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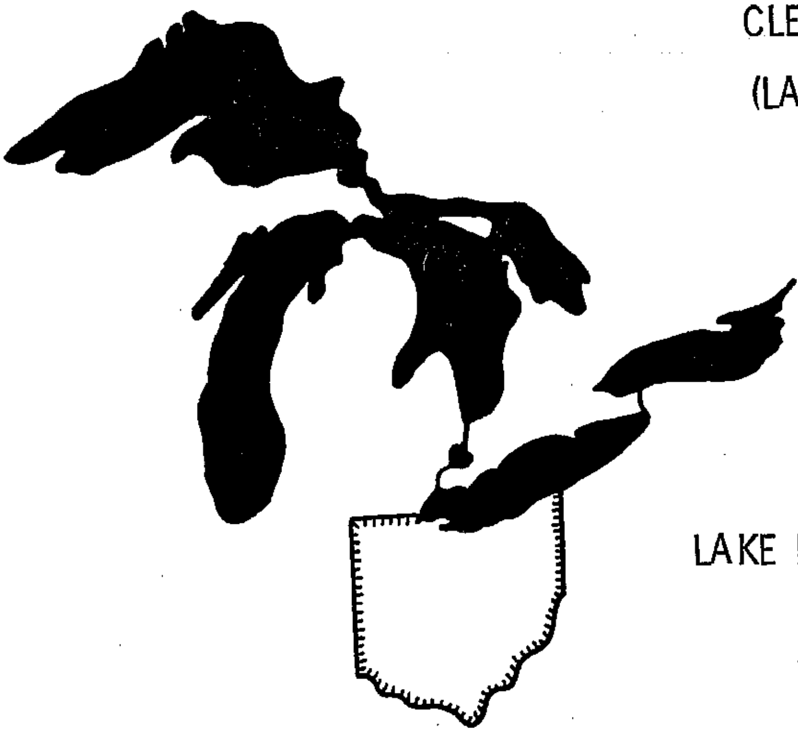

LAKE ERIE INTENSIVE STUDY: ANNOTATED BIBLIOGRAPHY OF LAKE ERIE BENTHIC MACROINVERTEBRATES

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PREFACE

The benthic macroinvertebrate population of Lake Erie has experienced a most dramatic change over the past century in conjunction with the eutrophication of the lake. This response to changes in water quality has shown that monitoring the benthic macroinvertebrate population can be a simple and yet gross test of water quality (Britt et al. 1973). Several artificial indices have been set up for determining degrees of pollution, based on the abundance of benthic macroinvertebrates (Wright 1955, Goodnight and Whitely 1960). Cook and Johnson (1974) demonstrated a shift through three species associations as one moves west to east that corresponds to the decrease in eutrophication. Pollution-tolerant species were found in the western basin and pollution-intolerant species were found in the eastern basin.

The importance of the benthic macroinvertebrate population to the study of Lake Erie and the need for an easy-to-use annotated bibliography prompted the compilation of this literature search. The annotations were taken entirely from two sources: the Annotated Bibliography of Limnological and Related Studies Concerning Lake Erie and Influent Tributaries - Vol. I, Biological, prepared for the Buffalo District, Corps of Engineers by Prantner, Oleszko, Vesley and Sweeney (1974); and the Annotated Bibliography for Lake Ontario, also prepared for the Buffalo District, Corps of Engineers. Abbreviations found in the annotations are given in the appendix.

Other titles were either found in bibliographies or in the reference lists of research papers. The most important of these works were by Osborn (1930), Wright (1955), and Herdendorf et al. (1974).

This bibliography makes no claims in being complete or error-free, but it is hoped that most of the pertinent publications have been contained within.

Abrams, J. P. and C. E. Taft, eds. 1971. A bibliography of research conducted at the Franz Theodore Stone Laboratory, and its predecessor, of The Ohio State University from 1895-1968. Ohio J. Sci. 71(2):81-105.

Adamstone, F. B. 1924. The distribution and economic importance of the bottom fauna of Lake Nipigon with an appendix on the bottom fauna of Lake Ontario. University of Toronto Studies, Biological Series No. 25, Publications, Ontario Fisheries Research Laboratory, No. 24, 1924, p. 34-100, 4 pl. Toronto.

Ahlstrom, E. H. 1930. Mollusks collected in Bass Island region, Lake Erie. Nautilus. 44(2):44-48.

A list of species collected during the summers of 1928 and 1929. The site of collection is noted in each case. (SM).

Ahlstrom, E. H. 1933. A quantitative study of Rotatoria in Terwilliger's Pond, Put-in-Bay, Ohio. The Ohio State University Bulletin, Vol. 38, No. 5, 1933, p. 1-36. Columbus.

Ahlstrom, E. H. 1934. A quantitative study of rotatoria in Terwilliger's Pond, Put-in-Bay, Ohio. Ohio Biol. Surv. Bull. 30. 6(1):1-36.

A report on a statistical study of a series of quantitative plankton collections of rotifers made in Terwilliger's Pond, Put-in-Bay, Ohio. These collections were made during the summer and fall of 1932 and the spring of 1933. A comparison is made between the rotifer fauna of this region and that of other American habitats. An attempt is made to illustrate the seasonal periodicity by genera of the rotifers. (SM)

Aldrich, J. W. 1943. Biological survey of the bogs and swamps in northeastern Ohio. Am. Mid. Nat. 30(2):346-402.

This study is intended to picture the composition and dynamics of the various biotic communities which make up the swamps and bogs (hydrosere) of northern Ohio. The report shows their successional relationship to each other, and indicates their dependence on climatic and physiographic factors. Ecological classifications of northwestern Ohio hydrach species are included. (SM)

Allen, H. E. 1970. Chemical and biological quality of Lake Erie. In: The Environmental Problems of the Lake Erie Basin. Carroll Business Bull. 10(1):17-22.

A discussion of the need for control of the disposal of organic materials in Lake Erie. The relationship of phosphorus to algal blooms and concentration of pesticides in fish, particularly those with higher levels of body fat, are discussed.

Allen, J. A. 1915. Shells of Put-in-Bay Island, Lake Erie. Nautilus. 29:18-22.

Alley, W. P. and C. F. Powers. 1970. Dry weight of the macrobenthos as an indicator of eutrophication of the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 595-600.

The dry weight of the macrobenthos was used to conduct inter-comparisons of benthic productivity among Lakes Superior, Michigan, Huron, and Erie. The grand average dry weight of macrobenthos was found to be 0.9 gm/m^2 for Lake Superior, 3.40 gm/m^2 for Lake Michigan, 1.48 gm/m^2 for Lake Huron, and 4.63 gm/m^2 for Lake Erie. These values were compared with similar values from Canadian lakes whose trophic levels were defined by Rawson (1953). These comparisons support the classification of Lake Erie as a well-developed eutrophic lake.

Allin, A. E. 1929. Seining records and food of the intermediate stages of Lake Erie fishes. In: Preliminary Report on the Cooperative Survey of Lake Erie, Season of 1928. Buffalo Soc. Nat. Sci. Bull. 14(3):188-194. Also in: A Biological Survey of the Erie-Niagara System. N. Y. Conserv. Dept. Suppl. 18th Annu. Rep., 1928. pp.95-99.

A discussion of the efficiency of the nets used for sampling as well as an account of the food taken by the fish of Eastern Lake Erie.

Allison, L. N. - See: David R. Wolfert, et al., No. 873.

Ambrosini, R. - See: L. R. Hedrick, et al., No. 344.

American Public Health Association. 1965. Standard methods for the examination of water and wastewater including bottom sediments and sludges. 12th Edition. APHA, NY. 769 p.

Anderson, B. G. 1944. The toxicity thresholds of various substances found in industrial wastes as determined by the use of _Daphnia magna_. Sewage Works J. 16(6):1156-1165.

The threshold concentrations for immobilization of _Daphnia magna_ by forty-two substances when added to Lake Erie water are given. The advantages, as well as a method, of using daphnids as test organisms are also discussed.

Anderson, D. V. 1960. Canada's Great Lakes research program. Conservationist Aug.-Sept. 2-5.

Anderson, D. V. 1969. The Great Lakes as an environment. Univ. Toronto, Great Lakes Inst. Rep. PR 39. 189 p.

Andrews, T. F. 1948. Temporary changes in certain limnological conditions in Western Lake Erie produced by a windstorm. Ecol. 29(4):501-505.

Observations before and after a windstorm on April 23, 1947.

Andrews, T. F. 1949. The life history, distribution, growth, and abundance of Leptodora kindtii (Focke) in Lake Erie. Abst. Ph.D. Diss. The Ohio State University. 57:5-11.

Anonymous. 1871. Survey of the Great Lakes. Amer. J. Sci. Arts 2(7):75.

Arnold, D. E. 1969. The ecological decline of Lake Erie. N. Y. Fish and Game J. 16(1):27-45.

Changes in Lake Erie due to natural processes and the activities of man are discussed with respect to geology, hydrology, pollution, chemistry, plankton, benthos and fisheries. In all of these areas, it is shown that many changes have taken place and that the rate of change has accelerated in recent years. Most of these changes are harmful to the lake's value as a resource for man and as a habitat for its natural fauna. Several proposed ideas for reversing this trend are reviewed.

Arnold, D. E. 1970. Lake Erie alive but changing. N. Y. State Dept. Env. Cons. Albany, N. Y. Conservationist. 25(3):23-30, 36.

This article reviews the changes that are taking place in Lake Erie. The geologic and physical changes, pollution problems, and chemical changes in the lake are all mentioned. Observations on the changing populations of phytoplankton and other algae, the zooplankton, benthic invertebrates and the fisheries are included. The statement is made that by any common measurement there is more life going on in Lake Erie now than there has ever been in the past. However, organisms which we have considered desirable have been replaced by others more adapted to the present conditions.

Baker, F. C. 1916. The relation of mollusks to fish in Oneida Lake. Technical Publication No. 4, The New York State College of Forestry, Vol. XVI, No. 21, 1916. 366 p. Syracuse.

Baker, F. C. 1918. The productivity of invertebrate fish food on the bottom of Oneida Lake, with special reference to mollusks. Technical Publication No. 9, The New York State College of Forestry, Vol. XVIII, No. 2, 1918. 264 p. Syracuse.

Baker, F. C. 1920. The life of the Pleistocene or Glacial Period. University of Illinois Bulletin, Vol. XVII, No. 41, 1920, xiv + 476 p., 62 pl. Urbana.

Baker, F. C. 1924. The fauna of the Lake Winnebago region. A quantitative and qualitative survey with special reference to the Mollusca. Transactions, Wisconsin Academy of Sciences, Arts, and Letters, Vol. XXI, 1924, p. 109-146. Madison.

Baker, F. C. 1928. The fresh water Mollusca of Wisconsin. Part I. Gastropoda. Part II. Pelecypoda. Bulletin, Wisconsin Geological Survey, No. 70, 1928, Part I, xx + 507 p. Part II, vi + 495 p. Madison.

Baker, F. C. 1933. Studies on the bottom fauna of fresh-water lakes. Sci. 78(2018):190-191.

A comparison of information about Lake Erie fauna, presented by F. H. Krecker and L. Y. Lancaster (1933), with data from Lake Winnebago and Lake Oneida. (SM)

Bangham, R. V. 1925. A study of the cestode parasites of the black bass in Ohio, with special reference to their life history and distribution. Ohio J. Sci. 25(6):255-270.

The study includes examinations of a large number of large and small-mouth bass from many sections of Ohio and from the island region of Lake Erie. In the small-mouth bass seven species of cestodes were found. Two of these were new species and six had not been previously reported for the bass. In the large-mouth bass two species of cestodes were found. It was determined that certain cestodes are obtained by young bass through an intermediate host, copepods, the chief food of the young bass. These cestodes are discussed as to their morphological characteristics, life histories, and distributions. (BU)

Bangham, R. V. and G. W. Hunter III. 1939. Studies on fish parasites of Lake Erie. Distribution studies. Zoologica. 24(4):385-448.

The fourth in a series of papers on fish parasites of Lake Erie. The fishes were collected from the eastern end of the lake during the summer of 1928. Collections were made from the western end of the lake in 1927, 1928 and 1929. In working with these collections emphasis was placed upon the helminthes, although each fish was examined for evidence of infection by ectoparasites such as leeches, flukes and copepods. The objectives of the study were: (1) to identify the parasites collected; (2) to describe any new species encountered; (3) to study the regional distribution of these parasites; and (4) to compare the infection by families of fishes and by degree of infestation. (SM)

Bardarik, D. G., J. C. Alden, R. L. Shema, and A. R. Kupiec. 1971. A study of the effects of heated discharges on the ecology of Presque Isle Bay, Erie, Pennsylvania - interim report, May-September, 1971. Environ. Sci. Inc. Pittsburgh, Penn. 232 p.

This study was prepared for the Pennsylvania Electric Company. Its purpose is to determine whether or not the discharge of heated water from Penelec's Front Street Station into Presque Isle Bay is altering the ecology, is injurious to aquatic life, is affecting other uses of the waters, or is having any beneficial effects.

A comparison of benthic collections from control stations (in Lake Erie) with those from Presque Isle Bay shows a marked reduction in the number of taxa of larvae of the family Chironomidae.

Barry, J. P. 1972. The Fate of the Lakes - A Portrait of the Great Lakes. Baker Book House. Grand Rapids, Mich. 192 p.

This book describes present conditions in the Great Lakes and details the many ways in which they are used. Historical data is interwoven with current information on industrial use, shipping, commercial and sport fishing, and recreation. There are numerous photographs of activities on the lakes, including several of the fishing industry on Lake Erie. There is some discussion of various types of water pollution with Lake Erie problems described in some detail. (SM)

Barton, D. R., and H. B. N. Hynes. 1978a. Wave-zone macrobenthos of the exposed Canadian shores of the St. Lawrence Great Lakes. J. Great Lakes Res. 4:27-45.

Barton, D. R., and H. B. N. Hynes. 1978b. Seasonal variations in densities of macrobenthic populations in the wave-zone of north-central Lake Erie. J. Great Lakes Res. 4:50-56.

Barton, D. R., and H. B. N. Hynes. 1978c. Seasonal study of fauna of bedrock substrates in wave zones of Lakes Huron and Erie. Can. J. Zool. 56(1):48.

Beaver, W. C. 1942. Bacterial activities in the subaquatic soils of Lake Erie. Ohio J. Sci. 42(3):91-98.

During the summers of 1939 and 1940, a bacteriological study was made of the bottom soils at various points in Lake Erie around the vicinity of Put-in-Bay. Particularly significant parts of the investigations dealt with the nitrogen transformations and the destruction of plant (algae and hornwort) and animal (mayflies) materials, which have a direct bearing upon the quantity and quality of available food, and hence upon the fisheries industry. (BU)

Beeton, A. M. 1960. Great Lakes limnological investigations. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:123-128.

Federal limnological research in the Great Lakes in the 1950's is reviewed, and broad comments are offered on the characteristics of the lakes and on evidence for change in certain areas, as Western Lake Erie. Particular stress is laid on the importance of long-term and continuing studies and on the value of interagency and interdisciplinary cooperation for attacks on problems beyond the capacities of a single group. (LO)

Beeton, A. M. 1961. Environmental changes in Lake Erie. Trans. Amer. Fish. Soc. 90(2):153-159.

Comparison of data compiled during the past 60 years with those from recent studies shows that major changes have occurred in the bottom and fish faunas of Lake Erie. The bottom fauna was formerly dominated by the nymphs of Hexagenia, but at present midge larvae and oligochaetes are most abundant. Blue pike (Stizostedion vitreum glaucum) and cisco (Coregonus artedii), which formerly dominated the commercial catch, are scarce, while other species are more plentiful than formerly.

Beeton, A. M. 1965. Eutrophication of the St. Lawrence Great Lakes. Limnol. Oceanogr. 10(2):240-254.

Lakes Huron, Michigan and Superior are classified as oligotrophic lakes on the basis of their biological, chemical and physical characteristics. Lake Ontario, although rich in nutrients, is morphometrically oligotrophic or mesotrophic because of its large area of deep water. Lake Erie, the most productive of the lakes and the shallowest, is eutrophic. Several changes commonly associated with eutrophication in small lakes have been observed in the Great Lakes. These changes apparently reflect accelerated eutrophication in the Great Lakes due to man's activity.

Beeton, A. M. 1966a. Indices of Great Lakes eutrophication. Pub. Great Lakes Res. Div. (in press), Vol. 14.

Indices of eutrophication were cited: (1) increases in nitrogen and phosphorus; (2) changes in species composition and an increase in the abundance of plankton; (3) decreases in the dissolved oxygen content of bottom waters; (4) changes in the fish population; (5) the replacement of Bosmina coregoni by B. Longirostris; and (6) extensive growths of cladophora. Other changes such as increases in TDS and major ions are regarded as representative of environmental changes and not necessarily indices of eutrophication. There are few offshore data on nutrients (nitrogen and phosphorus) from the Great Lakes other than Lake Erie, and even these data are questionable. Changes in the rates of growth of fish should be viewed with caution when relating them to eutrophication inasmuch as many environmental variables may be of influence as well as an increase in nutrients.

Beeton, A. M. 1966b. Indices of Great Lakes eutrophication. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:1-8.

The concept of eutrophication is discussed in terms of its relationship to aging of lakes, environmental changes, and pollution. Various changes in physical, chemical, and biological characteristics of the Great Lakes are reviewed. Increases in nitrogen and phosphorus, changes in species composition and increases in the abundance of plankton, decreases in the dissolved-oxygen content of bottom waters, changes in fish populations in Lake Erie, the replacement of Bosmina coregoni by B. longirostris, and extensive growths of Cladophora are acceptable indices of eutrophication and have been observed in other lakes. Increases in total dissolved solids and major ions may represent environmental changes not necessarily those of eutrophication. Changes in the benthic communities, amount of bacteria, and growth rate of fish may be due to environmental conditions not related to eutrophication, although they may be useful indices of eutrophication if evaluated in terms of conditions in the total environment.

Beeton, A. M. 1969. Changes in the environment and biota of the Great Lakes. In: Eutrophication: Causes, Consequences, Correctives. National Acad. Sci. Washington, D. C. pp. 150-187.

Although concern over changes in the Great Lakes has existed for many years, the idea that the lakes are undergoing accelerated eutrophication is recent. Environmental changes can be considered in three categories: pollution of inshore areas, long-term changes in open waters, and changes in sediments. On the basis of accepted physiological characteristics, Lakes Superior, Michigan and Huron are oligotrophic, Lake Erie is eutrophic and Lake Ontario is in an intermediate condition. Lake Erie has shown major changes in limnological factors and biota; effects of increased pollution and eutrophication of Lake Erie have spread to Lake Ontario. The most important changes apparently are those occurring in sediments owing to the contribution of large quantities of allochthonous materials resulting from urbanization and industrialization. Changes in sediments are important factors in the observed changes in limnological factors and fish populations.

Beeton, A. M. 1970. Statement on pollution and eutrophication of the Great Lakes. Univ. Wisc.-Milwaukee. Center for Great Lakes Studies. Milwaukee, Wisc. Spec. Rept. 11. 35 p.

This statement was delivered to the U.S. Senate Subcommittee on Air and Water Pollution of the Committee on Public Works in May of 1970. There is discussion of each of the Great Lakes. Changes in the benthos of the Western Basin of Lake Erie, the increase in blue-green algae, and changes in the fish populations of the lake are detailed. Tables concerning the distribution and abundance of mayfly nymphs and oligochaetes in Western Lake Erie and the commercial fish population between 1870 and the late 1960's are included.

Beeton, A. M. and D. C. Chandler. 1963. The St. Lawrence Great Lakes. In: D. G. Frey (Ed.), Limnology in North America. Univ. Wisc. Press. Madison, Wisc. pp. 535-558.

This paper constitutes a general review of the biological, chemical, and physical characteristics of the Great Lakes. Included is a discussion of the characteristic organisms of each lake as well as changes in species composition and quantity. A historical review of Great Lakes research and the agencies involved is also presented.

Beeton, A. M. and W. T. Edmondson. 1972. The eutrophication problem. J. Fish. Res. Bd. Can. 29:673-682.

The trophic state of a lake is maintained by continued inputs of nutrients. In very large lakes the inshore environments are affected first by increased nutrient loading and, depending upon the morphology and morphometry, gradually the offshore waters are altered. Data on plankton, nitrogen concentrations, and fish, from early studies on Lake Erie, show progressive changes from the shore lakeward and from the Western Basin eastward.

Berst, A. H. and H. R. McCrimmon. 1966. Comparative summer limnology of inner Long Point Bay, Lake Erie and its major tributary. J. Fish. Res. Bd. Can. 23(2):275-291.

This paper reports the first limnological studies to be undertaken of inner Long Point Bay and Big Creek. Data was collected between May and September of 1962. Water levels and temperatures were recorded and chemical analysis carried out. Approximately 90 percent of the bottom of the bay was covered with aquatic plants which included, in order of abundance, Chara, Valisneria, Potamogeton, Najas, Nitella and Anacharis. (SM)

Bigelow, N. K. 1922. Representative Cladocera of Southwestern Ontario. Ont. Fish. Res. Lab. Pub. 8. pp. 111-125.

Sampling for Cladocera was conducted in 1919 and 1920 throughout the waters of Ontario. Lake Erie and ponds on Point Pelee were included in the survey. Forty-nine species are recorded along with a brief note on each. Diagrams of 27 species are included. (CCIW)

Biggs, R. B. 1968. Environmental effects of overboard spoil disposal. J. San. Engr. Div., 94(SA3):477-487.

Birge, E. A. 1894. A report on a collection of Cladocera, mostly from Lake St. Clair, Michigan, with a table of species. Appendix II, Bulletin, Michigan Fish Commission, No. 4. p. 45-47. Lansing.

Bligh, E. G. 1970. Mercury contamination in fish. In: A Summary of the Material Presented at the Twentieth Annual Institute of Public Health Inspectors. Winnipeg, Manitoba. pp. 10-19.

A general discussion of mercury contamination including an analysis of the mercury content in the fish of Canadian waters.

Bligh, E. G. 1971. Environmental factors affecting the utilization of Great Lakes fish as human food. Limnos. 4(1):13-18.

A discussion of the effects of environmental degradation on the utilization of fish as human food. Lake Erie is mentioned in the context of mercury and pesticide contamination of fish.

Blum, J. L. 1965. Interactions between Buffalo River and Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 8th Conf. on Great Lakes Res. Pub. 13:25-28.

1964 data on temperature and conductivity of Buffalo River and receiving waters are reported. Although the river for some of its length is clearly polluted and toxic, such conditions are probably more severe close to the surface than on the bottom. Definite indications from many parameters show substantial improvement in the river well above its mouth. During the summer the river is thermally stratified due to the accession of warm industrial wastes. Dilution of lower portions of Buffalo River by the waters of Lake Erie is probably a key factor in rendering those portions of the river as well as most of Buffalo Harbor habitable to tolerant benthic organisms.

Bodola, A. 1966. Life history of the gizzard shad, _Dorosoma cepedianum_, (Le Sueur), in Western Lake Erie. U. S. Fish and Wildlife Service. Fish. Bull. 65(2):391-425.

The rapid increase in the stocks of gizzard shad in Lake Erie since 1950 unquestionably had an important effect on the ecology of the lake. The present study, based on almost 24,000 fish collected by various means in 1952-55 in or near the island area of Western Lake Erie was undertaken to provide information on the role of shad in the bionomics of the region. The age, seasonal growth, weight, length and anatomy of the digestive tract are discussed.

Boesel, M. W. 1937. The food of nine species of fish from the western end of Lake Erie. Trans. Amer. Fish. Soc. 67:215-223.

A study of the specific nature of the food of various fishes in Western Lake Erie. The fish species represented are basically insect eaters. (CCIW)

Boesel, M. W. 1940. The Chironominae of Ohio with special reference to those of the Put-in-Bay region. Abst. Ph.D. Diss. The Ohio State University. 31:17-23.

Boesel, M. W. 1948. _Holoconops_ in the western Lake Erie region. Ohio J. Sci. 48(2):69-72.

Boesel, M. W. 1965. Food of some Lake Erie fishes. Ohio Dept. Natural Resources, Div. Wildlife, Publication W-326:1-15.

Boesel, M. W. 1972. The early stages of _Ablabesmyia annulata_ (Say) (Diptera, Chironomidae). Ohio J. Sci. 72(3):170-173.

The larva of Ablabesmyia annulata is remarkably similar to Malloch's Tanypus sp. A. briefly described in 1915. It differs from other American species in the following characteristics: 3 inner teeth of lingua truncate, all claws of posterior prolegs yellow, and both anterior and posterior prolegs apically and densely armed with spinules. In the pupa, the respiratory organ is smooth and ovate, lacking a terminal papilla. The respiratory opening is distinctly preapical. The species is widely distributed in Ohio.

Boesel, M. W., and E. G. Snyder. 1944. Observations on the early stages and life history of the grass punky, Atrichpogon levis (Coquillett). Ann. Ent. Soc. Amer. 37(1):37-46.

Braidech, T. E., P. E. Gehring and C. O. Kleveno. 1971. Biological studies of oxygen depletion and nutrient regeneration processes in the Lake Erie Central Basin. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 805-817.

See also: Braidech, T., P. Gehring and C. Kleveno. 1972. Biological studies related to oxygen depletion and nutrient regeneration processes in the Lake Erie Central Basin. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo: An Intensive Study of the Lake Erie Central Basin Hypolimnion and Related Surface Water Phenomena. USEPA Tech. Rep. TS-05-71-208-24. pp. 51-70.

Algae found on the sediment in the Central Basin of Lake Erie during the summer of 1970 were predominantly Tribonema and Oedogonium. The algae were of planktonic origin and exhibited growth on the bottom after light became limiting for other sedimented forms. A reduced sediment oxygen demand indicates sedimented algae contributed oxygen to the hypolimnion for a period of time. The reduction of incident light available to the algae on the sediment, the result of increased plankton in the epilimnion and decreased photoperiod with the approach of the autumnal equinox, increases the rate of oxygen consumption. Respiring bacteria in the degradation of dead algae utilize the remaining oxygen in the hypolimnion. Nutrients regenerated from the sediments as a result of oxygen depletion in the hypolimnion became available to algae as reflected by increased growths of Anacystis in and near the thermocline.

Braidech, T. E., P. E. Gehring and C. O. Kleveno. 1972. Biological studies related to oxygen depletion and nutrient regeneration processes in the Lake Erie Central Basin. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo: An Intensive Study of the Lake Erie Central Basin Hypolimnion and Related Surface Water Phenomena. USEPA Tech. Rep. TS-05-71-208-24. pp. 51-70.

See also: Braidech, Thomas E., Philip E. Gehring and Conrad O. Kleveno. 1971. Biological studies of oxygen depletion and nutrient regeneration processes in the Lake Erie Central Basin. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 805-917.

Brinkhurst, R. O. 1964. Studies on the North American aquatic Oligochaeta. I: Naididae and Opistocystidae. Proc. Acad. Natural Sci., Philadelphia. Philadelphia, Penn. 116:195-230.

The occurrence and distribution of North American aquatic oligochaeta has been reviewed from a study of museum collections at the American Museum of Natural History, New York; the Academy of Natural Science, Philadelphia; and the United States National Museum, Washington, as well as collections loaned by limnologists from all over North America and some material collected by the author. Most of Naididae recorded in North American literature have been found, together with some not yet previously recorded, and these are described and figured. Keys to the species are also erected. The geophysical distribution of the species found is briefly discussed.

Brinkhurst, R. O. 1965. Studies on the North American aquatic Oligochaeta. II: Tubificidae. Proc. Acad. Natural Sci., Philadelphia. Philadelphia, Penn. 117(4):117-172.

Forty-four species known from North America are described and figured, and a key is erected for their identification. The following genera were collected from Lake Erie: Limnodrilus, Peloscolex, Euilyodrilus and Branchiura.

Brinkhurst, R. O. 1966. Detection and assessment of water pollution using oligochaete worms - Part 2. Water & Sewage Works. 113(11):438-441.

Brinkhurst, R. O. 1969. Changes in the benthos of Lakes Erie and Ontario. In: Robert A. Sweeney (Ed.), Proc. Conf. on Changes in the Biota of Lakes Erie and Ontario. Buffalo Soc. Natural Sci. Bull. 25(1):45-71.

One of the more striking features of the chironomid fauna of Lake Erie is the marked difference in species composition that occurs in different parts of the lake. A number of environmental factors have undoubtedly contributed to this, but the distributions of many of the species appear to be intimately related to the progressively more eutrophic conditions encountered towards the western end of the lake.

Only five genera were collected in the Western Basin of Lake Erie, all being tolerant of the eutrophic conditions. In contrast, 14 genera were collected in the Eastern Basin, including several forms considered as indicative of oligotrophic conditions. The fauna in the Central Basin was intermediate.

Brinkhurst, R. O. 1969. The fauna of pollution. In: Anderson, D. V. (Ed.). The Great Lakes as an environment. Great Lakes Inst., Univ. Toronto. Report PR 39. pp. 97-112.

The paper deals with the different types of fauna found in polluted waters from plankton to fish. Discussed is the concept of an ecosystem of a lake and the changes which occur when the lake undergoes eutrophication through the addition of sewage, meat packing wastes, dairy and cannery wastes. An emphasis is placed on the changes in the benthic community under enrichment conditions. The article generally covers the Great Lakes with a specific remark on the Bay of Qunite and Toronto Harbor. (Canada Centre for Inland Waters)

Brinkhurst, R. O. 1970. Distribution and abundance of tubificid (Oligochaeta) species in Toronto Harbour, Lake Ontario. J. Fish. Res. Bd. of Can. 27: 1961-1969.

Toronto Harbour, Lake Ontario, receives a considerable load of raw, partially treated and treated sewage, as well as other organic and inorganic pollutants from the Don River, the storm water overflows of the City of Toronto, large and small ships, summer homes on the Toronto islands and surrounding industries. A detailed study of the relation between the worm population and certain constituents of the sediment is currently being undertaken, following the pilot study of Brinkhurst and Chua (1969). In this paper the distribution and abundance of species present and some data on dry weight determinations are discussed. One set of samples was taken every 4 hours for a period of 20 hours to check for diurnal changes in vertical distribution of the worms.

Brinkhurst, R. O. and K. E. Chua. 1969. Preliminary investigation of the exploitation of some potential nutritional resources by three sympatric tubificid oligochaetes. J. Fish. Res. Bd. Can. 26:2659-2668.

Eight heterotrophic aerobic bacteria were identified in samples from Toronto Harbour. The three tubificid species present seem to ingest most if not all of these, but different species survive passage through the gut. One of the three worm species absorbs amino acid from solution in the absence of bacteria in the gut. It is suggested that the results indicate differences in the utilization of the potential nutritional resources by the worms, which may be reflected in the ability of three unspecialized sediment feeders to coexist in the same microhabitat.

Brinkhurst, R. O. and D. G. Cook. 1966. Studies on the North American aquatic Oligochaeta. III: Lumbriculidae and additional notes and records of other families. Proc. Acad. Natural Sci., Philadelphia. Philadelphia, Penn. 118(1):1-33.

The Lumbriculidae thus far recorded from North America are described and a key for their identification is provided. Preliminary notes for a revision of the Aeolosomatidae and Haplotaxidae are presented, together with the descriptions of species in the Naididae and Tubificidae recorded since the publication of Parts I and II of this study. Some amendments to the earlier descriptions are given. The following genera were collected from Lake Erie: *Tubifex*, *Psammoryctides*, *Limnodrilus*, *Peloscolex*, *Euilyodrilus* and *Aulodrilus*.

