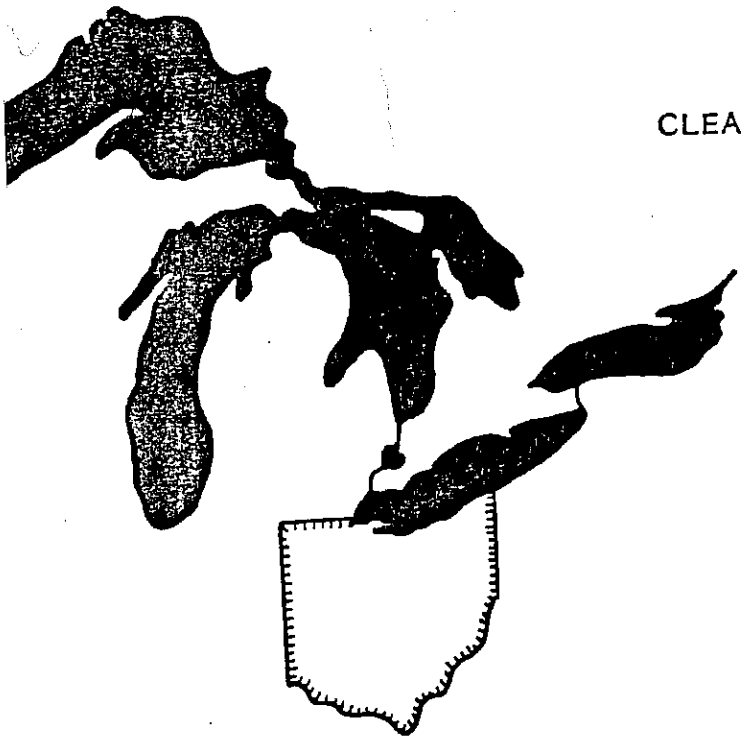

CLEAR TECHNICAL REPORT NO. 266

PHOSPHORUS IN LAKE ERIE

Charles E. Herdendorf, Ph.D.
Professor of Geology and Zoology
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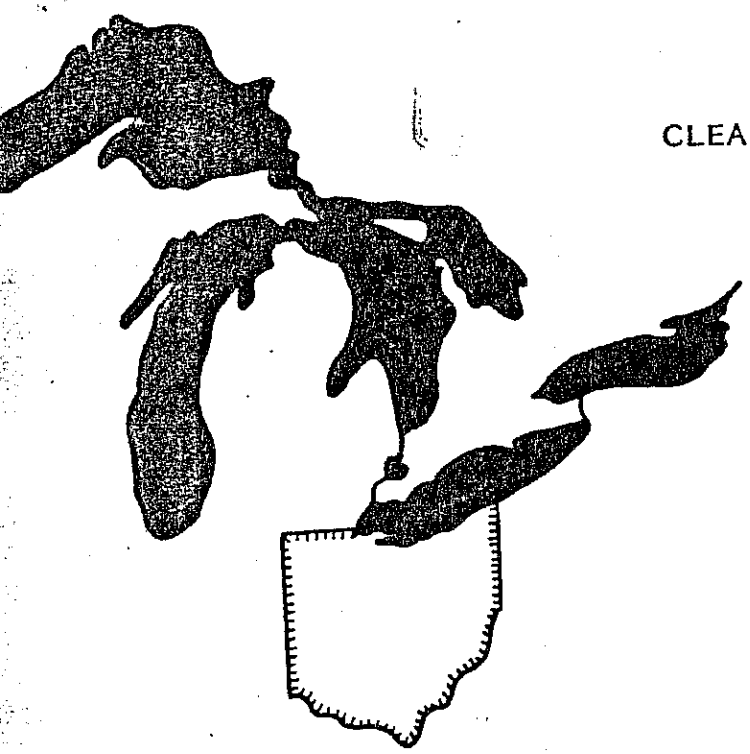

