NOAA Data Report ERL GLERL-3

LAKE HURON CHEMICAL AND PHYSICAL CHARACTERISTICS DATA FOR 1966

Gerald L. Bell

Great Lakes Environmental Research Laboratory
Ann Arbor, Michigan
January 1980

Data available on microfiche
Contact: pubs.glerl@noaa.gov

UNITED STATES
DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
Richard A. Frank, Administrator

Environmental Research
Laboratories
Wilmot N. Hess, Director

NOTICE

The NOAA Environmental Research Laboratories do not approve, recommend, or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to the NOAA Environmental Research Laboratories, or to this publication furnished by the NOAA Environmental Research Laboratories, in any advertising or sales promotion which would indicate or imply that the NOAA Environmental Research Laboratories approve, recommend, or endorse any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NOAA Environmental Research Laboratories publication.

CONTENTS

	Page
Abstract	1
1. INTRODUCTION	1
2. METHODS	1
2.1 Sampling Program	1
2.2 Chemical Analyses	6
3. PRECISION LIMITS	7
4. DATA PRESENTATION	9
5. ACKNOWLEDGMENTS	9
6. REFERENCES	9
Appendix A. LIMNOLOGICAL DATA	11
Appendix B. WIND, WAVE, AND SEDIMENT DATA	Microfiche
Appendix C. STATISTICAL SUMMARY	Inside Back Cover

FIGURE

		Page
1.	Station locations in Lake Huron during 1966.	2

TABLES

1.	Station locations in Lake Erie during 1965 (by latitude and longitude).	3
2.	Cruise schedule.	4
3.	Shipboard and laboratory measurements in connection with limnological studies.	5
4.	Measurement precision.	8

LAKE HURON CHEMICAL AND PHYSICAL CHARACTERISTICS DATA FOR 1966*

Gerald L. Bell

Water samples at standard depths, bottom sediment, and meteorological data were collected in Lake Huron at established stations in the course of eight cruises during the 1966 open-water season. The sampling program and analytical methods are described. Chemical characteristics of the water and bottom sediment are listed by cruise for each station and sampling depth. Wind and wave data are listed by cruise for each station. The statistical summaries showing lake-wide means, standard deviations, and sample sizes of selected variables are presented by depth for each cruise period.

1. INTRODUCTION

This basic data report presents data collected aboard the Research Vessel *Shenehon* by the Water Characteristics Branch of the Great Lakes Research Center, U.S. Army Corps of Engineers, Lake Survey District, between 24 May and 10 November 1966.

Data was collected systematically so that the vertical and lateral distribution of the chemical and physical characteristics of water in Lake Huron, as well as their variations with respect to time, were measured and examined. The sampling program was designed to provide the basic data that, together with other available data, are necessary for defining relationships of significant water characteristics, determining the rate and extent of mixing of introduced contaminants, forecasting water quality, estimating the nature and magnitude of past events, and developing simulation models for use in management and development of the lake (Great Lakes Research Center, 1969).

Interpretations of the data are not within the scope of this report and will be presented in subsequent publications. Meteorological conditions, as well as profiles of water temperature and transparency recorded at each station, are not included in this report. One presentation has been based on these data (Pinsak, 1970).

2. METHODS

2.1 Sampling Program

Water characteristics, bottom sediment and meteorological data were collected at 77 established stations (Figure 1, Table 1). Station 77 was occupied only once, while the other stations were each occupied six times. Eight cruises were made during the survey season (Table 2).

---

*GLERL Contribution No. 177.

