mi E of Point aux Peaux (at 41°57', 83°13') over clay bottom in about 18 ft of water (Organ et al. 1978).

Stony Point (41°56',83°16')--Plum Creek (41°54', 83°23'). Until the 1940s, spawning occurred along this shoreline at depths of 18-20 ft (Organ et al. 1978). From 1900-13, the entire area produced considerable amounts of spawn for hatchery use, but by 1919 no eggs could be collected. The decline occurred after large powder factories were established at Monroe (41°55', 83°24') and began dumping refuse into the lake (Clark 1886; Downing 1923; Langlois 1941; Wright and Tidd 1933). However, spawning may

have been reduced in the area before the turn of the century; fish caught there during mid-November to mid-December rarely weighed more than 1 lb (Smith and Snell 1891).

Stony Point (41°56', 83°16'). Historically, this area was a spawning ground (Lyons 1972). Since 1911, spawning occurred on a clay bottom area 1 mi S of Stony Point (at 41°55', 83°16'); until the 1940s, spawning occurred in an area (41°54', 83°14'--41°57', 83°13') 2 mi SE of Stony Point in about 20 ft of water (Organ et al. 1978).

Sandy Creek (41°56', 83°20'). Until the 1930s, spawning occurred off the mouth of Sandy Creek in 6-12 ft of -water at 41°55', 83°19' (Organ et al. 1978). In 1977, small numbers of larvae were collected in late April in Brest Bay (41°55', 83°18') just north of Sandy Creek out to about the 14 ft contour (Patterson 1979a).

Bolles Harbor (41°51', 83°24'). From the 1900s to the 1940s, lake whitefish spawned in 16-24 ft of water east of the harbor in an area 3 1/2 mi in diameter with a center at 41°51', 83°18' (Organ et al. 1978).

Toledo Beach (41°50', 83°24'). In 1977, early postlarvae were collected at a maximum density of 7/100 m^3 about 2-1/4 mi off Toledo Beach at approximately 41°49', 83°22' (Patterson 1979a).

Woodtick Peninsula (41°44', 83°25'). Lake whitefish have spawned in a narrow arc within 5 mi of shore, extending from 41°49', 83°24' south to Turtle Island (41°45', 83°23') (Organ et al. 1978).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Lake whitefish spawned in Maumee Bay until 1885-1899. The population declined drastically in about 1900, possibly due to smothering of the spawning beds in the bay and other areas of the western basin by the heavy silt load entering from the Maumee River (41°41', 83°28') (GLBC 1975; Pinsak and Meyer 1976; Smith 1969; Smith and Snell 1891; Trautman 1957; USDI 1967; Wright 1955). Many fish, however, were still taken at this time east of Cedar Point (41°42', 83°20') during the spawning season (Smith and Snell 1891). Presently spawning occurs from November 15 to December 1 in a gravel area 2 mi E of the Maumee River mouth, at 41°42', 83°15' (Pinsak and Meyer 1976).

Locust Point (41°36', 83°05'). Spawning occurred between Locust Point and Port Clinton (41°31', 82°56') (Smith and Snell 1891); a spawn collection station was located at Toussaint River (41°35', 83°04') (Clark 1886). In 1848, a storm drove many lake whitefish eggs onto Ottawa Beach (precise location unknown; probably near 41°32', 83°00') (Goode 1884). Spawning may still be occurring near Locust Point. In 1978, prolarvae in

small densities were found on April 30 at the intake of the Davis-Besse Power Station (41°36', 83°04') (Reutter 1979c).

Niagara Reef (41°40', 82°58'). In the late 1800s, the reef was a well-known spawning area for lake whitefish (Rathbun and Wakeham 1897); the run was fished in late October to early December (Smith and Snell 1891). Good spawning runs were still entering the area between 1940 and 1955, but the reef areas are now silted over and the runs have ceased (Trautman 1957, pers. comm. 1979).

West Sister Island (41°44', 83°06'). This area was an excellent spawning ground (Geare 1884). West Sister Island is presently a spawning area (Trautman 1957, pers. comm. 1979). Spawning was recently observed and eggs were collected in 5-15 ft of water over gravelly rock November 20 to December 1 (Reynolds, pers. comm. 1979).

Green Island (41°39', 82°52'). Lake whitefish spawned in 4-20 ft or more of water over reefs and rocky shore areas surrounding the island (Rathbun and Wakeham 1897).

Rattlesnake Island (41°41', 82°51'). The reefs and rocky shores around Rattlesnake Island were a well-known spawning area (Rathbun and Wakeham 1897).

Bass Islands (41°41', 82°49'). Historically, spawning occurred in the islands (Langlois 1941). In 1880, eggs were collected around the islands (Berst and Spangler 1970a); spawn collection stations were located at North Bass Island (41°43', 82°49'), and Put-In-Bay (41°39', 82°49') (Clark 1886). In 1933, most of the lake whitefish eggs that were collected from western Lake Erie came from the Bass Island area (Wright and Tidd 1933). Good runs of spawners were still arriving at the Bass Islands between 1939 and 1955 (Trautman, pers. comm. 1979).

North Bass Island (41°43', 82°49') and Middle Bass Island (41°41', 82°49'). The honeycombed reefs and rocky shores around these islands were some of the best known spawning grounds in Lake Erie (Rathbun and Wakeham 1897; Smith and Snell 1891). The best areas extended 3-1/2 mi off the west side of North Bass Island and from the north side of North Bass Island to the Hen and Chickens (41°47', 82°48') islands (True 1884; Kumlien and True 1887; Smith and Snell 1891). Spawning was recently observed and eqgs were collected in 5-15 ft of water during November ZO-December 1 over the rock and gravel reef off the west shore of North Bass Island (Reynolds, pers. comm. 1979).

South Bass Island (41°39', 82°50'). In 1897, lake whitefish eggs were found in the stomachs of mud puppies collected at Put-In-Bay (41°39', 82°49') in January (Stranahan 1898).

Kelleys Island (41°36', 82°42'). Some of the best known spawning areas were the two shoals north of Kelleys Island in 4-20 ft of water (Geare 1884; Kumlien and True 1887; Rathbun and Wakeham 1897). These

shoals were probably Kelleys Island Shoal (41°38', 82°39') and Gull Island Shoal (41°40', 82°41'). The spawning run began here 7-10 days earlier than at the other islands (Smith and Snell 1891). In 1933, lake whitefish eggs were collected here for hatchery use (Sterling 1876; Wright and Tidd 1933). Historically, Kelleys Island was an important spawning area. The peak of the spawning run occurred in late November (Wolfert, pers. comm. 1979). Lake whitefish are presently found on Kelleys Island Shoal in late fall (ODNR, undated). Spawning has been observed and eggs were collected in 5-15 ft of water in late November to December (Reynolds, pers. comm. 1979).

Gull Island Shoal (41°40', 82°41'). This is considered to be a major spawning area. Eggs were collected and spawning lake whitefish were observed November 20 to December 1 over gravel rock in 5-15 ft depths (Reynolds, pers. comm. 1979).

Sandusky (41°27', 82°42'). In 1872, ripe and spent fish were caught in November and December; eggs were collected on about October 1 for the Sandusky hatchery. Spawning occurred in this area over rocks and reefs (Howe 1907; Milner 1874a,c; Van Oosten and Hile 1949). Very large catches were made at East Harbor (41°32', 82°47') when pound nets were first used in 1850-51 (Klippart 18771, and a spawn collection station was located at Catawaba Island (41°35', 82°51"). It was reported that "Otsego bass" (probably lake whitefish) once migrated up the Sandusky River to spawn at Fremont (Van Oosten 1926).

O-2

Huron (41°24', 82°33'). Adults moved past Huron to spawning grounds and returned in early winter (Kumlien and True 1887; Smith and Snell 1891).

Chappel Creek (41°24', 82°27'). Spawning occurred on a small rocky area 5 mi E of Huron (Kumlien and True 1887); this is the approximate location of Chappel Creek. There is presently a rocky area about 1 mi off the creek mouth at 41°24', 82°28'.

Lorain (41°28', 82°11'). Collections of ripe fish were made off Lorain during the spawning season (Van Oosten and Hile 1949). In 1979, one prolarva was collected on April 19 in 36 ft of water at approximately 41°27', 82°17'; a second prolarva was taken on May 10 in 23 ft of water off Beaver Creek at approximately 41°26', 82°15'. There is no recorded presence of adults in these areas during the previous fall (Commonw. Assoc. 1979).

Dover Bay (exact location unknown). This lake whitefish spawning ground was 13-14 mi W of Cleveland (41°30', 81°43'), and was the closest such ground to Cleveland (Sterling 1883). A small rock reef (location unknown) between Dover Bay and Lorain (41°28', 82°11') was also used for spawning (Geare 1884).

O-3

Fairport (41°46', 81°17'). Many lake whitefish were taken during the spawning season at an unspecified location several miles east of Fairport (Geare 1884).

Conneaut (41°58', 80°33'). Ripe fish were taken during spawning runs in November; limited spawning occurred on the rocky shore off Conneaut (Smith and Snell 1891).

Pennsylvania

Historically, lake whitefish spawned along the Pennsylvania shore in mid-November (Moore 1894).

Elk Creek (42°01', 80°22'). Historically, spawning occurred in the lake off the creek (Smith and Snell 1891).

Northwest Sand Bar (42°19', 80°20'). This is probably a spawning area for lake whitefish. The area has an unstable sand bottom with no vegetation and is 48-66 ft deep. In the late fall, lake whitefish concentrate in the area; gravid females and males with running milt have been collected here as late as mid-November. Spawning probably occurs in less than 60 ft of water (Kenyon, pers. comm. 1979).

Erie (42°07', 80°05'). In the early 1900s, spawn was collected near Erie (Redband 191%). In the 1950s, ripe adults for hatchery use were also collected off Erie at 42°12', 80°15' and 42°17', 80°00' and just east of Walnut Creek (42°04', 80°14') in about 60 ft of water over sand, rubble, and gravel in October and November (Larsen, pers. comm. 1979).

New York

Dunkirk (42°29', 79°20'). Historically, a small spawning ground existed between Dunkirk and Westfield (42°19', 79°35'). In the 1890s, spawning fish were taken here as late as January 1 (Moore 1894).

Ontario

In the early 1900s, most lake whitefish were believed to spawn along the Canadian shore because pollution along the U.S. shore prevented spawning there (Reighard 1913).

OE-1

Hen and Chick Island Reef (41°47', 82°48'). Whitefish spawned in 4-20 ft of water over the reef areas (Rathbun and Wakeham 1897).

Pelee Island (41°47', 82°40'). In the 1920s, Pelee Island was a whitefish spawning ground and was historically the best fishing ground in the lake. Much spawn was collected for hatchery use. Whitefish spawned on Pelee Island reefs in less than 30 ft of water from November 20 into December. The substrate in this area is honeycombed limestone rock or gravel (Ferguson 1957; Kerr and Kerr 1860-1898; Koelz 1929; Rodd 1919). Much of the remnant lake whitefish population spawns around the island (Ferguson 1957).

Point Pelee (41°55', 82°30'). Much of the remnant lake whitefish population spawns at Point Pelee (Ferguson 1957).

OE-2

Kent County (42°04', 82°27'--42°27', 81°40'). In 1912, large catches were reported in the fall along this shoreline (Ont. Game Fish 1913a).

OE-3

Port Burwell (42°37', 80°48'). Historically, spawning occurred offshore (Rathbun and Wakeham 1897); spawners were plentiful on about October 1 along the shoreline of Elgin County (42°37', 80°43'--42°27', 81°40') (Ont. Game Fish 1913a).

OE-4

Clear Creek (42°34', 80°35'). Adults were caught here in November (Kerr and Kerr 1860-1898); the area (42°33', 80°41') just west of Clear Creek, at depths of 36-48 ft is presently a spawning area (Environ. Can. 1977a).

Long Point Bay (42°40', 80°10'). Until 1888, lake whitefish spawned at Inner and Outer Turkey Point (42°39', 80°21') on reefs within 1 mi of shore. Ripe adults were caught on the east and west sides of Bluff Bar (42°35', 80°09') on Long Point (42°33', 80°10') (Whillans, pers. comm. 1979). There is also evidence that Inner Bay (42°37', 80°22') was a nursery area for lake whitefish (Whillans 1977).

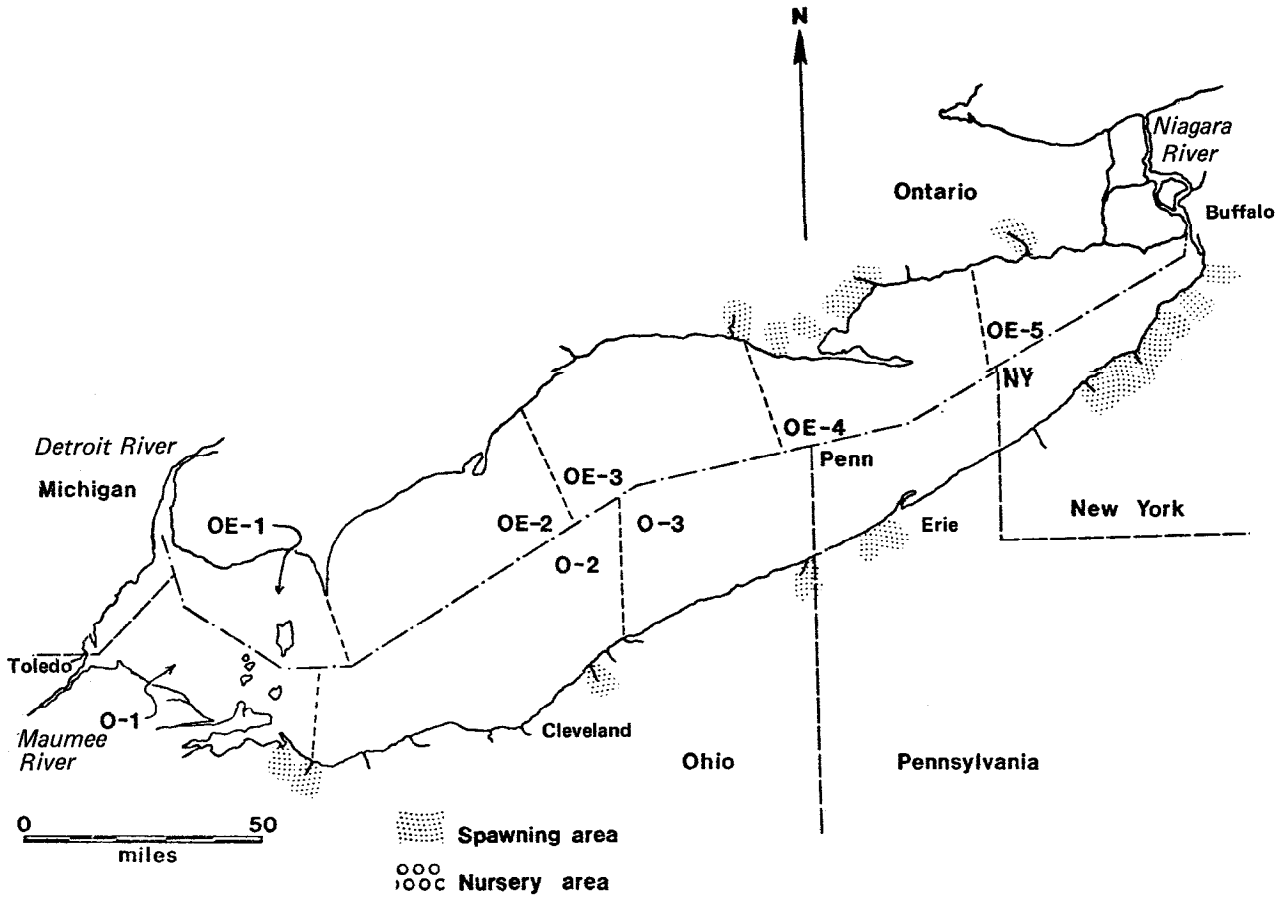
Port Dover (42°47', 80°12'). A spawning ground existed offshore (Rathbun and Wakeham 1897), and spawn was collected there from ripe fish (Ont. Game Fish 1943).

Nanticoke (42°48', 80°04'). Spawn was collected in this area (Ont. Game Fish 1911, 1912; Vokes 1912).

OE-5

Port Maitland (42°51', 79°35'). Spawning occurred offshore (Koelz 1929). Spawn also was collected from ripe fish in the Grand River at Dunnville (Rodd 1914). Adults were plentiful during fall off Haldimand County (42°47', 80°06'--42°52', 79°26'), and large quantities of spawn were taken (Ont. Game Fish 1913b, 1915).

COHO SALMON



In 1933, coho salmon fingerlings were stocked in Pickerel (41°26', 82°57') and Cold (41°27', 82°46') creeks, tributaries of Sandusky Bay; these plantings were unsuccessful (Parsons 1973). Annual plantings began in Ohio, Pennsylvania, and New York waters of Lake Erie in 1969 and in Michigan waters in 1974 (GLFC 1973a,b, 1975, 1976, 1978 in press; NYDEC 1977a; ODNR, undated). Spawning runs have developed in several tributaries, -primarily in the eastern and central basins, but little natural reproduction occurs.

Significant numbers of coho salmon are observed during September of each year, when they school near stream mouths (Shea 1972). An annual clockwise migration occurs between the eastern and central basins. In January and February, juvenile coho salmon concentrate near warm water discharges at Lorain (41°28', 82°11') and Cleveland (41°30', 81°43'), in May-August they concentrate between Point Pelee (41°55', 82°30') and Port Stanley (42°39', 81°13'), and in September and October, as adults, they move back to their home streams (Baker and Scholl 1971c; Shea 1972). Spawning runs enter a number of Lake Erie tributaries.

Ohio

O-1

Cold Creek (41°27', 82°46'). Spawning runs were documented in 1969 and 1970 (Raker and Scholl 1971c).

O-2

Huron River (41°24', 82°33'). In 1969-71, coho salmon from plantings made in 1968-70 entered the river. The run began in the second week of September at a water temperature of 72°F (Baker and Scholl 1971c).

Avon Lake Generating Station (41°30', 82°03'). In 1974, ripe and sexually mature coho were taken in October near the station; these fish may have been migrating to nearby streams to spawn (Aquat. Ecol. Assoc. 1975).

Chagrin River (41°41', 81°26'). In 1969-71, coho salmon from plantings made in 1968-70 entered the river. The run began in the second week of September, at a water temperature of 67°F (Baker and Scholl 1971c). Large runs presently occur (Environ. Resour. Assoc. 1978).

O-3

Conneaut (41°58', 80°33'). The spawning run enters the Conneaut River in the second week of September, when the water temperature is 67°F, and peaks in October (Baker and Scholl 1971c). In 1977, a fall migration of coho was observed nearshore at Conneaut. In 1977, three ripe adults were collected from Turkey Creek (41°58', 80°32') during September and October (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22') (Moccia, pers. comm. 1979). Adults are found near the creek mouth beginning in September, but little reproduction occurs (GPU Serv. Corp. 1979; U.S. Army Eng. Dist. 1973).

Trout Run (42°03', 80°16') (Knuth 1976; Moccia, pers. comm. 1979).

Walnut Creek (42°04', 80°14') (Moccia, pers. comm. 1979).

New York

Canadaway Creek (42°28', 79°22') and Scott Creek (42°30', 79°18') (NYDEC 1977b).

Beaver Creek (42°31′, 79°17') and Walnut and Silver Creeks (42°33', 79°10') (NYDEC I977b).

Cattaraugus Creek (42°34', 79°08'). Some natural reproduction occurs (GLFC 1977; NYDEC 1977a,b).

Delaware Creek (42°38', 79°04') (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Big Sister Creek (42°40', 79°04') (NYDEC 1977b).

Eighteenmile Creek (42°43', 78°58') (Buffalo Waterfront Devel. Comm., undated).

Athol Springs (42°46', 78°53') (NYDEC 1977b).

Ontario

OE-3

Big Otter Creek (42°37', 80°48'). (Environ. Can. 1977a; OMNR 1973).

OE-4

Clear Creek (42°34', 80°35') (Environ. Can. 1977a; OMNR 1973).

Big Creek (42°36', 80°27'). Runs enter Venison Creek (Environ. Can. 1977a; OMNR 1973). The coho salmon running into Inner Bay do not appear to be reproducing successfully (Whillans 1979b).

Potters Creek (42°43', 80°19′) and Fishers Creek (42°43', 80°18′) (OMNR 1973).

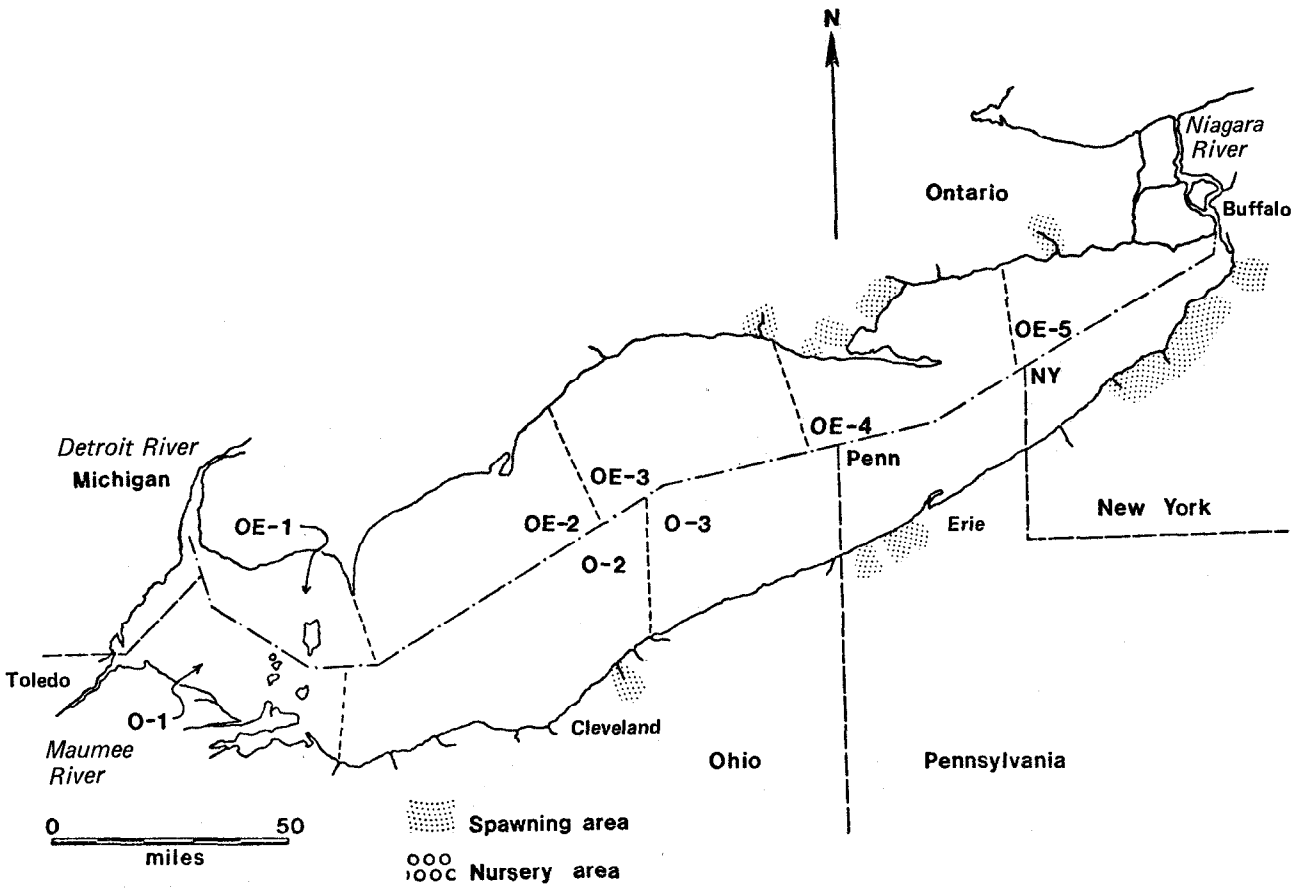
Younq Creek (42°45', 80°15′) (Kelso 1972; OMNR 1973).

Port Dover (42°47′, 80°12′). Spawning runs enter three tributaries at Port Dover (Teleki 1975a).

OE-5

Grand River (42°51', 79°35') (Environ. Can. 1977a; OMNR 1973).

CHINOOK SALMON



In 1873-80, chinook salmon fry were planted in Ohio tributaries to Lake Erie, mainly in the Maumee River, and also in five Michigan tributaries. In 1933, yearlings were planted in Pickerel (41°26′, 82°57′) and Cold (41°27′, 82°46′) creeks, tributaries of Sandusky Bay; only one survivor was reported (Parsons 1973). Plantings resumed in Ohio Waters in 1970, and were begun in Pennsylvania waters in 1971, and in Michigan and New York waters in 1973 (GLFC 1973a, 1975, 1976, 1978 in press; NYDEC 1977a). Spawning runs have developed in several tributaries, primarily in the eastern and central basins, but little natural reproduction occurs.

Significant numbers of chinook salmon are observed in September when they school near stream mouths (Shea 1972). An annual clockwise migration occurs between the eastern and central basins. In January and February chinook salmon concentrate near warm water discharges at Lorain (41°28′, 82°11') and Cleveland (41°30′, 81°43′), in May to August they concentrate between Point Pelee (41°55', 82°30') and Port Stanley (42°39', 81°13′), and in September and October, they move back to home streams (Shea 1972). Spawning runs enter a number of Lake Erie tributaries.

Ohio

O-2

Avon Lake Generating Station (41°30', 82°03'). In 1974, ripe and sexually mature chinook were captured in October near the station; these fish may have been migrating to nearby streams to spawn (Aquat. Ecol. Assoc. 1975).

Chagrin River (41°41', 81°26'). A large fall run occurs (Environ. Resour. Assoc. 1978).

O-3

Conneaut (41°58', 80°33'). In 1977, a fall migration occurred here offshore. One ripe male was taken from Turkey Creek (41°58', 80°32') on November 15, but was considered a stray. Other adults were collected from Turkey Creek and the Conneaut River in September-December; these also were considered strays (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22'). A small spawning run occurs (GPU Serv. Corp. 1979; Moccia, pers. comm. 1979; U.S. Army Eng. Dist. 1973).

Walnut Creek (42°04', 80°14') and Trout Run (42°03', 80°16'). Small spawning runs occur (Moccia, pers. comm. 1979).

New York

Canadaway Creek (42°28', 79°22*), Scott Creek (42°30', 79°18'), Beaver Creek (42°31', 79°17'), Walnut and Silver Creeks (42°33', 79°10'), and Cattaraugus Creek (42°34', 79°08') (NYDEC 1977b).

Delaware Creek (42°38', 79°04') and Big Sister Creek (42°40', 79°04'). Natural reproduction occurs (NYDEC 1977b).

Eighteenmile Creek (42°43', 78°58') (Buffalo Waterfront Devel. Comm., undated).

Athol Springs (42°46', 78°53') (NYDEC 1977b).

Ontario

OE-3

Big Otter Creek (42°37', 80°48') (Environ. Can. 1977a; OMNR 1973).

OE-4

Clear Creek (42°34', 80°35') (Environ. Can. 1977a).

Big Creek (42°36', 80°27'). Runs enter Venison Creek (Environ. Can. 1977a).

Young Creek (42°45', 80°15'), Fishers Creek (42°43', 80°18'), and Potters Creek (42°43', 80°19') (OMNR 1973).

OE-5

Grand River (42°51', 79°35') (OMNR 1973).

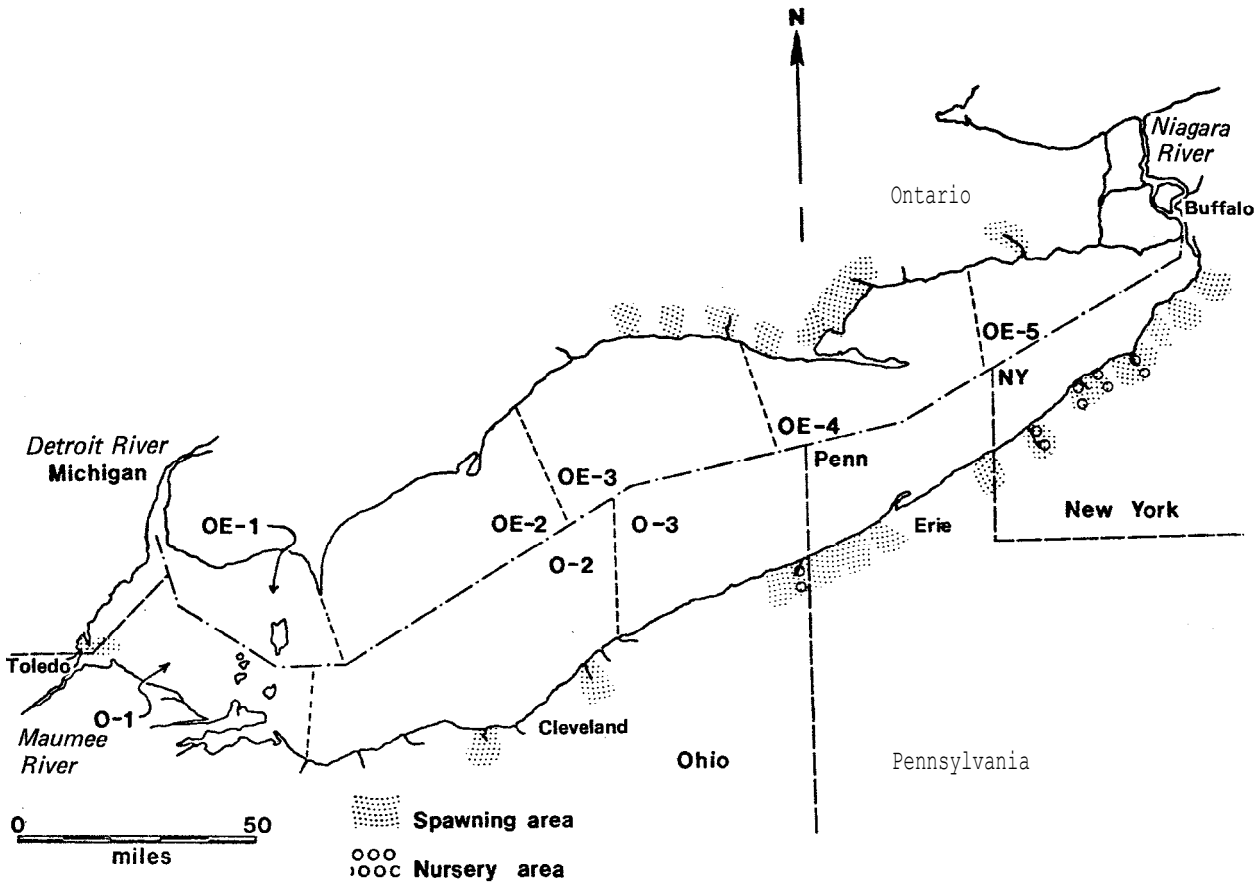
SALMON spp.

Ontario

OE-3

Talbot (42°38', 81°22'), Kettle (42°39', 81°13'), and Catfish creeks (42°39', 81°01'). Runs of unidentified species of salmon enter these creeks (Environ. Can. 1977a).

RAINBOW TROUT



The initial plantings of rainbow trout in the Lake Erie watershed occurred in the Huron River (42°02', 83°12'), Michigan, in 1882. Plantings were made in Cold Creek (41°27', 82°46'), Ohio, in 1886, in Pennsylvania tributaries before 1895, and in Cattaraugus Creek (42°34' 79°08'), New York, in 1899. Rainbow trout were caught in the Pennsylvania waters of Lake Erie by 1895. Plantings by the Province of Ontario began in 1936. Continued stocking of rainbow trout (steelhead) has produced spawning runs in several tributaries of Lake Erie (MacCrimmon and Gots 1972). Reproducing populations of rainbow trout occur entirely in the eastern and central basins.

Michigan

No runs were known to occur in Michigan waters (MacCrimmon and Gots 1972); however, commercial fishermen have identified the following spawning areas:

Woodtick Peninsula (41°44', 83°25'). From 1950 to 1970, adult steelhead were caught in the inlet west of Woodtick Peninsula (at 41°46', 83°27') near shore in less than about 9 ft of water; adult steelhead were also taken in Michigan waters around Turtle Island (41°45', 83°23') in 2-10 ft of water over hard bottom during May (Organ et al. 1978; Walter, pers. comm. 1981).

Ohio

O-1

Turtle Island (41°45', 83°23'). From 1950 to 1970, adult steelhead were caught around Turtle Island over hard bottom in 2-10 ft of water during May (Organ et al. 1978; Walter, pers. comm. 1981).

O-2

Rocky River (41°30', 81°50'). Spawning migrations occur September 15-April 15 (Cleveland Environ. Res. Group, undated; Teater 1976).

Chagrin River (41°41', 81°26'). Spring and fall runs occur (MacCrimmon and Gots 1972).

o-3

Conneaut River (41°58', 80°33'). Spring and fall runs occur (Aquat. Ecol. Assoc. 1977, 1978c; FWS 1979d; MacCrimmon and Gots 1972).

Turkey Creek (41°58', 80°32'). Ripe adults were collected in the creek during the spring and fall and were observed making redds in December and January. In 1977 and 1978, young-of-the-year (YOY) were collected in the creek, indicating that successful spawning occurred (Aquat. Ecol. Assoc. 1977, 1978c; USACE, undated b).

Pennsylvania

Raccoon Creek (41°59', 80°29'). Fall and spring runs occur (Aquat. Ecol. Assoc. 1978c), and natural reproduction occurs (USACE, undated b).

Crooked Creek (42°00', 80°26'). A limited spawning run occurs (Larsen, pers. comm. 1979), and natural reproduction is reported (USACE, undated b).

Elk Creek (42°01', 80°22'). This is a spawning area (Larsen, pers. comm. 1979; U.S. Army Eng. Dist. 1973; USDI 1967).

Trout Run (42°03', 80°16'). A limited spawning run occurs (Larsen, pers. comm. 1979).

Twenty Mile Creek (42°16', 79°47'). Anglers catch rainbow trout here during runs in the spring (Griswold and Galati, pers. comm. 1979; Larsen, pers. comm. 1979).

New York

Chautauqua Creek (42°20', 79°36'). The creek has a gravel and rock bottom and water depths of 2-4 ft. Ripe adults were caught in the fall and spring. Young-of-the-year are collected in the creek in the summer and fall (Griswold and Galati, pers. comm. 1979).

Canadaway Creek (42°28', 79°22'). Anglers catch gravid females in the creek in the spring; YOY were collected in October in 2-4 ft of water over gravel and rock (Griswold and Galati, pers. comm. 1979).

Scott Creek (42°30', 79°18'). Many gravid adults are collected here in the spring over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Unnamed tributary (42°31', 79°16'). Anglers catch gravid fish here in the spring; YOY are collected in the summer and fall, over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Walnut Creek (42°33', 79°10'). Anglers catch gravid adults here in the spring (Griswold and Galati, pers. comm. 1979; Larsen, pers. comm. 1979; USDI 1967).

Silver Creek (42°33', 79°10'). Fry and YOY were collected here in July-August in 2-4 ft of water over gravel and stone substrate (Griswold and Galati, pers. comm. 1979).

Cattaraugus Creek (42°34', 79°08'). Spawning occurs over gravel bottom at water depths to 6 ft. Gravid adults were collected here in September and October and YOY were observed in the creek in the summer (Griswold and Galati, pers. comm. 1979; MacCrimmon and Gots 1972; NYDEC 1977b; USDI 1967).

Delaware Creek (42°38', 79°04'). A limited run entering the creek and gravid adults have been collected. Spawning occurs over gravel in 1-3 ft of water (Buffalo Waterfront Devel. Comm., undated: Griswold and Galati, pers. comm. 1979).

Eighteenmile Creek (42°43', 78°58'). A fair to good run occurs; anglers catch gravid fish in the spring. Spawning takes place in the creek over gravel and stony bottom (Griswold and Galati, pers. comm. 1979).

Athol Springs (42°46', 78°53'). This is a planting site; concentrations of adults occur here in the spring and fall (NYDEC 1977b).

Ontario

OE-3

Kettle Creek (42°39', 81°13′) (Environ. Can. 1977a).

Catfish Creek (42°39', 81°01′) and Big Otter Creek (42°37', 80°48') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

OE-4

Clear Creek (42°34', 80°35') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Big Creek (42°36', 80°27'). A spawning run enters Big Creek in the spring and proceeds into Venison Creek and North Creek (Bidgood and Berst 1969; Environ. Can. 1977a; Kelso 1972; MacCrimmon and Gots 1972; OMNR 1973).

Forestville Creek (42°40', 80°22') and Gibsons Creek (42°39', 80°21′) (OMNR 1973).

Cranes Creek (42°43', 80°19') and Dedrick Creek (42°36', 80°27') (Environ. Can. 1977a).

Potters (Normandale) Creek (42°43', 80°19') and Fishers Creek (42°43′, 80°18′). A spawning run occurs in the spring (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Lawrence Creek (42°45', 80°16′). A spawning run enters the creek in the spring (OMNR 1973).

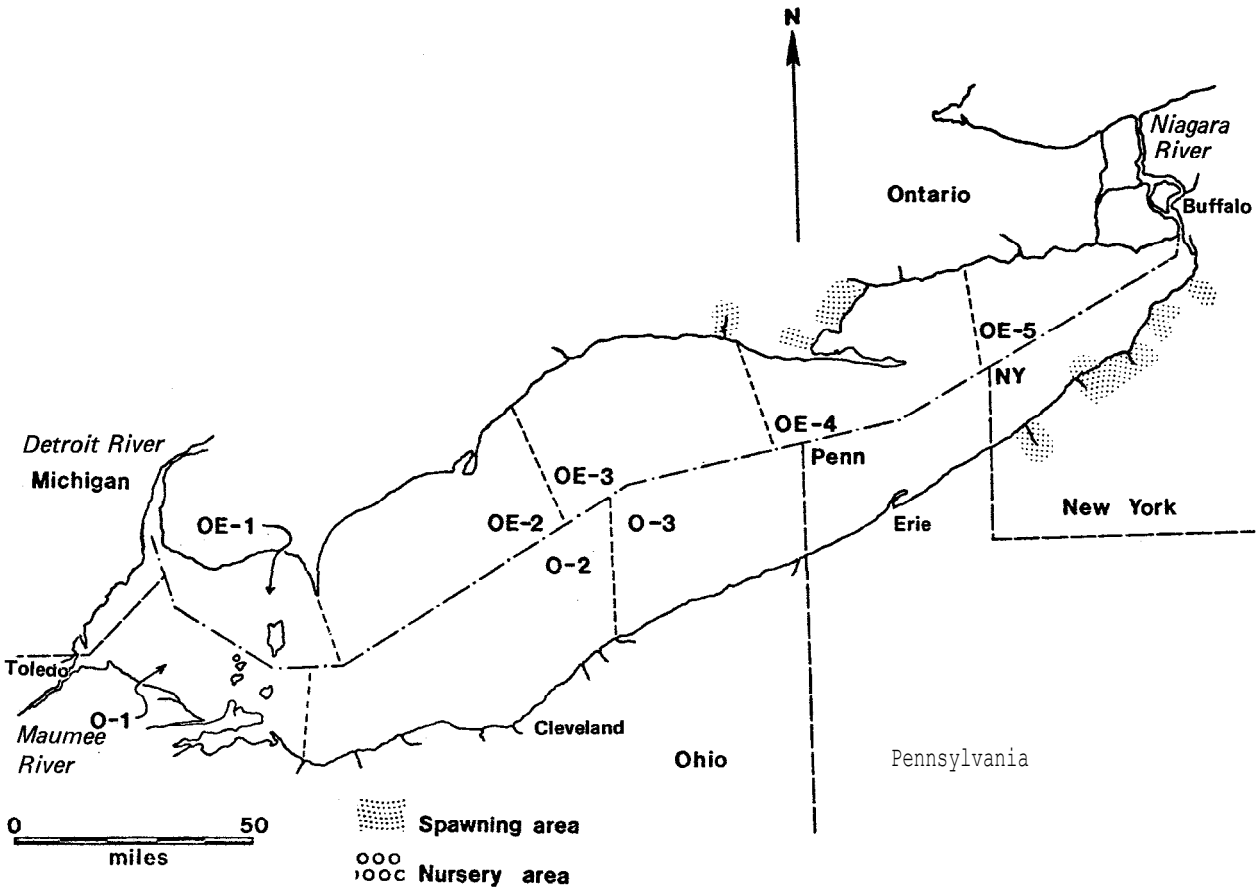
young Creek (42°45', 80°15′). A spawning run enters the creek in the spring (Environ. Can. 1977a; Kelso 1972; MacCrimmon and Gots 1972; ONMR 1973).

Lynn River (42°47', 80°12'). A spawning run enters the river in the spring (Environ. Can. 1977a; OMNR 1973).

OE-5

Grand River (42°51′ , 79°35′). Spawning runs enter the river in the fall and spring (Environ. Can. 1977a; OMNR 1979). Fish have been reported to proceed 35-40 mi upstream (MacCrimmon and Gots 1972).

BROWN TROUT



Brown trout were introduced into the United States in about 1883 and subsequently entered the Great Lakes, probably from stream stockings (Moffett 1958; Scott and Crossman 1973). Plantings in Lake Erie and its tributaries have produced spawning runs in several tributaries.

Ohio

O-2

Chagrin River (41°41', 81°26'). Spawning may occur in the river (Trautman, pers. comm. 1979).

New York

Chautauqua Creek (42°20', 79°36'). This is one of the primary salmonid spawning tributaries in Lake Erie and supports natural reproduction of brown trout (NYDEC 1977b).

Canadaway Creek (42°28', 79°22'). Concentrations of adults occur in fall (NYDEC 1977b).

Dunkirk Harbor (42°30', 79°20'). Ripe fish have been collected here in October-March over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Scott Creek (42°30', 79°18'), Beaver Creek (42°31', 79°17'1, Silver and Walnut Creeks (42°33', 79°10'), Cattaraugus Creek (42°34', 79°08'), Delaware Creek (42°38', 79°04'), and Big Sister Creek (42°40', 79°04'). Spawning runs occur in these streams (NYDEC 1977b).

Athol Springs (42°46', 78°53') (NYDEC 1977b).

Ontario

OE-3

Big Otter Creek (42°37', 80°48') (Environ. Can. 1977a; OMNR 1973).

OE-4

Big Creek (42°36', 80°27'), Potters Creek (42°43', 80°19'), Fishers Creek (42°43', 80°18'), Lawrence Creek (42°45', 80°16'), and Young Creek (42°45', 80°15'). Spawning runs occur in October and November (Environ. Can. 1977a; OMNR 1973).

LAKE TROUT

Native lake trout were abundant in the eastern basin, and very large catches were made annually in the late 1800s (Hartman 1972). Spawning occurred in October-December (Rathbun and Wakeham 1897) in shallow areas (Trautman 1957). Young-of-the-year were pelagic in open water (Greeley 1929). The population declined in the 1920s due to over-exploitation; few were taken after the mid-1930s, and the native stocks are extinct. Environmental degradation probably caused the extinction of the population that remained after the initial decline (Hartman 1972). Lake trout have been planted in Pennsylvania waters of Lake Erie since 1969 and in New York waters since 1975 (GLFC, in press).

New York

A substantial population of lake trout, which spawned about October 15-November 10, inhabited the eastern basin. The major reason for its decline was not pollution, but overfishing and wasteful spawn-taking operations (Moenig, undated).

Dunkirk Light (42°30', 79°21'). An historical spawning reef with rocky substrate extended west from Dunkirk Light between Dunkirk (42°29', 79°20') and Westfield (42°19', 79°35'). Fish from the deeper waters near the eastern end of the lake began to school in October, and spawning fish were taken near Dunkirk in November (Moore 1894; Rathbun and Wakeham 1897).

Ontario

OE-1

Point Pelee (41°55', 82°30') and Pelee Island (41°47', 82°40'). Rocky areas at the point and on the east side of the island may have provided limited spawning habitat (Moenig, undated).

OE-2

Rondeau (42°18', 81°55'). Rocky areas here may have provided limited spawning habitat (Moenig, undated).

OE-4

Long Point Bay (42°40', 80°10'). Lake trout spawned over rocky bottom in 18-24 ft of water between Port Ryerse (42°45', 80°15') and Port Dover (42°47', 80°12') (Moenig, undated). A commercial fisherman reported that a run entered Young Creek (42°45', 80°15') (Whillans, pers. comm. 1979).

COREGONUS spp.

Ohio

O-3

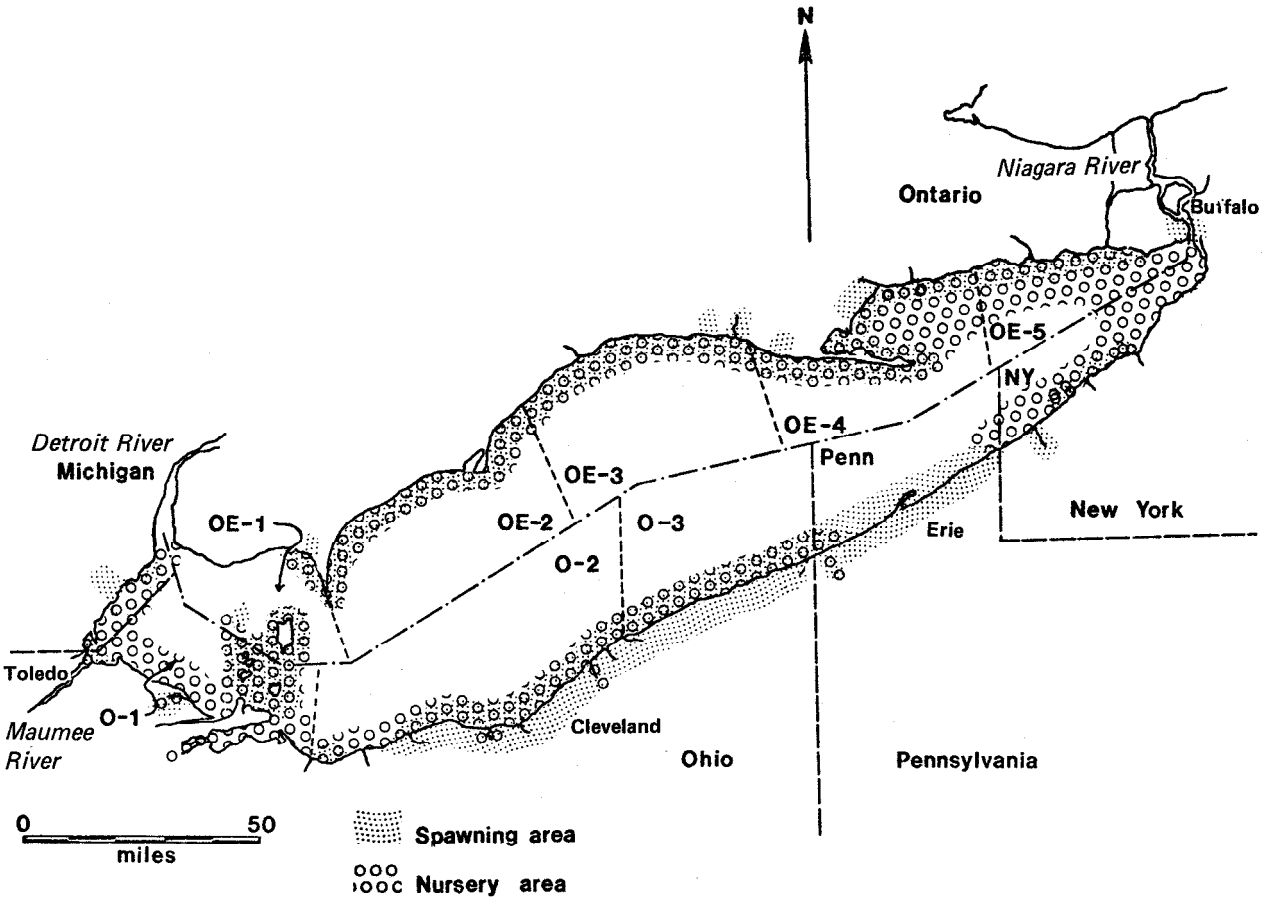
Perry Power Plant (41°48', 81°09'). In 1974, 1 coregonine larva, 0.6 in. long, was found nearshore in about 6-10 ft of water (NUS 1975).