Brinkhurst, R. O., and D. G. Cook. 1974. Ch. 5. Aquatic earthworms (Annelida: Oligochaeta). pp. 143-156. In: Hart, C. W., Jr., and Samuel L. H. Fuller (Eds.)

Brinkhurst, R. O., A. L. Hamilton, and H. B. Herrington. 1968. Components of the bottom fauna of the St. Lawrence Great Lakes. Great Lakes Inst., Univ. Toronto. PR 33, 50 p.

Bottom fauna were sampled during synoptic cruises through Georgian Bay, Lake Ontario, and Lake Erie and distributions of their major components determined. Oligochaeta, sphaeriidae, and chironomidae were separated. Identity of species and their distribution is discussed. Reference is made to other Great Lakes studies on benthos. Samples representing all seasons were included where possible. Results are presented in taxonomic groups and distribution maps. Maps of depth profiles, indicating degree of oxygen depletion in Lake Erie in summer, and bathymetrical maps are included. 31 species of tubificidae from the Great Lakes and some in Canadian lakes are recorded. In grossly polluted situations, the number of oligochaetes is very high. Species of the sphaeriidae identified in the Great Lakes Institute collection are listed. The taxa of chironomidae, reasonably complete in assessment of the profundal and sublittoral fauna, from these three lakes are listed. To facilitate comparison between these lakes a measure of the 'trophic conditions' of each area was calculated according to ability to withstand eutrophic conditions, providing numerical values which aid in the comparisons of various bodies of water. Key to tubificidae is given.

Britt, N. W. 1947. Observations on the life history of the collembolan Achorutes armatus. M.Sc. Thesis, The Ohio State Univ., Columbus. 29 p.

Britt, N. W. 1951. Observations on the life history of the collembolan, Achorutes armatus. Amer. Micros. Soc. 70(2):119-132.

Britt, N. W. 1953a. Differences between measurements of living and preserved aquatic nymphs caused by injury and preservatives. Ecol. 34(4):802-803.

Britt, N. W. 1953b. The life history and ecology of the white may fly, Ephoron album Say, in Lake Erie. Ph.D. Diss., The Ohio State Univ., Columbus. 115 p.

Britt, N. W. 1954a. Mayflies -- friends or foes? Ohio Conserv. Bull. 18(5):2-3, 31-32.

Britt, N. W. 1954b. Psuedo tides in Lake Erie. Inland Seas 19(4):294.

Britt, N. W. 1955a. New methods of collecting bottom fauna from shoals or rubble bottoms of lakes and streams. Ecol. 36(3):524-525.

A discussion of a new method for collecting benthic organisms which utilizes a concrete block with an attached buoy. (BU)

Britt, N. W. 1955b. Hexagenia (Ephemeroptera) population recovery in western Lake Erie following the 1953 catastrophe. Ecol. 36(3):520-522.

Bottom samples made in 1954 (June) from areas in Western Lake Erie where the Hexagenia population had been entirely wiped out in 1953 by low oxygen concentrations revealed that the mayfly was again inhabiting the area. This study gives two possible explanations for this phenomenon: (1) nymphs migrated from shallower waters back to these areas, or (2) they hatched from dormant eggs which had remained in the area during the stratification in the autumn of 1953.

Britt, N. W. 1955c. Stratification in western Lake Erie in summer of 1953: effects on the Hexagenia (Ephemeroptera) population. Ecol. 36(2):239-244.

Benthic samples collected in the summer of 1953 showed a marked reduction of Hexagenia (mayfly) population along with unusual thermal stratification and low dissolved oxygen concentrations.

Britt, N. W. 1961. Extended limnological studies in western Lake Erie sponsored by the Natural Resources Institute of The Ohio State University. (abstr.) Proc. 4th Conf. Great Lakes Res. Univ. Mich., Great Lakes Res. Div. Pub. 7:158.

Britt, N. W. 1962. Biology of two species of Lake Erie mayflies Ephoron album (Say) and Ephemera simulans Walker. Ohio Biol. Surv. Bull. N.S. 1(5). 70 p.

Britt, N. W. 1963. Some changes in the bottom fauna of the island area of western Lake Erie in the decade 1953-1963, with special reference to the aquatic insects. Proc. 6th Conf. on Great Lakes Res., Univ. Mich., Great Lakes Res. Div. Pub. 10:268.

Britt, N. W. 1965. A brief note on the distribution of the polychaete, Manayunkia speciosa Leidy, in western Lake Erie. Ohio J. Sci. 65(4):175-176.

Contains a brief presentation of the occurrence and distribution of the polychaete, Manayunkia, collected in the vicinity of Put-in-Bay, Ohio.

Britt, N. W. 1966a. Benthic changes in the island area of western Lake Erie during the past 15 years as indicated by 1959-1965 bottom fauna collections. Wheaton Club Bull. 11:14-15.

Britt, N. W., and J. T. Addis. 1966b. Limnological studies of the island area of western Lake Erie 1959-1965. The Ohio State Univ., Natural Resources Inst. Spec. Rep. 147 p.

Physical, chemical and biological studies were made of the island region of Lake Erie. The results are discussed and compared with data from earlier studies. The conclusion is reached that the entire Western Basin of Lake Erie has undergone drastic and adverse changes in recent years.

Britt, N. W., J. T. Addis, and R. Engel. 1973. Limnological studies of the island area of western Lake Erie. Bull. Ohio Biol. Surv. (N. S.) 4(3):i-x, 1-85.

Britt, N. W., E. J. Skoch, and K. R. Smith. 1968. Record low dissolved oxygen in the island area of Lake Erie. Ohio J. Sci. 68(3):175-179.

Britt, N. W., E. J. Skoch, and K. R. Smith. 1970. Relationships between phosphate and other chemicals at the water-substrate interface in Lake Erie. The Ohio State Univ., Water Resources Center, Proj. Rep. 333X. 30 p.

Brown, C. J. D., C. Clark and B. Gleissner. 1938. The size of certain naiades from Western Lake Erie in relation to shoal exposure. Amer. Midland Naturalist. 19(3):682-701.

During this study over 1,000 specimens were collected. The measurements of 8 species are presented. Three habitats were used for collection of species: protected; moderately exposed; and extremely exposed. Besides the individual variations found for each species and age group within each habitat, there are consistent differences in the average size and weight of age classes among the three habitats. The degree of stunting in Lake Erie for all species studied is definitely correlated with the degree of exposure found in the habitats, with the more stunted individuals found in the more exposed lake habitats. (SM)

Brown, E. H., Jr. 1953. Survey of the bottom fauna at the mouths of ten Lake Erie south shore rivers: its abundance, composition, and use as an index of stream pollution. Ohio Dept. Nat. Resources, Div. Water, Lake Erie Poll. Surv., Final Rep. 201 p.

Brown, E. H. Jr. and C. F. Clark. 1965. Length-weight relationships of northern pike, Esox lucius, from East Harbor, Ohio. Trans. Amer. Fish. Soc. 94(4):404-405.

Length-weight relationships between the two sexes of northern pike were determined from samples collected in East Harbor, Ohio between the months of March and April during which movements related to spawning reach a peak.

Brown, H. P. 1952. The life history of Climacia areolaris (Hagen), a neuropterous 'parasite' of fresh water sponges. Amer. Midland Naturalist. 47(1):130-160.

Eggs of Climacia areolaris were collected from Lake Erie waters at Put-in-Bay, Ohio and used to rear the three larval instars and the pupa. Descriptions and figures of each stage of the life cycle are included in this paper. The ecological factors affecting distribution, abundance, reproduction, and the relationships of Climacia to other organisms are also considered. (BU)

Bubna, M. 1902. Coleoptera of Cuyahoga, Ohio. Ohio Naturalist. 2(4):193-197.

Contains a list of the genera and species of Coleoptera found in Cuyahoga County, Ohio. (BU)

Buffalo Society of Natural Sciences, N.Y. and State Univ. of New York, Buffalo. Research Foundation. 1969. Proceedings of the conference on changes in the biota of Lakes Erie and Ontario. Bull. of the Buffalo Soc. of Natural Sciences. 25(1), 84 p. 19 fig., 2 ta., 141 ref. Sweeney, Robert A. (Ed.).

Growing public concern exists regarding changes effected by pollution and cultural eutrophication on the biota of Lakes Erie and Ontario, particularly regarding the decline of commercial and game fishes, the marked increase of less desirable species, and the alteration in quality and quantity of the flora. This publication reports the proceedings of a conference, held on April 16-17, 1968, of a small group of investigators interested in current or planned studies of these lakes. The conference was organized by the biology department, State University College at Buffalo and the Buffalo Society of Natural Sciences and supported by the Research Foundation of the State University of New York. Individual contributions, with names of author indicated in parentheses, are: Changes in the biology of the lower Great Lakes (Charles A. Dambach); Plants in Lakes Erie and Ontario, and changes of their numbers and kinds (Charles C. Davis); and Changes in the benthos of Lakes Erie and Ontario (Ralph O. Brinkhurst). Report includes an introduction, transcription of discussions following individual papers, and a transcription of a discussion by all participants of problems and techniques. (See also W70-01943 through W70-01945). (Eichhorn-Wisconsin)

Burch, J. B. 1973. Freshwater unionacean clams (Mollusca:Pelecypoda) of North America. USEPA Identification Manual No. 11. 176 p.

Burch, J. B. 1975. Freshwater sphaericean clams (Mollusca:Pelecypoda) of North America. Malacological Publications, Hamburg, Michigan. 96 p.

Burdick, G. E. 1940. A biological survey of the Lake Ontario watershed. Studies on the invertebrate fish food in certain lakes, bays, streams and ponds of the Lake Ontario watershed. N. Y. Conserv. Dept. Supplemental to the 29th Annu. Rep. for 1939. pp. 147-166.

Studies of the fish food (exclusive of plankton) of the Lake Ontario watershed dealt primarily with the areas that sustain the greatest intensity of fishing. One hundred eighty-seven collections will serve as a basis for calculation of the quantitative data and ecological notes on the mollusca. Stomach analyses of fish were undertaken in some of the areas that were studied. Pollution studies were made in some of the areas also. Graphs to show quantity of food, type of bottom and depth for each dredge line in several areas accompanied by outline maps to show the location of each line are included.

Burkholder, P. R. 1929a. Biological significances of the chemical analysis. In: Charles J. Fish (Ed.), Preliminary Report on the Cooperative Survey of Lake Erie, Season of 1928. Buffalo Soc. Natural Sci. Bull. Buffalo, N. Y. 14(3):65-72.

The relationship between nitrogen, oxygen, carbon dioxide, and hydrogen ion content of the waters of Eastern Lake Erie and organic life is discussed.

Burkholder, P. R. 1929b. Microplankton studies of Lake Erie. In: Charles J. Fish (Ed.), Preliminary Report on the Cooperative Survey of Lake Erie, Season of 1928. Buffalo Soc. Natural Sci. Bull. 14(3):79-93.

Studies of the microplankton life of Lake Erie were undertaken as part of the general biological survey during the summer of 1928. The objects of this particular phase of the work were the following: (1) To find out more about the kinds and quantity of micro-organisms existent in the lake; (2) To determine something of their distribution, both vertically and horizontally, and their seasonal variation during the period covered by these investigations; (3) To discover something of their economic significance in the economy of the lake, more particularly as regards their bearing on the problem of fish production. Chemical analyses and physical observations were made on all the regular plankton collecting trips. It was hoped that the evidence so obtained might make the plankton findings more meaningful.

Burkholder, P. R. 1930. A biological survey of Lake Erie. Science. New Series, 71(1837):288-289. New York.

Burns, N. M. and C. Ross. 1971a. "Project Hypo": A description of an intensive study of the Lake Erie Central Basin hypolimnion and related surface water phenomena. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 740-742.

See also: Burns, N. M. and C. Ross. 1972. "Project Hypo": An Introduction. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo: An Intensive Study of the Lake Erie Central Basin Hypolimnion and Related Surface Water Phenomena. USEPA Tech. Rep. TS-05-71-208-24. pp. 1-2.

Field work was done from June through August 1970. Focus of the study was the phenomenon of oxygen depletion in the Central Basin of Lake Erie during the summer months. Data was collected from 25 water sampling stations, of which 5 were used for intensive sampling for chemical, biological, bacteriological, and physical variables, and 16 additional bathythermograph recording stations.

Burns, N. M. and C. Ross. 1971b. "Project Hypo:" Discussion of findings. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 761-767.

The effects of algae build-ups in Lake Erie due to phosphorus input were investigated by depositing algae of planktonic origin intermittently into the hypolimnion and onto bottom sediments of the Central Basin.

Analysis of the data strongly indicates that: (1) Most algae sedimented to the bottom, died and added to the biological oxygen demand in the hypolimnion almost immediately; (2) The surviving genera of algae were under great stress due to unfavorable environmental conditions which caused the respiration rate to exceed the photosynthetic rate most of the time; and (3) The oxygen produced by the sedimented algae was small in comparison to the oxygen demand created by the expired algae.

The findings of this investigation lead to one definite conclusion: phosphorus input to Lake Erie must be reduced immediately. If this is done, a quick improvement in the condition of the lake can be expected; if it is not done, the rate of deterioration of the lake will be much greater than it has been in recent years.

Burns, N. M. and C. Ross. 1972a. Project Hypo: An introduction. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo: An Intensive Study of the Lake Erie Central Basin Hypolimnion and Related Surface Water Phenomena. USEPA Tech. Rep. TS-05-71-208-24. pp. 1-2.

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Burns, N. M. and C. Ross. 1972b. Project Hypo: Discussion of findings. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo: An Intensive Study of the Lake Erie Central Basin Hypolimnion and Related Surface Water Phenomena. USEPA Tech. Rep. TS-05-71-208-24. pp. 120-126.

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Butrico, F. A., C. J. Touhill and I. L. Whitman (Eds.). 1971. Resource Management in the Great Lakes Basin. Heath Lexington Books. D. C. Heath and Co. Lexington, Mass. 190 p.

A comprehensive analysis of the natural resources of the Great Lakes region. The biological aspects of Lake Erie are discussed. (CCIW)

Cairns, J. Jr., and K. L. Dickson. 1971. A simple method for the biological assessment of the effects of waste discharges on aquatic bottom dwelling organisms. J. Water Poll. Control Fed. 43(5):755-772.

Cairns, J. Jr., A. Scheier, and N. E. Hess. 1964. The effects of alkyl benzene sulfonate on aquatic organisms. Industrial Water and Wastes 9(1):7.

Canada. 1968. Annual report 1967. Fish. Res. Bd. Can. Ottawa, Ont. 17 p.

Aquatic insect larvae belonging to one family were analyzed in detail in over 1,000 dredge samples from Lake Erie, Lake Ontario, and Georgian Bay. The results confirm the existence of eutrophic conditions in the western end of Lake Erie. The genera in the eastern end of Lake Erie are more diversified and indicate a much lower degree of eutrophication. One small aquatic organism, an indicator of clean oligotrophic waters, was characteristic of samples from Georgian Bay, and to a lesser extent of those from Lake Ontario and the eastern end of Lake Erie. (SM)

Canada. 1969. Annual report 1968. Fish. Res. Bd. Can. Ottawa, Ont. 17 p.

The abundance of algae in the Great Lakes was measured to define present patterns of eutrophication and establish base lines for assessing the effectiveness of future remedial measures. The distribution and abundance of chironomid larvae in Georgian Bay, Lake Ontario and Lake Erie was used as the basis for a new index of the productivity level. (SM)

Canada. 1971. Annual report 1970. Fish. Res. Bd. Can. Ottawa, Ont. 24 p.

Lakewide studies on the effect of nutrient addition on the waters of Lakes Erie and Ontario showed that addition of phosphate and nitrate brought about the most pronounced responses in terms of algae growth, but with markedly varying results depending on locality and time of year. The effect of phosphate addition appeared to be more pronounced in Lake Ontario than Lake Erie.

Chironomids and other insect remains, in a sediment core from the Western Basin, showed increased eutrophication in the upper part of the core.

Experimental fertilization of a small lake in northwestern Ontario, at a rate corresponding to loading rates for phosphorus and nitrogen in Lake Erie, resulted in phytoplankton population increases of 10 times the first year, and 15-25 times the second year. (SM)

Canada Centre for Inland Waters. Undated. Annual Report - 1968. Dept. Energy, Mines and Resources. Fish. Res. Bd. Dept. National Health and Welfare. Burlington, Ont. 30 p.

The Fisheries Research Board studied the biological aspects of Great Lakes pollution. A large number of Daphnia longiremis were found during a study of zooplankton in Lake Erie. This form was previously unrecorded in the lake.

Canada Centre for Inland Waters. 1970. Annual report - 1969. Dept. Energy, Mines and Resources. Dept. National Health and Welfare. Burlington, Ont. 40 p.

A new device to separate zooplankton from filamentous algae was devised by a member of the Fisheries Research Board staff. A contract was awarded to the University of Guelph to assess the estuarial waters of the Grand River. One area for study was the productivity with respect to bottom fauna, plankton, and nekton including energy transfer.

Canada Centre for Inland Waters. 1971. Canada Centre for Inland Waters - 1970. Dept. Fish and Forestry. Burlington, Ont. 53 p.

The causes, effects and extent of oxygen depletion in the bottom waters of the Central Basin of Lake Erie were investigated between May and November 1970. The study showed that the tremendous algal blooms which occurred used up all the available phosphorus in the surface waters, and on sinking to the bottom and decaying, rendered an area of more than 1,000 square miles of bottom waters completely devoid of oxygen. It was also found that significant regeneration of phosphates from the decaying algae and from sediments occurred in the anoxic area, but that this was not the case if measurable dissolved oxygen concentrations were present.

Canada Centre for Inland Waters. 1972a. Canada Centre for Inland Waters - 1971. Dept. Environ. Burlington, Ont. 87 p.

A report on the investigations of the phyto- and zooplankton of Lakes Erie and Ontario conducted throughout 1971 is presented. Comparisons are made between the two lakes and also between the three Basins of Lake Erie.

Canada Centre for Inland Waters. 1972b. Canada Centre for Inland Waters - 1972. Dept. Environ. Burlington, Ont. 125 p.

A review of the work undertaken by the Canada Centre for Inland Waters during 1972 is presented. Included is a report on the microbiological water quality of the Grand River and other Ontario waters. The project goals are the establishment of parameters most suitable for microbiological water quality assessment, seasonal effect on bacterial and chemical parameters, optimal sampling frequency and minimum number of samples required for establishing the water quality of a specific body of water.

Also included is a comparative analysis of the zooplankton of Lakes Erie, Huron, and Ontario. First order estimates of standing crop biomass have been calculated from estimates of zooplankton abundance in the three lakes.

Canada Inland Waters Branch. 1970. The control of eutrophication. Dept. Energy, Mines and Resources. Ottawa, Ont. Tech. Bull. 26. pp. 1-10.

An analysis of data revealed that carbon is rarely a critical growth-limiting element in lakes, nitrogen is of more importance, and phosphorus, in most cases, is the critical and controlling factor in eutrophication. The data was collected from various lakes in Canada including Lake Erie.

Carpenter, G. F., E. L. Mansey and N. H. F. Watson. 1974. Abundance and life history of Mysis relicta in the St. Lawrence Great Lakes. J. Fish. Res. Bd. Can. 31(3):319-325.

A report on a sampling program for Mysis relicta in the St. Lawrence Great Lakes in 1971. Comparative abundances were obtained for four of the lakes, including Lake Erie, with the same sampling gear on several cruises from spring to fall. Attempts were made to determine life history patterns from size analysis of the catches. (SM)

Carr, J. F., and J. K. Hiltunen. 1963. Changes in the bottom fauna of Lake Erie, west of the islands, 1930-1961. Proc. 6th Conf. Great Lakes Res., Univ. Mich., Great Lakes Res. Div. Pub. 10:268.

Carr, J. F., and J. K. Hiltunen. 1965. Changes in the bottom fauna of western Lake Erie from 1930-1961. Limnol. Oceanogr. 10:551-569.

Chandler, D. C. 1940. Limnological studies of western Lake Erie I: plankton and certain physical-chemical data of the Bass Island region, from September, 1938, to November, 1939. Ohio J. Sci. 40(6):291-336.

Chandler, D. C. 1942a. Limnological studies of western Lake Erie II: light penetration and its relation to turbidity. Ecol. 23(1):41-52.

This report concluded that, biologically, turbidity and its variations in western Lake Erie may influence (1) composition, size, duration and time of occurrence of phytoplankton pulses; (2) rate of photosynthesis at various depths; (3) position of the compensation points of higher aquatic plants and phytoplankers; (4) vertical distribution of microcrustacea; and (5) magnitude of the commercial catch of saugers (Stizostedion canadense). (SM)

Chandler, D. C. 1942b. Limnological studies of western Lake Erie III: phytoplankton and physical-chemical data from November, 1939, to November, 1940. Ohio J. Sci. 42(1):24-44.

Chandler, D. C. 1944. Limnological studies of western Lake Erie IV: relation of limnological and climatic factors to the phytoplankton of 1941. Trans. Amer. Micros. Soc. 163:203-236.

A study reporting results of year-round limnological studies of western Lake Erie for the third consecutive year. It is concerned with annual variations in the abundance of phytoplankton and the factors responsible for them. In 1941 the spring phytoplankton pulse was several times larger than any other observed. Diatoms composed 98 percent of the total population and Asterionella was the predominant form. The autumn pulse was larger than those of previous years; greens and blue-greens constituted more than 50 percent of the population. The marked annual variation in the abundance of phytoplankton in western Lake Erie is intimately related to variations in lake turbidity and water temperature. Turbidity is determined by wind and precipitation and water temperature controlled by wind and solar radiation. (SM)

Chandler, D. C. 1963. Burrowing mayfly nymphs in western Lake Erie previous to 1947. Proc. 6th Conf. Great Lakes Res., Univ. Mich., Great Lakes Res. Div. Pub. 10:267-268.

Chandler, D. C. 1967. The St. Laurence Great Lakes. Great Lakes Res. Div., Univ. Mich. 1:280-296.

Presented is a general discussion of biological, chemical and physical characteristics of all the Laurential Great Lakes. Concerning biology species lists of phytoplankton, zooplankton, benthos and fish are presented and discussed only in general terms as applying to all the Great Lakes in general. A discussion of the history of research organizations and programs is also included.

Chandler, D. C., and O. B. Weeks. 1945. Limnological studies of western Lake Erie V: relation of limnological and meteorological conditions to the production of phytoplankton in 1942. Ecol. Monogr. 15:435-456.

Chapman, V. J. 1970. Lake eutrophication and biological problems. The Explorer. 12(1):18-22.

Cheatum, E. P. 1934. Limnological investigations on respiration, annual migratory cycle, and other related phenomena in freshwater pulmonate snails. Trans. Amer. Micros. Soc. 53(4):348-407.

Chiappetta, J. 1968. Great Lakes - great mess. Audubon Magazine (May-June). pp. 30-44.

This article stresses the importance of the Great Lakes to the economy of both the U. S. and Canada. An analysis is made of the causes and possible solutions to the problems of pollution in these five lakes.

Chutter, F. M. 1972. An empirical biotic index of the water quality in South African streams and rivers. Water Res. 6:19-30.

Clapp, G. H. 1916. Notes on the land-shells of the islands at the western end of Lake Erie and descriptions of new varieties. Ann. Carnegie Mus. Pittsburgh, Penn. 10(3-4):532-540.

A report on seven varieties of shells collected on islands in Western Lake Erie. The collection site, measurements, and description are included for each variety. (SM)

Clark, C. F. and F. Steinbach. 1959. Observations of the age and growth of the northern pike, Esox lucius L., in East Harbor, Ohio. Ohio J. Sci. 59(3):129-134.

Scale samples from 688 northern pike taken from East Harbor, Ohio during March 1951, 1952 and 1953 were used in this study. Growth was calculated on the assumption of direct proportion between scale measurements and lengths of the fish at the time of annulus formation. It was found that growth for individuals of the same age varied, the greatest annual increment was during the first year of life, and sexual dimorphism, females growing faster than males, was evident. (BU)

Clark, H. W., and C. B. Wilson. 1912. The mussel fauna of the Maumee River. U. S. Bur. Fish. Doc. 757. 72 p. Washington.

Clemens, H. P. 1949. Ph.D. diss. Life cycle and ecology of Germanus fasciatus Say. The Ohio State Univ., Columbus, Ohio. Abst. 61:89.

Clemens, H. P. 1951. The food of the burbot, Lota lota macalosa (LeSueur), in Lake Erie. Trans. Amer. Fish. Soc. 80:56-66.

This study includes results of stomach examinations of 5,253 burbots captured along the north shore of Lake Erie between May, 1946 and May, 1947. Variations in the major food items in relation to method of capture, season, locality, and the length of the burbot are examined. The major food items were evaluated by volume, number of items consumed, and the number of stomachs containing each item. Each criterion of abundance assisted in the determination of the role of the burbot in the food relationship of fish in the lake. (BU)

Clemens, W. A. 1915. Rearing experiments and ecology of Georgian Bay Ephemeridae. Contributions to Canadian Biology, being studies from the Biological Stations of Canada, 1911-1914. Fasciculus II. p. 113-128, 3 pl. Ottawa.

Clemens, W. A. 1922. Hydra in Lake Erie. Sci. 55(1426):445-446.

An account of the author's observation of the hydra, identified as Hydra oligactis Pallas, when pound nets were removed from Lake Erie for midsummer replacement and cleaning. Comment is made on the food consumed by the hydra in Lake Erie which might otherwise be eaten by fish. Areas of study are suggested. (SM)

Clemens, W. A. and N. K. Bigelow. 1922. The food of Ciscoes (Leucichthys) in Lake Erie. Contributions to Canadian Biology. No. V, p. 89-101. Toronto.

Coil, W. H. 1954. Contribution to the life cycles of gorgoderid trematodes. Amer. Midland Naturalist. 52(2):481-500.

A comprehensive study of the gorgoderid trematodes of Lake Erie. Several species, including one new species, are described morphologically and their life cycles are traced. A discussion is given concerning the evolution of gorgoderid cercariae. (BU)

Colby, P. J. 1973. Response of the alewifes, Alosa pseudoharengus, to environmental change. In: Walter Chavin (Ed.), Responses of Fish to Environmental Changes. Great Lakes Fish. Lab. Ann Arbor, Mich. Contrib. 472. Chapter 5. pp. 163-198.

A discussion of the behavioral and physiological responses of the alewife to environmental changes in the Great Lakes. The environmental stresses studied were temperature fluctuations and depletion of the food supply. The associated physiological changes included ion imbalance, proliferation of the thyroid and histological changes in the pituitary gland.

Cole, K. J. 1978. Zoobenthos in thermal discharge to western Lake Erie. Water Poll. Control Fed. J. 50(11):2509.

Cook, D. G. and J. K. Hiltunen. 1975. Phallodrilus hallae, a new tubificid oligochaete from the St. Lawrence Great Lakes. Can. J. Zool. 53:934-941.

Cook, D. G. and M. G. Johnson. 1974. Benthic macroinvertebrates of the St. Lawrence Great Lakes. J. Fish. Res. Board Can. 31:763-782.

Cornell Aeronautical Laboratory, Inc. 1972. Assessment of the environmental effects accompanying upland disposal of polluted harbor dredgings, Fairport Harbor, Ohio (Appendix A - Supporting Data and Calculations). Cornell Aeronautical Lab., Inc. Buffalo, N. Y. Tech. Rep. CAL. NC-5191-M-1. 42 p.

Analysis of sediments from four sampling stations at Fairport Harbor, Ohio showed coliform counts of 140 - 10,000 (colonies/100 ml) before filtering through Whatman No. 541 filter paper. None were found after filtering. Tests for chemical parameters were performed.

Coyle, E. E. 1930. The algal food of Pimephales promelas (Fathead minnow). Ohio J. Sci. 30(1):23-35.

A description of the food of the fathead minnow with special emphasis on the algal food. Mention is also made of animal forms and other materials found in the alimentary canal. The data gathered shows that this fish species consumes more plant than animal substances. The algal species found in the alimentary canal depended upon the habitat of the fish as well as the size of the fish's gill rakers. (BU)

Cummins, K. W., and G. H. Lauff. 1969. The influence of substrate particle size on the microdistribution of stream macrobenthos. Hydrobiol. 34(2):145-181.

Cutler, N. L. 1929. The biological investigation of pollution in the Erie-Niagara watershed. In: A Biological Survey of the Erie-Niagara System. N. Y. State Conserv. Dept. Albany, N. Y. Supplement 18th Annu. Rep. (1928). pp. 134-139.

Conditions of pollution in Cattaraugus Creek, Rush Creek, and the Lake Erie shore from Buffalo to the New York-Pennsylvania state line were determined by examination of samples taken from these regions. When applicable the specific industry discharging contaminants has been identified.

Daiber, F. C. 1952. The food and feeding relationships of the freshwater drum, Aplodinotus grunniens Rafinesque, in Western Lake Erie. Ohio J. Sci. 52(1):35-46.

A portrayal of the food habits of the sheepshead and how they affect the relationships with other organisms. This study was conducted from 1947 to 1948 in Sandusky Bay, the mouth of the Portage River, and around the islands of Western Lake Erie. Included is a diagramatic interpretation of the food web in Western Lake Erie using the sheepshead as the climax organisms. (SM)

Dambach, C. A. 1960. Status of biological research in waters of Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:109-113.

A presentation by the author giving historical background on the biological research of the Ohio waters of Lake Erie. The type of work undertaken by researchers of the Franz T. Stone Laboratory is summarized along with a listing of the agencies which support this research. (RL)

Dambach, C. A. 1969. Changes in the biology of the lower Great Lakes. In: Robert A. Sweeney (Ed.), Proceedings of the Conference on Changes in the Biota of Lakes Erie and Ontario. Bull. Buffalo Soc. Natural Sci. Buffalo, N. Y. 25(1):1-17.

Dramatic biological changes have appeared in bottom fauna and among certain fishes of the lower Great Lakes. Of special significance is the abundant increase, since 1959, of the midge Procladius, a supposedly more pollution-tolerant form, while Chironomus promosus has decreased, suggesting that pollution zones have extended further into the lakes. The mayfly is now rare. Benthic fauna is now dominated by oligochaetes and midges, with some fingernail clams, snails, and leeches on the increase. Species composition, once dominated by diatoms, are now dominated by blue-green algae. Decline of certain high-quality fishes, notably the blue pike and walleye pike, is largely responsible for the accelerated public interest in corrective measures.

Davis, C. C. 1953. Cleveland Harbor industrial pollution study. In: Lake Erie Pollution Survey. Ohio Dept. Natural Resources. Div. Water. Columbus, Ohio. pp. 170-188.

A study of the industrial pollution of the Cleveland Harbor and Cuyahoga River areas of Lake Erie. This study was conducted from September, 1950 to September, 1951. Emphasis is placed on the chemical and physical aspects of the problem although the effects of the pollution on various organisms are discussed.

Davis, C. C. 1954. A preliminary study of the plankton of the Cleveland Harbor area, Ohio. III. The zooplankton, and general ecological considerations of phytoplankton and zooplankton production. Ohio J. Sci. 54(6):388-408.

During the year September, 1950 through September, 1951. a study was made of the Cleveland Harbor area in connection with a survey of pollution conditions in Lake Erie. It is the purpose of this paper to describe the results of the analysis of the zooplankton obtained in the plankton samples, and in addition to discuss the dynamic interrelations of the plankton and the environment.

