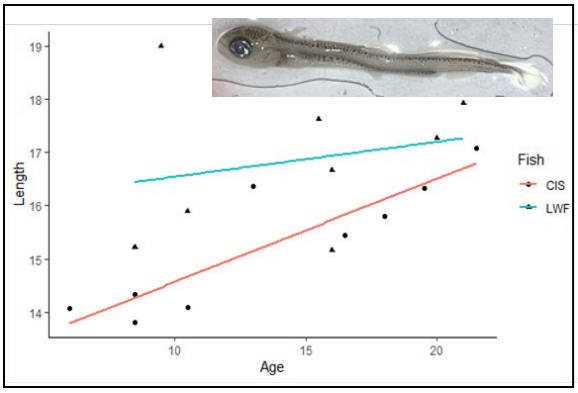
## Diet and growth of larval coregonines in the nearshore waters of Lake Michigan-Huron

Great Lakes nearshore zones, often defined as areas less than 10 meters deep, play a crucial role in the life history of many native fishes, as they provide nursery habitat for newly hatched fish. Nearshore areas are greatly affected by anthropogenic stressors such as sedimentation, nutrient addition, pollution, and climate change. Despite the importance of nearshore zones to native Great Lakes fishes, very little is known about ecology in this region.

Coregonus species lake whitefish (*Coregonus clupeaformis*) and cisco (*C. artedi*) rely heavily on these nearshore areas during several periods of their life history, including spawning, egg incubation, and larval development. Populations of lake whitefish and cisco have fluctuated dramatically throughout the upper Great Lakes since the early 1900s due to overfishing, predation, and changing environment. Since 2011, cisco have resurged in northern Lake Michigan, whereas lake whitefish have declined. Causes of differential recruitment, likely at early life stages, are not known but may include reduced nearshore zooplankton abundance following the dreissenid mussel invasion.

To determine if low food differentially affects young lake whitefish and cisco, I examined gut contents and growth of larval coregonines in relation to prey availability. I hypothesized that larval cisco would have higher prey intake at low prey densities, leading to growth rates surpassing those of larval Lake Whitefish. Tribal and state agencies collected larval fish and zooplankton samples at nearshore sites in 2019 and 2021. Ages were determined via otolith daily growth rings and lengths via imaging software. Zooplankton were enumerated and larval fish identified to species genetically.

Prey densities were exceptionally low in nearshore waters. Larval growth rates were positively associated with prey density and availability of midge larvae.




Larval Lake Whitefish (n = 8) and Cisco (n = 9) growth from a northern Lake Huron site. Larval Cisco were smaller in size but grew more rapidly than larval Lake Whitefish at this site in 2019.

Larval cisco consumed smaller prey items than larval lake whitefish. Larval cisco started out smaller than larval lake whitefish but grew faster (see figure). Fast larval growth amidst low prey availability could give cisco an advantage over lake whitefish in the northern Lake Michigan-Huron region.

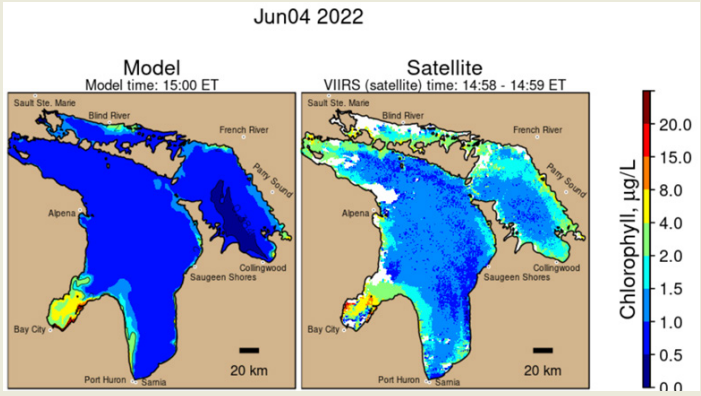
*By Kelly Hoyer, Central Michigan University.*

## An Experimental Biophysical Nowcast-Forecast System for Lakes Michigan and Huron

Declining offshore productivity in lakes Michigan and Huron has been a multi-decadal trend causing scientists to investigate the importance of nearshore primary productivity in supporting the lakes' fisheries. However, the dynamic nature of the nearshore environment in the Great Lakes makes studying these areas inherently challenging. Shifting currents, variable tributary nutrient inputs and flows, and coastal upwelling/downwelling effect a dynamic and patchy pattern of primary productivity "hot spots" in the nearshore that can be difficult for field researchers to locate and sample.

The Cooperative Science and Monitoring Initiative (CSMI) is a binational effort to coordinate research priorities and monitoring activities on one of the five Great Lakes each year. Research priorities guiding the CSMIs for Lake Michigan (2020) and Lake Huron (2022) included studying the importance of tributaries and nearshore areas to lake productivity and the need to focus sampling efforts on these productivity hot spots. The NOAA Great Lakes Environmental Research Laboratory and Cooperative Institute for Great Lakes Research, with funding from the U.S. Environmental Protection Agency, developed an Experimental Biophysical Nowcast-Forecast System for Lakes Michigan and Huron.

The experimental forecast system simulates lake hydrodynamics and the influence of runoff and phosphorus inputs from 124 tributaries on spatial patterns of chlorophyll-a concentration and dissolved organic carbon (DOC). Chlorophyll-a and DOC are displayed as indicators of the influence of rivers on primary productivity and as a tracer of river water as it disperses into the lake,




A comparison of model to independent satellite observations of Lake Huron chlorophyll concentrations from June 4, 2022. Transport of productive waters from Saginaw Bay near Bay City (highlighted in brighter colors) down to Port Huron, Michigan, is a common spatial pattern that emerged in the model and was confirmed by satellite imagery.

respectively. The same two variables are compared side by side to recent satellite imagery obtained from the Great Lakes CoastWatch node. In addition, the archived model and satellite imagery from past dates provide context to observations, and inform planning of future surveys. Use of biophysical nowcast-forecasts and recent satellite imagery to support field research may lead to new insights on transient features, such as river plumes and productivity hot spots, in dynamic nearshore areas. *Learn more about the physical model and development of the biophysical model.*

*By Mark Rowe, NOAA GLERL, and Peter Alsip and Aubrey Lashaway, CIGLR.*