SALMONID spp.

New York

Chautauqua Creek (42°20', 79°36'). This is one of the prime salmonid spawning streams entering Lake Erie (NYDEC 1977b).

RAINBOW SMELT



Rainbow smelt eggs planted in Crystal Lake (44°40', 86°10'), Michigan, in 1912 are believed to be the source of rainbow smelt found in all of the Great Lakes, except Lake Ontario. The first reported capture of smelt in Lake Erie occurred in 1935 at Port Dover (42°47', 80°12'), Ontario (Van Oosten 1937a). The first spawning run in Lake Erie occurred in 1940 in a drainage ditch west of Blenheim (42°18', 82°00'), Ontario (Roseborough 1962). Most of the successful spawning in Lake Erie occurs on sandy shoals along the Canadian shore (Applegate and Van Meter 1970; Scott 1967; Slastenenko 1958; USBCF 1966). Adults move inshore and into streams in late March and early April and move back to deeper waters just after spawning (FWS 1979d).

The western basin has few streams suitable for spawning, and, along the north shore, runs do not occur west of Point Pelee (41°55', 82°30') (Ferguson 1955; Regier 1963). Some rainbow smelt migrate into the western basin in the fall, spawn there in the spring, and then return to the central basin. Small concentrations of eggs have been recovered throughout the western basin on mud bottom; these eggs may have been spawned elsewhere on sandy bottom, which is the preferred spawning substrate in Lake Erie (Wolfert, pers. comm. 1979). Most hatching occurs May 1-15 at 50°F (Comm. Fish. Rev. 1961a).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1976, prolarvae were collected in mid-May near the plant (Detroit Edison 1978). In 1975 and 1977, slightly higher concentrations of early postlarvae were found in early and mid-June in approximately 6-18 ft of water off the plant (Patterson 1979a; Waybrant and Shauver 1979).

Sandy Creek (41°56', 83°20'). In 1975, moderate concentrations of postlarvae were found in early May in 12-24 ft of water off Sandy Creek (at 41°55', 83°18', and 41°54', 83°16') (Waybrant and Shauver 1979).

Monroe (41°55', 83°24'). Rainbow smelt larvae first appear in late May and are one of the most abundant larvae near Monroe (MacMillan 1976). In 1975, eggs were entrained at the Monroe Power Plant (41°53', 83°21') in early May (Detroit Edison 1976a). Larvae were collected in Brest Bay (41°55', 83°18') at densities as high as 31/100 m^3. The highest densities of larvae, in the area, probably result from influxes of larvae from the Detroit River (42°03', 83°08') (Cole 1976; MacMillan 1976). Postlarvae are often as abundant offshore as in estuaries (Cole 1978a). The highest densities of YOY in Michigan waters of Lake Erie tend to occur off Monroe (MDNR 1970-76).

Woodtick Peninsula (41°44', 83°25'). In 1974, 13 smelt eggs were collected on April 25 at the Whiting Power Plant (41°47', 83°27') (Consumers Power 1976a). In 1975, moderate densities of postlarvae were found in late May to late June in 12-18 ft of water off the peninsula at 41°47', 83°23' (Waybrant and Shauver 1979). In 1977, the highest density of early postlarvae (157 larvae/100 m^3) occurred at Turtle Island (41°45' 83°23') (Patterson 1979a).

Ohio

Rainbow smelt spawn in almost every creek and harbor along the Ohio shoreline from Lorain (41°28', 82°11') to Conneaut (41°58', 80°33') and also along shore over gravel and sand bars in water up to 10-12 ft deep (Trautman 1957, pers. comm. 1979; White, pers. comm. 1979). The stock is maintained primarily by shore spawning; recruitment from stream spawning is negligible (GLBC 1975). In the fall, young 1 to 1.5 in. long are generally found along the gravelly beaches, and outside the harbors, between Lorain and Conneaut (White, pers. comm. 1979). Large numbers of YOY were found all along the shoreline from Vermilion to Conneaut and alonq the south shore of the western basin (Anderson 1966; Baker 1966b, 1969c; Baker and Bower 1964, 1965; Baker and Scholl 1970, 1972; Mans 1963; Parker 1964; Rudolph and Scholl 1969; Seward 1967, 1968; Van Vooren and Davies 1974).

Maumee Bay (41°43', 83°25'). Larvae were collected at the mouth of the Maumee River (41°41', 83°28') (CLEAR 1977). In 1975-77, larvae were collected in Maumee Ray in May to July but not in the Maumee River, suggesting that spawning occurred only in the bay, possibly along the diked disposal area (41°43', 83°27') (Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Snyder 1978). Much lower concentrations of larvae were found in the inner bay than in the outer bay. In Ohio waters, rainbow smelt fry were most abundant in late May in the southwest section of the western basin (Baker 1965). It is believed that little spawning occurs in the Maumee River, in any of the small tributaries, or along the shoreline in the southwestern portion of the basin (Cole 1978a). Rainbow smelt postlarvae are easily distributed by currents and disperse widely from spawning areas. The Detroit River (42°03', 83°08') appears to be a major source of rainbow smelt larvae entering the basin (Cole 1978a,b; Heniken 1977).

Toussaint River (41°35', 83°04'). Spawning runs enter the river, and YOY are found there (Rawson, pers. comm. 1979). In 1978, YOY were occasionally numerous off Locust Point (41°36', 83°05') in mid-August (Barnes and Reutter 1979).

East Harbor (41°32', 82°47'). Large numbers of YOY were present just outside the harbor (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1970; Rudolph and Scholl 1970).

Island Region (41°40', 82°45'). In the 1940s, collections of newly hatched larvae and fry indicated that smelt probably spawned in June and July on current-swept gravel bars around the islands (MacKay 1958a, 1969; Trautman 1957). Large numbers of adults and small numbers of larvae were found around the Bass Islands (41°41', 82°49') and Kelleys Island (41°36', 82°42'). Larvae found in the area could have been carried into the area from the Detroit River (42°03', 83°08') (Heniken 1977). By August, young, 2-3 in. long, were collected in the open lake at depths greater than 20 ft (Trautman 1957). In 1966 and 1967, YOY were most abundant at a station just south of Middle Sister Island (41°51', 83°00') in July and early August (Baker 1967a,c).

South Bass Island (41°39', 82°50'). Spawning has been observed in seiche currents under the bridge between Terwilliger Pond (41°39', 82°50') and Squaw Harbor (41°39', 82°49') (Trautman, pers. comm. 1979).

Kelleys Island Shoal (41°38', 82°39'). Rainbow smelt spawn here at water depths of less than 12 ft before the walleye spawns (Wolfert et al. 1975; Wolfert, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). Larvae were collected at the mouth of the Sandusky River (41°27', 82°59') (CLEAR 1977). Young-of-the-year are abundant in the area around Johnson Island (41°30', 82°44') (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1970; Rudolph and Scholl 1970).

O-2

Erie Nuclear Plant site (41°23', 82°30'). In 1977, rainbow smelt larvae were captured near the plant site in May and June. Spawning at the site occurred in late April or early May when the water temperature was about 44-50°F. Hatching began in early May and was completed by the end of May (Ohio Edison 1977). Young-of-the-year are most abundant in 45 ft or less of water in the area between Huron and Lorain (FWS 197921). In 1962, YOY were found offshore between Huron and Lorain by early July (MacCallum and Regier 1970).

Beaver Creek (41°26', 82°15'). At sites to the 36 ft depth contour off the creek mouth, eggs have been collected in May, postlarvae in late May to September, and juveniles in July to September; YOY were collected in beach seines in late July (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). Lorain Harbor is a spawning area; adults are numerous in late April and larvae are abundant after late June (Geo-Marine 1978). In 1962, YOY were found offshore in this area by early July (MacCallum and Regier 1970).

Avon Lake Generating Station (41°30', 82°03'). Impingement of adults at the generating station indicate that large runs occurred in early May. A few prolarvae or fin-fold larvae were entrained in May but entrainment was greatest in June and mid-July, when postlarvae were most abundant (Applied Biology 1979c; Aquat. Ecol. Assoc. 1976c). In 1962, YOY were found offshore in this area by early July (MacCallum and Regier 1970).

Cleveland (41°31', 81°42'). In 1972-74 and 7976, YOY were abundant in Cleveland Harbor (41°31', 81°42') and in the Rocky River (41°30' 81°50') and adjacent shores; these sites may be spawning areas (Cleveland Environ. Res. Group, undated; White et al. 1975). At the Lakeshore Generating Station (41°32', 81°38'), most adults were impinged on May 9-10; many of these were believed to have died before they were impinged (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). In 1972-74, YOY smelt were collected in abundance in the Chagrin River and adjacent shores; these sites may be spawning areas (White et al. 1975). In 1975, prolarvae were collected at the East Lake Generating Station (41°40', 81°27') near the Chagrin River in May and June at water temperatures of 50-57°F. Spawning is believed to occur in the area or in the mouth of the Chagrin River, but only small numbers of larvae were collected here (Aquat. Ecol. Assoc. 1976b). In 1977-78, 8% of the larvae entrained at the plant were rainbow smelt. Most young rainbow smelt were entrained as postlarvae in August. Most adults were impinged in mid-May; many of these were believed to have died before they were impinged (Applied Biology 1979b).

O-3

Perry Nuclear Power Plant (41°48', 81°09'). Spawning begins in the area in late April and early May at water temperatures of 48-50°F. Eggs

were collected in May, and young were present in May-late August (NUS 1975).

Arcola Creek (41°51′, 81°00′). Rainbow smelt spawned here since 1949 (Langlois 1954; Trautman 1957); a run occurs in April (NUS 1975). Eggs were found at the mouth of the creek (Regier 1963).

Indian Creek (41°52', 80°55'). Spawning has occurred here since 1949 (Trautman 1957). Eggs were found at the barrier bar and in the gravel outwash at the mouth of the creek (Regier 1963).

Ashtabula (41°55', 80°47'). Rainbow smelt spawn near the Ashtabula power plants (41°55', 80°46') and in Ashtabula Harbor (41°55', 80°47'). More than 90% of fish impinged by the power plants in the spring were rainbow smelt. The largest run occurs in mid-May. Prolarvae were collected in late May. Rainbow smelt larvae are one of the few larvae collected regularly in the offshore waters at Ashtabula (Applied Biology 1979d,e; Aquat. Ecol. Assoc. 1976a; Hubbard 1977, as cited in Sweeney 1978; Sweeney 1978).

Conneaut (41°58', 80°33'). In 1977, larvae were collected in and at the mouths of the Conneaut River (41°58', 80°33') and Turkey Creek (41°58′, 80°32'), in Conneaut Harbor (41°58', 80°33'), and offshore at sites between Conneaut and Raccoon Creek (41°59', 80°29') from June through August. The peak abundance of rainbow smelt larvae in the area occurred in late June and early July at water temperatures of about 66-79°F. Larvae were fairly abundant in offshore, nearshore, and harbor collections throughout July and August (Aquat. Ecol. Assoc. 1976a). Larvae were more abundant inside Conneaut Harbor than offshore (USACE, undated b).

Pennsylvania

Rainbow smelt spawn along the entire shoreline and in all the Pennsylvania tributaries of Lake Erie. The shoreline consists of a rock and gravel bottom with limited vegetation. Spawning occurs in 2-3 ft of water in the surge zone along the shoreline. Spawning in creeks usually occurs in the lower 100 yd during late April and early May in moderate current over rock, gravel, mud, or silt bottom, and usually f ilamentous algae (Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). Rainbow smelt eqgs were found at the creek mouth (Regier 1963). Larvae were also found in the creek mouth and farther upstream in June and July (Aquat. Ecol. Assoc. 1976a; GPU Serv. Corp. 1979).

Crooked Creek (42°00', 80°26'), Trout Run (42°03', 80°16'), and Walnut Creek (42°04', 80°14'). Rainbow smelt eggs were found at the mouths of these creeks (Regier 1963).

Presque Isle (42°10', 80°06'). Spawning occurs on the sand bars along Presque Isle (Kenyon, pers. comm. 1979).

New York

In 1962, YOY were found throughout the eastern basin in September (MacCallum and Regier 1970).

Chautauqua Creek (42°20', 79°36'). Fishermen catch gravid fish in the creek, over gravel and rock bottom in 2-4 ft of water in the spring (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Eggs were collected in relatively high concentrations in April and May, mainly in nearshore waters, indicating that spawning occurs in the shallows of the bay or in Van Buren Creek (42°27', 79°24'). Rainbow smelt larvae were more abundant here than larvae of most other species. Prolarvae were collected in May to July. Rainbow smelt postlarvae were present until late August and constituted as much as 94% of the catch in late July. Rainbow smelt were 50% of YOY collected in the bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Canadaway Creek (42°28', 79°22'). Ripe adults were collected in the creek in the spring and spawning was observed over rock and gravel bottom (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 79°20'). Rainbow smelt eggs are present throughout the harbor (Niagara Mohawk Power Corp. 1976, as cited in Tex. Instrum. 1978; Tex. Instrum. 1976d). Ninety percent of the eggs entrained at the Dunkirk Steam Station (42°30', 79°21') during late April and May were rainbow smelt eggs (Tex. Instrum. 1977e). The presence of gravid, ripe, and spent fish in the harbor indicated that spawning occurred there (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). Rainbow smelt larvae were abundant; they were 70% of the total catch of larvae in near-surface waters. Prolarvae were present in May and June and postlarvae in May to July (Tex. Instrum. 1977d). Prolarvae were entrained from mid-May to late June and postlarvae from mid-May to September (Tex. Instrum. 1977e).

Scott Creek (42°30', 79°18'). Fishermen catch gravid rainbow smelt in the creek over gravel and rock bottom in the spring (Griswold and Galati, pers. comm. 1979).

Eagle Bay (42°32', 79°14'). Eggs were collected in high concentrations in April-May, mainly in nearshore waters, indicating that spawning occurs in the shallows of the bay or in Eagle Bay Creek (42°32', 79°14'). Rainbow smelt larvae were more abundant than larvae of most other species. Prolarvae were collected in May-July. Postlarvae were present until late August and were 90% of the postlarvae collected. Rainbow smelt made up 55% of YOY collected (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

The first smelt spawning run in Lake Erie occurred along the Canadian shore of the central basin in 1940 in a tributary west of Blenheim (42°18', 82°00') (Roseborough 1962). In the early 1940s, spawning occurred at Point Pelee (41°55', 82°30'). Egg collections have documented spawning along the entire northern shore of the central and eastern basins (Ferguson 1954; Regier 1963). Most spawning occurs on beaches and shoals in 10 ft or less of water. Few stream spawning populations remain, although runs also enter certain unpolluted and unobstructed tributaries (Applegate and Van Meter 1970; Ferguson 1954; USBCF 1966; USDI 1967). Rainbow smelt apparently prefer to spawn in smaller streams that have barrier bars or riffles near the mouth. They also spawn on gravel or bedrock along the north shore off Long Point (42°33', 80°10') and at Morgans Point (42°51', 79°21'), where there are strong currents (Regier 1963). Spawning runs usually occur in April or early May (Berst 1954; MacCallum and Regier 1970; Mahon, pers. comm. 1979; Nsembukya-Katuramu 1978; Regier 1963). Usually the spawning run begins at Point Pelee about the middle of April and lasts approximately 2 weeks; peak spawning occurs at 38-41°F. Subsequent runs follow the shore east of Point Pelee; spawning runs occur in the eastern basin about 2 weeks later than at Point Pelee (MacCallum and Regier 1970; Regier 1963). It has also been reported, however, that the spawning peaks occur throughout the lake at about the same time (late April) and that there is no progression from one end to the other (Berst 1954; Ferguson 1954, 1955).

Along the Canadian shore, YOY inhabit the inshore waters in the spring (MacCallum and Regier 1970). Fry are very abundant inshore at depths of 20 ft during mid-summer; they begin moving offshore in late summer (Ferguson 1965; Chen 1970). In 1962, YOY moved offshore from the spawning areas in the central and eastern basins and were collected by June in waters as deep as 50 ft (MacCallum and Regier 1970).

OE-1

Point Pelee (41°55', 82°30'). Spawning aggregations occur in 10 ft or less of water; spawning occurs on the current-swept beaches in April and early May (Regier 1962, 1963; Thomasson 1963). Point Pelee has large spawning runs in April, which usually last for 2 weeks (Ann Arbor News 1979b; Environ. Can. 1977a; MacCallum and Regier 1970; Regier 1962). The largest runs occurred during the late 1950s (Krause 1967). In 1959, spawning runs occurred at Point Pelee Park (41°58', 82°32') and the Learnington Dock (42°01', 82°36') in April (Roseborough 1962). Eggs were collected on the gravel bar that extends south off the tip of the point. Most eggs were deposited in water less than 10 ft deep in an area that extended at least 2,000 ft out from the tip of the point (Regier 1962). Until approximately 1944, major runs occurred in Sturgeon Creek (42°01', 82°34') (Ferguson 1954, 1955). Fry are abundant along the point during the summer (Ferguson 1955). In 1962, YOY were collected near Point Pelee;

some of these drifted south toward the Ohio shore. In late fall, YOY were collected throughout the eastern two thirds of the lake (MacCallum and Regier 1970).

OE-2

Wheatley (42°04', 82°26'). Spawning occurs on the beaches in late April (OMNR 1977b).

Kent County beaches (42°04', 82°27'--42°27', 81°40') and Mersea Township (42°01', 82°31') (Roseborough 1962).

Erieau (42°14', 81°55'). In 1961, runs occurred during the last week of April (Thomasson 1963).

Rondeau Park (42°17', 81°52') (Environ. Can. 1977a; Roseborough 1962). Many eggs were found here in the gravel (Regier 1963). Spawning peaks in late April (Ferguson 1955).

Point aux Pins (42°15', 81°52') (Environ. Can. 1977a). Many eggs were found in the gravel in current-swept areas, where spawning occurs (Regier 1963). In 1961, spawning occurred from mid-April to the second week of May (Thomasson 1963).

OE-3

Port Bruce (42°39', 81°01') and Port Stanley (42°39', 81°13') (Roseborough 1962).

Silver Creek (42°38', 80°53'). A run occurred in 1942 (Roseborough 1962).

Port Burwell Beach (42°37', 80°48') (Roseborough 1962).

South Otter Creek (42°37', 80°47'). A small run occurred in late April and early May (Nsembukya-Katuramu 1978).

OE-4

Clear Creek (42°34', 80°35'). A run occurs in early May (Nsembukya-Katuramu 1978).

Long Point Bay (42°40', 80°10'). Rainbow smelt spawn in water 5-12 ft deep (MacCallum and Regier 1970). Inner Bay (42°37', 80°22') is an important spawning area (Environ. Can. 1977a). Rainbow smelt have spawned or attempted to spawn in most of the streams entering Long Point Bay (Whillans, pers. comm. 1979); 60% of the larvae collected along the north shore of the bay are rainbow smelt (Hamley and MacLean 1979). Runs have been reported at the following sites:

Long Point (42°33', 80°10') (Roseborough 1962).

Pottohawk Point (42°37', 80°17'). Spawning occurs east of the point (Whillans 1977, pers. comm. 1979).

Turkey Point (42°39', 80°21'). Spawning occurs along the outer shores of the point (Roseborough 1962; Whillans 1977).

Normandale (Cranes) Creek (42°43', 80°19'). Runs have entered the creek since 1942 (Langlois 1954; Roseborough 1962); this is a prime spawning area (Mahon, pers. comm. 1979). Runs also occur on Normandale Beach (Roseborough 1962).

Fishers Creek (42°43', 80°18'). This is a prime spawning area (Mahon, pers. comm. 1979; Nsembukya-Katuramu 1978). Spawning also occurs at Fishers Glen Beach (Roseborough 1962).

Young Creek (42°45', 80°15'). This is a prime spawning area (Mahon, pers. comm. 1979). In 1959, spawning occurred at Port Ryerse (42°45', 80°15') (Roseborough 1962).

Port Dover (42°47', 80°12') (Roseborough 1962).

Nanticoke Generating Station (42°48', 80°03'). In 1974, 95% of YOY fish collected in entrainment samples at Nanticoke Generating Station in Long Point Bay were rainbow smelt. Young were most abundant from June 7-27, and were present in the collections through August 13 (Teleki 1976).

OE-5

Featherstone Point (42°49', 79°51') (Roseborough 1962).

Port Maitland (42°51', 79°35'). Spawning peaks in late April (Ferguson 1955).

Sandy Bay (42°56', 79°35'), Burnaby Bay (42°52', 79°22'), Sunset Bay (42°52', 79°20'), Ratheon Point (42°53', 79°19'), Port Colborne (42°53', 79°15'), and Niagara River (42°53', 78°55') (Roseborough 1962).

CENTRAL MUDMINNOW

In Lake Erie, spawning occurs in muddy, vegetated areas with sluggish water movement (Fish 1932).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). Spawning may still occur in the vegetated areas of some streams around Sandusky Bay (Trautman, pers. comm. 1979).

O-2

Rocky River (41°30', 81°50'). Spawning occurs in the muddy backwaters of marinas and yacht clubs on the west side of the river (White, pers. comm. 1979).

O-3

Geneva State Park (41°52', 80°57'). Gravid females were found in a swamp with thick mats of vegetation, primarily lizard's tail, on the bottom (MacLean, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10'). The central mudminnow breeds successfully in the vegetated, soft-bottomed lagoons during the spring when the water level is high (Mahon 1979, pers. comm. 1979). In 1977, one young-of-the-year was found in Long Point Crown Marsh (42°35', 80°25'), at the base of the point (Reid 1978).

GRASS PICKEREL

Ohio

O-2

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year (YOY) were found in the lower river; the river may be a spawning area (White et al. 1975).

O-3

Geneva State Park (41°52', 80°57'). In 1977, ripe adults were found in a swamp in the park in early April; this swamp had abundant growths of lizard's tail which formed mats 1 ft deep (MacLean, pers. comm. 1979).

Turkey Creek (41°58', 80°32'). Adults were present in the creek in April and May; a spawning run may enter the creek (USACE, undated b).

Pennsylvania

Presque Isle Ray (42°08', 80°07'). The lagoon area of Presque Isle Bay is a major spawning area; YOY were observed there in late May. The lagoon has a muck bottom, an average water depth of about 1 ft, negligible current, and clear water; emergent, submergent, and flooded terrestrial

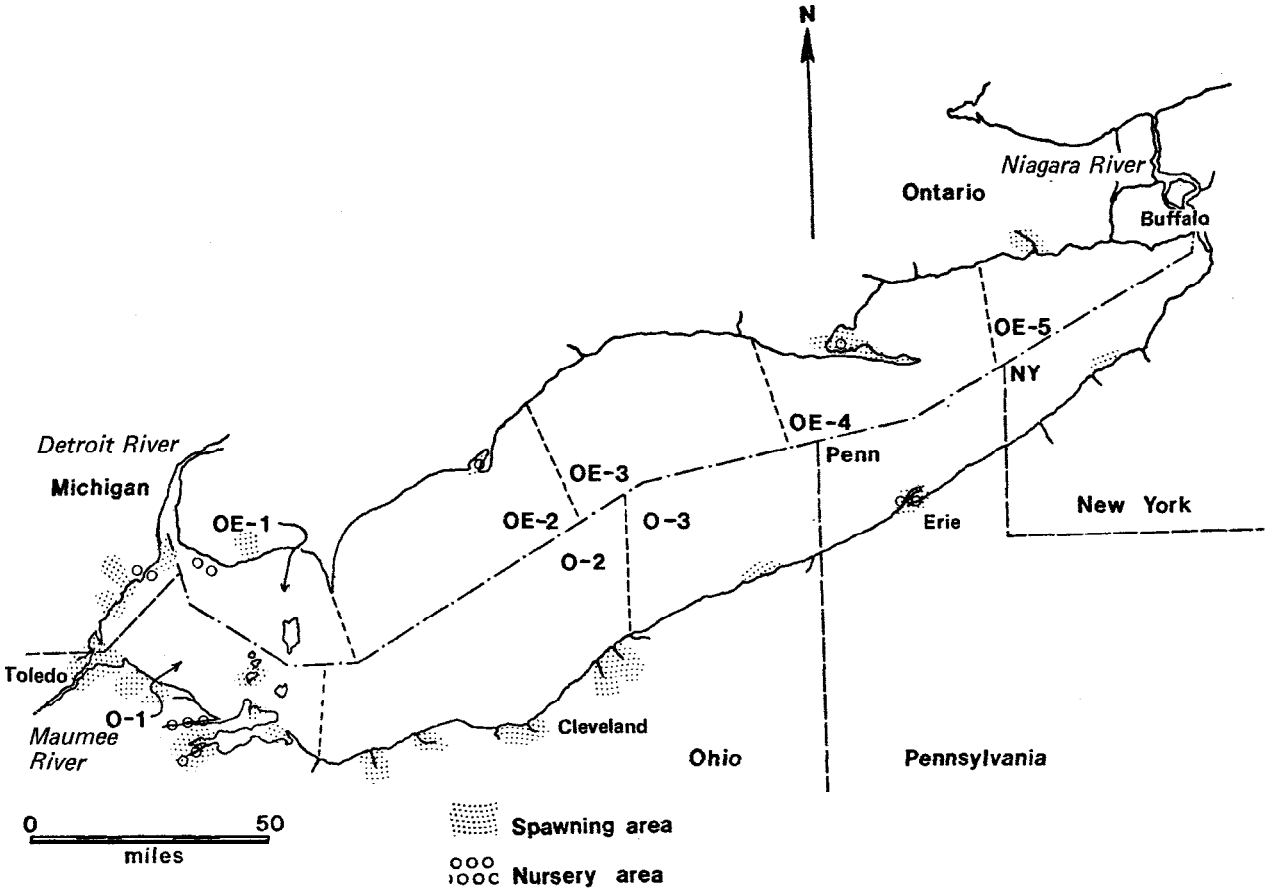
vegetation provide habitat seasonally (Kenyon, pers. comm. 1979). Pike Pond on the south side of the bay near the harbor entrance (exact location unknown) was known for the number and size of the grass pickerel that spawned there (Meehan 1895).

Ontario

OE-4

Long Point (42°33', 80°10′). A resident population exists in the marshes (42°33', 80°05‘) at the tip of the point; spawning is believed to occur in the vegetated, soft-bottomed lagoon areas (Mahon 1979, pers. comm. 1979; Whillans, pers. comm. 1979). Spawning is believed to occur in early April in Long Point Crown Marsh (42°35', 80°25′) at the base of the point; one YOY was captured there (Reid 1978).

NORTHERN PIKE



Northern pike make extensive spawning migrations from Lake Erie into tributaries; some runs proceed to tributary headwaters. The runs begin in early spring, usually in March or early April, when the warm spring rains and ice break-up begin. Spawning occurs in sheltered, vegetated shallows, and flooded bottomlands (Greeley 1929; Langlois 1954; Trautman 1957, 1977; White et al. 1975; White, pers. comm. 1979). Northern pike historically ran into most of the rivers of the central basin (White, pers. comm. 1979). Now spawning is limited to any area where there is vegetation, such as in harbors or marinas (White, pers. comm. 1979). Most of what remains of Lake Brie's northern pike population is confined to the western basin (Wolfert, pers. comm. 1979). They spawn in shallow marshes and often run far upstream in tributaries to spawn over flooded bottomlands. The runs occur in early spring, mainly March and April, before the ice is completely out of the streams (Brown and Clark 1965; Clark 1950; Langlois 1954). Much of the spawning habitat was destroyed when the marshes along the south shore were diked to prevent an influx of carp (Wolfert, pers. comm. 1979).

By 1950, the population in Lake Erie was reduced, primarily because dams prevented migrations to spawning grounds. Other factors involved

were ditching, draining, and diking of streams and marshes and the elimination of vegetation by turbidity and siltation (Trautman 1957, pers. comm. 1979).

Michigan

Huron River (42°02', 83°12')--Pointe Mouillee (42°01', 83°12'). Since 1911, northern pike have spawned along the shoreline over mud in 1-2 ft of water (Organ et al. 1978).

Swan Creek (41°58', 83°15'). Young were collected in July in channel cut-offs and small tributaries of lower Swan Creek (Langlois 1954). In 1975, larvae were collected in an area (41°59', 83°14') just north of Swan Creek in mid- to late June (Waybrant and Shauver, 1979).

Stony Creek (41°57', 83°18'). Since 1911, northern pike spawned over vegetation at the creek mouth (Organ et al. 1978).

Sandy Creek (41°56', 83°20'). Northern pike once spawned in the marshes of the estuary (Jaworski and Raphael 1978b).

Bolles Harbor (41°51', 83°24'). Northern pike suddenly appeared in fishermen's catches during the first week in February and began entering tributaries in early March, when the water temperature was 39°F (Langlois 1954). Spawning also occurs along the shoreline over gravel (Organ et al. 1978).

Woodtick Peninsula Bay (41°46', 83°27'). Spawning occurs on the inside of the peninsula over mud and gravel in 1-2 ft of water, from 41°47', 83°27' south to Indian Island (41°45', 83°27') (Organ et al. 1978).

Ohio

O-1

Maumee River (41°41', 83°28'). In the 1800s, northern pike ascended the river (Kirsch 1895), and spawning occurred in the Maumee Basin swamps. Spawning declined when spawning grounds were drained and blocked (Kettanek 1971; Pinsak and Meyer 1976). Limited spawning presently occurs in Maumee Bay (41°43', 83°25') from March 25 to April 20 (Pinsak and Meyer 1976).

Ward Canal (41°39', 83°14'). In 1948, a spawning run was observed in March at water temperatures of 31-52°F (Langlois 1954).

Turtle Creek (41°37', 83°08'). In 1948 and 1952, spawning runs were observed in March at water temperatures of 31-52°F (Kinney 1954; Langlois 1954).

Portage River (41°31', 82°56'). Young were collected in channel cutoffs and small tributaries of the lower river in July (Langlois 1954).

East Harbor (41°32', 82°47'). Spawning was observed and eggs were collected along the south and west shores of the harbor, which have cattail marshes and a substrate of fine silt and organic debris (Brown and Clark 1965; Clark 1950). In 1948, migrating fish were caught and spawning was observed in March in a ditch near the Ohio Highway #53 crossing (exact location unknown). Water temperature during the period ranged from 31-52°F (Langlois 1948).

south Bass Island (41°39', 82°50'). In 1950, spawning was observed in a small pond off Fishery Bay (41°39', 82°49') on April 15 at a water temperature of 60°F (Langlois 1954).

Sandusky Bay (41°29', 82°46'). Spawning runs enter small tributaries to the bay in March and April (Chapman 1954a, 1955). Presently spawning occurs in the marsh area in the southeast corner of the bay (41°26', 82°39'1, between the two causeways leading to Cedar Point (41°29', 82°41') (FWS 1979d). Young have also been collected in cut-offs and small tributaries of the lower Sandusky River (41°27', 82°59') in July (Langlois 1954).

O-2

Old Woman Creek (41°23', 82°31'). The creek contains excellent spawning habitat (FWS 1979d).

Vermilion River (41°26', 82°22') and Black River (41°28', 82°11'). Historically, these rivers supported spawning runs (McCormick 1892).

Rocky River (41°30', 81°50'). A small number of northern pike enter the river to spawn (White, pers. comm. 1979).

Cuyahoga River (41°30', 81°43'). Historically , northern pike spawned in the river, but by 1850 the run had disappeared (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Northern pike enter the lower river to spawn (White, pers. comm. 1979).

Mentor Marsh (41°44', 81°19'). This is probably the major spawning area remaining in the central basin (White, pers. comm. 1979).

O-3

Ashtabula Harbor (41°55', 80°47'). Northern pike spawn behind a free-standing wall inside the harbor in a vegetated strip about 50 ft wide (White, pers. comm. 1979).

Turkey Creek (41°58', 80°32'). Adults were collected in the creek in April and May; this may have been a spawning run, but no evidence of spawning was found (USACE, undated b).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Both the open bay and the lagoon area are major spawning sites for a resident population of northern pike. Ripe adults were collected in the bay in late March and early April. Northern pike spawn somewhat earlier than the muskellunge (Buss and Larsen 1971; Buss and Miller 1967; Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979). In 1960, a spawning run started in the lagoon area on March 31 at a water temperature of 37°F and peaked at water temperatures of 40-46°F. Ten days later, a run started in the bay area at a water temperature of 40°F and peaked at water temperatures of 40-50°F. Possibly two separate populations were involved (Buss and Larsen 1961). Northern pike spawn in shallower lagoons than do muskellunge (Buss and Miller 1967). Young-of-the-year were collected during late May and early June. The lagoon area is very shallow, has a muck bottom, negligible current, abundant submergent and emergent aquatic vegetation, and flooded terrestrial vegetation. The lagoon is considered to be a major spawning and nursery area (Kenyon, pers. comm. 1979).

New York

Dunkirk Harbor (42°30', 79°20'). This is a probable spawning area (NYDEC 1977b).

Ontario

OE-1

Colchester (41 °59′, 82°56′) . In 1975, larvae were present in low numbers in late June and early July in 24-30 ft of water at 41°59', 82°59', about 3 mi W of Colchester (Waybrant and Shauver 1979).

Cedar Creek (42°01', 82°47') and Wolf Creek (location unknown). In 1946, spawning was observed in small tributaries on March 15 (Langlois 1954).

OE-2

Rondeau Harbour (42°15′, 81°53′). "The Ponds," a marsh area along the southeast shore, is a spawning ground and a nursery area. Hundreds of fingerlings have been found here in June (Berst 1950).

OE-4

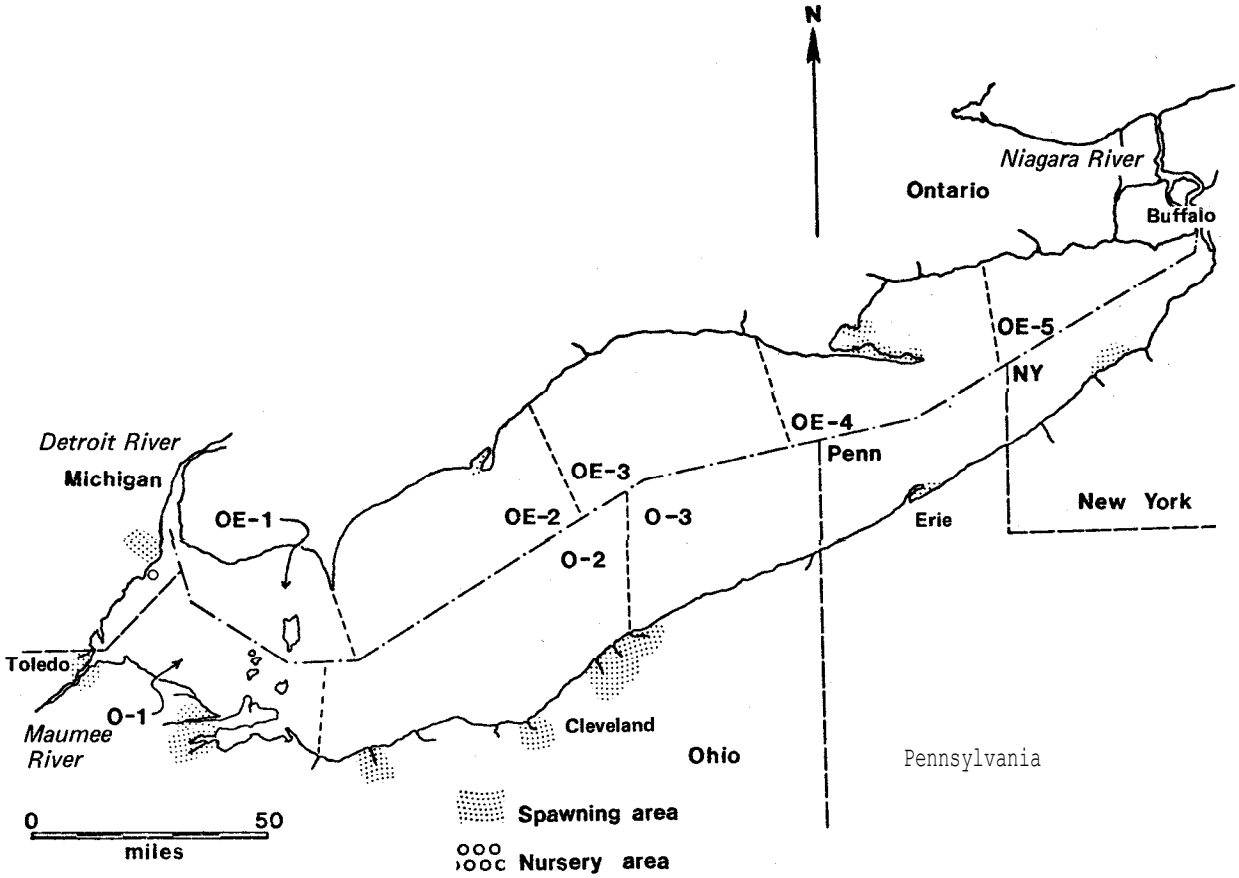
Long Point Bay (42°40', 80°10'). Spawning is believed to occur here in late March and early April (Reid 1978). The area is presently a migration route to the tributary rivers, and a large spawning migration occurs in the spring just after ice break-up or even under the ice. In 1894, the influx into Inner Bay (42°37', 80°22′) was on the order of

millions of fish, and in 1900, it was declared the finest spawning run on Lake Erie. Northern pike also spawned in Long Point Marsh (42°35', 80°17') and Turkey Point Marsh (42°39', 80°21'), as well as in the bay itself (Whillans 1977). By 1930, the main spawning grounds had shifted from Big Creek Marsh to the east along the south shore (Whillans 1979a). In recent years, spawning was observed in Big Creek (42°36', 80°27') and Big Creek Marsh (42°36', 80°27') (Whillans 1977). Spawning occurs in almost all of the shallow marshy areas of Inner and Long Point Bays and in the lagoon areas of Long Point (42°33', 80°10') (Hamley and MacLean 1979; Mahon 1979, pers. comm. 1979; Whillans, pers. comm. 1979). A few young-of-the-year were found in Long Point Crown Marsh (42°35', 80°25') at the base of the point (Reid 1978).

OE-5

Grand River (42°51', 79°35'). Large runs of northern pike entered the river (Kerr and Kerr 1860-1898).

MUSKELLUNGE



Muskellunge make extensive spawning migrations from Lake Erie into tributaries in early spring shortly before or after ice breakup; sometimes runs proceed to tributary headwaters. Spawning occurs in vegetated shallows, either among submerged aquatic or flooded terrestrial vegetation (Fish 1932; Langlois 1954; Trautman 1957, 1977, pers. comm. 1979; USDI 1967; White et al. 1975).

The demise of the muskellunge populations in Lake Erie by about 1850 was caused by blockage of tributary streams by dams, draining of marshes, ditching of streams, isolation of marshes by dikes, and elimination of aquatic vegetation by turbidity and siltation (Trautman 1957; USDI 1967). Historically, muskellunge migrated into the rivers of the western basin; this spawning habitat is now totally destroyed. Limited spawning may be occurring along the Michigan shore (Waybrant and Shauver, 1979).

Michigan

Huron River (42°02', 83°12'). Historically, spawning runs entered the river and proceeded upstream to Ann Arbor (Langlois 1945a).

Swan Creek (41°58', 83°15'). In 1976, a few larvae tentatively identified as muskellunge were captured in late April in 0-6 ft of water just north of the mouth of Swan Creek at 41°59', 83°14' (Waybrant and Shauver 1979).

Ohio

O-1

Maumee River (41°41', 83°28'). The streams of the Maumee River system were well suited for spawning; they contained clear water and overflowed the banks widely in the spring (Trautman 1957, pers. comm. 1979). Historically, runs entered the river and proceeded to Les Grandes Rapids (Langlois 1945a). In the 1970s, spawning occurred in late March and April (Pinsak and Meyer 1976).

Portage River (41°31', 82°56'). Historically, spawning runs probably entered the river (Langlois 1965).

Sandusky River (41°27', 82°59'). Historically, spawning runs entered the river and proceeded upstream to Fremont (Keeler 1904; Langlois 1945a); all of the lowland swamp and flooded prairies along the river were favorable spawning areas for muskellunge (Trautman 1975).

o-2

vermilion River (41°26', 82°22'). Runs occurred upstream to Wakeman (Langlois 1945a).

Cuyahoga River (41°30', 81°43'). Historically, runs proceeded upstream to the rapids at Akron (Langlois 1945a; Trautman 1957; White, pers. comm. 1979) until the river was destroyed by pollution (USDI 1967). Muskellunge spawned throughout the marshes that surrounded Cleveland and began to disappear about 1850 (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Very limited runs enter the lower river (White, pers. comm. 1979).

Mentor Marsh (41°44', 81°19'). A moderate run occurs (White, pers. comm. 1979).

O-3

Grand River (41°46', 81°17'). Historically, spawning runs entered the river (Langlois 1945a). The resident population in the upper Grand River is believed to be a remnant of the run that existed before a dam was built near the river mouth (GLBC 1975). Moderate runs still enter the river (White, pers. comm. 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Muskellunge spawn in the open bay areas of Presque Isle Bay (Buss and Miller 1967).

New York

Dunkirk Harbor (42°30', 79°20'). The harbor is a probable spawning area (NYDEC 1977b).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). In 1950, spawning was observed in "The Ponds," a marsh along the southeast shore (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). In 1888, muskellunge spawned in Turkey Point Marsh (42°39', 80°21') (Kerr and Kerr 1860-1898). In the 1920s, muskellunge were still spawning by the thousands in Big Rice Bay (42°36', 80°20') and around Pottohawk Point (42°37', 80°17'), and east to Bluff Rar (42°35', 80°09'), but by about 1930, the population suddenly collapsed possibly due to competition from northern pike, which were prevented from reaching their usual spawning grounds by a causeway built across the west end of the bay (42°36', 80°27') (Whillans 1977, 1979a,b).

STONEROLLER

Pennsylvania

Trout Run (42°03', 80°16'). Stonerollers spawn at the mouth of the creek, in about 1 ft of water, in moderately swift current, over gravel and rock substrate with no vegetation. One male in breeding color was collected in April (Kenyon, pers. comm. 1979).

GOLDFISH

Goldfish are native to eastern Asia. It is not definitely known when they were introduced into U.S. waters, but by 1889 a goldfish farm was operating in Maryland (Scott and Crossman 1973). The introduction of

goldfish into Lake Erie is not recorded. Goldfish in Lake Erie spawn in sheltered bays, creek mouths, and shoreline areas over mud and vegetation (Greeley 1929; Langlois 1954).

Michigan

Pointe Mouillee (42°01', 83°12'). Spawning occurs in the marshes over mud and vegetation (Organ et al. 1978).

Monroe (41°55', 83°24'). In 1973-74, spawning was observed in the discharge canal of the Monroe Power Plant (41°53', 83°21'); densities of larvae were greater here than in the lake (Cole 1976). Some young-of-the-year (YOY) were also found in the discharge canal (Parkhurst 1971).

Woodchuck Creek (41°51', 83°24')--Whitewood Creek (41°48', 83°26'). Since 1950, goldfish have spawned along this shoreline over mud at water depths of 12 ft or less (Organ et al. 1978).

Indian Island (41°45', 83°27'). Since 1950, goldfish have spawned around the island in water 2 ft deep (Organ et al. 1978).

Ohio

O-1

Goldfish spawn in marshes along the entire south shore of the western basin. Young-of-the-year then move from the marshes to shoreline areas, where they remain for much of their first year (Wolfert, pers. comm. 1979).

Maumee Bay (41°43', 83°25'). Goldfish spawn in nearshore areas from 41°44', 83°27' south to the Maumee River (41°41', 83°28') and east to Cedar Point (41°42', 83°20') from late May to August (Pinsak and Meyer 1976).

Locust Point (41°36', 83°05'). Goldfish spawn in the Davis-Besse Power Station intake canal (41°36', 83°04') (Reutter 1979a).

South Bass Island (41°39', 82°50'). Eggs were collected in Squaw Harbor (41°39'. 82°49') as late as August 17 (Battle 1940), and fry were found in Terwilliqer Pond (41°39', 82°50') over mud bottom among vegetation (Turner 1920a).

Sandusky Bay (41°29', 82°46'). Since 1953, goldfish have spawned on the vegetation in the bay (Chapman 1955; FWS 1979d; Hartley 1975; Keller 1964a). In 1974, YOY were present in the bay in June (Hartley and Berdendorf 1975).

O-2

Black River (41°28', 82°11'). In 1975, goldfish eggs were numerous in late June outside the west breakwall of the harbor (Wapora 1977a).

Cleveland (41°30', 81°43'). Goldfish spawn in Cleveland Harbor (41°31', 81°42'); eggs are deposited on the undersides of boats in marinas and on pilings (White, pers. comm. 1979; White et al. 1975). In 1972-74, fry and YOY were common in the harbor; YOY were also collected from the lower portions of the Rocky River (41°30', 81°50') (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, YOY were collected from the mouth of the river and along the adjacent lake shore (White et al. 1975). Goldfish enter the river to spawn for an extended period in mid-April to late July; greatest larvae production occurs in late June. Larvae are found in backwater areas upstream, in the lower river, and on beaches at the mouth (Environ. Resour. Assoc. 1978). Spawning also occurs in the warm water discharge of the Eastlake Generating Station (41°40', 81°27'), a few hundred yards west of the mouth of the Chagrin River in late March (White, pers. comm. 1979).

Pennsylvania

Elk Creek (42°01', 80°22'). Ripe adults were collected in May at the mouth of the creek (GPU Serv. Corp. 1979).

New York

Van Buren Bay (42°27', 79°25'). In 1975, a few prolarvae and postlarvae were found from mid-May to August in the lake near Van Buren Bay (Envirosphere 1977a; Tex. Instrum. 1977a).