Davis, C. C. 1955. Plankton and industrial pollution in Cleveland Harbor. Sewage and Industrial Wastes. 27(7):835-850.

Nine stations in the Cleveland Harbor area of Lake Erie were visited every two weeks during the year September, 1950 through September, 1951. Quantitative plankton samples were taken from the surface and from a 6.5 m depth at each station. The quantity of plankton was uniformly small at stations where the iron content was greatest. Since this is also true of unpolluted waters, the standing crop is not a reliable index of pollution in locations such as the one under study. (BECPL)

Davis, C. C. 1959. Damage to fish fry by cyclopoid copepods. Ohio J. Sci. 59(2):101-102.

Dead fish taken from Put-in-Bay, Ohio in 1958 were observed to have from five to seven cyclopoids clinging to them; cause of death of the fry could not be determined. Rockbass fry were collected and placed in a tank with five specimens of Mesocyclops edax. The copepods attacked the fry causing damage to its caudal and ventral fins. These observations are reported and discussed. (BU)

Davis, C. C. 1961a. Breeding of calanoid copepods in Lake Erie. Verh. Internat. Verein. Limnol. 14:933-942.

Lake Erie is the most productive of the North American Great Lakes, yet the copepods have been studied very little. Previous investigators reported 8 species of calanoids: Limnocalanus macrurus, Epischura lacustris, Diaptomus (Leptodiaptomus) ashlandi, D. (L.) minutus, D. (L.) sicilis D. (L.) siciloides, D. (Skistodiaptomus) oregonensis, and D. (S.) reighardi. In the present study, all of these species were encountered except D. reighardi. Samples of the plankton from all three of the basins of the lake were examined. Tables are included which show the progression of the breeding activity for Lake Erie calanoids and the number of eggs per female Diaptomus, by month, in the Eastern, Central and Western Basins.

Davis, C. C. 1961b. The biotic community in the Great Lakes with respect to pollution. In: Proceedings of the Conference on Water Pollution and the Great Lakes. DePaul Univ. Chicago, Ill. pp. 80-87.

A general analysis of pollution in the Great Lakes and its effect on the biotic community. Lake Erie is dealt with specifically because it is the most studied as well as the most polluted of the five lakes. The author has included descriptions of eutrophic and oligotrophic lakes in both physical and biological terms.

Davis, C. C. 1964. Evidence for the eutrophication of Lake Erie from phytoplankton records. Limnol. and Oceanogr. 9(3):275-283.

The Division Avenue Filtration Plant of the Cleveland Division of Water and Heat has undertaken almost daily phytoplankton counts of water samples from Lake Erie since 1919. Data exists for 25 full years and for 7 additional partial years between 1919 and 1963. There has been a consistent increase in the average quantity of phytoplankton. The vernal and autumnal phytoplankton maxima have consistently become more intense and have lasted longer. The periods of minimum phytoplankton development in winter and summer have become shorter and less well-marked, until the winter minimum failed to develop at all in some of the latest years. Certain marked qualitative changes also have occurred. These effects are thought to have been caused by an increasingly rapid eutrophication of the water in Lake Erie.

Davis, C. C. 1966a. Biological research in the Central Basin of Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:18-26.

Most of the limited scientific work that has been accomplished in the Central Basin of Lake Erie has been closely associated with practical matters, and hence has dealt mainly with hydrology, fisheries, the search for commercially useful sand deposits, shore erosion, or pollution. Aside from commercial fish-catch data, the only long-term records that have been published are for the phytoplankton of the Cleveland area. There has been a consistent increase of phytoplankton over the years, suggesting a rapid eutrophication of the water. A 1964 study shows an extensive area in the Central Basin where the oxygen content of the bottom waters was very low, or even lacking. A study that had been made in 1929 had failed to uncover any indication of low oxygen except in the immediate vicinity of large cities. An unpublished 1964 investigation of the benthos indicates predominance of pollution-tolerant forms over most of the Central Basin. Extensive previous studies, however, do not exist with which the 1964 results could be compared.

Davis, C. C. 1966b. Plankton studies in the largest great lakes of the world (with special reference to the St. Lawrence Great Lakes of North America). Univ. Mich. Great Lakes Res. Div. Pub. 14:1-36.

The purpose of the present report is to survey critically and in detail the plankton investigations, exclusive of studies of primary production, that have been accomplished to date in the St. Lawrence Great Lakes of North America, to compare these results with those obtained from certain others among the largest lakes of the world, and to suggest fruitful avenues for further study.

Davis, C. C. 1968. The July 1967 zooplankton of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. on Great Lakes Res. pp. 61-75.

Twenty-seven vertical tows were obtained along a longitudinal transect near the center of Lake Erie. Quantitative estimates were made of the number per m^3 of each species. There were distinct differences among the three basins. The Western Basin had a greater variety and number of rotifers and cladocerans than the other basins, several species being confined there. There were, however, fewer cyclopoid copepods, although Cyclops vernalis was seen only in the Western Basin. Other species occurring solely or mainly in the Western Basin included Synchaeta stylata, Brachionus angularis, Bosmina coregoni, Daphnia retrocurva, and Diaptomus siciloides. The Central Basin contained enormous numbers of Vorticella sp., correlated with abundance of Anabaena. The cladoceran Holopedium gibberum also was confined largely to the Central Basin. Cyclopoid copepods, especially Cyclops bicuspidatus, were distinctly more abundant there than elsewhere. The very common rotifer, Polyarthra vulgaris, was most abundant in the Eastern Basin, whereas most other species were least common there. The total number of zooplankters per m^3 was greatest in the Western Basin and smallest in the Eastern Basin, confirming previous judgments, which, however, were unsupported by detailed quantitative studies of zooplankton samples taken at the same time and in the same manner in all three basins.

Davis, C. C. 1969a. Lake Erie's shore and water. In: G. Dennis Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ. Inst. Limnol. Kent, Ohio. pp. 121-134.

A general discussion of the biological characteristics of Lake Erie and its tributaries. Changes in the lake's flora and fauna are emphasized.

Davis, C. C. 1969b. Plants in Lakes Erie and Ontario, and changes of their numbers and kinds. In: Robert A. Sweeney (Ed.), Proceedings of the Conference on Changes in the Biota of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 25(1):18-44.

A review of the changes in vegetation in Lakes Erie and Ontario. Effects of the introduction of foreign species of fish, siltation and changes in native animal populations on vegetation are discussed. Comment is made on the increased nutrient content of Lake Erie water. Suggestions are also made concerning research needs.

Davis, C. C. and H. B. Roney. 1953. A preliminary study of industrial pollution in the Cleveland Harbor area, Ohio. I. Physical and chemical results. Ohio J. Sci. 53(1):14-30.

A discussion of the extent and effects of industrial river effluents in the Cleveland Harbor area. It was found that these pollutants were deleterious to aquatic life in the river. Also, productivity was reduced and fish were either driven away or poisoned. (BU)

Dean, G. W. 1890. Distribution of the Uniondae in the three rivers, Mahoning, Cuyahoga, and Tuscarawas. Nautilus. 4:20-22.

A report on the author's observations of the distribution of Uniondae in three Ohio rivers. The forms Anodonta, Margaratana and Unio, are listed as occurring in the Cuyahoga River. (SM)

Deevey, E. S., Jr. 1941. The quantity and composition of the bottom fauna of thirty-six Connecticut and New York lakes. Ecol. Monogr. 11:413-453.

DeKay, J. E. 1842. Zoology of New York, or the New York Fauna. Part III. Reptiles and Amphibians. Carroll and Cook. Printers to the Assembly. 98 p.

The soft-shelled turtle, Trionyx ferox, and the banded proteus, or big water lizard, Menobranchus lateralis, are the species specifically described as being found in Lake Erie. (SM)

DeKay, J. E. 1843. Zoology of New York, or the New York Fauna. Part V. Mollusca. Carroll and Cook. Printers to the Assembly. 271 p.

An extensive description of Mollusca found in New York State. Emphasis is on description and classification with mention of the general area in which the specimen has been found. (SM)

DeKay, J. E. 1844. Zoology of New York, or the New York Fauna. Part VI. Crustacea. Carroll and Cook. Printers to the Assembly. 70 p.

A report on crustacea found in New York. Emphasis is on description and classification. There is mention of areas in which the specimens have been found. Lernea cruciata is identified as a parasite of the Lake Erie rock bass. (SM)

Dennis, C. A. 1928. Aquatic gastropods of the Bass Island region of Lake Erie. Franz Theodore Stone Lab. Contrib. No. 8. 34 p.

Dewey, C. 1856. List of naiades (clams) found in Western New York and sent to the State collection at Albany, with some chiefly from Ohio. In: 9th Annual Report on the Condition of the State Cabinet of Natural History with Catalogues of the Same. Regents of the State of New York. Albany, N. Y. pp. 31-38.

Forty-three species of naiades are listed, but only Unio rubiginosus Lea is attributed to Lake Erie. (SM)

Dexter, R. W. and E. C. Kinney. 1954. A record of the earthworm, Sparganophilus eiseni, from the basin of Western Lake Erie. Ecol. 35(2):289.

A brief account of the dates and collection sites of Sparganophilus from the island area of Western Lake Erie. (BU)

Dickerman, E. E. 1937. Cysticercus cercariae of the Mirabilis group from Lake Erie snails. J. Parasitol. 23(6):566.

Doan, K. H. 1938. Observations on dogfish (Amia calva) and their young. Copeia. 1938(4):204.

A brief report on the observations made on the habits of the dogfish, including a description of their eggs and nests. Data was collected in June, 1935 at Rondeau Bay, Ontario. (BU)

Doan, K. H. 1940. Studies of the smallmouth bass. J. Wildlife Manage. 4(3):241-266.

A study of the smallmouth bass in various waters in the Great Lakes region of Ontario. Specimens taken from Lake Erie were collected at Rondeau Bay and the island region in the Western Basin. This study was concerned with the factors governing the existence of this species and of the ecological relations that influence such activities as feeding, growth, and reproduction. (SM)

Doan, K. H. 1941. Relation of the sauger catch to turbidity in Lake Erie. Ohio J. Sci. 41(6):449-452.

Turbidity is an important factor relating to the abundance of certain fishes in Western Lake Erie. A high degree of correlation has existed from 1930 to 1940 between the mean April-May turbidities as measured at Cleveland and the total Ohio sauger catch three years later. Lake turbidities during these months bear a significant relationship to the mean precipitation during these same months. It is suggested that higher turbidities may act to prevent stickiness in sauger eggs, may give young fry protection from predators, and may facilitate the young sauger's feeding by concentrating plankton organisms near the surface. (BU)

Doan, K. H. 1942. Some meteorological and limnological conditions as factors in the abundance of certain fishes in Lake Erie. Ecol. Mono. 12(3):293-314.

By methods of correlation, a survey has been made of the physical factors concerned in the abundance of Lake Erie fishes. It was found that the mean temperatures decrease in order from southwest to the northeast (same applies to the water temperatures). Mean precipitation varies similarly along Lake Erie, as does turbidity and the latter decreases in value eastward. Turbidity of the lake water depends in part upon the amount of precipitation along the shore. These parameters are correlated to fish catches and occurrences. (SM)

Dutka, B. J., J. B. Bell and D. L. S. Liu. 1974. Microbiological examinations of offshore Lake Erie sediments. J. Fish. Res. Bd. Can. 31(3):299-308.

In August 1972 divers collected cores from the Central and Western Basins of Lake Erie for microbiological analysis. The cores were sectioned and examined for sulfur cycle bacteria, nitrogen cycle bacteria, total heterotrophs, iron oxidizing bacteria, and insoluble organic and inorganic solubilizing bacteria. Eh, nitrogen, organic carbon, and percentage moisture determinations were also made. (SM)

Edgecombe, G. R. 1974. The aquatic insects of Rocky River using Ephemeroptera (mayflies) as an indication of water pollution. Report on Research Project in Entomology. The Ohio State Univ., Columbus, Ohio. 34 p.

Edmondson, W. T. (Ed.) 1959. Fresh-water biology. 2nd Ed. John Wiley & Sons, New York. 1248 p.

Edsall, T. A. 1967. Biology of the freshwater drum in Western Lake Erie. Ohio J. Sci. 67(6):321-340.

Information on the biology of the freshwater drum or sheepshead (Aplodinotus grunniens) was collected in Lake Erie during a fishery and limnological study made by the Bureau of Commercial Fisheries in 1957 and 1958. Growth of the sheepshead in 1958 was slower than in 1927, and slower than the growth in most other waters. Males and females grew at the same rate through the 4th year of life, but thereafter the females grew faster. Males required more than 13 years and females 11 years to reach 17 inches. A weight of 2 pounds was attained in the 12th year of life by males and in the 10th year by females. Annulus formation extended from mid-June to early August for age-groups I-IV (2nd through 5th year of life). Younger fish started growth earlier in the season than the older fish, and the larger, faster-growing members of an age group began growth earlier than the smaller fish.

The growing season in 1958 ended in early October. Bottom-water temperatures were about 65°F when growth started (mid-June) and 58°F when growth ended. Growth was most rapid in August when temperatures were highest for the year (72°F). Growth of young of the year, but not that of older fish, was positively correlated with temperature during the 1951-57 growing seasons. The sex ratio of the 1958 samples shifted.

Eggleton, F. E. 1931. A limnological study of the profundal bottom fauna of certain fresh-water lakes. Ecological Monographs. 1(3):231-332. Durham, N.C.

Erikson, C. H. 1963. Respiratory regulation in Ephemera simulans Walker and Hexagenia limbata (Serville) (Ephemeroptera). J. Exp. Biol. 40:455-467.

Erikson, C. H. 1964. The influence of respiration and substrate upon the distribution of burrowing mayfly naiads. Verh. Int. Verein. Limnol. 15:903-911.

Erikson, C. H. 1968. Ecological significance of respiratioin and substrate for burrowing Ephemeroptera. Can. J. Zool. 46:93-103.

Ewers, L. A. 1933. Summary report of the crustacean used as food by the fishes of the western end of Lake Erie. Trans. Amer. Fish. Soc. 63:379-390.

A report on a survey of the stomach contents of twelve species of Lake Erie fish collected in the western end during 1928 and 1929. (CCIW)

Fabian, M. W. 1960. Mortality of fresh-water and tropical fish fry by cyclopoid copepods. Ohio J. Sci. 60(5):268-270.

A report on an experiment designed to test the effects of population density of cyclopoids and of various sizes of fish fry on predation rates. Results indicate that mortality and predation of fry increases as the concentration of the cyclopoids increases. (BU)

Farrell, M. A. 1932. Pollution studies. NYS Conserv. Dept., Supplemental to 21st Annu. Rep. for 1931. Biol. Surv., Albany, NY. 6:189-198.

The primary object of the study was to determine the stream mileage affected by various kinds of polluting substances. Special attention was given to the effect of dairy wastes on streams. In addition, an attempt was made to correlate the bottom fauna in polluted areas with the food taken by fish caught in such areas.

Fassett, N. C. 1940. A Manual of Aquatic Plants. McGraw-Hill Book Co., Inc. New York, N. Y. 379 p.

A comprehensive book intended to assist in the identification of aquatic plants. The Great Lakes region is included in the range of the plants described. An appendix details the use of aquatic plants by wildlife and the relation of plants to fish. (SM)

Federal Water Pollution Control Administration. 1966. Great Lakes-Illinois river basins project. Statement on water pollution in the Lake Ontario basin. Prepared for the Natural Resources and Power Subcommittee of the House Committee on Government Operations, Washington, D. C. Unnumbered.

Biological sampling consisted of analysis of benthic fauna, phytoplankton, attached algae, chlorophyll, light penetration and seston. Evaluation of biological conditions in Lake Ontario shows the lake can be classified as tending to become eutrophic. The benthic fauna of the lake indicates oligotrophic conditions. However, the phytoplankton and attached algae problems that occur tend to support a eutrophic nature. The ability of the lake to support algae blooms and great masses of Cladophora along the littoral zone is a definite indication of eutrophication. Apparently the major factor that saves Lake Ontario from becoming eutrophic is its deep water.

The microbiological study of the Lake Ontario basin included tributary, mouth, harbor-inshore and extended range stations. The parameters considered in the study were total coliform, fecal coliform, fecal streptococcus and total plate counts.

The section on water uses included a discussion of commercial fishing. The total pounds of fish reported by U. S. fisheries ranged from 233,000 to 351,200 during the years 1960-1964. Yellow perch, carp, eels and white perch were the principal species caught.

Federal Water Pollution Control Administration. 1968a. Lake Erie Environmental Summary 1963-1964.

Federal Water Pollution Control Administration. 1968b. Lake Erie Surveillance Data Summary, 1967-1968.

Federal Water Pollution Control Administration. 1968c. Water Pollution Problems and Improvement Needs, Lake Ontario and St. Lawrence River Basins. U. S. Federal Water Pollution Control Administration and N. Y. Dept. Health, Div. of Pure Waters, Albany, NY. 124 p.

The report summarizes the water pollution problems of the United States waters of Lake Ontario and the St. Lawrence River and their tributaries. It identifies the causes of these problems or sources of pollution, discusses the improvements needed and presents a program of recommended actions. The report is based on extensive field and office studies, initiated in 1964 and still continuing, by the Federal Water Pollution Control Administration's Rochester Program Office; and on information on the New York State Health Department.

Ferris, V. R., L. M. Ferris, and J. P. Tjepkema. 1976. Genera of freshwater nematodes (Nematoda) of eastern North America. USEPA, Cincinnati, Ohio. 38 p.

Fish, C. J. (Ed.). 1929a. Preliminary report on the cooperative survey of Lake Erie, season of 1928. Bull. Buffalo Soc. Natural Sci. Buffalo, N. Y. 14(3):7-15, 195-220.

The present report contains a preliminary statement on the results of a three-month survey of Eastern Lake Erie to determine the cause or causes for the decline in the fishery.

The program was designed with two objects in view: first, a determination of the natural requirements for successful production, such as the location of the spawning grounds, their relative importance as production centers, the food requirements of the fry, the abundance of this food, enemies, and migrations during the first years of their existence; second, careful tests to determine to what extent man has interfered with these natural requirements, to what degree the waters have been made impossible for fish life, what areas of the bottom have been rendered unfit for spawning, etc. By combining the results of these two lines of study it should be possible to determine where the natural requirements have been most seriously affected and how conditions may best be improved.

Fish, C. J. 1929b. A preliminary report on the joint survey of Lake Erie. In: A Biological Survey of the Erie-Niagara System. N. Y. Conserv. Dept. Albany, N. Y. Supplement 18th Annu. Rep. (1928). pp. 39-44.

The present report contains a brief summary of some of the results of a three-month survey of Eastern Lake Erie. The object of the investigation was to determine, if possible, the cause or causes for the decline in the fisheries of the lake. The results are presented as a series of 7 articles by different authors.

Fish, C. J. (Ed.). 1960. Limnological survey of Eastern and Central Lake Erie, 1928-1929. U. S. Fish and Wildlife Service. Spec. Sci. Rep. - Fish. 334. 198 p.

A report on a survey conducted during 1928-1929, the object of which was to ascertain the cause of fishery decline. The investigation was designed to determine the significant physical, chemical and biological conditions in Lake Erie at that time. After extensive study it was concluded that these three factors could afford no explanation for the fishery decline.

Foell, E. J. 1974. The age and growth of freshwater drum (Aplodinotus grunniens Rafinesque) from Lake Erie near Cleveland, Ohio. John Carroll Univ. Cleveland, Ohio. M.Sc. Thesis. 95 p.

A report on a study to determine the growth and condition of the freshwater drum in a severely polluted area of Lake Erie off Cleveland, Ohio. The existence of possible effects of pollution on drum growth rates was demonstrated by comparing the results of this study with existing data obtained in less polluted areas of the lake.

Foulk, C. W. 1925. Industrial water supplies of Ohio, with chapters on impurities in water, methods of analysis and the statement of results and their interpretation, the behavior of water in use, and the industrial purification of water. Geological Survey of Ohio, Fourth Series, Bulletin No. 29. 406 p. Columbus.

Frost, W. H. et. al. 1924. A study of the pollution and natural purification of the Ohio River. II. Report of surveys and laboratory studies. United States Public Health Service, Public Health Bulletin No. 143. xxi + 343 p. Washington.

Fruh, E. G., K. M. Stewart, G. F. Lee and G. A. Rohlich. 1966. Measurements of eutrophication and trends. J. Water Poll. Control Fed. 38:1237-1258.

A review of the parameters used by various investigators to determine the relative state and rate of eutrophication of natural waters. In addition, some of the significant advantages and disadvantages of each of these measurements are discussed. Lake Erie is referred to several times as a site for eutrophic samples.

Gaiser, L. O. 1949. Further distribution of Butomus umbrellantus in the Great Lakes region. Rhodera. 51(612):385-390.

An article reviewing the spread of the European plant, Butomus umbrellantus, from 1941-1949. A distribution map is included. (SM)

Gannon, J. E. and A. M. Beeton. 1969. Studies on the effects of dredged materials from selected Great Lakes Harbors on plankton and benthos. Univ. Wisc.-Milwaukee. Center for Great Lakes Studies. Milwaukee, Wisc. Spec. Rep. 8, 80 p.

Lake Erie stations included in the study are Buffalo, Cleveland, Toledo and the Rouge River. The harbor sediments fit into five categories in terms of their effects on the test organisms: (1) Some sediments were toxic, were avoided by benthic animals, and did not stimulate growth of phytoplankton or Cladophora. Sediments in this category came from Buffalo, Cleveland and the Rouge River. (2) A large number of sediments were toxic to the test animals, but they stimulated the growth of phytoplankton or Cladophora. Sediments in this category came from Buffalo, Cleveland and the Rouge River. (3) Some sediments were only somewhat toxic (i.e. killed some test animals but did not affect others), were avoided by Pontoporeia but not by midge larvae, and stimulated growth of phytoplankton or Cladophora. These sediments were from Cleveland and Toledo. (4) Three sediments from Green Bay (Lake Michigan) were not especially toxic and did not stimulate growth of algae. (5) Three sediments were not toxic and they stimulated growth of phytoplankton but not growth of Cladophora. These were not from Lake Erie harbors.

Gannon, J. E. and A. M. Beeton. 1971. Procedures for determining the effects of dredged sediments on biota-benthos viability and sediment selectivity tests. J. Water Poll. Control Fed. 43(3):392-398.

Sediment selectivity tests and viability experiments indicated some direct effects on the amphipod, Pontoporeia affinis. Sampling stations were scattered throughout the Great Lakes region. Every harbor tested had some sediments with mortality greater than the controls. Sediments from the river sections of badly polluted harbors were more toxic than those from the outer harbor. Many dead arthropods were observed to be covered with a film of oil. (BECPL)

Gary, L. B. 1910a. Naiades of Cedar Point, Ohio. Ohio Naturalist. 10(8):183-184.

A list of 16 species of naiades collected from Cedar Point is given. (BU)

Gary, L. B. 1910b. Naiades of Grand River, Ohio. Ohio Naturalist. 10(8):183.

A list of 20 species of naiades collected from the Grand River is given. (BU)

Gaufin, A. R. and C. M. Tarzwell. 1952. Aquatic invertebrates as indicators of stream pollution. Pub. Health Dept. Rep. Washington. 67:57-64.

Giltz, M. L. and W. C. Myser. 1954. A preliminary report on an experiment to prevent cattail die-off. Ecol. 35(3):418.

A brief report of an attempt to protect cattails in western Lake Erie from carp and muskrats by erecting a one-half inch mesh fence. It was concluded that intermittent preserved areas might offer one way to save the cattails and allow some channels and open areas which are desirable for wildlife management. (SM)

Glooschenko, Walter A., James E. Moore and Richard A. Vollenweider. 1974. Spatial and temporal distribution of chlorophyll _a_ and pheopigments in surface waters of Lake Erie. J. Fish. Res. Bd. Can. 31(3):265-274.

Chlorophyll _a_ analysis including pheopigments were made on water samples taken from Lake Erie between April and December 1970. The highest mean chlorophyll _a_ values occurred in the mid-Western Basin; the lowest in the Eastern Basin. Pheopigment concentration reached a maximum in late October. No significant correlation was found betwen zooplankton abundance and pigment concentration indicating that zooplankton food chains are primary detrital in Lake Erie. (SM)

Goodnight, C. J. 1973. The use of aquatic macroinvertebrates as indicators of stream pollution. Trans. Amer. Micros. Soc. 92:1-13.

Goodnight, C. J. and L. S. Whitely. 1960. Oligochaetes as indicators of pollution. Water Sewage Works. 107:311.

Goodnight, C. J. and L. S. Whitley. 1961. Oligochaetes as indicators of pollution. Proc. 15th Industrial Waste Conf., Purdue Univ. Eng. Ext. Service, 106(45):139-142.

Goodrich, C. 1911. _Lymnaea auricularia_ in Ohio. Nautilus. 25(1):11-12.

A brief note recording the discovery of _Radix auricularia_ L. on March 21, 1911
Bythinia tentaculata is the most common shell found in the mud flats of two marshy areas in that region. (SM)

Goodrich, C. 1916. A trip to the islands in Lake Erie. Ann. Carnegie Mus., Pittsburgh, Penn. 10(3-4):Article 20:527-531.

An account of a shell-collecting trip to the Lake Erie islands in July of 1915. The party visited West Sister Island, Green Island and Mouse Island in Ohio; Middle Island, Middle Sister Island, North Harbor Island and East Sister Island in Ontario. (SM)

Goodrich, C. 1920. Goniobasis of Ohio. Nautilus. 33(3):73-74.

A short article concerning distribution of Goniobasis livescens Monke and G. semicarinata Say within the borders of Ohio. G. livescens occurs in the Maumee River system, other tributaries of Lake Erie, and the shallows of Lake Erie. G. haldemanni was also found in the drifts of beaches along the lake. Other forms are found in the Ohio, Wabash and Muskingum systems. (SM)

Goodrich, C. and H. V. Schalie. 1932. I. On an increase in the naiad fauna of Saginaw Bay, Michigan. II. The naiad species of the Great Lakes. Occasional Papers, Museum of Zoology, University of Michigan. No. 238. 14 p. Ann Arbor.

Gorham, E. 1958. Observations on the formation and breakdown of the oxidized microzone of the mud surface in lakes. Limnol. Oceanogr. 3:291-298.

Gotaas, H. B. 1969. Outwitting the patient assassin: the human use of lake pollution. Bull. Atomic Scientists. (May). pp. 8-10.

A review of the problems of cultural eutrophication in freshwaterways, including Lake Erie. The author challenges some aspects of the emphasis on nutrient removal in current antipollution programs. He proposes alternate approaches such as seeding desirable fish species and re-establishing commercial fishing on the Great Lakes.

Gottschall, R. Y. 1930. Preliminary report on the phytoplankton and pollution in Presque Isle Bay, Lake Erie. Proceedings, Pennsylvania Academy of Science. 4:1-11. Philadelphia.

Gottschall, R. Y. and O. E. Jennings. 1933. Limnological studies at Erie, Pennsylvania. Trans. Amer. Micros. Soc. 52(3):181-191.

The report of a year-round survey of the phytoplankton and the chemical and physical conditions of the waters of Lake Erie in the vicinity of Erie, Pennsylvania. The work started in 1929 and was completed in June of 1931.

Great Lakes Institute. 1964a. Annual report - 1964. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rep. PR 18. 47 p.

A review of the observations of 1964, which includes the number of plankton hauls, bottom samples (fauna) and fish finder records for Lake Erie, is given in tabular form. A brief summary of each of the Great Lakes Institute research programs conducted during 1964 is given. The following are those programs dealing with the biology of Lake Erie: (1) Great Lakes bottom fauna investigations; and (2) Great Lakes plankton investigations.

Great Lakes Institute. 1964b. Annual report - 1965. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rep. PR 25. 55 p.

A review of the observations of 1965, which includes the number of plankton hauls, bottom samples (fauna) and fish finder records for Lake Erie, is given in tabular form. A brief summary of each of the Great Lakes Institute research programs conducted during 1965 is given. The following are those programs dealing with the biology of Lake Erie: (1) Bottom fauna of Lakes Ontario and Erie; (2) Studies on stream crayfishes - includes sampling sites from the Detroit River; (3) Great Lakes plankton investigations; and (4) Lake Erie phytoplankton investigations.

Great Lakes Institute. 1965. Great Lakes Institute data record - 1963 surveys. Part I: Lake Ontario, Lake Erie and Lake St. Clair. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rep. PR 23. 195 p.

This report is a compilation of data collected in 1963 with the research vessel C.C.G.S. Porte Dauphine by the Great Lakes Institute. The data consists primarily of physical, chemical and meteorological parameters. The only biological data included is the number of plankton hauls (zooplankton), bottom samples (fauna) and fish finder records.

Great Lakes Institute. 1968. Annual report - 1967. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rep. PR 31. 70 p.

A brief summary of each of the Great Lakes Institute research programs conducted during 1967 is given. The following deals with the biology of Lake Erie: studies on the benthos of the Great Lakes.

Great Lakes Institute. 1971. Great Lakes Institute data record surveys in 1964 of the CCGS Porte Dauphine for Lake Ontario, Lake Erie, Lake St. Clair, Lake Huron, Georgian Bay and Lake Superior. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rep. PR 42. 238 p.

This report is a compilation of data collected in 1964 with the research vessel C.C.G.S. Porte Dauphine by the Great Lakes Institute. The data consists primarily of physical, chemical and meteorological parameters. The only biological data included is the number of plankton hauls, bottom samples (fauna) and fish finder records.

Great Lakes Research Division. 1966. A review of Great Lakes benthos research. Univ. Mich., Great Lakes Res. Div. Pub. No. 14. 54 p.

Great Lakes Research Institute. 1955. The Great Lakes and Michigan. Univ. Mich., Great Lakes Res. Inst. 39 p.

Great Lakes Research Institute. 1973. Selected analysis and monitoring of Lake Erie water quality annual report 1973. Erie County Health Dept., Erie, Penn. 60 p.

The Lake Erie Water Quality Study was undertaken to develop the information necessary for effectively planning the management of desired water quality in the region of Erie, Pennsylvania. The study began with the 1972 season which has been previously reported. Biological parameters included evaluation of coliform patterns, level of algae and zooplankton, and benthic macroinvertebrates. It was concluded that water samples collected in the Pennsylvania region of Lake Erie during the 1973 season shows very little difference in the water quality between points east and points west of Erie, Pennsylvania. The pollutant input level in the Erie area is apparently not sufficient to have any adverse effects on the water quality of Lake Erie.

Great Lakes Water Quality Board. 1973. Great Lakes water quality annual report to the International Joint Commission. Great Lakes Water Quality Bd. Chicago, Ill. 315 p.

This report presents a current assessment of water quality in the boundary waters of the Great Lakes, and of the control programs and other measures set forth in the Great Lakes Water Quality Agreement of 1970. The most significant lakewide problem in Lake Erie is eutrophication due mainly to cultural over-enrichment by nutrients. A major symptom of eutrophication is the depletion of hypolimnetic dissolved oxygen in the Central and Eastern Basins in late summer. There are, however, significant near-shore areas which are strongly influenced by waste discharges from point sources and tributaries, particularly along the southern shore. The report details the regulations of Great Lakes states and Ontario and specifies cases of non-compliance with these regulations.

Greeley, J. R. 1956. The lamprey in New York waters. N. Y. State Dept. Environ. Conserv. Albany, N. Y. Conserv. 11(1):18-22.

