# 2000-2014 Lake Water Quality Summary

Iowa's lakes are an incredible and important 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. State wide water quality monitoring is important so that we can better understand the health and status of our lakes.

The Iowa DNR Monitors 138 publically-owned lakes 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 inform Iowan's about water quality in their lakes, used to track trends in water quality in order to target individual lakes for restoration activities, as well as used to perform Water Quality Assessments on lakes as mandated to the state by the Federal Clean Water Act.

| Water Quality Parameter | Number of Samples | Minimum Value | Percentiles | | | Maximum Value |
|---|---|---|---|---|---|---|
| | | | 25th | 50th | 75th | |
| **Ammonia (µg/L)** | 5,402 | 5 | 25 | 41 | 80 | 1,734 |
| **Dissolved Organic Carbon (mg/L)** | 4,088 | 0.5 | 3.8 | 6.1 | 8.1 | 56.6 |
| **Total Suspended Solids (mg/L)** | 6,935 | < 1.0 | 6.4 | 11.5 | 20.0 | 452.0 |
| **Inorganic Suspended Solids (mg/L)** | 6,753 | < 1.0 | 2.0 | 4.2 | 9.0 | 378.0 |
| **Volatile Suspended Solids (mg/L)** | 6,829 | < 1.0 | 4.0 | 6.0 | 11.0 | 130.0 |
| **Total Kjeldahl Nitrogen (mg/L)** | 4,168 | 0.1 | 0.8 | 1.2 | 1.8 | 14.0 |
| **Nitrate +Nitrite as N (mg/L)** | 6,971 | 0.03 | 0.05 | 0.19 | 0.84 | 24.53 |
| **Total Phosphorus as P (µg/L)** | 6,608 | 4.6 | 46.6 | 78.3 | 130.0 | 2,800.0 |
| **Orthophosphate as P (µg/L)** | 5,976 | < 1.0 | 4.0 | 7.0 | 19.6 | 720.0 |
| **Temperature (˚C)** | 6,985 | 7.0 | 21.0 | 24.1 | 26.4 | 33.8 |
| **Dissolved Oxygen (mg/L)** | 6,866 | 0.1 | 7.2 | 8.7 | 10.4 | 30.1 |
| **pH** | 6,945 | 6.1 | 8.2 | 8.4 | 8.7 | 10.8 |
| **Turbidity (NTU)** | 6,927 | < 0.3 | 7.2 | 15.9 | 31.6 | 2,332.7 |
| **Secchi Depth (m)** | 7,006 | 0.1 | 0.5 | 0.8 | 1.4 | 9.6 |
| **Chlorophyll a (µg/L)** | 6,862 | <1 | 10 | 26 | 51 | 743 |
| **Phytoplankton Wet Mass (mg/L)** | 6,712 | < 1.0 | 9.2 | 24.8 | 65.3 | 21,502.8 |
| **Zooplankton Dry Mass (mg/L)** | 6,572 | < 1.0 | 55.7 | 140.1 | 315.3 | 134,688.2 |

µg/L – micrograms per liter (parts per billion)
µmhos/cm – micromhos per centimeter
< - less than detection limit shown
mg/L – milligrams per liter (parts per million)
NTU – Nephelometric Turbidity Units
Raw data available through IASTORET: http://programs.iowadnr.gov/iastoret/

Note: This summary only includes data collected as a part of the Iowa DNR ambient lake monitoring program.