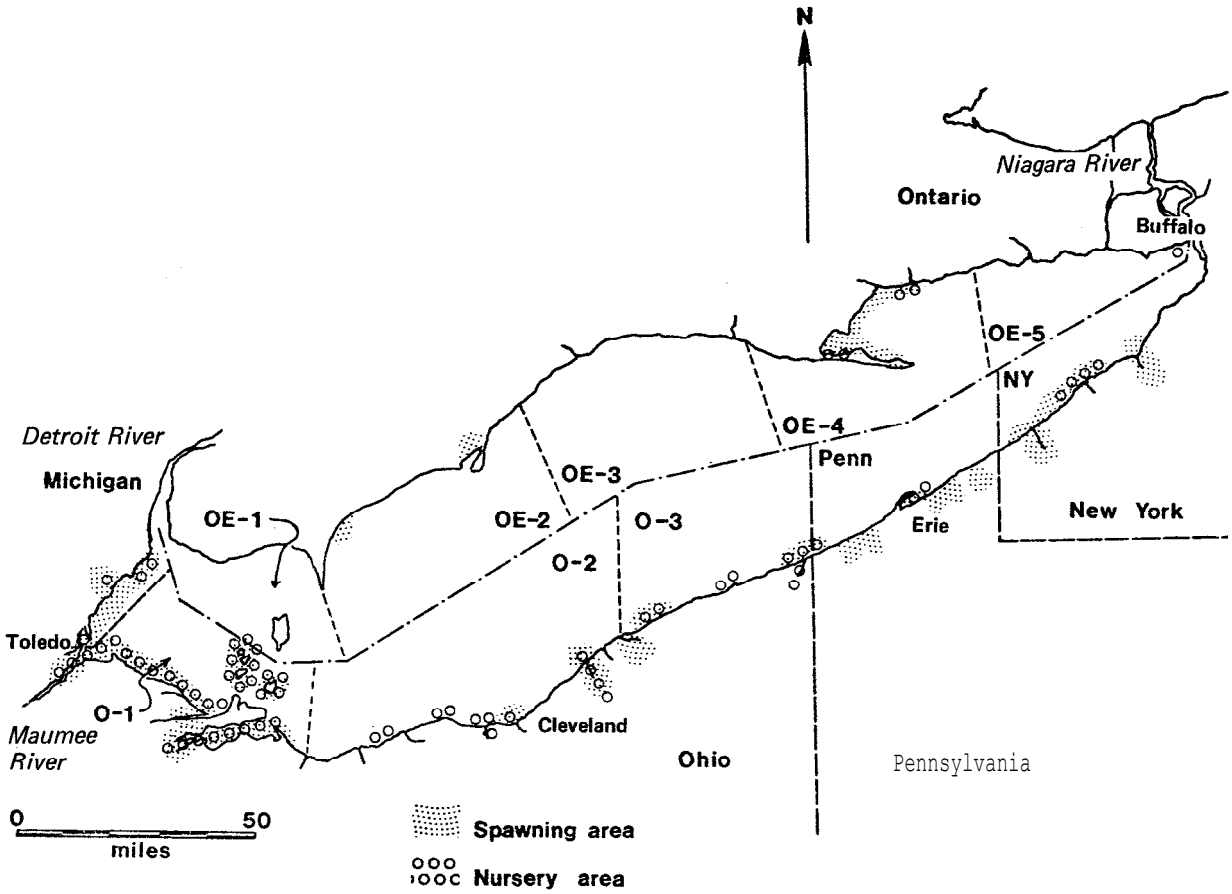
Dunkirk Harbor (42°30', 79°20'). Young goidfish were very abundant in Dunkirk Harbor during late summer (Greeley 1929). In 1975, spawning was observed in late June (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978).

Eagle Bay (42°32', 79°14'). In 1975, eggs were collected in the lake near Eagle Bay in early June. Prolarvae and postlarvae of goldfish were found in mid-May to July (Envirosphere 1977a; Tex. Instrum. 1977a).

Ontario

OE-4

Long Point (42°33', 80°10'). Goldfish enter the lagoons at the tip of the point to spawn. Very few young are found in the lagoons; the young evidently migrate to the lake (Mahon 1979; Mahon and Balon 1977b).



The initial plantings of carp were made in the inland waters of the U.S. as early as 1831 (McCrimmon 1968). The first recorded capture of carp in Lake Erie occurred near the mouth of the Raisin River (41°53', 83°20'), Michigan, in 1883. Carp were abundant in Lake Erie in the 1880s, and a major commercial carp fishery was established in U.S. waters by 1886 (Cole 1905; Smiley 1886). The origin of these fish is unknown. Plantings were made in the Sandusky River (41°27', 82°59') in 1879, in the Maumee River (41°41', 83°28'), Ten-mile Creek (41°41', 83°32'), and near Kelleys Island (41°36', 82°42') in 1881 (Smiley 1886), in inland waters of Michigan in the 1880s, and in the waters of Erie County, Pennsylvania, in 1880 (McCrimmon 1968).

The peak of the spawninq season in Lake Erie occurs in late May and early June (Cole 1905; Langlois 1954), but spawning may extend into Auqust (Fish 1932). In the western basin, spawning occurs in marshy, vegetated areas along the west and south shores (Cole 1905; Parkhurst 1971; Trautman 1957, pers. comm. 1979; Wolfert, pers. comm. 1979). The young move out of the marshes but stay along shore for most of their first year (Wolfert, pers. comm. 1979). Very few larvae are found in open lake waters (Nelson 1975; Nelson and Cole 1975). In the central basin, carp

also spawn in the vegetated, shallow protected areas, such as harbors and river mouths (White, pers. comm. 1979). In the eastern basin, carp spawn primarily in bays, harbors, and protected waters.

Michigan

Huron River (42°02', 83°12')--Pointe Mouillee (42°01', 83°12'). The vegetated backwater areas here support most of the carp production in Michigan waters (Waybrant and Shauver 1979). Since 1920, spawning has occurred throughout the marsh (Organ et al. 1978). In 1975, larvae were most abundant in an area (42°00', 83°11') off Qointe Mouillee in late June and early July in 6-12 ft of water (Waybrant and Shauver 1979).

Swan Creek (41°58', 83°15'). Carp spawn off the creek mouth over mud and to the 18 ft depth contour south to Stony Point (41°56', 83°16') over rock (Organ et al. 1978). In 1976, eggs, prolarvae, and early postlarvae were collected in the area near the Fermi Power Plant (41°57', 83°15') in May to August (Detroit Edison 1976g).

Brest Bay (41°55', 83°18'). Carp spawn over mud and vegetation throughout the bay (Organ et al. 1978).

Raisin River (41°53', 83°20'). In the early 1900s, the extensive marshes at Monroe (41°55', 83°24') were probable spawning habitat (Cole 1905). Yolk-sac larvae are abundant in the upper reaches of the river (Nelson 1975; Nelson and Cole 1975). Spawning carp are commonly seen, and prolarvae are abundant in the discharge canal of the Monroe Power Plant (41°53', 83°21'). In the heated water of the discharge canal, spawning temperatures are reached as early as late March; in the adjacent unheated waters of the Raisin River spawning temperatures are not reached until late May (Cole 1976, 1978a,b; Nelson 1975; Nelson and Cole 1975). Since 1952, spawninq has occurred over mud along the shoreline at the river mouth; since 1911, spawning has occurred over vegetation in the river backwaters (Organ et al. 1978).

La Plaisance Bay (41°52', 83°22')--Whitewood Creek (41°48', 83°26'). Since 1950, spawning has occurred here over mud and gravel (Organ et al. 1978).

woodtick Peninsula (41°44', 83°25'). Since the 1950s, carp have spawned over mud bottom on the lake side of the peninsula (at 41°46', 83°26') and also on the west side off Bay Creek (41°47', 83°27') and around Indian Island (41°45', 83°27') (Organ et al. 1978). Spawning has been observed in shallow water along the cattail-lined shores of Hooper Run (41°45', 83°28') (U.S. Army Eng. Dist., Detroit, 1976). In 1964, considerable spawning occurred in the diked marshes of southeast Monroe County from April to June (King and Hunt 1967). In 1978, carp larvae were entrained at the Whiting Power Plant (41°47', 83°27') and others were collected from the bay; peak catch in the bay occurred in June (Wapora 1979b).

O-1

Maumee Bay (41°43', 83°25'). Carp spawn in the marshy areas of the bay (Trautman, pers. comm. 1979). Spawning is believed to occur nearshore and north of the Maumee River between 41°44', 83°27' and 41°42', 83°28' and from the mouth of the Maumee River (41°41', 83°28') to Cedar Point (41=°42', 83°20') during June 1 to August 10 (Pinsak and Meyer 1976). In 1933, eggs were collected here from vegetation (Wright and Tidd 1933). In 1975-77, YOY were collected in the bay (Herdendorf 1977; Herdendorf and Cooper 1975, 1976). In 1975, ripe or gravid carp were collected in the bay during May and June, and a few YOY were subsequently collected in late July (USACE 1976c). Fairly high densities of early and late postlarvae were found at a location (41°44', 82°21') north of Cedar Point and around Turtle Island (41°45', 83°23') (Patterson 1979a). Carp larvae are more abundant on riffles in the Maumee River (41°41', 83°28') than in limnetic estuarine reaches (CLEAR 1977, 1978). In 1980, eggs were collected among Cladophora, attached to rock and/or in floating mats, on the Perrysburg riffles on May 16 at a water temperature of 66°F. Larvae that hatched from these eggs were identified as carp (Goodyear, pers. comm. 1980).

Ward Canal (41°39', 83°14'). In 1977, early and late postlarvae were most abundant in this area in early June (Patterson 1979a).

Metzger Marsh (41°39', 83°14'). In 1975, larvae were found here in early May (Herdendorf et al. 1976).

Portage River (41°31', 82°56'). The extensive marshes above Port Clinton were probable spawning habitat (Cole 1905).

Island Region (41°40', 82°45'). Carp eggs were collected in rocky reef areas around the Bass Islands (41°41', 82°49'), and larvae are concentrated in rocky areas among Cladophora around the Bass Islands and Kelleys Island (41°36', 82°42') (CLEAR 1978; Heniken 1977).

south Bass Island (41°39', 82°50'). Carp spawn in Fishery Bay (41°39', 82°49'). In 1949, eggs were collected from Cladophora fronds on bouldery shoals in early June (Langlois 1954). Fry were collected along the shoreline of the island at Terwilliger Pond (41°39', 82°50') and the Perry Monument (41°39', 82°49') in marshy areas over a mud bottom at water depths of 1-7 ft and in the bay on the east shore (at 41°39', 82°48') alonq the shallow, sandy beach among Eleochirus and submergent vegetation (Turner 1920a).

Middle Bass Island (41°41', 82°49'). Fry were collected on the north shore (at 41°42', 82°48') in shallow water. The substrate was gravel and boulders; submergent vegetation was present to water depths of 4 ft (Turner 1920a).

North Bass Island (41°43', 82°49'). Fry were collected on the south shore at 41°42', 82°49' along a sand beach with a steep slope and no vegetation (Turner 1920a).

Sandusky Bay (41°29', 82°46'). This is a major spawning area; carp spawn here in late spring and early summer among vegetation in the shallow shore and marsh areas (Chapman 1954b, 1955; Cole 1905; Edmister 1940; FWS 1979d; Trautman, pers. comm. 1979). Young-of-the-year (YOY) have been collected since the early 1950s in most areas of the bay, but they are especially common in protected areas among aquatic vegetation (Chapman 1955; Keller 1964a). Carp also enter the marshes along the Sandusky River (41°27', 82°59') to spawn in water less than 2 ft deep (Cole 1905). Larvae are more abundant in riffle areas of the river than in the limnetic estuarine areas (CLEAR 1977).

O-2

Beaver Creek (41°26', 82°15'). Prolarvae were collected in several areas off the creek during June 12-August 2; abundance of prolarvae peaked on July 5. Early postlarvae were present out to the 36 ft depth contour on June 12 and July 15 (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). Larvae were abundant in Lorain Harbor; this may be a spawning area (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, larvae were collected in the vicinity of the Avon Lake Power Plant in June (Aquat. Ecol. Assoc. 1976c). In 1977-78, larvae were entrained at the plant from April 13 through June and peak entrainment occurred during late May and June. About 22% of the larvae entrained annually at the plant were carp. Almost half of the larvae collected in the lake near the plant in the spring were carp (Applied Biology 1979c).

Cleveland (41°30', 81°43'). Carp spawn in Cleveland Harbor (41°31', 81°42') (White, pers. comm. 1979). In 1972-74, YOY were common in the harbor and also were collected in the Rocky River (41°30', 81°50'), which may be a spawning area (White et al. 1975). In 1977-78, carp was the most abundant larva entrained at the Lakeshore Power Plant (41°32', 81°38') in June and July (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). Carp enter the river to spawn in mid-April to late July; the greatest production of larvae occurs in late June. Young-of-the-year are collected in upstream backwaters, in the lower river, and on beaches at the mouth (Environ. Qesour. Assoc. 1978; White et al. 1975; White, pers. comm. 1979). In 1975, a few prolarvae were collected at the East Lake Power Plant (41°40', 81°27') near the river in July; spawning was believed to occur near the river mouth (Aquat. Ecol. Assoc. 1976b). In 1977-78, carp was the second most abundant larva entrained at the plant from late May through August (Applied Biology 1979b).

O-3

Grand River (41°46', 81°17'). Carp enter the river to spawn (White, pers. comm. 1979).

Perry Power Plant (41°48', 81°09'). Larvae were collected in early June and July; prolarvae were most abundant on July 12 at a water temperature of 68°F (NUS 1975).

Ashtabula (41°55', 80°47'). In 1977-78, larvae were collected at the Ashtabula power plants in May to August; abundance of larvae peaked on August 8 (Applied Biology 1979d,e). Carp larvae were almost half of the larvae entrained throughout the summer (Applied Biology 1979e).

Conneaut (41°58', 80°33'). In 1977, eggs and larvae were collected at both nearshore and offshore sites between Conneaut and Raccoon Creek (41°59', 80°29') in late June and early July. Larvae were also collected in Conneaut Harbor (41°58', 80°33') and the Conneaut River (41°58', 80°33') during June and July. Larval abundance peaked in offshore waters on July 5, and in nearshore waters during the week of July 12. Larvae were also collected at the mouth of Turkey Creek (41°58', 80°32') in July (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22'). Carp enter the creek and spawn in late May and early June in an area 1-6 ft deep with light but variable current; the substrate is mud, and filamentous algae and submergent vegetation are present (Kenyon, pers. comm. 1979). Ripe adults were collected in May at the creek mouth; larvae were also collected there (GPU Serv. Corp. 1979).

Walnut Creek (42°04', 80°14'). Carp enter the creek and spawn from late May to early June near the mouth; the substrate is bedrock with some mud, submergent vegetation, and filamentous algae (Kenyon, pers. comm. 1979).

Presque Isle Bay (42°08', 80°07'). The bay, including the lagoons of Presque Isle (42°10', 80°06'), is a major spawning area. Ripe adults were collected in the bay in mid- to late May. Spawning occurs over mud bottom at depths of 2-3 ft in the lagoons and at depths to 12 ft in the bay, where water currents are minimal and aquatic vegetation is abundant. Young-of-the-year were also collected in the bay (Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979). In the early 1900s, the marshes at Erie (42°07', 80°05') were reported to be probable breeding habitat (Cole 1905).

Outer Bay (42°09', 80°04'). Spawning adults were collected in late May and early June immediately outside the mouth of Presque Isle Bay. The area is 1-6 ft deep with a mud-muck bottom, variable currents, and little vegetation (Kenyon, pers. comm. 1979).

Fourmile Creek (42°09', 80°02'), Sixmile Creek (42°11', 79°59'), and Sixteenmile Creek (42°14', 79°50'). Spawning was observed in late May and early June in these creeks, within 100 yd of the lake. The substrate is bedrock and mud; some filamentous algae and submergent aquatic plants are present (Kenyon, pers. comm. 1979).

New York

Chautaugua Creek (42°20', 79°36'). Ripe adults enter the creek in June, and spawning has been observed in 2-4 ft of water over gravel and rock (Griswold and Galati, pers. comm. 1979).

Barcelona Harbor (42°20', 79°36'). Ripe adults were observed in the harbor in late May (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Prolarvae and postlarvae were collected in mid-May through July, suggesting spawning may occur in the area (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). Ripe adults were present in late May. Spawning was observed on rock and gravel in 2-4 ft of water (Grisold and Galati, pers. comm. 1979). In 1928, gravid adults were found in the harbor in late June (Greeley 1929). Recently, spawning was observed in the harbor in late June (Tex. Instrum. 197611, as cited in Tex. Instrum. 1978) and eggs were found throughout the harbor (Niagara Mohawk Power 1976, as cited in Tex. Instrum. 1978). Eggs of carp were present during June and July 1976 and were most abundant on June 14. Prolarvae were very abundant during June through August and were most abundant in mid-June, near the bottom. Postlarvae were collected in June through August (Tex. Instrum. 1977d).

Eagle Bay (42°32', 79°14'). In 1975, prolarvae and postlarvae were very abundant and were collected in mid-May through July; yolk sac prolarvae dominated surface collections (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undated a). In 1976, eggs were collected in high densities near bottom at the 10 ft depth contour in mid-June. Prolarvae were abundant in mid-June to early August; abundance peaked on June 18, when most of the larvae collected were carp. Postlarvae were present in July (Tex. Instrum. 1977a).

Cattaraugus Creek (42°34', 79°08'). Carp were collected here as they migrated to inshore areas and creek mouths to spawn (Greeley 1929).

Ontario

OE-1

In the early 1900s, the northern shore of the western basin had extensive marshes suitable for carp spawning (Cole 1905).

OE-2

Wheatley (42°04', 82°26'). In 1979, considerable spawning activity of carp was seen in a small pond immediately off the beach in late June and early July (Down, pers. comm. 1979).

Rondeau Harbour (42°15', 81°53'). In 1950, spawning was observed in late May in the creeks that empty into the northwest portion of the bay (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). Since 1896, carp have spawned in shallow water throughout the bay and surrounding marshes (Whillans 1977). Spawning was observed throughout the area in the shallow, vegetated soft-bottomed lagoon areas (Mahon, pers. comm. 1979; Whillans, pers. comm. 1979). In 1975, spawning occurred in the lagoons daily from May 21 to June 4 (Mahon and Balon 1977b); fishermen believe spawning may occur at three distinct times--early May, late May, and early June (Whillans, pers. comm. 1979). Carp enter the lagoons at the tip of Long Point (42°33', 80°05') to spawn, often in semi-isolated coves. All the fish collected in these areas were running ripe. Few young were collected in these areas; they apparently move out into the lake (Mahon 1979; Mahon and Balon 1977b). Young-of-the-year were collected in the Inner Bay (42°37', 80°22') marshes (Hamley and MacLean 1977), including Long Point Crown Marsh (42°35', 80°25') (Reid 1978). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') (Teleki 1976).

OE-5

Crescent Reach (possibly Crescent Park, 42°53', 78°58'). In 1929, carp larvae were found here June 29 (Fish 1932).

SILVERJAW MINNOW

Ohio

O-2

Rocky River (41°30', 81°50') and Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year were collected in the lower reaches of the rivers; these may be spawning areas (White et al. 1975).

SILVER CHUB

The silver chub, an endangered species in Lake Erie, entered rivers to spawn over clean gravel. Presently, they may spawn on beaches, because there are no suitable rivers remaining (White, pers. comm. 1979). Spawning occurred in June and the first week in July, and early larvae were commonly collected then throughout the lake (Fish 1932; Greeley 1929; Trautman 1957).

Ohio

O-1

Island Region (41°40', 82°45'). The silver chub spawned around the islands. In 1953, ripe females with running eggs were collected in late June in the open lake. Spawning occurred both in the open lake and in bay areas, but no specific sites were named. Spawning occurred from the second week in June to early August, at water temperatures of 66-74°F; peak spawning occurred in late June and early July at 73°F (Kinney 1954).

O-3

Grand River (41°46', 81°17'). In 1977, one individual in spawning condition was collected in the river in early June (White, pers. comm. 1979) .

GOLDEN SHINER

Ohio

O-2

Cleveland (41°30', 81°43'). In 1972-74, fry and YOY golden shiners were abundant in Cleveland Harbor (41°31', 81°42') and were also collected in the lower Rocky River (41°30', 81°50'); these may be spawning areas (White et al. 1975).

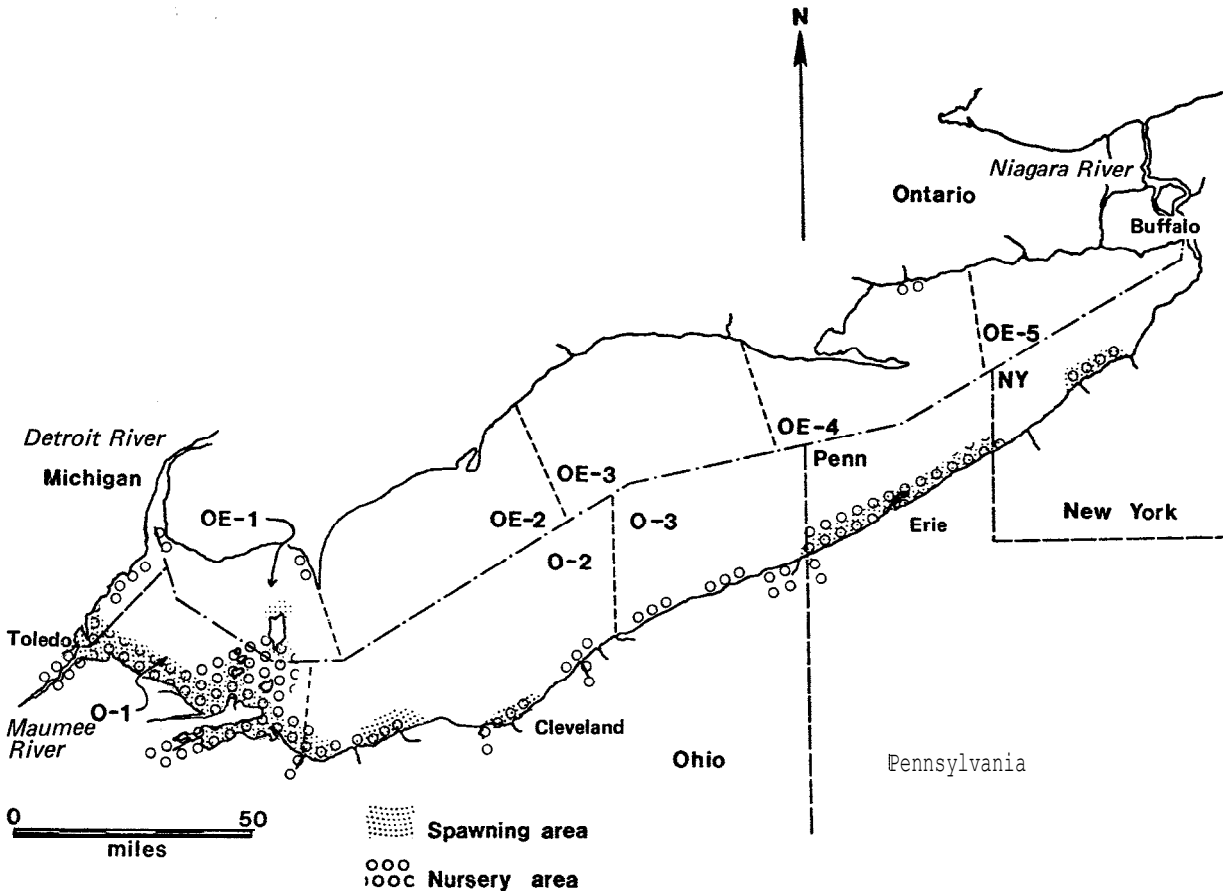
Chagrin River (41 °41', 81°26'). Fry and young-of-the-year (YOY) golden shiners were collected at the mouth and adjacent shoreline of the river; these may be spawning areas (White et al. 1975).

Ontario

OE-4

Long Point (42°33', 80°10'). Spawning occurs in late May-early June in Long Point Crown Marsh (42°35', 80°25'), and YOY golden shiners are most numerous in July and August (Reid 1978). Reproducing populations also occur in the lagoons at the tip of the point (42°33', 80°05') (Mahon 1979).

EMERALD SHINER



In Lake Erie, emerald shiners spawn from mid- or late June to mid-August on the surface of the open lake or in areas of calm quiet water (Fish 1932; Langlois 1954). Fry first appear at the lake surface from mid-June to late July; large schools are present as far as 10 mi from shore (Flittner 1964; White, pers. comm. 1979). In 1928, only six emerald shiner larvae were found; these six larvae were collected in Long Point Bay (42°40', 80°10') in late July; however, in 1929 emerald shiner larvae were abundant throughout the lake from June to August, especially in the western basin (Fish 1932). Young-of-the-year (YOY) move off shore after reaching a length of about 2 in. and disperse throughout the lake (Flittner 1964).

The western basin is a major spawning and nursery area for Lake Erie emerald shiners (Doremus 1975); spawning occurs along the entire south shore of the basin over a sandy bottom (Wolfert, pers. comm. 1979). In 1958-60, spawning began first in Sandusky Bay (41°29', 82°46'1, progressed along the south shore from Port Clinton (41°31', 82°56') east to Cedar Point Beach (41°29', 82°41'), and finally to the island area (41°40', 82°45') (Flittner 1964). In 1960, most larvae hatched during the first

two weeks of July when the water temperature was about 75°F (Comm. Fish. Rev. 1961a); YOY first appear offshore in late July (Van Vooren and Davies 1974).

Emerald shiner larvae are most abundant in the open, less turbid offshore waters, often in deep waters adjacent to rocky reefs, particularly in the island region (Heniken 1977; Herdendorf et al. 1976; Waybrant and Shauver 1979).

Emerald shiners spawn in June and July in the quiet waters of rivers and harbors of the central basin. Extensive spawning also occurs 1/2 to 1-1/2 mi offshore. Prolarvae were collected 5 mi offshore, and postlarvae as far as 10 mi offshore (White, pers. comm. 1979).

Preliminary data suggest that the central basin contains one population of emerald shiners that spawns in rivers and harbors and a second population that spawns in the open lake (White, pers. comm. 1979). Young-of-the-year move offshore during early summer and then return inshore in large aggregations in the fall (Aquat. Ecol. Assoc. 1978c).

In the 1930s, spawning was observed in eastern Lake Erie several miles from shore, beginning in June. Ripe and running adults were found from May to August; peak spawning occurred in June and July. Eggs were found at depths as great as 30 ft, and YOY were collected offshore, from the surface to the 12 ft depth stratum (Cooper 1938).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1977, early postlarvae were abundant at the plant (Patterson 1979a). In 1975, early and late postlarvae were collected at the plant as late as August (Detroit Edison 1978).

Brest Bay (41°55', 83°18'). In 1977, early postlarvae were abundant offshore, in an area (41°55', 83°19') north of Sterling State Park (Patterson 1979a).

Monroe (41°55', 83°24'). Larvae were entrained at the Monroe Power Plant (41°53', 83°21') (Detroit Edison 1976h). Emerald shiner larvae were one of the most common larvae near the power plant from early June to early July (MacMillan 1976); YOY were common in October and November (Parkhurst 1971). In Michigan waters, large concentrations of YOY were present off Monroe (MDNR 1970-76).

Ohio

O-1

Maumee Bay (41°43', 83°25'). The Maumee River estuary (41°41', 83°28') is a nursery area (CLEAR 1977; Snyder 1978). Young-of-the-year were collected in large numbers in the eastern half of Maumee Bay in June (Herdendorf 1977; Herdendorf and Cooper 1975).

Potters Pond (41°41', 83°18'). Young-of-the-year were abundant off Potters Pond (Ayers et al. 1970).

Ward Canal (41°39', 83°14'). In 1977, postlarvae were abundant off Ward Canal (Patterson 1979a). In 1960, extensive spawning occurred in this area (Flittner 1964).

Crane Creek (41°38', 83°12'). In 1960, YOY were abundant at Crane Creek Beach in the fall (Woner 1963). Young-of-the-year are found throughout the summer and are especially abundant along shore in mid-August (Barnes and Reutter 1979; CLEAR 1976).

Locust Point (41°36', 83°05'). The most abundant fry at Locust Point are emerald shiners; spawning occurs in open water near the surface from late June to late July (Reutter and Herdendorf 1977; USNRC 1975a). Eggs and larvae 0.3-0.7 in. long dominate collections at the intake and discharge of the Davis Besse Power Station (41°36', 83°04') especially during late June and early July (CLEAR 1975a; Reutter 1979c; Reutter and Herdendorf 1977; USNRC 1975b).

Toussaint Reef (41°38', 83°01'). Prolarvae and postlarvae were present in large numbers at Toussaint Reef in early July (Reutter 1979c; Reutter and Herdendorf 1977).

Portage River (41°31', 82°56'). In 1960, extensive spawning was reported from the Portage River (referred to as the Clinton River) east to Catawba Point (41°35', 82°51') (Flittner 1964).

Catawba Island (41°35', 82°51'). In 1958, larvae were collected off Catawba Point (41°35', 82°51') during the second week of June (Flittner 1964). In 1969, YOY were abundant here (Gehres and Scholl 1969).

East Harbor (41°32', 82°47'). In 1970 and 1971, YOY were abundant inside and outside the harbor (Hair and Scholl 1971; Rudolph and Scholl 1970).

Island Region (41°40', 82°45'). Emerald shiner larvae are abundant in the area (Heniken 1977; Herdendorf et al. 1976). Young in various developmental stages, from postlarvae to juveniles are found among the islands. In the Bass Islands area, emerald shiners hatch in August (Hair 1979).

South Bass Island (41°39', 82°50'). In 1942, YOY were first caught near Fast Point (41°40', 82°48') on July 11 and the last ripe adults were collected on July 15. YOY were also collected near Gibralter Island (41°39', 82°49') in Put-In-Bay (41°39', 82°49') (Gray 1942). In 1958, newly hatched larvae about 0.2 in. long were collected during July and August. In 1959, spawning began near Put-In-Bay in the last week of June, whereas in 1960 spawning began in about mid-July (Flittner 1964). In 1975, larvae were found in May (Herdendorf et al. 1976.)

Starve Island (41°38', 82°49'). In 1942, fry were found southwest of the island (Gray 1942).

Middle Bass Island (41°41', 82°49'). In 1942, large concentrations of YOY were observed southeast of the island in 30-35 ft of water (Gray 1942).

North Bass Island (41°43', 82°49'). In 1975, larvae were found in May in the open waters northwest of the island (Herdendorf et al. 1976).

Kelleys Island (41°36', 82°42'). In 1942, large concentrations of larvae were collected east of the island in water 30-35 ft deep (Gray 1942) l In 1958, larvae were also collected east of the island in August (Flittner 1964); in 1975, larvae were found in late June-early July (Herdendorf et al. 1976).

Gull Island (41°40', 82°41'). In 1942, YOY were collected south of Gull Island (Gray 1942).

Marblehead (41°32', 82°43'). In 1942, YOY were taken north of Marblehead Peninsula (Gray 1942).

Sandusky Bay (41°29', 82°46'). In 1958, larvae were collected at the surface during the second week of June. In 1960, spawning started in 10 ft of water on June 20 at a water temperature of 72°F; spawning decreased dramatically by July 20. Spawning was observed in the outer channel of the harbor (41°28', 82°43'); extensive spawning also occurred at Cedar Point Beach (41°29', 82°41') (Flittner 1964). In 1961-63 and in the 1970s, fry, 2.2-3.0 in. long were collected throughout the bay (Hartley 1975; Hartley and Herdendorf 1975; Keller 1964a). The Sandusky River estuary (41°27', 82°59') is a nursery area (CLEAR 1977).

O-2

Huron River (41°24', 82°33'). Large schools of fry were found in the lower river in 1976 (Cleveland Environ. Res. Group, undated).

Erie Nuclear Plant site (41°23', 82°30'). This is a major spawning and nursery area for emerald shiners (Wolfert, pers. comm. 1979). In 1974, larvae were abundant near the surface in July and August (Ohio Edison 1977). In 1974, YOY were also captured in this area in September in 10-33 ft of water over a bottom of shale bedrock covered by silt and clay (Wolfert, pers. comm. 1979).

Vermilion Harbor (41°26', 82°22'). In 1975, fry were collected from Vermilion Harbor on July 3 (U.S. Army Enq. Dist. Buffalo, 1976a), and the beach east of the river mouth is a nursery area (Cleveland Environ. Res. Group 1975).

Beaver Creek (41°26', 82°15'). In 1979, prespawning adults were collected at Oak Point Beach near the creek mouth and also farther offshore in mid-April and May. Gravid and spent females were first found in the area in July. Prolarvae were present in late May-July and postlarvae from late May to September out to the 36 ft depth contour (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). Spawning occurred in the harbor; adults were numerous in the spring and larvae were abundant after late June (Geo-Marine 1978). Spawning also occurs on the beaches in the harbor (Odin 1979).

Cleveland (41°30′, 81°43′). Spawning occurs here; in 1972-74 fry and YOY were abundant in Cleveland Harbor (41°31′, 81°42′) (White et al. 1975; White, pers. comm. 1979). The beaches and breakwaters in the harbor are spawning and nursery areas (Odin 1979). Fry and YOY were also collected in the lower Rocky River (41°30′, 81°50′); this may also be a spawning area (White et al. 1975).

Chagrin River (41°41′, 81°26′). During 1972-74, fry and YOY were collected in the lower river; this may be a spawning area (White et al. 1975). Larvae were most abundant on the beaches around the river mouth; spawning probably occurs in these areas (Environ. Resour. Assoc. 1978).

O-3

Perry Power Plant (41 °48′, 81°09′). In 1974, larvae were abundant in late June and early July; YOY were abundant along shore in late August (NUS 1975).

Ashtabula Harbor (41°55′, 80°47′). There is significant production of larvae in Ashtabula Harbor (Hubbard 1977, as cited in Sweeney 1978). Emerald shiner larvae is one of the few larvae collected regularly here in the offshore waters (Sweeney 19781.

Turkey Creek (41°58', 80°32') and Conneaut River (41°58', 80°33'). The emerald shiner is a transient species in these streams; YOY were collected in these streams in the spring and fall (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Ripe adults were observed along the entire Pennsylvania shoreline in 42 ft or less of water in June. Fry were collected in this same area in 42 ft or less of water. Both adults and fry tend to move eastward due to the shoreline current (Kenyon, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). The emerald shiner is a transient species in the creek. In 1977, YOY were collected in the creek during the spring and fall; in 1978 they were present in the creek only in the spring (Aquat. Ecol. Assoc. 1978c).

New York

Dunkirk Harbor (42°30', 79°20'). The presence of gravid, ripe, and spent adults, eggs, prolarvae, and postlarvae indicates that spawning occurs in the harbor (Tex. Instrum. 1976a, as cited in Tex. Instrum. 1978;

Tex. Instrum. 1977d). In 1976, postlarvae were entrained at the Dunkirk Steam Station (42°30', 79°21') in August (Tex. Instrum. 1977e).

Van Buren Bay (42°27', 79°25'). Emerald shiners spawn from Van Buren Bay Creek (42°27', 79°24') to Canadaway Creek (42°28', 79°22') in 1-4 ft of water over a rock bottom. Eggs were collected from vegetation in this area; fry were collected here in August (Griswold and Galati, pers. comm. 1979).

Ontario

OE-1

Bar Point (42°03', 83°06'). In 1975, large numbers of YOY were collected along shore west of Bar Point off Highway 18 in August (Paine 1976).

Pelee Island (41°47', 82°40'). In 1959, extensive spawning occurred in South Bay (Harbor) (41°44', 82°39') over a sand bottom on July 16. Larvae about 0.2-0.3 in. long were collected from the southern tip of Fish Point (41°43', 82°40') east to South Harbor (Flittner 1964). In 1942, ripe adults were taken from the North wharf (41°49', 82°39') on July 28 (Gray 1942).

Point Pelee (41°55', 82°30'). In 1975, YOY were captured in beach seines off the west beach of Point Pelee (Paine 1976).

OE-4

Long Point Bay (42°40', 80°10'). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in July (Teleki 1976). In 1976, YOY were collected east and west of the Stelco Dock (42°47', 80°05') from July to September (Chamberlain 1976a). Young-of-the-year entered the limnetic areas after leaving the littoral nursery sites in late summer (Chamberlain 1976b).

COMMON SHINER

Spawning occurred in Lake Erie during June. In 1928, spawning adults and a large number of eggs and larvae were found in an unnamed tributary in mid-June (Fish 1932).

New York

Silver Creek (42°33', 79°10'). Spawninq was observed in the creek over nests of the crested chub in clean gravel and strong current on July 9 at a water temperature of 83°F (Greeley 1929).

Cattarauqus Creek (42°34', 79°08'). Spent adults were collected in the creek on July 10 (Greeley 1929). It is not known if these fish were residents of the creek or migrants from the lake.

Ontario

OE-1

Point Pelee (41°55', 82°30'). In 1929, one larva was found in the lake south of Point Pelee and east of Pelee Island (41°47', 82°40') on June 19 (Fish 1932).

OE-4

Long Point (42°33', 80°10'). In 1929, numerous young-of-the-year were found at the tip of Long Point (42°33', 80°05') on July 8 (Fish 1932).

PUGNOSE MINNOW

Ohio

o-1

South Bass Island (41°39', 82°50'). This species migrated in large numbers to Put-In-Bay (47°39', 82°49') to spawn in mid-late April (Langlois 1954). Vegetation is required for successful spawning (Trautman, pers. comm. 1979).

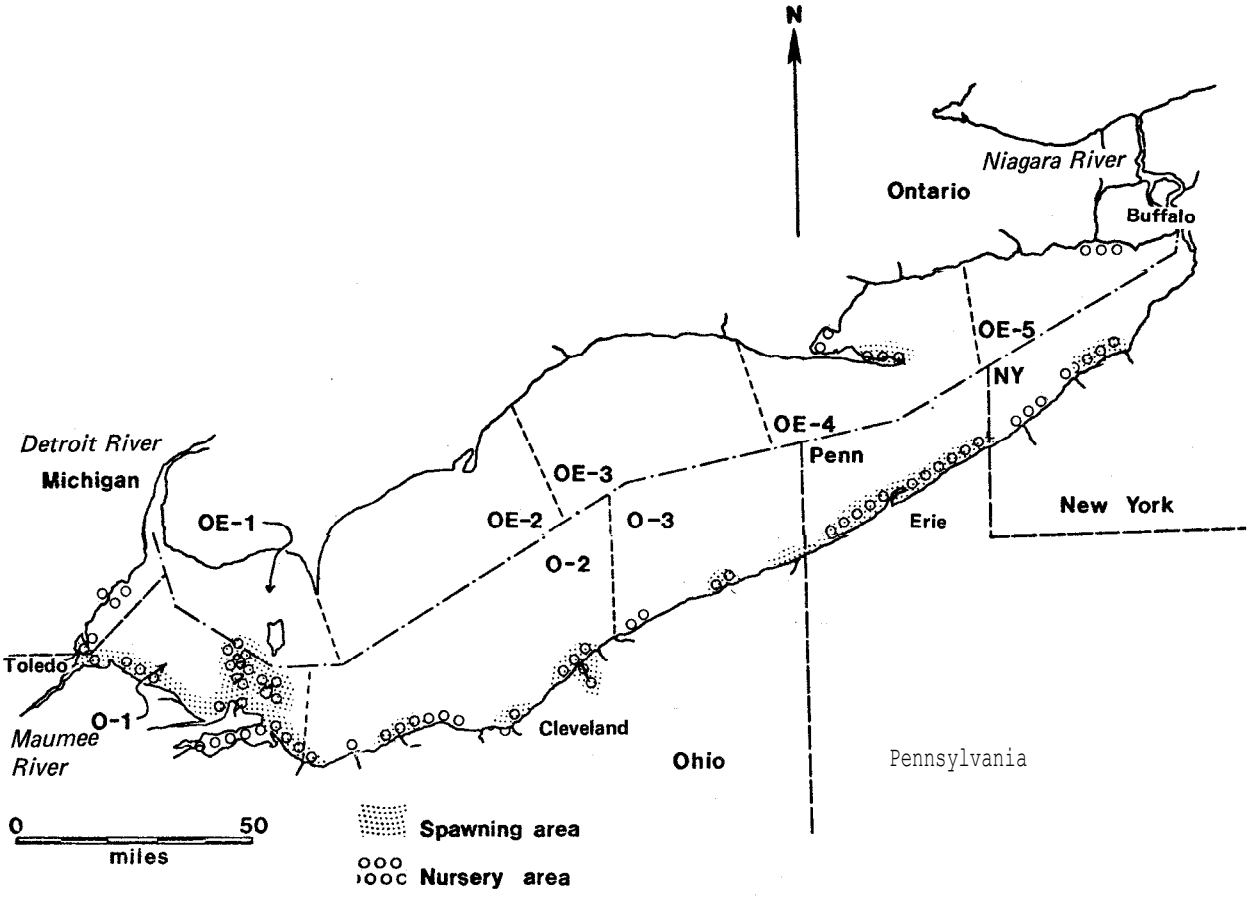
BLACKNOSE SHINER

Ontario

OE-4

Long Point (42°33', 80°10'). This species is believed to be established in lagoons at the tip of the point (42°33', 80°05'); young-of-the-year are numerous in these areas (Mahon 1979; Mahon and Balon 1977a).

SPOTTAIL SHINER



The western basin is the major spawning and nursery ground for spottail shiners (Doremus 1975). Spawning occurs over rocky areas around the islands and along the whole south shore, primarily within the 24 ft depth contour, in late June and early July (Greeley 1929; Heniken 1977; Waybrant and Shauver, undated; Wolfert, pers. comm. 1979). Many young-of-the-year (YOY) were collected from the Ohio waters of the western basin, beginning in late May to mid-June (Baker 1966b; Manz 1963; Van Vooren and Davies 1974; Van Vooren et al. 1977). In 1960, most larvae hatched from early to mid-June when the water temperature was about 68°F (Comm. Fish. Rev. 1961a). In the central basin, spottail shiners spawn over gravel on the beaches and in quiet river mouths. Larvae are most abundant on the beaches (Environ. Resour. Assoc. 1978).

Michigan

Monroe (41°55', 83°24'). Larvae were collected from the discharge canal of the Monroe Power Plant (41°53', 83°21') (Parkhurst 1971) and are one of the most common larvae in the area from early June to early July

(MacMillan 1976). In 1977, early postlarvae were found from early June to early July in Brest Bay at 41°56', 83°19' (Patterson 1979a). Trawl surveys showed YOY were more common off Monroe and Sterling State Park (41°55', 83°20') than farther south in the Michigan waters (MDNR 1970-1976).

Ohio

O-1

Maumee Bay (41°43', 83°25'). In 1975, a few ripe and gravid adults were collected near a dredge disposal site at 41°42', 83°26' in May. In 1975, spottail shiner larvae were collected in the bay in late July, and in 1977, they were collected in May and June (Herdendorf 1977; USACE 1976c).

Potters Pond (41°41', 83°18'). In 1965, YOY were abundant in the lake waters immediately offshore from the pond in August (Ayers et al. 1970).

Crane Creek (41°38', 83°12'). In 1970 and 1972, YOY were abundant off the creek mouth (Ball and Scholl 1973; Gehres and Scholl 1969; Rudolph and Scholl 1970).

Niagara Reef (41°40', 82°58'). In 1953, two ripe females were taken here (Langlois 19541.

Catawba Island (41°35', 82°51'). In 1966 and 1971-72, high densities of YOY were recorded off the west side of the island at 41°34', 82°53' (Baker 1967a; Ball and Scholl 1973; Hair and Scholl 1971).

East Harbor (41°32', 82°47'). In 1966-67 and 1970-72, YOY were abundant both inside and outside the harbor (Baker 1967a,c; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970).

Island Region (41°40', 82°45'). Larvae were collected around the Bass Islands (41 °41', 82°49') and Kelleys Island (41°36', 82°42') (Heniken 1977). Young-of-the-year shiners were captured in June around the Bass Islands, especially on the west shore of South Bass Island (41°39', 82°50') (Kinney 1954; Langlois 1954).

Sandusky Bay (41°29', 82°46'). In 1961-63 and 1965, YOY, 0.3-3.0 in. long, were abundant in western Sandusky Bay during May-October (Baker 1966b; Keller 1964a), and YOY were fairly abundant at Cedar Point (41°29', 82°41') (Rudolph and Scholl 1970).

o-2

Vermilion River (41°26', 82°22'). In 1975, fry were collected in Vermilion Harbor in July (U.S. Army Eng. Dist., Buffalo, 1976a); the beach

east of the Vermilion River mouth is a nursery area (Cleveland Environ. Res. Group 1975).

Beaver Creek (41°26', 82°15'). Ripe and spent females were collected from May to July, and prolarvae, postlarvae and YOY were collected from late May to September out to the 36 ft depth contour (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). In Lorain Harbor, adults were numerous in the spring and larvae were abundant in late May through June (Geo-Marine 1978; Odin 1979).

Avon Lake Power Plant (41°30', 82°03'). Larvae were collected in May-August at the Avon Lake Power Plant (Aquat. Ecol. Assoc. 1976c).

Cleveland (41°30', 81°43'). The beaches and breakwaters in the harbor (41 °31', 81°42') are spawning and nursery areas (Odin 1979). In 1972-74, fry and YOY were collected in the harbor and the lower Rocky River (41°30', 81°50') (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, fry and YOY were collected at the mouth off the river and along the adjacent lake shoreline (White et al. 1975). In 1975, larvae were collected during June-August; those collected on June 10 were prolarvae. Spawning is believed to occur in the immediate vicinity of the East Lake Generating Station (41°40', 81°27') or in the mouth of the Chagrin River; only small numbers of larvae were collected in the area (Aquat. Ecol. Assoc. 1976b).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, larvae were collected in low numbers during June; spawning apparently occurs over a short period in June (NUS 1975).

Ashtabula (41°55', 80°47'). Spottail shiners spawn in protected water with gravel bottom off the Ashtabula power plants (41°55', 80°46'), between Piney Dock and a breakwall (White, pers. comm. 1979). Significant production of larvae occurs in Ashtabula Harbor (Hubbard 1977, as cited in Sweeney 1978).

Conneaut Harbor (41°58', 80°33'). Spottail shiners spawn on Cladophora beds and sandy areas along the east breakwall (Odin 1979).

Pennsylvania

Spottail shiners generally spawn all along the shore of Pennsylvania to depths of 42 ft but tend to concentrate in Outer Presque Isle Bay (Kenyon, pers. comm. 1979).

outer Bay (42°09', 80°04'). Ripe adults and YOY were collected in this area in June (Kenyon, pers. comm. 1979).

New York

Barcelona (42°20', 79°36'). Young-of-the-year were collected in early July in water 1-4 ft deep over a bottom of rock and gravel; submergent vegetation was also present (Griswold and Galati, pers. comm. 1979).

van Buren Bay (42°27', 79°25'). In 1975, spottail shiner postlarvae were more abundant than those of most other species during June-August (Envirosphere 1977a).

Dunkirk Harbor (42°30', 79°20'). In 1976, spottail postlarvae were one of the most abundant species, especially in July (Tex. Instrum. 1977d). Postlarvae were also entrained at the Dunkirk Steam Station (42°30′, 79°21') in July and August (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14′). Spottail shiner eggs were collected on vegetation in St. Colombian's region, near shore between Walnut (42°33', 79°10') and Eagle Bay (42°32', 79°14') creeks. Prolarvae and postlarvae were collected here in July and August, and YOY were taken from July to September. The bottom in this area is rock and gravel, and the water depth is 1-3 ft (Envirosphere 1977a,b; Griswold and Galati, pers. comm. 1979; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Sturgeon Point (42°41', 79°03'). In 1928, many ripe spottail shiners were collected here in mid-June (Fish 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Spottail shiners are believed to spawn in a large lagoon at the end of Long Point (42°33', 80°05'); in 1975, numerous YOY were collected there (Mahon and Balon 1977a). In 1975, YOY were found off Port Rowan (42°38', 80°27') in open lake littoral areas over sand and gravel in the fall (Suns and Rees 1978).

OE-5

Port Colborne (42°53', 79°15′). In 1975, YOY spottail shiners were collected in open lake littoral areas over sand and gravel bottom in the fall (Suns and Rees 1978).

ROSYFACE SHINER

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1961-63, young-of-the-year rosyface shiners, 1.2-1.8 in. long, were collected in western Sandusky Bay (Keller 1964a).

SPOTFIN SHINER

Ohio

O-1

South Bass Island (41°39', 82°50'). Spotfin shiners in spawning colors have been observed in weed beds near Terwilliger Pond (41°39', 82°50') (MacLean, pers. comm. 1979).

O-2

Rocky River (41°30', 81°50'). In 1972-74, fry and YOY were collected in the lower river; this may be a spawning area (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). In 1972-74, fry and young-of-the-year (YOY) spotfin shiners were collected in the mouth and adjacent shoreline of the Chagrin River; this may be a spawning area (White et al. 1975).

