Observations on Asylum Lake, Kalamazoo, Michigan

Joseph G. Engemann

Western Michigan University

Asylum Lake is a lake of 19.9 hectares in the southwest portion of Kalamazoo. Although in an urban area, it's shores are wooded and devoid of buildings. State mental hospital buildings nearby were torn down in 1971 after their use was discontinued in 1969.

The lake has been deeded to Western Michigan University with the understanding that future uses will not seriously diminish it's natural state.

The data reported here were gathered by Western students and myself in a preliminary survey to determine the potential for future aquatic teaching and research on this conveniently located lake.

Table one provides some data on basic measurements. Figure one is a map showing depth contours determined by soundings with electronic depth finders read at timed intervals on transects made at uniform speeds. Maximum depth of 15.8 meters was confirmed with a sounding line. The long narrow deep portion curves sufficiently so that winds produce minimal wave action even though the long axis of the lake is oriented in the direction of prevailing westerly winds.

Some physical-chemical data is reported in Table two. During July, 1976, when observations were begun, the thermocline occupied the zone from about three meters to beyond nine meters depth. Dissolved oxygen decreased rapidly from near saturation at five meters depth to zero at thirteen meters. The July depth distributions of dissolved oxygen, alkalinity, and pH values are very similar to those described by Wetzel (1975) for nearby Lawrence Lake. Summer secchi disk transparency was in the range of three and one-half to five meters.

TABLE I. ASYLUM LAKE MORPHOMETRY

Maximum length	930 m	(3,050 ft)
Maximum width	290 m	(950 ft)
Mean width	214 m	(702 ft)
Maximum depth	15.8 m	(52 ft)
Mean depth	7.2 m	(23.5 ft)
Surface area	198,806 m^2	
" "	19.9 hectares	(49 acres)
Volume	1,439,419 m^3	(1,157 acre feet)
Volume of epilimnion July 1976	500,000 m^3	
Volume of hypolimnion July 1976	340,000 m^3	

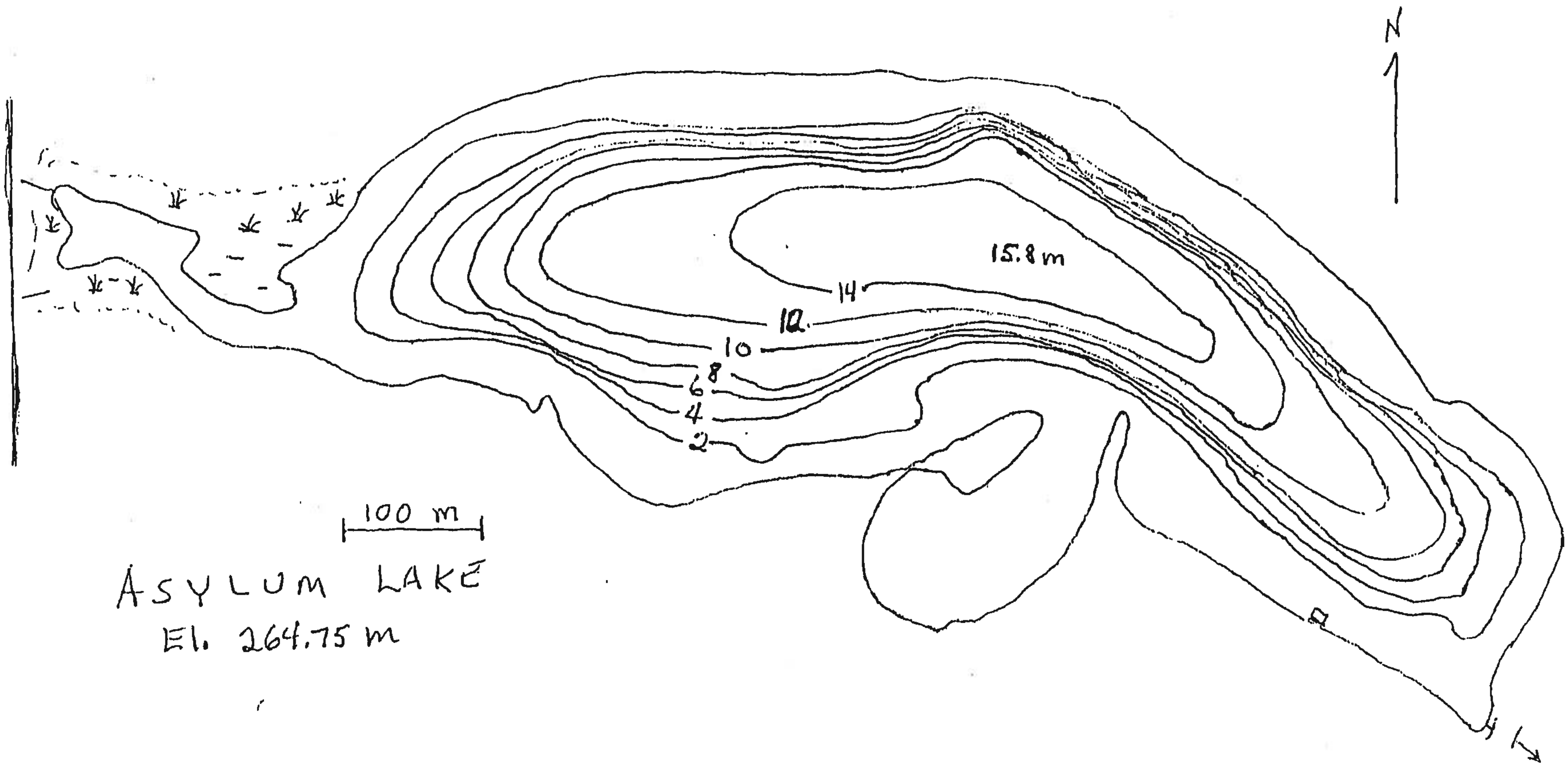
N
15.8 m
14
12
10
8
6
4
2
100 m
ASYLUM LAKE
El. 264.75 m