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1982

STATEMENT TO THE OHIO HOUSE OF REPRESENTATIVES
ENERGY AND ENVIRONMENT COMMITTEE: H.B. 649
(PHOSPHATE BAN FOR LAUNDRY DETERGENTS)

Statement by:

Charles E. Herdendorf, Ph.D.
Professor of Geology and Zoology
Director, Center for Lake Erie Area Research
The Ohio State University

October 14, 1981

PHOSPHORUS IN LAKE ERIE

Numerous investigations by the Great Lakes scientific community have indicated that Lake Erie is enriched with nutrients, such as phosphorus, and is undergoing rapid eutrophication. Changes in the lake's biota can be used as indices of eutrophication, especially increases in abundances and changes in the composition of plankton. Phosphorus has been shown to be a major nutrient controlling phytoplankton growth in the Great Lakes (Schelske, et al. 1972).

The International Joint Commission (1980) has documented the major environmental changes in Lake Erie. Changes in plankton populations have been observed in Lake Erie; data from the Cleveland water intake show long term increases in plankton abundance (Davis 1964). In the open lake, a trend can be seen which has shifted the diatom populations toward the dominance of species favored by nutrient rich conditions. In Lake Erie a major increase has occurred in the abundance of blue-green algae, a group commonly associated with eutrophic conditions. Extensive growths of the attached green alga, Cladophora, have been a problem in Lake Erie for several decades. In recent years the red alga, Bangia, has appeared in Lake Erie and has become abundant along the shoreline.

At the present time Canada limits the phosphate content of laundry detergent to 2.2 percent as phosphorus measured by weight. In the United States, all of the Great Lakes states except Ohio and Pennsylvania have legislative controls limiting the phosphorus content of laundry detergents to 0.5 percent. The existing controls are generally less restrictive or exempt formulations for automatic dishwashers and certain commercial and industrial uses. In those jurisdictions not covered by legislative controls, the soap and detergent industry has reduced the phosphorus content of household laundry detergent from about 11 percent to 5.5 percent thus providing some reduction in detergent related phosphorus discharges in those areas (IJC, 1980).

Municipal phosphorus discharges in the Lake Erie basin from Ohio in 1978 are estimated to have been 2,441 metric tons (IJC, 1979). In Ohio, where no controls have been established, the International Joint Commission (1980) estimates that detergent phosphorus accounts for 20 to 35 percent of the phosphorus in the municipal discharges or 490 to 850 tons/yr for Ohio.

In July 1980, the Phosphorus Management Strategies Task Force of the International Joint Commission stated that "detergent phosphorus controls have helped reduce the rate of eutrophication of the Great Lakes" and the Task Force pointed out that "extension of controls to uncontrolled areas should have a positive effect on the Great Lakes while municipal wastewater treatment facilities are being brought into compliance with phosphorus reduction requirements." Recommendation No. 4 of the Task Force specifically states that "existing laws and regulations to control the phosphorus content of detergents in the Great Lakes basin be retained and that controls be extended immediately to Ohio." Controls in Ohio at the 2.2 or 0.5 percent as phosphorus have the

attained, the basin-wide mean total phosphorus concentrations in the (1) Western Basin of Lake Erie in the spring should not exceed 15 µg/l to reduce the present levels of algal growth and to prevent nuisance growths of aquatic weeds and algae in this basin, (2) Central Basin of Lake Erie in the spring should not exceed 10 µg/l to restore year-round aerobic conditions in the bottom waters of this basin, and (3) Eastern Basin of Lake Erie in the spring should not exceed 10 µg/l to reduce the present levels of algal growth and to prevent nuisance growths of aquatic weeds and algae in this basin.

Investigations of total phosphorus by the Canada Centre for Inland Water (Burnes, 1976) and The Ohio State University (Herdendorf, 1980) in the spring for the years 1970 to 1979 show that Lake Erie has been relatively stable during this period (Figures 2 and 3) with the following mean concentrations:

Western Basin:	51.1 ± 17.3 µg/l
Central Basin:	18.3 ± 4.2 µg/l
Eastern Basin:	17.7 ± 6.4 µg/l

These data indicate that the Western Basin concentration is approximately three times greater than the recommended level and that the Central and Eastern Basins are about 80 percent above the recommended concentration (Figure 4).

