Combating Invasive Species 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 combating invasive species focus area. More information is available on the USGS GLRI Web page (*http://cida.usgs.gov/glri/*).

Innovative *Phragmites* Control Strategies

The common reed (*Phragmites*) is an invasive wetland plant that continues to spread throughout the Great Lakes and have negative impacts on coastal resources, including critical fish and wildlife habitat and coastal views. Current control strategies are time, labor, and resource intensive, so innovative methods to control the spread of *Phragmites* or minimize its invasive properties are needed.

USGS scientists are testing strategies to reduce the invasive properties of *Phragmites* and minimize its competitive advantage. The project includes a two-pronged approach. First, organisms that may help *Phragmites* spread are being investigated and, second, a molecular genetic approach to silence the genes in *Phragmites* that allow it to reproduce and grow is being used.

Risk Assessment and Monitoring of Asian Carp

The following six projects are focused on assessing the risk of Asian carp surviving in the Great Lakes. USGS feeding trials and bioenergetics modeling are providing information for the first two projects. Bioenergetics is the study of the flow and transformation of energy in and between living organisms and their environment.

Risk Assessment of Asian Carp Establishment in the Great Lakes Based on Available Food Sources

Asian carp have been observed to diversify their diets beyond preferred pelagic plankton sources (those living near the lake surface) and feed on detritus (organic matter on the bottom of lakes and rivers) during certain conditions and on the basis of availability of food resources. Silver carp are also thought to derive substantial nutrition from bacteria, both consumed and cultured in the gut. However, it is not known whether these food sources are adequate for growth and survival and, therefore, whether Asian carp can sustain themselves in the Great Lakes.

USGS scientists tested an established bioenergetics model that indicates Asian carp cannot survive in Lake Michigan given the available food types. The model is updated as new findings on what the carp will eat, such as types of algae, are documented.

Asian Carp and Blue Green Algae Dynamics: Great Lakes Invasion Risk Assessment

Unfortunately, blue green algae blooms (primarily *Microcystis* species) resulting from invasive Zebra mussels may provide an excellent food source for Asian carp species and enhance the carp invasion. Under some circumstances, noxious blue green algal blooms, can be enhanced by interaction with silver and bighead carp, and the presence of the carp may enhance toxin production by noxious algae. Results from this project provides decisionmakers with information about the magnitude of risk posed by an invasion of the Great Lakes by Asian carp.

Asian Carp Habitat Suitability: Great Lakes Tributary Assessment

This project is focused on determining the minimum river length, water velocity, and water-temperature characteristics required for spawning and growth of bighead and silver carp in order to assess the risk of their creating a breeding population in Great Lakes tributaries. An additional component of the study is examining the developmental stages of Asian carp eggs and larvae and the water flow and temperature requirements for transport and survival. This information is being used to create a Tributary Assessment Tool that takes into account the river water velocity and dispersion rates and the water temperature (which affects the egg and larvae development rate) to determine whether a river is long enough for bighead and silver carp to spawn and for the eggs and larvae to be carried to nursery areas. Identifying tributaries suitable for Asian carp spawning will help focus management efforts, as well as locate sites to implement control actions.

Feasibility Assessment of Inter-Basin Transfer of Aquatic Invasive Species between Des Plaines and CAWS

The transfer of invasive species such as Asian carp (larvae, small fish, eggs, or environmental DNA) between the Mississippi River and Great Lakes watersheds may be occurring through surface and rock fractures or solution features (openings in rocks created by dissolving minerals) between the Des Plaines River and Chicago Area Waterways System (CAWS). Project research has been conducted, and the information is currently being analyzed.

CAWS Network Evaluation

The current status of streamflow monitoring stations on the Chicago Area Waterways System (CAWS) is not sufficient to evaluate Asian carp detection sampling programs in the CAWS or proposed waterway separation conditions. Hydraulic and water-quality models of the CAWS are important tools for data-based decisionmaking. Development and calibration of these models requires streamflow data from throughout the CAWS. The USGS-Chicago Waterway Observatory Web page (*http://il.water.usgs.gov/data/cwo/*) was created to compile historical flow and water-quality data from the CAWS into a single database to streamline model development and calibration.