TABLE II. PHYSICAL-CHEMICAL DATA

Temperature in °C., thermistor thermometer readings

Depth m	1 July 7	2 July 26	3 Aug 4	1976 Aug 9	Aug 20	Sep 16	Oct 12	1977 Mar 9
0	25	27	25	24	25.8		15.5	ice
1	25	27	25	23	24.9	22	15.4	3.0
2	25	27	25	23	24.2	21	15.2	3.5
3	25	26.5	25	23	24.0	21	15.0	3.4
4	22	24	24.5	23	23.3	20.6	14.9	3.2
5	20	21	21.5	22	21.7	20.5	14.8	3.2
6	16	17	18	18	18.9	20	14.7	3.1
7	12.5	14	14	14	14.6	16.2	14.4	3.0
8	10.8	11	12	12	11.7	13	14.2	3.0
9	9	9.5	9.5	10	9.8	10.2	11.2	3.0
10	8	8.4	8.5	8	8.4	9	9.0	3.1
11	7	7.5	7.5	7.5	7.5	7.8	8.0	3.3
12	7	7	7	7	7.0	7.5	7.6	3.6
13	7		7	7	6.7	7	7.2	3.8
14				6.5	6.6		7.1	4.0
15				6.5	6.6		7.1	

	pH				Dissolved Oxygen				Total Alkalinity			
	7/26	9/16	10/12	3/9	7/26	9/16	10/12	3/9	7/26	9/16	10/12	3/9
1	8.2	8.1	8.2	7.5	7.8	9	10	4.5	112	120	128	124
3	8.2	8.0		7.6	9	8.5		2.0	108	120		160
5	8.2	7.8		7.6	8.6	6		2.0	136			162
7	7.7	7.5	8.0		4	1.5	9	2.7	150	158	128	
9	7.6	7.3	7.5		1.4	0.7	1	2.7	156	174	164	
11	7.5	7.3	7.5	7.5	0.9	0		2.0	166	180	166	176
13	7.4	7.2	7.2		0	0	0	0.7	186	210	206	

Chemistry

Iron was not found at any of the depths sampled (1, 3, 5, 7, 9, 11, and 13 meters). Phosphate was seldom detected above eleven meters but did reach 1.5 p.p.m. in September at the 13 meter depth. Nitrate levels were 0.04 p.p.m. at three meters on July 26 and zero at eleven meters. Ammonia was generally below one-half p.p.m. above eleven meters, but at thirteen meters went from 2.5 p.p.m. in July to 4.0 p.p.m. in October. The iron, phosphate, nitrate, and ammonia were run with Hach test cube kits. Alkalinity and oxygen were determined by titration methods except the March oxygen readings which were read from an oxygen meter with the probe lowered through the ice. Temperature was read from a thermistor thermometer with the probe lowered to depth.

Comparison of the alkalinity and pH values and the sharp drop-off from the two meter contour on the bathymetric map, with the observations of Hooper (1956) on the role of marl formation on basin depth profiles, indicates this lake is an excellent example of the contribution carbonate deposition makes to littoral shelf development and a consequent abrupt drop-off. This is further confirmed by the marl encrustation on shallow water macrophytes and the fine gray precipitate overlying shallow sediments in contrast to the dark black deeper sediments.