Phosphorus load to Lake Erie is difficult to measure and various agencies have derived diverse estimates. Based on 1976 data, the Lake Erie Wastewater Management Study of the U.S. Army Corps of Engineers, yielded the highest at about 19,500 tons/yr., while the IJC Water Quality Board estimate is lowest at about 15,500 tons/yr. The PLUARG estimate of 17,450 tons/yr. is about midway between the Water Quality Board and Corps of Engineers estimates. The main difference between the PLUARG and Corps of Engineers loads is the higher

estimate of the U.S. direct municipal load used by the Task Group. The major difference between the PLUARG and Water Quality Board loads is a lower tributary estimate used by the Water Quality Board. Based on a complete review of the available information, the Phosphorus Management Strategies Task Force (IJC, 1980) has made a "best estimate" of the 1976 phosphorus loads for Lake Erie at 18,425 metric tons (Table 1). Estimates of phosphorus loads to Lake Erie for 1972 to 1977, based on Water Quality Board calculation techniques, are listed below:

Year	Municipal Load tons/yr	Total Load tons/yr
1972	11,016	17,410
1973	10,493	16,670
1974	6,977	19,155
1975	6,829	16,907
1976	5,731	15,416
1977	5,681	14,560

It can be seen from these data that some improvement in the phosphorus load to Lake Erie has occurred in the past decade, particularly in the municipal load. To attain the IJC target load of 11,000 tons/yr., a further decrease of approximately 3,500 tons/yr. is required. If detergent controls were instituted in Ohio at the 0.5 percent level, the load to Lake Erie could be reduced by 730 tons/yr. or 21 percent of the total decrease needed to attain the target load.

More recent data on total phosphorus loads to Lake Erie provided by the IJC and the Center for Lake Erie Area Research at OSU show that in 1979 the total load was reduced to 13,800 metric tons. If it is assumed that 35-40% of this is direct municipal load (4,830 to 5,520 metric tons) a reduction of detergent phosphorus from 5.5 percent to 2.2 percent will provide a significant reduction

in the load to Lake Erie. From Ohio alone, approximately 2400 metric tons of phosphorus enters Lake Erie from municipal sources of which 20 to 35 percent is from detergents (480 to 850 metric tons). The proposed reduction to the 2.2 percent level would result in an estimated reduction of 40 percent or 190 to 340 metric tons. Based on the present load to Lake Erie of 13,800 metric tons and the target load of 11,000 metric tons, only 2,800 metric tons need to be eliminated to attain good oxygen conditions in central Lake Erie. The proposed action would provide for a reduction of up to 340 metric tons of phosphorus to Lake Erie or approximately 12 percent of the total decrease needed to attain the target load.

TABLE 1

PHOSPHORUS LOADS TO THE GREAT LAKES

TOTAL PHOSPHORUS OBJECTIVES WITH ESTIMATED LEVELS OF CHLOROPHYLL a, SECCHI DEPTH, AND TROPHIC STATE[3]

Lake Basin	Total Phosphorus (µg/L)	Chloro-phyll a (µg/L)	Secchi Depth (m)	Trophic State
Superior	5	1.3	8.0	Oligotrophic
Michigan	7	1.8	6.7	Oligotrophic
Huron	5	1.3	8.0	Oligotrophic
Saginaw Bay	15	3.6	3.9	Mesotrophic
Western Erie	15	3.6	3.9	Mesotrophic
Central Erie	10	2.6	5.3	Oligomesotrophic
Eastern Erie	10	2.6	5.3	Oligomesotrophic
Ontario	10	2.6	5.3	Oligomesotrophic