Rapid Genetic Asian Carp Detection Method

The goal of this project is to develop and validate a genetic-based method that can compliment the current surveillance methods for Asian carp. Studies are being conducted by the University of Illinois and USGS to identify unique bacteria that colonize the different regions of the gastrointestinal tract of Asian carp and native planktivores (plankton-eating animals) and to identify the unique microbial population in Asian carp feces. Also, scientists are working to determine how the unique microbial population changes throughout the year and to develop a genetic method to detect Asian-carp-specific microbial populations. This information will help focus management efforts and locate sites to implement control actions.

Asian Carp Control Technologies

Seismic Technology to Divert or Eradicate Invasive Asian Carps

The goals of this study are to determine the sensitivity and avoidance behavior of Asian carp associated with sound energy levels emitted from a seismic water gun and the effectiveness of water gun technology in clearing fish out of an area and keeping them away from the cleared zone.

Characterizing these responses is important in establishing and deploying a sound energy barrier and in using a water gun for future management actions.

The water guns were used in autumn 2011 during maintenance of U.S. Army Corps of Engineers' Electric Barriers 2A and 2B to help remove fish from the area between the two barriers.

Further testing of the water guns will take place in spring 2012 to collect more information on using them to move or repel carp.

Seismic Monitoring for Asian Carp Water Gun Deployment

The purpose of this project is to collect the information needed to assess the distribution of seismic energy when the water guns are used within the Chicago Sanitary and Ship Canal and other parts of the Chicago Area Waterways System near O'Brien Lock and Dam so that engineers can determine potential impacts on the structures and canal walls.

Oral Delivery Platforms for Species-Specific Control

Developing new selective chemical control tools is essential to successfully implement an integrated pest management system for Asian carp. Developing target delivery systems with high specificity for bighead and silver carps would enhance the ability of management agencies to control or limit Asian carp while minimizing potential impacts to native species. The primary outcome of this project will be the development of a selective targeted delivery system of rotenone to control bighead and silver carp. Concurrently, a selective targeted delivery system of a mollusicide (a toxin poisonous to mussels) to control Zebra and Quagga mussels (*Dreissenid* mussels) is being developed.

Asian Carp Organs Susceptible to Encapsulated Toxicants

Current toxicants used to control aquatic invasive species are non-selective and applied throughout the entire water column, resulting in equal exposures of native and invasive species to the toxicant. Development of a delivery system that is selectively consumed by or active in an invasive species would reduce non-target species exposure to the toxicant and may enhance selectivity and reduce effects to non-target species. Development of such delivery methods require a complete understanding of native and invasive species gill and gut enzyme activity and physiology because a targeted delivery system would likely require uptake through the mouth or gills, with ultimate delivery to or through the digestive system.

Identification of Potential Compounds for Toxicant Screening to Identify Selective Toxicants for Control of Asian Carp

A lack of registered piscicides (toxins poisonous to fish) severely limits the tools that aquatic resources managers have available to control aquatic invasive fishes. The identification and registration of new piscicides will improve the ability of managers to deal with aquatic invasive fish. Chemicals with structure or activities similar to known piscicides were evaluated for potential use to control aquatic invasive fish such as bighead or silver carp.

Scientists completed a structure-activity relationship (SAR) review of pharmaceutical and pesticide databases to identify candidate fish toxicants. SAR analysis is used to determine chemical groups that evoke a target biological effect in an organism.

Asian Carp Attraction/Repulsion Pheromones Identification

Technologies presently do not exist to specifically target Asian carp for control within aquatic ecosystems. Current applications of non-selective toxicants (for example rotenone) harm native fish species and must be applied to broad expanses of aquatic habitat if they are to have effect. Developing pheromone attractants with high specificity for Asian carp is necessary to control or eradicate them without further harm to native species and habitat.

Scientists found that attractant sex pheromone production could be hormonally induced in female Asian carp. Field tests will be conducted in the summer of 2012 to assess the attraction of wild male carp to hormonally induced caged female carp. Managers will be able to use this technology to concentrate carp for application of other controls or capture.

Great Lakes RESTORATION

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