CONSTRUCTING THE NEARSHORE LAKE MICHIGAN FOOD WEB USING MULTIPLE TROPHIC INDICATORS

A joint proposal to:

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OVERVIEW

Abstract
Food web studies in Lake Michigan have focused primarily on the pelagic food web, due to significant role of pelagic fishes in both commercial and sport fisheries. The trophic ecology of several nearshore species, particularly yellow perch, has received attention, but the nearshore food web as a whole is not well studied. The current need for a study of the nearshore community is highlighted by several recent changes that have occurred in Lake Michigan: 1) The populations of several indigenous fish species have drastically declined. These losses appear to be due at least in part to changing trophic structure related to the establishment of non-indigenous species, but the precise trophic interactions are poorly understood. 2) There has been an increase in the flow of energy to the nearshore zone, in the form of benthic algae (primarily *Cladophora* sp.) and dreissenid mussels. But there are few data to determine the degree to which this "new" energy source is being utilized by higher trophic levels. This is especially critical in light of recent declines in pelagic food sources, including plankton and the benthic amphipod, *Diporeia*. 3) In many parts of the lake the nearshore fish community has changed from one composed of a mixture of species with moderate numbers to one dominated by high densities of the round goby, whose trophic role is not well understood. We will use a combination of three methods – stomach content analysis, fatty acid analysis, and stable isotope analysis - to construct the nearshore food web and assess how it varies with substratum and location. Results will be used to determine how individual species have responded to change in community structure and energy flow. The information from this study will also be used to inform a Lake Michigan bioenergetics model.

Objectives
Our goal is to provide as complete a description of trophic linkages in Lake Michigan (with emphasis on the nearshore zone), and how these links vary with location and season. While we will attempt to define the trophic position of as many nearshore organisms as possible, we will focus on dominant pathways as revealed by previous studies and our initial sampling results. Specific food web components we will focus on include phytoplankton, zooplankton, *Cladophora*, benthic invertebrates (including dreissenid mussels), benthivorous fishes (especially the round goby, yellow perch, and spottail shiner), and piscivorous fishes (large yellow perch and lake trout). We will include other less studied fish species where they exist: mottled sculpin, longnose dace, longnose sucker, white sucker, and round whitefish. We will also create a foundation for a comprehensive, lake-wide program by including collaborative (no-cost) sampling in

Michigan and northern Wisconsin waters through cooperation with NOAA-GLERL, USGS-GLSC and WI DNR.

Methodology
Through a multi-institutional collaboration (University of Wisconsin-Milwaukee, Purdue University, Illinois Natural History Survey, and State University of New York), we will examine nearshore trophic structure at several locations spanning 200 km of Lake Michigan's southwestern shoreline. Auxiliary samples will also be obtained from other locations along the lake's eastern and northwestern shores through collaboration with several state and federal agencies. Plankton, fish, benthic invertebrate, and benthic algae samples will be collected at three rocky and three sandy nearshore sites, during three seasons, using standardized sampling methods – plankton nets, gill nets, and a benthic airlift sampler operated by SCUBA divers. This will allow for a comparison of the relative abundance of the various taxa among sites. CTD profiles and continuous, in situ temperature loggers will be used to determine whether sites differ with regard to temperature and other basic water quality parameters. To determine trophic positions, we will use a combination of stable isotope (C, N, H and O) analysis, fatty acid analysis, and stomach content analysis. The results of the three methods combined will be used to identify basal carbon source (phytoplankton vs. benthic algae) and trophic level for each species, as well as specific predator-prey linkages and the existence of any food web compartmentalization.

Rationale
The results of this proposed study will help to determine the extent to which relatively new nearshore energy sources in Lake Michigan support the lake's food web, and the roles of different fish species (including understudied species) within this restructured food web. This information has application in determining the carrying capacity for individual species, the movement of contaminants, and the potential for nearshore energy sources to offset the losses from the pelagic zone. Further, upon completion of our project we will contribute spatially-explicit data on understudied fish species abundance to the Great Lakes GIS project (glfc.org/glgis) to facilitate future spatial analyses of these data. While a complete nearshore dynamic food web model is beyond the scope of this study, the information on trophic links, fish species relative abundance, and size structure collected in this study, along with known bioenergetics parameters for some species will allow for the application of species-specific bioenergetic models, which will facilitate the prediction the response of Lake Michigan fish populations to any further changes to the food web base, and guide management decisions related to nutrient loading and fish stocking.

Keywords
Food web, stable isotopes, fatty acids, nearshore, benthic