Habitat and Wildlife Protection and Restoration Projects for the Great Lakes Restoration Initiative

The Great Lakes Restoration Initiative (GLRI) is an interagency program that addresses the most significant environmental problems in the Great Lakes ecosystem. Results from U.S. Geological Survey (USGS) scientific studies and monitoring are helping guide the restoration effort. The GLRI is made up of five focus areas that address these issues:

- Cleaning up toxic substances and areas of concern
- Combating invasive species
- Promoting nearshore health by protecting watersheds from polluted runoff
- Restoring and protecting habitats and wildlife
- Tracking progress and working strategically with partners

USGS project results are presented here for the habitat and wildlife restoration and protection focus area. More information is available on the USGS GLRI Web page (*http://cida.usgs.gov/glri/*).

Avian Botulism in Distressed Great Lakes Environments

Botulism outbreaks have contributed to die-offs of fish-eating water birds on the Great Lakes and are affecting ecosystem health. The USGS is investigating how ecological factors contribute to the production of botulism toxin by developing a rapid assay method, evaluating exposure pathways in the food chain, and identifying physical and biological linkages that drive outbreaks. The goal is to provide managers with options to break linkages that lead to botulism outbreaks.

Results include the following:

Assay Development

- An assay was developed to detect type-E botulism toxin (BoNT/E) rapidly and more effectively than current methods that take up to 5 days. Currently the assay is being tested on fish, invertebrate, and bird carcass samples.

Food-Chain Pathways

- Fish, invertebrates, zooplankton and sediment were sampled at fixed sites near Sleeping Bear Dunes National Lakeshore (SLBE) in northwestern Michigan along the shore of Lake Michigan. Sediment, mussels, and algae were sampled at randomly selected sites near SLBE. Preliminary analysis reveals that fish communities were dominated by round gobies. Fish diet analysis is ongoing.
- Using Polymerase Chain Reaction (PCR) and quantitative PCR (qPCR) techniques to sequence DNA, the samples collected at fixed and random sites were analyzed for the presence of the BoNT/E gene. The presence or absence PCR analysis has been completed for all mussel and Cladophora (green algae) samples and all sediment samples collected in 2010. Preliminary results suggest that vegetative *Clostridium botulinum* cells (bacteria that produce toxins) are widespread. The qPCR results will be analyzed to determine if there is a relationship to environmental conditions and food web structure.
- Benthic invertebrate samples, such as mussels, are being processed. Preliminary analysis has revealed high diversity in benthic communities. Benthic community structure will be related to presence of BoNT/E.

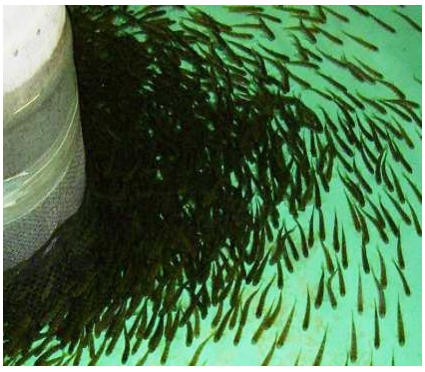
Waterbird Distribution Investigation

- Low-level, systematic aerial surveys were conducted over selected areas of northern Lake Michigan to document the fall distribution of waterbirds at risk for type-E botulism.
- Fall movements and foraging patterns of common loons were documented by tracking migration movements coupled with foraging (diving) depth profiles.
- Movements of radiomarked common loons are available on the Web (*http://www.umesc.usgs.gov/terrestrial/migratory_birds/loons/migrations.html*). This project is the first to collect data about how deep common loons dive to find food and when they feed. Loons dive as deep as 250 feet to find food.
- An aerial survey to document waterbird distribution of selected portions of northern Lake Michigan started in mid-September 2011 and and will run monthly between October 2011 and April 2012.

