Invader Watchers: The Next Generation

Since the early 1970s, NYSG has supported over 300 *Sea Grant Scholars*— students pursuing advanced degrees who assist researchers in NYSG-funded projects. What better measure of the long-term impacts of Sea Grant research and education could there be than the lives of such deserving scholars? We've tracked numerous scholars throughout the years. Their stories and accomplishments could easily fill volumes. We had to narrow down to just several vignettes. We start in this article with graduates who are playing instrumental roles in measuring invasive species in the Great Lakes and their impacts on related ecosystems.

Benthos Between Scholars

Being a Sea Grant scholar in the mid to late '90s allowed **Christine Mayer** to finish her graduate studies at Cornell in a relatively short time. "I was able to focus heavily on conducting my research rather than working as a teaching assistant," says Mayer, who received her PhD in three-and-a-half years. In 1994, she began working with **Ed Mills,** Director of Cornell University's biological field station at Shackelton Point along Oneida Lake, and researcher **Lars Rudstam.** The investigators were looking to identify what effects activities of zebra mussels were having on yellow perch and other fish in Oneida Lake. The lake is often the focus of studies addressing such concerns because its ever-changing environment makes it a model for processes in the Great Lakes.

While working on this project, Mayer learned to analyze large ecological data sets and how to approach research questions from an ecosystem-wide perspective. Nearly four decades of historical data suggested that zebra mussels, through filtering activities, were shifting the flow of energy in the aquatic food web from the water column to the bottom or benthic environment. This food web alteration, known as benthification, allows invertebrates - isopods, amphipods, mayflies, and mites - to flourish.

Mayer's efforts culminated in her 1998 thesis on the effects of zebra mussel introduction on the lake's benthic environment and yellow perch. She was a Thesis Completion Award

Photo courtesy of Ed Mills

Jocelyn Ban (left) and Erica Esser (right)— summer undergraduate interns of researchers Randy Jackson (Cornell) and Christine Mayer (Syracuse U)—are all smiles posing with a lake sturgeon aboard a research vessel on Oneida Lake. These protected benthic fish, which feed on the lake's invasive zebra mussels, have been the focus of a restoration program for nearly a decade.

winner that year. "My thesis work on Oneida Lake showed no negative impact on yellow perch associated with zebra mussels," says Mayer. In fact, she adds that young-of-year yellow perch grew significantly faster after mussel introduction than before. Also, zebra mussels eat only very small zooplankton, and at the time of her analysis, zooplankton numbers had not gone down. This is a good sign, because zooplankton are a primary food source for walleye, yellow perch, and other sport fish.

Photo by Ed Mills

Moments like these during *Christine Mayer*'s mid-90s graduate studies were priceless. Along with *Kristen Holleck*, a research technician at the Cornell Biological Field Station, the former Sea Grant scholar (left, head covered in plants) took this brief break from examining the effects zebra mussels were having on native species.

Mayer is currently a faculty member at Syracuse University, where she conducts research in aquatic ecology on NY's inland and Great Lakes. In addition to teaching undergraduate classes in ecology and environmental science, she's now mentoring three students, one of whom, **Bin Zhu,** is a Sea Grant scholar.

Zhu has worked with Mayer, Mills, and others since 2002 on a NYSG project examining the changing importance of benthic processes in lakes. In recent years, water clarity in the Great Lakes and inland lakes has increased thanks to grazing by zebra mussels and reductions in the amount of nutrients that human activity adds to the lakes. Because the water is clearer, light penetrates deeper into the lakes. Therefore, Mayer says, benthic habitats are becoming more productive and will play a greater role in the lakes' energy cycling and food web dynamics.

> *"The financial support I received from Sea Grant helped me focus more time on research."*
>
> *—Bin Zhu Sea Grant Scholar*

Zhu has been assembling and organizing data sets on a wide range of freshwater ecosystems to test hypotheses related to benthification. "One of the primary objectives of this research was to define the scope of benthification," he says. This involved quantifying the extent to which zebra mussel introduction has increased water clarity across a range of systems.

Building on preliminary studies involving plants and hydroacoustics in Oneida Lake, Zhu has assisted in similar analyses in Irondequoit Bay and Lake Ontario. This information will be compared to historical photographs to determine how this habitat suitable for various fish species has changed.