"BEST ESTIMATE" OF 1976 TOTAL PHOSPHORUS LOADS
(metric tons per year)

Lake	Direct Municipal	Direct Industrial	Tributary* Total	Atmosphere	Urban Direct	Upstream Load	Total
SUPERIOR	72	103	2,455	1,566	16	-	4,212
MICHIGAN	1,041	38	3,596	1,682	-	-	6,357
HURON	126	38	2,901	1,129	16	657	4,867
ERIE	6,292	275	9,960	774	44	1,080	18,425
ONTARIO	2,093	82	4,047	488	324	4,769	11,803

*consists of indirect point sources and nonpoint sources in tributary basin

SHORELINE EROSION AS A SOURCE OF LAKE-WIDE TOTAL PHOSPHORUS

Lake	Shoreline Erosion (total sediment) (t/yr)	Total Phosphorus Shoreline[2] Erosion (t/yr)	1976 Total Phosphorus All Other Sources (t/yr)
Superior	11,279,000	3,800 [1]	4,212
Michigan	21,778,000	3,700	6,357
Huron	1,763,000	794	4,867
Erie	11,131,000	10,536 [3]	18,425
Ontario	3,206,000	1,280	11,803

Notes:
1. U.S. load only
2. PLUARG reports on U.S. and Canadian shoreline erosion.[3]
3. Canadian estimate for short term used (1972-1973) @ 9512 t/yr - Canadian long term estimates (1953-1973) @ 5912 t/yr.

DATA SOURCE: International Joint Commission, Phosphorus Management Strategies Task Force (1980).

