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2000-2012 Lake Water Quality Summary

Iowa's lakes are an incredible water resource. They support excellent fisheries, provide a home to numerous plants and animals, create recreational opportunities for Iowans and tourists, and in some cases, supply Iowans with drinking water. Because our lakes are such an important resource, it is important that we better understand the health of our lakes through routine ambient water quality monitoring.

Monitoring at over 130 publically-owned lakes occurs three times each summer, once in early summer (May-June), once in mid-summer (July), and once in late summer (August-September). Lakes are monitored for a number of chemical and biological parameters. Results from monitoring are used to assess and report on water quality in Iowa as a part of the Clean Water Act, target individual lakes for restoration activities, build a long-term record to show trends in water quality, and help inform Iowan's about water quality in their lakes.

Monitoring began in 2000, and has occurred annually since. The Iowa State University Limnology Laboratory and the State Hygiene Laboratory have partnered with DNR over the years to complete monitoring around the state. A water quality table summarizing

Nitrogen – Nitrate + Nitrite as N, Ammonium Nitrogen, and Total Kjeldahl Nitrogen

Nitrogen is an essential nutrient for all plant life, however; too much nitrogen can pollute waters both locally and downstream. Nitrogen is an especially potent pollutant when it reaches the Gulf of Mexico and contributes to hypoxia observed annually. Nitrogen enters our lakes through natural plant decay, fertilizer runoff, manure, industrial waste waters, landfills, and atmospheric gas. Nitrate, the most common form of nitrogen found in Iowa's lakes can cause severe illness or death in infants and domestic animals. Ammonia, in its unionized form, can also be toxic to aquatic wildlife.

Phosphorus – Total Phosphorus and Orthophosphate

Phosphorus is an essential nutrient that plants use during photosynthesis. Phosphorus is generally regarded as the limiting nutrient in fresh waters, but even in low concentrations, phosphorus can cause algae blooms in lakes and rivers. Phosphorus occurs naturally in the earth's crust. Phosphorus is transported to lakes through plant and animal decay, manure, sewage, agricultural fertilizers, and industrial effluents. Total phosphorus concentrations as low as 30µg/L can cause visible algae blooms in lakes. Phosphorus frequently attaches to sediment and sinks to the bottom of lakes, where it builds up and reduces its availability to algae. Several chemical and biological processes can release phosphorus back into the water where it can be used by algae. Bottom-feeding fish, such as carp, can stir up sediments, releasing phosphorus into the water column.

Suspended Solids – Total, Fixed, and Volatile Solids

Solids eroded from the land frequently pollute our lakes by water clarity and negatively impacting aquatic life. Soil erosion, algae blooms, and re-suspension are the leading causes for high suspended solids in Iowa lakes. Fixed solids refer to the portion of the suspended solids that is inorganic. Volatile solids are organic and generally are comprised of algae and soil organic matter. Suspended solids in water limit how far light can penetrate in a lake and thus, can limit growth of submerged aquatic plants. Aquatic plants provide excellent structure and shelter for fish and invertebrates.

Phytoplankton and Zooplankton

Phytoplankton, or algae, are microscopic plants that grow in lakes. These organisms form the base for many aquatic food webs. In low densities, groups and types of algae found serve as excellent food sources for other organisms. When lakes are polluted with high levels of nutrients, such as nitrogen and phosphorus, however; algae become over-abundant, turning the surface of lakes green, forming dense algal scum, and causing taste and odor problems. The types of algae in these lakes also shifts with increased pollution, moving from a healthy community that serves as the base of food webs, to blue-green, or cyanobacterial forms. Many species of these blue-green algae produce toxins that can cause skin irritation and illnesses. At high levels, these toxins can also cause tissue damage and death in humans and animals. High phytoplankton biomasses can also contribute to low oxygen and high pH levels in lakes.

Zooplankton are microscopic animals (crustaceans) that feed on phytoplankton in lakes and important sources of food for fish and other aquatic life. Identifying and the diversity and abundance of these organisms in our lakes can help us better understand the overall health of the aquatic ecosystem. Reduced diversity of zooplankton is frequently observed in very nutrient rich, or eutrophic, lakes.

