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A Survey of Water Transparency in Iowa Lakes[1]

JOHN R. JONES[2] and ROGER W. BACHMANN

Dept. of Animal Ecology, Iowa State University, Ames, Iowa 50011

Measurements of Secchi disk transparency were made in 50 Iowa lakes and reservoirs in the summer of 1975. Averages of July and August readings for individual lakes ranged from 0.1 to 2.7 m. The man-made lakes in the southern part of the state generally had greater transparencies than the natural lakes in the north. Reduced transparency was related more to algal density than to suspended inorganic matter.
INDEX DESCRIPTORS: eutrophication, Iowa lakes, water quality, water transparency, Secchi depth.

The development of excess plankton algae in Iowa lakes and reservoirs is a major water-quality problem. Although plankton algae densities can lead to various water-quality problems, such as oxygen depletions and fishkills, increased costs for water purification, and taste and odor problems, water clarity reduction is most noticeable. Water clarity is readily evaluated as an index of water quality, and a clear lake has a greater aesthetic value than a turbid one. The public is concerned with the high algal levels and resulting low transparencies in Iowa lakes and desires improved water clarity.

Volunteers from throughout Iowa assisted in a program to monitor water transparency weekly in 50 Iowa lakes and reservoirs from May through August 1975 to determine if this is feasible (Table 1). This program was designed to expand water quality studies done on other Iowa lakes by including a larger sample.

Because cost was an important consideration, we looked for an alternative to commercial Secchi disks (ca. $30 each) for use by the volunteers. We made our own disks by adapting 19.5-cm diameter plastic dinner plates purchased from a local variety store (48¢ each). To supplement the measurements collected by volunteers, we visited each lake at least four times to collect information on algal densities measured by chlorophyll *a* and water chemistry (Jones and Bachmann, unpublished). Because our disks were not standard, being slightly concave and off-white, we used these opportunities to calibrate them against a standard 20-cm Secchi disk. We made 192 side-by-side measurements.

With a paired t-test, there was no significant difference between the readings with our plate disks and the standard disk (Figure 1). With a few exceptions, we also found good agreement between our measurements and those of volunteers.

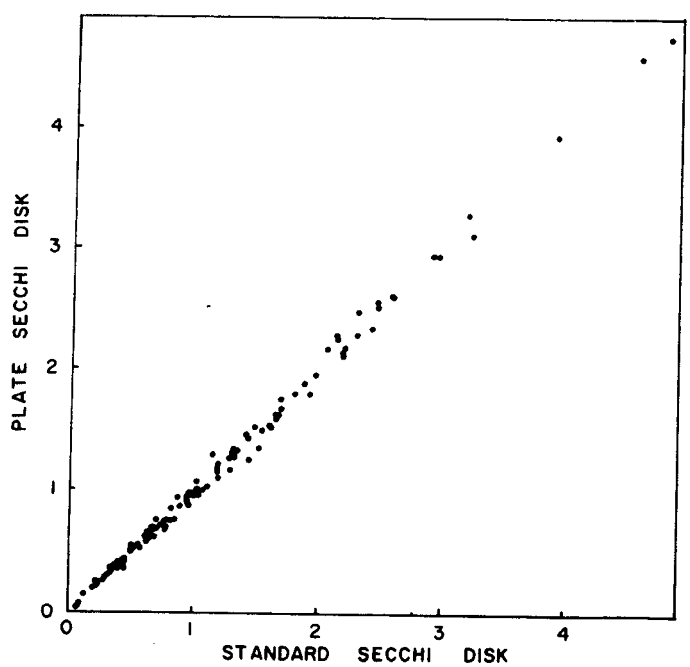
From previous studies, we have found that the clarity of Iowa lakes during the summer is determined by the magnitude of the algal bloom (Bachmann and Jones, 1974). We and others (Edmondson, 1972; Bachmann and Jones, 1974; Dillon and Rigler, 1975; Oglesby and Schaffner, 1975) have noted that there is a significant hyperbolic relationship between the lake transparencies as measured by the Secchi disk and algal biomass as measured by the chlorophyll concentration. This relationship is illustrated by data from 50 Iowa lakes sampled in 1975 (Figure 2). Transparencies in lakes with chlorophyll *a* values below 10 mg/m^3 are extremely sensitive to changes in algal abundance, whereas transparencies in lakes with chlorophyll *a* concentrations above 50 mg/m^3 differ little. July-August measurements of the chlorophyll *a* content of suspended materials in surface water samples from Iowa lakes are relatively high (Figure 3). The average value of 72 mg/m^3 places these lakes well into the eutrophic category (Sakamoto, 1966). Chlorophyll values in most Iowa lakes are well above 10 mg/m^3, and as a result these lakes have low transparencies (Figure 4).

There was wide variation in the transparency both among the Iowa lakes and within the lakes over the growing season (Table 1, Figure 4). In general, transparency is low in Iowa lakes, with most lakes having late-summer values under 1 m. The natural lakes, located primarily in north-central Iowa, had poorer transparencies than the man-made lakes. Natural lakes are indicated by the shaded portions of the bars in Figure 4.