O-3

Ashtabula (41°55', 80°47'). Spotfin shiners spawn at the east side of the mouth of Ashtabula Harbor and deposit eggs in the crevices of various objects such as branches, pilings, and concrete. Spawning usually occurs in mid-July when the water temperature is above 70°F (White, pers. comm. 1979).

SAND SHINER

Sand shiners spawn in sheltered locations, such as creek mouths, and on sandy lake shoals in June and July (Greeley 1929; Langlois 1954).

Ohio

O-1

South Bass Island (41°39', 82°50'). Spawning sand shiners have been observed over gravel beaches on South Bass Island (Trautman, pers. comm. 1979).

O-2

Rocky River (41°30', 81°50') and Chagrin River (41°41', 81°26'). In 1972-74, fry and young-of-the-year (YOY) were collected in the lower reaches of the rivers; these might be spawning areas (White et al. 1975).

O-3

Ashtabula (41°55', 80°47'). Sand shiners spawn on sandbars in Ashtabula Harbor in mid-July when the water temperature rises above 70°F (White, pers. comm. 1979).

New York

Muddy Creek (42°37', 79°06'). In 1928, some larvae were collected at the creek mouth in late July (Fish 1932).

Sturgeon Point (42°41', 79°03'). In 1929, larvae were abundant from the Sturgeon Point area over to Port Dover beginning in early August (Fish 1932).

Ontario

OE-1

Point Pelee (41°55', 82°30'). In 1929, larvae and postlarvae were abundant around Point Pelee in August (Fish 1932).

OE-4

Long Point Bay (42°40', 80°10'). Numerous YOY have been found in a large lagoon at the tip of Long Point (42°33', 80°05'), and spawning is believed to have occurred in the lagoon (Mahon and Balon 1977a). In 1929, larvae and postlarvae became abundant in early August from the Port Dover area (42°47', 80°12') over to Sturgeon Point, New York (42°41', 79°03') (Fish 1932).

OE-5

In 1929, larvae were abundant throughout the area from Port Dover (42°47', 80°12') to Sturgeon Point (42°41', 79°03') (Fish 1932).

MIMIC SHINER

Ohio

Spawning occurs over silt-free sand (White et al. 1975).

O-1

south Bass Island (41°39', 82°50'). Mimic shiners spawn around South Bass Island in silt-free, quiet water (Trautman, pers. comm. 1979). Larvae less than 1 in. long were commonly found in the Stone Cove area (41°38', 82°51') in September (Kinney 1954).

Sandusky Bay (41°29', 82°46'). Larvae less than 1 in. long were commonly collected in Sandusky Bay during September (Kinney 1954).

O-3

Ashtabula (41°55', 80°47'). A few mimic shiners spawn on sand bars in Ashtabula Harbor (White, pers. comm. 1979).

NORTHERN REDBELLY DACE

Ohio

This species enters the streams of northern Ohio to spawn on riffles in April and May. The adults return to Lake Erie by July 1 (McCormick 1892).

BLONTNOSE MINNOW

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1961, young-of-the-year (YOY) were collected in small numbers from May to October (Keller 1964a).

o-2

The bluntnose minnow spawns in protected waters of the central basin, such as harbors and lower sections of rivers (White, pers. comm. 1979).

Rocky River (41°30', 81°50'), Cleveland Harbor (41°31', 81°42') and Chagrin River (41°41', 81°26'). In 1972-74, YOY were common in the harbor and the lower reaches of the rivers; these might be spawning areas (White et al. 1975).

New York

Sister Creek (42°40', 79°04'). In 1928, eggs and young were found in a nest guarded by a male under a flat stone near the creek mouth on July 13 at a water temperature of 82°F (Fish 1932; Greeley 1929).

Ontario

OE-4

Long Point (42°33', 80°10'). The bluntnose minnow spawns in late May and early June in Long Point Crown Marsh (42°35', 80°25'); YOY are common here (Reid 1978). Reproducing populations are established in the lagoons at the end of the point (42°33', 80°05'), and YOY are numerous in these lagoons (Mahon 1977a, 1979).

FATHEAD MINNOW

Ohio

O-2

Cleveland Harbor (41°31', 81°42'). In 1972-74, young-of-the-year were collected in the harbor in small numbers; this may be a spawning area (White et al. 1975).

LONGNOSE DACE

In Lake Erie, the longnose dace spawns in streams and along wave-washed beaches from Sandusky eastward (Trautman, pers. comm. 1979) in the habitat it occupies throughout the year (White, pers. comm. 1979).

Ohio

Along the Ohio shoreline, ripe adults are present and spawning occurs along the beach from Lakewood (41°30', 81°47') to Conneaut (41°58', 80°33'), where the substrate is composed of rocks of approximately 4 in. diameter; larvae are found in this same area (White, pers. comm. 1979).

O-2

Beaver Creek (41°26', 82°15'). In 1979, five YOY were seined at Oak Point Beach near the creek mouth on July 24 (Commonw. Assoc. 1979).

Lakewood (41°30', 81°47'). The beach approximately 3-1/2 mi E of the mouth of the Rocky River (41°30', 81°50') is an excellent spawning site (White, pers. comm. 1979).

Cleveland Harbor (41°31', 81°42'). The beaches and breakwaters here are spawning and nursery areas (Odin 1979). Young-of-the-year (YOY) were also collected here (White, pers. comm. 1979).

Gordon Park (41°33', 81°38'). The area just east of the Cleveland Municipal Boat Docks is a spawning area (White, pers. comm. 1979).

Moss Point (41°37', 81°31'). This is a probable spawning site (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Postlarvae were collected from the lower river; the area just east of the river mouth is a spawning site (White, pers. comm. 1979).

O-3

Ashtabula (41°55', 80°47'). Spawning occurs both inside and outside the harbor (White, pers. comm. 1979).

Conneaut Harbor (41°58', 80°33'), Spawning occurs here (White, pers. comm. 1979).

Pennsylvania

Collections of gravid males and females suggest spawning occurs in May in the surge zone along the entire Pennsylvania shoreline. The surge zone, at a depth of 1 ft, has rock bottom, moderate-strong current, and no vegetation. The longnose dace probably inhabits this shoreline area throughout the year (Kenyon, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10'). Young-of-the-year were seen here in late summer in sandy pools along the south shore of Long Point (Mahon, pers. comm. 1979).

CREEK CHUB

Ohio

O-2

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year were collected in the lower river; this may be a spawning area (White et al. 1975).

SHINER spp.

Michigan

Woodtick Peninsula (41°44', 83°25'). Larvae of shiners were found in high densities in 6-12 ft of water off the Woodtick Peninsula at 41°46', 83°25' in late June and early July and were either spottail or emerald shiners (Waybrant and Shauver 1979). In 1978, at the Whiting Power Plant (41°47', 83°27'), larvae of shiners were collected in the bay; peak catches occurred in June. Larvae were first entrained in May; peak entrainment occurred in July (Wapora 1979b).

Ohio

O-2

Avon Lake Power Plant (41°30', 82°03'). In 1977-78, up to 97% of the larvae caught here in the spring and summer were spottail and emerald shiners (Applied Biology 1979c).

Cleveland (41°30', 81°43'). In 1977-78, 12% of the larvae entrained at the Lakeshore Power Plant (41°32', 81°38') were spottail and emerald shiners (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). In 1977-78, emerald and spottail shiner larvae were the most abundant larvae present at the Eastlake Power Plant (41°40', 81°27') in the spring; they were entrained June-August (Applied Biology 1979b).

O-3

Ashtabula Harbor (41°55', 80°47'). In 1977-78, shiners were among the most abundant fishes present and entrained at the Ashtabula power plants (41°55', 80°46'). Shiner larvae were present from May to August; they were 53% of the larvae collected annually and 75% of the larvae collected during the summer (Applied Biology 1979d,e).

New York

Van Buren Bay (42°27', 79°25'). In 1975-76, many shiner eggs, prolarvae, postlarvae, and YOY were abundant in the lake off the bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1976, shiner eggs, prolarvae, and postlarvae were collected in the harbor from June to August (Tex. Instrum. 1977d), and entrained at the Dunkirk steam station (42°30', 79°21') (Tex. Instrum. 1977e). Eggs were entrained in June and July and prolarvae and postlarvae were entrained from June to August (Tex. Instrum. 1977e).

Eagle Ray (42°32', 79°14'). Shiner eggs, prolarvae, postlarvae, and young-of-the-year (YOY) were found in the lake off the bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

MINNOW spp.

Ohio

O-2

Avon Lake Power Plant (41°30', 82°03'). Minnow larvae were entrained in May and were 12% of the total entrained from April to June (Applied Biology 1979c).

O-3

Conneaut (41°58', 80°33'). In 1977, many minnow eggs were collected in Lake Erie near shore between Conneaut and Raccoon Creek (41°59', 80°29'), in Conneaut Harbor (41°58', 80°33'), and approximately 1/2 mi offshore at Turkey Creek (41°58', 80°32') from June to August. Larvae were collected nearshore between Conneaut and Raccoon Creek and in Conneaut Harbor from late May through August. Large numbers of larvae were also collected in the Conneaut River (41°58', 80°33') and Turkey Creek (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Raccoon Creek (41°59', 80°29'). In 1977, many minnow larvae were collected in the creek (Aquat. Ecol. Assoc. 1978c).

New York

Eagle Bay (42°32', 79°14'). In 1975, eggs of carp, goldfish, and their hybrids were found at the 10 ft and 30 ft contours in early June. Prolarvae and postlarvae were very abundant in mid-May through July; prolarvae dominated surface collections (Envirosphere 1977a,b; U.S. Army Eng . Dist., Buffalo, undatd a).

CYPRINID spp.

Michigan

Raisin River (41°53', 83°20'). Larvae of carp, goldfish, and their hybrids are more abundant in the river than in the surrounding lake (Cole 1978b); this is one of the most abundant species present in the area from May to July (MacMillan 1976).

New York

Van Buren Bay (42°27', 79°25'). In 1976, carp-goldfish prolarvae were collected in mid-June through July; postlarvae were collected in late June (Tex. Instrum. 1977a).

Dunkirk Harbor (42°30', 79°20'). In 1976, eggs of carp, goldfish, and their hybrids were present during June and July, peaking on June 14. Prolarvae were very abundant and were present during June through August, peaking in mid-June, near the bottom. Postlarvae were collected in June through August (Tex. Instrum. 1977d,e).

RIVER CARPSUCKER

Ohio

O-2

Lorain Harbor (41°28', 82°11'). A few larvae were found in the harbor (Geo-Marine 1978).

QUILLBACK

Two populations of the quillback exist in the Lake Erie drainage basin; a lake-run quillback and a riverine quillback. The lake-run quillback migrates into harbors and lower rivers to spawn and scatters its

eggs over vegetation or gravel. The riverine quillback inhabits rivers and migrates further upstream to spawn in very small tributaries (White, pers. comm. 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). A major spawning area is located on the shoal north of Cedar Point at 41°43', 83°21'; spawning occurs over a sand bottom at depths of 1-6 ft, during May (Reynolds, pers. comm. 1979). From June 10 to July 10, spawning occurs nearshore at 41°42', 83°24' approximately 2-1/2 mi E of the Maumee River (Pinsak and Meyer 1976).

Sandusky Bay (41°29', 82°46'). Spawning occurs in the bay (FWS 1979d).

O-2

Cranberry Creek (41°23', 82°29'). In 1974, quillback larvae were abundant near Cranberry Creek on June 19 (Ohio Edison 1977).

Lorain Harbor (41°28', 82°11'). Larvae were collected in Lorain Harbor (Geo-Marine 1978).

Cleveland (41°30', 81°43'). Spawning runs enter the Rocky River (41°30', 81°50') and Cleveland Harbor (41°31', 81°42'). Many migrating adults were collected in the Rocky River over a 3-day period during the latter part of May. Quillbacks also migrated into Cleveland Harbor (White, pers. comm. 1979). In 1972-1974, larvae and YOY were collected in the Rocky River, Cleveland Harbor, and along the adjacent lakeshore (White et al. 1975).

Chagrin River (41°41', 81°26'). A spawning run enters the river in mid-May. Larvae and young-of-the-year (YOY) were found in the river and along adjacent shorelines (Environ. Resour. Assoc. 1978; White, pars. comm. 1979; ‘White et al. 1975).

New York

Cattaraugus Creek (42°34', 79°08'). In the late 1920s, many quillhacks were seined in the creek in the spring, and young were abundant along shallow mud flats several miles upstream from the mouth (Greeley 1929).

Sister Creek (42°40', 79°04'). In the late 1920s, one very young fry was found at the creek mouth in mid-July (Greeley 1929).

Ontario

OE-4

Long Point Ray (42°40', 80°10'). Quillbacks migrate through Inner Bay (42°37', 80°22′) to spawn. Big Creek (42°36*, 80°27') and the Turkey Point area (42°39', 80°21′) have spawning runs in the spring (Whillans 1977).

LONGNOSE SUCKER

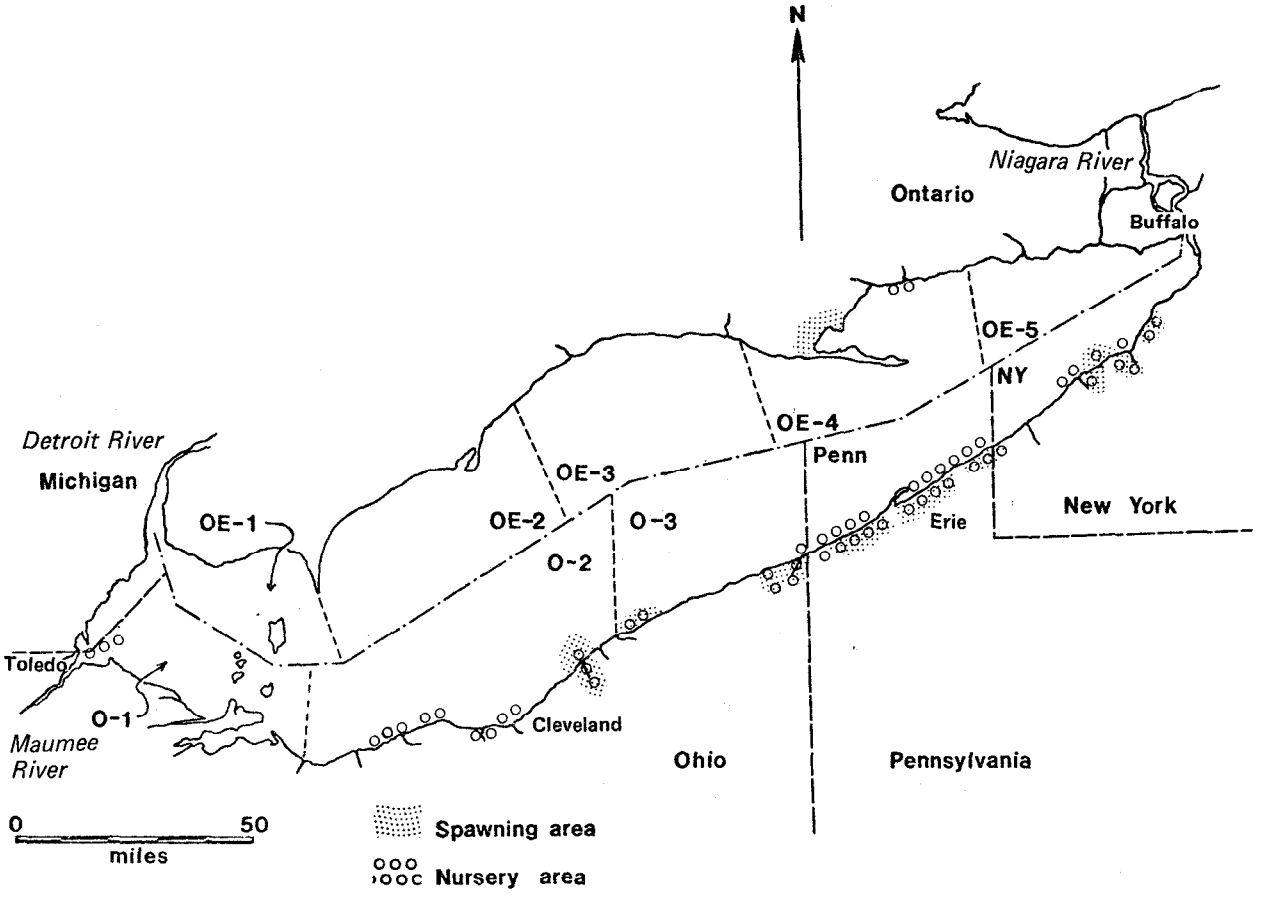
Ohio

Longnose suckers spawn on beaches and current-swept shoals over gravel (White, pers. comm. 1979).

o-l

The longnose sucker moves into water less than 25 ft deep during the spring, presumably to spawn around reefs (Trautman 1957).

WHITE SUCKER



In Lake Erie, white suckers spawn in tributaries in April or May, soon after ice breakup, and then return to the shallow nearshore waters of the lake (Fish 1932; FWS 1979d; Langlois 1954). Spawning also occurs in the lake; many fry were found alongshore far from tributary mouths (Applegate and Van Meter 1970; Greeley 1929). In 1928, fry about 0.6-1.0 in. long were abundant in shallow water at the east end of the lake from mid-June to mid-July (Fish 1932). The decline of suckers in Lake Erie was partly caused by destruction or blocking of the preferred spawning grounds in streams (USDI 1967).

Ohio

Along the Ohio shoreline of the central basin, white suckers spawn at night in almost all tributaries that have gravel or rubble riffles; they also spawn on gravel bars and beaches in the lake where there is suitable current. Adults only remain in the tributaries for a few days, then return to the lake (White, pers. comm. 1979). The earliest runs occur in late March (Cleveland Environ. Res. Group, undated).

O-1

Maumee Bay (41°43', 83°25'). In 1977, a few larvae were collected in April in the shipping channel of the bay (Herdendorf 1977).

O-2

Beaver Creek (41°26', 82°15'). In 1979, eggs were found near t'ne creek mouth on June 12, prolarvae were collected from May 10 to June 12, and early postlarvae were collected on May 10 in nearshore waters (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). A few larvae were collected here (C&o-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, larvae were collected in the vicinity of the plant in May and July (Aquat. Ecol. Assoc. 1976c).

Cleveland (41°30', 81°43'). In 1972-74, larvae were collected in Cleveland Harbor (41°31', 81°42') and the lower Rocky River (41°30', 81°50'); these may be spawning areas (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year (YOY) were collected in the lower river and along adjacent shores ('White et al. 1975). In 1977, small numbers of prolarvae were collected in May and July at the Eastlake Power Plant (41°40', 81°27') near the river; spawning is believed to have occurred at the plant or in the mouth of the river (Aquat. Ecol. Assoc. 1976b).

O-3

Perry Power Plant (41°48', 81°09'). Spawning occurs in the area during early spring; in 1974, early larvae were collected in the vicinity of the plant (NUS 1975).

Conneaut River (41°58', 80°33'). In 1977-78, ripe adults were captured in the river during spawning runs; eggs were found in the river in late April, prolarvae were taken at the river mouth, and YOY were collected in the river in September (Aquat. Ecol. Assoc. 1978c).

Turkey Creek (41°58', 80°32'). Spawning occurs during April and May (USACE, undated b). In 1977-78, ripe adults were captured during spawning runs; eggs were found in April and May at water temperatures of about 50-55°F. Larvae were collected at the creek mouth and also 1/2 mi offshore in early June; YOY were also collected in the creek (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Generally, all continuously flowing tributaries support runs and are nursery areas (Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979); included are Raccoon (41°59', 80°29'), Crooked (42°00', 80°26'), Elk (42°01' 80°22'), Trout Run (42°03', 80°16'), Walnut (42°04', 80°14'), Fourmile (42°09', 80°02'), Sixmile (42°11', 79°59'), Sevenmile (42°11', 79°59'), Eightmile (42°11', 79°58'), Twelvemile (42°13', 79°55'), Sixteenmile (42°14', 79°50'), Eighteen Mile (42°15', 79°48'), and Twenty Mile (42°16', 79°47') creeks (Kenyon, pers. comm. 1979). The substrate in these tributaries consist of rubble, gravel, and shale bottom with no vegetation. Spawning usually occurs in 1/2 to 1-1/2 ft of water in areas with moderate current. In Pennsylvania tributaries, spawning white suckers were collected in May. After spawning, adults return to the lake. Fry are first collected during late May or June; they migrate from the tributaries to rocky beach areas in the lake (Kenyon, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). In 1977, larvae were found at the mouth of the creek during late May and June after the spring run of adults (Aquat. Ecol. Assoc. 1978c).

Elk Creek (42°01', 80°22'). Ripe adults were collected in the creek in May; larvae were subsequently found in the creek (GPU Serv. Corp. 1979).

New York

Van Buren Bay (42°27', 79°25'). In 1976, postlarvae were collected in the bay (Tex. Instrum. 1977a).

Canadaway Creek (42°28', 79°22'). White suckers spawn in the creek over rocky gravel bottom in 2-4 ft of water; YOY were collected in the creek from July to October (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 79°20'). In 1976, prolarvae were collected in May (Tex. Instrum. 1977d).

Eagle Bay (42°32', 79°14'). In 1976, postlarvae were collected from the bay (Tex. Instrum. 1977a).

Silver Creek (42°33', 79°10′). White suckers spawn in the creek over stone and gravel in 2-4 ft of water; YOY were collected in the creek in July and August (Griswold and Galati, pers. comm. 1979).

Delaware Creek (42°38', 79°04'). This is assumed to be a spawning and nursery area; YOY were collected in the creek in July and August (Griswold and Galati, pers. comm. 1979).

Big Sister Creek (42°40', 79°04'). Spawning occurs over rock and gravel in 2-4 ft of water; YOY were collected in the creek (Griswold and Galati, pers. comm. 1979).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). White suckers migrate through Inner Bay (42°37', 80°22') to spawn. Major spawning runs occur in the Turkey Point area (42°39', 80°21'), in the lower reaches of Big Creek (42°36', 80°27'), and in many small creeks (Whillans 1977, pers. comm. 1979). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') during June 6-12 and June 21-27 (Teleki 1976).

CREEK CHUBSUCKER

Ohio

O-2

Avon Lake Power Plant (41°30', 82°03'). In 1975, larvae were collected at the plant in May and July (Aquat. Ecol. Assoc. 1976c).

Chagrin River (41°41', 81°26'). In 1975, small numbers of eggs and prolarvae were collected at the Eastlake Power Plant (41°40', 81°27') near the river in May, June, and August. Spawning is thought to occur in the immediate area, probably in the river or at its mouth (Aquat. Ecol. Assoc. 1976b).

LAKE CHUBSUCKER

Ontario

OE-4

Long Point Bay (42°40', 80°10'). This is probably the only area in Canada where lake chubsuckers are common (Mahon, pers. comm. 1979). Adults migrate through Inner Bay (42°37', 80°22') to spawn in mid- to late April in Long Point Crown Marsh (42°35', 80°25'), the lower reaches of Big Creek (42°36', 80°27'), and the Turkey Point area (42°39', 80°21') (Reid 1978; Whillans 1977). Large numbers of young-of-the-year were seen in late summer in a muddy, vegetated lagoon on Long Point (42°33', 80°10'); reproducing populations are probably established in the lagoons (Mahon 1979, pers. comm. 1979).

young of this species were found along Lake Erie shores near stream mouths but were more common in shallow, warm creeks and rivers (Fish 1932).

Ohio

O-3

Turkey Creek (41°58', 80°32'). Adults were found in the creek during April and May; this may have been a spawning run (USACE, undated b).

BIGMOUTH BUFFALO

Michigan

Swan Creek (41°58', 83°15'). Until 1968, spawning occurred in an area (41°58', 83°10') 3 mi E of the mouth of the creek over mud and rock in 9-12 ft of water (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Since 1958, spawning has occurred over gravel in water shallower than about 6 ft along the shore from 41°49', 83°26' south to North Cape (41°44', 83°25') (Organ et al. 1978).

Pay Creek (41°47', 83°27'). Since 1952, spawning has occurred at the mouth of the creek over mud bottom (Organ et al. 1978).

Indian Island (41°45, 83°27'). Since 1950, spawning has occurred over mud in the area surrounding the island (Organ et al. 1978).

Ohio

O-1

Maumee Ray (41°43', 83°25'). Spawning occurs from mid-June to mid-July in the shallow, warm nearshore areas of Maumee Bay from an area north of the mouth of the Maumee River at 41°43', 83°27' to Cedar Point (41°42', 83°20') (Pinsak and Meyer 1976).

Sandusky Bay (41°20', 82°46'), A resident population ascended tributaries to spawn in late March-May (Trautman 1957).

Ontario

OE-4

Long Point Bay (42°40', 80°10′). Bigmouth buffalo migrate through Inner Bay (42°37', 80°22') to spawn. Big Creek (42°36', 80°27') and the Turkey Point area (42°39', 80°21') have spawning runs in the spring (Whillans 1977).

SILVER REDHORSE

Spawning runs ascend tributary streams as the ice goes out (Greeley 1929); the young are generally found at creek mouths (Fish 1932). Historically, this species ran into all the rivers of the central basin (White, pers. comm. 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Spawning occurs during April 1-May 10 in an area (41°41′, 83°28′) just west of the mouth of the Maumee River and in an area (41°42', 83°26') along the shipping channel (Pinsak and Meyer 1976).

O-3

Grand River (41°46', 81°17'). A spawning run presently enters the river; adults with breeding tubercles were collected in the river (White, pers. comm. 1979).

Pennsylvania

Elk Creek (42°01′, 80°22'). Many ripe adults were collected in the creek in May; these had probably entered the creek from the lake (GPU Serv. Corp. 1979).

New York

During the late 1920s, young-of-the-year (YOY) were found at the mouths of several unnamed tributaries (Greeley 1929).

Cattaraugus Creek (42°34', 79°08'). In the late 1920s, runs entered the creek (Greeley 1929).

Eighteenmile Creek (42°43', 78°58'). In the late 1920s, YOY were found at the creek mouth (Greeley 1929).

BLACK REDHORSE

Ohio

Spawning runs entered all the rivers along the northeastern Ohio shoreline (White, pers. comm. 1979).

O-2

Chagrin River (41°41', 81°26'). Spawning runs enter the river. Adults with breeding tubercles were collected in the river. Larvae were found in an upstream backwater, the lower river, and at the river mouth (Environ. Resour. Assoc. 1978; White, pers. comm. 1979; White et al. 1975).

O-3

Grand River (41°46', 81°17'). A spawning run enters the river; adults with breeding tubercles were collected in the river (White, pers. comm. 1979).

New York

Eighteenmile Creek (42°43', 78°58'). Small (age not given) black redhorses were numerous at the mouth of the creek (Greeley 1929).

GOLDEN REDHORSE

Ohio

O-1

Maumee Ray (41°43', 83°25'). Spawning is believed to occur during April 1-May 10 in an area (41°41', 83°28') just west of the mouth of the Maumee River and in an area (41°42', 83°26') along the shipping channel (Pinsak and Meyer 1976).

O-2

Rocky River (41°30', 81°50'). In 1972-74, fry and young-of-the-year were collected from the lower river and adjacent shorelines; the river may be a spawning area ('White et al. 1975).

Chagrin River (41°41', 81°26'). A spawning run enters the river. Larvae were found in upstream backwater areas, in the lower river, and at the river mouth from mid-May to mid-June (Environ. Resour. Assoc. 1978; White et al. 1975).

O-3

Turkey Creek (41°58', 80°32'). Adults were collected in April and May; these fish may have entered the creek from the lake (USACE, undated b).

Pennsplvania

Elk Creek (42°01', 80°22'). Ripe adults were collected in May at the creek mouth (GPU Serv. Corp. 1979).

SHORTHEAD REDHORSE

Small runs enter Lake Erie tributaries in the spring (Langlois 1954; Trautman 1957).

Ohio

O-1

Maumee Ray (41°43', 83°28'). Spawning occurs during April 1 -May 10 in an area (41°41', 83°28') just west of the mouth of the Maumee River and in an area (41°42', 83°26') along the shipping channel (Pinsak and Meyer 1976).

O-2

Cuyahoga River (41°30', 81°43'). In the late 1800s, adults congregated on riffles with rapid current in the river; they migrated into tine river in April, before the ice was out, and returned to the lake by mid-May (McCormick 1892).

O-3

Turkey Creek (41°58', 80°32'). Adults were collected in the creek in April and May; these fish may have entered the creek from the lake (USACE, undated °01.

New York

Cataraugus Creek (42°34', 79°08'). In the late 1920s, spawning runs entered the creek in May (Greeley 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Adults migrate through Inner Bay (42°37', 80°22') to spawn in the lower reaches of Big Creek (42°36*, 80°27') and in the Turkey Point area (42°39', 80°21') (Whillans 1977). The runs in Rig Creek were very large during the early 1940s; these runs declined between 1945 and 1950 and have not recovered (Whillans, pers. comm. 1979). In 1974, young-of-the-year were entrained at the Nanticoke Generating Station (42°48', 80°03') (Teleki 1976).

CATOSTOMID spp.

Historically, unidentified species of suckers entered streams in the eastern basin in the spring, remained for no more than 3 weeks, and then returned to the lake (Kerr and Kerr 1860-1898). Runs still enter tributaries; spawning may also occur in the lake (Applegate and Van Meter 1970; USBCF 1966).

Michigan

Huron River (42°02', 83°12'). Suckers enter the river to spawn. In 1979, the run peaked in mid-April (UPI 1979).

Pointe Mouillee (42°01', 83°12'). Spawning runs occurred here in early spring (Warren 1946).

Swan Creek (41°58', 83°15'). In 1976, larvae were collected along shore in an area (41°59', 83°14') just north of the mouth of Swan Creek in late April-early May (Waybrant and Shauver 1979).

Woodchuck Creek (41 °51', 83°24')--La Plaisance Creek (41°52', 83°23'). Suckers spawn here close to shore over gravel (Organ et al. 1978).

otter Creek (41°51', 83°24'). Suckers spawn over mud in the embayment at the creek mouth (Organ et al. 1978).

Ohio

O-3

Conneaut (41°58', 80°33'). In 1977, unidentified sucker larvae were collected in April, June, and August; these larvae probably originated from spawning that occurred in the tributaries between Conneaut and Raccoon Creek (41°59', 80°29'). Sucker larvae were collected in the Conneaut River (41°58', 80°33') in late April and early June, at the mouth of Turkey Creek (41°58', 80°32') in June, and in Conneaut Harbor (41°58', 80°33') (Aquat. Ecol. Assoc. 1978c).

Ontario

Runs entered the following Ontario tributaries (Kerr and Kerr 1860-1898).

OE-4

Big Creek (42°36', 80°27'). In the late 1800s, many suckers were still entering the creek, even though a dam had been built that curtailed the run.

Nanticoke Creek (42°48', 80°04'). In 1886, a run of suckers and "mullet" occurred in late March, but this run was curtailed by a dam.

OE-5

Grand River (42°51', 79°35'). In 1890, a large run of suckers and mullet occurred.

BLACK BULLHEAD

Black bullheads are common in the central basin of Lake Erie. They spawn in harbors, where they make nests in breakwalls, or in rivers with overhung banks or much deadfall (White, pers. comm. 1979).

Ohio

O-1

Magee Marsh (41°37', 83°10'). In 1952, schools of young were observed in the channels of the marsh during late July (Langlois 1954).

Sandusky Bay (41°29', 82°46'). In 1953-54, black bullheads entered Sandusky Bay to spawn in the spring and returned to the lake in the summer

and fall. Young-of-the-year (YOY) were collected throughout most of the bay, and were most abundant in protected waters with aquatic vegetation (Chapman 1955; Keller 1964b).

O-2

Vermilion River (41°26', 82°22'). A spawning run enters the river in July and August (U.S. Army Eng. Dist., Buffalo, 1976a).

Rocky River (41°30', 81°50'). A spawning run enters the river in early May (Cleveland Environ. Res. Group, undated).

Chagrin River (41°41', 81°26'). During 1972-74, YOY or fry were collected in the lower Chagrin River and adjacent shoreline areas; this is probably a spawning area (White et al. 1975).

YELLOW BULLHEAD

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1953-54, yellow bullheads entered Sandusky Bay to spawn in the spring and returned to Lake Erie in the summer and fall. Spawning occurred during late spring and early summer. Young-of-the-year (YOY) were found throughout most of Sandusky Bay, and were most abundant in protected waters with aquatic vegetation (Chapman 1955).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Young-of-the-year were seined from the marshes of Inner Bay (42°37', 80°22') (Hamley and MacLean 1979), and reproducing populations are probably established in the lagoons on Long Point (42°33', 80°10') (Mahon 1979).

BROWN BULLHEAD

In the central basin, brown bullheads spawn in harbors, where they build nests in breakwalls, and in rivers with overhung banks and submerged fallen trees (White, pers. comm. 1979). In the western basin, brown bullheads are present mainly in the marshlands and near marinas (Wolfert, pers. comm. 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Brown bullheads are believed to spawn in an area (41°41', 83°22') about 1-1/2 mi SW of Cedar Point (41°42', 83°20'); spawning occurs along shore in 3 ft of water from June 1 to July 15 (Pinsak and Meyer 1976).

Magee Marsh (41°37', 83°10'). In 1952, YOY were collected in a channel of the marsh in late July (Langlois 1954).

South Bass Island (41°39', 82°50'). Brown bullheads spawn at the mouth of Terwilliger Pond (41°39', 82°50'); males were observed guarding fry in this area (MacLean, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). In 1953-54, brown bullheads migrated into Sandusky Bay in the sprinq and spawned in the late spring and early summer. In the summer and fall, there was a return migration from Sandusky Bay into Lake Erie. Young-of-the-year (YOY) were found throughout most of Sandusky Bay, but were most abundant in protected waters with aquatic vegetation (Chapman 1955; Keller 1964a).

O-2

Old Woman Creek (41°23', 82°31'). The lower reaches of the creek contain excellent spawning habitat (FWS 1979d).

vermilion River (41°26', 82°22'). Brown bullheads migrate from Lake Erie into the river to spawn in July and August (U.S. Army Eng. Uist., Buffalo, 1976a).

Rocky River (41°30', 81°50'). A spawning migration enters the river in early May (Cleveland Environ. Res Group, undated), and fry and YOY have been found in the river (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, fry and YOY were collected in the lower Chagrin River and adjacent shorelines; this might be a spawning area (White et al. 1975).

O-3

Turkey Creek (41°58', 80°32'). Adults are found in the creek in April and May; these fish may have entered the creek from the lake (USACE, undated b).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Gravid females from a resident population were collected during April. Adults were also collected in the

Outer Bay area (42°09', 80°04') in June over a mud, silt, and muck bottom with limited vegetation, in less than 8 ft of moderately turbid water (Kenyon, pers. comm. 1979).

New York

Dunkirk Harbor (42°30', 79°20'). Adults in spawning condition were found here in late June (Greeley 1929).

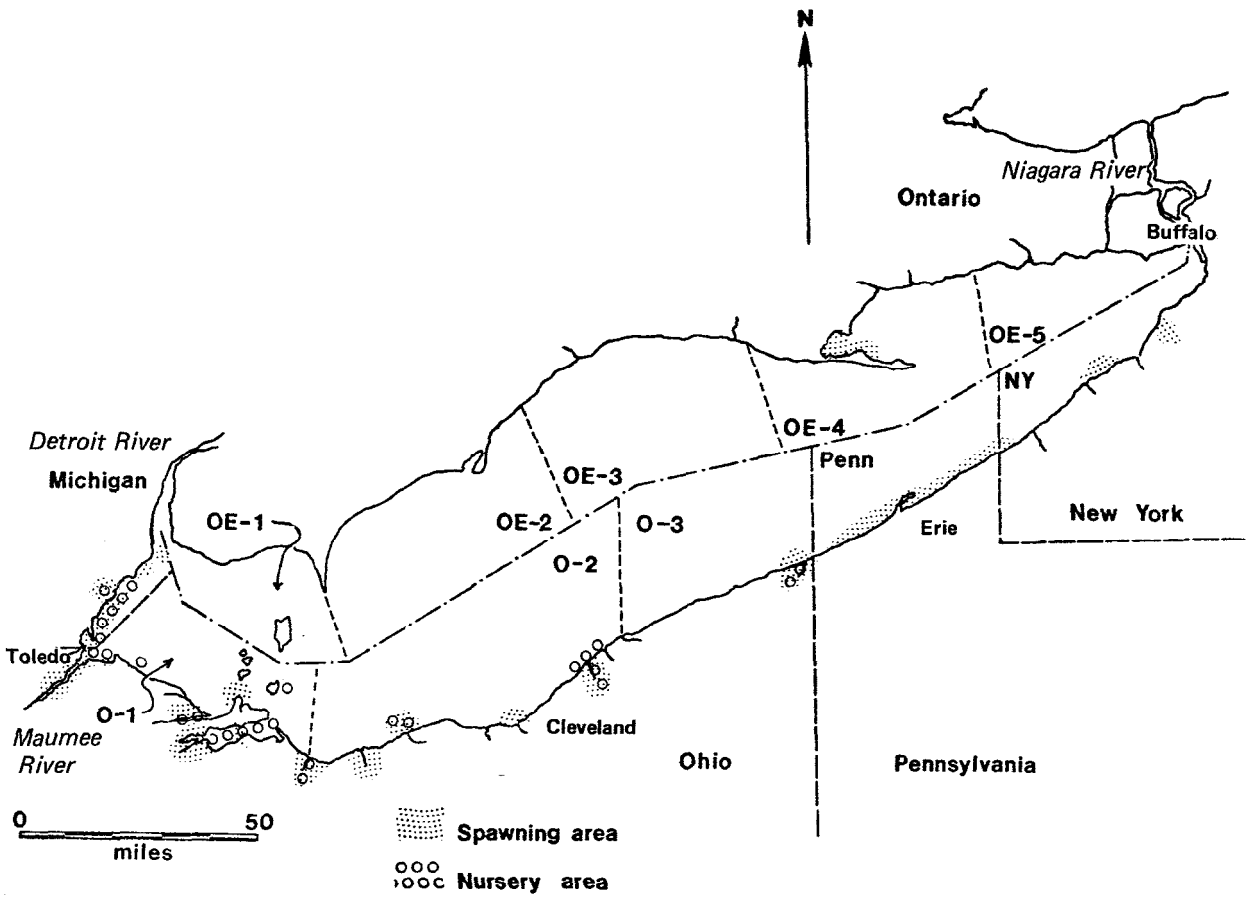
Big Sister Creek (42°40', 79°04'). Young-of-the-year were collected in July and August over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Brown bullheads historically spawned in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898). Both bay and lake residents move into the backwater marshes of Turkey Point (42°39', 80°21'), Big Creek (42°36', 80°27'), and the western part of Long Point, including Long Point Crown Marsh (42°35', 80°25'), in late May-early June to spawn (Reid 1978; Whillans, pers. comm. 1979); YOY have been found in these areas (Hamley and MacLean 1979; Whillans, pers. comm. 1979). Reproduction also appears to occur in the lagoons near the tip of Long Point (42°33', 80°05') (Mahon 1979).

CHANNEL CATFISH



Channel catfish enter Lake Erie tributaries to spawn. Young-of-the-year (YOY) apparently move downstream after hatching and take up residence in bays and nearshore areas of the lake (Barnes 1979); they are widely distributed along the south shore of the lake in up to 15 ft of water (Wolfert, pers. comm. 1979). Channel catfish are fairly abundant in the central basin of Lake Erie. Spawning is highly successful in. unpolluted water and on stone breakwalls; they also migrate up many tributaries to spawn ('White, pers. comm. 7979). Young-of-the-year are found at many sites in the nearshore waters of the western basin by July (Van Vooren and Davies 1974; Van Vooren, Davies, and Emond 1977).

Michigan

The entire shoreline from Brest Bay (41°55', 83°18') to North Cape (41°44′, 83°25') is a spawning and nursery area. Spawning occurs on shallow exposed rock and rubble in May and June (Wolfert, pers. comm. 1979). Young-of-the-year were more abundant near the Woodtick Peninsula (41°44′, 83°25') than farther north MDNR 1970-76). Several spawning sites have been identified:

Pointe Mouillee State Game Area (42°02', 83°12'). Since the 1950s, spawning has occurred in an area (42°02', 83°10') about 1 -1/2 mi east of the northern boundary of the game area (Organ et al. 1978).

Pointe Mouillee (42°01', 83°12'). In 1935-68, spawning occurred in an area (41°59', 83°13') south of Pointe Mouille over mud (Organ et al. 1978).

Brest Bay (41°55', 83°18'). Channel catfish spawn in the northern part of the bay over mud (at 41°56', 83°17') (Organ et al. 1978).

Raisin River (41°53', 83°20'). Spawning occurs in the marshy areas at the mouth of the river (Organ et al. 1978). Larvae and YOY are very abundant in the lower discharge canal at the Monroe Power Plant (41°53', 83°21') in May and June and are much more common in the discharge canal and in the Raisin River than in the surrounding lake waters (Cole 1976, 1978b; MacMillan 1976; Nelson 1975; Nelson and Cole 1975; Parkhurst 1971). Based on these collections, spawning and hatching were assumed to occur in the discharge canal (Cole 1976).

La Plaisance Bay (41°52', 83°22'). Spawning occurs in the marshy areas in the north part of the bay (Organ et al. 1978).

Muddy Creek (41°50', 83°25'). Channel catfish spawn in the marshy areas off the creek mouth and also at the dumping ground (41°48', 83°21') about 4 mi offshore (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Spawning occurs, on the lake shore just off the mouth of Whitewood Creek (41°48', 83°26') over vegetation, on the inside of the Peninsula off the Whiting Power Plant (41°47', 83°27'), and around Indian Island (41°45', 83°27') in areas of mud and vegetation (Organ et al. 1978).

Ohio

O-1

Maumee River (41°41', 83°28'). The river is a spawning'area (Barnes 1979; Pinsak and Meyer 1976). Channel catfish spawn from May 25 to July 20 in the bay in an area (41°44', 83°27') north of the river mouth and from the river mouth east along shore to Cedar Point (41°42', 83°20') (Pinsak and Meyer 1976). Young-of-the-year were collected throughout Maumee Bay (41°43', 83°25') in late July (USACE 1976c).

Metzger Marsh (41°39', 83°14'). YOY were captured just off the marsh in mid-July (Van Vooren and Davies 1974).

Portage River (41°31', 82°56'). Adults migrate from the deeper waters of the island region into the river to spawn (Reynolds, pers. comm. 1979). Newly hatched fry were collected in Four Mile Creek, a tributary of the Portage River located 15 mi upstream from Lake Erie, in early July (Lanqlois 1954).

Scott Point (41°35', 82°50'). Spawning occurs on shallow, exposed rock and rubble during May and June (Wolfert, pers. comm. 1979).

Kelleys Island (41°36', 82°42'). In 1951, YOY 2 in. long were collected east of Kelleys Island just above the bottom in 58 ft of water in August. Young appeared to have moved from shallower water to feed in the deeper area (Langlois 1954).

Sandusky Bay (41°29', 82°46'). A major spawning run enters Sandusky Bay and proceeds up the Sandusky River (41°27', 82°59') in the spring (Chapman 1954a, 1955; FWS 1979d; Langlois 1954; Reynolds, pers. comm. 1979). Spawning occurs in May and June in areas with strong current, including the riprap of the Bay Bridge off Martin Point (41°28', 82°50'), the railroad bridge (41°29', 82°49'), and where streams enter the bay (Wolfert, pers. comm. 1979). During 7953-54, a spawning run entered the bay in the spring, and a return migration to the lake occurred in the fall (Chapman 1955). Sandusky Bay is also a nursery area (Wolfert, per-s. comm. 1979). Young-of-the-year were found throughout the bay in May-October but were most abundant in protected waters with aquatic vegetation (Chapman 1955; Keller 1964a; Ianglois 1954). In 1953, newly hatched larvae were found in Muddy Creek, a tributary of the Sandusky River, on July 15 (Langlois 1954). The young evidently move out of rocky areas onto mud bottom (Wolfert, pers. comm. 1979).

O-2

Huron River (41°24', 82°33'). This is a major spawning area. Channel catfish migrate upstream to a backwater area where they spawn on the stone breakwall, and on sandy, gravelly shallows (White, pers. comm. 1979). Fry were found in the lower river and at the river mouth; these may have originated from spawning that occurred in the river or the lake (Cleveland Environ. Res. Group, undated).

vermilion River (41°26', 82°22'). Channel catfish migrate into the river to spawn in July and August (U.S. Army Eng. Dist., Buffalo, 1976a).

Lorain Harbor (41°28', 82°11'). Spawning occurs on the breakwalls (Odin 1979), and larvae were found in the harbor (Geo-Marine 1978).

Cleveland Harbor (41°31', 81°42'). A major spawning area exists just inside the west marina (Odin 1979).

Chagrin River (41°41', 81°26'). Major spawning occurs in the lower 3/4 mi of the river, which has numerous islands, deadfall, and crevices. During 1972-74, YOY or fry were collected in the lower river and adjacent shoreline areas of the lake (White et al. 1975; White, pers. comm. 1979). In July, many larvae were found at the mouth and farther upstream; later they were found at the mouth and beach areas of the lake (Environ. Resour. Assoc. 1978).

O-3

Conneaut (41°58', 80°33'). Channel catfish enter the Conneaut River (41°58', 80°33'). In 1977, larvae were collected in the lower river

during July and August (Aquat. Ecol. Assoc. 1978c). Spawning also occurs in Cladophora beds and sandy areas along the east breakwall of Conneaut Harbor (41°58′, 80°33′) (Odin 1979).

Pennsylvania

Channel catfish spawn all along the rocky Pennsylvania shoreline in water less than 42 ft deep. Adults may also migrate into tributaries to spawn (Kenyon, pers. comm. 1979).

New York

Spawning occurs along the New York shore in creeks or near creek mouths in early summer, and young are also found in these areas (Greeley 1929).

Sister Creek (42°40', 79°04'). Spawning females were found on clay banks at the creek mouth in early July (Greeley 1929).

Silver Creek (42°33', 79°10'). A fry about 2 in. long was found at the creek mouth in late August (Greeley 1929).

Dunkirk (42°29', 79°20'). Ripe females were collected in late June near Dunkirk (Greeley 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10′). Channel catfish spawn in the marshy areas of Inner Bay (42°37', 80°22'). Major spawning areas within the Inner Bay are Long Point Marsh (42°35', 80°17′), Little Rice Bay (42°35′, 80°21′), Turkey Point Marsh (42°39', 80°21'), and the shallows off Turkey Point (42°39', 80°21′) (Kerr and Kerr 1860-1898; Whillans 1977, pers. comm. 1979).

BULLHEAD spp.

Michigan

The following areas are spawning sites for unidentified species of bullheads (Organ et al. 1978):

Swan Creek (41°58′, 83°15′). In 1921-46, bullheads spawned over mud at the creek mouth in less than 8 ft of water.

Brest Bay (41°55', 83°18'). Until 1956, bullheads spawned over mud in an area (41°56', 83°17') in northern Brest Bay, from shore to the 16-ft depth contour.

Sterling State Park (41°55', 83°20'). Since 1911, bullheads have spawned along shore over rock and gravel.

Raisin River (41°53', 83°20'). Since 1911, bullheads have spawned at the river mouth over vegetation.

Plum Creek (41°54', 83°23'). Since 1950, bullheads have spawned among aquatic vegetation over mud and sand bottom at the mouth of the creek and along the adjacent shoreline.

Woodchuck Creek (41°51', 83°24')--La Plaisance Creek (41°52', 83°23'). Bullheads spawn here close to shore over gravel substrate.

Otter Creek (41°51', 83°24'). Bullheads spawn over mud in the embayment at the creek mouth (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Spawning occurs in muddy areas 1-8 ft deep, both inside (41°46', 83°27') and on the lake side (41°46', 83°26') of the peninsula.

