Studies Program: Project Descriptions

NGRREC's mesocosms became available to researchers for the first time in 2015. The facility provides scientists with the means for a broad range of basic and applied experimental research, permitting the use of replicated treatments and controls. These mesocosms have allowed researchers to conduct tests of ecological relationships which would not be possible in the field or in smaller outdoor tanks because of uncontrollable variables in natural settings or because of the size of organisms used in the study.

Researchers are able to submit project proposals to gain use of the mesocosms. Forms and information regarding proposal submission can be found here. Learn more about studies that have utilized NGRREC's mesocosms by reading the project descriptions below.

Principal Investigator (PI) Name: Scott F Collins
Co-PI Name(s): David H Wahl
PI and Co-PI Affiliation(s): Illinois Natural History Survey, Kaskaskia Biological Station
Project title: Nutrient recycling by highly invasive fishes: Do Asian carp create biogeochemical hotspots in large river ecosystems?

Fishes can influence the productivity of freshwater ecosystems by recycling nutrients in the water column. When fishes consume food resources, a portion of the consumed materials (e.g., nitrogen, phosphorus) is assimilated as fish biomass, and other portions are re-mineralized as dissolved or particulate forms through egestion or excretion. Non-native fishes such as the highly productive Silver and Bighead carp have the potential to influence nutrient recycling due to their high rates of growth and high densities. Although the direct effects of Asian carp on planktonic food webs are

understood, the role of these invaders as drivers of nutrient dynamics in large river ecosystems is unclear. Presumably, high rates of productivity will have corresponding positive effects on nutrient recycling. We conducted a study to evaluate how these invasive planktivores impact nutrient recycling. Our study utilized both field based sampling and a manipulative experiment that was conducted at the National Great Rivers Research and Education Center.

The mesocosms at the NGRREC allowed us to evaluate the impacts of Bighead carp on nutrient concentrations in a controlled setting. By sourcing water from the Mississippi River, we were able to create ambient water conditions (temperature, water chemistry) similar to large rivers of the region. We manipulated densities of Bighead carp through time and tracked corresponding changes in water chemistry. The NGRREC mesocosms allowed us to evaluate at what threshold Bighead carp increase dissolved nutrient concentrations in the water column. In the coming months, we will be using data from this experiment, in conjunction with our field experiments, to determine the degree to which these invasive fishes alter nutrient dynamics in large river ecosystems.

Principal Investigator (PI) Name: John Sloan
PI and Co-PI Affiliation(s): NGRREC
Project title: Predicting total phosphorus (TP) concentrations in surface waters from in-situ orthophosphate and turbidity measurements

Background
The total phosphorus (TP) content of surface waters consists of both dissolved and particulate forms. There is currently no existing technology to continuously monitor real-time TP concentrations in rivers and streams, but through a technology called micro-fluidics, it is possible to continuously monitor dissolved orthophosphate concentrations in near real-time. However, orthophosphate accounts for only a fraction of the TP transported in surface water, and furthermore, the phosphorus nutrient reduction target of 25% by 2025 for Illinois is based on TP rather than orthophosphate. A large fraction of TP in rivers and streams is associated with suspended particles and there are currently reliable sensors for continuously monitoring turbidity in water. Therefore, it would be useful to have a valid in-situ method for quantifying TP in surface waters based on orthophosphate, turbidity, and possibly other water quality parameters that can be measured real-time with sensor-based technology.

Objective
Determine whether the TP concentration in surface waters can be accurately predicted based on its relationship with orthophosphate and total dissolved solids (TDS).

Methodology
In order to develop a relationship between TP, orthophosphate, and turbidity, it is necessary to measure these three parameters over a wide range of values. This can be difficult and time-consuming in an actual river because the suspended sediment concentration does not vary rapidly. The NGRREC mesocosm facility provided the opportunity to create a range of suspended sediment concentrations in actual Mississippi River water using a supply of sediments that were retrieved from the Mississippi River following a recent flood event. A Cycle-PO4 analyzer was used to measure orthophosphate concentrations while a YSI 6600 sonde was simultaneously measuring turbidity. An Isco sampler was used to collect water samples that corresponded to each of the Cycle-PO4 measurements. The water samples were analyzed for total suspended sediments and total P.