A report on the six species of lampreys found in New York. Four of the six are non-parasitic. The parasitic Ichthyomyzon concdor is thought to be responsible for some scars on Lake Erie fish. The parasitic sea lamprey, Petromyzon marinus is the largest and most numerous. The first specimen was recorded in Lake Erie in 1921. Since Lake Erie has never produced lake trout in any large quantity, but instead produces a wide variety of species, the effect of the sea lamprey has not been as pronounced there as in the upper Great Lakes. There is also a lack of suitable spawning streams for sea lamprey on Lake Erie. (SM)

Grier, N. M. 1918. New varieties of naiades from Lake Erie. Nautilus. 32(1):9-12.

Three new varieties of naiades collected at Presque Isle, Pennsylvania are carefully described and measurements given. It is suggested that these forms are generally distributed throughout the lake. They include Elliptio dilatatus var. sterkii, Lasmigona costata var. eriganensis, and Fusconaia flava var. parvula. (SM)

Grier, N. M. 1920a. On the erosion and thickness of shells of the freshwater mussels. Nautilus. 34(1):15-22.

This report brings together information on shell thickness of mussels from the upper Ohio drainage and Lake Erie. Lake Erie shells are comparatively less eroded, shorter, and have a greater relative degree of inflation. Some species also possess characteristics indicating a depauperate type of growth. In all species from Lake Erie it appears that the thickness of the shell is negatively correlated with the percentage of calcium carbonate in the water. (SM)

Grier, N. M. 1920b. Variations in epidermal color of certain species of naiades inhabiting the Upper Ohio drainage and their corresponding ones in Lake Erie. Amer. Midland Nat. 6(12):247-285.

An extensive analysis of the epidermal color of certain species of freshwater mussels of Lake Erie and the upper Ohio drainage. The author attempts to determine the prevalent color of each species, the effect of the body of water on the color, and the relationships between age and color and sex and color. (BU)

Grier, N. M. 1920c. Variations in nacreous color of certain species of naiades inhabiting the Upper Ohio drainage and their corresponding ones in Lake Erie. Amer. Midland Nat. 6(10):211-243.

An extensive analysis of the nacreous color of certain species of freshwater mussels of Lake Erie and the upper Ohio drainage. The author attempts to determine the prevalent color of each species, the effect of the body of water on the color, and the relationship between sex and color. (BU)

Hall, A. R. 1925. Effects of oxygen and carbon dioxide on the development of the whitefish. Ecol. 6(2):104-116.

A report on an experiment designed to find out the relative sensitivity of the stages in the early life history of the whitefish and to test the resistance and reactions of normally hatched individuals as compared with the reactions of those hatched under experimental conditions. The fish eggs were obtained from a hatchery at Put-in-Bay, Ohio and the water for the normal hatching was taken from Lake Erie. (BU)

Harman, W. N., and C. O. Berg. 1971. The freshwater snails of central New York, with illustrated keys to the genera and species. Search 1(4):1-67.

Hart, C. W., Jr., and S. L. H. Fuller. (Eds.) 1974. Pollution ecology of freshwater invertebrates. Academic Press, N. Y. 389 p.

Hartman, W. L. 1970. Resource crises in Lake Erie. Explorer. 12(1):6-11.

The effect of accelerated enrichment, unabated pollution, over-exploitation, and accidental and intentional introduction of exotic species on Lake Erie's fish populations.

Hartman, W. L. 1973. Effects of exploitation, environmental changes, and new species on the fish habitats and resources of Lake Erie. Great Lakes Fish. Comm., Ann Arbor, Mich. Tech. Rept. 22. 43 p.

No other lake as large as Lake Erie (surface area, 25,690 km^2) has been subjected to such extensive changes in the drainage basin, the lake environment, and the fish populations over the past 150 years. Siltation of spawning grounds as a result of deforestation and prairie burning, drainage of marsh spawning areas, blockage of lake-to-river migrations by mill dams, accelerated cultural nutrient loading resulting in an increase in dissolved solids, and oxygen depletion led to the disappearance or severe depletion of fish species. The sequence of disappearance or depletion was as follows: lake trout, sturgeon, lake herring, lake whitefish, sauger, blue pike, and walleye. Yellow perch are now declining.

Hartund, R. and G. W. Kingler. 1970. Concentration of DDT by sedimented polluting oils. Environ. Sci. Tech. 4(5):407-410.

Significant amounts of polluting oils settle out in rivers and lakes after oil pollution incidents. This study investigates the relationship between oils and DDT in sediments from the Detroit River. It is suggested that the biological implications of the concentrating behavior of these oils should be investigated. (BECPL)

Hasler, A. D. and M. E. Swenson. 1967. Eutrophication. Sci. 158(3798):278-282.

A report on an international symposium on eutrophication held at the University of Wisconsin, June 11-16, 1967. Lake Erie was one of several eutrophic lakes discussed. The ideas presented by various participants are summarized. (SM)

Heard, W. H. 1962. The Sphaeriidae (Mollusca: Pelecypoda) of the North American Great Lakes. Amer. Midland Naturalist. 67(1):194-198.

The mollusk fauna of the Great Lakes is not well known, and the sphaeriid clams have never been recorded. Although ignored until recently, specific identification is necessary when studying food relationships, parasitology and distribution. Lists of sphaeriids from each of the Great Lakes reveal that Superior has 6 species; Lake Michigan, 20; Lake Huron, 20; Lake Erie, 14; and Lake Ontario, 26 species. Among the sphaeriids, some species are more common than others, and occurrence varies with depth of water and type of substrate.

Hegner, R. W. and J. G. Engemann. 1968. *Invertebrate Zoology*. Macmillan Co., New York.

Henson, E. B. 1966. A review of Great Lakes benthos research. Univ. Mich. Great Lakes Res. Div. Pub. 14:37-54.

Research attention to the earth-water interface and to the associated plant and animal populations inhabiting the bottom substrata of the Great Lakes has recently both gained in intensity and changed in emphasis. An objective of this article is to focus attention to Great Lakes benthos research that serves as an oar in the movement of future limnological understanding. An effort is made here to contribute to unified knowledge of Great Lakes benthos by adopting one vantage point and bringing out salient historic aspects, summarizing present investigations, evaluating benthos composition, and refocusing this in terms of temporal dynamics. The selected vantage point will consider the benthos as an entity in geologic time subject to the eutrophic forces of biological succession.

Herbst, R. P. 1969. Ecological factors and the distribution of *Cladophora glomerata* in the Great Lakes. Amer. Midland Naturalist. 82(1):90-98.

Nutrient enrichment in the Great Lakes has provided fertile areas for growth of algal nuisances. One of these species, *Cladophora glomerata*, has become a major problem for many cities bordering the Great Lakes. Ecological factors concerning its growth in Milwaukee's harbor were studied, and its distribution in the Great Lakes determined. Phosphorus levels appear to be closely linked with *Cladophora* increases. (SM)

Herdendorf, C. E. 1970. Lake Erie physical limnology cruise, midsummer 1967. Ohio Dept. Natural Resources. Div. Geol. Surv. Columbus, Ohio. Rep. Invest. 79. 77 p.

This report provides information on the physical limnology of Lake Erie, with particular attention to circulation patterns and to changes in the quality of the water as it passes through the lake. The objective of the field survey was to measure several physico-chemical properties of Lake Erie water from its major inflow at the Detroit River to outflow in the Niagara River. Station data sheets also show the presence of algae turbidity, *Aphanizomenon*, in Western Lake Erie, and plankton turbidity, *Daphnia*, in Central Lake Erie.

Herdendorf, C. E. and L. L. Braidech. 1972. Physical characteristics of the reef area of western Lake Erie. Ohio Dept. Natural Resources. Columbus, Ohio. Rep. Invest. 82. 90 p.

A three-year study was made to determine the physical characteristics of the reefs and surrounding areas in Western Lake Erie. The investigation was undertaken to provide state and federal fisheries biologists with information in support of their resource management programs, particularly as the physical makeup of the area relates to the spawning, nursery, and feeding grounds for such species as walleye (Stizostedion vitreum vitreum), white bass (Roccus chrysops), and channel catfish (Ictalurus punctatus). The project extended from April 1, 1967 to March 31, 1970.

Hetherington, M. F. 1964. Studies of the naiades of the central basin of Lake Erie. M.Sc. thesis, Ohio State Univ., Columbus, Ohio.

Higgins, E. 1928a. Cooperative fishery investigations in Lake Erie. Sci. Monthly. 27:301-306.

A review of the principles and an examination of the field of study of numerous research projects presented at a conference of biologists called by the U. S. Commissioner of Fisheries on February 6, 1928 at Cleveland, Ohio.

Higgins, E. 1928b. Conference of Lake Erie biologists. Science. 67(1734):309-310. New York.

Hill, G. 1965. The Great and dirty lakes. Saturday Rev. 48:32-34.

A general discussion of pollution in the Great Lakes with an emphasis on Lake Erie. Reference is made to both industrial and municipal wastes and the extent of their entry into the lakes.

Hilsenhoff, W. 1966. Corixidae as indicators of water quality. Unpublished paper given at 14th Annual Meeting of Midwest Benthological Soc.

Hilsenhoff, W. L. 1975. Aquatic insects of Wisconsin, with generic keys and notes on biology, ecology, and distribution. Wisc. Dept. Natural Resources, Tech. Bull. No. 89. 53 p.

Hiltunen, J. K. 1965. Distribution and abundance of the polychaete, Manayunkia speciosa Leidy, in western Lake Erie. Ohio J. Sci. 65(4):183-185.

The abundance and distribution of the freshwater polychaete, Manayunkia speciosa, in 1961, is described for western Lake Erie. Previous records reveal that the species has either been generally overlooked or presently its numbers have greatly increased in the area considered.

Hiltunen, J. K. 1966. Moss from the bottom of the Great Lakes. Mich. Bot. Ann Arbor, Mich. 5(2):62-63.

A short article describing the discovery of the moss, Fissidens debilis Schwaegr, growing on a submerged clay surface in Lake Erie. Specimens of Fissidens have also been found in Lakes Michigan, Superior and Ontario. (SM)

Hiltunen, J. K. 1967. Some oligochaetes from Lake Michigan. Trans. Amer. Micros. Soc. 86:433-454.

Hiltunen, J. K. 1969a. Distribution of oligochaetes in western Lake Erie, 1961. Limnol. and Oceanogr. 14(2):260-264.

A total of 52,390 oligochaetes were collected from 40 stations in Western Lake Erie in spring 1961. The population was composed of two families, Naididae and Tubificidae. Only six species of naidids were found. One, Paranais frici, is apparently new to the list of North American freshwater Naididae. Among the 14 tubificids found, five species of Limnodrilus were most abundant; they contributed 90% or more of all oligochaetes at 33 of the 40 stations. Numbers of Limnodrilus were generally large near the mouths of the Detroit, Raisin and Maumee rivers and decreased progressively lakeward. Stylodrilus heringianus, a pollution-intolerant species common in eastern Lake Erie, was not found in the western end of the lake. (Gabriel-USGUS)

Hiltunen, J. K. 1969b. The benthic macrofauna of Lake Ontario. Great Lakes Fish. Comm., Ann Arbor, Mich. Tech. Rep. 14. pp. 39-50.

The presence and relative abundance of bottom macrofauna in Lake Ontario are documented. Bottom samples were collected at 24 stations in September 1964. The quantity of organisms and the distribution of some species were affected by depth of water. Samples from the shallower stations (47.5 m or less) yielded an average of 41,631 organisms per m whereas the deeper stations (91.5 m or more) yielded an average of only 7,938. The Oligochaeta, the most abundant group of macroinvertebrates, were represented by four families -- Enchytraedae, Lumbriculidae, Naididae and Turificidae. The lumbriculid worm, Stylodrilus heringianus and the burrowing amphypod, Pontoporeia affinia, were rare or absent in areas affected by pollution. In kinds and abundance of organisms, the bottom fauna in Lake Ontario was generally similar to that in Lake Michigan.

Hiltunen, J. K. 1970. A Laboratory Guide: Keys to the tubificid and naidid Oligochaeta of the Great Lakes region (unpublished).

Hiltunen, J. K. 1973. A laboratory guide. Keys to the tubificid and naidid Oligochaeta of the Great Lakes region. (Unpublished).

Hine, J. S. 1901. Dragonflies of Sandusky. Ohio Naturalist. 1(6):94-95.

Hine, J. S. 1903. Tabanidae of Ohio. Proc. Ohio Acad. Sci., Special Paper No. 5. 63 p.

Hinton, H. E. 1960. Cryptobiosis in the larva of Polypedilum vanderplanki Hint. (Chironomidae). J. Insect Physiol. 5:186-300.

Hitchcock, S. W. 1965. Field and laboratory studies of DDT and aquatic insects. Connecticut Exp. Sta. Bull. 668:1-32.

Holsinger, J. R. 1976. The freshwater amphipod crustaceans (Gammaridae) of North America. USEPA, Cincinnati, Ohio. 89 p.

Howard, D. L., J. I. Frea, R. M. Pfister and P. R. Dugan. 1970. Biological nitrogen fixation in Lake Erie. Sci. 169:61-62.

Biological nitrogen fixation, as determined by acetylene reduction, occurs in Lake Erie. Fixation potential by blue-green algae in situ in water and by bacteria in collected sediments was demonstrated. Nitrogen-fixing activity occurred from June through November suggesting that it is significant over the extremes of seasonal variation in light, temperature, and nutrients.

Howard, D. L., J. I. Frea and R. M. Pfister. 1971. The potential for methane-carbon cycling in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 236-240.

Biological methane production and oxidation were studied by in situ methods in the Western Basin of Lake Erie and in the laboratory of isolated cultures obtained from the lake. Two gram negative bacillae capable of producing methane in simple salts medium were isolated several times during the summer months of 1970. Two methane oxidizing bacteria were also isolated from the lowest meter of the water column and from the surface of sediments, but no methane oxidation or isolates could be obtained from areas devoid of sediments.

Howmiller, R. and M. S. Loden. 1976. Identification of Wisconsin Tubificidae and Naididae. Wisc. Acad. Sciences, Arts, and Letters. 64:185-197.

Howmiller, R. P. and M. A. Scott. 1976. Oligochaetes as indicators of environmental quality: an index based on relative abundance of species (unpublished).

Hoy, P. R. 1872. Deep-water fauna of Lake Michigan. Transactions, Wisconsin Academy of Sciences, Arts and Letters. Vol. I, 1870-1872. p. 98-101. Madison.

Hubbs, C. L. 1921. An ecological study of the life history of the fresh-water atherine fish Labidesthes sicculus. Ecol. 2(4):262-276.

This paper deals with Labidesthes sicculus, a freshwater fish collected and observed in the waters of southeastern Michigan. Diurnal, seasonal and age changes in its habits and in habit reaction as well as the varied effects of the environment on its rate of growth and the main features of its life history are discussed. (BU)

Hubschman, J. H. 1971. Lake Erie: pollution abatement, then what? Sci. 171:536-540.

The article presents another possible solution to eutrophication in Lake Erie. Pollution abatement can only solve the problem to a limited extent. The author suggests the possibility of introducing selected species of benthic macrofauna which could help establish a system that would be ecologically as well as economically desirable.

Hubschman, J. H. and W. J. Kishler. 1972. Craspedacusta sowerbyi Lankester 1880 and Cordylophora lacustris Allman 1871, in western Lake Erie (Coelenterata). Ohio J. Sci. 72(6):318-321.

Thirty-seven stations, representing a variety of rocky habitats in the Lake Erie island region were sampled over a three-year period. Rock samples were hand-picked by diving and identification made from living material. The colonial hydroid Cordylophora lacustris was collected at fourteen widely separated locations. The minute polyp form of the freshwater jellyfish Craspedacusta sowerbyi was collected at all of the stations sampled. New hydranth buds, frustules, and medusoid buds were produced in the laboratory by the polyps collected.

Hudson, P. L. 1971. The Chironomidae (Diptera) of South Dakota. Proc. S. Dak. Acad. Sci. 50:155-174.

Hufford, T. L. 1965. A comparison of photosynthetic yields in the Maumee River, Steidtmann's Pond, and Urschel's Quarry under natural conditions. Ohio J. Sci. 65(4):176-183.

A study of photosynthetic rates under natural conditions in the Maumee River, Steidtmann's Pond, and Urschel's Quarry, computed from pH and O_2 measurements in the natural habitat at 4- to 6-hr intervals, revealed average rates of 1.4 to 20.9 umol CO_2 absorbed per liter of water per hour, and 0.27 to 1.32 umol CO_2 absorbed per uliter of plant matter per hour, and about 0.012 to 2.22 umol O_2 evolved per uliter of plant matter per hour. These values lie within the range of values for ponds, quarries, lakes, and streams reported in the literature. They are much lower than published values for clear flowing streams. It seems likely that poor light supplies resulting from suspended silt particles cancel any ecological advantage the turbulence of flowing water might provide. The ratios of O_2 production to CO_2 absorption were close to unity except during the spring flood period when ratios below 0.1 were observed, similar to ratios found in a shallow pond near Bowling Green.

Hunt, G. S. 1962a. Seasonal aspects of Berchtold's pondweed. Mich. Bot., Ann Arbor, Mich. 1(1):35.

A summary of observations of the Berchtold's pondweed, Potamogeton berchtold, made during 1953, 1954, and 1955 on the lower Detroit River. Spectacular seasonal changes in abundance were noted. During each year this aquatic plant was abundant during early July. By July 15 it began to disintegrate and float off in large masses. By the end of July it had been replaced by wild celery and other aquatic plants. (SM)

Hunt, G. S. 1962b. Water pollution and the ecology of some aquatic invertebrates in the lower Detroit River. Univ. Mich. Great Lakes Res. Div. Pub. 9:29-49.

A study regarding waterfowl, their habitat, and their foods was conducted in the vicinity of Grosse Ile, Michigan, during 1948 to 1956. This paper reports the findings made on water quality, underwater soils, and macroscopic invertebrates. Particular effort was made to determine the relationship of snails and fingernail clams to the intensity of water pollution, to other water conditions, and to soils. Bottom samples were collected during 1954 to determine the kinds and numbers of invertebrates in the area studied. A map of the invertebrate aggregations was constructed from the sample data in conjunction with a U.S. Lake Survey chart and aerial photographs.

The following were determined for the soils of the sample sites: physical type, pH, oil content, amounts of phosphorus, calcium, nitrogen, potassium, and presence of carbonates. The following were determined for the water at each sample site: depth, temperature, pH, and transparency. Additional water data were obtained from the literature. The effects on the invertebrates of the foregoing soil and water factors were discussed. A comparison between this study and two earlier ones was made.

Hunt, G. S. 1963. Wild celery in the lower Detroit River. Ecol. 44(2):360-370.

Water quality and characteristics, soils, and submerged aquatic plants in the lower Detroit River were studied to determine the relationship of wild celery to the intensity of pollution, other water conditions, and the underwater soil. The aquatic vegetation was assessed qualitatively and quantitatively from 1950 through 1955, and a series of aquatic plant-type maps were developed. (SM)

Hunter, G. W. III and W. S. Hunter. 1929. Further experimental studies on the bass tapeworm, Proteocephalus amblоplitus (Leidy). In: A Biological Survey of the Erie-Niagara System. N. Y. State Dept. Conserv., Albany, N. Y. Suppl. 18th Annu. Rep. (1928). pp. 198-207.

A comprehensive study of Proteocephalus ambloplitus, the bass tapeworm. Their occurrence in Lake Erie bass and other fish is discussed.

Huntsman, A. G. 1913. XX. Invertebrates other than insects and mollusks. In: Faull, J. H. (Ed.). The Natural History of the Toronto region, Ontario. Can. Inst., Toronto, Ont. pp. 272-286.

Contains a relatively complete list of invertebrates found in the Toronto region. The groups included are the Crustacea, Annelida, Bryozoa, Rotifers, Nematelminthes, Platyhelminthes, Coelenterata, Porifera and Protozoans. (Toronto Royal Ontario Mus.)

Huntsman, A. G. 1915. The fresh-water malacostraca of Ontario. Contributions to Canadian Biology Fas. II Fresh Water Fish and Lake Biology. Sessional Paper No. 39b. pp. 145-163.

Hutchinson, G. E. 1957. A treatise on limnology. Vol. I. Geogr., phys. and chem. John Wiley and Sons, New York.

Hydroscience, Inc. 1973. Limnological systems analysis of the Great Lakes, phase I - preliminary model design. Great Lakes Basin Comm., Ann Arbor, Mich. 474 p.

The purpose of this report is to present an assessment of the feasibility of applying a Limnological Systems Analysis to the water resource problems of the Great Lakes. A demonstration modeling framework was constructed and includes: regional models of western Lake Erie for chlorides and bacteria, eutrophication model of western Lake Erie, and food chain model of western Lake Erie.

Hynes, H. B. N. 1960. Biology of polluted waters. Liverpool.

Hynes, H. B. N. 1973. The ecology of running waters. Univ. of Toronto Press. Toronto, Ontario, Can. 555 p.

International Joint Commission. 1914. Progress report in re the pollution of boundary waters, including report of the sanitary experts. Government Printing Office, Washington. 388 p.

International Joint Commission. 1918. Pollution of boundary waters. Report of the consulting sanitary engineer upon remedial measures. Government Printing Office, Washington. 159 p.

International Joint Commission. 1918a. Final report of the International Joint Commission in the matter of the reference by the United States and the Dominion of Canada relative to the pollution of boundary waters. Government Printing Office, Washington. 56 p.

International Joint Commission. 1969a. Pollution of Lake Erie, Lake Ontario and the international section of the St. Lawrence River. I - Summary.

Internat. Lake Erie Water Poll. Bd. and Internat. Lake Ontario-St. Lawrence River Water Poll. Bd. I.J.C., Washington, D. C. 150 p.

This summary report contains a discussion of the excessive algal growth which interferes with water use, the decline in value of fish catches, and bacterial contamination in specified areas along the shore of Lake Erie. Findings are summarized and critical problems of pollution are identified.

International Joint Commission. 1969b. Pollution of Lake Erie, Lake Ontario and the international section of the St. Lawrence River. II - Lake Erie. Internat. Lake Erie Water Poll. Bd. and Internat. Lake Ontario-St. Lawrence River Water Poll. Bd. I.J.C., Washington, D.C. 316 p.

This volume contains the scientific and engineering data and findings used to determine the sources and levels of pollution in Lake Erie as well as recommendations for the necessary remedial measures. Biological data include: pesticide residues in fish, phytoplankton, zooplankton, Cladophora, bottom fauna, fish populations, and bacteriological studies.

International Joint Commission. 1969c. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Volume 3. I.J.C., Washington, D. C. 329 p.

The report has been prepared in three volumes. Volume 3 contains the scientific and engineering data and findings which have been used to determine the sources and levels of pollution in Lake Ontario, as well as recommendations for the necessary remedial measures. The report combines a historical review of aquatic biological data with the results of more recent surveys conducted by the FWPCA and OWRC.

International Lake Erie Water Pollution Board. 1969c. Pollution of Lake Erie: A report to the International Joint Commission. Chicago. 315 pp.

International Joint Commission. 1970. Pollution of Lake Erie, Lake Ontario and the international section of the St. Lawrence River. I.J.C., Washington, D.C. 174 p.

This report of the International Joint Commission deals with an extensive inquiry into the pollution of Lake Erie, Lake Ontario and the international section of the St. Lawrence River. Bacterial and viral contamination are discussed in reference to pollution problems. Included is a section on the effects of pollutants with sub-sections dealing with biological changes, fish, bacterial contamination and wildlife.

Iovino, A. J., and F. D. Miner. 1970. Seasonal abundance and emergence of Chironomidae of Beaver Reservoir, Arkansas (Diptera). J. Kans. Entomol. Soc. 43:187-216.

Jenkins, D. W. 1939. The mayflies of the west end of Lake Erie. M.Sc. thesis, Ohio State Univ., Columbus.

Jennings, H. S. 1898. Trochosphaera again. Sci. 8(199):551.

A brief paper discussing the discovery of the rotifer, Trichospaera, in Lake Erie. Samples were collected in a swamp area near Put-in-Bay, Ohio in the summer of 1898. (BU)

Jennings, H. S. 1900. A report of work on the protozoa of Lake Erie, with especial reference to the laws of their movements. Bulletin, United States Fish Commission for 1899, Washington. 19:105-114.

Jennings, H.S. 1903. Rotatoria of the United States. II. A monograph of the Rattulidae. Bulletin, United States Fish Commission for 1902 (1904), Washington. p. 273-352, 15 pl.

Jennings, O. E. 1909. A botanical survey of Presque Isle, Erie County, Pennsylvania. Ann. Carnegie Mus., Pittsburgh, Penn. Pub. 53. 5(1):289-421.

This study describes the vegetation found on Presque Isle between May and September of 1906. The collections were classified and a systematic catalog of the ferns and flowering plants of Presque Isle is included. Successions of plants in the various habitats of Presque Isle, including the beach, bays, lagoons, marshes, sand plains, dunes, etc. are described. Comparisons are drawn between vegetation found on Cedar Point, in western Lake Erie and on Presque Isle. (SM)

Jennings, Otto E. 1930. Peregrinating Presque Isle. Carnegie Mag. Pittsburgh, Penn. 4(6):171-175.

This article deals with the succession of plant societies observed on Presque Isle. The author notes that in a walk of three miles remnants of four important plant societies can be seen as well as indications that a climax forest is being formed. Changes in aquatic and shore vegetation were observed from the newer to the older ponds. When a pond is left inland by the further growth of the peninsula, there is an active change in its plant life. Studies indicate that when a pond is of a certain age the appearance of certain types of plants can be expected. These, in turn, replace previously existing vegetation. For example, when a pond is about 40 years old, white and yellow water lilies appear. How they reach the pond is not known. Photographs are included showing the types of vegetation on Presque Isle. (SM)

Johannsen, O. A. 1937. Aquatic Diptera. Entomol. Reprint Specialists, Los Angeles, Calif. Parts I-V, individually paginated.

Johnson, M. G. and R. O. Brinkhurst. 1971. Associations and species diversity in benthic macroinvertebrates of Bay of Quinte and Lake Ontario. J. Fish. Res. Bd. Can. 28(11):1683-1697.

The objective of this study was to determine the number and character of macroinvertebrate associations in the Bay of Quinte, which is grossly polluted, and the adjacent area of Lake Ontario, which is oligotrophic. This data was compared to that of Lake Erie.

Johnson, M. G. and D. H. Matheson. 1968. Macroinvertebrate communities of the sediments of Hamilton Bay and adjacent Lake Ontario. Limnol. and Oceanogr. 13(1):99-111.

The distribution and abundance of benthic macroinvertebrates in Hamilton Bay and adjacent Lake Ontario were related to physical and chemical characteristics of the water and sediments and to hydrodynamic factors. The profundal sediments of Hamilton Bay, rich in organic matter, contained an abundance of Limnodrilus hoffmeisteri and Tubifex tubifex, while lesser numbers of five Limnodrilus species occupied poorer sublittoral sediments. No macroinvertebrate community occurred in sediments containing more than 25% Fe_2O_3. The combination of more favorable water chemistry, circulation, and moderately rich sediments near the canal connecting the bay with Lake Ontario increased biomass of oligochaetes over that in the richer, profundal sediments of the main basin of the bay. In Lake Ontario the oligochaetes, L. hoffmeisteri, T. tubifex and Stylodribes heringionus and the amphipod, Pontoporeia affinia increased in numbers with increasing depth and richness of sediments. Emissions of bay water to Lake Ontario clearly influenced the specific composition of macroinvertebrate communities. The community of several oligochaetes and Chironomum attenuatus found in the lake near the canal resembled the sublittoral bay community. T. tubifex occurred in the lake only in the plume of rich sediments projected into the lake from the canal, while Sphaeriid populations were more abundant and contained more species in the sandy or loamy sediments outside the plume.

Johnson, M. G. and D. S. Osmond. 1969. Benthic macroinvertebrates of the Great Lakes - A list of recorded species and their distribution. Great Lakes Inst., Univ. Toronto. Appendix 6(3):70-86.

This paper presents a list of benthic macroinvertebrate species by lake. A total of 85 accounts published between 1872 and 1968 were examined in the preparation of this list. (Canada Centre for Inland Waters).

Jonasson, P. M. 1969. Bottom fauna and eutrophication. In Eutrophication: causes, consequences, correctives. Internat. Symp. on Eutrophication. Natural Acad. Sci. Washington, D. C.

Jones, John A. 1970. The nature of aquatic pollution. State Univ. Coll., Fredonia, N. Y. Lake Erie Environ. Studies. Public Info. Rep. No. 2. 36 p.

Water pollutants have been categorized as biological, chemical, and physical. The potential presence of most disease organisms may be detected by tests which determine the numbers of coliform bacteria. Chemical pollutants include substances exerting an oxygen demand, lethal and sublethal toxic substances, unpleasant non-toxic materials, and fertilizing nutrients. Presence and quantity of these pollutants are determined by chemical analyses, and their effects are generally readily evident in the environment. Physical pollutants include suspended sediments, floating debris, nuclear waste materials, and heat energy; these affect basic biological processes of organisms inhabiting natural waters or destroy the values of aquatic resources. Pollutants exert synergistic effects on aquatic organisms; thus, the presence of one pollutant increases the susceptibility of organisms to the other pollutants and environmental stresses. Chemical and physical pollutants appear to be the most problematical to the general environment; these include especially oxygen demand, eutrophication, toxic substances, and waste heat. The most hazardous pollution directly affecting the health of people are biological and chemical, including parasitic diseases and biologically accumulated toxic substances. Recovery and reuse of 'wastes' appears to be the only feasible solution to waste disposal in the long-term view. (Jones-Wisconsin)

Jones, L. 1912. A study of the avifauna of the Lake Erie islands. Wilson Bull., Oberlin, Ohio. 24(1):6-18; 24(2):95-108; 24(3):142-153; 24(4):171-186.

Kellicott, D. S. 1878. Notes of the microscopic life in the Buffalo water supply. Am. J. Microscopy and Pop. Sci. 3(11):250-252. New York.

Kellicott, D. S. 1879. The discovery of a new species of marine crustacea in the waters of Lake Erie. Reviewed in: Journal, Royal Microscopical Soc. 2:152. London.

Kellicott, D. S. 1884. Observations on Infusoria with descriptions of new species. Proc. Amer. Soc. Micros. Seventh Annu. Meeting. Rochester, N. Y. August 19-22, 1884. pp. 110-124.

A report on freshwater species of Infusoria. Most of the species studied were from Buffalo, New York area with a few from Corunna, Michigan. The *Acinta tuberosa* Ehr, on a small species of *Mysis* was identified as being from Lake Erie. (SM)

Kellicott, D. S. 1896. The Rotifera of Sandusky Bay. Proceedings, Amer. Microscopical Soc. 18:155-164. Buffalo.

Kellicott, D. S. 1897. The Rotifera of Sandusky Bay. Transactions, Amer. Microscopial Soc. 19:43-54. Buffalo.

Kemmerer, G., J. F. Bovard and W. R. Boorman. 1923. Northwestern lakes of the United States: Biological and chemical studies with reference to possibilities in production of fish. Bulletin, Bureau of Fisheries, Washington. 34:52-140.

Kemp, H. T., R. L. Little, V. Holoman, and R. L. Darby, (Eds.). 1973. Water Quality Criteria Data Book - Vol. 5. Effects of chemicals on aquatic life. (Compilation from the literature dated 1968-1972.) U.S. Environ. Protection Agency. ca 540 p.

Kennedy, C. H. 1922. The ecological relationships of the dragonflies of the Bass Islands of Lake Erie. Ecol. 3(4):325-336.

