Diets and Condition of Forage Fish in Southern Lake Huron

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Overview

As part of a multi-agency research group (Year of Lake Huron) working on Lake Huron during 2007, we collected lower food web data along a transect in southern Lake Huron near Harbor, Beach, MI. Sampling took place in May, July, and October 2007. We will evaluate the seasonal diet composition, diet selectivity and depth distribution of forage fish in southern Lake Huron. The focus of this work is to examine food web linkages in an area of Lake Huron where *Diporeia* have been nearly absent for at least 7 years and to provide a cross lake comparison with data collected in Lake Michigan during 2000-2002. This comparison should provide researchers with an improved ability to predict generalities about the impact of *Diporeia* declines on fish production and condition across systems and make more informed management policies. Work for 2008 will be confined to data processing and analysis.

Objectives

Increase number of regional coastal and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood.

Meet annual targets for the number of coastal, marine, and Great Lakes ecological characterizations that meet management needs.

Proposed Work

During 2008, work focused on analyzing samples collected in 2007. To date, all fish diets and condition analyses, and nearly all zooplankton and benthos analyses are completed. Ongoing work includes preparing manuscripts that integrate results with those of other agencies and using data for inter-lake comparisons with lakes Michigan and Erie to further our understanding of ecosystem processes within the Great Lakes.

Accomplishments

- Quantify abundance, diet composition, diet selectivity and condition of Rainbow Smelt, Deepwater Sculpin, Round Goby, and Bloater that were collected in May, July, and October 2007
- Quantify zooplankton abundance (including *Mysis*) and species composition for samples collected in 2007.
- Quantify abundance of predatory cladocerans (*Leptoodra, Bythotrephes, Cercopagis*) and their role in the food web as planktivores
- Quantify benthos abundance and composition for samples collected in 2007.

- Compare results for diets and selectivity to data collected in Lake Michigan during 2000-2002.

Scientific Rationale

The Lake Huron food web is currently undergoing dramatic changes. The recent invasion and proliferation of Quagga mussels along with continued rapid declines of *Diporeia* may be altering lower food web pathways and impacting fish production. For example, in Lake Michigan, the decline of *Diporeia* altered diets of some planktivores, shifting diet composition to alternative prey including zooplankton and *Mysis* relicta (Hondorp et al. 2005). On the other hand, some fish species such as deepwater Sculpin continued to eat *Diporeia* regardless of their abundance in the environment (Hondorp et al. 2005). Condition of some fish including deepwater Sculpin and Alewife was also lower in areas of Lake Michigan where *Diporeia* were rare (Hondorp et al. 2005. Recent declines in forage fish abundance in Lake Huron, particularly Alewives, have been attributed to high predation from naturally reproduced Chinook Salmon that had not been accounted for in food web models (J. Johnson pers. comm.). Data from Lake Michigan suggests the loss of *Diporeia* may further exacerbate high predation demands on Alewife because as Alewife condition declines, Salmon are forced to eat more prey in order to maintain growth rates (Madenjian et al. 2006). Finally, despite declining abundances of planktivorous fishes, zooplankton abundance in Lake Huron is declining and cladocerans and some copepod taxa are nearly absent from many areas of the offshore zooplankton community (R. Barbiero, pers. comm.).

There is little information on which invertebrate prey groups currently support forage fish production in Lake Huron. Recent data from southern Lake Huron indicate that Lake Whitefish, a benthivore, now eat mainly Quagga mussels, chironomids, and fish, despite fairly low numbers of Quagga mussels and chironomids in the region (Pothoven and Nalepa 2006). *Diporeia* were completely absent from Lake Whitefish diets in southern Lake Huron during the 2002-04 study. Although we anticipate that pelagic forage fish such as Alewives and Rainbow Smelt will include higher proportions of zooplankton or *Mysis* in their diets following the decline of *Diporeia*, it is unclear whether they will be able to replace the actual diet biomass formerly filled by *Diporeia*, especially given recent declines in some zooplankton taxa. In Lake Michigan, bioenergetics modeling indicated that Alewives simply ate less overall food and grew slower after the decline of *Diporeia* (Pothoven and Madenjian, in press).

Sculpins are of particular interest when examining the effects of *Diporeia* declines on forage fish because they are obligate benthivores. Data from Lake Michigan indicated that in an area where *Diporeia* were rare, slimy Sculpin ate alternative prey but deepwater Sculpin still ate considerable amounts of *Diporeia*. The comparison of Sculpin depth distribution and diet composition between Lake Michigan and Huron is particularly interesting, because in Lake Huron, in contrast to Lake Michigan, the Sculpin community is dominated by one species (deepwater). It is possible that changes in prey composition/abundance could be impacting competitive dynamics between the historically more abundant deepwater Sculpin and the less abundant slimy Sculpin in Lake Huron, as well as in Lake Michigan.