Indian Island (41°45', 83°27'). Since 1911, bullheads have spawned here over mud and gravel in water 1-2 ft deep.

Ohio

O-1

Sandusky Bay (41°29', 82°46'). Bullheads spawn successfully in the bay in large numbers (FWS 1979d).

O-2

vermilion River (41°26', 82°22'). Bullheads enter the river to spawn in July and August (U.S. Army Eng., Buffalo Dist. 1976a).

Cleveland Harbor (41°31', 81°42'). A major spawning area exists just inside the west marina (Odin 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Ripe adults were collected in the shallows and lagoons of the north and west shores of the bay, including Thompson Bay (42°10', 80°05') and Horseshoe Pond (42°10', 80°05'); these are probably spawning areas (Larsen, pers. comm. 1979).

STONECAT

In Lake Erie, stonecats spawn from early June to late August; spawning peaks in the last 2 weeks of June (Gilbert 1953). Adults caught in mid-June had large eggs (Scott 1967). Eggs are deposited under stones, submerged boards, and other flat objects. Both parents guard the eggs and young. The incubation period is 2 weeks, and hatching begins in mid-June (Gilbert 1953).

Ohio

O-1

Portage River (41°31', 82°56'). In 1952 and 1953, young-of-the-year (YOY) were collected from the undersides of flat stones on the riffles in late June and July. Spawning occurred on the lowermost riffles. Adults may enter the river from Lake Erie to spawn; YOY may migrate downstream to the lake (Langlois 1954).

south Bass Island (41°39', 82°50'). Stonecats spawn on the bouldery shoals of Put-In-Bay (41°39', 82°49') in early June. Egg masses were found under rocks on these shoals. In 1947, gravid females were collected on Peach Point reef (41°40', 82°50') off northern South Bass Island on June 27 (Langlois 1954).

O-2

Huron River (41°24′, 82°33′). Spawning occurs in the lowermost riffles of the river (Langlois 1954).

O-3

Conneaut (41°58', 80°33'). In 1977, larvae were collected near shore just east of Conneaut Harbor during August (Aquat. Ecol. Assoc. 1978c).

Turkey Creek (41°58', 80°32'). In 1977, larvae were collected at the mouth of the creek on July 13 (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

The entire shoreline of Pennsylvania at depths of 42 ft or less is a major spawning area for a resident population of stonecats. During June, gravid females were observed over rock and gravel bottom with no vegetation (Kenyon, pers. comm. 1979).

New York

Sister Creek (42°40', 79°04'). Stonecat egg masses were observed under flat stones in the lower creek on July 13 at a water temperature of 82°F. The eggs were being guarded by adults (Greeley 1929).

TADPOLE MADTOM

Ohio

O-1

Spawning occurs in bays, along shore, and in low gradient streams in the western basin of Lake Erie over muddy bottom (Trautman 1948).

Ontario

OE-4

Long Point (42°33', 80°10′). Reproducing populations are probably established in the lagoons on Long Point (Mahon 1977, 1979). In 1975, ripe females were found here in late May and early August. Spawning probably did not occur until August; no young-of-the-year (YOY) were found in August but they would have been too small to have been collected at that time (Mahon 1977, pers. comm. 1979). In 1977, a few YOY were found in Long Point Crown Marsh (42°35', 80°25') at the base of Long Point (Reid 1978).

BRINDLED MADTOM

Ohio

O-1

Spawning occurs on rocky reefs (Langlois 1954), in bays, along shore, and in low gradient streams over a clean bottom (Trautman 1948).

South Bass Island (41°39', 82°50'). Prior to 1955, egg masses were observed under boulders on the beaches of South Bass Island (Trautman, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10′). Spawning evidently occurs at Long Point; one young-of-the-year was found in Long Point Crown Marsh (42°35', 80°25') (Reid 1978).

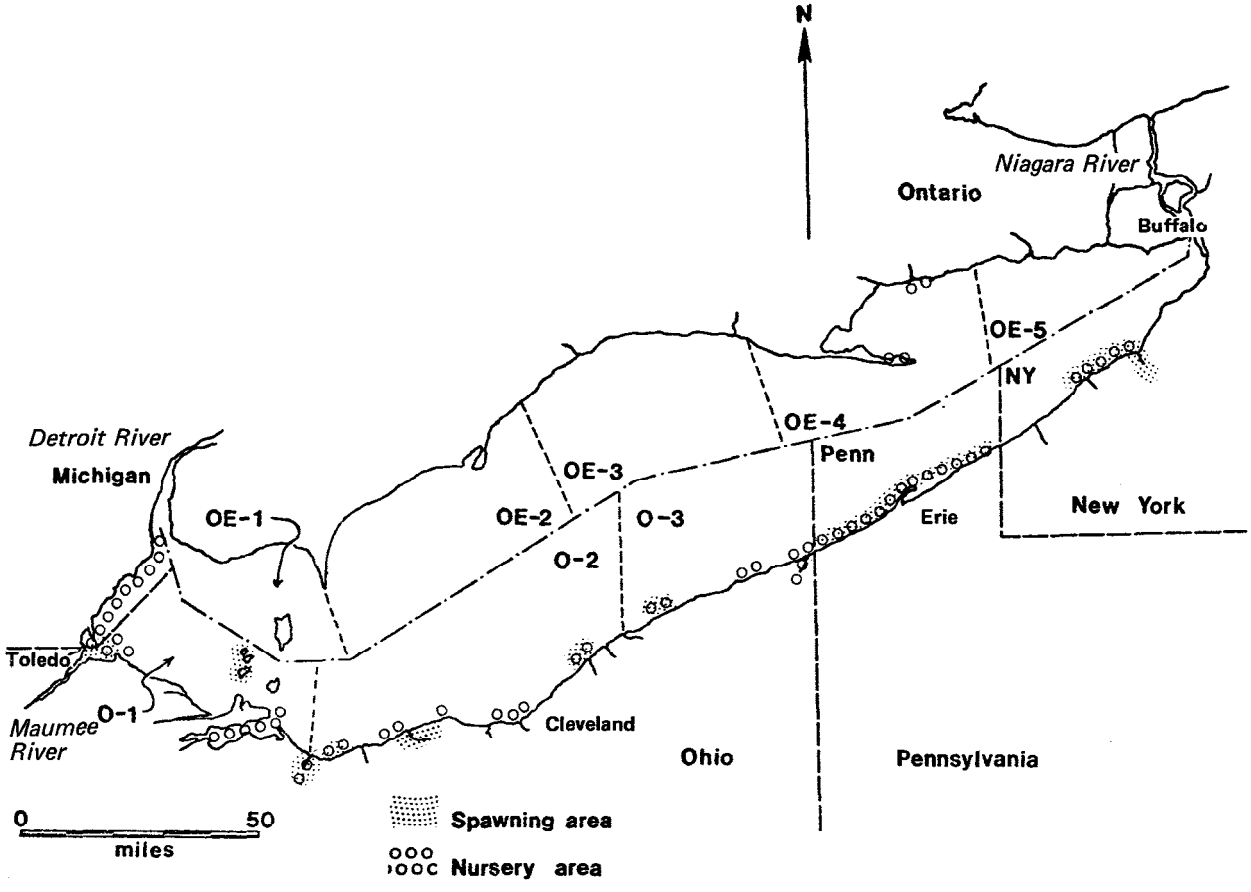
FLATHEAD CATFISH

Ohio

O-2

Old Woman Creek (41°23', 82°31'). The mouth of the creek contains excellent spawning habitat (FWS 1979d).

vermilion River (41°26', 82°22'). Flathead catfish migrate from Lake Erie into the river to spawn in July and August (Teater 1976; U.S. Army Eng. Dist., Ruffalo, 1976a).



In Lake Erie, trout-perch spawn over pebbly beaches near river mouths (Environ. Resour. Assoc. 1978; White, pers. comm. 1979). Spawning may occur from June to late July (Scott 1967). In northern Ohio, adults are ripe in the latter part of April or early May and spawn usually from late spring to August (Fish 1932; McCormick 1892; White, pers. comm. 1979). In the eastern basin, trout-perch came inshore in large numbers and often ascended creeks from late June to mid-July (Greeley 1929). In western Lake Erie trout-perch spawn over sand and gravel shallows, inshore and in tributary streams. Spawning usually occurs from May to August and peaks in mid- to late June (Fish 1932; Kinney 1950; Langlois 1954; Scott 1967; Trautman 1957). The major hatching period is June 1-15 at approximately 68°F (Comm. Fish. Rev. 1961a). Young-of-the-year were collected in western Lake Erie in June and July (Baker 1966b).

Michigan

Detroit River (42°03', 83°08')--La Plaisance Bay (41°52', 83°22'). In 1966, young were abundant in the area from the mouth of the Detroit

River to La Plaisance Bay (Baker 1967a). Young-of-the-year (YOY) were present in this area, and were most abundant off Sterling State Park (41°55', 83°20') in August 1972 (MDNR 1970-76). In 1975 and 1976, larvae were entrained at the Monroe Power Plant (41°53', 83°21') (Detroit Edison 1976h).

Muddy Creek (41°50', 83°25'). In the late 1970s, larvae were collected off the creek mouth (Wapora 1979b); in 1953, fry were collected here in mid-July (Langlois 1954).

Woodtick Peninsula (41°44', 83°25'). In the late 1970s, larvae were abundant near the Whiting Power Plant (41°47', 83°27') (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). In 1975, ripe or gravid adults were collected in May, and a few YOY were collected in late July (USACE 1976c). From 1960 to 1964, the fry were most abundant in Ohio waters in the southwest corner of the basin near Maumee Bay (Baker 1965).

Bass Islands (41°41', 82°49'). Spawning was observed in quiet water with very little current, primarily near the surface or well above the substrate in about 12 ft of water (Trautman, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). In 1961-63, YOY were abundant in the western part of the bay (Keller 1964a). In 1965, they were also collected in the bay and in nearshore areas east of the bay in June-late July; in 1966, they were present in all parts of the bay in August (Baker 1966b, 1967a).

O-2

Huron River (41°24', 82°33'). Trout-perch enter the river in April, and YOY are found in the river later in the summer (Rawson, pers. comm. 1979).

Erie Power Plant (41°23', 82°30'). In 1974, trout-perch larvae were taken in May-July at the plant; one egg was also collected (Ohio Edison 1977).

Beaver Creek (41°26', 82°15'). Historically, trout-perch were common in the creek; adults with well-developed gonads were collected in the creek in late April (McCormick 1892). In 1979, sampling to the 36-ft depth contour off the mouth of the creek yielded eggs from mid-April to late May, prolarvae from late May to mid-July, and postlarvae from late May to mid-August; juveniles and YOY were also captured there (Commonw. Assoc. 1979).

Black River (41°28', 82°11'). Historically, trout-perch were common in the river; adults with well-developed gonads were collected in the river in late April (McCormick 1892). In 1977, small numbers of larvae were collected in Lorain Harbor (41°28', 82°11') (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1977-78, trout-perch larvae were entrained at the plant and collected in the lake from April to June (Applied Biology 1979c).

Cleveland Harbor (41°31', 81°42'). In 1972-74, small numbers of YOY were collected in the harbor; the harbor may be a spawning area (White et al. 1975). Large numbers of larvae were collected on the beaches both east and west of the harbor (White, pers. comm. 1979). In 1977-78, larvae were entrained at the Lakeshore Power Plant (41°32', 81°38') in May-July; 14% of the larvae entrained throughout the year and 38% of the larvae entrained in the spring were trout-perch (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). Trout-perch spawn near the mouth of the river (Environ. Resour. Assoc. 1978; White, pers. comm. 1979). Gravid and spent adults were found at the river mouth and along the beach; no larvae were found in the river. Peak production of larvae was in mid-May (Environ. Resour. Assoc. 1978). In 1977-78, 15% of the larvae collected near the Eastlake Power Plant from mid-April to late June were trout-perch (Applied Biology 1979b).

Perry Power Plant (41°48', 81°09'). In 1974, eggs, prolarvae and postlarvae were collected in the vicinity of the plant, indicating that trout-perch spawned in the area. Trout-perch eggs were 40% of the eggs collected in mid-May. Prolarvae were present in May and June (NUS 1975).

Ashtabula (41°55', 80°47'). In 1977-78, larvae were entrained at the Ashtabula power plants (41°55', 80°46') in the spring (Applied Biology 1979e).

Conneaut (41°58', 80°33'). In 1977, trout-perch larvae were collected between Conneaut and Raccoon Creek (41°59', 80°29') in June and July. Larvae were abundant nearshore in mid-June and offshore in mid- and late June. The larvae were most abundant inshore near the hatching grounds. Larvae were collected in the Conneaut River (41°58', 80°33') on May 10 and in Conneaut Harbor (41°58', 80°33') in June (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

The entire offshore area is a major spawning area for a resident population of trout-perch. There may be a slight inshore movement associated with spawning. Spawning occurs inside the 54-ft depth contour over clean mud or gravel-rubble substrates. Gravid females are generally present in June. Fry are present inside the 36-ft depth contour in August and inside the 60-ft depth contour in November (Kenyon, pers. comm. 1979).

New York

Van Buren Bay (42°27', 79°25'). Running ripe adults were found. Trout-perch eggs were found during late April to mid-June and made up 21% of all eggs collected. Prolarvae were found in May-July and postlarvae in June and July, indicating that spawning occurs through June (Envirosphere 1977a; Tex. Instrum. 1977a).

Dunkirk Harbor (42°30', 79°20'). Trout-perch eggs were found throughout the harbor (NMPC 1976, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d) and were entrained at the Dunkirk Steam Station (42°30', 79°21') from April to June (Tex. Instrum. 1977e). Prolarvae were found in the harbor from May to August and pstlarvae in June and July (Tex. Instrum. 1977d). Prolarvae were entrained at the Dunkirk Steam Station in late May to mid-July and postlarvae in June to mid-July (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14'). Running ripe adults were found in the bay (Tex. Instrum. 1977a). Trout-perch eggs were found in late April to mid-June and made up 56% of all eggs collected at Eagle Bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a). Prolarvae were found from late May to mid-July and postlarvae in June and July, indicating that spawning occurs through June (Envirospnere 1977a,b; lJ.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). Adults in spawning condition were seen in the creek, and one egg was collected from gravel riffles in early July (Greeley 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Trout-perch are believed to spawn in Long Pond on Long Point (42°33', 80°05') based on the presence of numerous YOY (Mahon and Balon 1977a). In 1974, a few YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in early June and early July (Teleki 1976).

BURBOT

Historical reports indicate that burbot were full of spawn from November to mid-March, and that the hatching period extended from early summer until late June. More recent information indicates that spawning may begin in early fall (Kenyon, pers. comm. 1979) in some areas and extend into early May (White, pers. comm. 1979) in others. In 1928-29, larvae about 0.1-0.6 in. long were commonly collected in water up to about

200 ft deep throughout the central and eastern basins from June to August (Fish 1929, 1930, 1932). Fishermen indicated that spawning occurred in March and no later than April 15. Ripe and spent females were caught during the spawning period in open water 9 mi from shore and 60-66 ft deep. Fishermen reported there were both deep- and shallow-water spawners (Clemens 1951). Burbot historically spawned in open water (Greeley 1929). Burhot presently move to shallow areas to spawn (White et al. 1975).

Michigan

Fermi Power Plant (41°57', 83°15'). Burbot eggs were entrained at the plant in February and March (Detroit Edison 1976g); small numbers of burbot larvae were collected in the vicinity of the plant (Detroit Edison 1978).

Monroe (41°55', 83°24'). In 1975, burbot eggs were entrained at the Monroe Power Plant (41°53', 83°21') in early February (Detroit Edison 1976h).

Ohio

O-1

Portage River (41°31', 82°56'). Historically, burbot probably entered the Portage River to spawn; by 1965 runs no longer occurred (Langlois 1965).

Bass Islands (41°41', 82°49'). Ripe females were collected under the ice in an area between South Bass (41°39', 82°50') and Rattlesnake (41°41', 82°51') islands in January and February (Kinney 1954; Langlois 1954).

O-2

Chagrin River (41°41', 81°26'). Burbot run into water 20-40 ft deep near the river mouth to spawn in May (White, pers. comm. 1979).

O-3

Ashtabula (41'-°55', 80°47'). Spawning occurs in late April-early May at water temperatures of about 46-50°F in 20-40 ft of water; adults and larvae were collected here (White, pers. comm. 1979). In 1929, moderate numbers of larvae about 0.2-0.5 in. long were found at 42°00', 80°55' and 42°20', 81°05' northwest of Ashtabula (Fish 1930).

Conneaut (41°58', 80°33'). Spawning occurs in late April-early May at water temperatures of about 46-50°F in 20-40 ft of water; adults and larvae were collected here (White, pers. comm. 1979).

Pennsylvania

Northwest Sand Bar (42°19′, 80°20′). Burbot spawn in late fall on this sand bar, which is about 18 mi offshore, and is bounded approximately by latitudes 42°10' and 42°20' and longitudes 80°15' and 80°20'; water depth on the sand bar averages 60 ft (Kenyon, pers. comm. 1979). In 1928, fairly high concentrations of burbot larvae about 0.2-0.5 in. long were found in an area extending northward past the west side of the sand bar toward the base of Long Point (42°32', 80°25') and then westward to the mouth of Clear Creek, Ontario (42°34', 80°35') (Fish 1930).

McCord's Point (42°14′, 79°52′). The Pennsylvania Fish Commission classifies this area as a minor burbot spawning area, based on the collection of one gravid female here in the fall. The bottom is broken shale and rock, the water depth is about 36 ft, and the current is onshore and moderate to light. It is assumed that burbot spawn on rocks along the shore (Kenyon, pers. comm. 1979).

Eighteen Mile Creek (42°15′, 79°48′). Fair numbers of larvae about 0.2-0.5 in. long were found off the creek mouth at 42°20', 79°50' (Fish 1930).

New York

Westfield (42°19', 79°35'). Fair numbers of larvae about 0.2-0.5 in. long were found near shore in an area (42°22', 79°32') east of Westfield (Fish 1930).

Van Buren Bay (42°27', 79°25'). A few eggs were collected here in late April and early May. Prolarvae were found in late April-June (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). Larvae, including prolarvae, were entrained at the Dunkirk Steam Station (42°30', 79°21') and were present in Dunkirk Harbor in May and June (Tex. Instrum. 1977d,e).

Eagle Bay (42°32', 79°14'). In 1975, a few eggs were collected in April and early Nay. Prolarvae were collected in May and a few postlarvae were taken in June (Envirosphere 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). In 1929, fair numbers of larvae about 0.2-0.5 in. long were collected off the creek mouth (Fish 1930).

Eighteenmile Creek (42°43', 78°58′). In 1929, fair numbers of larvae about 0.2-0.5 in. long were found near the mouth of the creek (Fish 1932).

Seneca Shoal (42°47', 78°55'). In 1929, fair numbers of larvae about 0.2-0.5 in. long were found near the shoal (Fish 1932).

Ontario

OE-2

Pointe aux Pins (42°15', 81°52'). In 1929, moderate numbers of larvae about 0.2-0.5 in. long were collected at a location (42°10', 81°55') about 4 mi S of the point and at a location (42°00', 82°00') about 20 mi SW of the point (Fish 1930).

OE-3

Port Stanley (42°39', 81°13'). In 1947, running-ripe males and spent females were found 9 mi off Port Stanley to depths of 60-66 ft during mid-March to early April (Clemens 1951). In 1929, moderate numbers of larvae about 0.2-0.5 in. long were found at 42°30', 81°10', about 12 mi S of Port Stanley (Fish 1930).

OE-4

Clear Creek (42°34', 80°35'). In 1928, fairly high concentrations of larvae about 0.2-0.5 in. long were found from Clear Creek east toward the base of Long Point (42°32', 80°25') and then south to the Northwest Sand Bar (42°19', 80°20') (Fish 1930).

Long Point Bay (42°40', 80°10'). In 1928, the largest concentration of burbot larvae occurred in the 105-115 ft deep hole (at approximately 42°31', 79°58') off the tip of Long Point. Larvae were also found off Port Ryerse (42°45', 80°15') and Port Dover (42°47', 80°12') at depths of 99-132 ft (Fish 1932). In 1947, spent females were found off Port Dover in late March to mid-April (Clemens 1951).

OE-5

LOW Point (42°50', 79°40'). Fair numbers of larvae about 0.2-0.5 in. long were found offshore in an area (42°35', 79°40') about 17 mi S of Low Point (Fish 1930).

Point Abino (42°50', 79°06'). In 1929, fair numbers of larvae about 0.2-0.5 in. long were found off the point (Fish 1932).

BANDED KILLIFISH

The banded killifish spawns in localized areas of Lake Erie in June (Fish 1932), usually in sheltered locations, including bays and creek mouths (Greeley 1929).

Ohio

O-3

Ashtabula (41°55', 80°47'). The banded killifish spawns on a sand bar at the mouth of Ashtabula Harbor (White, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10'). Reproducing populations are probably established in some of the lagoons on Long Point. Young-of-the-year (YOY) were numerous in one of the lagoons (Mahon 1979; Mahon and Balon 1979a), and a few were found in Long Point Crown Marsh (42°35', 80°25') at the base of the point (Reid 1978).

OE-5

Crescent Beach (possibly Crescent Park, 42°53', 78°58'). In 1929, YOY were found here in 3 ft of water at Crescent Reach in late June (Fish 1932).

BROOK SILVERSIDE

Michigan

Swan Creek (41°58', 83°15'). In 1975, larvae were collected in small numbers along the beach in an area (41°59', 83°14') just north of the creek in mid- to late June (Waybrant and Shauver 1979).

Ohio

O-1

West Harbor (41°34', 82°49'). In 1919, fry were collected along a flat, sandy beach with no vegetation (Turner 1920a).

Starve Island (41°38', 82°49'). A few fry were collected around the shores of the island, which had precipitous, jagged limestone walls and rock masses and no vegetation. Ballast Island (41°41', 82°47'). Fry were found along the southwest shore over a steep gravel and rubble beach with little vegetation. South Bass Island (41°39', 82°50'). Fry were collected along beaches on the southern shore of Squaw Harbor (41°39', 82°49') in 1-4 ft of water over fine sand, mud, and gravel with spike rushes and other vegetation; they were exceedingly abundant in an area (41°39') 82°47') on the northeast shore on a rock and gravel beach with no

vegetation. Middle Bass Island (41°41', 82°49'). Fry were found on the north shore (at 41°42', 82°48') and on the west point (at 41 °41', 82°50') along shallow gravel and stone beaches with a few boulders, and submergent vegetation within 4 ft of shore (Turner 1920a).

Sandusky Bay (41°29', 82°46'). In 1961, a few young-of-the-year (YOY) were collected in the western part of the bay from May to October (Keller 1964a).

O-2

Lorain Harbor (41°28', 82°11'). In 1977, a few larvae were collected in the harbor (Geo-Marine 1978).

Chagrin River (41°41', 81°26') and Cleveland Harbor (41°31', 81°42'). In 1972-74, fry or YOY were collected in these areas which may be spawning areas (White et al. 1975).

O-3

Conneaut Harbor (41°58', 80°33'). In 1977, fry were collected at the surface in mid-August (Aguat. Ecol. Assoc. 1977).

Ontario

OE-1

Holiday Beach (42°01', 83°02'). In 1975, large numbers of YOY were collected with seines here in July (Paine 1976).

Colchester (41°59', 82°56') and Cedar Beach (42°01', 82°47'). In 1975, YOY were collected along the beach in July (Paine 1976).

OE-4

Long Point (42°33', 80°10'). Reproducing populations are probably established in the larger lagoons of Long Point (Mahon 1979). A few YOY were found in Long Point Crown Marsh (42°35', 80°25') at the base of the point, where spawning was believed to occur in mid-late April (Reid 1978).

BROOK STICKLEBACK

Ohio

O-2

Rocky River (41°30', 81°50'). The river may be a spawning area; young-of-the-year were collected here (White et al. 1975).

WHITE PERCH

The first reported capture of white perch in Lake Erie occurred in 1953 near Erie, Pennsylvania. How this species entered Lake Erie is unknown (Larsen, pers. comm. 1981).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1976, prolarvae were collected in small numbers near the plant in early July (Detroit Edison 1978).

Monroe (41°55', 83°24'). An area (at 41°52', 83°20') off Plum Creek (41°54', 83°23') is a nursery ground for young-of-the-year (YOY) white perch; they are found here from about mid-May to October over sand, clay, and gravel, at a water depth of about 10 ft (Rawson, pers. comm. 1979).

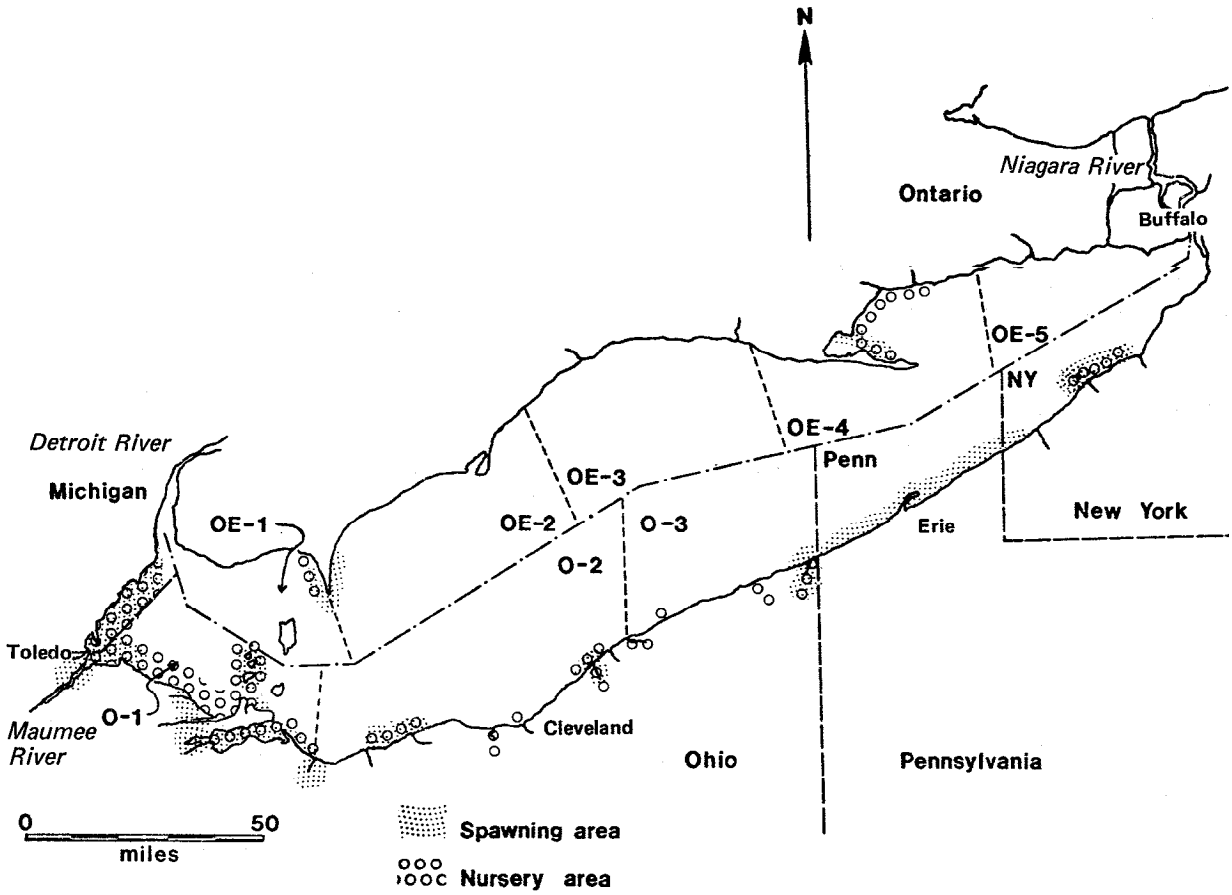
Ohio

O-1

Maumee Bay (41°43', 83°25'). A major spawning area for white perch exists off the north shore of Cedar Point (41°42', 83°20') in 1-6 ft of water (Reynolds, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). In 1978, YOY were collected at the mouth of the bay at 41°29', 82°43', over a sand bottom in 4-6 ft of water (Wolfert, pers. comm. 1979).

WHITE BASS



In the western basin of Lake Erie, white bass migrate into the tributaries along the south shore, and proceed upstream as far as the first riffle, to spawn in late April and May (Rawson, pers. comm. 1979). White bass also spawn on rocky reefs and shoals and along shore where there is a current in 10-20 ft of water (FWS 197911; Riggs 1952; Van Vooren and Davies 1974; Wolfert, pers. comm. 1979). Peak spawning occurs at a water temperature of approximately 55°F (Wolfert, pers. comm. 1979). In 1960, most hatching occurred during July 1-15 at an average water temperature of 75°F (Comm. Fish. Rev. 1961a). In 1929, white bass larvae were abundant in the western part of the lake (Fish 1932). Larvae are most abundant in bays. They are probably carried downstream from the rivers, which are the primary spawning areas, into the bays, which serve as nursery grounds (Heniken 1977; Reutter et al. 1978). Young-of-the-year (YOY) first appear in June (Baker 1966b; Baker and Scholl 1971c; Barnes and Reutter 1979; Van Vooren and Davies 1974; Van Vooren et al. 1974).

In the 1960s and 1970s, YOY were often more abundant in the central basin than in the western basin (Anderson 1966; Baker 1966c; Baker and Bower 1964, 1965; Baker and Scholl 1970, 1972; Parker 1964; Rudolph and Scholl 1969; Seward 1967, 1968; Van Vooren and Davies 1974; Van Vooren et

al. 1977). White bass probably enter all of the rivers of the central basin to spawn (USBCF 1966; USDI 1967; White, pers. comm. 1979). No larvae less than about 0.5 in. long were found in the rivers; larvae 0.5-1.0 in. long are present in the lake, on the beaches, and in the harbors (White, pers. comm. 1979). Spawning may also occur in the open lake (Applegate and Van Meter 1970; USBCF 1966; USDI 1967). Tagging studies conducted along the Ohio shoreline have shown that adults migrate out into the lake after spawning in shallow water; some of these adults enter Canadian waters (Greeley 1955).

Michigan

Since 1925, spawning has occurred over rock substrate all along shore from Swan Creek (41°58', 83°15') south to Turtle Island (41°45', 83°23') at depths of about 12-18 ft (Organ et al. 1978). Areas reported to support spawning are:

Swan Creek (41°58', 83°15'). White bass are reported to spawn over mud just off the creek mouth and south to Point aux Peaux (41°57', 83°15'). In 1935-68, spawning also occurred in an area (41°58', 83°10') about 4 mi off the creek mouth over rock and clay in 9-12 ft of water (Organ et al. 1978). In 1976, prolarvae were collected near the Fermi Power Plant (41°57', 83°15') in late May and early June.

Brest Bay (41°55', 83°18')--Raisin River (41°53', 83°20'). White bass spawn in this area to a depth of about 18 ft (Organ et al. 1978); spawning may also occur on the rip-rap in the discharge canal of the Monroe Power Plant (41°53', 83°21') (Cole 1976, 1978b; Parkhurst 1971). Adults are located offshore prior to spawning; they enter the discharge canal on spawning runs. Ripe and spent fish have been collected in the canal (Cole 1976; Lavis 1976; MacMillan 1976; Nelson 1975; Nelson and Cole 1975). White bass larvae are one of the most common larvae in the area; large numbers of white bass larvae were collected in the vicinity of the plant and entrained at the plant from mid-May to late July or August (Cole 1976; Detroit Edison 1976h; MacMillan 1976; Nelson 1975; Nelson and Cole 1975) 1 Larvae are abundant in the discharge canal; they tend to appear in the discharge before they appear at the plant intake (Cole 1976, 1978b).

An area off Monroe (at approximately 41°52', 83°20') in 6-10 ft of water with bottom of sand, hard clay, and gravel, is a nursery area (Rawson, pers. comm. 1979). In most years YOY white bass are most abundant in the Michigan waters of Lake Erie off Monroe (MDNR 1970-76). In 1970, moderately large numbers of YOY were collected near Monroe. After July 22, 95% of the white bass collected were YOY; they were most abundant off Sterling State Park (41°55', 83°20') over a muck and sand bottom in 6-10 ft of water (Parkhurst 1971). Abundance of YOY near Monroe, however, is low relative to that observed in June-September in other areas, such as Sandusky Bay (41°29', 82°46') and Catawba Island (41°35', 82°51') (Baker 1967a, 1967c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970; Van Vooren

et al. 1977). The Monroe area could be a very important nursery area for young white bass because dense concentrations of larvae enter this area from the Detroit River (42°03', 83°08') (Cole 1978b; MacMillan 1976).

La Plaisance Bay (41°52', 83°22'). White bass spawn along the shore from La Plaisance Bay to the Woodtick Peninsula (41°44', 83°25') out to about the 18 ft contour over rock and gravel (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Since the 1920s, spawning has occurred along the entire shore of the peninsula over gravel and rock to depths of about 15 ft; since 1911, spawning has also occurred around Turtle Island (41°45', 83°23') and over sand and mud west of North Cape, on the Michigan-Ohio border (at 41°44', 83°26') (Organ et al. 1978). In 1975, white bass larvae were most abundant in the southern portion of the Michigan waters of the lake. Highest abundance was found in 6-12 ft of water off the Woodtick Peninsula, at 41°47', 83°26' and 41°46', 83°25' (Waybrant and Shauver 1979). In 1978, larvae were entrained at the Whiting Power Plant (41°47', 83°27') and collected from North Maumee Bay; peak abundance occurred in June (Wapora 1976b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Spawning migrations of white bass enter the bay and the Maumee River (41°41', 83°28'). Downstream migrations of larvae occur as the yolk sac is being absorbed (CLEAR 1977; Fraleigh and Tramer 1974; Herdendorf and Cooper 1976; Ohio DNR 1976; Pinsak and Meyer 1976; Rawson, pers. comm. 1979; Reutter, Herdendorf and Sturm 1978a,b; Scholl 1977; Synder 1978; Wapora 1977b,c). In 1980, running-ripe adults were caught during the spawning run on the Perrysburg riffles on May 16 at a water temperature of 66°F (Goodyear, pers. comm. 1980). From July to December, large numbers of YOY are impinged at the Acme Power Station, 4 mi upstream from the river mouth; adults are also impinged when they migrate upstream to spawn (Reutter, Herdendorf and Sturm 1978a). The shallows around the island area in the upper Maumee River estuary, about 15 mi upstream from the lake, are important white bass spawning grounds; more spawning occurs here than in the riffle area farther upstream (Reutter, Herdendorf and Sturm 1978b; Herdendorf and Cooper 1976). Spawning was observed in the river above the bridge at Maumee in 18 in. of water over rock bottom (Langlois 1954). Maumee Bay may be a major spawning area (Cole 1978a), but there is disagreement on this subject (U.S. Army Eng. Dist., Detroit, 1976). Spawning is believed to occur on both sides of the shipping channel (from 41°43', 83°26' to 41°45', 83°23') and in the southern portion of the bay over a sandy, gravel substrate (41°43', 83°24') from May 12 to June 25 (Pinsak and Meyer 1976). The shoal off Cedar Point (41°42', 83°20') is a major spawning area; it has a sand bottom and water 1-6 ft deep (Reynolds, pers. comm. 1979). In 1966-72, YOY were abundant here from June to September (Baker 1967c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970). Maumee Bay is an important nursery area for

prolarvae. Larvae prefer quiet bottom areas of the bay with slow current and depths greater than 6 ft (Snyder 1978). In 1975-77, YOY were abundant in the bay from April to July; these fish were believed to have originated from spawning that occurred in the Maumee River (Herdendorf 1977; Herdendorf and Cooper 1975, 1976). In 1976, larvae were found in the bay from April 27 to June 8, and were most abundant in the mid- and lower reaches of the river during the first week in June (Reutter, Herdendorf and Sturm 1978a,b). In 1975 and 1977, larvae were most abundant at the mouth of the bay in late May to mid-June (Herdendorf et al. 1976; Patterson 1979a). The bay is an overwintering area for YOY (FWS 1979d).

Ward Canal (41°39', 83°14'). Large numbers of YOY were found here, especially in July and August (Ayers et al. 1970; Van Vooren et al. 1977, 1978).

Crane Creek (41°38', 83°12'). In 1966-68, YOY were collected at Crane Creek from June to August (Baker 1967a,c, 1969).

Locust Point (41°36', 83°05'). Young-of-the-year are abundant from June to September (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Reutter and Herdendorf 1975, 1977; Rudolph and Scholl 1970; USAEC 1973; USNRC 1975a,b).

Toussaint River (41°35', 83°04') and Portage River (41°31', 82°56'). A spawning run enters the river (Rawson, pers. comm. 1979).

Catawba Island (41°35', 82°51'). In 1966-72, YOY were collected in an area (41°34', 82°53') west of Catawba Island from July to September (Baker 1967a,c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1970; Rudolph and Scholl 1970).

West Harbor (41°34', 82°49'). In 1919, fry were collected in July on a flat sandy beach with no aquatic vegetation (Turner 1920a).

East Harbor (41°32', 82°47'). Large numbers of YOY were found inside and outside the harbor from June to September (Baker 1967a,c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970; Van Vooren et al. 1977, 1978).

Bass Islands (41°41', 82°49'). Spawning generally occurred around the islands in 1-5 ft of water over rocky, gravelly bottom (Trautman, pers. comm. 1979).

South Bass Island (41°39', 82°50'). In 1919, fry were collected at two sites along the eastern shore in July; one site (41°39', 82°49') had a steep sloping rubble beach with no vegetation except filamentous algae, and the other site (41°39', 82°48') was a shallow, sandy gravel beach with some submerged vegetation (Turner 1920a). Spawning occurs off Peach orchard Point over bedrock limestone, large boulders, big rock, and aggregate gravel, from shore out to the 10 ft contour (MacLean, pers. comm. 1979).

Middle Bass Island (41°41', 82°49'). In 1919, fry were collected in July on the north shore (41°42', 82°48') on a shallow -gravel beach with a few boulders and some submergent vegetation. Lost Island (41°41', 82°47'). Fry were collected in July on a steep gravel beach with some pond weed. Ballast Island (41°41', 82°47'). Fry were collected in July over steep, gravel and rubble bottom with aquatic vegetation (Turner 1920a).

West Reef (West Island Shoal, 41°43', 82°51'). In 1973 and 1974, adults were collected from spawning concentrations on West Reef (Van Vooren and Davies 1974; Van Vooren et al. 1975).

Sandusky Bay (41°29', 82°46'). White bass migrate into Sandusky Bay in the spring; catches increase in mid-April, and spawning occurs in April-June. A return migration to Lake Erie occurs in the fall (CLEAR 1977; Cleveland Environ. Res. Group, undated; Chapman 1954a, 1955; FWS 1979d; Lake Erie Fish. Res. Unit Staff 1977; Langlois 1954; Rawson, pers. comm. 1979; Riggs 1952, 1955; Snyder 1978; Van Vooren and Davies 1974; Van Vooren et al. 1975). A resident population is also reported in the Sandusky River (41°27', 82°59') throughout the late spring and summer; the population undergoes considerable fluctuation during the spawning period (Griswold et al. 1978). In the mid-1800s, tremendous numbers of white bass migrated into the Sandusky River; they filled the whole channel in the spring (Keeler 1904). Prior to 1916, large schools migrated up the Sandusky River as far as Fremont to spawn; in 1926, white bass were rarely found at Fremont (Van Oosten 1926). Spawning is also reported to occur in Sandusky Bay (FWS 1979d). Young-of-the-year were abundant throughout the bay beginning in May (Baker 1966b; Baker and Scholl 1971c; Ball and Scholl 1973; Chapman 1955; Gehres and Scholl 1969; Hair and Scholl 1971; Hartley 1975; Hartley and Herdendorf 1975; Keller 1964a; Rudolph and Scholl 1970; Van Vooren and Davies 1974; Van Vooren et al. 1977). In 1976, YOY were collected off the mouth of Sandusky Bay at Cedar Point (41°29', 82°41') in late July (Van Vooren et al. 1977).

O-2

Huron River (41°24', 82°33'). A spawning run enters the river and proceeds upstream to the first riffle area in late April and May (Cleveland Environ. Res. Group, undated; FWS 1979d; Rawson, pers. comm. 1979).

Beaver Creek (41°26', 82°15'). In 7979, eggs were collected in an area (approximately 41°28', 82°15') off the creek mouth at the 36 ft contour on July 5. Prolarvae were found throughout the area from June 12 to August 22; postlarvae were collected from July 12 to August 22 (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). Numerous adults were collected in the harbor in early summer; a few larvae were later found in the harbor (Geo-Marine 1978). White bass attempt to run up French Creek, a harbor tributary, but are unsuccessful due to low water quality in the creek (Odin 1979).

Rocky River (41°30', 81°50') and Cleveland Harbor (41°31', 81°42'). In 1972-74, YOY were collected in the harbor and the river (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, YOY were collected in the lower river and along the adjacent lake shore (White et al. 197.5). Prolarvae were collected at the Eastlake Generating Station (41°40', 81°27') near the river in June at a water temperature of 65°F. Spawning is believed to occur near the plant or in the mouth of the river (Aquat. Ecol. Assoc. 1976b).

O-3

Grand River (41°46', 81°17'). Young-of-the-year were collected in the river in July (White, pers. comm. 1979).

perry Power Plant (41°48', 81°09'). In 1974, a few early larvae were collected near the plant on July 12 at a water temperature of 68°F (NUS 1975).

Ashtabula River (41°55', 80°47'). Large numbers of young are present in the river (Odin 1979); YOY were collected at the mouth of the river in July (White, pers. comm. 1979).

Conneaut (41°58', 80°33'). The western corner of Conneaut Harbor (41°58', 80°33') is a spawning area; the substrate is sand and gravel with emergent vegetation (Odin 1979). In 1977, white bass larvae and YOY were collected in the Conneaut River (41°58', 80°33') during the fall, indicating that successful spawninq occurred in the river (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

White bass spawn along the Pennsylvania shoreline, including Presque Isle Bay (42°08', 80°07'). Spawning occurs in June over rock, rubble, and sand-clay bottom in water shallower than 42 ft (Kenyon, pers. comm. 1979).

New York

In the late 1920s, YOY were fairly common in creek mouths and at unidentified locations along shore (Greeley 1929).

Van Buren Bay (42°27', 79°25'). In 1975, a few eggs were collected on June 9. A few yolk-sac larvae were found in June to mid-July, post-larvae in June and July, and YOY in August and September (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). Eggs were found throughout Dunkirk Harbor (Niagara Mohawk Power 1976, as cited in Tex. Instrum. 1978). In 1976, eggs were present in June, prolarvae in June and July, and postlarvae in July (Tex. Instrum. 1979d). Prolarvae were entrained on June 14-21 and postlarvae on June 21 and from July 12 to August 3 at the Dunkirk Steam Station (42°30', 79°21') (Tex. Instrum. 1979e).

Eagle Bay (42°32', 79°14'). In 1975, off Eagle Bay, prolarvae were collected from mid-May to late July and postlarvae from mid-June to early August (Envirosphere 1977a; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a); YOY were present near Eagle Bay in August-October (U.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). In the late 1920s, adults were collected along shore in the spring (Greeley 1929).

Ontario

OE-1, OE-2

Point Pelee (41°55', 82°30'). The shoals along the entire shoreline of the point are important spawning areas (Environ. Can. 1977a). Young-of-the-year were collected on the northwest beach on the point (Paine 1976).

OE-4

Long Point Bay (42°40', 80°10'). In 1888, white bass were observed spawning at Turkey Point (42°39', 80°21') in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898; Whillans 1977). Fishermen catch gravid adults entering Doctors Inlet (42°34', 80°16') in the spring (Whillans, pers. comm. 1979). White bass larvae were seined inshore near the Nanticoke Generating Station (42°48', 80°03'); they appear to favor the littoral areas during August (Kelso 1972; Teleki 1975a). In 1974, YOY were entrained at the Nanticoke Station in June-August (Teleki 1976). Long Point Bay is a nursery ground for white bass (Teleki 1975b).

ROCK BASS

Michigan

Sterling State Park (41°55', 83°20'). Since 1921, spawning has occurred along the entire shoreline of the park out to the 6 ft depth contour over rock and mud (Organ et al. 1978).

O-1

Rock bass build nests on shallow sand and gravel shoals around the islands in the western basin, in protected bays and harbors, and in the lower reaches of south shore tributaries. The dates of spawning depend on water temperatures; in the islands area, spawning generally occurs from mid-June to July (Langlois 1954; Trautman, pers. comm. 1979).

West Harbor (41°34', 82°49'). In 1919, fry were collected on a flat sand beach at the mouth of the harbor (Turner 1920a).

South Bass Island (41°39', 82°50'). In 1919, fry were collected during July over a stone bar off Beach Point (41°40', 82°50'), and over mud in Terwilliger Pond (41°39', 82°50'); they were most abundant on a stone bar off the southwest end of Gibraltar Island (41°39', 82°49') (Turner 1920a). In 1958, fry were collected in Rut-in-Bay (41°39', 82°49') in early July (Davis 1959). Ripe adults were collected during June and July off the west side of Gibraltar Island, and spawning was observed under the docks in water 2-3 ft deep at a water temperature of about 72°F (Ernest 1960). Nesting has also been observed on Alligator Bar (41°391, 82°49') between Gibraltar Island and Oak Point (41°39', 82°49') (Trautman, pers. comm. 1979).

Middle Bass Island (41°41', 82°49'). In 1919, fry were collected from the large bay on the north shore (41°42', 82°48') along a gravel beach with submergent vegetation (Turner 1920a).

North Bass Island (41°43', 82°49'). Fry were collected over fine sand along the southern shore (41°42', 82°49') and on a rubble beach on the southwest point (41°43', 82°50') (Turner 1920a).

Sandusky Bay (41°29', 82°46'). This is a minor spawning area for rock bass (FWS 1977d).

O-2

Rocky River (41°30', 81°50'), Cleveland Harbor (41°31', 81°42'), and Chagrin River (41°41', 81°26'). In 1972-74, fry or young-of-the-year (YOY) rock bass were collected in the harbor and in the lower rivers; these may be spawning areas (White et al. 1975).

O-3

Fairport (41°46', 81°17') and Ashtabula (41°55, 80°47'). Adults spawn on the harbor breakwalls at these locations (White, pers. comm. 1979) .

Conneaut (41°58', 80°33'). A large number of ripe adults was collected in Conneaut Harbor (41°58', 80°33'), spawning was observed on the breakwall, and YOY were later collected in the vegetated shallows of

the harbor in 5-10 ft of water. In 1977, larvae were collected from the harbor and from the Conneaut River (41°58', 80°33') during June and July (Aquat. Ecol. Assoc. 1978c).

New York

Chautauqua Creek (42°20', 79°36'). Young-of-the-year were collected in the fall in the lower creek over gravel and rock in 2-4 ft of water; this is assumed to a spawning and nursery area (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Postlarvae were found in July in waters off Eagle Bay (Tex. Instrum. 1977a).

Canadaway Creek (42°28', 79°22'). Young-of-the-year were collected in the fall in the lower creek over gravel and rock in 2-4 ft of water; this is assumed to be a spawning and nursery area (Griswold and Galati, pers. comm. 1979).