There is a tendency for transparency to decrease in Iowa lakes and reservoirs as the summer progresses (Table 1). This likely corresponds to the increase in algal populations. Using monthly averages for all the lakes combined, we found transparencies of 1.34 m in May, 1.19 m in June, 0.94 m in July, and 0.88 m in August.

Several lakes did not follow this pattern, but instead had increasing transparency as the season progressed. These were man-made reservoirs that receive large silt inputs during spring runoff. As the silt settles from the water column during the summer, transparency improves. Early summer transparencies in these waters would be dependent upon silt concentrations rather than algal populations.

In looking at the extremes, we found that West Okoboji was the clearest natural lake and that three reservoirs, Big Creek, Geode, and



1. Comparison of Secchi disk transparency values obtained with a standard Secchi disk with the plate disk used in this study.

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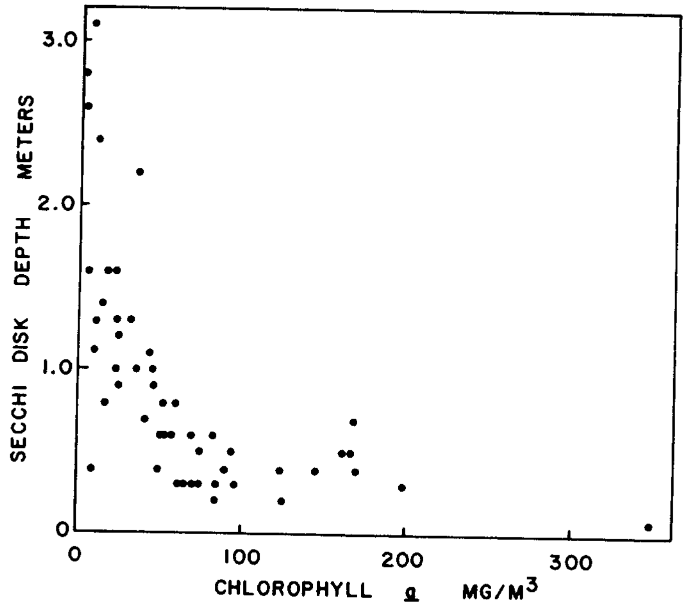
[2]Present address: School of Forestry, Fisheries and Wildlife, University of Missouri, Columbia.

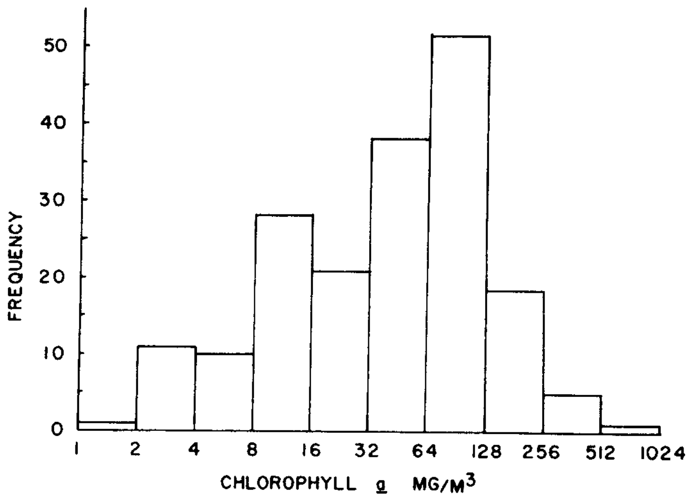
Table 1. *1975 monthly average Secchi disk transparencies (meters) for several Iowa lakes and reservoirs.*