FIGURE 1. GENERAL RELATIONSHIPS BETWEEN PHOSPHORUS FORMS AND ALGAE

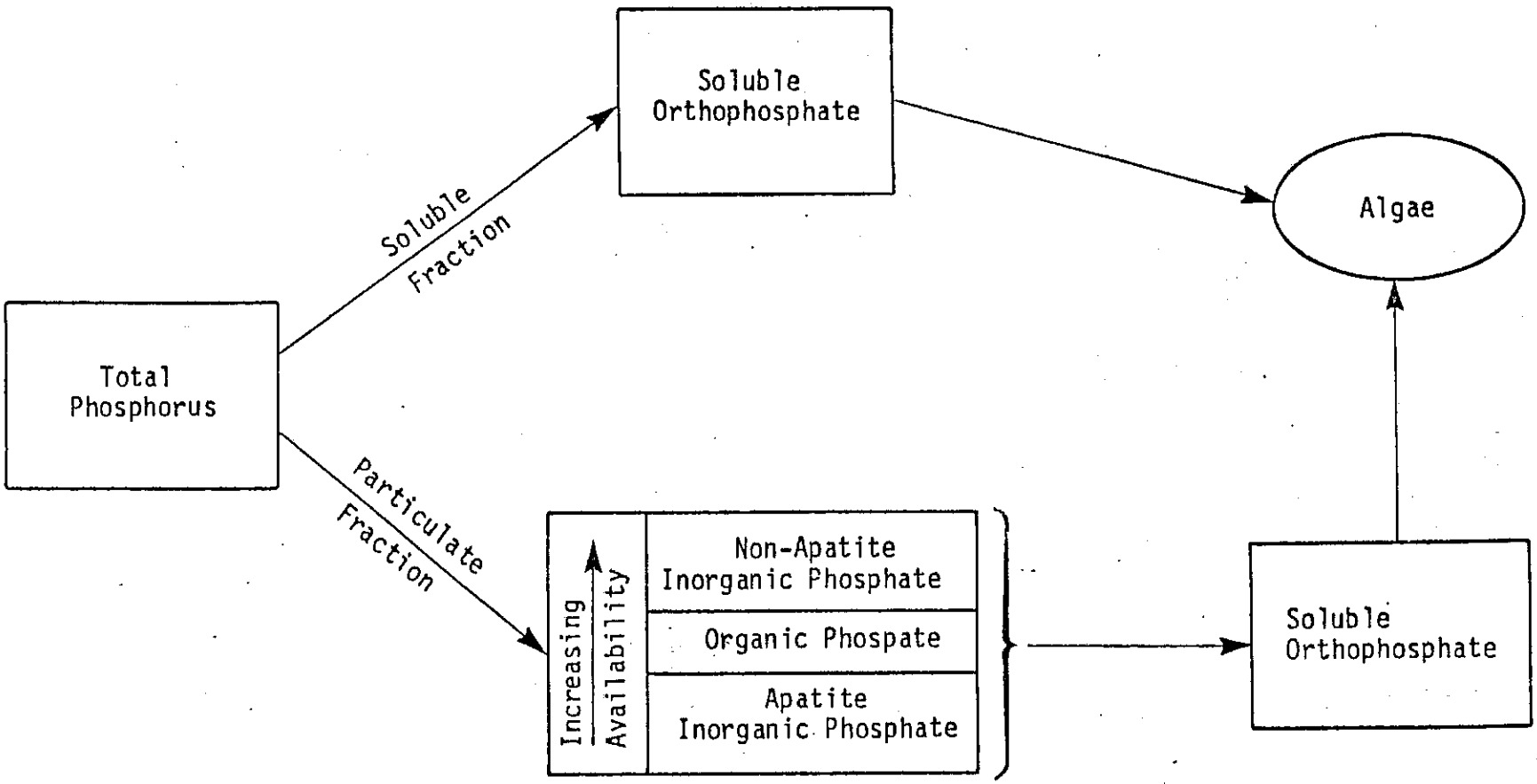


FIGURE 2. TOTAL PHOSPHORUS CONCENTRATIONS IN LAKE ERIE 1970 - 1976

