Final Report

Lake Trout Reproduction at the Mid-Lake Reefs, Lake Michigan.

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Introduction

These United States Fish and Wildlife Service Restoration Act projects targeted evaluation of lake trout restoration efforts at Lake Michigan's Mid-Lake Reef Complex. The Mid-Lake Reef Complex was, historically, one of the most important sites for natural reproduction of lake trout in Lake Michigan. Lake Michigan, historically, produced the greatest harvest of lake trout prior to their extirpation. Offshore stocking of lake trout at these reefs began in the late 1980's and our effort was focused on both preliminary evaluation of success as well as technological development of new techniques applicable to deepwater habitats. These projects overlap in many ways, including their titles, so the final report is a composite.

Objectives

2003-2004.

(1) Map part of the Mid-Lake Reef Complex where we have seen the largest numbers of presumptive lake trout and successfully collected live eggs and egg predators.
(2) Characterize where eggs incubate, using ROV
(3) Use ROV to collect live eggs, embryos, larvae, and their predators

2004-2005.

(4) Make improvements to the ROV based suction sampler to generate microhabitat-specific relative abundances of lake trout eggs and sac-fry at the Mid-Lake Reef Complex.
(5) Beam trawl for post sac-fry lake trout to further out knowledge of the fry habitat relationships.

Results

Objective 1. The maps, based on multibeam sonar, have been constructed and versions of East Reef and Sheboygan Reef are published in Janssen et al. (2006) The maps have also been archived, along with the bathymetry data, with the Lake Michigan GIS (http://www.glfc.org/glgis/support_docs/html/lake_GISs/LMGIS_index.htm).

Objectives 2and 3. The maps vastly improved our ability to locate likely spawning habitat and collect eggs, with one site at Sheboygan Reef and three sites at East

Reef. The improvement went from a total of 2 eggs collected prior to mapping, to several hundreds in 2003 and 2004, to almost 2000 eggs in 2005. In addition, our ability to find, videotape, and collect lake trout fry has improved greatly. Our current archive of lake trout fry, while sparse, is about 20 fry, sufficient that we can initiate genetic analyses of the survivors of egg incubation.

Objective 4. The suction sampler is now able to view the collection from individual sampling events and deposit viewed samples in a composite chamber. The viewer does not "see" all of the eggs, we think because the eggs are often lodged inside of dead quagga mussel shells. None-the-less, we have been able to demonstrate that eggs are concentrated at features, such as Edsall Ridge on Sheboygan Reef (see Janssen et al. in press, Fig 4. attached PDF), similar to where they are deposited on shallow reefs. In addition, we now have documentation of egg deposition at 60 meters at East Reef. This means that the amount of area that might get egg deposition at the Mid-Lake Reef Complex may be much larger than anticipated.

Objective 5. We beam trawled on Sheboygan Reef three days in 2005 and on East Reef three days in 2006. We collected no lake trout fry on Sheboygan Reef and four lake trout fry on East Reef. One of the fry from East Reef had prey and one had a filled swim-bladder, probably indicating a successful excursion to the water's surface and back down. The trawling has been primarily done on an exploration basis, with maximal coverage of both reefs. The Sheboygan Reef results were disappointing, but, our suction sampling suggests that eggs are deposited at lower densities at Sheboygan Reef than at East Reef. The results at East Reef, while sparse, are encouraging, especially because the spawner lake trout densities may be near a "critical mass" above which much greater recruitment can occur.

Additional accomplishments: The unanticipated collection of a large number of lake trout eggs and embryos in fall, 2003 and their fairly successful incubation allowed collaboration with a team of geneticists to produce a preliminary analysis of the what lake trout strains are producing viable eggs. The results are presented in deKoning et al. (2006) and they indicate that the Seneca strain is dominant. The Seneca strain is also relatively abundant among the spawner strains.

A graduate student is completing his M.S. thesis on the distribution, diet, and abundance of slimy sculpins at Sheboygan Reef and East Reef. This is pertinent to our long-term goals as slimy sculpins appear to be consuming a large number of lake trout eggs and also appear to be very abundant. The study has also produced information about *Mysis* abundance at the mid-lake reefs. *Mysis* is an important diet item for lake trout fry elsewhere in the Great Lakes and the young lake trout may (or could) be competing with slimy sculpins for this prey at the Mid-Lake reefs.

Papers

There are three papers resulting from this work.

Janssen et al. (2006) is essentially a "foundation" paper in which we present the new bathymetry maps, physical descriptions of habitats where lake trout eggs and fry are found, document egg predation, and provide conservative estimates of egg/embryo/fry viability.

DeKoning et al. (2006) presents genetic analyses of eggs and embryos collected in 2004. This forms the basis for an upcoming genetic project supported by the U.S. F. W. S.

Janssen et al. (in revision) anticipates many of the new directions that the research needs to pursue for successful re-establishment of deep-water lake trout. Challenges to lake trout spawning in deep water include annual temperature cycles that are different from those in shallow water, difficulties regarding swim-bladder inflation, and difficulties regarding food supply in deep water for first-feeding fry. We present some new data, including a preliminary analysis of relative egg density across Edsall Ridge on Sheboygan Reef.

DeKoning J, Rhydderch, J., Noakes, M., Keatley, K, R. and Janssen, J. 2006. Genetic analysis of wild lake trout embryos recovered from Lake Michigan. *N. Amer. J. Fish. Manage*. 135:399–407.

Janssen, J., Jude, D. J., Edsall, T. A., Paddock, R. W., Wattrus, N., Toneys, M., and McKee, P. 2006. Evidence of lake trout reproduction at Lake Michigan's mid-lake reef complex. *J. Great Lakes Res.* 32: 749-763.

Janssen, J, Marsden, J.E., Bronte' C. R., Jude, D. J., Sitar, S. , and Goetz, F. W. in revision. Challenges to deep-water reproduction by lake trout: Pertinence to restoration in Lake Michigan. J. Great Lakes Res.

Presentations

Janssen, J and P. McKee. Evidence of lake trout reproduction at the mid-lake reef, Lake Michigan. Wisconsin Chapter of the American Fisheries Society. Jan. 2003

Janssen, J., Jude, D., McKee, P., and Meadows G. Lake trout reproduction at the Lake Michigan Mid-Lake sea mounts. IAGLR . June 2003

Janssen, J. Limnology and/or Oceanography? Invited presentation for the National Underseas Research Program Retirement Conference in honor of Dick Cooper. April 30, 2004.

Janssen, J., R. L. Cuhel, C. Aguilar. Seamounts in the Great Lakes? IAGLR, Ann Arbor (May, 2005)

Janssen, J., R. Paddock, and N. Wattrus. Lake trout spawning habitat at Lake Michigan's Mid-Lake Reef Complex. State of Lake Michigan Meeting, Green Bay, Nov., 2005