A study concerning the dragonfly fauna of the Put-in-Bay region. The relationships between the pond and lake species are discussed. The prediction is made that the lake shore will eventually be colonized by specialized Libellulinae. (SM)

Kerr, J. R. 1976. Environmental parameters affecting the distribution of the isopod Asellus r. racovitzai in the western and central basins of Lake Erie. M.S. thesis. The Ohio State Univ., Columbus, Ohio.

Kerr, J. R. 1978. Some aspects of life history and ecology of the isopod Asellus r. racovitzai in western and central Lake Erie. Ohio J. Sci. 78:298-300.

Kettaneh, A. (Ed.). 1971. Troubled waters, Lake Erie, 1971. Great Lakes Res. Inst., Erie, Penn. 121 p.

This volume has been prepared as an introduction to the subject of pollution and pollution abatement in Lake Erie. It is divided into two sections; the first is based on a series of conversations with experts in various fields, and the second consists of a series of bibliographies accompanied by brief topical abstracts, many of which deal with the biological aspects of pollution in Lake Erie.

Kikuchi, K. 1930. Diurnal migration of plankton crustacea. Quarterly Review Biol. 5(2):189-206.

Kindle, E. M. 1925. The bottom deposits of Lake Ontario. Transactions Royal Soc. Can., 3rd Ser. 19(4):47-102.

Included in this paper is a discussion of the organic features of the bottom deposits in Lake Ontario. The plant zones begin with the cattails which give way to the bullrushes (depth 4-5'), then to the pond weeds (depth 6-15') and finally to the diatom and algal flora (depth up to 150') of which Cladophora is quite common. At depths below 200' there doesn't seem to be any plant life.

The discussion of plant zones is followed by a discussion of faunal zones. The extent to which the distribution of different groups or invertebrates depends upon depth of water is shown in a table. As can be seen from the table, the invertebrates range from approximately 1 to 450' with the greatest abundance in the shallower zones.

King, D. R. and G. S. Hunt. 1967. Effects of carp on vegetation in a Lake Erie marsh. J. Wildlife Manage. 31(1):181-188.

This study was made in 1964 and 1965 at the Erie Shooting Club on western Lake Erie to determine: (1) the effect of carp on the abundance and species composition of aquatic vegetation; (2) the stage in the life cycle of plants most affected by carp; and (3) the recovery made by vegetation after carp were reduced or eliminated. The data revealed that carp significantly affected the total abundance of vegetation in both years. (BU)

Kinney, W. L. 1971. The macrobenthos of Lake Ontario. Abst. of paper presented at the 14th Conf. Great Lakes Res., Toronto, Ontario, April 19-21, 1971. pp. 111-112.

The distribution and abundance of the macrobenthos of Lake Ontario and selected adjacent bays, harbors, river mouths and inshore sites were investigated during the past four years in an effort to relate macroinvertebrate benthic ecology to water quality.

Lake Ontario bottom faunal data indicate that organic pollution influences the composition of the macrobenthic communities in nearshore environments.

Kirtland, J. P. 1838. Report on the zoology of Ohio. Columbus.

1844-1846. Descriptions of the fishes of Lake Erie, the Ohio River, and their tributaries. Boston J. Natural History. 4:231-240. Boston J. Natural History. 5:265-276; 330-344.

Kisicki, D. R. 1973. Environmental management of the Great Lakes international boundary areas: a case study of the Niagara urban region. N. Y. State Sea Grant Program. Great Lakes Manage. Problem Ser., Albany, N.Y. 301 p.

This study has looked at the environmental problems and government in an international urban environment, the Niagara Frontier. The biological investigation was limited largely to the Niagara River although some mention is made of Lake Erie.

Kittrell, F. W. 1969. A practical guide to water quality studies of streams. U. S. Dept. Interior, F.W.P.C.A. 135 p.

Kormondy, E. J. 1962. Recent evolution along Lake Erie. Explorer. Cleveland, Ohio. 4(2):12-16.

This article describes the vegetation found in ponds on Presque Isle. The colonization of a new pond and the processes which make the habitat suitable for other clusters of plants and animals are outlined. Estimates of the ages of several ponds are included. (SM)

Kraatz, W. C. 1923. A study of the food of the minnow *Campostoma anomalum*. Ohio J. Sci. 23(6):265-283.

The food of the minnow *Campostoma anomalum* from various Ohio waters was studied. It was found that in adults inorganic material comprises a large percentage of the intestinal contents while plant material is far more abundant than animal. In the young, diatoms comprise one-half to nine-tenths of the total intestinal content. (BU)

Krecker, F. H. 1915. Phenomena of orientation exhibited by Ephemeridae. Biol. Bull. 29(6):381-388.

Krecker, F. H. 1916. Sunfish nests of Beimiller's Cove. Ohio J. Sci. 16(4):125-134.

A study was made of the sunfish nests of Beimiller's Cove during July 1915. The characteristics of the nest and the surface upon which it is built are described. The author attempts to determine those factors which influence the location of a sunfish nest. Also discussed is the effect of sewage upon these nests. (BU)

Krecker, F. H. 1919a. The fauna of rock bottom ponds. Ohio J. Sci. 19(7):427-474.

This investigation was undertaken to study both the fauna and physical changes in a series of rock bottom ponds successively greater in age. Within a radius of fifteen miles of the Sandusky Bay area is a series of five ponds, which at the time of the investigation, were one, five, ten, fifteen and thirty years old. Each pond with its component fauna is discussed. The distribution of the various species through the five ponds is then summarized. (BU)

Krecker, F. H. 1919b. Circulation of coelomic fluid in a nematode. Biol. Bull. 37:183-187.

Krecker, F. H. 1920. Caddis-worms as agents in distribution of freshwater sponges. Ohio J. Sci. 20(8):355.

A brief discussion of the encrustation of the freshwater sponge, *Spongilla fragilis*, upon cases of the caddis-fly larva, Rhyacophilidae. (BU)

Krecker, F. H. 1922. Emergence of a mayfly from its nymphal skin. Ohio J. Sci. 22(6):155-157.

An account from direct observation of the emergence of a subimago mayfly from its nymphal skin. (BU)

Krecker, F. H. 1924. Conditions under which _Goniobasis livescens_ occurs in the island region of Lake Erie. Ohio J. Sci. 24(6):299-310.

A discussion of the various habitats and distribution of _Goniobasis livescens_ in both the Put-in-Bay area and the island region. With reference to distribution, wave action was found to be the controlling factor either indirectly, by moving the substratum, or directly, by moving the snails themselves. (BU)

Krecker, F. H. 1928. Periodic oscillations in Lake Erie. Franz Theodore Stone Lab. Contrib. No. 1. 22 p.

Krecker, F. H. 1931. Vertical oscillations or seiches in lakes as a factor in the aquatic environment. Ecol. 12(1):156-163.

In four inches of water along the shores of Lake Erie there were found 661 individuals, within an area three feet square, representing eleven different species and in another instance 1,189 individuals representing seventeen species. These forms may be partly or entirely exposed by seiche oscillations resulting in exposure to air and to grinding action of waves. The observations are in the hope that the seiche phenomena will attract more attention in connection with limnological studies. (SM)

Krecker, F. H. 1939. A comparative study of the animal population of certain submerged aquatic plants. Ecol. 20(4):553-562.

The results reported in this paper are based on a plant-by-plant examination of seven species of submerged, leafy aquatic plants from the western Basin of Lake Erie, the examination being made with a view to determining both the composition and quantity of the animal population. The plants examined were _Potamogeton compressus_, _P. pectinatus_, _P. crispus_, _Myriophyllum spicatum_, _Elodea canadensis_, _Naias flexilis_ and _Vallisneria spiralis_. Representatives of 29 genera were found inhabiting this community. (BU)

Krecker, F. H., and L. Y. Lancaster. 1933. Bottom fauna of western Lake Erie: Population study to a depth of six feet. J. Ecol. 14(2):79-93.

The density of the bottom population and the variety of its forms within the six foot contour of western Lake Erie were found to depend upon the type of the substratum, the character of the vegetation and the depth of the water. The densest population was in less than 36 inches of water. Half of the animals represented occurred in maximum numbers within the six inch contour, although, due to great numbers of chironomids, the largest total population was at the 18-inch contour. Shelving rock shore zones were the most densely populated whereas rubble shores, covered with coarse angular or water-worn pieces of stone, have the greatest variety of animals present in maximum numbers. The smallest number of forms occurred on sand bottoms. (SM)

Lancaster, L. Y. 1931. A seasonal quantitative study of the bottom shore fauna of Lake Erie. Ph.D. diss., The Ohio State University, Columbus, Ohio. Abst. 7:187.

Landacre, F. L. 1908. The protozoa of Sandusky Bay and vicinity. Ohio Acad. Sci. Special Paper 13. 4(10):423-470.

A report on collections of protozoa in Sandusky Bay taken in the summers of 1902, 1903 and 1904. A list of the protozoa found is included. Collections were particularly rich in Infusoria and Mastigophora. The plankton of Sandusky Bay was found to be small in quantity and in number of species. This was thought to be because of the unusual amount of sediment in the water when it was agitated by the wind. The most protozoa are found in coves where duckweed, Lemna minor is found in abundance. (SM)

Langlois, T. H. 1932. Problems of pondfish culture. Trans. Amer. Fish. Soc. 62:156-166.

Langlois, T. H. 1935. Notes on the spawning habits of the Atlantic smelt. Copeia. Oct. 15, 1935. 3:141-142.

Langlois, T. H. 1936a. The survival value of aggregational behavior of bass under adverse conditions. Ecol. 17(1):177-178.

Langlois, T. H. 1936b. Notes on the habits of the crayfish, Cambarus rusticus Girard, in fish ponds in Ohio. Trans. Amer. Fish. Soc. 65:189-192.

Langlois, T. H. 1936c. A note in answer to a question. Prog. Fish. Cult. No. 18, p. 16.

Langlois, T. H. 1941. Two processes operating for the reduction in abundance or elimination of fish species from certain types of water areas. Trans. 6 North Amer. Wildlife Conf.: 189-198.

Langlois, T. H. 1944a. Where state meets state. Ohio Conserv. Bull. 8(8):10.

Langlois, T. H. 1944b. The role of legal restrictions in fish management. Trans. 9 North Amer. Wildlife Conf.:197-202.

Langlois, T. H. 1945a. Water, fishes, and cropland management. Trans. 10 North Amer. Wildlife. Conf.:192-196.

Langlois, T. H. 1945b. Ohio's fish program. Special Bull. Ohio Div. Conserv. and Natural Resources.

Langlois, T. H. 1946. The herring fishery of Lake Erie. Inland Seas. 2:101-104.

Langlois, T. H. 1948. North American attempts at fish management. Bull. Bingham. Oceanogr. Coll. 11(4):33-54.

Langlois, T. H. 1951. The mayfly crop of 1951. Ohio Conserv. Bull. Nov. 15(11):15,32.

Langlois, T. H. 1954. The western end of Lake Erie and its ecology. J. W. Edwards, Inc. Ann Arbor, Mich. 479 p.

A report summarizing a series of studies made during a span of 60 years. Its aim is to supply a basis for a fish management program for Ohio waters of Lake Erie. A review of studies on the flora and fauna of Lake Erie is included. There is extensive discussion of the techniques used by Lake Erie fishermen and possible causes of changes in the catch. Sewage treatment plants in Ohio cities bordering Lake Erie are described. (SM)

Langlois, T. H. 1964. Amphibians and reptiles of the Erie islands. Ohio J. Sci. 64(1):11-25.

A catalog of 31 species of reptiles and amphibians found in the vicinity of Put-in-Bay, on South Bass Island, Ottawa County, Ohio, between 1936 and 1961. Characteristics such as diet and habitat are recorded when available.

Langlois, T. H. 1964a. Hackberry butterflies at South Bass Island. Explorer. Cleveland, Ohio. 6(3):8-11.

Observations and photographs of the hackberry butterfly which repeatedly defoliated a grove of hackberry trees on South Bass Island between 1949 and 1953. The trees were destroyed. (SM)

Langlois, T. H. 1964b. Lake Erie: Progress towards disaster. In: J. R. Dymond (Ed.), Fish and Wildlife. T. H. Best Printing Co. Limited, Can. 9 p.

Reference is made to anoxic conditions in the island region of Lake Erie and resulting mortality of mayfly larva, and the development of sulfur bacteria, <u>Sporophilus</u>, and areas inhabited only by oligochaetes and bloodworms. There is discussion of changes in dominant species of fish with elimination of northern forms and growing numbers of southern forms

such as gizzard shad, carp and catfish. Proposals are made for rejuvenation of the lake to save the fisheries.

Langlois, T. H. 1965. Portage River watershed and fishery. Ohio Dept. Natural Resources, Div. Wildlife, Columbus, Ohio. Pub. W-130. 22 p.

This publication contains a study of the factors which influence fish populations in the watershed. It contains a list of species found from 1940 to 1961, numbering 69 species. Methods of improving this watershed are also discussed.

La Rocque, A. 1953. Catalogue of the recent mollusca of Canada. National Mus. Ca. Queen's Printer, Ottawa, Ont. Bull. 129. 406 p.

A catalog listing all species found within the geographic boundaries of Canada. There is some discussion of the economic importance of the mollusca for human and animal food and as water scavengers and purifiers. Attributed to Lake Erie are: Unionidae, naiades, Sphaeriidae and *Lymnaea*. (SM)

League of Women Voters. 1966. Lake Erie: Requiem or reprieve? League of Women Voters. Lake Erie Basin Comm., Cleveland, Ohio. 50 p.

This publication is a description of Lake Erie and its relationship to the economic and social development of the Lake Erie region. It describes ways in which population pressures and industrial growth have hastened the aging of the lake and reviews the necessary actions which must be taken to preserve Lake Erie as a viable resource. There is discussion of clean-up programs and the agencies involved in implementing legislation and regulations designed to abate pollution.

Lehman, J. W. 1973. Tritium cycling in a Lake Erie marsh ecosystem. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. on Great Lakes Res. pp. 65-75.

Preliminary results of tritium (^3H) cycling in a Lake Erie marsh ecosystem are presented. The objective of the research was to determine if bioaccumulation and translocation of tritium occur in a marsh ecosystem. Air, water, water vapor, sediment cores and invertebrate samples were collected from a two-hectare study unit which had been treated with approximately 1 curie of tritium. An exponential loss rate of tritium from the treated water was determined. Tritium loss by evaporation was determined to parallel the loss rate from the water. A possible tritium sink was indicated from the ^3H activities of the sediment cores. Invertebrate samples of two snail species (*Viviparus malleatus* and *Lymnaea exilis*) and glass shrimp (*Palaemonetes* sp.) were analyzed for tritium activity. In general the tritium uptake and loss paralleled the tritium activity in the water, though niche preferences affected these rates. No long-term bioaccumulation of tritium was indicated, but there was an indication of translocation of tritium

through the food chain. Further research should indicate more definite trends.

Leshniowsky, W. O., P. R. Dugan, R. M. Pfister, J. I. Frea and C. I. Randles. 1970. Aldrin, removal from lake water by flocculent bacteria. Sci. 169(3949):993-995.

Floc-forming bacteria isolated from Lake Erie adsorb and concentrate aldrin from colloidal dispersion so that the settling of the bacterial flocs removes aldrin from the water phase. Contemporary sediments forming in Lake Erie contain aldrin and could adsorb more. The sediments consist of a conglomerate floc of bacteria, diatoms, and inorganic and detrital particles. Flocculent bacteria also adsorb microparticulates and this adsorption capacity represents a mechanism for sediment formation and for the removal of suspended particles including aldrin from the water column. (SM)

Le Sueur, C. A. 1818. Description of several new species of North American fishes. J. Acad. Natural. Sci. Philadelphia. Philadelphia, Penn. 1(2):222-235, 359-368, 413-417.

The species described come from various parts of the country. Those attributed to Lake Erie include: (1) Coregonus artedi, a very delicate food called the herring salmon; and (2) Coregonus albus, Lake Erie whitefish.

A proposal is made that a new genus, Hiodon, be established to include the several fish of the Ohio River and Lake Erie known under the popular name of herring. Two species were described of this genus: (1) Hidon tergisus, observed in Lake Erie at Buffalo; and (2) Hidon clodalus, which was not a Lake Erie specimen. Also described was the Esox estor, called pike, pickrel and muskellunge. A specimen three feet long was taken at Buffalo. (SM)

Letson, E. 1905. Checklist of the molluska of New York. New York State Mus. Bull. 88:1-112.

A list of species of mollusks in New York State with reference to distribution within the state.

Letson, E J. 1909. A partial list of the shells found in Erie and Niagara Counties, and the Niagara Frontier. Bull. Buffalo Soc. Natural Sci. Buffalo, N. Y. 9(2):239-245.

A list of species of freshwater shells, found in the vicinity of Buffalo, New York, from the records of the Conchological Section of the Buffalo Society of Natural Sciences. It is intended to assist collectors in knowing what has been found in various areas. Tributaries to Lake Erie and the lake itself have yielded the following: Goniobasis luvescens Mke.; Campeloma decisum Say; Polygra albolabris var. denta Try.;

Pyramidula alterna Say; Succinea retusa Lea.; Physa niagarensis Lea.; Lampsilis ventricosus Barnes; Lampsilis alatus Say; Unio gibbosus Barnes; and Quadrula coccinea Conr. (SM)

Lewis, C. F. M., T. W. Anderson and A. A. Berti. 1966. Geological and palynological studies of early Lake Erie deposits. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:176-191.

Coring and echo sounding of Lake Erie bottom sediments have indicated a thin lag concentrate of sand, in places with plant detritus, pelecypods, gastropods and other fossils, underlying recent silty clay muds and overlying clay till or late-glacial lacustrine clays. Buried shallow pond organic sediments in the Western Basin and relict beach deposits, wave-cut terraces and intrabasinal discharge channels in the Central Basin, some of which are buried, all indicate former low water levels in central and western Lake Erie much below those at present. This evidence, combined with radiocarbon dates of 10,200 and 11,300 years B. P. on the organic material and information from nearby regions, suggests that early Lake Erie came into existence about 12,400 years ago.

Examination of the cores indicated that pollen is sufficiently abundant and well-preserved in the sediments for palynological studies. Pollen diagrams can be correlated with one another, and with those outside of the Lake Erie Basin. Palynological studies support the geological evidence of a low-lake stage and provide a means for dating and correlating sediment sequences which do not contain enough organic matter for radiocarbon analysis.

Lewis, C. F. M. and R. N. McNeely. 1967. Survey of Lake Ontario bottom deposits. Proc. 10th Conf. Great Lakes Res. pp. 133-142.

Short gravity cores and grab samples, recovered during a continuing reconnaissance survey initiated in 1966, were used to study the distribution, stratigraph and chronology of Lake Ontario bottom deposits. Three major groups of surficial deposits were recognized: complex nearshore sediments; glaciolacustrine clays; post-glacial muds. Organic contents of 2 to 6% and median particle diameters of 1 to 4 microns are typical of the offshore surficial muds. Pollen in these sediments facilitates correlation and subdivision and indicated that the present sedimentation rate in the main basin is approximately 10 cm per century. Several sediment sequences confirm the post-glacial low-level Admirality Lake stage and suggest it may have reached lower levels than previously believed.

Lewis, P. A. 1969. Mayflies of the genus Stenonema as indicators of water quality. Unpublished paper presented at 17th Annu. Meeting of the Midwest Benthological Soc.

Loeb, H. C. 1954. Experimental carp control. N. Y. State Dept. Environ. Conserv. Albany, N. Y. Conservationist. 9(1):10-11.

An experimental carp control research project was initiated under Dingell-Johnson federal aid funds. Two points were investigated: (1) does carp control benefit game and pan fish, and if so, in what manner and in which waters; and (2) if the more desirable species are significantly benefited will control be economically feasible?

Large commercial catches of carp are being taken from bays of Lake Erie. Several states have promoted sport fishing for carp in winter and summer. (SM)

Lowden, R. M. 1969. A vascular flora of Winous Point, Ottawa and Sandusky Counties, Ohio. Ohio J. Sci. 69(5):257-285.

This study describes the present-day vascular flora of the marshes, woodlots, dikes, and drainage ditches of Winous Point, which is located approximately 3-1/2 miles southwest of Port Clinton, Ohio near the mouth of Muddy Creek, at the western end of Sandusky Bay. Vascular plants found are recorded in a catalog. Changes in the floristic composition of the marshes are discussed by comparing A. J. Pieters' observations (1901) of some marsh plants at the western end of Lake Erie with the present marsh flora.

Lucas, A. M. and N. A. Thomas. 1971. Sediment oxygen demand in Lake Erie's Central Basin - 1970. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 781-787.

Sediment oxygen demand (SOD) rates were measured at five locations in Lake Erie's Central Basin in June, August and September 1970. The rates were determined from changes in the dissolved oxygen concentration of water sealed and circulated within black and clear plexiglass chambers imbedded in the lake bottom. SOD rates recorded in June varied from 1.2 to 2.2 gm O_2/m^2/day and were indicative of eutrophic conditions. In August, rates measured during the daylight hours with the clear chamber (0.0-0.4 gm O_2/m^2/day) were less than those measured at night with the clear chamber or with the black chamber during the day (0.7-1.0 gm O_2/m^2/day). Oxygen produced by the photosynthetic activity of algae on the lake bottom offset the SOD during part of the day resulting in daily SOD rates of 0.4 to 0.7 gm O_2/m^2/day. Rates measured in September with oxygenated surface water trapped and carried to the bottom in the chambers ranged from 1.0 to 2.4 gm O_2/m^2/day.

Lucas, A. M. and N A. Thomas. 1972. Sediment oxygen demand in Lake Erie's Central Basin. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo: An intensive study of the Lake Erie Central Basin hypolimnion and related surface water phenomena. USEPA Tech. Rep. TS-05-71-208-24. pp. 45-50.

Luck, A. D. 1967. Lake Erie - A study in resource geography. M.A. thesis, Univ. Okla., Norman, Okla. 79 p.

A review of the physical characteristics, changes in hydrology, and economic impact of pollution in Lake Erie. Included is a detailed listing of the industries adding pollutants to the lake and its biological consequences. The conclusion is made that several uses of the lake have been damaged, lessened, or destroyed and that Lake Erie as a whole can definitely be termed polluted.

Ludwig, J. P. 1969. Great Lakes gulls. Limnos. 2(1):3-11.

The general characteristics and habits of the Great Lakes gulls are discussed. Included are environmental factors affecting their habitats.

Lyman, F. E. 1944. Notes on emergence, swarming, and mating of _Hexagenia_ (Ephemeroptera). Entomol. News. 55:207-210.

The western end of Lake Erie produces yearly prodigious numbers of _Hexagenia_ mayflies belonging to three species: _H. limbata_ (Serville), _H. rigida_ McDunnough, and _H. affiliata_ McDunnough, named in order of relative abundance and seasonal emergence. The emergence, swarming, and mating behavior of these organisms are discussed. (BU)

MacCallum, W. R. and H. A. Regier. 1970. Distribution of smelt, _Osmerus mordax_, and the smelt fishery in Lake Erie in the early 1960's. J. Fish. Res. Bd. Can. 27(10):1823-1846.

A report on the seasonal, horizontal and vertical distributions of young-of-the-year, yearling and adult smelt of Lake Erie. Also included is an examination of commercial fishing statistics. All data was collected during the late 1950's and 1960's. (BU)

MacKay, H. H. 1930. Pollution problems in Ontario. Transactions Amer. Fish. Soc. 60:297-305.

Although the waters of Ontario are not subjected to the same degree of pollution as those of the more industrialized cities and towns of Ontario, the problem of disposal of trade waste is one which calls for more than an ordinary amount of vigilance if we are to preserve fish, and the life on which fish depend, from its destructive effects.

The paper deals with the intensive studies done by the Fish Culture Branch of the Ontario Department of Game and Fisheries of suspected pollution situations in the waterways of Ontario. In the studies standardized field methods were used in order to leave the way open for legitimate comparisons. The preliminary studies have been carried out in the following centers of suspected pollution: Sarnia, Chatham, Bridgeport, Burlington Bay, Bridgeburg, Lindsay, Peterborough, Bauch, Midland, Huntsville, Sturgeon Falls, Temiskaning, Haileybury, Timmins, Iroquois Falls, Smooth Rock Falls, Kapuskaing, Sault Ste. Marie and Kenna.

Mackenthum, K. M. 1969. The practice of water pollution biology. U.S. Dept. Interior, F.W.P.C.A. 281 p. (pp. 10-11)

Mallard, G. E. and J. I. Frea. 1972. Methane production in Lake Erie sediments: temperature and substrate effects. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 87-93.

Methane produced in the laboratory by microorganisms in Lake Erie sediment was monitored. The effects of variation in temperature and the addition of various compounds as additional substrate were noted.

Manz, J. V. 1964. A pumping device used to collect walleye eggs from offshore spawning areas in western Lake Erie. Trans. Amer. Fish. Soc. 93(2):204-206.

A description and evaluation of a pumping device used to collect bottom samples, especially fish eggs, from western Lake Erie. (BU)

Marshall, A. C. 1939a. A qualitative and quantitative study of the Trichoptera of western Lake Erie. Ann. Entomol. Soc. Amer. 32(4):665-688.

This study is based on a collection of 70,000 specimens representing 7 families, 21 genera and 47 species. Graphs are presented which indicate that some species occur in two broods per season while others are definitely limited to one. The purpose of the paper is to record a listing of the species of Trichoptera of western Lake Erie which are attracted to light traps and to discuss some of the aspects of their relative abundance and seasonal distribution. (SM)

Marshall, A. C. 1939b. A qualitative and quantitative study of the Trichoptera of western Lake Erie. Ph.D. diss., The Ohio State Univ., Columbus, Ohio. Abst. 30:85.

Marshall, J. S., A. M. Beeton and D. C. Chandler. 1964. Role of zooplankton in the freshwater strontium cycle and influence of dissolved salts. Verh. Internat. Verein. Limnol. 15:665-672.

A report on a study of the freshwater strontium cycle using radioassay techniques. The test organism employed was _Daphnia magna_.

Mason, W. T., chairman. 1972. Current and select bibliographies on benthic biology 1971. Midwest Benthological Soc., Cincinnati, Ohio. 63 p.

Mason, W. T. 1974. Table 4. Biological water pollution index classifications. From Ohio Biol. Surv. Info. Circular No. 8.

Mason, W. T., Jr. 1973. An introduction to the identification of chironomid larvae. USEPA, Cincinnati, Ohio. 90 p.

Mason, W. T., Jr. 1976. Portable, hand-operated cycle sieve for washing macroinvertebrate samples. Progressive Fish-Culturist 38:30-32.

Mason, W. T., Jr. and Philip A. Lewis. 1968. Using macroinvertebrate collections for water quality monitoring in the Ohio River basin 1963-1966. Unpublished paper presented at the 16th Annu. Meeting of the Midwest Benthological Soc.

Mason, W. T., Jr. and J. E. Sublette. 1971. Collecting Ohio River basin Chironomidae with a floating sticky trap. Can. Entomol. 103:397-404.

Mastin, M. 1970. Game fish and the parasite problem. Audubon. Can. Audubon Soc., Toronto, Ont. 32(2):59-62.

A discussion of parasites which commonly affect game fish. Included are photographs of Lake Erie white bass infected with Triaenophorus nodulosus; and Lake Erie perch infected with "black grub" or black spot infection. Ways in which the fisherman may inadvertently spread parasites by dumping minnows of undetermined origin into lakes and streams at the end of the day, or be careless cleaning of fish, are mentioned. (SM)

McDunnough, J. 1927. Notes on the species of the genus Hexagenia with description of a new species. Can. Entomologist. 59:116-120.

McKee, R. 1966. Great Lakes Country. Thomas Y. Crowell. New York, N. Y. 242 p.

This book describes the history and present condition of the Great Lakes. The changing fish populations and bottom dwellers in Lake Erie are mentioned. Emphasis is on the way in which people around the lakes have lived and the use they have made of the lakes. (SM)

McMillan, G. L. and J. Verduin. 1953. Photosynthesis of natural communities dominated by Cladophora glomerata and Ulothrix zonata. Ohio J. Sci. 53(6):373-377.

The littoral zone in western Lake Erie is populated by attached filamentous algal communities dominated in summer by Cladophora glomerata (L.) Kutz, and in winter by Ulothrix zonata (Weber & Mohr) Kutz. During 1950-51 these communities were studied to determine their photosynthetic activity under near natural conditions. Graphs showing the relationship between photosynthesis and light intensity are reproduced and discussed. (BU)

Melin, B. E. and R. C. Graves. 1971. The water beetles of Miller Blue Hole, Sandusky County, Ohio (Insecta: Coleoptera). Ohio J. Sci. 71(2):73-77.

Thirty-one species of aquatic beetles, representing the families Dytiscidae, Hydrophilidae, Haliplidae, and Gyrinidae, were collected in the Miller Blue Hole, a large spring, between October 21, 1967 and January 27, 1969. The numbers of each species collected are tabulated by monthly intervals. Some of the species present in this unusual habitat are rare; Tropisternus columbianus is apparently recorded from Ohio for the first time.

Menge, B. A. and J. P. Sutherland. 1976. Species diversity gradients: synthesis of the roles of predation, competition, and temporal heterogeneity. Amer. Naturalist. 110:351-369.

Metcalf, I. S. H. 1942. The attraction of fishes by disposal plant effluent in a freshwater lake. Ohio J. Sci. 62(5):191-197.

The apparent attraction of white bass by the disposal plant effluent emptied into Lake Erie by the City of Lakewood, Ohio is investigated. A comparison of the plankton population in the region of the effluent outlet is made with that at a point in the open lake which is believed to be unpolluted by effluent. Four genera of algae and three groups of zooplankton organisms are used as bases for this comparison.

Meunscher, W. C. 1929. A biological survey of the Erie-Niagara system. VIII. Vegetation of the Niagara River and the eastern end of Lake Erie. NYS Conserv. Dept., Supplemental 18th Annu. Rep. for 1928. Biol. Surv. pp. 189-197.

A brief survey of the distribution and composition of the vegetation in the Niagara River and the eastern end of Lake Erie was made between August 14-30, 1928. This report covers observations made on the American side of the Niagara River, including the shores of Grand Island and several small islands near it, as well as the shallow channels between the islands and from Buffalo Harbor along the south shore of Lake Erie to the Pennsylvania State boundary. A list of aquatic plants observed throughout this study is included.

Meyer, B. S. 1939. The daily cycle of apparent photosynthesis in a submerged aquatic. Amer. J. Bot. 26(9):755-760.

An apparatus is described with which it is possible to make consecutive hourly determinations of the rate of apparent photosynthesis in a submerged aquatic without disturbing or handling the plant in any way during the course of an experiment. On clear days in late July and in August with the temperature of the water in which the plant is immersed showing only a slight daily variation, the rate of apparent photosynthesis in apical shoots of Ceratophyllum demersum L. shows a rapid rise during the morning hours to a peak value which is attained between 10 a.m. and 12 noon, after which it shows a consistent decline. (BU)

Meyer, B. S., F. H. Bell, L. C. Thompson and E. E. Clay. 1943. Effect of depth of immersion on apparent photosynthesis in submerged vascular aquatics. Ecol. 24(3):393-399.

A study has been made of the relative rates of apparent photosynthesis in five species of vascular plants when immersed at a series of depths ranging to ten meters in Lake Erie near Put-in-Bay, Ohio. In all five species the rate of apparent photosynthesis decreases less rapidly with depth of immersion than does light intensity.