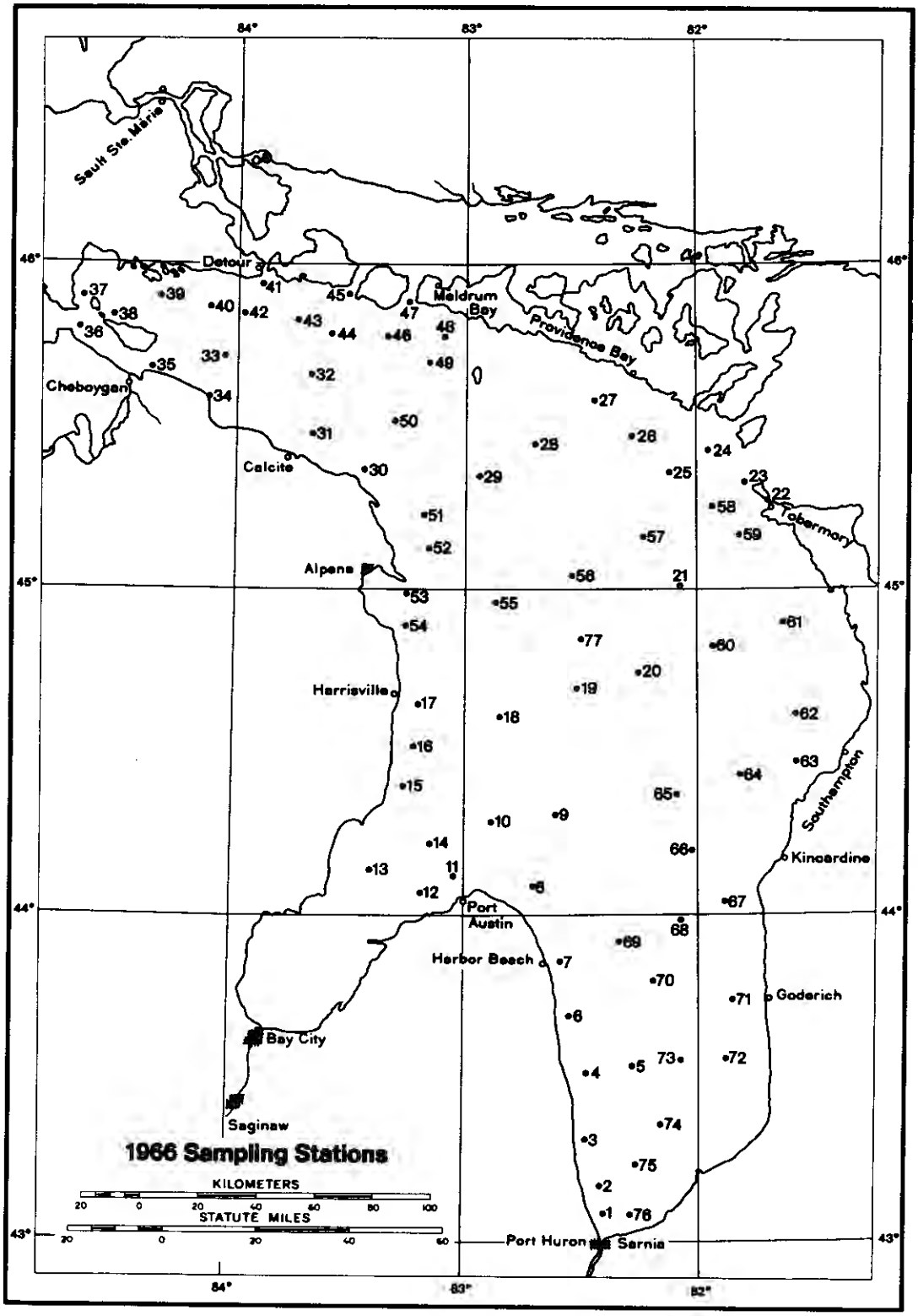

Figure 1. Station locations in Lake Huron during 1966.

Table 1. Station Locations in Lake Huron During 1966 (by Latitude and Longitude)