Lake Michigan Citizens Aid Research

- A citizen science program named Lake Michigan Volunteer AMBLE (Avian Monitoring for Botulism Lakeshore Events) was established. Knowledge of timing, numbers, and species affected by avian botulism has increased as a result of the volunteer efforts. USGS scientists are working with other groups around Lake Michigan that are monitoring bird mortality.
- During the development of AMBLE, enhanced partnerships were established with The Ridges Sanctuary, Wisconsin Department of Natural Resources, The Nature Conservancy, Northeastern Wisconsin Audubon Society, Crossroads at Big Creek in Wisconsin, the National Park Service SLBE, Common Coast Research and Conservation, and Tip of the Mitt Watershed Council in Michigan.
- Bird and beach data collected by volunteers from Door County, Wisconsin and SLBE have been and will continue to be compared to data collected by biologists in the Upper Peninsula of Michigan.
- Bird specimens are being submitted to the USGS National Wildlife Health Center to verify BoNT/E toxin related deaths.

Strategies to Restore Aquatic Habitats and Species—Lake Ontario



The USGS is identifying the techniques and strategies that are most likely to succeed in restoring native fish species. The goal is to accelerate the recovery of Atlantic salmon, deepwater coregonids (e.g., lake whitefish or lake herring), and lake sturgeon in Lake Ontario and improve the resiliency and stability of Great Lakes fish communities by enhancing ecosystem function.

Results include the following:

- To prevent the spread of fish diseases, a state-of-the-art water effluent treatment building was constructed to house the ultraviolet treatment equipment at the USGS Tunison Laboratory of Aquatic Science near Cortland, New York. The eggs and adults of wild Atlantic salmon and coregonids are scheduled to be raised at the station.

- About 100,000 juvenile Atlantic salmon were reared and released or will be released as as follows:
  - 70,000 fall fingerlings stocked in Lake Ontario tributaries
  - 10,000 fall fingerlings stocked in St. Lawrence River tributaries
  - 20,000 yearling smolts (young salmon) to be stocked in Lake Ontario tributaries

Fish Habitat Enhancement Strategies for the Huron-Erie Corridor

USGS scientists and partners have developed scientific strategies and methods and are improving techniques to address loss of fish spawning habitat in the Huron-Erie Corridor (St. Clair and Detroit Rivers and Lake St. Clair). The USGS and Huron-Erie Corridor (HEC) Initiative partners are developing science-based adaptive management strategies to help restore high fishery productivity in the HEC and to develop criteria that reduce fish habitat loss. In the future, fish spawning habitat will be constructed in areas that are suitable for all stages of the fish life cycle.

Results include the following:

- An integrated environmental assessment was developed that defines the restoration approach needed for the HEC.
- Innovative sampling techniques were developed to assess fish spawning and nursery habitat use in deep river systems.
- Spawning of endangered fish, as well as sport and commercial fish, has been documented for both natural and recently constructed habitats.
- Native fish spawning activity is much greater in the Detroit River than the St. Clair River, which demonstrates some success in restoring Detroit River habitats and suggests that restoration efforts in the St. Clair River also may be successful.
- Assessment surveys indicate that tributaries to the main river stems may be important contributors to fish population because better habitat conditions exist in tributaries than in main river channels.
- Because field-collected data have validated the modeled biological and physical conditions, the model will serve as the foundation for decisionmaking about spawning habitat restoration in 2012–13.

New Strategies for Restoring Coastal Wetland Function

To improve fish and wildlife habitat along diked coastal wetlands in western Lake Erie, the USGS is working to restore natural hydrologic processes in the Ottawa National Wildlife Refuge in Ohio. Since the 1860s, more than 95 percent of the original wetland habitats along the shoreline of western Lake Erie have been lost. Most of the remaining coastal wetlands have been isolated by earthen dikes that were constructed to protect habitat from wave attack and provide migratory waterfowl habitat. Although these diked wetlands are adjacent to the Lake Erie shoreline, they are hydrologically separated from the lake and no longer provide many of the functions and values of coastal wetlands. Aquatic animals with limited mobility are especially affected by the lack of hydrologically connected wetland habitats. Unfortunately, most of the few remaining undiked wetlands are severely degraded and cannot provide spawning and nursery habitat needed for about 43 fish species in the Great Lakes.