Water Quality Parameter	Number of Samples	Minimum Value	Percentiles			Maximum Value
			25th	50th	75th	
Ammonia (µg/L)	4,607	7	25	50	73	1734
Alkalinity (mg/L of $CaCO_3$)	6,025	15	108	137	175	317
Chlorophyll a (µg/L)	6,068	< 1	10	26	51	743
Dissolved Organic Carbon (mg/L)	3,294	< 7.6	< 7.6	< 7.6	8.3	56.6
Dissolved Oxygen (mg/L)	6,071	0.1	7.2	8.7	10.4	30.1
Inorganic Suspended Solids (mg/L)	5,959	< 1	2	4.4	9	378
Nitrate +Nitrite as N (mg/L)	6,176	< 0.58	< 0.58	< 0.58	0.95	20.1
Orthophosphate as P (µg/L)	5,184	< 0.02	< 0.02	< 0.02	< 0.06	0.72
pH	6,150	6.1	8.2	8.5	8.7	10.8
Phytoplankton Wet Mass (mg/L)	5,917	< 1.0	9.5	25	66	21,503
Secchi Depth (m)	6,211	0.1	0.5	0.8	1.4	9.6
Specific Conductance (µmhos/cm)	6,170	56	276	361	470	1,361
Temperature (˚C)	6,190	7.0	21.0	24.2	26.5	33.8
Thermocline Depth (m)	5,899	NIL	NIL	2.0	3.5	17.0
Total Kjeldahl Nitrogen (mg/L)	3,373	< 0.5	0.8	1.2	1.8	14
Total Phosphorus as P (µg/L)	5,817	< 0.02	0.05	0.08	0.14	2.8
Total Suspended Solids (mg/L)	6,178	< 1.0	6.4	11.5	20.0	452
Turbidity (NTU)	6,132	< 0.3	7.7	16.7	33.2	2,333
Volatile Suspended Solids (mg/L)	6,035	< 1.0	4.0	5.8	11.0	122.9
Zooplankton Dry Mass (mg/L)	5,777	< 1.0	54.3	138.1	317.6	134,688.2

µg/L – micrograms per liter (parts per billion)
mg/L – milligrams per liter (parts per million)
µmhos/cm – microhoms per centimeter
NTU – Nephelometric Turbidity Units
< - less than detection limit shown

Raw data available through STORET: http://programs.iowadnr.gov/iastoret/

Note: This summary only includes lakes monitored as a part of the ambient lake monitoring program. Additional lake sites throughout Iowa are also monitored, but are not included in this summary since their sampling frequency, sites, and parameters vary from the fixed network.

Carlson's Trophic State Index

The Carlson's Trophic State Index (TSI) is an index that was developed to compare different lake water quality values against one another on the same scale. The index uses raw numbers from analyses and converts them on a scale from <30 – 100+. Ranges of index numbers inform the reader about the overall nutrient status and productivity of the lake. There are 4 classes of lakes that are described within this index. In Iowa, we see 3 of these classes. Classes are described below and the maps (figures 1 and 2) show the trophic state of Iowa's lakes based on 12 years of monitoring for water clarity (Secchi depth) and algae production (chlorophyll a). DNR uses both of these index values to assess water quality in our public lakes under the Clean Water Act.

Lake type:	Description:
Oligotrophic	Oligotrophic lakes have low algae production, or primary productivity, due to low nutrient content. They are often characterized by clear waters with little to no aquatic vegetation. They typically have ample dissolved oxygen and support diverse fisheries and communities of aquatic organisms. These types of lakes are most often found in colder regions of the world with igneous bedrock.
Mesotrophic 	This group of lakes has as intermediate level of algal productivity. Lakes are characterized by relatively clear water and an abundance of submerged plants. These lakes typically support large fish populations, although they may not support very oxygen sensitive fish.
Eutrophic 	The majority of Iowa lakes fall into this category. This group is characterized by high levels of nutrients (especially phosphorus and nitrogen) that cause frequent algae blooms and an abundance of aquatic plants (where light penetrates to the bottom of the lake). Oxygen concentrations in these lake vary with algae production and decomposition, thus, large fisheries can be sustained under the right conditions but are frequently subjected to oxygen stress.
Hypereutrophic 	This class of lakes is characterized by extremely high levels of nutrients that cause frequent algae blooms, usually dominated by blue-green algal species, and very low water clarity (typically less than 3 feet of transparency). These lakes often are pea-soup colored and filled with thick algal scums. They also can have very low oxygen concentrations as algae decompose and sink to the bottom of the lake. As a result, they may not be able to support thriving fisheries or other aquatic life.