Currently, Zhu is examining the effects of zebra mussels on invasive watermilfoil and purple loosestrife, native cattails, and other plants. He is measuring nutrient levels in a series of experiments with and without the presence of the invaders.

Mills has mentored his share of scholars as well. Since the early 1990s, this internationally renowned invasive species researcher has overseen over a half dozen NY Sea Grant research projects - and as many Sea Grant scholars - addressing these invaders.

In 1992, Mills and a research team, including Sea Grant scholar **Adrian Spidle,** analyzed differences between two similar invaders - zebra and quagga mussels (*Dreissena polymorpha* and *D. bugensis*, respectively). With their impacts on the Great Lakes fishery costing close to a billion dollars by the end of the 20th century, Mills saw importance in making distinctions between them.

"The discovery of quagga mussels in North American waters raised legitimate concerns about their ecological impact, cost, and control," he says. "We found the quagga was more susceptible to death at elevated temperatures than the zebra mussels." Because quagga mussels were responding to thermal control techniques already in use for zebra mussels, Sea Grant-funded findings such as these helped save time and money from developing new control methods.

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> *—Christine Mayer Former Sea Grant Scholar*

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Sea Grant scholar and Cornell graduate student **Allison Gamble** took part in a nearly completed Mills study. State-of-the-art spectrometers were used to generate data to assess Oneida Lake's evolving ecosystem patterns and structure. One of the first measures undertaken by the team was to determine the system's quantities of phytoplankton and zooplankton. Gamble's analysis of this data was the basis of her graduate work, for which she won a Thesis Completion Award in Fall 2002.

The data showed more benthic invertebrates and less plankton were present in the lake environment. This led Mills to wonder: Are yellow perch responding to these populations by consuming differing amounts of invertebrate prey? In his mid-1990s study with then Sea Grant scholar Mayer, some of the groundwork was laid.

In that study, the team examined the feeding rate of yellow perch consuming amphipods with and without zebra mussels and under different light conditions. The presence of zebra mussel shells lowered the number of amphipods that yellow perch ate and the exotic's shells provided hiding places for the amphipods. However, the fish ate more benthic amphipods with greater light, suggesting that in a mussel-invaded lake, yellow perch may get more invertebrate food off the bottom, but only in areas where there are not large numbers of mussel shells. Further studies showed that larger perch consumed greater numbers and larger amphipods than smaller fish.

> *"Sea Grant's research and extension efforts generate a better understanding of coastal resources, and their results are well applied where it is needed."*
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> *—J. Ellen Marsden Former Sea Grant Scholar*

The importance of all this work? Says Mayer, "After zebra mussel introduction, we saw fewer adult yellow perch with empty stomachs and more with zooplankton and benthic prey. However, we did not detect an increase in adult perch growth rate. It is possible that although more fish are consuming invertebrate prey, each fish is not consuming a lot of prey mass. Also, since the young-of-year fish are growing faster, it is possible that they enter the adult phase larger and therefore need more food to sustain the same growth rate."

Overall, findings had an immediate extension value to lake managers, fishermen, utilities, scientists and policy makers. How? "We've provided coastal managers with critical information on how these processes work so that they can make more informed decisions," says Mayer. "Detailing what species are present and what kind of plant productivity is passed through the food web has helped managers understand the ecological dynamics of the systems they are trying to monitor."

Invasive Effects

As a doctoral student and Sea Grant scholar in the late '80s, **J. Ellen Marsden** worked under Cornell researchers Charles C. Krueger and Bernie May on a NYSG-funded study to help further enhance trout fishing.

Lake trout – once a top-level predator and important species for the Great Lakes' sport and commercial fishery – were in severe decline by 1960 because of sea lamprey predation and overfishing. While efforts to restore lake trout populations have been underway since the early '70's, evidence of natural reproduction by stocked trout was not found until the late '80's. But, thanks to this research conducted by Marsden and others, the goal of achieving a self-reproducing population of lake trout is closer at hand.