Results include the following:

- An innovative fish-passage structure was constructed to provide a hydrologic connection to a coastal wetland.
- Extensive data about fish, wetland vegetation, benthic (bottom-dwelling) invertebrates, birds, water quality, and hydrology ware collected to determine the status and trends of the wetland before and after restoration.
- Data collected using a cutting-edge device—Duel-Frequency Identification Sonar—at the fish-passage structure have shown that large numbers of fish are moving through the structure at all times of the day and throughout the ice-free year.
- Fish diversity and abundance in the restored wetland increased after wetland habitats were reconnected. Important commercial and recreational fish species are using the restored habitat.
- Water-quality sampling results suggest that about 62 percent of the total phosphorus in source water from Crane Creek was retained in the restored area during a 24-hour period in April. High levels of retention also were observed for nitrogen and other constituents demonstrating that the wetland is acting as a filter to water flowing into Lake Erie.
- The success of the reconnected wetland serves as a foundation for restoring six other western Lake Erie coastal wetlands.

Nutrient Transfer Changes Within Great Lakes Food Webs: Implications for Fish Production

USGS is conducting seasonal sampling of benthic invertebrates (such as mussels), zooplankton (such as copepods, a small crustacean), prey fish, sport fish, and their diets to supplement the seasonal lower trophic level (food chain) sampling by the U.S. Environmental Protection Agency (USEPA). This data will provide a more holistic understanding of how invasive-species-driven food web changes could be altering energy available to sport fishes in the Great Lakes and used to build ecosystem models and make cross-lake comparisons of food web changes. The study will help better understand nutrient transfer and the effects of invasive species on Great Lakes food webs.

Results include the following:

For Lake Michigan—

- An ecosystem model (based on data from 1987 to 2010) was completed. The model will be used to assist managers in making decisions about changes in fish stocking and to simulate various phosphorus loading scenarios.
- In collaboration with the Michigan Department of Natural Resources, 10 research surveys were conducted to collect the samples (listed below) at 2 northern Lake Michigan sites—Frankfort, Michigan, and Sturgeon Bay, Wisconsin. Samples were collected at depths of 18, 46, and 110 meters, unless otherwise stated, and all samples have been or will be analyzed for stable isotopes.
  - Chlorophyll and nutrients samples were collected, and some samples were frozen to estimate total phosphorus and nitrogen at a later date.
  - 140 Zooplankton samples were collected during the day and at dusk and were measured and counted in the lab to estimate species density and biomass.
  - At 46 and 100 meter depths, 100 *Mysis* (a small crustacean) samples were collected at night and preserved to be counted later to estimate biomass. Mysis density was estimated using dual-frequency acoustics.

  - Benthic invertebrates were collected and preserved to be counted later to estimate taxa-specific biomass.
  - Using the two methods listed below, 600 prey fish were collected so that species-specific density and diet could be determined.
    1. Bottom trawl samples were collected during the day to provide density estimates for invasive species such as ninespine stickleback, deepwater sculpins, slimy sculpins, and round gobies.
    2. A midwater trawl and acoustic sampling during the night was conducted to determine alewife, rainbow smelt, and bloater density and to provide depth-specific estimates of fish community composition.
  - 800 predator (piscivore) fish (lake trout and Chinook salmon) were caught with overnight gill-nets so their diet could be estimated.

For Lake Superior—

- USGS scientists collected and processed *Mysis*, benthic fish (those living near the lake bottom) and pelagic fish (those living near the lake surface) and identified trophic linkages using stable isotopes.
- USEPA scientists sampled and processed nutrients, phytoplankton (microscopic plants in the upper, sunlit part of the lake), zooplankton, and benthic organisms.
- Results of the sampling and analysis:
  - The most diverse fish fauna were found at all but the deepest depths.
  - A dominance of large, long-lived native fish species that undergo diurnal vertical migration was documented.
  - A widespread distribution of siscowet (lake trout) was found at all regions and all depths greater than 50 meters.

Great Lakes RESTORATION

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