Minnesota's Intensification of the National Lakes Assessment Survey

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The Minnesota Pollution Control Agency (MPCA) utilizes EPA's National Lakes Assessment (NLA) survey to answer a wide range of questions about Minnesota's lakes that are important to statewide lake condition assessment. NLA provides an opportunity to gather chemical, physical, and biological data to determine statewide and ecoregion based condition estimates. Minnesota conducts sampling on 50 lakes in accordance with EPA's NLA survey design and analyte suite. MPCA collected data on 48 lakes, while two lakes were located within the jurisdiction of the Leech Lake Band of Ojibwe and Fond du Lac Band of Lake Superior Chippewa and were sampled by EPA and tribal staff. In addition, MPCA adds 100 lakes from the overdraw pool to allow for ecoregion-based assessments of lakes greater than 10 acres (four ha) for the three aggregated Level II ecoregions that comprise Minnesota, namely Northern Forests, East Temperate Forests, and Great Plains. These lakes combined with the national and statewide data sets will provide comprehensive and representative coverage of lakes across Minnesota.

Minnesota leverages the supplemental funding available for the survey to sample a variety of add-on parameters. For the 2017 survey, herbicides, zooplankton, phytoplankton, and algal toxins were added. In addition, utilizing state funds, Minnesota was able to gather data on emerging contaminants, sediment chemistry, and pesticides. What follows is an overview of the work Minnesota was able to accomplish during the 2017 field season, with the use of supplemental funding and partnerships with sister agencies.

Pesticides and herbicides

The Minnesota Department of Agriculture (MDA) analyzed pesticide water quality samples collected from Minnesota lakes during the 2017 NLA, similar to the 2007 and 2012 efforts. The NLA provides an opportunity for the MDA to collect pesticide water quality data in lakes across Minnesota, and to track results over time.

In 2017, samples from 50 lakes were analyzed for 150 pesticide compounds including Glyphosate with an additional 101 lakes targeted specifically for Glyphosate analysis. Seventeen different pesticide-related compounds were detected at least once and a total of 147 pesticide detections were measured. Of the 147 pesticide detections, 97 detections were herbicide degradates, 47 detections were herbicides, two detections were insecticides, and there was one fungicide detected. Hydroxyatrazine and 2,4-D were the most frequently detected pesticide compounds; both were detected in 46 percent of the lakes sampled. Neither Glyphosate nor the Glyphosate degradate, AMPA, were detected in any Minnesota lake. With the exception of the two insecticide detections, all pesticide concentrations were well below the applicable water quality benchmarks. Total pesticide concentrations were generally higher in western and south-central Minnesota lakes and lower in north and northeast Minnesota lakes.

Chemicals of emerging concern

As part of the 2017 NLA study, 50 lakes across Minnesota were randomly sampled and analyzed for 157 chemicals of emerging concern, including pharmaceuticals and personal care products, hormones, and other commercial or industrial chemicals not routinely analyzed in surface water. Of the 157, 55 were detected, including antidepressants, antibiotics, and hormones. While the data for the 2017 study have not yet been finalized, Figure 1 shows the results of a similar study of these chemicals in the 2012 NLA survey (Ferrey 2013). In that study, the insect repellent DEET was found in 76 percent of the lakes sampled, making this chemical the most frequently discovered in lake water. Endocrine active chemicals – chemicals that behave like hormones, including bisphenol A and nonylphenol – were frequently detected as well. Figure 1 shows that several medications were found, all at very low concentration. The sources and mechanism of transport of these contaminants to many of these lakes are not entirely clear. However, the results of these studies for 2012 and 2017 considerably broaden our understanding of the types of contaminants found in Minnesota's lakes.

Zooplankton

The crustacean zooplankton community is an important component of the aquatic food web. Zooplankton are known to be efficient phytoplankton grazers as well as primary food sources for larger invertebrates and young-of-the-year-fish. Studies have shown promising results using crustacean zooplankton as indicators of lake productivity and changing environmental conditions. Because of their importance in the aquatic food web and use as indicators of lake productivity, coupled with the opportunity to document the distribution of species from a randomly selected cross section of Minnesota lakes, the collection of crustacean zooplankton was included in both the 2012 and 2017 Minnesota National Lakes Assessment studies.