Figure 1. 2000-2014 Average Carlson's Trophic State Index for Secchi Transparency

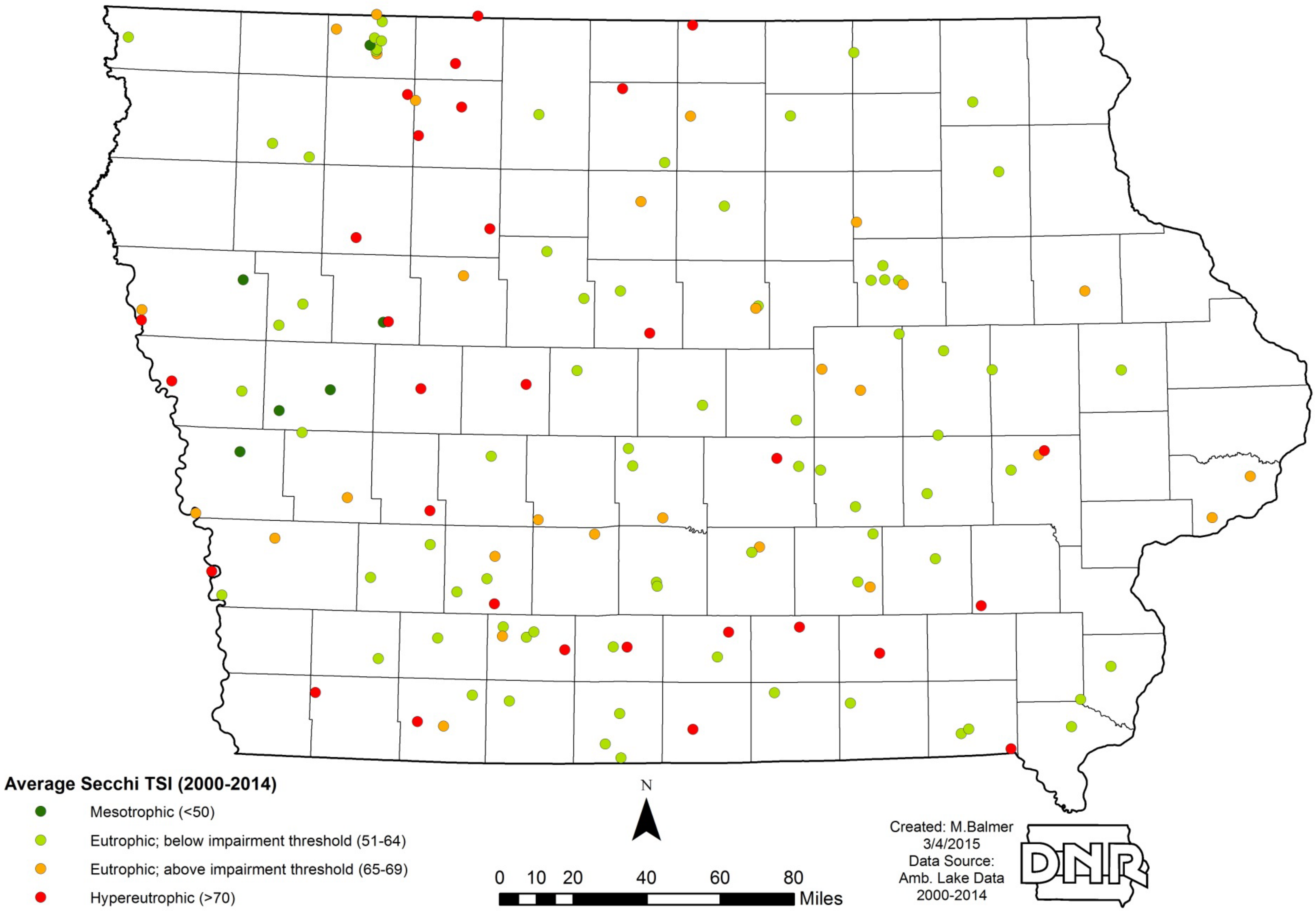
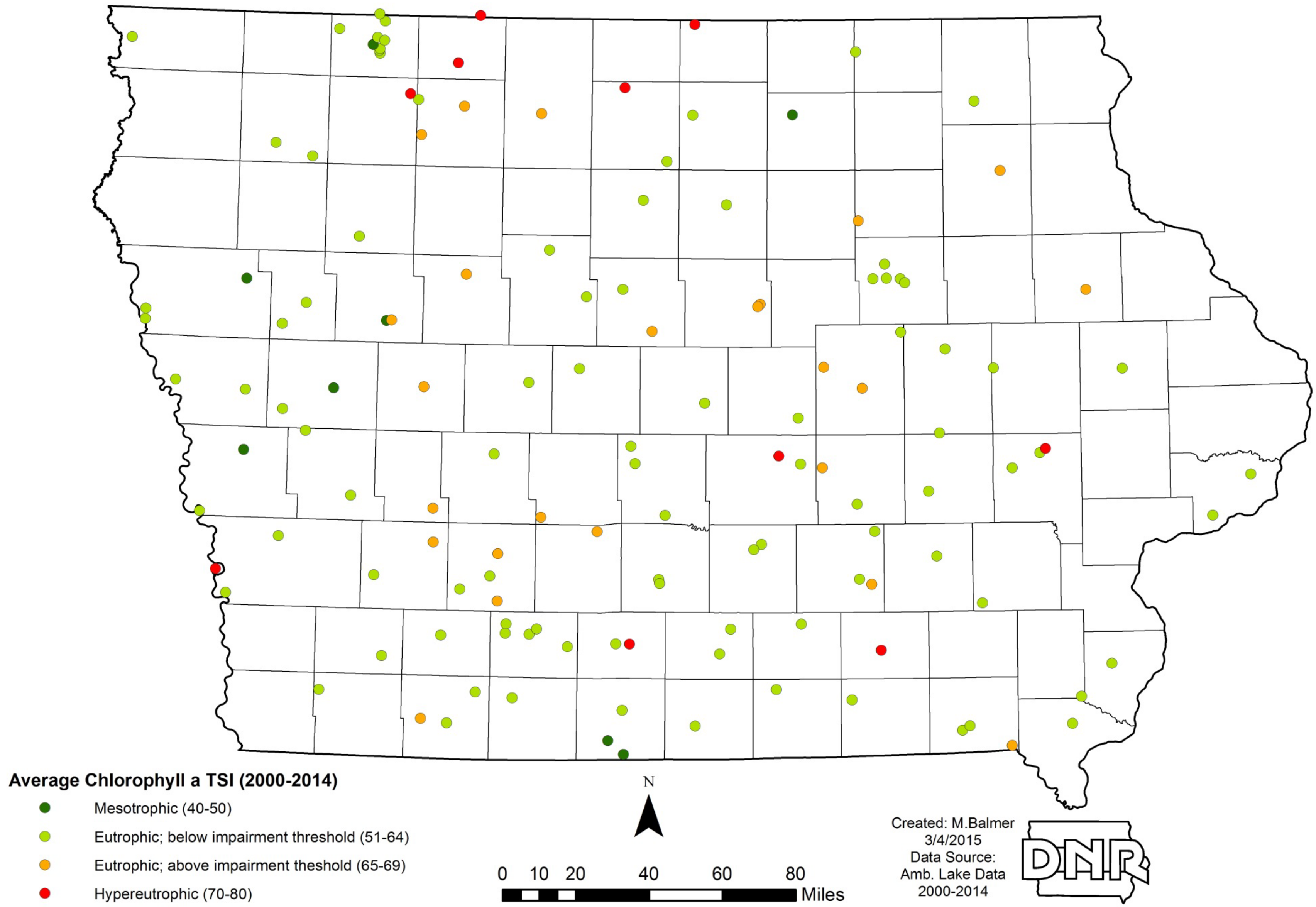