Eagle Bay (42°32', 79°14'). Postlarvae have been found in waters off Eagle Bay in July (Tex. Instrum. 1977a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Inner Bay (42°37', 80°22') is a nesting area for rock bass; spawning occurs in late May to early June throughout the marshy shoreline areas (MacLean and Teleki 1977; Reid 1978; Whillans 1977, pers. comm. 1979). In the spring, rock bass migrate westward about 22-25 mi along the north shore of Long Point Bay to spawning grounds in Inner Bay. There is a return migration after spawning. Most of the movement occurs in 12 ft or less of water within 1 to 1-1/2 mi of shore (Chamberlain 1976a; Hamley 1979; Hamley and MacLean 1979; MacLean and Teleki 1977; Teleki et al. 1977). Young-of-the-year rock bass were captured along the north shore of Lake Erie, only at shoreline seining sites in or near Inner Bay (Hamley and MacLean 1979; MacLean and Teleki 1977; Reid 1978). Reproducing populations of rock bass are also probably established in the lagoons at the end of Long Point (42°33', 80°05') (Mahon 1979).

GREEN SUNFISH

Ohio

O-1

south Bass Island (41°39', 82°50'). In 1919, fry were collected in Terwilliger Pond (41°39', 82°50') off Put-In-Bay. The pond was 1-7 ft deep, with a mud bottom and aquatic vegetation (Turner 1920a).

O-2

Cleveland (41°30', 81°43'). Green sunfish have been observed on nests in the old channel of the Cuyahoga River (41°30', 81°43'). During 1972-74, small numbers of fry or YOY were collected in Cleveland Harbor (41°31', 81°42') and also in the lower Rocky River (41°30', 81°50') and along the adjacent lake shore, which may also be spawning areas (White et al. 1975; White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). In 1972-74, a few larvae and young-of-the-year (YOY) were collected in the lower river; spawning probably occurs on the rock breakwaters (Environ. Resour. Assoc. 1978; White et al. 1975).

PUMPKINSEED

Ohio

Pumpkinseeds spawn in all of the harbors along the Ohio shoreline (White, pers. comm. 1979).

O-1

Sandusky Bay (41°29', 82°46'). Sandusky Bay is a minor spawning area for pumpkinseeds (FWS 1979d). In 1915, pumpkinseeds were observed on nests in Beimiller's Cove (41°28', 82°40') on Cedar Point in July. Nests as large as 36 x 27 in. guarded by large adults were located 10-20 ft from shore on sandy stretches of bottom at depths of 11-15 in. Nests as large as 7 x 7 in. guarded by small adults were located within 6 ft of shore on pebhle bottom, among reeds in water less than 7 in. deep. All nests occurred in groups (Krecker 1916).

O-2

Cleveland (41°30', 81°43'). In 1972-74, adults were observed tending nests in Cleveland Harbor (41°31', 81°42'1, and young-of-the-year were abundant in the harbor. Young-of-the-year were also collected in the lower Rocky River (41°30', 81°50') and adjacent shorelines; these may be spawninq areas (White, pers. comm. 1979; White et al. 1975).

Chagrin River (41°41', 81°26'). In 1975, a few prolarvae were collected in June at the Eastlake Power Plant (41°40', 81°27'), sugqesting that spawning takes place in the immediate plant area or in the mouth of the river (Aquat. Ecol. Assoc. 1976b).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Historically, pumpkinseeds spawned in the marshy shoreline areas of Inner Bay (42°37', 80°22') (Whillans

1977, pers. comm. 1979). Spawning is believed to occur in mid-June in Long Point Crown Marsh (42°35', 80°25'1 at the base of Long Point, where many YOY were found through August (Reid 1978). Reproducing populations are also established in the lagoons at the end of Long Point (42°33', 80°05') (Mahon 1979, pers. comm. 1979).

ORANGESPOTTED SUNFISH

Ohio

O-2

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year were collected in the lower river and adjacent shoreline areas of the lake (White et al. 1975). Spawning may occur on the rocky breakwaters (Environ. Resour. Assoc. 1978).

BLUEGILL

Michigan

Bay Creek (41°47', 83°27'). Bluegills spawn near the mouth of Bay Creek in shallow water (Organ et al. 1978).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). The bay is a spawning area for bluegills (FWS 1979d). In 1953-54, bluegills spawned in the bay throughout the summer, and young-of-the-year (YOY) were widely distributed throughout the bay (Chapman 1955). In 1961-63, YOY approximately 1 in. long were taken in the western end of the bay in May to October (Keller 1964a).

O-2

Cleveland (41°30', 81°43'). In 1972-74, YOY or fry were collected in the Rocky River (41°30', 81°50') and Cleveland Harbor (41°31', 81°42'); these are probably spawning areas (White et al. 1975).

Chagrin River (41 °41', 81°26'). In 1972-74, YOY or fry were collected in the lower river and adjacent shores (White et al. 1975). Spawning probably occurs on the rocky breakwaters, and the spawners could be river residents (Environ. Resour. Assoc. 1978).

New York

Van Buren Bay (42°27', 79°25'). Postlarvae were found in July in waters off the bay (Tex. Instrum. 1977a).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). The weedy coves in the harbor are excellent habitat for bluegills, and considerable spawning was seen in these areas (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). Historically, bluegills spawned in the marshy areas of Inner Bay (42°37', 80°22') (Whillans 1977, pers. comm. 1979). A few YOY were found in Long Point Crown Marsh (42°35', 80°25') at the base of Long Point (Reid 1978). Reproducing populations are also established in the lagoons on Long Point (42°33', 80°10'), where ripe females were found in May (Mahon 1979, pers. comm. 1979; Mahon and Balon 1977b).

SUNFISH spp.

Michigan

Brest Bay (41°55', 83°18'). In 1977, early postlarvae were collected in early July in an area (41°55', 83°17') off Detroit Beach (Patterson 1979).

Raisin River (41°53', 83°20'). Larvae appear to be more abundant in the river than in the lake; spawning probably occurs in the marshy and protected shorelines of the river (Cole 1978b).

Whitewood Creek (41°48', 83°26'). In 1975, a few larvae were collected in late July in an area (41°47', 83°26') just south of Whitewood Creek (Waybrant and Shauver 1979).

Ohio

O-3

Conneaut (41°58', 80°33'). In 1977, sunfish larvae were collected in Conneaut Harbor (41°58', 80°33') and in Lake Erie at nearshore and offshore sites near Turkey Creek (41°58', 80°32') in late June and early

July. Larvae were most abundant in the mouth of Turkey Creek. The abundance of larvae in the nearshore area probably reflects a movement of larvae into the lake from Turkey Creek (Aquat. Ecol. Assoc. 1978c).

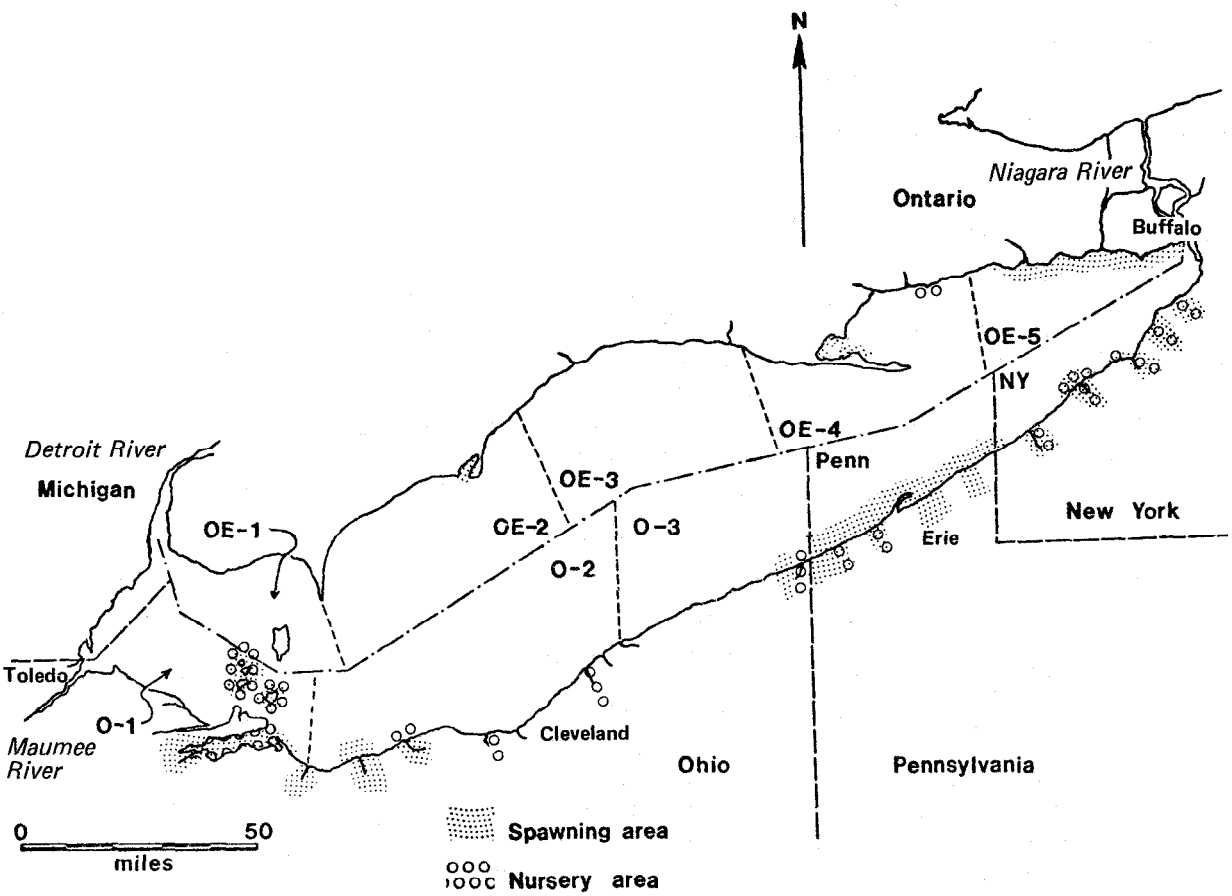
Ontario

OE-1

Point Pelee (41°55', 82°30'). The marshes of Point Pelee National Park (41°58', 82°32') are important spawning areas (Environ. Can. 1977a).

OE-2

Rondeau Harbour (42°15', 81°53'). The marshes and open water areas of the bay are important spawning areas (Environ. Can. 1977a).



Smallmouth bass spawn inshore on shallow, rocky shoals in Lake Erie; they also enter tributaries to spawn (Trautman 1957, pers. comm. 1979). Historically, spawning occurred in May to early July (Fish 1932; Jordan 1877; Rathbun and Wakeham 1897).

Ohio

After 1810, many dams on Ohio streams blocked spawning migrations, and siltation also deqraded spawning areas (Trautman 1957).

O-1

smallmouth bass spawn in shallow bays on the islands and also in tributaries (Langlois 1954).

Bass Islands (41°41′, 82°49′). The islands provide protected areas and excellent gravel and rubble substrate for spawning (Hair 1979). Spawning occurs from mid-May to the end of June, over rock, gravel, or

sand bottom, usually in areas protected from wave action but with a current. Ripe adults are observed in waters as deep as 12-15 ft, but spawninq usually occurs in 2-4 ft of water. Spawning begins when temperatures rise to 59-60°F (Doan 1942; Jordan 1877; Wolfert, pers. comm. 1979). Hatching begins in late May or early June (Wickliff 1938). Tagqing studies in Put-In-Bay (41°39', 82°49') on South Bass Island have shown that smallmouth return annually to a few preferred spawning sites; these sites are in 6-10 ft of water with a gravel and sand bottom, close to natural or man-made structures, and protected from east and northeast winds. After spawning, the adults move to nearshore reefs and deeper shoreline areas (Hair 1978, 1979).

Historically, smallmouth bass fry were widely distributed throughout the islands; they appeared to prefer the edges of aquatic plant beds and to avoid areas with mud bottom (Osburn 1923; Turner 1920a; Wickliff 1920). Young-of-the-year (YOY) were collected from shallow areas, first as fry up to 0.5 in. long in late May or early June and then as fingerlings approximately 3 in. long through early September (Hair 1978). Young tend to concentrate in rocky areas close to shore in waters less than 12 ft deep (Wolfert, pers. comm. 1979).

South Bass Island (41°39', 82°50'). Smallmouth bass nest on the rock shoals around the island (Trautman, pers. comm. 1979). Spawning occurred and fry were collected at most locations except on the extreme southern shore. In Stone Cove (41°38', 82°51') on the southwest shore, males were observed guarding nests on gravel and cobble against a concrete dock, and YOY were found around the dock and under boats (MacLean, pers. comm. 1979). In 1919, fry were collected in this area at the Hotel Victory site on a stone beach in July (Turner 1920a). Ripe adults were collected off the northeast shore of the island (41°391, 82°48') and around Buckeye Island (41°40', 82°47') over gravel, cobble, and rubble in 4-5 ft of water (MacLean, pers. comm. 1979). Historically, fry were abundant on the rubble beaches in these same areas (Turner 1920a). Put-In-Bay (41°39', 82°49') is a well-known spawning and nursery area. In 1919, fry were collected on stone and sand beaches in July off Peach Point (41°401, 82°50'1, Gibraltar Island (41°39', 82°49'1, and East Point (41°40', 82°48'), and along the south shore of Squaw Harbor (41°39', 82°49'1 (Turner 1920a). In 1938-41, nesting was observed from mid-May to late June, and young fry were collected near Hatchery Bay (41°39', 82°49'1, Gibraltar Island, and Put-In-Bay Harbor (Doan 1942; Lanqlois 1954). In 1975-77, fry about 0.4-1.3 in. long were collected at Peach Point, Gibraltar Island, the Fish Hatchery dock, and the city docks in June to September (Hair 1979). Running-ripe males were collected over rock and gravel at Miller's Dock off East Point and at old stone cribbings in the harbor. Many males and subsequently swarms of young were collected at Nate's Bock in the harbor. Concentrations of YOY were found over boulders, cobble, and gravel on Alligator Bar (41°39', 82°49') between Gibraltar Island and Oak Point (41°39', 82°49') (MacLean, pers. comm. 1979).

Middle Bass Island (41°41', 82°49'). Running ripe males were collected in late May to early June off the western point of the island at 41°41', 82°50' over gravel and cobble in 3-5 ft of water (MacLean, pers. comm. 1979). In 1919, fry were collected in July on a stone and boulder beach on the western point (41°41', 82°50'), on a sand beach on the northwest point (41°411, 82°49'), on a gravel beach in the bay on the north shore (41°42', 82°48'), and on a stone and boulder beach on the southeast point (41°40', 82°48') (Turner 1920a).

Green Island (41°39', 82°52'). In 1919, fry were collected on gravel and stone beaches and bars in July. Rattlesnake Island (41°41', 82°51'). Fry were collected off the southeast shore in July (Turner 1920a).

Ballast Island (41°41', 82°47'). In 1919, fry were collected on a steep gravel beach off the southwest shore in July (Turner 1920a). Ballast Island Harbor (41°41', 82°47') on the west shore is a spawning area where males guarding nests on gravel and rock were collected (MacLean, pers. comm. 1979).

Lost Island (41°41', 82°47'). In 1919, fry were collected on a steep gravel beach off the northeast shore. Sugar Island (41°42', 82°49'). Fry were collected on a gravel and boulder beach along the north shore on the edge of a dense weed bed. North Bass Island (41°43', 82°49'). Fry were collected in July on a protected sand and gravel beach in Manila Bay (41°43', 82°50'), on a rubble beach with dense vegetation off the southwest point (41°43', 82°50'), on a fine sand beach along the south shore (41°42', 82°49'), and on a sand bar off the southeast point (42°42', 82°48') (Turner 1920a).

Gull Island Shoal (41°40', 82°41'). This spawning ground, which covered an estimated 30 acres, was the largest one among the islands. Nests were seen in the gravel or sand near every boulder (Jordan 1877).

Kelleys Island (41°36', 82°42'). Ripe fish were collected around the island in areas of strong current and emergent vegetation in late May and early June. young were observed in rocky areas close to shore in less than 12 ft of water (Wolfert, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). The bay is a minor spawning area (FWS 1979d). In 1961-63 and in the 1970s, a few fry were collected in the bay (Hartley 1975; Hartley and Herdendorf 1975; Keller 1964a). In the early 1900s, smallmouth bass migrated up the Sandusky River (41°27', 82°59') to Fremont to spawn; but it was not known if these fish were from Lake Erie (Van Oosten 1926).

O-2

Huron River (41°24', 82°33'). Smallmouth bass enter the river to spawn in late April to early June (Cleveland Environ. Res. Group, undated; FWS 1979d; Teater 1976).

Chappel Creek (41°24', 82°27'). The substrate along the shoreline near the creek is favorable for spawning (Rawson, pers. comm. 1979).

Vermilion River (41°26', 82°22'). Smallmouth bass enter the Vermilion River in May and June. Spawning occurs in shallow water in and adjacent to the river (Odin 1975; Teater 1976; U.S. Army Eng. Dist. 1976a).

Beaver Creek (41°26', 82°15'). Historically, spawning runs entered the creek (Langlois 1945b). In 1979, late postlarvae were collected off the creek mouth in July in water 12 and 23 ft deep (Commonw. Assoc. 1979).

Rocky River (41°30', 81°50') and Chagrin River (41°41', 81°26'). In 1972-74, fry or YOY were collected in the lower reaches of the rivers; these may be spawning areas (White et al. 1975).

O-3

Conneaut (41°58', 80°33'). Large runs of smallmouth bass entered the Conneaut River (41°58', 80°33') each spring, prior to the construction of dams on the river (Langlois 1945b). In Conneaut Harbor (41°58', 80°33'), smallmouth bass spawn on the east side of the breakwall over large stone blocks (White, pers. comm. 1979). Spawning also occurs in the west corner of the harbor over sand and gravel with emergent vegetation (Odin 1979). In 1977, qravid females were collected between the Conneaut River and Raccoon Creek (41°59', 80°29'), in late June to late July; water temperatures were 66-68°F during late June. In 1977, larvae were collected near Turkey Creek (41°58', 80°32') on June 19 (Aquat. Ecol. Assoc. 1978c); the creek was a nursery area in summer and fall (USACE, undated b).

Pennsylvania

Smallmouth bass spawn in creek mouths along the Pennsylvania shoreline and also along shore in 16 ft or less of water over rock and rubble substrate. The adults move out into 36-42 ft of water after spawning. Substrate in the creeks includes sand, silt, and mud to rubble and gravel; current is moderate to low; and vegetation is usually present (Kenyon, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). Nest building was observed and ripe adults were collected in the creek mouth (Kenyon, pers. comm. 1979).

Crooked Creek (42°00', 80°26'). Nest building was observed and ripe adults were collected in the creek mouth. Concentrations of adults were found in May and early June on the 17-ft rock shoal (42°01', 80°25') off the creek mouth (Kenyon, pers. comm. 1979).

Elk Creek (42°01', 80°22'). Nest building was observed and ripe adults were collected in the creek mouth; the creek is a nursery area (GPU Serv. Corp. 1974; Kenyon, pers. comm. 1979).

Walnut Creek (42°04', 80°14'). Nest bulding was observed and ripe adults were collected in the creek mouth; the creek is a nursery area (Kenyon, pers. comm. 1979).

Sixmile Creek (42°11', 79°59') and Twelvemile Creek (42°13', 79°55'). Nest building was observed and ripe adults were collected in the creeks (Kenyon, pers. comm. 1979).

Sixteenmile Creek (42°14', 79°50'). Nest building was observed and ripe adults were collected in the creek (Kenyon, pers. comm. 1979). Concentrations of adults were also seen just offshore near the mouth of the creek in May and early June (Kenyon, pers. comm, 1979).

New York

Chautauqua Creek (42°20', 79°36'). Adults guarding nests were observed in the creek in June over rock and gravel in 2-4 ft of water; YOY were collected in July and August (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Spawning may occur in the bay; prolarvae and postlarvae were collected here in mid-August (Tex. Instrum. 1977a).

Point Gratiot (42°28', 79°23'). This is a nursery area; YOY were collected here in late August in 30-60 ft of water over rock and bedrock substrate (Griswold and Galati, pers. comm. 1979).

Canadaway Creek (42°28', 79°22'). Adults guarding nests were observed in June over rock and gravel in 2-4 ft of water, and YOY were collected in July and August (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 79°20'). The harbor is a prime spawning and nursery ground for smallmouth bass (NYDEC 1977b); adults apparently prefer to spawn on the sand bottom and rock breakwater at the eastern end of the harbor (Tex. Instrum. 1977d). Ripe and spent fish were found here (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). Adults guarding nests were observed in June, and fry were collected in July and August among vegetation in 2-4 ft of water (Griswold and Galati, pers. comm. 1979).

Silver Creek (42°33', 79°10'). The littoral zone off the creek mouth is a spawninq area (NYDEC 1977b). Adults have been observed guarding nests in June, and YOY are found here in July and August (Griswold and Galati, pers. comm. 1979).

Cattaraugus Creek (42°34', 79°08'). Spawning occurs in early June, and YOY are found in late summer (Griswold and Galati, pers. comm. 1979).

Big Sister Creek (42°40', 79°04'). Fry and YOY were collected in the creek over gravel, rock, and bedrock in July, August, and September; this is probably both a spawning and nursery area (Griswold and Galati, pers. comm. 1979).

Eighteenmile Creek (42°43', 78°58'). Fair spawning runs enter the creek in the spring (Buffalo Waterfront Dev. Comm., undated). Young-of-the-year were found in the creek over gravel and stone in 3-6 ft of water in September and October (Griswold and Galati, pers. comm. 1979). In 1928, fry about 0.5-0.8 in. long were taken at the mouth of the creek in mid-July (Fish 1929, 1932; Greeley 1929).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). Some smallmouth bass nests were found, but spawning sites appear limited by wind exposure (Loftus 1948).

OE-4

Long Point Bay (42°40', 80°10'). Smallmouth bass migrate westward along the north shore of Long Point Bay into Inner Bay (42°37', 80°22') (Chamberlain 1976b; Hamley 1979; Hamley and MacLean 1979; Teleki 1975b; Teleki et al. 1977). During the past 60 years, the main spawning grounds of smallmouth bass have shifted from the north shore to the south shore of Inner Bay, and east along the south shore toward the mouth of Inner Bay. In the late 1880s, many more smallmouth bass spawned at Turkey Point (42°39', 80°21') than at present. In the mid 1890s, documented spawning grounds were in the marsh south of Port Rowan (42°38', 80°27'), in Sturgeon Bay (42°36', 80°23'), and Rice Bay (42°36', 80°20'), and from Pottohawk Point (42°37', 80°17') along the south shore. In the 1930s, smallmouth bass spawned around Becker's Point (42°36', 80°25') and Old Cut Point (42°36', 80°24'); in the 1940s, spawning shifted to waters off Thoroughfare Point (42°36', 80°20'). A fair amount of spawning still occurs in some of the historic locations (Whillans 1977), but spawning in the Inner Bay area now occurs mainly between Thoroughfare Point and Pottohawk Point and in the more open, sandy areas south of Pottohawk Point in the Outer Bay (Hamley and MacLean 1979; Kerr and Kerr 1860-1898; Whillans, 1977, 1979b, pers. comm. 1979). Rice Bay, Sturgeon Bay and Whitefish Bay (42°39', 80°21') were still regarded as spawning areas in 1953, as were many sheltered coves along the entire south shore and along the north shore from St. Williams (42°40', 80°24') to Deep Hole Point (42°39', 80°20') (Berst 1953a,b). Reproducing populations are also probably established in some of the larger lagoons at the end of Long Point (42°33', 80°05') (Mahon 1977). In Long Point Bay and Inner Bay, ripe females are found at water temperatures greater than 64°F; nest building begins in late May or early June, and most egg deposition occurs in the latter half of June or early July (Berst 1953a,b; Teleki 1975a,b). In the 1940s, fry were not found in nests until late June (Ont. Game Fish 1944). Collections of YOY indicate several areas near Inner Bay and Nanticoke (42°48', 80°04'), including Peacock Point (42°47', 79°59'), are nursery areas (Kelso 1972); YOY are generally not found in the marshes (Hamley and MacLean 1979).

OE-5

Grand River (42°51', 79°35')--Fort Erie (42°53', 78°56'). Spawning occurs on sandy beaches along this shoreline from 1 mi W of the Grand River to Fort Erie at the head of the Niagara River. Specific locations identified are Rock Island (42°52', 79°26'), Gravelly Bay (42°53' 79°16'), and Abino Bay (42°51', 79°05') (Environ. Can. 1977a).

LARGEMOUTH BASS

In Lake Erie, the largemouth bass historically spawned in early April to July (Fish 1932).

Ohio

O-1

Catawba Island (41°35', 82°51'). Largemouth bass reproduced in the enclosed harbors of Catawba Island (Osburn 1923). Fry were collected in Reedy Marsh at West Harbor (41°34', 82°49') (Turner 1920a). Largemouth bass were very abundant in East (41°32', 82°47'), Middle (41°33', 82°49'), and West Harbors where they spawned on sandy bottom among the vegetation. East Harbor contained six spawning areas, one of which was over 2 acres in size (Van Oosten 1926).

South Bass Island (41°39', 82°50'). In 1919, fry were collected in the bay on the northeast side of the island (41°39', 82°49') over a rubble beach with filamentous algae; in Stone Cove near the Hotel Victory site (41°38', 80°51') over a stony beach; and in Put-in-Bay (41°39', 82°49'), including Squaw Harbor (41°39', 82°49') over sand, mud, and vegetation; at Peach Point (41°40', 82°50') on a flat stone bar; off the southwest tip of Gibraltar Island (41°39', 82°49') over a flat stone bar; and in marshy, mud areas of Terwilliger Pond (41°39', 82°50') (Turner 1920a).

Green Island (41°39', 82°52'). A few fry were collected off the east and the west points of the island. Middle Bass Island (41°41', 82°49'). Young-of-the-year (YOY) were collected on the northern shore (41°42', 82°48') among boulders and submergent vegetation. Worth Bass Island (41°43', 82°49'). Fry were collected on the south shore (41°42', 82°49') over fine sand bottom with no vegetation (Turner 1920a).

Sandusky Bay (41°29', 82°46'). This is a minor spawning area for largemouth bass (FWS 1979d).

O-2

Old Woman Creek (41°23', 82°31'). The estuary is excellent largemouth bass spawning habitat (FWS 1979d).

Lorain Harbor (41°28', 82°11'). Largemouth bass were observed spawning in the harbor (White, pers. comm. 1979).

Cleveland (41°30', 81°43'). Largemouth bass spawn in Cleveland Harbor (41°31', 81°42') (White, pers. comm. 1979). In 1972-74, adults were observed guarding nests, and a few YOY were collected in the harbor. A few YOY were also collected in the lower Rocky River (41°30', 81°50'); this may be a spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). A few YOY were collected in the lower river; this may be a spawning area (White et al. 1975).

O-3

Conneaut (41°58', 80°33'). In 1977, YOY were collected in the lower Conneaut River (41°58', 80°33') and lower Turkey Creek (41°58', 80°32') in July and August. Mo adults were collected in these streams, but a few larvae were collected in the Conneaut River; YOY in these streams may be due to limited spawning in the nearshore area or they may be strays from Lake Erie (Aquat. Ecol. Assoc. 1978c; USACE, undated b). A few largemouth bass larvae were captured nearshore, immediately east of the Conneaut Harbor (41°58', 80°33') breakwall (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Raccoon Creek (41°59', 80°29'). In 1977, YOY were collected in the creek after July. Few adults were found, and there was no evidence of a resident population. The presence of YOY was attributed to limited spawning in the creek or the use of the creek as a nursery area by strays from Lake Erie (Aquat. Ecol. Assoc. 1978c).

Presque Isle Bay (42°08', 80°07'). The lagoons and shallows of the north and west shores of Presque Isle Bay, including Thompson Bay (42°10', 80°05') and Horseshoe Pond (42°10', 80°05') are spawning areas (Larsen, pers. comm. 1979).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). Historically, this was a spawning area (Kerr and Kerr 1860-1898). In the late 1940s to 1950, spawning occurred in the extensive marshy, lagoon areas in June, when the water temperature reached about 65°F; nests, eggs, and fry were observed. The largest spawning area was "the Ponds" on the southeast side of the bay. Nests were also seen on the southwest shore between Erieau (42°14', 81°55') and Rondeau (42°18', 81°55'). Large schools of fingerlings were seen along the northeast shore in late June (Berst 1950; Loftus 1948).

OE-4

Long Point Bay (42°40', 80°10'). Largemouth bass spawned in Long Point Marsh (42°35', 80°17') and in an area east of Port Rowan (42°38', 80°27') on the north shore of the bay. In the late 1880s, largemouth bass spawned at Turkey Point (42°39', 80°21'). In the mid-1890s, spawning was documented in the marsh south of Pottohawk Point in the outer bay, from Old Cut (42°35', 80°24') to Pottohawk Point (42°37', 80°17') in Rice Bay (42°36', 80°20'), in Sturgeon Bay (42°36', 80°23'), and in marsh areas south of Port Rowan. At the turn of the century, the main spawning grounds extended from Pottohawk Point to Rice Bay along the south shore (Kerr and Kerr 1860-1898; Whillans 1977, 1979b). Largemouth bass presently spawn the marsh inside Ryerson's Island (42°36', 80°17'), Big Creek Marsh (42°36', 80°27'), and in Turkey Point Marsh (Whillans, pers. comm. 1979). Spawning also occurs in Long Point Crown Marsh (42°35', 80°25'), at the base of Long Point, in May (Reid 1978). Reproducing populations are resident in the larger lagoons on Long Point (42°33', 80°10') (Mahon 1979; Mahon and Balon 1977b). In late 1928, YOY were seined in Long Point Bay in late August (Fish 1932). In 1976, YOY were collected in seines at the Nanticoke Generating Station (42°48', 80°03') (Chamberlain 1976); more recently, YOY were collected in the Long Point marshes (Hamley and MacLean 1979; Reid 1978).

OE-5

Abino Bay (42°51', 79°05'). This is a spawning and nursery area for the largemouth bass (Environ. Can. 1977a).

BLACK BASS

Michigan

Swan Creek (41°58', 83°15'). In 1975, a few larvae were collected in an area (41°59', 83°14') along the beach just north of the mouth of the creek in mid- to late June (Wayhrant and Shauver 1979).

Stony Creek (41°57', 83°18'), Sandy Creek (41°56', 83°20'), and Plum Creek (41°54', 83°22'). From 1949 to the 1970s, black bass spawned in the lower reaches of the creeks over sand and rock (Organ et al. 1978).

Pennsylvania

Erie (42°07', 80°05'). Historically, fishermen caught black bass in Erie Harbor during the spawninq season (Meehan 1895),

Ontario

OE-1

Point Pelee (41°55', 82°30'). The marshes of Point Pelee National Park (41°58', 82°32') are important spawning areas (Environ. Can. 1977a).

OE-2

Rondeau Harbour (42°15', 81°53'). The marshes and also the open water areas are important spawning areas (Environ. Can. 1977a).

OE-4

Inner Bay (42°37', 80°22'). This is an important spawning area for black bass (Environ. Can. 1977a). Historically, spawning occurred near Port Rowan (42°38', 80°27') in May (Ont. Game Fish 1911).

WHITE CRAPPIE

Ohio

O-1

Maumee Bay (41°43', 83°25'). White crappie spawn in the bay in May (Pinsak and Meyer 1976).

Locust Point (41°36', 83°05'). Spawning occurs in the Davis-Besse Power Plant intake canal (41°36', 83°04') (Reutter 1979a). Many YOY are impinged at the plant, and many fry were collected on the bottom of the canal (CLEAR 1975b; Reutter 1979a).

South Bass Island (41°39', 82°50'). White crappie spawned in a warm shallow pool at South Bass Island in mid-June (Langlois 1954).

Sandusky Bay (41°29', 82°46'). The bay is a spawning site for white crappie in May and June; young-of-the-year (YOY) have been found throughout the bay (Chapman 1955; Keller 1964a).

O-2

Old Woman Creek (41°23', 82°31'). The estuary contains excellent spawning habitat for white crappie (FWS 1979d).

Rocky River (41°30', 81°50'). Spawning runs entering the river peak in the second week in May (Cleveland Environ. Res. Group, undated; White, pers. comm. 1979). In 1972-74, a few YOY were collected in the lower river (White et al. 1975).

Cleveland (41°30', 81°43'). A few fry were collected in Cleveland Harbor (41°3.1', 81°42'); this could be a Spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). Spawning runs entering the river peak in the second week of May (White, pers. comm. 1979). In 1972-74, fry were collected in the lower river and along the adjaeent shoreline of the lake (White et al. 1975). In 1975, a few prolarvae were collected at the East Lake Power Plant (41°40', 81°27') near the Chagrin River in June and July. Spawning is assumed to have occurred in the immediate area or in the mouth of the river (Aquat. Ecol. Assoc. 197633).

BLACK CRAPPIE

Ohio

O-1

Maumee Bay (41°43', 83°25'). Black crappie spawn in May and June in the bay (Pinsak and Meyer 1979).

Locust Point (41°36', 83°05'1. Black crappie spawn in the intake canal of the Davis-Besse Power Plant (41°36', 83°04') (Reutter 1979a). In 1975, a few fry were collected nearshore in mid-June, and many young-of-the-year (YOY) are impinged at the plant (CLEAR 1975b; Reutter 1979a).

Sandusky Bay (41°29', 82°46'). Black crappie spawn here in May and June; YOY are widely distributed throughout the bay (Chapman 1955).

O-2

Old Woman Creek (41°23', 82°31'). The estuary contains excellent spawning habitat for black crappie (FWS 1979d).

Rocky River (41°30', 81°50'). Spawning runs peak in mid-May (Cleveland Environ. Res. Croup, undated; White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Spawning runs entering the river peak in mid-May (White, pers. comm. 1979). Fry or YOY were collected in the lower river (White et al. 1975).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Historically, black crappie spawned in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898) and spawning still occurs there along the marshy shore areas (Whillans, pers. comm. 1979).

In Long Point Crown Marsh (42°35', 80°25') spawning occurs in late May to early June, and YOY are abundant (Reid 1978). Reproducing populations also probably occur in the lagoons at the tip of the point (42°33', 80°05') (Mahon 1979).

CRAPPIE spp.

Michigan

Sterling State Park (41°55', 83°20'). Spawning occurs along the entire shoreline of the park over rock and mud (Organ et al. 1978).

Monroe (41°55', 83°24'). Crappies spawn in the discharge canal of the Monroe Power Plant (41°53', 83°21') (Organ et al. 1978).

Bay Creek (41°47', 83°27'). Crappies spawn off the mouth of the creek (Organ et al. 1978).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). Crappies spawn successfully in large numbers in the bay (FWS 1979d).

O-2

Cleveland (41°30', 81°43'). A major spawning area exists just inside the west marina in Cleveland Harbor (41°31', 81°42') (Odin 1979).

O-3

Conneaut (41°58', 80°33'). In 1977, larvae were captured offshore between the Conneaut River (41°58', 80°33') and Raccoon Creek (41°59', 80°29') in mid-July. Larvae were also collected in the Conneaut River during June and in the mouth of Turkey Creek (41°58', 80°32') in early June (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Crappies spawn in the shallow areas and lagoons on the north and west shores, including Thompson Bay (42°10', 80°05') and Horseshoe Pond (42°10', 80°05') (Larsen, pers. comm. 1979).

Ontario

OE-4

Inner Bay (42°37', 80°22'). In 1888, crappies were observed spawning at Turkey Point (42°39', 80°21'); they are still reproducing in the bay (Whillans 1977).

GREENSIDE DARTER

Ohio

O-1

South Bass Island (41°39', 82°50'). In 1919, fry were found during July on the east shore (41°39', 82°49') in shallow water on flat rock bottom, in which there were deep pools in depressions, and at Peach Point (41°40', 82°50') in 2 ft of water along a flat stony bar with no vegetation (Turner 1920a).

Middle Rass Island (41°41', 82°49'). Fry were found along the southeast shore (41 °41', 82°48') in a few inches of water in patches of moss over flat rock (Turner 1920a).

RAINBOW DARTER

Pennsylvania

The rainbow darter is primarily a stream resident; along the Pennsylvania shoreline, it spawns in creek mouths and in the nearshore surge zone. Males in breeding color were observed in all tributaries in May, and concentrations of advanced young-of-the-year were collected along the lakeshore. The rainbow darter is usually found on rock and gravel bottom with little vegetation in water less than 1 ft deep with a fast current (Kenyon, pers. comm. 1979).

IOWA DARTER

Ontario

OE-4

Long Point (42°33', 80°10'). In 1977, 2% of the young-of-the-year fish collected in Long Point Crown Marsh (42°35', 80°25') in July were Iowa darters (Reid 1978). This darter is also probably established in the lagoons at the tip of Long Point (42°33', 80°05') (Mahon 1979).

FANTAIL DARTER

Ohio

O-1

south Bass Island (41°39', 82°50'). In 1919, fry were collected in July along the water's edge off the northeast point of the island (41°40', 82°47'); they were found in moss patches and under stones along a level rubble beach that was subject to constant wave action (Turner 1920a).

Middle Bass Island (41°41', 82°49'). Fry were found on the east shore (41°41', 82°48') of the island over a shallow flat rock bottom, either exposed or covered with sand, with some boulders and some submergent vegetation (Turner 1920a).

JOHNNY DARTER

In Lake Erie, the johnny darter spawns in May and June; this species attaches its eggs to the flat sides of stones or other objects about a foot below the surface (Fish 1932).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1961, young-of-the-year (YOY) were taken in small numbers in the western end of the bay from May to October (Keller 1964a).

O-2

Chagrin River (41°41', 81°26'). In 1972-74, YOY were collected in the lower river; this may be a spawning area (White et al. 1975).

O-3

Ashtabula (41°55', 80°47'). The johnny darter spawns in a small harbor on the eastern edge of Ashtabula in 10 ft of water over a stony, gravel substrate; larvae were collected there (White, pers. comm. 1979).

Pennsylvania

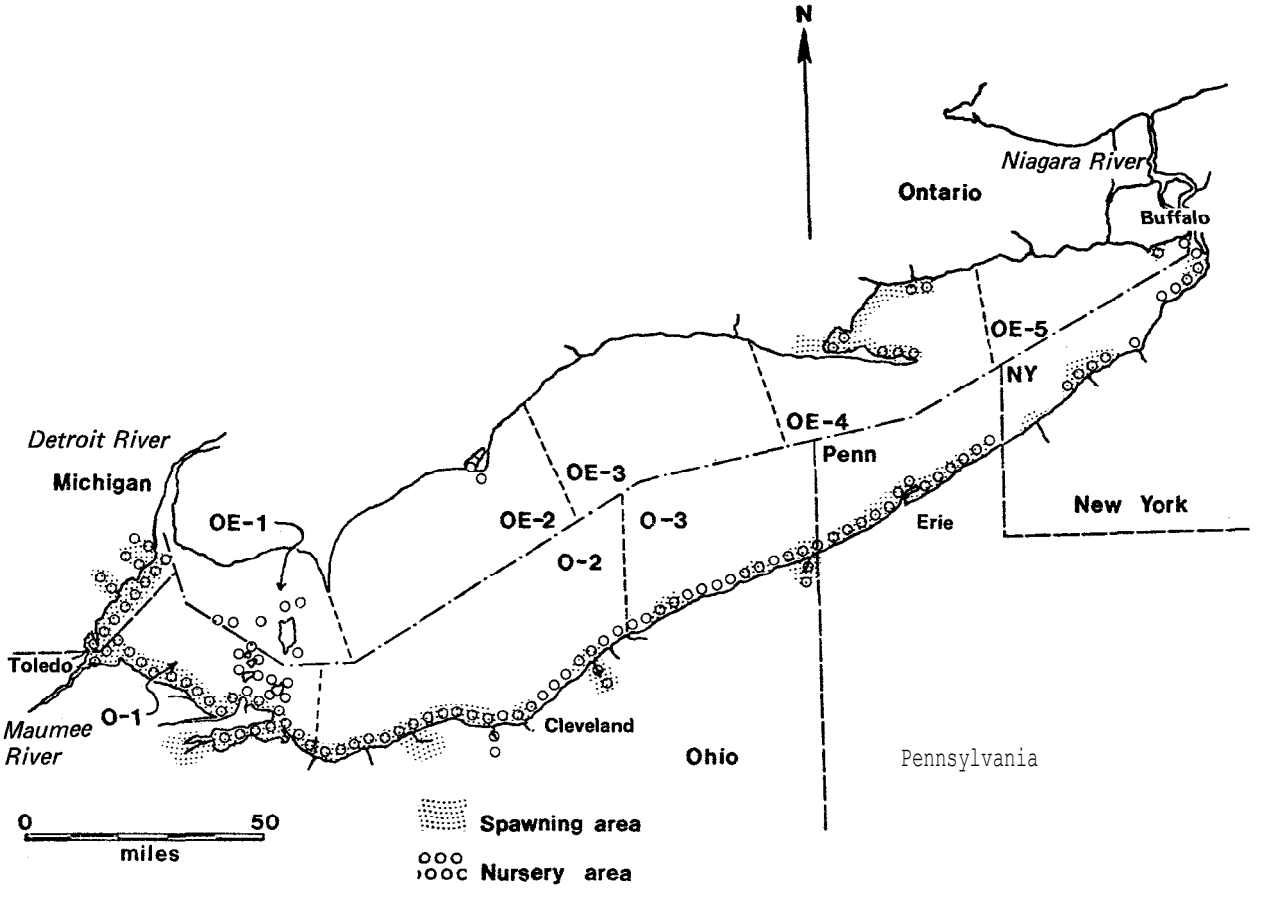
Young-of-the-year were collected from August to October all along the Pennsylvania shoreline at depths of 42-60 ft over a mud bottom with no vegetation (Kenyon, pers. comm. 1979).

Elk Creek (42°01′ , 80°22′). Larvae were collected off the creek mouth (GPU Serv. Corp. 1979).

New York

Sturgeon Point (42°41', 79°03'). In the 1920s, eggs were collected at Sturgeon Point in June (Fish 1929, 1932); YOY were found in June to August near shore between Dunkirk (42°29', 79°20') and Buffalo (42°55', 78°53') (Fish 1932).

YELLOW PERCH



In Lake Erie, spawning runs of yellow perch begin as early as April. Spawning occurs in shallow water along the shorelines and in tributaries in April and May when the water temperature reaches about 44-58°F. Eggs are deposited in flat, ribbon-like masses. Incubation usually lasts about 2 weeks, and hatching can occur as early as the first week of May and continue into July. In June, yellow perch larvae become free-swimming and move away from the shoreline (Barnett 1969; Bowman 1974; Doan 1942; Fish 1929, 1932; Jobes 1952; Teleki 1975b; Van Meter 1960; Van Oosten and Bile 1949). In 1928-29, larvae were abundant throughout the lake from June to August and were usually found in the shallow inshore areas (Fish 1932). Since 1958, young-of-the-year (YOY) have been abundant in the central basin from Erie, Pennsylvania (42°07', 80°05'), to Vermilion, Ohio (41°26', 82°22') (Anderson 1966; Baker 1969; Baker and Bower 1964, 1965; Baker and Scholl 1970, 1971; Bowman 1974; Parker 1964; Rudolph and Scholl 1969; Seward 1967, 1968; Van Vooren and Davies 1974; Van Vooren et al. 1977).

The western basin is the major spawning and nursery ground for Lake Erie yellow perch (Doremus 1975). Some of the yellow perch that spawn in the western basin in the spring migrate to the central basin after spawning and return to the western basin in the fall to overwinter

(Rawson, pers. comm. 1979). Yellow perch in the western basin apparently prefer to spawn in the nearshore waters at depths of 20 ft or less over sand, mud, and rooted aquatic vegetation (Rawson, pers. comm. 1979; Wolfert, pers. comm. 1979). Peak spawning occurs at water tempratures of about 50-54°F (Wolfert, pers. comm. 1979; Wolfert et al. 1975). Spawning success is positively correlated with high mean air temperature in May, rapidly increasing water temperature in April and May, and a low frequency of occurrence of strong winds (Scott et al. 1978b). Yellow perch do not usually spawn on the same sites used by walleyes in western Lake Erie (Wolfert et al. 1975).

Most hatching occurs May 1-15 when the water temperature reaches about 50°F (Comm. Fish. Rev. 1961a). Large numbers of yellow perch larvae are found throughout the western basin, but prolarvae are consistently concentrated at the bottom along beach fronts and nearshore areas (Baker 1966b; Baker and Scholl 1971c; Cole 1978a; Heniken 1977; Manz 1960, 1963; Waybrant and Shauver 1979). Older postlarvae are widely distributed; either spawning occurs over a very wide area or the larvae are widely dispersed soon after hatching (Cole 1978a; Waybrant and Shauver 1979). Considerable mixing of larvae from separate spawning areas in the western basin can occur; up to 50% of the larvae hatched within about 1/2 mi of the Michigan shoreline could be carried by currents into international waters within 10 days (Patterson 1979b). Large numbers of larvae also enter the basin from the Detroit River (42°03', 83°08') (Cole 1978b; MacMillan 1976; Waybrant and Shauver, undated).

In the 1920s, fry and eggs were collected in the western basin from mid-May to early September at depths of less than 13 ft; greatest concentrations occurred along the south and southwest shores from Marblehead Point (41°32', 82°43') to Monroe (41°55', 83°24') and among the Bass Islands (41°41', 82°49') (Wickliff 1928a). Many larvae were also found to depths of 66 ft (Fish 1929). Peak numbers of YOY are generally found during the last week of July in shallow, inshore areas (Van Vooren et al. 1975).

Michigan

Spawning occurs along the entire shoreline south from Stony Point (41°56', 83°16') over clay, mud, sand, gravel and aquatic vegetation (Organ et al. 1978). In 1975, yellow perch larvae were abundant along the beach area from the Raisin River (41°53', 83°20') to the Maumee River estuary (41°41', 83°28'); they were less abundant north of the Raisin River (Patterson 1979b). In 1976, larvae were abundant along the west shore of the western basin (Cole 1978a).

Huron River (42°02', 83°12'). This is a spawning and nursery area. Larvae move from the river into the lake (Patterson 1979b).

pointe Mouillee (42°01', 83°12')--Swan Creek (41°58', 83°15'). Yellow perch spawn in Swan Creek, and larvae move out of the creek into

the lake (Patterson 1979b). In 1935-68, yellow perch spawned in an area (41°591, 83°12') at the 6 ft depth contour 2 mi offshore, halfway between Pointe Mouillee and Swan Creek (Organ et al. 1978). Ichthyoplankton samples near the Fermi Power Plant (41°57', 83°15') were dominated by yellow perch larvae, most of which were early postlarvae (Detroit Edison 1978); yellow perch larvae were entrained at the plant in June (Detroit Edison 1976g). In 1976, yellow perch larvae were found along the beach (41°59', 83°14') just north of Swan Creek (Waybrant and Shauver 1979).

Brest Bay (41°55', 83°18'). Spawning occurs throughout the bay over mud and clay (Organ et al. 1978). The backwater area from Stony Point (41°56', 83°16') along the north shore of the bay (41°56', 83°18') is a major spawning and nursery area. This area has rooted aquatic vegetation, a depth of 4 ft, and little current. Spawning occurs in May at a water temperature of 48°F. Larvae 3 to 4 days old move from the spawning area into the bay (Thomas, pers. comm. 1979). In Michigan waters, YOY are more abundant off Sterling State Park (41°55', 83°20*) than in areas to the south (Jaworski and Raphael 1978b; MDNR 1970-76).

Monroe (41°55', 83°24'). Spawning occurs along shore throughout this area (Organ et al. 1978). The Monroe Power Plant (41°53', 83°21') is located near one of the largest yellow perch spawning areas in Lake Erie. Egg masses are entrained and accumulate on plant intake trash racks and screens in mid-May; many larvae are entrained in early June (Detroit Edison 1976h; Parkhurst 1971). There is a concentration of yellow perch larvae in June in the lower Raisin River (41°53', 83°20'); prolarvae are most abundant in the lower river, and postlarvae are most abundant in surrounding lake waters. The first larvae usually appear in collections in mid-May and most are taken before mid-June (MacMillan 1976; Nelson 1975; Nelson and Cole 1975; Patterson 1979b). In 1973-74, larvae were abundant in May in the mouth of the Raisin River and in the plant discharge canal (Cole 1976).