Throughout her professional career, Marsden has had a number of highly productive collaborations with Sea Grant extension specialists, whom she values for their skill at communicating science to the public. Now at the University of Vermont, she's working with **Mark Malchoff**, a Sea Grant Aquatic Resources Specialist, and Cornell's **Patrick Sullivan** on a three-year sea lamprey tagging project in Lake Champlain funded by the Great Lakes Fisheries Commission through July 2004.

A new wave of invaders

Former Sea Grant scholar Christine Mayer and Cornell collaborator Nancy Tisch are studying how the Eurasian crustacean *Echinogammarus ischnus* is affecting native species of New York's Lake Ontario and the Seneca and Oswego rivers, such as long-time resident *Gammarus fasciatus*. A Great Lakes invader since 1995, this freshwater relative of shrimp lives in between the shells of zebra mussels and in other habitats.

Oneida Lake has served as a control environment for Mayer's studies, a place where she thought the invader did not live. That was, until early November 2002, when she discovered the translucent amphipod in a clump of benthic algae near the lakeshore off Shackelton Point.

Top: NYSG researcher and former Sea Grant scholar Ellen Marsden (center), along with US Fish and Wildlife's Wayne Bouffard (right) and Steve Smith, uses equipment to shock sea lamprey out of their muddy burrows, then scoops them up into nets.
Photo courtesy of Mark Malchoff

Bottom: Marsden captures lake trout in traps submerged on spawning reefs at areas along NY's Lake Champlain shoreline.
Photo by Brian Ellrott

Estimates on the number of sea lamprey entering the lake will help fisheries managers set realistic targets for an effective control program.

In a separate National Sea Grant-funded project, Marsden, Malchoff and others are identifying and evaluating potential solutions for a fish-repelling barrier at the Lake Champlain Canal. Closing this route to aquatic invaders has been an issue for at least a decade now, as the canal continues to be a major vector for transporting exotics into the lake and, from there, inland waters in the lake's basin.

Along with UVM's Mark Beekey, Marsden is also tracking the spread of zebra mussels in Lake Champlain's soft sediments in a NYSG-funded study. It is here that activities of the filter feeders are most likely having a negative effect on the type and availability of prey for bottom-feeding fish. The flourishing of zebra mussels may benefit fish preying on the aquatic invader. But, their increase could also lead to the decline of the endangered sturgeon and other species relying on the soft sediments as an environment for juvenile foraging. "Lake sturgeon are currently the focus of a developing re-establishment plan in Lake Champlain, so there is a critical need for information relating to the evaluation of their current status and potential restoration," says Marsden.

Photo courtesy of Dave Warner

"We've concluded that *Cercopagis* was a competitor for zooplankton," says Sea Grant scholar Dave Warner on findings that the *Journal of Great Lakes Research* will publish this summer. *Cercopagis* – a native of the Caspian and Aral Seas – is considered a new prey for alewives and rainbow smelt in Lake Ontario.

Seeking out Cercopagis

With help from Sea Grant scholar **David Warner** and undergraduate Tara Bushnoe (pictured) researchers from Cornell are helping define the role of aquatic invader *Cercopagis pengoi* in Lake Ontario's food web in a late '90s study. For their part, Warner and Bushnoe collected samples of the "fishhook water flea" aboard SUNY Brockport's *RV/Madtom*.

"As a Sea Grant scholar, I have been fortunate to work with a group of such accomplished researchers," says Warner, who completes his doctoral studies this December. "I've learned a great deal from interacting with investigators such as Ed Mills and Lars Rudstam and now realize how vital this work is to resource conservation."

—Paul C. Focazio

> *"Sea Grant is training people like me to look at coastal resources in a diversity of ways that will allow us to provide the knowledge required for conservation of these resources."*
>
> *—Dave Warner*
> *Sea Grant Scholar*

Congratulations are in order to Sea Grant Scholar Walter Mann for his 2003 Thesis Completion Award. Mann, a graduate student at SUNY Cortland has worked under NYSG investigator Sharon Todd to survey preferences of SCUBA divers who seek the depths of Lake Ontario. Here Todd and Mann present their survey results at the dedication of the *David W. Mills,* Lake Ontario's first shipwreck dive site in New York.

Photo by Barbara A. Branca