IOWA'S WATER

Ambient Monitoring Program

Nutrients in Iowa Lakes

Lake water quality is strongly influenced by variations in climate and the relative abundance of nutrients within the lake system. The key to understanding Iowa's lake water quality is determining what the natural state of these lakes was historically and should be today, and how the year-to-year variations in climate influence the picture. To piece together that picture, it is essential to improve our knowledge of how lakes function in the landscape. In many ways, lakes function as sinks, slowing the in-flowing water and trapping sediment that is carried by streams or by erosion of lake banks. Sediment carried by the streams is a reflection of the land it drains. Fertile soils that sustain our rich agricultural heritage also stimulate growth and production of plant life within our lakes. As with most things, a moderate amount of nutrients enhances the lake ecosystem by providing a food source for living organisms. A lake is unable to sustain life if there are too few nutrients, while too many can cause overproduction of life forms and suffocate a lake.

Table 1. *The effects of increasing phosphorus concentrations on lakes. The majority of Iowa lakes are eutrophic or hyper eutrophic.*

Parameter	Oligotrophic	Mesotrophic	Eutrophic	Hyper Eutrophic
Clarity	Excellent	Good	Poor	Very Poor
Oxygen	Abundant	Adequate	Hypoxic	Anoxic
Toxic Algae	Absent	Absent	Frequent	Constant
Bacteria	Rare	Rare	Abundant	Very Abundant
Silt/Filling	Very Slow	Slow	Rapid	Very Rapid
Toxin Mobility	Bound	Bound	Mobile	Very Mobile
Ammonia Toxicity	Improbable	Infrequent	Frequent	Constant
Biodiversity and Stability	High	Good	Poor	Very Poor
Fish Habitat	Good	Excellent	Poor	Very Poor
Wildlife Habitat	Good	Excellent	Poor	Very Poor
Fish Production	Low	Moderate	High	Moderate
Fish Community	High Quality	Good Quality	Poor Quality	Rough Fish
Phosphorus Supply	0-20 ppb	20-70 ppb	70-200 ppb	> 200 ppb

Hypoxic = Low level of oxygen
Anoxic = Complete lack of oxygen

Source: Dr. John Downing, Iowa State University.

Collection of water samples from one of Iowa's lakes.

How Much Is Too Much?

A central question surrounding the restoration and management of Iowa's lakes is "What level of nutrients are appropriate for healthy lakes?" In freshwater lakes, the most common nutrient that limits excessive plant and algae growth is phosphorus. Table 1 illustrates the changes that occur in lake quality with increasing levels of phosphorus. When phosphorus levels are below 20 parts per billion (ppb), lakes have low levels of plant production, resulting in clear water. However, these nutrient-poor waters (oligotrophic) can't sustain large fish populations. As the level of phosphorus increases, the production of algae and aquatic plants that support the food system of the lake increases. These moderately productive lakes (mesotrophic) still have an adequate supply of oxygen, but have an increased level of fish production due to a broader food base.

When phosphorus levels are consistently above 70 ppb, the excess nutrients begin to negatively impact the lake water quality. Nutrient-rich lakes (eutrophic) experience large algae blooms that color the water a vivid green and create shortages in oxygen when the algae die and are then consumed by bacteria. Water clarity decreases as the algae cloud lake water. Changes in water chemistry allow toxins that were once bound to sediment to become mobile and circulate throughout the water. The abundance of nutrients enhances overall fish production, but the quality of the fish found in the lake begins to drop, as the more sensitive fish are unable to live in low-oxygen waters. With still higher phosphorus levels (> 200 ppb), lake health may be further jeopardized. Algae blooms become nearly constant, and a type of blue-green algae called cyanobacteria may be found.

Cyanobacteria can have a variety of negative effects on aquatic systems including taste and odor problems in drinking water supplies and recreational areas. Several types of cyanobacteria produce toxins hazardous to humans, livestock, and other aquatic organisms. In these very nutrient-rich lakes (hyper eutrophic), water clarity is very poor and oxygen is severely limited or absent in portions of the water column. These lakes also support the occurrence and longevity of bacteria, which may pose a threat to human health. As with eutrophic lakes, toxins are released from the sediment and may have impacts on the aquatic life. Unlike eutrophic lakes, overall fish production drops and only the most tolerant fish species can survive.

How Do Iowa Lakes Fare?