La Plaisance Bay (41°52*, 83°22'). Spawning occurs throughout the bay over mud and clay (Organ et al. 1978). The area is a turbid backwater about 10 ft deep with rooted aquatics and little current. Water temperature during spawning is about 48°F. Larvae 3 to 4 days old move from the inshore area into the surrounding lake waters (Thomas, pers. comm. 1979). The bay is a nursery area; in 1970, YOY were most abundant in the bay in August (Parkhurst 1971).

Toledo Beach (41°50', 83°24'). In 1977, the highest densities of prolarvae and early postlarvae were found at Toledo Beach in early May (Patterson 1979a).

Woodtick Peninsula (41°44', 83°25'). Spawning occurs over gravel along the entire shoreline (Organ et al. 1978). In 1975, larvae were abundant along shore (41°48', 83°26') just north of the Woodtick Peninsula (Waybrant and Shauver 1979). In 1978, maximum impingement of yellow perch at the Whiting Power Plant (41°47', 83°27') occurred in April; these fish were mainly adults that had moved to the shallows to spawn. Larvae were entrained at the plant and collected near the plant in May and June (Wapora 1979b).

0-1

The entire south shore of the western basin of Lake Erie is a yellow perch spawning and nursery area (Wolfert, pers. comm. 1979; Wickliff 1928a; CLEAR 1978).

Maumee Bay (41°43', 83°25'). Yellow perch spawn in the bay on the spoil areas along the channel, from April 15 to May 5 (Pinsak and Meyer 1976; U.S. Army Eng. Dist. 1976). Ripe or gravid adults were observed, and eggs were collected at a beach west of Cedar Point (41°42', 83°20'), over hard sand, clay, and gravel in water shallower than 20 ft (Rawson, pers. comm. 1979). Yellow perch larvae were collected in the bay and the Maumee River estuary (41°41', 83°28') and were most abundant on the bottom (CLEAR 1977; Reutter, Herdendorf, and Sturm 1978a,b; Patterson 1979b; Paul and Patterson 1977). The east side of the river mouth (41°42', 83°27') is a major nursery area; large concentrations of YOY yellow perch were documented here. This area to water depths of 3 ft has a silt-mud substrate, and dense, diverse strands of macrophytes (Fraleigh, pers. comm. 1979). In 1975-77, larvae were collected in the bay from April to June. The lack of perch larvae in the river indicated that spawning occurred primarily in the bay, possibly around the dredge disposal dike (Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Snyder 1978).

Cedar Point (41°42', 83°20')--Rena Beach (41°40', 83°16'). This is a major spawning area for yellow perch. Adults move inshore to spawn and return to offshore waters after spawning. Ripe adults were observed here, and eggs were collected in this area at the end of April; at depths of 3-20 ft the bottom is hard clay with patches of soft mud and gravel (Rawson, pers. comm. 1979; Reynolds, pers. comm. 1979; Wolfert, pers. comm. 1979).

Metzger Marsh (41°39', 83°14'). In 1975, larvae were abundant just off the marsh in late April (Herdendorf et al. 1976). In 1977, prolarvae and postlarvae were collected off Ward Canal (41°39', 83°14') in early May (Patterson 1979a). In 1961, large numbers of YOY were also found off Potters Pond (41°41', 83°18') (Ayers et al. 1970).

Crane Creek (41°38', 83°12'). Young-of-the-year were abundant off the creek mouth (Raker and Scholl 1971c; Gehres and Scholl 1969).

Locust Point (41°36', 83°05'). Yellow perch fry are one of the most common fry in the area (Reutter and Herdendorf 1977). In 1974-75, large numbers of very small yellow perch larvae were found in mid-May near the intake and discharge structures of the Davis-Besse Power Plant (41°36', 83°04') (CLEAR 1975b, 1976; USNRC 1975b). Smaller numbers of larvae and YOY were found in June and July along shore and in the plant intake canal (CLEAR 1975a, 1976; Herdendorf et al. 1976; Patterson 1979a; Reutter and Herdendorf 7975). Yellow perch may be spawning on the riprap of the intake and discharge areas (CLEAR 1975b, 1976).

Catawba Island (41°35', 82°51'). In 1919, YOY were collected in West Harbor (41°34', 82°49') (Turner 1920a). More recently, ripe-running adults and eggs were collected from Lakeside (41°33', 82°45') to Scott Point (41°35', 82°50') over sand bottom in 20 ft or less of water (Rawson, pers. comm. 1979; Wolfert, pers. comm. 1979). Young-of-the-year were very abundant inside and outside Fast Harbor (41°32', 82°47') (Baker and Scholl 1971c; Hair and Scholl 1971; Rudolph and Scholl 1970; Van Vooren et al. 1978), and along the west side of Catawba Island (Ball and Scholl 1973). In late May to early June 1975 and late April to early May 1976, the greatest concentrations of larvae were found in the shallow inshore areas, particularly from Catawba Island west to the Portage River (41°31', 82°56'). This area has sandy to gravelly substrate with Cladophora as the main vegetation. The larvae collected were newly hatched, suggesting that spawning grounds were nearby, but these larvae could also have been carried to shore from the offshore reefs by southerly currents from the Detroit River (42°03', 83°08') (Heniken 1977).

Island Region (41°40', 82°45'). Young-of-the-year yellow perch have been abundant in collections on the shoals around the Bass Islands (41°41', 82°49') usually in June, July, and August (Baker 1967c; Langlois 1954).

south Bass Island (41°39', 82°50'). In 1919, YOY were collected along the northeast shore (41°39', 82°48'), in Put-in-Bay (41°39', 82°49'), Terwilliger Pond (41°39', 82°50'), at Gibraltar Island (41°39', 82°49'), and on the western shore near the Hotel Victory (41°38', 82°51') (Turner 1920a).

Ballast Island (41 °41', 82°47'). Young-of-the-year were collected off the southwest tip of the island (Turner 1920a).

Middle Bass Island (41°41', 82°49'). Young-of-the-year were collected at the southeast (41°41', 82°48'), northeast (41°42', 82°48'), and northwest (41°41', 82°49') corners of the island (Turner 1920a).

Rattlesnake Island (41°41', 82°51'). Yellow perch larvae were collected off the north shore of the island (Turner 1920a).

Worth Bass Island (41°43', 82°49'). Young-of-the-year were collected along the southeast shore (at 41°42', 82°49' and 42°42', 82°48') and on the southwest point (41°43′, 82°50′) (Turner 1920a).

Kelleys Island (41°36', 82°42'). In early May 1976, the density of yellow perch larvae in this area was higher than elsewhere in the western basin (Heniken 1977).

Marblehead Light (41°32', 82°43'). In 1979, spawning adults were collected off Marblehead Light in 10-20 ft of water in April. After spawning, adults move away from the shore area. This is also a nursery area (Wolfert, pers. comm. 1979).

Sandusky Bay (41°29', 82°46') and Sandusky River (41°27', 82°59'). Yellow perch spawn in the bay and the river in April and early May, about 1-2 weeks earlier than in the lake proper; eggs are deposited on sticks and submerged vegetation. After spawning, adults migrate out of the bay into the lake. Adults return to the bay in the late summer, overwinter in the bay, and spawn there in the spring (Chapman 1954a, 1955; FWS 1979d; Hartley 1975; Hartley and Herdendorf 1975; Manz 1963).

In the early 1950s, YOY yellow perch were widely distributed throughout the bay (Chapman 1955). YOY are abundant in the bay and in the river from May through October (Baker 1967c; CLEAR 1977; Hartley 1975; Hartley and Herdendorf 1975). In late May 1975, the density of yellow perch larvae was higher in the bay than in other areas of the western basin (Heniken 1977). Both Cedar Point and Johnson Island (41°30', 82°44') have had high concentrations of YOY (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970). In 1974, 98% of the YOY caught in Ohio waters was taken at Cedar Point (41°29', 82°41') (Emond 1977); in 1976, the highest concentrations again occurred at Cedar Point (Van Vooren et al. 1977).

Cedar Point (41°29', 82°41')--Huron River (41°24', 82°33'). Ripe adults were observed and eggs were collected over sand bottom in 20 ft or less of water (Rawson, pers, comm. 1979).

O-2

Erie Nuclear Plant site (41°23', 82°30'). Spawning occurred in late April and early May at water temperatures below 54°F. Larvae were abundant in water 10-13 ft deep in May and early June, and in late June they were found at a depth of about 33 ft (Ohio Edison 1977).

Vermilion (41°26', 82°22'). Many YOY were collected in deep water off Vermilion (Van Vooren et al. 1975, 1978).

Beaver Creek (41°26', 82°15'). In 1979, many prolarvae and postlarvae were found out to the 36 ft depth contour in the lake near the creek mouth from May to July and from May to August, respectively. Juveniles were found from June to September (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). Spawning occurs in the harbor (Geo-Marine 1978), particularly on breakwalls; spawners also attempt, unsuccessfully, to run up French Creek, a harbor tributary (Odin 1979).

Avon Lake Power Plant (41°30', 82°03'). The area has rocky shorelines that are excellent yellow perch spawning habitat (Ohio EPA 1976). In 1975, adults were numerous in June; most were in spawning condition. A few larvae were collected in the vicinity of the plant in May at water temperatures of about 53-55°F (Aquat. Ecol. Assoc. 1976c). In 1977-78, 2-3% of the larvae entrained at the plant in April to June were yellow perch; 22% of the larvae collected in the lake in the spring were also yellow perch (Applied Biology 1977c).

Cleveland (41°30', 81°43'). In 1972-74, yellow perch spawned in Cleveland Harbor (41°31', 81°42'); egg masses were found on a wide variety of refuse (plastic, paper, wire, mops, Christmas trees), collecting nets, and Cladophora. Yellow perch were observed spawning on the Federal Wall Breakwall (at 41°30', 81°44' and 41°32', 81°40'), and YOY were commonly collected in the harbor (White, pers. comm. 1979; White et al. 1975). The beaches and breakwaters here serve as spawning and nursery areas (FWS 1979d). In 1972-74, YOY were also commonly collected in the Rocky River (41°30', 81°50') and adjacent shores; this may be a spawning and nursery area (White et al. 1975).

Chagrin River (41°41', 81°26'). A spawning run enters the river; most spawning occurs in heavy vegetation in the lower river. Young-of-the-year were common in the lower river and along adjacent lake shores, west of the river to the Eastlake Power Plant (41°40', 81°27') and also east of the river (Environ. Resour. Assoc. 1978; White, pers. comm. 1979; White et al. 1975). In 1975, small numbers of prolarvae were collected in the vicinity of the plant from May to August; in 7977-78, prolarvae were present near the river from April to June (Applied Biology 1979; Aquat. Ecol. Assoc. 1976b).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, large numbers of ripe and nearly ripe adults were collected on May 17-22, when water temperatures were 48-63°F. Eggs were collected on May 11, and small numbers of larvae and YOY were collected from May to July (NUS 1975).

Ashtabula (41°55', 80°47'). Historically, spawning sites here were within 1 mi of shore (Goode 1884). Currently, yellow perch spawn in 3-4 ft of water in the Ashtabula Harbor area and in the vicinity of the Ashtabula power plants (41°55', 80°46') (Aquat. Ecol. Assoc. 1976; White, pers. comm. 1979). Yellow perch collected in the area of the power plants were ripe or in near-spawning condition in May (Aquat. Ecol. Assoc. 1976). The nearshore catch of adults dramatically increases in May and decreases in July (Sweeney 1978). Larvae were collected inside and outside the harbor around the breakwall in vegetated areas 5-6 ft deep (Aquat. Ecol. Assoc. 1976; White, pers. comm. 1979). In 1977-78, larvae were entrained at the power plants from mid-May to mid-June. Yellow perch larvae were 40% of the total larvae collected in the area off the plants in the spring (Applied Biology 1979d,e).

Conneaut (41°58', 80°33'). Spawning occurs in Conneaut Harbor (41°58', 80°33'), in the lower sections of the Conneaut River (41°58', 80°33'), and along the surrounding shoreline. Young-of-the-year were also collected in these areas (White, pers. comm. 1979). An inshore spawning migration as well as a movement from west to east along shore between Conneaut and Raccoon Creek (41°59', 80°29') occur in late April and May (Aquat. Ecol. Assoc. 1978c; USACE, undated b). In May, the majority of adults here were found less than 1 mi from shore (Goode 1884). In 1977, ripe males were collected in the lake on May 9-11 and larvae were collected offshore in late June, between Conneaut and Raccoon Creek, indicating that spawning may have occurred from May to mid-June.

The inshore area immediately east of Conneaut Harbor provides a good spawning area because it is protected by the harbor breakwall. Larvae were also collected onshore, immediately west of Conneaut Harbor during June. There is also a spawning migration into the Conneaut River; the upstream portion of the Conneaut estuary is an important spawning area. On May 9-11, a large number of ripe males were collected in the river; larvae were collected during May and June in the river and harbor (Aquat. Ecol. Assoc. 1978c; USACE, undated b).

Pennsylvania

In 1894, the peak yellow perch run along the Pennsylvania shoreline of Lake Erie occurred between April 25 and May 15; spawning occurred during May to June (Moore 1894). Yellow perch spawning and nursery areas occur along the entire shore of Pennsylvania (Kenyon, pers. comm. 1979).

Elk Creek (42°01', 80°22'). Adults in breeding condition were found near Elk Creek in the spring, and larvae were also collected there (GPU Serv. Corp. 1979; USACE, undated b).

Presque Isle Bay (42°08', 80°07'). The shallows and lagoons of Presque Isle Bay are major spawning and nursery areas that have been used by yellow perch for a long period of time. The substrate of the lagoons is sand and rock with some vegeiation. Concentrations of gravid females have been collected in the bay and all along the shore in the spring in 10-50 ft of water. Yellow perch eggs, demersal fingerlings, and YOY have been collected. Adults move into the bay to spawn, and young yellow perch move offshore in the summer (Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979; USDI 1967).

New York

Barcelona Harbor (42°20*, 79°36'). Barcelona Harbor is a productive littoral area where yellow perch spawn (NYDEC 1977b).

Van Buren Bay (42°27', 79°25'). Yellow perch spawn in 3-4 ft of water over gravel and rock bottom with no vegetation. Concentrations of ripe and spent adults are present in late April (Griswold and Galati, pers. comm. 1979; U.S. Army Eng. Dist., Buffalo, undated a). In 1976, adults were very abundant in May during what may have been a spawning run (Tex. Instrum. 1977a). In 1976, eggs were collected in waters off Van Buren Point (42°27', 79°25') in early June. Prolarvae and postlarvae were abundant in May to July. Yellow perch was the dominant larva collected; peak numbers occurred in late May to early June. Yellow *perch* postlarvae were found at the 10 and 30 ft contours in late May to early June; about 80% of the postlarvae collected were yellow perch. Young-of-the-year were found in June to August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1976, many gravid, ripe, and spent adults were found in the harbor during the spawning season; spawning occurred over suitable habitat, probably in mid-April to early June at about 38°F. Eggs were entrained at the Dunkirk Steam Station (42°30', 79°21') in early May. Prolarvae and postlarvae were present in the harbor and entrained at the steam station in May and June and from May to July respectively (Tex. Instrum. 1977d,e).

Eagle Bay (42°32', 79°14'). In 1975, increased catches of adults in April and May were probably related to inshore spawning movements. Ripe-running adults were observed as late as June, and spawning probably began in late April and continued into June. Eggs were collected in late May. Yellow perch was the dominant prolarva collected in early May to mid-July; peak numbers occurred in late May to early June. Postlarvae were abundant at the 10-30 ft contours in mid-May to July; most of the postlarvae were collected in late May. Young-of-the-year were collected in June to September (Envirosphere 1977a,b; Tex. Instrum. 1976; U.S. Army Eng. Dist., Buffalo, undated a).

Silver Creek (42°33', 79°10'). In 1928, larvae were found off the creek (Fish 1932).

Sturgeon Point (42°41', 79°03'). In 1928, larvae were abundant in the area from Bertie Bay (42°53', 78°58') to Sturgeon Point in mid-July (Fish 1932). Recently, gravid yellow perch were observed in a shoal area, midway between Seneca Shoal (42°47', 78°55') and the New York shoreline, at a depth of about 13-26 ft; this may be a spawning area (Griswold and Galati, pers. comm. 1979).

Ontario

OE-1

Middle Sister Island (41°51', 83°00'). In 1967, YOY were abundant here in late July (Baker 1967c).

East Sister Island (41°48', 82°51). In 1967, fry were abundant just east of the island in May and June (Baker 1967c).

Pelee Island (41°47', 82°40'). In 1967, fry were abundant just north and south of the island in May and June (Baker 1967c).

Kingsville (42°02', 82°44'). In 1939 and the 1940s, yellow perch spawn was collected from ripe fish in the vicinity of Kingsville (Ont. Game Fish 1939, 1940, 1941, 1943, 1944, 1945, 1948).

OE-2

Rondeau Harbour (42°15′, 81°53′). In 1951-52, a few YOY were collected in the harbor (Scott 1955). In the late 1920s, a large concentration of larvae was found off the harbor in approximately 63 ft of water in mid-June (Fish 1932).

OE-4

Long Point Bay (42°40', 80°10'). Yellow perch begin to move inshore from deeper waters during mid-April when the water temperature rises to . 43°F from approximately 35°F. Spawning occurs in 26-33 ft of water from mid-April to June, and peaks about the first 2 weeks of May. Spawning begins when water temperature reaches 43-50°F. In the western part of the bay, spawning begins, peaks, and ends 2 weeks earlier than in the eastern portion (Sztranko and Teleki 1977; Teleki 1975a,b; Teleki et al. 1977). In 1971, ripe males and females were collected throughout Long Point Bay; very few were found in Inner Bay (42°37', 80°22') (Kelso 1972). Short migrations occur along the north shore. The gravel ridge running eastward from Kitchen Point (42°47', 80°08') to the Stelco dock (42°47', 80°05') is a prime fishing ground during the spawning season and may be a spawning area (Hamley and MacLean 1979).

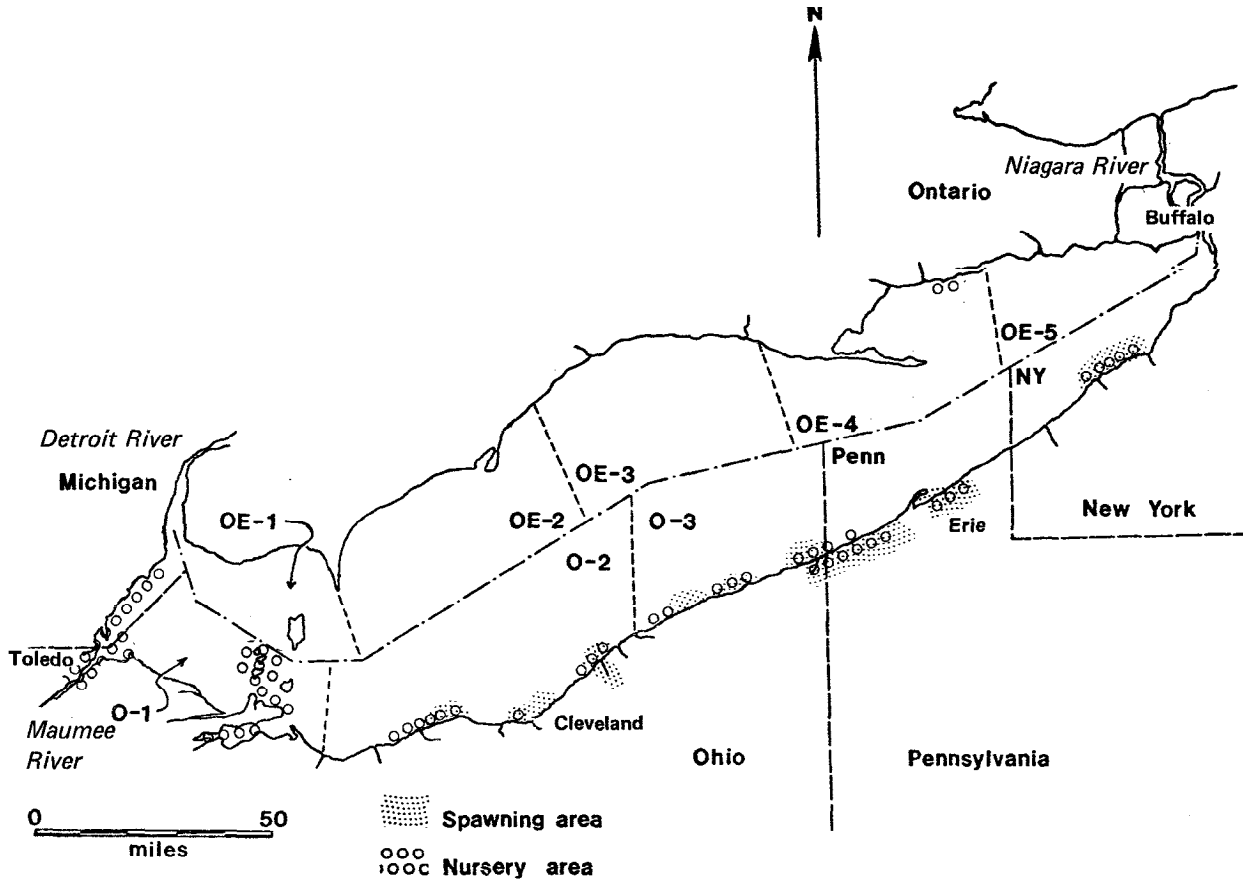
Inner Bay (42°37', 80°22') is a major spawning area (Environ. Can. 1977a). Yellow perch historically spawned in Big Creek (42°36', 80°27'), but access to the creek was blocked when a dam was constructed at the mouth in 1889. Although the route was opened again about 1895, the disruption was severe, and by 1930 yellow perch spawning in Inner Bay was limited to the north shore from Big Creek Marsh to Turkey Point Marsh (42°39', 80°21'). Spawning now occurs along the south shore of Long Point Bay and on bong Point (42°33', 80°10'), where yellow perch run into the lagoons in early April and early May; there may be resident reproducing populations in some of these lagoons (Mahon 1979, pers. comm. 1979; Mahon and Balon 1977a; Reid 1978). Yellow perch also spawn along the north shore from Port Rowan (42°38', 80°27') to St. Williams (42°40', 80°24') and from Fishers Glen (42°43', 80°18') to Port Dover (42<47', 80°12') (Whillans 1977, pers. comm. 1979).

Young-of-the-year are numerous throughout the bay in marsh areas at the Long Point lagoons, Big Rice Bay (42°36', 80°20'), Long Point Crown Marsh (42°35', 80°25'), Big Creek, and at Nanticoke (42°48', 80°04') (Hamley and MacLean 1979; Kelso 1972; Mahon and Balon 1977a; Reid 1978; Teleki 1976; Whillans, pers. comm. 1979).

OE-5

Abino Bay (42°51', 79°05'). This is a spawning and nursery area (Environ. Can. 1977a).

Bertie Bay (42°53', 78°58'). In 1928, larvae were abundant in the area from Bertie Bay to Sturgeon Point (42°41', 79°03'), New York, in mid-July (Fish 1930).



Michigan

Fermi Power Plant (41°57', 83°95′). In 1976, early postlarvae were collected in early July near the intake of the plant (Detroit Edison 1978).

Brest Bay (41°55', 83°18′). Larvae were abundant in Brest Bay (Cole 1978a; Patterson 1979a). In 1977, early postlarvae were collected in early June off Detroit Beach at 41°56′, 83°19' (Patterson 1979a).

Whitewood Creek (41°48′, 83°26′). In 1975, logperch larvae were collected along the beach (41°48′, 83°26′) north of Whitewood Creek in late June. Logperch larvae were generally more common in the southern portion of the Michigan waters; spawning occurs about 2 weeks earlier there than in more northern waters (Waybrant and Shauver 1979).

O-1

Maumee Bay (41°43', 83°25'). In 1975 and 1977, larvae were collected throughout the bay in small numbers in April, June and July (Herdendorf 1977; Herdendorf and Cooper 1975). The Maumee River estuary (41°41', 83°28') is a nursery area (CLEAR 1977; Snyder 1978).

West Harbor (41°34', 82°49'). In 1919, fry were collected in an area with no aquatic vegetation, except Eleocharis (Turner 1920a).

South Bass Island (41'-°39', 82°50'). In 1919, fry were collected at many sites all around the island usually on shallow, gravel, sand, and rock beaches with little or no aquatic vegetation. Fry were found at the Hotel Victory site in Stone Cove (41°38', 82°51'), off Peach Point (41°40', 82°50'), off East Point (41°40', 82°48'), off the northeast tip (41°40', 82°48'), and in the bay along the east shore (41°39', 82°48'). Green Island (41°39', 82°52'). Fry were collected off the west and east ends of the island on protected gravel and stone beaches. Lost Island (41°41', 82°47'). In 1919, fry were collected on a steep, gravel beach with pondweed. Middle Bass Island (41°41', 82°49'). Fry were collected in rocky beach areas off the southeastern side of the island at 41°40', 82°48' and 41°41', 82°48', and on a sandy beach with much aquatic vegetation off the northwest tip of the island (41°41', 82°49'). North Bass Island (41°43', 82°49'). Fry were collected on rubble and sand beaches both with and without aquatic vegetation, off the southeastern end of the island at 41°41', 82°49' and 42°42', 82°48' (Turner 1920a).

Sandusky Bay (41°29', 82°46'). In the 1960s, a few young-of-the-year (YOY) logperch about 1.0-3.4 in. long were collected in the western portion of the bay from May to October (Baker 1966b; Keller 1964a). The Sandusky River estuary (41°27', 82°59') is a nursery area (CLEAR 1977).

O-2

Beaver Creek (41°26', 82°15'). In 1979, early and late postlarvae were collected out to the 36 ft depth contour off the creek mouth from late June to late August (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). Logperch larvae were collected in Lorain Harbor (41°28', 82°11'); only 1% of the catch of larvae here were logperch (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, a few prolarvae were collected near the plant in June (Aquat. Ecol. Assoc. 1975).

Cleveland (41°30', 81°43'). Logperch spawn on the beach at Lakewood (41°30', 81°47') approximately 3-1/2 mi E of the mouth of the Rocky River; logperch spawn in this area on slightly larger rocks than do longnose dace (White, pers. comm. 1979). In 1972-74, a few YOY or fry were collected in Cleveland Harbor (41°31', 81°42'); this may be a spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1975, logperch prolarvae were in the vicinity of the Eastlake Power Plant (41°40', 81°27') in June. Spawning is believed to occur in the immediate area or at the mouth of the Chagrin River (Aquat. Ecol. Assoc. 1976b; Environ. Resour. Assoc. 1978).

O-3

Garry Power Plant (41°48', 81°09'). In 1974, logperch were more abundant tha other percid larvae in the vicinity of the plant from early May to mid-July; peak abundance occurred in late June at a water temperature of about 59°F. Prolarvae were collected in July, indicating a prolonged spawning season in the area (NUS 1975).

Arcola Creek (41°51', 81°00'). Ripe adults were collected on the beach just west of the mouth of the creek over gravel and stones of 4-6 in. diameter (White, pers. comm. 1979).

Ashtabu a (41°55', 80°47'). Logperch spawn in Ashtabula Harbor (41°551, 80°47') in 5-15 ft of water; larvae were collected in the harbor (White, pers. comm. 1979). In 1977-78, about 2% of all larvae entrained at the Ashta ula power plants (41°55', 80°46') during mid-April to late June were lo$_I$perch (Applied Biology 1979e).

Conneau (41°58', 80°33'). Logperch enter the Conneaut River (41°58', 80°33') and Turkey Creek (41°58', 80°32') to spawn. In 1977, larvae were collected from both tributaries in May and June. In late August, fry ere collected on the bottom, 1/2 mi offshore from Turkey Creek. Larvae were also collected inshore and offshore between Conneaut and Raccoon Creek (41°59', 80°29'), and in Conneaut Harbor (41°58', 80°33') (Aquat. Ecol. Assoc. 1978c). Logperch spawn in Conneaut Harbor in 5-15 ft of water. Spawning takes place on the eastern and western outer edge of the h rbor as well as inside the harbor itself. Ripe adults were collected on the beach in the same area where johnny darters and longnose dace were tak n; logperch usually spawned over slightly larger rock than did the other two species. Logperch fry were also collected here (White, pers. comm. 1979).

Pennsylvania

In the spring, large spawning runs enter tributaries that are not near falls. Spawning occurs in the warm, shallow pool areas not too far up stream in 1 ft or less of water probably over vegetation. Young-of-the-year are found in late May and early June in the streams; downstream to the lake, where they are found in 36 to August. The following are spawning and nursery areas.

Raccoon Creek (41°59', 80°29'). Larvae were collected in the creek in June (Aquat. Ecol. Assoc. 1978c).

(42°00', 80°26'). In 1975, many logperch were seen he creek over sand and gravel in swift water in late April; less than 33 ft upstream from the creek mouth

but did occur as far as 4,000 ft upstream. Ripe adults were collected as late as May 30, and larvae were collected in Lake Erie in June and July (Cooper 1978).

Elk Creek (42°01', 80°22'). In 1974, the abundance of adults increased in the riffle areas from early May to early June and decreased sharply after June (GPU Serv. Corp. 1979). Many larvae were collected off the creek mouth in June and July (USACE, undated b; GPU Serv. Corp. 1979).

Trout Run (42°03', 80°16'), Walnut Creek (42°04', 80°14'), Presque Isle Bay (42°08', 80°07'), Fourmile Creek (42°09', 80°02'), Sixmile Creek (42°11', 79°59'), Eightmile Creek (42°1 I', 79°58*), and Twelvemile Creek (42°13', 79°55') (Kenyon, pers. comm. 1979).

New York

In eastern Lake Erie, logperch ascend streams to spawn on riffles until late June (Greeley 1929).

Van Buren Bay (42°27', 79°25'). In 1975, logperch was one of the most abundant species of larvae in waters off Van Buren Bay. Both prolarvae and postlarvae were collected from May to August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1976, eggs were entrained at the Dunkirk Steam Station (42°30', 79°21') from early to late June, prolarvae from late May to July, and postlarvae from June to August. Logperch was one of the most abundant species entrained (Tex. Instrum. 1977e). Prolarvae were abundant in the harbor from May to August and postlarvae from June to August; it was assumed that spawning occurred in or near the harbor area (Tex. Instrum. 1977d).

Eagle Bay (42°32', 79°14'). In waters off Eagle Bay, logperch was one of the most abundant species of larvae. Both prolarvae and postlarvae were collected during May to August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03'); YOY were present in the area from June 7 through July 26 (Teleki 1976).

CHANNEL DARTER

Channel darters ascend Lake Erie tributaries to spawn (Greeley 1929); they also spawn on bouldery lake shoals in the western basin (Langlois 1954).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1976, small numbers of late postlarvae were collected offshore from the plant in mid-July (Detroit Edison 1978).

Ohio

0-1

Middle Bass Island (41°41', 82°49'). In 1949, breeding adults were collected at Lutz's Point (location unknown) in late June (Garrett 1949, as cited by Langlois 1954).

New York

Eighteenmile Creek (42°43', 78°58'). Ripe males were found in mid-July on riffles 1/4 mi upstream from the creek mouth (Greeley 1929).

SAUGER

Saugers were virtually extinct in Lake Erie but have recently been reintroduced (Rawson and Scholl 1978b; White, pers. comm. 1979). Historically, saugers in the western basin moved inshore and spawned in April and May, often before ice-breakup (Doan 1941, 1942b; Moore 1894; Rawson and Scholl 1972b), and large catches were made at this time (MSBFC 1887). Saugers spawned along shore at the extreme western end of Lake Brie and in other shallow places in the western basin (Rathbun and Wakeham 1897). Runs entered tributaries, where spawning occurred over rocky and sandy bottom; spawning also occurred in the inshore waters along the south shore, particularly near Maumee Bay (Fish 1929; Regier et al. 1969). Eggs were collected from the bottom in shallow water along the south and west shores of the western basin (Wickliff 1928a). In 1928, fry appeared to be concentrated in May to August along the southwest and south shores from Monroe (41°55', 83°24') and Lakeside (location unknown), Michigan, east across the entrance to Maumee Bay (41°43', 83°25') to Marblehead (41°32', 82°43') (Wickliff 1928a).

Michigan

Swan Creek (41°58', 83°15')--Stony Point (41°56', 83°16'). Since 1921, saugers have spawned in an area along the shore over mud bottom out to about the 20 ft depth contour (Organ et al. 1978).

woodchuck Creek (41°51', 83°24'). Since 1921, spawning has occurred in an area (extending from 41°51', 83°20' to 41°50', 83°19') about 3-4 mi off the creek over gravel in 14-20 ft of water (Organ et al. 1978).

Otter Creek (41°51', 83°24'). Since 1921, saugers have spawned in an area (41°50', 83°21') 3-4 mi off the mouth of the creek over clay in about 14 ft of water (Organ et al. 1978).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Historically, a very large sauger fishery existed at Toledo (41°40', 83°30'); saugers were the major catch in the bay until April 15 (Moore 1894). Eggs were collected from pondweeds inside the bay (Wickliff 1928a). Saugers presently migrate into the Maumee River (41°41', 83°28') to spawn in March and April (Lake Erie Fish. Unit Staff 1979; Rawson, pers. comm. 1979; Rawson and Scholl, 1978a,b). Concentrations of mature adults are found in the bay *in* May (USACE 1976c) and on cobble and boulder riffles in the river (Rawson and Scholl 1978a,b). In 1977, prolarvae and postlarvae were found in small numbers in early May and early June at the entrance to the bay, around Cedar Point (41°42', 83°20') and between the point and the shipping channel (41°43', 83°22'). In 1976, one larva was collected on the riffles above Perrysburg on April 8 (Herdendorf 1977; Berdendorf and Cooper 1976; Patterson 1979a).

Locust Point (41°36', 83°05'). Historically, saugers were caught until April 15 in the area from (Upper) Cedar Point (41°42', 83°20') to Locust Point (Moore 1894). Mature saugers are presently collected off Locust Point (Rawson and Scholl 1978a,b).

Island Region (41°40', 82°45'). In the spring, fishermen first caught migrating adults south of Green Island (41°39', 82°52'), then between the islands, and then in the deep hole (at approximately 41°37', 82°38') northeast of Kelleys Island. Until 1953, saugers either spawned en route to or in the deep hole (Trautman, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). Saugers presently migrate from the western basin into the Sandusky River (41°27', 82°59') in March and April (Lake Erie Fish. Unit Staff 1979; Rawson, pers. comm. 1979; Rawson and Scholl 1978a,b; Wolfert, pers. comm. 1979) to spawn on the riffles at Fremont (FWS 1979d). In 1976-77, mature adults were collected in the bay and the river along shale bedrock ridges and over sand and gravel

substrate from March 15 to May I; running-ripe females were caught on April 12-15 (Rawson and Scholl 1978a,b). Until the 1950s, there was also a lake spawning population in the Sandusky area (Wolfert, pers. comm. 1979).

O-2

Lorain (41°28', 82°11'). Larvae were collected in very small numbers in Lorain Harbor (41°28', 82°11') (Geo-Marine 1978).

Chagrin River (41°41', 81°26'). A few young-of-the-year (YOY) were collected off the river mouth (White, pers. comm. 1979).

O-3

Ashtabula River (41°55', 80°47'). A few YOY have been collected off the river (White, pers. comm. 1979). Larvae were entrained during April to June at the Ashtabula power plants (41°55', 80°46') (Applied Biology 1979e).

Conneaut River (41°58', 80°33'). In 1979, a few larvae were collected off the Conneaut River (White, pers, comm. 1980).

Ontario

OE-4

Inner Bay (42°37', 80°22'). Saugers historically spawned during April in the lower waters of Big Creek (42°36', 80°27') and occasionally in the bay outside the mouth of Big Creek and in other tributaries leading into the bay (Kerr and Kerr 1860-1898; Whillans 1977).

BLUE PIKE

The blue pike was once an abundant and commercially important fish in the lower Great Lakes. Although there was disagreement about the taxonomic differences between blue pike and walleye, the blue pike was usually considered a subspecies. Populations of blue pike were mainly confined to central and eastern Lake Erie, the Niagara River, and western and southern Lake Ontario. The Lake Erie fishery for blue pike collapsed in 1958, and the last confirmed specimen in the lower Great Lakes was collected in 1965 (Blue Pike Recovery Team 1975; Parsons 1967).

The blue pike generally spawned on gravel bars in Lake Erie, in about 20-40 ft of water, in May and June; it was found in water shallower than 36 ft only durinq the spawning season (Deason 1933; Doan 1942; Scott 1967; Slastenenko 1957; Van Oosten and Hile 1949; Wolfert, pers. comm. 1979). In the 1890s, the best runs of blue pike along the Pennsylvania

shoreline occurred in May. Blue pike appeared in catches east of Sandusky and Kelleys Island in April; they were most abundant there in the latter part of May and in June (Moore 1894; Rathbun and Wakeham 1897). Until the 1960s, blue pike spawned on gravel bars in the central basin in 20-40 ft of water; primarily in an area from Lorain (41°28', 82°11') to Conneaut (41°58', 80°33') (White, pers. comm. 1979). Until about 1965, eggs were collected from ripe blue pike in an area extending east from Sandusky (41°27', 82°42') through the basin, about 5-10 mi from shore (Reynolds, pers. comm. 1979).

Although blue pike have been reported to spawn only in the central and eastern basins (Trautman, pers. comm. 1979; White, pers. comm. 1979; Wolfert, pers. comm. 1979), spawn from ripe fish was collected in the western basin (Ont. Game Fish 1939, 1940).

Michigan

Stony Point (41°56', 83°16'). Blue pike spawned between Point aux Peaux (41°57', 83°15') and Stony Point in an area extending from 41°58', 83°13' to 41°55', 83°13' and from the shoreline offshore for 2-3 mi to the 20 ft depth contour (Organ et al. 1978).

Pennsylvania

Spawn was collected from ripe fish in Pennsylvania waters (Bean 1913). In 1953, gravid walleyes and blue pike were collected together in gill nets on the bottom in 50 ft of water at a water temperature of 48°F in May. It was concluded that blue pike spawned at about the same temperature in Lake Erie and Lake Ontario. In Lake Erie, blue pike usually spawned about 1 month later than walleyes, because the deeper waters of the eastern basin where blue pike spawned warmed more slowly in spring than did the waters where walleyes spawned (Blue Pike Recovery Team 1975).

Long Point Bar (Northwest Sand Bar) 42°19', 80°20'. In 1960 and 1961, small numbers of eggs were found in Pennsylvania waters at the end of Long Point Bar (GLFC 1960, 1961).

Erie (42°07', 80°05'). In the 1950s and 1960s, ripe blue pike were collected in 60 ft of water off Erie (at approximately 42°12', 80°15' and 42°17', 80°00') in April and May (Larsen, pers. comm. 1979).

New York

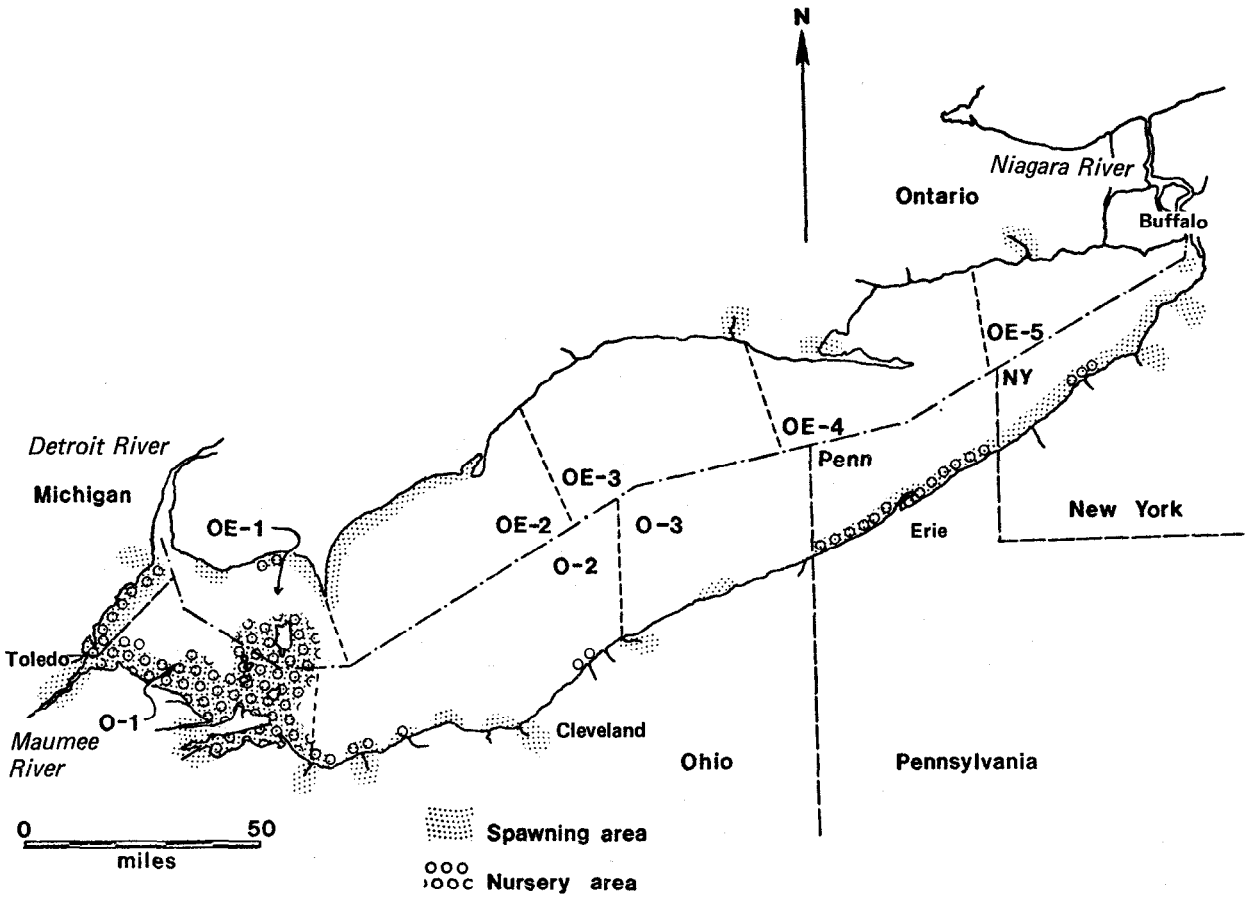
In the New York waters, blue pike migrated to breeding areas and spawned somewhat later than walleyes (N.Y. Dep. Conserv. 1921).

OE-4

Long Point Ray (42°40', 80°10'). Historically, spawning occurred in the lower reaches of Big Creek (42°36', 80°27') and occasionally in Inner Bay (42°37', 80°22') outside the creek mouth (Kerr and Kerr 1860-1898; Whillans 1977). This stock of blue pike disappeared about 1960 (Whillans 1977).

OE-5

Lowbanks (42°52', 79°27'). In 1910, a spawning run occurred in the vicinity (Ont. Game Fish 1911).



In Lake Erie, walleyes spawn in late March to mid-May; spawning peaks in late April or early May (NYDEC 1977a; Rathbun and Wakeham 1897; Schuter and Koonce 1977; Wickliff 1957), when the ice breaks up and the water temperature approaches 45°F (Fish 1932; FWS 1945; Parsons 1972; Van Oosten and Hile 1949). Spawning occurs near reefs, in streams, bays, and along most of the shoreline. Walleyes exhibit a homing tendency; each reef may support its own discrete spawning population (Lake Erie Res. Unit Staff 1978; Wolfert, pers. comm. 1979). Historically, spawn was collected in Lake Erie in March and April (Langlois 1945b). Spawning success is more affected by rate and regularity of water warming in spring than by water level. If slow warming occurs, the incubation period is lengthened, and eggs are more vulnerable to the adverse effects of storms, siltation, etc. (Busch et al. 1975; Harris and Eschmeyer 1975; Muth 1977; Scott et al. 1978a; Tait 1973). Spawning grounds on reefs may not be used if wind-induced wave action is too strong (Leach et al. 1977).

The western basin of Lake Erie is the major spawning and nursery area for walleyes in Lake Erie (Nepszy 1977; Parsons 1971; Schneider and Leach 1979; Wolfert 1963). Spawning occurs in tributaries, on reefs, and along most of the shoreline (CLEAR 1978; Frank et al. 1978; Rathbun and Wakeham

1897; Wapora 1977a). Historically, spawn was collected in the western end of the lake in April (MSBFC 1895). Spawning has begun as early as March 31, at a water temperature of 39°F, and as late as April 19. Spawning usually begins in approximately the second week in April at a water temperature of 42°F and peaks during the third week of April at a temperature of 46-47°F (Baker and Scholl 1971a; Rudolph and Scholl 1970b). Hatching usually occurs May 1-15 at 50°F (Comm. Fish Rev. 1961a). Young-of-the-year (YOY) are generally found over sand or hard clay (Wright and Tidd 1933), usually in no more than 20 ft of water. Young-of-the-year remain near the spawning areas, or in areas slightly closer to shore, throughout the summer (Wolfert, pers. comm. 1979). In the 1920s, eggs and fry were concentrated along the south and west shore from Marblehead, Ohio (41°32', 82°43'), to Monroe, Michigan (41°55', 83°24') (Wickliff 1928a).

Walleyes make extensive spawning and post-spawning migrations within the western basin. Some migrate west from the central basin along the south shore, to spawning reefs in the lake and to spawning areas in bays, streams, and the larger rivers such as the Sandusky (41°27', 82°59'), Portage (41°31', 82°56'), Toussaint (41°35', 83°04'1, and Maumee (41°41', 83°28') (Rawson, pers. comm. 1979). The walleyes in the western basin are believed to intermingle to some extent with those of the St. Clair-Detroi t River System; movement occurs freely between the water bodies (Applegate and Van Meter 1970). Walleyes migrate from Lake St. Clair into the western basin to spawn; they also migrate from the western basin to spawn in Lake St. Clair (Manz, unpublished data; Christie, unpublished data, as cited in Regier et al. 1969; Wolfert, pers. comm. 1979) l Young-of-the-year move into Lake Erie from Lake St. Clair (USDI 1967) and also move from the western basin of Lake Erie into the St. Clair System (USBCF 1966). Extensive post-spawning migrations occur from the Maumee Bay area (41°43', 83°25') into Lake St. Clair (Van Vooren 1976a). Fishermen historically followed walleyes as they moved toward the Detroit River in the fall. Tagging recoveries indicate a post-spawning migration northward to the Canadian reef area (41°48', 82°49') then west to the Detroit River (42°03', 83°08') and into Lake St. Clair and southern Lake Huron (Julien 1967). A spawning migration occurs from southern Lake Huron and Lake St. Clair to the mouth of the Detroit River, and then to spawning grounds on the western and southern shore of Lake Erie (Baker 1967d, 1969a; Baker and Scholl 1969; van Vooren 1978). In 1979, tagging recoveries indicated that a post-spawning migration also occurs from the Michigan waters of the western basin to Pennsylvania waters (Kenyon, pers. comm. 1979).

walleyes spawn along the shoreline throughout the entire eastern basin from the Ohio-Pennsylvania border to Little Sister Creek (42°40', 79°04'). The spawning grounds are rocky and usually in water 4-6 ft deep. There are few reefs or shoals in this area, and spawning takes place wherever rocky areas exist. This area has probably been used for spawning since the early 1950s, based on the collection of ripe fish (Wolfert, pers. comm. 1979).