Meyer, B. S. and A. C. Heritage. 1941. Effect of turbidity and depth of immersion on apparent photosynthesis in Ceratophyllum demersum. Ecol. 22(1):17-22.

Marked changes in turbidity are characteristic of Lake Erie waters in the vicinity of the Bass Islands. This investigation studies the influences of the turbidity factor upon the rate of apparent photosynthesis in a submerged aquatic plant - the hornwort, Ceratophyllum demersum Linn. (BU)

Miles, J. R. W. and C. R. Harris. 1971. Insecticide residues in a stream and a controlled drainage system in agricultural areas of southwestern Ontario, 1970. Pestic. Monit. J. 5(3):289-294.

Big Creek, flowing into Lake Erie near Long Point, Ontario, and a drainage system which enters Lake Erie near Eriea, Ontario were monitored for insecticide residues during 1970. Water, mud and fish samples were analyzed. While the residue concentrations of the water were extremely low, the concentrations in the mud and fish were between 820 and 80,000 times that found in the water.

Miller, E. M. 1932. Bibliography of Ohio botany. Ohio Biol. Surv. Bull. 27. 5(4):281-376.

A bibliography of the flora of Ohio including those areas bordering on Lake Erie and its tributaries, from 1755 to 1931. (SM)

Miller, J. A. 1929. The leeches of Ohio. The Ohio State University. Franz Theodore Stone Lab. Contrib. No. 2:1-38. Columbus.

Monakov, A. V. 1967. Review of studies on feeding of aquatic invertebrates conducted at the Institute of Inland Waters, Academy of Science, U.S.S.R. J. Fish. Res. Bd. Can. 29:363-383.

Moore, E. 1928. A biological survey of the Erie-Niagara system. N. Y. Conserv. Dept., 18 Annu. Rep. Supplement.:1-244.

Moore, E. 1929. Introduction - A biological survey of the Erie-Niagara system. In: A Biological Survey of the Erie-Niagara System. N. Y. Dept. Conserv., Albany, N. Y. Supplement 18th Annu. Rep. (1928). pp. 9-18.

A general introduction to the survey of the Erie-Niagara system conducted by the New York Conservation Department in 1928. Reviewed are such topics as: area of survey, authorization, the watershed as a unit, program of the survey, organization of staff, conditions of pollution, and results of the survey.

Moore, J. P. 1906. Hirudinea and Oligochaeta collected in the Great Lakes region. Bull. U.S. Bur. Fish. 25:153-171.

Morgan, J. J. (Ed.). Lake Erie dying but not dead. Environ. Sci. Tech. 1(3):212-218.

This reference is a feature article on changes taking place in Lake Erie. Included is a discussion of growth of aquatic organisms brought about by siltation and temperature changes. The changes in Lake Erie fish population in the past fifty years are graphed and the disappearance of the blue pike, whitefish, cisco and sauger commented upon. Less valuable species are becoming dominant. A suggested area for study is the role of bacteria as the causative agent in producing chemical changes in both overlying water and in sediment. (BECPL)

Moseley, E. L. 1928. Flora of the oak openings west of Toledo. Proc. Ohio Acad. Sci. Special Paper 20. 8(3):79-134.

A description of flora that grows in the sandy soil near Toledo that was once covered by Lake Warren, the glacial lake which stood about 100 feet higher than Lake Erie now stands, and extended over a much greater area than Lake Erie now covers. A catalog of the flora is included. In addition, soil analysis was done to determine the most suitable crops for the area. (SM)

Moseley, E. L. 1930. Fluctuations of bird life with changing water levels. Wilson Bull. 42(3):191-193.

A brief discussion of the advantages which high water on Lake Erie affords to bird life by increasing the food supply in marshes and offering increased protection from predators. Increase in numbers of bitterns, ducks and grebes was noted. (SM)

Muenscher, W. C. 1929. Vegetation of the Niagara River and the eastern end of Lake Erie. In: A Biological Survey of the Erie-Niagara System. N. Y. Conserv. Dept., Albany, N. Y. Supplement 18th Annu. Rep. (1928). pp. 189-197.

A brief survey of the distribution and composition of the vegetation in the Niagara River and the eastern end of Lake Erie was made between August 14 and August 30, 1928. More specifically, this report covers observations made on the American side of the Niagara River, including the shores of Grand Island and several small islands near it, as well as the shallow channels between the islands, and from Buffalo Harbor along the south shore of Lake Erie to the Pennsylvania State boundary.

The discussion of the vegetation of the region under consideration may for convenience be taken up under the following areas: (1) the south shore of Lake Erie; (2) Buffalo Harbor; (3) the upper Niagara River; and (4) the lower Niagara River.

Muttkowski, R. A. 1918. The fauna of Lake Mendota: a qualitative and quantitative survey with special reference to the insects. Transactions, Wisc. Acad. Sciences, Arts and Letters, Part I. 19:374-482. Madison.

Neave, F. 1932. A study of the May flies (Hexagenia) of Lake Winnipeg. Contributions to Can. Biology and Fisheries, New Series. 7(15):178-201. Toronto.

Nebeker, A. V. 1971. Effect of high winter water temperatures on adult emergence of aquatic insects. Water Res., Pergamon Press 5:777-783.

Nebeker, A. V. 1972. Effect of low oxygen concentration on survival and emergence of aquatic insects. Trans. Amer. Fish. Soc. 101(4):675-679.

Nebeker, A. V., and A. E. Lemke. 1968. Preliminary studies on the tolerance of aquatic insects to heated waters. J. Kans. Entomol. Soc. 41:413-418.

Neil, J. H. and G. E. Owen. 1964. Distribution, environmental requirements and significance of Cladophora in the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub. 11:113-121.

Excessive growths of Cladophora sp. along certain sections of the Great Lakes shoreline create serious nuisance conditions which affect the use of water for recreational, industrial and municipal purposes. Information on the ecology of this algae was collected as part of a study directed towards the development of control measures.

Nicholson, H. A. 1873. Contributions to a fauna canadensis, being an account of the animals dredged in Lake Ontario in 1872. Can. J. N. S. 13:490-506.

A series of dredgings were carried out during the summer of 1872 in the vicinity of Toronto. A list containing a description and chief characters of the animals obtained in these dredgings was given. Some of the groups represented were the algae, annelida, arthropoda, mollusca, osteichthys and amphibia.

Nickell, W. P. 1966. Common terns nest on muskrat lodges and floating cattail mats. Wilson Bull. 78(1):123-124.

A brief article concerning the discovery of 35 nests of the common tern, Sterna hirundo, on two floating mats of cattails which had died. The water was five to seven feet deep. Muck and cattail roots held the mats together. Ten nests were found on top of muskrat lodges. (SM)

Northington, C. W. 1965. Is Lake Erie dying? Sierra Club Bull. 50(9):3-7.

A popular article outlining the known pollution problems of the tributaries and shoreline of the United States section of Lake Erie. Conditions from the Western Basin to the Eastern Basin are described and remedial measures suggested. (SM)

Odell, T. T. 1940. A biological survey of the Lake Ontario watershed. III. Bays and ponds of the shore area. New York State Conserv. Dept. Supplemental to 29th Annu. Rep. for 1939. Biol. Surv. pp. 82-97.

The more important bays and ponds are discussed with particular reference to the physical, chemical, biological and historical data relating to fish production. Tabulations summarize miscellaneous data and give estimates of relative abundance of fishes. A chart of Irondequoit Bay shows hydrographic data. The general discussion deals with: the stocking policy; the lack of correlation between the fisherman's catch and the relative abundance of certain fishes; migrations of fish to and from Lake Ontario; creel limits; open bays versus closed bays; and the need for further study to determine the best management policy.

Odum, E. P. 1971. Fundamentals of ecology. 3rd Ed. W. B. Saunders Co., Philadelphia. 574 p. (p. 152).

Oglesby, R. T. 1970. Lakes which produce too much. N. Y. State Dept. Environ. Conserv. Albany, N. Y. Conservationist. 24(6):18-21.

A general discussion of the causes, symptoms, and effects of cultural eutrophication of lakes. The increase in vegetation is associated with (1) flood, (2) decreased visibility, and (3) the amount of dissolved oxygen. The course which must be followed to slow the eutrophication process is outlined. Lake Erie is mentioned as a nationally known example of a lake with serious eutrophication problems. (SM)

Ohio Department of Natural Resources. 1953. Lake Erie Pollution Survey - Final Report. Ohio Dept. Natural Resources. Columbus, Ohio. 201 p.

This publication is a comprehensive evaluation of the condition of Lake Erie and its Ohio tributaries. Bacterial and sanitary analysis is included. The following biological studies are reported: the suspended silt in the western waters of Lake Erie in the spring of 1951; study of the distribution of phosphorus in western Lake Erie and its utilization by natural phytoplankton populations; the presence of toxic materials at the mouth of Ohio streams...

Oliver, D. R. 1971. Life history of the Chironomidae. Annu. Review Entomol. 16:211-230.

Orr, L. P. 1969. The fishes of the upper Cuyahoga River. In: G. Dennis Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ. Inst. Limnol. Kent, Ohio. pp. 57-86.

A survey of the influence of the chemical and physical characteristics of twelve sampling sites on the Cuyahoga River on the fish of this river. Thirty-one fish species were collected and identified. Little change in the numbers and kinds of fish species in the upper Cuyahoga River has occurred in the last forty years.

Ortmann, A. E. 1909. A preliminary list of the Uniondae of western Pennsylvania, with new localities for species from eastern Pennsylvania. Ann. Carnegie Mus., Pittsburgh, Penn. Article 8. 5(2,3):178-210.

Seventeen forms are listed which were found in the Lake Erie drainage. Collections were primarily from Presque Isle Bay between 1900 and 1908. (SM)

Ortmann, A. E. 1919. A monograph of the naiades of Pennsylvania. Part III. Systematic account of the genera and species. Mem. Carnegie Mus. 8(1):1-384.

Ortmann, A. E. 1920. Distribution features of naiades in tributaries of Lake Erie. Amer. Midland Naturalist. 9(3):101-117.

Ortmann, A. E. 1924. Distribution features of naiades in tributaries of Lake Erie. Amer. Midland Naturalist. 9(3):101-117.

A report of the author's distributional records, and previous known distribution, of the Naiad-fauna in Lake Erie tributaries in northeast Ohio and in Pennsylvania. Nineteen species were found. A theory explaining the distribution is presented. (SM)

Ortmann, A. E. and Bryant Walker. 1922. On the nomenclature of certain North American naiades. Univ. Mich. Mus. Zool., Ann Arbor, Mich. Occasional Paper 112. 75 p.

The paper attempts to clarify the classifications of North American naiades by application of the provisions of the International Code of Nomenclature. Attributed to Lake Erie are Amblema plicata (Say), and Ligumia recta (Limarck). Two forms, Pleurobema clava (Lamarck), and Elliptio crassidens (Lamarck) are mentioned as having been incorrectly ascribed to Lake Erie in the past. (SM)

Osborn, H. 1930. Bibliography of Ohio zoology. Ohio Biol. Surv. Bulletin No. 23. 4(8):353-410. Columbus.

Osburn, R. C. 1926a. A preliminary study of the extent and distribution of sewage pollution in the west end of Lake Erie. Mimeog. rep. The Ohio State University, Franz Theodore Stone Lab. 6 p.

Osburn, R. C. 1926b. Details regarding preliminary pollution survey of Lake Erie. Mimeographed report. 14 p. Columbus.

Osmond, D. S. 1970. Bottom fauna survey of Long Point Bay in the Nanticoke region 1969. Ministry Environ. Biol. Branch. Toronto, Ont. 9 p.

Thirty-one different macroinvertebrate taxa were found at 8 stations in Long Point Bay in 1969. The number of taxa per station ranged from 15 to 20 while the annual average number of organisms per station was 259 (the range being from 53 to 833). Benthic associations varied seasonally both qualitatively and quantitatively. Comparisons were drawn between the species compositions of each station.

Parsons, J. W. 1971. Selective food preferences of walleyes of the 1959 year-class in Lake Erie. Trans. Amer. Fish. Soc. 100(3):474-485.

Stomachs were examined from 1,473 walleyes (Stizostedion vitreum vitreum) of the 1959 year class collected in western Lake Erie from June 1959 to October 1960. In the same period, the relative abundance and lengths of potential forage species were determined from trawl catches. The walleyes fed almost entirely on fish. (BU)

Parsons, J. W. 1972. Life history and production of walleyes of the 1959 year-class in western Lake Erie, 1959-1962. Trans. Amer. Fish. Soc. 101(4):655-661.

Because of the near collapse of the fishery for walleyes (Stizostedion vitreum vitreum) in Lake Erie in the late 1950's, walleyes of the 1959 year-class were studied to gain a better understanding of the life history of the species and the dynamics of the population. In the summer of 1959 most walleyes of the year-class were in water 10 to 20 feet deep among the south and west shores of the Western Basin. By fall they averaged about 10 inches long and were rather widely distributed throughout the basin. By September 1960 most had reached legal length (then 13 inches in Ohio), and in October they made up nearly the entire commercial walleye production and made the highest monthly contribution during the life of the year-class. Walleyes of the 1959 year-class were cropped intensively and remained in the fishery for only a relatively short time. About 97% of the females of the year-class were caught before they had spawned once. (BU)

Patalas, K. 1972. Crustacean plankton and the eutrophication of St. Lawrence Great Lakes. J. Fish. Res. Bd. Can. 29(10):1451-1462.

The crustaceans found in the summer plankton of Lakes Superior, Huron, Erie and Ontario during 1967 and 1968 were analyzed for species composition; 14 copepods and 13 cladoceran species were found. A general trend was seen from oligotrophic Lake Superior to eutrophic Lake Erie: the diminishing significance of calanoids accompanied by the increasing predominance of cyclopoids and cladocerans. The average crustacean abundance for Lake Erie was 400 per cm^2, which was related to the heat and chlorophyll and phosphorus content of the water. (SM)

Paulus, R. D. 1969. Walleye fry food habits in Lake Erie. Ohio Fish Mono. 2. 45 p.

Walleyes, <u>Stizostedion vitreum vitreum</u>, have been drastically reduced in western Lake Erie. Reasons for the population decrease are not known, but it is thought that environmental factors are somehow causing a reduction in numbers during the early fry stage.

Pennak, R. W. 1978. Fresh-water invertebrates of the United States. 2nd Ed. John Wiley & Sons, New York. 803 p.

Pettibone, M. H. 1953. Fresh-water polychaetous annelid, <u>Manayunkia speciosa</u> Leidy, from Lake Erie. Biol. Bull. 105(1):149-153.

A description of the fresh-water sabellid polychaete genus, <u>Manayunkia</u> Leidy, collected from western Lake Erie is presented. Also included is a brief note on their distribution. (BU)

Phelps, B. 1917. Control of pollution of streams. The International Joint Commission and the pollution of boundary waters. U.S. Public Health Service, Public Health Reports, Washington. 32(4):167-174.

Popchenko, V. I. 1971. Consumption of Oligochaeta by fishes and invertebrates. J. Ichthyol. 11:75-80.

Posten, H. W. and C. R. Ownbey. 1968. The Great Lakes water resource. J. Waterworks Assoc. 60(1):15-20.

A review of water resource problems on the Great Lakes. Lake Erie is described as having the largest population in its watershed with only token nutrient reduction by treatment plants. The need for improved institutional arrangements to provide adequate sewage treatment is discussed. A TVA of the Great Lakes is suggested. (BECPL)

Potos, C. 1970. Hypolimnetic oxygen depletion mechanisms in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 707-714.

To the present, the mechanism of hypolimnetic deoxygenation of temperate lakes has been little understood. It is the consensus among limnological investigators that a slow, progressive, sediment biochemical oxygen uptake rate, exerted by microbiological flora in the decomposition of sedimented plankton and other degradable organic debris, is the mechanism responsible for depleting any hypolimnion of oxygen during stratification periods. Success in the measurement of a positive depletion rate in the summer of 1968 in the Lake Erie Central Basin and correlation of this rate with existing sediment and hypolimnion oxygen demand, infers the probability of still another operative factor - that of chemical oxygen demand satisfaction. The total mechanism of the depletion, abetted by sediment resuspension due to wind-induced water turbulence, can be chemical and microbiological in nature, both at one and the same time.

Powers, C. F. and A. Robertson. 1966. The aging Great Lakes. Scientific Amer. 215(5):95-104.

Natural aging of a lake results from a process called eutrophication, which is biological enrichment of its water. Lake Erie is a prime example of a lake in which this process has been accelerated by cultural pollution, resulting in a marked change in species population of various fishes.

Price, J. W. 1934. The embryology of the whitefish, *Coregonus clupeaformis* (Mitchell). Part I. Ohio J. Sci. 34(5):287-305.

The first of a series of papers representing a general survey of the embryology of the whitefish from fertilization until hatching. Samples were collected from Put-in-Bay, Ohio. This first paper traces the major events of segmentation and germ layer formation and general development up through the closure of the blastopore. (BU)

Price, J. W. 1934. The embryology of the whitefish, *Coregonus clupeaformis* (Mitchell). Part II. Organogenesis. Ohio J. Sci. 34(6):399-414.

This paper is the second in a series of three papers on the embryology of the whitefish. Samples were collected from Put-in-Bay, Ohio. The author's purpose is to locate the incipient stages in the development of each of the organ systems and to trace their general development in this particular series of embryos. The completion of organogenesis marks the halfway point in the whitefish incubation period. (BU)

Price, J. W. 1935. The embryology of the whitefish, *Coregonus clupeaformis* (Mitchell). Part III. The second half of the incubation period. Ohio J. Sci. 35(1):40-53.

This paper is the third in a three-part series describing the embryology of the whitefish. Samples were collected from Put-in-Bay, Ohio. The second half of the incubation period is dealt with. The development of the organ systems to produce a self-supporting, highly coordinated individual organism at the time of hatching is discussed. (BU)

Price, J. W. 1963. A study of the food habits of some Lake Erie fish. Ohio Biol. Surv. Bull. 2(1):89 p.

A study of the food habits by means of stomach analysis of ten species of Lake Erie fish. The species studied were: smelt, yellow perch, troutperch, spottail shiner, sheepshead, yellow walleye, gizzard shad, alewife, white bass, and channel catfish. All specimens were collected during the 1958 season except for the alewife and walleye which were collected in 1957. A total of 14,118 fish stomachs were analyzed.

Puleo, J., M. C. Lanighan and C. O. Masters. 1974. 1973 Erie County Stream Survey. Erie County Lab. Buffalo, N. Y. 294 p.

The survey was conducted between June 19 and October 3, 1973. The Sanitary Biology Section studied 18 streams for the presence of pollution bacteria (total coliform and fecal coliform bacteria) and benthic organisms, indicators of organic pollution. Sixty-seven sampling stations were established on these 18 streams. One hundred ninety-one benthic samples were obtained and 1462 water samples taken for sanitary bacteriological studies. Findings are detailed in the report. Streams studied which are tributary to Lake Erie are Big Sister Creek, Spring Brook, Rush Creek and Eighteenmile Creek.

Raudkivi, A. J. 1962. Loose Boundary Hydraulics. Pergamon Press.

Rawson, D. S. 1930. The bottom fauna of Lake Simcoe and its role in the ecology of the lake. University of Toronto Studies, Biol. Series No. 34, Pub. of the Ontario Fisheries Res. Lab. 40:183. Toronto.

Regier, H. A. and W. L. Hartman. 1973. Lake Erie fish community: 150 years of cultural stress. Sci. 180(4092):1248-1255.

A review of changes in the Lake Erie fishing industry over the past 150 years. The authors feel that cultural stresses on the fish community of Lake Erie include the following: an opportunistic, uncontrolled fishery; erosion and nutrient loadings; invading species; stream destruction and shoreline restructuring; and toxic pollutants and biocides. (SM)

Reighard, J. E. 1897. Some characteristics of recent work on the biology of fresh waters. Proc. Amer. Fisheries Soc., Detroit. p. 41-46.

Reighard, J. E. 1899. A plan for the investigation of the biology of the Great Lakes. Transactions, Amer. Fisheries Soc. p. 65-76.

Reighard, J. 1899. The biology of the Great Lakes. Science. 9(235):906-907.

A brief paper announcing a planned lake survey during the summer of 1899. (BU)

Reinert, R. E. 1970. Pesticide concentrations in Great Lakes fish. Pestic. Monit. J. 3(4):233-240.

During the past four years the Ann Arbor Great Lakes Fishery Laboratory has been monitoring insecticide levels in fish from the Great Lakes. The two insecticides found in all Great Lakes fish have been DDT (DDT, DDD, DDE) and dieldrin. Fish from Lake Michigan contain from 2 to 7 times as much of these insecticides as those from the other Great Lakes. Insecticide levels calculated on a whole-fish basis show a marked difference from species to species. Within a species there is also an increase in DDT and dieldrin levels with an increase in size. If these insecticide levels are, however, calculated as ppm of insecticide in the extractable fish oil, the differences in concentration between species and the differences between size groups becomes considerably less. Laboratory experiments indicate that fish can build up concentrations of DDT and dieldrin at the parts-per-million level from parts-per-trillion concentrations in the water.

Reitz, R. D. 1973. Distribution of phytoplankton and coliform bacteria in Lake Erie. Ohio EPA. Div. Surveillance. Columbus, Ohio. 67 p.

Conclusions of this report on bacteriological and phytoplankton data are limited to the shoreline waters of the Ohio portion of Lake Erie. The data were gathered at 14 water treatment facilities for the bacteriological data and at 10 water treatment facilities for phytoplankton data in conjunction with the Lake Erie Water Quality Program. The data were collected during the period from July 1968 through December 1972. Statistical analysis of monthly coliform means compiled during the 4-1/2 year period indicate a significant (P .05) difference among months with respect to coliform counts. Lorain, Avon Lake, Mentor, Painesville, Madison, and Ashtabula exhibit a large increase during October, November and December then an abrupt decrease to lower levels in January. Other stations (Port Clinton, Lorain, Cleveland Division, Painesville) exhibit large summer increases.

Phytoplankton (algae) data appear to indicate that levels of enrichment and eutrophication have been returned to levels recorded in the 1940's at the Port Clinton area and to levels recorded in the 1920's for the Cleveland Harbor area. All stations have recorded reductions in the total phytoplankton standing crop during the 5-year sampling period. Further indications of change in Lake Erie have been the reduction of the blue-green pulse, which normally causes widespread "fouling" of the water, to a pulse occurring for a short time only.

Reitze, A. W., Jr. 1968. Wastes, water, and wishful thinking: The battle of Lake Erie. Case Western Reserve Law Review. 20(1):5-86.

A review of pollution sources and resulting changes in fish populations and algal growth, as indicators of the condition of Lake Erie. Emphasis is placed on legal history of pollution abatement in Ohio, and interrelationships of responsible agencies. Necessary measures for reversing the degradation of Lake Erie, and preserving it as a source of drinking water and as a commercial and recreational resource are discussed.

Rhodes, R. G. and A. J. Terzis. 1970. Some algae of the upper Cuyahoga River system in Ohio. Ohio J. Sci. 70(5):295-300.

A qualitative survey of algae made during June and September, 1967, in three tributaries of the Cuyahoga River in Geauga County: West Branch, East Branch, and Tare Creek. Sixty-four species of algae found in this survey are reported here: Eight species which were collected at the majority of the 14 stations sampled are Cladophora glomerata, Aphanochaete repens, Rhizoclonium hieroglyphicum, Euglena gracilis, Vaucheria sessilis, Tribonema bombycinum, Oscillatoria nigra and O. limosa.

Richardson, R. E. 1926a. Changes in the small bottom fauna of Peoria Lake, 1920-1922. Bull. Illinois State Natural Hist. Surv. 15(5) (1924-1925):327-390.

Richardson, R. E. 1926b. The Illinois River bottom fauna in 1923. Bull. Illinois State Natur. Hist. Surv. 15(5) (1924-1925):391-422.

Richardson, R. E. 1928. The bottom fauna of the middle Illinois River, 1913-1925, its distribution, abundance, valuation, and index value in the study of stream pollution. Bulletin, Ill. Natural Hist. Surv. 17(12):387-472.

Ritchie, G. A. and J. N. Speakman. 1973. Effects of settling time on quality of supernatant from upland dredge disposal facilities. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. on Great Lakes Res. pp. 321-328.

Analysis of sediments dredged from Ashtabula and Fairport Harbors, Ohio showed coliform counts ranging from 10 to 10,000 (colonies/100 ml) in initial samples. No colonies were found after filtering by Whatman No. 541 filter paper.

Roback, S. S. 1974. Insects (Arthropoda: Insecta). In Pollution Ecology of Freshwater Invertebrates. C. W. Hart, Jr. and S. L. H. Fisher., Eds. Academic Press, New York.

Roberts, M. L. 1972. Wolffia in the bladders of Utricularia: A herbivorous plant? Mich. Bot., Ann Arbor, Mich. 11(2):67-69.

In a ponded bay of Lake Erie, near Locust Point, aquatic plants of the genus Utricularia (bladderworts) were found to have trapped Wolffia (duckweed, watermeal). The observation was repeated several times through a summer and Wolffia was found in the traps on all visits. (SM)

Robertson, I. C. Strickler and C. L. Blakeslee. 1948. The mollusca of the Niagara Frontier region and adjacent territory. Bull. Buffalo Soc. Natural Sci., Buffalo, N. Y. 19(3):1-191.

A systematic account of the mollusks found within a fifty-mile radius of Buffalo, New York. The study area includes a part of the Niagara Peninsula in Ontario drained by the Grand River. There is a description of each species and a note about where it has been found. Photographs of the specimens are included. (SM)

Rodgers, G. K. (Ed.). 1972. Great Lakes Institute data catalogue and methods for 1960-1970. Univ. Toronto. Inst. Environ. Sci. Eng. Toronto, Ont. Pub. EG 7. Sec. A-D. 301 p.

Section A is a general guide to the methods and instruments used to make measurements and analyze samples. Section B concerns data processing and retrieval methods. Section C contains data summary tables for 1960 through 1970 in which the number of observations, stations occupied, samples and analyses of various kinds, etc. have been tabulated for each survey. Biological entries for Lake Erie include plankton hauls, bacteria analyses, bottom samples (fauna) and fish finder records. Section D consists of survey charts on which the positions of the stations are plotted.

Roecker, R. 1961. Osmerus mordax - the smelt. Some big questions and a few answers about a little fish. N. Y. State Dept. Environ. Conserv., Albany, N. Y. Conservationist. 15(5):16-18.

An article describing the spawning habits, food and distribution of the smelt. Information concerning fishing regulations and methods used for catching the smelt, both commercially and by the individual fisherman, is included. The Lake Erie smelt fishing industry is of particular importance and is described in some detail. Over sixty Province of Ontario vessels have been licensed to trawl for smelt. (SM)

Rogick, M. D. 1934a. Additions to North American fresh-water bryozoa. Ohio J. Sci. 34(5):316-317.

A table on the distribution of those bryozoa collected in Lake Erie is presented. Twenty-one species and varieties of freshwater bryozoa are known from North America - sixteen of which are represented in Lake Erie. (BU)

Rogick, M. D. 1934b. Studies on fresh-water bryozoa. I. The occurrence of Lophopodella carteri (Hyatt) 1866 in North America. Trans. Amer. Micros. Soc. 53(4):416-424.

Samples of Lophopodella carteri were collected in western Lake Erie in 1932 and 1933. The morphological characteristics of this species are described; illustrations are also provided. (BU)

Rogick, M. D. 1935c. Studies on fresh-water bryozoa. II. The bryozoa of Lake Erie. Trans. Amer. Micros. Soc. 54(3):245-263.

A report on the bryozoa of Lake Erie collected in the island region during 1932 and 1933. Morphological descriptions for 17 species, 10 of which were previously unreported from Lake Erie, are given. General ecological data related to these bryozoa is included. (BU)

Rogick, M. D. 1935d. Studies of freshwater bryozoa. III. The development of Lophopodella carteri var. typica. Ohio J. Sci. 35(6):457-463.

Contains laboratory observations of Lophopodella carteri var. typica through two generations and to the beginning of the third. Careful accounts were kept of the development of two colonies in particular - the date of their germination, the time intervals between evagination of succeeding polypides and the rate of development, release and germination of statoblasts from these colonies. (BU)

Rogick, M. D. and H. van der Schalie. 1950. Studies on fresh-water bryozoa. XVII. Michigan bryozoa. Ohio J. Sci. 50(3):136-146.

The purpose of this paper was to record the occurrence of several bryozoan species from localities new to Michigan and other regions; to compile a list of the bryozoa previously recorded from Michigan; and to correct or revise the identification of some of the species collected in the past. Collection sites included a station near the mouth of the Huron River, in Lake Erie. (BU)

Rolan, R. G. 1970a. The phytoplankton, phytobenthos and phytoperiphyton of the Great Lakes. Contribution to the Great Lakes Basin Commission's Framework Studies, Ann Arbor, Mich. 91 p. (Unpublished).

The Great Lakes flora discussed in this paper include the phytoplankton, phytobenthos and the phytoperiphyton only. The terrestrial and semi-terrestrial plants of the region are not included. Factors taken up in the paper include algae blooms, floral gradients in the Great Lakes, trophic relations, seasonal changes in the algae and factors which control the growth and abundance of algae.

Rolan, R. G. 1970b. The zooplankton, zoobenthos and periphytic invertebrates of the Great Lakes. Contribution to the Great Lakes Basin Commission's Framework Studies, Ann Arbor, Mich. 283 p. (Unpublished).

The zooplankton and zoobenthos of the Great Lakes are of interest to planners and policy-makers primarily as indicators of environmental quality and as intermediate members of aquatic food webs upon which fisheries and many waterfowl depend. The literature on the invertebrates of the Great Lakes is extensive, but this review reveals numerous and rather significant gaps of knowledge. This paper deals with the components of the fauna; the use of zooplankton and zoobenthos as indicators of environmental conditions in the lakes; feeding and reproduction and seasonal patterns in population fluctuations.

Rolan, R. G. 1970c. The bacteria and fungi of the Great Lakes. In: Great Lakes Basin Framework Study. Limnology of Lakes and Embayments. Great Lakes Basin Comm., Ann Arbor, Mich. Appendix 4, Draft 1. pp. 8-29 to 8-62.

This study investigates the bacteria and fungi of the Great Lakes emphasizing their roles in nutrient cycling and indicators of pollution as well as their pathogenic properties.

Rolan, R. G. 1973. Zooplankton and benthos of the Cleveland nearshore zone of Lake Erie. 1971-1972. Report to the City of Cleveland, Water Quality Control Program, Dept. of Public Utilities.

Roosen, J. J. and R. C. Ball. 1971. Ecological effects of a thermal power plant on the aquatic habitat of a large fresh water lake in the United States. Proc. Eighth World Energy Conf. Bucharest, Rumania. 19 p.

Recent expansion of electrical use in the area has resulted in the siting of a 3200-megawatt fossil-fueled plant on the Michigan shore of the Western Basin of Lake Erie, the geologically oldest of the five lakes. This paper describes the qualifying and quantifying of the chemistry and biology of the aquatic environment of the lake receiving discharges from the large generating plant. Included are the design basis and description of the ecological program that was formulated by Michigan State University to determine the impact of the plant on the aquatic habitat. The paper details information to be collected in the areas of: (1) basic plant producing groups - the periphyton, the phytoplankton and the macrophytes, (2) zooplankton, (3) bottom fauna, (4) fish, and (5) waterfowl. Physical and chemical studies are also described.