Iowa lakes have been monitored in a limited capacity in the past. In 1980, Iowa State University completed a study of 115 significant publicly owned lakes. States were required by the U.S. Environmental Protection Agency to survey their public lakes in need of restoration and/or protection and to develop a priority ranking of lakes for restoration projects. Significant publicly owned lakes are those lakes which are principally maintained for public use, contain a minimum surface area of 10 acres, and are capable of supporting fish stock of at least 200 pounds per acre. An additional survey was completed in the early 1990s to update the lake database and establish a revised priority list of lakes for restoration. Each lake was monitored three times during the period May through August. Secchi depth measurements were collected, as were samples for nutrient and chlorophyll analyses. These two studies revealed that Iowa's lakes were nearly all eutrophic or hyper eutrophic. When compared to lakes around the world, the Iowa State University studies showed that Iowa lakes were some of the most nutrient rich found.

Using the studies from 1980 and 1990 as a template, the water-monitoring program began a new partnership with Dr. John Downing and Iowa State University to assess the current status of Iowa's lakes. Since the year 2000, 132 lakes throughout Iowa are being monitored annually (including the 115 lakes and an additional 17). Each lake is sampled three times during the year; spring/early summer, mid summer, and late summer/fall, which allows for the assessment of seasonal variability. Samples are taken at the deepest point in each lake basin. For the first time, vertical probes were lowered through the water column to develop a vertical profile of water quality parameters (temperature, dissolved oxygen, specific conductivity, pH, turbidity, and chlorophyll). In addition to parameters monitored in the previous studies, the concentrations of pesticides and metals in both water and bottom sediments will be analyzed from each lake.

Algae visible in Arbor Lake, Poweshiek County.

Results from the first three years of monitoring show that Iowa's lakes are still nutrient rich a decade after they were last studied. Figure 1 illustrates lake water clarity as determined by secchi depth. A larger secchi depth reading means that the water had greater clarity and generally indicates better water quality. The lakes are classified into four categories by their median secchi depth reading (median value is the value where 50% of the readings are above and 50% of the readings are below this value). During this period, only 5 lakes had

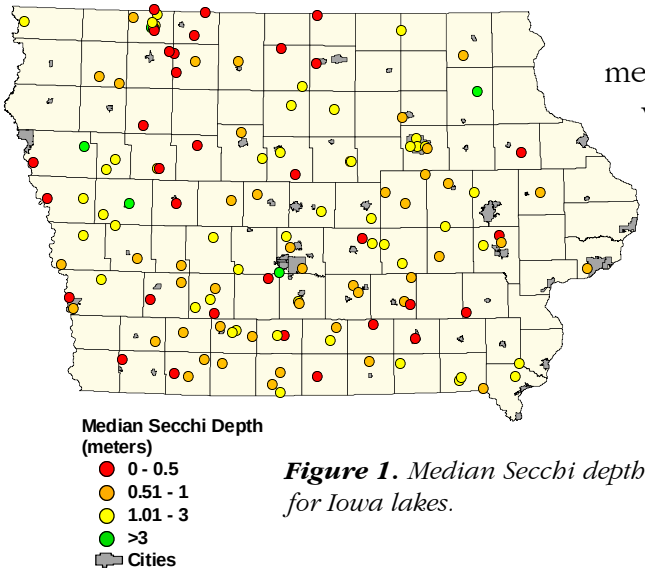

Figure 1. *Median Secchi depth for Iowa lakes.*

median secchi readings greater than 3 meters, while the majority of lakes (78), had readings of one meter or less. Lakes in western Iowa (Loess Hills) had the highest median secchi depths overall. The lack of water clarity in Iowa's lakes is clearly a reflection of their nutrient status. The average total phosphorus concentration for all 132 lakes in 2002 was 105 ppb. More than half of the lakes had average total phosphorus values greater than 70 ppb and seventeen lakes had average phosphorus values greater than 200 ppb during 2002. Of course, these values are strongly influenced by climate conditions and two of the first three years of the monitoring program were much drier than normal. Continued monitoring will help to determine how these nutrient values change through time and the status of Iowa's precious lake resources.

Future Plans

To improve the knowledge of water quality in Iowa's lakes will require additional information on the cycling of nutrients between the lakebed and water column. Additionally, more data on inputs of nutrient-rich sediment from the lake watershed will be needed to assess continued sources of nutrients. Appropriate management and potential restoration of Iowa's lakes require a fundamental understanding of how lakes have changed through time and what the beneficial level of nutrients should be at this point in time.

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Water Monitoring Program Web Site – www.igsb.uiowa.edu/water

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