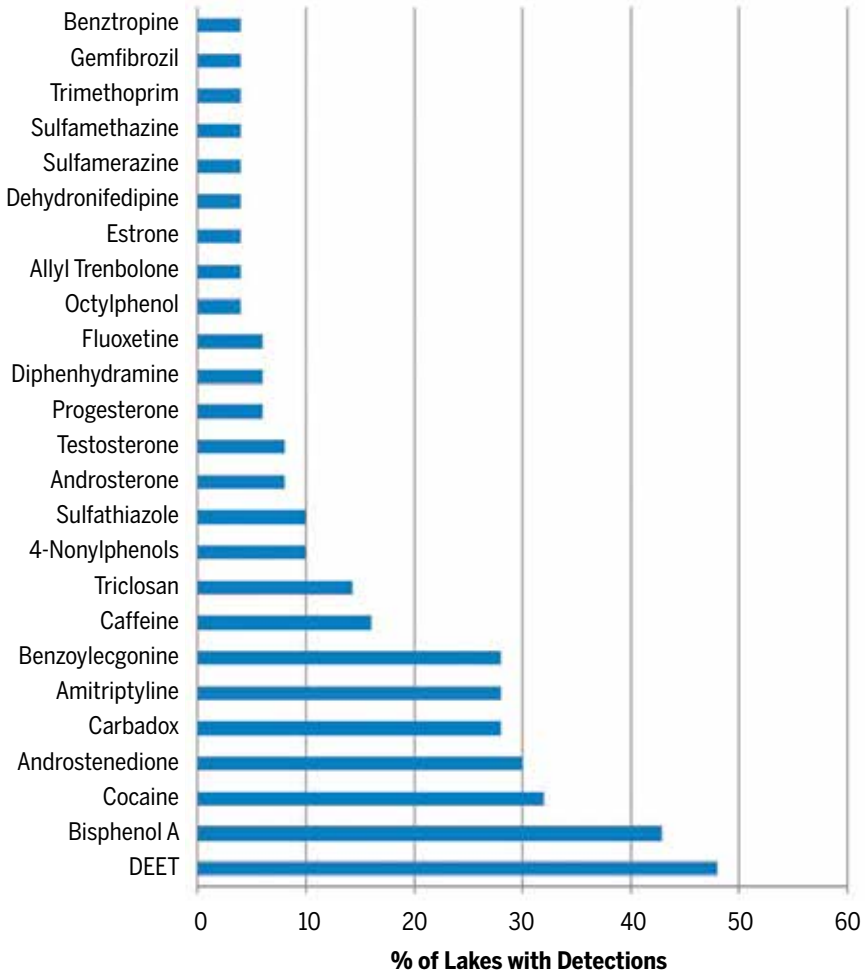

Figure 1. The Detection Frequency of Individual Chemicals Found in a Random Sampling of 50 Minnesota Lakes.

During both assessment years, we found significant differences in total zooplankton densities and biomass between lakes in the three different ecoregions of Minnesota. Higher densities were generally found in lakes in the southern portion of the state, and lower densities in northern Minnesota lakes. In addition, individual species distributions were documented across the state, and one species of particular interest was *Daphnia longiremis*. This daphnia is a cold-water species found below the thermocline in well-oxygenated deep lakes. During both assessment years, we found this species present only in the north-central portion of the state, in lakes greater than 15 meters deep. In 2017, we found *Daphnia longiremis* in only three lakes (Figure 2). In contrast, the more ubiquitous *Daphnia pulicaria* was present in 33 of the lakes sampled across the state. Similar distributions of these species were found in the 2012 assessment as well (Hirsch 2014). Documenting the presence of these less common species such as *Daphnia longiremis* is valuable, as they may be important indicators of lake changes such as increasing eutrophication and warming waters due to climate change.