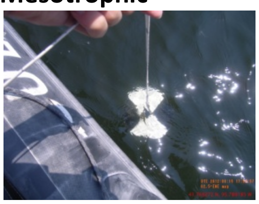
Figure 2. 2000-2014 Average Carlson's Trophic State Index for Chlorophyll a



# Description of Water Quality Parameters

## 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. While nutrients are important for aquatic life, an overabundance of nutrients can lead to nuisance algae blooms, limit water clarity, and have other negative impacts on 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 in the table below and the maps (figures 1 and 2) show the trophic state of Iowa's lakes based on 14 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 (black and white disc pictured) at 0.2 meters deep.

| Lake type: | Chlorophyll a (µg/L): | Total Phosphorus (µg/L): | Secchi Transparency (meters): | Trophic State Index value: |
|---|---|---|---|---|
| Mesotrophic | 2.6 – 20 | 12 - 24 | 2 - 4 | 40 - 50 |
| Eutrophic | 21 - 56 | 25 - 96 | 0.5 - 2 | 51 - 70 |
| Hypereutrophic | 57 + | 97 + | < 0.5 | 71 + |

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

Nitrogen is an essential nutrient for all plant and animal life; however too much nitrogen can create problems in our lakes, rivers, streams, and oceans. Nitrogen is an especially potent pollutant when in excess. In its various forms (Nitrite, Nitrate, Ammonia, and Unionized Ammonia), it can cause the formation of harmful algal blooms, toxic environmental conditions for our fish and other aquatic life, and toxins in our drinking water that can cause severe illness or death in very young infants and domestic animals. In addition to the local effects excess nitrogen, it can also contribute to global pollution. An example of this is the hypoxic zone in the northern Gulf of Mexico, a dead zone where oxygen levels (depleted by the decomposition of algal blooms created by excess nitrogen) are too low for animals to live. 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. Relative to other parts of the country, Iowa lakes have very high nitrate concentrations (especially in regions where tile-drained agriculture is the prominent land use, such as the Des Moines Lobe).

## 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. Total Phosphorus concentrations as low as 30µg/L (ppb) can cause visible algae blooms in lakes. Phosphorus occurs naturally in the earth's crust. Phosphorus is transported to lakes through plant and animal decay, manure, sewage, agricultural fertilizers, soil erosion, and industrial effluents. Orthophosphate often referred to a Soluble Reactive Phosphorus is readily taken up by algae and in excess contributes to harmful algal blooms. Additional Phosphorus frequently attaches to sediment and will sinks to the bottom of lakes, where it is relatively unavailable to algae in stable conditions. Spring and fall turnovers, wind mixing, and bottom-feeding fish, such as carp, can stir up sediments, releasing phosphorus into the water column. Several chemical and biological processes can then unlock the phosphorus from the sediment back into the water where they can be utilized by the algae. In excess these events can cause more frequent harmful algal blooms.

## Suspended Solids – Total, Fixed, and Volatile Solids

Soils eroded from the land frequently pollute our lakes by reducing water clarity and negatively impacting aquatic life. 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. Soil erosion, algae blooms, and re-suspension of lake sediments are the leading causes of high Totals Suspended Solid values in Iowa lakes. Fixed Suspended Solids refer to the portion of the Total Suspended Solids that are inorganic matter (sands, silts and clays). Volatile Suspended Solids are organic and generally are comprised of algae, aquatic and terrestrial detritus, and other soil organic matter.

## Phytoplankton and Zooplankton

Phytoplankton (green algae, diatoms, cyanobacteria (blue green algae), dinoflagellates, etc.) are microscopic plants and animals that photosynthesize in lakes. These organisms form the base for many aquatic food webs. In low densities, certain groups and types of algae serve as excellent food sources for other organisms. When lakes are polluted with high levels of nutrients, such as nitrogen and phosphorus, however; phytoplankton become over-abundant, turning the surface of lakes green, forming dense algal scums and mats, and causing water taste and odor problems. The types of phytoplankton found 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, putting stress on fish and other plants and animals.

Zooplankton are microscopic animals, mainly crustaceans, that feed on phytoplankton in lakes and serve as important sources of food for fish and other aquatic life. Identifying and measuring 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 hypereutrophic, lakes. Some species of zooplankton have also been used as an indicator for good water quality.

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