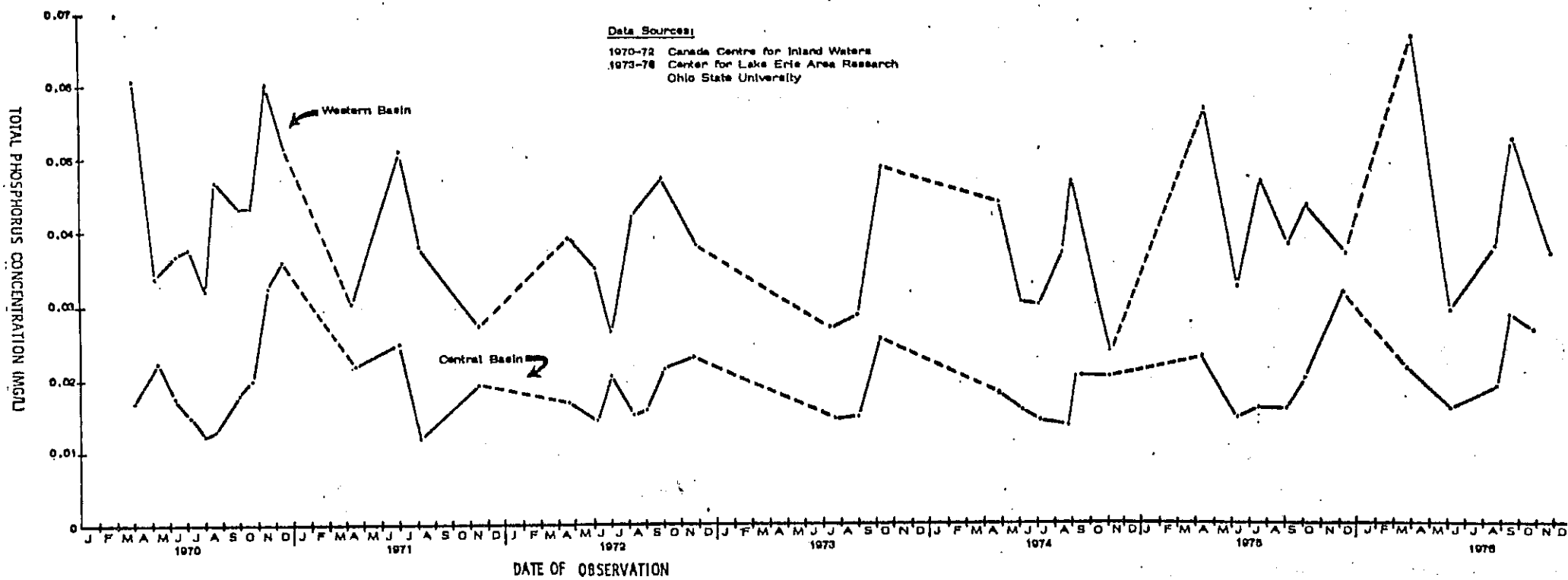


FIGURE 3. QUANTITY OF PHOSPHORUS IN LAKE ERIE 1970 - 1976

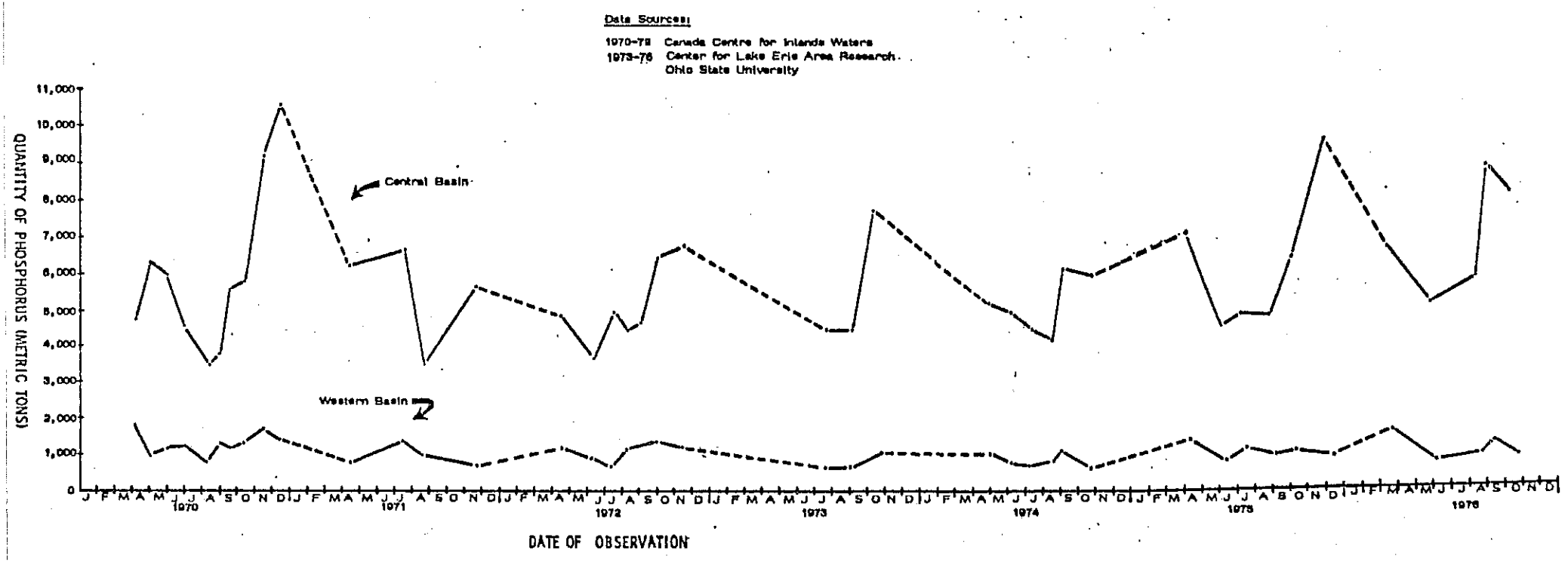