Plankton

Plankton analysis showed a rather typical assemblage for lakes of this region with moderately hard water. Fragilaria, Ceratium, and Anabaena were most abundant. A large variety of other organisms were generally encountered in plankton tows made in July and August. They included Eudorina, Oscillatoria, Microcystis, Keratella, Kellicotia, Daphnia, Pandorina, Cyclops, Diaptomus, Asplanchna, and Dinobryon. Encountered at lesser frequencies were an association of Anabaena with attached Vorticella, Rotaria, Spirogyra, Cosmarium, Navicula, and four additional genera. *Asplanchna*, *Dinobryon*, and *Microcystis* showed declining abundance with increasing depth. Crustaceans generally showed reduced abundance in near surface waters. *Kellicotia* was absent in surface and one meter collections. Less extensive sampling in September revealed *Aphanizomenon flos-aquae* in great abundance and lesser amounts of *Lyngbya* and *Polyarthra* all of which were absent in systematic July and August samples.

Littoral algae

Green algae were the predominant algae in the littoral zone, although the blue-green alga, *Oscillatoria* was very common on macrophytes and sediments. *Spirogyra* was very common. *S. crassa* was found in nearly pure growths. *S. ellipsospora* was found in floating mats. *Zygnema* was often mixed with *Spirogyra*. *Cladophora insignis* was a major component of floating mats on the northwest side of the lake. *Mougeotia* spp., *Ulothrix*, and the diatom, *Melosira*, were the other filamentous genera encountered. *Chara* dominated the littoral zone in most areas, often in pure stands. At many places along the drop-off from the littoral shelf thick growths of it extended out and draped over in a slight overhang. In many areas *Chara* formed a mat nearly half a meter thick.

Submersed macrophytes

Macrophytes other than *Chara* were also abundant, sometimes as sparse growth through the *Chara*, sometimes as less extensive pure stands, or as mixed growths. *Anacharis canadensis* and *Ceratophyllum demersum* both formed beds of single species in some areas, *Ceratophyllum* more commonly on the slope below the drop-off. *Potamogeton* spp. were widely distributed, sometimes in clumps, often emerging through beds of other macrophytes. *P. gramineus*, *P. illinoensis*, and *P. pectinatus* were most common. More scattered, sometimes in small clumps or beds were *P. epihydrus*, *P. crispus*, *P. foliosus*, *P. natans*, and *P. nodosus*. *Utricularia vulgaris* was common, especially in the bay along the south side of the lake. The only sizeable area of the littoral shelf not heavily covered by macrophytes was a small area at the east end used as an entry point by swimmers.

Najas marina was found in a few locations in the lake and represents it's only known occurrence in southwestern Michigan. It has also been found in southeastern Michigan (Near and Belcher, 1974), and central Michigan.

Floating-leaved macrophytes

Nuphar advena was very common in the bay, Nymphaea tuberosa made more extensive patches elsewhere. Nuphar microphyllum was scattered with the two larger species of waterlilies. The duckweeds, Lemna minor and Wolffia punctata, were very abundant in the bay, marsh, and downwind side of the lake, often floating across the open water as winds shifted. Unusual was the fact that Wolffia often contributed the greatest part of the bulk of the floating mass.

Potamogeton natans and P. nodosus are part of the floating-leaved group also. Polygonum natans was also present but limited to protected areas near the shrub Decodon.

Emergent macrophytes

Scirpus validus was common from the middle of the littoral shelf to shore, where it was replaced by Typha latifolia as the most common emergent. Other emergents included Decodon verticillatus, Cephalanthus occidentalis, Sagittaria, Eleocharis obtusa, Nasturtium officinale, and other species of Scirpus and Carex.

Benthos

Benthic invertebrates showed little abundance and variety. This highlights the need for further investigation as to the cause of the paucity of this portion of the biota. Most notable was the absence of any large clams, or their shells. Fingernail clams did occur in the gray sediments. Helisoma, Physa, and a few smaller snails were found associated with some vegetation or as empty shells near shore. Very few leeches and only a moderate quantity of aquatic insects were found. The only organism from the deep black sediment beneath the hypolimnion was Chaoborus albipes, which was also picked up in some deep plankton tows. Amphipods, midges, caddisflies, a variety of hemipterans, and a few Odonata were found in shallow water. A general absence of beetles represents another omission that should be investigated.

Vertebrates

A typical variety of warm water fish has been reported in the lake by fishermen. An experimental gill net set in the upper thermocline and lower epilimnion along the south side yielded only a few bluegills and two large perch. A few minnows and small bluegills were taken in seines. Fishing yielded bluegills, sunfish, largemouth bass, and perch. Visual sightings included larger bass and dogfish, also large numbers of moderate sized bluegills or sunfish in shallow shaded areas on a few occasions. Other vertebrates present included soft-shelled, painted, and snapping turtles; green frogs were seen and at least one bullfrog heard; at least one clutch of mallard ducks were reared and perhaps were responsible for the late season marked reduction of duckweeds in the bay and elsewhere; a variety of other birds use the lake or near shore vegetation. Little work was done in the marsh at the west end of the lake where most vertebrates other than fish would be expected.