Results
Data is still being analyzed, but initial results showed that we were able to successfully create a range of turbidity values that had a direct impact on the TP concentration in the water. The fraction of TP attributed to orthophosphate can be significant at low suspended sediment concentrations, but as the suspended sediment concentration increases, the relative importance of orthophosphate diminishes as particulate forms of P become more dominant.

Principal Investigator (PI) Name: Andrew Mathis
Co-PI Name(s): Dr. James Lamer
PI and Co-PI Affiliation(s): Western Illinois University
Project title: Radio Telemetry on Asian Carp

Our project deals with assessing the movement and habitat of two Asian carp species, the silver carp (Hypophthalmichthys molitrix), and the bighead carp (Hypophthalmichthys nobilis), in the Dresden Pool of the Des Plaines River. The study area was chosen due to its proximity to the Great Lakes, and it being at the leading edge of the spread of Asian carp. To assess their movement, we will be deploying external radio/GPS transmitters to fish with a tether that is run through the fish.

Before we deployed tags in the field, we wanted to evaluate the retention of the transmitters on the fish in a controlled area. The mesocosms at NGRREC presented the perfect opportunity to simulate river conditions because we had a constant flow of water through the raceways. To prevent fish from jumping from the mesocosms we used metal cattle paneling to cover the top. We were successful in our attempts to retain the transmitters on the fish during our trial run in the mesocosms. We now have fish with transmitters attached in the field, and are tracking their daily movements.

Principal Investigator (PI) Name: Dr. John H. Chick
Co-PI Name(s): Mr. Edward F. Culver
PI and Co- PI Affiliation(s): INHS, UIUC, NGRREC
Project title: Evaluating mortality of silver carp from pulsed-DC electrofishing.

Project summary
Previous research by the authors has demonstrated that pulsed-DC electrofishing causes spinal injuries to silver carp at

a high rate (>= 50%) in the Mississippi and Illinois rivers (Culver and Chick in press). This research examined injury to six species of fish, of which only silver carp and channel catfish experienced spinal injuries. The electric barriers in the Chicago Sanitary and Shipping Canal use pulsed-DC electrofishing, raising the possibility that altering pulse-frequency and other settings of these barriers may improve their ability to prevent the movement of silver carp to Lake Michigan through this canal by injuring, and potentially killing, silver carp attempting to pass through the barriers. Here, we assessed the 72-hour mortality rate of silver carp captured with pulsed-DC electrofishing, and tested whether mortality is associated with spinal injury. This study also evaluated 72-hour mortality of fish species that our previous research demonstrated were not injured by pulsed-DC electrofishing: common carp and gizzard shad. The addition of these species also provided valuable information about the performance of the mesocosms as experimental facilities for research on riverine fishes. These additional species were not only useful as controls for assessing mortality from other factors, but also acted as dither fish – fish previously acclimated to the experimental facilities. The presence of dither fish allows other fishes to more quickly acclimate to new experimental facilities.

For each experiment, the three mesocosm units were split into two channels, providing a total of six replicates, and flow rates within each replicate were maintained at 400 gpm. Fish were collected with electrofishing from the Mississippi River in the immediate vicinity of NGRREC. In each of the six mesocosm channels, we introduced common carp and ten gizzard shad on the first day of the experiment, and five silver carp were introduced to each channel on day two. We monitored the mesocosms for dead fish on days three and four, and all remaining fish were removed from the mesocosms on day five. All silver carp used in these experiments were necropsied to determine spinal injury rate. All surviving dither fish (common carp and gizzard shad) were returned to the Mississippi River at the completion of the experiment.

The silver carp and common carp used in these experiments were large fishes (e.g., 300 – 700 mm total length) and would not be amenable to smaller experimental facilities. The mesocosms are also advantageous because of the use of Mississippi River water, which will minimize issues of acclimating fish to new water quality conditions. Finally, the fact that phytoplankton, zooplankton, and aquatic macroinvertebrates are delivered to the mesocosms with the Mississippi River water allows these fishes to continue feeding on their natural prey items.

The results of this experiment showed high mortality of silver carp. We are currently investigating ways to redesign our methods to include a control group (i.e. silver carp captured using nets instead of pulsed-DC electrofishing).

References

Culver, E.F. and J.H. Chick. *In Press*. Shocking results: Assessing the injury rates of fishes from pulsed-DC electrofishing. North American Journal of Fisheries Management.