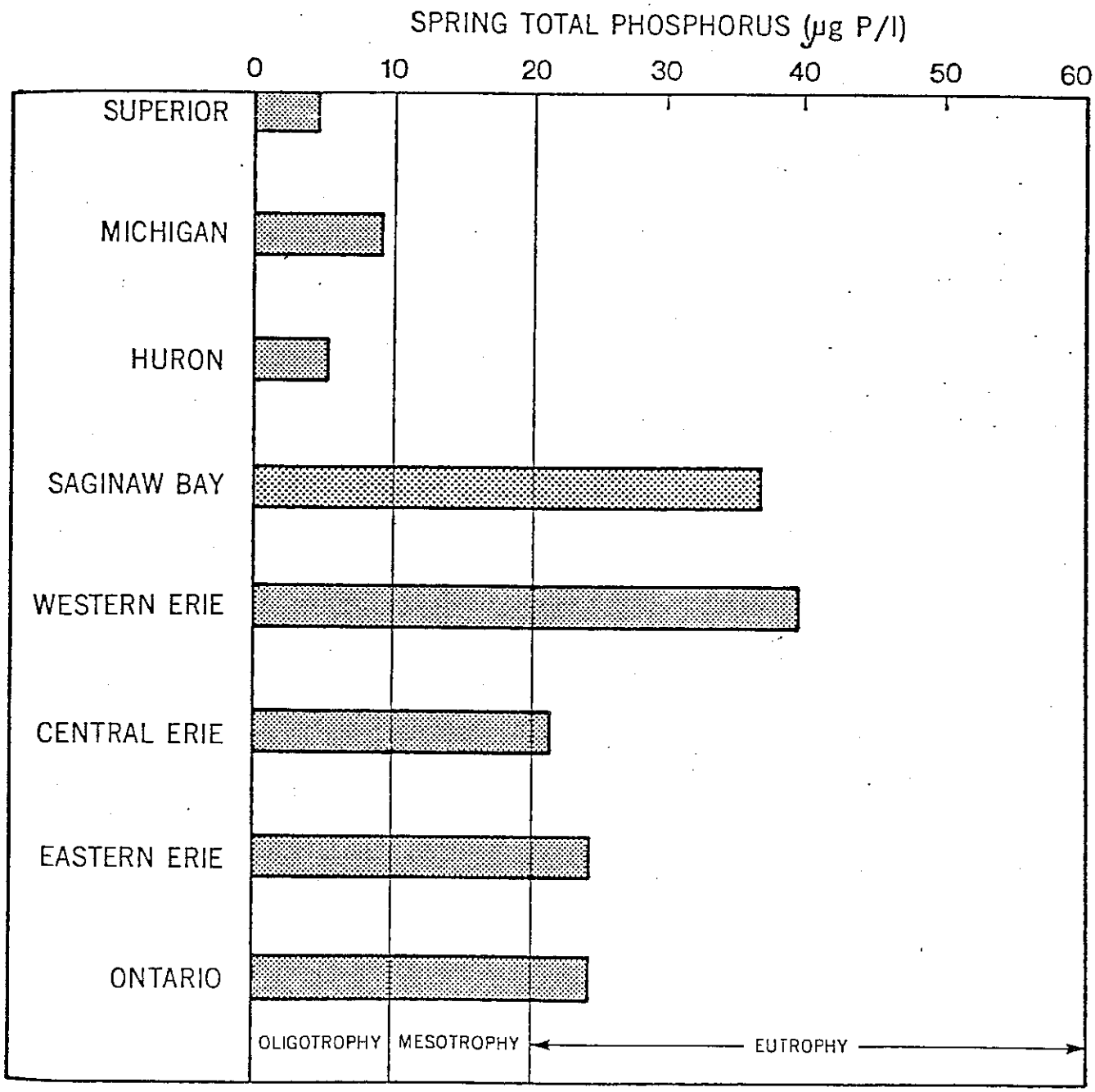


Figure 4. CURRENT TROPHIC STATUS OF THE GREAT LAKES



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