Lake	County	May	June	July	August	July-August Average
Ahquabi	Warren	1.80	1.74	.98	1.04	1.01
Anita	Cass	—	1.31	1.86	1.83	1.86
Backbone	Delaware	.27	.27	.52	.40	.46
Bays Branch	Guthrie	1.68	1.16	.46	.18	.34*
Beeds	Franklin	.98	.79	1.10	.82	.98
Big Creek	Polk	.30	1.55	2.90	2.44	2.68
Black Hawk	Sac	.61	.82	.34	.27	.34
Bob White	Wayne	.09	.15	.24	.64	.46
Center	Dickinson	1.04	.91	.61	.58	.61
Clear	Cerro Gordo	1.28	1.04	.79	.76	.79
Cornelia	Wright	.70	.76	.73	.67	.70
Crystal	Hancock	.34	.46	.18	.18	.18
Darling	Washington	.73	.91	.52	.43	.49
Don Williams	Boone	.40	1.04	1.55	1.19	1.37
East Okoboji	Dickinson	1.43	.88	.61	.55	.58
East Twin	Hancock	.24	.15	.09	.12	.12
Five Island	Palo Alto	1.55	1.65	1.34	1.40	1.37
Geode	Henry	3.29	3.57	3.08	2.44	2.77
Green Valley	Union	1.80	.67	1.77	1.55	1.68
Hickory Grove	Story	.49	1.43	.91	1.13	.98
High	Emmet	.46	.46	.52	.91	.73
Ingham	Emmet	1.22	2.13	1.65	1.19	1.43
Iowa	Emmet	.91	.98	.76	.55	.67
Keomah	Mahaska	.82	.91	.67	.64	.67
Lacey-Keosauqua	Van Buren	2.04	3.11	2.62	2.26	2.44
Little Wall	Hamilton	.40	.37	.24	.30	.27
Lost Island	Clay-Palo Alto	1.07	.70	.46	.30	.40
Lower Gar	Dickinson	.76	.37	.40	.49	.43
McBride	Johnson	—	2.47	1.52	1.68	1.62*
McFarland	Story	.52	.64	.91	.85	.88
Manawa	Pottawattami	.61	.52	.64	.30	.49
Minnewashta	Dickinson	2.26	1.07	.76	.91	.85
Nine Eagles	Decatur	2.68	2.35	2.50	2.83	2.68
North Twin	Calhoun	—	.52	.34	.34	.34
Pine	Hardin	1.52	1.83	1.46	.70	1.10
Prairie Rose	Shelby	1.07	1.49	.82	.88	.85
Red Haw	Lucas	3.84	1.31	1.28	1.37	1.34
Rock Creek	Jasper	—	—	.79	.24	.52
Silver	Dickinson	1.92	1.46	.49	.46	.49
Spirit	Dickinson	1.62	1.65	1.13	.94	1.04
Spring	Greene	—	—	1.01	1.16	1.10
Storm	Buena Vista	.58	.58	.43	.34	.40
Swan	Emmet	1.46	1.98	1.34	.85	1.10
Three Fires	Taylor	—	.55	.88	.91	.91
Trumbell	Clay	—	—	.43	.24	.34
Tuttle	Emmet	.70	.76	.27	.15	.21
Twelve Mile	Emmet	1.55	1.37	1.10	.61	.85
Union Grove	Tama	.76	.61	.85	.76	.82
Upper Gar	Dickinson	1.83	.76	.34	.27	.30
Viking	Montgomery	—	—	1.83	1.40	1.62
Wapello	Davis	.46	.55	.94	1.58	1.28
West Okoboji	Dickinson	4.42	3.51	2.68	2.80	2.74

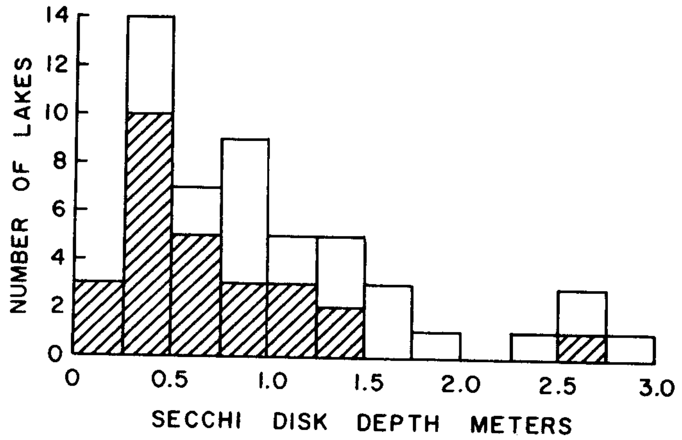
*Chlorophyll data not collected on these lakes.



2. Relationship between July-August Secchi disk depths and chlorophyll *a* concentrations in Iowa lakes and reservoirs measured in 1975.



3. Frequency distribution of average July-August chlorophyll *a* concentrations of 46 Iowa lakes and reservoirs in 1975.



4. Frequency distribution of July-August average Secchi disk transparency values obtained for various Iowa lakes and reservoirs in 1975. Shaded areas represent natural lakes and clear areas man-made lakes.

Nine Eagles, had similar values. Together, these water bodies had the most transparent waters within our sample. The least transparent water was found in four natural lakes, East Twin, Tuttle, Crystal, and Little Wall. Frequently, these lakes had transparency values of 0.3 m or less.

Transparency is an important indicator of water quality in Iowa lakes and reservoirs because of its close relationship with algal biomass. Our research has shown the importance of phosphorus as the nutrient controlling plankton algae levels in Iowa lakes (Jones and Bachmann, 1976). This is in agreement with the results of similar studies (Vollenweider, 1976). Phosphorus and chlorophyll *a* concentrations in Iowa lakes, are, in general, quite high (Jones and Bachmann, unpublished). This explains why Iowa lakes are eutrophic and have low transparency values. Little could be done to reduce algal levels in these lakes by diversion or nutrient-reduction programs because phosphorus loading to the natural lakes is from general land runoff rather than from point sources (Bachmann and Jones, 1976). In most Iowa lakes, the results of nutrient-abatement programs would not be sufficient to reduce chlorophyll *a* values below 10 mg/m^3. This is the inflection point in the hyperbolic relationship between algal biomass and transparency at which water clarity begins to improve. In a few lakes, such as West Okoboji, where algal levels are relatively low, special programs of nutrient control on the agricultural lands would be of value in preventing heavy algal concentrations and reduced transparencies.

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