Ryck, F., Jr., and E. H. Fuchs. 1973. The relationship between diversity index values and the total number of mayfly and stonefly taxa in Missouri Ozark streams. Unpublished paper presented at the 21st Annu. Meeting of the Midwest Benthological Soc.

Schaffner, J. H. 1914. Catalog of Ohio vascular plants. Ohio Biol. Surv. Bull. 2. 1:125-247.

A listing of the vascular plants of Ohio including those areas bordering on Lake Erie and its tributaries. The catalog is arranged according to the phyletic classification; with notes on the geographical distribution in the state based mainly on specimens in the State Herbarium, Botanical Laboratory, Ohio State University. (SM)

Schaffner, J. H. 1932. Revised catalog of Ohio vascular plants. Ohio Biol. Surv. Bull. 25. 5(2):89-215.

A revised listing of the vascular plants of Ohio, including those areas bordering on Lake Erie and its tributaries. The arrangement of the species and larger groups follows the phyletic system of classification as developed by the author. (SM)

Schelske, C. and J. C. Roth. 1973. Limnological survey of Lakes Michigan, Superior, Huron and Erie. Univ. of Mich. Great Lakes Res. Div. Pub. 17. 108 p.

A report on an extensive survey of the physical, chemical and biological characteristics of Lakes Michigan, Superior, Huron and Erie conducted during the summer of 1970. There were 20 sampling stations located throughout the western portion of Lake Erie. Data for each lake is discussed separately followed by a comparison of the lakes.

Schindler, D. W. 1974. Eutrophication and recovery in experimental lakes: Implications for lake management. Sci. 184:897-899.

Combinations of phosphorus, nitrogen, and carbon were added to several small lakes in northwestern Ontario, Canada, at rates similar to those in many culturally eutrophied lakes. Phosphate and nitrate caused rapid eutrophication. When two basins of one lake were fertilized with equal amounts of nitrate and sucrose, and phosphorus was also added to one of the basins, the phosphate-enriched basin quickly became highly eutrophic, while the basin receiving only nitrogen and carbon remained at prefertilization conditions.

The author expresses concern over eutrophication of the St. Lawrence Great Lakes and supports the view that a basin-wide ban on detergent phosphates would bring about a partial recovery of Lakes Erie and Ontario.

Schrag, P. 1969. Life on a dying lake. Saturday Review. Sept. 20. pp. 19-21, 55-56.

The waters of Lake Erie and its tributaries are in a deplorable condition. The cause of this sad state is the indiscriminate dumping of wastes into the lake by both industries and municipalities alike. The direct result of this pollution is the loss of many valuable species of fish as well as the loss of the lake as a source of recreation.

Scott, D. C. 1955. Activity patterns of perch, _Perca flavescens_, in Rondeau Bay of Lake Erie. Ecol. 36(2):320-327.

Activity patterns of various fishes were studied at Rondeau Bay, Ontario in 1951 and 1952. Perch were found to be the most abundant fish large enough to be caught by gill-nets. The perch were divided into two chief groups: (1) migratory, traveling daily into Lake Erie, and (2) non-migratory, remaining in the bay. Data shows that the activity patterns of these two classes vary during daylight hours, but both classes were inactive during the hours of darkness. (SM)

Shelford, V. E. and M. W. Boesel. 1942. Bottom animal communities of the island area of western Lake Erie in the summer of 1937. Ohio J. Sci. 42(5):179-190.

A qualitative and quantitative study was made of the bottom communities in the island region north of Sandusky Bay, Ohio.

Sibley, C. K. 1929. The food of certain fishes of the Lake Erie drainage basin. In: A Biological Survey of the Erie-Niagara System. N. Y. Dept. Conserv., Albany, N. Y. Supplement 18th Annu. Rep. (1928). pp. 180-188.

During the summer of 1928 food records were obtained for 64 species of fish. The alimentary tracts of 2,010 individuals were examined and 1,128 of these contained food. In all cases, the length to the base of the tail is used, that is, the distance from the end of the snout to the end of the vertebral column. The percentages given are estimates of the volume of the various food organisms present in stomachs. The species examined are grouped according to food preferences in order to facilitate comparison.

Sibley, C. K. 1931. Fish food studies. N. Y. Conserv. Dept. Supplemental 21st Annu. Rep. for the Year 1930. Biol. Surv. 6:120-132.

During the summer of 1931 fish food studies were made in Black Lake, Cranberry Lake, Black River Bay, Chaumont Bay, Chippewa Bay, Morristown Bay and French Creek. The purpose of the study was to determine the numbers and lands of bottom animals suitable for food and to study the stomach contents of fish. Included in the paper is productivity estimated in pounds per acre for Black River Bay, a list of predaceous species with the fish food found in their digestive tracts and a summary of fish foods.

Simpson, G. D., L. W. Curtis and H. K. Merkle. 1969. The Cuyahoga River: Lake Rockwell to Lake Erie. In: G. Dennis Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ., Inst. Limnol. Kent, Ohio. pp. 87-120.

A survey of the chemical, biological, and physical characteristics of the Cuyahoga River from Lake Rockwell to Lake Erie. Forty-three sampling sites were established along this route, and sampling took place weekly from June to September, 1967. Characteristics found are listed for each sampling site.

Skoch, E. J. and C. S. Sikes. 1973. Mercury concentrations in chironomid larvae and sediments from Sandusky Bay of Lake Erie: Evidence of seasonal cycling of mercury. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. on Great Lakes Res. pp. 183-189.

Chironomid larvae, sediment and water were collected on a monthly basis at two sites in Sandusky Bay of Lake Erie from February through November

1972. The mercury concentrations in each were analyzed to illustrate the relationships between the three. Comparison of concentrations of mercury in sediment and organisms show no correlation between the two. Although monthly mercury variation was shown in the sediments, a seasonal variation was found in the chironomid larvae.

Sladecek, V. 1973. System of water quality from the biological point of view. Arch. Hydrobiol., Ergebn. Limnol. 7(1-4):1-218.

Sly, P. G. 1976. Lake Erie and its basin. J. Fish. Res. Board Can. 33:355-370.

Smith, H. M. 1898. Biological survey of Lake Erie. Sci. 8(183):13-14.

A brief paper announcing a planned survey of Lake Erie during the summer of 1898. The investigators who will take part in this survey are named and their assignment areas are given. (BU)

Smith, K. R. 1966. A comparison of benthic oligochaete fauna from different stations in the Put-in-Bay region of Lake Erie. M. S. thesis, The Ohio State Univ., Columbus, Ohio.

Smith, S. H. 1956. Limnological surveys of the Great Lakes - early and recent. Trans. Amer. Fish. Soc. 86:409-418.

Early explorations on the Great Lakes were concerned largely with things easily collected or observed, i.e. common organisms, water levels, surface temperatures, etc. Effective surveys became possible only through inter-agency cooperation which permits a pooling of facilities, staff, and equipment. Expansion of limnological research on the Great Lakes has been rapid in later years and the outlook for the future is good.

Smith, S. H. 1962. Lake Erie or Lake Eerie? Izaak Walton Magazine. 27(4):4-5.

Lake Erie is aging at a rapid rate due to cultural pollution. Changes in its biological characteristics are already threatening its potential industrial and recreational usefulness. Some of these changes are pointed out.

Spangler, M. B. 1969. The role of marine sciences in the multiple uses of the coastal zone of Lake Erie and Lake Superior. National Planning Assoc. Center for Techno-Economic Studies. Washington, D. C. Rept. PB 185 163. 302 p.

The results of a study designed to derive important general principles concerning marine and related science and technology and institutional developments which can contribute to effective social and economic utilization of the nation's coastal margins; and to determine the unique characteristics of the different coastal regions as guidelines to formulating research needs and making decisions tailored to the socio-economic activity along these coastal areas. This study has sought to identify measures in marine sciences which can be applied to promoting the optimum use of the coastal zone of the Great Lakes. Lakes Superior and Erie were selected for this study because of their contrasting characteristics.

Speery, K. 1967. The battle of Lake Erie: Eutrophication and political fragmentation. Sci. 158(3799):351-355.

A general article describing the eutrophication problem in Lake Erie with comment on its relationship to phosphates which enter the lake through sewage and detergents. Photographs of algal masses along the lake are included. Legislative action concerning the problem is discussed. (SM)

Spencer, D. R. 1977. A species of Pristina (Oligochaeta:Naididae) new to Lake Erie. Ohio J. Sci. 77:24-25.

Stack, J. 1920. Aquatic life: with special reference to Entomostraca. Amer. Midland Naturalist. 6(7):128-145.

A report on a zoological survey of Beimiller's Cove, Cedar Point, Ohio and of numerous ponds and streams in that vicinity. The survey was confined for the most part to invertebrate forms. (BU)

Stansbery, D. H. 1960. The Unionidae (Mollusca, Pelecypoda, Unionacea) of Fishery Bay, South Bass Island, Lake Erie. Ph.D. diss., The Ohio State Univ., Columbus, Ohio. 216 p.

Stansbery, D. H. 1961. The naiades (Mollusca, Pelecypoda, Unionacea) of Fishery Bay, South Bass Island, Lake Erie, Part I. Introduction, history, faunal origins, and physiography. Sterkiana 5:1-37.

Stansbery, D. H. 1970. A study of the growth rate and longevity of the naiad Amblema plicata (Say 1817) in Lake Erie (Bivalvia:Unionidae). Amer. Malacol. Union Bull. 37:78-79.

Stehle, M. E. 1923. Surface plankton protozoa from Lake Erie in the Put-in-Bay region. Ohio J. Sci. 23(1):41-54.

A qualitative and quantitative analysis of the species of surface plankton protozoa collected from Fishery Bay, Terwilliger's Pond and the open lake is presented in tabular form. This is followed by a brief discussion of the diurnal migration of the protozoans. (BU)

Stein, C. B. 1962. Key to the fresh-water mussels (family Unionidae) of western Lake Erie. The Ohio State Univ., F. T. Stone Lab. Mimeo. Rep. 5 p.

Stein, C. B. 1963. The Unionidae (Mollusca: Pelecypoda) of the Olentangy River in central Ohio. M.Sc. thesis, Ohio State Univ., Columbus.

Stephenson, E., E. D. Anderson, and R. A. Cole. 1970. Hydrobiological evaluation of stream and nearshore systems: field studies. Mich. State Univ., East Lansing Inst. of Water Res. Proc. National Symp. on Data and Instrumentation for Water Quality Management., Conf. of State Sanitary Engineers and Wisc. Univ. Madison, Wisc. p. 299-309.

Hydrobiological evaluations may be conducted under the assumption that the most representative indicators of changing water quality are functions of the indigenous biological community. These responses may occur as a result of the introduction of foreign biological populations or change in physical and chemical properties. Field investigations were made on four Michigan stream systems and a nearshore environment in western Lake Erie to evaluate the response of these environments to urbanization and agriculture practices. An ecological evaluation of thermal discharge from a fossil fuel power plant at the mouth of the Raisin River in western Lake Erie was initiated in July, 1969. Community components elected to characterize changes are phytoplankton, periphyton, zooplankton, benthos, fish, and waterfowl. The physical and chemical parameters include temperature, oxygen, phosphorus, organic nitrogen, total nitrogen, nitrate, ammonia, organic carbon, and silica. In addition, pesticide analyses are being performed on the fish collected in the biological program. (See also W71-08550) (Knapp-USGS)

Stephenson, J. 1930. The Oligochaeta. Verlag von Cramer, 1972 Reprint. Stechert-Hafner Service Agency, Inc., New York.

Sterki, V. 1907. A preliminary catalogue of the land and fresh-water Mollusca of Ohio. Proc. Ohio State Acad. Sci. Special Paper 12. 4(8):367-402.

A catalog of Ohio Mollusca recognized by the author, or cited on good authority. About 30 species of Unionidae have been seen by the author in Lake Erie. They are generally smaller, of different shapes, and often of different colors from those found in the rivers.

A few lake forms of Sphaeridae and Gastropoda have been found. It is suggested that all Mollusca of the lake should be systematically collected and compared with the inland forms as well as with those of the other Great Lakes. (SM)

Sterki, V. 1916. A preliminary catalog of the North American Sphaeriidae. Ann. Carnegie Mus., Pittsburg, Penn. 10(1,2):429-477.

The catalog presents known forms of Sphaeriidae with their habitat and location of fossil finds for each form. No listed species is attributed to Lake Erie. Mention is made of the need to do systematic collection in Lakes Michigan and Erie and compare the fauna of the several lakes. (SM)

Stevenson, A. L. and W. S. Benninghoff. 1969. Late post-glacial rise of Lake Erie and changes in vegetation on the Maumee Lake plain. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. on Great Lakes Res. pp. 347-350.

Benthic sampling on the southern coast of the Western Basin of Lake Erie reveals that a forest once existed at this site, suggesting a recent and continuous rise of the lake in the Bass Island area.

Stimpson, W. 1870. On the deep-water fauna of Lake Michigan. Amer. Naturalist. 4(7):403-405.

A look at the plants and animals living at the bottom of Lake Michigan. Contains a note on the occurrence of Mysis at Kingston, the highest point in the valley at which such shells have been found.

Stuckey, R. L. 1967. The "lost" plants of Thomas Nuttall's 1810 expedition into the old Northwest. Mich. Bot., Ann Arbor, Mich. 6(3):81-94.

A report on the probable identity of plants collected by Thomas Nuttall on a walking tour along the southern shore of Lake Erie and through the northwest in 1810. The plants were lost and replaced on a later expedition. Locality data for 20 species from the Great Lakes Region is given. (SM)

Stuckey, R. L. 1968. Distributional history of Butomus umbellatus (flowering-rush) in the western Lake Erie and Lake St. Clair region. Mich. Bot., Ann Arbor, Mich. 7:134-142.

This article concerns the distributional history of the flowering-rush in the western Lake Erie region. The species was introduced from Europe but the date of this introduction is disputed. The author attempts to interpret previous investigations.

Stuckey, R. L. 1969. The introduction and spread of Lycopus asper (western water horehound) in the western Lake Erie and Lake St. Clair region. Mich. Bot., Ann Arbor, Mich. 8(2):111-120.

This paper compares data from past literature and herbarium specimen records with modern surveys of plants in the field. The evidence indicates that Lycopus asper Greene, a species indigenous to western North America, is non-indigenous to the shore flora of the Western Lake Erie region.

Stuckey, R. L. 1970. Distributional history of Epilobium hirsutum (great hairy willow-herb) in North America. Rhodora. 72(790):164-181.

The known distribution of a member of the evening primrose family (Onagraceae), Epilobium hirsutum L., is described in this article. The species has become established in eastern North America in the past 140 years. A map of its distribution with dates of the oldest known collection of the plant for each locality is included. (SM)

Stuckey, R. L. 1971. Changes of vascular aquatic flowering plants during 70 years in Put-in-Bay Harbor, Lake Erie, Ohio. Ohio J. Sci. 71(6):321-342.

Based on a survey in 1898, 40 spp. of vascular aquatic flowering plants were reported for Put-in-Bay Harbor in western Lake Erie. Studies of this flora at various times since then have revealed a loss of species from this harbor to the extent that today 20 spp. of the original 40, or 50%, of the flora have disappeared. Only 3 of the original 40 can be considered to be common or abundant today in the harbor. During the same 70-yr period, only 4 submersed species have invaded the harbor. Possible reasons for these changes, such as increase in water temperature, decrease in oxygen, increase in turbidity, and man's influence on the harbor by dredging, building retaining walls, increasing use of motor boats, dumping of domestic sewage, and runoff from agricultural land are all considered as possible factors that have, independently and interrelatedly, in part or in total, been responsible for this 50% loss in species composition. (BU)

Stuckey, R. L. and W. L. Phillips. 1970. Distributional history of Lycopus europaeus (European water-horehound) in North America. Rhodora. 72(791):351-369.

This article traces the distributional history of Lycopus europaeus in northeast North America. Included is a distribution map showing the date of the earliest known collection of the plant for each locality. It is thought that the species invaded western Lake Erie via a water route rather than overland and is now being spread in western Lake Erie by propagules. (SM)

Sublette, J. E. 1957. The ecology of the macroscopic bottom fauna in Lake Texoma (Denison Reservoir), Oklahoma and Texas. Amer. Midland Naturalist. 57:371-402.

Sublette, J. E. 1964. Chironomidae (Diptera) of Louisiana. I. Systematics and immature stages of some lentic chironomids of west-central Louisiana. Tulane Studies Zool. 11(4):109-150.

Sublette, J. E., and M. E. Sublette. 1965. Family Chironomidae. In: A. Stone et al., Eds. A catalog of the Diptera of America north of Mexico. Agri. Handbook No. 276. U. S. Dept. Agri., Washington, D. C. 1696 p.

Sweeney, Robert A. (Ed.). 1969. Problems and techniques. In: Proc. of the Conf. on Changes in the Biota of Lakes Erie and Ontario. Bull. Buffalo Soc. Natural Sci., Buffalo, N. Y. 25(1):72-84.

Problems encountered and techniques employed in the collection and analysis of aquatic organisms are discussed.

Taft, C. E. and C. W. Taft. 1971. The algae of western Lake Erie. Bull. Ohio Biol. Surv. New Series. 4(1):189 p.

The physiology of the various algal habitats existing in the island region of western Lake Erie is discussed. This is followed by a section on the relative abundance of the algal groups. The systematic presentation includes keys to classes, orders and genera, as well as a taxonomic description and collection sites for each of the genera and species identified.

Tait, H. D. 1971. Great Lakes Fishery Laboratory. In: Progress in Sport Fishery Res. 1971. Bur. Sport Fish. and Wildlife, Washington, D.C. pp. 86-120.

A summary of research in 1971 on the Great Lakes divided on the basis of geographic boundaries into fishery research on each of the five lakes, and also on the basis of subject, environment, fish physiology and behavior, heavy metals and pesticides, and biometrics.

Tarzwell, C. M., (Ed.) 1957. Biological problems in water pollution. Transactions of a seminar held at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio in 1956. U. S. Dept. Health, Educ. and Welfare. 272 p.

Tarzwell, C. M., (Ed.) 1965. Biological problems in water pollution. Third Seminar, 1962. U. S. Dept. of Health, Educ. and Welfare. 424 p.

Thienemann, A. 1954. Chironomus, Laben, Verbreitung und wirtsschaftliche Bedentung der Chironomiden. Binnengewasser 20. 834 p.

Thommes, M. M., H. F. Lucas, Jr. and D. N. Edgington. 1972. Mercury concentrations in fish taken from offshore areas of the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 192-197.

Twenty-four fish species collected from offshore regions of Lakes Erie, Michigan and Superior during 1967 and 1968 were analyzed for mercury concentration by the neutron activation method. For two individual species, bloater and lake trout (where individual fish sampled were of widely differing size), no correlation could be seen between mercury content and weight. The fish were grouped according to feeding habits and both significant differences and similarities were seen between trophic levels and lakes. Generally, the concentrations of mercury in piscivores were higher than those in either bottom feeders or planktivores. No significant difference was seen for the same feeding groups from each lake. It is suggested that these offshore levels result from natural geochemical sources of mercury.

Thut, A. N. 1969. Study of the profundal bottom fauna of Lake Washington. Biol. Monographs 39(1):79-110.

A review of the macrofauna in the profundal zone of Lake Washington between September 1963 and September 1964 and discussion. Although sewage diversion began in 1963, phosphate and oxygen values indicated the lake was still in the eutrophic phase. Ten stations were chosen at 5-meter depth intervals from 10 to 55 meters and sampled approximately monthly with an Ekman dredge. Twenty-four species were recognized from the profundal zone, each presented separately, with the exception of oligochaeta species, along with their depth and population dynamics throughout the year. The chironomidae were most numerous of bottom fauna constituents (about 45% of the total). Thirteen species were found during the study, including predators, deposit-feeders, and filter-feeders. Larvae were most common at the shallow-water stations and became progressively diminished with increase in depth. The oligochaeta comprised about 1/2 of the total number and 1/3 of the total biomass of the profundal fauna. Four species were identified. The oligochaeta were found in the greatest numbers and biomass at the greatest depth sampled; their abundance progressively declined with decrease in depth. Amphipoda and Sphaeridae were present but in smaller numbers. (Haskins-Wisconsin)

Tidd, W. M. 1934. Recent infestations of goldfish and carp by the "anchor parasite," Lernaea carassii. Trans. Amer. Fish. Soc. 64:176-180.

A discussion of the effects of the "anchor parasite," Lernaea carassii, on goldfish and carp in ponds around western Lake Erie. A table listing eight other fish hosts as well as a frog tadpole and the locality at which each was found is included. (CCIW)

Tiffany, L. H. 1937. The filamentous algae of the west end of Lake Erie. Amer. Midland Naturalist. 18(6):911-951.

A systematic listing of the filamentous green, blue-green, and yellow-green algae collected during the summers of 1927-36. All specimens were obtained from the island region of Lake Erie. (BU)

Tomkiewicz, L. A. 1970. Typical fish mortality rates in eastern Lake Erie. State Univ. College, Fredonia, N. Y. Lake Erie Environ. Studies. Tech. Data Rep. 4. 15 p.

This study was conducted to establish a base line of natural fish mortalities in eastern Lake Erie throughout a yearly cycle. Seasonal variations in mortality rate indices are shown graphically for the eight most common species (smelt, black bullhead, white sucker, sheepshead, yellow perch, white bass, smallmouth bass, and rock bass). No direct cause for the mortality could be given although the author stated possible causes as predation, diseases and parasitism, pollution, and physical damage caused by man. Most causes of high fish mortality rates were related to commercial and sports fishing activity.

Trautman, M. B. 1939. The effects of man-made modifications on the fish fauna in Lost and Gordon Creeks, Ohio, between 1887-1938. Ohio J. Sci. 39(5):275-288.

A study of the numerical fluctuations of various fish species in Lost and Gordon Creeks of the Maumee River Basin from 1887 to 1938. The author hopes to use this data to provide an understanding of the fundamental principles regulating the present numerical abundance of each speices. The effect of stream dredging is emphasized. (BU)

Trautman, M. B. 1944. An Ohio specimen of the purple sandpiper. Wilson Bull. 56(1):46.

A short account of the capture of a purple sandpiper specimen on Starve Island in November of 1943. Stomach analysis was performed and showed the bird had eaten mostly algae of the genus *Ulothrix*. Remnants of beetles, gravel, and otolith of a fish and fish scales were also found. The bird was seen feeding in *Cladophora*, but apparently did not consume it. (SM)

Trautman, M. B. 1948. A natural hybrid catfish, *Schilbeodes miurus* X *Schilbeodes mollis*. Copeia. 1948(3):166-174.

A discussion of the hybrid between *Schilbeodes miurus* and *S. mollis* which was previously classified as *S. nocturnus*. A comparison of morphological characteristics is made between the hybrid and its parental types and also to *S. nocturnus*. Included is a possible explanation of hybridization as being a direct response to environmental conditions. (BU)

Turner, Charles L. 1920. Distribution, food and fish associates of young perch in the Bass Island region of Lake Erie. Ohio J. Sci. 20(5):137-152.

Forty-two sampling sites in the Bass Island region of Lake Erie are described individually as to their physical characteristics, fauna and flora. This data was used to study the distribution and diet of the perch of this region. It was found that young perch generally remain in shore waters at a depth of between two and five feet. The diet consists of entirely copepods when young and gradually changes to insect larvae. This change in diet is associated with a change in feeding behavior from a surface feeder to a bottom feeder. (BU)

Tressler, W. L. and T. Austin. 1939. A limnological study of some bays and lakes of the Lake Ontario watershed. N. Y. Conserv. Dept., Supplemental 29th Annu. Rep. for 1939. Biol. Surv. pp. 188-210.

During the summer of 1939 a number of bays and lakes of the Lake Ontario watershed were investigated to determine the amount and quality of microscopic life, the environmental conditions under which this life existed and the extent to which fish were utilizing this important food element in their diet. Vertical series at several depths were made in the water areas studied during the months of July and August. Four bays were found to produce much more plankton than the lake itself. The stomachs of perch and large-mouthed bass from Irondequoit Bay contained a greater amount of plankton than the same species from Sodus Bay.

Turner, C. L. 1921. Food of the common Ohio darters. Ohio J. Sci. 22(2):41-62.

Common Ohio darters of 11 different species were collected in the Bass Island region of Lake Erie as well as from other lakes and streams of Ohio. Through stomach analysis the diets of each species was determined. Any differences in the diet within a species collected from Lake Erie as opposed to a stream or inland lake was also noted. Using this data the author divides the darters into 3 classes based upon the character of the food at the different periods in their lives. Also discussed are the factors governing food changes and the relationship between food and distribution of the darter. (BU)

Turner, C. L. 1922. Notes on the food habits of young of <u>Cottus ictalops</u> (Millers Thumb). Ohio J. Sci. 22(3):95-96.

Around the shores of Buckeye Island, Lake Erie, young of <u>Cottus ictalops</u> were fairly abundant. One hundred specimens were collected and 35 of their stomachs were analyzed for food content. The results are reported and discussed. (BU)

Turner, C. L. 1926. The crayfishes of Ohio. Ohio Biol. Surv. Bull. 13. 3(3):145-195.

A study of the crayfishes of Ohio including Lake Erie and its tributaries. Statements are made concerning historical background, external structures and their functions, copulation and reproduction, regeneration and moulting, life history and habits, economic aspects, classification, descriptions of each species and distribution. (SM)

U. S. Army Corps of Engineers. 1969. Dredging and water quality in the Great Lakes. Buffalo District. Vol. 1-12.

U. S. Army Corps of Engineers. 1971. Cuyahoga River Basin Ohio Restoration Study. U. S. Army Corps of Eng., North Central Div. Chicago, Ill. 104 p.

This first interim report of the Cuyahoga River Restoration Study presents the scope of the longer-term framework plan plus an early-action program that will begin in fiscal 1973. Specific actions recommended to improve water quality include: (a) Reduce bacterial and viral contamination to levels safely below those recommended for total body contact; (b) Provide dissolved oxygen to levels which will promote a clean-water aquatic community; (c) Eliminate sources of excesssive nutrients which promote nuisance algae growths; (d) Reduce the suspended solids load carried by the stream; (e) Terminate the release of heavy metals into the aquatic environment; and (f) Remove physical or chemical barriers to the passage of migrating fish as far upstream as Cuyahoga Falls, where natural falls constitute a barrier.

U. S. Army Corps of Engineers. 1973. Summary report on Cleveland-Akron Metropolitan and Three Rivers watershed areas of Ohio wastewater management study. U. S. Army Corps of Eng., North Central Div. Chicago, Ill. 207 p.

This study is concerned with the formulation, design, and assessment of the impacts of alternative plans for area-wide wastewater management for the watershed areas in northern Ohio. The basic wastewater sources considered in the study are municipal sewage, industrial waste flows, and combined and separate urban stormwater runoff. The rivers included in the Three Rivers Watershed are the Rocky River, the Cuyahoga River and the Chagrin River. Evaluation of water quality included identification of bottom dwelling organisms and determination of levels of coliform bacteria.

U. S. Bureau of Outdoor Recreation. 1966. Water oriented outdoor recreation, Lake Erie Basin. Bur. Outdoor Recreation. Lake Central Region. Ann Arbor, Mich. 102 p.

A review of recreational demand and opportunities in the Lake Erie Basin. Included is discussion of the closing of beaches due to high coliform counts, and the negative effects of excessive aquatic growth on swimming and sport fishing.

U. S. Department of Health, Education, and Welfare. 1963. Water pollution surveillance system annual compilation of data October 1, 1962 - September 30, 1963. Public Health Service, Div. Water Supply and Pollution Control. Washington, D. C. 1:63-71 (Northeast Basin); 4:25-26, 85-102 (Western Great Lakes and Lake Erie Basins).

The 6th annual compilation of data is information collected by the Public Health Service Water Pollution Surveillance System (formerly the National Water Quality Network). The biological parameters associated with water quality were monitored. (BECPL)

U. S Department of Health, Education and Welfare. 1965a. Conference in the matter of pollution of Lake Erie and its tributaries. In: Conference Proceedings, August 3-6, 1965, Cleveland, Ohio. U. S. Dept. Health, Educ., and Welfare, Washington, D. C. Vol. 1-4. 1099 p.

Proceedings of a conference held at the request of the Governor of Ohio under the provisions of Section 8 of the Federal Water Pollution Control Act. Statements concerning changes in Lake Erie and their relationship to industrial and municipal waste discharges are included. The technical report considers the quality characteristics of the waters as they exist and trends in recent years. It evaluates the effects of waste discharges on water uses and summnarizes the principal problems and needed corrections. The report is based on studies made over a two-year period under the supervision of the Department of Health, Education, and Welfare. Data obtained from other federal, state and local agencies were also used in the report.

U. S. Department of Health, Education, and Welfare. 1965b. Conference in the matter of pollution of Lake Erie and its tributaries. In: Conference Proceedings, August 10-11, 1965, Buffalo, New York. U. S. Dept. Health, Educ., and Welfare, Washington, D. C. Vol. 1-2. 467 p.

Proceedings of the conference held under the provisions of Section 8 of the Federal Water Pollution Control Act. Major sources of municipal and industrial wastes in the Pennsylvania and New York sections of Lake Erie were identified and necessary corrective actions recommended in Part 3 of the Federal Report prepared under the supervision of the Department of Health, Education and Welfare. Data obtained from other federal, state and local agencies were also used in the report. The Erie County, Pennsylvania Division of Environmental Health presented a report on pollution of tributaries and condition of beaches. The New York State presentation included an explanation of the state system of stream classification. Financing of sewage treatment facilities is discussed in relation to federal, state and local responsibility.

U. S. Department of Health, Education, and Welfare. 1965c. Conference in the matter of pollution of the navigable waters of the Detroit River and Lake Erie and their tributaries in the state of Michigan. In: Proceedings Second Session, June 15-18, 1965. U. S. Dept. Health, Educ., and Welfare, Washington, D. C. Vol. 1-6. 1787 p.

A complete report of the conference proceedings held under the provisions of Section 8 of the Federal Water Pollution Control Act. An extensive report on studies by the Public Health Service analyzing the waters and bottom deposits is presented in Volumes 1-3. Forty-four types of bacteriological, chemical, physical and biochemical tests were performed. Summaries of technical data in the forms of maps, charts, graphs and tables are included in the publication.

U. S. Department of Health, Education, and Welfare. 1965d. Report on the pollution of Lake Erie and its tributaries. Part 1: Lake Erie. U. S. Dept. Health, Educ., and Welfare. Public Health Service, Div. Water Supply and Pollution Control. Washington, D. C. pp. 1-50.

This report contains a description of conditions in Lake Erie and its tributaries. There is discussion of changes in the biology of the lake during the past 35 years. Changes in the amount of algae found in water samples and changes in types of bottom organisms are noted.

U. S. Department of Health, Education, and Welfare. 1965e. Report on the pollution of Lake Erie and its tributaries. Part 2: Ohio, Indiana and Michigan sources. U. S. Dept. Health, Educ., and Welfare. Public Health Service, Div. Water Supply and Pollution Control. Washington, D. C. pp. 51-101.

This part of the report deals with problems in local areas tributary to Lake Erie within Michigan and Ohio, encompassing headwater areas in Indiana. The area is divided into six subareas: the Maumee River Basin; Western Ohio, including the Portage, Sandusky, Huron, Vermilion and Black Rivers; Rocky River Basin; Cuyahoga River Basin; Eastern Ohio, including the Grand River, Ashtabula River and Conneaut Creek; and the Detroit River and Michigan tributaries, including the Huron and Raisin Rivers.