There was a major emphasis to evaluate the Lake Huron food web in 2007 by several agencies including USGS-GLSC, Environment Canada, and the US EPA. Of particular interest is developing an understanding of the fish-zooplankton interactions. For example, there is concern that in the absence of fish predation, the invasive predatory cladoceran Bythotrephes may now be a dominant planktivore in the system and could control fish production in the future. Most work by these partners took place in the northern portion of the lake, or strictly in offshore waters. Our work focused on the southern basin and nearshore-offshore gradients. *Diporeia* have been in decline in the southern basin since at least 2000, and the area provides an ideal comparison to southern Lake Michigan, where similar drastic declines of *Diporeia* were observed.

Sampling took place in 2007 in the southern basin of Lake Huron between Harbor Beach, Michigan and Goderich, Ontario. Sampling occurred seasonally, spring (May), summer (August), and fall (October). Sampling occurred along a transect from nearshore to offshore at depths of 18, 37, 46, 55, 66, and 90m where USGS and EPA sampling routinely take place. At each station, sampling took place during day and night. During the day, zooplankton were collected with vertical net tows (in duplicate with 153 um and 64 um mesh nets), water was collected for chlorophyll, silica, and phosphorus analysis, benthos were collected with a ponar grab, and fish were collected with a bottom trawl. At night, *Mysis diluviana* were collected with vertical net tows (1000 um mesh) and fish were collected with bottom trawls. Additional samples of zooplankton were collected by the EPA during months that we did not sample (June, July, September).

Results

1. To date, all *Mysis* samples have been analyzed. *Mysis* numbers were very low in the region, ranging from 2-15/m2 in May, and 0-28/m2 in July. There is essentially no historical *Mysis* catch data for comparison in this region of Lake Huron.
2. The main planktivore captured was bloater. Nearly all bloater stomachs have been analyzed (n=221). During both May and July, zooplankton were the main prey eaten, with few *Mysis* and no *Diporeia* found in bloater stomachs.

Governmental/Societal Relevance

Changes in the lower food web can alter production potential for important commercial and recreational fisheries. Fishery managers need to understand how changes in the lower food web are contributing to altered fish production, so they can adapt public expectations and alter management strategies to ensure sustainable and healthy fisheries. Managers need to account for changes in forage fish condition that could affect survival, reproduction, or energy available to higher trophic levels. By collecting data that is directly comparable to similar data sets from Lake Michigan, we can begin to make broader generalizations about how dreissenid induced changes are altering fisheries in the Great Lakes.

Relevance to Ecosystem Forecasting

This project will help us predict changes in fish distribution, diets, and condition following dreissenid mussel induced changes in southern Lake Huron. There is a clear need to understand how invasive species are impacting the food web so ecosystem models can be changed to reflect the changes. This project will help provide an understanding of which pathways in the lower food web support forage fish production, and which prey are currently supporting forage fish production in the southern Lake Huron. The data will provide insight into the capacity for macroinvertebrate and zooplankton prey to continue to support forage fish production and if production should be expected to increase or decrease in the future based on current food resources for forage fish. The project will also provide data to better model how ongoing changes in the food web will impact commercial and recreational fisheries and make better predictions on the outcome of management decisions.

The project provides the framework for a cross-system comparison of dreissenid induced changes (i.e. *Diporeia* declines) on fish diets, distributions, and condition. By understanding similarities and generalities of food web linkages and dreissenid induced changes across systems, modelers can better predict the long-term consequences of dreissenids and future invasive species on fish production.

Products

Presentations

Pothoven, S. A. and Nalepa, T. F. *Fish diets and condition in Lake Huron*. (poster). 51st Conference on Great Lakes Research, IAGLR, May 19-23, 2008; Peterborough, Ontario

References

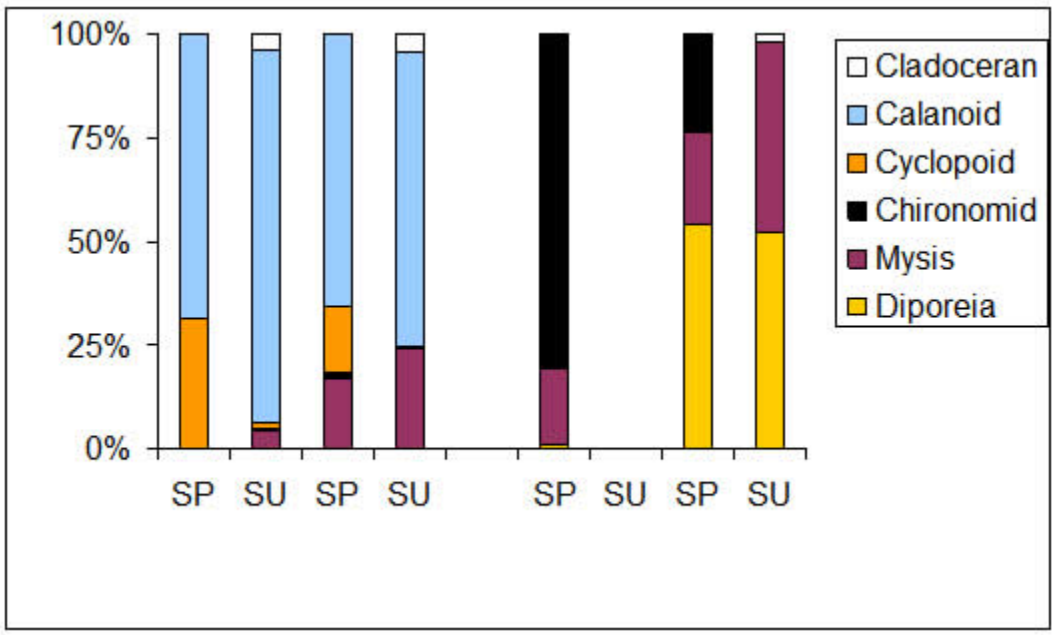
Hondorp, D. W., S. A Pothoven, and S. B Brandt. 2005. Influence of *Diporeia* density on diet composition, relative abundance, and energy density of planktivorous fishes in southeast Lake Michigan. *Transactions of the American Fisheries Society* 134:588-601.