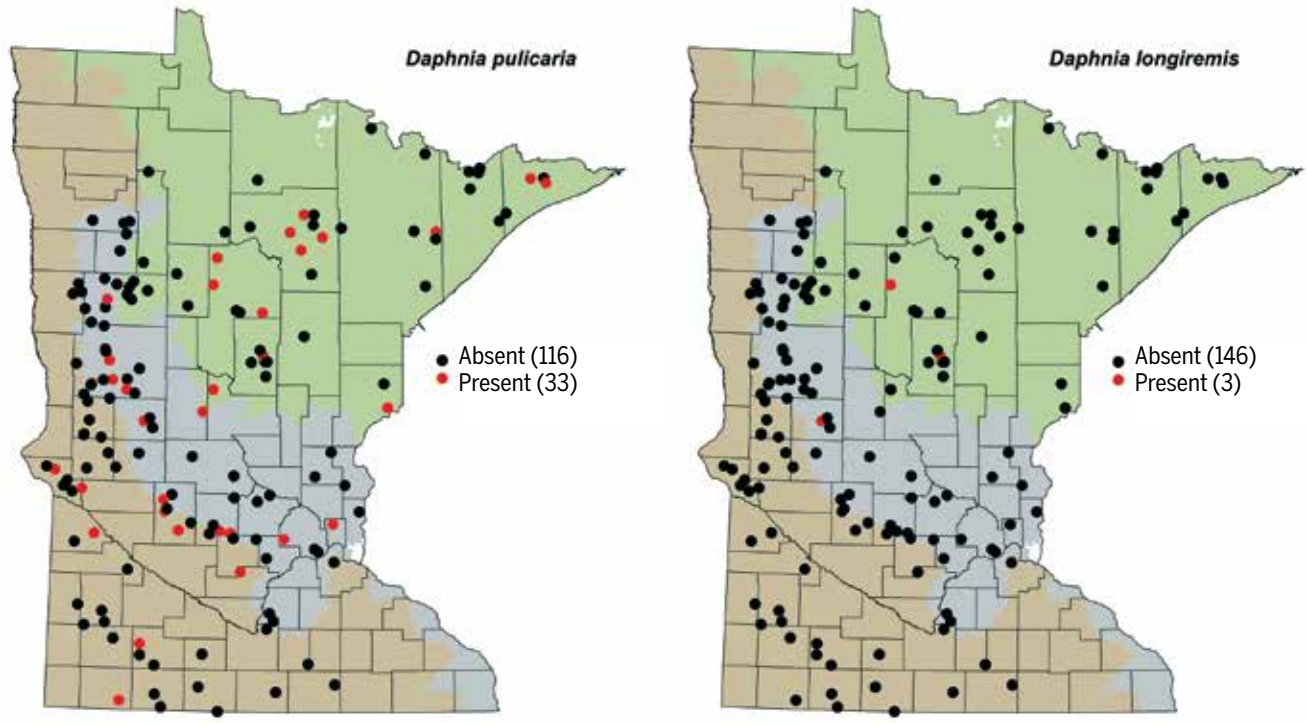

Figure 2. Distribution of Daphnia pulicaria *and* Daphnia longiremis *in Minnesota NLA lakes, 2017.*

Algal toxins

The MPCA has collected algal toxin data in all three surveys (2007, 2012, and 2017). While the 2017 data set is not yet complete, the 2007 and 2012 work was reviewed to determine regional patterns in Minnesota. Heiskary et al. found that randomly measured microcystin concentrations are quite low in Minnesota Lakes and the concentrations in more eutrophic areas of the state have higher concentrations than less impacted areas (Heiskary et al. 2014).

New for the 2017 survey was the collection of samples for the analysis of Anatoxin-a; a potent neurotoxin produced naturally by cyanobacteria. Anatoxin-a samples were collected on 50 lakes utilizing the NLA survey design. Water samples were collected at a mid-lake site along with at a nearshore site location. The nearshore site was sampled to determine the presumed "worst case scenario," presumably yielding a higher Anatoxin-a concentration due to down-wind piling or better growing conditions for algal production. Anatoxin-a samples were analyzed by the Minnesota Department of Health and had a detection limit of 0.15 ug/L. Of the 50 lakes sampled, 12 were found to have a measurable concentration of Anatoxin-a. Concentrations ranged from 0.15 ug/L to 0.83 ug/L. In addition, five lakes had measureable concentrations at both the mid-lake and nearshore sites. This was the first statewide data collection effort to see what range of Anatoxin-a concentrations exist in Minnesota based on random sampling. A photo of an algal bloom observed on a Minnesota lake during the 2017 NLA work is shown in Figure 3. Concentrations that pose health threats to humans and animals are still the focus of research at the national level; there currently is no benchmark concentration to which MPCA can relate the results. Future data analysis will compare algal toxin concentrations and phytoplankton taxonomic data, collected at each NLA site, to determine what phytoplankton species were present at the time of sampling.

Technical reports are planned as data become available. Examples under consideration include ecoregion and statewide results from the 2017 survey, parameter-specific reports for add-on parameters (pesticides, zooplankton, algal toxins, etc.) and a comparison of survey results to Minnesota's condition monitoring results.

Figure 3. Algae bloom observed on Minnesota Lake during NLA sampling, 2017.

The Minnesota Pollution Control Agency received assistance from many partners, including the Minnesota Departments of Natural Resources, Health, and Agriculture, U.S. Forest Service (Superior and Chippewa National Forests), U.S. Department of Agriculture, US National Park Service (Voyageurs National Park), Red Lake Nation, Leech Lake Band of Ojibwe, Mille Lacs Band of Ojibwe, Fond du Lac Band of Lake Superior Chippewa, and White Earth Nation. It is our hope that results from the 2007, 2012, and 2017 NLA sampling efforts can benefit our partners' land and water management activities. Equally as important are the many landowners across Minnesota that allowed sampling crew's access to their private properties to sample lakes.

References

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