U. S. Department of Health, Education, and Welfare. 1965f. Report on the pollution of Lake Erie and its tributaries. Part 3: New York and Pennsylvania sources. U. S. Dept. Health, Educ., and Welfare. Public Health Service, Div. Water Supply and Pollution Control. Washington, D. C. pp. 103-122.

This report describes water quality in the Pennsylvania and New York sections of Lake Erie and its tributaries under three geographical headings: the Pennsylvania Basin; the western New York Basin; and the Erie-Niagara Basin. Sources of pollution, both industrial and municipal, are identified and recommendations made for improved sewage treatment by specific individual industries and municipalities.

U. S. Federal Water Pollution Control Administration. 1967. Laboratory Manual -Cleveland Program Office. F.W.P.C.A. Cleveland Program Office. Cleveland, Ohio. 49 p.

This manual presents the procedures for chemical, biological and microbiological analysis of sediments and water as used by the laboratories of the Federal Water Pollution Control Administration, Cleveland Program Office. These procedures were employed in a surveillance program on Lake Erie which was conducted by the Cleveland Program Office.

U. S. Federal Water Pollution Control Administration. 1968a. Lake Erie report. F.W.P.C.A. Great Lakes Region. Cleveland, Ohio. 107 p.

This report recommends a plan of action combining immediate and long-range needs. It describes the pollution problem and the ominous threat of continued pollution. It also describes what must be done to save Lake

Erie, who will take these actions, and how much it will cost. Data concerning the basin, use of water, pollution problems and their causes, water quality standards, and costs for municipal and industrial waste treatment are included.

U. S. Federal Water Pollution Control Administration. 1968b. Lake Erie environmental summary, 1963-1964. F.W.P.C.A. Great Lakes Region. Cleveland, Ohio. pp. 130-160.

Included in this environmental summary of Lake Erie are two sections pertaining to its biological aspects. The first deals with the population changes of the lake's fauna and flora. The second analyzes the bacteriological characteristics, including separate discussions on each of the three major basin regions as well as its major tributaries.

U. S. Federal Water Pollution Control Administration. 1968c. Lake Erie surveillance data summary, 1967-1968. F.W.P.C.A. Great Lakes Region, Cleveland Program Office. Cleveland, Ohio. 65 p.

This program is a study of the chemical, biological, and microbiological conditions of Lake Erie including a survey of the lake under ice cover. Comparisons are drawn between this 1967-68 data and that obtained in 1963-64. The data indicates that dissolved solids have increased by 9% since 1964 and that most chemical constituents in both water and sediment have increased during the same period. Diatoms were found to dominate the phytoplankton populations in the spring, fall and winter; green and blue-green dominated in the summer depending on the basin.

U. S. Federal Water Pollution Control Administration. 1969. Progress evaluation meeting, pollution of Lake Erie and its tributaries - Indiana, Michigan, New York, Ohio, Pennsylvania. F.W.P.C.A. Washington, D. C. 467 p.

Proceedings of a conference to evaluate progress in pollution abatement with reports from the states of Michigan, Indiana, Ohio, Pennsylvania and New York and the cities of Detroit and Cleveland. Included is the Lake Erie Environmental Summary 1963-1964 and the Lake Erie Surveillance Data Summary 1967-1968 published by the Federal Water Pollution Control Administration. Material concerning proposed drilling operations for oil and gas in Lake Erie and regulation by individual states is included. Testimony concerning the disposal of dredgings from Lake Erie harbors is also presented.

U. S. Water Resources Council. 1968. Great Lakes region. In: The Nation's Water Resources. U. S. Water Resources Council. Washington, D. C. Parts 1-7. pp. 6-3-1 to 6-3-11.

This assessment of the nation's water resources includes a discussion of the problems of the Great Lakes. Lake Erie is mentioned specifically as an example of quality control problems, in particular the large amounts of algal blooms supported by nutrient additions from waste discharges. Damages to fishery and waterfowl habitat have been the immediate consequences.

Van der Schalie, H. 1938. The naiad fauna of the Huron River in southeastern Michigan. Univ. Mich. Mus. Zool. Ann Arbor, Mich. Misc. Pub. 40. 83 p.

The study found the naiad fauna of the Huron River consists of 25 species, three doubtful ones were not counted. The species Lasmigona complanata and Carunculina parva are reported in the system for the first time. Fourteen types of habitats are listed, each with a distinctive fauna. Man and the muskrat are the most destructive forces for the naiads of this drainage. (SM)

Van Oosten, J. 1929. Some fisheries problems on the Great Lakes. Trans. Amer. Fish. Soc. 59:63-85.

A preliminary report on an evaluation of the various factors held responsible for the decline in the fisheries of Lake Erie and the other Great Lakes. Extensive data on the destructiveness of the various types of fishing gear in several areas of the lake and during different seasons of the year, as well as biological data on the nine most important commercial fish species were collected. (CCIW)

Van Oosten, J. 1935. First record of the alewife, Pomolobus psuedoharengus, for the state of Michigan. Copeia. 1935(4):194-195.

A report on the historical background of the appearance of the alewife in the waters of Michigan. Alewife findings in Lake Erie are discussed and it is postulated that their entrance to this lake was via the Welland Canal. (BU)

Van Oosten, J. 1948. Turbidity as a factor in the decline of Great Lakes fishes with special reference to Lake Erie. Trans. Amer. Fish. Soc. 75:281-322.

Exhaustive treatment of the controversial question as to whether an increase of turbidity due to improper land use or improper fishing has caused the decline of the Lake Erie fisheries. Review of literature on effects of turbidity on fish is followed by presentation of argument in support of conclusions: beach erosion and wind action rather than cropland erosion are principal sources of turbidity in Lake Erie; levels of turbidity are generally too low to affect fish adversely; trends in turbidity since 1910-15 have been downward not upward as many have believed; fluctuations of turbidity have shown no correlation with fluctuations of growth and strength of year classes; and restoration of the fisheries must come through scientific fishery management - not scientific farming. (CCIW)

Van Oosten, J., (Ed.). 1957. Great Lakes fauna, flora and their environment -a bibliography. Great Lakes Comm., Ann. Arbor, Mich. 86 p.

Van Oosten, J. 1961. Records, ages and growth of the mooneye, Hiodon tergisus, of the Great Lakes. Trans. Amer. Fish. Soc. 90(2):170-174.

The mooneye is scarce in Lakes Huron and Michigan but common in Lakes Erie and Ontario. Commercialization is limited to Ohio and Michigan waters of Lake Erie; reports of commercial catches elsewhere are errors resulting from misuse of common names. In Lake Erie the total lengths (inches) of certain age groups ran: I, 8.4; IV, 12.2; VII, 13.1. The largest fish was 14.5 inches and weighed 14.8 ounces. All are mature at 8.8 inches and 3.2 ounces. (BU)

Veal, D. M., and D. S. Osmond. 1968. Bottom fauna of the Western Basin and near-shore Canadian waters of Lake Erie. Proc. 11th Conf. Great Lakes Res. Internat. Assoc. Great Lakes Res. pp. 151-160.

Bottom fauna in western Lake Erie and in the near-shore Canadian waters of the Central and Eastern Basins were investigated by the Ontario Water Resources Commission in 1967. A total of 109 stations were sampled once or twice between April and August. Benthic communities varied considerably throughout the area. The Eastern Basin supported a wide variety of taxa, the most abundant species being Pontoporeia affinis. In the Central Basin, macroinvertebrate communities were characterized by a predominance of Pontoporeia affinis near Long Point and the tubificid Peloscolex ferox between Pte. aux Pins (Rondeau) and Point Pelee. Western Lake Erie supported relatively high tubificid populations, including Limnodrilus hoffmeisteri and L. cervix as the most abundant species. In general, there appears to be a gradation from communities indicative of moderately oligotrophic to mesotrophic conditions in the Eastern and Central Basins, to communities indicative of eutrophic conditions in western Lake Erie.

Verber, J. L. 1952. Morphology of Lake Erie. (Unpublished) F.T. Stone Laboratory, Ohio State University at Put-in-Bay, Ohio.

Verduin, J. 1956. Energy fixation and utilization by natural communities in western Lake Erie. Ecol. 37(1):40-50.

From 1951 to 1955 the rate of energy fixation and utilization by natural aquatic communities in western Lake Erie were studied under near-natural conditions at all seasons of the year. The photosynthesis and respiration rates exhibited by communities concentrated by screening water through No. 25 silk bolting cloth, and by communities studied at their natural population density, are presented. Measurements of respiration of bottom fauna are included. These are related to environmental variables and the energy flow is estimated for (1) the total community, (2) the fraction retained by bolting cloth, and (3) the bottom fauna. (BU)

Verduin, J. 1961. Changes in western Lake Erie during the period 1948-1962. Proc. of Internat. Assoc. of Theoretical and Applied Limnol., Bowling Green State Univ. 15:639-644.

Extensive studies of western Lake Erie have been made since 1948. The area of approximately 3100 square kilometers is stirred continually by the seiches resulting in relatively homogeneous temperatures, chemical characteristics, and biological populations vertically. The Detroit River enters the basin's northwest corner contributing most of the water flowing through the lake. The Maumee River enters at the southwest corner, adding most of the silt load and nutrients to the lake. About 100 years ago the land of the Maumee watershed was drained and converted from swamp to agricultural land. In the years from 1948-1962, major changes were observed in the phytoplankton, benthic fauna, and fish communities. Chemical changes also noted include decreasing oxygen saturation near the bottom, increasing pH maxima, increasing carbon dioxide change rates per day, and increasing nitrate and phosphate levels. All these changes suggest an enrichment of western Lake Erie occurring rather sharply between 1949 and 1953. Records of nitrate and phosphate concentrations for the Maumee River show that it contributes significantly greater nutrient supplies to western Lake Erie than it did fifteen years ago. This can be attributed primarily to increased fertilization on farms in the river's watershed. (Ketelle-Wisc.)

Verduin, J. 1962. Energy flow through biotic systems of western Lake Erie. Amer. Assoc. Adv. Sci. Great Lakes Basin. Pub. 71. pp. 107-121.

Western Lake Erie has a high vertical turbulence which is created by the seiche-generated currents. A relatively high rate of photosynthesis, amounting to 500 millimoles of CO_2 fixed per square meter per day, is supported by a well-mixed water column in which the products of respiration from the dysphotic zone are transported to the eukphotic zone, and products of photosynthesis are moved to the dysphotic zone at a high rate. Several quantities related to energy flow have been established for western Lake Erie and are considered to have wide application to other aquatic habitats. Photosynthetic yields per microliter of phytoplankton have been revised upward, as a result of investigations under completely natural conditions, from 0.5 to 3 or more micromoles of CO_2 fixed per hour, by populations whose average densities are 3 to 6 microliters per liter of water. The diurnal photosynthetic CO_2 absorption in excess of community respiration is practically equal to nocturnal respiration, but a slight net CO_2 absorption from air is estimated at less than 13 millimoles per square meter per day.

Verduin, J. 1964a. Principles of primary productivity: photosynthesis under completely natural conditions. In: D. F. Jackson (Ed.), Algae and Man. Plenum Press, New York, N. Y. pp. 221-238.

A comparison of photosynthesis and respiration in two small Pennsylvania ponds revealed that the two processes were in approximate equilibrium. The photosynthetic rates in the ponds were found to be significantly lower than those observed in western Lake Erie. However, these higher rates were always associated with phytoplankton densities an order of magnitude lower than those in the ponds.

Verduin, J. 1964b. Changes in western Lake Erie during the period 1948-1962. Verh. Internat. Verein. Limnol. 15:639-644.

Verduin, J. 1969. Man's influence on Lake Erie. Ohio J. Sci. 69(2):65-70.

Conversion of northwestern Ohio's Great Black Swamp to farm land during the last half of the nineteenth century had a profound, by scantily documented influence on Lake Erie. Silts, once largely filtered out by the swampland vegetation, were, with the destruction of that vegetation, carried into Lake Erie, where their effect in reducing light penetration has significantly altered the lake's biota.

More recently a spectacular enhancement of plant nutrients, especially phosphorus, which has increased five-fold since 1948, has supported nuisance levels of plant growth. This plant growth creates severe oxygen depletion near the lake bottom and is therefore responsible for additional major and undesirable changes in species composition of plant and animal communities. The obvious solution to this problem is the removal of the plant nutrients from the waters before they enter Lake Erie. The "living filter" treatment, in which sewage-plant effluents are filtered through root zones of plant communities, seems most promising. (BU)

Verduin, J. 1970. Significance of phosphorus in water supplies. In: Wallrich and Smith (Eds.), Agricultural and Water Quality. Chapter 5, Part 2. pp. 63-71.

A report on the biological effects of plant nutrient pollutants, particularly phosphorus, in Lake Erie and other freshwater habitats.

Verrill, A. E. 1874. Synopsis of the North American freshwater leeches. U. S. Comm. Fish. Rep. 2:125-129.

Vila-Pinto, I. 1964. Studies of phytoplankton in western Lake Erie from the years 1961, 1962, 1963. M.Sc. thesis, The Ohio State Univ., Columbus, Ohio. 54 p.

Vollenweider, R. A. 1974. The production biology of the lower Laurentian Great Lakes - a preamble. J. Fish. Res. Bd. Can. 31(3):251-252.

An introduction to a series of articles which are a report on an initial study of the production biology of Lakes Erie and Ontario. Twenty-five stations were established in Lake Erie at which studies of the distribution of chlorophyll, phyto- and zooplankton, dry weight, and measurements on board ship of primary production were conducted. (SM)

Wagner, F. E. 1929. Chemical investigations of the Erie-Niagara watershed. In: A Biological Survey of the Erie-Niagara System. N. Y. Conserv. Dept., Albany, N. Y. Supplement 18th Annu. Rep. (1928). pp. 107-133.

A survey of the effects of water pollution on Lake Erie fish. The influences of tributary streams, municipalities and industries are discussed.

Walker, B. 1913. The Unione fauna of the Great Lakes. Nautilus. 27(2):18-23; (3):29-34; (4):40-47; (5):56-59.

A comparison of Atlantic fauna, Unione, with that of Lake Erie and the Detroit River. Fifteen genera and 39 species were attributed to Lake Erie. The relationship of distribution of Unione fauna to glacial movement is discussed in some detail. The present existence of so large a representation of the Mississippian fauna in Lake Erie is ascribed to a post-glacial invasion from the Mississippi Valley through the Maumee outlet into the post-glacial Lake Maumee. The original pre-glacial fauna of the present St. Lawrence system was absolutely exterminated during the glacial period. The peculiar fauna now characteristic of Lake Erie is the result of modification from environmental causes of the post-glacial immigrants from the south and not the result of any survival in that region of any part of the pre-glacial fauna. (SM)

Walker, B. 1917. The type of Pleurocera Rafinesque. Univ. Mich. Mus. Zool., Ann Arbor, Mich. Occasional Paper 38. 10 p.

A review of the problems arising from the classification of freshwater univalve mollusca by Rafinesque. The author believes that Pleurocera acuta was not from Lake Erie but from the Niagara River. (SM)

Walton, L. B. 1906. Naididae of Cedar Point, Ohio. Amer. Naturalist. Vol. XL. No. 478. October 1906:683-706.

Walton, L. B. 1915. A review of the described species of the order Euglenoidina Bloch. class Flagellata (Protozoa) with particular reference to those found in the city water supplies and in other localities of Ohio. Ohio Biol. Surv. Bull. 1(4):341-459.

Ward, H. B. 1916. Notes on two free-living larval trematodes from North America. J. Parasitol. 3(1):10-20.

A description is given of the structure and activity of two new cercariae of peculiar type captured free in Lake Erie and Lake St. Clair. They are designated Cercaria anchoroides nov. sp. and C. gorgonocephala nov. sp. A comparison is made between these species and known European species. (BU)

Warnick, S. L., and H. L. Bell. 1969. The acute toxicity of some heavy metals to different species of aquatic insects. J. Water Poll. Control Fed. Part 1, 41(2):279-284.

Warren, C. E. 1971. Biology and water pollution control. W. B. Saunders Co., Philadelphia. 434 p.

Watson, J. R. 1900. Preliminary list of filamentous algae of Cuyahoga County. Ohio Acad. Sci., 8th Annu. Rep. 1900:15.

A list of algae found in Cuyahoga County, Ohio. No collection sites or notes are included. (SM)

Watson, N. H. F. and G. F. Carpenter. 1974. Seasonal abundance of crustacean zooplankton and net plankton biomass of Lakes Huron, Erie and Ontario. J. Fish. Res. Bd. Can. 31(3):309-317.

Crustacean zooplankton concentrations (number/m^3) in the upper 50 meters of Lakes Ontario and Erie in 1970 and of Lake Huron in 1971 during all or most of the seasons, showed that the species of crustacean zooplankton present in the three lakes were generally identical, although the time of maxima and relative species composition differed. Biomass values were highest in Lake Erie, especially in the Western Basin. (SM)

Weber, C. I., (Ed.). 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. National Environ. Res. Center, Office of Res. and Dev., USEPA, Cincinnati, Ohio. EPA-670/4-73-001. Program Element 1 BA027. ca 150 p.

Webster, E. J. 1967. An autoradiographic study of invertebrate uptake of DDT-Cl^{36}. Ohio J. Sci. 67(5):300-307.

This research sought to locate autoradiographically DDT-Cl^{36} in tissues of leeches, amphipods, and copepods three months after their Sandusky Bay marsh habitat was treated with the amount of insecticide routinely used for mosquito control. Isotope DDT or its metabolite was found in cytoplasm of nerve cell bodies, gut mucosa, and vascular tissue of leeches. No isotope DDT was detected in the tissue of amphipods and copepods.

Weeks, O. B. 1944. A survey of the heterotrophic bacterial population in the sediments of western Lake Erie. Ph.D. diss., The Ohio State Univ., Columbus, Ohio. 63 p.

Bottom samples from the Bass Islands region of western Lake Erie were examined for their aerobic and anaerobic bacterial population and some of the environmental factors which were thought to influence these populations.

Wentz, W. A. and R. L. Stuckey. 1971. The changing distribution of the genus Najas (Najadaceae) in Ohio. Ohio J. Sci. 71(5):292-302.

Over the past 70 years, the distributions of the species in the genus Najas in Ohio have undergone changes. Najas gracillima and N. flexilis, native species of northern, cool, clear waters, have disappeared or become reduced in abundance, while N. marina and N. minor, European species, and N. guadalupensis, a southern native species, have invaded, spread, and/or have become more common in the state. Factors apparently responsible for these changes are (1) an increase in the numbers of artificial ponds and lakes, (2) an increase in the turbidity of Ohio waters, and (3) a gradual warming and overall general eutrophication of Ohio river and lake waters. Dated dot-distribution maps show the Ohio distribution of these species. Notes on the distribution of the species in nearby states are given. (BU)

Wickliff, E. L. 1920. Food of young small-mouth black bass in Lake Erie. Transactions, Amer. Fisheries Soc., Washington. p. 364-371.

Wickliff, E. L. 1931. Fishery research by the Ohio Division of Conservation. Trans. Amer. Fish. Soc. 61:199-207.

A summary of the major research projects in progress at the time of this article, at the Bureau of Scientific Research, State Division of Conservation, of the Department of Agriculture. (CCIW)

Wiebe, A. H. 1926. Variations in the freshwater snail, Goniobasis livescens. Ohio J. Sci. 26(2):49-68.

This study was undertaken to see if a correlation exists between the shape and size of the shells of the snail, Goniobasis livescens, and the degree of exposure to wave action. Collection sites included stations in the vicinity of Put-in-Bay and a station in the Olentangy and Scioto Rivers for comparative purposes. Tables are presented which show that the average obesity is directly proportional to the degree of wave action. (BU)

Wilhm, J. L. 1965. Species diversity of benthic macroinvertebrates in a stream receiving domestic and oil refinery effluents. Ph.D. diss., Oklahoma State Univ., Stillwater, Okla.

Wilhm, J. L. 1970. Range of diversity index in benthic macroinvertebrate populations. J. Water Poll. Control Fed. 42(5):R221-224.

Williams, S. R. 1921. Concerning "larval" colonies of Pectinatella. Ohio J. Sci. 21(4):123-127.

A discussion of the sexual reproduction of the Bryozoan, Pectinatella. (BU)

Williams, W. D. 1976. Freshwater isopods (Asellidae) of North America. USEPA, Cincinnati, Ohio. 45 p.

Wilson, C. B. 1929a. The macroplankton of Lake Erie. In: Charles J. Fish (Ed.), Preliminary Report on the Cooperative Survey of Lake Erie, Season of 1928. Bull. Buffalo Soc. Natural Sci., Buffalo, N. Y. 14(3):94-135.

This survey presents an excellent idea of the composition of the macroplankton of Eastern Lake Erie as well as of its horizontal distribution. Plankton species are of adequate size, present in sufficient numbers and contain a percentage of nutritive material high enough to make them capable of furnishing ample food to an exceptionally large number of small fish. Therefore, the decrease in the lake fisheries cannot be attributed to any kind of an inadequacy in their food supply.

Wilson, C. B. 1929b. The macroplankton of Lake Erie. In: Charles J. Fish (Ed.), A Preliminary Report on the Joint Survey of Lake Erie. A Biological Survey of the Erie-Niagara System. N. Y. Conserv. Dept., Albany, N. Y. Supplement. 18th Annu. Rep. (1928). pp. 67-76.

Survey presenting the type and amount of macroplankton in eastern Lake Erie; also their horizontal distribution with suggestions as to vertical and seasonal distribution.

Wilson, C. B. 1960. The macroplankton of Lake Erie. In: Charles J. Fish (Ed.), Limnological Survey of eastern and central Lake Erie, 1928-1929. U. S. Fish and Wildlife Service, Washington, D. C. Special Sci. Rep. Fish. 334. pp. 145-172.

The results of a survey conducted in Lake Erie, exclusive of that area west of the island region. Discussed are: components and amounts of plankton, species present, horizontal and seasonal distribution, littoral and lacustric zone macroplankton, and macroplankton as intermediate hosts.

Wolfert, D. R., V. C. Applegate and L. N. Allison. 1967. Infection of the walleye, *Stizostedion v. vitreum* of western Lake Erie with *Bothriocephalus cuspidatus* (Cooper). Papers Mich. Acad. Sci., Arts, and Letters. 52(1):105-114.

This paper describes the caecal and intestinal parasites of the walleye, *Stizostedion vitreum vitreum*. The study concerns the type and degree of intestinal parasitic infestations in a single year class of walleyes during their first 3 years of life, seasonal changes in the incidence and maturity of the dominant parasite, *Bothriocephalus cuspidatus*, and the effects of the infestations on the physical condition of the host.

Wolfert, D. R. and J. K. Hiltunen. 1968. Distribution and abundance of the Japanese snail, Viviparus japonicus, and associated macrobenthos in Sandusky Bay, Ohio. Ohio J. Sci. 68(1):32-40.

A survey of the macrobenthos of Sandusky Bay, Lake Erie, in June 1963, provided information on the abundance and distribution of the introduced Japanese snail, Viviparus japonicus, which has become a nuisance to commercial seine fishermen. Environmental characteristics were nearly uniform and had no apparent effect on the distribution; concentrations in different areas at different times appeared to result from water movements induced by winds. The frequency distributions of shell height and diameter suggested the presence of two age groups of adults in the population. Only three other gastropods were observed in the bay; the most abundant was another viviparid, Campeloma decisum. Other mollusks present were four species of Sphaeriidae and 18 species of Unionidae. A summary of invertebrates found, other than the mollusks, is also presented.

Wood, K. G. 1953. Distribution and ecology of certain bottom living invertebrates of the Western Basin of Lake Erie. Abst. Ph.D. diss., The Ohio State Univ., Columbus, Ohio. Stone Inst. Hydrobiol.

Wood, K. G. 1963. The bottom fauna of western Lake Erie, 1951-1952. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:258-265.

Western Lake Erie was found to contain a diverse and abundant bottom fauna. Sixty-two different organisms were found in 204 samples. The most abundant groups were: Unionidae, aquatic insects, sphaeriids, snails and leeches. The most abundant organisms were Lampsilis siliquoidea, and the now scarce Hexagenia spp. The most productive area in the lake seemed to be a sand habitat near Maumee Bay. Mollusca in general were more abundant in the western half of the Western Basin. The particle-size distribution of the substrate seemed less important than other environmental factors in determining the distribution of most species. (RL)

Wright, J. 1966. The coming water famine. Cowan-McCann, Inc., N. Y. 255 p.

This book reviews the uses of water in modern society and emphasizes the importance of it as a resource. Receding water levels in the Great Lakes are the subject of much concern with regard to water supply and shoreline changes. The importance of water conservation and pollution control are stressed. (BECPL)

Wright, S. 1955. Limnological survey of western Lake Erie. U. S. Fish and Wildlife Service Special Sci. Rep. Fish. 139.

Wright, S. and W. M. Tidd. 1933a. Summary of limnological investigations in western Lake Erie in 1929 and 1930. Trans. Amer. Fish. Soc. 63:271-285.

A report on the 1929-30 study of the pollution situation in western Lake Erie as indicated by chemical analyses, phytoplankton, zooplankton, and bottom fauna. It was held that the harm from the heavy pollution of certain limited areas was in some measure counterbalanced by fertilizing effects of pollutants and that pollution probably was not the controlling factor in the production of fish in western Lake Erie. (CCIW)

Wright, S. and W. M. Tidd. 1933b. Summary of limnological investigations in western Lake Erie in 1929 and 1930. Trans. Amer. Fish. Soc. 63:271-285.

Wright, S., L. H. Tiffany, and W. M. Tidd. 1955. Limnological survey of western Lake Erie. U. S. Dept. Interior, Fish & Wildlife Service Special Sci. Rep., Fish. No. 139. 341 p.

Wurtz, C. B. and J. S. Penny. 1969. Measuring the biological effects of heated discharges. Proc. Amer. Power Conf., La Salle Coll., Philadelphia. 31:344-349.

Thermal effects in an aquatic habitat represent but one of a multiplicity of environmental factors. Biological studies directed toward the effect of a heated discharge must include satisfactory measurements of the biological structure of the habitat in relation to all major environmental factors. Any of several sampling and data-processing methods can be used to secure adequate information. The particular method employed should be the one where maximum information is secured at minimum cost, which is to say, by the least time-consuming method. In the authors' opinion, the most satisfactory approach to biological studies under most conditions is a study based on the total number of macroinvertebrate species forming the resident community. The collected data should be processed by standard statistical methods and the results expressed in terms of these statistics. Such terms are meaningful descriptive terms and can be used for direct comparison with results from other surveys. (Mortland-Battelle)

Zenkert, C. A. 1934. The flora of the Niagara Frontier region. Bull. Buffalo Soc. Natural Sci., Buffalo, N. Y. 16:1-328.

A monograph tracing the history of botanical explorations in the Niagara Frontier region from 1750 to 1934. The area studied is within a fifty-mile radius of Buffalo, N. Y. Climatic conditions influencing the flora of the region and aquatic vegetation along the Lake Erie shore are described. Included is a systematic account of the species found. (SM)

Zillig, A. M. 1929a. Bacterial studies of Lake Erie. In: Charles J. Fish (Ed.), A Preliminary Report on the Joint Survey of Lake Erie. A Biological Survey of the Erie-Niagara System. N.Y. Conserv. Dept., Albany, N. Y. Supplement 18th Annu. Rep. (1928). pp. 56-58.

This report presents the sanitary condition of eastern Lake Erie during July and August 1928, including methods and results obtained with interpretations.

Zillig, A. M. 1929b. Bacteriological studies of Lake Erie. In: Charles J. Fish (Ed.), Preliminary Report on the Cooperative Survey of Lake Erie, Season of 1928. Bull. Buffalo Soc. Natural Sci., Buffalo, N. Y. 14(3):51-59.

This report presents the sanitary condition of Eastern Lake Erie during July and August 1928, including both methods and results obtained with interpretations.

APPENDIX

ABBREVIATIONS

Acad.	Academy
Admin.	Administration
Adv.	Advancement
Agric.	Agriculture
Amer.	American
Annu.	Annual
ASChE	American Society of Chemical Engineers
ASCE	American Society of Civil Engineers
ASME	American Society of Mechnical Engineers
Assoc.	Association
Bd.	Board
BECPL	Buffalo and Erie County Public Library
Biol.	Biology, Biological
BL	Bell Library - SUNY at Buffalo
Bot.	Botany, Botanist
BU	Butler Library - SUNY at Buffalo
Bull.	Bulletin
Bur.	Bureau
CA	California
Calif.	California
Can.	Canada, Canadian
CCIW	Canada Centre for Inland Waters Library
CE	Corps of Engineers - Buffalo District Library
Chem.	Chemistry, Chemical
Circ.	Circular
Co.	Company
Comm.	Commission
Conf.	Conference

Conn.	Connecticut
Conserv.	Conservation
Contrib.	Contribution
CT	Connecticut
Cult.	Cultural, Culturist
Dept.	Department
Dev.	Development
Diss.	Dissertation
Div.	Division
ECHO	Environmental Clearing House Organization
Ecol.	Ecology, Ecological
Ed.	Editor, Edition
Eng.	Engineering
Environ.	Environment, Environmental
EPA	Environmental Protection Agency
Exp.	Experiment, Experimental
Fish.	Fishery
FWPCA	Federal Water Pollution Control Administration
Gaz.	Gazette
Geogr.	Geographic, Geographical, Geography
Geol.	Geologic, Geological, Geology
Geophys.	Geophysical
GLL	Great Lakes Laboratory
Gov't.	Government
IL	Illinois
Ill.	Illinois
Inc.	Incorporated
Info.	Information
Inst.	Institute
Internat.	International
Invest.	Investigation
J.	Journal
Lab.	Labaoratory
LO	Lockwood Library - SUNY at Buffalo

MA	Massachusetts
M.A.	Master of Arts
Mag.	Magazine
Manage.	Management
Mar.	Marine
Mass.	Massachusetts
Memo.	Memorandum
Meteor.	Meteorological, Meteorology
MI	Michigan
Mich.	Michigan
Micros.	Microscopical
Mid.	Midland
Minn.	Minnesota
MN	Minnesota
Mon.	Monthly
Monit.	Monitoring
Mono.	Monographs
M.S.	Master of Science
M.Sc.	Master of Science
Mus.	Museum
Nat.	Natural, Naturalist
NOAA	National Oceanic and Atmospheric Administration
NY	New York
OK	Oklahoma
Okla.	Oklahoma
Ont.	Ontario
p.	Page, Pages (inclusion), Pages (total in report)
PA	Pennsylvania
Pt.	Part
Penn.	Pennsylvania
Pestic.	Pesticides
Petrol.	Petrology
Phil.	Philosophical
Pop.	Popular
Proc.	Proceedings

Prog.	Progress, Progressive
Publ.	Publication, Publisher, Publishing
Rec.	Record
Rep.	Report
Res.	Research
Rev.	Review
RL	Ridge Lea Library - SUNY at Buffalo
Sci.	Science, Scientific
SE	Science and Engineering Library - SUNY at Buffalo
Sec.	Section
Sed.	Sedimentary
Ser.	Series
SL	Sears Library - Case Western Reserve University
SM	Buffalo Museum Science Research Library
Soc.	Society
Spec.	Special
SUNY	State University of New York
Suppl.	Supplement
Surv.	Survey
Tech.	Technical
Trans.	Transactions
Univ.	University
U.S.	United States
Vol.	Volume
WA	Washington
Wash.	Washington
Weat.	Weather
WI	Wisconsin
Wisc.	Wisconsin
Zool.	Zoology

NOTE: Ohio Naturalist - See: Beginning volumes of Ohio Journal of Science