Station	Latitude	Longitude	Station	Latitude	Longitude
1	43.09°	82.41°	39	45.84°	84.33°
2	43.17°	82.42°	40	45.87°	84.12°
3	43.31°	82.48°	41	45.94°	83.89°
4	43.52°	82.48°	42	45.85°	83.97°
5	43.54°	82.28°	43	45.83°	83.74°
6	43.69°	82.55°	44	45.79°	83.60°
7	43.86°	82.56°	45	45.91°	83.52°
8	44.09°	82.70°	46	45.78°	83.34°
9	44.31°	82.61°	47	45.89°	83.25°
10	44.29°	82.88°	48	45.78°	83.09°
11	44.12°	83.04°	49	45.70°	83.15°
12	44.07°	83.18°	50	45.52°	83.31°
13	44.14°	83.40°	51	45.23°	83.18°
14	44.22°	83.14°	52	45.13°	83.16°
15	44.40°	83.26°	53	44.99°	83.25°
16	44.52°	83.21°	54	44.89°	83.25°
17	44.65°	83.20°	55	44.96°	82.87°
18	44.61°	82.85°	56	45.04°	82.54°
19	44.70°	82.52°	57	45.16°	82.23°
20	44.76°	82.21°	58	45.26°	81.93°
21	45.00°	82.03°	59	45.17°	81.81°
22	45.28°	81.68°	60	44.83°	81.93°
23	45.33°	81.78°	61	44.90°	81.93°
24	45.43	81.95°	62	44.62°	81.57°
25	45.36°	82.12°	63	44.47°	81.57°
26	45.47°	82.28°	64	44.43°	81.81°
27	45.58°	82.44°	65	44.37°	82.09°
28	45.45°	82.70°	66	44.20°	82.02°
29	45.35°	82.94°	67	44.04°	81.87°
30	45.37°	83.44°	68	43.98°	82.07°
31	45.48°	83.67°	69	43.92°	82.33°
32	45.66°	83.68°	70	43.80°	82.18°
33	45.72°	84.05°	71	43.74°	81.85°
34	45.59°	84.12°	72	43.56°	81.88°
35	45.68°	84.36°	73	43.56°	82.07°
36	45.80°	84.67°	74	43.36°	82.16°
37	45.90°	84.66°	75	43.24°	82.28°
38	45.84°	84.53°	76	43.09°	82.29°
			77	44.85°	82.50°

Table 2. Cruise Schedule

Cruise	Date
1	24 May-16 June
2	20 June-6 July
3	11 July-26 July
4	2 Aug.-17 Aug.
5	22 Aug.-9 Sept.
6	13 Sept.-18 Oct.
7	19 Oct.-4 Nov.
8	8 Nov.-10 Nov.

A cruise is defined as the time period starting when the R/V *Shenehon* left port in the Black River at Port Huron, Mich., and ending upon return to the same port. A full cruise normally required 15-17 days. The shipboard and laboratory determinations made during each cruise are summarized in Table 3.

The ship was navigated and stations were established by using a gyro compass, radar, a sextant, and visual fixes. Polystyrene floats were used to mark the deep-water stations and to facilitate the return to the same location. Water sample depths in feet were determined by a meter wheel and converted to the nearest meter. The water depth to the bottom was determined by a Raytheon Precision Survey Fathometer, Model DE-723B, with a range of 0 to 250 in feet or fathoms and the depth presented as a graphic record on a calibrated paper chart.

Water samples were collected in Fjarlie bottles at multiple levels at each station. The samples from stations located in shallow water (30 m or less) were taken at the surface, mid-depth, and near bottom. Samples at stations located in deep water were taken at the surface and spaced at 10, 20-, 25-, or 50-m intervals, with the deepest sample usually 3- to 5-m above bottom, depending upon the depth of the water. Bottom sediment samples were taken with an orange-peel dredge.

Water temperatures were recorded at sampling depth to the nearest hundredth degree Celsius by protected reversing thermometers (±0.02° accuracy) attached to each Fjarlie bottle. The temperature of the water circulating through the sea chest, approximately 1.5 m below the surface, was recorded to the nearest tenth degree Celsius and printed with the meteorological data at 6-min intervals. Temperature profiles were recorded at each station to a maximum depth of 80 m with a Marine Advisors, Inc., Electronic Bathythermograph, Model 0-5a. The bathythermograph profiles were corrected by adding or subtracting the average

Table 3. Shipboard and Laboratory Measurements in Connection with Limnological Studies

Shipboard Measurements

Meteorological data (Printout each 6 min)

- Wind speed (m/sec) (10 m above water)
- Wind direction (10 m above water)
- Barometric pressure (millibars) (3 m above water)
- Air temperature (°C) (10 m above water)
- Water temperature (1.5 m below water surface)
- Solar radiation (incident) (gram-calories per sq. cm; 10 m above water)
- Relative humidity (3 m above water)

On station

Water
- Water temperature (°C)
  - Reversing thermometers at sample depth
  - Electronic bathythermograph
  - Infrared thermometer for surface temperature
- Transparency (relative to 100% in air)
- pH
- Eh (volts)
- Total and phenolphthalein alkalinity (mg/l $CaCO_3$)
- Chloride (mg/l)
- Specific conductance (micromhos at 25°C)
- Dissolved oxygen (mg/l and pct. sat.)

