COASTAL RESTORATION

Degradation and Restoration of Lake Michigan: Past and Future of Nonindigenous Species

Final Report

Objectives

Our overall goal is to provide quantitative descriptions of species characteristics that increase the probability of successful invasion. We then want to communicate this information so that management agencies may develop strategies to more effectively prevent future introductions. We are looking at invasion of the Great Lakes by fish in three different scenarios: invasion of Lake Michigan after glaciation; movement through one particular canal system, the Chicago Ship and Sanitary Canal (CSSC) system; and invasion of the Great Lakes from fish outside the Great Lakes drainage. To accomplish this overall goal, our proximate goals are listed below.

Goal 1. Development of fish species lists

No up-to-date lists of fish species inhabiting the Great Lakes, Lake Michigan or the Illinois River are available in the published literature. Therefore, our first goal is to develop these lists with the best data (published and unpublished) available. In addition, we need to determine whether each fish species is native or exotic to each of the basins, and the vector of introduction where applicable.

Goal 2. Collection of fish life history ecological characteristics from the literature

There are a number of characteristics that various authors have hypothesized are typical of invading species, e.g., young age at maturity, high fecundity, small (others say large) body size, and ability to withstand habitat degradation. We will test these ideas quantitatively by comparing the characteristics of fish species that invaded in each of the scenarios listed above (and described more fully in the Narrative below) to the characteristics of those fishes that did not. We first need to collect as many data as possible from literature sources on each fish species inhabiting the Great Lakes, Lake Michigan, and the Illinois River system.

Goal 3. Quantitative analyses

After accomplishing Goal 2 (collecting quantitative data on species characteristics), we will perform statistical analyses to determine if the tolerances or characteristics of fish species that have invaded during the three different scenarios differ from those that have not.

Progress Summary

First we will present findings that are common to all three scenarios and then detail findings unique for each one.

Goal 1.

Development of fish species lists. We developed separate lists of species of extant fish with reproducing populations for the Illinois River system (n = 129), Lake Michigan (n = 123), and the Great Lakes (n = 152). We also determined additional species that have been extripated from each water body (n = 9, 10, 6, respectively) and those that have been reported but are not yet established (n = 0, 9, 9, respectively). We also categorized each species as being either native or exotic to each drainage in which it was present.

Goal 2:

Collection of fish life history characteristics from the literature. We collected data on the same five environmental tolerances and 12 life history characteristics for each fish species. Environmental tolerance

variables were: size of native range (km2); turbidity tolerance (categorical variable ranked from very intolerant to very tolerant species); siltation tolerance (ranked same as turbidity tolerance); degree of lentic association (categorical variable from species found in lotic only, found in either type of environment, to exclusively lentic environments); and use by humans (categorical variable ranking species from species with no direct use, to being an important prey fish, used as bait, or supporting a sport or commercial fishery). Life history characteristics were: length (mm) at maturity; age (years) at maturity; annual fecundity (number of eggs produced per female per year); parental care (categorical variable ranking species from broadcast spawners to parental guarding of the nest and young fish); egg diameter (mm); egg duration (days until hatch from spawning); hatch length of larval fish (mm); two measures of relative growth rate (percent of mature length after 1 year, and after 2 years); diet breadth (number of types of food in diet—generally number of taxonomic classes consumed for animals and number of divisions for plants); longevity (years); and number of parasite species associated with fish species.

Goal 3.

Statistical Analyses. In each scenario, we conducted separate one-way analyses of variance (ANOVA) on each environmental tolerance and life history characteristic to determine if species that invaded were different than those that did not (in the first two scenarios) or from the native community (in the last scenario). In the second year, we will perform multivariate analyses to determine if invading species tend to possess a suite of characteristics.

Narrative Report

We have documented the number of veligers that move annual between Lake Michigan and the Chicago Canal System and have a preliminary estimate of the numbers of zebra mussel veligers moving from Lake Michigan into the Chicago Canal system and the Illinois River.

