Minnesota is Performing Long-term Monitoring to Help Detect Climate Variability

Overview

Minnesota is thinking long-term when it comes to effectively monitoring their water resources and shaping management decisions that sustain water resources for future generations. Several statewide, long-term monitoring programs are taking steps to better understand and predict the effects of land use and climate change on Minnesota's lake, stream, and wetland resources. The information gathered from these efforts is being used to develop and inform management solutions that minimize the negative impacts caused by climate change.

Program Partners: Minnesota Pollution Control Authority (MPCA), Minnesota Department of Natural Resources (MDNR), USGS

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Background

Observed trends and future projections of climate change point to increased annual temperatures, more extreme weather events, droughts, and greater annual precipitation in Minnesota. Climate impacts leading to increased runoff are of particular concern, as greater pollution loads can degrade the health of receiving waters. The State's lakes and rivers are especially vulnerable to warming temperatures and changes in precipitation, among other climate threats. Climate related effects have already surfaced with the rise of invasive species, changing fish populations and suitable habitat, and reductions in water clarity.

To address these impacts, Minnesota formed an Interagency Climate Adaptation Team (ICAT) with members from the Pollution Control Agency (MPCA) and the Department of Natural Resources (MDNR), among others. ICAT released a report in 2010, *Adapting to Climate Change in Minnesota,* describing projected climate change impacts, State agency adaptation activities, and priority action items for all State agencies. The report called for improved climate research and monitoring efforts such as the *Sentinel Lakes Program* and *Long-term Biological Monitoring Reference Stream Network,* which monitor waterbody conditions in response to impacts from climate change and other major stressors.

The Sentinel Lakes Program

In partnership with MPCA, MDNR is leading a collaborative effort known as the Sentinel Lakes Program (SLP). SLP aims to monitor the region's major stressors and also evaluate the impacts these stressors have on the biological, physical, and ecological features of lakes to promote sustainable management. Climate change, invasive species, and changing land use and development were among some of the major stressors being evaluated.

While first phase of the Program (2008-2011) focused on intensive data gathering and exploring drivers of change, the second phase (2013-2016) involved evaluating a suite of metrics and identifying the most sensitive indicators of lake condition to establish a robust monitoring framework (see box). MDNR Fisheries, in conjunction with various State and local partners, selected and sampled 25 sentinel lakes that represent the State's major aquatic ecosystem types. These sites are being monitored for physical, chemical, and biological indicators and the data collected will serve a baseline for establishing trends in lake condition. The data collected will also improve overall understanding of lake ecosystems, how they react to stressors, and how stressors may interact synergistically. Monitoring and evaluating climate change effects on aquatic habitats will further allow the State to establish stronger cause and effect relationships, as well as predict future ecological responses to climate change and land use.

Lake specific assessment reports, monitoring strategies, and models were produced by SLP to better facilitate early detection of impairments to habitat and fish communities. The SLP proposed effective indicators and monitoring schedules for sentinel lakes, as well as for additional lake types

covering a broader geographic range. The data will allow MDNR and their partner organizations to establish climate-smart management strategies and policies that achieve sustainable lake systems. Moreover, the SLP data is helping managers evaluate the effectiveness of current best management practices and prioritize future monitoring actions.

Indicator Categories Evaluated by the Sentinel Lakes Program

- Climate change
- Habitat
- Fish Population Trends
- Land cover
- Human health

Climate Change Specific Indicators

- Evaporation
- Ice-off/on
- Lake levels
- Precipitation
- Relative humidity
- Solar radiation
- Tributary flow
- Wind energy

Fish Species Sensitive to Climate Change and Land Use

- Lake Trout
- Cisco
- White Sucker

As an outcome of SLP, additional research and modeling investigations have been performed to simulate Cisco habitat in lakes under future climate change scenarios, as well as the combined effects of future watershed land cover and climate change on cold water fish habitat. USGS used SLP's climate change specific indicators (see box) to build models that can predict future impacts of climate change and land use on water quality conditions. This research clarified the relationship between Cisco and key stressors, identified target fish species for monitoring climate change and land use, and informed the development of methods to monitor fish species sensitive to climate change and land use in lakes. After establishing land use and climate change are causing state wide decline in Cisco (Tullibees), MDNR launched the Tullibee Lake Watershed Forest Stewardship Project to financially assist private landowners with stewardship activities in vulnerable Cisco watersheds. Following a study with the University of Minnesota-Duluth to identify future cold water refuge lakes for Cisco, MDNR is acquiring and protecting land from development within the watersheds of five refuge lakes via Minnesota Forests for the Future.

Additional Long-term Biological Monitoring of Reference Streams and Wetlands

Started in 2013, the Long-term Biological Monitoring Reference Stream Network is comprised of 60 reference stations which are monitored to provide a better understanding of how reference conditions change over time due to climate change. The stations are evenly divided across all of Minnesota's ecoregions and stream types, and were chosen due to their minimal anthropogenic stress to help distinguish between naturally occurring and human caused changes. In the short-term, the Network will measure and evaluate the health of fish, macroinvertebrates, and plants to help quantify the temporal variability of bioindicators. Over time, the Network will help detect and account for climate change impacts in aquatic life use assessment and stressor identification processes, while also enabling the assessment of reference site drift and the potential need to revise aquatic life criteria.

MPCA is also performing long-term wetland monitoring at sentinel sites to assess whether large scale factors, such as climate change and atmospheric deposition, are impacting wetland quality. To date, the State has conducted two statewide surveys intended to provide baseline status, is linking wetland condition to the provision of ecosystem services, and identifying protection or restoration opportunities that can enhance water quality.

Image 1. The Cisco (or Tullibee) is an important source of food for large game fish. The Tullibee Lake Watershed Forest Stewardship Project has resulted in hundreds of landowners contacted, and nearly 200 of them have received low-cost private forest stewardship plans for a total of more than 20,000 acres. It also has provided over $100,000 in financial assistance for private land enhancements that benefit water quality.