Waves
- Height (m)
- Period (sec)
- Direction (nearest 10°)

Bottom Sediment
- Description (physical)
- pH
- Eh

Chemistry Laboratory

Dissolved ions (Beckman DU2 Spectrophotometer)

- Nitrate (Brucine method, A.P.H.A.*, 1965)
- Phosphate (Ammonium molybdate method, U.S.G.S.**, 1965)
- Sulfate (Turbidimetric method, A.P.H.A.*, 1965)
- Silica (Molybdate blue method U.S.G.S.**, 1960)
- Magnesium (Eriochrome black T method, U.S.G.S.**, 1960)
- Calcium (Flame photo tech, A.P.H.A.*, 1965)
- Sodium (Flame photo tech, A.P.H.A.*, 1965)
- Potassium (Flame photo tech, A.P.H.A., 1965)

*American Public Health Association.
**U.S. Geological Survey.

difference between the reversing thermometer and bathythermograph temperature.

Transparency profiles were made to a maximum depth of 80 m with a G. M. Mfg. and Instrument Corp Deep-Water Turbidity Meter, Model 17-M-11, modified by the U.S. Lake Survey. Color filters were not used. Transparency was determined by relating light transmission along a 1-m path through the water to the transmission along the same path through air, expressed as a percent.

Meteorological observations were recorded automatically at 0.1 hour intervals by a digital system employing solid state data gathering modules. Wind and wave observations were made while on station. The wave direction was not reported at all stations and in such cases the wind direction was used. Wave height observations were made with a damped staff-type gage or by estimating and periodically checking with the gage. The period is based on an average time of 10 successive waves.

2.2 Chemical Analyses

The methods used in the water analyses are those described in Standard Methods (American Public Health Association, 1965), Rainwater and Thatcher (1960) and Fishman and Skougstad (1965).

Water samples were analyzed immediately in the R/V *Shenehon* laboratory for dissolved oxygen, specific conductance, chloride, phenolphthalein and total alkalinity, pH, Eh (oxidation-reduction potential), and the pH and Eh of the interstitial water of the bottom sediment.

Dissolved oxygen values were determined with a Beckman Dissolved Oxygen Analyzer, Model 777. After two separate tests were made on each sample, the highest partial pressure and the lowest sample temperature readings were used for calculating the dissolved oxygen. *In situ* temperature was recorded by the reversing thermometer at the sampling depth.

Specific conductance was measured with an Industrial Instruments Conductivity Bridge, Model RC-16B2J. Two separate tests were made on each sample and the average expressed in micromhos at 25°C.

Chloride concentrations were determined by the argentometric method and titration of a 50-ml sample of lake water. The silver nitrate was standardized and the reagent blank value determined at the beginning of each day.

Phenolphthalein and total alkalinity values were determined by titrating 100-ml water samples with standard acid (H_2SO_4) to the end-points of pH 8.2 and 4.5, respectively. The end-points were determined with the pH meter and the results expressed in mg/l of calcium carbonate.

Measurements of pH and Eh were made with a Beckman Zeromatic pH Meter, a glass pH electrode, calomel fiber junction reference electrode, and a platinum Eh electrode. As a means of avoiding contamination, the electrodes were rinsed in a sample of the lake water to be tested. Between tests the electrodes were immersed in distilled water. Tests of the interstitial water of the bottom sediment were made by inserting the electrodes into the soft sample.

Unpreserved water samples in 500-ml plastic bottles were stored in a dark area below deck and transferred at the end of each cruise to the Great Lakes Research Center laboratory in Detroit for additional testing. A Beckman DU-2 Spectrophotometer with flame attachment was used to analyze samples. Standard curves were constructed for each test and cruise. Sample concentrations were determined by computer application of the absorbancy values to a standard curve adjusted by paired test standards run after each set of 10 to 20 samples to compensate for any change or drift in the spectrophotometer response. Single test standards were run for nitrate nitrogen during the first five cruises, and for phosphate during the first four cruises.