In 1997, during the summer spawning season for veligers in Lake Michigan,

- About 13.2 trillion veligers moved into the canal system from Lake Michigan.
- About 834 billion veligers reached Lockport, 37 miles downstream of Lake Michigan.

We have documented water quality in the Illinois River and Chicago Canal System from the late 1800's to the present. This extends currently published records of water quality over 30 years into the past, and 30 years to the present, allowing the evaluation of water quality in the Chicago Canal as a filter for movement of fishes. From the 1920's to the 1970's there were extended periods during which the dissolved oxygen in the Canal and as far downstream as Peoria Lake reached 0 mg/l.

We have begun documenting known dates of movement of fishes between the Illinois River system and Lake Michigan. Preliminary studies indicate that species have been able to move across the canal system only during periods of higher water quality. The exception is the Mosquitofish, whose first record in Lake Michigan was 1924. However, this species is extremely tolerant of low dissolved oxygen, and may be the exception that proves the rule.

Illinois River to Lake Michigan

- Gizzard shad 1884
- Mosquitofish 1924

Lake Michigan to Illinois River

- Round goby 1991
- Oriental weatherfish 1994
- White Perch 1991

As the water quality has improved, the canal system is no longer a barrier to aquatic organisms, and we might expect increased rates of exotic species introductions, unless we develop a barrier.

Accomplishments

Presented an invited lecture to the North American Benthological Society meeting in Prince Edward Island, Canada, on the initial results.

Back to Research Project List >> (../../research_coastal.php)

Research Information

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- **Initiation Date**: September 1, 1997
- **Completion Date**: August 1, 2000
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- ☐ AQUACULTURE (/topic_aquaculture.php)
- ☐ AQUATIC INVASIVE SPECIES (/topic_ais.php)
- ☐ CLIMATE CHANGE (/topic_climate.php)
- ☐ COASTAL RESTORATION (/topic_coastal.php)
- ☐ GREAT LAKES ECOSYSTEMS (/topic_glecosystems.php)
- ☐ GREAT LAKES LITERACY (/education.php)
- ☐ MEDICINE DISPOSAL (http://web.extension.illinois.edu/unusedmeds/)
- ☐ NATURAL LAWN CARE (/l2l.php)
- ☐ NUTRIENTS (/topic_nutrients.php)
- ☐ RECREATION AND FISHERIES (/topic_recreation.php)
- ☐ RESILIENT COMMUNITIES (/topic_resilient.php)
- ☐ WATER RESOURCES (/topic_water.php)

Products

- ☐ AQUACULTURE (/products_aquaculture.php)
- ☐ AQUATIC INVASIVE SPECIES (/products_ais.php)
- ☐ CLIMATE CHANGE (/products_climate.php)
- ☐ COASTAL RESTORATION (/products_coastal.php)
- ☐ EDUCATION (/products_education.php)
- ☐ FISH CONSUMPTION (/products_fishcon.php)
- ☐ GREAT LAKES HEALTH (/products_glhealth.php)
- ☐ LAND USE PLANNING (/products_landuse.php)
- ☐ MEDICINE DISPOSAL (/products_gros.php)
- ☐ PROGRAM (/products_program.php)
- ☐ NATURAL LAWN CARE (/products_lawncare.php)
- ☐ WATER RESOURCES (/products_water.php)

Resources

- ☐ ABOUT US (/about.php)
- ☐ CHICAGO WATER WALK APP (http://www.chicagowaterwalk.org/)
- ☐ FUNDING (/funding.php)
- ☐ NEWSROOM (/newsroom)
- ☐ OTHER WEBSITES (/other_sites.php)
- ☐ PEOPLE (/staff.php)
- ☐ PHOTOS (http://iisg.photoshelter.com/)
- ☐ SOCIAL SCIENCE (/glssn.php)
- ☐ TEACHERS (/education.php)

Careers

☐ **TEACHER TRAINING (/education.php)**

☐ **FELLOWSHIPS (/fellowships.php)**

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