Since 1925, spawning has occurred along shore from Swan Creek (41°58', 83°15') south to Turtle Island (41°45', 83°23') in about 12-18 ft of water over rock bottom (Organ et al. 1978).

Huron River (42°02', 83°12'). Walleyes migrated up the Huron River to Ann Arbor to spawn (Langlois 1945a), but dams, pollution, and sedimentation destroyed these spawning grounds (Schneider and Leach 1977).

Pointe Mouillee (42°01', 83°12'). Spawning occurred here (Laarman 1971). Since 1921, walleyes have spawned 1 and 3 mi off Pointe Mouillee at 42°01', 83°11' and 42°00', 83°09', respectively. Spawning also occurs over gravel and mud about 2 mi east of the point, along the western edge of the shipping channel, from 42°01', 83°09' to 42°03', 83°08' (Organ et al. 1978).

Swan Creek (41°58', 83°15')--Stony Point (41°56', 83°16'). Historically, adults in spawning condition were taken at Stony Point. Fishermen's catches indicated that the run started near Vermilion (41°26', 82°22'), moved past the Catawba peninsula (41°35', 82°51'), and then to stony Point (Hosko 1967). Walleye presently spawn at Point aux Peaux (41°571, 83°15') and Stony Point (Reynolds, pers. comm. 1979). Since 1911, spawning has occurred throughout the area from Swan Creek to Stony Point out to the 20 ft contour over gravel, rock, clay, and mud. In 1935-68, spawning occurred about 4 mi E (41°58', 83°10') of the mouth of Swan Creek over rock and clay (Organ et al. 1978). Larvae were entrained during June at the Fermi Power Plant (41°57', 83°15') (Detroit Edison 1976g). In 1959, small concentrations of YOY were collected along the shore from the Detroit River (42°03', 83°08') south to the Raisin River (41°53', 83°20'); YOY were most abundant over sand in 10-19 ft of water (Parsons 1972).

Monroe (41°55', 83°24'). In the 1950s, spawn was collected by commercial fishermen at Monroe (Westerman 1954). Spawning occurs in an area (41°52', 83°21') just off the mouth of Plum Creek in up to 6 ft of water (Reynolds, pers. comm. 1979); until the 1950s, spawning also occurred over rock in an area (41°52', 83°17') about 3 mi from the creek mouth, at depths to 18 ft (Organ et al. 1978). Walleyes also spawn on the reefs along the shipping channel (41°53', 83°20'--41°53', 83°17') at the mouth of the Raisin River (Reynolds, pers. comm. 1979). At the Monroe Power Plant (41°53', 83°21'), eggs and larvae were entrained in early May and early June (Detroit Edison 1976h). Young-of-the-year were relatively abundant off Monroe (MDNR 1970-76); they appeared to be concentrated over hard clay, sand and gravel in 10 ft of water in an area (41°52', 83°20') off the mouth of Plum Creek (Rawson, pers. comm. 1979).

Otter Creek (41°51', 83°24'). Since 1921, spawning has occurred in an area (41°50', 83°21') about 3 mi offshore over clay (Organ et al. 1978).

Muddy creek (41°50', 83°25'). Walleyes spawned (no dates given) in an area (41°49', 83°25') off the mouth of the creek in 1-7 ft of water (Reynolds, pers. comm. 1979).

Whiting Power Plant (41°47', 83°27'). Maximum impingement occurs in May, and most of the fish are adults that had moved to the shallows to spawn. Larvae were collected in North Maumee Bay and entrained at the plant in May and June (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Historically, the bay area was the most productive walleye spawning ground in Lake Erie; walleyes were the most abundant fish taken in the bay beginning around mid-April (Moore 1894; Rathbun and Wakeham 1897). Spawning migrations were recorded as early as 1885, and until 1950, spawning occurred as far as 30 mi upstream at Grand Rapids ("Les Grand Rapides") (Langlois 1945a; Trautman 1957). During the late 1800s, spawn was collected in and near the bay in April (MSBFC 1897, 1899). Walleyes migrate through Maumee Bay to spawn on the rocky areas of the Maumee River (41°41', 83°28') in March and April; some migrate as far upstream as the rapids at Perrysburg (CLEAR 1977, 1978a; Lake Erie Res. Unit Staff 1977, 1978; Langlois 1941, 1944, 1945a; Nepszy 1977; Pinsak and Meyer 1976; ODNR 1976; Rawson, pers. comm. 1979; Rawson and Scholl 1978b; Regier et al. 1969; Snyder 1978; Trautman 1957, pers. comm. 1979; Van Vooren 1976a,b, 1978; Wapora 1977b, 1978a,b; Wolfert, pers. comm. 1979). Temperatures in the river during spawning range from 37 to 64°F (Van Vooren 1978). Tagging studies have shown that the spawning population exhibits homing tendencies (Van Vooren 1976a,b; Wolfert, pers. comm. 1979). Rapidly warming water temperatures of the tributaries may decrease the duration of spawning migrations (Lake Erie Res. Unit Staff 1978). Dams, pollution and sedimentation have severely damaged the spawning grounds in the river (Parsons 1972; Schneider and Leach 1977). In addition to serving as a migration pathway for walleye stocks that spawn in the river (Fraleigh and Tramer 1974; Frank et al. 1978; USACE 1976; Wapora 1977c), Maumee Bay also contains a number of spawning grounds. Collections of eggs on the rock shoals in the eastern part of the bay (at 41°42', 83°25'; 41°42', 83°24'; and 41°44', 83°20') and around the shoals, spoils area, and dredge islands along the shipping channel in the central bay (from 41°42', 83°27' to 41°47', 83°19') indicated that spawning occurs in water 1-16 ft deep at temperatures of 42-61°F, from late March to late April (Fraleigh and Frank, undated a,b; Frank et al. 1978; Organ et al. 1978; Reynolds, pers. comm. 1979). Since 1900, or earlier, spawning occurred offshore at a site (41°42', 83°25') southeast of the spoils area; this spawning area may have been destroyed by power plant discharges. Since 1931, spawning has occurred on the dredge spoils areas; the spoils site (41°42', 83°27') at the mouth of the Maumee River was filled in about 1960 and no longer supports spawning (Reynolds, pers. comm. 1979). The ODNR believes that silt deposits prevent walleyes from spawning in the bay (Fraleigh and Tramer 1974; USACE

1976). Limited early season sampling of larvae has indicated that Maumee Bay is an important spawning area (Herdendorf 1978; Hendendorf and Cooper 1975, 1976).

The bay is also a nursery area (USACE 1976). In 1975-77, larvae were collected in the bay from late April to June. Downstream movement of larvae from the Maumee River occurs as the yolk-sac is being absorbed (Snyder 1978).

Ward Canal (41°39', 83°14'). In 1976, fairly high densities of prolarvae and postlarvae were found just off the canal in early May (Patterson 1979a).

Crane Creek (41°38', 83°12'). Young-of-the-year were abundant near Crane Creek (Baker and Scholl 1971c; Hair and Scholl 1971; Rudolph and Scholl 1970; USNRC 1973, 1975).

Locust Point (41°36', 83°05') and Locust Point Reef Complex (41°39', 83°02'). This entire reef complex including West Sister Island (41°44', 83°06') and Locust Point (41°39', 83°04'), Niagara (41°40', 82°58'), Crib (41°39', 83°00'), and Toussaint (41°38', 83°01') reefs is a major spawning area (Ayers and Anderson 1969; Ayers et al. 1970; Baker and Scholl 1971a; Regier et al. 1969; Rudolph and Scholl 1970b). Eggs and fry were collected throughout the area (Hohn 1966; Regier et al. 1969). Sampling during the early 1960s showed that the smaller fry, about 0.2-0.3 in. long, were collected among the reefs in this area. Later in the season, the larger fry about 0.4-0.5 in. long were found about 4 mi SW of the reef area, inshore near Locust Point, in 6-10 ft of water over mud and sand (Manz 1963).

West sister Island (41°44', 83°06'). The area from the island south to Locust Point is a major spawning area; spawning occurs at water temperatures of about 43-59°F, and many eggs have been collected in April and early May (Keller 1964b; Keller and Manz 1960, 1963).

Turtle Reef (41°40', 83°06'). Eggs were collected here (Baker 1964).

Locust Point Reef (41°39', 83°04'). This is a major spawning area; many eggs have been collected from the reef (Baker 1964, 1967d; Manz 1960; Rudolph and Scholl 1970b).

Niagara Reef (41°40', 82°58'). This is a major spawning area where eggs and many larvae have been collected. Spawning begins anytime from late March to mid-April at water temperatures of 36-46°F and usually peaks about the third week of April at a water temperature of 46°F (Baker 1964, 1966b, 1967d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Heniken 1977; Manz 1960; Rudolph and Scholl 1970b; Wolfert, pers. comm. 1979).

Crib Reef (41°39', 83°00'). This is a major spawning area where eggs have been collected. Spawning begins anytime from late March to mid-April at water temperatures of about 36-46°F and peaks about the

third week of April at water temperatures of about 41-53°F (Baker 1964, 1966b, 1967b, 1967d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Lake Erie Fish. Unit Staff 1977, 1978; Manz 1960; Rudolph and Scholl 1970b; Van Vooren 1978; Wolfert, pers. comm. 1979).

Toussaint Reef (41°38', 83°01'). This is a major spawning area where eggs have been collected and spawning has been observed in 1-16 ft of water. Spawning begins any time from late March to mid-April at 36-46°F and peaks about the third week of April at water temperatures of about 41-53°F. Peak abundance of adults on the reef has occurred on April 14 at 41°F (Baker 1964, 196633, 1967b,d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Manz 1960; Reynolds, pers. comm, 1979; Rudolph and Scholl 1970b; Van Vooren 1976a,b; Van Vooren and Davies 1974).

Locust Point (41°36', 83°05'). Walleye eggs are abundant off Locust Point over rock bottom (Heniken 1977). Spawning occurs in the Sand Beach area (41°37', 83°05') just off Locust Point, in 9-12 ft of water over gravel and rock (Reynolds, pers. comm. 1979). In 1976-78, prolarvae and postlarvae were found in fairly high densities in May just off shore over sand and rock (Heniken 1977; Patterson 1979a; Reutter 1979b, 1979c). A few larvae were found on either side of Locust Point, west to Cedar Point (41°42', 83°20') and east to Catawba Island (41°35', 82°51'); these could have been carried off the spawning reefs by southerly currents (Heniken 1977). In 1959, YOY were abundant along the shore from Sandusky Bay west to Cedar Point; they tended to concentrate over sand bottom in water 10-19 ft deep and none were found in water deeper than 29 ft (Parsons 1972). Recent collections of YOY indicate that the sandy shoreline areas from Locust Point east to Catawba Island and west to Cedar Point may be nursery areas (Wolfert, pers. comm. 1979). Historically, adults were caught in the area from Locust Point to Cedar Point only during April (Moore 1894).

Toussaint River (41°35', 83°04'). Spawning occurs off the mouth of the river (at 41°36*, 83°04') (Reynolds, pers. comm. 1979).

Portage River (41°31', 82°56'). Spawning runs enter the river and proceed upstream to rock and gravel areas, where spawning occurs in water 1-16 ft deep at temperatures of 43-55°F (Lake Erie Fish. Res. Unit Staff 1977; Langlois 1965; Rawson, pers. comm. 1979; Reynolds, pers. comm. 1979). Spawning occurs at Port Clinton (41°31', 82°56') (Laarman 1971). In 1966, ripe females were collected near Port Clinton in April (Wolfert 1969).

Sugar Bluff (possibly Sugar Rock; 41°34', 82°51'1, Mouse Island (41°35', 82°50'), and Moore's Point (location unknown). Historically, spawning occurred on these extensive grounds (Goode 1884).

West Harbor (41°34', 82°49'). Historically, this was an extensive spawning ground (Goode 1884). In the 1960s, eggs were collected on reefs (41°34', 82°48'; 41°35', 82°49'; and 41°35', 82°48') just offshore (Baker 1964).

East Harbor (41°32', 82°47'). Historically, this was a spawning ground (Goode 1884). In 1977, 40% of the YOY collected in Ohio waters were captured in East Harbor (Van Vooren et al. 1978); they were also abundant during 1969 and 1970 (Baker and Scholl 1971c).

spit Island (location unknown). Historically, this was an extensive spawning ground (Goode 1884).

Bass Islands (41°41', 82°49'). Historically, spawning occurred over extensive grounds at Put-In-Bay (41°39', 82°49'), North Bass (41°43', 82°49'), and Middle Bass (41°41', 82°49') Islands (Goode 1884). The islands and associated reefs have been acknowledged as major spawning sites based on collections in 1943-62 of adults, eggs, and fry (Baker and Manz, as cited in Regier et al. 1969; Baker and Scholl 1971a; Parsons 1970). In 1961-62, fry were collected in May near spawning grounds on the west side of the Bass Islands (Hohn 1966). Egg collection around the islands indicate that most spawning occurs over rocky substrate in less than 15 ft of water (Baker and Scholl 1971a; Heniken 1977; Keller 1964b; Keller and Manz 1963; Manz 1960; Regier et al. 1969). Eggs were collected from the Bass Islands-Kelleys Island Shoal (41°38', 82°39') complex and associated shoals from April to early May at water temperatures of 43-59°F (Keller 196433). West Island Shoal (West Reef; 41°43', 82°51'), west of North Bass Island, was a major egg collecting site (Baker 1964, 1966b, 1967d, 1969a; Baker and Scholl 1971a; Manz 1960; Rudolph and Scholl 1970b). A few fry and YOY were collected from the islands area (Baker 1965; Hohn 1966; Parker 1964; Parsons 1972; Selden and Van Meter 1960).

Starve Island Reef (41°37', 82°49'). This is a major spawning area (Baker 1964, 1966, 1967b, 1969a; Baker and Scholl 1969, 1971a; Manz 1960; Rudolph and Scholl 1970b). A number of fry 3 in. long were collected at a depth of 26 ft at an unidentified location between Starve Island (41°38', 82°49') and Middle Island (41°41', 82°41') (Langlois 1954).

Kelleys Island Shoal (41°38', 82°39'). This is a major spawning reef (Busch et al. 1975; Goode 1884; Rudolph and Scholl 1970b; Wolfert, pers. comm. 1979; van Vooren 1976a,b, 1978). Spawning adults were collected here (Wolfert et al. 1975), and spawning was observed over rubble and boulder bottom at a depth of 5-6 ft in late April at a water temperature of 48°F (Baker 1967b). Spawning on the shoal begins at a water temperature of 39°F and peaks at 45°F (Wolfert et al. 1975). Eggs have often been collected from the shoal (Baker 1964, 196633, 1967b,d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Keller 1964b; Keller and Manz 1963; Manz 1960; Rudolph and Scholl 1970b).

Gull Island Shoal (41°40', 82°41'). Egg collections indicate that this is a major spawning area (Baker 1964, 1966b, 1967d, 1969a; Manz 1960; Rudolph and Scholl 1970b).

Marblehead Peninsula (41°32', 82°43'). Historically, this was an extensive spawning ground (Goode 1884). Sampling in 1943-62 also showed that the area around Marblehead Peninsula is a spawning and nursery ground (Parsons 1970).

Sandusky Bay (41°29', 82°46'). Walleyes enter the bay and the Sandusky River (41°27', 82°59') to spawn in March to May; some spawning occurs as far upstream as Fremont (Baker 1967d; Baker and Scholl 1969, 1971a; Chapman 1955; CLEAR 1977; FWS 1979d; Griswold et al. 1978; Lake Erie Res. Unit Staff 1978; Langlois 1945a; Rawson, pers. comm. 1979; Rawson and Scholl 1978b; Regier et al. 1969; Reynolds, pers. comm. 1979; Wapora 1977; Wolfert, pers. comm. 1979). Historically, walleyes were so abundant at the Sandusky River rapids in the spring that one could not cross the rapids without stepping on them (Keeler 1904). Eggs for hatchery use were collected in the Sandusky area on about April 1 (Howe 1907). Presently, the river is a minor spawning area compared to the reef areas (Applegate and Van Meter 1970; USBCF 1966; USDI 1967), and walleye are not very common in the bay except during the spawning run (Van Meter 1963). Spawning also occurs in the bay itself (FWS 1979d; Laarman 1971; Regier et al. 1969), and a spawning ground historically existed at Cedar Point (41°29', 82°41′) (Goode 1884). Water temperatures during the spawning season range from 37-64°F (Van Vooren 1978). Tagging studies have shown that the spawning population in the Sandusky River exhibits a homing tendency and may be discrete from the populations of the reefs (Van Vooren 1976a,b, 1978; Wolfert, pers. comm. 1979). Rapidly warming temperatures may decrease the duration of spawning migrations (Lake Erie Res. Unit Staff 1978). Pollution, dams, and siltation have damaged the spawning areas in the river (Busch et al. 1975; Schneider and Leach 1977; USDI 1967).

Young-of-the-year were collected in the bay and at the entrance to the bay at Cedar Point in May to October (Baker 1966b; Baker and Scholl 1971c; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Keller 1964a; Rudolph and Scholl 1970a; Selden and Van Meter 1960; Van vooren and Davies 1974; van Vooren et al. 1978); YOY were most abundant in Sandusky Bay and adjacent sites along the shore at Cedar Point (Van Vooren et al. 1977). In 1974, 48% of the YOY captured in Ohio waters were taken at Cedar Point (van Vooren 1975). Catches of YOY indicate that the shoreline from Cedar Point east to Old Woman Creek (41°23', 82°31′) is a nursery area (Wolfert, pers, comm. 1979).

O-2

Huron River (41°24′, 82°33′). A spawning migration enters the river (PWS 1979d).

Vermilion (41 °26′, 82°22′). Historically, walleyes entered the Vermilion river (41°26′, 82°22,) and proceeded at least 30 mi upstream to spawn above Wakeman (Langlois 1945a). In 1960, walleye eggs were collected just off Vermilion (Manz 1960). In 1973-77, YOY were abundant at Vermilion (Van Vooren et al. 1978),

Beaver Creek (41°26′, 82°15′). In 1979, prolarvae were found out to the 36 ft depth contour in late May, postlarvae in mid-June, and juveniles in early July. A few YOY were captured at Oak Point Beach near the creek mouth in mid-June and in late August (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). Ripe adults were collected over gravel in about 10 ft of water in an area (41°28', 82°12') just west of Lorain; this may be a spawninq area (White, pers. comm. 1979). In 1973-77, YOY were abundant at Lorain (Van Vooren et al. 1978).

Avon Lake Power Plant (41°30', 82°03'). Ripe adults were collected nearshore, (41°30', 82°04') in about 10 ft of water over a gravel bottom (White, pers. comm. 1979). In 1975, walleyes were abundant in June near the power plant; these may have been mature adults seeking suitable spawning sites (Aquat. Ecol. Assoc. 1976c).

Cuyahoga River (41°30', 81°43'). Spawning migrations entered the river and moved upstream to the rapids above Akron, but dams, pollution, and sedimentation destroyed these spawning areas (Langlois 1945a; Schneider and Leach 1977). Presently, walleyes spawn in about 10 ft of water on a gravel beach at Lakewood (41°30', 81°47'), just west of the river mouth (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Larvae were collected in water 25 ft deep off the river mouth (White, pers. comm. 1979).

O-3

Grand River (41°46', 81°17'). Historically, spawning migrations entered the river, but dams, pollution, and sedimentation have destroyed the spawning areas (GLBC 1975; Langlois 1945a; Schneider and Leach 1977). Walleyes in the river are believed to be remnants of the run that existed before a dam was built at the river mouth (GLBC 1975).

Perry Power Plant (41°48', 81°09'). In 1974, one prolarva was collected here in early May (NUS 1975).

Ashtabula (41°55', 80°47'). Adults in spawning condition were collected off the Ashtabula power plants (41°55', 80°46') just east of the Ashtabula River (Aquat. Ecol. Assoc. 1976).

Pennsylvania

Walleyes spawn along the entire Pennsylvania shoreline over rock in water approximately 4-12 ft deep. Ripe males and females were collected in May at the mouths of creeks flowing into Lake Erie; YOY were taken in August, on rocky beach areas, usually within the 36 ft depth contour. After spawning, approximately 10% of the walleyes on the east side of Presque Isle peninsula migrate to areas from Barcelona (42°20', 79°36') to Buffalo (42°55', 78°53') (Kenyon, pers. comm. 1979; Moore 1894).

Raccoon creek (41°59', 80°29'). Walleyes spawn on gravel bars off the mouth of the creek and east to Crooked Creek (42°00', 80°26') (White, pers. comm. 1979).

Presque Isle Bay (42°08', 80°07'). Pipe walleyes were collected in the inner portion of the bay (Kenyon, pers. comm. 1979).

New York

Major nursery areas exist along the New York shore (Schneider and Leach 1979).

Barcelona (42°20', 79°36'). There is a major spawning reef near Barcelona (Harris and Eschmeyer 1975). In 1966, ripe walleyes were collected here in April, and in 1968, spawning walleyes were captured offshore in May (Wolfert 7969; Wolfert and Van Meter 1978). In June and July, soon after spawning at Barcelona, walleyes migrate along the south shore to Buffalo (42°55', 78°53'); in late summer and fall, these fish return along the south shore to Barcelona (Harris and Eschmeyer 1975; Moore 1894; Wolfert and Van Meter 1978). In 1979, ripe and spent adults were caught 3 mi W of Barcelona in April over rocks and gravel in 3-6 ft of water (Griswold and Galati, pers. comm. 1979).

Lake Erie State Park (42°25', 79°26'). The collection of ripe and spent adults in late April suggests that this is a major spawning area. Spawning occurs on a smooth gravel and rock bottom with no vegetation in water approximately 3-6 ft deep (Griswold and Galati, pers. comm. 1979).

Van Buren Point (42°27', 79°25'). This is a spawning area (NYDEC 197733). In 1976, walleye eggs and prolarvae were collected here in late April (Tex. Instrum. 1977a).

Van Buren Bay (42°27', 79°25'). The presence of ripe adults and the collection of spent adults in late April suggest that this is a major spawning ground. Spawning takes place over gravel and rock in 3-4 ft of water with no vegetation (Griswold and Galati, pers. comm. 1979). Catches of adults increased in the bay in May reflecting the inshore run. Many walleye eggs were found in yellow perch stomachs. A few prolarvae and postlarvae were collected in late May and a few YOY in August (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1967, gravid, ripe and spent fish were found in the harbor (Tex. Intrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). A few adults were impinged at the Dunkirk Steam Station (42°30', 79°21') in March and April. Some adults apparently entered the harbor, although the bottom is silted and unsuitable for spawning (Tex. Instrum. 1977d). Walleye eggs were found throughout the harbor in April (Niagara Mohawk Power 1976, as cited in Tex . Instrum. 1978; Tex. Instrum. 1977d); eggs were entrained at the Dunkirk Steam Station in April and May (Tex. Instrum. 1977e). A few prolarvae were entrained at the station in May; postlarvae were entrained on June 1 (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14'). Young-of-the-year are present in the area in July (U.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). Large spawning migrations enter the creek, and the creek mouth is one of the most important spawning areas in New York waters (Buffalo Waterfront Dev. Comm., undated; GLFC 1977).

Evangola State Park (42°37', 79°07'). The entire shoreline from the park to Sturgeon Point (42°41', 79°03') may support spawning (NYDEC 197733). Catches of ripe and spent adults in April suggest that the park is a major spawning ground. Spawning takes place over rock and gravel in areas with no vegetation in about 3-6 ft of water (Griswold and Galati, pers. comm. 1979).

Eighteenmile Creek (42°43', 78°58'). Anglers report that a spawning run enters the creek (Buffalo Waterfront Dev. Comm., undated). Sunset Bay (42°43', 78°59'), off the mouth of the creek, is one of the best walleye spawning areas in Lake Erie (NYDEC 1977b).

Seneca Shoal (42°47', 78°55'). Gravid fish have been observed here, and spawning occurs. The shoal, composed of sand and rock, is in water approximately 13 ft deep (Griswold and Galati, pers. comm. 1979).

Ontario

OE-1

Comet (42°01', 83°00'). Walleyes spawn about 1 mi offshore (42°00', 83°00') in 23 ft of water (Environ Can. 1977a).

Grecian Shoal (41°58', 82°56'). The rocky shoreline near Colchester (41°59' , 82°56') and for several miles west was considered by fishermen to be a spawning ground (Krause 1967).

Canadian reefs (41°48', 82°49'). Egg collecting attempts indicate that the reefs north of the Bass Islands support only limited spawning (Baker 1967b). Only a few eggs were found in the area around East Sister Island (41°48', 82°51'), on Chick Island Shoal (41°46', 82°49'), and on the shoals (41°45', 82°48') south of the Hens and Chickens (Baker 1967b,d; Keller 1964b; Keller and Manz 1963; Manz 1960). Hen Island Shoal (41°49', 82°47') may be a spawning area (Wolfert, pers. comm. 1979).

Pelee Island (41°47', 82°40'). Until recently, large runs of fully ripe adults moved to the shoals around the island; nets set in the area were sometimes covered with spawn (Julien 1967; Krause 1967; Regier et al. 1969; Tiessen 1967). During the 1960s, eggs were collected around the island, mainly off Mill Point (at 41°45', 82°38*) (Baker 1964, 1967b; Keller 1964b) and on Chickenolee Reef (41°43', 82°37') (Baker 1964; Keller and Manz 1963); a few were found off Middle Point (41°48', 82°37') (Keller 1964b) and Lighthouse Point (41°50', 82°38') (Keller and Manz 1963). Fry 1.5-2.0 in. long were seined over rocky substrate along the north and east shores of the island (Langlois 1954).

Kingsville (42°02', 82°44'). Ripe walleyes moved onto sand and gravel areas here (Regier et al. 1969); one spawning area was located about 1-3/4 mi offshore (42°00', 82°45') in 28 ft of water (Environ. Can. 1977a). Young-of-the-year were found at Kingsville in September (Selden and Van Meter 1960).

Point Pelee (41°55', 82°30'). The entire shoreline of Point Pelee National Park (41°58', 82°32') is a spawning area (Environ. Can. 1977a). Until recently, large numbers of ripe walleyes moved onto the reefs off the point and onto the gravel and sand areas along the west shore (Julien 1967; Krause 1967; Tiessen 1967); by about 1950, these areas were degraded by domestic and cannery wastes from Leamington (42°01', 82°36') and neighboring towns (Regier et al. 1969). In the spring, adults were first taken by fishermen about 15 mi SE of Point Pelee; the fish then moved towards the shore areas of Pelee Island (41°47', 82°40') and Point Pelee (Krause 1967).

OE-2

Erieau (42°14', 81°55'). Historically, the bays here were spawning grounds (Kerr and Kerr 1860-1898). Walleyes in spawning condition were taken inshore from Wheatley (42°04', 82°26') to Erieau; this area was considered a minor spawning ground (Krause 1967).

OE-3

Big Otter Creek (42°37', 80°48'). A spawning run enters the creek (Environ. Can. 1977a).

OE-4

Inner Bay (42°37', 80°22'). Historically, spawning occurred in lower Big Creek (42°36', 80°27') and at times in the bay off the creek mouth in April or early May. Between 1880 and 1889, it was recognized that the habitat in the creek was being degraded; silt from deforestation and sawdust and bark from sawmills covered the substrate. A dam built in 1889 1 mi upstream from the creek mouth inhibited spawning migrations at least until 1894, and walleyes from the run that spawned in the river were forced to spawn in the bay. In 1930, spawning was further inhibited when a causeway constructed along the west end of Inner Bay cut off the creek from the bay. By 1940, walleyes were almost entirely absent from Inner Bay. Walleyes now rarely spawn in the bay (Kerr and Kerr 1860-1898; Whillans 1977, 1979a,b, pers. comm, 1979),

OE-5

Grand River (42°51', 79°35'). In 1890, a run of walleyes entered the river in the spring (Kerr and Kerr 1860-1898). In 1945, the need for a fish way over the dam near Dunnville was recognized (Ont. Game Fish 1946).

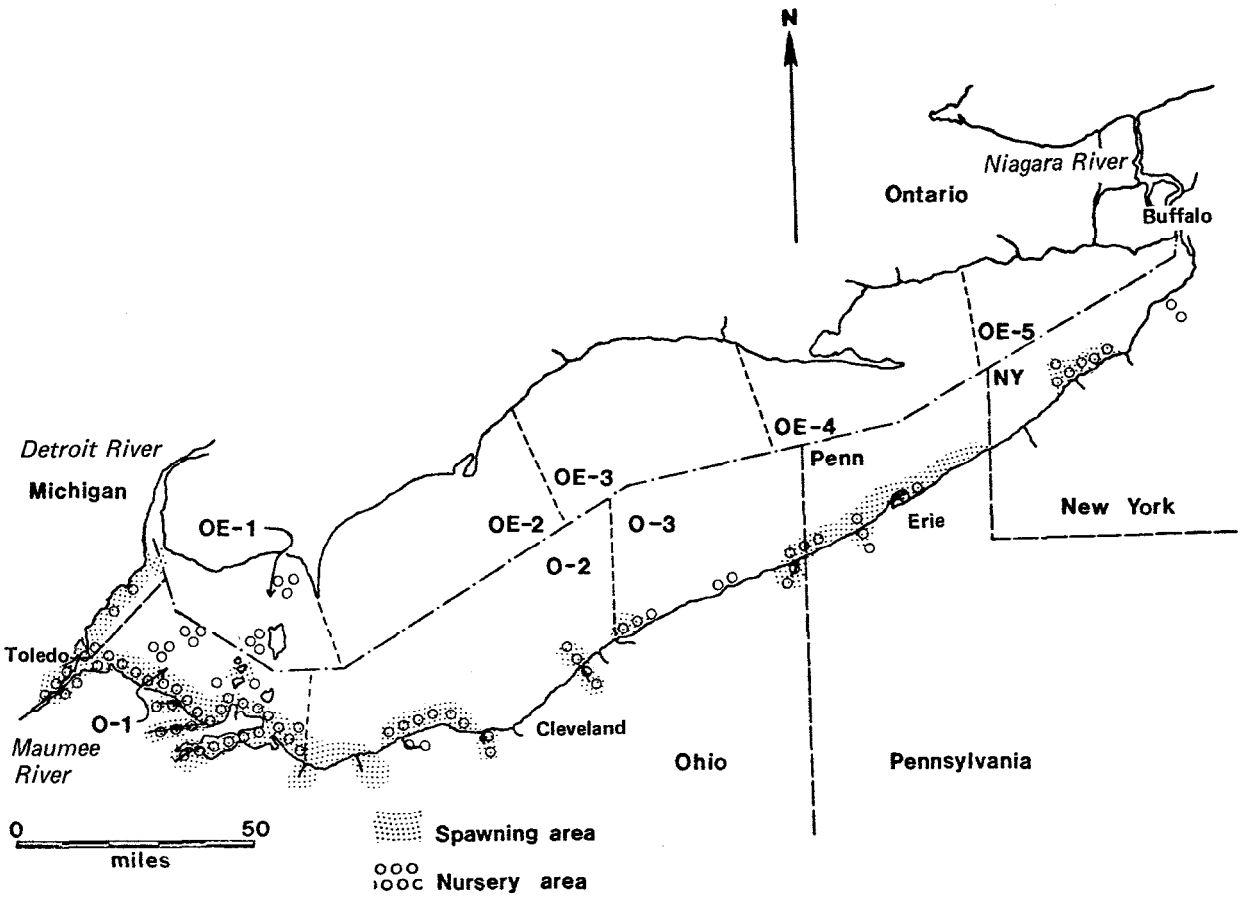
DARTER spp.

Ohio

O-2

Cleveland Harbor (41°31', 81°42'). The beaches and breakwaters here are spawning and nursery areas for darters (Odin 1979).

FRESHWATER DRUM



In Lake Erie, freshwater drum generally spawn in the spring or early summer at water temperatures of 68-70°F. Movement to spawning areas may begin as early as April at water temperatures of 43°F. Spawning occurs from May through August but mainly in June and July (Bur, pers. comm. 1979; Daiber 1950, 1953; Edsall 1967; Kinney 1954; Scott 1967; Van Oosten 1938; Van Oosten and Hile 1949). Spawning occurs anywhere in bays, on shoals,- and in the open lake (FWS 1979d).

The western basin is the major area in Lake Erie used by drum for reproduction; sheltered bays and lower river sections are important spawning and nursery areas (CLEAR 1977; Daiber 1953; Foell 1974; FWS 1979d). The entire south shoreline of the western basin is also a spawning and nursery area (Bur, pers. comm. 1979). Spawning may also occur in the open lake at depths of less than 40 ft (Daiber 1950, 1953). In 1958, spawning occurred from late June to early August (Edsall 1967).

In 1960, the peak hatching period for the western basin was July 1-15 at an average water temperature of 75°F (Comm. Fish. Rev. 1961a). In 1960-76, the highest densities of YOY in U.S. waters usually occurred in the western basin (Anderson 1966; Baker 1966b; Baker and Bower 1965;

Baker and Scholl 1970, 1972; Rudolph and Scholl 1969; Seward 1967; Van Vooren and Davies 1974; Van Vooren et al. 1977). The large adults probably move from the western basin into deeper waters to the east after spawning (Daiber 1950).

In the central basin, drum prefer the slack water of the lower reaches of rivers and harbors (White, pers. comm. 1979). During lakewide surveys conducted during 1958-71, the central basin contained the second highest density of young-of-the-year (YOY) next to the western basin (Anderson 1966; Baker 1966a,b,c, 1969c; Baker and Bower 1965; Baker and Scholl 1970; Rudolph and Scholl 1969; Seward 1967, 1968).

Michigan

In Michigan waters, the freshwater drum usually spawns in early June; larvae are found until mid-July or August (Waybrant and Shauver 1979). Until the 1950s, spawning occurred along the entire shoreline from Stony Point (41°56', 83°16') to the Woodtick Peninsula (at 41°46', 83°26') (Organ et al. 1978).

Pointe Mouillee (42°01, 83°12'). Since the 1950s, spawning has occurred over gravel and mud about 2 mi east of the point, along the western edge of the shipping channel, at 42°03', 83°08'--42°01', 83°09' (Organ et al. 1978).

Pointe Mouillee (42°01', 83°12')--Swan Creek (41°58', 83°15'). In 1935-68, freshwater drum spawned in an area (41°59', 83°12') 2 mi offshore between Pointe Mouillee and Swan Creek at about the 4-6 ft depth contours (Organ et al. 1978).

Fermi Power Plant (41°57', 83°15'). In 1976, prolarvae were collected inshore near the plant intake in early July (Detroit Edison 1978).

Raisin River (41°53', 83°20'). Larvae were very common at the mouth of the river and in nearby lake waters (MacMillan 1976; Nelson 1975); 99% of the freshwater drum larvae taken here were prolarvae, indicating that spawning may have occurred in the immediate area. Larvae were most abundant in the nearshore waters; these either hatched in the- area or drifted into the area from Maumee Bay (Cole 197830; MacMillan 1976). Postlarvae were abundant offshore (Cole 1978a). In 1975-76, many larvae were entrained at the Monroe Power Plant (41°53!, 83°21') in June and July (Detroit Edison 1976h).

Woodtick Peninsula (41°44', 83°25'). In 1975-76, very small larvae were most abundant in 6-12 ft of water off the Woodtick Peninsula (at 41°46', 83°25') in mid-July; in 1976, many eggs were collected here and also farther offshore in 12-18 ft of water (at 41°47', 83°23') in early to mid-June (Waybrant and Shauver 1979). In August 1974, YOY were most abundant off the Woodtick Peninsula (MDNR 1970-76). In 1978, larvae were

entrained at the Whiting Power Plant (41°47', 83°27'); peak entrainment occurred in June. In 1978, larvae were also collected in the bay off the plant and were most abundant in July (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25') and Maumee River (41°41', 83°28'). Spawning migrations enter the bay and the river in May and June. In 1975, most of the adults collected in the bay in May and June were ripe or gravid (USACE 1976c). Spawning is believed to occur in the bay from approximately June 15 to July 15 at a water temperature of 68°F. Floating eggs were collected in water 5 ft deep (Pinsak and Meyer 1976). Eggs were also collected in the lower Maumee River (CLEAR 1977). Since 1950, freshwater drum have spawned around Turtle Island (41°45', 83°23'), at the mouth of the bay, in 2-10 ft of water (Organ et al. 1978). In the river, young are carried downstream by the current as they absorb their yolk sac. The bay is a nursery area. In the bay, most larvae are found near the bottom (Cole 1978a; Heniken 1977; Snyder 1978). Larvae are found almost exclusively in highly turbid areas; the greatest concentrations in the western basin are found in Maumee Bay and the lower Maumee River, usually in June (Heniken 1977; Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Herdendorf et al. 1976; Patterson 1979a). In 1975, larvae were collected near the mouth of the river and the Bayshore Power Station discharge channel (41°42', 83°26') in July (USACE 1976c). In 1975-77, larvae were abundant throughout the bay in May to July (Herdendorf 1977; Herdendorf and Cooper 1975, 1976). In late June 1975, concentrations of larvae were higher in the inner bay near the mouth of the river and in the lower river than offshore in the bay (Herdendorf et al. 1976).

Locust Point (41°36', 83°05'). Eggs and ripe adults were collected in the Toussaint River (41°35', 83°04') in late May (Rawson, pers. comm. 1979). In 1978, prolarvae were found in moderate densities at the intake of the Davis-Besse Power Station (41°36', 83°04') in late June (Reutter 1979c).

Portage River (41°31', 82°56'). Eggs and ripe adults were collected in the river in late May; YOY were also taken in the river (Daiber 1950, 1952; Rawson, pers. comm. 1979). Drum from the island region enter the river and spawn over clay bottom (Reynolds, pers. comm. 1979).

East Harbor (41°32', 82°47'). In 1969-73, many YOY were collected both inside and outside the harbor; higher concentrations occurred outside the harbor (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolf and Scholl 1969).

Island Region (41°40', 82°45'). In 1953, males with running milt were captured west of Green Island (41°39', 82°52') in late June at a water temperature of 72°F (Kinney 1954). In 1958, eggs were collected in Hatchery Bay (41°39', 82°49') and Squaw Harbor (41°39', 82°49') on South

Bass Island in early July (Davis 1959). Spawning probably also occurs in the open lake, but spawning sites are difficult to identify because the pelagic eggs and larvae are easily transported by currents (Daiber 1950, 1953; Davis 1959). Young-of-the-year were caught in the deep, open lake water around the Lake Erie islands from July to October (Daiber 1950, 1953; Edsall 1967). In 1958, YOY were most abundant among the islands in western Lake Erie and south to the Ohio shore and were relatively scarce off Monroe (at 41°57', 83°12') and the mouth of the Detroit River (at 41°59', 83°05'); they were also moderately abundant north of Huron (at 41°29', 82°33') and at 41°49', 83°00' south of Middle Sister Island (Edsall 1967; pers. comm. 1980).

Sandusky Bay (41°29', 82°46') and Sandusky River (41°27', 82°59'). Large spawning runs enter the bay in late spring and then return to the lake in summer and fall (Bur, pers. comm. 1979; Chapman 1955; Foell 1974). In 1816, large numbers of freshwater drum were observed in the river during the spring (Keeler 1904). Collections of ripe adults and eggs in late May and later collections of YOY indicate that the lower river and the bay are important spawning and nursery grounds (Ball and Scholl 1973; CLEAR 1977; Daiber 1950, 1952, 1953; FWS 1979d; Gehres and Scholl 1969; Hair and Scholl 1971; Hartley 1975; Keller 1964a; Rawson, pers. comm. 1979; Rudolf and Scholl 1969). In the bay, spawning occurs in 6 ft of water over sand or mud bottom (Daiber 1950). Young-of-the-year are collected in May and June (Hartley and Herdendorf 1975). Many YOY were taken in weedy areas at the upper end of the bay from May to October and also around Johnson Island (41°30*, 82°44') in lower Sandusky Bay (Ball and Scholl 1973; Daiber 1950; Gehres and Scholl 1969; Hair and Scholl 1971; Keller 1964a; Rudolph and Scholl 1969).

O-2

Huron River (41°24', 82°33'). Heavy spawning runs enter the river in the spring (White, pers. comm. 1979). Eggs and ripe adults have been collected in the river in late May (Rawson, pers. comm. 1979). In 1976, numerous pelagic eggs that were possibly freshwater drum eggs were collected in the lower river during mid-June to late July (Cleveland Environ. Res. Group, undated).

Erie Power Plant site (41°23', 82°30'). In 1974, freshwater drum eggs were abundant in the area. Spawning probably starts in mid-June and continues through August at water temperatures of 62-76°F (Ohio Edison 1977).

Vermilion River (41°26', 82°22'). Historically, large adults were observed in April, along with suckers, on riffles in the river (McCormick 1892). Heavy spawning runs enter the river in the spring (White, pers. comm. 1979).

Beaver Creek (41°26', 82°15'). In 1979, eggs were collected throughout the area off the creek mouth from June 12 to July 5. Prolarvae were found from June 12 to August 22; postlarvae were collected from June 21 to September 4; YOY were found from July 23 to September 4 (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). In 1892, young (no age given) were common below the dam on the Black River in August and September (McCormick 1892). In 1977, freshwater drum were present onshore during the spawning season, but only a few larvae were collected in the harbor (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, a few eggs and larvae were collected here in June and July (Aquat. Ecol. Assoc. 1976c).

Rocky River (41°30', 81°50'). Spawning occurs in the river mouth; in 1972-74, YOY were collected in the river (White, pers. comm. 1979; White et al. 1975).

Chagrin River (41°41', 81°26'). A spawning run enters the river; in 1972-74, YOY were collected in the lower river (White et al. 1975). Most larvae were found around the river mouth, but some were collected upstream (Environ. Resour. Assoc. 1978). In 1975, eggs and larvae were collected at the Eastlake Power Plant (41°40', 81°27') near the Chagrin River in June and July; in 1977, they were collected in the same area in late June (Applied Biology 1979b; Aquat. Ecol. Assoc. 1976b). It was assumed that spawning occurred in the immediate vicinity of the power plant (Aquat. Ecol. Assoc. 1976b).

O-3

Perry Power Plant (41°48', 81°09'). In 1972, an inshore run occurred in June; this movement coincided with the spawning season and was probably a spawning migration (NUS 1973). In 1974, freshwater drum eggs were collected at the site from June through August and were most abundant on July 12. Spawning probably occurred from mid-June through August at water temperatures of 59-76°F. Eggs were found almost exclusively in the upper portion of the water column and were most abundant at the middle and offshore stations. Eggs were present as early as June 12, but larvae were not found until July 12. Prolarvae were collected mainly near the bottom. Larvae about 0.2-0.3 in. long were collected at all depths (NUS 1975).

Ashtabula (41°55', 80°47'). In 1977, larvae were collected at the Ashtabula power plants (41°55', 80°46') on June 27 and July 11 (Applied Biology 1979d,e).

Conneaut (41°58', 80°33'). In 1977, eggs were collected in the area extending from Conneaut to Raccoon Creek (41°59', 80°29'), in Conneaut Harbor (41°58', 80°33'), and in the Conneaut River (41°58', 80°33') in June and July at water temperatures of 55-77°F. Larvae were also collected at these locations (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Freshwater drum spawn anywhere along the Pennsylvania shoreline in water less than 42 ft deep over rock, rubble and clay bottom. Gravid females were collected during spawning season in late June and July along the Pennsylvania shoreline.

Elk Creek (42°01', 80°22′). Ripe adults were present in the creek during May and in the lake during July. Eggs and larvae were collected near the creek (GPU Serv. Corp. 1979).

Presque Isle Bay (42°08', 80°07'). This is a major spawning and nursery area (Kenyon, pers. comm. 1979).

New York

Van Buren Bay (42°27', 79°25'). In waters off Van Buren Bay, freshwater drum eggs were collected in June and July; 95-100% of the eggs collected there were freshwater drum. Prolarvae were collected in mid-June and July, indicating that spawning occurred in late May or early June. Qeak abundance of prolarvae occurred in early July. Small numbers of postlarvae were collected in July (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Enq. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1976, prolarvae were entrained on July 6-12 at the Dunkirk Steam Station (42°30', 79°21') (Tex. Instrum. 1977e). Postlarvae were present in Dunkirk Harbor during July (Tex. Instrum. 1977d).

Eagle Bay (42°32′, 79°14′). In waters off Eagle Bay, freshwater drum eggs were collected from mid-June to July; 47-99% of the eggs collected there were freshwater drum. Prolarvae were collected in June and July, indicating that spawning occurred in late May or early June; peak abundance of prolarvae occurred in July. Small numbers of postlarvae were collected in July (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Eighteenmile Creek (42°43', 78°58'). Historically, YOY were found in the creek mouth in August (Greeley 1929).

Ontario

OE-1

Pelee Island (41°47′, 82°40′). In 1958, YOY were abundant in areas (41°45′, 82°45′ and 41°50′, 82°45′) west of the island and in an area (41°56′, 82°41′) north of the island (Edsall 1967, pers. comm. 1980).

MOTTLED SCULPIN

In the western basin, mottled sculpins spawn over bouldery shoals in late March or April (Langlois 1954). In the central basin, spawning adults and prolarvae were found over a substrate of large rocks including

the rock breakwalls of harbors (White, pers. comm. 1979). In 1929, prOlarVae and postlarvae were generally found from early June to mid-July, especially along the Canadian shore west of Long Point (Fish 1932).

Ohio

O-1

Portage River (41°31', 82°56'). Historically, a spawning run of mottled sculpins may have entered the Portage River; in 1965 no run occurred (Langlois 1965)

South Bass Island (41°39', 82°50'). Young were abundant around the shores of Buckeye Island (41°40', 82°47') under rocks and among vegetation (Turner 1920a); young were also collected at the end of East Point (41°40', 82°48') under rocks (Langlois 1954).

O-2

Lorain (41°28', 82°11'). A few larvae were collected in Lorain Harbor (41°28', 82°11') (Geo-Marine 1978).

O-3

Ashtabula (41°55', 80°47'). Larvae were collected in the lake from mid-April to late June; 12% of the larvae collected in the spring were mottled sculpin (Applied Biology 1979d,e).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in June and July (Hamley and MacLean 1979; Teleki 1976).

SLIMY SCULPIN

New York

In 1928, larvae were collected in small numbers from the New York-Pennsylvania state line (42°16', 79°46') around to Tecumseh Reef (42°48', 79°44'), Ontario, in 63-76 ft of water in August (Fish 1929, 19321.

van Buren Point (42°27', 79°25'). In 1975, prolarvae and postlarvae were collected in the lake from early June to July (Tex. Instrum. 1977a).

Eagle Bay (42°32', 79°14'). In 1975, prolarvae and postlarvae were collected in the lake off Eagle Bay from early June to July (Tex. Instrum. 1977a).

Ontario

OE-5

In 1928, larvae were collected in small numbers from Tecumseh Reef (42°48', 79°44') east into New York waters in 63-76 ft of water in August (Fish 1929, 1932).

SCULPIN spp.

Ohio

O-3

Conneaut (41°58', 80°33'). In 1977, sculpin larvae were collected in the Conneaut River (41°58', 80°33'), Conneaut Harbor (41°58', 80°33'), and offshore between Conneaut and Turkey Creek (41°58', 80°33') in June and July; these larvae were believed to have originated from spawning that occurred in nearby tributaries (Aguat. Ecol. Assoc. 1978c).

50272-101

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This document is one of a set of fourteen volumes.

16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and coordination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.

The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.

The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

17. Document Analysis . a. Descriptors

Fishes, aquatic animals, bass, carp, catfishes, minnows, perch, salmon, shiners, trout, aquatic biology, water resources, atlas, marine biology

b. Identifiers/Open-Ended Terms

Great Lakes, spawning areas, nursery areas, Lake Erie

c. COSATI Field/Group 47D; 48B

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