3. PRECISION LIMITS

The degrees of precision of the various tests are summarized in Table 4. The estimated precision of the dissolved oxygen determination is based on the assumption that the partial pressure is accurate to 1 mm of mercury. The average difference in the two partial pressure readings for each sample was less than 1 mm of mercury. For specific conductance, the estimated precision is based on the assumption that the average difference in the two conductance readings for each sample is less than 1 micromho. For both chloride and alkalinity, the estimated precision is based on the value of one drop (0.05 ml) of titrant and on the assumption that the accuracy was within ± one drop.

In order to determine the repeatability of the tests with the spectrophotometer, one must compare the pairs of test standards to the standard curve for that ion. Table 4 shows the average deviation of the individual standards from the best-fit curve. The precision was estimated for nitrate nitrogen and where single test standards were run for phosphate to correct for machine drift.

Tests for nitrate nitrogen and phosphate were made on unfiltered samples. From the end of a cruise to the date of analysis, there was an interval ranging from 6 to 49 days for phosphate and from 3 to 35 days for nitrogen. These samples were not preserved to fix the phosphorus and nitrogen, nor were they refrigerated. Therefore, possible deterioration must be considered when using these values.

Table 4. Measurement Precision

Variable	Units	Estimated precision	Average deviation*
Dissolved Oxygen	percent	±1.0	
	mg/l	±0.1	
Specific conductance	micromhos at 25°C	±1.0	
Chloride	mg/l	±0.5	
Alkalinity	mg/l	±0.5	
Nitrate-N**	mg/l	±0.1	
Phosphate-P**	mg/l		±0.004
Sulfate	mg/l		±0.25
Silica	mg/l		±0.04
Calcium	mg/l		±0.33
Magnesium	mg/l		±0.07
Sodium	mg/l		±0.10
Potassium	mg/l		±0.04

*Average of the deviations of the test standards from the standard curve.
**Analysis performed on unfiltered samples of uncertain storage history.

4. DATA PRESENTATION

The limnological data are summarized by cruise for each sampling depth at a given station (Appendix A). Phosphorus concentrations were calculated from phosphate by multiplying by a factor of 0.326.

The wind and wave data are summarized by cruise and station (Appendix B).

In the statistical summary, lake-wide means, standard deviations, and sample sizes are presented by depth and cruise period for selected variables (Appendix C).

5. ACKNOWLEDGMENTS

The program was formulated and directed by A. P. Pinsak. Ship and computer services were provided by the Detroit District Corps of Engineers. R/V *Shenehon* operations were under the direction of R. E. Ruh.

I wish to thank the Data Processing Branch for computer operations, programming, and keypunching; Party Chief R. Sides and staff for field operations and sample collection; chemistry laboratory staff for laboratory analyses; B. C. Doughty for programming and computer data reduction; J. Grumblatt for meteorological data reduction; members of the Water Characteristics Branch personnel for assistance in data reduction; and A. Robertson and B. J. Eadie for review and suggestions. Final programming was by V. Maxey, J. Manor, and J. Boyd of GLERL.

6. REFERENCES

American Public Health Association (1965): *Standard Methods for the Examination of Water and Wastewater*, 12th ed. American Public Health Association, Washington, D.C.

Fishman, M. J., and M. W. Skougstad (1965): Rapid field and laboratory determination of phosphate in natural water, U.S. Geological Survey Professional Paper 525-B, pp. B167-169, U.S. Government Printing Office, Washington, D.C. 20402.

Great Lakes Research Center (1969): Great Lakes Research Center 1970 Program. Dept. of the Army, Corps of Engineers, Lake Survey District, Detroit, Mich.

Pinsak, A. P. (1970): Thermal characteristics of Lake Huron (Abs.). In: *Proceedings of the 13th Conference on Great Lakes Research*, International Association for Great Lakes Research, Ann Arbor, Mich., pp. 19-20.

Rainwater, F. H., and L. L. Thatcher (1960): Methods for collection and analysis of water samples, U.S. Geological Survey Water-Supply Paper 1454, U.S. Government Printing Office, Washington, D.C.

☆GPO 1980—677-308/245