Madenjian, C. P., S. A. Pothoven, J. M. Dettmers, and J. D. Holuszko. 2006. Changes in seasonal energy dynamics of Alewife (*Alosa pseudoharengus*) in Lake Michigan after invasion of dreissenid mussels. *Canadian Journal of Fisheries and Aquatic Sciences* 63:891-902.

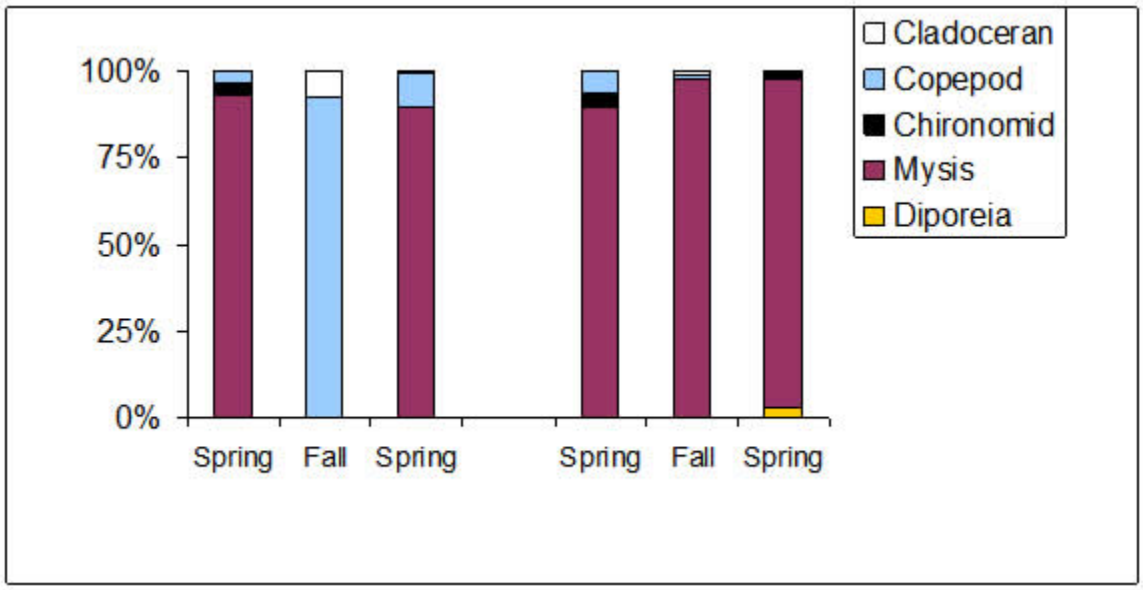
Pothoven, S.A., and Vanderploeg, H. A. 2004. Diet and prey selection of Alewives in Lake Michigan: seasonal, depth, and interannual patterns. *Transactions of the American Fisheries Society* 133:1068-1077.

Pothoven, S. A. and Nalepa, T. F. 2006. Feeding ecology of Lake Whitefish in Lake Huron. *Journal of Great Lakes Research* 32:489-501.

Additional Information



Diet composition (% total calculated dry weight) for bloater in Lake Huron in spring (SP) and summer (SU) 2007 compared to Lake Michigan (1998-2002). Both small (‹ 120 mm) and large (120-205 mm) bloater in Lake Huron were much more dependent on zooplankton, particularly calanoid copepods, than in Lake Michigan. Mysis were consumed mainly by large bloater, and accounted for 17-24 % of the diet in Lake Huron, and 22-45% of the diet in Lake Michigan. Diporeia were important for large bloaters in Lake Michigan, but were not found in bloater diets in Lake Huron. Chironomoid larvae and pupae were also important diet items in Lake Michigan during spring.



Diet composition (% total calculated dry weight) for rainbow smelt in Lake Huron in spring and fall 2007 compared to Lake Michigan (1998-2001). Mysis were an important part of the diet for both small (‹ 90 mm) and large (90-132 mm) rainbow smelt in both lakes. However, in the fall, small rainbow smelt in Lake Huron relied mainly on calanoid copepods as prey. Diporeia were rarely eaten even when available in southern Lake Michigan.