Photos courtesy of the Iowa State University Limnology Laboratory. Photos show water clarity with Secchi disc at 0.2 meters deep.

Figure 1. Carlson's TSI for Secchi Depth (Water Transparency)

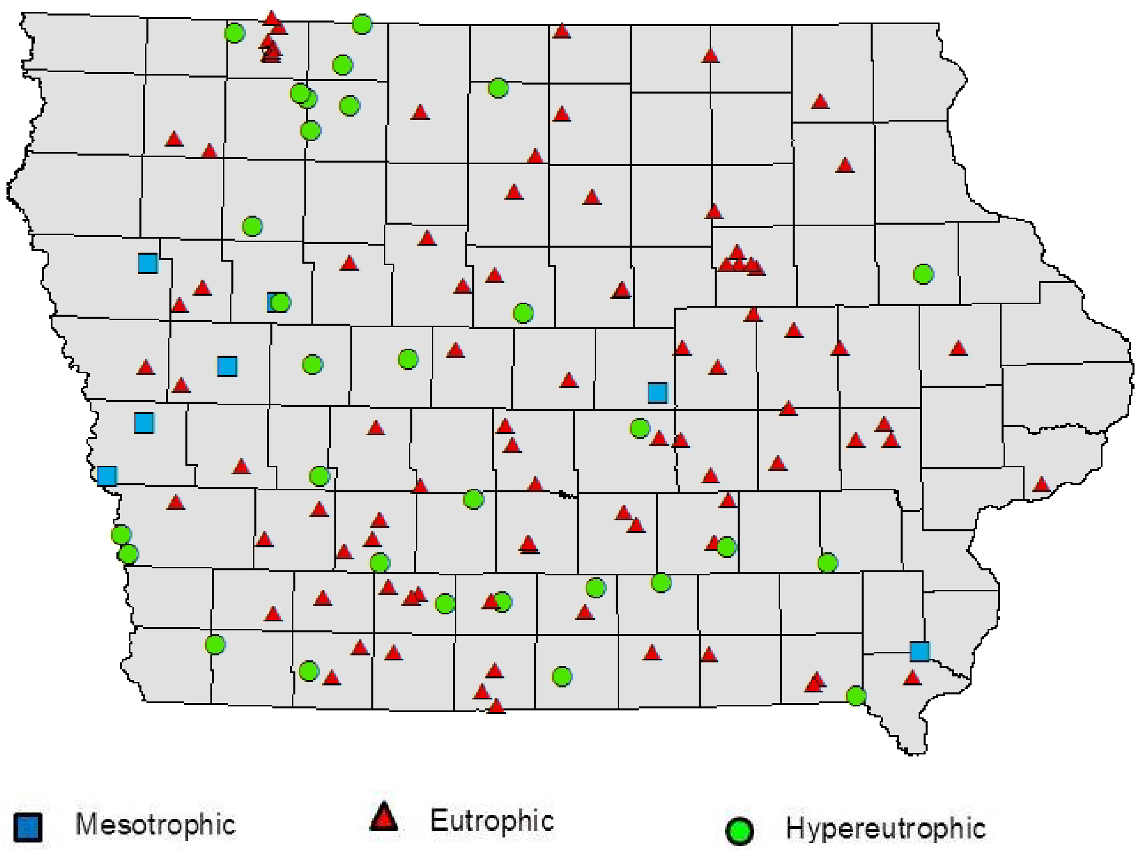

Figure 2. Carlson's TSI for Chlorophyll a (a pigment in algae)