Chloride chemocline

The extreme cold and great snow accumulation of the winter made field work impractical following the development of ice cover in November. Predictions of widespread winterkill appeared in the local newspaper because of the thick ice and snow cover obscuring light, needed for photosynthesis, by it's early development and persistence. By March 9 the snow was gone, except in areas where drifts had been on the surrounding ground, and only thirty-three centimeters of icy-snow and ice covered the lake. A Secchi disk could be seen at a depth of nine and one half meters below the ice. Only the upper meter or two had oxygen levels adequate for game fish, although live microcrustaceans were found in Kemmerer samples from one, three, and five meters. One live daphnid was also found in the nine meter sample upon return to the laboratory. The most remarkable finding was the high chloride levels that were present in the lake as well as evidence of stratification of different concentration levels. At one meter chloride was 82 p.p.m. which is nearly three times the level found in tap water from groundwater sources in Kalamazoo. At three meters the level was 32% higher, but the five meter sample was only 26% higher than the one meter sample. The nine meter sample had chloride concentrations 53% higher than the one meter sample. Since chloride is an ion expected to be uniformly distributed in fresh water, these amounts indicate tens of tons of salt have been added recently. Thus the peculiar temperature profile for this date (Table II) could represent a uniform density gradient due to the interaction of the effects of both temperature and dissolved salts on density. The highest value of 126 p.p.m. is well below the levels reported from Irondequoit Bay (Bubeck, et al., 1971) or Seneca Lake (Ahrnsbrak, 1975). In Seneca Lake a plume developed near the top of the thermocline at much diluted concentrations as compared to the concentration of about one percent chloride near the discharge point. In Irondequoit Bay a chloride concentration of about 400 p.p.m. was sufficient to prevent complete mixing during the summer of 1970. Thus Asylum Lake has much lower salt levels at present but a shopping plaza in the drainage area has only been open a few years. A major intersection and a trailer court may also be large sources of salt in the drainage area. More extensive mapping of salt intrusions under the ice may clarify circulation patterns in an ice protected lake if conditions are repeated as expected. Since only a few centimeters of water depth are in the drain pipe that serves as an outlet salt is expected to be retained with a proportionality to the "flushing time". On March 15, 1977, flow at the discharge pipe was estimated to be about three cubic meters per minute based on water velocity of just over one-half meter per second and a depth of 19 centimeters in a 61 centimeter round pipe which had three centimeters of gravel on the bottom. Thus the "flushing time" would be about one year if this rate of flow were maintained. However, two-thirds of the volume of the lake would not be expected to participate in this discharge during the time it is trapped in the thermocline and hypolimnion.

More startling was the observation that the discharge was stratified. There was a temperature inversion, with the top 4° C. and the bottom 5° C. Chloride concentration at the top was 28 p.p.m. and at the bottom 48 p.p.m. That is a chloride gradient of over one p.p.m. per centimeter. Although ice still covered over half of the lake surface, there were areas around the edge with many meters of open water. Surface water in one such area had 16 p.p.m. chloride.

Such winter stratification is of concern if groundwater aquifers used by the Kalamazoo water supply system have recharge from this surface water. Water resource managers should consider it's implications.

ACKNOWLEDGEMENTS

The help of the following students is acknowledged with appreciation. History of the area- Diane Salin; morphometry- Gerald D. Bird; mapping- Eldon Dodd, Kris Dodd, Larry Boelema, Dave DeGraff; plankton- Sandra Swayman; algae- Allen Kowalkowski; macrophytes- Peg McCann; invertebrates- Donald D. Myers; Fish- R. James Williams. Assistance given to each other and the help Arland Heistand and several others is appreciated. A gill net was loaned by the DNR.

LITERATURE CITED

Ahrnsbrak, W. F. 1975. A saline intrusion into Seneca Lake, New York. Limnol. and Oceanog. 20:275-278.

Bubeck, R. C., W. H. Diment, B. L. Deck, A. L. Baldwin, and S. D. Lipton. 1971. Runoff of deicing salt: effect on Irondequoit Bay, Rochester, New York. Science. 172:1128-1132.

Hooper, F. F. 1956. Some chemical and morphometric characteristics of southern Michigan lakes. Pap. Mich. Acad. Sci., Arts, and Letters. 41:109-130.

Near, K. A., and R. O. Belcher. 1974. New localities for *Najas minor* and *N. marina* in southeastern Michigan. Mich. Bot. 13:181-185.

Wetzel, R. G. 1975. Limnology. W. B. Saunders. Philadelphia. 743pp.